A REPORT FROM

The State Hygienic Laboratory

MEDICAL LABORATORIES BUILDING

THE UNIVERSITY OF IOWA
IOWA CITY, IOWA 52242

WATER QUALITY SURVEY OF THE CEDAR RIVER - CHARLES CITY AREA #79-13

Prepared for the Iowa Department on Environmental Quality by the University of Iowa Hygienic Laboratory.

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ABSTRACT

A water quality survey of the Cedar River from Floyd to Nashua, Iowa was conducted during September and October 1978. Previous water quality studies had indicated arsenic values substantially above background and trace amounts of an organic compound ortho-nitroaniline. The major purpose of this survey, therefore, was to attempt to identify the source or sources of the arsenic and ONA. Based on the usual assessed water quality parameters, general water quality in the reach under study was good. However, elevated levels of arsenic and ONA occurred in the Cedar River within and below Charles City. Salsbury Laboratories, manufacturer of veterinary pharmaceuticals, utilize both arsenic and ONA in their manufacturing processes and appear to be the only source of the chemicals in the Charles City area. The arsenic and ONA reach the Cedar River via (1) direct discharge to Wildwood Creek then to the Cedar River, (2) manufacturing, and process waste discharged to the municipal wastewater treatment plant and then discharged to the river and (3) leaching of solid waste material deposited in a landfill located in the Cedar River floodplain. Of the three, the major contributor of arsenic and ONA is the leachate from the landfill. Leaching of chemicals from the landfill is expected to continue varying with hydraulic conditions.

INTRODUCTION

The Cedar River originates near Hayfield, Minnesota, enters Iowa in Mitchell County and flows over 483 kilometers (300 miles) before it joins with the Iowa River at Columbus Junction. Cedar River fishing is excellent in the upper reaches for smallmouth bass (Micropterus dolomieni) and throughout the entire length for channel catfish (Ictalurus punctatus).

Several water quality studies (1-4) have been conducted on various segments of the Cedar River but only one on the upper reaches (5). Results of the previous upper Cedar River survey indicated generally good overall water quality with the exception of an elevated arsenic value observed downstream from Charles City. Since that survey, a substantial amount of arsenic and traces of an organic compound, ortho-nitroaniline (ONA), have been found in the Cedar River at Charles City and as far downstream as Vinton by the United States Environmental Protection Agency (USEPA) and the University Hygienic Laboratory. The primary purpose of this survey was to assess Cedar River water quality in the Charles City area in an attempt to more clearly define the source or sources of the arsenic and organic contamination. Two major suspected contributors of these substances are the municipal Wastewater Treatment Plant and a landfill located on the flood plain of the Cedar River. The landfill (also known as the LaBounty Site) has been used for disposal of waste materials from Salsbury Laboratories which manufactures chemicals used in veterinary pharmaceuticals. Several known hazardous substances (arsenic, phenol, ortho-nitroaniline, nitrobenzene, 1,1,2-trichloroethane) have been reported in the waste material of the landfill (6). As a result of the alluvial deposits associated with the flood plain, the potential for contamination of the river from the landfill exists. The municipal Wastewater Treatment Plant treats the industrial wastes generated by Salsbury Laboratories and has a relatively high arsenic level (averaging over 1 mg/l) in their final effluent.

