

**YELLOWSTONE NATIONAL PARK
BASELINE WATER QUALITY SURVEY REPORT**

**ENVIRONMENTAL PROTECTION AGENCY
REGIONS VII AND VIII
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ABSTRACT

The report summarizes and evaluates water quality data obtained from the May 1970 to September 1970 investigation of the surface waters of Yellowstone National Park. Water quality analyses were made at some 100 sites located in and adjacent to the Park. The report presents physical, chemical, biological, microbiological, radiological and pesticides data. Causes and effects of water quality changes are evaluated and recommendations are made for actions to preserve and enhance existing conditions.

14. Traces of chlorinated hydrocarbon pesticides were detected in the Snake, Madison, and Yellowstone Rivers. The maximum levels found did not exceed those background values found in other areas of minimal pesticides use.

RECOMMENDATIONS

1. A water quality monitoring system and data collection program should be instituted to detect changes in quality resulting from man's use of the Park.

2. Water quality standards should be established to assure that the waters of the Park are maintained in their natural state. Standards are needed to provide the legal framework for preserving the waters from pollution flowing into the Park from sources located outside the Park boundaries. The basic policy of the standards should be non-degradation.

3. Coordinated comprehensive regional planning should be carried out to minimize the environmental impact of visitor use on the Park and surrounding public and private lands.

4. No additional developments of visitor facilities should be made without a detailed assessment of the potential impact on the natural environment of the Park.

5. Project planning should be finalized and construction initiated at an early date in order to implement the wastewater treatment facilities improvement program outlined for the Park.

6. Wastewater treatment works should have backup systems to minimize interruptions in operation due to mechanical and electrical system malfunctions. Adequate supplies of spare parts should be maintained for electrical and mechanical equipment.

7. Increased emphasis should be placed on operation and maintenance of the wastewater treatment facilities. Additional qualified personnel should be provided to achieve active supervision of the treatment works. Operating personnel should be trained in the basic fundamentals of wastewater treatment.

8. Elimination of the direct discharges to Yellowstone Lake should be expedited. Results of the monitoring program should be evaluated periodically to determine the effectiveness of evaporation-percolation lagoons. If the lagoons are ineffective then other alternatives for disposal should be evaluated, e.g., spray irrigation or tertiary treatment of effluent.

9. A policy of water conservation should be adopted to reduce to a minimum the quantity of wastewater to be treated and discharged.

10. Routine activities in the Park which can cause damage or disrupt the natural environment such as road maintenance, fueling of motorboats, and disposal of boat wastes should receive critical review by the Park Service.

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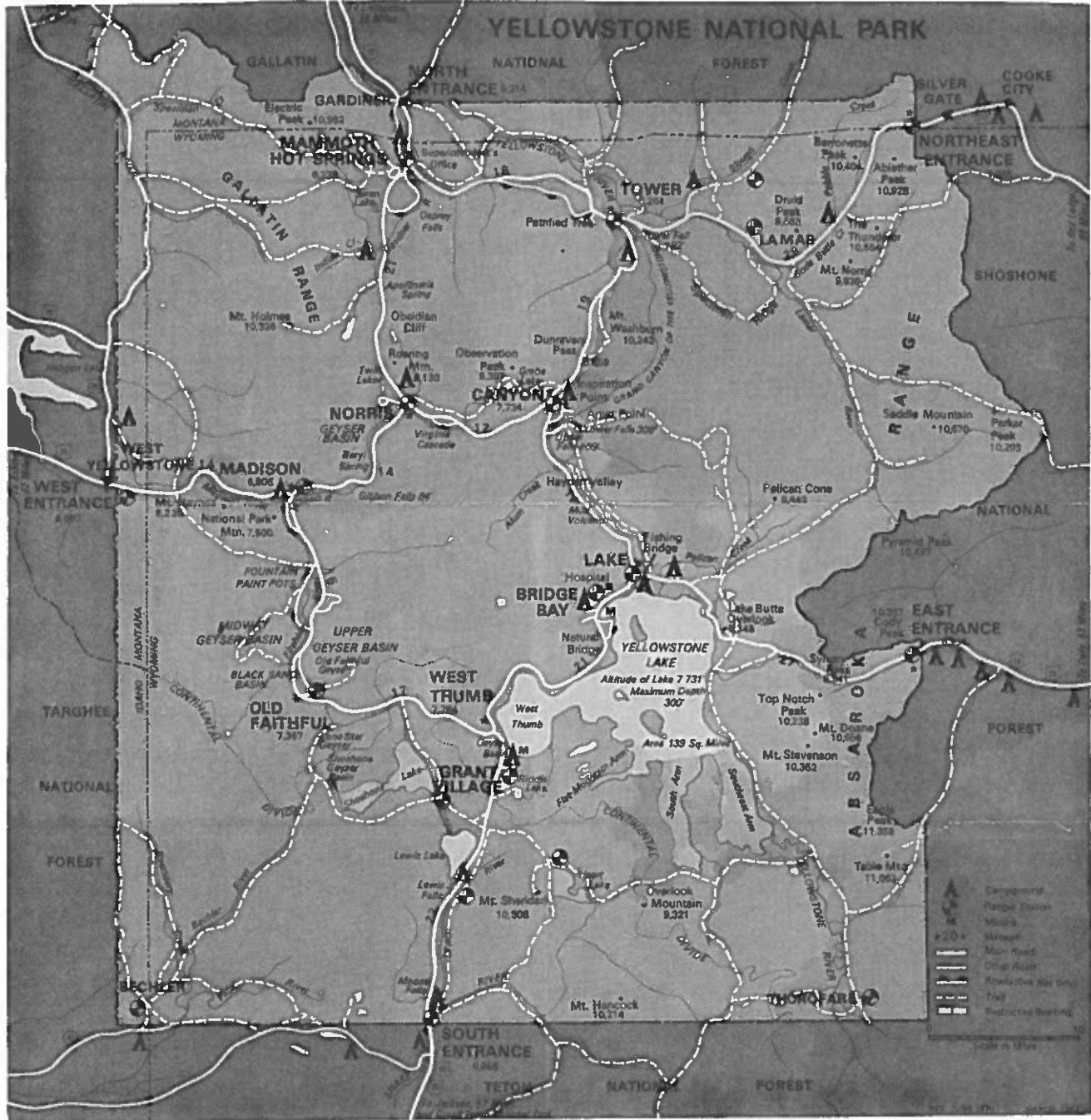
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DESCRIPTION OF AREA

PHYSICAL

The world's first national park, Yellowstone, is a wonderland of geysers, hot springs, mud volcanos, canyons, and a wildlife display unsurpassed in the United States. The Park was established on March 1, 1872, and now contains about 3,400 square miles in the northwest corner of Wyoming, overlapping into Montana on the north and west, and Idaho, on the west and south.

The Park is characterized by several broad, forested volcanic plateaus. Elevations range from 5,000 feet near Gardiner to 11,358 feet at Eagle Peak in the southeastern corner. The plateaus of Yellowstone, as are seen today, were formed from great flows of lava that spread outward to the foothills of the surrounding mountain ranges, and then accumulated to depths of nearly 6,000 feet. The area is undulating and broken by abrupt escarpments and long table-like ridges of steeply inclined rocks. Deep canyons and gorges also cut the plateau and penetrate nearly to the base of the accumulated lavas. The foothills, contrasting with the plateaus, provide a more broken character with inter-mountain valleys becoming deeper and gradually growing rougher until the higher summit of the ranges present an array of crags and precipices reaching 2,000 to 4,000 feet above the enclosed tableland.

The Park is bordered on the north by mountains of the Beartooth Range, to the east by the Absaroka Range, to the south by the high rolling foothills of the Wind River Range, to the southwest by the Teton Range, and to the northwest by the Gallatin Range. The Continental Divide traverses the region in a southeasterly to northwesterly line beginning near the headwaters of the Yellowstone River and running to the west boundary of the Park at the Montana-Idaho State line.

About eighty-two percent of the Park is forested, ten percent grassland and eight percent nonvegetated. Nearly all trees are conifer with about seventy-five percent being lodgepole pine.

Visitors number over 2 million annually. Most of the visitations occur between May 15 and September 15. Visitor accommodation facilities have been developed at Bridge Bay, Canyon Village, Fishing Bridge, Grant Village, Lake, Madison Junction, Mammoth Hot Springs, Norris Junction, Old Faithful, Tower Falls, and West Thumb.

CLIMATE

Weather extremes in Yellowstone have ranged from a recorded high of 98 degrees to a low of 66 degrees below zero. Summer temperatures generally range from 50 degrees at night into the 70's in the daytime. However, freezing temperatures have been recorded at all stations during all months of the year. Precipitation averages about 25 inches per year, mostly in the form of snow. Snowfall varies with the elevation, those areas along the Continental Divide and on the Absaroka Range along the East boundary getting 200 to 400 inches, and the Mammoth area at 6,000 feet receiving only about 90 inches. Climate in the park area, especially at the higher elevations would be "moderate subpolar," according to the system of Koeppel.^{1/}

During the 1970 survey period the existing conditions closely approximated the climatic average. Details of the temperature and precipitation during the 1970 survey period are shown in Table 1.

HYDROLOGY

Much of the headwaters areas of the Snake and Missouri River systems lie within the boundaries of Yellowstone Park. In an average year nearly 3 3/4 million acre-feet of water leave the Park boundaries in the surface streams. Of this 3 3/4 million acre-feet, 2.2 million flow in the Yellowstone River, 0.6 million in the Snake River and 0.9 million in the Madison-Gallatin River systems to the Missouri River. Most of the smaller streams in the Park originate from snowmelt entirely and hence freeze completely during the winter months. Typical average annual hydrographs for selected streams in the basin are shown as Figures 1, 2, and 3.

During the course of the survey the average monthly flows at the flow measurement stations ranged from 100.7 percent to 146.6 percent of the long-term average monthly flows. However, this departure from normal is not considered to be excessive and the data, as gathered during the 1970 survey, should be characteristic for all streams within the Park. Daily flow levels for typical stations, Madison River at West Yellowstone and Yellowstone River at Corwin Springs, for the period of the survey are plotted on the following pages (Figures 4 and 5). These flows indicate a slow gradual thaw already in progress on May 1 and continuing until after the 20th of May when rising temperatures caused melting rates to increase. During the last week of May, when a set of general chemical samples were collected, the Madison River was in flood stage in the Park. At this time all other streams appeared to also be experiencing maximum runoff levels.

TABLE 1

SUMMARY OF CLIMATIC CONDITIONS - DURING 1970 WATER QUALITY INVESTIGATION

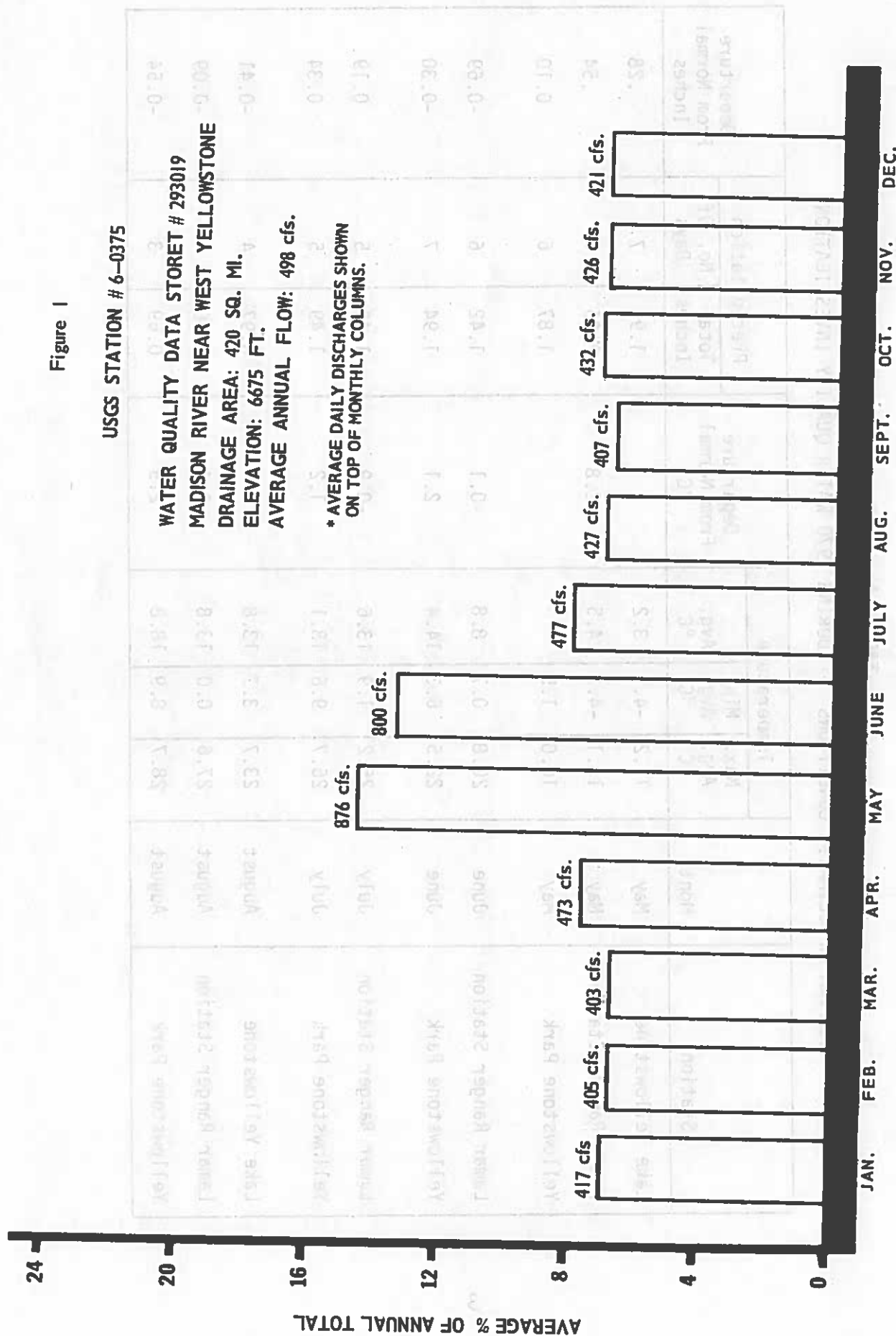
Station	Month	Temperature			Departure From Normal °C	Precipitation		Departure From Normal Inches
		Max. Avg. °C	Min. Avg. °C	Avg. °C		Total Inches	No. Of Days	
Lake Yellowstone	May	12.2	-4.8	3.2		1.92	7	.28
Lamar Ranger Station	May	13.1	-4.3	4.5	-2.8	2.05	7	.54
Yellowstone Park	May	16.0	1.5			1.87	6	0.10
Lamar Ranger Station	June	20.8	0.7	8.8	-0.1	1.42	6	-0.69
Yellowstone Park	June	22.5	6.3	14.4	2.1	1.94	7	-0.30
Lamar Ranger Station	July	25.2	1.9	13.6	-0.9	1.45	5	0.19
Yellowstone Park	July	26.7	9.6	18.1	1.2	1.49	5	0.34
Lake Yellowstone	August	23.7	3.7	13.8		0.97	4	-0.41
Lamar Ranger Station	August	27.6	0.0	13.8	0.4	1.20	4	-0.09
Yellowstone Park	August	28.7	8.9	18.8	2.9	0.69	3	-0.54

Figure 1

USGS STATION # 6-0375

WATER QUALITY DATA STORET # 293019
MADISON RIVER NEAR WEST YELLOWSTONE
DRAINAGE AREA: 420 SQ. MI.
ELEVATION: 6675 FT.
AVERAGE ANNUAL FLOW: 498 cfs.

* AVERAGE DAILY DISCHARGES SHOWN
ON TOP OF MONTHLY COLUMNS.



USGS STATION # 6-1865

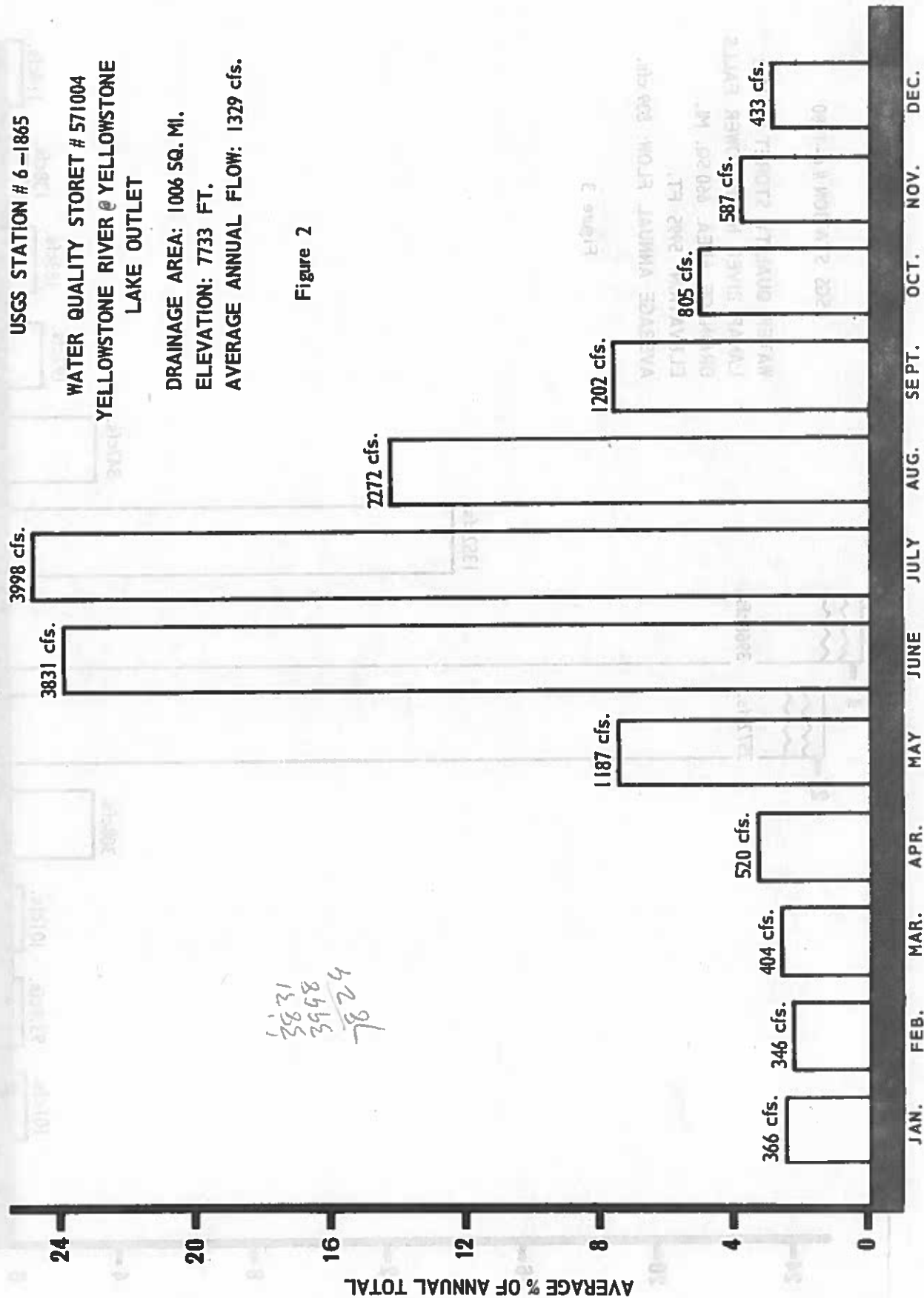
WATER QUALITY STORET # 571004
YELLOWSTONE RIVER @ YELLOWSTONE
LAKE OUTLET

DRAINAGE AREA: 1006 SQ. MI.

ELEVATION: 7733 FT.

AVERAGE ANNUAL FLOW: 1329 cfs.

Figure 2

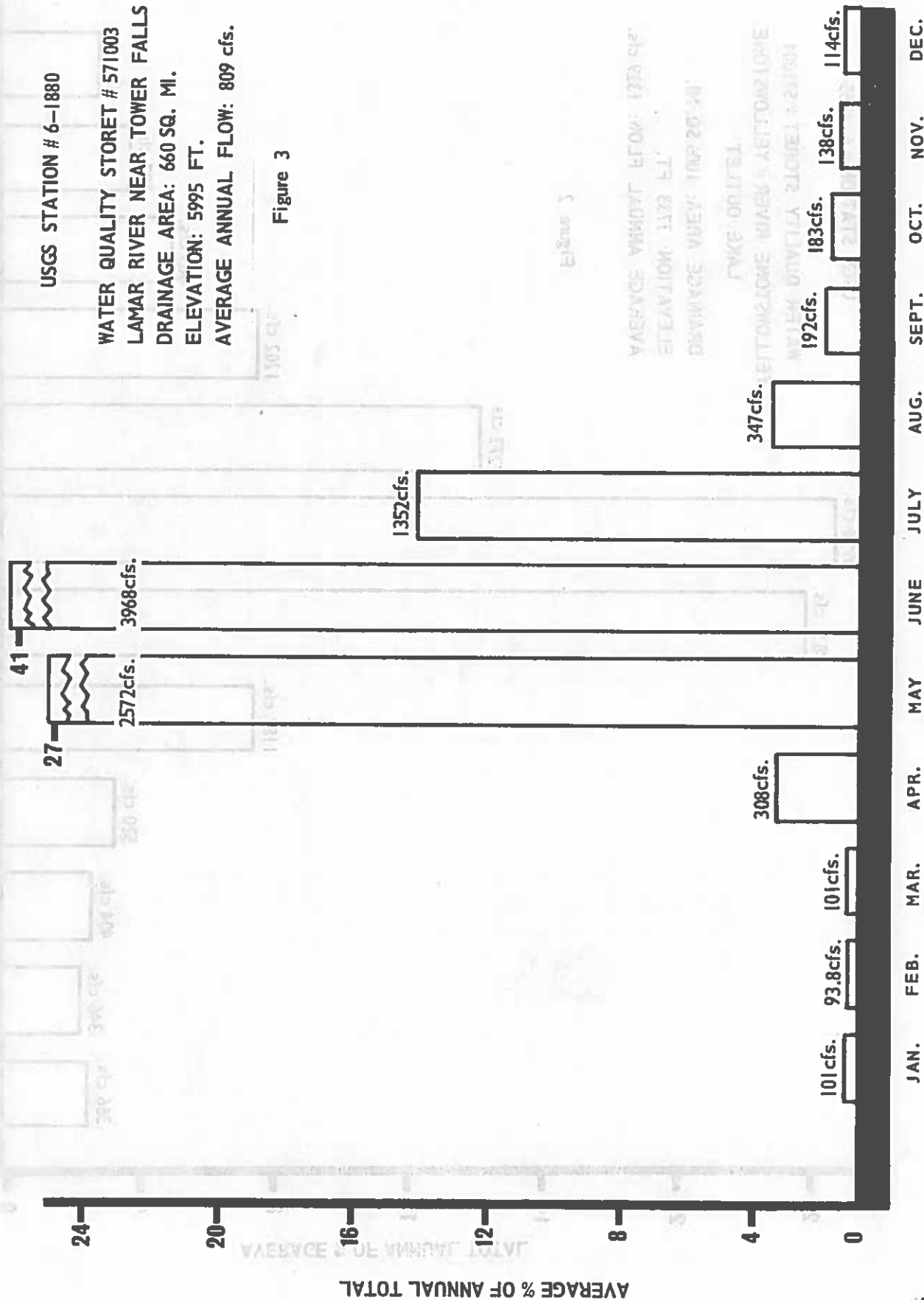


3831
3998
7829

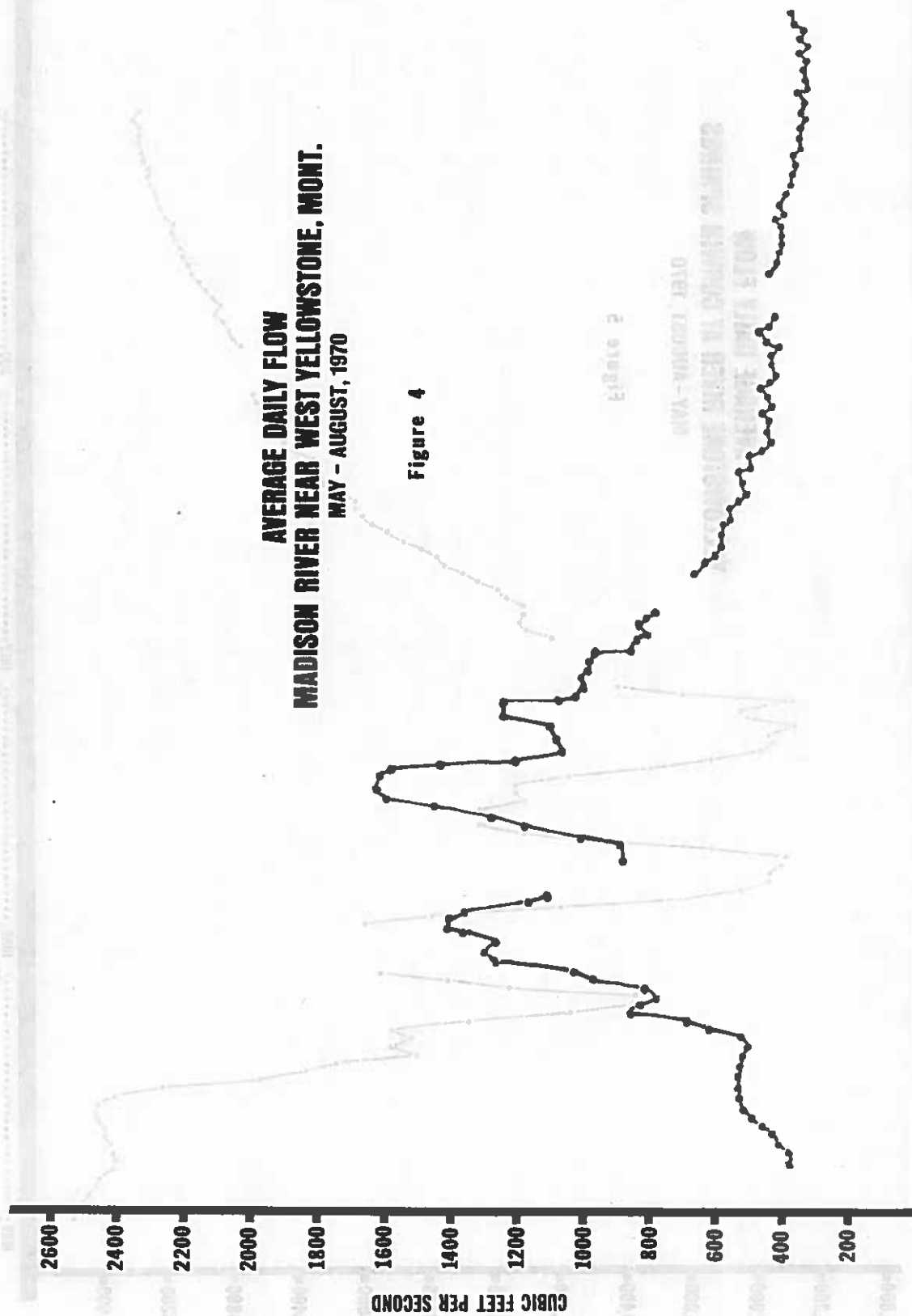
USGS STATION # 6-1880

WATER QUALITY STORET # 571003
 LAMAR RIVER NEAR TOWER FALLS
 DRAINAGE AREA: 660 SQ. MI.
 ELEVATION: 5995 FT.
 AVERAGE ANNUAL FLOW: 809 cfs.

Figure 3



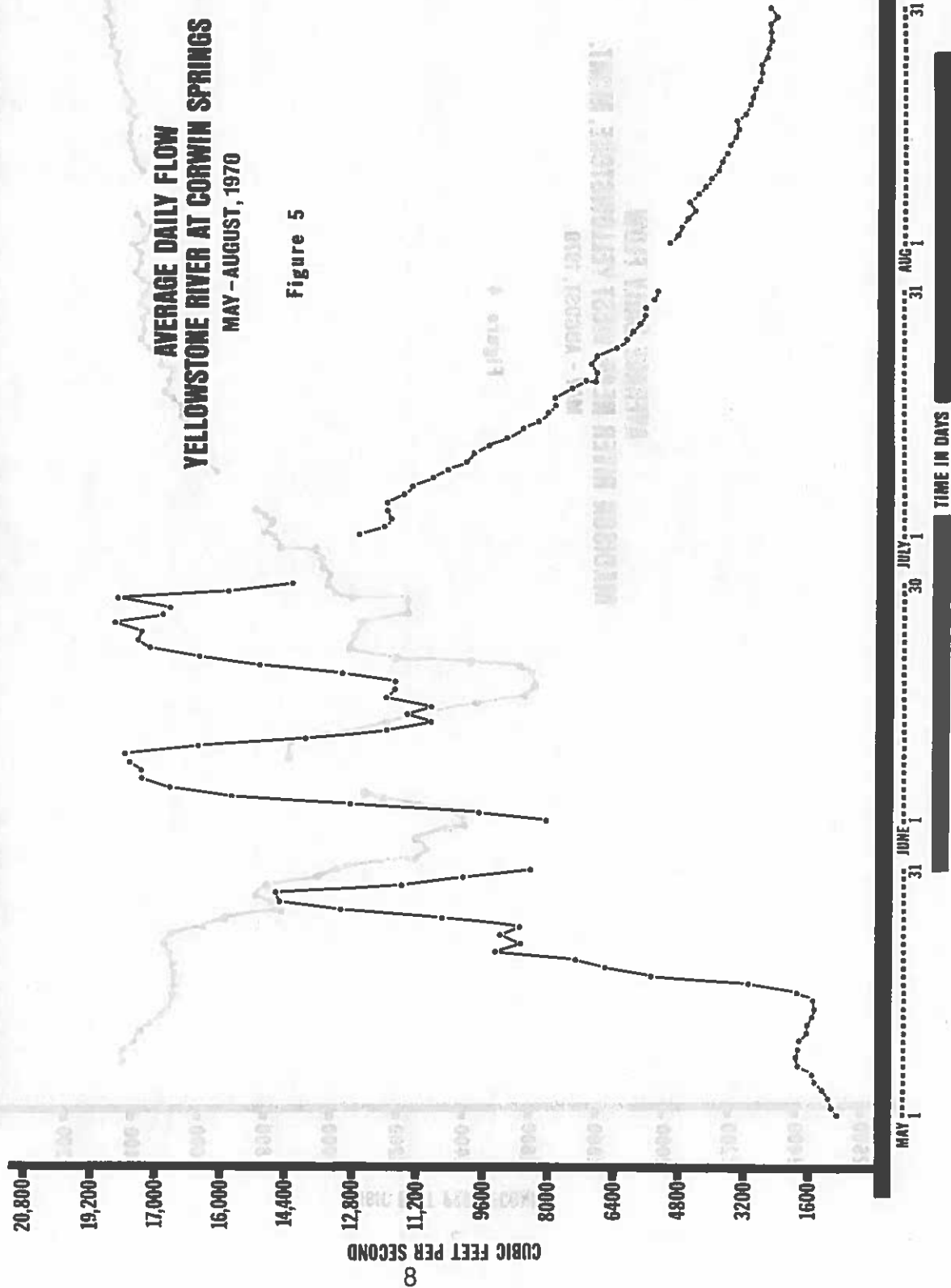
11-4



**AVERAGE DAILY FLOW
MADISON RIVER NEAR WEST YELLOWSTONE, MONT.
MAY - AUGUST, 1970**

Figure 4

MAY 1 JUNE 1 JULY 1 AUG 1 31
 31 30 31
 TIME IN DAYS



During the latter portion of the survey in July and August, flows were uniform and within twenty percent of the long-term average for that time of the year.

Data from the following flow measurement stations operated by the U.S. Geological Survey are of value in evaluating surface waters in the Park area:

<u>USGS STATION NUMBER</u>	<u>LOCATION</u>
6-0375	Madison River near West Yellowstone
6-0435	Gallatin River near Gallatin Gateway
6-1865	Yellowstone Lake at Yellowstone Lake Outlet
6-1870	Yellowstone River near Canyon Hotel
6-1880	Lamar River near Tower Falls Ranger Station
6-1910	Gardner River near Mammoth Hot Springs
6-1915	Yellowstone River at Corwin Springs, Montana
13-0475	Falls River near Squirrel, Idaho
13-0460	Henry's Fork near Ashton, Idaho

Yellowstone Lake, Shoshone Lake, Lewis Lake and Heart Lake are the largest of the numerous lakes and ponds found in the Park. Yellowstone Lake, with a surface area of 139 square miles at an altitude of 7,730 feet, is the largest body of water at such an altitude in the North American Continent. The maximum depth of Yellowstone Lake is 300 feet.

Nowhere else in the world is there such a concentration of geyser phenomena as is found in Yellowstone Park where there are more than 10,000 thermal features. The geysers, hot springs, fumaroles, pots, and terraces are the most extensive and spectacular in the world.

