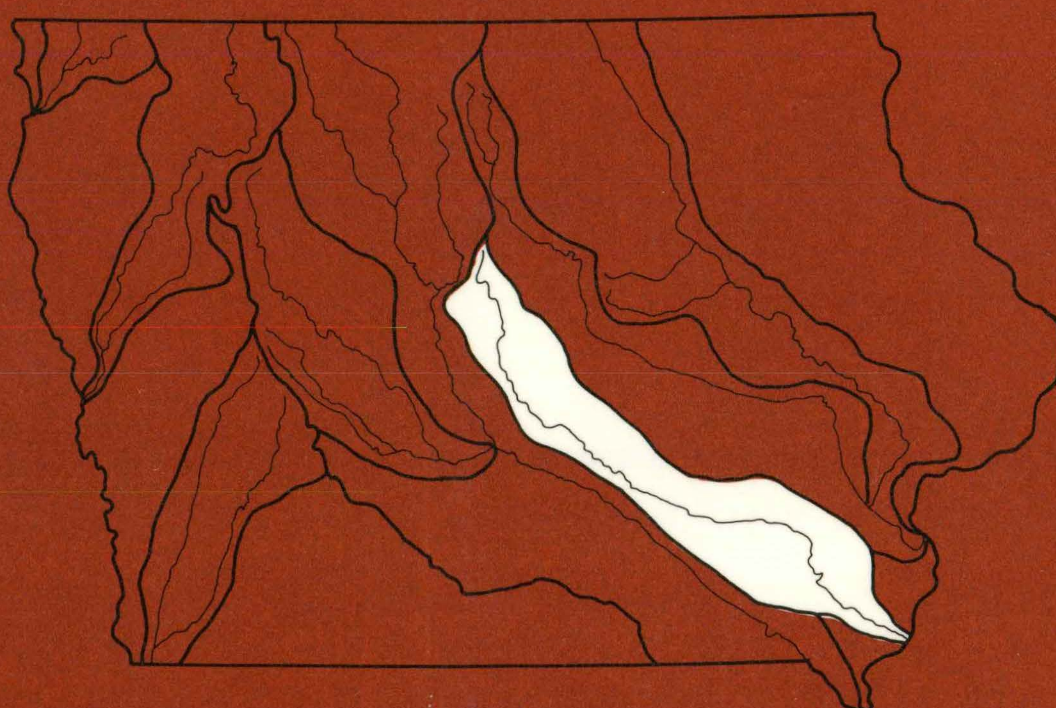
iowa department of environmental quality
Water Quality Management Division

SKUNK RIVER BASIN



WASTE LOAD ALLOCATION STUDY

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

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December 12, 1974

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Quality
3920 Delaware Avenue
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Gentlemen:

We are pleased to submit our report entitled "Skunk 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.

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SKUNK RIVER BASIN

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SYNOPSIS

The Skunk River Basin encompasses an area of approximately 4,355 square miles as a long, narrow drainage basin flowing from central to southeast Iowa. Topography is rolling and the drainage pattern of the basin is tree-shaped (dendritic). Stream flows per square mile in the Skunk River Basin are generally less than those of the state of Iowa as a whole, especially for the 7-day, 1-in-10 year low flow.

Most of the main streams in the basin have a Class B (warm water fisheries) water quality criteria classification. There is a lack of comprehensive water quality data on existing conditions within the basin.

Within the basin, 78 communities are incorporated. Of these, 51 have wastewater treatment facilities. Also, there are 28 industrial and 27 semipublic wastewater dischargers. Twenty-five municipalities 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 25 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.

Increased treatment levels above those required to meet secondary treatment are necessary for most municipalities during winter low flow conditions. During summer low flow conditions, most dischargers in the upstream portion of the basin will require better than secondary treatment; while most dischargers in the lower portion of the basin can meet water quality standards when providing secondary treatment.

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PART I
INTRODUCTION

Purpose

The Iowa Department of Environmental Quality (IDEQ) is charged with the responsibility of protecting and maintaining surface and underground water quality throughout the state. This report on the Skunk River Basin has been prepared for IDEQ to provide waste load allocations.

This report provides basic inventory information relative to comprehensive river basin planning and meets many of the objectives specified for Section 303 (e) plans. Waste load allocations are necessary to facilitate issuance of permits under the National Pollutant Discharge Elimination System (NPDES). All material presented herein is relevant to Section 303 (e) plans, but it is anticipated that additional effort is required to develop a complete river basin plan as now defined. In addition, as with any planning tool, periodic revisions are necessary to assure that the data base and subsequent extrapolations are current and valid. Each expansion of a planning report should build upon previous efforts in order to meet current planning objectives.

The specific purposes of this study and resulting report, as specified by IDEQ, are:

1. To inventory point source wastewater discharges.
2. To define stream low flow characteristics for the study area.
3. To determine waste load allocations for all uncontrolled wastewater discharges to streams within the basin boundary.

Scope

The scope of the completed investigation is summarized below. Topics described relate to major parts of the report.

1. Background Data. Significant physical features in the Skunk River Basin are identified for future reference. These include such factors as geology, soil type, and stream and groundwater characteristics.

2. Water Quality. Water quality data pertinent to the study have been tabulated and evaluated to present the most accurate possible picture of water quality throughout the basin.
3. Point Source Wastewater Discharges. Available records have been reviewed to determine the location and characteristics of point source wastewater discharges. This information forms the basis for waste load allocation investigations.
4. Waste Load Allocation Investigations. Water quality modeling techniques have been utilized to evaluate the impact of wastewater discharges upon stream quality characteristics under both summer and winter critical low flow conditions. Reducations in allowable waste load discharges from various point sources have been identified, as required to maintain water quality within the streams at a level consistent with adopted stream standards.

Water Quality Management Deadlines

As indicated, this report will provide the waste load allocations for utilization in water quality management programs. The 1972 Federal Water Pollution Control Act Amendment and Iowa Pollution Abatement Schedule specifies several deadlines that must be met in the implementation of a management program. Following are several key dates which have been established:

Date	Action
December 31, 1974	NPDES permits issued.
June 30, 1975	Section 303 (e) basin plans completed.
July 1, 1977	Secondary treatment required for all publicly-owned treatment works.
July 1, 1977	Best practical waste treatment technology for all industrial discharges.
January 1, 1978	Ammonia removal to meet IDEQ water quality standards.
July 1, 1983	Best practical waste treatment technology for all publicly-owned treatment works.
July 1, 1983	Best available technology for all industrial discharges.
July 1, 1985	Zero pollutant discharge.

PART II
BACKGROUND DATA

General

The Skunk River Basin lies entirely within the state of Iowa and comprises an area from northern Hamilton County southeast to the confluenct with the Mississippi River. The drainage basin is long and narrow encompassing approximately 4,355 square miles (2.788 million acres) in 19 counties. Portions of each county within the drainage basin are given as percentages in the following table.

Boone	22%	Mahaska	67%
Des Moines	17%	Marion	11%
Hamilton	61%	Marshall	16%
Hardin	3%	Polk	21%
Henry	96%	Poweshiek	20%
Jasper	90%	Story	84%
Jefferson	90%	Van Buren	10%
Keokuk	81%	Wapello	40%
Lee	11%	Washington	47%
Louisa	1%		

The major tributaries to the Skunk River are the North and South Skunk Rivers. Several other smaller tributaries are important because they receive wastewater discharges and have a major effect on water quality in the study area. The following table lists the more important streams along with the corresponding lengths and drainage areas.

Average annual precipitation within the basin is approximately 33.6 inches, with 22.7 inches falling during the April through September growing season.

Stream	Stream Length (miles)	Drainage Area (1,000 acres)	(square miles)
Skunk River	94	402	628
Big Creek	40	107	167
Crooked Creek	50	183	286
Cedar Creek	70	362	565
South Skunk River	177	713	1,114
Spring Creek	8	10	16
Thunder Creek	15	19	30
Cherry Creek	15	26	40
Indian Creek	60	265	413
Squaw Creek	35	145	227
North Skunk River	97	496	775
Bridge Creek	15	25	39
Sugar Creek	25	35	55

Political Subdivisions

There are 78 incorporated communities in the study area containing a total population of more than 146,000. Three of these (Ames, Newton, and Oskaloosa) have populations greater than 10,000 and account for 45 percent of the incorporated population, while 62 communities have populations less than 1,000 and account for only 18 percent. There are 8 communities with populations between 1,000 and 5,000 accounting for 12 percent, and 5 communities with population between 5,000 and 10,000 accounting for the remaining 25 percent of the incorporated population. Populations are summarized for each county and city in Table 1.

Population projections for 1990 (see Table 1) have been made by the Iowa State Department of Health (Provisional Projections of the Population of Iowa Counties and Cities: 1975 to 1990, by James R. Taylor, June, 1972). These projections were utilized in determining future waste loads.

TABLE 1

EXISTING AND PROJECTED POPULATIONS
FOR WASTE LOAD ALLOCATIONS

	1970	1990
DES MOINES COUNTY	46,952	61,512
Danville	948	1,464
Middletown	443	684
HAMILTON COUNTY	18,383	19,996
Blairsburg	287	296
Ellsworth	443	457
Jewell	1,152	1,188
Kamrar	243	251
Randall	179	185
Stanhope	482	497
Williams	456	470
HENRY COUNTY	18,114	21,955
Hillsboro	252	320
Mt. Pleasant	7,007	7,852
Mt. Union	173	219
New London	1,900	2,413
Olds	206	262
Rome	135	171
Salem	458	582
Wayland	702	892
Winfield	897	1,139
JASPER COUNTY	35,425	43,475
Baxter	788	955
Colfax	2,293	2,779
Kellogg	607	756
Lambs Grove	239	290
Lynnville	381	462
Mingo	260	315
Monroe	1,389	1,683
Newton	15,619	19,464
Reasoner	284	344
Sully	685	830
Valerie	96	116
JEFFERSON COUNTY	15,774	19,125
Batavia	525	614
Fairfield	8,715	10,875
Lockridge	232	271
Packwood	157	183
Pleasant Plain	121	141
KEOKUK COUNTY	13,943	14,661
Delta	475	499
Harper	405	426
Hayesville	93	98
Hedrick	790	830
Keota	707	743
Martinsburg	140	147
Ollie	268	282
Richland	595	625
Sigourney	2,319	2,437
Thornburg	98	103
Webster	130	137
What Cheer	868	912

	1970	1990
MAHASKA COUNTY	22,177	24,822
Fremont	480	493
New Sharon	944	969
Oskaloosa	11,224	13,575
Rose Hill	192	197
University Park	534	548
MARION COUNTY	26,352	32,951
Pella	6,668	11,001
MARSHALL COUNTY	41,076	55,778
Laurel	245	320
Melbourne	661	863
Rhodes	347	453
POLK COUNTY	286,130	384,859
Elkart	269	353
POWESHIEK COUNTY	18,803	22,173
Barnes City	20	20
Grinnell	8,402	11,553
Montezuma	1,353	1,381
Searsboro	140	143
STORY COUNTY	62,783	106,547
Ames	39,505	76,185
Cambridge	661	960
Collins	404	587
Colo	606	880
Gilbert	521	757
Huxley	937	1,361
Kelley	235	341
Maxwell	758	1,101
McCallsburg	307	446
Nevada	4,952	8,737
Roland	803	1,167
Story City	2,104	3,057
VAN BUREN COUNTY	8,643	8,891
Stockport	334	344
WASHINGTON COUNTY	18,967	22,355
Brighton	632	711
Coppock	13	15
Crawfordsville	288	324
Washington	6,317	8,133
West Chester	199	224

Physiography

The topography of the basin varies from level to very gently undulating in the northern one-third of the basin, to rolling and steeply rolling in the southern portion. At the northern end of the basin, moranic hills about 50 to 75 feet high remain as evidence of the Wisconsin glaciation. Low sandy and gravelly knolls also occur in this area. Numerous depressions occupy the landscape. There are some level areas in the uplands of the southern portion. Narrow strips of rough broken land with steep slopes border the large streams. River valleys vary in width, but are generally narrow. The basin slopes to the southeast.

The drainage pattern in the basin is dendritic. Natural drainage in the northern portion of the basin is inadequate because drainageways are not well developed and subsoils are impervious. In the southern two-thirds of the basin, natural surface drainage is good with the exception of small areas on flat uplands. Bottomlands and some terraces are poorly drained. Surface drainage ditches and drain tile facilitate water removal where natural drainage is inadequate.

The upland soils of the basin have been formed from glacial drift and loess. Drift soils occur on the northern one-third of the basin with loess soils occupying the remainder of the basin. Most soils have moderate permeability. Clarion soils are representative of glacial drift soils while Grundy and Tama soils are representative of loess soils. Small amounts of organic (peat and muck) soils also occur.

Terrace soils occupy a very small portion of the basin. Drainage on terrace soils ranges from poorly to excessively drained. Waukesha is representative of terrace soils.

Bottomland soils are formed from alluvial materials. These soils have slow permeability, a high water table, and are subject to flooding. Wabash soils are representative of bottomland soils.

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

A portion of the southeastern Mississippian outcrop area occurs in the basin. The aquifer is exposed or overlain by soil material consisting of semi-permeable loess, glacial drift, or locally by permeable water bearing alluvium. Glacial drift in the southeastern outcrop area is more clayey than the north central part. Groundwater recharge is less in the southeastern outcrop area but the potential groundwater contamination hazard still exists.

Soil conditions on the upland areas are variable. Potential pollution problems exist for sewage lagoons because some soils have moderate permeability and contain layers of sand and gravel. On flat and depressional areas, moderately slow permeability and a seasonal high water table create a potential pollution hazard for the installation of both unsealed sewage lagoons and septic tank filter fields.

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

Potential contamination of groundwater in alluvial aquifers is great. Pollutants can infiltrate the soil by flowing over highly permeable terraces. Since these aquifers are located adjacent to streams, contaminated groundwater can transmit to streams any pollutants which are present. These areas have severe limitations for wastewater disposal. Bottomlands also have severe limitations for wastewater disposal because they have slow permeability, a high water table and are subject to flooding.

All sites where wastewater disposal are proposed should be carefully evaluated on an individual basis.

Streams

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 Skunk River Basin is significantly less than the state average when results are reduced to the common basis of discharge per square mile. The following tabulation shows a comparison of averages from 6 long-term continuous-record stations within the basin to the average for 84 stations within the state of Iowa.

	Percentage of Time Flow Equaled 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
Skunk River Basin Average (cfs/sq mi)	0.198	0.020	0.012	0.006	0.004

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

The above table refers to daily average discharges recorded at each gaging station regardless of chronological sequence. Averages for the Skunk River Basin were derived from the entire period of record for each gaging station, ranging from 5 to 41 years and totaling 124 years.

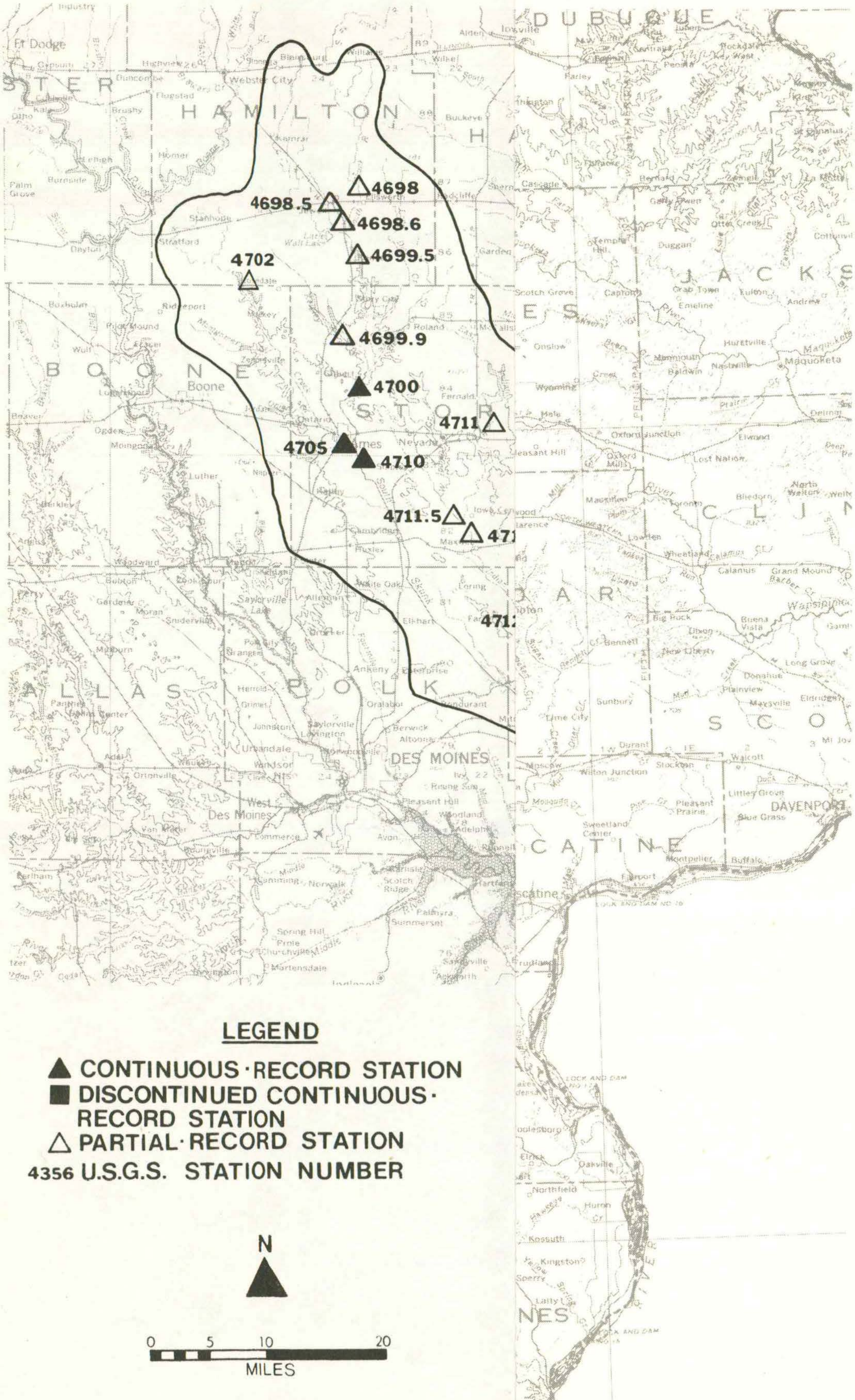
As with the daily flow data presented, the average 7-day, 1-in-10 year low flow for the basin is considerably lower than that for the entire state. The Skunk River Basin averages 0.00286 cfs/sq mi, while the state of Iowa averages 0.020 cfs/sq mi.