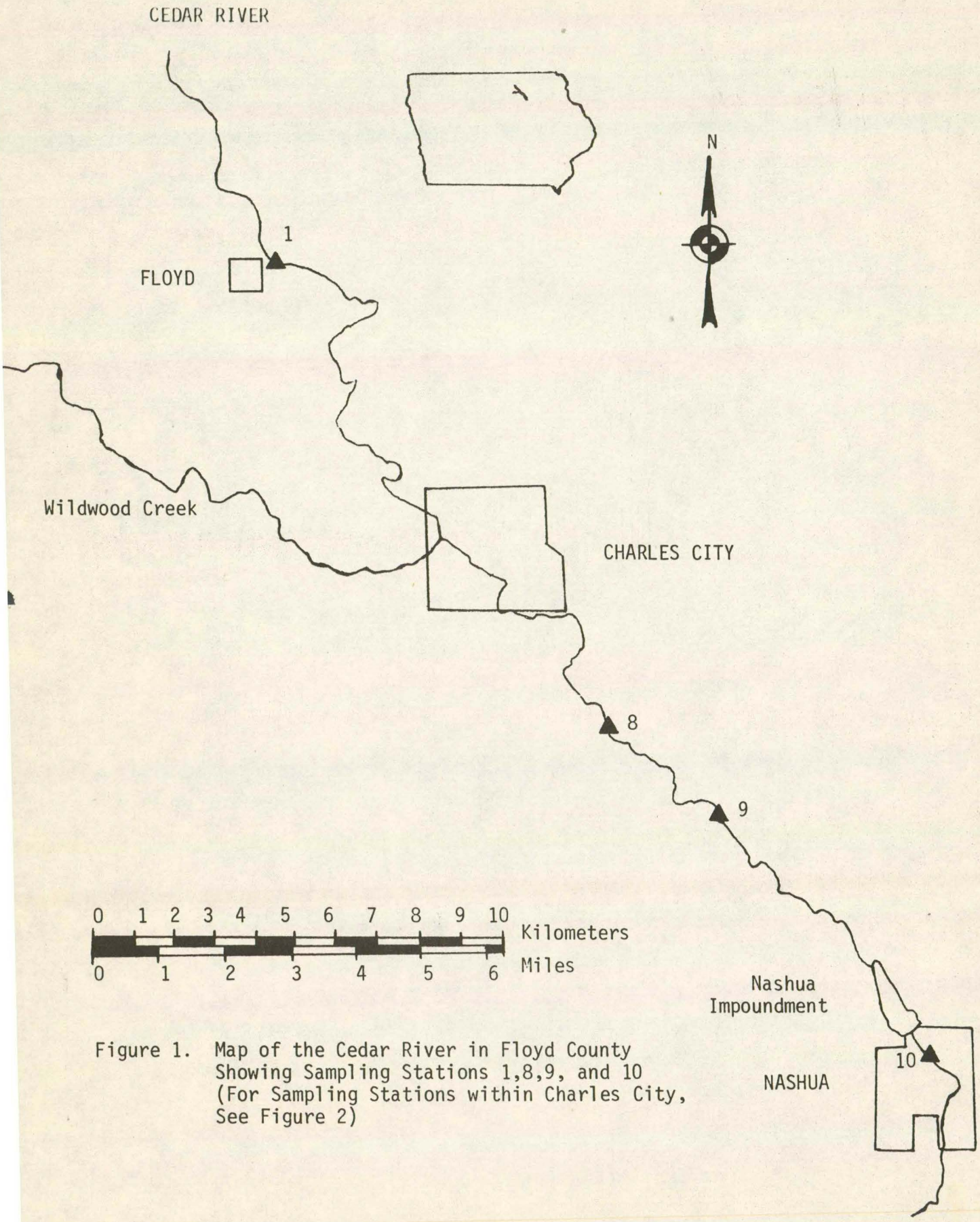

Figure 1. Map of the Cedar River in Floyd County Showing Sampling Stations 1,8,9, and 10 (For Sampling Stations within Charles City, See Figure 2)

