astewater Infiltration near the city of Mount Shasta Siskiyou County California

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 20-73

Prepared in cooperation with

the Siskiyou County Flood Control and Water Conservation District

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The first layer of tuff was found at depths ranging from 1.5 to 8 feet below land surface and apparently is contiguous throughout the glacial material. All the sites available for exploration were in the glacial material and new ponds at any of these sites probably will perform about the same as the existing ponds.

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WASTEWATER INFILTRATION NEAR THE CITY OF MOUNT SHASTA, SISKIYOU COUNTY, CALIFORNIA

By Gilbert L. Bertoldi, 1938-

U.S. GEOLOGICAL SURVEY Water Resources Division

Water-Resources Investigations 20-73

Prepared in cooperation with the Siskiyou County Flood Control and Water Conservation District

September 1973

UNITED STATES DEPARTMENT OF THE INTERIOR

Rogers C. B. Morton, Secretary

GEOLOGICAL SURVEY

Vincent E. McKelvey, Director

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September 1973

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WASTEWATER INFILTRATION NEAR THE CITY OF

MOUNT SHASTA, SISKIYOU COUNTY, CALIFORNIA

By Gilbert L. Bertoldi

ABSTRACT

Disposal of waste discharged from the city of Mount Shasta is by use of sewage-disposal ponds. The Siskiyou County Flood Control and Water Conservation District, under order from the California Regional Water Quality Control Board is required to stop discharging effluent from the ponds to the Sacramento River during the recreation season.

Sewage discharge at the input to the disposal ponds is about three times the quantity that should be expected from a city the size of Mount Shasta. The input to the ponds probably includes a large quantity of ground water leaking into the sewage system.

The area where the ponds are located is underlain by glacial material containing several thin intercalated layers of nearly impermeable tuff. The layers of tuff, found from the surface downward, are barriers to vertical movement of water and prevent the disposal ponds from operating at the design level of efficiency. Infiltration rates, calculated and measured, at the existing ponds are about one-third the design capacity of the ponds.

The first layer of tuff was found at depths ranging from 1.5 to 8 feet below land surface and apparently is contiguous throughout the glacial material. All the sites available for exploration were in the glacial material and new ponds at any of these sites probably will perform about the same as the existing ponds.

INTRODUCTION

Location and General Features

The study area, including the city of Mount Shasta and vicinity (fig. 1), lies in the canyon formed by the Trinity Mountains to the west and Mount Shasta about 10 miles to the northeast. The study area ranges in altitude from about 3,200 to 3,600 feet above mean sea level.

Climatological data of the National Weather Service (formerly U.S. Weather Bureau) show that for the study area, summers are mild; daytime temperatures reach an average maximum of 85 degrees and rarely rise above 90 degrees (less than 18 days a year). From late autumn to early spring, the city of Mount Shasta weather station has recorded about 140 days when the temperature drops below freezing, and an average minimum temperature of 24 degrees. Total precipitation has averaged 36.72 inches per year, with 93 percent falling in the period from October through May. Much of the precipitation is in the form of snow; average annual snowfall is 102 inches.

The early-day economy of the area included lumbering and cattle raising. In addition, many of the permanent residents worked for the railroad in the nearby town of Dunsmuir. With reduction of marketable timber, the switch from steam to diesel locomotives, and improved roads, the role of lumbering and the railroad in the economy of the area has diminished. Agricultural activity has remained at about a constant level. In recent years, tourism and recreation have become increasingly important as a new source of income.

History of the Problem

In 1953 the California Regional Water Quality Control Board, Central Valley Region, established requirements governing the nature of waste-effluent discharge by the city of Mount Shasta. At that time, disposal facilities consisted of ponds adjacent to the Sacramento River at a site about 3,500 feet upstream (northwest) from the present sewage-disposal ponds (fig. 2). Periodic inspections by the Regional Board and the State Department of Public Health, Bureau of Sanitary Engineering, found the system generally adequate and that water was confined to the ponds during the recreation season from May 1 to October 31.

When Box Canyon Dam was built by the Siskiyou County Flood Control and Water Conservation District in 1967-68, the sewage ponds were relocated. Siskiyou County provided new ponds with approximately twice the surface area of the former facilities. Data obtained by laboratory and field testing of soils similar to those at the new pond site indicated that complete land disposal of sewage by percolation could be achieved at the new site. However, shortly after operation of the ponds began, it became apparent that complete disposal by percolation could not be achieved.

The city of Mount Shasta refused to accept the new sewage ponds from the county and, by court order, Siskiyou County was required to operate them. On June 21, 1968, the California Regional Water Quality Control Board, Central Valley Region, adopted Resolution No. 68-238 which established waste-discharge requirements for operation of the new ponds. To comply with the requirements, Siskiyou County added chlorination facilities and established procedures to insure adequate disinfection of sewage. On March 26, 1971, the California Regional Water Quality Control Board adopted order No. 71-210 rescinding Resolution No. 68-238 and established waste-discharge limits on residual chlorine, BOD (biochemical oxygen demand), color, foam, and coliform bacteria. Provision 3 of order No. 71-210 requires that "After May 1, 1973, there shall not be a direct discharge to the Sacramento River during the recreational season, May 1 to October 31." Compliance with provision 3 has become a major problem for Siskiyou County engineers and planners because the quantity of wastewater flowing into the ponds exceeds infiltration capacity.

Purpose and Scope

The Siskiyou County Flood Control and Water Conservation District, shortly after the adoption of order No. 71-210, requested that the U.S. Geological Survey make a preliminary study of the wastewater-disposal problem at Mount Shasta. The purpose of this study was to investigate geologic and hydrologic factors related to infiltration at the existing pond site and at proposed pond sites.

The scope of the study included the following items:

1. Drill several test wells, collect and interpret subsurface geologic data from the wells.

2. Obtain data from springs, wells, and other sources downgradient from the ponds to determine any effects on water quality due to percolation of wastewater.

3. Determine the elevation of the water table in relation to the elevation of collection and tranfer pipes of the city sewage system.

4. Determine the direction of ground-water movement in the study area.

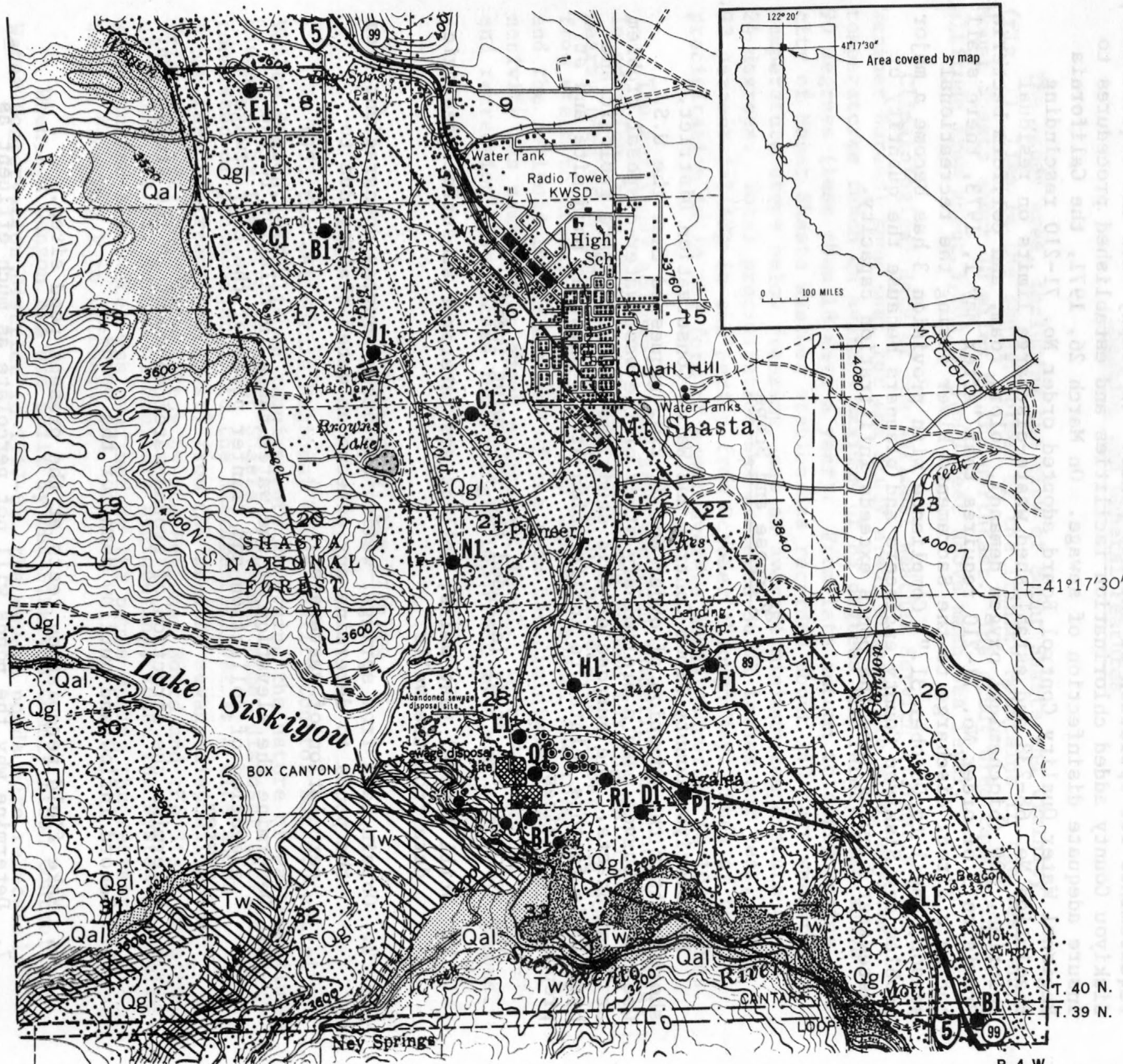
5. Record inflow and outflow data for the ponds.

6. Make field percolation tests at the present pond sites.

7. Determine why the ponds will not percolate as much effluent as expected.

8. Determine the suitability of other sites for percolation ponds.

A special acknowledgment is made to E. W. Schilling and J. M. Mello of the Siskiyou County Engineer's office for technical and logistic support during the study.