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

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 upon 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 physical characteristics which are required to define the 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



U.S.G.S. GAGING STATION

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FIG.1

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)
4698	S. Skunk River	Near Ellsworth	54.9	0	0
4698.5	Mud Lake Drainage Ditch 71	Jewell	64.1	---	---
4698.6[2]	Mud Lake Drainage Ditch 71	Jewell	65.4	---	---
4699.5	S. Skunk River	Randall	160	---	---
4699.9[2]	Keigley Branch	Near Story City	31.0	---	---
4700	S. Skunk River	Near Ames	315	---	---
4702	Squaw Creek	Near Stanhope	62.6	---	---
4705	Squaw Creek	Ames	204	---	---
4710	S. Skunk River	Near Ames	556	---	---
4711	E. B. Indian Creek	Near Nevada	65.7	---	---
4711.5	W. B. Indian Creek	Near Iowa Center	65.9	---	---
4711.8	Indian Creek	Near Iowa Center	203	---	---
4712	Indian Creek	Near Mingo	276	---	---
4713.5	Clear Creek	Near Mingo	84.1	---	---
4714	Elk Creek	Near Taintor	59.9	<0.1	<0.065
4715	S. Skunk River	Near Oskaloosa	1,635	4.8	3.1
4720.9[2]	N. Skunk River	Near Baxter	52.2	---	---
4721	N. Skunk River	Near Newton	101	---	---
4722.9[2]	Sugar Creek	Near Searsboro	52.7	---	---
4723	N. Skunk River	Near Searsboro	385	---	---
4723.9[2]	Middle Creek	Near Lacey	23.0	---	---
4724	Middle Creek	Near Rose Hill	58.5	0	0
4724.45[2]	Rock Creek	Sigourney	26.3	---	---
4724.5	Cedar Creek	Near Sigourney	92.5	<0.1	<0.065
4725	N. Skunk River	Near Sigourney	730	0.98	0.63
4730	Skunk River	Coppock	2,916	20	12.9
4730.2	E. F. Crooked Creek	Near Winfield	65.3	<0.1	<0.065
4730.5	Crooked Creek	Near Coppock	259	0	0
4731	Walnut Creek	Germanville	66.3	0	0
4732	Cedar Creek	Near Highland Center	73.6	0	0
4732.5	Competine Creek	Near Batavia	68.8	0	0
4733	Cedar Creek	Near Batavia	252	0	0
4733.5	L. Cedar Creek	Near Salem	55.0	---	---
4734	Cedar Creek	Near Oakland Mills	522	<0.1	<0.065
4734.5	Big Creek	Mt. Pleasant	58	0	0
4735	Big Creek	Near Mt. Pleasant	106	---	---
4740	Skunk River	Augusta	4,303	20	12.9

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

[2] Water Resources Data for Iowa, USGS, 1971.

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 range from approximately 1.0 ft/mi to approximately 1.5 ft/mi, with an average slope of approximately 1.3 ft/mi.

Determination of time of travel is dependent only upon distance traveled and stream velocity. Distance is easily measured by use of USGS topographic maps. Determination of stream velocity is described in detail in PART V. The two physical characteristics required to calculate stream velocity are the width of stream and value of the Manning coefficient ("n"). Values of both the width and "n" are dependent upon the stream flow, and so these values must be determined for the 7-day, 1-in-10 year low flow. Values for these two characteristics can be obtained at USGS gaging stations, but data available at the stations do not usually include measurements at the 7-day, 1-in-10 year low flows. Available data must be extrapolated to obtain an approximate value for these characteristics under low flow conditions. Since there are few USGS gaging stations at which these characteristics may be obtained, the values of "n" and stream width for other reaches of the stream must be estimated from the approximations available at the gaging stations and from field observations. Field observations of stream widths at low flows (not 7-day, 1-in-10 year low flows) also aid in estimating stream widths under the low flow condition. The approximate "n" values at the gaging stations, visual examination of the stream, and use of the method for estimating "n" presented in Open Channel Hydraulics (by V. T. Chow) are all aids in estimating "n" values for stream reaches which do not have a USGS gaging station.

Estimated values of the Manning coefficient and stream width at 7-day, 1-in-10 year low flows are given in Table 3.

TABLE 3

ESTIMATED PHYSICAL CHARACTERISTICS
AT USGS GAGING STATIONS

Station No.	Stream Width (ft)	"n"
4698	7	0.07
4699.5	7	0.03
4700	7	0.04
4710	7	0.02
4710.5	28	0.03
4715	20	0.02
4721	4	0.08
4723	10	0.04
4725	28	0.04
4730	63	0.02
4740	80	0.02

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 is aided by knowledge of the existing water quality resulting from the interaction of man with nature within the Skunk River Basin.

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 the North Skunk River, South Skunk River, and the Skunk River has been identified based upon analyses of available data obtained from various sources. The data indicate some areas with degraded water quality and provide limited information on overall water quality within the basin. Review of existing data shows major deficiencies in the extent of water quality monitoring in the study area.

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), Class C, and certain designated areas must satisfy the Class A requirements. Figure 2 indicates which streams within the study area must satisfy Class A, Class B, and Class C requirements. Other streams have not been classified and must satisfy General Water Quality Criteria. Tables 4 through 7 summarize the applicable standards for the classifications.

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 4 contains stream standards applicable for warm water fisheries.

TABLE 4

WATER QUALITY STANDARDS

Water Quality Parameter	Class A	Class B	Class C
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.	Not less than 6.5, nor greater than 9.0.
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	Maximum allowable count of 200 per 100 ml when the count is attributable to waste discharges which may contain human pathogens or parasites.	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 7 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 nonpoint sources. All substances toxic or detrimental to aquatic life shall be limited to non-toxic or non-detrimental concentrations in the surface water.	The concentrations given in Table 7 shall not be exceeded at the point of withdrawal. Allowable levels of radioactive substances are given in Table 6. All substances toxic or detrimental to humans or detrimental to treatment processes shall be limited to non-toxic or non-detrimental concentrations in the surface water.

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.

TABLE 6

WATER QUALITY STANDARDS
RADIOACTIVE SUBSTANCES - CLASS C

Gross beta activity: Shall not exceed 1,000 picocuries per liter.
Radium 226: Concentrations shall not exceed 3 picocuries per liter.
Strontium 90: Concentration shall not exceed 10 picocuries per liter.
Other radionuclides: Annual average concentration for the 168-hour week as set forth by the International Commission of Radiological Protection and the National Committee on Radiation Protection - Handbook 69.

TABLE 7

WATER QUALITY STANDARDS
CHEMICAL CONSTITUENTS

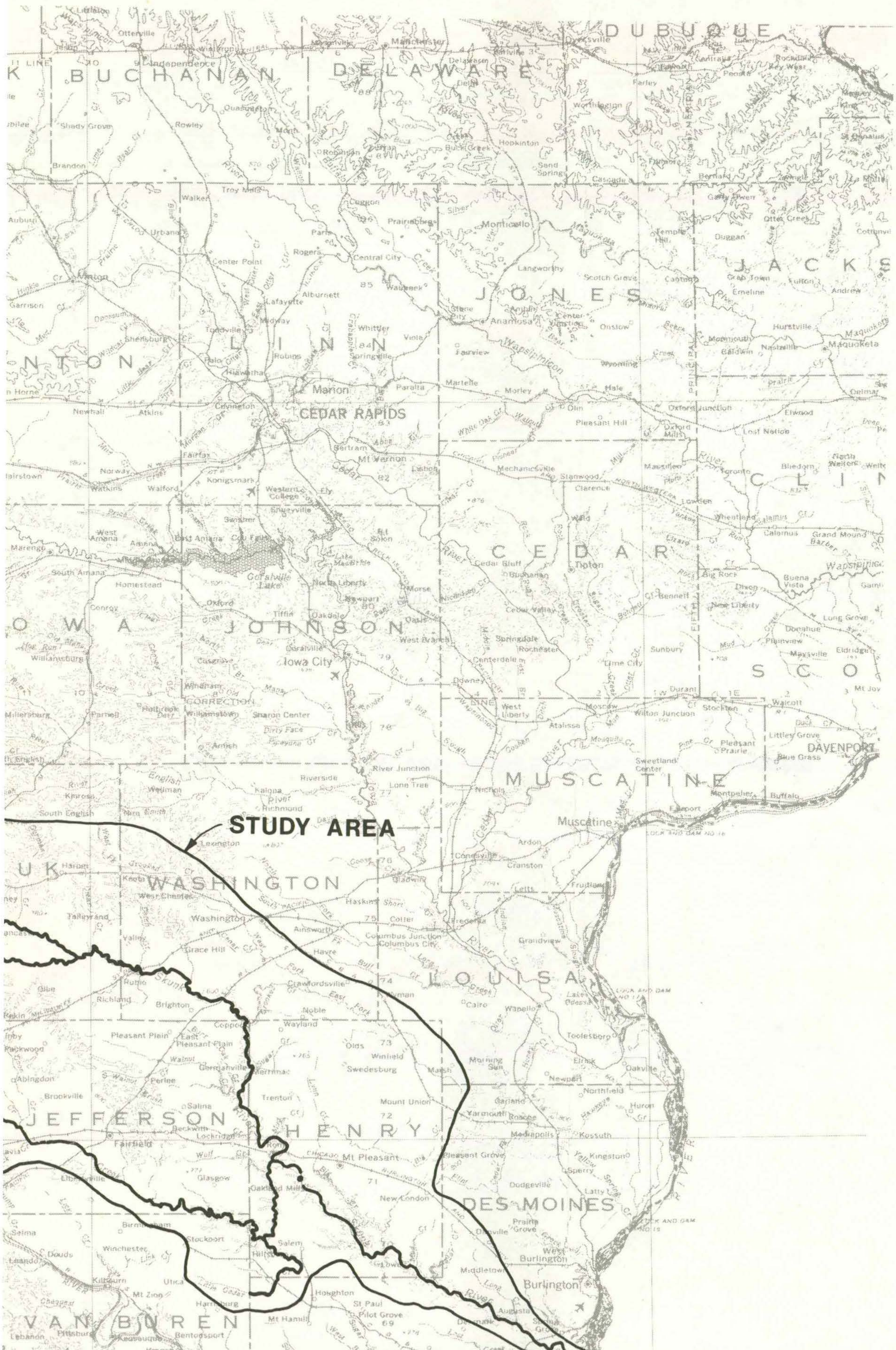
Chemical Constituent	Allowable Concentration[1] Class B (mg/l)	Allowable Concentration[1] Class C2 (mg/l)
Ammonia Nitrogen-N	2.0	---
Nitrate	---	45.0
Phenols (other than natural sources)	0.001	0.001
Total Dissolved Solids	750.	750.
Chlorides	250.	250.
Arsenic	1.00	0.05
Barium	1.00*	1.00
Cadmium	0.05*	0.01**
Chromium (hexavalent)	0.05*	0.05**
Chromium (trivalent)	1.00*	---
Copper	0.02*	1.00
Cyanide	0.025	0.025
Fluoride	---	1.5
Lead	0.10*	0.05**
Mercury	0.005*	0.005**
Selenium	1.00*	0.01**
Zinc	1.00*	0.00

[1]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.

[2]Shall not be exceeded at point of withdrawal.

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

**Sum of these constituents shall not exceed 1.5 mg/l.



STUDY AREA
DUBUQUE
BUCHANAN
DELAWARE
JONES
JACKS
LINN
CEDAR RAPIDS
CEDAR
CLIN
IOWA
JOHNSON
Iowa City
SCO
DAVENPORT
MUSCATINE
Muscatine
WASHINGTON
Washington
LOUISA
JEFFERSON
HENRY
Mt Pleasant
DES MOINES
Burlington
VAN BUREN
LEE
Ft Madison

FIG. 2

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
- 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]

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 on 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 8 for reference.

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

TABLE 8

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]
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 [illegible]
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 4.
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.

Water Quality Criteria Summary - Examination of Table 8 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 bioassay 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.

Existing Water Quality

Data Sources - The study area is the total drainage basin of the Skunk River. 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 1972.

South Skunk River - The stream rises in Hamilton County and ends with its confluence with the North Skunk River. The only comprehensive data for the South Skunk River come from Report No. 74-21, "Iowa Internal Stream Quality Survey," containing data collected from August through December, 1973.

Only four samples were analyzed from the single sampling station near Colfax. During the sampling period, stream flows were much higher than normal so that the data do not indicate stream quality conditions at low flows. The data are summarized in Table 9. No violations of stream quality criteria are indicated.

Skunk River - This stream begins at the confluence of the North and South Skunk Rivers and continues to its confluence with the Mississippi River. Definitive data for the Skunk River come from Report No. 74-21, "Iowa Internal Stream Quality Survey," containing data obtained from August through December, 1973, and from samples taken during the quarterly stream monitoring survey beginning in June, 1973.

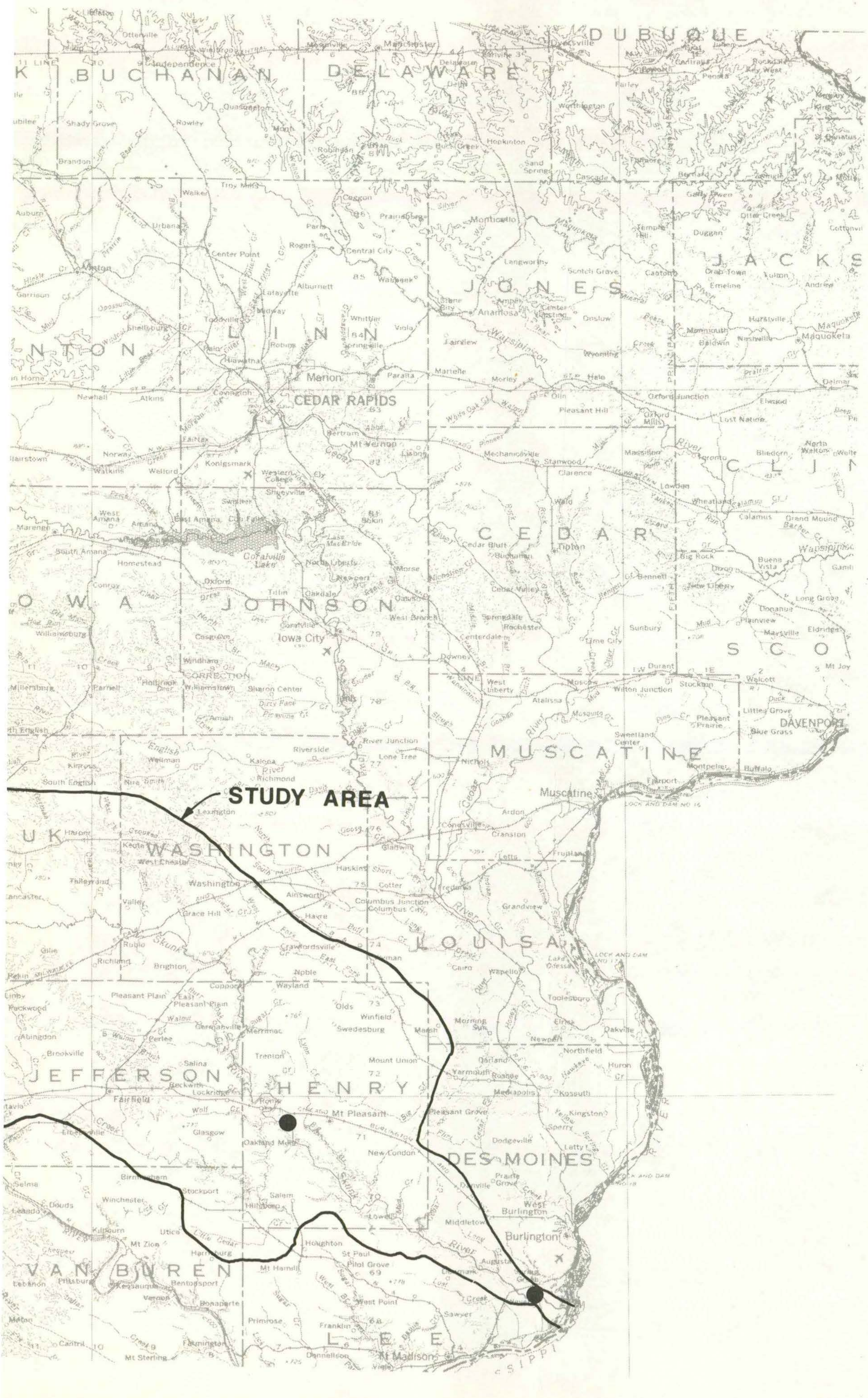
Data taken from Report No. 74-21 are summarized in Table 10. These data are from a single sampling station near Spring Grove, and again the sampling periods coincide with periods of high flow in the stream. No stream quality criteria violations were recorded, although there was a relatively low value of 5.5 mg/l for dissolved oxygen in August, 1973. Fecal coliform counts show considerable range and are high during warm weather.

