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WATER QUALITY STUDY FOR PLATT NATIONAL PARK

Submitted to

United States Department of the Interior
National Park Service
Southwest Region
P.O. Box 728
Santa Fe, New Mexico 87501

Prepared by

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and
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Norman, Oklahoma 73069

March 1976



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CHAPTER I

INTRODUCTION

Since 1906 Platt National Park has been very popular among the people of Oklahoma and other states. The park is located in Murray County in south central Oklahoma (Figure 1). Purchased in 1902 from the Choctaw Nation, the area was known as Sulphur Springs Reservation. An area of 1.33 square miles was designated as Platt National Park on June 29, 1906 (1). Even though the park is relatively small, it has many natural features which attract thousands of tourists annually. A beautiful hardwood forest covers the entire park area and provides a natural habitat for a variety of wildlife. Several hiking trails in the park enable the visitor to experience not only the natural beauty of the forest but also the very interesting geology of the park's surface which is characteristic of the Arbuckle Mountain region.

Adding to the beauty of the park are many natural springs. The springs are located in all parts of the park and flow from orifices in the rock formations. A spring's water quality will vary greatly depending on its general location in the park.

Medicine Spring and Bromide Spring are classified as "mineralized" as a result of the large quantities of minerals present in the water. The two springs are located in the western end of the park (Figure 2). The mineralized water is one of the attractions for which the park is historically famous. Many people collect the water from the springs for

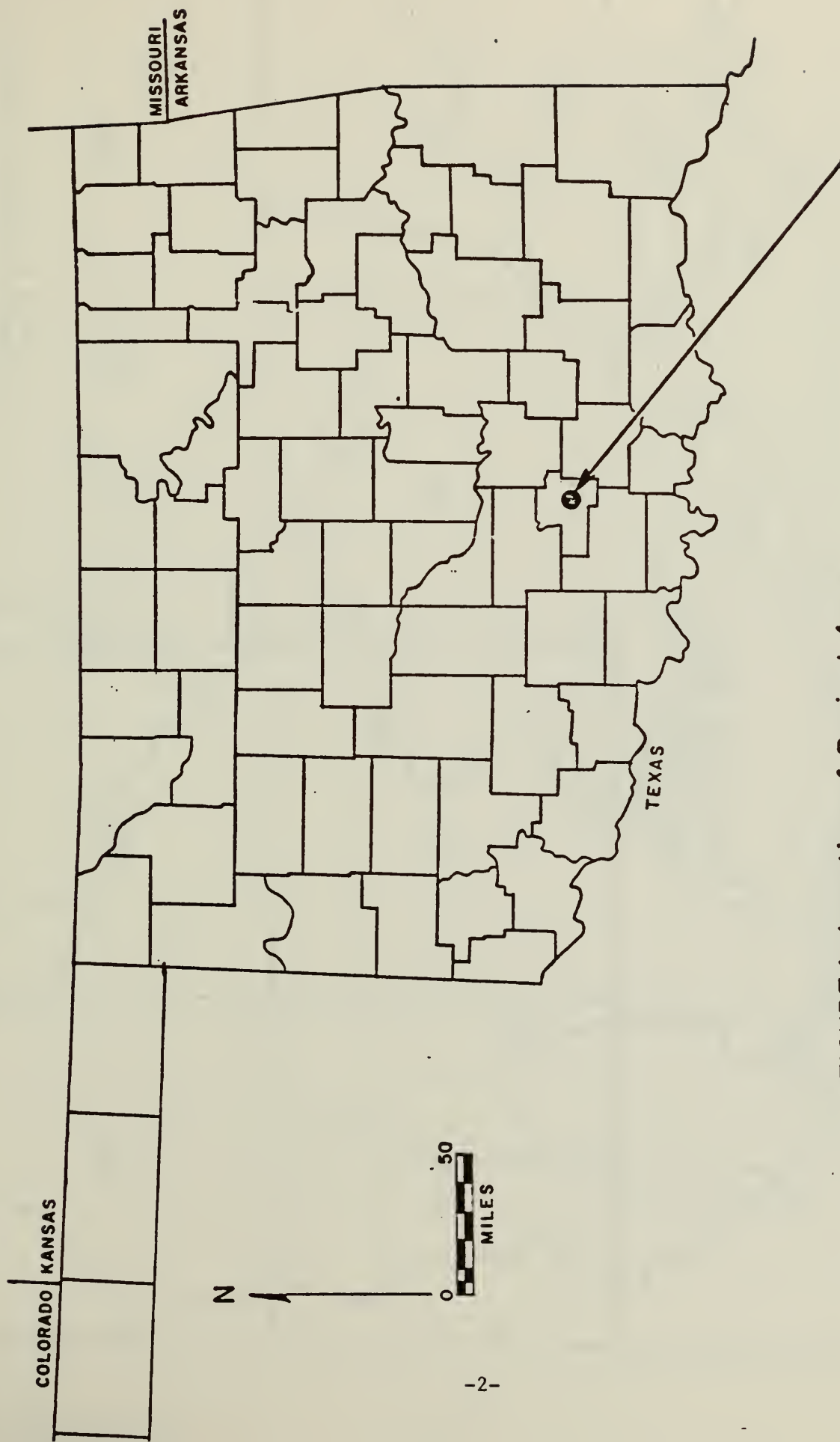
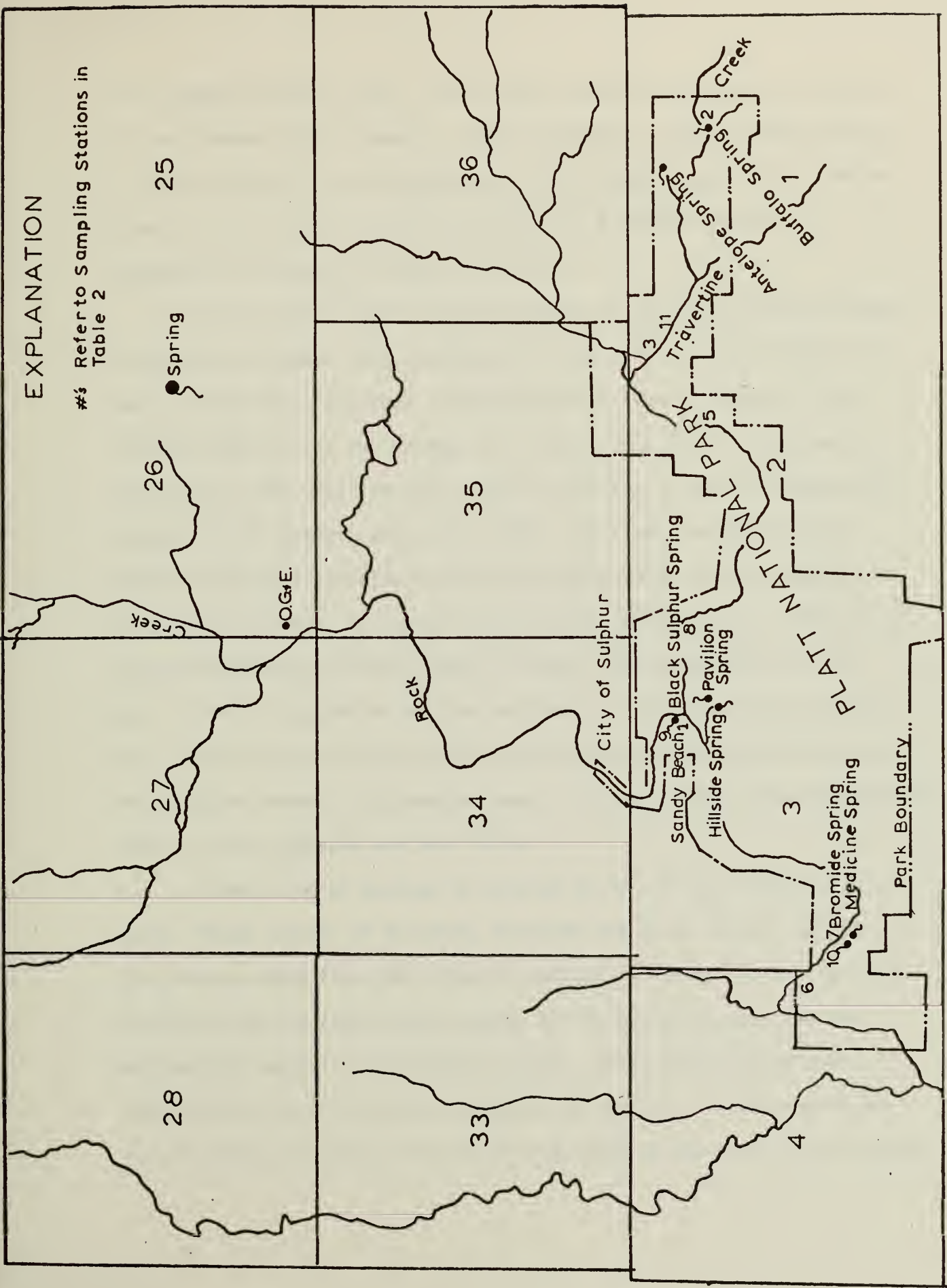


