COMPILATION OF WATER RESOURCES DEVELOPMENT AND HYDROLOGIC DATA OF SAIPAN, MARIANA ISLANDS

By Otto van der Brug

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 84-4121

Prepared in cooperation with the

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

Honolulu, Hawaii

March 1985

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey, WRD
Rm. 6110, 300 Ala Moana Blvd.
Honolulu, Hawaii 96850

Copies of this report
can be purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, Colorado 80225
(Telephone: [303] 234-5888)

CONTENTS

CONTENTS

ILLUSTRATIONS

Figure

ILLUSTRATIONS

TABLES

TABLES

TABLES

CONVERSION TABLE

The following table may be used to convert measurements in the inch-pound system to the International System of Units (SI).

Multiply	By		To obtain
Length			
inch (in)	25.4	----	millimeter (mm)
foot (ft)	0.3048	----	meter (m)
mile, statute (mi)	1.609	----	kilometer (km)
Area			
acre	4,047	----	square meter (m^2)
square foot (ft^2)	0.0929	----	square meter (m^2)
square mile (mi^2)	2.590	----	square kilometer (km^2)
Volume			
acre-foot (acre-ft)	1,233	----	cubic meter (m^3)
cubic foot (ft^3)	0.02832	----	cubic meter (m^3)
gallon (gal)	3.785	----	liter (L)
million gallons (Mgal)	3,785	----	cubic meter (m^3)
Volume Per Unit Time (includes Flow)			
cubic foot per second (ft^3/s)	0.02832	----	cubic meter per second (m^3/s)
gallon per minute (gal/min)	0.06309	----	cubic decimeter per second (dm^3/s)
gallon per day (gal/d)	90.85	----	cubic decimeter per second (dm^3/s)
million gallons per day (Mgal/d)	0.04381	----	cubic meter per second (m^3/s)
Miscellaneous			
cubic foot per second per square mile [$(ft^3/s)/mi^2$].	0.01093	----	cubic meter per second per square kilometer [$(m^3/s)/km^2$].
micromho per centimeter at 25° Celsius (µmho/cm).	1.000	----	microsiemens per centimeter at 25° Celsius (µS/cm at 25°C).

DEFINITION OF TERMS

Water Resources

Acre-foot (acre-ft) is the quantity of water required to cover one acre to a depth of one foot and is equivalent to 43,560 cubic feet or 325,851 gallons.

Control designates a feature downstream from the gage that determines the stage-discharge relation at the gage. This feature may be a natural constriction of the channel, an artificial structure, or a uniform cross section over a long reach of the channel.

Cubic foot per second (ft^3/s) is the rate of discharge representing a volume of one cubic foot passing a given point during one second and is equivalent to 7.48 gallons per second or 448.8 gallons per minute.

Cubic foot per second day [(ft^3/s)-d] is the volume of water represented by a flow of one cubic foot per second for 24 hours. It is equivalent to 86,400 cubic feet, 1.9835 acre-feet, or 646,317 gallons.

Discharge is the volume of water that passes a given point within a given period of time.

Mean discharge (mean) is the arithmetic average of individual daily mean discharges during a specified period.

Instantaneous discharge is the discharge at a particular instant of time. If this discharge is reported instead of the daily mean, the heading of the discharge column in the table is "Discharge".

Dissolved is that material in a representative water sample which passes through a 0.45-µm membrane filter.

Drainage area of a stream at a specific location is that area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the river above the specified point.

Gage height is the water-surface altitude referred to some arbitrary gage datum.

Gaging station is a particular site on a stream where systematic observations of hydrologic data are obtained.

Hardness of water is a physical-chemical characteristic that is commonly recognized by the increased quantity of soap required to produce lather, due to the presence of alkaline earths (principally calcium and magnesium) and is expressed as equivalent calcium carbonate ($CaCO_3$).

Micrograms per liter (µg/L) is a unit expressing the concentration of chemical constituents in solution as mass (micrograms) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter.

Milligrams per liter (mg/L) is a unit expressing the concentration of chemical constituents in solution as mass (milligrams) of solute per unit volume (liter) of water.

Partial-record station is a particular site where limited streamflow and (or) water-quality data are collected systematically over a period of years for use in hydrologic analyses.

Recurrence interval is the average interval of time within which an event will be equaled or exceeded once.

Runoff in inches is the depth to which the drainage area would be covered if all of the runoff for a given time period were uniformly distributed on it.

Sediment is solid material that originates mostly from disintegrated rocks and is transported by, suspended in, or deposited from water; it includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics, and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors are degree of slope, length of slope, soil characteristics, land usage, and quantity and intensity of precipitation.

Specific conductance is a measure of the ability of water to conduct an electrical current. It is expressed in micromhos per centimeter at 25°C. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved-solids content of the water. Commonly, the concentration of dissolved solids (in milligrams per liter) is about 65 percent of the specific conductance (in micromhos). This relationship is not constant from stream to stream, and it may vary in the same source with changes in the composition of the water.

Stage is the water-surface altitude referred to some arbitrary gage datum (gage height).

Stage-discharge relation is the relation between gage height (stage) and volume of water per unit of time, flowing in a channel.

Streamflow is the discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

COMPILATION OF WATER RESOURCES DEVELOPMENT AND HYDROLOGIC DATA OF SAIPAN, MARIANA ISLANDS

By Otto van der Brug

ABSTRACT

Saipan is the largest island of the Northern Mariana Islands, a chain of 14 islands north of Guam. Saipan is the administrative, commercial, educational, and transportation center of the islands and comprises one third of the land area of the islands.

No long-term rainfall record is available at any location but rainfall records for periods up to 16 years are available at various locations since 1901. Average annual rainfall for the island is 81 inches, with the southern end receiving about 10 inches less annually than the rest of the island.

Runoff to rainfall comparisons for the Talufofo Stream basin indicate that the amount of rainfall which runs off in northeast Saipan ranges from 23 to 64 percent depending on the rainfall during the year and averages about 40 percent. Runoff on the rest of the island is from springs or occurs only during heavy rainfall. Surface-water development appears impractical because of minimal discharge during the long dry season and limited storage potential.

Ground water is the main source of water for the island and production reached more than 4 million gallons per day in September 1983. However, chloride concentration in ground water exceeds 1,000 milligrams per liter in many locations. By mixing this ground water with springflow and high-level ground water of excellent quality, the average chloride concentration of the domestic water usually stays near the maximum permissible level of the World Health Organization standards (600 milligrams per liter). About two thirds of the water produced is lost during transmission or is wasted.