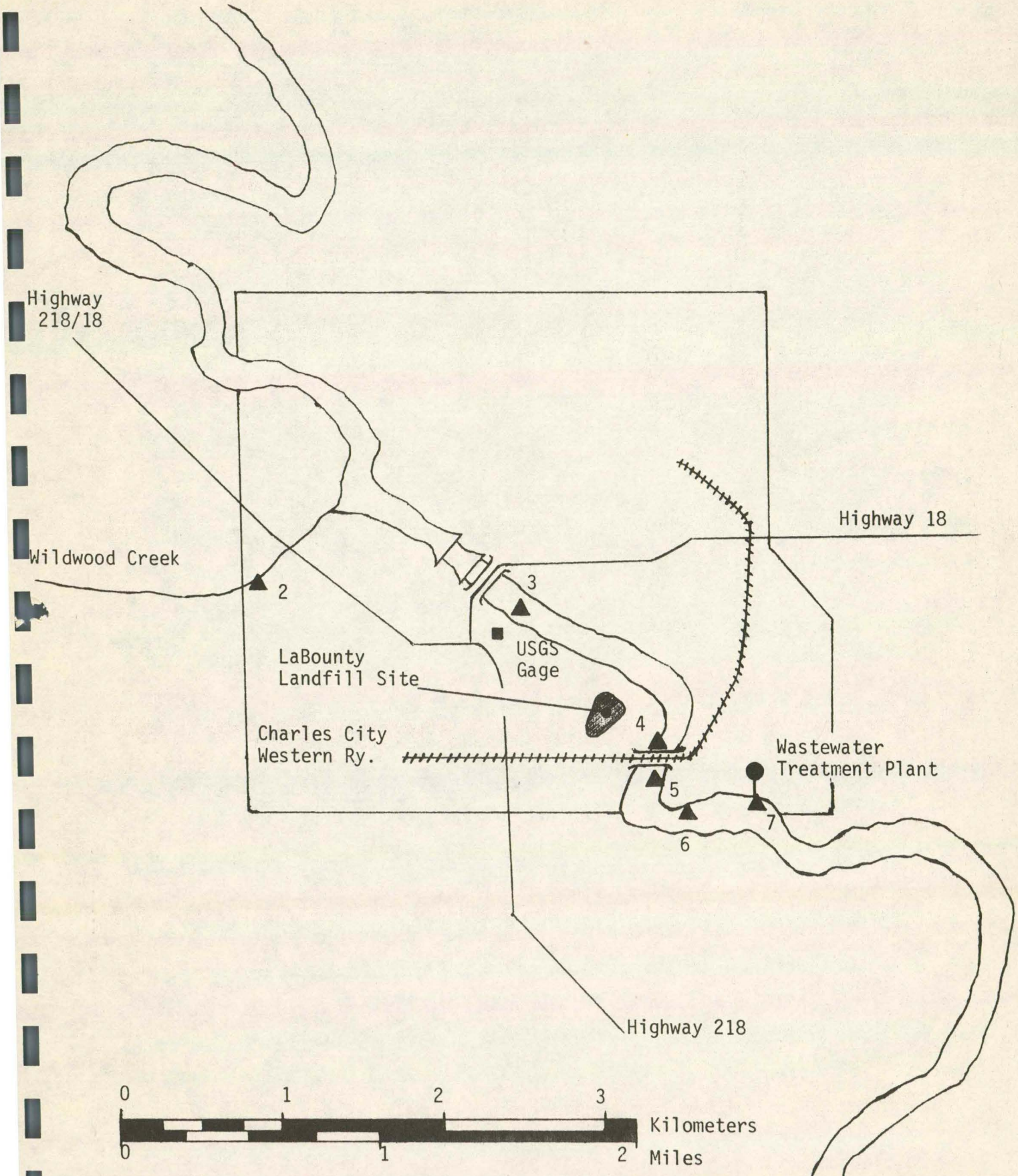

Figure 2. Map of the Cedar River in Charles City Showing Sampling Locations 2-7

TABLE 1

Cedar River Sampling Locations

September 11 and 12, 1978

	Station	Location
1.	Cedar River	3m (10') upstream from Floyd County Hwy 218 Bridge, R16W, T96N, Sec. 16, mid-channel.
2.	Wildwood Creek	Grove St., Charles City, Floyd County, R16W, T95N, Sec. 1, mid-channel.
3.	Cedar River	10m (33') downstream from USGS gage near Hwy 218, Charles City, Floyd County, R15W, T95N, Sec. 7, 4.5m (15') from right* edge of water.
4.	Cedar River	4.5m (15') upstream from Charles City Western Ry. Bridge, Charles City, Floyd County, R15W, T95N, Sec. 7, 4.5m (15') from left edge of water.
5.	Cedar River	100m (328') downstream of Charles City Western Ry. Bridge, Charles City, Floyd County, R15W, T95N, Sec. 7, 4.5m (15') from left edge of water.
6.	Cedar River	300m (984') upstream from Charles City WWTP final effluent, Charles City, Floyd County, R15W, T95N, Sec. 7, mid-channel.
7.	WWTP final effluent	Municipal WWTP, Charles City, Floyd County, R15W, T95N, Sec. 17, 4.8 km (3 mi.) downstream from Charles City WWTP.
8.	Cedar River	Near bend in Floyd Co. Rd., R15W, T95N, Sec. 20/21, 4.5m (15') from left edge of water.
9.	Cedar River	100m (328') upstream from Floyd Co. Rd. B-59 Bridge, R15W, T95N, Sec. 34, 4.5m (15') from left edge of water.
10.	Cedar River	125m (410') downstream from Nashua Impoundment, Nashua, Chickasaw County, R14W, T95N, Sec. 18, 4.5m (15') from right edge of water.