FIGURE 1. Location of Project Area
Murray County, Oklahoma



EXPLANATION

#s Referto Sampling Stations in Table 2

● Spring

FIGURE 2. PLATT NATIONAL PARK AREA

its alleged medicinal value. The water comes from an artesian aquifer in the Simpson group formation. The groundwater becomes mineralized as it flows through the soft sandstone of the Simpson group. The combined flow of the springs is small averaging 3 to 8 gallons per minute. An analysis of the water is shown in Table 1.

The two largest fresh water springs in the park are Antelope Spring and Buffalo Spring. These springs are found in the eastern end of the park and are close together. During years of average rainfall, the combined flow of the two springs will vary from 2,500 to 5,000 gallons per minute. The water is very fresh in contrast to the two mineralized springs in the western end of the park. The flow from Antelope and Buffalo Springs originates from an artesian aquifer in the limestone of the Arbuckle group. The waters from the two springs quickly converge to form Travertine Creek which tends to bisect the eastern half of the park. Over a long period of time deposits of travertine from the water have formed many small water falls and pools along the creek which are very popular summer time swimming areas. These swimming areas have names such as Little Niagara and Bear Falls.

A final group of springs is located in the central region of the park. These consist of Hillside, Pavilion and Black Sulphur Springs. The water issuing from this group of springs is thought to be a mixture of water from the fresh water aquifer in the Arbuckle group and the mineralized aquifer in the Simpson group. The mixing results from faulting and other geological phenomena in the area. A water analysis of this group of springs shows characteristics of the fresh water springs

Table 1. WATER ANALYSIS OF SPRINGS AT
PLATT NATIONAL PARK

Location	Water Analysis, mg/l							TDS
	Na	Ca	Mg	Cl	HCO ₃	SO ₄	CaCO ₃	
Bromide Spring	1340	50	30	2020	610	48	249	3960
Medicine Spring	1490	68	36	2370	610	14	318	4520
Antelope Spring	44	50	30	8	290	0	249	293
Buffalo Spring	40	52	32	7	300	0	262	295
Black Sulphur Spring	254	51	28	350	316	0	244	816
Pavilion Spring	110	60	38	140	305	0	307	588

in the eastern end of the park and the mineralized springs in the western end of the park. The combined flow of the Hillside, Pavilion, and Black Sulphur Springs is usually less than 300 gallons per minute.

Two major streams flow through the park. As described previously, Travertine Creek originates from the combined flow of the Antelope and Buffalo Springs and flows generally west through the center of the park. The pools along Travertine Creek provide a playground for all park visitors. The average flow of the stream varies from 3,000 to 6,000 gallons per minute during a year of average precipitation which is 32.2 inches for the area. In the central region of the park, Travertine Creek flows into Rock Creek. Rock Creek then continues on through the western half of the park. The combined flow of Travertine and Rock Creek will vary from approximately 5,000 to 10,000 gallons per minute. Rock Creek also forms many wading and swimming areas along its reach in the park. One of the favorite pools along Rock Creek is called Sandy Beach and is located just above the point of convergence with Travertine Creek. Rock Creek originates some distance to the north of Platt National Park. Before entering the park, Rock Creek flows through the center of Sulphur, Oklahoma, a town setting directly adjacent to the northern boundary of the park.

Currently the natural beauty of the park is being threatened by pollution in Rock Creek and Travertine Creek. As recently as May 1975, the park service began to monitor high coliform counts at several points along the two streams. Fecal coliform counts in excess of 2000/100 ml were being reported. Table 2 lists the dates, sampling sites and test

Table 2. SAMPLING SITES AND ANALYSIS FOR PLATT NATIONAL PARK
(NATIONAL PARK SERVICE)

Sample Site	Date	Total Coliform ¹	Fecal Coliform
1. Sandy Beach	5/13/75	200+ MPN Swim Area	
	5/13/75	300+ MPN Swim Area	
	6/11	1600+	
	8/5	200+	
	--	200+	
2. Buffalo Spring	6/11	2 MPN	
	--	200+	
	--	200+	
	8/5	140	
	9/2	3	
3. Little Niagara	5/13	200+ MPN Swim Area	
	5/13	2100 MPN Swim Area	
	6/11	140 MPN	
	--	200+	
	8/20	200+	
4. Rock Creek Campground Comfort Station # 1	5/13	1	
	5/28	2	
	6/11	3	
5. Bear Falls	5/28	200+ MPN Swim Area	
	7/22	200+	
	9/2	8000 MPN Swim Area	
	9/14	900 MPN Swim Area	2500 MPN
	9/17		
	9/21	600 MPN Swim Area	
6. Rock Creek Campground swim area near Site 26	6/24	1600+ MPN	
	8/20	200+	
7. Rock Creek (Bromide Area)	5/28	200+ MPN Swim Area	
	8/5	200+	
8. Central Campground Swim Area	8/5	200+	
9. Black Sulphur Beach	9/21		3100 MPN
10. Bromide Foot Bridge	9/21		3500 MPN
11. Travertine Creek below Nature Center	9/12	2700 MPN Swim Area	
	9/14	2100 MPN Swim Area	
	9/17		400 MPN

¹ Values/100 ml unless otherwise noted

results obtained by the park service from May 1975 through September 1975. The locations of these sites are shown in Figure 2. As a result of indicated pollution in the streams, the park service closed several areas along Rock Creek and Travertine Creek to public use. At the request of the National Park Service an investigation was initiated in October 1975 to determine the sources causing the high coliform counts.

The stream pollution study included four field investigations during the months of October, November and December 1975 and January 1976. The methods and procedures of the different phases of the stream pollution study are described in the following chapters. The final two chapters present the conclusions and recommendations resulting from the study.

CHAPTER II
STREAM POLLUTION AND ITS RAMIFICATIONS
IN THE STUDY AREA

Many different conceptions exist today about what constitutes stream pollution. A definition of stream pollution frequently used, which adheres closely to legal interpretation, is given by N. Nemerow in his book, Scientific Stream Pollution Analysis. He defines the term pollutant to mean, "too much of any given contaminant such that it renders the receiving water unusable in its existing state for its desired best usage". Indeed, the most recent water quality standards for Oklahoma are structured around eight "present and potential uses of the waters of the State" (2). Beneficial uses include, municipal water supplies, fish and wildlife propagation, agriculture, hydroelectric power and water recreation. In Oklahoma each major river and stream is classified according to its beneficial uses and the water quality criteria for each stream or river is based on its beneficial uses.