This report summarizes the history of the water-resources development on Saipan and presents all available hydrologic data. Hydrologic data include rainfall records since 1901 from German, Japanese, and U.S. sources, streamflow records since 1968, and an almost complete compilation of drilling logs, pumping tests, chemical analyses, and production figures for the 180 testholes and wells drilled on Saipan.

INTRODUCTION

Cooperation

In 1968, the Water Resources Division of the U.S. Geological Survey and the Trust Territory of the Pacific Islands signed a joint-funding agreement to systematically collect water-resources data throughout most of the Trust Territory. Under this program, the Trust Territory provided labor, equipment, services, and funds to be matched on an equal-value basis by the Geological Survey. The Survey assumed responsibility for supervision, data compilation and analyses, and publication.

During 1968, three gaging stations were constructed and four partial-record stations established on Saipan. The program was expanded in 1974, with the assignment of a senior geologist, Dan A. Davis, nearly full-time to Trust Territory Headquarters to advise on exploratory drilling and ground-water development.

After the formation of the Commonwealth of the Northern Mariana Islands, the joint-funding agreement was continued between the Commonwealth and the Geological Survey. In 1977, two recording rain gages were established and for the 1981 fiscal year the level of funding was increased to include the construction and operation of a lake-level and two ground-water-level recording stations and the collection and analyses of water samples.

Purpose and Scope

The main purpose of this report is to provide a complete compilation of the historical and current development of Saipan's water resources and to present all available hydrologic information which can be used as the basis for making decisions on the development and management of the resource.

To explore the potential for surface-water development, the continuous record of gaging stations is used for flow duration curves and for statistical analyses. Runoff-rainfall comparisons are made and chemical analyses of water, especially chloride concentrations of ground water is discussed.

Geographic Setting

Saipan is the principal island of the Commonwealth of the Northern Mariana Islands, a chain of 14 islands north of Guam. Saipan is located between 15°05'30" and 15°17'30" N. latitude and 145°41'30" to 145°50'00" E. longitude, 1,500 statute miles south-southwest of Tokyo, 1,700 statute miles east of Manila and 3,740 statute miles west of Honolulu (fig. 1). The island is 48 mi^2 (square miles) in size, about 13 miles long with an average width of 4 miles.

A central ridge extends over most of the length of the island. In the center of the ridge lies Mount Takpochau, at 1,530 feet above sea level the highest point on Saipan (fig. 2). Between the ridge and coast lie benches and terraces, with a wide coastal area along the west coast. A barrier reef, separated from the coast by a shallow lagoon, lies along the western coast. A fringing reef extends along the coast of the rest of the island.

The rocks of the islands consist predominantly of limestone overlying an old volcanic core.

The climate is tropical with uniform temperatures, high humidity and adequate precipitation. The average annual rainfall is 81 inches with most of it falling during the wet season, July to December. The dominant winds are northeast trade winds. Westerly moving storm systems usually bring much rain, and occasionally a typhoon will bring violent winds and heavy rains. Because of the permeability of the limestone, there are few streams on Saipan; most flow only intermittently. Much of the rain infiltrates vertically into aquifers and drains into the ocean.

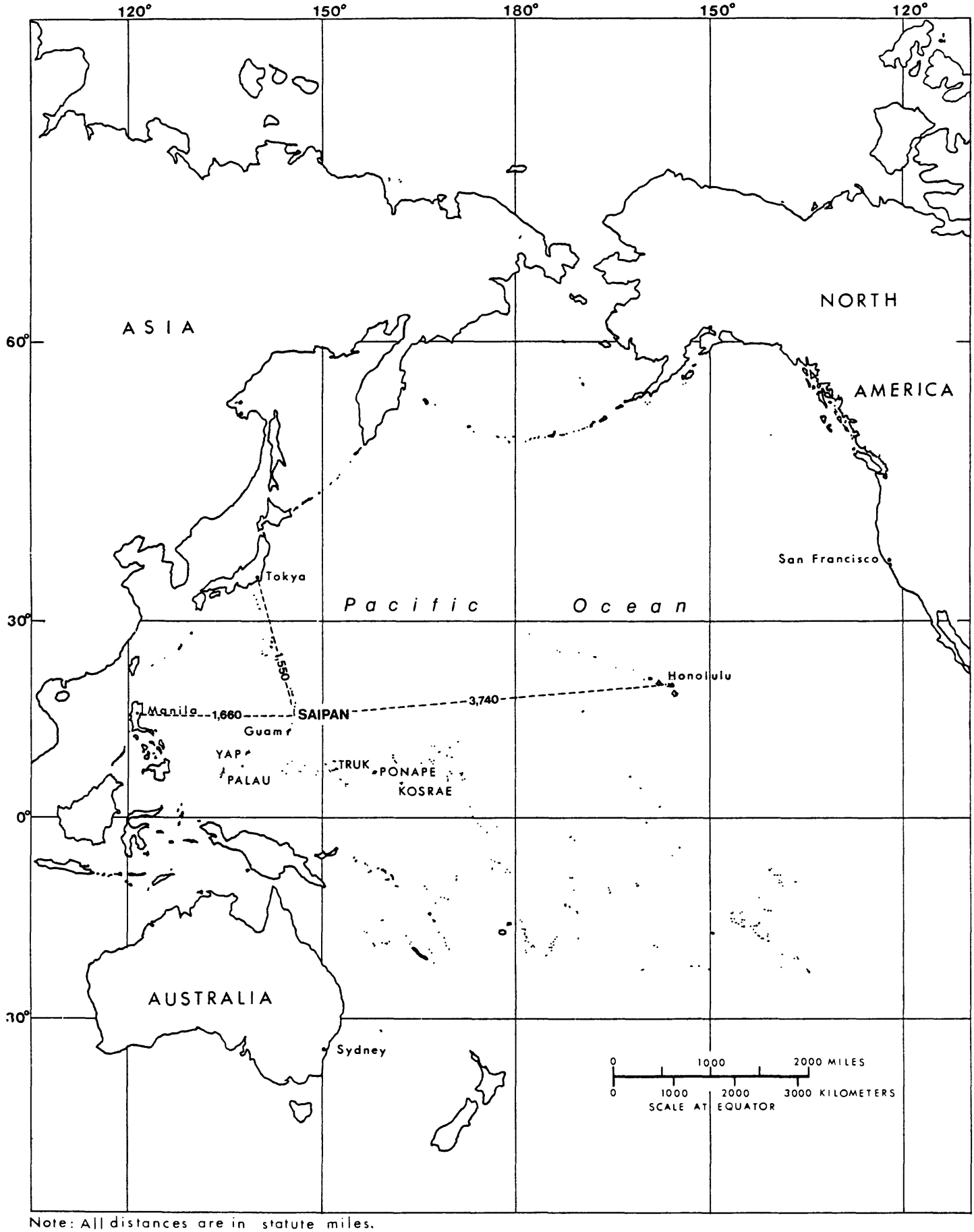
Historical Development

The first European to sight Saipan apparently was Magellan, prior to his landing on March 6, 1521, on Guam. After a route following the prevailing trade winds was established from Mexico to the Philippines, the Mariana Islands, especially Guam, became a regular stopover for Spanish ships to obtain provisions (Spoehr, 1954).