Since August, 1972, quarterly samples have been taken from a station near Mount Pleasant. None of the data indicate any violation of stream quality standards. Some indication of pollution is given by high fecal

TABLE 9

1973 WATER QUALITY DATA
SOUTH SKUNK RIVER - NEAR COLFAX

Parameter	Date of Sampling			
	Aug. 21 1973	Sept. 18, 1973	Oct. 15, 1973	Nov. 14, 1973
Temperature (° C)	25.5	14.0	13.0	8.5
Dissolved oxygen (mg/l)	14.5	9.6	9.6	11.0
Fecal coliforms (MPN/100 ml)	310	6,000	5,600	700
pH (SU)	8.15	7.65	7.75	7.7
Total Kjeldahl nitrogen (mg/l)	0.64	0.64	0.8	0.38
Ammonia nitrogen (mg/l)	0.06	0.30	0.5	0.14
Nitrate nitrogen (mg/l)	0.2	3.4	6.2	6.0
Total suspended solids (mg/l)	--	88	--	27
Phosphate (filterable) (mg/l)	--	0.18	--	0.21
BOD_5 (mg/l)	10	2	1	2
Total chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Hexavalent chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Arsenic (mg/l)	--	<0.01	--	<0.01
Barium (mg/l)	--	0.2	--	0.1
Cadmium (mg/l)	--	<0.01	--	<0.01
Copper (mg/l)	--	<0.01	--	<0.01
Lead (mg/l)	--	<0.01	--	<0.01
Mercury (µg/l)	--	<1	--	<1
Zinc (mg/l)	--	0.03	--	0.05



STUDY AREA
DUBUQUE
BUCHANAN
DELAWARE
JONES
LINN
CEDAR RAPIDS
CEDAR
CLINTON
JOHNSON
Iowa City
SCOTT
DAVENPORT
MUSCATINE
Muscatine
WASHINGTON
Washington
LOUISA
JEFFERSON
Fairfield
HENRY
Mt Pleasant
DES MOINES
Burlington
VAN BUREN
LEE
Ft Madison

FIG.3

TABLE 10

1973 WATER QUALITY DATA
SKUNK RIVER - NEAR SPRING GROVE

Parameter	Date of Sampling: Aug. 14, 1973	Sept. 10, 1973	Oct. 8, 1973	Nov. 5, 1973
Temperature (° C)	24.0	22.0	20.0	8.0
Dissolved oxygen (mg/l)	5.5	8.2	8.4	12.1
Fecal coliforms (MPN/100 ml)	24,000	840	1,600	30
pH (SU)	7.7	7.75	7.95	7.55
Total Kjeldahl nitrogen (mg/l)	0.78	0.62	2.7	1.0
Ammonia nitrogen (mg/l)	0.32	0.10	0.72	0.70
Nitrate nitrogen (mg/l)	1.1	0.5	4.2	3.5
Total suspended solids (mg/l)	--	104	--	33
Phosphate (filterable) (mg/l)	--	0.10	--	0.21
BOD_5 (mg/l)	5	4	4	2
Total chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Hexavalent chromium (mg/l)	<0.01	<0.01	<0.01	<0.01
Arsenic (mg/l)	--	<0.01	--	<0.01
Barium (mg/l)	--	0.4	--	0.2
Cadmium (mg/l)	--	<0.01	--	<0.01
Copper (mg/l)	--	<0.01	--	<0.01
Lead (mg/l)	--	<0.01	--	<0.01
Mercury (μg/l)	--	<1	--	2.2
Zinc (mg/l)	--	0.29	--	<0.01

coliform counts and a relatively low dissolved oxygen concentration of 5.6 mg/l during August, 1973. Again, stream flows during the sampling period were higher than normal. Water quality data from the quarterly samples are given in Table 11.

Summary

Available water quality data for the Skunk River Basin do not allow definition of stream quality along the stream. The best available data has been taken during periods of high flow. A much more comprehensive water quality sampling program is needed to show the effect of wastewater discharges upon stream quality in this basin.

TABLE 11

QUARTERLY WATER QUALITY DATA
SKUNK RIVER - NEAR MOUNT PLEASANT

Parameter	Date of Sampling: Aug. 23, 1972	Nov. 9, 1972	Feb. 21, 1973	June 27, 1973	Aug. 14, 1973	Nov. 5, 1973
Temperature (° C)	25.0	8.0	1.0	24.0	25.0	8.0
Dissolved oxygen (mg/l)	8.2	10.7	12.3	6.8	5.6	11.9
Fecal coliforms (MPN/100 ml)	500	2,000	560	8,000	25,000	170
Conductance (micro mhos)	--	--	--	400	390	680
pH (SU)	--	--	--	7.6	7.85	8.25
Organic nitrogen (mg/l)	1.2	1.1	0.99	11	2.8	0.43
Ammonia nitrogen (mg/l)	<0.01	0.09	0.40	0.04	0.04	<0.01
Nitrate nitrogen (mg/l)	0.2	7.8	2.4	4.7	1.4	<0.1
Total solids (mg/l)	626	742	515	3,510	332	468
Total volatile solids (mg/l)	134	145	73	462	170	193
Total suspended solids (mg/l)	218	305	214	3,246	83	41
Volatile suspended solids (mg/l)	26	13	2	318	60	0
Phosphate (filterable) (mg/l)	0.22	0.18	0.09	0.12	0.13	0.20
Total phosphate (mg/l)	0.40	0.41	0.29	1.5	0.56	0.23
BOD_5 (mg/l)	3	2	4	5	5	<1
COD (mg/l)	24.7	27	24	262	71	16

PART IV
POINT SOURCE WASTEWATER DISCHARGES

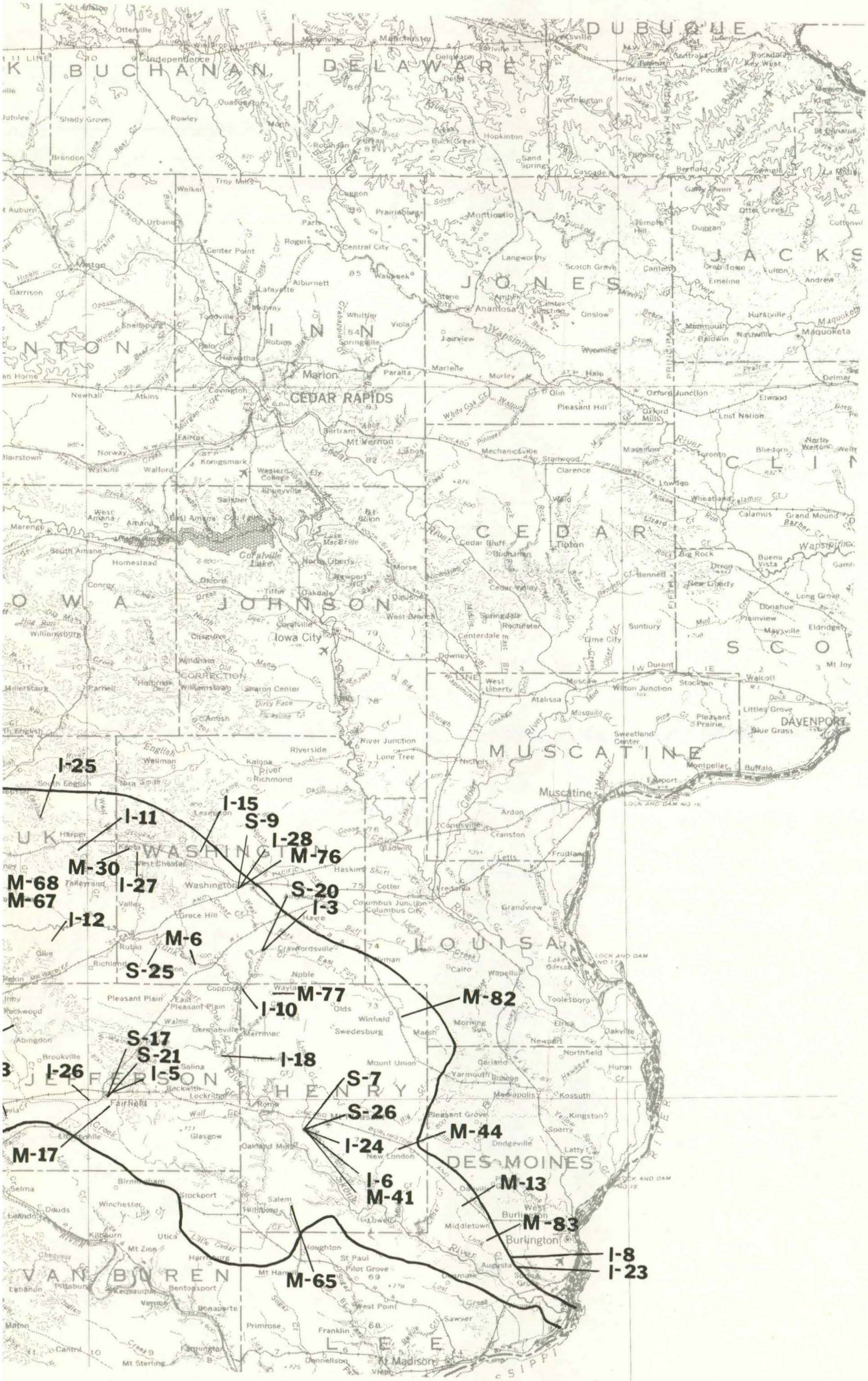
General

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 the surface waters of the Skunk River Basin. 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 12, at the end of this PART, lists individual wastewater discharges, location, and river mile. An identification system has been established whereby "M," "I," or "S" precedes the wastewater discharge number. Municipal discharges are represented by "M," industrial by "I," and semipublic by "S." River mile locations are identified for each discharge with reference to mile zero at the mouth of the major stream.

Table 13, 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 South Skunk River. The tabulation continues downstream picking up the tributaries. The point source farthest upstream on a tributary is identified and the tabulation proceeds downstream to the confluence. The procedure is repeated at the confluence of the North Skunk River. Figure 4 shows the location of each existing point source wastewater discharge.

Available wastewater quality and quantity information is tabulated in Table 13. Average flow, BOD_5, suspended solids, ammonia nitrogen, phosphorus, total dissolved solids, temperature, and other miscellaneous constituents are reported. 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.



DUBUQUE
BUCHANAN
DELAWARE
JACKSON
JONES
LINN
BENTON
CEDAR
CLINTON
IOWA
JOHNSON
SCOTT
MUSCATINE
WASHINGTON
LOUISA
KEOKUK
JEFFERSON
HENRY
DES MOINES
VAN BUREN
LEE
CEDAR RAPIDS
Marion
Iowa City
DAVENPORT
Muscatine
Washington
Fairfield
Burlington
I-25
I-15
S-9
I-11
I-28
M-76
M-30
I-27
M-68
M-67
S-20
I-3
I-12
M-6
S-25
M-77
I-10
M-82
S-17
S-21
I-5
I-18
I-26
S-7
S-26
M-44
I-24
M-17
I-6
M-41
M-13
M-83
I-8
I-23
M-65

FIG. 4

Municipal

Sewage flow and quality data for 51 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."

Most quality data were collected from "Effluent Quality Analysis Program" (EQAP) by IDEQ. These data were supplemented by 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 summer BOD_5 average values would result. The adequacy of this reporting 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 of data, engineering judgment was applied to arrive at representative values rather than taking straight averages of available data.

Industrial

Information for 28 industries discharging wastewater to streams within the study area was obtained. The majority of these consist either of quarry operations where the discharge consists of quarry dewatering and rock washing or industrial operations where only cooling water is discharged to the receiving stream. The best sources of available discharge information utilized were the IDEQ industrial files, the National

Pollutant Discharge Elimination Systems (NPDES), and U. S. Army Corps of Engineers discharge permit applications (Discharge Permit Program, River and Harbors Act of 1899). Table 13 represents a tabulation of available information; however, caution must be exercised in data interpretation as information has been submitted by the individual industries with very little verification.

Semipublic

Information identifying 27 semipublic facilities was obtained from IDEQ files. Due to the minimal surveillance provided, quality and quantity relationships are practically nonexistent with very little information available.

Existing Wastewater Treatment Facilities

Inventory information for existing wastewater treatment facilities has been compiled in Table 14 at the end of this PART. The order of presentation in Table 14 is identical to that utilized in Table 13 beginning with the facilities at the upstream reaches and continuing downstream to the Mississippi River.

Table 14 contains existing design average day capacity, present average day flow, both influent and effluent concentrations for BOD_5 and suspended solids where available, type of treatment process, and comments about the facility or process. 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 operations, age of existing facilities, specific IDEQ permit requirements, IDEQ orders for additional treatment, and delineation of proposed facilities.

A total of 57 municipal, 4 industrial and 20 semipublic treatment facilities have been identified in the study area. In addition, 27 small communities presently without collection or treatment systems are also included in Table 14. Some of these are in various stages of municipal treatment facility development.

Summary

Total hydraulic and organic loads (after existing treatment) upon the streams in the Skunk River Basin from the three types of point source wastewater discharges are summarized in Table 15.

TABLE 15

REPORTED POINT SOURCE WASTEWATER DISCHARGE SUMMARY

	Total	Municipal	Industrial	Semipublic
Flow, mgd	22.75	17.03	5.55	0.17
Percent		75	24	1
BOD_5, lb/day	4,070	4,020	50	NA
Percent		99	1	---
Ammonia-N, lb/day	894	890	4	NA
Percent		99	1	---
Phosphorus-P, lb/day	2,432	2,420	12	NA
Percent		99	1	---

Table 16 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 two communities having populations of less than 600 have trickling filter plants, while two communities with more than 1,000 maintain waste stabilization ponds.

TABLE 16

WASTEWATER TREATMENT FACILITIES PROCESS SUMMARY

Type of Plant	Communities Served	Population Served
Trickling Filter	25	122,200
Waste Stabilization Pond	25	15,200
Aerated Stabilization Pond	1	534

TABLE 12
POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal						
Ames	M-1	Story	219	South Skunk River	43	49
Barnes City	M-2	Poweshiek			NEMTF	53
Batavia	M-3	Jefferson	42	Rock Creek	--	56
Baxter	M-4	Jasper	184	Fullington Creek	44	50
Blairsburg	M-5	Hamilton	243	Drainage Ditch	43	48
Brighton	M-6	Washington	72	Skunk River	46	54
Cambridge	M-7	Story	212	South Skunk River	43	50
Colfax	M-8	Jasper	187	South Skunk River	44	50
Collins	M-9	Story	184	Wolf Creek	44	50
Colo	M-10	Story	184	Dye Creek	44	50
Coppock	M-11	Washington			NEMTF	55
Crawfordsville	M-12	Washington			NEMTF	55
Danville	M-13	Des Moines	8	Long Creek	47	57
Delta	M-14	Keokuk			NEMTF	53
Elkart	M-15	Polk	202	South Skunk River	44	50
Ellsworth	M-16	Hamilton	246	South Skunk River	43	48
Fairfield	M-17	Jefferson	42	Cedar Creek	47	56
Fremont	M-18	Mahaska	42	Cedar Creek	47	56
Gilbert	M-19	Story	220	Keigley Bridge	43	48
Grinnell	M-20	Poweshiek	68	Sugar Creek	46	53
Harper	M-21	Keokuk			NEMTF	54
Hayesville	M-22	Keokuk			NEMTF	53
Hedrick	M-23	Keokuk	114	Sugar Creek	45	52
Hillsboro	M-24	Henry			NEMTF	56
Huxley	M-25	Story	211	Ballard Creek	43	49
Jewell	M-26	Hamilton	243	Drainage Ditch	43	48
Kamrar	M-27	Hamilton			NEMTF	48
Kelly	M-28	Story			NEMTF	49
Kellogg	M-29	Jasper	84	North Skunk River	45	52
Keota	M-30	Keokuk	82	Dutch Creek	46	54
Lambs Grove	M-72	Jasper	176	Cherry Creek	44	51
Laurel	M-31	Marshall			NEMTF	52

TABLE 12 (Cont.)
POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal (Cont.)						
Lockridge	M-32	Jefferson			NEMTF	55
Lynnville	M-33	Jasper	71	North Skunk River	45	53
Martinsburg	M-34	Keokuk			NEMTF	52
Maxwell	M-35	Story	184	Rock Creek	44	50
McCallsburg	M-36	Story			NEMTF	50
Melbourne	M-37	Marshall	96	Snipe Creek	45	52
Middletown	M-83	Des Moines	2	Brush Creek	47	57
Mingo	M-38	Jasper	184	Indian Creek	44	50
Monroe E	M-39	Jasper	169	Buck Creek	45	51
Montezeuma	M-40	Poweshiek	49	Moon Creek	46	53
Mt. Pleasant	M-41	Henry	26	Big Creek	47	56
Mt. Union	M-42	Henry			NEMTF	55
Nevada	M-43	Story	184	West Branch Indian Creek	44	50
New London (U)	M-44	Henry	26	Big Creek	47	56
New Sharon	M-45	Mahaska	36	Middle Creek	46	53
Newton NW	M-46	Jasper	176	Cherry Creek	44	51
Newton S	M-47	Jasper	176	Sewer Creek	45	51
Newton SW	M-48	Jasper	176	Cherry Creek	44	51
Newton W #1	M-49	Jasper	176	Cherry Creek	44	51
Newton W #2	M-50	Jasper	176	Cherry Creek	44	51
Olds	M-51	Henry			NEMTF	55
Ollie	M-52	Keokuk			NEMTF	52
Oskaloosa NE	M-53	Mahaska	137	Spring Creek	45	52
Packwood	M-54	Jefferson	42	Coon Creek	47	56
Pella NE	M-55	Marion	156	Thunder Creek	45	51
Pella NW	M-56	Marion	156	Thunder Creek	45	51
Pleasant Plain	M-57	Jefferson			NEMTF	55
Randall	M-58	Hamilton			NEMTF	48
Reasoner	M-59	Jasper	172	South Skunk River	45	51
Rhodes	M-60	Marshall	184	Clear Creek	44	50
Richland	M-61	Keokuk			NEMTF	54
Roland	M-62	Story	230	Bear Creek	43	48