DISCUSSION OF RESULTS

The quality characteristics of the waters within Yellowstone National Park are unique due to the naturally occurring geothermal phenomena of the region. The unique chemical and physical characteristics of the waters along

with the unique biological communities of the Park set the waters of the Park apart from other waters in the world. The mandate expressed by Congress in the establishment of Yellowstone Park requires that the natural resources of the Park be preserved in their natural condition. An evaluation of water quality must take into account the uniqueness of the water resources and the charge to preserve the water quality in its natural state.

Generally speaking, water quality in the study area is excellent. No areas of major man-caused water quality degradation can be identified, except in the headwaters of Soda Butte Creek where the effects of past mining activity has resulted in excessive discharge of sediment and toxic metals. The fact that no major degradation was noted, however, does not mean that incremental changes too small to be measured are not taking place, especially in waters receiving discharges from waste water treatment plants. Additionally, water quality data collected to date are not adequate to fully describe the complex variations in the aquatic environment.

Due to a lack of long-term data it is difficult to evaluate quality in terms of degradation from historical conditions. In the absence of adequate historical data and the lack of established criteria for measuring the quality of the Park's water, other commonly used criteria have been used for water quality evaluation. It is important to note, however, that most water quality criteria are based on the beneficial use concept, i.e., standards of quality are designed to protect designated beneficial uses. While the beneficial use concept may apply in some cases in the Park, an overriding consideration in the evaluation of the waters of Yellowstone is the responsibility to preserve the unique characteristics of the waters.

In order to provide the framework for evaluating man's impact on the aquatic environment of Yellowstone, additional studies should be pursued to determine the natural condition of the Park's water. To assure that a policy of non-degradation is adhered to, Water Quality Standards should be established for the Park in accordance with the Federal Water Pollution Control Act, as amended, and Executive Order #11507, entitled, "Prevention, Control, and Abatement of Air and Water Pollution at Federal Facilities."

METHODOLOGY

Sampling and analytical procedures for the data presented in this report are in accordance with procedures outlined in

"Standard Methods" ^{2/} or "Federal Water Pollution Control Administration Methods for Chemical Analysis." ^{3/} All stream and lake samples were grab samples. Effluent samples from the various waste treatment plants were composited in order to overcome variations that occur during each day.

Each of the various water quality parameters for which samples were analyzed during the survey is discussed below. A description of the significance of the parameters to the over-all water quality levels of occurrence and possible causes or explanations for unusual levels are offered.

To place some of the analytical levels in perspective with other waters, Table 2 was constructed to show the average level of selected parameters at various comparable areas in the Missouri River System and in Lake Tahoe, California.

PHYSICAL TESTS

Specific Conductance

Specific conductance is the ability of a substance to conduct an electrical current. The determination of conductivity is a quick method for estimating the ion concentration of water. Conductivity of rain and snow melt waters range from 5 to 10 umhos/cm. Surface waters generally have a lower level of conductance than groundwaters, due primarily to less contact with soluble portions of the soil and rock. Most of the streams within the Park originate from snowmelt which is relatively low in dissolved minerals. Geyser waters are extremely rich in dissolved minerals. The varied inflows from the hot underground water sources create considerable differences in stream water quality as the streams flow through the geyser areas. ^{4/}

In the Yellowstone Park surface waters, the conductivity values are all less than 450 umhos/cm or about $\frac{1}{2}$ the average level of waters in the Missouri River at Kansas City. Most small streams originating from snow melt have values of less than 100 umhos/cm. The waters of all major lakes, including Yellowstone Lake, have levels of 75 to 125 umhos/cm. Duck Lake, used as a water supply for the West Thumb area, had a conductivity of less than 25 umhos/cm and was the lowest level recorded at any of the locations sampled.

In those areas where the contribution of subsurface water from springs and geysers was significant, the conductivity values were routinely higher. Maximum levels were recorded on the Gardner River below Mammoth Hot Springs (Avg. 426 umhos/cm) and on the Firehole River near its mouth (Avg. 387 umhos/cm).

TABLE 2

COMPARATIVE WATER QUALITY CHARACTERISTICS

Station	Drainage Area Sq. Mi.	Average Flow cfs	Specific Conductance micromhos/cm	Hardness as mg/l CaCO ₃	Chloride mg/l Cl	TOC mg/l C	Total NH ₃ + ORGN mg/l N	Total PHOS-P mg/l P	BOD ₅ mg/l
Snow and Rain Selected Locations United States			5.3						
Lake Tahoe, California ^{11/}	506	198	88		0.50		0.43*	0.05	
Duck Lake Near West Thumb, Wyoming		Closed	20	5.8	1.6	2.4	<0.005	0.009	1.26
Yellowstone River At Lake Outlet	1,006	1,288	88	18.7	5.2	2.9	0.13	0.05	0.94
Madison River At West Entrance	420	473	340	7.0	41.8	6.8	0.28	0.11	1.37
Yellowstone River At Sidney, Montana	68,812	12,880	624	210	20.8	8.14	1.48	0.17	--
Missouri River At Williston, North Dakota	164,500	21,960	661	226	10.9	5.04	0.93	0.07	1.58
Missouri River At Gavins Point, South Dakota	279,500	24,370	765	236	17.1	4.63	0.92	0.04	1.55
Missouri River At Kansas City, Missouri	322,800	27,680	721	233	17.9	10.56	2.57	0.24	2.96
Missouri River at Hermann, Missouri	528,200	79,050	454	206	22.7	11.03	3.32	0.32	2.53

* Ammonia Only

In the upper reaches of Soda Butte Creek on the northeast corner of the Park, there has been extensive mining for metal ores. This problem area is discussed in greater detail in a separate report 22 but the occurrence of high conductivity levels in this area would appear to be related at least partially, to leaching of the tailings piles from the old mine workings.

Hydrogen-ion Concentration

The symbol "pH" represents the base 10 logarithm of the reciprocal of the hydrogen ion concentration. In a practical way, the "pH" is a measure of the over-all balance of the series of equilibria existing in solution. Inasmuch as excessive concentrations of specific ions frequently over-balance the equilibrium in one direction or the other, the pH is an indicator of pollution problems. Guidelines for evaluating pH levels are 5:

TABLE 3

<u>Limiting pH Values</u>		<u>Remarks</u>
Minimum	Maximum	
6.0	7.2	Optimum range for fish eggs.
6.5	8.4	Range tolerated by most freshwater fish.
7.5	8.4	Good range for plankton production.

Measured levels of pH recorded in park waters ranged from 5.4 to 9.2, well beyond both ends of recommended scales. The major portion of the surface waters sampled had pH levels between 7.3 and 7.6. In waters of low mineral content such as were encountered in the Park, the existing equilibrium is easily destroyed by small additions of strongly dissociating compounds. Low pH levels were recorded in samples taken in areas of sulfurous hot spring contributions to natural surface waters. In Mary Bay, where the 5.4 level was recorded, the situation is clearly of a transient nature as hydrogen sulfide gas is continually being given off in this area to the atmosphere and the amount of this gas absorbed by the water is rapidly converted to weak sulfurous acid. The high pH levels recorded, 9.2 on the Firehole River, also appear to be a transient condition related to the groundwater contributions from the springs and geysers in this area. These groundwater contributions were stable at the high temperature and pressure existing in the underground environment and are subject to rapid geochemical changes on exposure to atmospheric pressure

and temperatures. Evidence of the rapid geochemical changes in these waters is provided by the spectacular mineral deposits around the more active springs and geysers. Normal levels of pH are generally achieved in all areas except those close to geyser activity.

Turbidity

Turbidity is a measure of the extent to which the intensity of light passing through a sample is reduced by suspended and colloidal matter. This suspended and colloidal matter is generally a combination of natural silt and clay particles, microorganisms or organic debris or mineral substances precipitating as a result of changes of chemical equilibrium in the water.

The USPHS 1962 Drinking Water Standards ^{6/} specify that turbidity in finished waters for domestic consumption should not exceed 5 Jackson Turbidity Units (JTU). A survey of the literature indicates that with respect to direct lethal effects turbidities as high as 200 JTU are harmless to fish. Using this level as some guide to significant turbidity levels it would be safe to say that observed levels in Park waters were generally negligible. Within the major lakes of the Park the average level from four or more samples was generally less than 1.5 JTU and in several areas averages were less than 0.5 JTU. Natural increases in stream turbidities due to runoff associated with the spring thaw caused the levels observed in streams to be somewhat higher at that time but still less than 10 JTU and in most cases less than 5 JTU. The maximum single observed turbidity was 110 JTU on the Lamar River following a rainstorm above this station. The average levels and ranges observed on the major streams leaving the Park are as follows:

TABLE 4

TURBIDITY LEVELS

JACKSON TURBIDITY UNITS

<u>Location</u>	<u>Max.</u>	<u>Min.</u>
Snake River at South Entrance (5711998)	65	0.5
Madison River at West Entrance (293019)	3.8	0.6
Yellowstone River Below Gardiner (293014)	17	0.9
Gallatin River at Weat Park Boundary (293018)	9.0	0.6

Temperature

Temperature levels in Park waters result from natural climatic phenomena and from the addition of natural thermal waters from underground sources. Because of the importance in relation to suitability of waters as a habitat for aquatic life, temperature is a frequently measured parameter.

In relation to trout which are one of the significant end products of the aquatic life chain in the Park waters the literature contains the following references. 5 & 7 /

1. Median high temperature (TLM time not specified) tolerance limit for adult lake trout is reported as 23.5°C with optimum temperature for growth and reproduction given as 13°C.
2. For spawning and hatching of eggs for trout, a maximum level of 14.4°C is reported.

Waters at the surface in the major part of Yellowstone Lake achieved a maximum temperature at nearly all stations of 13.5°C during July. This temperature is almost identical with the optimum range for lake trout growth and production. Surface temperatures on the smaller streams which receive snowmelt all year long generally ranged from supercooled flows in early May to a maximum of 10°C (10°C = 50°F) or less in July. On the larger streams, the annual fluctuation was somewhat greater with summer maximum temperatures approaching 20°C (20°C = 68°F). In the Madison River and its tributaries, the presence of significant additions of thermal water maintain the winter minimum temperatures between 5 and 10°C and summer maximums of near 20°C.

Radioactivity Investigations

As part of the collection effort, samples for radiological analyses were collected at selected sites in early May and late July and analyses are found in Table 5.

All of the analyses for radioactivity refer to materials in the dissolved state after filtration through a membrane filter. Individual results, as listed in Table 5, show concentration at low natural levels at all stations.

CHEMICAL TESTS

Oxygen

Dissolved oxygen levels in water receive attention because of their relationship to the ability of the water to support

TABLE 5
RADIOACTIVITY LEVELS

<u>STORET Number</u>	<u>Station Location</u>	<u>Date</u>	<u>Tritium pCi/l</u>	<u>Radium 226 pCi/l</u>	<u>Uranium µg/l</u>
293015	Yellowstone River at Gardiner	5/07/70 7/22/70	961 ± 157	0.03 0.10	0.3 0.1
571001	Lamar River near Tower Falls	5/09/70 7/22/70	946 ± 157	<0.01 <0.05	0.3 0.1
571004	Yellowstone River at Fishing Bridge	5/07/70 7/19/70	940 ± 157	<0.01 <0.05	<0.1 <0.1
169998	Falls River at Cave Falls	6/17/70	380 ± 150	0.06	0.3
571998	Snake River at South Park Boundary	5/08/70 7/20/70	633 ± 153	0.09 0.14	0.2 0.1
571996	Lewis River at Lewis Lake Outlet	5/08/70 7/20/70	672 ± 153	<0.01 0.08	0.4 <0.1
293018	Gallatin River below Specimen Creek	5/08/70 7/17/70	<378	0.05 0.11	0.1 0.2
293019	Madison River near West Entrance	5/08/70 7/21/70	616 ± 153	<0.01 0.09	0.3 0.5
571037	Gibbon River near Mouth	5/08/70 7/21/70	<378	<0.01 0.05	0.8 0.8
571043	Sylvan Lake	5/07/70 7/19/70	802 ± 156	<0.01 0.11	<0.1 <0.1
571044	Middle Creek near East Entrance	5/07/70 7/19/70	548 ± 152	<0.01 0.05	2.6 <0.1

aquatic life and their importance as indicators of the general nature of the equilibrium being established between oxygen being supplied and that used in the decomposition of organic matter.

Oxygen saturation levels in water are related to temperature and salinity of the water and the partial pressure of oxygen in the atmosphere at the surface of the water body. Because of the changes in elevation in the Park, the table below gives saturation values of oxygen for two temperatures for the range of elevation occurring in the Park.

TABLE 6
OXYGEN SATURATION VALUES

<u>Elevation</u> <u>Ft. Above Sea Level</u>	mg/l	
	Water Temperature	
	°C	
	<u>10°</u>	<u>20°</u>
6240	8.65	7.02
6560	8.51	6.91
6900	8.38	6.81
7200	8.32	6.75
7550	8.20	6.65
7880	8.13	6.60

Most dissolved oxygen levels measured near the surface, especially of the turbulent flowing streams, were at or above saturation values. Small depressions were noted only in those areas of a swampy nature where biological decomposition is expected to be greater. In Pelican Creek and the Yellowstone

River upstream of the Lake, average D.O. levels were depressed below saturation but above 7.0 mg/l.

There is no general statement which can be made to give the minimum dissolved oxygen concentration required to support fish life. This is owing to the fact that the oxygen requirements of fish vary with species, age, prior acclimatization, temperature of the water and a complex of other factors. Since many species probably require full air saturation for their full scope of activity ^{9/} it would be unrealistic in the National Park waters to specify an acceptable minimum standard for these waters which allowed degradation from the natural state. In regard to water quality standards, various investigators recommend minimum levels of 6.0 mg/l for sixteen hours of any 24 hour period for waters used for multiple purposes.

Samples were collected at various depths off Stevenson Island in Yellowstone Lake in the early afternoon of August 4th. The results are presented in table 7. Concentrations of Dissolved Oxygen increase nearly 1 mg/l from top to bottom while temperature of the water falls some 8.5°C. Conditions at the surface are slightly supersaturated, as would be expected on a warm sunny summer afternoon even in an oligotrophic lake. At the bottom, although the concentrations are higher, the percent saturation is 70 to 75 percent.

TABLE 7

DISSOLVED OXYGEN

YELLOWSTONE LAKE NEAR STEVENSON ISLAND

ELEVATION 7,792

August 4, 1970 at 1300 to 1400 Local Time

Depth Below Surface Ft.	Temperature °C	Dissolved Oxygen mg/l	Dissolved Oxygen % Saturation
1	15	7.80	108
50	14	7.90	106
100	6.5	8.65	72.6
110 (Bottom)	6.5	8.70	73.1

Alkalinity

Alkalinity is a measure of the ability of the solution to neutralize hydrogen ions and not a specific polluting substance. In common with the pH and conductivity, the alkalinity is used to evaluate the natural quality and to understand natural conditions well enough to forecast the effects of added pollutants. In a general way, alkalinity could be expressed as a buffer capacity or an ability to resist sudden changes from the natural pH levels. It is generally recognized that the best waters for the support of a diversified freshwater aquatic life are those with pH values between 7 and 8 and total alkalinity levels of 100 to 120 mg/l.⁵

Only the waters of the Gardner River below Mammoth had an average alkalinity of 120 mg/l. At this location the range of values was 146 mg/l to 92 mg/l. These higher levels are due to the thermal discharges in the Mammoth area. Higher than average levels in the Madison River drainage can also be attributed to thermal water contributions. In this area, the average levels ranged close to 100 mg/l. Throughout the Yellowstone drainage and the smaller streams of the Park, average levels were generally between 20 and 40 mg/l indicating a relatively dilute and unbuffered water. In the Yellowstone drainage, slightly higher levels were encountered where waters were more stagnant, as in Pelican Creek, and in the waters draining the northeast corner of the Park where different geological formations may be responsible for a different mineral content in the water.

It is interesting to note that from the limited data it would appear the percentage of water which freezes each year in the smaller closed lakes is sufficient to cause a significant increase in the alkalinity of the remaining water. In both Duck Lake and Sylvan Lake, the alkalinities under ice cover were relatively high. As soon as the ice melted in the spring, a low alkalinity resulted and by July the lakes had levels close to their annual average. Because of the depth of Yellowstone Lake, this effect was not observed there. The table below summarizes the variation of alkalinity with season in the Park.

TABLE 8

<u>Alkalinity Levels mg/l</u>				
<u>Location</u>	<u>Under Heavy Ice & Snow</u>	<u>Early Summer</u>	<u>Lake Summer</u>	<u>Yearly Average</u>
Duck Lake	18	4	8	8.9
Sylvan Lake	38	9.9	29	26.7
Yellowstone at Fishing Bridge	36	22	30	28.8

Biochemical Oxygen Demand

Biochemical Oxygen Demand tests measure the amount of oxygen required to remove organic matter from the waters in the process of decomposition by aerobic bacteria. In areas of population concentration and industrial development, BOD levels are frequently used as a guide to effluent standards in order to protect waters from organic pollution. Levels of BOD which could cause harmful effects vary widely with the characteristics of a water body. In a slow, warm, sluggish stream or lake, a five-day BOD of 5 mg/l might be sufficient to produce deoxygenation resulting in anaerobic conditions. A swift cold mountain stream, on the other hand, can easily handle 50 mg/l without appreciable reduction of dissolved oxygen levels.

BOD levels throughout Park waters were very low and indicative of only natural levels of organic matter being discharged to Park waters. Average concentrations generally ranged from less than 1 mg/l in the smaller headwater streams to near 2 mg/l in the major streams leaving the Park. The highest level observed was a single sample with 2.7 mg/l taken under ice on Yellowstone Lake at the entrance to West Thumb.

Detergents (MBAS)

Because of the lack of a natural source, it was felt that detergent levels in Park waters would be a good chemical test to evaluate levels of contamination by human use of the Park. One mg/l of the surfactant component has been known to cause frothing of some water supplies. Work in regard to lethal effects of surfactant on aquatic life is somewhat incomplete due to the variety of compounds used in the surface active portion of the detergent. Generally levels less than 5.0 mg/l were not observed to have any toxic effects.

MBAS levels were analyzed for at only a few downstream locations in the Park and below Cooke City on Soda Butte Creek. The maximum level observed from fifteen analyses was 0.06 mg/l. Although the detection limit is 0.01 mg/l, no surfactant was detected in more than one-half of the samples.

Hardness

Although the composition is difficult to define, the analysis of hardness in water has been universal in past studies of water quality. Over the years the property of hardness has generally been associated with the effects observed in the use of soap and with the incrustations left by some types of water when it is heated.

Most of the effect observed with soap and incrustations results from the presence of calcium, magnesium, and other cations. The accurate method for determining hardness is to compute it from the results of the specific cation analyses. Since this is a computed rather than an analytically determined number, it is not reported in the data contained in the Appendix. Trial computations were carried out for several stations, as listed below and on Table 2.

TABLE 9

<u>Location</u>	<u>Hardness (mg/l as CaCO₃)</u>
Yellowstone River at Lake Outlet	18.7
Duck Lake	5.8
Madison River at West Entrance	7.0

The levels observed in the Park waters are very low.

Phenolic Compounds

Analysis of Park waters for phenolic type compounds was done primarily to provide current and future investigators with a precise idea of current concentrations. As measured by current analytical techniques, the phenolic-type compounds can come from either industrial or natural sources. Previous investigators have shown that the natural decomposition of organic debris, particularly under anaerobic conditions, results in the production of phenolic-type compounds.^{5/} The significance of phenols is primarily related to their ability to cause taste and odor problems in water supplies at concentrations of 10 ug/l or less, especially when such waters are subjected to chlorination which enhances the odor producing ability. Fifteen samples were analyzed for phenolics with a maximum observed level of 4.9 ug/l on the Yellowstone River at Fishing Bridge; other results ranged from 0.6 to 3.5 ug/l. These levels are indicative of not only unpolluted water but also of water relatively uncontaminated from natural sources such as decaying vegetation.

Silica

The natural weathering of rocks is usually the main source of silica in water. Crystalline silica as quartz is a major constituent of many rock types. The common range of silica concentrations in water is from 10 to 60 mg/l. Many sources of groundwater related to part of present volcanic activity have a high concentration of silicates in dissolved or colloidal form. The thermal springs and geysers of Yellowstone Park are

in this category. In the Madison River drainage, silica levels rise from 40 to 50 mg/l near Norris on the Gibbon River and Kepler Cascades on the Firehole River to near 100 mg/l in downstream reaches. In other streams of the Park the silica content ranges from slightly less than 10 mg/l in Yellowstone Lake to around 20 mg/l in the Yellowstone River and tributaries and to near 40 mg/l in the Snake River drainage. Since diatoms are the dominant species in this oligotrophic lake, removal of silica by this route is anticipated. An average silica level of 1.5 mg/l was observed in the small closed basin lake (Duck Lake) which serves as the water supply for the West Thumb area. Silica does not appear to have any effects on humans or aquatic life at the levels observed.

Total Residue

Analyses for either "total" or other solids type determinations are subject to considerable variations. In these gravimetric determinations, a known amount of representative sample is evaporated to dryness at a preselected temperature and the residue is weighed. Small errors in the several weighings involved can make substantial differences in the concentration, especially at the low levels observed in areas of Yellowstone Park. The total residue is defined as the sum of the homogeneous suspended and dissolved materials in a water as present after a 105°C drying period.

In a general way, the total residue, when compared to filterable or dissolved residue, may be used to evaluate the load in the waters under study. In the Park, the total residue average levels are almost uniformly 30 mg/l or less above the filterable levels. The discharge of thermal waters in the Firehole, Gibbon, and Gardner Rivers causes the maximum solids to occur in these areas. Based on only a few samples, it would appear that there is a significant increase in total solids related to disruption of the natural terrain in the vicinity of past mining activity at Jardine and Cooke City. Because of the reduced velocities and long-settling time, total residue in Yellowstone Lake was less than 100 mg/l, and in Duck Lake was 66 mg/l.

Filterable Residue

In natural water, the filterable residue consists mainly of carbonates, bicarbonates, chlorides, sulfates, phosphates and possibly nitrates of calcium and magnesium, sodium and potassium, with traces of iron manganese and other substances. This analysis, therefore, is a general indication of the level of all ions in solution. At all levels the residue in a given stream is related to conductivity. Since conductivity is relatively easy to measure, especially in remote locations,

TABLE 10

CONDUCTANCE VERSUS FILTERABLE RESIDUE AT SELECTED STATIONS

<u>Location</u>	<u>Conductance</u> <u>µmhos/cm</u>	<u>Filterable Solids</u> <u>mg/l</u>	<u>Solids/Cond</u> <u>Ratio</u>
Yellowstone River at Fishing Bridge (571004)	94	72	0.76
	80	59	0.73
	65	57	0.87
	92	79	0.84
	88	108	1.22
	-	-	0.89
Avg.			
Firehole River near Mouth (571040)	376	337	0.89
	283	213	0.75
	454	309	0.68
	439	343	0.78
	-	-	0.77
	-	-	-
Avg.			

construction of conductivity versus stream stage versus solids rating curves for specific sites is fairly common. Table 10 is presented to show the relationships between residue and conductivity for two stations with somewhat different filterable residue levels. These two stations are typical of the stations in the Yellowstone and Madison River drainages. In the Yellowstone area, nearly all filterable residue levels were in the range of 60 to 100 mg/l except the Gardner River below Mammoth, which was 311 mg/l average.

In the Madison River area downstream, average filterable residue levels ranged from 200 to 300 mg/l. The source of this increase is clearly additions of thermal water, as shown by changes in the concentration in the Firehole River as listed below.

TABLE 11

FILTERABLE RESIDUE LEVELS

<u>Location</u>	<u>Filterable Residue*</u> <u>mg/l</u>
Firehole River near Kepler Cascades	86
Firehole River below Little Firehole River	195
Firehole River near Mouth	300

* Samples dried at 180°C

Similar changes are observed in the Gibbon and Gardner Rivers.

At levels recorded in Park waters the filterable residue should not interfere with any beneficial uses. Levels for irrigation and domestic water supply are two or three times the maximum observed in Park waters. 5/

Trace constituents analyses were not performed at all locations. Those substances which were difficult to determine analytically and were not expected to occur at significant levels were determined only at selected stations (Table 12). In general, the same stations were used for each of the trace constituents; these stations are:

TABLE 12

SELECTED STATIONS FOR TRACE ELEMENT ANALYSES

<u>STORET No.</u>	<u>Location</u>
571000	Soda Butte Creek at Northeast Entrance

STORET No.Location

293014
and
293015

Yellowstone River near Gardiner, Montana

571998

Snake River at South Park Boundary

293018

Gallatin River near West Park Boundary

293019

Madison River near West Entrance

Arsenic

Arsenic is notorious for its toxicity. A considerable proportion is retained at low intake levels. For this reason the 1962 USPHS Drinking Water Standards recommend the concentration of arsenic in drinking water should not exceed 0.01 mg/l and concentrations in excess of 0.05 mg/l are grounds for rejection of the supply. Toxic levels for aquatic life, as reported in the literature, are generally 1 mg/l or more, or 100 times greater than levels significant for human consumption.

All samples collected at the Snake River at South Entrance, the Yellowstone River near Gardiner and especially the Madison River near West Entrance exceeded the recommended levels of 0.01 mg/l. All samples collected from the Madison River near West Entrance exceeded the maximum limit of 0.05 mg/l by a factor of four or five, with the average level at this point being 0.22 mg/l. It is probable that this cation is contributed by the thermal springs in the Old Faithful and Norris areas. Stream concentrations in these areas could easily be double the concentrations observed on the Madison River at West Entrance. Further work is needed to adequately evaluate arsenic in Park waters.

Barium

Barium is not normally present in surface waters. The sulfate and carbonate salt are highly insoluble and consequently any barium ions discharged to natural waters would be quickly precipitated and removed by adsorption and sedimentation. In a few areas of springs in sedimentary rocks or evaporite deposits, barium has been found in measurable concentrations.

Because of a suspected toxic effect on the heart, blood vessels and nerves of humans, the 1962 USPHS Drinking Water Standards have established a limit of 1.0 mg/l for barium. One mg/l is also the detection limit for the normal analytical procedure for this cation. Four replicate samples at each of nearly fifty sites in the Park were tested for barium with no results above the detectable limit.

Boron

The occurrence of boron in nature is generally limited to a few igneous and metamorphic rock types and to some evaporite deposits. Hot springs in volcanic areas are known to contain relatively high concentrations of this element. One analysis ^{4/} on a spring in the Norris Geyser Basin contained 2.5 mg/l of boron. Boron has been studied extensively in many areas of the Western United States because small amounts of boron in irrigation water and soil are damaging to certain crops. This toxic effect begins at levels as low as 1 mg/l. Levels in Park waters were not observed to be as high as 1.0 mg/l. Only selected stations were analyzed for this constituent; however, and the level in the Madison River at West Entrance (0.51 mg/l) indicates levels in excess of 1 mg/l probably do occur in the Firehole River below the Old Faithful area and perhaps in other streams which receive significant additions of thermal water. Recommended limits of boron in drinking water in the literature are 20 to 30 mg/l. Concentrations at this level were not found to occur in surface waters in Yellowstone Park.

Calcium

Calcium salts and calcium ions are among the most commonly encountered substances in water since it is a major constituent of many rock types, is relatively soluble and is not precipitated from normal streams. Large travertine deposits built around some of the major thermal discharges in the Park are indicative of deposition of calcium carbonate when these thermal waters attempt to reach equilibrium with the atmosphere. In the Gardner River below Mammoth the milky color of the water and the increased turbidities would appear to be calcium carbonate precipitating from the water.

Calcium in excess of the concentration normally found in water is an essential item of human nutrition. Based on a complex of factors, including consumption and other household uses, 75 mg/l of calcium is given as a permissible limit for waters for domestic use by the World Health Organization.

In Park waters, calcium levels are low and in nearly all cases less than 10 mg/l. Levels tend to rise in a downstream direction with headwaters streams generally having concentrations of less than 5 mg/l reflecting more direct run-off from precipitation and less contact with the lithosphere. In Duck Lake the average calcium level was 1.5 mg/l, the lowest level observed in the Park.

The data on each station is limited to four or five analyses and it is, therefore, difficult to draw any definite conclusions concerning trends. It would appear that maximum calcium levels occur during winter periods of minimum flow when

groundwater contributions of more mineralized water to stream flow is at its highest percentage. A very distinct maximum occurs on Soda Butte Creek at Cooke City (293011) where disruption of the natural terrain by mining activity has resulted in considerable more opportunity for water contact with soil and rock. In this location, calcium levels at winter low flows are as high as 130 mg/l, more than four times the summer average of about 30 mg/l, which is still more than double levels in undisturbed neighboring watersheds.

Copper

Copper generally occurs in natural surface waters in trace amounts up to about 50 ug/l. Levels above this can generally be regarded as indicative of pollution. Concern over copper levels in regard to human consumption is related to the taste caused in water by concentrations on the order of 1,000 ug/l. This level has been recommended as a standard in the 1962 USPHS Drinking Water Standards, primarily because of the taste problem. Long before copper levels become of concern to humans they become a significant threat to many types of aquatic life. The toxicity of copper to aquatic organisms varies significantly with species of aquatic life and with physical and chemical characteristics of the water. Copper also exerts synergistic effects, especially in combination with zinc, cadmium, and mercury. Literature reports of toxicity studies involving copper are numerous. A summary of the findings indicates that concentrations varying from 100 to 1,000 ug/l have been found to be not toxic for most fish; whereas, other investigations report concentrations of 15 to 3,000 ug/l are toxic to many kinds of fish, crustacea, mollusks, insects, phytoplankton, and zooplankton.^{5/}

In the waters of the Park, four replicate analyses were performed on samples from fifty locations in the Park. All values with the exception of Soda Butte Creek near Cooke City are less than the detectable limit of 20 ug/l. At Cooke City, below the McLaren Mine tailings pile (293010 and 293011), the results vary widely with two analyses showing concentrations of 600 and 780 ug/l, while in others copper was not detectable.

Iron

Iron is an abundant constituent of rocks and soils. Because of the importance of iron in relation to the usability of waters for domestic and industrial purposes, iron is commonly determined in water analyses. The limits of iron for domestic consumption are not based on physiological considerations but rather on

esthetic and taste considerations, as iron and manganese tend to deposit dark stains on laundry and porcelain fixtures. The 1962 USPHS Drinking Water Standards give 0.3 mg/l soluble iron as a recommended limit for domestic uses.

If iron salts are added to unbuffered water, the pH may be lowered to a toxic level and the deposition of iron hydroxide may have lethal effects on fish and other aquatic life. There are literature reports of death of pike, tench, and trout at pH 5.0 to 6.7 in waters with one to two mg/l of iron.

The current analytical technique in use by the Environmental Protection Agency, Region VII, Laboratory has a detection limit for iron of 10 ug/l. At many stations, especially in the Yellowstone drainage, samples were collected in which iron was not detected. Average concentrations at nearly all locations were less than 0.3 mg/l with exceptions apparently due to natural conditions. These natural conditions were apparent on the Gibbon River below Norris Geyser Basin (571038), on Pelican Creek (571016), and on the Gardner River below Mammoth Hot Springs (571005).

In the area of the McLaren Mine tailings on Soda Butte Creek near Cooke City (293011), iron levels as high as 85 mg/l were observed and heavy deposits of ferric hydroxide are observed on the stream bottom. Above normal iron levels are apparent on Soda Butte Creek inside of the Park (571000 and 571001).

Lead

Lead is not a normal constituent of the human body and may be regarded as a cumulative poison. Both human and animals exhibit toxic effects from chronic ingestion of relatively low levels of lead in water. The 1962 USPHS Drinking Water Standards have a recommended limit of 0.05 mg/l for lead in order to minimize the intake from water. Toxic effects on aquatic life are reported to vary widely with hardness and type of aquatic life but generally to be above 0.1 mg/l.

Four replicate samples were analyzed for lead from some fifty stations within Park waters and all analyses were less than the detectable limit of 0.01 mg/l.

Magnesium

In natural waters, magnesium is a common constituent along with calcium and is generally one of the main cations contributing to hardness of the water. Except in certain dolomitic areas, magnesium is generally present in smaller amounts than calcium.

Like calcium, magnesium is relatively nontoxic and is in fact an essential nutrient for humans. Natural magnesium levels in Park waters are generally less than 2.5 mg/l with concentration of 0.5 mg/l or less occurring at Duck Lake and in the Madison River drainage. Levels below Mammoth Hot Springs on the Gardner River average 12.6 mg/l, apparently from contributions of geothermal water; and concentrations in Soda Butte Creek range from 7 to 12 mg/l associated with general increased dissolved mineral levels in this area.

Manganese

Manganese and iron are often discussed together because of their similar occurrence and behavior in water. Since manganese is much less abundant than iron in most soil and rocks, it is also generally less abundant in water. In concentrations not causing unpleasant tastes, manganese is regarded by most investigators to be of no physiological significance in water. However, because of the staining of laundry and porcelain, the 1962 USPHS Drinking Water Standards has set a recommended limit for manganese of 50 ug/l.