No colonization occurred, however, until the Spanish Jesuit De Sanitores landed on Guam in 1668. The Jesuits then named the islands the Mariana Islands in honor of Queen Marie Anna of Austria, the mother and regent of the infant Spanish King Charles II.

For the remainder of that century, the population often rebelled against Spanish authority. In order to control the inhabitants of the Northern Marianas, all were concentrated on Guam in 1698, with the exception of a few people from Rota. For the next 117 years, no one lived permanently on Saipan.

After Guam was ceded to the United States by Spain in 1898, Spain sold the Northern Mariana Islands to Germany in 1899 for 4-1/2 million pesetas (Bowers, 1950). During the German Administration, there were only a few German officials on Saipan. The Germans were interested primarily in the copra production but they started public health care, and schools, and issued certificates of title to all landowners.



Note: All distances are in statute miles.

Figure 1. Location of Saipan.

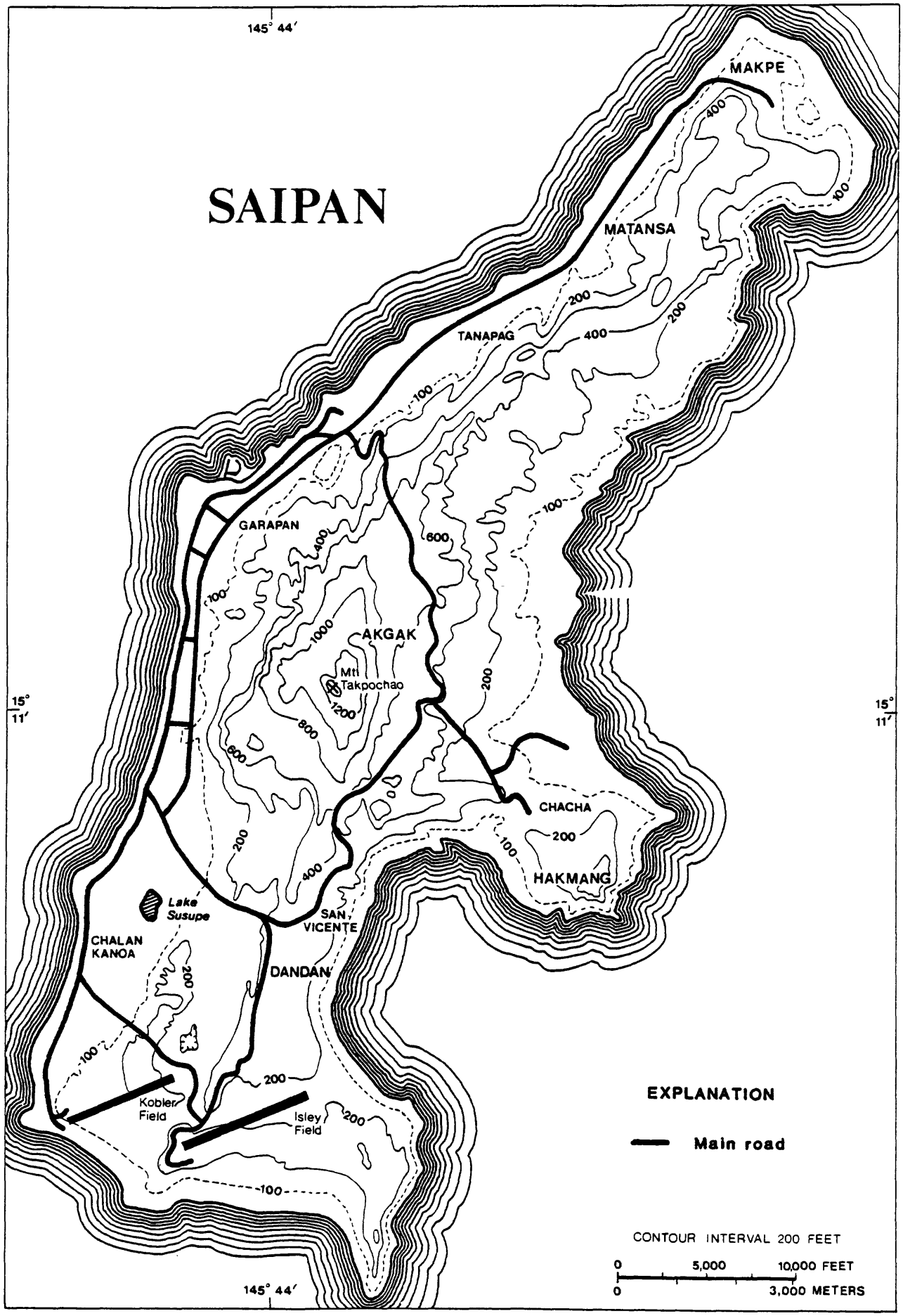


Figure 2. The island of Saipan.

Shortly after the outbreak of World War I, the Japanese Navy occupied all German-held islands and after the end of the war, Japan received a mandate over the islands from the League of Nations. On Saipan, the Japanese cleared most of the arable land for agriculture, mainly sugarcane. Many Japanese settled on Saipan and when the American Forces landed during World War II, there were about 29,000 Japanese troops stationed on Saipan. During the fighting, 3,426 Americans and about 25,000 Japanese soldiers lost their lives (Pacific Island yearbook, 1978).

After the end of World War II, all Japanese were repatriated. The island was administered by the U.S. Navy from 1946 to 1961, except for 1951-52, when the Department of the Interior was the Administrator. After 1961, the administration was resumed by the Interior Department until the Commonwealth of the Northern Mariana Islands was established in 1978.

Population

An estimate of the population of Saipan in 1521, when the first Europeans landed on Guam, was 11,000 (Hawaii Architects and Engineers, 1968). In 1668, the population of all the Mariana Islands was estimated at 100,000 by De Savitores. This figure seems high and 50,000 appears more likely (Spoehr, 1954). Von Kotzebue (1821) estimated the population at 40,000. The first census in 1710, after all of the Chamorros had been moved to Guam in 1698, listed a total Chamorro population of 3,197 to 3,678, depending on the source of information. In 1790, only 1,639 full-blooded Chamoros and 1,825 Chamorros of mixed blood were reported (Oliver, 1961). In 1815, about 200 Carolinians from the Truk District sailed to Guam after their islands had been devastated by a typhoon and were given permission to settle on Saipan (U.S. Navy Department, 1944). More migrated later and in the middle of the 19th century, the Spaniards allowed Chamorros from Guam to move to the Northern Mariana Islands. In 1889, 849 people were reported living in Saipan's only town, Garapan, two-thirds of them Carolinians (Spoehr, 1954).