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal (Cont.)						
Rome	M-63	Henry			NEMTF	55
Rose Hill	M-64	Mahaska			NEMTF	52
Salem	M-65	Henry	29	Fish Creek	47	56
Searsboro	M-66	Poweshiek			NEMTF	53
Sigourney - East	M-67	Keokuk	12	Bridge Creek	46	54
Sigourney - West	M-68	Keokuk	12	Rock Creek	46	54
Stanhope	M-69	Hamilton	220	Squaw Creek	43	49
Stockport	M-70	Van Buren			NEMTF	56
Story City	M-71	Story	237	South Skunk River	43	48
Sully	M-73	Jasper	73	Slater Creek	45	52
Thornburg	M-74	Keokuk			NEMTF	54
University Park	M-84	Mahaska	137	Spring Creek	45	52
Valeria	M-75	Jasper			NEMTF	50
Washington	M-76	Washington	62	West Fork Crooked Creek	46	55
Wayland	M-77	Henry	57	Unnamed Creek	47	55
Webster	M-78	Keokuk			NEMTF	54
West Chester	M-79	Washington			NEMTF	54
What Cheer	M-80	Keokuk	17	Coal Creek	46	53
Williams	M-81	Hamilton	271	Drainage Ditch No. 64	43	48
Winfield	M-82	Henry	62	East Fork Crooked Creek	46	55
Industrial						
Ames Laboratory - Research Reactor Atomic Energy Commission	I-1	Story	220	Onion Creek	43	49
City of Ames, Power Plant	I-2	Story	222	South Skunk River	43	49
Cargill Inc.	I-3	Washington	62	Crooked Creek	46	55
Clow Corporation, Plant No. 2	I-4	Mahaska	137	Spring Creek	45	52
Dexter Company	I-5	Jefferson	42	Cedar Creek	47	56
Douds Stone, Inc.	I-6	Henry	26	Big Creek	47	56

TABLE 12 (Cont.)
POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Industrial (Cont.)						
Hallett Construction Co.	I-7	Story	230	South Skunk River	43	48
Iowa Ammunition Plant	I-8	Des Moines	2	Brush Creek	47	57
Iowa State University Physical Plant	I-9	Story	220	Squaw Creek	43	49
Kaser Construction Co., Coppock Quarry	I-10	Washington	62	Crooked Creek	47	55
Kaser Construction Co., Harper Quarry	I-11	Keokuk	91	Unnamed Creek	46	54
Kaser Construction Co., Ollie Quarry	I-12	Keokuk	99	Ditch to South Skunk River	45	52
Kaser Construction Co., Oskaloosa Quarry	I-13	Mashaska	137	South Skunk River	45	52
Kaser Construction Co., Sully Quarry	I-14	Jasper	73	Slater Creek	45	52
Kaser Construction Co., West Chester Quarry	I-15	Washington	62	West Fork Crooked Creek	46	54
Martin Marietta Cambridge Mine	I-16	Story	211	Ballard Creek	43	49
Martin Marietta Delta Quarry	I-17	Keokuk	29	North Skunk River	46	53
Martin Marietta Anderson Quarry	I-18	Jefferson	55	Walnut Creek	47	55
Martin Marietta Robertson Quarry	I-19	Story	228	South Skunk River	43	48
Maytag Dairy Farms, Inc.	I-20	Jasper	176	Benjamin Creek	44	51
Maytag Co., Plant No. 1	I-21	Jasper	176	Cherry Creek	44	51

TABLE 12 (Cont.)
POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Industrial (Cont.)						
Maytag Co., Plant No. 2	I-22	Jasper	176	Cherry Creek	45	51
Medusa Aggregate Co., Hienold Quarry	I-23	Des Moines	2	Unnamed Creek	47	57
Mt. Pleasant Municipal Utilities	I-24	Henry	26	Big Creek	47	56
Natural Gas Line Co.	I-25	Keokuk	8	German Creek	46	54
North American Rockwell Corp-ation	I-26	Jefferson	42	Mitchell Creek	47	56
The River Products Co., Keota Quarry	I-27	Washington	82	Dutch Creek	46	54
The River Products Co., Young American Quarry	I-28	Washington	62	West Fork Crooked Creek	46	55
Semipublic						
Bob Welch Truck Stop	S-1	Hamilton	271	Drainage Ditch No. 64	43	48
Crestview Trailer Park	S-2	Story	220	Squaw Creek	43	49
Edgetown Mobile Home Park	S-3	Jasper	176	Benjamin Creek	44	50
Esther Estates Mobile Home Park	S-4	Story	184	Dye Creek	44	50
Glenbrook Mobile Home Park	S-5	Story	220	Worle Creek	43	49
G M Mobile Home Park	S-6	Jasper	176	Cherry Creek	44	51
Green Valley Court, Inc.	S-7	Henry	26	Unnamed Creek	47	56

TABLE 12 (Cont.)
POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Semipublic (Cont.)						
Hickory Grove Mobile Home Park	S-8	Story	222	South Skunk River	43	49
Hidden Valley Mobile Home Park	S-9	Washington	62	West Fork Crooked Creek	46	55
Hillsdale Mobile Home Park	S-10	Story	222	College Creek	43	49
The Homestead Colony	S-11	Story		Iowa Creek	43	49
Iowa Hwy. Commission Rest Area No. 007R (Grinnell)	S-12	Jasper	68	Sugar Creek	46	53
Iowa Hwy. Commission Rest Area No. 008R (Grinnell)	S-13	Jasper	68	Sugar Creek	46	53
Iowa Hwy. Commission Rest Area No. 019R (Ames)	S-14	Story	230	Bear Creek	43	48
Iowa Hwy. Commission Rest Area No. 020R (Ames)	S-15	Story	230	Bear Creek	43	48
Jasper County Home	S-16	Jasper	156	Elk Creek	45	51
Jefferson County Home	S-17	Jefferson	42	Cedar Creek	47	56
Jewell - School	S-18	Hamilton	243	Drainage Ditch	43	48
Keokuk County Home	S-19	Keokuk	12	Bridge Creek	46	54
Kings Terrace Mobile Home Park	S-24	Boone	220	Squaw Creek	43	49
Lake Darling State Park	S-25	Washington			-	54
Lake Trio Home-owner Assn., Inc.	S-20	Washington	62	Crooked Creek	46	55

TABLE 12 (Cont.)
POINT SOURCE
WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Semipublic (Cont.)						
Mardan Mobile Home Park	S-26	Henry	26	Big Creek	47	56
Newberg Elementary School,	S-27	Poweshiek	68	Sugar Creek	45	53
Rural Subdivision and Mobile Home Court	S-21	Jefferson		Cedar Creek	-	56
Sully-Lynn Consolidated School	S-22	Jasper	73	Slater Creek	45	52
Sully School for Christian Training	S-23	Jasper		North Skunk River	45	53

NEMTF: No Existing Municipal Treatment Facility.

* South Skunk and Skunk Rivers: 0 mile at confluence with Mississippi River.
North Skunk River: 0 mile at confluence with South Skunk River.
Where flow discharges into smaller tributaries, the river mile where the tributary joins the North Skunk, South Skunk, or Skunk River is listed.

TABLE 13

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)
South Skunk River																		
Drainage Ditch #64																		
M-81	0.053	30	13	80	35			1	0	30	13	6	3					
S-1																		
South Skunk River																		
M-16	0.209	25	44	25	44													
Drainage Ditch																		
M-5	0.033	35	10	60	17					1	0	2	1					
M-26	0.081	25	17	35	24			2	1	8	5	13	9					
S-18	0.010																	
South Skunk River																		
M-71	0.312	25	65	35	91			2	5	16	42	15	39					
Bear Creek																		
M-62	0.036	25	8	35	11			1	0	2	1	4	1					
S-14	0.003																	
S-15	0.003																	
Keigley Branch																		
M-19	0.052	35	15	60	26			1	0	16	7	4	2					
South Skunk River																		
I-19	0.050																	
I-7	1.80					2	30											
I-2	0.043	3	1									2	1			83	76	SS = 6 TDS = 1,500
S-8	0.001																	
S-10	0.010																	
S-11																		
Squaw Creek																		
M-69	0.041	35	12	50	17			1	0.3	4	1	16	5					
Onion Creek																		
I-1																		
Squaw Creek																		
S-24		40		40														
S-2	0.0084	25	2	35	2													
I-9	0.14	2	2					0.1	0			0.5	1			70	40	TDS = 1,400 SS = 2
Worle Creek																		
S-5	0.010																	
South Skunk River																		
M-1	4.85	40	1,618	60	2,427			12	485	28	1,133	24	971					
Ballard Creek																		
I-16	0.05																	
M-25	0.112	25	23	40	37			1	1	4	4			11	10			
South Skunk River																		
M-7	0.061	25	13	50	25			1	1	1	1							

TABLE 13 (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)
<u>South Skunk River</u> (cont.)																		
M-15	0.013	35	4	60	7			1	0	2	0	8	1					
M-8	0.127	25	26	30	32			3	3	4	4	18	19					
<u>West Branch Indian Creek</u>																		
M-43	0.435	25	91	30	109													
<u>East Branch Indian Creek</u>																		
M-36																		
<u>Dye Creek</u>																		
M-10	0.004	30	1	65	2	1	0	1	0	1	0	2	0					
S-4	0.010																	
<u>Indian Creek</u>																		
M-35	0.066	25	14	60	33					14	8	19	10					
<u>Wolf Creek</u>																		
M-9	0.024	25	5	25	5			1	0	1	0	3	1					
<u>Indian Creek</u>																		
M-38	0.025	25	5	40	8			2	0	4	1	2	0					
<u>Clear Creek</u>																		
M-60	0.035																	
<u>Fullington Creek</u>																		
M-4	0.068	30	17	45	26					3	2	5	3					
<u>Cherry Creek</u>																		
<u>Benjamin Creek</u>																		
S-3	0.005																	
I-20	0.0044	510	19	510	19			10	0.4	26	1							
<u>Cherry Creek</u>																		
M-46	0.173	30	43	50	72			6	9	13	19	15	22					
M-72	0.010	25	2	40	3			2	0	6	1	6	1					
M-48	0.153	30	38	55	70			4	5	10	13	21	27					
M-49	0.037*	25		30				1		1		7						
M-50		35		50				5		18		34						
S-6	0.07																	
I-21	0.20	7	12			7	12					2	3			66	35	pH = 9.6 SS = 7 TDS = 192 NH_3-N = 1.0 NO_3-N = 1.2 COD = 14 TS = 199 TVS = 48

*Total discharge from M-49 and M-50.

TABLE 13 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD5 Summer (mg/l)	BOD5 Summer (lb/day)	BOD5 Winter (mg/l)	BOD5 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)
South Skunk River (cont.)																		
Cherry Creek (cont.)																		
I-22	0.05	22	9			14	6					3	1			68	35	TDS = 994
																		NH_3-N = 1.2
																		NO_3-N = 2.2
																		pH = 9.5
																		COD = 30
																		TS = 1,008
																		TVS = 10
																		Kjel-N = 0.26
Sewer Creek																		
M-47	1.86	25	388	25	388			4	62	8	124	16	248					
South Skunk River																		
M-59	0.010	35	3	100	8			10	1	80	7	50	4					
Buck Creek																		
M-39	0.087	25	18	50	36			5	4	32	23	18	12					DO = 6.3
Thunder Creek																		
M-55	1.058	30	265	43	379			10	88	17	150	19	168					
M-56	0.062	25	13	25	13			2	1	5	3	13	7					
Elk Creek																		
S-16																		
South Skunk River																		
I-13	0.360					13	39									105	90	pH = 7.8
Spring Creek																		
M-84	0.054	25	11	40	18			9	4	15	7	18	8					
M-53	0.980	25	204	55	450			6	49	30	245	20	163					
I-4	0.013																	
Sugar Creek																		
M-23	0.035	25	7	25	7			1	0	1	0	6	2					
South Skunk River																		
I-12	0.134																	SS = 24
																		TDS = 624
																		Turbidity = 32 J.T.U.
North Skunk River																		
Snipe Creek																		
M-37	0.048	35	14	65	26			2	1	8	3							
North Skunk River																		
M-29	0.023	40	8	80	15			8	2	18	3							
Slater Creek																		
M-73	0.084	30	21	40	28													
S-22	0.005																	
I-14	0.053																	
North Skunk River																		
S-23																		
M-33	0.010	35	3	75	6			4	0									
Sugar Creek																		
S-27	0.0005	30	0.1	40	0.2													

TABLE 13 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD_5 Summer (mg/l)	(lb/day)	BOD_5 Winter (mg/l)	(lb/day)	Suspended Solids (mg/l)	(lb/day)	Ammonia Nitrogen (N) Summer (mg/l)	(lb/day)	Ammonia Nitrogen (N) Winter (mg/l)	(lb/day)	Phosphorus (Total P) (mg/l)	(lb/day)	Total Dissolved Solids (mg/l)	(lb/day)	Temperature Summer (°F)	Temperature Winter (°F)	Other (mg/l unless noted otherwise)
North Skunk River (cont.)																		
Sugar Creek (cont.)																		
M-20	1.836	25	172	25	172			4	28	7	48	17	117					
S-12	0.003																	
S-13	0.003																	
Moon Creek																		
M-40	0.097	25	20	25	20	2	2	12	10			6	5					
Middle Creek																		
M-45	0.069	25	14	25	14			1	1	6	3							
North Skunk River																		
I-17	0.050 (max.)																	
Cedar Creek																		
Coal Creek																		
M-80	0.069	25	14	40	23			1	1	16	9	23	13					
Rock Creek																		
M-68	0.095	25	20	25	20			17	13			31	25					
Bridge Creek																		
M-67	0.100	25	21	30	25			8	7			20	17					
S-19	0.001																	
German Creek																		
I-25	0.010																	
Skunk River																		
Clear Creek																		
I-11	0.100					13	11									80		TDS = 1,183 pH = 8.1 Turbidity = 12 J.T.U.
Dutch Creek																		
M-30	0.105	30	26	50	44	13	11	4	4	18	16							
I-27	0.50	1	4			1	4	1	4	1	4	1	4					TDS = 418
Skunk River																		
M-6	0.043	25	9	30	11													
West Fork Crooked Creek																		
I-15	0.016					0	0									71		TDS = 460 pH = 8.1
M-76	1.058	25	221	40	353			7	62	19	168	20	176					
S-9	0.004																	
I-28	0.320	1	3					0.11	0	0	0	0.1	0					TDS = 516 NO_3-N = 0.8
East Fork Crooked Creek																		
M-82	0.045	25	9	25	9			10	4	25	9	31	12					
Crooked Creek																		
S-20	0.001															25	55	
I-3	0.282	1	2	1	2	100	235					1	2					TDS = 3,448 NO_3-N = 16 pH = 7.7

TABLE 13 (Cont.)

POINT SOURCE
WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD5 Summer (mg/l)	BOD5 Summer (lb/day)	BOD5 Winter (mg/l)	BOD5 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)
Skunk Creek (cont.)																		
Crooked Creek (cont.)																		
I-10	0.65																	pH = 7.9 TDS = 560
Sugar Creek																		
M-77	0.021	25	4	30	5			1	0	5	1	5	1					
Walnut Creek																		
I-18	0.140															60	32	pH = 7.85
Cedar Creek																		
M-18	0.048	30	12	40	16			3	1	10	4	10	4					
Coon Creek																		
M-54	0.016	25	3	25	3													
Mitchell Creek																		
I-26	0.080	2	1	2	1	0	0	0.2	0	1	1	0.59	0					NO_3-N = 0.23 COD = 78 Oil and Grease = 5 pH = 7.8 TDS = 120 TVS = 100 Turbidity = 3.7 J.T.U.
Cedar Creek																		
M-17	0.729	25	152	25	152			3	18	19	116	23	140					
I-5	0.025															75	60	pH = 8.0
S-17	0.005																	
Fish Creek																		
M-65	0.035	25	7	45	13			1	0	8	2	8	2					
Big Creek																		
M-41	0.988	25	206	25	206			3	25	22	181	19	157					
S-7	0.016																	
S-26	0.003	70	2	70	2													
I-24	0.010															60	60	pH = 7.2
I-6	0.050					29	12											
M-44	0.254	25	53	25	53			1	2	20	42	15	32					
Long Creek																		
M-13	0.103	25	21	25	21													
Brush Creek																		
I-23	0.023					169	32											
M-83	0.044	25	9	25	9			6	2	11	4	20	7					
I-8	0.8																	Possibility of TNT contamination.

TABLE 14

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
South Skunk River										
Drainage Ditch No. 64										
Williams (M-81)	0.120	0.053		40			Lo	Lo		
Bob Welch Truck Stop (S-1)										
South Skunk River										
Ellsworth (M-16)	0.213	0.209		25			(Ln)Lo	Lp		Total surface area equals 10.32 acres.
Drainage Ditch										
Blairsburg (M-5)	0.045	0.033		35			Lo	Lo		
Kamar (M-27)										No existing municipal treatment facility. A waste stabilization lagoon has been proposed.
Jewell (M-26)	0.073	0.081		30			Lo	Lo		Waste stabilization lagoon has a total surface area of 10.33 acres. Existing sewers have a large quantity of infiltration during periods of wet weather.
Jewell-School (S-18)										No existing treatment facility. As of 1/11/61, they were considering a waste stabilization lagoon with a total surface area of 1.5 acres.
South Skunk River										
Randall (M-58)										No existing municipal treatment facility.
Story City (M-71)	0.228	0.312		30			Sh Ci	Ftr Cp	Bo	Plant constructed in 1963.
Bear Creek										
Roland (M-62)	0.051	0.036		25			Lo	Lo		
Iowa Highway Commission Rest Area No. 019 R (S-14)		0.003					Lo	Lo		
Iowa Highway Commission Rest Area No. 020 R (S-15)		0.003					Lo	Lo		
Kiegley Branch										
Gilbert (M-19)	0.074	0.052		40			Lo	Lo		Total surface area equals 3.37 acres. Plant constructed in 1969.
South Skunk River										
Martin Marietta - Robertson Quarry (I-19)		0.050								
Hallett Construction Co. (I-7)		1.80								

TABLE 14 (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
South Skunk River (cont.)										
City of Ames, Power Plant (I-2)		0.043		3						Power plant discharges cooling water.
Hickory Grove Mobile Home Park (S-8)		0.001					Cs	Ft		
Hillsdale Mobile Home Park (S-10)							Lo	Lo		Total surface area equals 0.87 acres.
The Homestead Colony (S-11)							Lo			
Squaw Creek										
Stanhope (M-69)	0.057	0.041		40			Lo	Lo		Total surface area equals 4.24 acres. Plant constructed in 1970.
Onion Creek										
Ames Laboratory Research Reactor Atomic Energy Commission (I-1)										
Squaw Creek										
Kings Terrace Mobile Home Park (S-24)				40				Ae Lp		To be connected to city of Ames municipal system at some future date
Crestview Trailer Park (S-2)				30			La			Total surface area equals 0.51 acres.
Iowa State University Physical Plant (I-9)		0.14		2		2				No existing treatment facility. Plant discharges cooling water only.
Worle Creek										
Glenbrook Mobile Home Park (S-5)							Lo			
South Skunk River										
Ames (M-1)	5.50	4.85		48			Scka Gm Cm	Ftr Cm Ecg	Dfgh Bo	
Kelley (M-28)										No existing municipal treatment facility.
Ballard Creek										
Martin Marietta - Cambridge Mine (I-16)		0.05								
Huxley (M-25)	0.068	0.112		30			Sh Cl	Ftr Cp	Bo	Plant constructed in 1959.