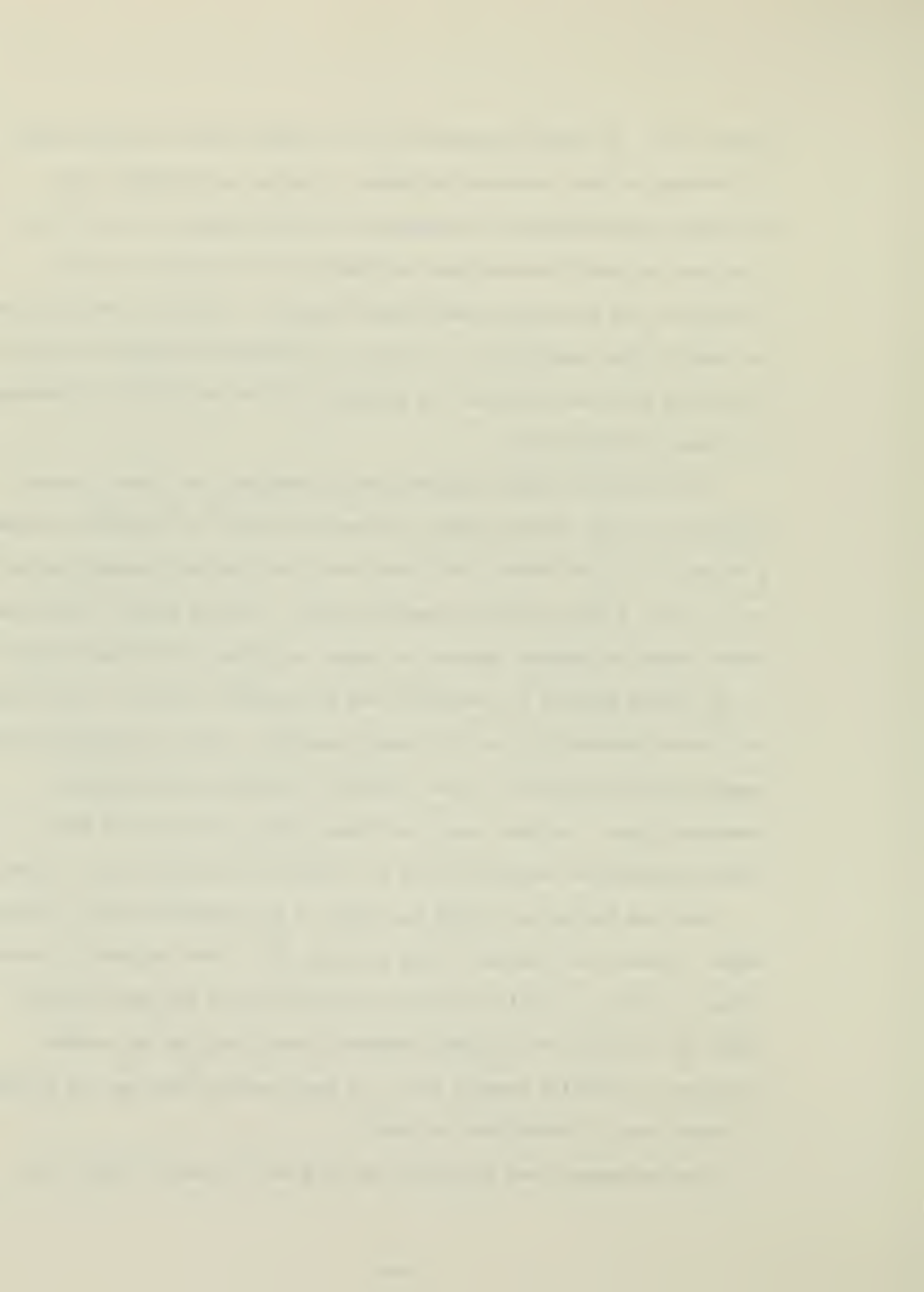
For many streams in Oklahoma, a very important beneficial use is coded G_1 in the "Water Quality Standards". This code refers to the following use, "recreation, primary body contact (includes recreational uses where the human body may come in direct contact with the water to the point of complete submergence)" (2). Failure to maintain water quality conditions in a stream which are consistent with code G_1 has paramount public health significance. Numerous reports present epidemiological evidence that particular bathing areas were the sources of epidemics and

disease (3). In several instances (4-7), typhoid fever has been linked to swimming in water polluted by sewage. Cholera and swimmers itch have also been attributed to swimming in polluted waters (1,8). This list also includes diseases such as pinkeye, ear infections, nasal infections, and other gastrointestinal diseases. The Public Health Service reports that hepatitis A, a virus, is transmitted through the fecal-oral route thus implying that the disease could be contracted by swimming in sewage polluted water.

In addition to public health aspects stemming from direct contact with water, there are many other detrimental effects of polluted streams. A severely polluted stream could mean death for the many animals depend on it as a water supply or aquatic home. Floating solids, discolored water, odors and rampant growths of algae resulting from the pollutants in the stream destroy its aesthetic and recreational values. Many streams and rivers eventually flow into large reservoirs. They may significantly degrade the water quality in the reservoir thereby restricting its beneficial uses. In this case, Rock Creek flows into Arbuckle Lake, a large multipurpose reservoir which is a source of municipal water supplies.

Rock and Travertine Creeks have many of the beneficial uses described above. Inside Platt National Park the main use of the streams is recreational. In fact, of all the attractions in the park the most popular among the visitors are the many swimming areas along the two creeks. More than one million persons visit the park annually and use the streams for some type of recreational activity.

The maintenance and protection of good water quality within Rock



and Travertine Creeks is especially important to the vitality of the national park. The opportunity for swimming appeals to the many visitors. If this opportunity is eliminated through unsafe water, its usage will drop significantly. This will result in an economic loss for the City of Sulphur because the tourists purchase some goods from the local businesses. Hence, the ramifications of stream pollution along Travertine and Rock Creeks are numerous and consequently, the streams must be maintained in a nonpolluted state.

CHAPTER III

BIOLOGICAL AND CHEMICAL ANALYSES

A stream pollution analysis was initiated in October 1975 at the request of the National Park Service. The objective of the Platt National Park study was to locate the sources of high coliform counts monitored by the park service in recent months. The coliform group includes all of the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod shaped bacteria which ferment lactose with gas formation within 48 hours at 35°C. High concentrations of certain coliforms indicate sewage pollution in a stream. Sewage contains extremely high numbers of coliform bacteria which live in the intestines of warm blooded animals. The Oklahoma Water Quality Standards establishes definite limits on the levels of the fecal coliform group in drinking and recreational waters. The standards specify that for waters used for recreational purposes where there is primary body contact (complete submergence) the density of fecal coliform shall not exceed a monthly geometric mean of 200/100 ml based on a minimum of not less than five samples (2).

There are two tests which are currently accepted for measuring densities of the coliform and streptococcus group. One is a statistical method called the multiple tube fermentation method. The results of this method are given in the form of a most probable number (MPN) based on probability formulas relating to the production of gas in fermentation tubes. The other method is the membrane filter technique. In this test

bacteria are directly plated on a filter pad and placed on a petri dish with medium favorable to the growth of coliform bacteria. Results of the test provide a direct enumeration of the coliform densities. The membrane filter technique is especially well suited for detecting the location of pollution sources and, therefore, this technique was chosen.

The testing procedure followed is given in Standard Methods for the Examination of Water and Wastewater (9). Quality control techniques were also important. These included proper sterilization of equipment and media and preservation methods (such as cooling on ice) after the samples were collected.

Three different dilutions of each sample were prepared in the laboratory using sterilized dilution water. The dilutions were 1:10, 1:100, 1:1000 (i.e., 1:10 means 1 part sample to 10 parts dilution water). Standard millipore filter equipment was used to plate the samples. Two 10 ml portions of each dilution were plated in separate petri dishes. One petri dish contained an absorbent pad saturated with M-endo broth, a medium favorable to the growth of those coliform bacteria specified in Standard Methods as total coliforms. The second petri dish contained solidified M-enterococcus agar, a medium used to detect the coliform bacteria specified as fecal streptococcus coliform. The petri dishes were then inverted and incubated at 35°C. The petri dishes containing M-endo broth were removed at the end of 24 hours and a count of the characteristically metallic green colonies was taken and the result reported as total coliform bacteria per 100 ml of sample. At the end of 48 hours the petri dishes containing M-enterococcus agar were removed from the incubator and all red and pink colonies were counted and reported

as fecal streptococcus density per 100 ml of sample. The three dilutions used provided a very adequate range to measure the different levels which occurred. Counts from the petri dishes which were between 30 and 300 were chosen as the most representative of the dilutions prepared.