At nearly all locations sampled in the Park natural manganese levels were from 15 to 25 ug/l or generally less than half the drinking water limit. In the vicinity of the high proportions of thermal water in Mary Bay (571020) and Pelican Creek (571016), levels in excess of 100 ug/l were determined. The maximum level observed at any station was 870 ug/l at Cooke City on Soda Butte Creek (293011) just below the mine tailings pile of the McLaren Mine. Average concentration at this station is 361 ug/l based on ten samples over a two-year period. Because of the difficulty of access to this stream during winter minimum flow periods, it is probable that maximum concentrations have not been observed. At several locations in Yellowstone Lake, away from shore, the presence of manganese was undetectable on repeated samples with a detection limit on the analyses of 5 ug/l.

Mercury

Mercury, because of its toxicity, is an undesirable impurity in water. Natural mercury contamination is known from only a few hot springs which deposit the sulfide ore, cinnabar. Inorganic mercury is converted by microbial systems in bottom muds to methyl mercury which is concentrated in fish and shellfish, partly through contamination of their food and partly through its presence in the water.

Because of recent interest in this element and its high toxicity to humans and aquatic life, samples were analyzed from several locations in the Park as part of the 1970 baseline water

quality investigation. Results of the analyses of fish and water samples are presented below:

TABLE 13
RESULTS OF MERCURY INVESTIGATIONS

STORET NO.	DATE	LOCATION	71900	71930	REMARKS
			Hg ug/l	Hg mg/kg WET FISH FLESH	
293019	5/05/70	Madison at West Entrance	2.4		
	5/23/70		1.6		
	7/21/70		1.4		
	7/30/70		1.5		
571040	5/08/70	Firehole at Madison Junction	2.1		
	5/23/70		1.6		
	7/21/70		1.0		
	8/03/70		1.2		
	5/27/71			0.24	Rainbow Trout 6 to 8"
				0.14	
				0.18	
				0.30	
				0.27	
				0.21	
				0.22	
				0.28	
				0.18	
				0.24	
				0.20	
				0.40	
				0.26	
				0.34	
				0.26	
				0.31	
571041	5/08/70	Firehole River Below Little Firehole	1.8		
	5/23/70		3.4		
	7/21/70		2.4		
	8/03/70		1.6		
				0.27	

STORET NO.	DATE	LOCATION	71900	71930	REMARKS
			Hg ug/l	Hg mg/kg WET FISH FLESH	
	4/06/71		0.5		
571042	5/08/70	Firehole River above Old Faithful Area	3.4		
	5/23/70		2.8		
	7/21/70		3.2		
	8/03/70		2.0		
	4/06/71		1.0		
				.15	Brown Trout 6 to 10"
				.15 (2)	
				.15 (2)	
				.10	
				.15	
				.15	
				.15	
				.19 (2)	
				.11 (3)	
				.11 (3)	
				.14 (2)	
571061	4/06/71	Firehole at Old Faithful Water Supply Dam	0.4		
571005	5/07/70	Gardner River at Gage Below Mammoth	2.6		
	5/24/70		2.4		
	7/22/70 ✓		7.4		
	8/03/70 ✓		5.1		
	4/06/71		0.9		
				0.18	Brown Trout 6 to 11"
				0.11	
				0.11	
				0.09	
				0.09	
				0.09	
				0.11	
				0.10	
				0.12	
				0.09	
				0.09	
				0.11	
				0.12	
				0.07	
				0.34	

STORET NO.	DATE	LOCATION	71900	71930	REMARKS
			Hg ug/l	Hg mg/kg WET FISH FLESH	

0.08
0.12
0.10
0.09
0.08
0.07
0.07
0.07
0.13
0.06

571005	4/06/71	Surface Runoff from Mammoth Terraces at Mammoth to Tower Road Crossing	1.7		
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571006	4/06/71	Gardner River Upstream of Mammoth Area	0.4		
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7/09/71

0.04 Brook Trout 6 to 9"

0.04
0.05
0.06
0.08
0.02
0.07
0.06
0.04
0.05
0.07
0.06 (3)
0.01 (3)
0.06 (3)
0.03 (3)
0.05 (3)
0.02 (3)
0.06

571004	7/07/71	Yellowstone Lake at Fishing Bridge		0.28	Cutthroat Trout 10 to 14"
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0.49
0.18
0.26
0.21
0.14
0.21
0.34

In total, 107 fish and 25 water samples have been collected and analyzed for mercury content. Of these samples, only two water samples had a mercury content above 5 ug/l, the recommended limit set forth in the USPHS Drinking Water Standards. No fish flesh samples contained mercury in excess of 0.5 mg/kg, the tentative FDA limit for human consumption. Based on these analyses, it would appear that there is no significant hazard to human health from eating fish caught in Park waters. There is much work which could be undertaken to document the actual distribution of mercury levels by fish species, age, and location.

Potassium

Both sodium and potassium are common alkali earth metals and each constitutes several percent of the material in the earth's crust. Both sodium and potassium occur in some minerals which are readily dissolved by precipitation or circulating groundwaters; hence, ions of these elements are present in nearly all waters. At low concentrations, as observed in Park waters, potassium is an essential nutrient, especially for plant growth. Reports in the literature concerning detrimental effects of potassium in water are all concerned with levels in excess of 50 mg/l in a water of normal ion makeup. The maximum observed level in Park waters was 8.15 mg/l in the Madison River (571036). All locations sampled below the thermal spring areas on the Gibbon, Gardner, and Firehole Rivers had concentrations of potassium at two or three times the levels observed elsewhere in the Park indicating the probable origin of much of the element to be the discharges from the thermal springs.

Selenium

Selenium is chemically similar to sulfur in a number of respects. Selenium is found in some soils and in waters draining these soils. It is toxic to humans and animals at low levels. The 1962 USPHS Drinking Water Standards level for this element is a mandatory limit of 10 ug/l which is the lowest detectable limit in the current analytical procedure for this element. Waters from several selected main stream locations were tested for selenium but levels in all samples were below the 10 ug/l detectable limit.

Sodium

As discussed under potassium, sodium is generally in relatively easily dissolved minerals in rocks and soil and occurs in nearly all water. All levels observed in Park waters are low, with levels in the Yellowstone and Snake Drainage being 20 mg/l or less. In the Madison River Drainage concentrations downstream of the main thermal areas range from 35 to 75 mg/l, with the Firehole River having the highest levels.

When a high percentage of the total cations in solution are sodium, the water is not suitable for agricultural uses as the exchangeable sodium tends to deflocculate the soil and make it impermeable to water. At the mouth of the Firehole River (571040) the calculated Sodium Absorption Ratio (SAR) is 26.12 and the average conductivity is 388 umhos/cm. According to the data of the U.S. Salinity Laboratory, this would be a C2-S4 water, which has a medium salinity and a very high alkali hazard. ^{2/} Agricultural water uses in this immediate area are nonexistent; the potential losses due to this natural water quality condition are low.

Zinc

Zinc occurs naturally in waters draining areas of occurrence of the ore sphalerite, an important source of zinc. In zinc mining areas, naturally occurring concentrations of 50 mg/l have been observed. There is some evidence of strong permanent absorption of zinc on silt particles with a resultant removal of zinc from solution. Because of undesirable tastes, poor finished water appearance and other undesirable esthetic effects, the USPHS 1962 Drinking Water Standards recommends a limit of 5 mg/l in drinking water.

The literature reports that levels of zinc in excess of 10 ug/l may be harmful to aquatic life. In particular, the hatching and growth of Rainbow trout may be inhibited by concentrations of 10 to 500 ug/l. Other reports on effects to bacteria and other aquatic life indicate levels of about 100 ug/l are cause for concern. ^{5/}

Zinc levels in most waters of Yellowstone Park were less than the 5 ug/l detection limit for this analysis. Zinc was found routinely only on stations in Soda Butte Creek below the McLarens Mill. Current levels at the mouth of Soda Butte Creek average 29 ug/l. On two occasions levels of zinc in excess of 100 ug/l were obtained from analyses of single samples. Other analyses of samples from these same stations indicated levels below detectable limits; additional work should be done in this area to clarify these isolated high results

Chloride

Chloride is present in all natural waters. Table 2 indicates that chloride in detectable quantities occurs even in snow in areas far removed from oceanic waters. Chloride is also present in all rock types, especially evaporite sediments. Chloride may also be present in connate waters trapped in an area during an earlier geologic period and now being added to surface waters. Chloride limits, both those in use as standards and those recommended for use as possible standards, vary over a wide range. A summary of the recommendations for the various beneficial uses indicates that no

significance is attached to levels of less than 50 mg/l. All analyses of Park waters have levels less than this figure.

Maximum concentrations in Park water are found below the thermal spring areas on the Gibbon and on the Firehole Rivers. Average levels in these streams are between 35 to 45 mg/l. Most observed levels in other areas of the Park are less than 10 mg/l.

Measurement of the concentration of the chloride ion is routine, precise, and not too difficult. Routine monitoring of waters for possible indications of pollution generally include chloride analysis.

Cyanide

Current standards for cyanide appear to be based on the toxicity to aquatic life rather than effects on man. Trout are extremely sensitive and are killed by levels of 0.1 to 0.2 mg/l in a short time. The USPHS 1962 Drinking Water Standards mandatory limit has been set at 0.2 mg CN/l, which provides an approximate factor of safety of 100 for human consumption. Cyanide is reported to be toxic to fish at 0.05 mg/l when exposed for a period of five days. 5/

Since cyanide was used in the extraction of ore at the McLaren operation near Cooke City, samples from selected stations in Park waters were analyzed for this constituent. Approximately fifteen samples were tested for cyanide and all levels were less than the detectable limit of 0.01 mg/l.

Sulfate

Sulfates occur naturally in all surface waters as a result of leaching from a number of common minerals. In the waters of Yellowstone Park, sulfate levels are increased by the oxidation of sulfide ions which enter the water from many of the springs and geysers. In many of the geyser areas a sulfur smell is present in the air at all times. The Mud Volcano group of geysers and spring just north of Yellowstone Lake would appear to be responsible for nearly doubling the average concentration of sulfate in the Yellowstone River at this point. Levels in the Yellowstone River upstream of the Mud Volcano are near 8 mg/l, while levels immediately downstream are near 16 mg/l.

Sulfate levels observed in the Park are low and offer no potentially detrimental effects for beneficial uses of the water. At Pelican Creek an average level of 51.8 mg/l was observed which was a maximum for natural conditions in the Park. During winter low flow periods the level of sulfates draining from the tailings piles of the McLaren Mine in Soda

Butte Creek are recorded as high as 210 mg/l but this effect does not appear to extend into Park waters.

At all other locations sampled in the Park the sulfate level was less than 25 mg/l and in many cases less than 10 mg/l.

Total Organic Carbon

The determination for organic carbon utilizes a strong oxidant to oxidize the carbon material in water under standardized conditions. As in the case of BOD, this is an attempt to develop a criterion for the strength of the waste or, in this case, the potential for support of aquatic life in the waters. General levels of TOC in Park waters are near 2.5 mg/l. TOC levels, as observed in Park waters, are all quite low when compared with normal stream water levels in downstream locations, except below areas of thermal water inflows (See Table 2). Much of the limited carbon which is present is expected to be tied up in lignin complexes and humic type acids, as would be expected from this well-wooded area and, hence, is not available for immediate uptake by aquatic life. The low BOD/TOC ratio of all Park waters would tend to support this.

Nitrogenous Compounds

Nitrogen occurs abundantly in nature, is an essential constituent of protein in all living organisms and is frequently recycled within the environment. In sanitary survey work it is common to measure ammonia, organic nitrogen, and nitrates because the relative levels of these forms are indicative of the pollutional state of the waters under study. In Park waters where natural conditions control, interpretation of results is difficult beyond the point that "no significant pollution was found in the locations sampled."

The combined nitrogen available in unpolluted surface waters is probably mainly derived from inflow sources such as precipitation and uncollected surface runoff. Indeed, average nitrogen measurements made on snows in various locations indicate average levels twice those observed in the waters of Yellowstone Park, indicating a substantial uptake of the nutrient by plant and animal life. In lakes like Yellowstone which have seasonal pulses of anabaena, it is likely that this alga makes a significant contribution to the nitrogen undergoing biogeochemical transformation.

Literature reports indicate that ammonia levels of less than 0.2 mg/l are generally the maximum natural stream level and are not detrimental to any beneficial uses. In Park waters, the maximum average ammonia level observed was in the swampy Pelican Creek area and here the concentration was only 0.10 mg/l.

Kjeldahl Nitrogen, which is organic nitrogen plus ammonia, and nitrate-nitrogen levels were less than one-half the average nitrogen level which occurs in snow and rain. Nuisance blooms of aquatic plants in lakes and streams do not generally occur if the nitrate as N is kept below 0.3 mg/l and the total nitrogen as N is below 0.6 mg/l. ^{5/} All average levels within the Park waters are in this range. It does appear that nitrogen compounds may be contributed by some of the thermal discharges, as indicated by higher levels in these areas. It may be more likely though that these higher levels result from increased biologic activity resulting from higher water temperatures near the thermal areas.

Phosphorus

Phosphorus is commonly the most likely macro-nutrient to be deficient in an aquatic environment and, hence, to limit the biologic activity. For this reason, phosphorus levels are most important to the ecologist. Waters draining the crystalline rocks of mountain regions generally are the most deficient in phosphorus. The literature reports levels in relatively uncontaminated lake districts to be on the order of 10 to 30 ug/l, with ortho or soluble phosphorus being generally a tenth of the total. A maximum concentration of 100 ug/l of total phosphorus in flowing streams and 50 ug/l where waters enter a lake or reservoir should be observed to avoid the danger of supporting undesirable growths. ^{9/}

Only limited analyses were performed at about fifty locations in Park waters. Total P levels range from less than 10 ug/l to 140 ug/l, with nearly all levels between 50 and 70 ug/l. The distribution of the data do not suggest substantial increases from heavily utilized recreational areas, although there is insufficient data to adequately disprove this point. Ortho-phosphorus levels range from less than 10 ug/l to 110 ug/l, with nearly all stations having levels of 10 to 20 ug/l. It would appear that a delicate balance exists with phosphorus levels in many locations at or just below levels necessary to support nuisance growths of aquatic life and serious disruption of the natural aquatic environment.

Sewage effluents are a major source of this nutrient. In Yellowstone Lake near Dot Island, the average concentration of orthophosphate was 30 ug/l during the survey period, which indicates a level of 0.25 pounds of this element per million gallons. At the time of the 1970 survey, the waste treatment plant at Grant Village discharged into Yellowstone Lake a partially treated effluent at a rate of approximately 90 gpm during the tourist season. This effluent contained an average of 13,700 ug/l of orthophosphate. This is equivalent to 114 pounds per million gallons or between 10 and 15 pounds per day over the sixty to ninety day season. Levels at the Bridge Bay

STP, which also discharged into the Lake, were about one-half those at Grant Village. Park Service plans outline higher levels of treatment for the waste waters from these sources.

MICROBIOLOGY

Bacteria have been used as indicators of the sanitary quality of water since 1880, when E. coli and similar organisms were shown to be normal in fecal material. The coliform group, as presently analyzed for, includes organisms that vary in their natural sources and habitats. Included in the Total Coliform analyses are organisms from the feces of human and other warm-blooded animals, from soil, from water and from vegetation. Current practice is to place increasing emphasis on the techniques which are sensitive only to those organisms of fecal origin.

Fecal coliform organisms may be considered to be indicators of recent fecal pollution from warm-blooded animals. It is necessary to consider all fecal coliform organisms as indicative of dangerous contamination. In the absence of fecal coliform organisms, the presence of other coliform group organisms may be the result of less recent fecal pollution, soil-runoff water or, infrequently, fecal pollution containing only those organisms.

The fecal streptococcus group bacteria are now being recommended for consideration in water quality criteria and are used in many stream pollution measurements. Since this group includes several biotypes of limited sanitary significance, colony counts of less than 100 per 100 ml should not be considered as having much value for interpretation other than indicating a lack of severe bacteriological contamination.^{10/}

The publication, "Report of the Committee on Water Quality Criteria,"^{11/} provides the following numerical guidelines for evaluating coliform levels in raw waters:

TABLE 14

GUIDELINES FOR COLIFORM LEVELS

<u>Use</u>	<u>Total Coliform</u>	<u>Fecal Coliform</u>
Public Water Supply*		
Mandatory	10,000 MF Colonies/100 ml	2,000 MF Colonies/100 ml
Desirable	100 MF Colonies/100 ml	20 MF Colonies/100 ml

<u>Use</u>	<u>Total Coliform</u>	<u>Fecal Coliform</u>
Primary Contact Recreation**		
Mandatory		200 MF Colonies/100 ml
*Arithmetic monthly mean		
**Geometric monthly mean with maximum less than 400 colonies/100 ml		

These criteria were developed to provide for adequately safeguarding the public health without unduly restricting the use of the waters for recreational and water supply purposes. Since the use of Total Coliform densities has been well-established in the past, some samples were analyzed for Total, as well as Fecal, Coliform organisms to provide comparative data. In the second portion of the survey effort, Fecal Coliform and fecal streptococcus densities were determined to provide some baseline information according to the currently recommended methods. Sampling for coliform type analysis took place on all major surface water areas in the Park. Samples were collected beginning in early May of 1970 prior to the influx of tourists and also during the maximum Park utilization periods in late July and August of 1970.

The map (Figure 6) presents the maximum and arithmetic average fecal coliform counts on all locations sampled during the survey with the exception of the waste treatment plant data which are presented in Appendix A. Fecal streptococcus counts were generally below the level of sanitary significance at all stations during the survey.

In evaluating the data, the initial conclusion must be that no serious fecal pollution directly attributable to human discharges can be demonstrated in Park waters. Of the twenty-three locations which were sampled in both May and August, fourteen had maximum recorded counts occurring during the pretourist period. Of the other nine, eight had maximum recorded fecal coliform counts of less than 100 colonies per 100 ml. The only station which had a higher count (120 colonies/100 ml) was located outside Park boundaries on the Yellowstone River several miles below Gardiner, Montana. Inadequately treated wastes were known to be discharged by Gardiner to the Yellowstone River.

The highest fecal coliform densities observed during the survey (300 to 500 colonies/100 ml) occurred on the Madison River concurrently with the high snowmelt flows which caused the river to exceed bankfull stage. High concentrations of geese, ducks, and elk were observed in this area at this time and the observed counts are probably from this source. High counts which occurred in Pelican Creek in the Yellowstone



drainage area can also be attributed to wastes from the numerous wildfowl and other animals concentrated in this area at the time of sample collection.

The maximum count of 170 fecal coliform/100 ml which occurred on the Lamar River was concurrent with the turbid runoff from a severe thunderstorm in that area. This relatively high count also is attributable to animal waste sources, probably most comes from small rodents living near the water.

It should be reiterated at this point that nearly all stations had some fecal coliform counts. Fecal coliform counts are evidence of recent fecal contamination and constitute some public health hazard to persons who use these waters for consumption without adequate disinfection.

BIOLOGY

Introduction

Biological surveys of Yellowstone National Park waters began with the work done by Forbes (1893)^{11/}, who described common zooplankton and general features of Yellowstone Lake. Following Forbes's work was the first intensive report on the flora and fauna of selected streams which was done by Muttkowski (1929)^{12/}. Since then there has been limited biological work published concerning the Lake and streams within the Park (Seamans, 1940^{13/}; Benson, 1961^{14/}; and Sharpe and Arnold, 1966^{15/}). A discussion of aquatic life and the relationship to water quality and the work of previous investigators follows. Biological surveys were conducted during July 10-21, 1970. In addition, plankton samples were collected in May and August of 1970.

Study Methods

Benthos - Bottom samples from the Lake stations were collected with a Petersen dredge and organisms were separated from bottom sediments by sieving through a U. S. Standard 30 mesh screen. Collections at stream stations utilized a Surber stream bottom sampler used in riffle areas having rocks or rubble of near uniform size. Qualitative samples were obtained from all stream stations by hand or dip net from rocks and other submerged debris. All samples were stored in glass jars and preserved with four percent formalin. Sorting and identification was done in the laboratory.

Phytoplankton - Collections were made in the Lake approximately one foot below the surface using a Kemmerer water sampler. Samples were stored in one liter containers and preserved with four percent formalin. Identification and counting

of the phytoplankton using the Sedgwick-Rafter Cell technique followed the procedure outline in Standard Methods for the Examination of Water and Wastewater, 12th Edition, Park TX, 1965. 9/

Periphyton - Samples were collected at all stream stations by scraping slime from rocks and other submerged objects. Scrapings were stored in glass jars and preserved with four percent formalin. Only diatoms were enumerated using permanent hyrax slides from which proportional counts were made according to procedures outlined by Weber and Raschke (1966). 16/

Station Description

Figure 7 depicts the biological stations for the July 1970 survey. Because of the distance between stations and the many streams sampled, a description of the station locations is presented in Table 15.

TABLE 15

BIOLOGICAL SAMPLING STATIONS AND LOCATION YELLOWSTONE NATIONAL PARK AND SURROUNDING AREAS JULY 1970

<u>Station No.</u>	<u>Chem. Data STORET No.</u>	<u>Location</u>
<u>Yellowstone Lake</u>		
YL-1	571025	30 yards offshore from Grant Village STP at West Thumb.
YL-2		65 yards offshore from Grant Village STP.
YL-3		200 yards offshore from Grant Village STP.
YL-4	571026	100 yards offshore from Solution Creek at West Thumb.
YL-5		Inside breakwater at Grant Village Marina.
YL-6		50 yards outside Grant Village Marina entrance.
YL-7		100 yards offshore from Lake Lodge at Bridge Bay.
YL-8		50 yards outside Bridge Bay Marina entrance.

<u>Station No.</u>	<u>Chem. Data STORET No.</u>	<u>Location</u>
YL-9	571017	100 yards inside Bridge Bay Marina.
YL-10		Center slips at Bridge Bay Marina.
YL-11	571004	500 yards south of Fishing Bridge at the outflow of the Lake.
YL-12	571020	200 yards offshore from Beach Springs at Mary Bay.
YL-13		50 yards offshore, southwest point of Stevenson Island.

Madison River

MR-1	293019	1.5 miles east of West Yellowstone, Montana at USGS gaging station.
MR-2	571036	1 mile downstream from Madison Junction campground at second road turnout.

Gibbon River

GR-1	571038	3.5 miles northeast of Madison Junction at Mesa Road intersection.
GR-2	571039	3 miles southwest of Norris Junction at Gibbon River Rapids.

Firehole River

FH-1	571040	0.5 miles upstream from confluence with Gibbon River at Madison Junction.
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Little Firehole River

LF-1		200 yards upstream from confluence with Firehole River at Upper Geyser Basin.
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Iron Creek

IC-1		100 yards upstream from service road bridge and oxidation lagoon fields for Old Faithful resort area.
IC-2		0.5 miles downstream from IC-1, directly behind Emerald Pool.

<u>Station No.</u>	<u>Chem. Data STORET No.</u>	<u>Location</u>
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Soda Butte Creek

SBC-1	293008	0.5 miles east of Cooke City at McLaren Mine, 100 yards upstream from tailings.
SBC-2	293011	Footbridge crossing to Forest Service Amphitheater at Cooke City.
SBC-3	571000	Soda Butte Picnic Area, 2.5 miles southwest of Silver City.
SBC-4	571001	300 yards upstream from Lamar River Confluence.

Lamar River

LR-1	571010	100 yards upstream from Soda Butte Creek Confluence.
LR-2	571003	20 yards downstream from Northeast Entrance Road bridge crossing.

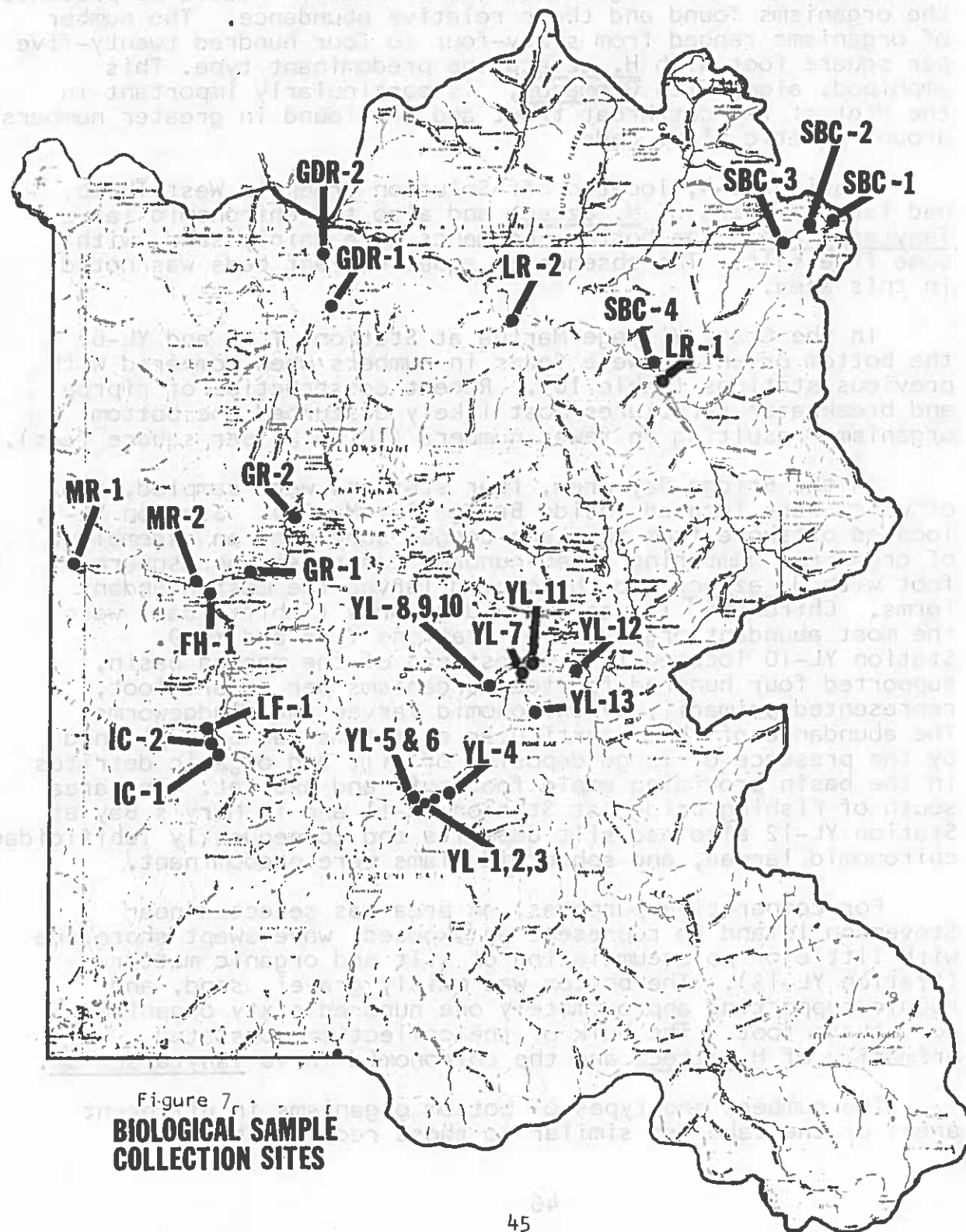
Gardner River

GDR-1	571006	3 miles northeast of Indian Creek campground at Sheepeater Cliffs Monument.
GDR-2	571050	1.5 miles north of Mammoth Hot Springs at North Entrance Road bridge crossing.

Lake Benthos

Yellowstone Lake is characteristic of large oligotrophic lakes that have deficiencies in nutrient concentrations and low water temperatures, which in turn limit primary productivity. The limited primary production in Yellowstone Lake is in part compensated by the great production depth, according to Benson (1961)¹⁴, with the most production in terms of benthos occurring at the twenty to thirty foot depth.

The benthos sampling in Yellowstone Lake utilized thirteen stations (Figure 7). Sampling was done along the shoreline in depths of twenty to thirty feet, dredging until soft substrates were found. Stations YL-1 through YL-3 were located in the vicinity of the Grant Village Sewage Treatment Plant outfall in the West Thumb area. The bottom sediments were soft, comprised of fine silt, sand and organic detritus (aquatic plant material). Overlying beds of aquatic plants were



prevalent in this area with Potamogeton sp., Lemna sp., and Ceratophyllum sp. the most dominant types.

The bottom fauna in this area was composed primarily of amphipods Hyalella azteca, Gammarus lacustris, Diptera (Chironomidae) and Oligochaeta (Tubificidae). Table 16 presents the organisms found and their relative abundance. The number of organisms ranged from sixty-four to four hundred twenty-five per square foot with H. azteca the predominant type. This amphipod, along with Gammarus, is particularly important in the diet of the cutthroat trout and are found in greater numbers around aquatic plant beds.

Station YL-4, located off Solution Creek in West Thumb, had large numbers of H. azteca and also the chironomid larva Tanytarsus sp. The bottom sediments were mainly sand, with some fine silt. The absence of aquatic plant beds was noted in this area.

In the Grant Village Marina at Stations YL-5 and YL-6, the bottom organisms were fewer in numbers when compared with previous stations (Table 16). Recent construction of riprap and breakwater structures most likely disturbed the bottom organisms resulting in fewer numbers (10 to 91 per square feet).

In the Bridge Bay area, four stations were sampled, two of which were located inside Bridge Bay Marina. Station YL-7, located offshore from the Lake Lodge, supported an assemblage of organisms numbering seven hundred twenty-six per square foot with H. azteca and chironomid larvae the most abundant forms. Chironomid larvae and sludgeworms (Tubificidae) were the most abundant organisms at stations YL-8 and YL-9. Station YL-10 located in the west end of the marina basin, supported four hundred fourteen organisms per square foot, represented primarily by chironomid larvae and sludgeworms. The abundance of these particular organisms can be explained by the presence of large deposits of silt and organic detritus in the basin providing ample foodstuff and habitat. The area south of Fishing Bridge at Station YL-11 and in Mary's Bay at Station YL-12 also had silt deposits and consequently Tubificidae, chironomid larvae, and sphaeroid clams were predominant.

For comparative purposes, an area was selected near Stevenson Island to represent an exposed, wave-swept shoreline with little or no accumulation of silt and organic matter. (Station YL-13). The bottom was mainly gravel, sand, and rubble supporting approximately one hundred sixty organisms per square foot. The bulk of the collection consisted primarily of H. azteca and the chironomid larva Tanytarsus sp.

The numbers and types of bottom organisms in different areas of the Lake are similar to those recorded by Benson

Table 16 Lake Benthos Types
Macroinvertebrates From Yellowstone Lake, July 1970

STATION ORGANISM	YL-1		YL-2		YL-3		YL-4		YL-5		YL-6		YL-7		YL-8		YL-9		YL-10		YL-11		YL-12		YL-13		
	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	Qual	No/Sq Ft	
ANNELIDA																											
Glossiphoniidae		13		3		64		3		3		2		6		2		40		170		2		1		1	
Lumbriculidae		16		9								2		10		32						2		5		2	
Tubificidae		19		2																	54		37				
CRUSTACEA																											
Gammarus lacustris																											
Hyalella azteca		151		22		3		3		3		51		320		4										117	
DIPTERA																											
Cardiocladius sp.		3																									
Chironomidae		16																									
Chironomus sp.																											
Cricotopus sp.		6		3		3		1		1		3		6		2		5		10		3				2	
C. Cryptochironomus sp.																											
C. Dicrotendipes																											
Culicidae																											
Glyptotendipes sp.		3																									
Hamischia sp.																											
Microtendipes sp.		3																									
Nannocladius sp.		10																									
Orthocladius sp.		3																									
Polypedium fallax		10																									
Procladius sp.		10																									
Procladius sp.		3																									
Psectrocladius sp.		6																									
Stenochironomus sp.		35																									
Tanytarsus sp.		131																									
EPHEMEROPTERA																											
Ameletus sp.																											
Ephemerella sp.																											
PELECYPODA																											
Pisidium sp.																											
Sphaerium sp.																											
TRICHOPTERA																											
Athripsodes sp.																											
Hydropsyche sp.																											
Oecetis sp.																											
TOTAL NO./SQ. FT.		425		91		1,406		10		91		726		54		54		54		414		79		64		160	
TOTAL NO. TYPES		15		8		11		5		8		16		11		11		5		7		9		8		8	

(1961)^{14/} during the 1957-1958 limnological study conducted by the Rocky Mountain Sport Fishery Investigations. The areas of the Lake protected from wind and heavy wave action supported the largest number of bottom organisms. Sediments composed of fine silt and organic materials with overlying plant beds provided excellent habitat for bottom organisms. In contrast, the rocky, wave-swept shorelines supported only limited populations because of molar action among the rubble bottom and limited food supply.

Stream Benthos

Typically, the mountain streams in Yellowstone National Park are cold, fast-flowing, and highly aerated with a distinctive flora and fauna. During the study period, nine major streams were sampled (Figure 6). The stations were located near population centers to evaluate the possible impact of waste treatment plant effluent discharges into the streams. High flows during the study period hindered sampling of some streams and prohibited the sampling of the Yellowstone River.

All streams sampled upstream and downstream from population centers, with the exception of Soda Butte Creek which will be discussed later, exhibited bottom organism communities typical of unpolluted mountain streams. The species composition of the streams sampled are quite similar to those recorded by Muttkowski (1929)^{12/} for selected trout streams in the Park. Table 17 lists the types of benthic organisms and their relative abundance found in the representative streams.