During the German administration, the population increased from 2,102 (1,330 Chamorros) to 3,110 (1,920 Chamorros) owing to a high birth rate and migration from Guam. Soon after the Japanese occupied the islands, the local population was outnumbered by Japanese settlers. In 1936, the local population numbered 3,222 and the Japanese, 20,293, with almost all of the local population and almost half of the Japanese residing in Garapan (Reyes, undated). After the Japanese were repatriated following the end of World War II, 4,462 people remained on Saipan with more than half under the age of 15 (Bryan, 1946). Since then, the population increased rapidly; 6,654 in 1958, 9,035 in 1967, 11,833 in 1973 (Trust Territory Census, in M. and E. Pacific, 1978), and 14,585 in 1980 (U.S. Army Corps of Engineers, 1981). At present, in 1983, there are more than 15,000 people living on Saipan and the population is expected to continue growing at an annual rate of 3-4 percent.

Previous Investigations

A large number of scientific studies and observations have been made on Saipan, starting with a Spanish expedition in 1792. A complete listing of all studies made on the island, prior to 1956, is given in U.S. Geological Survey Professional Paper 280A (Cloud and others, 1956, p. 9-15).

Probably the major scientific publication since 1956 is the Military Geology of Saipan in three volumes. Volume 2 discusses the water resources of Saipan (Davis, 1958).

Since 1956, a dozen consultant firms have studied various aspects of the water problems of Saipan. Their publications are listed under "References".

Acknowledgments

Throughout the years of joint funding of the program beginning in 1968, the cooperation from officials of the Trust Territory of the Pacific and the Commonwealth of the Northern Mariana Islands has been invaluable.

Special acknowledgments are made to Governors Carlos S. Camacho and Pedro P. Tenorio and their staffs, Lt. Governor Pedro A. Tenorio, the Directors of Public Works, especially Antonio C. Tenorio, David M. Atalig, and John C. Pangelinan, and the personnel of Public Works, especially Gregorio G. Demapan and Epi Cabrera. Most of the field work on Saipan has been done by Leonardo D. L. G. Camacho, 1968-72; Jose R. Lizama, 1972-80; and Antony B. Camacho, 1980-83.

CLIMATE

General

The climate of Saipan is uniformly warm and humid throughout most of the year. Afternoon temperatures are normally about 30°C and nighttime temperatures are around 20°C. Relative humidity is usually about 70 percent in the afternoon and 90 percent at night.

There are two main seasons on Saipan and these are defined by the amount of rainfall. The dry season normally lasts from December to June, the wet season from July to November. Mean annual rainfall is 81 inches, with two-thirds of the rain falling during July to November.

Saipan lies in the path of typhoons spawned in the Western Pacific and moving west or northwest towards the Philippines or Japan. On April 30, 1963, typhoon Olive moved directly over Saipan, damaging 95 percent of the homes. The most destructive typhoon to hit Saipan since World War II was typhoon Jean, which passed directly over the island on April 11, 1968. At the U.S. Coast Guard weather station, winds of 115 mi/h (miles per hour) were recorded until the instruments failed and the Loran tower, designed to withstand 200 mi/h winds, was toppled. Ninety percent of the homes were destroyed.

The largest amount of rainfall recorded on Saipan occurred during typhoon Carmen, when 44-1/2 inches of rain were recorded at the Hakmang (Kagman) rain gage in 48 hours during August 10-12, 1978.

The dominant winds on Saipan are trade winds blowing from the east or northeast.

Rainfall

Rainfall records for Saipan are available for most of the years since 1901 from German, Japanese, and U.S. sources (table 1, fig. 3). During the German Administration, rainfall data were collected from 1901-12 and the Japanese collected rainfall records at seven locations during 1924-42. Apparently there is some confusion about their locations. The location of the Japanese station at Garapan, for instance, was called Southwest Lowlands by Cloud (1956) and Garapan by Cox (1956) and Taylor (1973), but Taylor gives a latitude and a longitude of Kobler Field (As Gonna).

After World War II, some rainfall data were collected for short periods prior to 1954. The U.S. Weather Bureau published rainfall records collected by the U.S. Navy during 1954-63 and records collected by the U.S. Coast Guard during 1963-76. Taylor (1973), gives a rainfall table for 1927-72 but the table is a combination of rainfall from different sources at several locations.

Since 1968, daily rainfall data have been collected by the Commonwealth of the Mariana Islands at Hakmang Communication Center and since 1976, at the nearby Agriculture Station. The U.S. Geological Survey has collected continuous records of rainfall since 1977 at the 9-Mgal (million gallon) reservoir and at Isley Field.

Table 1. Rainfall records of Saipan

Location	Latitude north	Longitude east	Altitude (ft)	Period of record	Source	Frequency of reading	Remarks
Garapan	15°12'	145°43'	30	1901-12	German	Daily	
Chalan Kanoa	15°08'	145°43'	4	1924-40	Japanese[1/]	--	Japanese spelling: Tyarankanoa.
Chacha, Hakmang.	15°11'	145°47'	--	1924-40	do.[1/]	--	Japanese spelling: Tyattya.
Tanapag (Capitol Hill)	15°13'	145°45'	627	1924-40	do.[1/]	--	Japanese spelling: Tanabako.
Tanapag[2/]	15°14'	145°46'	680	1926-41	do.	Bi-hourly	At Mount Talufofo.
Garapan	15°12'	145°43'	21	1927-42	do.	--	
As Gonna	15°09'	145°45'	--	1931-40	do.[1/]	--	Japanese spelling: Asugonno.
As Lito	15°09'	145°44'	33	do.	do.[1/]	--	Japanese spelling: Asurito.
Garapan (?)	15°07'	145°42'	105	1954-59	U.S. Navy	Daily (mid-day).	Latitude, longitude is for Kobler Field.
Garapan	15°13'	145°42'	105	1959-60	do.	do.	Latitude correction.
Do.	15°13'	145°43'	495	1960-61	do.	do.	Relocated.
Do.	15°13'	145°46'	495	1961-63	do.	do.	Longitude correction.
San Antonio	15°07'38"	145°41'31"	10	1963-76	U.S. Coast Guard.	Daily (10 a.m.).	At Loran station.
Hakmang	15°10'37"	145°46'32"	150	1968-83	U.S. Weather Bureau.	do.	At Communication Center.
Do.	15°10'21"	145°46'05"	205	1976-83	Commonwealth	Twice daily	At Agricultural Station.
9-Mgal Reservoir.	15°13'29"	145°44'28"	60	1977-83	U.S. Geological Survey.	Continuous	Recording rain gage.
Isley Field	15°07'33"	145°43'00"	200	1977-83	do.	do.	Do.
				Rainfall records not obtained for this report:			
Hakmang (Kagman).	15°10'	145°47'		1945	U.S. Navy		Two months only[3/].
Marpi Point	15°17'	145°49'		do.	do.		Do[3/].
As Gonna	15°07'	145°43'		1945-46	do.		Do[3/].
Tanapag	15°13'	145°44'		do.	do.		Ten months[3/].