Chemical analyses are also valuable in accomplishing the objectives of a stream pollution analysis. They enable one to measure the concentrations of many of the pollutants. The Oklahoma Water Quality Standards list several chemical parameters. These include chemical oxygen demand (COD), biochemical oxygen demand (BOD), oil and grease, solids, dissolved oxygen (DO), minerals (chloride, sulfate, and total dissolved solids) and certain metals. In addition to the microbiological tests described above, the COD of each sample was determined. The COD test measures the levels of organic material present, thus indicating the presence of sewage pollution.

Procedures as detailed in Standard Methods were followed in performing this analysis. Approximately 2 ml of concentrated sulfuric acid were added to each sample as a preservative. Each sample was tested within 24 hours. The results of the test were reported as COD in mg/l. Rigid adherence to sterilization, sampling and testing techniques resulted in consistent results for each of the four sampling trips.

CHAPTER IV
STREAM POLLUTION ANALYSIS FOR
PLATT NATIONAL PARK

The overall objective of the stream pollution analysis for Platt National Park was to locate pollution sources causing high coliform counts along Travertine and Rock Creeks in the park. High coliform counts had been monitored by the park service since May 1975. Table 2 shows the location of the areas and coliform test results obtained by the park service. As explained in the previous chapter, tests were initially chosen which would indicate fecal contamination in the water. The tests chosen were total coliform, fecal streptococcus and COD. These tests and the related testing procedures have been described in Chapter 4. Four field investigations were conducted during the stream pollution analysis on the following dates: October 18 and 28, 1975, December 22, 1975 and January 9, 1976.

On October 18, ten sampling stations were chosen along Rock and Travertine Creeks in Platt National Park. The locations of the stations were governed by the results of previous tests made by the park service. The location of each station is described in Table 3 along with the test results. These locations may be found in Figure 3 by using the descriptions and numbers given for the stations in Table 3. The results of the test indicate that several points along Travertine and Rock Creeks have high numbers of total coliform and fecal streptococcus present.

Sample Site Description	Date	Total Coliform		Fecal Strep		COD mg/l
		Values/100 ml		Values/100 ml		
1. Antelope Spring	10/18/75	0		0		8
2. South side of nature center	10/18	600		0		45
3. Little Niagara Foot Bridge	10/18	1000		0		4
	10/28	0		0		--
4. 0.35 mile east of Cold Spring Campground Ranger Station	10/18	200		0		0
5. 0.2 mile east of Cold Spring Campground Ranger Station	10/18	100		0		4
6. 200 ft east of Lincoln Bridge on Travertine Creek	10/28	3400		0		0
7. Below Lincoln Bridge and just above inverted siphon	10/18	380,000		2600		11
8. West of Lincoln Bridge about 100 ft on Travertine Creek below siphon	10/28	3200		0		0
9. Vendome Well	10/28	0		0		--
10. Below bridge north of Sulphur on Rock Creek	10/28	2100		200		45
11. South of Broadway Bridge about 20 ft before discharge from storm drain	10/28	500		200		11
12. Storm culvert south of Broadway Bridge about 20 ft	10/28	420,000		200,000		272
13. Sandy Beach on Rock Creek above confluence with Travertine Creek	10/18	25,000		400		45
	10/28	340,000		39,000		83
14. 50 ft south of Low Water Bridge just below confluence Travertine and Rock Creek	10/18	2000		--		8
15. Bromide Foot Bridge	10/18	8000		100		11
16. South side of bridge at entrance to Rock Creek campground	10/28	300		0		0
17. Point approximately midway between 2 siphons crossing Rock Creek in vicinity of Rock Creek Campground	10/28	200		0		0
18. South of siphon approximately 200 yd crossing Rock Creek near west boundary of Rock Creek Campground	10/28	600		100		7