To illustrate the types and numbers found throughout the Park, the Gardner River will serve as an excellent example, as it has a major population center (Mammoth Hot Springs) situated along its course. Station GDR-1, located approximately three miles northeast of Indian Creek, was selected as the upstream station from Mammoth, Wyoming. Quantative sampling revealed an abundance of organisms, particularly mayflies (Ephemeroptera) and caddisflies (Trichoptera). Of the two-hundred ninety-four organisms per square foot, the mayflies numbered seventy-eight, with cinygmula sp., Ephemerella sp., and Heptagenia sp., the predominant forms. The caddisflies numbered one-hundred twenty-six per square foot, Glossosoma sp. and Brachycentrus sp. the most abundant types. The Diptera were represented by a wide variety of types (Table 17), but primarily in the chironomid family. Stoneflies, although not present in large numbers in quantative samples, were present in qualitative collections. The stoneflies were undergoing mass emergence from the nymphal to adult stage, particularly the Pteronarcys sp. and Acroneuria sp. forms. When this transformation occurs, the nymph climbs out of riffle areas onto dry stones, brush or logs to shed the nymphal skin. This movement from rifle

Table 17 Stream Benthos Types

[illegible]

areas undoubtedly influenced the numbers collected in the quantitative samples.

Station GDR-2 was located approximately 1.5 miles downstream from the Mammoth resort area and waste disposal facilities. Sewage treatment is accomplished by a large septic tank, followed by two retention ponds. Effluent from the ponds is chlorinated and dispersed via a ground infiltration ditch in the Gardner River Canyon. The benthos downstream from this area did not reflect the presence of sewage wastes or excessive nutrients. The numbers and types of organisms at this station were similar to those collected upstream at GDR-1 (Table 17). In the quantitative sample, the mayflies and caddisflies were most numerous (104/square foot). The stoneflies, as noted previously, were common in qualitative samples. The numbers and types of bottom organisms collected from the Gardner River indicated exceptional water quality upstream and downstream from large population centers.

In comparison, organisms collected from certain reaches of Soda Butte Creek reflect water quality degradation directly attributed to man's activities centered in the watershed. From 1933 to 1953 the McLaren Gold Mine and Mill operation was located east of Cooke City, Montana, on the north bank of Soda Butte Creek at its confluence with Miller Creek. According to an unpublished report by Mills and Sharpe (1968)¹⁷, the general productivity of the stream has decreased notably since the start of the tailings pile erosion. The leaching of toxic materials from tailings was suspected as the main reason for a decrease in productivity.

In an effort to define the extent of the affected area in Soda Butte Creek, four sampling stations were utilized (Table 15). Station SBC-1, situated upstream from the tailings area, was characterized by a wide variety and abundance of bottom organisms (214/square foot), mayflies and caddisflies were the predominant forms. Approximately 0.75 miles downstream at Station SBC-2 the numbers and types were substantially reduced (62/square foot) compared with the upstream station. Mayflies, caddisflies, and stoneflies were decreased in numbers and types, while the Diptera (chironomid larva) were present in large numbers (Table 17). The gravel bottom was covered with heavy sediment deposits mixed with what appeared to be iron oxides. These sediment deposits and the possible presence of toxic materials eliminated many of the sensitive organisms.

Downstream at Station SBC-3, just inside the Park boundary, and at Station SBC-4, upstream from the confluence with the Lamar River, the bottom organisms improved in numbers and types (Table 17), particularly the mayflies and stoneflies. The stream bottom at these stations was relatively free from silt

deposits and iron oxides common at Station SBC-2.

It is evident that numbers and types of bottom organisms in the vicinity of Cooke City and downstream from the mining operation have been severely affected by either heavy siltation or toxic materials or a combination of both. Partial recovery of aquatic life began within the Park boundary and appears complete downstream at the confluence with the Lamar River.

Yellowstone Lake Phytoplankton

Sampling for phytoplankton in the Lake was limited to grab samples at a predetermined depth for the various stations. Because of the scarcity of phytoplankton, which is characteristic of oligotrophic waters, this type of sampling was intended to evaluate the common genera present and no attempt was made to calculate relative abundance. The phytoplankton from most of the one-liter collections were present in too few numbers to enumerate using the Sedgwick-Rafter Cell techniques, even after concentration by centrifugation. The most abundant phytoplankton present were the diatoms Melosira sp., Gomphonema sp., and Asterionella sp. During the August sampling period at the outlet of the Lake, the diatoms were replaced in predominance by a bloom of blue-green algae Anabaena sp., which give a green cast to the water and sometimes form wind-driven deposits on downwind lake shore areas. The phenomenon, which has been previously reported in the literature¹⁴, is thought to be the natural result of the climatic sequence in the area and not attributable to pollution by waste discharges. Table 18 lists the more common genera of phytoplankton encountered during the May, July, and August collections.

Stream Periphyton

The streams and rivers of the Park are free of higher aquatic plants, which is characteristic of cold, fast-flowing mountain streams. Lower plants such as the attached filamentous algae and diatoms occur in small numbers, usually covering rocks in sheltered areas out of the main current. The attached algae Cladophora sp. was found forming long plumes in areas of slow current, particularly in the Lamar and Gardner Rivers. For the most part, however, the diatoms forming slime coatings on rocks were the predominant forms of algae. Table 19 lists the periphyton encountered in the Park.

SUMMARY OF BIOLOGICAL INVESTIGATIONS

Biological investigations were conducted on Yellowstone Lake and nine major streams flowing through Yellowstone

TABLE 18

SOME COMMON PHYTOPLANKTON FROM YELLOWSTONE LAKE

May, July, and August 1970

Blue-green Algae (Myxophyceae)

Anabaena sp.

Green Algae, Non-Motile (Chlorophyceae)

Ankistrodesmus sp.

Flagellates (Chlorophyceae, Chrysophyceae)

Chlamydomonas sp.

Chrysococcus sp.

Dinobryon sp.

Diatoms (Bacillariophyceae)

Achnanthes sp.

Asterionella sp.

Cocconeis sp.

Cymbella sp.

Fragilaria sp.

Gomphonema sp.

Melosira sp.

Navicula sp.

Nitzschia sp.

Synedra sp.

TABLE 19

SOME COMMON PERIPHYTON FROM YELLOWSTONE NATIONAL PARK STREAMS

July 1970

Green Algae (Chlorophyceae)

Cladophora sp.

Spirogyra sp.

Diatoms (Bacillariophyceae)

Achnanthes sp.

Cocconeis sp.

Cyclotella sp.

Cymbella sp.

Diatoma sp.

Epithemia sp.

Eunotia sp.

Fragilaria sp.

Gomphonema sp.

Melosira sp.

Navicula sp.

Nitzschia sp.

Pinnularia sp.

Rhizosolenia sp.

Rhoicosphenia sp.

Rhopalodia sp.

Surirella sp.

Synedra sp.

National Park. Comparison of the flora and fauna with previous studies was done to evaluate current and past water quality features in the study areas. From these observations the following conclusions may be drawn:

1. Yellowstone Lake is an oligotrophic body of water with a relatively deep benthic productive area occurring in the twenty to thirty foot range.
2. The predominant lake benthos are the amphipods Hyalella azteca and Gammarus lacustris with oligochaets and chironomids occurring in large numbers in areas of heavy silt deposits. The rocky shorelines free from large silt deposits supported smaller numbers of bottom organisms.
3. Areas of degradation caused by sewage disposal or other man-related activities centered around the Lake were not evidenced by the presence or absence of bottom organisms.
4. The phytoplankton which was never very abundant (typical of oligotrophic waters) was represented mainly by the diatoms Melosira sp. and Gomphonema sp. However, a large bloom of blue green algae Anabaena sp., which apparently occurs annually, was observed in the Lake outlet during August 1970.
5. The benthos and phytoplankton collected in 1970, when compared with previous studies on the Lake during 1954-1959, indicated no significant change in species composition.
6. The stream benthos and periphyton reflected water of excellent quality throughout the Park, with the exception of Soda Butte Creek.
7. In the vicinity of Cooke City, Montana, a decrease of numbers and types of bottom organisms in Soda Butte Creek indicated marginal water quality. Heavy sediment deposits and the probability of toxic materials leaching from upstream mine tailings severely affected aquatic life in this area. However, the stream benthos in the downstream reaches within the Park improved in numbers and types, indicating recovery in the Lamar River below its junction with Soda Butte Creek.
8. The flora and fauna of the Park streams have remained relatively unchanged since the first intensive surveys in 1929.

PESTICIDES

The following key locations were selected for pesticide analyses to provide background information for future investigators.

TABLE 20

PESTICIDES SAMPLING LOCATIONS

<u>STORET No.</u>	<u>SEWL Lab. No.</u>	<u>Sampling Date</u>	<u>Location</u>
293015	4341 and 6529	5/07/70 7/22/70	Yellowstone River at Gardiner upstream of US-89 bridge from left bank looking upstream.
571998	4342 and 6530	5/08/70	Snake River at South Park Boundary. Left bank at Gaging Station.
293019	4343 and 6531	5/08/70 7/23/70	Madison River near West Entrance. Sampled from right bank looking upstream at turnout about 1.5 miles east of West Yellowstone

Samples were analyzed in the Environmental Protection Agency's Southeast Water Laboratory, Athens, Georgia, by conventional gas chromatography. The minimum detection limits for the pesticides included in the analyses are tabulated below:

TABLE 21

ANALYTICAL DETECTABLE LIMITS

	<u>ug/l Minimum Detection Limit</u>
Aldrin	0.005
Lindane	0.002
Chlordane	0.05
Chlorobenzilate	0.5
DDD	0.01
DDT	0.02

Dieldrin	0.01
Endrin	0.02
Heptachlor Epoxide	0.01
Heptachlor	0.005
Methoxychlor	0.1
Toxaphene	0.25
Diazinon	0.2
Guthion	0.5
Malathion	0.2
Methyl Paration	0.02
Parathion	0.04

Results of the analyses are as follows:

TABLE 22

PESTICIDES ANALYTICAL RESULTS

<u>Station Number</u>	<u>Date</u>	<u>Results</u>
293015 - Yellowstone River	5/08/70	No pesticides detected
	7/22/70	DDE 0.01 ug/l Arachlor 1248* 0.1 + 0.05 ug/l
571998 - Snake River	5/08/70	No pesticides detected
	7/20/70	DDE 0.03 ug/l DDT 0.02 ug/l Arachlor 1248 0.2 + 0.1 ug/l
293019 - Madison River	5/08/70	No pesticides detected
	7/23/70	DDE 0.06 ug/l DDT 0.01 ug/l Arachlor 1248 0.2 + 0.1 ug/l

* Arachlor 1248 is not a pesticide. Its significance is discussed below.

DDT has been used so widely that it has been found to be present in the air, water, and plant and animal tissues at nearly all locations in civilized areas.^{18/} In a recent study in England, rain water was analyzed for a number of pesticides, including DDT. At all sites and throughout the year rain water contained alpha-BHC, gamma-BHC, dieldrin, pp'DDT, pp'DDE, and pp'TDE. The concentrations were minute, being of the order of parts /10¹¹ or part /10¹².^{19/}

Evaluation of the toxic effects of pesticide, especially long-term effects is extremely complex. Such factors as type of pesticide, method of application, species, age, position in the food chain, and a host of other environmental factors influence the long and short-term effects of pesticides.^{20/}

The only current statement regarding desirable limits for general environmental preservation is one of 0.050 ug/l for chlorinated hydrocarbons recommended by the Committee on Water Quality Criteria.^{7/}

Arachlor 1248 is a polychlorinated biphenyl (PCB), a class of chemicals recently found to be prevalent and persistent in the environment. These chemicals are widely used in the electrical industry because of their thermal stability and fire resistance. Other uses include epoxy paints, wood coatings, adhesives, and carbonless reproducing paper. The major suspected route of entry into the ecosystem is by incineration, especially of business forms containing carbonless paper and plastics and spent ballasts from fluorescent light fixtures. Another suspected source is land runoff from dump areas.

Significance of these compounds is related to their chronic toxicity, especially relating to the formation of thin-shelled birds eggs. This relatively recently discovered pollutant is discussed in detail in a paper by Carl G. Gustafson in Environmental Science and Technology.^{21/}

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APPENDIX A
Evaluation Of Treatment Facilities
Yellowstone National Park

I. INTRODUCTION

During the period from August 10-17, 1970, an evaluation of the treatment facilities in Yellowstone National Park was made in conjunction with the water quality study conducted by the Federal Water Quality Administration. The objectives of the evaluation were two-fold. Those treatment plants that were discharging directly to the natural surface waters in the Park were sampled to determine their waste contributions, including the plants at Canyon, Bridge Bay, and Grant Village. Secondly the operational procedures at all the secondary treatment facilities were observed with the purpose of improving operation where possible. The majority of other facilities in the Park which do not provide secondary treatment were also observed.

II. DISCUSSION

The most common type of treatment presently used in the Park is a septic tank followed by some type of land disposal. Present plans, however, call for major changes in the wastewater treatment program within the Park to upgrade treatment levels. The construction of new or expanded treatment facilities is planned at each disposal site. A description of present and proposed treatment works is presented in Table A-1. Plans for future actions are included in a report entitled "Master Sewerage Study, Yellowstone National Park, November 1968" prepared by Metcalf and Eddy Engineers and other more detailed project planning for the various facilities. Facilities planning is in conformance with the Park Service Master Plan for management of Yellowstone Park.

A. Canyon Village

The effluent from the Canyon Village septic tank discharges directly to the Yellowstone River. To determine the plant's efficiency and the strength of the waste being discharged, the influent and chlorinated effluent were composited hourly for a six-hour period beginning at 6:00 a.m. August 16, 1970. Table A-2 lists the results of the Canyon Village Composite. Since no flow measuring devices were available at Canyon Village to allow proportional compositing, uniform grab samples were composited.

As shown in Table A-2, the chlorinated effluent showed an increase in pH from 6.9 at 6:00 a.m. to 7.9 at 12:00 noon, a decrease in dissolved oxygen from 1.9 mg/l at 7:00 a.m. to 0.7 mg/l at 11:00 a.m. and a decrease in chlorine residual from 2.5 mg/l at 7:00 a.m. to 0.5 mg/l at 11:00 a.m. All of these trends are typical of the increasing waste load that occurred during the period of the composite.

The B.O.D. of the influent composite was 155 mg/l, while the B.O.D. of the chlorinated effluent was 92 mg/l. This represents a reduction of about 41 percent. Since chlorine has the

TABLE A-1
PRESENT AND PROPOSED WASTEWATER TREATMENT FACILITIES
YELLOWSTONE NATIONAL PARK
YELLOWSTONE WATER QUALITY SURVEY
AUGUST 1970

Location	Present Type Of Treatment	Final Effluent Disposal	Proposed Treatment
Mammoth Hot Springs	Septic tank plus chlorination and sludge drying beds	Percolation lagoons	Wastewater is to be piped to community of Gardiner, Montana for disposal in municipal lagoons.
Norris Area	Septic tanks	Subsurface percolation	Septic tanks plus improved subsurface disposal systems - septic tanks to be sized to hold sludge for entire season
Madison Junction	Trickling filter secondary treatment plus chlorination - anaerobic sludge digestion	Percolation lagoons	Secondary treatment by aerated lagoon followed by evaporation - percolation lagoons
Old Faithful Area	Septic tank and sludge drying beds	Percolation lagoons	Secondary treatment by variations of the activated sludge process with phosphorus removal - discharge to evaporation percolation lagoons
West Thumb Area	Septic tank and pumping system	Spray irrigation	Abandon facilities and discharge to Grant Village sewage system
Grant Village	High rate trickling filter secondary treatment plus chlorination - anaerobic sludge digestion	Dilution in Yellowstone Lake	Expand the present system to include growth and West Thumb - effluent disposal to evaporation percolation lagoon.
Bridge Bay Area	Secondary treatment by extended aeration activated sludge followed by chlorination	Dilution in Yellowstone Lake	Abandon facilities and discharge to new secondary plant to be constructed near Fishing Bridge Area
Lake Area	Septic tank	Sand filtration	Abandon facilities and discharge to new secondary plant to be constructed near Fishing Bridge Area
Fishing Bridge Area	Septic tanks and a sludge lagoon	Percolation lagoons	Secondary treatment by variations of the activated sludge process, anaerobic denitrification lagoons. Final effluent to percolation - evaporation lagoons.
Canyon Area	Septic tank plus chlorination also sludge drying bed	Dilution in Yellowstone River	Secondary treatment by variations of the activated sludge process plus chlorination - effluent to go to Yellowstone River <u>a/</u>
Tower Area	Pit toilets, cess-pools and septic tanks	Spray irrigation and subsurface percolation	New septic tanks and drain fields

a/ Plant scheduled for completion in 1973.

TABLE A-2

CANYON VILLAGE COMPOSITE
YELLOWSTONE WATER QUALITY SURVEY

August 16, 1970

PLANT INFLUENT							
Time	Temp. °C	pH	BOD mg/l	Fecal Coliform Bacteria MF/100 ml	Fecal Streptococci Bacteria MF/100 ml		
6:00 a.m.	13.5	6.9	-	-	-		
7:00 a.m.	16.5	7.3	-	-	-		
8:00 a.m.	16.0	7.5	-	2,500,000	2,300,000		
9:00 a.m.	16.0	7.7	-	-	-		
10:00 a.m.	17.5	7.8	-	-	-		
11:00 a.m.	17.0	7.7	-	-	-		
12:00 Noon	18.5	8.1	-	-	-		
Composite	-	-	155	-	-		

CHLORINATED PLANT EFFLUENT							
Time	Temp. °C	pH	Dissolved Oxygen mg/l	Chlorine Residual mg/l	BOD mg/l	Fecal Coliform Bacteria MF/100 ml	Fecal Streptococci Bacteria MF/100 ml
6:00 a.m.	13.5	6.9	-	-	-	-	-
7:00 a.m.	17.5	7.4	1.9	2.5	-	-	-
8:00 a.m.	17.0	7.7	-	-	-	<1	<1
9:00 a.m.	17.0	7.5	1.4	2.5	-	-	-
10:00 a.m.	17.0	7.6	-	-	-	-	-
11:00 a.m.	17.5	7.8	0.7	0.5	-	-	-
12:00 Noon	17.5	7.9	-	-	-	-	-
Composite	-	-	-	-	92	-	-

effect of oxidizing the B.O.D., a portion of this reduction can be attributed to the relatively high chlorine residuals maintained at the plant.

The effectiveness of the chlorination is indicated by the effluent concentrations of fecal coliform and fecal streptococcus bacteria. Both were less than one per 100 ml.

At the time of the composite the sludge drying bed was full of wet sludge. The plant operator informed us that they had always experienced difficulty in dewatering the sludge on the Canyon drying bed.

B. Madison Junction

Since the Madison Junction Plant is a secondary (trickling filter) treatment facility, an investigation was made to determine if any improvements could be made in operational procedures. No samples were scheduled to be taken, since the plant is designed to discharge to percolation lagoons and, therefore, it should not directly effect the surface waters of the Park. However, a visit to the Madison Plant on August 15, 1970, revealed that the trickling filter was not functioning properly and the effluent was being discharged to a drainage ditch which eventually led to the Madison River.

The visit also revealed that the distribution arms on the trickling filter were not functioning. The plant was operating in this manner because the recirculation pump for the filter and the effluent pump had broken down and Park personnel were unable to get the needed parts for repair. In effect, the plant at Madison was providing only primary treatment with chlorination.

C. Grant Village

Grant Village is provided secondary treatment by a high rate trickling filter plant which was constructed in 1962. The chlorinated plant effluent is discharged directly to Yellowstone Lake. Future plans call for expanding the present trickling filter plant and disposal of the effluent to an evaporation-percolation lagoon. Monitoring wells are to be installed to monitor for possible movement of pollutants from the lagoons to Yellowstone Lake.

An investigation of the Grant Village Plant was made on August 12, 1970, including a twelve-hour composite. The results of the composite sampling are shown in Table A-3. The percentages of B.O.D. (69%) and turbidity (42%) reductions indicate that the plant was not performing at optimum. The plant operator stated that they had experienced a power failure at the plant during the week prior to the investigation. As a result, all of the growth on the filter media had been lost. Table A-4

TABLE A-3
GRANT VILLAGE COMPOSITE^a
YELLOWSTONE WATER QUALITY SURVEY

August 12, 1970

	BOD ₅ mg/l	pH SU	Turb. JTU	Total Kjeldahl Nitrogen As N mg/l	Ammonia-Nitrogen As N mg/l	NO ₂ + NO ₃ Nitrogen As N mg/l	Ortho Phosphorus As P mg/l	Total Phosphorus As P mg/l	Fecal Coliform Colonies MF/100 ml	Fecal Streptococci Colonies MF/100 ml	Flow gpd
Grant Village Influent Composite	232	8.1	60	78	59	0.06	12.6	17.0	20,000,000 ^b 7,200,000 ^c	19,000,000 ^b 5,300,000 ^c	180,000
Grant Village Effluent Composite (Chlorinated)	71	7.3	35	61	50	0.90	14.4	17.2	1 ^b 1 ^c	1 ^b 1 ^c	180,000
% Reduction	69	-	42	-	-	-	-	-	-	-	-
Lbs. Discharged To Yellowstone Lake Per Day	104	-	-	91	75	1.4	21.6	25.8	-	-	-

- a. Compositd 12 hours (8:00 a.m. to 8:00 p.m.)
b. Grab sample taken at 10:00 a.m.
c. Grab sample taken at 12:00 Noon

gives values obtained from grab samples taken before the power failure occurred which indicate that the plant was producing a somewhat better effluent.

TABLE A-4
GRANT VILLAGE STP EFFLUENT
GRAB SAMPLES
YELLOWSTONE WATER QUALITY SURVEY

<u>Date</u>	<u>B.O.D. 5</u> <u>mg/l</u>	<u>Turbidity</u> <u>JTU</u>
July 31, 1970	48	24
August 2, 1970	34	20
August 3, 1970	--	22

The plant operator was only able to spend a few hours per day operating the Grant Village Plant. Most of that time was spent maintaining the equipment and pumping the raw sludge from the primary clarifier. No sludge was drawn from the final clarifier since the sludge scraper mechanism was inoperable. This condition added to the degradation of the effluent quality. Limited testing was done at the plant to increase process control and thus effluent quality. Samples were collected for analysis to monitor the plant's performance. The effectiveness of the chlorination at the Grant Village Plant is indicated by the very low (less than 1) concentration of fecal coliform and fecal streptococcus in the plant effluent. As at other plants, the chlorine residual in the Grant Village effluent was maintained at 2 mg/l or greater.

Table A-3 shows the calculated load in pounds per day of total nitrogen (92.4), total phosphorus (25.8) and B.O.D. (104) discharged to Yellowstone Lake. Although these loads are small in comparison with loads from normal domestic plants, they are large in an area such as Yellowstone since they represent a real source of degradation to the high quality waters in Yellowstone Lake.

D. Bridge Bay

The Bridge Bay Area waste is treated by a package extended aeration plant followed by chlorination with the effluent discharging directly to Yellowstone Lake. Future plans include abandoning the Bridge Bay Plant and combining the wastes from Bridge Bay, Lake and Fishing Bridge Areas for treatment in a new secondary plant to be constructed near the Fishing Bridge Area. Final effluent disposition will be to evaporation percolation lagoons. Monitoring wells are to be installed to

check for movement of pollutants towards the Yellowstone River.

A twelve-hour composite was made at the Bridge Bay Plant on August 13, 1970. The results are listed in Table A-5. The percentage of B.O.D. reduction at the Bridge Bay Plant (83%) was the highest observed anywhere in the Park. It is noted that the effluent sample was taken prior to chlorination and thus the effluent B.O.D. concentration would have been lower due to the oxidation of a portion of the B.O.D. by the chlorine.

The percentage reduction of turbidity (93%) and the low turbidity value (4 JTU) for the effluent also indicate that the plant was functioning well.

The sample taken of the chlorinated effluent for fecal coliform and fecal streptococcus analysis was contaminated by sludge deposits in the effluent channel because no suitably accessible location was available to obtain a good sample. Therefore, the high concentration of these organisms found in the effluent are not believed to be representative. As at other plants, a 2 mg/l or greater concentration of chlorine was maintained in the effluent.

As at Grant Village, the contributions of total nitrogen (27.2 lbs/day), total phosphorus (3.1 lbs/day) and B.O.D. (22 lbs/day) are small but they do constitute a controllable source of pollutants to the pristine waters of Yellowstone Lake.

E. Other Facilities

Other visitor centers in Yellowstone Park, other than those discussed previously, are all served by septic tanks. This type of treatment is no longer acceptable at the larger installations in the Park. This has been recognized and Park Service planning recommends abandonment of most of the Park's septic tanks and replacement with more advanced forms of treatment.

The majority of the septic tanks and their locations were observed during the plant evaluation. However, other than the infrequent interval of sludge draw off for disposal at dump sites and the maintenance of chlorination equipment at the sites where it was used, little can be done to influence the performance of a septic tank. Therefore, no recommendations or detailed evaluations were made at the visitor centers served by septic tanks.

III. SUMMARY AND CONCLUSIONS

1. Efforts in the past and future plans for protecting water quality bear out the desire of the Park Service to maintain the high quality waters in Yellowstone Park. The

TABLE A-5

BRIDGE BAY COMPOSITE^a
YELLOWSTONE WATER QUALITY SURVEY

August 13, 1970

	BOD ₅ mg/l	pH SU	Turb. JTU	Total Kjeldahl Nitrogen mg/l	Ammonia-Nitrogen As N mg/l	NO ₂ + NO ₃ Nitrogen As N mg/l	Ortho Phosphorus As P mg/l	Total Phosphorus As P mg/l	Fecal Coliform Colonies MF/100 ml	Fecal Streptococci Colonies MF/100 ml	Flow gpd
Bridge Bay Influent Composite	377	8.3	60	98	45	0.08	7.8	11.8	2,800,000 ^b 1,300,000 ^c	21,000,000 ^b 4,100,000 ^c	41,000
Bridge Bay Effluents Composite (Unchlorinated)	64	7.8	4	72	68	0.63	7.8	9.2	840 ^b	63,000 ^b	41,000
% Reduction	83	-	93	--	--	--	--	--	--	--	--
Lbs. Discharged To Yellowstone Lake Per Day	22 ^d	-	--	25	23	2.2	2.7	3.1	--	--	--

- a. Compositing 12 hours (8:15 a.m. to 8:15 p.m.)
 b. Grab sample taken at 10:00 a.m. (Effluent sample was contaminated)
 c. Grab sample taken at 12:00 Noon (No effluent sample taken)
 d. Does not include reduction due to heavy chlorination

investigation found that many wastewater treatment facilities were no longer adequate to meet the demands of increased visitation. However, construction of new or modified facilities is either underway or being planned to upgrade treatment at all major visitor centers.

2. Many treatment facilities in the Park have no back-up systems to keep them operating if failure occurs. Examples are the pumps that failed at Madison Junction and the power failure at Grant Village. In both of these cases, the failures reduced treatment to unacceptable levels. Even short breakdowns can cause loss of biological secondary treatment systems which can be catastrophic to plant efficiencies due to seasonal operation of the plants.

3. Additional attention to the operation and maintenance of wastewater treatment works is needed. Consistent and improved performance from treatment facilities can be achieved through better operational control. The number of personnel assigned to wastewater management was insufficient to allow adequate time for operational control. Personnel responsible for operating wastewater treatment facilities, although sincere, were not always aware of the fundamentals of treatment and as such were unable to adequately control the plant processes to obtain optimum plant efficiencies. Proper operation will become increasingly important considering that planned facilities will be much more complex than existing systems.

4. The potential for degradation of Yellowstone Lake exists from the existing direct discharges of treated effluent to the lake. A policy of no direct discharges to the lake has been established for the new treatment facilities. The no discharge policy has also been applied to all other new facilities except Canyon Village where it wasn't deemed necessary at this time. The use of evaporation - percolation lagoons for final effluent disposition will be monitored to determine if pollutants are reaching surface or ground waters.

5. The practice of heavy chlorination in the Park proved very effective in killing the indicator organisms fecal coliform and fecal streptococcus. Chlorination is adequate for disinfection of wastewater but it is no substitute for proper treatment. The practice of heavy chlorination should be viewed with caution however, since research has indicated that chlorine and chloramine residuals may be toxic to aquatic life. Provision of backup systems and use of evaporation percolation lagoons will minimize the need for intensive dosage of partially treated effluent during times of operational difficulties.

IV RECOMMENDATIONS

1. Project planning should be finalized and construction initiated at an early date in order to implement the facilities improvement program outlined for the Park.

2. Wastewater treatment works should have backup systems to minimize interruptions in operation due to mechanical and electrical system malfunctions. Standby electrical power systems should be provided at all electrically operated treatment works. Adequate supplies of spare parts should be maintained for electrical and mechanical equipment.

3. Increased emphasis should be placed on facilities operation and maintenance. Additional qualified personnel are needed to provide active supervision of the treatment works. Training of operating personnel is needed to provide the operators with a basic understanding of wastewater characteristics and the functions of various treatment units. Training should also provide the operators with the ability to perform essential analytical tests and to maintain plant operating records. The training objectives can be met by sending the operators to short courses on fundamentals of waste water treatment and providing on-the-job training by qualified personnel. Assistance is available from the Environmental Protection Agency for the establishment of an operator training program.

4. Elimination of the direct discharges to Yellowstone Lake should be expedited. Results of the monitoring program should be evaluated periodically to determine the effectiveness of evaporation-percolation lagoons. If the lagoons are ineffective then other alternatives for disposal should be evaluated, e.g., spray irrigation or tertiary treatment of effluent.