TABLE 14 (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
South Skunk River (cont.)										
Cambridge (M-7)	0.066	0.061		31			Lo	Lo		Plant constructed in 1970.
Elkart (M-15)	0.031	0.013		40			Lo	Lo		
Valeria (M-75)										No existing municipal treatment facility.
Colfax (M-8)	0.235	0.127		25			Sh Ci	Ftr Cp	Bo	Plant constructed in 1958.
West Branch Indian Creek										
Nevada (M-43)	0.496	0.435		25			Sch Gm Cm	Ftr Cm	Dfh Mt Bo Xl	Plant originally constructed in 1930.
East Branch Indian Creek										
McCallsburg (M-36)										City is in the process of constructing a new waste stabilization lagoon. Plant will discharge only in periods of wet weather.
Dye Creek										
Colo (M-10)	0.041	0.004		50			Lo	Lo		Plant put into operation during 1968.
Esther Estates Mobile Home Park (S-4)							Lo			
Indian Creek										
Maxwell (M-35)	0.120	0.066		40			Sh Ci	Ftr Cp	Bo	Plant constructed in 1968.
Wolf Creek										
Collins (M-9)	0.032	0.024		25			Lo	Lo		
Indian Creek										
Mingo (M-38)		0.025		31			Lo	Lo		
Clear Creek										
Rhodes (M-60)		0.035					Lo	Lo Lp		Plant constructed in 1973.
Fullington Creek										
Baxter (M-4)	0.072	0.068		35			Lo	Lo		
Cherry Creek										
Benjamin Creek										
Edgetown Mobile Home Park (S-3)							Lo			Twenty units.

TABLE 14 (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
South Skunk River (cont.)										
Benjamin Creek (cont.)										
Maytag Dairy Farms, Inc. (I-20)		0.0044		150+		77				
Cherry Creek										
Newton NW (M-46)	0.218	0.173		38			Gh Ci	Ft Cp	Bo	
Lambs Grove (M-72)	0.044	0.010		35			Ci	Ftn	Bo	
Newton SW (M-48)	0.5	0.153		34			Ci	Ftn Cp	Bo	
Newton W #1 (M-49)	0.095*	0.037*		28			Lo	Lo		
Newton W #2 (M-50)				37			Lo	Lo		
G M Mobile Home Park (S-6)										Mobile home park (281 units) has been issued a permit to construct a waste stabilization lagoon.
Maytag Co., Plant No. 1 (I-21)		0.20		7		7				Plant discharges cooling water. Sanitary wastes (0.5 mgd) are handled by the municipal treatment facility.
Maytag Co., Plant No. 2 (I-22)		0.05		22		14				Sanitary wastes (0.6 mgd) are handled by the municipal treatment facility.
Sewer Creek										
Newton S (M-47)	3.1	1.86		25			Sc Gm Ka Cm	Ftr Cm	Dfh Ho Bo	
South Skunk River										
Reasoner (M-59)	0.018	0.010		54			Lo	Lo		Plant constructed in 1967
Buck Creek										
Monroe E (M-39)	0.072	0.087		28			Sh Ci	Ftr Cp	Bo	Plant placed in operation during 1951.
Thunder Creek										
Pella NE (M-55)	1.12	1.058		35			Sh Cm	Fth Cm	Bo	
Pella NW (M-56)	0.43	0.062		25			Sh Ci	Ftr Cp	Dfh Bols	
Elk Creek										
Jasper Co. Home (S-16)							Lo			Latest available data 1964.

* Total discharge from M-49 and M-50.

TABLE 14 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD5 Influent Conc. (mg/l)	BOD5 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
South Skunk River (cont.)										
Kaser Construction Co. - Oskaloosa Quarry (I-13)		0.360				13				Plant not in operation during winter months.
Spring Creek										
University Park (M-84)		0.054		25			Cs	La		
Oskaloosa NE (M-53)	0.40	0.980		40			Sc Cm	Ftr Cm Ecg	Ha Vv Zl Xp	
Clow Corporation Plant No. 2 (I-4)		0.013								Plant discharges cooling water only.
South Skunk River										
Rosehill (M-64)										No existing municipal treatment facility.
Sugar Creek										
Hedrick (M-23)	0.090	0.035		25			Lo	Lo		
South Skunk River										
Martinsburg (M-34)										No existing municipal treatment facility.
Ollie (M-52)										No existing municipal treatment facility.
Kaser Construction Co. - Ollie Quarry (I-12)		0.134				24	L			
North Skunk River										
Snipe Creek										
Melbourne (M-37)	0.030	0.048		45			Sh Ci	Ftr Cp	Bo	Plant constructed in 1946.
Alloway Creek										
Laurel (M-31)										No existing municipal treatment facility.
North Skunk River										
Kellogg (M-29)	0.100	0.023		58			Sh (Cp Do)	Fth Cp	Bo	Plant constructed in 1958.
Slater Creek										
Sully (M-73)	0.112	0.084		33			La	Lo Lo Lo		
Sully-Lynnville Consolidated School (S-22)							Cs	Ft		
Kaser Construction Co. - Sully Quarry (I-14)		0.053								

TABLE 14 (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
North Skunk River (cont.)										
Sully School for Christian Training (S-23)										A permit was issued October 6, 1959 by IDEQ to construct a treatment facility.
Lynnville (M-33)	0.041	0.010		52			Lo	Lo		Total surface area equals 3.6 acres. Plant was placed in operation during 1967.
Sugar Creek										
Newburg Elementary School (S-27)		0.0005		30				Ae		
Grinnell (M-20)	0.825	1.838	120	25			Gm Sch (Ka Oa) Cm	Ftr Cm	Dfh Bo Xl	Plant constructed in 1951. City has been experiencing much growth resulting in an increased flow.
Iowa Highway Commission Rest Area No. 007 R (S-12)		0.003					Lo	Lo		
Iowa Highway Commission Rest Area No. 008 R (S-13)		0.003					Lo	Lo		
West Creek										
Searsboro (M-66)										No existing municipal treatment facility.
Moon Creek										
Montezuma (M-40)	0.232	0.097		25			Lo	Lo		Total surface area equals 11.71 acres.
Pleasant Creek										
Barnes City (M-2)										No existing municipal treatment facility.
Middle Creek										
New Sharon (M-45)	0.092	0.069		25			Sh Gh Cm	Ftn Cp	Dfp Bo	Plant was revised in 1953.
North Skunk River										
Martin Marietta - Delta Quarry (I-17)		0.050 (max.)								
Hayesville (M-22)										No existing municipal treatment facility.
Cedar Creek										
Coal Creek										
What Cheer (M-80)	0.074	0.069		30			Sh Ci	Ftn Cp	Bo	
Cedar Creek										
Delta (M-14)										No existing municipal treatment facility.

TABLE 14 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD5 Influent Conc. (mg/l)	BOD5 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
North Skunk River (cont.)										
Cedar Creek (cont.)										
Rock Creek										
Thornburg (M-74)										No existing municipal treatment facility.
Sigourney W (M-68)	0.108	0.095		25			Sh Gh Ci	Ftr	Bo	Plant constructed in 1935.
Bridge Creek										
Sigourney E (M-67)	0.108	0.100		30			Sh Gh Ci	Ftr	Bo	Plant constructed in 1935
Keokuk County Home (S-19)										Latest available data was in 1967.
German Creek										
Webster (M-78)										No existing municipal treatment facility.
Natural Gas Line Co. (I-25)	0.01							Ae		Plant constructed in 1962.
Skunk River										
Clear Creek										
Harper (M-21)										No existing municipal treatment facility.
Kaser Construction Co. - Harper Quarry (I-11)		0.100				13				Quarry is closed during winter months.
Dutch Creek										
Keota (M-30)	0.102	0.105		30			Ci	Ftr Cp	Bo	Plant constructed in 1930's. Existing sewers have a large quantity of infiltration during periods of wet weather.
The River Products Co. - Keota Quarry (I-27)		0.50		1		1				Discharge is quarry dewatering and/or rockwash.
Skunk River										
Richland (M-61)										Waste stabilization lagoon has been proposed.
Lake Darling State Park (S-25)							Lo	Lo		There are two waste stabilization pond systems at the park. Both are designed for complete retention of flow (zero discharge).
Brighton (M-6)	0.060	0.043		25			Gh Ci	Fs	Bo	Plant constructed in 1919. Existing sewers have a large quantity of infiltration during periods of wet weather.
West Fork Crooked Creek										
West Chester (M-79)										No existing municipal treatment facility.
Kaser Construction Co. - West Chester Quarry (I-15)		0.016								Quarry closed during winter months. (Season 80 days year.)

TABLE 14 (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
Skunk River (Cont.)										
West Fork Crooked Creek (Cont.)										
Washington (M-76)	0.500	1.058		30			Sh Gm Cm	Ftr Cm	Dfh Ho X1	
Hidden Valley Mobile Home Park (S-9)										Mobile home park (15 units) was issued a permit 1/12/71 to build a waste stabilization lagoon.
The River Products Co. - Young American Quarry (I-28)	0.320			1		10	L			Discharge is surface water runoff only.
East Fork Crooked Creek										
Mt. Union (M-42)										No existing municipal treatment facility.
Winfield (M-82)	0.050	0.045		25			Gh Sh Cs	Ftr Cp	Bo	Plant constructed in 1967. Total surface equals 5.5 acres.
Olds (M-51)										No existing municipal treatment facility.
Crawfordsville (M-12)										No existing municipal treatment facility.
Crooked Creek										
Lake Trio Homeowner Assn. Inc. (S-20)		0.001					La			
Cargill, Inc. (I-3)		0.282		1		100				Discharges cooled and treated water into the municipal storm sewer.
Coppock (M-11)										No existing municipal treatment facility.
Kaser Construction Co. - Coppock Quarry (I-10)		7.65				0				
Sugar Creek										
Wayland (M-77)	0.075	0.021		30			Lo	Lo		Plant constructed in 1967. Total surface area equals 5.5 acres.
Walnut Creek										
Martin Marietta - Anderson Quarry (I-18)		0.140								
Burr Oak Creek										
Pleasant Plain (M-57)										No existing municipal treatment facility.
Brush Creek										
Lockridge (M-32)										No existing municipal treatment facility.
Skunk River										
Rome (M-63)										No existing municipal treatment facility.

TABLE 14 (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
Skunk River (Cont.)										
Cedar Creek										
Fremont (M-18)	0.045	0.048		35			Lo	Lo		Plant constructed in 1967. Total surface area equals 4.5 acres.
Coon Creek										
Packwood (M-54)		0.016		25			Lo	Lo		Plant constructed in 1971.
Rock Creek										
Batavia (M-3)										In process of constructing a waste stabilization lagoon, construction started in 1973.
Mitchell Creek										
North American Rockwell Corp. (I-26)		0.080		2			L(with oil skimmer)			Discharge is cooling water.
Cedar Creek										
Fairfield (M-17)	1.60	0.729		25			Gm Sch Cm	Ftr Cm	Dfh Dcp Xl	Plant constructed in 1968.
Dexter Co. (I-5)		0.025								Discharge is cooling water.
Jefferson County Home (S-17)							Lo			Total surface area equals 0.52 acres.
Rural Subdivision and Mobile Home Court (S-21)										A waste stabilization lagoon was proposed to IDEQ in 1966.
Stockport (M-70)										No existing municipal treatment facility.
Hillsboro (M-24)										No existing municipal treatment facility.
Fish Creek										
Salem (M-65)	0.048	0.035		30			Lo	Lo		Total surface area equals three acres.
Big Creek										
Mt. Pleasant (M-41)		0.988		25			Sr Gm Sch Cm	Ftr Cm	Dfh Dg Xl	
Green Valley Court, Inc. (S-7)							Lo			Mobile home park containing 62 units.
Mardan Mobile Home Park (S-26)		0.003		70			Lo	Lo		Mobile home park containing 30 units.
Mt. Pleasant Public Utilities (I-24)		0.010								
Douds Stone Products (I-6)		0.050				29				
New London (M-44)	0.115	0.254		25			Sh Gh Cm	Ftr Cp	Do Bo	

TABLE 14 (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
Skunk River (cont.)										
Long Creek										
Danville (M-13)		0.103		25			Lo	Lo		Plant constructed in 1973.
Brush Creek										
Medusa Aggregate Co. - Heinold Quarry (I-23)		0.023				169				
Middletown (M-83)				55			Ci	Fs	Bo	
Iowa Ammunition Plant (I-8)		0.8								

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 floating cover
Dg----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 Skunk 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 Skunk 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:

$$\frac{dD}{dt} = K_1 L + K_n N - K_2 D$$

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:

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

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 within the Skunk River Basin 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 Skunk River Basin, specific assumptions are required. 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 model. For all gaging stations on the Skunk River, the wastewater flow from present point source discharges exceeds the

calculated 7-day, 1-in-10 year low flow. Two possible explanations for this phenomenon are as follows:

a. During extreme dry periods (7-day, 1-in-10 year low flow), evaporation and exfiltration exceed any infiltration taking place with the result being a net loss of natural flow from the river. Some flow is maintained as a result of wastewater discharges from communities and industries.

b. The 7-day, 1-in-10 year low flow is a statistical number based upon the flow in the river for the number of years of record at the various gaging stations. Most present point source discharge quantities are higher than they were in past years, and this accounts (at least in part) for the higher flows based upon present discharges.

Sufficient information is not available in the Skunk River Basin to establish the exact water balance during low flow conditions and, in reality, some combinations of these two factors probably cause the point source discharges to exceed the 7-day, 1-in-10 year low flow.

In order to obtain river flows for use in the stream model which approximate the 1990, 7-day, 1-in-10 year low flow, the following assumptions were made regarding groundwater inflow and groundwater recharge:

a. The present flow from point source discharges upstream of Oskaloosa is more than three times the calculated 7-day, 1-in-10 year low flow at USGS gaging station 4715 near Oskaloosa. Uniform exfiltration from the Skunk River was assumed to take place between Ames and Oskaloosa under existing conditions to meet the 7-day, 1-in-10 year low flow at the gage. Between the present time and 1990, the flow from point source dischargers upstream from Oskaloosa is expected to increase by approximately 10 cfs. It is expected that the 7-day, 1-in-10 year low flow in the river will increase somewhat by 1990 due to the additional flow discharged to the river. For purposes of the computer model, the percent of groundwater recharge due to the incremental increase in flow from point source dischargers was assumed to equal the percent of groundwater recharge under existing conditions. This results in an increase in the 7-day, 1-in-10 year low flow from 4.8 to 7.9 cfs at the Oskaloosa gage.

b. Between the upstream gaging stations at Oskaloosa on the South Skunk River and at Sigourney on the North Skunk River and the downstream gaging station near Coppock on the main stem of the Skunk River, river flow increases by more than the point source discharges. The sum of the flows from the point source dischargers in this section of the stream was subtracted from the increase in river flow. The remaining flow was assumed to be due to groundwater infiltration and was allocated along the length of the channel in relationship to the area contributing to the stream. Values of 4.0 mg/l BOD_5, 0.0 mg/l ammonia nitrogen, and 2.0 mg/l dissolved oxygen concentrations were assumed as the water quality of the groundwater contribution.

c. The 7-day, 1-in-10 year low flow at USGS gaging station 4730 near Coppock is equal to the 7-day, 1-in-10 year low flow at the downstream USGS gaging station 4740 near Augusta. For purposes of the computer model, groundwater recharge was assumed to equal the flow from all point source dischargers in this section of the river with no net increase in river flow.

d. In the remaining sections of the Skunk River Basin, either the wastewater discharges from point sources approximated the 7-day, 1-in-10 year low flow or low flow information was not available and no infiltration or exfiltration was assumed.

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 discharger.

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
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 physical and climatological conditions for the basin.

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, and ammonia nitrogen concentrations of 0.0 mg/l in the summer and 0.5 mg/l in the winter.

Discussion of Results

Summer Conditions - Waste load allocations for each discharger with summer conditions are given in Table 17. The upper limit for wastewater discharges is secondary treatment for municipal discharges and BPT for industrial dischargers. IDEQ has set the allowable ammonia nitrogen level for secondary treatment as 10 mg/l in summer.

Dissolved oxygen concentration profiles for the North Skunk River, South Skunk River, and Skunk River for 1990 discharges with the waste allocations given in Table 17 are shown on Figures 5, 6, and 7. The stream quality criteria of 5.0 mg/l are met in all sections of the streams which are water quality classified. Dissolved oxygen concentrations will fall below 5 mg/l in many of the smaller streams, which are not classified, during low flow conditions.

Summer ammonia nitrogen concentrations are shown on Figures 5, 6, and 7. The allocations given in Table 17 maintain ammonia nitrogen concentrations below 2 mg/l for all classified sections of the streams. Wastewater discharges in many of the smaller unclassified streams will cause the ammonia nitrogen concentrations to be above 2 mg/l in the unclassified portions of the streams.

To meet water quality criteria under summer low flow conditions, all communtiies except Huxley and Hedrick which discharge to the South Skunk River or its tributaries must provide a level of wastewater treatment exceeding that of secondary treatment. In addition, the city of Grinnell which discharges to the North Skunk River and the city of Fairfield which discharges into Cedar Creek must also provide a level of treatment exceeding that of secondary treatment. Some form of ammonia nitrogen removal will be required at the treatment facilities for these communities.