1/ Monthly and annual means from Austin, Smith and Associates, 1967.

2/ Station called "Saipan" in Austin, Smith and Associates, 1967.

3/ On 16-mm microfilm on file with U.S. Navy Department, Washington, D.C. (Bryan, 1946).

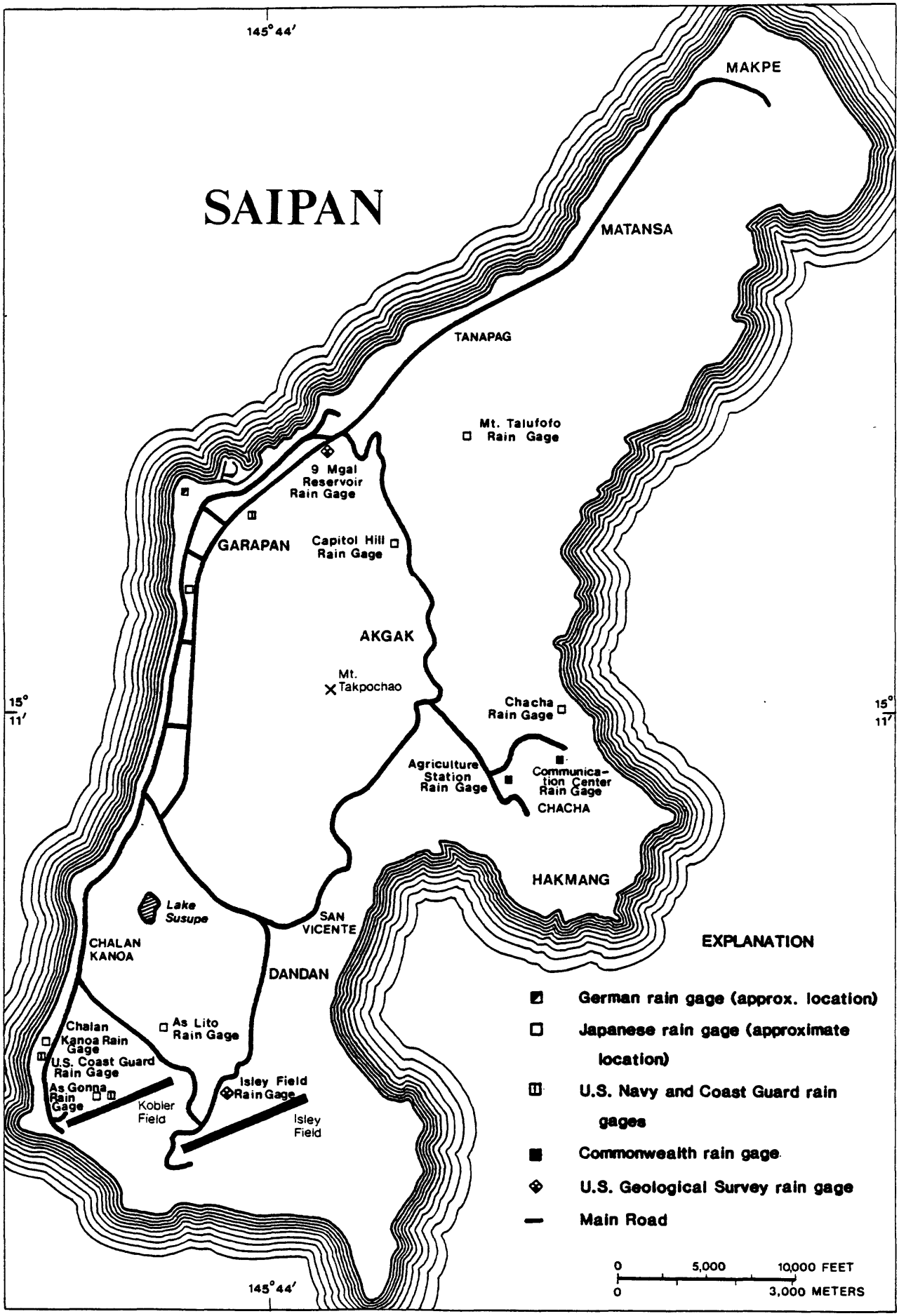


Figure 3. Location of rain gages.

The monthly and annual means of all stations with at least 5 years of record are given in table 2. The table shows that there is not much difference in total rainfall between locations on the island except at Isley Field. There is a distinct dry season from December to June, with March and April normally the driest months of the year. August and September are the wettest months of the year and usually account for one-third of the annual rainfall.

Because no long-term rainfall records are available for any location, a mean annual rainfall for Saipan was determined by averaging the means of all available annual rainfall totals for each year. For the period 1901-83, annual totals were available for 48 years with a mean annual rainfall of 81 inches. The total of monthly means of 52-57 years for west coast locations with consecutive years of record, showed a mean annual rainfall of 80 inches. (See table 2.)

A comparison, in percentage of total, between the streamflow of Middle Fork Talufofo Stream (1968-82), the springflow of Denni Spring (1969-82), the rainfall at Communication Center (1968-72, 1975-83), and the pan evaporation on Guam (1956-82) is shown in figure 4. Rainfall during August 1978 was 73.25 inches. The unusually high rainfall that month caused some distortion of the monthly mean rainfall for August because of the relatively short period of record.

Evaporation

No evaporation data have been collected on Saipan, but pan evaporation data are available for Guam since 1956. As the islands of Saipan and Guam are only 140 statute miles apart and have similar air temperatures and annual distribution of rainfall (rainfall on Guam is 25 percent more than on Saipan), evaporation on Saipan probably will be about the same as that on Guam. Table 3 lists the monthly pan-evaporation data for Guam during 1956-82.