APPENDIX B
Sample Station Location
Descriptions

STORE#STATION NAME NUMBER	*STATE	*DESCRIPTION	*MAJOR BASIN	*MINOR BASIN
169996*WARM R AT WM. R. RR STATIONS	*IDAHO	WARM RIVER AT *ARM RIVER RAILROAD STATION FWQA - YP-102	*PACIFIC NORTHWEST	*SNAKE RIVER
169997*SNAKE RIVER AT US-191 BRIDGE	*IDAHO	SNAKE RIVER AT US-191 BRIDGE AT ASHTON IN FREMONT COUNTY, IDAHO FWQA - YP-101	*PACIFIC NORTHWEST	*SNAKE RIVER
169998*FALLS R 2 MI W OF TARGHEE FOREST	*IDAHO	FALLS RIVER 2 MILES WEST OF TARGHEE NATIONAL FOREST BOUNDARY AT COUNTY ROAD BRIDGE IN FREEMONT COUNTY, IDAHO. FWQA - YP-100	*PACIFIC NORTHWEST	*SNAKE RIVER
169999*FALLS R. BELOW BECHLER R. JUNC	*IDAHO	ON FALLS RIVER BELOW JUNCTION WITH BECHLER RIVER AT THE COUNTY ROAD BRIDGE IN FREMONT CO., IDAHO. TO REACH SAMPLE COLLECTION POINT GO SIX MILES EAST OF JUNCTION US-20 AND IDAHO SR-47. FWQA STA YP-39	*PACIFIC NORTHWEST	*SNAKE
293038*SODA BUTTE CR ABOVE MCLAREN MINE	*MONTANA	ON SODA BUTTE CREEK ABOVE MCLAREN MINE .5 MILE EAST OF COOKE CITY, PARK COUNTY, MONT. TO REACH SAMPLE COLLECTION POINT PARK AT THE YELLOW WASTE PILES AND WALK TO THE NORTH BANK OF THE CREEK 150 YARDS ABOVE THE MINE NE 1/4 SEC 25, T95, R14E, FWQA STA YP-14, SB-1 LAT 4501000 10955000 LONG	*MISSOURI RIVER	*YELLOWSTONE RIVER
293009*CR. ABOVE MCLAREN MINE TAILINGS	*MONTANA	ON AN UNNAMED CREEK ABOVE THE MCLAREN MINE TAILINGS ONE THIRD MILE EAST OF COOKE CITY, PARK CO., MONTANA. TO REACH THE SAMPLE COLLECTION POINT PARK ON THE GRAVELED ROAD TO MCLAREN'S MINE AND GO UPSTREAM BUT DOWN-STREAM FROM THE CONCRETE CULVERTS UNDER U.S. HIGHWAY 212. NE 1/4 SEC 25, T95, R14E FWQA STA YP-13, SB-2 LAT 4501000 10956000 LONG	*MISSOURI RIVER	*YELLOWSTONE RIVER
293010*CR. BELOW MCLAREN MINE TAILINGS	*MONTANA	ON AN UNNAMED CREEK BELOW MCLAREN MINE TAILINGS IN PARK CO., MONT. TO REACH THE SAMPLE COLLECTION POINT GO .25 MILES EAST OF COOKE CITY, PARK ON GRAVEL ROAD TO THE WHITE CABIN AND WALK TO THE NORTH BANK OF THE STREAM CLOSE TO THE CORNER OF THE OLD CONCRETE FOUNDATION. NE 1/4 SEC 25, T95, R14E, FWQA STA YP-12, SB-3 LAT 4501000 10956000 LONG	*MISSOURI RIVER	*YELLOWSTONE RIVER
293011*SODA BUTTE CR. AT COOKE CITY	*MONTANA	ON SODA BUTTE CREEK AT COOKE CITY, PARK CO., MONT. TO REACH SAMPLE COLLECTION POINT DRIVE ACROSS BRIDGE OVER SODA BUTTE CREEK ON THE GRAVELED ROAD TO THE AMPHITHEATER. PARK AT THE FOREST SERVICE AMPHITHEATER AND GO TO THE SOUTH BANK AT THE FOOT BRIDGE FROM COOKE CITY TO THE AMPHITHEATER. SW 1/4 SEC 25, T95, R14E, FWQA STA YP-11, SB-4 LAT 4501000 10956000 LONG	*MISSOURI RIVER	*YELLOWSTONE RIVER
293012*WOODY CR. ABOVE COOKE CITY	*MONTANA	ON WOODY CREEK .125 MILES SOUTH AND ABOVE COOKE CITY, PARK CO., MONT TO REACH POINT DRIVE ACROSS THE BRIDGE OVER SODA BUTTE CREEK AND GO JUST UPSTREAM FROM THE METAL CULVERT OVER WOODY CREEK ON THE NORTH BANK. SW 1/4 SEC 25, T95, R14E, FWQA STA YP-10, SB-5 LAT 4501000 10956000 LONG	*MISSOURI RIVER	*YELLOWSTONE RIVER

STORE#STATION NAME NUMBER	STATE	DESCRIPTION	MAJOR BASIN	MINOR BASIN
293013	*MONTANA	*SODA BUTTE CR. BELOW COOKE CITY ON SODA BUTTE CREEK .75 MILES BELOW AND WEST OF COOKE CITY, PARK CO., MONT. THE SAMPLE COLLECTION POINT CAN BE REACHED BY DRIVING TO THE END OF THE FIRST DIRT ROAD TURNING LEFT OUT OF COOKE CITY AND GOING TO THE NORTH BANK OF THE STREAM SW 1/4 SEC 26, T9S, R14E, FWOA STA YP-9, SB-6 LAT 4501000 10957000 LONG	*MISSOURI RIVER	*YELLOWSTONE RIVER
293014	*MONTANA	*YELLOWSTONE R. BELOW GARDINER ON SHORE OF STREAM NEAR THE NORTH YELLOWSTONE PARK BOUNDARY STATION 4.4 MILES BELOW GARDINER, PARK CO., MONT. SAMPLE COLLECTION POINT IS REACHED BY DRIVING ALONG US-89 ABOVE GARDINER ON EAST SIDE OF RIVER AND CLIMBING DOWN BANK. FLOW FOR THIS STATION IS DETERMINED FROM USGS-6-1915 AT CORWIN SPRINGS, FWOA STA YP-0.5	*MISSOURI RIVER	*YELLOWSTONE RIVER
293015	*MONTANA	*YELLOWSTONE RIVER AT GARDINER AT BANK OF YELLOWSTONE R. OPPOSITE CONCESSIONAIRES WAREHOUSE BLDG. SITE IS REACHED BY CLIMBING DOWN BANK AT US-89, CROSSING AND WALKING UPSTREAM ON NORTH BANK. ACCESS IS DIFFICULT. FWOA STA YP-1	*MISSOURI RIVER	*YELLOWSTONE RIVER
293017	*MONTANA	*GALLATIN R. AT US-191 CROSSING ON THE GALLATIN RIVER AT THE US-191 HIGHWAY CROSSING IN GALLATIN CO., MONTANA, IT IS 23.6 MILES NORTH OF WEST YELLOWSTONE, FWOA STA, YP-47	*MISSOURI RIVER	*YELLOWSTONE RIVER
293018	*MONTANA	*GALLATIN R. AT WEST PARK BOUND. ON GALLATIN RIVER AT THE WEST PARK BOUNDARY, 30.0 MI. NORTH OF WEST YELLOWSTONE ON US-191 IN GALLATIN CO., MONTANA. TAKE SAMPLE FROM STREAM BANK, FWOA STA YP-48 LAT 4502555 11108460 LONG	*MISSOURI RIVER	*YELLOWSTONE RIVER
293019	*MONTANA	*MADISON RIVER NEAR WEST ENTRANCE ON MADISON RIVER 1.5 MI. EAST OF WEST YELLOWSTONE ON THE WEST ENTRANCE ROAD IN GALLATIN COUNTY, MONTANA. TAKE SAMPLE FROM LEFT BANK AT RIVER-SIDE. SW 1/4 SEC 36, T13S, R5E, FWOA STA YP-49 LAT 4439200 11104000 LONG FLOWS FOR THIS STATION FROM USGS 6-0375	*MISSOURI RIVER	*YELLOWSTONE RIVER
293020	*MONTANA	*BEAR CR MINE SPOIL SPILLS BEAR CREEK ABOVE MINE SPOIL PILES AT JARDINE IN PARK COUNTY, MONTANA FWOA - YP-103	*MISSOURI RIVER	*YELLOWSTONE RIVER
293021	*MONTANA	*BEAR CR BELOW MINE SPOIL PILES BEAR CREEK BELOW MINE SPOIL PILES NEAR JARDINE IN PARK COUNTY, MONTANA FWOA YP-104	*MISSOURI RIVER	*YELLOWSTONE RIVER
293022	*MONTANA	*ACID MINE ABOVE COOKE CITY ACID MINE DRAINAGE SEEP WATER FROM MCLAREN MINE TAILINGS AREA ON SODA BUTTE CREEK ABOVE COOKE CITY, PARK CO., MONT., FWOA - ML-2	*MISSOURI RIVER	*YELLOWSTONE RIVER

STORET#STATION NAME NUMBER	*STATE DESCRIPTION	*MAJOR BASIN	*MINOR BASIN
293023*ACID MINE DRAINAGE DISCHARGE	*MONTANA ACID MINE DRAINAGE DISCHARGE WATER FROM MCLAREN MINE TAILINGS AREA ON SODA BUTTE CREEK NEAR OLD SODA BUTTE CHANNEL, PARK CO., MONT., FWQA ML3		*YELLOWSTONE RIVER
571000*SODA BUTTE CREEK AT PARK BOUN.	*WYOMING ON SODA BUTTE CREEK AT THE PARK BOUNDARY IN YELLOWSTONE NATIONAL PARK, WYOMING TO REACH SAMPLE COLLECTION POINT GO .125 MILES SOUTH OF N.E. ENTRANCE STATION TO THE NORTH BANK OF THE STREAM, FWQA STA YP-15, SB-7		*YELLOWSTONE RIVER
571001*SODA BUTTE CREEK NEAR MOUTH	*WYOMING AT SODA BUTTE CREEK 4.5 MI. ABOVE LAMAR RIVER CONFLUENCE IN YELLOWSTONE N.P., WYO. THE COLLECTION POINT IS ON THE WEST BANK OF THE STREAM AT THE END OF THE FOOT TRAIL FROM TROUT LAKE PARKING LOT, FWQA STA YP-8, SB-8		*YELLOWSTONE RIVER
571002*LAMAR RIVER ABOVE MOUTH	*WYOMING LAMAR R 50 YDS UPSTREAM FROM CONFLUENCE WITH YELLOWSTONE R IN YELLOWSTONE NATIONAL PARK, WYO., BSF6W SAMPLE STA LA-1 ANALYSED BY FWQA LAT 4456000 11024000 LONG		*YELLOWSTONE RIVER
571003*LAMAR RIVER NEAR MOUTH	*WYOMING ON LAMAR RIVER ABOVE CONFLUENCE WITH YELLOWSTONE RIVER IN YELLOWSTONE NATIONAL PARK, WYO. TO REACH THE SAMPLE COLLECTION POINT GO 50 YARDS UPSTREAM ON THE NORTH BANK FROM THE BRIDGE AT THE HIGHWAY CROSSING ON NORTHEAST ENTRANCE ROAD. IT MAY BE REACHED BY FOOT TRAIL FROM THE PARKING LOT AT THE BRIDGE. FWQA STA YP-6, LA-2 LAT 4454390 11019240 LONG USE FLOWS FOR USGS STATION 6-1880		*YELLOWSTONE RIVER
571004*YELLOWSTONE R. AT FISHING BRIDGE	*WYOMING ON YELLOWSTONE RIVER AT FISHING BRIDGE IN TETON COUNTY, WYOMING. TAKE GRAND LOOP ROAD TO THE FISHING BRIDGE AND GO TO THE WEST BANK ON THE UPSTREAM SIDE TO REACH COLLECTION POINT. USGS STATION 6-1865 LOCATED ON BRIDGE AT RIVER MILE 594.8 FWQA STA YP-23, YS-1.		*YELLOWSTONE RIVER
571005*GARDINER RIVER BELOW MAMMOTH	*WYOMING ON GARDINER RIVER 1.5 MILES BELOW MAMMOTH, PARK CO., WYO. THE SAMPLE COLLECTION POINT CAN BE REACHED BY DRIVING 1.5 MILES NORTH OF MAMMOTH ON THE NORTH PARK ENTRANCE ROAD AND WALKING 400 FEET UPSTREAM FROM THE HIGHWAY BRIDGE ON THE LEFT BANK. USGS STREAM STATION 6-1910 LOCATED AT THIS SITE. FWQA STA YP-3 LAT 4559350 11041250 LONG		*YELLOWSTONE RIVER
571006*GARDINER RIVER ABOVE MAMMOTH	*WYOMING ON GARDINER RIVER AT THE BRIDGE 7.9 MILES UPSTREAM FROM THE MAMMOTH AREA IN PARK CO., WYOMING. THE SAMPLE COLLECTION POINT CAN BE REACHED FROM THE BRIDGE ON GRAND LOOP ROAD, FWQA STA YP-3.5 LAT 4457240 11040470 LONG		*YELLOWSTONE RIVER

STORE#STATION NAME NUMBER	STATE	DESCRIPTION	MAJOR BASIN	MINOR BASIN
571007	LAVA CREEK	LAVA CREEK PICNIC G*WYOMING AT THE GRAND LOOP CROSSING AT LAVA CREEK PICNIC GROUND IN PARK CO., WYO. 4.6 MILES OUT THE GRAND LOOP ROAD FROM MAMMOTH TOWARD TOWER JUNCTION. SAMPLE FROM BRIDGE. FWQA STA YP-4	MISSOURI RIVER	*YELLOWSTONE RIVER PICNIC GROUND IN PARK CO., WYO.
571008	SLOUGH CREEK ABOVE CAMPGROUND	*WYOMING ON SLOUGH CREEK ABOVE THE SLOUGH CREEK CAMPGROUND IN PARK CO., WYO. SAMPLE POINT IS ON THE BANK AT THE UPSTREAM EDGE OF THE CAMPGROUND AREA FWQA STA YP-7 LAT 4456440 11018180 LONG	MISSOURI RIVER	*YELLOWSTONE RIVER
571009	SLOUGH CREEK BELOW CAMPGROUND	*WYOMING ON SLOUGH CREEK BELOW THE SLOUGH CREEK CAMPGROUND IN PARK COUNTY, WYO. THE SAMPLE POINT IS ON THE BANK AT THE DOWNSTREAM EDGE OF THE CAMPGROUND AREA. FWQA STA YP-7.5 LAT 4456460 11018090 LONG	MISSOURI RIVER	*YELLOWSTONE RIVER
571010	LAMAR R. ABOVE SODA BUTTE INFLOW	*WYOMING ON THE LAMAR RIVER ABOVE THE INFLOW FROM SODA BUTTE CREEK IN PARK CO., WYOMING. TO REACH SAMPLE COLLECTION POINT, WADE SODA BUTTE CREEK MOUTH ON N.E. ENTRANCE HWY. ACCESSIBLE WITH DIFFICULTY ONLY. FWQA STA YP-16	MISSOURI RIVER	*YELLOWSTONE RIVER
571011	YELLOWSTONE R. AT TOWER JUNCTION	*WYOMING ON THE YELLOWSTONE RIVER ONE MILE NORTHEAST OF THE TOWER JUNCTION HWY. BRIDGE ON THE N.E. ENTRANCE HWY. IN YELLOWSTONE N. P. WYOMING. FWQA STA YP-17	MISSOURI RIVER	*YELLOWSTONE RIVER
571012	TOWER CR. NEAR TOWER FALLS	*WYOMING ON TOWER CREEK 2.4 MILES SOUTHEAST OF TOWER JUNCTION IN PARK CO., WYO. SAMPLE POINT IS AT GRAND LOOP ROAD BRIDGE BELOW TOWER FALLS CAMPGROUND. FWQA STA YP-18	MISSOURI RIVER	*YELLOWSTONE RIVER
571013	YELLOWSTONE R. AT THE UPPER FALL	*WYOMING ON THE YELLOWSTONE RIVER AT THE UPPER FALLS IN THE CANYON VILLAGE AREA PARK CO., WYOMING. SAMPLE ABOVE FALLS. FWQA STA YP-20	MISSOURI RIVER	*YELLOWSTONE RIVER
571014	YELLOWSTONE R. IN HAYDEN VALLEY	*WYOMING ON YELLOWSTONE RIVER IN HAYDEN VALLEY. PARK COUNTY, WYOMING. TO REACH WALK IN FROM GRAND LOOP HIGHWAY TROUT CREEK SAMPLE ABOVE CREEK. FWQA STA YP-21	MISSOURI RIVER	*YELLOWSTONE RIVER
571015	YELLOWSTONE R. BELOW FISHING BR.	*WYOMING ON YELLOWSTONE RIVER ABOUT 1.5 MILES BELOW FISHING BRIDGE IN PARK CO., WYOMING. TAKE GRAND LOOP ROAD AND MEASURE DISTANCE FROM FISHING BRIDGE BY CAR ODOMETER. PICK SPOT ON BANK FOR EASY ACCESS. FWQA STA YP-22	MISSOURI RIVER	*YELLOWSTONE RIVER
571016	PELICAN CREEK NEAR MOUTH	*WYOMING ON PELICAN CREEK NEAR MOUTH IN PARK CO., WYOMING. TO REACH SAMPLE COLLECTION POINT GO 1.4 MILES EAST OF FISHING BRIDGE ON EAST ENTRANCE ROAD AND SAMPLE AT ROAD BRIDGE. FWQA STA YP-24	MISSOURI RIVER	*YELLOWSTONE RIVER

STORET*STATION* NAME NUMBER	*STATE	*DESCRIPTION	*MAJOR BASIN	*MINOR BASIN
571017*YELLOWSTONE LAKE IN BRIDGE BAY	*WYOMING	SAMPLE AT BRIDGE ENTRANCE TO BRIDGE BAY MARINA. FWQA STA YP-23	*MISSOURI RIVER	*YELLOWSTONE RIVER
571018*YELLOWSTONE LAKE NEAR DOT ISLAND*WYOMING	*WYOMING	ON YELLOWSTONE LAKE NEAR DOT ISLAND IN TETON CO., WYOMING. BOAT STATION FWQA STA. YP-27	*MISSOURI RIVER	*YELLOWSTONE RIVER
571019*YELLOWSTONE L. INLET TO W. THUMB*WYOMING	*WYOMING	BOAT TO CENTER OF LINE FROM BREEZE POINT TO PUMICE POINT. DURING MAY, SAMPLES COLLECTED BY CHOPPING THROUGH ICE APPROX 100 YDS OFFSHORE FWQA STA. YP-28	*MISSOURI RIVER	*YELLOWSTONE RIVER
571020*YELLOWSTONE L. IN MARY BAY AREA	*WYOMING	ON YELLOWSTONE LAKE IN MARY BAY AREA IN TETON COUNTY, WYOMING. TAKE EAST ENTRANCE ROAD TO VICINITY OF HOLMES POINT AND SAMPLE FROM BANK. FWQA STA YP-29	*MISSOURI RIVER	*YELLOWSTONE RIVER
571021*YELLOWSTONE L. IN FLAT MT. ARM	*WYOMING	ON YELLOWSTONE LAKE IN FLAT MOUNTAIN ARM IN TETON CO., WYOMING. USE BOAT TO REACH SAMPLE POINT. FWQA STA YP-30	*MISSOURI RIVER	*YELLOWSTONE RIVER
571022*YELLOWSTONE L. AT SOUTH ARM	*WYOMING	ON YELLOWSTONE LAKE AT SOUTH ARM IN TETON COUNTY, WYOMING. TAKE A BOAT TO REACH SAMPLE COLLECTION POINT. FWQA STA YP-31	*MISSOURI RIVER	*YELLOWSTONE RIVER
571023*YELLOWSTONE LAKE AT S. EAST ARM	*WYOMING	ON YELLOWSTONE LAKE AT THE SOUTHEAST ARM IN TETON CO., WYOMING. TAKE A BOAT TO REACH SAMPLE COLLECTION POINT. FWQA STA YP-32	*MISSOURI RIVER	*YELLOWSTONE RIVER
571024*YELLOWSTONE L WHERE RIVER ENTERS*WYOMING	*WYOMING	ON YELLOWSTONE LAKE AT ENTRANCE OF RIVER INTO LAKE IN TETON, CO., WYO. TAKE A BOAT TO SAMPLE COLLECTION POINT. FWQA STA YP-33	*MISSOURI RIVER	*YELLOWSTONE RIVER
571025*YELLOWSTONE L. NEAR GRANT V. STP*WYOMING	*WYOMING	ON YELLOWSTONE LAKE NEAR GRANT VILLAGE STP EFFLUENT IN TETON CO., WYO. TAKE BOAT TO REACH SAMPLE COLLECTION POINT, APPROX. 100' OFF OUTFALL MANHOLE ON BANK. FWQA STA YP-34	*MISSOURI RIVER	*YELLOWSTONE RIVER
571026*YELLOWSTONE L. NEAR WEST THUMB	*WYOMING	ON YELLOWSTONE LAKE NEAR THE WEST THUMB AREA IN TETON CO., WYOMING. SAMPLE ABOUT 100' OFFSHORE FROM UNNAMED CREEK SOUTH OF PAINTPOTS. THE SOUTH ENTRANCE ROAD. FWQA STA YP-36	*MISSOURI RIVER	*YELLOWSTONE RIVER
571027*DUCK LAKE NR W. THUMB CAMP GR.	*WYOMING	ON DUCK LAKE NEAR THE WEST THUMB CAMPGROUND IN TETON CO., WYOMING. IT IS THE AREA WATER SUPPLY. WALK IN FROM GRAND LOOP ROAD. FWQA STA YP-37	*MISSOURI RIVER	*YELLOWSTONE RIVER

SECRET-STATION NAME
NUMBER

*STATE *MAJOR BASIN *MINOR BASIN

DESCRIPTION

571036*WADISON R. BELOW WADISON JUNC. CO.*WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON THE MADISON RIVER BELOW THE MADISON JUNCTION CAMPGROUND IN TETON
COUNTY, WYOMING. TAKE SAMPLE FROM BANK AT FIRST TURNOUT ON WEST ENTRANCE
ROAD *WEST OF CAMPGROUND AREA. FWQA STA YP-50

571037*GIBBON R. NEAR FIREHOLE R. JUNC.*WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON GIBBON RIVER NEAR ITS JUNCTION WITH THE FIREHOLE RIVER IN
WYOMING. TAKE THE GRAND LOOP ROAD TO THE BRIDGE SOUTH OF THE AMPHI-
THEATER TO REACH THE SAMPLE COLLECTION POINT. FWQA STA YP-52

571038*GIBBON R. AT GIBBON R. RAPIDS *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON THE GIBBON RIVER AT THE GIBBON RIVER RAPIDS IN PARK CO., WYOMING.
TAKE SAMPLE FROM BANK AT THE SIDE OF GRAND LOOP ROAD FWQA STA YP-53

571039*GIBBON RIVER BELOW NORRIS CAMPGROUND *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON THE GIBBON RIVER AT BRIDGE JUST BELOW NORRIS CAMPGROUND. PARK CO.,
WYOMING. FWQA STA YP-54

571040*FIREHOLE R. AT WADISON JUNCTION *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON FIREHOLE RIVER AT MADISON JUNCTION IN TETON CO., WYOMING. TAKE
SAMPLE FROM BANK OFF FIREHOLE LOOP ROAD. FWQA STA YP-55

571041*FIREHOLE R. BELOW LITTLE FIREHOLE R. *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON FIREHOLE RIVER JUST BELOW CONFLUENCE WITH THE LITTLE FIREHOLE RIVER
IN TETON COUNTY, WYOMING. TAKE SAMPLE FROM BANK AT GRAND LOOP ROAD
TURNOUT .4 MI. BELOW SAPPHIRE POOL. FWQA STA YP-56.5

571042*FIREHOLE R. NEAR KEPLER CASCADES *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON FIREHOLE RIVER NEAR KEPLER CASCADES IN TETON CO., WYOMING. TAKE
SAMPLE AT BRIDGE CROSSING ON GRAND LOOP ROAD AT THE S.E. EDGE OF THE
OLD FAITHFUL AREA. FWQA STA YP-57

571043*SYLVAN LAKE AT EAST ENTRANCE RD. *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON SYLVAN LAKE AT EAST ENTRANCE ROAD 9.6 MI. WEST OF EAST ENTRANCE IN
PARK CO., WYOMING. TAKE SAMPLE FROM BANK. FWQA STA YP-58

571044*MIDDLE CR. AT EAST PARK BOUNDARY *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
ON MIDDLE CREEK AT EAST PARK BOUNDARY AT EAST ENTRANCE ROAD IN PARK
COUNTY, WYOMING. TAKE SAMPLE FROM BANK. FWQA STA YP-59

571045*GRANT VILLAGE STP EFFLUENT *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
AT THE GRANT VILLAGE SEWAGE TREATMENT PLANT IN TETON CO., WYOMING.
FWQA STA YP-35

571046*BRIDGE BAY C.T.P. *WYOMING *MISSOURI RIVER *YELLOWSTONE RIVER
BY BRIDGE BAY SEWAGE TREATMENT PLANT IN TETON CO., WYOMING. COLLECT
INFLUENT AND EFFLUENT SAMPLES AT THIS STATION. FWQA STA YP-26

SECRET-STATION NAME NUMBER	STATE	DESCRIPTION	MAJOR BASIN	MINOR BASIN
571047	WYOMING	LOST CREEK AT GRAND LOOP ROAD BRIDGE BELOW ROOSEVELT LODGE IN PARK COUNTY, WYOMING, FWQA - YP-18.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571048	WYOMING	YELLOWSTONE LAKE ABOUT MIDWAY ON A LINE BETWEEN STEVENSON ISLAND & GULL POINT, TETON CO., WYO., FWQA - YP-27.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571049	WYOMING	GARDNER RIVER AT MAMMOTH AREA INCINERATOR, PARK CO., WYO., FWQA YP-3.4	MISSOURI RIVER	*YELLOWSTONE RIVER
571050	WYOMING	GARDNER RIVER ABOVE MAMMOTH AT MAMMOTH TO TOWER ROAD BRIDGE, PARK CO., WYO., FWQA - YP-3.6	MISSOURI RIVER	*YELLOWSTONE RIVER
571051	WYOMING	SERVICE RD 1.2 MI S OF FISH. BR. YELLOWSTONE LAKE AT SERVICE ROAD 1.2 MILES SOUTH OF FISHING BRIDGE IN TETON COUNTY, WYOMING, FWQA - YP-23.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571052	WYOMING	YELLOWSTONE L. S OF FISH. BR. YELLOWSTONE LAKE AT TURNOUT 2.3 MILES SOUTH OF FISHING BRIDGE, TETON CO., WYO., FWQA - YP-23.8	MISSOURI RIVER	*YELLOWSTONE RIVER
571053	WYOMING	YELLOWSTONE L. E. OF FISH. BR. YELLOWSTONE LAKE AT EAST EDGE OF SQUAW LAKE 3.3 MILES EAST OF FISHING BRIDGE, TETON CO., WYO., FWQA - YP-24.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571054	WYOMING	YELLOWSTONE L. S. OF FISH. BR. YELLOWSTONE LAKE AT TURNOUT NEAR GULL POINT DRIVE 5.8 MILES SOUTH OF FISHING BRIDGE, TETON CO., WYO., FWQA - YP-25.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571055	WYOMING	YELLOWSTONE L. S. OF FISH. BR. YELLOWSTONE LAKE AT TURNOUT 16.1 MILES SOUTH OF FISHING BRIDGE, TETON CO., WYO., FWQA - YP-28.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571056	WYOMING	YELLOWSTONE L. E. OF FISH. BR. YELLOWSTONE LAKE AT BOAT LAUNCH AREA-7.2 MILES EAST OF FISHING BRIDGE, TETON CO., WYO., FWQA-YP-29.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571057	WYOMING	MADISON R. W. OF MADISON JCT. MADISON RIVER AT WEST ENTRANCE ROAD CROSSING ABOUT 5 MILES WEST OF MADISON JUNCTION IN TETON COUNTY, WYOMING, FWQA - YP-49.5	MISSOURI RIVER	*YELLOWSTONE RIVER
571058	WYOMING	GIBBON AT UPPER END OF ELK PARK GIBBON RIVER AT UPPER END OF ELK PARK, JUST BELOW NORRIS CAMPGROUND AREA IN PARK COUNTY, WYOMING, FWQA - YP-53.5	MISSOURI RIVER	*YELLOWSTONE RIVER

STORE#STATION NAME NUMBER	*STATE DESCRIPTION	*MAJOR BASIN	*MINOR BASIN
571059#GIBBON R UPSTM FEM NORRIS CAMP.	*WYOMING GIBBON RIVER AT BRIDGE ON CANYON TO NORRIS ROAD JUST UPSTREAM OF THE NORRIS CAMPGROUND IN PARK COUNTY, WYOMING. FWQA - YP-54.5		*YELLOWSTONE RIVER
571060#FIREHOLE R AT BRIDGE	*WYOMING FIREHOLE RIVER AT BRIDGE JUST NORTH OF OLD FAITHFUL AREA, TETON CO., WYO., FWQA- YP-56.8		*YELLOWSTONE RIVER
571061#FIREHOLE RIVER AT SERVICE ROAD	*WYOMING FIREHOLE RIVER AT SERVICE ROAD AT OLD FAITHFUL WATER SUPPLY DAM, TETON CO., WYO., FWQA - YP-57.5		*YELLOWSTONE RIVER
571062#IRON SPR. CR BLW OLD FATH LAGOON	*WYOMING IRON SPRING CREEK BELOW OLD FAITHFUL LAGOONS, TETON CO., WYO., FWQA YP-57.7		*YELLOWSTONE RIVER
571063#IRON SP CR ABOVE OLD FAITH LAGN	*WYOMING IRON SPRING CREEK ABOVE OLD FAITHFUL LAGOONS, TETON CO., WYO., FWQA YP-57.8		*YELLOWSTONE RIVER
571064#CANYON VILLAGE STP INF. AND EFF.	*WYOMING CANYON VILLAGE STP-INFLUENT AND EFFLUENT, PARK CO., WYO., FWQA - YP 19.5		*YELLOWSTONE RIVER
571972#HEART LAKE OUTLET	*WYOMING AT THE HEART LAKE OUTLET IN TETON CO., WYOMING. WALK IN-COLLECTION BY NPS. FWQA YP-46		*COLUMBIA
571993#SHOSHONE LAKE NEAR PATROL CABIN	*WYOMING ON SHOSHONE LAKE NEAR PATROL CABIN IN TETON CO., WYOMING. WALK IN TO SAMPLE POINT-COLLECTION BY NPS. FWQA STA YP-45		*COLUMBIA
571994#LEWIS LAKE AT INLET TO LAKE	*WYOMING ON LEWIS LAKE AT INLET TO LAKE IN TETON CO., WYOMING. FWQA STA YP-44		*COLUMBIA
571995#LEWIS LAKE AT LEWIS L. CAMP AREA	*WYOMING ON LEWIS LAKE AT LEWIS LAKE CAMPGROUND IN TETON CO., WYOMING. SAMPLE BY WADING INTO LAKE. FWQA STA YP-43		*COLUMBIA
571996#LEWIS R AT S. ENTRANCE RD BRIDGE	*WYOMING ON THE LEWIS RIVER AT THE SOUTH ENTRANCE ROAD BRIDGE CROSSING 10.4 MI. NORTH OF SOUTH ENTRANCE ON SOUTH ENTRANCE ROAD IN TETON CO., WYOMING. SAMPLE AT BRIDGE. FWQA STA YP-42		*COLUMBIA
571997#SNAKE R. ABOVE LEWIS R. JUNC.	*WYOMING ON SNAKE RIVER ABOVE ITS JUNCTION WITH THE LEWIS RIVER IN TETON CO., WYOMING. WALK TO SAMPLE COLLECTION POINT FROM THE SOUTH ENTRANCE RANGER STATION. ACCESSIBLE ONLY WITH DIFFICULTY. FWQA STA YP-41		*COLUMBIA
571998#SNAKE R. AT SOUTH PARK BOUNDARY	*WYOMING ON SNAKE RIVER AT THE SOUTH PARK BOUNDARY ON US-89 AT THE SOUTH ENTRANCE RANGER STATION IN TETON CO., WYOMING. FWQA STA. YP-40		*COLUMBIA

APPENDIX C
Automatic Monitor Operation

A Schneider Instrument Company Model RM-25 Robot Water Quality Monitor was mounted in a 3/4 ton carryall type vehicle provided with pumps and generators for completely independent operation at selected locations in conjunction with field data collection efforts.

The Robot Monitoring equipment was used at five predetermined locations throughout the study area to record the diurnal effect, if any, over a forty-eight hour period to assist in evaluating other biological and chemical data. The parameters recorded were temperature, conductivity, dissolved oxygen and pH.

A brief description of each location, pump placement and weather conditions during the recording time is listed below:

Site 1

This location was on the south side of West Thumb near Grant Village, approximately one-half mile west of the STP discharge. This site was as close to the discharge as the vehicle could get because of the terrain along the lake shore. The chemical and microbiological analyses for this area are at Station 571026.

A submersible pump was rigged with a float and anchored about eighty feet offshore. Water depth at this point was ten to twelve feet. The pump intake was eighteen inches below the surface. Floats were taped to the intake hose and electric cable at fifteen foot intervals back to the shore.

Operation of the monitor began at 1200, July 9, 1970. Data recording was from 1800, July 9, 1970, to 1600, July 11, 1970. The weather conditions during the recording time were overcast with intermittent rain.

The Lake surface in this area was partly covered with pine pollen but seemed to have no ill effects except for appearance.

Site 2

This location was at the west end of Fishing Bridge (571004), about 0.2 of a mile downstream from the Lake on the Yellowstone River. The River at this point was approximately 300 feet wide with a channel depth of about ten feet.

The pump was hung from the bridge, on a cable, about 100 feet from the bank with the pump intake eighteen inches below the surface. The intake hose and power cable was taped to the railing.

Recording time was from 1900, July 11, 1970, to 0700, July 14, 1970. The weather conditions varied from cloudy to overcast with sleet and rain showers to clear and calm.

Site 3

The Firehole River location (571041) was in Bisquit Basin about two miles below the activity in the Old Faithful Area. A footbridge, leading to a large geyser, crossed the River 200 feet below the confluence of the Little Firehole and West Fork Rivers. At this point the River was approximately sixty feet wide and two to three feet deep. A pump was anchored with a cable near the center of the bridge with the intake one foot below the water surface. Some record was lost during the night of July 17, 1970, because algae accumulated on the pump screen stopping the flow to the monitor. The pump was moved to the downstream side of a bridge piling and operated one extra day with no problem.

During the day, the turbidity in the River would change rapidly, caused by a road construction project about one-half mile upstream. Weather conditions during this recording period were clear and calm.

A large amount of the River flow appeared to be from the geyser water entering along the banks of the two tributaries and the main stream.

Data collected at this point was from 1000, July 15, 1970, to 0900, July 18, 1970.

Site 4

This location was near the west entrance of the Park on the Madison River (293019). The site was at a U.S.G.S. gage station about one mile east of the Park entrance on a service road. This segment of the River averaged approximately 150 feet wide and 2 to 2.5 feet deep, with an estimated velocity of three feet/second. A submersible pump was anchored on some rocks in the main flow, about eighteen feet from the bank.

Weather conditions during the recording period were clear and calm. The chart data covered a period from 1200, July 18, 1970, to 1300, July 20, 1970.

Site 5

The final location was near the north entrance to the Park on the Gardner River (571005). This site was about 2.5 miles above the confluence with the Yellowstone River.

The stream at this point was estimated to be forty feet wide with an average depth of three feet. The pump was placed in the main channel and anchored to rocks with the intake one foot below the surface. Water velocity was estimated to be five or six feet/second.

Weather conditions during the recording time varied from clear to cloudy with rain.

Data recorded was from 1800, July 20, 1970, to July 22, 1970.

Recorded parameter values from each location were taken at four hour intervals from each chart and are presented in Tables C-1 through C-5. The tables are also shown in graph form.

The West Thumb and Yellowstone River locations indicated very little change in the parameters during a twenty-four hour period. Slight changes attributable to rainfall periods were recorded but due to the high dilution available for wastes discharged to the streams, no biological responses were noted.

Some trouble was encountered periodically in the electrical circuit of the temperature parameter. During the day, several checks were made with a thermometer to keep the data as reliable as possible.