R. 4 W.
Base from U.S. Geological Survey
Weed, 1954

Geology modified after California Dept. of Water Resources (1964, pl. 4)

1 ½ 0 1 MILE

3000 0 3000 6000 FEET

CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

Holocene	Qal	ALLUVIUM, UNDIFFERENTIATED AND COLLUVIUM--Includes rounded boulders, gravel, and sand derived from various volcanic rock types	QUATERNARY
Pleistocene	Qgl	GLACIAL DEPOSITS, UNDIFFERENTIATED--Includes glacial moraines and glacial drift that has intercalated tuff and lava	QUATERNARY
Pliocene and Pleistocene	QTl	LAKE DEPOSITS--Weakly indurated beds of sand, silt, clay, and ash	TERTIARY AND QUATERNARY
Eocene and Miocene	Tw	WESTERN CASCADE VOLCANIC ROCK TYPES--Fine-grained andesite flows and tuff	TERTIARY

Contact

A——A'
Line of section (see figure 7)

Boundary of study area

C1
Water well and number

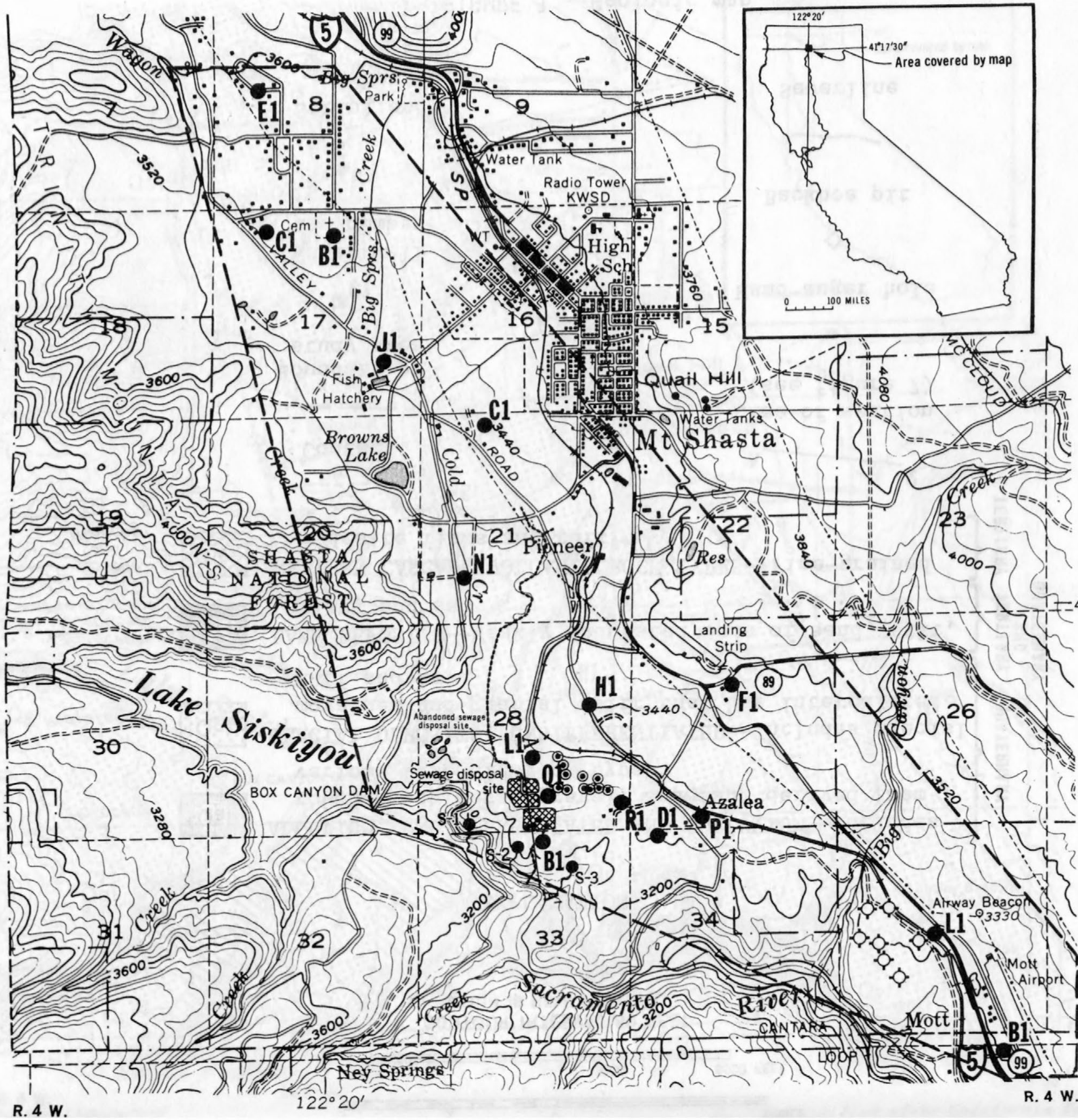
Hand-auger hole

Backhoe pit

S-3
Spring and number

Sewerline

FIGURE 1.--Geologic map.


122°20′
41°17′30″
Area covered by map
0 100 MILES
Mt Shasta
Big Sprs Park
Water Tank
Radio Tower KWSD
High Sch
Quail Hill
Water Tanks
Fish Hatchery
Browns Lake
Pioneer
Res
Landing Strip
SHASTA NATIONAL FOREST
Lake Siskiyou
BOX CANYON DAM
Abandoned sewage disposal site
Sewage disposal site
Azalea
Airway Beacon 3330
Mott Airport
Mott
CANTARA
LOOP
Ney Springs
Sacramento River
E1
C1
B1
J1
N1
H1
F1
L1
Q1
R1
D1
P1
S-1
S-2
S-3
T. 40 N.
T. 39 N.
R. 4 W.
122°20′
R. 4 W.

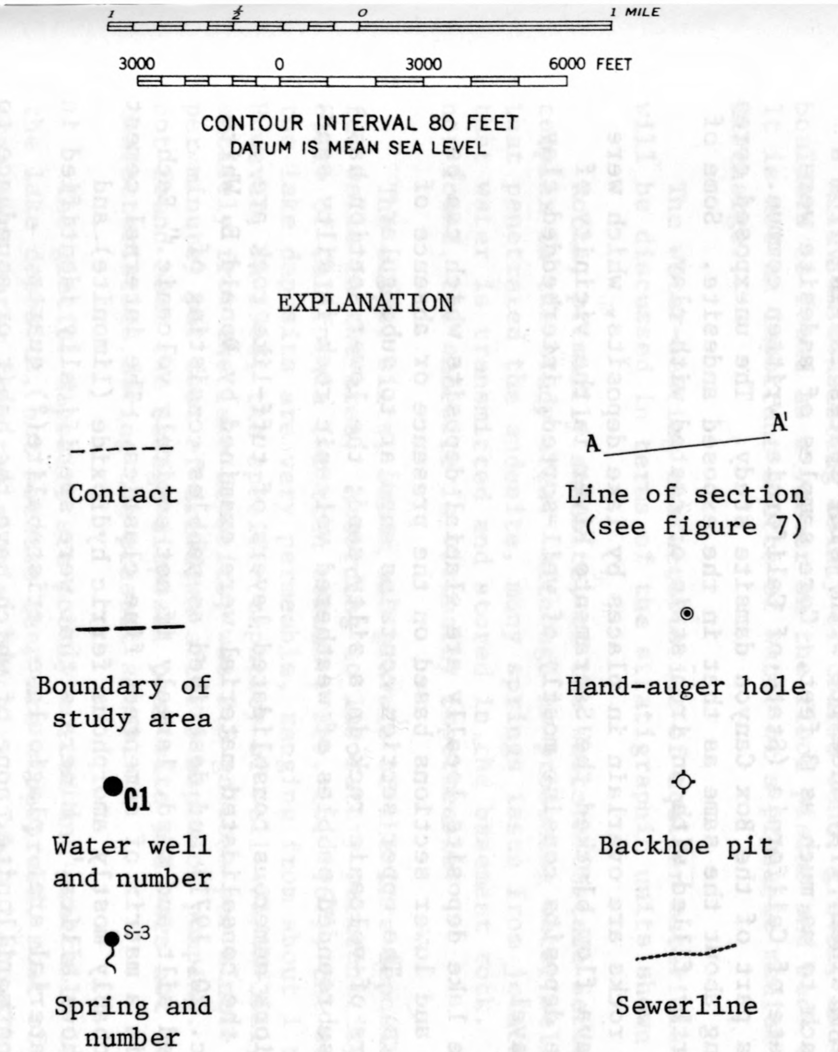


FIGURE 2.--Location of test holes, wells, and springs.

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

The geologic development of the study area has been dominated by glacial, volcanic, and lake processes. The city of Mount Shasta is at the southernmost end of the Cascade Range. In this area, the Cascade Range contains principally two rock complexes, termed by Williams (1949, p. 20, 35) the Western Cascade Series and the younger High Cascade Series. The Western Cascade Series underlies most of the study area and is exposed on the north and south sides of the Sacramento River in Box Canyon (fig. 1). There, it is a dense, hard, fine-grained, gray andesite with joint spaces ranging from a few tenths of an inch to as much as 3 feet. Core samples of andesite were examined by the State of California (State of California, written commun., Feb. 15, 1967) as a part of the Box Canyon damsite study. The unexposed cores showed joint spacing about the same as that in the exposed andesite. Some of the joints were partly filled with an iron stain or coated with clay.

The volcanic rocks are overlain in places by lake deposits, which were laid down when a lava flow blocked the Sacramento River in the vicinity of Mott (fig. 1). The deposits consist mostly of well-sorted, interbedded clay, silt, sand, and gravel.

Overlying the lake deposits locally are glacial deposits which can be divided into upper and lower sections based on the presence or absence of cobbles and boulders. The upper section contains angular to subangular cobbles and boulders of volcanic rock in a silty sand; the lower section has variously colored subrounded pebbles of weathered volcanic rock in silty sand.

In both sections numerous consolidated layers of tuff-like rock are found. Samples of the consolidated material were examined by Donald E. White (written comm., Dec. 20, 1971) and described as pebbles consisting of "thoroughly cemented silt and sand, largely if not entirely volcanic." Each pebble in turn is in a matrix of cemented, fine clastics. The internal cement and coating is "probably mostly amorphous ferric hydroxide (limonite) and perhaps also amorphous silica." Minerals that were specifically identified in the consolidated material are: plagioclase, cristobalite(?) quartz, dolomite(?), and montmorillonite, none of which have the habit or abundance to account for cementation.

The origin of the consolidated layers is speculative, but their proximity to areas of major volcanic activity and hot springs suggests that they are ash beds which weathered rapidly and subsequently were cemented by iron- or silica-rich water discharged by springs that are no longer identifiable. Therefore, in this report the compacted and cemented layers in the glacial drift are identified as tuffs.

In table 1, the logs of three test wells show the lithologic variability of the glacial deposits at sites near the sewage-disposal ponds. Tuffs were identified primarily by drilling rate and examination of well cuttings at the site. Only one feature of the glacial deposits (aside from their obvious heterogeneous nature) is extensively identifiable throughout the study area, and that is a tuff about 3 feet thick at a depth of 1½ to 4 feet below land surface. The near-surface tuff was found in 14 auger holes, 8 backhoe pits, and 3 test wells. At the north end of the sewage ponds and throughout most of the undisturbed glacial deposits, a thin, moderately permeable soil cover has developed.

Alluvium consisting mainly of coarse sand, gravel, and some rounded boulders is found as a veneer on the flood plains and beds of most streams. It is not an important source of water or a probable medium for waste discharge.

The water-bearing characteristics of aquifer materials in the study area will be discussed in terms of the stratigraphic units shown in figure 1.

Rocks, primarily andesite, of the Western Cascade Series are the basement complex in the study area. Although no producing water wells could be found that penetrated the andesite, many springs issue from joints in it indicating that water is transmitted and stored in the basement rock. Where joints are not found, the andesite is virtually impermeable.