An estimate of 30 inches of annual evaporation for Saipan was first given by Cox (1956) and later repeated by T. Davis (1973), M and E Pacific (1978), and Ayers (1981), but this estimate seems too low in view of the long-term annual mean of 76.76 inches reported for Guam. (U.S. Weather Bureau, 1956-70; U.S. National Oceanic and Atmospheric Administration, 1970-72, 1973-82). If a coefficient of 0.7 is used to adjust the total for the increase in evaporation owing to warming of the pan, the annual mean evaporation for Guam would be 54 inches.

Table 2. Monthly and annual mean rainfall in inches

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
						German rainfall records. See table 38								
*Garapan	1901-12	2.11	3.48	4.35	3.04	3.13	5.92	9.46	13.96	12.74	11.90	7.95	5.63	83.67
						Japanese rainfall records (Austin, Smith and Associates, 1967)								
Chalan Kanoa	1924-40	4.4	2.2	1.9	1.9	4.1	3.6	11.0	11.5	12.6	10.4	6.0	4.1	73.7
Chacha	do.	4.5	2.9	2.0	2.3	3.7	5.1	10.6	12.3	13.0	9.9	6.5	4.2	77.0
Tanapag (Mt. Talufofo).	1926-41	5.36	3.39	2.69	2.49	4.29	5.26	11.36	13.06	15.76	10.29	6.30	4.95	85.20
Tanapag (Capitol Hill)	1924-40	4.4	3.0	3.2	4.1	3.4	5.5	10.4	10.7	13.6	9.8	5.8	3.8	77.7
Garapan	1931-40	6.8	3.5	3.1	3.4	4.5	6.8	10.7	14.4	16.7	9.6	7.4	5.1	92.0
As Gonna (Kobler Field).	do.	5.4	2.7	2.5	2.6	4.1	5.2	8.2	12.6	13.2	9.9	7.3	4.6	78.3
As Lito	do.	5.6	2.9	2.4	2.7	5.0	6.2	8.9	13.5	14.7	10.1	7.5	4.7	84.2
						Japanese rainfall records (Taylor, 1973). See table 40								
*Garapan	1927-42	5.24	4.03	2.94	2.84	4.55	5.35	11.36	13.44	15.24	10.36	5.92	5.13	86.40
						U.S. rainfall records. See tables 45-53								
*U.S. Navy	1954-63	3.83	2.74	2.90	3.79	2.84	4.86	6.43	11.75	11.78	10.65	6.77	3.99	72.33
*U.S. Coast Guard LORAN station.	1963-76	4.79	3.27	3.70	3.82	3.51	4.36	9.73	11.26	13.32	9.28	8.25	4.71	80.00
Communication Center, Hakmang.	1968-72, 1975-83.	3.28	2.76	1.97	1.88	3.12	3.04	9.78	[1/]17.47	10.65	8.94	7.14	3.37	73.40
Agriculture Station, Hakmang.	1976-83	3.42	2.86	3.31	2.08	3.71	3.99	9.21	15.70	14.86	10.46	7.80	4.36	81.76
*9-Mgal reservoir.	1977-83	2.37	2.37	1.60	1.86	2.49	3.03	7.72	10.22	12.40	11.91	9.77	3.66	69.40
Isley Field	do.	2.04	1.83	1.54	.98	2.24	2.44	7.19	10.54	11.97	10.80	5.25	2.79	59.61
Mean of rain gages marked * (52-57 years):														
In inches		3.91	3.34	3.23	3.12	3.50	4.93	9.50	12.45	13.43	10.60	7.46	4.80	80.27
In percentage of total		4.9	4.2	4.0	3.9	4.4	6.1	11.8	15.5	16.7	13.2	9.3	6.0	100

[1/] August mean without total of August 1978: 11.89 inches (August 1978 rainfall not available at other rain gages).

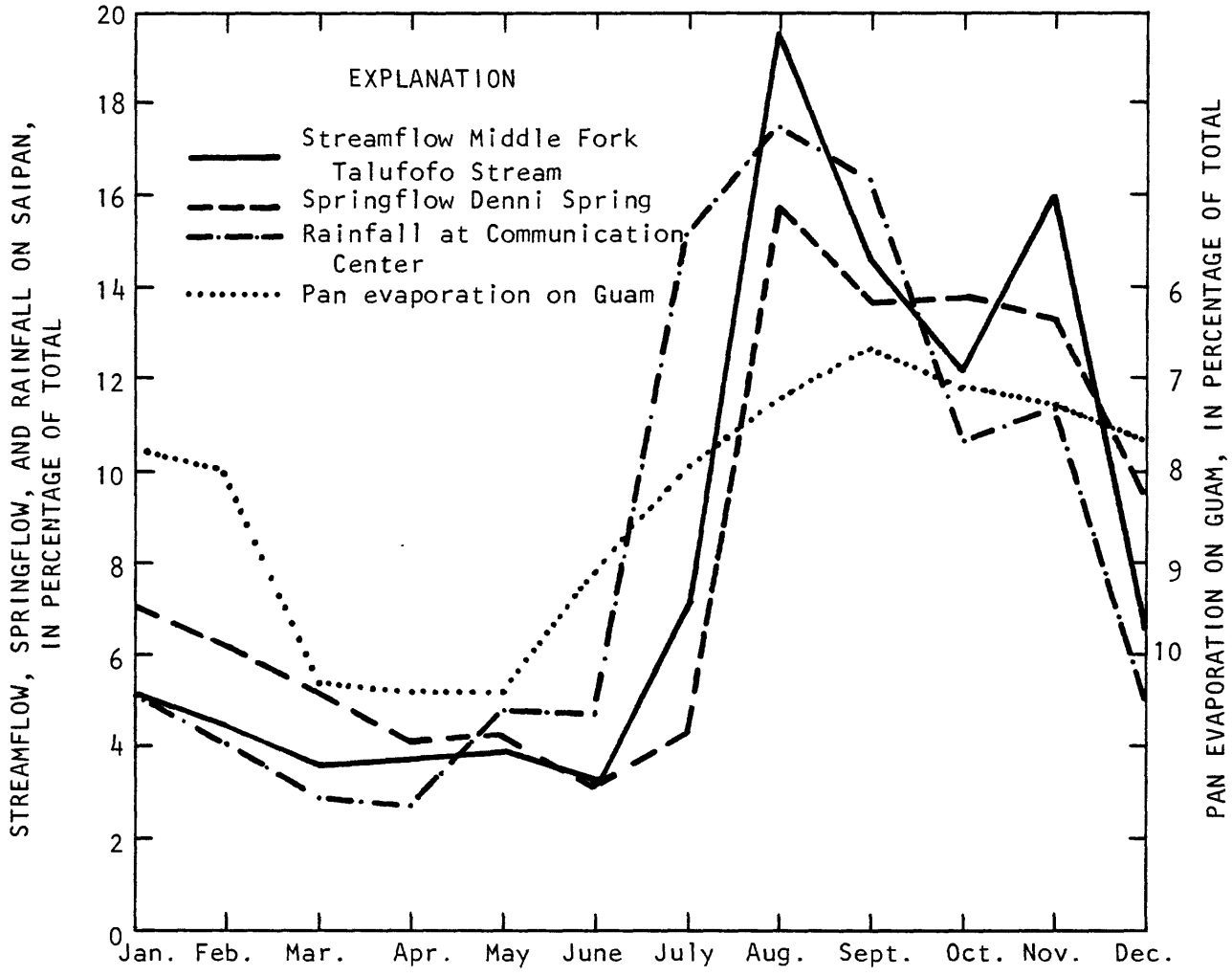


Figure 4. Comparison of streamflow, springflow, and rainfall on Saipan and pan evaporation on Guam.