Because of the time spent in close surveillance of the unit at each location, the data collected is reliable and useful in evaluating the water quality at the monitoring locations.

TABLE C-1

GARDNER RIVER - YELLOWSTONE PARK

Date	Time MST	Water Temp. °F	Cond. µmhos	DO mg/l	pH	Remarks
7/20/70	1800	71.5	460	7.2	7.30	Clear,
	2200	67.5	465	7.1	7.30	calm
7/21/70	0200	65.0	470	7.2	7.30	Cloudy,
	0600	61.5	470	7.5	7.30	light
	1000	62.5	460	7.8	7.35	rain
	1400	70.0	470	7.5	7.35	
	1800	68.5	475	7.2	7.35	
	2200	64.5	460	7.4	7.35	
7/22/70	0200	--	450	7.6	7.35	Cloudy,
	0600	57.5	455	7.9	7.38	rained
	1000	58.5	455	8.0	7.40	during
	1400	64.0	455	7.8	7.40	night and
	1730	63.5	450	7.8	7.40	most of day

TABLE C-2

MADISON RIVER - YELLOWSTONE PARK

Date	Time MST	Water Temp. °F	Cond. µmhos	DO mg/l	pH	Remarks
7/18/70	1200	73.0	425	6.9	7.80	Clear, calm
	1600	77.5	435	6.8	7.95	
	2000	75.5	445	6.8	8.00	
	2400	--	445	6.4	7.80	
7/19/70	0400	68.5	440	6.4	7.70	Clear, calm
	0800	68.0	440	6.8	7.75	
	1200	74.5	445	7.0	7.90	
	1600	77.0	440	6.9	8.00	
	2000	72.0	445	6.8	8.00	
	2400	68.0	440	6.4	7.80	
7/20/70	0400	65.5	440	6.5	7.75	Clear, calm
	0800	--	440	7.0	7.80	
	1200	72.5	445	7.0	7.90	
	1300	75.0	445	7.1	7.95	

TABLE C-3

FIREHOLE RIVER - YELLOWSTONE PARK

Date	Time MST	Water Temp. °F	Cond. µmhos	DO mg/l	pH	Remarks
7/15/70	1000	63.0	280	7.8	7.90	Partly
	1400	74.0	280	7.7	8.13	cloudy,
	1800	77.5	280	7.1	8.05	light
	2200	70.0	280	6.0	7.55	wind
7/16/70	0200	64.0	290	6.1	7.45	Partly
	0600	61.0	280	-	7.45	cloudy,
	1000	65.5	295	7.7	7.80	calm
	1400	75.5	280	7.7	8.10	
	1800	76.5	285	6.9	8.10	
	2200	--	-	-	--	
7/17/70	0200	--	-	-	--	Algae covering pump intake
	0600	--	-	-	--	
	1000	69.0	270	8.0	7.90	Readings during serv.
	1400	75.0	280	7.7	8.05	Partly
	1800	78.0	280	7.1	8.05	cloudy,
	2200	--	285	6.0	7.50	windy
7/18/70	0200	68.5	290	6.0	7.45	
	0600	64.0	275	6.3	7.40	Clear,
	0900	66.5	300	7.4	7.80	calm

TABLE C-4

FISHING BRIDGE - YELLOWSTONE PARK

Date	Time MST	Water Temp. °F	Cond. µmhos	DO mg/l	pH	Remarks
7/11/70	1900	57.5	105	8.0	7.35	Cloudy
	2300	56.5	105	7.8	7.30	
7/12/70	0300	56.0	105	7.7	7.20	Rain
	0700	57.5	110	7.6	7.30	showers,
	1100	60.0	115	7.8	7.35	some
	1500	61.0	110	7.9	7.45	sleet
	1900	60.0	115	8.1	7.45	
	2300	57.5	110	8.0	7.40	
7/13/70	0300	--	110	8.3	7.40	Rain
	0700	54.0	115	8.5	7.35	showers
	1100	56.0	110	8.0	7.30	
	1500	57.5	115	7.9	7.40	
	1900	58.5	110	7.9	7.55	
	2300	56.5	115	8.1	7.45	
7/14/70	0300	--	110	8.1	7.35	Clear,
	0700	54.5	110	8.0	7.35	calm

TABLE C-5

YELLOWSTONE LAKE - WEST THUMB

Date	Time MST	Water Temp. °F	Cond. µmhos	DO mg/l	pH	Remarks
7/9/70	1800	56.5	110	8.6	7.60	Cloudy, calm
	2200	55.0	110	8.4	7.55	
7/10/70	0200	54.0	110	8.2	7.55	Rain and fog
	0600	55.0	110	8.2	7.50	
	1000	55.0	110	8.3	7.55	
	1400	57.0	115	8.3	7.50	
	1800	56.0	120	8.4	7.60	
	2200	--	115	8.5	7.55	
7/11/70	0200	--	115	8.5	7.50	Cloudy, light rain
	0600	54.5	110	8.3	7.55	
	1000	54.5	105	8.4	7.35	
	1400	55.0	110	8.6	7.30	
	1600	56.5	110	8.9	7.25	

APPENDIX D
Summary of Water Quality Data

STORET DATE 72/11/28

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WARM R AT WM. R. RR STATIONS
16 IOAHO
PACIFIC NORTHWEST
SNAKE RIVER
1117M8R
0000 77777777

INDEX 1021500	PARAMETER	TEMP	CENT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
MILES 1149.40	00010 WATER	TEMP	CENT	1	12.0000					12.0000	12.0000	70/07/30	70/07/30
	00020 AIR	TEMP	CENT	1	13.0000					18.0000	16.0000	70/07/30	70/07/30
	00070 TURB	JKSN	JTU	1	.600000					.600000	.600000	70/07/30	70/07/30
	00095 CNDUCTVY	AT 25C	MICROMHJ	1	117.000					117.000	117.000	70/07/30	70/07/30
	00300 DO		MG/L	1	10.0000					10.0000	10.0000	70/07/30	70/07/30
	00400 PH		SU	1	7.90000					7.90000	7.90000	70/07/30	70/07/30
	00403 LAB	PH	SU	1	7.50000					7.50000	7.50000	70/07/30	70/07/30
	00410 T ALK	CAC03	MG/L	1	44.0000					44.0000	44.0000	70/07/30	70/07/30
	00500 RESIDUE	TOTAL	MG/L	1	135.000					139.000	139.000	70/07/30	70/07/30
	00515 RESIDUE	DISS-105	MG/L	1	99.0000					99.0000	99.0000	70/07/30	70/07/30
	00610 NH3-N	TOTAL	MG/L	1	.000000					.000000	.000000	70/07/30	70/07/30
	00625 TOT KJEL	N	MG/L	1	.300000					.300000	.300000	70/07/30	70/07/30
	00630 N2END03	N-TOTAL	MG/L	1	.040000					.040000	.040000	70/07/30	70/07/30
	00665 PHOS-T	P-WET	MG/L	1	.030000					.030000	.030000	70/07/30	70/07/30
	00680 T ORS C	C	MG/L	1	4.30000					4.30000	4.30000	70/07/30	70/07/30
	00915 CALCIUM	CA, DISS	MG/L	1	7.70000					7.70000	7.70000	70/07/30	70/07/30
	00925 MGNSTUM	MG, DISS	MG/L	1	2.00000					2.00000	2.00000	70/07/30	70/07/30
	00930 SODIUM	NA, DISS	MG/L	1	13.0000					13.0000	13.0000	70/07/30	70/07/30
	00935 PTSSIUM	K, DISS	MG/L	1	1.80000					1.80000	1.80000	70/07/30	70/07/30
	00940 CHLORIDE	CL	MG/L	1	5.00000					5.00000	5.00000	70/07/30	70/07/30
	00945 SULFATE	SO4	MG/L	1	5.00000					5.00000	5.00000	70/07/30	70/07/30
	00950 FLUORIDE	F, DISS	MG/L	1	2.10000					2.10000	2.10000	70/07/30	70/07/30
	00955 SILICA	DISOLVED	MG/L	1	41.0000					41.0000	41.0000	70/07/30	70/07/30
	01005 BARIUM	BA, DISS	UG/L	1	.000000					.000000	.000000	70/07/30	70/07/30
	01040 COPPER	CU, DISS	UG/L	1	.000000					.000000	.000000	70/07/30	70/07/30
	01045 IRON	TOTAL	UG/L	1	.000000					.000000	.000000	70/07/30	70/07/30
	01049 LEAD	PB, DISS	UG/L	1	.000000					.000000	.000000	70/07/30	70/07/30
	01055 MANGNESE	MN	UG/L	1	.000000					.000000	.000000	70/07/30	70/07/30
	01090 ZINC	ZN, DISS	UG/L	1	.000000					.000000	.000000	70/07/30	70/07/30
	70507 PHOS-T	ORTHO	MG/L P	1	.000000					.000000	.000000	70/07/30	70/07/30

STREET DATE 12/1/20

160-99
44 05 00.0 111 13 00.0 3
FALLS E. BELOW BECHLER A. JUNIC
16 10400
PACIFIC NORTHWEST
SHAKE
1117MR
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77777777

PARAMETER	TEMP	CENT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER	TEMP	CENT	2	13.2500	3.12500	1.76777	.133416	1.25000	14.5000	12.0000	70/07/17	70/07/30
00020 AIR	TEMP	CENT	2	21.0000	2.00000	1.41421	.067343	1.00000	22.0000	20.0000	70/07/17	70/07/30
00070 TH3	JKN	JTU	2	.500000	.000000	.000000	.000000	.000000	.500000	.500000	70/07/17	70/07/30
00095 CNUJCTVY	AT 25C	MICROMHU	2	132.500	59.0000	9.89949	.074996	7.00000	139.000	125.000	70/07/17	70/07/30
00300 DO		MG/L	2	8.69399	.020203	.142136	.015970	1.00505	9.00000	8.80000	70/07/17	70/07/30
00400 PH		SU	2	8.00000	.180008	.424273	.053034	.300007	8.30000	7.70000	70/07/17	70/07/30
00430 LA3	PH	SU	2	7.65000	.004990	.070637	.009234	.043348	7.70000	7.60000	70/07/17	70/07/30
00410 T ALK	CAC03	MG/L	2	43.0000	18.0000	4.24264	.098666	3.00000	46.0000	40.0000	70/07/17	70/07/30
00500 RESIDUE	TOTAL	MG/L	2	155.000	200.000	14.1421	.091240	10.0000	165.000	145.000	70/07/17	70/07/30
00515 RESIDUE	DISS-105	MG/L	2	120.000	392.000	19.7990	.164992	14.0000	134.000	106.000	70/07/17	70/07/30
00610 NH3-N	TOTAL	MG/L	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/07/30
00625 TOT KJEL	N	MG/L	2	.030000	.232E-09	.000000	.000000	.000000	.030000	.030000	70/07/17	70/07/30
00630 N2EM03	N-TOTAL	MG/L	2	.010000	.145E-10	.000000	.000000	.000000	.010000	.010000	70/07/17	70/07/30
00665 PHOS-T	P-MET	MG/L	2	.010000	.145E-10	.000000	.000000	.000000	.010000	.010000	70/07/17	70/07/30
00690 T ORG C	C	MG/L	2	.010000	.145E-10	.000000	.000000	.000000	.010000	.010000	70/07/17	70/07/30
00315 CALCIUM	CA+DISS	MG/L	2	5.85000	23.8050	4.87904	.834023	3.45000	9.30000	2.40000	70/07/17	70/07/30
00525 MAGSIUM	MAGDISS	MG/L	2	3.95000	.005005	.070745	.017910	.050024	4.00000	3.90000	70/07/17	70/07/30
00530 SODIUM	NA+DISS	MG/L	2	20.5000	4.50000	2.12132	.103479	1.50000	22.0000	19.0000	70/07/17	70/07/30
00335 PTSSIM	K+DISS	MG/L	2	3.30000	.020004	.141436	.042860	1.00011	3.40000	3.20000	70/07/17	70/07/30
00340 CHLORIDE	CL	MG/L	2	5.00000	7.00000	1.41421	.157135	1.00000	10.0000	6.00000	70/07/17	70/07/30
00345 SULFATE	SO4	MG/L	2	4.20000	.160008	.424273	.101017	.300007	4.50000	3.90000	70/07/17	70/07/30
00950 FLUORINE	F+DISS	MG/L	2	2.95000	.244995	.494970	.167786	.349997	3.30000	2.60000	70/07/17	70/07/30
00555 SILICA	DISOLVED	MG/L	2	36.5000	12.5000	3.53553	.096864	2.50000	39.0000	34.0000	70/07/17	70/07/30
01005 BARIUM	BA+DISS	UG/L	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/07/30
01040 COPPER	CU+DISS	UG/L	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/07/30
01045 IRON	TOTAL	UG/L	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/07/30
01045 LEAD	PB+DISS	UG/L	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/07/30
01055 MANGNESE	MN	UG/L	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/07/30
01030 ZINC	ZN+DISS	UG/L	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/17	70/07/30
01050 PHOS-T	PTHO	MG/L P	2	.005000	.000050	.007071	1.41421	.005000	.010000	.000000	70/07/17	70/07/30

SIGREI DATE 2/11/23

170367

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SODA BUTTE CR. AT COOKE CITY
MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
117MR
0000 77777777

INDEX 1021500
MILES 1149.40
PARAMETER
70507 PHOS-T

NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
9	.018000	.000766	.028036	1.55754	.009345	.090000	.000000	69/05/17	70/08/02

45/L p

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24302

45 01 00 J 10 50 00 J 3
ADCOY C. ABOVE CLARK CITY
00 MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
1117MEK 77777777
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[illegible]

START DATE 12/11/23

233015
45 02 00.0 110 42 30.0 3
YELLOWSTONE RIVER AT GARDINER
30 MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR
0000
77777777

INDEX 1021500
MILES 1149.40

PARAMETER	TEMP	UNIT	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00020 AIR	TEMP	CENT	12.0000	47.8333	6.91616	.576347	3.45808	20.0000	5.50000	70/05/07	70/08/01
00070 TURB	JKSN	CENT	18.5000	107.0000	10.3441	.559139	5.17204	32.0000	9.00000	70/05/07	70/08/01
00095 CONDUCTVY	AT 25C	MICRONHD	8.05000	45.4767	6.74364	.837720	3.37182	16.0000	1.00000	70/05/07	70/08/01
00300 DT		MG/L	117.250	907.583	30.1261	.256939	15.0631	161.000	92.0000	70/05/07	70/08/01
00400 PH		SU	9.09999	.853392	.945194	.103868	.472597	10.4000	8.40000	70/05/07	70/08/01
00400 PH		SU	7.42500	.249237	.499236	.067237	.249618	8.10000	6.90000	70/05/07	70/08/01
00410 T ALK	PH	SU	7.45000	.043386	.208293	.027959	.104146	7.70000	7.20000	70/05/07	70/08/01
00500 RESIDUE	CACN3	MG/L	41.0000	75.3333	8.67948	.211695	4.33374	54.0000	36.0000	70/05/07	70/08/01
00510 RESIDUE	TOTAL	MG/L	128.667	179.435	42.3598	.329221	24.4564	162.000	51.0000	70/05/07	70/07/22
00610 NH3-N	NISS-105	MG/L	100.333	1302.35	36.0831	.359682	20.8354	142.000	79.0000	70/05/07	70/07/22
00625 TOT KJEL	TOTAL	MG/L	0.50000	.002533	.050332	1.00664	.025166	1.20000	.000000	70/05/07	70/08/01
00630 NDT-VN3	N	MG/L	1.67500	.008092	.039953	.537036	.044977	3.00000	1.00000	70/05/07	70/08/01
00660 PHOS-T	N-TOTAL	MG/L	0.65000	.001500	.038730	.595845	.019365	1.20000	.030000	70/05/07	70/08/01
00670 T ORG C	P-WET	MG/L	0.95000	.007367	.085829	.703467	.042915	2.00000	.020000	70/05/07	70/08/01
00915 CALCIUM	C	MG/L	4.40000	10.7467	3.27621	.745049	1.63911	9.20000	2.20000	70/05/07	70/08/01
00925 MGNSTIUM	CA, DISS	MG/L	8.80000	5.59334	2.36502	.268753	1.18251	12.0000	6.50000	70/05/07	70/08/01
00930 SODIUM	MG, DISS	MG/L	3.37500	.049164	.221729	.065697	.110865	3.60000	3.10000	70/05/07	70/08/01
00935 PTSSIUM	NA, DISS	MG/L	10.2000	19.4934	4.41513	.432856	2.20757	16.0000	5.80000	70/05/07	70/08/01
00940 CHLORIDE	K, DISS	MG/L	2.32500	.982503	.991213	.426328	.495606	3.40000	1.00000	70/05/07	70/08/01
00945 SULFATE	CL	MG/L	5.00000	4.66667	2.16025	.432049	1.08012	8.00000	3.00000	70/05/07	70/08/01
00950 FLUORIDE	SO4	MG/L	17.0000	116.667	10.8012	.635367	5.40062	33.0000	10.0000	70/05/07	70/08/01
00955 SILICA	F, DISS	MG/L	4.75000	.042500	.206155	.434011	1.03078	7.00000	2.00000	70/05/07	70/08/01
01000 ARSENIC	DISSOLVED	MG/L	15.0000	2.00000	1.41421	.094281	1.00000	16.0000	14.0000	70/07/22	70/08/01
01005 BARIUM	AS, DISS	UG/L	63.3333	3433.34	58.5947	.33.8296	33.8296	130.000	20.0000	70/05/07	70/08/01
01020 BORON	BA, DISS	UG/L	0.00000	.000000	.000000	.925179	.000000	.000000	.000000	70/05/07	70/08/01
01040 COPPER	R, DISS	UG/L	176.667	933.375	30.5512	.172931	17.6387	210.000	150.000	70/05/07	70/08/01
01045 IRON	CU-DISS	UG/L	1050.00	752400	867.410	.826105	433.705	1800.00	240.000	70/05/07	70/08/01
01049 LEAD	TOTAL	UG/L	0.00000	.000000	.000000	1.45138	.000000	.000000	.000000	70/05/07	70/08/01
01055 MANGNESE	PB, DISS	UG/L	32.5000	2225.00	47.1699	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01090 ZINC	MN	UG/L	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01093 ZN MUJ	ZN, DISS	MG/KG-ZN	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01145 SELFNIUM	DRY WGT	UG/L	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
09503 RA-226	SE, DISS	UG/L	1.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
22703 U-NAT	DISSOLVED	UG/L	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
38260 N2AS	DISSOLVED	MG/L	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
39305 NDE	4HL S4PL	UG/L	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/07/22
39370 DDT	4HL S4PL	UG/L	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/22	70/08/01
70507 PHOS-T	ORTHO	UG/L P	0.00000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/22	70/08/01

44 57 30.0 111 05 00.0 3
GALLATIN R. AT US-191 CROSSING
30 MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
1.17MAR
0000 77777777

TEMP	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
CENT	2	14.5000	4.5000	2.12132	-1.46293	1.50000	16.0000	13.0000	70/07/17	70/07/30
CENT	2	23.5000	40.5000	6.36396	-270937	4.50000	29.0000	13.5000	70/07/17	70/07/30
FLOW	2	184.5000	5724.50	75.6604	-410084	53.5000	238.000	131.000	70/07/17	70/07/30
JKSN	2	950000	005001	070719	074440	050005	1.00000	900000	70/07/17	70/07/30
AT25C	2	269.5000	220.5000	14.8492	0.55039	10.5000	280.000	259.000	70/07/17	70/07/30
	2	7.550000	2.205000	1.48493	1.96679	1.05000	8.60000	6.50000	70/07/17	70/07/30
W5/L	2	8.24999	045227	212666	0.25778	1.50376	8.40000	8.10000	70/07/17	70/07/30
P4	2	8.10000	000031	005524	0.00682	0.03306	8.10000	8.10000	70/07/17	70/07/30
CAC03	2	109.5000	000031	005524	0.00682	0.03306	111.0000	106.000	70/07/17	70/07/30
TOTAL	2	237.0000	12.5000	3.53553	0.032586	2.50000	237.000	237.000	70/07/17	70/07/17
DISS-105	1	190.0000	000200	0.014142	1.41421	01.0000	020000	190.000	70/07/17	70/07/17
TOTAL	1	010000	036450	1.90919	1.41421	1.35000	0270000	000000	70/07/17	70/07/30
N	2	135000	036450	1.90919	1.41421	1.35000	0270000	000000	70/07/17	70/07/30
-TOTAL	2	010000	1455-10	000000		050000	010000	010000	70/07/17	70/07/30
P-WET	2	080000	005000	070711	-883883	050000	030000	030000	70/07/17	70/07/30
C	2	7.05000	045013	212164	030094	150022	7.20000	6.90000	70/07/17	70/07/30
A, DISS	2	28.5000	180.5000	13.43350	471404	9.50000	38.0000	19.0000	70/07/17	70/07/30
G, DISS	2	9.20000	13.5201	3.67697	399670	2.60001	11.8000	6.60000	70/07/17	70/07/30
A, DISS	2	1.75000	005002	070725	040414	050010	1.80000	1.70000	70/07/17	70/07/30
K, DISS	2	1.000000	179999	424263	424263	300000	1.30000	700000	70/07/17	70/07/30
CL	2	250000	125000	353533	1.41421	250000	500000	000000	70/07/17	70/07/30
S04	2	31.5000	24.5000	4.94975	157135	350000	35.0000	26.0000	70/07/17	70/07/30
F, DISS	2	15.5000	005000	070711	471404	050000	200000	100000	70/07/17	70/07/30
ISOLVED	2	15.5000	4.50000	2.12132	136859	1.50000	17.0000	14.0000	70/07/17	70/07/30
AA, DISS	2	000000	000000	000000		000000	000000	000000	70/07/17	70/07/30
CU-DISS	2	000000	000000	000000		000000	000000	000000	70/07/17	70/07/30
TOTAL	2	90.0000	16200.0	127.279	1.41421	90.0000	180.000	000000	70/07/17	70/07/30
B, DISS	2	000000	000000	000000		000000	000000	000000	70/07/17	70/07/30
W	2	000000	000000	000000		000000	000000	000000	70/07/17	70/07/30
N, DISS	2	15.0000	450.000	21.2132	1.41421	15.0000	30.0000	020000	70/07/17	70/07/30
ORTHO	2	020000	232E-09	000000		000000	020000	020000	70/07/17	70/07/30

293018
45 02 55.5 11 08 46.0 3
GALLATIN R. AT WEST PARK BOUND.
00 MONTANA
00 MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

[illegible]

STATION DATE 72/11/73

293012
 02 55.2 111 08 46.3 3
 CALLATIN 2. AT WEST PARK BRUND.
 00 MONTANA
 MISSOURI RIVER
 YELLOWSTONE RIVER
 117MBR 7777777
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INDEX 1021503
 MILES 1149.40

PARA4ETER

31615 FEC COL:

21673 FECSTREP

32730 PHENJLS

38260 MRAS

70507 PHOS-T

4FM-FCBR

4KFCAGAP

URTHO

/1004L

/1004L

J3/L

43/L

4G/L P

NUMBER

MEAN

VARIANCE

STAN DEV

COEF VAR

STAND ER

MAXIMUM

MINIMUM

BEG DATE

END DATE

9

39.3333

1811.75

42.5647

1.11038

4

88.7500

10199.2

100.986

1.46889

2

1.40000

.500000

.707107

.505076

3

.010000

.000100

1.00000

.005773

4

.031750

.001058

.032520

1.02427

.016260

.090000

.020000

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70/08/19

70/08/16

70/08/16

70/08/19

70/05/23

70/05/08

70/05/08

70/05/08

70/07/30

70/07/30

44 35 20.0 111 04 00.0 3
MADISON RIVER NEAR WEST ENTRANCE
60 MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

D-17

STOPPED DATE 72/11/73

233019
44 35 20.0 111 04 00.0 3
MADISON RIVER NEAR WEST ENTRANCE
60 MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR
0000
77777777

INDEX 1021500
MILES 1142.40
PARAMETER
31615 FEC COLI
31673 FECSTREP
32730 PHENJLS
38260 MBAS
39365 DDE
39370 DDT
70507 PHOS-T
71503 MERCURY

PARAMETER	UNIT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
YF4-ECAP	/100ML	12	63.3333	6984.06	83.5707	1.31954	24.1243	280.000	5.00000	70/05/18	70/08/19
YF4-FACAP	/100ML	6	48.0000	92.8000	9.63327	.200693	3.93277	66.0000	40.0000	70/08/12	70/08/19
	UG/L	2	3.10000	6.40000	2.54558	.821156	1.30000	4.90000	1.30000	70/05/08	70/05/23
	MG/L	3	.020000	.000400	.020000	1.000000	.011547	.040000	.000000	70/05/08	70/07/30
4HL SMPL	UG/L	1	.060000					.060000	.060000	70/07/23	70/07/23
4HL SMPL	UG/L	1	.010000					.010000	.010000	70/07/23	70/07/23
ORTHO	UG/L P	4	.106000	.004421	.066488	.627247	.033244	.160000	.009000	70/05/08	70/07/30
HG,TOTAL	UG/L	4	1.72500	.209167	.457348	.265129	.228674	2.40000	1.40000	70/05/08	70/07/30

45 04 10.0 110 37 45.0 2
BEAR CR WINE SPOIL SPILLS
30 MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
11174BR
0000 777777

1174B

PARAMETER	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
TEMP WATER	CENT	14.0000	32.0000	5.65685	.404061	4.00000	18.0000	10.0000	70/07/22	70/08/01
TEMP AIR	CENT	24.7500	105.125	10.2530	.414265	7.25000	32.0000	17.5000	70/07/22	70/08/01
JKSN	TU	13.2500	325.125	18.0312	1.36085	12.7500	26.0000	.500000	70/07/22	70/08/01
CONDCTV AT 25C	MICROMHO	74.0000	58.0000	9.89949	.133777	7.00000	81.0000	67.0000	70/07/22	70/08/01
DJ	UG/L	8.39999	.080185	.283169	.033711	2.00231	8.60000	8.20000	70/07/22	70/08/01
PH	SU	7.20000	.319992	.565678	.078566	.399995	7.60000	6.80000	70/07/22	70/08/01
LAB	SU	7.05000	.005020	.070853	.010050	.050101	7.10000	7.00000	70/07/22	70/08/01
TALEK	MG/L	35.0000	18.0000	4.24264	.121218	3.00000	38.0000	32.0000	70/07/22	70/08/01
RESIDUE TOTAL	MG/L	216.500	1200.250	34.6482	1.60038	24.5000	241.000	192.000	70/07/22	70/08/01
RESIDUE C	MG/L	59.0000	3362.00	57.9828	.651492	41.0000	130.000	48.0000	70/07/22	70/08/01
NH3-N	MG/L	.005000	.000050	.007071	.141421	.005000	.010000	.000000	70/07/22	70/08/01
TUT KJEL N	MG/L	1.00000	.005000	.070711	.707107	.050000	.150000	.050000	70/07/22	70/08/01
NITROGEN D3	MG/L	.045000	.002450	.049497	.109994	.035000	.080000	.010000	70/07/22	70/08/01
PHOS-T	MG/L	.060000	.001600	.042426	.707106	.030000	.090000	.030000	70/07/22	70/08/01
TJCS-C	MG/L	2.30000	1.26000	1.13137	.491901	.800001	3.10000	1.50000	70/07/22	70/08/01
CALCIUM	MG/L	7.25000	.604996	.777815	.107285	.549998	7.80000	6.70000	70/07/22	70/08/01
MAGNESIUM	MG/L	2.50000	180003	.424268	.169707	300003	2.80000	2.20000	70/07/22	70/08/01
SODIUM	MG/L	3.65000	.244995	.494970	.135608	.349997	4.00000	3.30000	70/07/22	70/08/01
POTASSIUM	MG/L	1.35000	.045002	.212137	.157138	.150003	1.50000	1.20000	70/07/22	70/08/01
CHLORIDE CL	MG/L	2.00000	.000000	.000000	.000000	.000000	.200000	.200000	70/07/22	70/08/01
SULFATE S04	MG/L	10.7000	56.1800	7.49534	.700499	5.30000	16.0000	5.40000	70/07/22	70/08/01
FLOUORIDE F-DISS	MG/L	.050000	.005000	.070711	.141421	.050000	.100000	.000000	70/07/22	70/08/01
SILICA UNOLVED	MG/L	13.0000	2.00000	1.41421	.108786	1.00000	14.0000	12.0000	70/07/22	70/08/01
ARSENIC AS-DISS	UG/L	5.00000	50.0000	7.07107	.141421	5.00000	10.0000	.000000	70/07/22	70/08/01
BARIUM BA-DISS	UG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/22	70/08/01
COPPER CU-DISS	UG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/22	70/08/01
IRON DI10340	UG/L	750.000	1125000	1060.66	1.41421	750.000	1500.00	.000000	70/07/22	70/08/01
LEAD DI10345	UG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/22	70/08/01
MANGANESE MN	UG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/22	70/08/01
ZINC ZN-DISS	UG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/22	70/08/01
PHOS-T PHTG	UG/L P	.010000	.000200	.014142	1.41421	.010000	.020000	.000000	70/07/22	70/08/01

45 03 45.0 110 33 05.0 2
DEAR CR BELOW YINE SPOIL PILES
30 MOUNTAIN
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
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D-20

STREET DATE 72/11/23

293022
45 01 00.0 :07 50 10.0 2
ACID MINE ABOVE COOKE CITY
30 MONTANA
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

INDEX	DATE	TIME	STAN	DEV	COEF	VAR	STAND	ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
1021500	72/11/23	10:00	1	0.0000	0.0000	0.0000	0.0000	0.0000	7.70000	7.70000	70/06/25	70/03/25
1149.40			1	0.0000	0.0000	0.0000	0.0000	0.0000	84.0000	84.0000	70/08/25	70/08/25
PARA-METER			1	0.0000	0.0000	0.0000	0.0000	0.0000	6.00000	6.00000	70/08/25	70/08/25
034J1 PH			1	0.0000	0.0000	0.0000	0.0000	0.0000	650.000	650.000	70/08/25	70/08/25
034J2 T ALK			1	0.0000	0.0000	0.0000	0.0000	0.0000	84000.0	84000.0	70/08/25	70/08/25
00432 T ACIDITY			1	0.0000	0.0000	0.0000	0.0000	0.0000	800000	800000	70/08/25	70/08/25
00445 SULFATE			1	0.0000	0.0000	0.0000	0.0000	0.0000	800000	800000	70/08/25	70/08/25
01045 IRON			1	0.0000	0.0000	0.0000	0.0000	0.0000	800000	800000	70/08/25	70/08/25
71000 MERCURY			1	0.0000	0.0000	0.0000	0.0000	0.0000	800000	800000	70/08/25	70/08/25

243123

45 00 50.0 09 57 30.0 2
ACID MINE DRAINAGE DISCHARGE
30 43YAMA
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

INDEX 1021500
MILES 1149.40
PARATEMER PH
00400 T ALK
00410 T ACIDITY
00435 Sulfate
00445 IRON
01045 MERCURY
71600

	SU	NUMBER	MEAN
CAC03	465/L	1	7.60000
CAC05	465/L	1	63.00000
S04	465/L	1	7.00000
TOTAL	465/L	1	730.000
H5, TOTAL	465/L	1	80000.0
		1	700000

MAXIMUM	MINIMUM	BEG DATE	END DATE
7.60000	7.60000	70/08/25	70/03/25
63.00000	63.00000	70/08/25	70/08/25
7.00000	7.00000	70/08/25	70/08/25
730.0000	730.0000	70/08/25	70/08/25
800000.0	800000.0	70/08/25	70/08/25
7000000.0	7000000.0	70/08/25	70/08/25

42 00 10.0 110 01 00.0 3
SSGDA BUTTE CREEK AT PARK FOUR.
50 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
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D-23

571000
45 00 10.0 110 01 00.0 3
SODA BUTTE CREEK AT PARK BLVD.
56 WYCHING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

INDEX 1021503	WILES 1149.40	PAR:WTFEP	W1=CHE	W2=CAGAM	W3=L	W4=L P	NUMSE	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
31614 REC JULI							12	3.65667	7.97880	2.60692	.765523	.810288	9.00000	1.00000	70/05/13	70/05/11
31672 REC STRM							6	18.00000	1022.80	31.9812	1.77674	13.0563	83.0000	2.00000	70/07/25	70/08/11
32603 43.5							3	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	70/05/24	70/08/02
70507 PHCS-T							9	.043778	.002336	.048337	.971052	.016112	.170000	.004000	69/05/17	70/08/02

571U01 44 05 30.0 110 07 30.0 3
SSDA BUTTE CREEK NEAR MOUTH
50 WYOMING
MISSOJMI RIVER
YELLOWSTONE RIVER
1117MBK 77777777
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D-25

STGEF DAT = 72/11/23

571 J93

44 54 33.0 110 19 24.0 3

LAMAR RIVER NEAR YOUTH

Soaring

MISSOURI RIVER

YELLOWSTONE RIVER

1217MHA

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INDEX 1021503
MILES 1149.40
PARAV=TEP
70507 PH05-T