*Right and left edge of water when facing downstream

The study area for this survey was limited to a segment of the Cedar River from the town of Floyd to just below the dam at Nashua (see Figure 1). This reach has been designated by the Iowa Water Quality Standards as a class B waters and is to be protected for wildlife, fish, aquatic and semi-aquatic life and secondary contact water uses. In addition, the Nashua impoundment and the Charles City impoundment are designated as class A waters which are to be protected for primary contact water use.

Water samples were collected the week of September 11 and October 17, 1978. During the September sampling several stream flow measurements were made and a twenty-four hour dissolved oxygen, total organic carbon and arsenic study was conducted.

SAMPLING AND ANALYTICAL METHODOLOGY

Procedures used in sample collection, preservation and analysis were as described in Standard Methods (7) and Manual of Methods for Chemical Analysis of Water and Waste (8). Grab samples were collected using a high density polyethylene sampling bucket and a weighted stainless steel dissolved oxygen sampler. Composite samples were obtained by automated samplers (9) programmed to collect hourly samples over a twenty-four hour period. Stream flow measurements were conducted using the U.S. Geological Survey method of computing cross sectional area (10). A Price AA current meter and a top setting wading rod were used to measure velocity and depth.

RESULTS AND DISCUSSION

The September study was cut short as a result of heavy rains that occurred in the watershed. On September 11, when the study commenced, stream flow at the USGS Gage in Charles City was approximately 190 cubic feet per second (cfs) and remained at that level until late the evening of

September 12 at which time rainfall began. Stream flow at 0700 on September 13 was 610 cfs and was over 1100 cfs by 0800 on September 14. All September samples discussed in this report were collected prior to the September 12 rainfall.

Stream flow measurements were made at stations 1, 3 and 4 yielding values of 202 cfs, 195 cfs and 188 cfs respectively. The variation is typical of flow measurement with the station 3 value within 3% (within 5% is usually considered good) of the USGS gage station reading of 190 cfs. The calculated 7 day Q_{10} for Charles City is 38 cfs.

A twenty-four hour dissloved oxygen (DO) profile was conducted at six stations (1, 3, 4, 8, 9 and 10). Results (Table 2) were typical of most Iowa streams with the lowest values occurring around daybreak and the highest values in late afternoon and early evening. Station 10, below the dam at Nashua, had the lowest average of 6.5 mg/l. Normally, water flowing over a dam with a fifteen foot fall would exhibit DO values approaching 100% saturation. Using the 6.5 mg/l average for DO and 25^{o}C for average temperature, DO saturation was approximately 76%. At 25^{o}C, 100% saturation will be obtained at approximately 8.4 - 8.5 mg/l of dissolved oxygen. The shallow Nashua impoundment is rich in organic matter having a high oxygen demand and is most probably responsible for the lower DO observed at station 10.

In conjunction with the DO samples, samples were collected for total organic carbon (TOC) and arsenic (Tables 3 and 4). Total organic carbon exhibited a narrow range of values (5 - 15 mg/l) with the station below the Nashua impoundment having the highest average value (11 mg/l) while station 1 at Floyd had the lowest (6 mg/l).