Evaporation

Table 3. Monthly and annual evaporation data, in inches, for Guam

[1956 to May 1958 at Fena Lake, August 1958 to present at Weather Service Station. Source: U.S. National Oceanic and Atmospheric Administration, 1956-82]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1956	6.83	6.54	8.24	9.13	8.82	7.81	5.74	5.86	4.49	5.01	5.26	5.92	79.65
1957	6.18	5.99	7.32	8.42	8.71	9.10	7.41	7.76	6.52	5.57	7.28	7.22	87.48
1958	7.48	6.08	7.65	9.34	9.49	--	--						--
								5.48	5.61	6.08	4.64	5.30	--
1959	5.63	6.66	7.60	7.58	9.03	7.96	6.98	5.31	4.52	5.12	4.59	4.89	75.87
1960	4.86	6.26	7.05	8.05	7.17	6.54	5.41	4.71	4.38	4.30	5.03	5.16	68.92
1961	4.27	5.73	6.27	7.00	6.87	5.57	5.08	4.67	4.44	4.63	5.07	4.96	64.56
1962	6.15	4.94	7.81	6.17	7.00	5.20	4.99	4.91	4.28	5.00	4.45	5.26	66.16
1963	4.73	4.31	6.44	6.57	6.21	5.37	5.09	5.82	4.29	5.26	5.11	--	--
1964	5.91	6.39	7.01	6.99	6.76	7.47	6.18	4.75	4.58	4.73	5.95	6.50	73.22
1965	5.35	6.31	8.58	--	--	--	7.35	6.75	4.59	5.56	5.81	5.88	--
1966	7.07	6.55	7.78	9.17	8.88	7.37	7.21	4.71	4.76	5.36	5.39	5.92	80.17
1967	5.18	5.32	5.32	6.07	7.00	5.43	5.06	4.71	4.64	4.60	5.72	5.67	64.72
1968	5.89	6.31	8.50	7.57	7.58	5.89	5.77	4.95	4.49	5.53	4.32	5.35	72.15
1969	5.57	--	8.46	8.96	8.04	8.06	5.74	5.67	4.90	4.55	5.09	5.78	--
1970	4.68	5.90	7.93	8.98	8.06	7.30	6.27	4.28	4.86	4.62	5.80	6.02	74.70
1971	4.61	6.21	6.41	6.65	8.77	6.03	5.38	5.91	5.78	5.74	5.59	7.31	74.39
1972	6.55	6.65	5.75	7.85	8.06	7.26	5.66	5.00	5.87	5.55	4.71	5.67	74.58
1973	5.94	5.46	7.47	8.46	8.14	6.49	5.46	4.79	5.64	5.33	6.26	5.29	74.73
1974	5.81	6.62	6.90	8.27	7.21	5.88	--	5.09	5.61	6.28	5.73	6.93	--
1975	6.13	6.80	8.08	8.35	9.01	9.29	6.18	5.69	6.14	5.70	6.73	6.39	84.49
1976	6.27	5.58	7.22	7.62	7.37	7.65	6.59	6.33	5.47	7.36	6.43	6.56	80.45
1977	6.64	6.49	8.20	9.03	8.48	7.89	7.83	6.99	5.24	5.53	6.27	6.90	85.49
1978	7.30	6.10	9.46	7.72	8.85	6.55	5.90	6.10	5.33	6.32	5.46	5.95	81.04
1979	7.26	6.68	7.76	9.50	10.33	8.44	6.44	6.34	5.26	5.16	5.93	6.36	85.46
1980	7.73	6.43	7.85	7.93	8.05	6.91	6.33	4.84	5.14	5.98	7.10	6.20	80.49
1981	5.54	7.22	8.94	8.13	6.80	7.14	6.78	6.55	7.38	7.01	6.66	5.35	83.30
1982	--	6.20	7.64	8.28	8.06	6.90	5.89	6.38	6.60	5.27	6.08	6.31	--
Mean	5.98	6.14	7.54	7.99	8.03	7.02	6.11	5.56	5.22	5.45	5.65	5.96	76.76
Percent	7.8	8.0	9.8	10.4	10.4	9.2	8.0	7.3	6.8	7.1	7.4	7.8	100

Total of monthly means: 76.65 inches.

WATER RESOURCES

General

As most of Saipan is composed of limestone through which rainwater percolates easily, there are no large streams nor any perennial streams on the island. Only for parts of the Talufofo and Hasngot Streams where the riverbeds are composed mainly of volcanic rock, flow is perennial. Middle Fork Talufofo Stream at the gaging station is not known to go dry although at very low flow the water will disappear before reaching the confluence with South Fork Talufofo Stream, 700 feet downstream. Similarly, when the discharge at South Fork Talufofo Stream gaging station drops below 0.1 ft^3/s (cubic feet per second), the stream will be dry at the location of the old station, 1,000 feet downstream.

A fairly large number of springs occur on the island but most of the springs are insignificant. Exceptions are Denni Spring with a mean daily discharge of 400,000 gal/d (gallons per day) and the Tanapag Springs with a combined flow of about 60,000 gal/d. These springs have contributed to the water supply of the island since the time of the Japanese Administration.

By far, the most important source of water on Saipan is ground water. More than 70 wells were drilled in 1944-45 to supply the large numbers of U.S. Forces on the island. More than a hundred testholes and wells have been drilled since 1969. With the exception of springflow from Denni Spring and Tanapag Springs, all water for the central water system is ground water.

Surface Water

General

A gaging station was established on Denni Spring in 1952 and operated for nearly 2 years. Long-term collection of surface-water data was begun with the construction of five gaging stations in 1968. Of these, the water-stage recorder on Talufofo Stream was destroyed by flood a few months later and the station was converted to a partial-record station. A recorder on Rapugao Stream was operated for several years but as runoff occurred only during heavy rainfall, the station was discontinued in 1972. For the flood of August 12, 1978, an indirect measurement showed a peak flow of 666 ft^3/s at this location.