NUMBER

100

707-47

MEAN

VAR

533

TAN [

Ev C

133

AR ST

3 DNA

R MAX

IMU

211

STREET DATE 7/2/11/22

571004

44 33 45.0 1.0 23 00.0 3

YELLOWSTONE R. AT FISHING BRIDGE

SU ARMING

MISSOURI RIVER

YELLOWSTONE RIVER

111743R

0000

INDEX 1021500
MILES 1149.40

PAPAMETER

00110 WATER

00020 AIR

00070 TURB

00375 CONDUCTV

00300 CH

00304 BOD

00310 SOD

00400 PH

00403 LAB

00410 TALK

00500 RESIDUE

00515 RESIDUE

00610 NH4-N

00625 TOT KJEL

00670 NJCND3

00665 PHOS-T

00630 TORG C

00720 CYANIDE

00700 TOT HARD

00715 CALCIUM

00725 MGNSTIUM

00930 SODIUM

00925 PTSSIUM

00940 CHLORIDE

00945 SULFATE

00950 FLORIDE

00955 SILICA

01005 BARIUM

01040 COPPER

01045 IRON

01049 LEAD

01055 MANGNESE

01070 ZINC

09503 RA-226

22703 U-NAT

31501 TOT COLI

31616 FEC COLI

31673 FECSTREP

32730 PHENDLS

INDEX	STREET DATE	STAN	VAR	COEF	STAN	DEV	MEAN	VARIANCE	NUMBER	UNIT	REMARKS	MAXIMUM	MINIMUM	BEG DATE	END DATE
00110	WATER	10.5476	42.7226	0.5325	619690	1.42633	18.0000	0.00000	21	CENT		18.0000	0.00000	70/05/07	70/08/19
00020	AIR	13.7381	57.2407	7.50576	550714	1.65098	24.0000	1.00000	21	CENT		24.0000	1.00000	70/05/07	70/08/19
00070	TURB	3.51428	41.4445	6.44037	183277	2.43442	18.0000	300000	7	JTU		18.0000	300000	69/05/20	70/08/02
00375	CONDUCTV	87.3571	142.143	11.92226	135704	4.50631	100.0000	65.00000	7	MICROVHO		100.0000	65.00000	69/05/20	70/08/01
00300	CH	9.59999	82.6741	9.09253	105727	4.54627	9.80000	7.80000	4	MG/L		9.80000	7.80000	70/05/07	70/08/01
00304	BOD	6.40000	12.9000	3.57772	559018	1.60000	1.00000	200000	5	MG/L		1.00000	200000	70/05/14	70/08/10
00310	SOD	9.40000	0.93000	0.313050	333032	1.40000	1.40000	7.00000	5	MG/L		1.40000	7.00000	69/05/20	70/08/01
00400	PH	7.23571	0.41463	203625	027949	076963	7.60000	6.00000	7	SU		7.60000	6.00000	70/05/14	70/08/10
00403	LAB	7.35434	0.00698	301161	040949	090804	7.80000	6.90000	11	SU		7.80000	6.90000	70/05/07	70/08/17
00410	TALK	28.8000	18.6459	4.34119	150736	1.37280	36.0000	22.0000	10	MG/L		36.0000	22.0000	69/05/20	70/08/17
00500	RESIDUE	129.750	5178.25	71.9600	554605	35.9800	212.000	59.0000	4	MG/L		212.000	59.0000	70/05/07	70/08/01
00515	RESIDUE	75.0000	423.500	20.5791	274388	9.20326	108.000	57.0000	5	MG/L		108.000	57.0000	69/05/20	70/08/01
00610	NH4-N	0.007500	0.00092	0.09574	1.27657	0.04787	0.02000	0.00000	4	MG/L		0.02000	0.00000	70/05/07	70/08/01
00625	TOT KJEL	1.30000	0.00867	0.29440	226459	0.14720	0.16000	0.30000	4	MG/L		0.16000	0.30000	70/05/07	70/08/01
00670	NJCND3	0.010000	0.00200	0.01442	1.41421	0.07071	0.03000	0.00000	4	MG/L		0.03000	0.00000	70/05/07	70/08/01
00665	PHOS-T	0.050000	0.02033	0.045092	819864	0.22546	0.12000	0.20000	4	MG/L		0.12000	0.20000	70/05/07	70/08/01
00630	TORG C	2.92500	2.54316	1.59661	545850	0.98305	4.90000	1.10000	4	MG/L		4.90000	1.10000	70/05/07	70/08/01
00720	CYANIDE	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	2	MG/L		0.00000	0.00000	70/05/24	70/05/24
00700	TOT HARD	21.0333	11.7236	4.42398	162788	1.97683	24.2000	17.4000	3	MG/L		24.2000	17.4000	69/05/20	69/07/16
00715	CALCIUM	4.20000	1.32002	1.34908	321210	0.674541	5.30000	2.30000	4	MG/L		5.30000	2.30000	70/05/07	70/08/01
00725	MGNSTIUM	2.20000	0.180003	0.424267	192349	0.212134	2.60000	1.60000	4	MG/L		2.60000	1.60000	70/05/07	70/08/01
00930	SODIUM	8.15000	2.59009	1.60337	197469	0.804687	10.0000	6.10000	4	MG/L		10.0000	6.10000	70/05/07	70/08/01
00925	PTSSIUM	1.67500	0.62502	0.250003	149256	0.125002	2.00000	1.40000	4	MG/L		2.00000	1.40000	70/05/07	70/08/01
00940	CHLORIDE	5.21428	4.94799	7.03420	134902	0.265868	6.00000	4.00000	7	MG/L		6.00000	4.00000	69/05/20	70/08/01
00945	SULFATE	9.91429	1.00210	1.00404	113910	0.379491	10.0000	7.00000	7	MG/L		10.0000	7.00000	69/05/20	70/08/01
00950	FLORIDE	4.75000	0.09167	0.095745	201568	0.047872	6.00000	4.00000	4	MG/L		6.00000	4.00000	70/05/07	70/08/01
00955	SILICA	9.00000	0.00000	0.00000	157135	1.00000	10.0000	8.00000	2	MG/L		10.0000	8.00000	70/07/19	70/08/01
01005	BARIUM	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	4	MG/L		0.00000	0.00000	70/05/07	70/08/01
01040	COPPER	117.500	7225.00	85.0000	723404	42.5000	200.000	0.00000	4	MG/L		200.000	0.00000	70/05/07	70/08/01
01045	IRON	10.0000	400.000	20.0000	2.00000	10.0000	40.0000	0.00000	4	MG/L		40.0000	0.00000	70/05/07	70/08/01
01049	LEAD	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	4	MG/L		0.00000	0.00000	70/05/07	70/08/01
01055	MANGNESE	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	4	MG/L		0.00000	0.00000	70/05/07	70/08/01
01070	ZINC	0.010000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	4	MG/L		0.00000	0.00000	70/05/07	70/08/01
09503	RA-226	14.5000	1093.50	33.0681	2.28056	13.5000	82.0000	1.00000	1	PC/L		82.0000	1.00000	70/05/13	70/05/26
22703	U-NAT	7.52941	455.515	21.3428	2.63459	5.17639	88.0000	1.00000	6	MG/L		88.0000	1.00000	70/05/13	70/08/19
31501	TOT COLI	9.91818	376.164	19.3949	1.97541	5.84730	66.0000	1.00000	17	/100ML		66.0000	1.00000	70/07/30	70/08/19
31616	FEC COLI	2.30000	2.80000	1.70000	739131	981436	4.00000	0.60000	11	/100ML		4.00000	0.60000	70/05/07	70/08/05
31673	FECSTREP								3	/100ML					
32730	PHENDLS									UG/L					

STATE DATE 7/21/11/23

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PARAMETER	TEST	UNIT	MEAN	VARIANCE	STAN. DEV.	COEF. VAF.	STAND. ER.	MAXIMUM	MINIMUM	BEG. DATE	END. DATE
00010 WATER	TEMP	CENT	14.1250	25.7267	3.46957	.282447	.597392	22.0000	6.50000	70/05/07	70/08/11
00020 AIR	TEMP	CENT	16.4375	58.5292	7.65044	.465426	.91261	32.0000	5.00000	70/05/07	70/08/11
00030 TSS	JKN	MG/L	11.9167	320.425	17.9004	1.51485	7.30782	45.0000	.400000	70/05/07	70/08/01
00040 CUCULITY	AT 25C	MG/L	4.26500	10725.7	103.565	.242825	51.7824	538.000	290.000	70/05/07	70/08/01
00050 DO	2 DAY	MG/L	8.57500	.529297	.727528	.084843	.363764	9.60000	7.50000	70/05/07	70/08/01
00060 PH	5 DAY	MG/L	8.45995	.230000	.479593	.564216	.239791	1.30000	.300000	70/05/14	70/07/28
00070 LAL	PH	SU	1.02500	.082499	.287227	.280222	.143614	1.20000	.600000	70/05/07	70/08/01
00080 TALK	PH	MG/L	7.27500	.042531	.206231	.028348	.103116	7.50000	7.10000	70/05/07	70/08/01
00090 RESIDUE	CACO3	MG/L	7.53333	.045013	.212164	.028163	.070721	7.50000	7.10000	70/05/07	70/08/01
00100 RESIDUE	TOTAL	MG/L	12.0000	298.800	17.2856	.142858	7.05691	146.000	92.0000	70/05/07	70/08/01
00110 RESIDUE	TISS-105	MG/L	389.500	10675.0	103.320	.265946	51.6599	468.000	237.000	70/05/07	70/08/01
00120 JH3-1	TOTAL	MG/L	.007500	.000225	.015000	.000000	.007500	.030000	.000000	70/05/07	70/08/01
00130 TQ4 KJFL	TOTAL	MG/L	.310000	.054867	.234236	.755601	.117116	.630000	.130000	70/05/07	70/08/01
00140 PHOS-T	P-WET	MG/L	.052500	.001625	.040311	.767835	.020156	.110000	.020000	70/05/07	70/08/01
00150 CALCIUM	C	MG/L	.047500	.000358	.018930	.398521	.009465	.060000	.020000	70/05/07	70/08/01
00160 MAGNESIUM	CA, DISS	MG/L	.114250	53.5892	7.32046	.640741	3.66023	18.0000	1.70000	70/05/07	70/08/01
00170 SODIUM	MG, DISS	MG/L	40.2500	134.317	11.6154	.288580	5.80763	50.0000	27.0000	70/05/07	70/08/01
00180 POTASSIUM	MG, DISS	MG/L	12.6250	16.5625	4.06970	.322353	2.03485	18.0000	5.00000	70/05/07	70/08/01
00190 CHLORIDE	CL	MG/L	7.64999	8.83011	2.61345	.341627	1.30672	10.4000	4.10000	70/05/07	70/08/01
00200 SULFATE	SO4	MG/L	11.7500	28.9167	5.37742	.457653	2.68871	17.0000	5.00000	70/05/07	70/08/01
00210 FLUORIDE	F, DISS	MG/L	73.5000	851.666	29.1833	.371742	14.5917	120.000	52.0000	70/05/07	70/08/01
00220 SILICA	MG, DISS	MG/L	1.02500	.202500	.450000	.439025	.225000	1.60000	.500000	70/05/07	70/08/01
00230 RADIUM	MG, DISS	MG/L	24.0000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
00240 COPPER	CU, DISS	MG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
00250 IRON	TOTAL	MG/L	1225.04	1235712	1111.63	.907422	.555.813	2700.00	.150000	70/05/07	70/08/01
00260 LEAD	PB, DISS	MG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
00270 MANGANESE	MN	MG/L	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
00280 ZINC	ZN, DISS	MG/L	30.0000	466.666	21.6025	.720082	10.8012	50.0000	.000000	70/05/07	70/08/01
00290 TOT. CULI	4P1MEVDO	MG/L	5.00000	33.3333	5.77350	1.15470	2.89675	10.0000	.000000	70/05/13	70/05/28
00300 FEC. CULI	WFM-FCAR	MG/L	21.8333	990.366	31.4796	1.44131	12.8515	77.0000	1.00000	70/05/13	70/08/11
00310 FEC. CULI	WFM-FCAR	MG/L	11.0000	271.454	16.4759	1.49781	4.75617	57.0000	3.00000	70/07/25	70/08/11
00320 PHENOLS	WFKFAGAP	MG/L	53.1667	1162.97	34.3943	.646915	14.0414	93.0000	1.80000	70/05/07	70/05/07
00330 PHOS-T	PHOS-T	MG/L	1.00000	.000474	.021772	.604765	.010886	.060000	.009000	70/05/07	70/08/01
00340 MERCURY	HG, TOTAL	MG/L	3.83000	6.59704	2.56847	.687955	1.14965	7.40000	.900000	70/05/07	71/04/06

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PARAMETER

0001 WATER

0002 AIR

0003 STREAM

0004 TUNNEL

0005 CUMULATIVE

0006 DAY

0007 DAY

0008 PH

0009 LAT

0010 TALK

0011 RESIDUE

0012 RESIDUE

0013 H43-1

0014 TOT KIEL

0015 NG2600

0016 PLS-T

0017 T 265 C

0018 CALCIUM

0019 MAGNESIUM

0020 MGNSTUM

0021 SODIUM

0022 POTASSIUM

0023 CHLORIDE

0024 SULFATE

0025 FLUORIDE

0026 SILICA

0027 BARIUM

0028 COPPER

0029 IRON

0030 LEAD

0031 MANGANESE

0032 ZINC

31616 PFC COLY

31613 FERTILIZER

70007 PHOS-T

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INDEX	DESCRIPTION	UNIT	MEAN	VARIANCE	STAN. DEV.	COEF. VAR.	STAN. ER.	MAXIMUM	MINIMUM	BEG. DATE	END. DATE
00010	WATER	TEMP	11.6429	19.0165	4.24458	.364565	1.13441	16.5000	6.00000	70/05/09	70/08/02
00020	WATER	TEMP	14.3629	45.6223	6.75443	.469230	1.30520	23.0000	4.00000	70/05/09	70/08/02
00030	WATER	TEMP	5.55000	27.1669	5.21219	.539135	2.12787	14.0000	.900000	70/05/09	70/08/02
00040	WATER	TEMP	122.750	344.916	25.0674	.236802	14.5337	166.000	104.000	70/05/09	70/08/02
00050	WATER	TEMP	8.57500	429.251	6.55195	.076408	327.597	9.40000	3.00000	70/05/09	70/08/02
00060	WATER	TEMP	8.25000	255.833	5.05799	.613090	252.900	1.40000	.400000	70/05/09	70/08/02
00070	WATER	TEMP	1.17500	1.49167	3.86222	.326700	1.93111	1.60000	.800000	70/05/09	70/08/02
00080	WATER	TEMP	7.37500	202.550	4.50056	.061025	225.023	7.90000	6.80000	70/05/09	70/08/02
00090	WATER	TEMP	7.23749	86.5534	2.55957	.035371	.090508	7.60000	6.50000	70/05/09	70/08/02
00100	WATER	TEMP	33.5000	47.9000	6.92098	.206596	2.82548	47.0000	27.0000	70/05/09	70/08/02
00110	WATER	TEMP	116.250	2324.92	48.2174	.414773	24.1087	162.000	49.0000	70/05/09	70/08/02
00120	WATER	TEMP	75.7500	3264.25	57.1336	.754239	28.5666	134.000	2.00000	70/05/09	70/08/02
00130	WATER	TEMP	117500	805425	97082	.826233	045541	240000	030000	70/05/09	70/08/02
00140	WATER	TEMP	230000	840533	202320	.79651	101160	460000	060000	70/05/09	70/08/02
00150	WATER	TEMP	080000	004067	063770	.797132	031885	170000	030000	70/05/09	70/08/02
00160	WATER	TEMP	122500	006625	092871	.758130	046435	240000	030000	70/05/09	70/08/02
00170	WATER	TEMP	287500	271583	1.64798	.573210	.823989	4.40000	1.40000	70/05/09	70/08/02
00180	WATER	TEMP	5.92500	1.32250	1.15000	.194093	.575000	7.30000	4.50000	70/05/09	70/08/02
00190	WATER	TEMP	2.22500	189168	4.34335	.195476	217467	2.80000	1.80000	70/05/09	70/08/02
00200	WATER	TEMP	14.5000	32.3333	5.68624	.392154	2.84312	23.0000	11.0000	70/05/09	70/08/02
00210	WATER	TEMP	3.27500	1.06249	1.03077	.314740	.515387	4.30000	2.60000	70/05/09	70/08/02
00220	WATER	TEMP	8.25000	20.2500	4.50000	.545454	2.25000	15.0000	6.00000	70/05/09	70/08/02
00230	WATER	TEMP	18.6250	142.562	11.9400	.641071	5.96999	35.0000	9.50000	70/05/09	70/08/02
00240	WATER	TEMP	550000	003334	057738	.104979	.028869	600000	500000	70/05/09	70/08/02
00250	WATER	TEMP	13.0000	000000	000000	.000000	.000000	13.0000	13.0000	70/05/09	70/08/02
00260	WATER	TEMP	000000	000000	000000	.000000	.000000	000000	000000	70/05/09	70/08/02
00270	WATER	TEMP	367.500	10225.0	101.119	.275153	50.5594	450.000	220.000	70/05/09	70/08/02
00280	WATER	TEMP	000000	000000	000000	.000000	.000000	000000	000000	70/05/09	70/08/02
00290	WATER	TEMP	15.0000	300.000	17.3205	1.15470	8.66026	39.0000	000000	70/05/09	70/08/02
00300	WATER	TEMP	000000	000000	000000	.000000	.000000	000000	000000	70/05/09	70/08/02
00310	WATER	TEMP	10.5000	271.700	16.4833	1.52623	7.37157	40.0000	1.00000	70/05/09	70/08/02
00320	WATER	TEMP	16.4000	763.377	27.6293	1.68471	8.73715	88.0000	16.0000	70/05/09	70/08/02
00330	WATER	TEMP	43.8000	1489.70	38.5967	.881203	17.2609	110.000	16.0000	70/05/09	70/08/02
00340	WATER	TEMP	103750	008540	092410	.649740	.046205	220000	005000	70/05/09	70/08/02

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PARAMETER	UNIT	NUMBER	MEAN	VARIANCE	STAN. DEV.	COEFF. VAR.	STAND. ER.	MAXIMUM	MINIMUM	BEG. DATE	END DATE
00010 TOTAL		16	9.15625	64.7573	8.04719	.878874	2.01130	24.0000	.000000	70/05/07	70/08/19
00011 WATER	CENT	16	11.8750	71.3500	9.47644	.713805	2.11911	26.0000	.000000	70/05/07	70/08/19
00012 TAP	CENT	4	1.12500	32.5163	.573711	.509984	.286866	1.30000	.600000	70/05/07	70/08/01
00013 TUB	JUN	4	83.5000	313.666	17.71106	.212103	9.85532	94.0000	57.0000	70/05/07	70/08/01
00015 CNDUCTV	AT 25C	4	8.19999	1.26678	1.13436	.138337	.567183	9.40000	6.70000	70/05/07	70/08/01
00017 DO	MG/L	3	8.33333	1.63334	.404166	.484975	.233334	1.30000	.600000	70/05/14	70/08/10
00018 BOD	MG/L	3	1.00000	.12000	.346411	.346411	.200000	1.20000	.000000	70/05/14	70/08/10
00019 BOD	MG/L	3	7.22499	.042567	.206367	.028563	.103183	7.40000	7.00000	70/05/07	70/08/01
00020 PH	SU	9	7.32222	.213482	.463490	.063982	.156163	8.50000	7.00000	70/05/07	70/08/17
00021 TALK	MG/L	5	29.0000	23.5000	4.84768	.167161	2.16795	34.0000	21.0000	70/05/07	70/08/17
00022 RESIDUE	MG/L	4	116.250	1512.92	38.8962	.334591	19.4681	167.000	76.0000	70/05/07	70/08/01
00023 RESIDUE	C MG/L	4	70.5000	715.000	26.7395	.379283	13.3697	104.000	41.0000	70/05/07	70/08/01
00024 NH3-N	MG/L	4	.035000	.000433	.020817	.594762	.010409	.060000	.010000	70/05/07	70/08/01
00025 TOT KJEL	MG/L	4	.295000	.002300	.047959	.162573	.023779	.340000	.230000	70/05/07	70/08/01
00026 NUTR	MG/L	4	.010000	.000200	.014142	1.411421	.007071	.030000	.000000	70/05/07	70/08/01
00027 PHOS-T	MG/L	4	.072500	.006292	.079320	1.09407	.039660	.190000	.020000	70/05/07	70/08/01
00028 T JRG C	MG/L	4	3.97500	7.46250	2.73176	.687235	1.36528	7.80000	1.50000	70/05/07	70/08/01
00029 CALCIUM	MG/L	4	4.42500	1.75584	1.32508	.299454	.662541	5.50000	2.50000	70/05/07	70/08/01
00030 MAGNIUM	MG/L	4	2.20000	.256669	.476098	.216408	.238049	2.50000	1.50000	70/05/07	70/08/01
00031 SODIUM	MG/L	4	7.65000	3.59004	1.64121	.240680	.920603	9.50000	5.10000	70/05/07	70/08/01
00032 PTSSIUM	MG/L	4	1.82500	.022499	.149938	.082191	.074399	2.00000	1.70000	70/05/07	70/08/01
00033 CHLORIDE	CL	4	4.25000	1.58333	1.25831	.296072	.629153	6.00000	3.00000	70/05/07	70/08/01
00034 SULFATE	SO4	4	10.6250	20.2292	4.49766	.423311	2.24884	17.0000	6.50000	70/05/07	70/08/01
00035 FLUORIDE	F, DISS	4	.525000	.003167	.03743	.182368	.047371	.600000	.400000	70/05/07	70/08/01
00036 DISOLVED	DISSOLVED	2	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01005 FATIOUM	MG/L	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01043 COPPER	CJ- DISS	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01045 IRON	TOTAL	4	212.500	50825.0	283.945	1.33621	141.973	600.000	.000000	70/05/07	70/08/01
01047 LEAD	PP, DISS	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01055 MANGNESE	MG/L	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
01050 ZINC	MG/L	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/07	70/08/01
31501 TOT COLI	MG/L	6	3.66667	17.4567	4.17932	1.13981	1.70620	12.0000	1.00000	70/05/13	70/05/26
31615 FEC COLI	/100ML	12	6.16667	175.970	13.2654	2.15114	3.32738	48.0000	1.00000	70/05/13	70/08/19
31672 FECSTREP	/100ML	6	105.333	9490.27	97.4180	.924855	39.7707	210.000	4.00000	70/08/10	70/08/19
70507 PHOS-T	MG/L P	4	.026750	.000549	.023429	.875849	.011714	.060000	.005000	70/05/07	70/08/01

571J12
44 27 30.0 110 24 30.1 3
YELLOWSTONE LAKE NEAR DUT ISLAND
60 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
11174BK
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D-43

44 32 16.0 110 17 51.0 3
YELLOWSTONE L. IN MARY BAY AREA
60 WYJ41NG
MISSOURI RIVER
YELLOWSTONE RIVER
1117M9 77777777
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D-45

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44 51 40.0 22 040 3
YELLOWSTONE L. IN FLAT MT. 220
60 Y. KING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MER
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D-46

571 023

44 27 JUL 01 20 20.0 2
YELLOWSTONE L. AT SOUTH ARM
60 WY MIPG
MISSOULI RIVER
YELLOWSTONE RIVER
1117MAR
0030 77777777

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[illegible]

44 20 00.0 110 10 00.0 3
YELLOWSTONE LAKE AT S. EAST ARM
BU RYMING
MISSOURI RIVER
YELLOWSTONE RIVER
111748R 7777777
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PARAMETER	TEMP	CENT	NUMBER	MEAN	VARIANCE	STAN. DEV	COEF. VAR	STAND. ER	MAXIMUM	MINIMUM	BEG. DATE	END DATE
WATER	TEMP	CENT	14	11.7357	5.75746	2.3547	.192159	.602301	13.5000	6.40000	70/07/23	70/08/03
WATER	TEMP	CENT	14	11.0000	2.51466	1.58508	.171007	.502740	14.0000	5.00000	70/07/23	70/08/03
WATER	TEMP	CENT	5	1.04000	.03000	.03000	.430000	.201435	1.70000	5.00000	70/06/07	70/06/03
WATER	TEMP	CENT	3	31.3333	156.336	13.6505	.167834	7.96111	97.0000	72.0000	70/06/07	70/08/03
WATER	TEMP	CENT	1	8.10000	.00000	.00000			8.10000	3.10000	70/07/20	70/07/20
WATER	TEMP	CENT	2	4.00000	.00000	.00000		.000000	.400000	.400000	70/07/31	70/06/02
WATER	TEMP	CENT	2	8.00000	.005001	.070712	.083195	.050005	.900000	.800000	70/07/31	70/08/02
WATER	TEMP	CENT	2	7.10000	.020020	.141400	.019928	.100049	7.20000	7.00000	70/07/20	70/07/23
WATER	TEMP	CENT	5	7.24000	.043130	.233322	.035924	.125934	7.50000	6.90000	70/06/07	70/08/03
WATER	TEMP	CENT	5	27.0000	2.00000	1.41421	.052376	.632455	23.0000	25.0000	70/06/07	70/08/03
WATER	TEMP	CENT	2	72.5000	.005000	.777617	.107285	.500000	75.0000	67.0000	70/06/07	70/08/03
WATER	TEMP	CENT	2	62.0000	2.00000	1.41421	.022310	1.000000	63.0000	51.0000	70/06/07	70/08/03
WATER	TEMP	CENT	3	.016667	.000133	.011547	.692820	.006667	.030000	.010000	70/06/07	70/08/03
WATER	TEMP	CENT	3	.056667	.015433	.125033	.123345	.072188	.240000	.010000	70/06/07	70/08/03
WATER	TEMP	CENT	3	.010000	.000300	.017321	.173205	.010000	.030000	.000000	70/06/07	70/08/03
WATER	TEMP	CENT	3	.103333	.014033	.118462	.1.14641	.068394	.240000	.030000	70/06/07	70/08/03
WATER	TEMP	CENT	3	4.53333	.660334	2.56970	.461622	.88361	8.30000	3.20000	70/06/07	70/08/03
WATER	TEMP	CENT	3	5.53333	.023338	.152769	.033699	.048201	4.70000	4.40000	70/06/07	70/06/03
WATER	TEMP	CENT	3	1.83333	.053332	.230936	.125966	.133332	2.10000	1.70000	70/06/07	70/08/03
WATER	TEMP	CENT	3	2.80000	1.42015	1.21661	.160081	.702412	9.00000	6.80000	70/06/07	70/06/03
WATER	TEMP	CENT	3	2.23333	1.21333	1.10151	.493215	.635559	3.50000	1.50000	70/06/07	70/06/03
WATER	TEMP	CENT	3	3.33333	.333334	1.52753	.456255	.851919	3.00000	2.00000	70/06/07	70/08/03
WATER	TEMP	CENT	3	7.63333	2.77337	1.66534	.218167	.961486	9.50000	6.30000	70/06/07	70/09/03
WATER	TEMP	CENT	2	4.50000	.005000	.070711	.157135	.050000	.500000	.400000	70/07/20	70/08/03
WATER	TEMP	CENT	2	11.5000	.500300	.737107	.061488	.500000	12.0000	.000000	70/07/20	70/08/03
WATER	TEMP	CENT	2	.000000	.000000	.000000		.000000	.000000	.000000	70/07/20	70/08/03
WATER	TEMP	CENT	3	73.3333	4133.33	64.2910		37.1194	120.000	.000000	70/06/07	70/08/03
WATER	TEMP	CENT	3	.000000	.000000	.000000		.000000	.000000	.000000	70/06/07	70/08/03
WATER	TEMP	CENT	3	.000000	.000000	.000000		.000000	.000000	.000000	70/06/07	70/08/03
WATER	TEMP	CENT	3	.000000	.000000	.000000						

START DATE 7/27/77

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YELLOWSTONE L WHEFE RIVER ENTERS

60 AYC4ING

MISSOURI RIVER

YELLOWSTONE RIVER

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INDEX 1021500

MILES 1145.60

PARAMETER

00010 WATER

00020 AIR

00030 T P3

00040 CINDUCTIV

00050 ON

00060 BUD

00070 PH

00080 LA

00090 T ALK

00100 PFSI DUE

00110 RESIDUE

00120 NH3-T

00130 TOT KIEL

00140 M26AD3

00150 PHUS-T

00160 T OPS C

00170 CALCIUM

00180 MG/USIA

00190 SODIUM

00200 P-SIUA

00210 CHLORIDE

00220 SULFATE

00230 FLUORIDE

00240 SILICA

00250 BASELUA

00260 COPPER

00270 IRON

00280 LEAD

00290 MANGANESE

00300 ZINC

00310 FEE COLI

00320 ELECTROD

00330 PHYS-T

PARAMETER	TEMP	TEMP	IKSN	AT 25C	UNIT	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER	TEMP	TEMP	IKSN	AT 25C	UNIT	11.7000	2.55007	1.71755	.146802	.763124	13.0000	9.00000	70/07/23	70/08/03
00020 AIR	TEMP	TEMP	IKSN	AT 25C	UNIT	10.4167	7.24167	2.69105	.258341	1.09862	15.0000	7.00000	70/07/20	70/08/03
00030 T P3	TEMP	TEMP	IKSN	AT 25C	UNIT	4.12500	35.1359	5.92924	1.43739	2.36462	13.0000	0.00000	70/07/20	70/08/03
00040 CINDUCTIV	TEMP	TEMP	IKSN	AT 25C	UNIT	47.5000	220.300	14.9492	.312616	10.5000	58.0000	37.0000	70/07/20	70/08/03
00050 ON	TEMP	TEMP	IKSN	AT 25C	UNIT	7.10000	.005000	.070711	.157135	.050000	7.10000	7.10000	70/07/20	70/07/20
00060 BUD	TEMP	TEMP	IKSN	AT 25C	UNIT	4.50000	.005001	.070716	.063156	.050000	5.00000	4.00000	70/07/21	70/08/02
00070 PH	TEMP	TEMP	IKSN	AT 25C	UNIT	7.05000	.045013	.212164	.030094	.150022	7.20000	6.90000	70/07/20	70/07/23
00080 LA	TEMP	TEMP	IKSN	AT 25C	UNIT	7.22500	.015954	.125912	.017427	.062956	7.40000	7.10000	70/07/20	70/08/03
00090 T ALK	TEMP	TEMP	IKSN	AT 25C	UNIT	23.7500	.250000	.500000	.021052	.250000	24.0000	23.0000	70/07/20	70/08/03
00100 PFSI DUE	TEMP	TEMP	IKSN	AT 25C	UNIT	45.5000	36.4500	19.0919	.213317	13.5000	103.000	76.0000	70/07/20	70/08/03
00110 RESIDUE	TEMP	TEMP	IKSN	AT 25C	UNIT	79.5000	1012.50	31.8158	.400249	22.5000	102.000	57.0000	70/07/20	70/08/03
00120 NH3-T	TEMP	TEMP	IKSN	AT 25C	UNIT	.005000	.000050	.007071	1.41421	.005000	.010000	.000000	70/07/20	70/08/03
00130 TOT KIEL	TEMP	TEMP	IKSN	AT 25C	UNIT	.150000	.003300	.028234	.188561	.020000	.170000	.130000	70/07/20	70/08/03
00140 M26AD3	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/20	70/08/03
00150 PHUS-T	TEMP	TEMP	IKSN	AT 25C	UNIT	.075000	.000050	.037071	.094282	.005000	.060000	.070000	70/07/20	70/08/03
00160 T OPS C	TEMP	TEMP	IKSN	AT 25C	UNIT	2.20000	.060000	.232843	.128565	.200000	2.40000	2.00000	70/07/20	70/08/03
00170 CALCIUM	TEMP	TEMP	IKSN	AT 25C	UNIT	4.25000	.044358	.212128	.045912	.149997	4.40000	4.10000	70/07/20	70/08/03
00180 MG/USIA	TEMP	TEMP	IKSN	AT 25C	UNIT	1.85000	.004339	.070705	.036219	.049336	1.50000	1.50000	70/07/20	70/08/03
00190 SODIUM	TEMP	TEMP	IKSN	AT 25C	UNIT	3.50000	.200000	1.41421	.404061	1.00000	4.50000	2.50000	70/07/20	70/08/03
00200 P-SIUA	TEMP	TEMP	IKSN	AT 25C	UNIT	1.30000	.000000	.000000	.000000	.000000	1.30000	1.30000	70/07/20	70/08/03
00210 CHLORIDE	TEMP	TEMP	IKSN	AT 25C	UNIT	5.00000	.320000	.565686	.942809	.400000	1.00000	.200000	70/07/20	70/08/03
00220 SULFATE	TEMP	TEMP	IKSN	AT 25C	UNIT	5.70001	5.70001	2.40417	.437121	1.70000	7.20000	3.20000	70/07/20	70/08/03
00230 FLUORIDE	TEMP	TEMP	IKSN	AT 25C	UNIT	1.50000	.005000	.070711	.471404	.050000	.200000	.100000	70/07/20	70/08/03
00240 SILICA	TEMP	TEMP	IKSN	AT 25C	UNIT	15.0000	15.0000	4.24264	.235702	3.00000	21.0000	15.0000	70/07/20	70/08/03
00250 BASELUA	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00260 COPPER	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00270 IRON	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00280 LEAD	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00290 MANGANESE	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00300 ZINC	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00310 FEE COLI	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00320 ELECTROD	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03
00330 PHYS-T	TEMP	TEMP	IKSN	AT 25C	UNIT	.000000	.000000	.000000	.000000	.000000	.070000	.000000	70/07/20	70/08/03

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YELLOWSTONE L. NEAR GRANT V. STP
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MISSOURI RIVER
YELLOWSTONE RIVER
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INDEX 102500
MILES 1149.00

PARAMETER

00000 WATER

00000 AIR

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STREET DATE 72/11/73

571026
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YELLOWSTONE L. NEAR WEST THUMB
60 WYJING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR
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INDEX 1021500
MILES 1147.43

PARAMETER

0001 WATER

0002 AIR

0003 TUB

0004 CADJECTIV

0005 DJ

0006 HOB

0007 HOB

0008 HOB

0009 LA3

0010 T ALK

0011 RESIDUE

0012 RESIDUE

0013 RESIDUE

0014 TOT KJEL

0015 WGT%N

0016 PHOS-T

0017 T JBT C

0018 CALCULUM

0019 WGT%N

0020 PTSS-T

0021 CHLORIDE

0022 SULFATE

0023 FLUORIDE

0024 SILICA

0025 BARITA

0026 COPPER

0027 IRON

0028 LEAD

0029 MANGNESE

0030 ZINC

0031 TOT COLI

0032 FEC COLI

0033 FECSTRAP

0034 PHOS-T

CENT

CENT

JTU

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712390

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START DATE 7/21/79

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44 25 30.3 110 35 00.0 3
DUCK LAKE NF W. THUMB CAMP GR.
60 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
111743R
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IN724 1021500
MILES 1143.40

PARAMETER

00010 WATER

00020 ALP

00030 TUPA

00045 CONDUCTV

00102 DO

00304 BOD

00310 UDD

00400 PH

00403 LAP

00410 TALK

00500 RESIDUE

00513 RESIDUE

00612 NH3-I

00623 TCT-KJFL

00630 NO2E-UE

00665 PHOS-T

00680 T ORS C

00715 CALCIUM

00725 MG-MIS-14

00730 SODIUM

00735 OTS-14

00740 CHLORIDE

00745 SULFATE

00750 FLUORIDE

00755 SILICA

01005 BARIUM

01040 COPPER

01045 IRON

01047 LEAD

01055 MANGNESE

01060 ZINC

31501 TUT COLI

31616 FEC COLI

31672 EFFSTREP

70527 PHOS-T

UNIT

CENT

CENT

JTU

MG/L

MG/L

MG/L

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MEAN

9.00000

12.0357

1.11667

20.0000

7.53333

8.40000

2.26000

7.30000

6.48333

8.90000

66.0000

23.7500

0.12500

1.92500

0.07500

0.01800

2.40000

1.50000

5.00000

1.00000

1.57500

5.67500

0.35000

1.50000

0.00000

0.00000

62.5000

0.00000

7.50000

0.00000

2.60000

1.00000

6.20000

0.11750

VARIANCE

83.2077

36.7571

1.318767

66.6667

573456

263000

323001

436740

173645

22.2201

38.0000

48.250

0.00225

0.15225

0.00225

0.01800

739955

286663

0.13333

0.06666

0.26667

2.62917

9.11590

0.03333

0.50000

0.00000

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15625.0

0.00000

225.000

0.00000

12.3000

0.00000

100.700

0.00131

STAND. ER.