EXPLANATION

Sample Stations in Table 3

Sample Stations in Table 4

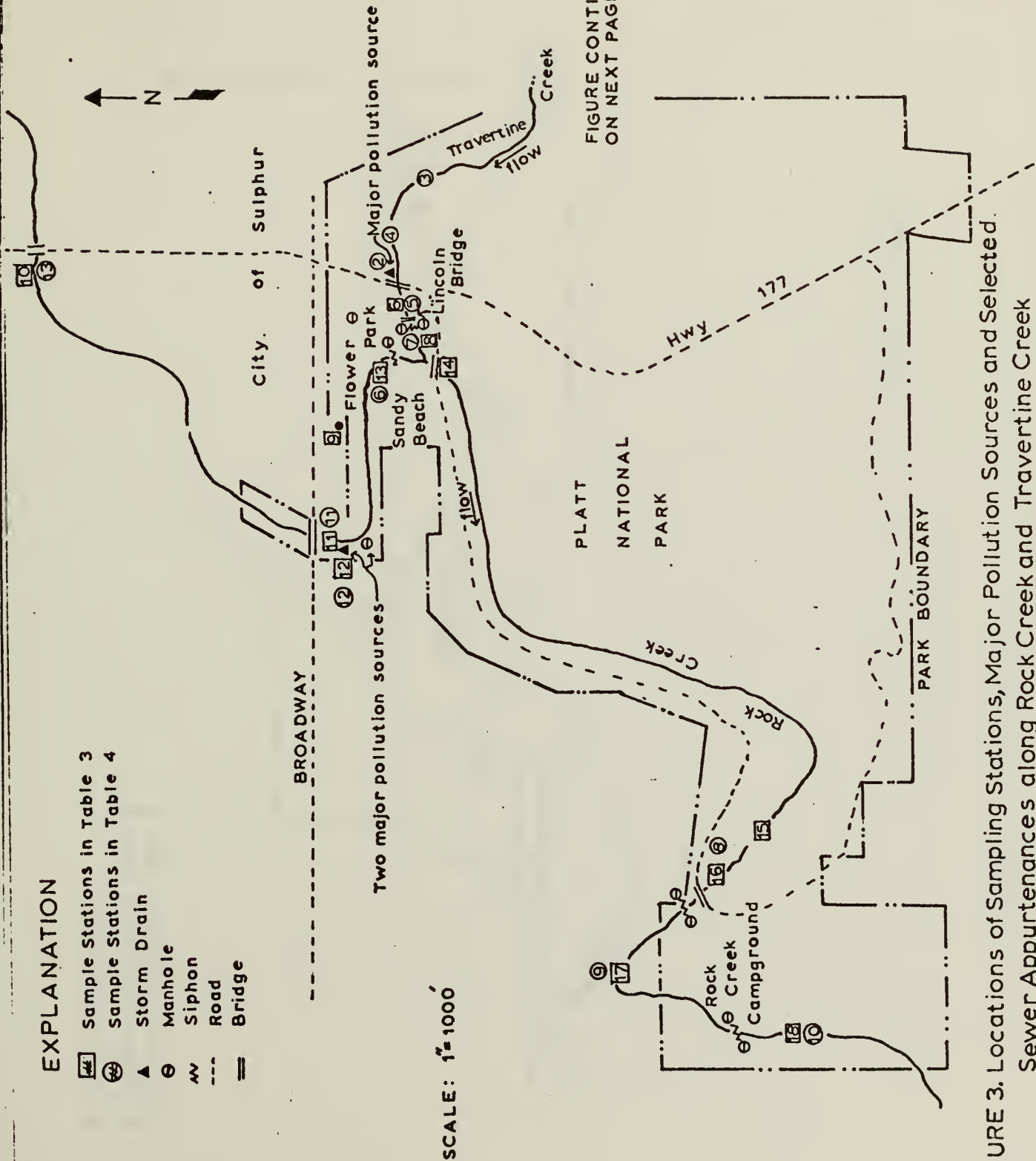
Storm Drain

Manhole

Siphon

Road

Bridge



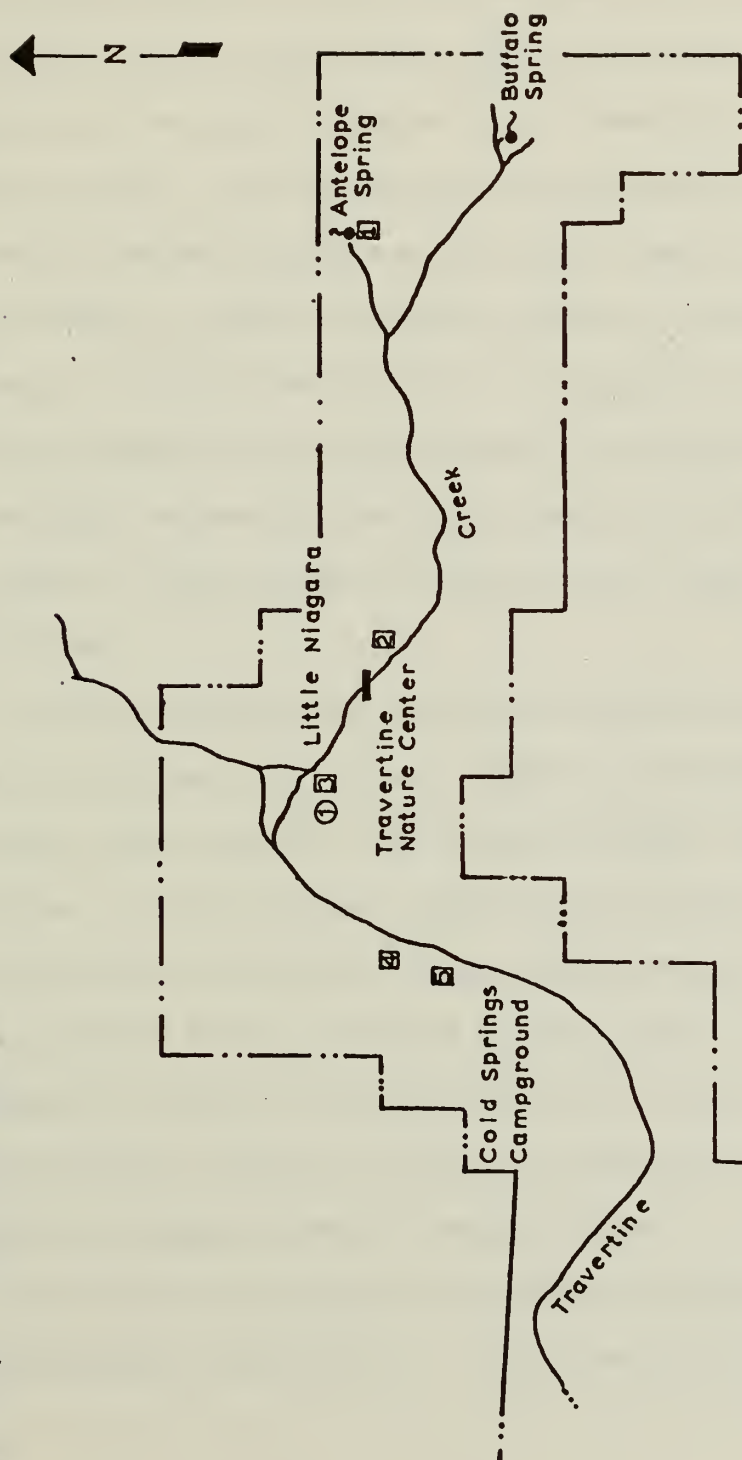
SCALE: 1"=1000'

FIGURE CONTINUED
ON NEXT PAGE

FIGURE 3. Locations of Sampling Stations, Major Pollution Sources and Selected Sewer Appurtenances along Rock Creek and Travertine Creek

EXPLANATION

- Sample Stations in Table 3
- ⊕ Sample Stations in Table 4



SCALE: 1" = 1000'

FIGURE 3 CONTINUED

Along Travertine Creek high counts are encountered in the vicinity of the Lincoln Bridge. Extremely high counts along Rock Creek were found in the Sandy Beach area before the confluence with Travertine Creek. High counts were also encountered around the Bromide Foot Bridge and along Rock Creek in the area of the Rock Creek Campground. It is of interest to note, however, that the counts are the highest in the Sandy Beach area and tend to decrease significantly further downstream. During the trip, large growths of algae were observed along all sections of Rock Creek in the park. The algae growths tend to be greatest in the Sandy Beach area with large numbers of floating clumps of algae beginning to accumulate at some point between the Sandy Beach area and the Bromide Foot Bridge. The clumps of algae become very dense in Rock Creek below the Bromide Foot Bridge.

A second trip was made to Platt National Park on October 28, 1975. A map was obtained from the park maintenance department from which sanitary sewer lines, manholes, and inverted siphons could be located in the park area. A city sewer main enters the park in the area of the Vendome Well and tends to follow Rock Creek through the park. Another city main enters the park from the Veterans Hospital south of the park. The two city mains are united in Flower Park inside the park boundaries. The sewer mains were observed to cross the streams in the park a total of four times through the use of inverted siphons.

The first siphon observed was immediately west of Lincoln Bridge on Travertine Creek (Figure 3). The direction of flow is north across

Travertine Creek into the Flower Park area. The sewer line feeding this siphon comes from the area south of the park and includes the flow from the Veterans Hospital. The siphon was replaced recently by the park service and appears to be functioning properly. The flow from this line unites with the flow from another city main in the Flower Park area. The combined flow then passes underneath Rock Creek in a second siphon.

The siphon carrying the combined flow mentioned above crosses Rock Creek in the vicinity of Sandy Beach. The direction of flow is west from the Flower Park to Sandy Beach. A manhole for this siphon is found in Flower Park. Upon inspection, the flow appears to be greatly restricted in one barrel of the siphon. The other barrel is partially obstructed. The manhole shows the siphon to be functioning poorly. Also, the manhole sides have collapsed letting dirt and roots enter the sewer lines and letting the raw sewage seep out into the ground. The manhole is located approximately eight feet from the bank of Rock Creek and approximately 150 yards north of Lincoln Bridge in Flower Park. There is another manhole in Flower Park approximately 50 feet north and west of the comfort station. The flow out of the manhole was obviously blocked as sewage was backing up in the manhole and consequently, complete inspection of the manhole condition was impossible.

From Flower Park the city main proceeds on through the park along and in the direction of Rock Creek. The main crosses Rock Creek next at a point near the entrance to the Rock Creek Campground in the west end of the park. The siphon is located approximately 100 feet north of a bridge which crosses Rock Creek just prior to the entrance to Rock

Creek Campground. Both manholes were inspected and the siphon appeared to be functioning fairly well. The manhole on the east side of the bank, however, has an overflow outlet which apparently discharges into Rock Creek during peak periods of use. The main continues on through the campground and then crosses Rock Creek once again on the west boundary of the campground. A manhole is located on the bank of Rock Creek permitting inspection of the siphon. The siphon was functioning poorly with one barrel plugged and the other obstructed with debris. The manhole was poorly constructed with the top approximately 3.5 feet above the ground surface. The manhole cover was constructed of barrel tops.