Cedar River arsenic values (Table 4) demonstrated a more definite trend as compared to DO and TOC. Station 1 at Floyd had no reportable arsenic values. Station 3, located at the U.S. Geological Survey gaging station

TABLE 2

Twenty-Four Hour Dissolved Oxygen Profile
Cedar River
September 11 and 12, 1978

(All values in mg/l)

Station	0200	0600	1000	1400	2200	Range	Average
1	7.1	6.1	8.7	7.6	8.1	6.1-8.1	7.5
3	8.0	8.0	10.2	8.4	9.4	8.0-10.2	8.0
4	7.3	7.4	8.7	7.7	8.9	7.3-8.9	8.0
8	6.6	5.5	7.3	8.5	9.5	5.5-9.5	7.5
9	9.2	6.2	7.4	8.7	13.7	6.2-13.7	9.0
10	6.8	6.2	5.8	4.9	8.7	4.9-8.7	6.5
Average	7.5	6.6	8.0	7.6	9.7		

TABLE 3

Twenty-Four Hour Total Organic Carbon Data
Cedar River
September 11 and 12, 1978

(All values in mg/l)

Station	0200	0600	1000	1400	2200	Average
1	5	6	7	7	7	6
3	8	9	8	9	9	9
4	8	8	8	15	11	10
8	7	7	7	9	9	8
9	9	6	9	7	11	8
10	10	10	11	11	12	11

TABLE 4

Twenty-Four Hour Arsenic Profile
Cedar River
September 11 and 12, 1978

(All values in mg/l)

Station	0200	0600	1000	1400	2200	Average
1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3	0.02	0.02	0.02	0.02	0.02	0.02
4	0.06	0.06	0.08	0.05	0.04	0.06
8	0.05	0.03	0.03	0.04	0.04	0.04
9	0.04	0.04	0.03	0.03	0.04	0.04
10	0.05	0.03	0.04	0.05	0.04	0.04

station in Charles City, had an average value of 0.02 mg/l. Station 4 was located just downstream from the LaBounty Site and upstream of the municipal WWTP discharge. Arsenic values were highest at station 4, ranging from 0.04 to 0.08 mg/l and averaged 0.06 mg/l. Stations 8, 9 and 10 downstream from Charles City exhibited a fairly constant level of arsenic ranging from 0.03 to 0.05 and averaging 0.04 mg/l at all stations.

In a further attempt to identify the source or sources of arsenic and associated compounds a transect study was performed at stations 1, 3 and 4. At station 1 the river was flow divided equally and each half sampled for arsenic, TOC and phenol. Results are listed below. (Note: left edge and right edge of water are determined when facing downstream).

Cedar River
Station 1

September 12, 1978

	Right Half	Left Half
Arsenic	<0.01 mg/l	<0.01 mg/l
TOC	12 mg/l	8 mg/l
Phenol	2.9 µg/l	3.4 µg/l

All values at station 1 are low and considered background levels.

The river at station 3 was divided into three equal segments with samples collected from each segment.

Cedar River
Station 3

September 12, 1978

	Right One-Third	Middle One-Third	Left One-Third
Arsenic	0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Phenol	6.6 µg/l	1.7 µg/l	0.2 µg/l

The right one-third of the river at station 3 had slightly higher values than the other two-thirds. A seep or spring area at the river's right edge has been observed upstream from station 3. The origin of the spring has been speculated to be in the area of Salsbury Laboratories and at one time several years ago, Salsbury had a broken sewer line that drained into the underground spring (personal communication with superintendent of the Charles City WWTP). This spring area is most probably responsible for the elevated right one-third values.

Immediately downstream from the LaBounty Site (located on the right side of the river) the river was divided into 30 foot increments starting at the left edge of water. Water samples were collected at 5 - 30 foot intervals and one additional sample collected approximately six feet from the right edge of water. Results for those samples are listed below:

Cedar River
Station 4
September 12, 1978

	REW 176'	170'	150'	120'	90'	60'	30'	LEW 0'
Arsenic (mg/l)		0.12	0.07	0.05	0.02	<0.01	<0.01	
TOC (mg/l)		25	16	11	8	9	8	
Phenol (µg/l)		16	8.7	4.0	7.0	3.0	1.7	

As can be seen from the table, there is a definite gradient for arsenic, TOC and phenols from the left edge of water to the right edge. The arsenic value from the right river edge is in violation of the Iowa Water Quality Standards. There are no known waste dischargers located between stations 3 and 4 discharging arsenic; therefore, the LaBounty Landfill would appear to be the source. No surface runoff was occurring from the LaBounty Site during this sampling.