TABLE 17

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River							
Drainage Ditch No. 64							
Williams (M-81)		0	Controlled Discharge				
South Skunk River							
Ellsworth (M-16)		0	Controlled Discharge				
Drainage Ditch							
Blairsburg (M-5)		0	Controlled Discharge				
Jewell (M-26)		0	Controlled Discharge				
Jewell School (S-18)		0	Controlled Discharge				
South Skunk River							
Story City (M-71)	0	0.453	10	38	2	8	5.0
Bear Creek							
Roland (M-62)		0	Controlled Discharge				
Iowa State Hwy. Comm. Rest Area 019R (S-14)		0	Controlled Discharge				
Iowa State Hwy. Comm. Rest Area 020R (S-15)		0	Controlled Discharge				
Kiegley Branch							
Gilbert (M-19)		0	Controlled Discharge				
South Skunk River							
Martin Marietta Robertson Quarry (I-19)			No Discharge Limitation Necessary[2]				
Hallett Construction (I-7)			No Discharge Limitation Necessary[2]				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River (cont.)							
City of Ames Power Plant (I-2)	0.45	0.043	No Discharge Limitations Necessary[2]				
Hickory Grove Mobile Home Park (S-8)	0.45	0.001	45	0.4	10	0.1	3.0
Hillsdale Mobile Home Park (S-10)		0	Controlled Discharge				
The Homestead Colony (S-11)		0	Controlled Discharge				
Squaw Creek							
Stanhope (M-69)		0	Controlled Discharge				
Kings Terrace Mobile Home Park (S-24)	0		10		2		5.0
Crestview Trailer Park (S-2)		0	Controlled Discharge				
Iowa State University Physical Plant (I-9)	0	0.140	No Discharge Limitation Necessary[2]				
Worle Creek							
Glenbrook Mobile Home Park (S-5)		0	Controlled Discharge				
South Skunk River							
Ames (M-1)	0.63	9.353	10	780	2	156	5.0
Ballard Creek							
Martin Marietta Cambridge Mine (I-16)			No Discharge Limitation Necessary[2]				
Huxley (M-25)	0	0.163	45[3]	61	10[3]	14	3.0
South Skunk River							
Cambridge (M-7)		0	Controlled Discharge				
Elkhart (M-15)		0	Controlled Discharge				
Colfax (M-8)	4.83	0.330	30	83	2	6	3.0

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River (cont.)							
West Branch Indian Creek							
Nevada (M-43)	0	0.800	30	200	2	13	3.0
East Branch Indian Creek							
Dye Creek							
Colo (M-10)		0			Controlled Discharge		
Esther Estates Mobile Home Park (S-4)		0			Controlled Discharge		
Indian Creek							
Maxwell (M-35)	0.77	0.096	30	24	2	2	3.0
Wolf Creek							
Collins (M-9)		0			Controlled Discharge		
Indian Creek							
Mingo (M-38)		0			Controlled Discharge		
Clear Creek							
Rhodes (M-60)		0			Controlled Discharge		
Fullington Creek							
Baxter (M-4)		0			Controlled Discharge		
Cherry Creek							
Benjamin Creek							
Edgetown Mobile Home Park (S-3)		0			Controlled Discharge		
Maytag Dairy Farms (I-20)	0	0.004	20	0.7	10	0.3	3.0

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River (cont.)							
Cherry Creek							
Newton Northwest (M-46)	0	0.216	10	18	2	4	3.0
Lambs Grove (M-72)	0	0.012	10	1	2	0.2	3.0
Newton Southwest (M-48)	0	0.191	10	16	2	3	3.0
Newton West No. 1 (M-49)		0	Controlled Discharge				
Newton West No. 2 (M-50)		0	Controlled Discharge				
GM Mobile Home Park (S-6)		0	Controlled Discharge				
Maytag Plant No. 1 (I-21)	0	0.200	10	17	1	2	8.0
Maytag Plant No. 2 (I-22)	0	0.050	10	4	1	0.4	8.0
Sewer Creek							
Newton South (M-47)	0	2.325	10	194	2	39	3.0
South Skunk River							
Reasoner (M-59)		0	Controlled Discharge				
Buck Creek							
Monroe E. (M-39)	0	0.105	10	9	2	2	3.0
Thunder Creek							
Pella Northeast (M-55)	0	1.746	10	146	2	29	3.0
Pella Northwest (M-56)	0	0.150	10	13	2	3	3.0
Elk Creek							
Jasper County Home (S-16)		0	Controlled Discharge				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River (cont.)							
Kaser Construction Co. Oskaloosa Quarry (I-13)			No Discharge Limitations Necessary[2]				
Spring Creek							
University Park (M-84)	0	0.055	10	5	2	1	3.0
Oskaloosa NE (M-53)	0	1.185	10	99	2	20	3.0
Clow Corp. Plant No. 2 (I-4)	0	0.013	No Discharge Limitations Necessary[2]				
Sugar Creek							
Hedrick (M-23)	0	0.037	45[3]	14	10[3]	3	3.0
South Skunk River							
Kaser Construction Co. Ollie Quarry (I-12)			No Discharge Limitations Necessary[2]				
North Skunk River							
Snipe Creek							
Melbourne (M-37)	0	0.063	45[3]	24	10[3]	5	3.0
North Skunk River							
Kellogg (M-29)	0.06	0.100	45[3]	38	10[3]	8	3.0
Slater Creek							
Sully (M-73)		0	Controlled Discharge				
Sully-Lynnville Consolidated School (S-22)	0	0.005	45[3]	2	10[3]	0.4	3.0
Kaser Construction Co. Sully Quarry (I-14)			No Discharge Limitations Necessary[2]				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
North Skunk River (cont.)							
Lynnville (M-33)		0	Controlled Discharge				
Sugar Creek							
Newburg Elementary School (S-27)	0	0.0005	20	0.1	4	0.02	3.0
Grinnell (M-20)	0	2.527	20	422	4	84	3.0
Iowa State Hwy. Comm. Rest Area 007R (S-12)		0	Controlled Discharge				
Iowa State Hwy. Comm. Rest Area 008R (S-13)		0	Controlled Discharge				
Moon Creek							
Montezuma (M-40)		0	Controlled Discharge				
Middle Creek							
New Sharon (M-45)	0	0.117	45[3]	44	10[3]	10	3.0
North Skunk River							
Martin Marietta Delta Quarry (I-17)		No Discharge Limitations Necessary[2]					
Cedar Creek							
Coal Creek							
What Cheer (M-80)	0	0.080	45[3]	30	10[3]	7	3.0
Rock Creek							
Sigourney West (M-68)	0	0.105	45[3]	39	10[3]	9	3.0
Bridge Creek							
Sigourney East (M-67)	0	0.100	45[3]	38	10[3]	8	3.0
Keokuk Co. Home (S-19)		0	Controlled Discharge				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
North Skunk River (cont.)							
German Creek							
Natural Gas Line Co. (I-25)	0	0.010	45	4	10	1	3.0
Skunk River							
Clear Creek							
Kaser Construction Co. Harper Quarry (I-11)			No Discharge Limitations Necessary[2]				
Dutch Creek							
Keota (M-30)	0	0.124	45[3]	47	10[3]	10	3.0
The River Product Co. Keota Quarry (I-27)			No Discharge Limitations Necessary[2]				
Skunk River							
Brighton (M-6)	14.66	0.048	45[3]	18	10[3]	4	3.0
West Fork Crooked Creek							
Kaser Construction Co. West Chester Quarry (I-15)			No Discharge Limitations Necessary[2]				
Washington (M-76)	0	1.360	45[3]	510	10[3]	113	3.0
Hidden Valley Mobile Home Park (S-9)		0	Controlled Discharge				
The River Product Co. Young America Quarry (I-28)			No Discharge Limitations Necessary[2]				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Skunk River (cont.)							
East Fork Crooked Creek							
Winfield (M-82)	0	0.100	45[3]	38	10[3]	8	3.0
Crooked Creek							
Lake Trio Homeowner Assn. (S-20)		0	Controlled Discharge				
Cargill, Inc. (I-3)	1.42	0.282	No Discharge Limitations Necessary[2]				
Kaser Construction Co. Coppock Quarry (I-10)			No Discharge Limitations Necessary[2]				
Sugar Creek							
Wayland (M-77)		0	Controlled Discharge				
Walnut Creek							
Martin Marietta Anderson Quarry (I-18)			No Discharge Limitations Necessary[2]				
Cedar Creek							
Fremont (M-18)		0	Controlled Discharge				
Coon Creek							
Packwood (M-54)		0	Controlled Discharge				
Mitchell Creek							
North American Rockwell Corp. (I-26)	0	0.080	No Discharge Limitations Necessary[2]				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Skunk River (cont.)							
Cedar Creek							
Fairfield (M-17)	0	1.600	10	133	2	27	5.0
Dexter Company (I-5)	0	0.025	No Discharge Limitations Necessary[2]				
Jefferson Co. Home (S-17)	0	0.005	45[3]	2	10[3]	0.4	3.0
Fish Creek							
Salem (M-65)		0	Controlled Discharge				
Big Creek							
Mt. Pleasant (M-41)	0	1.107	45[3]	415	10[3]	92	3.0
Green Valley Court (S-7)		0	Controlled Discharge				
Mardan Mobile Home Park (S-26)		0	Controlled Discharge				
Mt. Pleasant Municipal Utilities (I-24)	0	0.010	No Discharge Limitations Necessary[2]				
Douds Stone Products, Inc. (I-6)			No Discharge Limitations Necessary[2]				
New London (M-44)	0	0.323	45[3]	121	10[3]	27	3.0
Long Creek							
Danville (M-13)		0	Controlled Discharge				

TABLE 17 (Cont.)

WASTE LOAD ALLOCATION

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

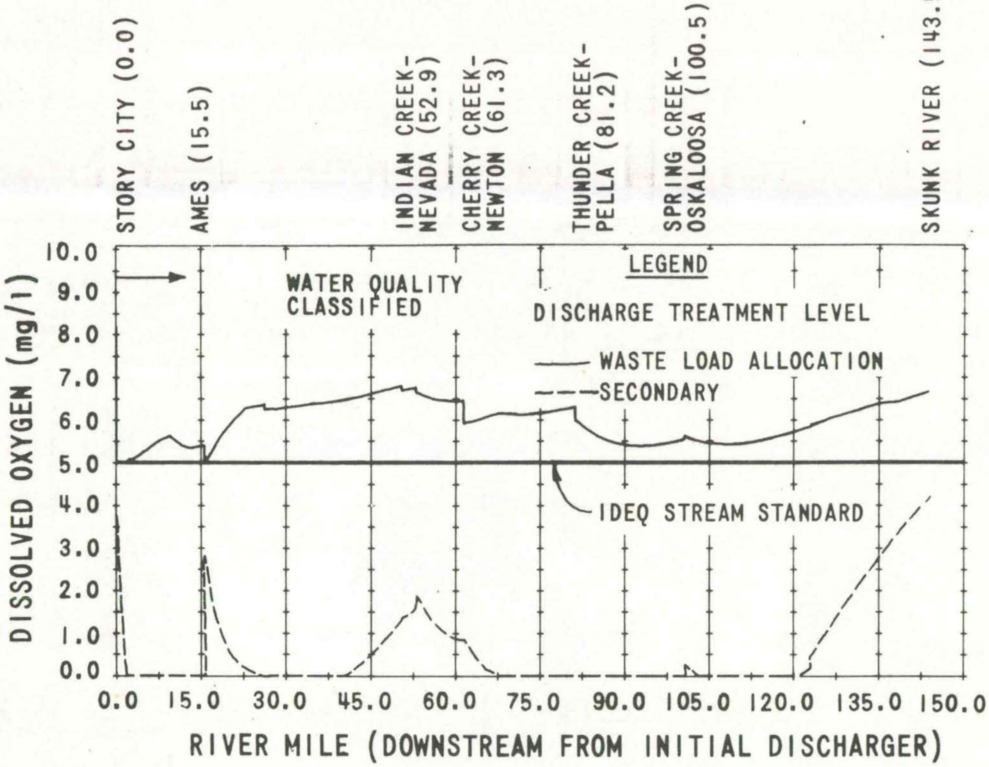
SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow	1990 Discharge	Ultimate BOD[1]		Ammonia Nitrogen (N)		Effluent Dissolved Oxygen
	(mgd)	(mgd)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)
Skunk River (cont.)							
Brush Creek							
Medusa Aggregate Co. Heinold Quarry (I-23)			No Discharge Limitations Necessary[2]				
Middletown (M-83)	0	0.068	45[3]	26	10[3]	6	3.0
Iowa Ammunition Plant (I-8)	0	0.800	45	300	10	66	3.0

[1] Ultimate BOD = 1.5 (BOD_5).

[2] Discharge does not contain significant levels of BOD or ammonia nitrogen.

[3] Meet BPWTT guidelines. Higher discharge quantities could satisfy stream criteria.



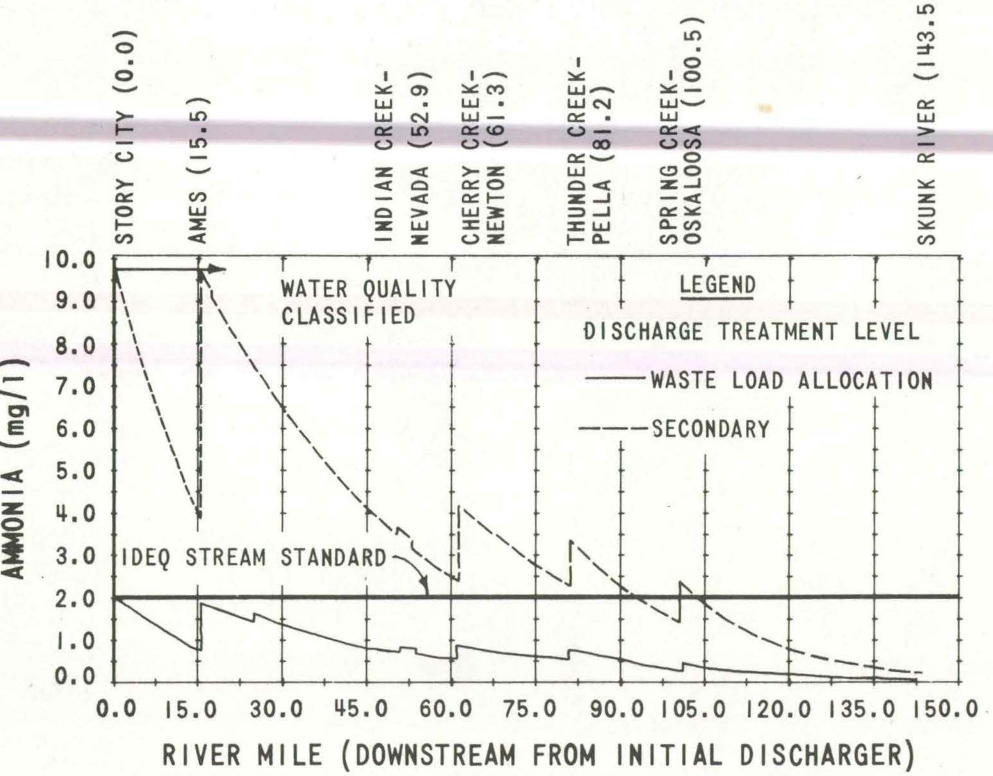
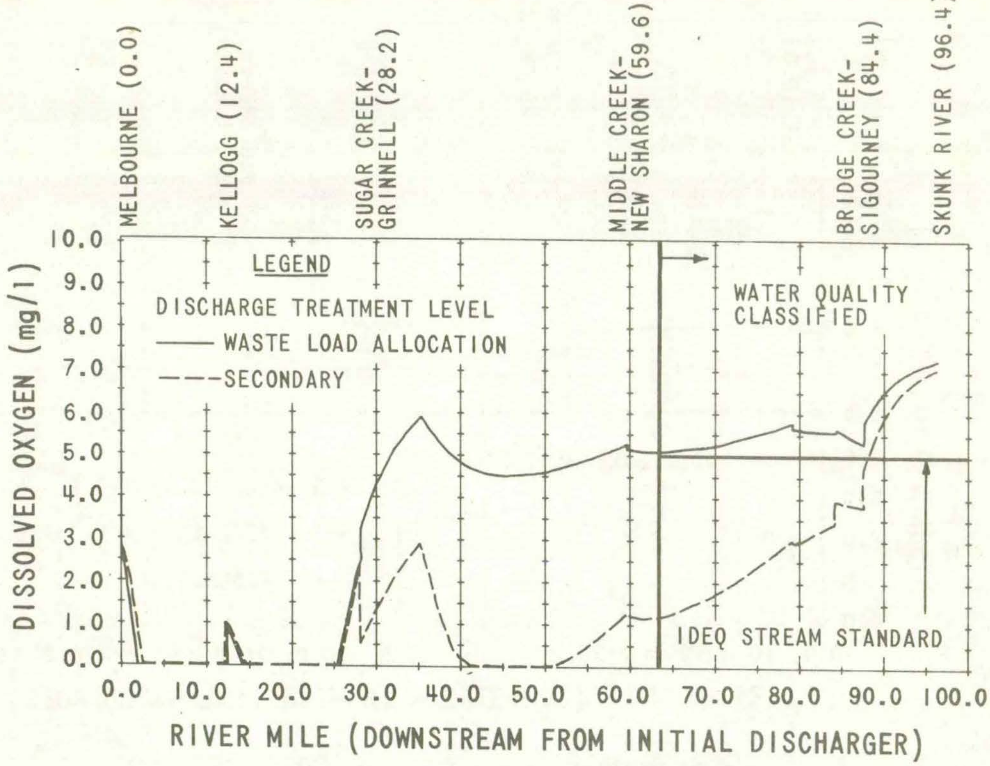