In addition to inspecting the conditions of the manholes and siphons in the park, a section of the city sewer lines located along Rock Creek north of the park boundary was examined. Approximately 20 feet south of a bridge crossing Broadway in Sulphur, a storm drainage culvert was found to be discharging directly into Rock Creek. The water from the culvert was examined and the analyses are given in Table 3. The analyses indicate that the discharge is composed of raw sewage. A city sewer main runs from the north toward the south and passes through the bottom of the culvert and normal to the alignment of the culvert. The sewage flows over the top of the main line and then out of the culvert. It was not possible, however, to ascertain the origin of the flow in the culvert. The main line proceeds to follow the bank of Rock Creek south and into the park from the bridge. A manhole was located approximately 300 yards south of the bridge on Broadway which crosses Rock Creek. At the manhole, raw sewage was discharging directly into Rock Creek. Inspection

of the manhole indicated that the main line was plugged causing raw sewage to back up in the manhole. The discharge was estimated to be approximately 30 gallons/minute. It is noteworthy that the manhole and culvert described above are located approximately one-tenth of a mile above the Sandy Beach area. Another siphon was located in the center of town and crossed Rock Creek. The siphon was partially obstructed and its flow restricted.

During the examination of the sewer lines, manholes and siphons in and outside the park, several water samples were taken along the streams. The location of each station is described in Table 3 and shown in Figure 3. One sampling station was chosen above and one below each siphon encountered. The analyses yielded very high bacterial counts in the Sandy Beach area. It is emphasized that this point on Rock Creek is below the manhole and culvert found to be discharging into Rock Creek. A sample taken above the culvert (Table 3, sample 11) shows low counts in comparison to those recorded in the Sandy Beach area. The general trend of the second analyses was the same as the first. High counts prevailed on Rock Creek and the Sandy Beach area. Also, high counts were obtained on Travertine Creek in the vicinity of Lincoln Bridge. These counts significantly decreased on down Rock Creek in the Rock Creek Campground area. Heavy algae growths were present along all stretches of Rock Creek in the park area with dense floating clumps of algae present in Rock Creek below the Sandy Beach area.

From the test analyses and observations from the first two trips, several observations can be made. The high counts obtained in the Sandy

Beach area are due mainly to the conditions of the city sewer system above this area along Rock Creek. In particular, direct discharge from the manhole and culvert described previously are causing high counts in the Sandy Beach area. The condition of the manholes in Flower Park and the siphon crossing Rock Creek in the Sandy Beach area suggest possible infiltration of sewage into the normal flow of the stream.

The high counts in the vicinity of Lincoln Bridge were not explained. Results obtained from samples taken above and below the siphon located next to Lincoln Bridge suggest the pollution is not from the siphon but instead some source above the bridge on Travertine Creek.

A third field trip was conducted on December 22, 1975, in order to locate the pollution source east of Lincoln Bridge whose existence was suggested by the first two sets of test results. Another purpose of the third investigation was to further monitor the conditions of the pollution sources uncovered previously.

Approximately 50 feet east of the bridge on Highway 177, there appeared to be raw sewage discharging from a storm drain directly into Travertine Creek. The storm drain is located on the north bank of the creek. The discharge was estimated to be 20 gallons/minute. Above the point of discharge, the water in Travertine Creek was clear and free of any significant algae growth. However, below the point of discharge the water became murky and numbers of algae blooms were observed in the stream. A sample of the discharge was taken and analyzed. The total coliform count was 230,000 per 100 ml of sample, the fecal count was 150,000 per 100 ml of sample and had a COD value of 180 mg/l (Table 4). Thus the discharge was shown to be raw sewage.

Table 4. SAMPLING SITES AND ANALYSIS FOR PLATT NATIONAL PARK
(December 22, 1975 & January 9, 1976)

Sample Site and Station	Date	Total Coliform (values/100 ml)	Fecal Strep (values/100 ml)	COD (mg/l)
1. Little Niagara Foot Bridge	12/22/75	0	0	0
	1/9/76	0	0	0
2. Discharge from culvert, 50' east of bridge crossing Travertine Creek on Highway 177		230,000-410,000	150,000-400,000	180
		22,000	6700	75
3. One-fourth mile east of sample station 2		0	0	0
		0	0	0
4. 50-75 yds east of sample station 2		0	0	0
		0	0	0
5. Half way between Lincoln Bridge and bridge on Highway 177 crossing Travertine Creek (below station 2)		2300	1500	11
		900	300	0
6. Sandy Beach on Rock Creek above confluence with Travertine Creek		11,000	4000	25
		1,000	100	0
7. West of Lincoln Bridge about 100' on Travertine Creek below siphon		2,600	1500	0
		1,200	400	0
8. South side of bridge at entrance to Rock Creek campground		0	0	0
		100	0	0
9. Point approximately midway between 2 siphons crossing Rock Creek in the vicinity of the Rock Creek Campground		0	0	0
		0	0	0
10. Approximately 200 yds south of siphon crossing Rock Creek near west boundary of Rock Creek Campground		700	100	0
		400	100	0
11. South of Broadway Bridge about 20' before discharge from storm drain		2,400	500	7
		200	100	0
12. Storm culvert south of Broadway Bridge about 20'		40,000	8600	150
		1,000	400	80
13. Below bridge north of Sulphur on Rock Creek		1,900	300	15
		1,600	300	20

Two sampling stations were located above and two below the point of discharge described in the preceding paragraph. The two sampling stations were chosen above the discharge at distances of approximately 50 feet and 1300 feet. Also, the two sampling stations located downstream from the discharge were halfway between Lincoln Bridge and the bridge on Highway 177 and west of Lincoln Bridge approximately 100 feet. Samples were taken at each of the four locations described above and the results are given in Table 4. Test results on the upstream sampling stations show no pollution to be present while test results on the two downstream sampling stations are very consistent with results obtained at the same locations on two previous trips showing significantly high densities of fecal coliforms to be present in the stream water. Therefore, the high coliform counts being recorded in the area of Lincoln Bridge may be attributed to the discharge from the storm drain east of the bridge on Highway 177.

During the third field investigation the two pollution sources south of the bridge on Broadway were revisited. The storm drain was still discharging but about 75% less than on the previous trip. The manhole on further south of the bridge had apparently been repaired and was no longer discharging. The repairs had been made recently since inspection of the creek just below the manhole revealed large quantities of pooled water still showing quite visible signs of raw sewage such as floating solids. It is also possible that sewage could be seeping from the banks into the creek.

Samples were again taken along Rock and Travertine Creeks at the same sampling sites used in the second field investigation. The results

of the analysis are shown in Table 4. Comparison of the test results with those of the first two sampling trips will show the same general trends to exist along the streams. However, it is important to notice a significant reduction in the reading at Sandy Beach of 90% in the fecal coliform densities. This is quite certainly the result of repairs made on the manhole south of the Broadway Bridge. Inspection of Rock Creek still revealed large growths of algae beginning at Sandy Beach and extend-
on downstream. Floating clumps of algae were still present on downstream in Rock Creek.

The fourth and final field investigation was conducted on January 9, 1976. The general condition of the stream and the pollution sources described previously were examined once again. South of Broadway Bridge, the storm culvert was still discharging a small amount of the same magnitude as observed during the third field trip. The manhole on further south of the Broadway Bridge was still operating properly and not overflowing. However, the creek below the manhole still showed signs of sewage in water which was backed up. Discharge from the storm drain into Travertine Creek east of the bridge on Highway 177 has decreased in magnitude by about 60%. On Travertine Creek below the storm drain large growths of algae were still present and these growths extended on down-
stream along all of Travertine Creek. Numerous algae blooms were also visible along Rock Creek beginning in the proximity of Sandy Beach and extending on downstream where accumulations of floating algae begin to form. However, the density of the floating algae was observed to be much less than on the three previous trips.

Samples were taken at the same stations as used on the third investigation. Analysis of the test results shows several interesting trends. First, all stations above the storm drain on Travertine Creek east of Highway 177 were indicating no signs of pollution. This is consistent with the results obtained during the three previous sets of tests and an apparent trend is established. Sampling stations below Sandy Beach indicate no significant degree of pollution which is also consistent with previous results. In addition, the densities measured at Sandy Beach continued to decrease to a nonalarming level. This further indicates the effect of the repaired manhole and reduced flow from the storm drain south of the bridge on Broadway. Counts in Travertine Creek in the area of Lincoln Bridge had decreased significantly owing to the decrease in discharge from the storm drain east of the bridge on Highway 177.