The clays, silts, sands, and gravels of the lake deposits yield water to a few wells in the area. According to laboratory permeability tests made by the State of California (written commum., Feb. 15, 1967), the sand and gravel of the lake deposits are very permeable, ranging from about 1 to 30 feet per day. However, in 1968, the specific capacity of well 40N/4W-35L1, yielding water entirely from the lake deposits, was 2.5 gallons per minute (0.33 cubic foot per minute) per foot of drawdown after 9 hours of pumping. Lake deposits were not found near the sewage-disposal pond site and were not tested for hydraulic characteristics during the present study.

The glacial deposits are poorly sorted and generally less permeable than the lake deposits, but because they are widespread, most of the wells in the area pump water from the glacial deposits. Table 2 shows hydraulic conductivity, porosity, and depth of samples from the glacial deposits near the sewage-disposal ponds. Samples 1 through 6 are unconsolidated material and samples 7 and 8 are tuff. The permeability of the tuff beds is small relative to superjacent and subjacent deposits. The tuff beds probably function as either perching or confining layers in the glacial deposits.

The specific capacity of a well is calculated as discharge divided by drawdown and is a measure of not only the productivity of the well, but also an indicator of the transmissivity of an aquifer. Results of specific capacity tests on wells pumping from the glacial deposits are summarized in table 3. Values for specific capacity less than 5 gallons per minute (0.7 cubic foot per minute) per foot of drawdown, imply that the aquifer is incapable of transmitting large quantities of water.

Table 1.--*Geologists' logs of test wells*

Material	Thickness (in feet)	Depth (in feet below land surface)
Well number - 40N/4W - 28L1. County of Siskiyou. Test well, altitude 3,337 feet. Drilled October 1971, by Don Enloe. 8-inch casing. Water first encountered at 38 feet, hole dry at 43 feet, water at 48 feet, heavy inflow of water at 58 feet.		
Sand, brown, silty	2	2
Tuff, reddish-brown, hard	1	3
Clay, brown, silty and volcanic rock fragments, multi-colored, angular	2	5
Sand, brown, fine to medium	8	13
Clay, gray-brown, sandy	4	17
Clay, brown, silty	7	24
Tuff, gray, firm	11	35
Sand, brown, medium to coarse, well sorted	5	40
Tuff, hard	10	50
Boulders and cobble in clay, gray	7	57
Boulders, cobble, gravel	5	62
Clay, gravel	1	63
Clay, sandy, hard	2	65
Boulders, cobble in sand, silty	17	82
Conglomerate, deeply weathered	6	88
Tuff, gray, hard	7	95
Sand, brown, medium, well sorted	2	97
Silt with angular fragments of volcanic rocks of various types	21	118
Tuff, gray, hard	34	152
Andesite, black, deeply weathered	16	168
Andesite, black, fresh - bottom of hole		168
Well number - 40N/4W - 28Q1. County of Siskiyou. Test well, altitude 3,288 feet. Drilled October 1971, by Larry Enloe. 6-inch casing. Water first encountered at 17 feet.		
Sand, brown, silty	2	2
Tuff, brown, hard	2	4
Cobbles, multi-colored in clay, reddish-brown, sandy	13	17
Boulders, cobble, and gravel, tightly packed	8	25
Tuff, hard	3	28
Pebbles, multi-colored in clay, brown, sandy	3	31
Tuff, gray, firm	4	35
Sand, brown, medium to very coarse, poorly sorted	5	40
Bottom of hole		40
Well number - 40N/4W - 33B1. County of Siskiyou. Test well, altitude 3,266 feet. Drilled October-November 1971 by Larry Enloe. 6-inch casing. Heavy inflow of water at 17-18 feet, hole dry at 35 feet, heavy inflow of water at 45-50 feet.		
Sand, red, silty	2	2
Tuff, gray, hard	2	4
Clay, red, sandy with angular andesite fragments	6	10
Boulder, bit moved alongside	2	12
Sand, reddish-brown, silty	8	20
Gravel, multi-colored, subangular, highly weathered	10	30
Tuff, brown, hard	10	40
Sand, gray-brown, coarse to very coarse, contains large amount of volcanic rock fragments	10	50
Sand, gray, clayey	15	65
Andesite fragments, gray to black, subangular in matrix of sand	10	75
Tuff, yellow-brown, hard	29	104
Clay, brown, sandy, containing many angular volcanic rock fragments	4	108
Sand, gray, clayey	7	115
Andesite, gray to black, very weathered, and pumice	25	140
Andesite, gray, fresh		143

Table 2.--*Porosity and hydraulic conductivity of glacial deposits*

Laboratory sample number	Depth (feet)	Total porosity (percent)	Hydraulic conductivity (feet per day)
72CAL 1	0.5- 1.0	60.0	7.218
2	3.0- 3.5	58.4	3.018
3	6.5- 7.0	58.1	.558
4	14.5-15.0	60.0	2.789
5	3.0- 4.0	51.1	4.265
6	59.0-60.0	40.8	.689
7	2.0- 3.0	8.3	.001
8	2.0- 3.0	9.1	.006

Table 3.--*Specific-capacity tests of wells in glacial deposits*

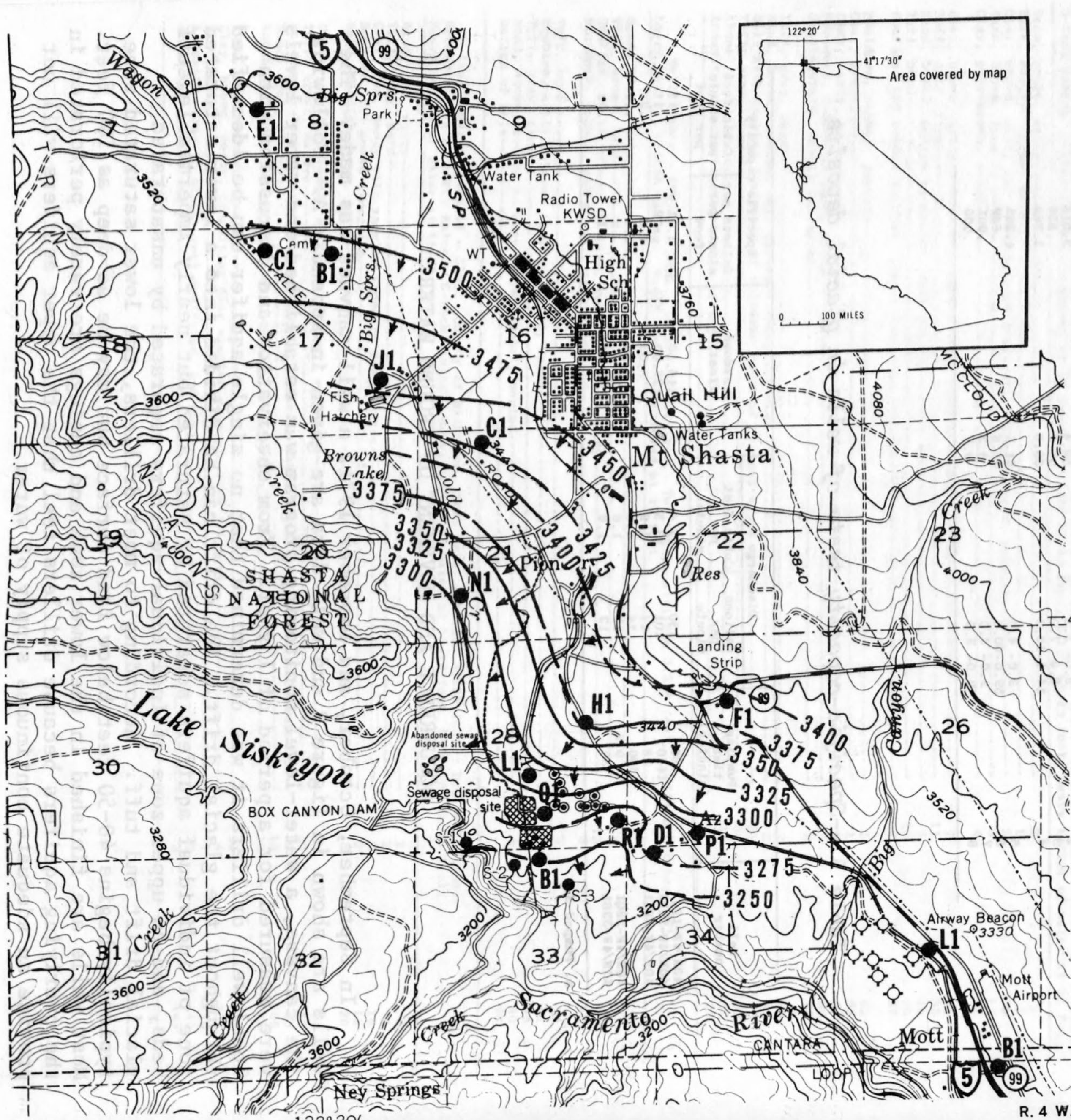
Well number	Pumping time (minutes)	Discharge		Drawdown (feet)	Specific capacity	
		Gallons per minute	Cubic feet per minute		Gallons per minute per foot	Cubic feet per minute per foot
40N/4W-17J1	480	130	17.4	116.50	1.11	.15
40N/4W-21N1	1440	101	13.5	127.00	.79	.11
40N/4W-28L1	38	14	1.9	9.05	1.6	.21
	380	14	1.9	9.94	1.4	.19
40N/4W-28Q1	0.5	12	1.6	23	a	a
40N/4W-33B1	30	12	1.6	109.84	.11	.01

a. Pumped dry

OCCURRENCE AND MOVEMENT OF GROUND WATER

In September, October, and November 1971, a well canvass was made. The wells are shown in figure 2 and well data are given in appendix A. Following the canvass, a water-level monitoring program was established and water levels were measured for a period of 1 year. From observation and discussion with local well drillers it was determined that no single aquifer can be identified throughout the glacial drift. The drift can be divided into a lower saturated zone of individual aquifers separated by saturated but nearly impermeable tuff beds, and an upper zone of individual aquifers separated by unsaturated glacial drift and tuff. According to most drillers, the lower saturated zone typically begins 40-50 feet below land surface but may be as deep as 100 feet. Most wells are finished in the lower zone and casings are rarely perforated in the overlying aquifers because drillers feel that the upper aquifers will not provide an adequate continuous supply of water.

The general direction of movement of ground water can be determined from water-level contours (fig. 3); movement is downgradient at right angles to the contours. Ground water moves south-southwesterly from the city of Mount Shasta toward the Sacramento River with a gradient of about 150 feet per mile. In the vicinity of the sewage-disposal ponds, movement is due south at about the same gradient.



R. 4 W.
Base from U. S. Geological Survey

1 ½ 0 1 MILE

3000 0 3000 6000 FEET

CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

3500 — ?

Water-level contour

Shows altitude of water level; dashed and queried where data are inconclusive; contour interval 25 feet; arrow indicates direction of ground-water flow; datum is mean sea level

Contact

A A'

Line of section (see figure 7)

C1

Water well and number

Hand-auger hole

Backhoe pit

S-3

Spring and number

Sewerline

FIGURE 3.--Water-level contours, September 1971 through June 1972.

One of the reasons for preparing the water-level contour map was to show the position of the water table relative to the city sewer lines. Unfortunately, water-level data are sparse for the southwestern part of the city and engineering drawings of the older parts of the sewer system could not be found. Ponds and bogs observed along the reported alinement of the old segment of the sewer line indicate that the water table probably is, in places, higher than the sewer line.