Twenty-four hour composite samples were collected at all ten stations for determining the presence of ONA. Results of those samples and grab samples collected at selected stations during the October 17 survey are reported below:

Ortho-nitroaniline Values for the Cedar River

September and October, 1978

(All values in parts per billion)

Station	September	October
1	<0.02	<0.03
2	0.67	Not Collected
3	4.6	Not Collected
4	12.0	21.5
5	0.20	0.91
6	3.2	Not Collected
7	0.26	Not Collected
8	8.5	21.4
9	0.77	Not Collected
10	<0.02	Not Collected
Plainfield*	Not Collected	19.6

*The Cedar River station at Plainfield is approximately 25 river miles downstream from Charles City.

The September ONA results are similar to the arsenic data. Essentially no ONA (less than 0.03 ppb) was found at station 1. A trace amount of ONA was observed in Wildwood Creek. Wildwood Creek reportably receives cooling water discharge from Salsbury Laboratories and, if so, is probably responsible for the Wildwood Creek value. Station 3, located upstream from the LaBounty Site, had a relatively high ONA value which may be originating from the spring area located just upstream. Immediately below the LaBounty Site (station 4 on the right bank) the ONA concentration was the greatest (12.0 ppb). It is noteworthy that during the survey, except for station 1 and 10, the Charles City Wastewater Treatment Plant final effluent had the lowest ONA concentrations of all stations.

TABLE 5

Selected Bacteriological and Chemical Data

Cedar River

October 17, 1978

(All values in mg/l unless indicated otherwise)

Station	Fecal Coliforms per 100 ml	pH	Specific Conductance*	Ammonia Nitrogen	Total Phosphate	BOD	COD	TOC	Chloride	Arsenic
1	10	8.9	590	0.01	0.15	2	22	8	30	<0.01
2	64	8.2	600	0.03	0.14	2	21	5	31	0.15
3	230	8.7	580	0.05	0.12	2	20	6	26	0.01
4	50	8.65	590	0.75	0.13	3	22	7	28	0.10
5	73	8.65	580	0.33	0.12	3	22	6	26	0.02
6	55	8.6	560	0.39	0.14	2	28	5	26	0.04
7	3,900,000	7.3	2300	21	6.2	80	368	130	480	3.2
8	600	8.6	580	0.06	0.14	3	28	10	27	0.05
9	250	8.5	580	0.07	0.13	3	28	9	33	0.04
10	<10	8.5	610	0.08	0.21	3	29	9	31	0.03

*Micromhos

The October 17 ONA sampling demonstrated a similar pattern with values much higher and not exhibiting the downstream decline. Stream flow during October was slightly higher (248 cfs) than the September study (190 cfs), therefore the increased ONA values are not a result of decreased flow.

On October 17, 1978 the Cedar River sampling stations were collected again. Stream flow at this time was approximately 248 cfs at the USGS gaging station (station 3). In addition to the previously mentioned sites, samples were collected from Wildwood Creek and the municipal WWTP. Data for October 17 are found in Table 5 . The general water quality parameters (arsenic not included) were in expected ranges and water quality appeared good. A review of the arsenic data indicates a violation of Iowa's arsenic standard at station 4 below the LaBounty Site and a relatively high value (0.15 mg/l) from Wildwood Creek (station 2). Wildwood Creek, as mentioned previously, receives cooling water discharge from Salsbury Laboratories and was probably responsible for the arsenic in Wildwood Creek. The remaining station exhibited the same general trend of consistent arsenic values (0.03 - 0.05 mg/l) downstream to Nashua. Monitoring of the Cedar River at station 9 has been conducted for several months with arsenic values ranging from 0.03 - 0.05 mg/l in all samples.