2.44668

1.66448

0.431260

1.29099

437209

229347

254166

348334

1.38702

1.92441

3.08221

10.5860

0.07500

0.61695

0.07500

0.21213

430115

2.67707

0.57735

0.04824

0.31650

0.810735

1.50963

0.29367

0.50000

0.00000

62.5000

0.00000

7.50000

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1.00000

0.00000

4.48776

0.05721

MINIMUM

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BEG DATE

70/05/11

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70/05/11

70/05/11

START DATE 72/11/23

571036
44 34 00.0 110 52 00.0 3
MADISON R BELOW MADISON JUNC. CG
60 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117M8R 77777777
0000

INP-X 1021500	TEMP	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
MILES 1149.40	TEMP	15	14.4333	16.4595	4.05704	.281088	1.04752	20.0000	9.00000	70/05/08	70/06/19
PARATEP	TEMP	16	12.2500	41.1333	6.41353	.523553	1.03338	24.0000	4.00000	70/05/08	70/08/19
00023 ALK	JKSN	4	1.82500	2.02917	1.42549	.780542	71.2244	3.90000	.800000	70/05/08	70/07/30
00073 TUB	AT 25C	4	356.250	732.215	36.2105	.241394	43.1052	428.000	236.000	70/05/08	70/07/30
00095 CONDUCTV		4	3.12500	.762614	.873278	.107480	.436639	9.30000	1.20000	70/05/08	70/07/30
00309 OJ	2 DAY	3	3.00000	.070000	.264575	.293973	.152753	1.10000	.600000	70/05/20	70/08/12
00304 900	5 DAY	3	1.43333	.263330	.513163	.358021	.296275	2.00000	1.00000	70/05/20	70/08/12
00310 BTJ		4	7.03999	.020091	.141742	.019364	.070871	7.20000	6.90000	70/05/08	70/07/30
00400 PH	DH	3	7.42222	.259491	.503403	.068632	.169801	3.70000	7.60000	70/05/08	70/08/17
00403 LAR	CAC3	5	99.4000	612.808	24.7550	.249044	11.0708	124.000	58.0000	70/05/08	70/08/17
00413 T ALK	TOTAL	4	310.500	3113.67	55.8002	.179711	27.9001	372.000	237.000	70/05/08	70/07/30
00500 RESIDJE	DISS-105	4	261.000	4866.00	69.7567	.267267	34.8784	329.000	167.000	70/05/08	70/07/30
00513 RESIDJE	TOTAL	4	.010000	.000133	.011547	.115470	.005773	.020000	.000000	70/05/08	70/07/30
00613 NH4-N	N	4	.152500	.009225	.096047	.629815	.048023	.250000	.320000	70/05/08	70/07/30
00623 TBT KJEL	N-TOTAL	4	.017500	.000052	.009574	.547101	.004787	.030000	.010000	70/05/08	70/07/30
00633 N028N03	P-WET	4	1.20000	.006733	.082057	.683807	.041028	.220000	.020000	70/05/08	70/07/30
00655 PHOS-T	C	4	5.27500	13.6492	3.72145	.705489	1.86073	10.0000	2.20000	70/05/08	70/07/30
00683 T ORG C	CA, DISS	4	5.90000	.140055	.374240	.064524	.187120	6.30000	5.40000	70/05/08	70/07/30
00713 CALCIUM	MG, DISS	4	750000	.016667	.129102	.172130	.064551	900000	.600000	70/05/08	70/07/30
00723 MAGNESIUM	NA, DISS	4	64.5000	203.000	14.2473	.220396	7.12380	77.0000	44.0000	70/05/08	70/07/30
00733 SODIUM	K, DISS	4	5.14997	2.63013	1.62177	.198990	.610883	9.60000	5.90000	70/05/08	70/07/30
00753 PTSSIJM	CL	4	45.0000	115.333	10.7393	.238652	5.38967	52.0000	29.0000	70/05/08	70/07/30
00763 CHLORIDE	SO4	4	17.2500	38.2500	6.18466	.358531	3.05233	26.0000	12.0000	70/05/08	70/07/30
00793 FLUORIDE	F, DISS	4	5.75000	2.77670	1.66634	.289799	.533172	6.80000	3.30000	70/05/08	70/07/30
00833 SULFATE	DISOLVED	2	92.0000	50.0000	7.07107	.076859	5.00000	97.0000	57.0000	70/07/21	70/07/30
00853 SILICA	HA, DISS	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/08	70/07/30
01005 BARIUM	CU-DISS	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/08	70/07/30
01040 COPPER	TOTAL	4	360.000	56733.3	238.188	.661632	119.094	703.000	190.000	70/05/08	70/07/30
01045 IRON	PH, DISS	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/08	70/07/30
01049 LEAD	MN	4	22.5000	691.666	26.2996	1.16887	13.1498	50.0000	.000000	70/05/08	70/07/30
01055 MANGNESE	ZN, DISS	4	.000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/08	70/07/30
01373 ZINC	WEI-MEDQ	6	181.000	17142.0	130.327	.723356	53.4509	390.000	76.0000	70/05/18	70/08/27
31501 TUT CJLI	MEM-FCR	12	96.0000	9390.91	96.9067	1.00944	27.5745	350.000	12.0000	70/05/18	70/08/19
31615 FEC COLI	4KFAAGAR	6	56.1667	584.170	24.1696	.415524	94.8720	79.0000	19.0000	70/08/12	70/08/19
31673 FECSTREP	PH THO	4	.090750	.003322	.057639	.635141	.025820	.128003	.005000	70/05/08	70/07/30
70507 PHOS-T											

44 35 JO-J 110 52 JO-0 3
313000 R. NEAR FIREHOLE F. JUNC.
60 WYJING
MISSOURI RIVER
YELLOWSTONE RIVER
1117M8R 77777777
0000

D-54

57104J
44 50 30.0 110 52 15.0 3
FIREHOLE R. AT MADISON JUNCTION
60 WYJING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MR
G000
77777777

D-57

44 27 30.0 110 44 00.0 3
FRICHELLE R. NEAR KEPLER CASCADES
60 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MAR 77777777
0000

D-59

2710+3
64 21 300 115 10 00.0 3
SYLVAN LAKE AT EAST ENTRANCE RD.
60 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
11174R 7777777
U000

SYNDET DATE 72/11/74

071046
44 32 00.0 110 26 00.0 3
BRIDGE DAY S.T.P.
50 WYHNG
MISSOURI RIVER
YELLOWSTONE RIVER
111749K 77777777
0000

PARAMETER	TURR	JKSN	JTU	NUMBER	MEAN	VARIANCE	STAN DEV	COFF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00070	900	5 DAY	46/L	2	32.0000	1568.00	39.5980	1.23744	28.0000	60.0000	4.00000	70/08/13	70/08/13
00300	LAB	PH	SU	2	220.500	48984.5	221.324	1.00374	156.500	377.000	64.0000	70/08/13	70/08/13
00403	NH3-N	TOTAL	M3/L	2	8.05000	125122	353726	.043941	.250122	8.30000	7.80000	70/08/13	70/08/13
00610	TOT KJEL	N	M3/L	2	56.5000	264.500	16.2635	.287849	11.5000	68.0000	45.0000	70/08/13	70/08/13
00625	NO3-N	N-TOTAL	M3/L	2	85.0000	338.000	18.3848	.216291	13.0000	96.0000	72.0000	70/08/13	70/08/13
00530	NO3-N	P-NET	M3/L	2	355000	151250	388909	1.09552	.275000	.630000	.080000	70/08/13	70/08/13
00665	PHOS-T	4F4-FCBR	/100ML	3	10.5000	3.38028	1.83855	.175100	1.30005	11.8000	9.20000	70/08/13	70/08/13
11616	FEC COLI	4F4-FCBR	/100ML	3	1366746	.196E+13	1400781	1.02475	808741	2600000	840.000	70/08/13	70/08/13
31673	FECSTREP	4F4-FCBR	/100ML	3	9367664	.123E+15	.111E+08	1.32427	6412942	.210E+08	63000.0	70/08/13	70/08/13
70507	PHOS-T	ORTHO	M3/L P	2	7.80000	.000000	.000000		.000000	7.90000	7.80000	70/08/13	70/08/13

571045
44 31 35.7 110 24 05.0 2
YELLOWSTONE L. NR STEVENSON IS.
50 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

D-65

SECRET DATE 2/11/74

571052
44 21 59.5 110 25 30.5 2
YELLOWSTONE L. S OF FISH. RP.
50 WYU411G
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

INDEX 1021500	PARAMETER	TEMP	CENT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
MTLES 1149.40	WATER	TEMP	CENT	2	3.00000	72.0000	8.48523	1.06066	6.00000	14.0000	2.00000	70/05/26	70/08/10
00073 AIR	TEMP	CENT	CENT	2	10.0000	16.0000	4.24264	.424264	3.00000	13.0000	7.00000	70/05/26	70/09/10
31613 FEC COLI	MPH=CHR	/100ML	/100ML	1	1.00000					1.00000	1.00000	70/06/10	70/06/10
31673 FECSTREP	MPH=AGAR	/100ML	/100ML	1	6.00000					6.00000	6.00000	70/06/10	70/08/10

STORE DATE 72/11/72

571223
 44 32 50.5 110 17 10.3 2
 YELLOWSTONE L. E. OF FISH. BR.
 56 MYSING
 MISSOURI RIVER
 YELLOWSTONE RIVER
 1117MBR
 0000 77777777

INDEX	1021500	PARAMETER	00010 WATER	00020 ALP	00030 BJO	00040 LAB	31501 TOT COLI	31616 FEC COLI	31673 FECSTREP	TEAP	TEAP	2 DAY	P4	4F14MEND	MFH-FCBR	MFH-FCBR	PK-FCBR	NUMBER	MEAN	VARIANCE	STAN DEV	CDEF	VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
																		3	13.1667	103.063	10.1530	.771114	5.86184	20.0000	1.50000	70/05/26	70/08/15	
																		3	12.3333	39.0835	6.17115	.490271	3.56293	12.0000	6.00000	70/05/26	70/08/15	
																		1	7.80000				7.80000	7.80000	70/05/10	70/08/10		
																		1	7.80000				7.80000	7.80000	70/05/15	70/08/15		
																		2	190.000				180.000	180.000	70/05/26	70/05/26		
																		2	1.00000	.000000	.000000		1.00000	1.00000	70/05/26	70/08/10		
																		1	29.0000				29.0000	29.0000	70/05/10	70/08/10		

STG#-T DAT= 72/11/23

571055
44 26 50.5 110 34 20.5 2
YELLOWSTONE L. S. OF FISH. BR.
56 HYUMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117M6R 77777777
0000

INDEX 1021500
MILES 1149.40

[illegible]

START DATE 72/11/21

571050
44 30 40.0 110 16 45.0 2
YELLOWSTONE L. E OF FISH. BR.
50 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 7777777
0000

INDEX	1021000	MILES	1149.40	PARAMETER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	3	12.1667	25.5835	9.25113	.760367	5.34114	18.0000	1.50000	70/05/26	70/08/15		
00020	AIR	3	12.0000	7.00000	2.64575	.220479	1.52752	14.0000	5.00000	70/05/26	70/08/15		
00403	L13	2	7.40000	.152E-04	.000000	.000000	.000000	7.40000	7.40000	70/08/10	70/08/15		
31501	TOT COLI	1	10.0000	.000000	.000000	.000000	.000000	10.0000	10.0000	70/05/26	70/05/26		
31614	FEC COLI	3	1.00000	.000000	.000000	.000000	.000000	1.00000	1.00000	70/05/26	70/08/10		
31672	FECSTREP	2	7.00000	72.0000	8.46528	1.21218	6.00000	13.0000	1.00000	70/08/10	70/08/10		

STATE DATE 7/21/74

57107
44 35 42.7 110 57 42.5 2
4-DIST. S. W. OF MADISON JCT.
50 MILE
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 7777777
0000

INDEX 1021500
MILES 1149.40

PARAMETER	TRAP	UNIT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00300 WATER	TRAP	CENT	3	14.0000	15.0000	4.35230	.311350	2.51661	17.0000	5.00000	70/05/27	70/06/15
00303 AIR	TRAP	CENT	3	16.0000	15.0000	4.00000	.250000	2.30940	20.0000	12.0000	70/05/27	70/06/15
00304 BIR	2 DAY	M/L	1	.300000					.300000	.300000	70/06/12	70/06/12
00310 BIR	5 DAY	M/L	1	.300000					.300000	.300000	70/06/12	70/06/12
00403 LAR	P-4	SU	2	7.65000	.004930	.070637	.009234	.049348	7.70000	5.00000	70/06/12	70/06/12
31501 TGT COLI	MFIMENDO	/100ML	1	320.000					380.000	7.60000	70/05/27	70/06/15
31615 REC COLI	MFV-ECOR	/100ML	3	115.333	31441.3	177.317	1.53743	102.374	320.000	380.000	70/05/27	70/06/15
31573 FECSTREP	MEF-CAGAK	/100ML	2	53.0000	200.000	14.1421	.266333	10.0000	63.0000	43.0000	70/06/12	70/06/15

STREET DATE 72/11/24

571053
44 42 30.4 110 44 20.5 2
GIBBON AT UPPER END OF ELK PARK
50 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MSR 77777777
0000

INDEX 1021500	PARAMETER	TEMP	UNIT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAP	STAND EF	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	3	12.0000	37.0000	6.08276	.506897	3.51188	16.0000	5.00000	70/05/29	70/08/15
00020	AIR	TEMP	CENT	3	16.3333	66.3336	8.14455	.498646	4.70226	22.0000	7.00000	70/05/29	70/08/15
00304	BOD	2 DAY	MG/L	1	.400000					.400000	.400000	70/08/09	70/08/09
00310	BOD	5 DAY	MG/L	1	1.00000					1.00000	1.00000	70/08/09	70/08/09
00403	LAB	PH	SU	2	7.10000	.020020	.141490	.019926	.100043	7.20000	7.00000	70/06/09	70/08/15
31501	TOT COLI	MFIMENDO	/100ML	1	90.0000					90.0000	80.0000	70/05/29	70/05/29
31515	FEC COLI	MFIMENDO	/100ML	1	10.0000					10.0000	10.0000	70/05/29	70/05/29

START DATE 7/21/79

571057
44 42 50.5 110 41 35.5 1
GIBBS & JPSIN FRM NURKIS CAMP.
50 HYDUNG
MISSOURI RIVER
YELLOWSTONE RIVER
1117MR 7777777
0000

INDEX 1021500
MILES 1143.40

PARAMETER

00010 WATER

00020 AIR

00060 STREAM

00304 RND

00310 RND

00403 LAR

00410 TALK

31501 TCT CULI

31516 FFC CULI

31673 FECSTEP

TEMP

TEMP

FLW

2 DAY

5 DAY

PH

CAC03

4F142MHC

4F4-FCBK

4FKFACAN

CERT

CERT

CES

MG/L

MG/L

SU

4G/L

/1004L

/1004L

/1004L

NUMBER

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7

3

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1

3

1

7

6

MEAN

10.0427

15.0000

60.3666

1.50000

1.50000

7.23333

1.360000

23.0000

10.0000

52.1667

VARIANCE

10.1762

15.3333

2762.36

52.5582

30.3445

0.03410

0.008073

3.62106

74.3333

501.770

STAN DEV

3.31304

3.31578

52.5582

0.008073

0.008073

3.62106

3.62106

22.4002

COEF VAR

0.311292

0.261052

0.261052

0.008073

0.008073

0.008073

0.008073

0.008073

0.008073

0.008073

STAND ER

1.25221

1.48003

30.3445

0.033716

0.033716

0.033716

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0.033716

0.033716

0.033716

MAXIMUM

15.0000

20.0000

121.000

1.50000

2.50000

7.30000

36.0000

23.0000

28.0000

84.0000

MINIMUM

4.00000

10.0000

27.0000

1.50000

2.50000

7.30000

36.0000

23.0000

28.0000

14.0000

BEG DATE

70/05/29

70/05/29

70/05/27

70/06/09

70/08/09

70/08/09

70/08/17

70/08/17

70/05/29

70/08/19

END DATE

70/03/19

70/08/19

70/06/19

70/08/09

70/08/09

70/08/09

70/08/17

70/08/17

70/05/29

70/08/19

START DATE 72/11/23

571000
44 2c 05.2 110 51 20.3 2
FIREHOLE K AT BRIDGE
56 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MBR 77777777
0000

INDEX	1021500	PARAMETER	TEMP	CENT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
MILES	1143.40													
00010	WATER	TEMP	CENT	2	11.2500	66.1250	9.13173	.722820	5.75000	17.0000	5.50000	5.50000	70/05/27	70/08/12
00020	AIR	TEMP	CENT	2	15.5000	40.5000	6.36396	.410573	4.50000	20.0000	11.0000	11.0000	70/05/27	70/08/12
00304	ROD	2 DAY	MG/L	1	.500000					.500000	.500000	.500000	70/08/12	70/08/12
00310	ROD	5 DAY	MG/L	1	.600000					.600000	.600000	.600000	70/08/12	70/08/12
00403	LAB	PH	SU	1	8.000000					8.000000	8.000000	8.000000	70/08/12	70/08/12
31616	FEC CDLI	4FM-FCBR	/1004L	1	26.0000					26.0000	26.0000	26.0000	70/08/12	70/08/12
31673	FECSTREP	4FKFASAR	/1004L	1	12.0000					12.0000	12.0000	12.0000	70/08/12	70/08/12

START DATE 7/21/76

571061
44 26 15.2 110 43 15.3 2
FIREHOLE RIVER AT SERVICE ROAD
53 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER
111748R 7777777
0000

INDEX	1021500	PARAMETER	TEMP	CENT	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	2	9.50000	80.5000	112.500	10.6066	.731490	7.53000	14.0000	3.00000	70/05/27	70/08/12
00020	AIR	TEMP	CENT	2	14.5000	112.500	10.6066	.731490	7.53000	22.0000	7.00000	70/05/27	70/08/12	
00030	ROD	5 DAY	MG/L	1	.500000					.500000	.500000	70/08/12	70/08/12	
00040	ROD	5 DAY	MG/L	1	.700000					.700000	.700000	70/08/12	70/08/12	
00050	LAN	PH	SU	1	7.40000					7.40000	7.40000	70/08/12	70/08/12	
31501	TOT COLI	MFIMENDO	/100ML	1	130.000					130.000	130.000	70/05/27	70/05/27	
31616	FEC COLI	MF4-FCBR	/100ML	2	40.0000	2178.00	46.6630	1.16673	33.0000	73.0000	7.00000	70/05/27	70/08/12	
31673	FECSTREP	MF4-FAGAR	/100ML	2	8.000000					8.00000	8.00000	70/08/12	70/08/12	
71030	MERCURY	MG, TOTAL	US/L	1	.400000					.400000	.400000	71/04/06	71/04/06	

571062
44 25 15.0 110 51 25.0 2
IKON SPR. CR BLW OLD FATH LAGOON
56 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER 77777777
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0-79

STATION DATE 7/12/76

571003
44 27 30.0 110 51 20.5 2
FROM SP CP ABOVE OLD FAITH LEAN
50 AYLING
MISSOURI RIVER
YELLOWSTONE RIVER
1117MUR 77777777
0000

INDEX 1021500
MILES 1142.43
PARAMETER
00020 WATER
00020 AIR
00374 SOL
00310 BOD
00433 LAB
31501 TOT COLI
31616 REC COLI
31673 FECSTREP

TEMP	WATER	AIR	SOL	BOD	LAB	TOT COLI	REC COLI	FECSTREP
2 DAY	2	1	1	1	1	1	1	1
5 DAY	2	1	1	1	1	1	1	1
PH	1	1	1	1	1	1	1	1
MEIENDO	1	1	1	1	1	1	1	1
W4-FCRE	2	1	1	1	1	1	1	1
WKFATAR	1	1	1	1	1	1	1	1

DATE 72/11/23

571064
44 44 30.5 110 25 50.0 2
CANYON VILLAGE STP INF. AND EFF.
50 WYOMING
MISSOURI RIVER
YELLOWSTONE RIVER 77777777
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[illegible]

071-2-
44 16 00-0 110 27 00-0 3
HEART LAKE OUTLET
600 WYALING
PACIFIC NORTHWEST
COLUMBIA
1117MBR
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PARAMETER	JKSN	JTU	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAN ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00070 TUF-1	AT 25C	MG/L	1	350000					350000	350000	70/10/18	70/10/18
00075 CONDUCTV		MG/L	2	155.000	2450.00	49.4975	.263284	35.0000	223.000	153.000	70/06/08	70/10/18
00400 pH		SU	1	7.50000					7.50000	7.50000	70/10/18	70/10/18
00403 LAB		MG/L	1	7.40000					7.40000	7.40000	70/06/08	70/06/08
00410 TALK		MG/L	2	35.0000	50.0000	7.07107	.202030	5.00000	40.0000	30.0000	70/06/08	70/06/08
00500 RESIDUAL		MG/L	1	125.000					125.000	125.000	70/06/08	70/06/08
00515 RESIDUAL		MG/L	2	127.500	420.500	20.5061	.160632	14.5000	142.000	113.000	70/06/08	70/10/18
00519 RESIDUAL		MG/L	2	010000	.145E-10	.000000		.000000	.010000	.010000	70/06/08	70/10/18
00625 TOT KJEL		MG/L	1	040000					040000	040000	70/06/08	70/06/08
00630 NITROGEN		MG/L	2	015000	.000050	.007071	.471404	.005000	020000	010000	70/06/08	70/10/18
00665 PHOS-T		MG/L	2	060000	.000200	.014142	.235704	.010000	070000	050000	70/06/08	70/10/18
00670 TARS C		MG/L	2	9.75000	3.12500	1.76777	.181309	1.25000	11.0000	8.50000	70/10/18	70/10/18
00710 CALCIUM		MG/L	1	4.20000					4.20000	4.20000	70/10/18	70/10/18
00715 CALCIUM		MG/L	1	2.50000					2.50000	2.50000	70/06/08	70/06/08
00725 MAGNESIUM		MG/L	2	750000	.045001	.212134	.282846	.150002	900000	600000	70/06/08	70/10/18
00730 SODIUM		MG/L	2	27.0000	242.000	15.5503	.576161	11.0000	35.0000	16.0000	70/06/08	70/10/18
00735 POTASSIUM		MG/L	1	2.50000					2.50000	2.50000	70/06/08	70/06/08
00940 CHLORIDE		MG/L	1	26.0000					26.0000	26.0000	70/10/18	70/10/18
00945 SULFATE		MG/L	1	17.0000					17.0000	17.0000	70/10/18	70/10/18
01045 TKN		MG/L	2	230.000	33500.0	103.846	.795338	130.000	360.000	100.000	70/06/08	70/10/18
01047 LEAD		MG/L	1	000000					000000	000000	70/06/08	70/06/08
01055 MERCURSE		MG/L	2	000000	.000000	.000000		.000000	000000	000000	70/06/08	70/10/18
01350 ZINC		MG/L	1	000000					000000	000000	70/06/08	70/06/08
70507 PHOS-T		MG/L P	2	040000	.000200	.014142	.353554	.010000	050000	030000	70/06/08	70/10/18

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44 20 30.0 110 46 30.0 3
SHUSHONE LAKE NEAR PATROL CABIN
60 WYOMING
PACIFIC NORTHWEST
COLUMBIA
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STREET DATE 72/11/73

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44 17 30.0 110 37 30.0 3
LEWIS LAKE AT LEWIS L. CAMP AREA
60 WYJING
PACIFIC NORTHWEST
COLUMBIA
1117MR
3000

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PARAMETER	TEMP	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER	TEMP	8.10714	71.7761	8.47208	1.04501	2.26426	20.0000	.000000	70/05/08	70/07/31
00011 AIA	TEMP	13.5714	67.3407	8.20614	.604663	2.19315	24.0000	.000000	70/05/08	70/07/31
00012 TURB	JKSN	1.13000	.992001	.995993	.903444	.406612	3.00000	.400000	70/05/08	70/07/31
00015 CONDUCTV	AT 25C	4 70.7500	200.916	28.3005	.400006	14.1502	92.0000	31.0000	70/05/08	70/07/31
00303 PH	PH	4 7.59959	.713427	.955734	.125754	.477867	8.90000	.600000	70/05/08	70/07/31
00304 H2O	2 DAY	5 3.60000	.032000	.179886	.470754	.080000	.600000	.200000	70/05/20	70/07/28
00310 H2O	5 DAY	5 .69599	.070000	.264576	.377966	.116322	1.10000	.400000	70/05/20	70/07/28
00400 PH	PH	5 7.15395	.103088	.321074	.044843	.143563	7.60000	.600000	70/05/08	70/07/31
00403 LAP	PH	5 6.76666	.527436	.726269	.107333	.242096	7.90000	.500000	70/05/08	70/07/31
00410 T ALK	CAC03	5 22.9667	49.9270	7.06551	.307659	2.88464	26.0000	.800000	70/05/08	70/07/31
00500 RESIDUE	TOTAL	4 119.750	2372.92	48.7126	.406786	24.3563	157.000	50.0000	70/05/08	70/07/31
00515 PESTICIDE	DISS-105	4 95.5000	1603.67	40.0458	.419328	20.0229	143.000	49.0000	70/05/08	70/07/31
00610 NH3-N	TOTAL	4 .055000	.003100	.055676	1.01232	.027639	.130000	.000000	70/05/08	70/07/31
00625 TMT KJFL	N	4 .173000	.002333	.048304	.284143	.024152	.240000	.130000	70/05/08	70/07/31
00630 MCEX03	N-TOTAL	4 .052500	.003825	.061847	1.17303	.030523	.120000	.000000	70/05/08	70/07/31
00665 PHOS-T	P-WET	4 .080000	.003600	.060000	.750000	.030000	.130000	.010000	70/05/08	70/07/31
00690 T TKS C	C	4 1.77500	.089167	.298608	.168230	.149304	3.70000	1.50000	70/05/08	70/07/31
00715 CALCIUM	CA-DISS	4 3.02500	.209162	.457343	.151188	.228671	4.00000	2.70000	70/05/08	70/07/31
00725 MG-SILUM	MG-DISS	4 .400000	.000000	.000345	.000863	.000173	.400000	.400000	70/05/08	70/07/31
00730 SODIUM	NA-DISS	4 13.0000	2.00000	1.41421	.108786	.707107	15.0000	12.0000	70/05/08	70/07/31
00735 PTSSIUM	K-DISS	4 2.82500	.255834	.505800	.179044	.252900	3.40000	2.40000	70/05/08	70/07/31
00940 CHLORIDE	CL	4 7.50000	1.00000	1.41421	.133333	.500000	9.00000	7.00000	70/05/08	70/07/31
00945 SULFATE	SO4	4 6.87500	20.2092	4.49547	.653886	2.24773	13.0000	2.30000	70/05/08	70/07/31
00950 FLUORIDE	F-DISS	4 2.05000	.930002	.911044	.444412	.455522	2.60000	.700000	70/05/08	70/07/31
00955 SILICA	DISSOLVED	2 36.0000	.000000	.000000	.000000	.000000	.000000	.000000	70/07/20	70/07/31
01005 BARIUM	BA-DISS	4 .000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/08	70/07/31
01040 COPPER	CU-DISS	3 116.667	10833.3	104.083	.892143	60.0926	200.000	.000000	70/05/08	70/07/31
01045 IRON	TOTAL	4 .000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/08	70/07/31
01045 LEAD	PB-DISS	4 .000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/08	70/07/31
01055 MANGANESE	MN	4 17.5000	425.000	20.5155	1.17303	10.3078	40.0000	.000000	70/05/08	70/07/31
01070 ZINC	ZN-DISS	4 .000000	.000000	.000000	.000000	.000000	.000000	.000000	70/05/14	70/05/22
31500 TMT COLI	MT-100	5 1.00000	.000000	.000000	.000000	.000000	1.00000	1.00000	70/05/14	70/05/22
31616 FEC COLI	MFM-FCB	10 1.00000	.000000	.000000	.000000	.000000	1.00000	1.00000	70/07/29	70/07/29
31673 FECSTREP	MFK-FAGAR	5 10.4000	178.300	13.3529	1.28393	5.97160	33.0000	1.00000	70/07/25	70/07/29
70507 PHOS-T	ORTHO	4 .007000	.000013	.003559	.508433	.001780	.010000	.003000	70/05/08	70/07/31

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LEWIS PLAT S. ENTRANCE RD 30USE
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PACIFIC NORTHWEST
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SNAKE R. ABOVE LEWIS R. JUNC.
60 WYOMING
PACIFIC NORTHWEST
COLUMBIA
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SNAKE R. AT SOUTH PARK BOUNDARY
60 HYDING
PACIFIC NORTHWEST
COLUMBIA
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STREET DATE 72/11/23

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44 35 00.0 110 40 00.0 3
SNAKE R. AT SOUTH PARK BOUNDARY
60 MYOMING
PACIFIC NORTHWEST
COLUMBIA
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PARAMETER	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
31616 FEC COLI	10	60.2000	7620.35	87.2949	1.45008	27.6051	300.000	1.00000	70/05/18	70/07/29
31673 FECSTREP	5	58.0000	2931.50	54.1433	.933506	24.2136	150.000	22.0000	70/07/25	70/07/29
32720 PHENJLS	2	2.20000	3.38000	1.83848	.835672	1.30000	3.50000	.900000	70/05/08	70/05/25
39260 MBAS	3	.033333	.000933	.030551	.916516	.017638	.060000	.000000	70/05/08	70/07/31
39365 DDE	1	.030000					.030000	.030000	70/07/20	70/07/20
39370 DDT	1	.020000					.020000	.020000	70/07/20	70/07/20
70507 PHOS-T	4	.013500	.000062	.007895	.584825	.00394E	.020000	.004000	70/05/08	70/07/31