Seasonal water-level fluctuations (fig. 4) are small; for the period of the study the maximum seasonal change was about 10 feet and the average water-level fluctuation was 4 feet. Comparing the precipitation to water-level fluctuations, there is little apparent recharge to the deeper aquifers from precipitation that falls in the study area. Ground water in the deeper aquifers is probably recharged by melt water from the snowpack and glacier fields on the slopes of Mount Shasta. The cumulative effect of precipitation on water levels cannot be determined from a 1-year record.

Where water occurs at the surface in ponds, bogs, swamps, and open ditches, nearby wells show rapid water-level response to local impoundment. For example, well 40N/4W-33B1 is south of the ponds, about 200 feet south of the contact basin, and south of the intercepter drain (fig. 5). When the well was being drilled, water was first encountered at about 17-20 feet below land surface, just above a 10-foot thickness of impermeable tuff (fig. 7). As casing was driven past the underlying tuff, the flow of water into the hole stopped and the material subsequently encountered was dry until a second aquifer was encountered 45-50 feet below land surface. The well casing was perforated from about 10-25 feet below land surface and from about 40 feet to the bottom of the hole. The hydrograph of 40N/4W-33B1 (fig. 6) shows a definite relation between water-level fluctuations and events in the ditches and ponds to the north. The water level in the well during wet periods (altitude about 3,240 feet) probably represents a composite of the water levels in both aquifers when the basin, drain, or ponds to the north are filled; the water level during dry periods (altitude about 3,200 feet) probably is representative of the deeper aquifer. If the thickness of the tuff is subtracted from the total thickness of sediment between the two water levels in well 40N/4W-33B1, the remainder (30 feet) probably is a good estimate of the thickness of sediment available for storage and transmission of fluid away from the ponds.

Using 30 feet as the thickness, a maximum hydraulic conductivity of 7 feet per day (table 2), a maximum hydraulic gradient estimated at about 150 feet per mile, a flow face about 0.60 mile long, and a form of Darcy's law $Q = TIL$, the theoretical maximum total daily subsurface discharge from the ponds is about 141,000 gallons per day (19,000 cubic feet per day). Results of theoretical calculations should be used cautiously because measured percolation (shown later) is greater than the calculated potential.

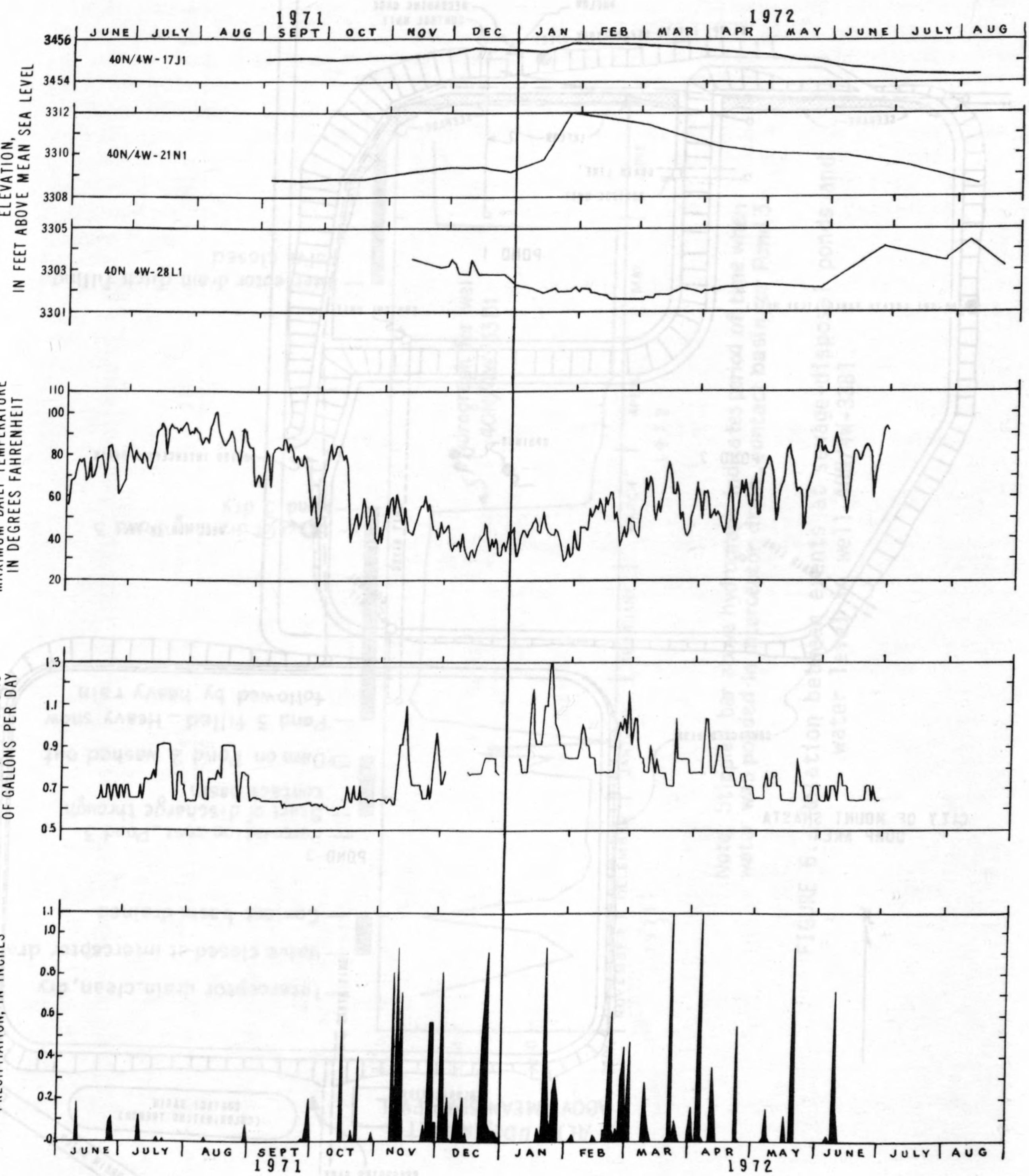


FIGURE 4.--Graphs of water-level fluctuations, temperature, inflow, and precipitation.

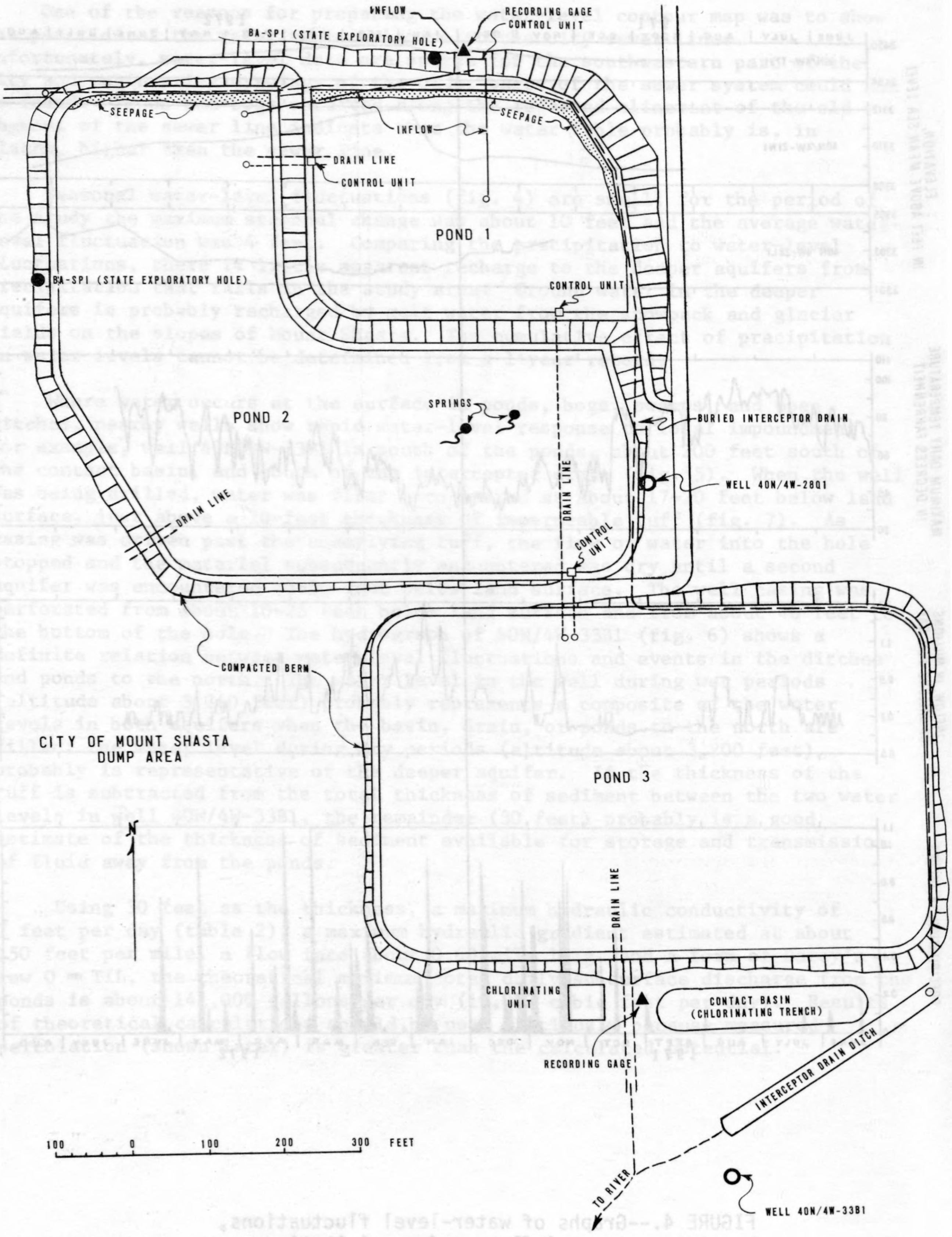
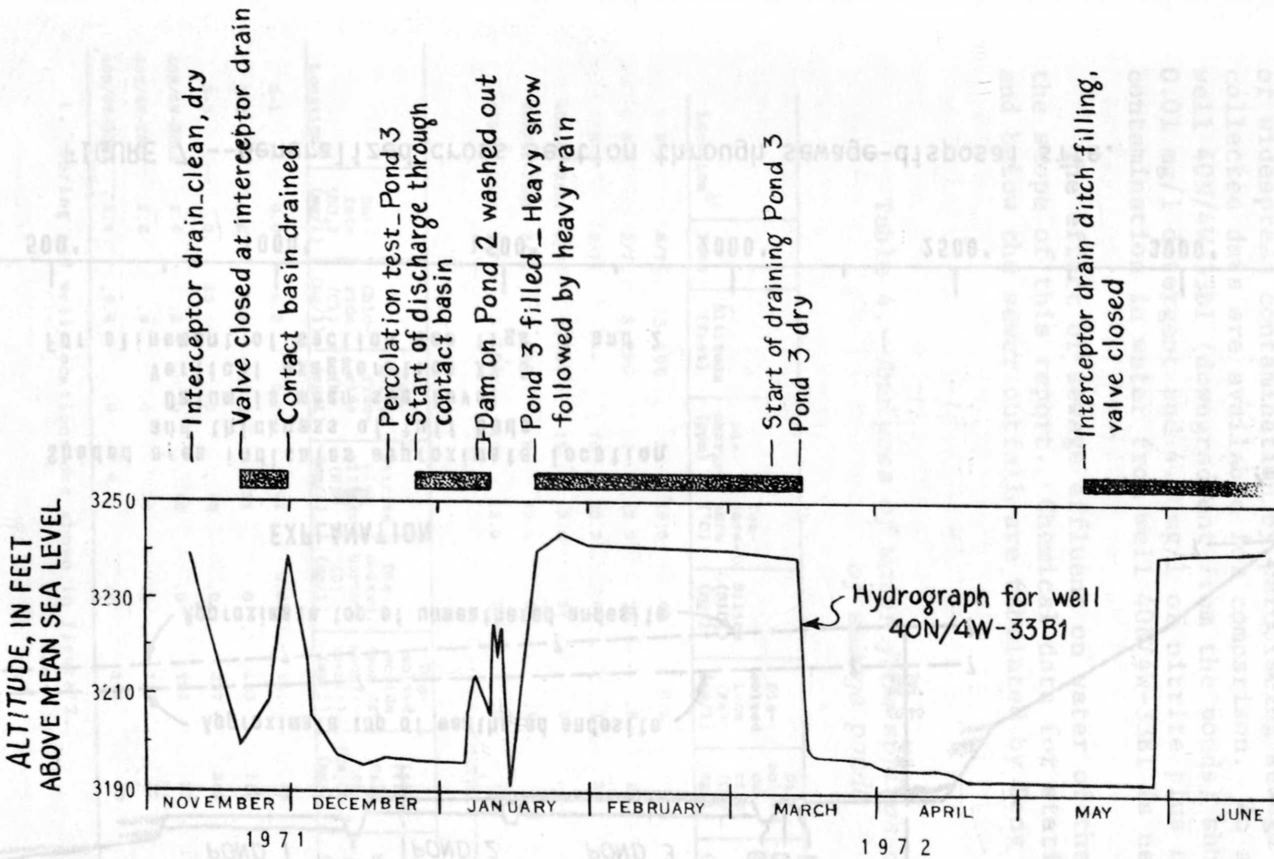