CHAPTER V

SUMMARY AND CONCLUSIONS

A stream pollution analysis was conducted for Platt National Park with the objective of locating the pollution sources causing high coliform densities along Rock and Travertine Creeks. The high coliform densities had been monitored by the park service since May 1975. Subsequently, several swimming and recreational areas were closed by the park service due to public health considerations. The stream pollution analysis began in October 1975 and extended to January 9, 1976. Four field investigations were conducted to monitor pollution levels in the streams and to search for pollution sources. The stream pollution analysis was successful in locating the major pollution sources along the streams.

The field investigations and test results clearly indicate that the sewer collection system of the City of Sulphur, Oklahoma is responsible for pollution along Travertine Creek and Rock Creek in the park. Three major pollution sources were located during the study period. Two of the pollution sources are located south of the Broadway Bridge crossing Rock Creek and on the west bank of the creek. First, a storm drain located approximately 20 feet south of the bridge was shown to be discharging large quantities of raw sewage into Rock Creek on October 28, 1975. The related test analyses are in Table 3. The second source is a manhole located approximately 200 feet south of the bridge just as Rock Creek bends to the east. On October 28, 1975 the manhole

was observed to be overflowing into Rock Creek due to some type of plugged condition in the main. Samples of stream water were taken from Rock Creek in the vicinity of Sandy Beach on four different occasions during the study. Sandy Beach is located approximately 1000 feet below the sources described above. Also, samples were taken at a point just above the two pollution sources on three different occasions. The test results all indicated that the manhole and storm culvert were the main causes of fecal contamination in the Sandy Beach area. The results of the tests on samples taken on October 28, 1975 indicated extremely high fecal coliform counts in the Sandy Beach area and much lower counts above the two pollution sources. These results further substantiated those made on October 18, 1975. During the final two field investigations (December 22, 1975 and January 9, 1976) the manhole had ceased to overflow and the storm drain discharge was reduced approximately 75%. The test results obtained during these final two field trips show an accompanying decrease in pollution levels at Sandy Beach. These trends are graphically shown in Figure 4. The graph clearly indicates the two sources described above are mainly responsible for pollution along Rock Creek in the park.

Another indicator of the origin of the pollution along Rock Creek in the park is the algae growth observed during the study. During October 1975, the algal blooms became very numerous in the Sandy Beach area with heavy densities of floating algae on downstream. As the discharge from the storm drain was decreased and the manhole ceased to overflow during December 1975 and January 1976, a significant decrease in the density of floating algae was observed.

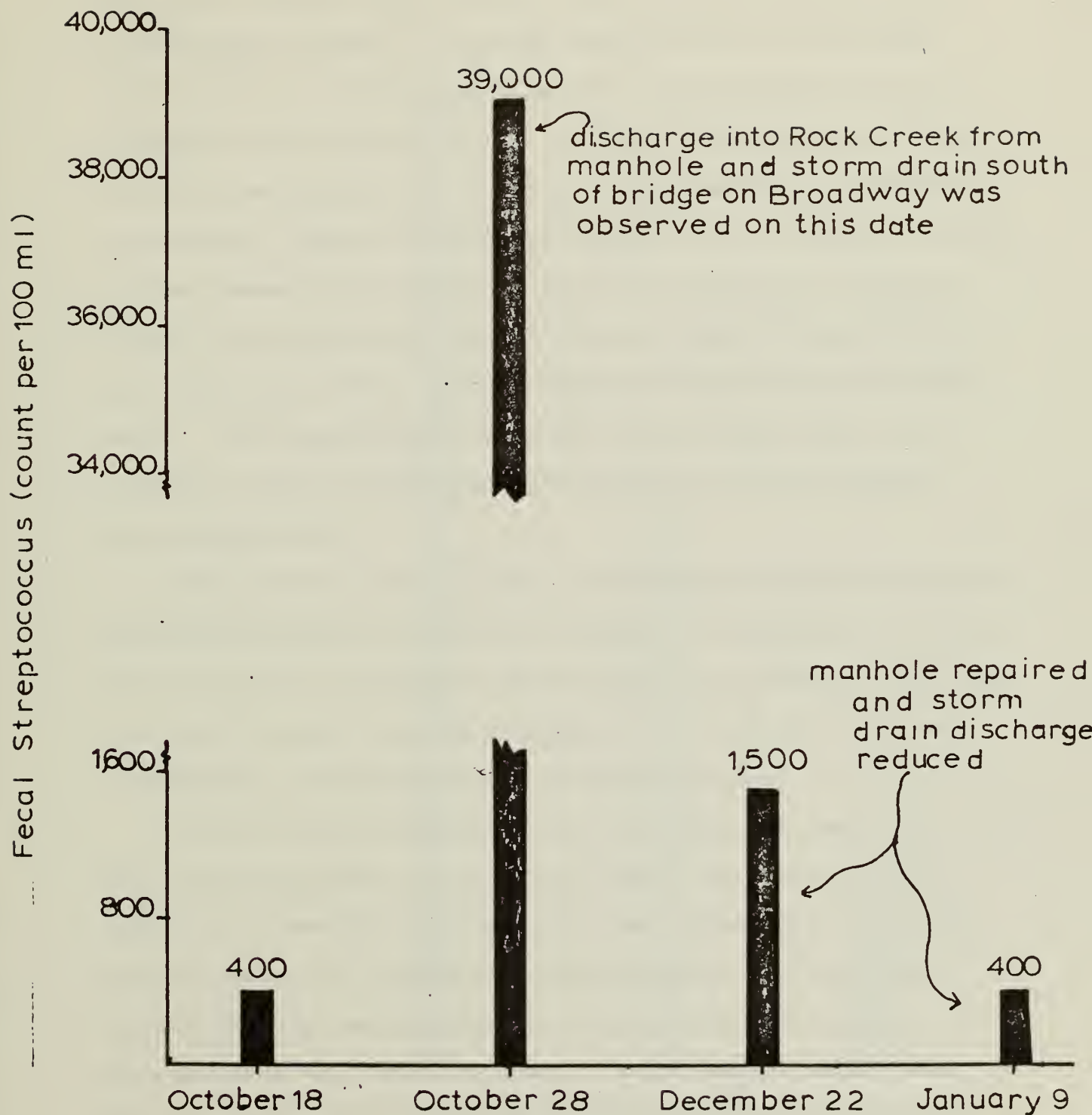


Figure 4 : Variation in Fecal Streptococcus Count at Sandy Beach During the Study

The discharge from a storm drain into Travertine Creek was the third major pollution source located. The storm drain is 20 feet east of the bridge on Highway 177 crossing Travertine Creek. Test results from the first two investigations indicated a large pollution source to be upstream from the Lincoln Bridge. The storm drain was located during the third investigation and a discharge of approximately 20 gallons/minute was observed. Analysis indicated the discharge to be raw sewage. Sampling stations located directly above the storm drain indicated no pollution present in the stream while stations below the storm drain continued to yield high fecal coliform densities indicating significant fecal contamination. Also large growths of algae were observed downstream from the storm drain while no significant algae growths were observed upstream from the storm drain.

During the final two field trips, the discharge from the storm drain decreased approximately 50% and was accompanied by a decrease in coliform densities below the discharge as shown graphically in Figure 5. The facts establish the storm drain east of Highway 177 in the park as the source of pollution in the lower stretches of Travertine Creek.