SUMMARY AND CONCLUSIONS

A water quality survey of the Cedar River above and below Charles City was conducted on September 11 and 12 and October 17, 1978. Most chemical and bacteriological parameters were within normal expected ranges for good water quality. Two notable exceptions were the increases in arsenic and orthonitroaniline levels within and below Charles City. Results of this study indicate that arsenic and ONA are reaching the Cedar River via (1) Wildwood Creek, (2) the final effluent from the municipal wastewater treatment plant, and (3) leaching of waste material from

the LaBounty Site. In all instances, the material leaching from the landfill has shown the highest levels and represents the major source of arsenic and ONA. Information to date indicates continuous and persistent arsenic and ONA levels in the Cedar River downstream from Charles City. Based on current information, chemical lechates from the LaBounty landfill are expected to continue.

Jack O. Kennedy
Limnologist

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APPENDIX

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

Town	Floyd	Charles City	Charles City
Source	Cedar River	Wildwood Creek	Cedar River
Specific Location	Hwy 218 bridge, station 1	Wildwood Country Club, station 2	USGS gage, station 3
Date Collected	10/17/78	10/17/78	10/17/78
Date Received	10/18/78	10/18/78	10/18/78
Lab Number	2431	2432	2433
	FIELD DATA		
Collection Time	1630	1610	1600
pH			
Temperature	10°C	9°C	10°C
Dissolved Oxygen			
	BACTERIOLOGICAL EXAMINATION		
Fecal Coliform/100 ml	10	64	230
	CHEMICAL ANALYSIS (as mg/l unless designated otherwise)		
Conductance (micromhos)	590	600	580
MBAS (as LAS)			
pH (units)	8.9	8.2	8.7
Alkalinity: P	34.6	none	20.8
T	225	203	221
NITROGEN: Organic N	0.27	0.12	0.34
Ammonia N	0.01	0.03	0.05
Nitrite N			
Nitrate N	3.6	8.9	3.6
Nitrate as NO_3			
RESIDUE: Total	354	390	382
Fixed	274	298	296
Volatile	80	92	86
Filtrable Residue T	354	390	374
F	274	298	296
V	80	92	78
Nonfiltrable Residue T	0	0	8
F	0	0	0
V	0	0	8
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	0.14	0.11	0.12
Total P	0.15	0.14	0.12
Dissolved Oxygen	19.5	12.7	13.3
BOD	2	2	2
COD	22	21	20
Grease or Oil			
Turbidity (JTU)	2.4	2.0	5.1
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	30	31	26
Sulfate (SO_4^{--})			
Arsenic	<0.01	0.15	0.01
otal Organic Carbon	8	5	6

REMARKS:

COLLECTOR Limnology Division
REPORT TO UHL, Des Moines Branch

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

Town	Charles City	Charles City	Charles City
Source	Cedar River	Cedar River	Cedar River
Specific Location	West bank RR bridge, station 4	E bank RR bridge, station 5	Koebricks, station 6
Date Collected	10/17/78	10/17/78	10/17/78
Date Received	10/18/78	10/18/78	10/18/78
Lab Number	2434	2435	2436
	FIELD DATA		
Collection Time	1545	1505	1530
pH			
Temperature	10°C	10°C	10°C
Dissolved Oxygen			
	BACTERIOLOGICAL EXAMINATION		
Fecal Coliform/100 ml	50	73	55
	CHEMICAL ANALYSIS (as mg/l unless designated otherwise)		
Conductance (micromhos)	590	580	560
MBAS (as LAS)			
pH (units)	8.65	8.65	8.7
Alkalinity: P	19.2	18.0	15.6
T	221	219	219
NITROGEN: Organic N	0.10	0.01	0.04
Ammonia N	0.75	0.33	0.39
Nitrite N			
Nitrate N	3.6	3.5	3.6
Nitrate as NO_3			
RESIDUE: Total	386	382	342
Fixed	282	298	274
Volatile	104	84	68
Filtrable Residue T	380	374	336
F	282	296	274
V	98	78	62
Nonfiltrable Residue T	6	8	6
F	0	2	0
V	6	6	6
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	0.12	0.12	0.14
Total P	0.13	0.12	0.14
Dissolved Oxygen		15.1	14.7
BOD	3	3	2
COD	22	22	28
Grease or Oil			
Turbidity (JTU)	5.0	5.4	4.9
otal Organic Carbon	7	6	5
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	28	26	26
Sulfate (SO_4^{--})			
Arsenic	0.10	0.02	0.04
or at pH 7.6:			
minant Wave Length			none
ie			colorless
minance			100%
rity			0%