FIGURE 5.--Plan of sewage-disposal ponds.



Note: Stippled bar above hydrograph indicates period of time when water was ponded in interceptor drain, contact basin, or Pond 3

FIGURE 6.--Relation between events at sewage-disposal ponds and water level in well 40N/4W-33B1.

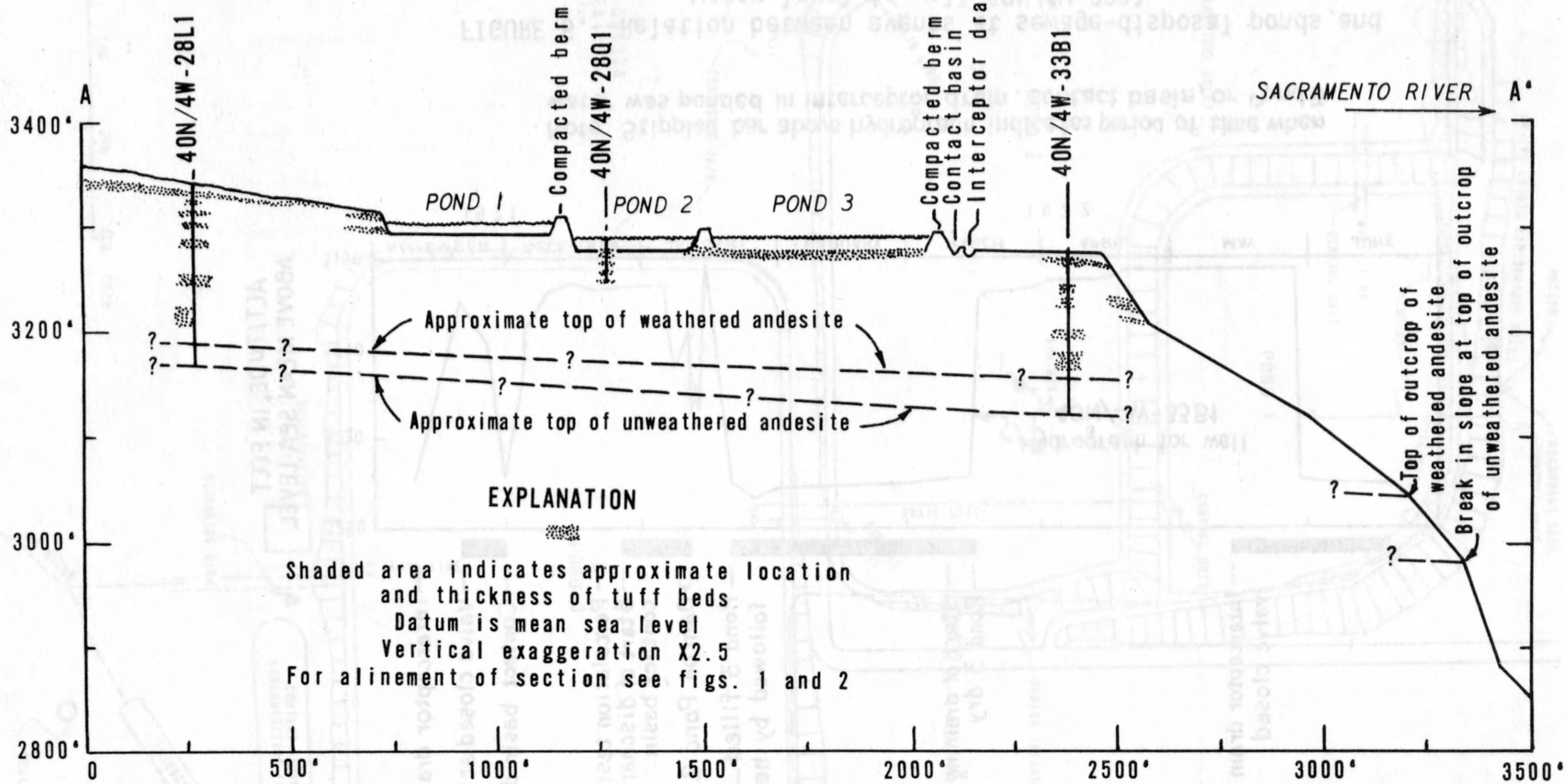


FIGURE 7.--Generalized cross section through sewage-disposal site.

Water samples from three wells and three springs near the sewage-disposal site were analyzed at the Geological Survey laboratory (table 4). The water in all six samples was calcium bicarbonate or sodium calcium bicarbonate type with dissolved solids less than 350 mg/l (milligrams per liter). The general quality of water is good for most purposes. There is no positive indication of widespread contamination by percolating sewage effluent, but no previously collected data are available for comparison. An analysis of water from well 40N/4W-33B1 (downgradient from the ponds) showed a concentration of 0.01 mg/l detergent and 4.3 mg/l of nitrite plus nitrate. The degree of contamination in water from well 40N/4W-33B1 is negligible.

The effect of sewage effluent on water of the Sacramento River is beyond the scope of this report. Chemical data for stations along the river, above and below the sewer outfall, are tabulated by Dong and Tobin (1973).

Table 4.--*Analyses of water from springs and wells in vicinity of sewage ponds*

Location[1]	Date	Altitude (feet)	Discharge (gpm)	Temperature (°C)	Silica (SiO_2) (mg/l)	Dissolved iron (Fe) (mg/l)	Dissolved calcium (Ca) (mg/l)	Dissolved magnesium (Mg) (mg/l)	Sodium (Na) (mg/l)	Potassium (K) (mg/l)	Bicarbonate (HCO_3) (mg/l)	Carbonate (CO_3) (mg/l)
S-1	8/71	3,190	1	19.5	43	0.2	9.8	4.3	6.4	2.4	59	0
S-2	8/71	3,150	5	12.5	36	.6	16	9.1	15	1.3	136	0
S-3	8/71	--	10	10.2	67	.1	21	32	38	3.5	303	0
40N/4W-28L1	3/72	3,337	15	7.0	57	.0	8.2	2.9	5.1	1.3	52	0
40N/4W-28Q1	3/72	3,288	8	10.0	56	.1	8.8	3.7	6.0	2.5	65	0
40N/4W-33B1	3/72	3,266	15	12.0	18	.0	9.1	3.9	18	3.0	71	0

Location[1]	Sulfate (SO_4) (mg/l)	Chloride (Cl) (mg/l)	Dissolved fluoride (F) (mg/l)	Nitrite plus nitrate (N) (mg/l)	Dissolved boron (B) (mg/l)	Dissolved solids (sum of constituents) (mg/l)	Hardness (Ca,CO_3) (mg/l)	Noncarbonate hardness (mg/l)	Percent sodium	Specific conductance (micromhos at 25°C)	pH (units)	Detergents (MBAS) (mg/l)
S-1	0.0	4.5	0.2	0.21	0.0	101	48	0	24	101	7.3	0.00
S-2	.8	6.8	.2	.21	.0	153	112	0	29	209	7.6	.00
S-3	.0	25	.2	.08	.0	337	249	0	30	484	7.7	.00
40N/4W-28L1	1.4	.2	.0	.60	.0	104	32	0	25	85	6.3	.00
40N/4W-28Q1	1.6	.8	.0	.30	.1	113	37	0	24	101	6.5	.00
40N/4W-33B1	1.4	6.4	.0	4.3	.3	114	39	0	48	172	7.2	.01

1. Spring and well locations are shown in figure 2.

SEWAGE-DISPOSAL SYSTEM

Description and Operation

Sewage from the city of Mount Shasta is carried through various collector lines to a main transfer line southwest of the city, then through the transfer line about 2 miles southward where it is discharged into three sewage-disposal ponds. The ponds are bordered on the east and north by a buried interceptor drain, on the south by a contact basin (where the water is chlorinated) and a ditch that carries water from the buried interceptor drain to a discharge point on the rim of Box Canyon. Figures 5 and 7 show the general features of the system in the vicinity of the ponds. The total surface area of the ponds is 15.6 acres (680,000 square feet) and total capacity about 24.2 million gallons (3.24 million cubic feet). Sewage coming into the ponds enters pond 1, then is routed through the other ponds while bacteria break down organic matter. From November through May, wastewater is discharged through pond 2 into the Sacramento River. During the recreation season from May through October, all outflow from the ponds is chlorinated. Theoretically, during the detention period (about 60 days), water should percolate into the ground.

The original design criteria for the ponds assumed that there would be no outflow from the ponds because average daily percolation would be greater than average daily inflow. This assumption was based on 600,000 gpd (gallons per day) (80,000 cubic feet per day) inflow at the old ponds and percolation rates ranging from 0.75 to 3.1 feet per hour obtained during tests at the new pond site in February 1967. The ponds were built, but after about September 1968, they began to overflow. At first, overflow was attributed to excess inflow due primarily to a deteriorated sewerage system in Mount Shasta that acted as a drain for springs in the area.