The city collection system was found to permeate the park area. Mains cross the streams a total of four times in the park by inverted siphons. In Flower Park three manholes permit inspection of the conditions in the mains. The siphon crossing Travertine Creek just west of the Lincoln Bridge has been replaced recently by the park service and was functioning well during the study. A second manhole inside Flower Park is approximately 50 feet north and west of the comfort station and indicates the conditions of the sewer collection system in the area of

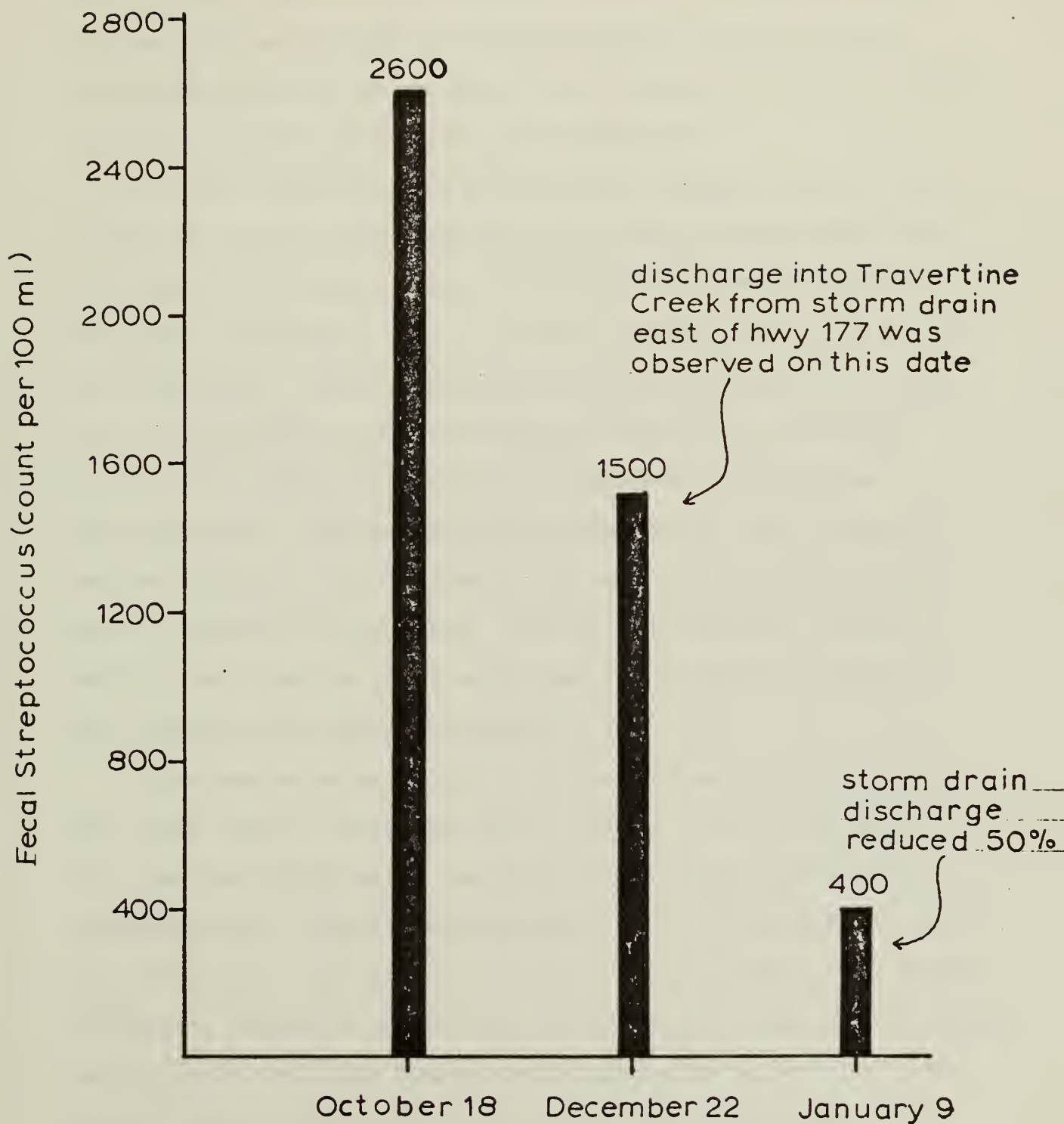


FIGURE 5. Variation in Fecal Streptococcus Count at Point Near Lincoln Bridge Below Storm Drain on Travertine Creek

the two later manholes described above as unsatisfactory. It is noted that no direct connection was established between the collection system in Flower Park and pollution in Rock and Travertine Creeks. However, during peak periods of use and after large rainstorms it is quite possible that the two manholes will overflow into Rock Creek.

Two other inverted siphons crossing Rock Creek were located in the vicinity of the Rock Creek Campground. One siphon is approximately 100 feet north of the bridge crossing Rock Creek prior to entrance in the campground. The second siphon is located on the west side of the Rock Creek Campground. The test analysis made during the study did not indicate the two siphons to be contributing any pollution to Rock Creek. However, both siphons were observed to be partially obstructed and operating poorly. This was especially evident in the second siphon on the west boundary of the campgrounds. The manhole for this siphon was poorly constructed and maintained. The top of the manhole is approximately 3 feet above the ground surface and strong odors were present in the vicinity of the manhole throughout the study.

The stream pollution analysis also examined conditions along Travertine Creek above the storm drain east of Highway 177 described above. The storm drain discharge was the only pollution source located along Travertine Creek. Sampling stations were located at six different points above the drain. Two stations were located in the vicinity of the Central Campground, two more in the vicinity of Cold Springs Campground, one station was located at the Little Niagara Foot Bridge and one at Antelope Spring. Samples taken from these points consistently indicated throughout the

study that no pollution sources were present on Travertine Creek above the storm drain.

In conclusion, it is noted that the study was conducted during a period of no significantly large rainfalls. Thus, it is possible other secondary pollution sources might appear during periods after the rainfalls. However, these sources probably would be related to the conditions of the city sewer collection system along Rock Creek and the lower reaches of Travertine Creek.

CHAPTER VI

RECOMMENDATIONS

As a result of the findings of the stream pollution analysis, several recommendations can be made to ameliorate the conditions along Travertine and Rock Creeks. Two possible alternatives seem to be indicated for the City of Sulphur sewer collection system inside the park and immediately south of the bridge on Broadway crossing Rock Creek.

The first alternative suggests the replacement of all the sewer mains, manholes and siphons inside the park boundary. Also, the sewer main south of the Broadway Bridge should be replaced. The origins of the discharges from the storm drain south of Broadway Bridge and the storm drain east of the bridge on Highway 177 crossing Travertine Creek should be determined immediately and the appropriate repairs or replacements made.

The second alternative is to reroute the sewer collection system around the park. This alternative would be more satisfactory than the replacement of the sewer collection system inside the park. Routing the sewer around the park would remove any possible future pollution sources and also enhance the natural beauty of the park by removing the unsightly siphons and manholes now existing in the park.

In addition to the alternatives above, a new policy of maintenance should be employed by the City of Sulphur. All siphons crossing Rock Creek in the City of Sulphur should be kept free of debris and properly maintained. Without a new policy of maintenance the conditions in the

streams will continue to deteriorate. The community should be made aware of the conditions in the streams and the possible health and economic ramifications of the problem in an attempt to encourage positive action.

The recommendations suggested above are thought to be the best solutions to the problems now existing in the park. Immediate attention must be paid to the storm drains or swimming in areas below these points should continue to be prohibited. The study indicates that the upper reaches of Travertine Creek are pollution free and thus could be reopened to public use. However, further monitoring of coliform levels should be made during peak flow conditions to determine possible secondary pollution sources. Also, during periods when the swimming areas and camping areas are used, it is suggested that a study be conducted to determine any effects of this activity. Rock Creek has already begun to show signs of recovery as a result of the cessation of flow from the manhole above Sandy Beach. If the discharge from the two drains is stopped, further improvements would result. However, it is important to remember that the effects of the pollution will linger some time after the pollution itself has been removed. Therefore, it will take time for the streams to revert to their natural condition. This is especially true of the algae growths along the streams. Thus, appropriate steps should be taken immediately for it to be possible for the public to benefit in the coming year.

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