FIGURE 5
SOUTH SKUNK RIVER
SUMMER CONDITION



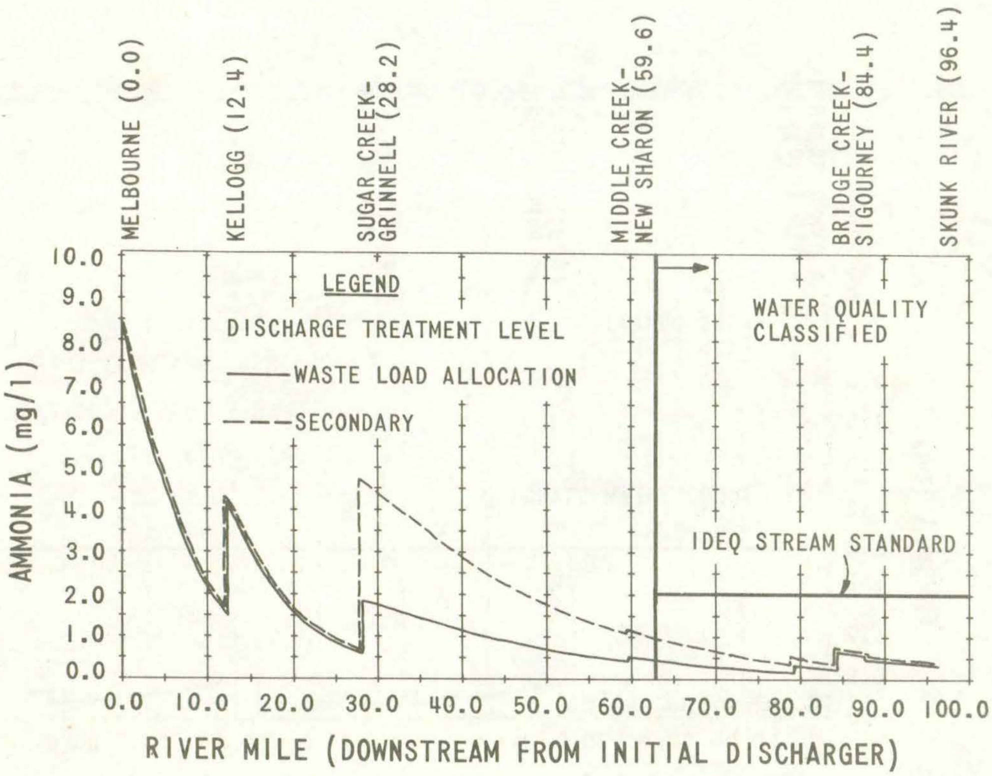
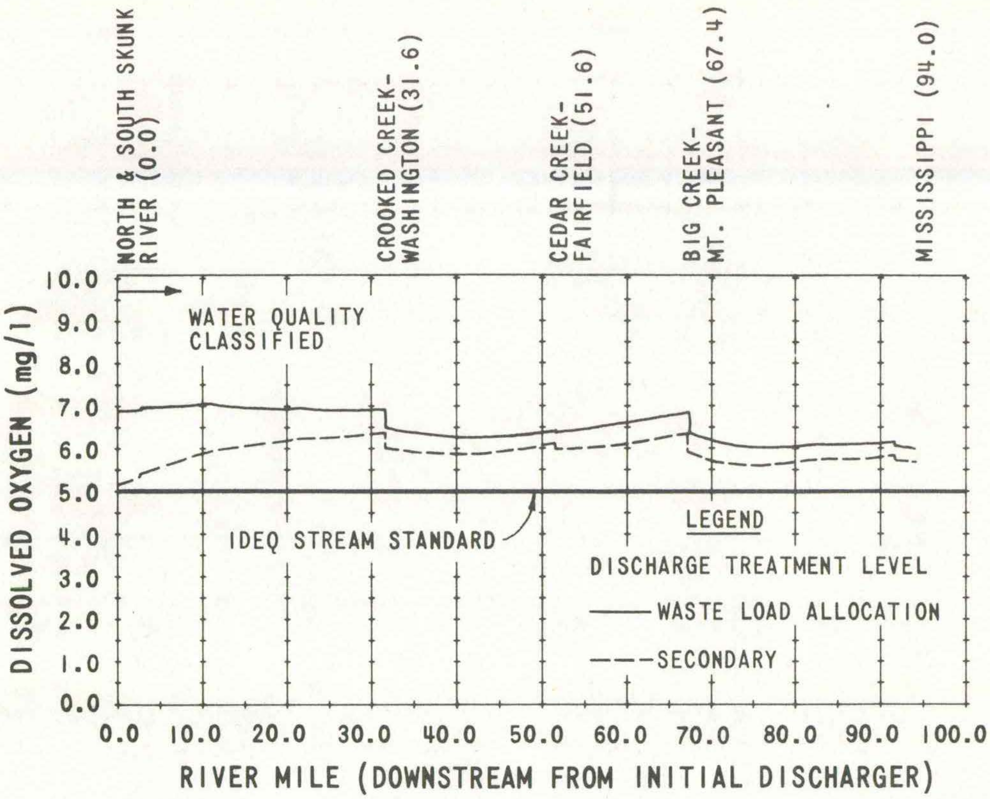


FIGURE 6
NORTH SKUNK RIVER
SUMMER CONDITION



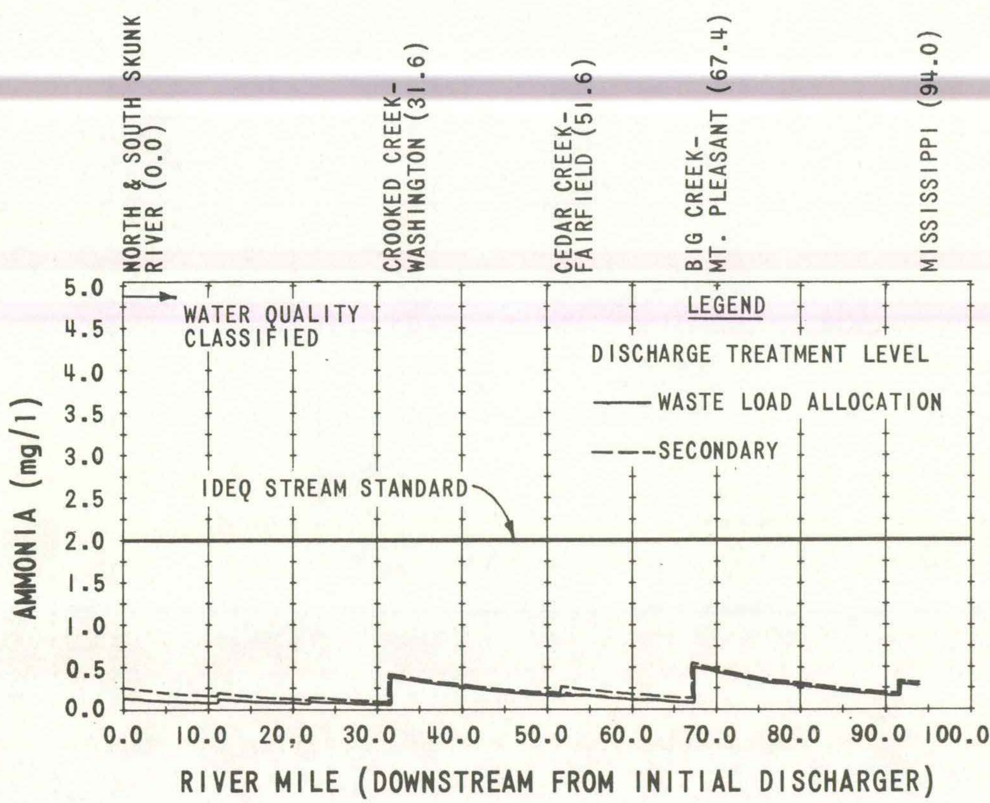


FIGURE 7
SKUNK RIVER
SUMMER CONDITION

Winter Conditions - Waste load allocations under winter low flow conditions for dischargers within the basin are given in Table 18. The allowable ammonia nitrogen concentration in secondary effluents has been set as 15 mg/l by IDEQ for winter conditions.

Dissolved oxygen concentrations for the North Skunk River, South Skunk River, and the main stem of the Skunk River are shown on Figures 8, 9, and 10. The model shows that for the waste load allocations given in Table 18, dissolved oxygen concentrations meet the water quality criteria in all classified portions of the streams. The dissolved oxygen concentration can be expected to fall below 5 mg/l during low flow conditions in many of the smaller unclassified streams.

Ammonia nitrogen concentrations for the streams under winter low flow conditions are shown on Figures 8, 9, and 10. The water quality criteria for ammonia nitrogen are met for all classified sections of the streams for the given waste load allocations. Reduction of ammonia nitrogen concentrations within the streams is less evident in the winter than the summer because of the lack of bio-oxidation of ammonia at low temperatures.

In most cases, the winter allocations are equal to or more restrictive than the summer allocations. Most of the municipalities in the Skunk River Basin which discharge wastewater during low flow conditions must provide a level of wastewater treatment exceeding that of secondary treatment.

Thermal Discharges

Several relatively small power plants are located within the basin and several industries discharge water which has been used for cooling purposes. None of these discharges is of sufficient magnitude to cause violation of the temperature criteria in the stream quality standards. The South Skunk River will essentially become the temperature of the Ames wastewater treatment plant discharge, downstream from Ames, during low flow conditions. Effluent from this facility comprises approximately 95 percent of the stream flow at this point.

TABLE 18

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River							
Drainage Ditch No. 64							
Williams (M-81)		0		Controlled Discharge			
South Skunk River							
Ellsworth (M-16)		0		Controlled Discharge			
Drainage Ditch							
Blairsburg (M-5)		0		Controlled Discharge			
Jewell (M-26)		0		Controlled Discharge			
Jewell School (S-18)		0		Controlled Discharge			
South Skunk River							
Story City (M-71)	0	0.453	10	38	2	8	5.0
Bear Creek							
Roland (M-62)		0		Controlled Discharge			
Iowa State Hwy. Comm. Rest Area 019R (S-14)		0		Controlled Discharge			
Iowa State Hwy. Comm. Rest Area 020R (S-15)		0		Controlled Discharge			
Kiegley Branch							
Gilbert (M-19)		0		Controlled Discharge			

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River (cont.)							
Martin Marietta Robertson Quarry (I-19)			No Discharge Limitations Necessary[2]				
Hallett Construction (I-7)			No Discharge Limitations Necessary[2]				
City of Ames Power Plant (I-2)	0.45	0.043	No Discharge Limitations Necessary[2]				
Hickory Grove Mobile Home Park (S-8)	0.45	0.001	45	0.4	15	0.1	4.0
Hillsdale Mobile Home Park (S-10)		0	Controlled Discharge				
The Homestead Colony (S-11)		0	Controlled Discharge				
Squaw Creek							
Stanhope (M-69)		0	Controlled Discharge				
Kings Terrace Mobile Home Park (S-24)	0		10		2		5.0
Crestview Trailer Park (S-2)		0	Controlled Discharge				
Iowa State University Physical Plant (I-9)	0	0.140	No Discharge Limitations Necessary[2]				
Worle Creek							
Glenbrook Mobile Home Park (S-5)	0.49	0	Controlled Discharge				
South Skunk River							
Ames (M-1)	0.63	9.353	10	780	2	156	5.0

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Ballard Creek							
Martin Marietta Cambridge Mine (I-16)			No Discharge Limitations Necessary[2]				
Huxley (M-25)	0	0.163	10	14	2	3	4.0
South Skunk River							
Cambridge (M-7)		0	Controlled Discharge				
Elkhart (M-15)		0	Controlled Discharge				
Colfax (M-8)	4.83	0.330	10	28	2	6	4.0
West Branch Indian Creek							
Nevada (M-43)	0	0.800	10	67	2	13	4.0
East Branch Indian Creek							
Dye Creek							
Colo (M-10)		0	Controlled Discharge				
Esther Estates Mobile Home Park (S-4)		0	Controlled Discharge				
Indian Creek							
Maxwell (M-35)	0.77	0.096	10	8	2	2	4.0
Wolf Creek							
Collins (M-9)		0	Controlled Discharge				
Indian Creek							
Mingo (M-38)		0	Controlled Discharge				
Clear Creek							
Rhodes (M-60)		0	Controlled Discharge				

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
South Skunk River (cont.)							
Indian Creek (cont.)							
Fullington Creek							
Baxter (M-4)		0			Controlled Discharge		
Cherry Creek							
Benjamin Creek							
Edgetown Mobile Home Park (S-3)		0			Controlled Discharge		
Maytag Dairy Farms (I-20)	0	0.004	20	0.7	15	0.5	
Cherry Creek							
Newton Northwest (M-46)	0	0.216	10	18	2	4	4.0
Lambs Grove (M-72)	0	0.012	10	1	2	0.2	4.0
Newton Southwest (M-48)	0	0.191	10	16	2	3	4.0
Newton West No. 1 (M-49)		0			Controlled Discharge		
Newton West No. 2 (M-50)		0			Controlled Discharge		
GM Mobile Home Park (S-6)		0			Controlled Discharge		
Maytag Plant No. 1 (I-21)	0	0.200	10	17	1	2	10.0
Maytag Plant No. 2 (I-22)	0	0.050	10	4	1	0.4	10.0
Sewer Creek							
Newton South (M-47)	0	2.325	10	194	2	39	4.0

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1]		Ammonia Nitrogen (N)		Effluent Dissolved Oxygen (mg/l)
			(mg/l)	(lb/day)	(mg/l)	(lb/day)	
South Skunk River (cont.)							
Reasoner (M-59)		0	Controlled Discharge				
Buck Creek							
Monroe E. (M-39)	0	0.105	10	9	2	2	4.0
Thunder Creek							
Pella Northeast (M-55)	0	1.746	10	146	2	29	4.0
Pella Northwest (M-56)	0	0.150	10	13	2	3	4.0
Elk Creek							
Jasper County Home (S-16)		0	Controlled Discharge				
South Skunk River							
Kaser Construction Co. Oskaloosa Quarry (I-13)			No Discharge Limitations Necessary[2]				
Spring Creek							
University Park (M-84)	0	0.055	10	5	2	1	4.0
Oskaloosa NE (M-53)	0	1.185	10	99	2	20	4.0
Clow Corp. Plant No. 2 (I-4)	0	0.013	No Discharge Limitations Necessary[2]				
Sugar Creek							
Hedrick (M-23)	0	0.037	10	3	2	0.6	4.0
South Skunk River							
Kaser Construct Co. Ollie Quarry (I-12)			No Discharge Limitations Necessary[2]				

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
North Skunk River							
Snipe Creek							
Melbourne (M-37)	0	0.063	45[3]	24	2	1	4.0
North Skunk River							
Kellogg (M-29)	0.06	0.100	45[3]	38	2	2	4.0
Slater Creek							
Sully (M-73)		0	Controlled Discharge				
Sully-Lynville Consolidated School (S-22)	0	0.005	45[3]	2	15[3]	0.6	4.0
Kaser Construction Co. Sully Quarry (I-14)			No Discharge Limitations Necessary[2]				
North Skunk River							
Lynnville (M-33)		0	Controlled Discharge				
Sugar Creek							
Newburg Elementary School (S-27)	0	0.0005	10	0.04	2	0.01	4.0
Grinnell (M-20)	0	2.527	10	211	2	42	4.0
Iowa State Hwy. Comm. Rest Area 007R (S-12)		0	Controlled Discharge				
Iowa State Hwy. Comm. Rest Area 008R (S-13)		0	Controlled Discharge				
Moon Creek							
Montezuma (M-40)		0	Controlled Discharge				
Middle Creek							
New Sharon (M-45)	0	0.117	45[3]	44	2	2	4.0

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
North Skunk River (cont.)							
Martin Marietta Delta Quarry (I-17)			No Discharge Limitations Necessary[2]				
Cedar Creek							
Coal Creek							
What Cheer (M-80)	0	0.080	45[3]	30	2	1	4.0
Rock Creek							
Sigourney West (M-68)	0	0.105	45[3]	39	2	2	4.0
Bridge Creek							
Sigourney East (M-67)	0	0.100	45[3]	38	2	2	4.0
Keokuk Co. Home (S-19)		0	Controlled Discharge				
German Creek							
Natural Gas Line Co. (I-25)	0	0.010	45	4	15	1	4.0
Skunk River							
Clear Creek							
Kaser Construction Co. Harper Quarry (I-11)			No Discharge Limitations Necessary[2]				
Dutch Creek							
Keota (M-30)	0	0.124	45[3]	47	15[3]	16	4.0
The River Products Co. Keota Quarry (I-27)			No Discharge Limitations Necessary[2]				

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Skunk River (cont.)							
Brighton (M-6)	14.66	0.048	45[3]	18	15[3]	6	4.0
West Fork Crooked Creek							
Kaser Construction Co. West Chester Quarry (I-15)			No Discharge Limitations Necessary[2]				
Washington (M-76)	0	1.360	20	227	3	34	4.0
Hidden Valley Mobile Home Park (S-9)		0	Controlled Discharge				
The River Products Co.-Young America Quarry (I-28)			No Discharge Limitations Necessary[2]				
East Fork Crooked Creek							
Winfield (M-82)	0	0.100	20	17	3	3	4.0
Crooked Creek							
Lake Trio Homeowner Assn. (S-20)		0	Controlled Discharge				
Cargill, Inc. (I-3)	1.42	0.282	No Discharge Limitations Necessary[2]				
Kaser Construction Co. Coppock Quarry (I-10)			No Discharge Limitations Necessary[2]				
Sugar Creek							
Wayland (M-77)		0	Controlled Discharge				
Walnut Creek							
Martin Marietta Anderson Quarry (I-18)			No Discharge Limitations Necessary[2]				

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Skunk River (cont.)							
Cedar Creek							
Fremont (M-18)		0			Controlled Discharge		
Coon Creek							
Packwood (M-54)		0			Controlled Discharge		
Mitchell Creek							
North American Rockwell Corp. (I-26)	0	0.080	No Discharge Limitations Necessary[2]				
Cedar Creek							
Fairfield (M-17)	0	1.600	20	267	2	27	5.0
Dexter Company (I-5)	0	0.025	No Discharge Limitations Necessary[2]				
Jefferson Co. Home (S-17)	0	0.005	45	2	15	0.6	4.0
Fish Creek							
Salem (M-65)		0			Controlled Discharge		
Big Creek							
Mt. Pleasant (M-41)	0	1.107	20	185	2	18	4.0
Green Valley Court, Inc. (S-7)		0			Controlled Discharge		
Mardan Mobile Home Park (S-26)		0			Controlled Discharge		
Mt. Pleasant Municipal Utilities (I-24)	0	0.010	No Discharge Limitations Necessary[2]				
Douds Stone Products, Inc. (I-6)			No Discharge Limitations Necessary[2]				
New London (M-44)	0	0.323	20	54	2	5	4.0

TABLE 18 (Cont.)