Dr. Kenneth D. Kerri, sanitary engineering consultant to Siskiyou County, in a letter to the County Engineer dated February 22, 1969, stated that:

> "A cursory review of flow data collected from December 17, 1968 through January 5, 1969, revealed that the inflow [to the ponds] was a function of climatic conditions, i.e. when there was precipitation, the inflow increased. The daily fluctuation was remarkably consistent with the difference between the maximum and minimum inflow apparently around 0.24 MGD. The average inflow appeared to be around 0.14 MGD above the minimum. Average inflow appeared to be near 0.8 to 0.9 MGD and the effluent flow apparently was less than 0.6 MGD. The severe infiltration in the City's collection system should be corrected."

Because Kerri's analysis was based on a short inflow record (20 days) during an exceptionally wet year, inflow records, precipitation, and temperature records for a longer period were studied and hydrographs made. Figure 4 shows the hydrographs for June 1971 through June 1972.

Except for two short periods in July and August 1971, inflow peaks are definitely related to precipitation (fig. 4). The July-August peaks are due to heavy use of camping facilities at Lake Siskiyou during that period. The maximum daily inflow was 1.29 mgd (million gallons per day) (170,000 cubic feet per day) on January 21 and 22, and the minimum of 0.59 mgd (80,000 cubic feet per day) occurred on October 7, 8, and 9, 1971. It is obvious from the hydrographs that average daily inflow not only fluctuated with individual storms, but also remained high during the wet months, implying gradual release of water from melting snow that remains on the ground between storms. Mean daily inflow to the ponds for the period of study was 0.70 mgd (93,000 cubic feet per day), far greater than the expected 0.23 mgd (30,000 cubic feet per day) for cities the size of Mount Shasta (U.S. Public Health Service, 1963).

Percolation was estimated from the difference between the recorded inflow to pond 1 and recorded outflow at the outlet from pond 3. A 3-inch Parshall flume with a water-stage recorder was installed at the inlet, and another water-stage recorder was installed about 8 feet upstream from a V-notch weir in the outflow. The difference between daily mean inflow and daily mean outflow was computed and adjustments were made to the daily figures for evaporation and precipitation (see appendix B for unadjusted daily records). Based on mean daily flow records for 160 days during the period June 1971 through June 1972, the estimated average percolation rate was 227,000 gpd (30,000 cubic feet per day).

Percolation Test

Percolation tests (Johnson, 1963) were made at each of the sewer ponds. Staff gages were installed in each pond, water levels were stabilized, then each pond was isolated from the system by cutting off inflow and outflow. Stage readings were taken twice daily and recorded. From these data the daily change in stage was computed. Average daily change was multiplied by the size of the pond to give the average daily infiltration rate. Evaporation was not computed because the pond surfaces were frozen during the tests. Precipitation during the test period was negligible. Results are shown in table 5.

The only pond effectively infiltrating any water was pond 3, and it was functioning at a rate far less than that required for total land disposal of wastewater. In addition, the percolation rate has declined since the ponds were built, and ponds 1 and 2 have never percolated much water (table 6).

Table 5.--*Summary of percolation tests*

Pond	Date	Water surface measured on staff gage (feet)	Daily change (feet)	Mean daily change (feet)	Pond area (acres) (square feet)	Mean daily percolation: Millions of gallons per day	Mean daily percolation: Cubic feet per day
1	2- 1-72	2.50	0.00				
1	2- 2-72	2.50	.00				
1	2- 3-72	2.50	.00	0.00	2,296 / 100,000	0.00	0.00
1	2- 4-72	2.50	.00				
1	2- 5-72	2.50	.00				
1	2- 6-72	2.50	.00				
2	12-27-71	1.95	.00				
2	12-28-71	1.96	.01				
2	12-29-71	1.96	.00				
2	12-30-71	1.97	.01	.01	6,267 / 273,000	.02	2,700
2	12-31-71	1.98	.01				
2	1- 1-72	1.99	.01				
2	1- 2-72	2.00	.01				
2	1- 3-72	2.01	.01				
3	12- 6-71	4.80	.00				
3	12- 7-71	4.60	.20				
3	12- 8-71	4.48	.12				
3	12- 9-71	4.43	.02				
3	12-10-71	4.38	.05				
3	12-11-71	4.31	.07	.07	7,018 / 305,700	.16	21,300
3	12-12-71	4.30	.01				
3	12-13-71	4.23	.07				
3	12-14-71	4.17	.06				
3	12-15-71	4.09	.08				
3	12-16-71	4.05	.04				
3	12-17-71	3.96	.09				
3	12-18-71	3.88	.08				
3	12-19-71	3.82	.06				

Table 6.--*Comparison of percolation tests*

Date	Source of information	Millions of gallons per day / cubic feet per day: Mean daily percolation: Pond 1	Pond 2	Pond 3	Total	Estimated evaporation 1/	Adjusted mean daily percolation
June-July 1968	Siskiyou County engineer	0.00 / 0	0.12 / 16,000	1.38 / 50,800	0.50 / 66,900	0.02 / 2,700	0.48 / 64,100
October 1968	Calif. Dept. of Public Health, Bureau of Sanitary Engineering	.00 / 0	.08 / 10,700	.28 / 37,400	.36 / 48,100	.01 / 1,300	.35 / 46,800
December 1971	U.S. Geological Survey--Field Test	.000 / 0	.020 / 2,700	.160 / 21,400	.178 / 23,800	.01 / 0	.178 / 23,800

1/ Estimates of evaporation based on curve derived from regression analysis of pan evaporation versus maximum daily temperature for 302 randomly picked observations at nearby weather stations. Zero evaporation December 1971--pond surfaces frozen.

After each pond was tested, an attempt was made to drain it completely for visual inspection and for excavations in the pond bottom. During draining operations, several springs were found in the bottoms of ponds 1 and 2; the two largest springs were in pond 2 near the northeast corner (fig. 5). The combined flow in the two largest springs is 10-15 gpm (gallons per minute) (1.3-2.0 cubic feet per minute) or about 14,000-22,000 gpd (1,870 to 2,940 cubic feet per day) with heads of about 0.5-0.7 foot above the pond bottom. To determine if the springs were actually subsurface flow between ponds 1 and 2, field biological and chemical analyses of water samples from the springs were made. On the basis of similarities of pH (6.5), conductivity (98 micromhos), and temperature (6°C) to well water, plus lack of detergents, the springs probably are from ground water. In addition to the springs, seepage was found along the entire north berm of pond 1. Ponds 1 and 2 could not be entirely drained because of the seeps and springs, and therefore no excavations were made.

Logs of bucket-auger holes BA-SP1 and BA-SP2 (fig. 5), drilled in 1967 for exploratory purposes, indicated that water occurred about 3 feet below land surface in BA-SP1 and about 10 feet below land surface in BA-SP2. Further evidence supporting the contention that springs in the bottom of the ponds are fed by ground water is contained in the following paragraph in a letter from the California State Department of Public Health, Bureau of Sanitary Engineering, to the city of Mount Shasta, dated February 1, 1968:

> "A recent inspection of your new lagoon system showed the first two lagoons were full and the third lagoon more than half full with a discharge to the Sacramento River. Inspections during construction of the lagoons showed ground water flowing into the lagoons. This ground water could reduce the lagoon capacity and limit sewage effluent percolation."

When pond 3 was emptied, four pits were dug in the bottom of the pond, and an examination of the soils beneath the pond was made by Jesse J. Newlun, Soil Scientist, U.S. Department of Agriculture, members of the Siskiyou County Engineer's staff, and the author. Conclusions reached during the examination are basically that the floor of pond 3 is a cemented volcanic tuff and that percolation through the tuff is mainly along fractures that are filling with silt and clay particles and organic matter. The excavations also showed that although the tuff had been mechanically ripped, to depths of 1.75 to 2.5 feet, at intervals of about 4 feet, the ripping had little lateral effect.

Prospective Sites

Two sites chosen by the Siskiyou County Engineer were explored for their potential as disposal sites; both were in glacial deposits.

The first site was on unused, county-owned property, surrounding the present ponds. Fourteen holes were drilled by hand auger (fig. 2) at this site and without exception, augering could proceed only to the top of a layer of tuff 1.7 to 4.2 feet below land surface. In several of the holes a large iron wrecking bar was used in unsuccessful attempts to break through the tuff. During construction of the ponds, workers reported that the uppermost tuff could be penetrated only by use of an air hammer. Thickness of the uppermost tuff, as determined by examination at a road cut on the access road to the ponds, varied between 1 and 2 feet. Also observed in the cut were several other layers of tuff of various thicknesses below the uppermost layer. About 40 percent of the material exposed in the cut consisted of tuff.

The second site examined was on privately-owned property in T. 40 N., R. 4 W., sec. 35, where seven pits approximately 20 feet long and 4 feet wide were dug (fig. 2) with a backhoe-equipped tractor. The surface soils were deeper and sandier at the second site, containing only about 8-10 percent clay and a 0.50- to 0.67-foot section of organic debris mixed with the upper part of the soil zone. The first layer of tuff was 6 to 10 feet below land surface, and as at other sites, the backhoe could not penetrate the tuff. Examination of cuts along the railroad and highway revealed about the same kind of depositional history as at the first site, namely, numerous intercalated tuffs in glacial debris.

Both sites are similar to the site presently in use for ponds. If new ponds are constructed at either site, they probably will perform similarly to the existing ponds.

SUMMARY AND CONCLUSIONS

The most significant subsurface features in the sedimentary material overlying volcanic rocks in the study area near the city of Mount Shasta are several thin beds of tuff. These beds are found repeatedly from the surface downward in the glacial deposits; they are nearly impermeable, and effectively prevent vertical movement of water. Lateral movement of water in the area is southwesterly, generally from the high ground formed by Mount Shasta toward the Sacramento River.

The average daily discharge of water to the city sewage-disposal ponds is about three times the quantity that is usually expected from a city the size of Mount Shasta. Ground water leaking into the city sewerage system, particularly during rain storms and the wet season, probably is the source of the excessive discharges to the ponds. Some ground water from springs enters the sides and floors of the ponds; however, the quantities from these inflows are not important compared to the total quantity of water from the city.

The sewage-disposal ponds (figs. 2 and 5) are in glacial drift material that contains numerous intercalated, nearly impermeable beds of tuff. One of the tuffs forms the floor of pond 3. Vertical percolation, in pond 3, is mainly through minute cracks in the underlying tuff; lateral movement of water can occur through the berms surrounding the pond. The ponds were designed to percolate an inflow of about 600,000 gpd. However, in practice, percolation rates have been much less and have declined since the ponds went into service in 1968.

The average daily percolation rate is about 200,000 gpd, less than one-third of the average daily inflow, though nearly equal to the quantity usually expected from a city the size of Mount Shasta.

Exploration at the existing ponds and other sites in the study area indicates that barriers to downward percolation of the sewage effluent are formed by beds of tuff that occur throughout the area. Tuff was found in test wells, hand-auger holes, and small backhoe excavations at depths ranging from about 1½ to 8 feet. The 8-foot depths are in backhoe pits in the area near Mott. The performance of new ponds, if built in the glacial material, probably will be about the same as the existing ponds.

Exploration of sites in areas outside the glacial material is being undertaken by consultants to Siskiyou County.