COLLECTOR Limnology Division
REPORT TO UHL, Des Moines Branch

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

Town	Charles City		Carville
Source	WWTP	Cedar River	Cedar River
Specific Location	Station 7	Floyd Co. (YMCA), station 8	Floyd Co. B-59, station 9
Date Collected	10/17/78	10/17/78	10/17/78
Date Received	10/18/78	10/18/78	10/18/78
Lab Number	2437	2438	2439
FIELD DATA			
Collection Time	1445	1430	1415
pH			
Temperature	17°C	10°C	10°C
Dissolved Oxygen			
BACTERIOLOGICAL EXAMINATION			
Fecal Coliform/100 ml	3,900,000	600	250
CHEMICAL ANALYSIS (as mg/l unless designated otherwise)			
Conductance (micromhos)	2300	580	580
MBAS (as LAS)			
pH (units)	7.3	8.6	8.5
Alkalinity: P	none	18.0	8.6
T	228	218	219
NITROGEN: Organic N	17	0.49	0.31
Ammonia N	21	0.06	0.07
Nitrite N			
Nitrate N	0.1	3.4	3.5
Nitrate as NO_3			
RESIDUE: Total	1430	360	366
Fixed	1260	270	244
Volatile	170	90	122
Filtrable Residue T	1380	360	366
F	2160	270	244
V	120	90	122
Nonfiltrable Residue T	54	0	0
F	2	0	0
V	52	0	0
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	5.3	0.14	0.12
Total P	6.2	0.14	0.13
Dissolved Oxygen		17.1	13.6
BOD	80	3	3
COD	368	28	28
Grease or Oil			
Turbidity (JTU)	21	3.3	3.0
Total Organic Carbon	130	10	9
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	480	33	27
Arsenic	3.2	0.05	0.04
Color	pH 6.9:	pH 7.6:	pH 7.6:*
Dominant Wave Length	571 mm	573 mm	580 mm
	Greenish/yellow	Greenish/yellow	Yellow
Dominance	98%	93%	95%
Purity	11%	13%	1.5%

*Color was borderline on minimum detectable range for dominant wave length, hue, purity.

COLLECTOR

REPORT TO Limnology Division
UHL, Des Moines Branch

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

WATER QUALITY REPORT

STATE HYGIENIC LABORATORY, Des Moines Branch
H.A. WALLACE BUILDING
DES MOINES, IOWA 50309

Town	Nashua		
Source	Cedar River		
Specific Location	Downstream from Cedar Lake Dam, station 10		
Date Collected	10/17/78		
Date Received	10/18/78		
Lab Number	2440		
Collection Time	1400	FIELD DATA	
pH			
Temperature	9°C		
Dissolved Oxygen			
	BACTERIOLOGICAL EXAMINATION		
Fecal Coliform/100 ml	<10		
	CHEMICAL ANALYSIS (as mg/l unless designated otherwise)		
Conductance (micromhos)	610		
MBAS (as LAS)			
pH (units)	8.5		
Alkalinity: P	7.0		
T	223		
NITROGEN: Organic N	0.81		
Ammonia N	0.08		
Nitrite N			
Nitrate N	3.7		
Nitrate as NO_3			
RESIDUE: Total	408		
Fixed	316		
Volatile	92		
Filtrable Residue T	356		
F	274		
V	82		
Nonfiltrable Residue T	52		
F	42		
V	10		
Settleable Matter (ml/l)			
PHOSPHATE: Filtrable P	0.21		
Total P	0.21		
Dissolved Oxygen	12.4		
BOD	3		
COD	29		
Grease or Oil			
Turbidity (JTU)	25		
Total Hardness (as $CaCO_3$)			
Calcium (Ca^{++})			
Magnesium (Mg^{++})			
Chloride (Cl^-)	31		
Sulfate (SO_4^{--})			
Arsenic	0.03		
Total Organic Carbon	9		

REMARKS:

COLLECTOR REPORT TO: Limnology Division, UHL, Des Moines Branch

W.J. HAUSLER, JR., Ph.D.
DIRECTOR

DEC 04 1978