WASTE LOAD ALLOCATION

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

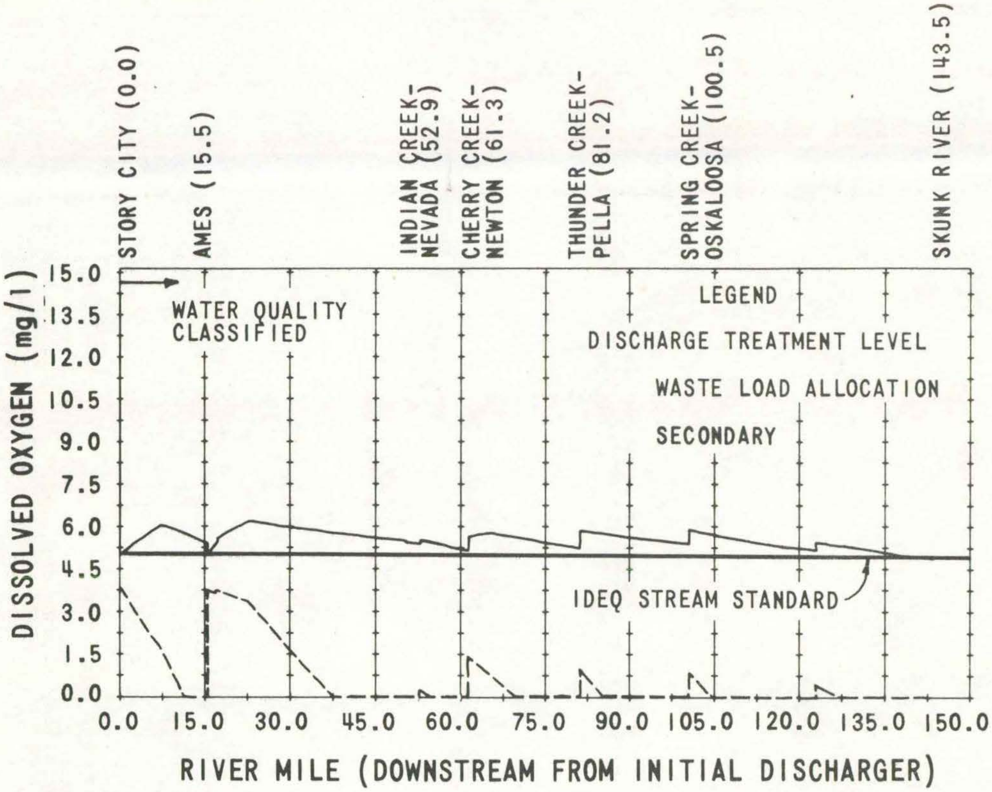
WINTER CONDITION

Discharger (Ref. No.)	Stream Flow (mgd)	1990 Discharge (mgd)	Ultimate BOD[1] (mg/l)	Ultimate BOD[1] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Skunk River (cont.)							
Long Creek							
Danville (M-13)		0	Controlled Discharge				
Brush Creek							
Medusa Aggregate Co. Heinold Quarry (I-23)			No Discharge Limitations Necessary[2]				
Middletown (M-83)	0	0.068	45[3]	26	15[3]	9	4.0
Iowa Ammunition Plant (I-8)	0	0.800	20	133	2	13	4.0

[1] Ultimate BOD = 1.5 (BOD_5).

[2] Discharge does not contain significant levels of BOD or ammonia nitrogen.

[3] Meet BPWTT guidelines. Higher discharge quantities could satisfy stream criteria.



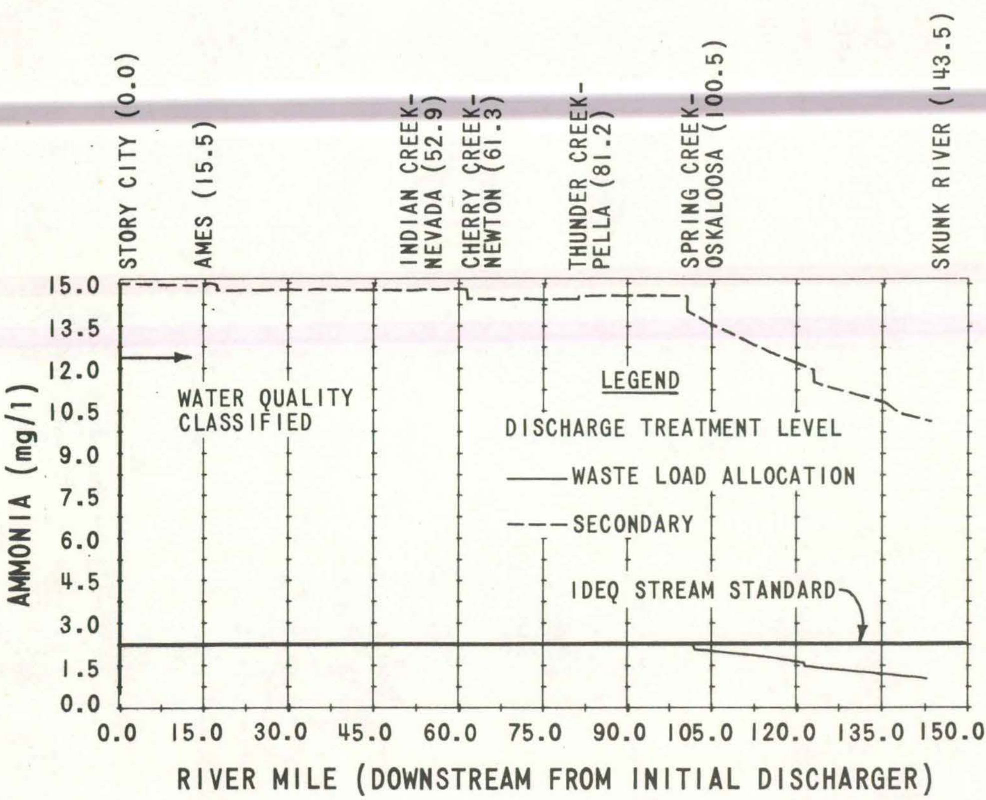
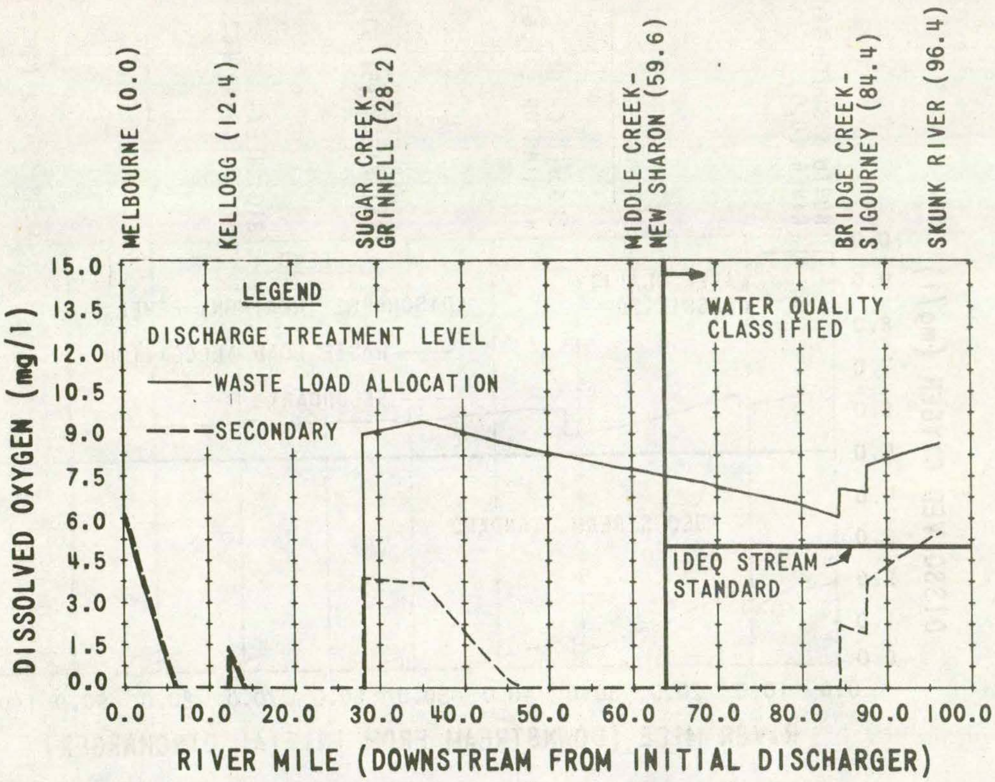
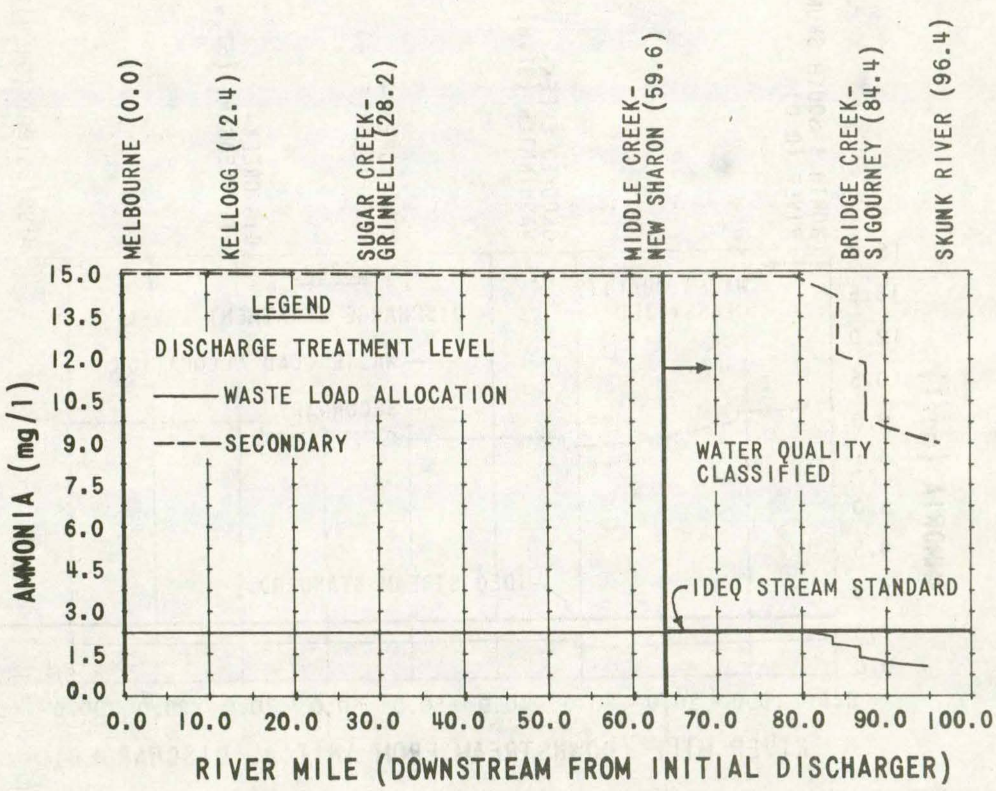
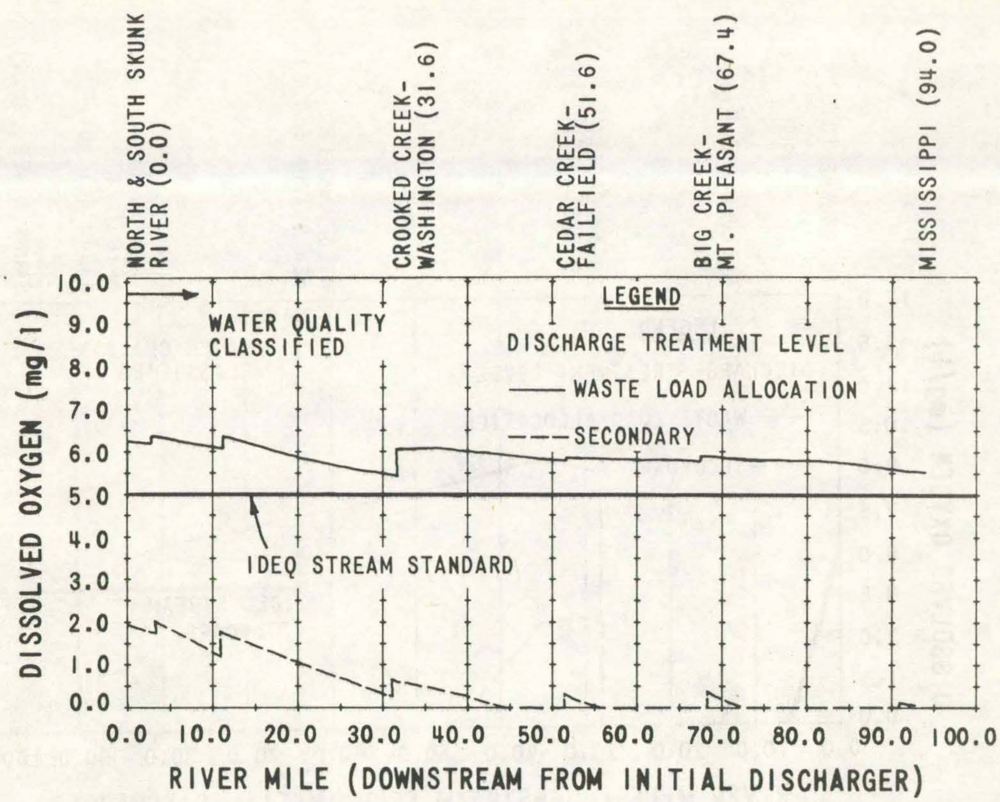


FIGURE 8
SOUTH SKUNK RIVER
WINTER CONDITION





FIGIRE 9
NORTH SKUNK RIVER
WINTER CONDITION



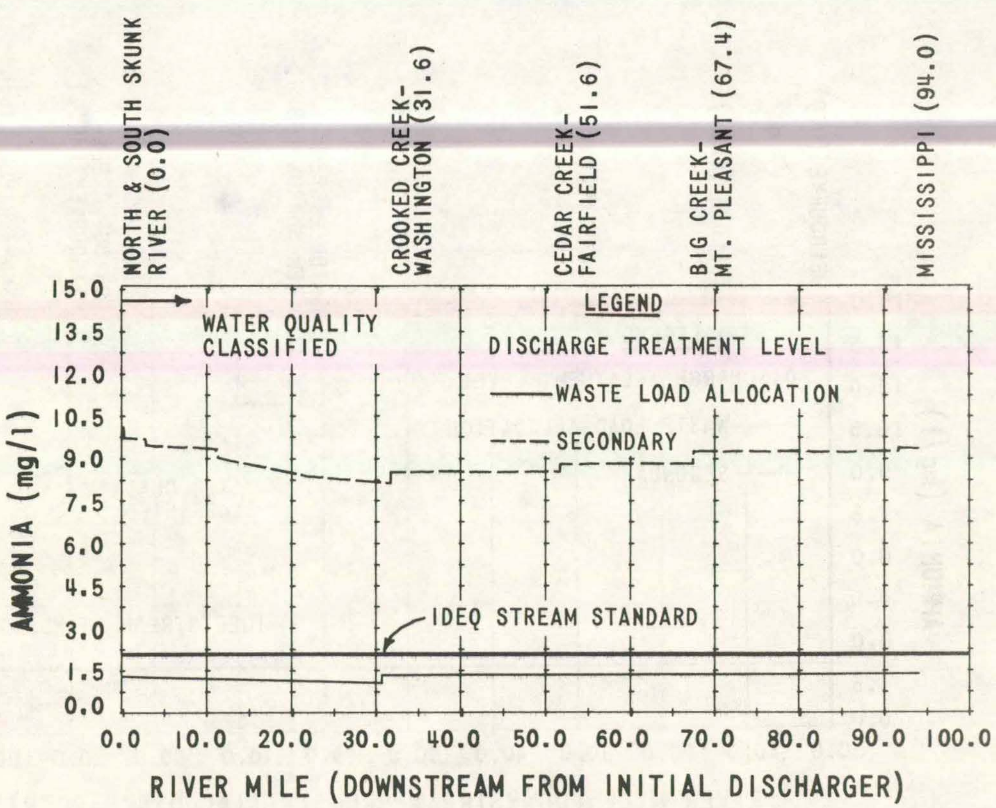


FIGURE 10
SKUNK RIVER
WINTER CONDITION

Waste Load Allocations for Non-regulated Substances

Within the Skunk River Basin, sludge discharges from potable water treatment plants are the main type of wastewater discharges which could have an impact upon the aquatic environment, but are not covered by water quality standards. The main pollutant constituent of these discharges is suspended solids, which is not covered by Iowa water quality standards. Identification of these discharges has not been done as they will be effluent limited and usually restricted to zero discharge.

Summary

Examination of Tables 17 and 18 shows that restrictions on allowable discharges of BOD_5 and ammonia nitrogen are more stringent under winter low flow conditions than summer. Factors which contribute to this condition are the winter ice cover which reduces reaeration of the stream and the absence of infiltration into the stream in most parts of the basin. Removal of ammonia nitrogen is particularly critical under winter low flow conditions because the pollutant is not being removed by biological oxidation at the low temperatures. Increased treatment levels above those required to meet secondary treatment are necessary for most municipalities during winter low flow conditions. During summer low flow conditions, most dischargers in the upstream portion of the basin will require treatment in addition to secondary treatment, while most dischargers in the downstream portion of the basin can meet water quality standards when providing secondary treatment.

Respectfully submitted,

STANLEY CONSULTANTS, INC.

By Bennett Reischauer
Bennett Reischauer

Approved by Robert L. Thoem
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
Robert L. Thoem

December 12, 1974   Reg. No. 5802

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