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APPENDIX A.--Description of wells

[Boxhead explanations are abstracted from U.S. Geological Survey "Instructions for Using the Punch-Card System for the Storage and Retrieval of Ground-Water Data"]

State well number: The wells are identified according to their location in the rectangular system for the subdivision of public land. The identification consists of the township number, north or south; the range number, east or west; and the section number. The section is further subdivided into sixteen 40-acre tracts lettered consecutively (excepting I and O), beginning with A in the northeast corner of the section and progressing in a sinusoidal manner to R in the southeast corner. Wells within the 40-acre tract are numbered sequentially. The base line and meridian are indicated by the final letter, as follows: H, Humboldt; M, Mount Diablo; S, San Bernardino.

Owner or user: The apparent owner or user on the date indicated.

Ownership:
- C County
- F Federal Government
- M City, town, or unincorporated village
- N Corporation or company, churches, lodges, and other nonprofit, nongovernment groups
- P Private
- S State agency
- W Water district.

Use of water:
- A Air conditioning
- B Bottling
- C Commercial
- D Dewatering
- E Power generation
- F Fire protection
- H Domestic
- I Irrigation
- M Medicinal
- N Industrial, including mining
- P Public supply
- R Recreation
- S Stock supply
- T Institutional
- U Unused
- V Repressurization
- W Recharge
- X Desalination, public supply
- Y Desalination, other use
- Z Other.

Use of well:
- A Anode
- D Drainage
- G Seismic hole
- H Heat reservoir
- O Observation
- P Oil or gas
- R Recharge
- T Test hole
- U Unused
- W Withdraw water
- X Waste disposal
- Z Destroyed.

Well data: In tabulation below, C, complete data; N, no data; P, partial data. Complete physical data include depth, diameter, and finish. Complete geologic data include lithology and aquifer thickness. Complete water-level data include altitude of land-surface datum, in feet above mean sea level; water level, in feet above(+) or below land-surface datum; and date of measurement. Complete yield data include rate of pumping and drawdown.

Code symbol	1	2	3	4	5	6	7	8	9	0
Physical	C	C	P	C	C	P	C	C	P	P
Geologic	C	C	P	C	C	N	C	N	P	N
Water level	C	C	C	N	N	P	P	C	C	N
Yield	C	N	C	C	N	P	C	N	N	P

Chemical analyses:
- C Complete
- G Dissolved gases
- J Conductance and chloride
- K Conductance
- L Chloride
- M Multiple (complete and one or more partials)
- P Partial
- R Radiochemical (plus partial or complete chemical)
- S Special (tritium, carbon-14, and all other special determinations)
- T Trace elements (spectrographic).

Log data:
- A Drilling-time
- B Casing-collar
- C Caliper (diameter) survey
- D Driller's
- E Electric
- F Fluid-conductivity or fluid-resistivity
- G Geologist or sample
- H Magnetic
- I Induction
- J Gamma-ray
- K Dipmeter or directional (inclinometer) survey
- L Laterolog
- M Microlog
- N Neutron
- O Microlaterolog
- P Photographic
- Q Radioactive-tracer
- R Radiation (includes both neutron and gamma-ray)
- S Sonic
- T Temperature
- U Temperature and fluid-conductivity (resistivity)
- V Fluid-velocity
- W Electric and radiation
- X Electric, radiation, caliper, and fluid-velocity
- Y Electric, radiation, and sample (or driller's)
- Z Electric, radiation, temperature, and fluid-conductivity.

Depth of well: Depth, in feet below land-surface datum, as reported by owner, driller, or others, or as measured by the Geological Survey.

Depth cased: Length of casing, in feet below land-surface datum, to the top of the first perforations.

Diameter: Inside diameter of the well, in inches; nominal inside diameter, in inches, of the innermost casing at the surface for drilled cased wells

Well finish:
- C Porous concrete
- F Gravel wall, perforated or slotted casing
- G Gravel wall, commercial screen
- H Horizontal gallery or collector
- O Open end
- P Perforated or slotted casing
- S Screen
- T Sand point
- W Walled or shored
- X Open hole in aquifer (generally cased to aquifer)
- Z Other.

Method drilled:
- A Rotary
- B Bored or augered
- C Cable-tool
- D Dug
- H Hydraulic-rotary
- J Jetted
- P Air percussion
- R Reverse-rotary
- T Trenching
- V Driven
- W Drive-wash
- Z Other.

Lift type:
- A Air
- B Bucket
- C Centrifugal
- J Jet
- L Multiple (centrifugal)
- M Multiple (turbine)
- N None
- P Piston
- R Rotary
- S Submergible
- T Turbine
- Z Other.

Power:
- 1 Hand
- 2 Natural gas engine
  - A 0-20 hp
  - B >20-50
  - C >50-100
  - D >100-200
  - E >200
- 3 Gasoline engine
  - F 0-5 hp
  - G >5-20
  - H >20-50
  - J >50-100
  - K >100-200
  - L >200
- 4 Diesel engine
  - M 0-50 hp
  - N >50-150
  - P >150-400
  - Q >400-750
  - R >750
- 5 Electric motor
  - S 0-1 hp
  - T >1-5
  - U >5-15
  - V >15-100
  - W >100
- 6 Wind
- 7 LP gas engine (propane or butane)
  - A 0-20 hp
  - B >20-50
  - C >50-100
  - D >100-200
  - E >200
- 8 Other.

Altitude of lsd: Altitude of land-surface datum, in feet, above mean sea level. Land-surface datum is an arbitrary plane closely approximating land surface at the time of the first measurement and used as the plane of reference for all subsequent measurements.

Water level: Depth to water, in feet, above(+) or below land-surface datum.

Date measured: Month and year of the water-level measurement; other data given generally apply for this date.

Yield of well: Yield, in gallons per minute; drawdown, in feet.

State well number	Owner or user	Ownership	Use of water	Use of well	Well data	Chemical analyses	Log data	Depth of well (feet below lsd)	Depth cased (feet below lsd)	Diameter (inches)	Well finish	Method drilled	Year drilled	Lift type	Power	Altitude of lsd (feet)	Water level (feet below lsd)	Date measured	Yield of well: Gallons per minute	Yield of well: Drawdown (feet)
39N/04W-12B01M	U.S. FOREST SERV	F	H	W				210		6	P		62	S	S	3211	69	9-71		
40N/04W-08E01M	LYLE HUGHES	P	H	W				31		6		C	51	S	S	3354	11	9-71		
40N/04W-17B01M	MT SH MEM PARK	N	I	W						6		C	58	Z	U	3513	23	9-71		
40N/04W-17C01M	J. MESSENGER	P	U	U				23			X	D		N		3509	16	9-71		
40N/04W-17J01M	CALIF DEPT F&G	S	U	T	8		D	400	282	16	P	C	69	N		3465	10	8-71	130	
40N/04W-21C01M	DICK MALIN	P	H	W						6		C		S	S	3432	6	9-71		
40N/04W-21N01M	SISKIYOU COUNTY	C	U	W	6			198		8	P	C	64	S	U	3323	14	9-71	101	127
40N/04W-27F01M	DON HILTON	P	H	W				230		8	P	C	47	S	S	3556	161	9-71		
40N/04W-27P01M	ROY GEER	P	H	W	5		D	96	40	6	P	C	64	J	S	3328	49	9-71		
40N/04W-28H01M	W. W. GREENE	P	H	W				130		8	P	C	67	S	T	3454	79			
40N/04W-28L01M	SISKIYOU COUNTY	C	U	O	8		GD	168	58	8	P	C	71	N		3337	34	10-71		
40N/04W-28Q01M	SISKIYOU COUNTY	C	U	O	8		GD	40	20	6	P	C	71	N		3288	6	10-71		
40N/04W-28R01M	PAUL AIELLO	P	H	W	8			68	56	6	P	C	66	J	T	3257	5	9-71		
40N/04W-33B01M	SISKIYOU COUNTY	C	U	O	8		GD	143	12	6	P	C	71	N		3266	14	11-71		
40N/04W-34D01M	DEL HASEN	P	H	W				45	45	6	P	C	63	J	S	3288	6	9-71		
40N/04W-35L01M	CALIF DIV HWYS	S	P	W						10				S	U	3211	144	9-71	270	107

APPENDIX B.--Flow records at sewage ponds

SACRAMENTO RIVER BASIN

11341368 MT SHASTA SEWAGE POND EFFLUENT AT INLET, NEAR MT SHASTA, CALIF.

LOCATION.--Lat 41°16'53", long 122°18'54", in NE¼SW¼ sec.28, T.40 N., R.4 W., Siskiyou County, at inflow to sewage ponds, 2.1 miles south of town of Mount Shasta.

PERIOD OF RECORD.--June 1971 to September 1972.

GAGE.--Water-stage recorder and 3-inch Parshall flume.

EXTREMES.--June to September 1971: Maximum daily discharge recorded, 1.4 cfs Aug. 16-22; minimum daily recorded, 0.76 cfs July 17.

Water year 1972: Maximum daily discharge recorded, 2.0 cfs Jan. 21, 22; minimum daily recorded, 0.88 cfs Sept. 24.

REMARKS.--Records excellent except for periods of no gage-height record and Dec. 16-27, 1971, which are poor.

DISCHARGE, IN CUBIC FEET PER SECOND, JUNE TO SEPTEMBER 1971

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1									--	1.1	--	1.0
2									--	1.1	--	1.0
3									--	1.0	--	.99
4									--	1.0	--	.99
5									--	1.0	1.2	--
6									--	1.0	1.2	--
7									--	1.0	1.0	--
8									--	1.1	.99	--
9									--	1.1	1.0	--
10									--	.86	1.1	--
11									--	.83	1.1	--
12									--	.84	1.1	--
13									--	.86	1.1	--
14									--	.83	1.2	--
15									--	.81	1.1	.93
16									--	.79	1.4	.96
17									--	.76	1.4	.95
18									1.0	.83	1.4	.95
19									1.1	.99	1.4	--
20									1.0	.98	1.4	--
21									1.0	.93	1.4	--
22									1.1	.95	1.4	--
23									1.1	1.1	1.2	--
24									.98	--	.99	--
25									1.1	--	.98	--
26									1.1	--	1.2	--
27									1.0	--	1.2	--
28									1.1	--	1.1	--
29					------				1.1	--	1.1	.96
30					------				1.0	--	.99	.96
31		------			------		------		------	--	1.0	------
TOTAL									--	--	--	--
MEAN									--	--	--	--
MAX									--	--	--	--
MIN									--	--	--	--
AC-FT									--	--	--	--

APPENDIX B.--Continued

SACRAMENTO RIVER BASIN

11341368 MT SHASTA SEWAGE POND EFFLUENT AT INLET, NEAR MT SHASTA, CALIF.--Continued

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.96	1.0	1.1	--	1.3	1.4	1.2	1.0	1.0	1.0	1.0	.96
2	.95	1.0	1.2	--	1.3	1.6	1.2	1.0	1.0	1.0	1.0	.97
3	.94	1.0	1.2	--	1.3	1.6	1.2	1.0	1.1	1.0	1.0	.91
4	.96	.97	--	--	1.3	1.4	1.2	1.1	1.0	1.0	1.1	.96
5	.94	.99	--	--	1.4	1.3	1.6	1.2	1.1	1.1	1.1	1.2
6	.93	.99	--	--	1.6	1.3	1.6	1.1	1.1	1.1	1.0	1.2
7	.91	.97	--	--	1.5	1.2	1.4	1.1	1.1	.99	1.1	1.1
8	.92	.97	--	1.2	1.4	1.2	1.3	1.2	1.0	.97	1.0	1.1
9	.92	1.2	--	1.2	1.4	1.2	1.2	1.2	1.2	.97	1.1	1.1
10	.92	1.2	--	1.2	1.3	1.4	1.2	1.2	1.2	.99	1.1	1.0
11	.93	1.4	--	1.3	1.3	1.3	1.3	1.1	1.1	1.0	1.1	1.1
12	.92	1.5	--	1.7	1.3	1.2	1.4	1.1	1.1	1.0	1.1	1.0
13	.93	1.7	1.2	1.8	1.2	1.3	1.4	1.0	1.1	1.0	.98	.96
14	.94	1.3	1.1	1.5	1.2	1.2	1.3	1.0	1.0	1.0	1.0	.93
15	1.0	1.2	1.1	1.4	1.2	1.2	1.2	1.0	1.0	1.0	1.0	.92
16	1.1	1.1	1.1	1.4	1.2	1.2	1.2	1.0	1.0	.99	1.0	.94
17	.99	1.1	1.1	1.4	1.2	1.2	1.2	1.0	1.0	1.0	.99	.90
18	.98	1.1	1.1	1.5	1.2	1.1	1.2	1.0	1.0	1.0	.99	.92
19	1.0	1.1	1.1	1.7	1.2	1.1	1.2	1.0	1.0	1.0	.97	.93
20	1.1	1.1	1.1	1.7	1.2	1.1	1.1	1.3	1.0	1.1	.93	.95
21	1.0	1.0	1.3	2.0	1.2	1.1	1.1	1.2	1.0	1.1	.96	.95
22	1.0	1.0	1.3	2.0	1.4	1.6	1.1	1.1	1.1	1.1	.97	.91
23	1.1	1.0	1.3	1.9	1.5	1.4	1.2	1.1	1.1	1.0	.93	.89
24	1.0	1.1	1.3	1.6	1.6	1.3	1.2	1.0	1.1	1.1	.92	.88
25	1.0	1.0	1.3	1.5	1.5	1.3	1.1	1.0	1.0	1.0	.97	.92
26	1.0	1.2	1.3	1.4	1.6	1.3	1.1	1.0	1.1	1.0	1.1	.96
27	.97	1.3	1.2	1.4	1.5	1.3	1.1	1.0	1.0	.99	.98	.95
28	.98	1.5	--	1.4	1.8	1.3	1.1	1.1	1.0	1.0	.96	.91
29	.98	1.3	--	1.3	1.6	1.3	1.0	1.1	1.0	1.0	.94	.94
30	.98	1.2	--	1.3	------	1.2	1.0	1.1	1.0	1.0	.97	1.0
31	.98	------	--	1.3	------	1.2	------	1.0	------	1.0	.96	------
TOTAL	30.23	34.49	--	--	39.7	39.8	36.6	33.3	31.5	31.50	31.22	29.36
MEAN	.98	1.15	--	--	1.37	1.28	1.22	1.07	1.05	1.02	1.01	.98
MAX	1.1	1.7	--	--	1.8	1.6	1.6	1.3	1.2	1.1	1.1	1.2
MIN	.91	.97	--	--	1.2	1.1	1.0	1.0	1.0	.97	.92	.88
AC-FT	60	68	--	--	79	79	73	66	62	62	62	58

APPENDIX B.--Continued

SACRAMENTO RIVER BASIN

11341370 MT SHASTA SEWAGE POND EFFLUENT AT OUTLET, NEAR MT SHASTA, CALIF.

LOCATION.--Lat 41°16'35", long 122°18'51", in NW¼NE¼ sec.23, T.40 N., R.4 W., Siskiyou County, on right bank at outflow weir from sewage ponds, 2.3 miles south of town of Mount Shasta.

PERIOD OF RECORD.--June 1971 to September 1972.

GAGE.--Water-stage recorder and 90° V-notch weir. Altitude of gage is 3,270 ft (from topographic map).

EXTREMES.--June to September 1971: Maximum daily discharge recorded, 0.89 cfs July 2; no flow June 24-26, Sept. 4.
Water year 1972: Maximum discharge, 2.25 cfs Feb. 11 (gage height, 1.96 ft); no flow many days.

REMARKS.--Records good. During periods of no flow, water was diverted through ponds 1 and 2 bypassing the gage.

COOPERATION.--The log of diverted discharge furnished by Siskiyou County Flood Control and Water Conservation District and is in the files of the Geological Survey.

DISCHARGE, IN CUBIC FEET PER SECOND, JUNE TO SEPTEMBER 1971

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1									--	.44	.56	.64
2									--	.89	.59	.62
3									--	.70	.59	.47
4									--	.64	.59	0
5									--	.59	.59	.26
6									--	.56	.59	.70
7									--	.56	.62	.76
8									--	.56	.59	.73
9									--	.62	.14	.62
10									--	.64	.82	.54
11									--	.62	.22	.54
12									--	.56	.49	.52
13									--	.49	.82	.52
14									--	.47	.67	.54
15									--	.45	.59	.54
16									--	.42	.56	.52
17									--	.40	.56	.49
18									1.0	.40	.59	.45
19									.99	.42	.59	.45
20									.82	.47	.46	.35
21									.70	.49	.59	.52
22									.67	.49	.56	.52
23									.56	.49	.54	.54
24									0	.54	.54	.54
25									0	.56	.54	.54
26									0	.56	.54	.54
27									.65	.56	.53	.54
28									1.3	.56	.62	.54
29					------				1.3	.39	.64	.59
30					------				.94	.62	.64	.59
31		------			------		------		------	.56	.64	------
TOTAL									--	16.72	17.61	15.72
MEAN									--	.54	.57	.52
MAX									--	.89	.82	.76
MIN									--	.39	.14	0
AC-FT									--	33	35	31

APPENDIX B.--Continued

SACRAMENTO RIVER BASIN

11341370 MT SHASTA SEWAGE POND EFFLUENT AT OUTLET, NEAR MT SHASTA, CALIF.--Continued

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.56	.56	.89	.79	.86	1.1		0	.49	.42	.47	.49
2	.54	.54	.94	.79	.86	.96		0	.49	.40	.45	.49
3	.54	.56	1.0	.79	.63	.89		0	.45	.42	.45	.49
4	.54	.56	.92	.79	.10	.82		0	.38	.42	.42	.49
5	.54	.59	.89	.76	0	.70		0	.38	.42	.45	.47
6	.54	.56	.78	.73	0	.92		0	.42	.42	.47	.47
7	.54	.59	.23	.70	0	.73		0	.49	.40	.49	.49
8	.52	.59	.02	.67	0	.29		0	.62	.40	.49	.52
9	.52	.70	0	.64	0	.07		0	.70	.36	.49	.52
10	.52	.86	0	.64	.07	0		0	.79	.34	.49	.52
11	.52	1.1	0	.70	1.8	0		0	.79	.32	.47	.52
12	.49	1.3	0	.79	1.5	0		0	.73	.34	.47	.52
13	.49	1.5	0	1.1	.73	0		0	.67	.36	.47	.54
14	.47	1.3	0	1.1	.23	0		0	.62	.32	.47	.54
15	.52	1.2	0	1.0	.01	0		0	.59	.32	.47	.52
16	.56	1.1	0	.96	0	0		0	.52	.40	.49	.52
17	.54	.96	0	.92	0	0		0	.47	.45	.52	.52
18	.56	.82	0	.92	0	0		0	.45	.45	.52	.49
19	.62	.76	0	1.0	0	0		0	.38	.42	.52	.49
20	.70	.70	0	1.2	0	0		0	.40	.40	.52	.52
21	.70	.67	0	1.5	0	0		0	.42	.40	.52	.52
22	.70	.64	0	1.6	.03	0		.34	.45	.38	.52	.52
23	.79	.64	.15	1.6	.45	0		.64	.42	.45	.52	.49
24	.76	.64	.16	1.5	.79	0		.79	.42	.49	.49	.47
25	.70	.64	.56	1.4	.79	0		.73	.42	.49	.49	.45
26	.67	.73	.71	1.2	.54	0		.64	.40	.47	.49	.49
27	.64	.82	.93	1.1	.79	0		.62	.40	.35	.49	.54
28	.59	.96	.99	.99	1.1	0		.56	.42	.49	.52	.54
29	.56	.96	.92	.92	.89	0		.52	.42	.47	.52	.54
30	.56	.92	.82	.92	------	0		.49	.42	.47	.49	.54
31	.59	------	.79	.89	------	0	------	.49	------	.45	.49	------
TOTAL	18.09	24.47	11.70	30.61	12.17	6.48	0	5.82	15.02	12.69	15.13	15.23
MEAN	.58	.82	.38	.99	.42	.21	0	.19	.50	.41	.49	.51
MAX	.79	1.5	1.0	1.6	1.8	1.1	0	.79	.79	.49	.52	.54
MIN	.47	.54	0	.64	0	0	0	0	.38	.32	.42	.45

WTR YR 1972 TOTAL 167.41 MEAN .46 MAX 1.8 MIN 0

KALINITY···GAINING STREAM···SPECIFIC YIELD···MILLIGRAMS P
ANSMISSIVITY···TEST WELL···HYDRAULIC CONDUCTIVITY···MO
PRINGS···FLOOD FREQUENCY···DIGITAL MONITOR···RAIN GAGE
SSOLVED SOLIDS···WATER QUALITY···TEMPERATURE···STAGE
C···FLOODFLOW···PERCOLATION···CONFINING BED···METEORIC
ABLEWAY···TOTAL KJELDAHL NITROGEN···RUNOFF···PRECIPIT
TOMATIC ANALYZER···TURBIDITY···BIODEGRADATION···E. COL
ONE OF SATURATION···BASE OF FRESH WATER···DEPOSITION
CTRICAL LOGS···SAFE YIELD···EFFECTIVE PRECIPITATION···
SCHARGE···SALTWATER INTRUSION···HYDROGRAPHS···CONE OF
···HYDROLOGIC BUDGET···LIMNOLOGY···AQUICLUDE···WATER
OROSITY···LAKES···DRAINAGE DIVIDE···RESERVOIRS···CANALS
OUGHNESS COEFFICIENT···GLACIER···SNOWMELT···PARTICLE S
···HEAD DECLINE···EUTROPHICATION···MOISTURE EQUIVALENT·
CORDER···SEDIMENT TRANSPORT···DYE TRACER···STREAM GA
ISSOLVED OXYGEN···SODIUM ADSORPTION···BIOCHEMICAL OXY
OTENTIOMETRIC SURFACE···INFILTRATION···HEAD···ACRE-FEE
EVE SIZE···STREAMS···TOTAL NITROGEN···GRAIN SIZE···
···CUBIC FEET PER SECOND···SLOPE-AREA METHOD···DRAINA
GANIC POLLUTION···SPECIFIC CONDUCTANCE···TOTAL ORGANI
ATER TABLE···HYDROLOGY···SUBSURFACE GEOLOGY···DIVERS
OOD PLAIN···COMPUTER READOUT···NO-FLOW BOUNDARY···AQ

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7042