The remaining three gaging stations, one at Denni Spring and two at South and Middle Fork Talufofo Streams have been in operation until 1982 when the Denni Spring and Middle Fork stations were discontinued.

The gaging station on South Fork Talufofo Stream, first established on October 1, 1968, was moved to the present location, 0.2 mile upstream, on March 31, 1971. At the original location, normally there was no flow during the dry season because of underflow through the sand. At the present location, underflow is precluded because of a solid rock channel and since April 1971, the stream has been dry only for 4 days in July 1977. All sites on Saipan where surface-water data were collected are listed in table 4 and the location of the sites are shown in figure 5.

Table 4. List of surface-water, springflow, and lake-level stations

Station number	Station name	Drainage area (mi^2)	Location: Latitude north	Location: Longitude east	Location: Altitude (ft)	Period of record (water years)	Remarks
			Surface water				
16800500	Hasngot Stream	0.45	15°12'45"	145°46'21"	100	1967-75, 1977.	Low-flow partial record.
16801000	South Fork Talufofo Stream.	.64	15°13'00"	145°46'25"	85	October 1968 to September 1983.	Continuous record.
16801500	Middle Fork Talufofo Stream.	.28	15°13'09"	145°46'30"	65	March 1968 to June 1980, February to September 1982.	Do.
16801800	North Fork Talufofo Stream.	.39	15°13'07"	145°46'41"	40	1968-71	Low-flow partial record.
16802000	Talufofo Stream	1.43	15°13'05"	145°46'43"	30	1968-73	Do.
			Springflow				
16800000	Denni Spring	--	15°11'57"	145°46'05"	261	August 1952 to June 1954, March 1968, January 1969 to September 1982.	Continuous record.
16802500	East Achugau Spring	--	15°13'56"	145°46'25"	410	1965, 1968-72, 1974	Partial record.
16804000	West Achugau Spring	--	15°13'58"	145°45'23"	120	1967-72	Do.
			Lake level				
16805200	Lake Susupe	--	15°09'15"	145°42'12"	5	February 1981 to September 1983.	Lake level record.

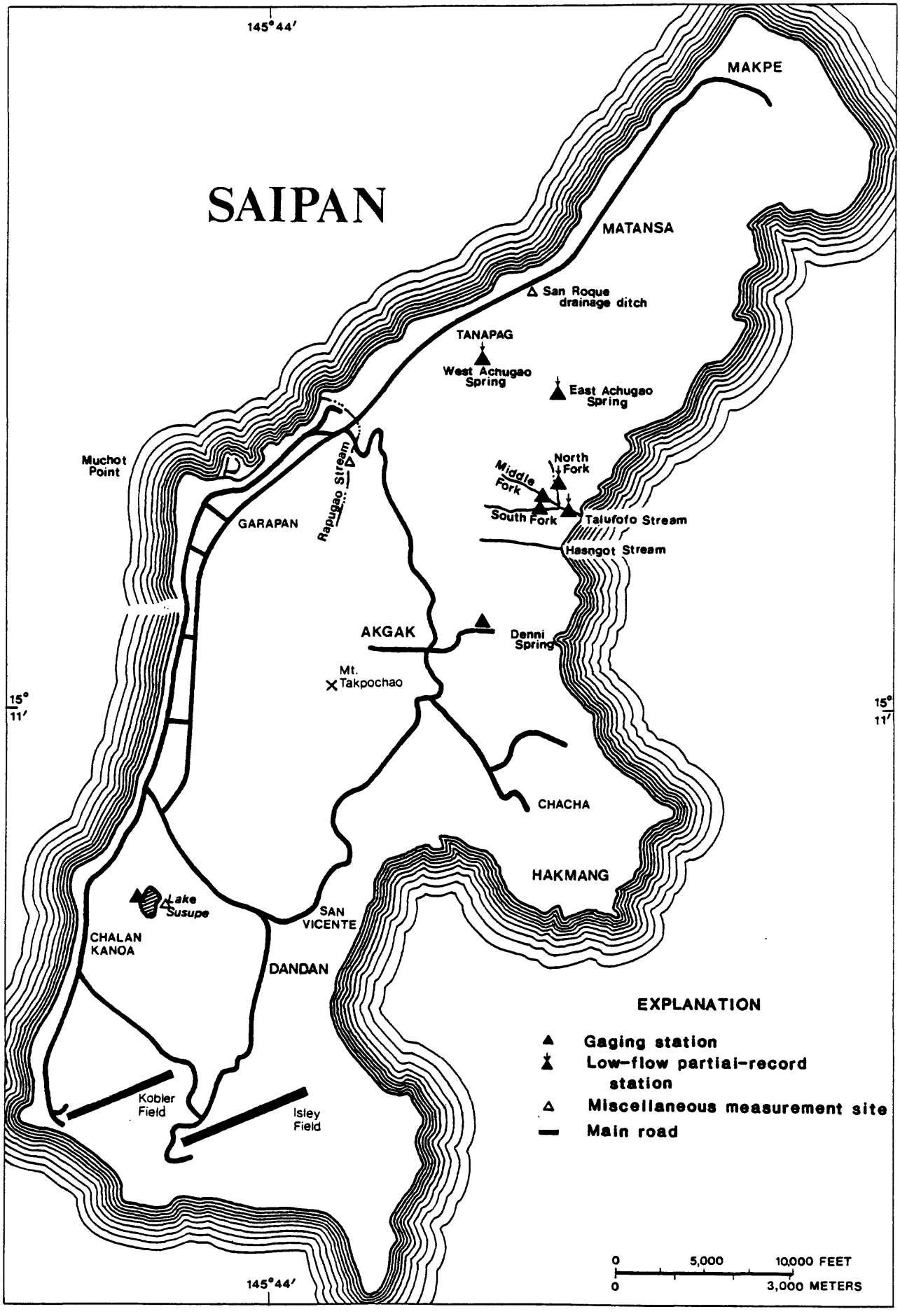


Figure 5. Location of surface-water and spring-water data collection sites.

Data collected at a gaging station consist of records of stage and measurements of discharge. Records of stage are obtained from a water-stage recorder that produces a continuous graph of stream fluctuations. Measurements of stream discharge are made with a current meter. From records of stage and discharge, stage-discharge relationship curves are derived. The relation is used to compute daily mean discharges from which the monthly and annual mean discharges are computed. Tables with monthly and annual totals, annual maximums and minimums, and means are presented in the Hydrologic Data section. Also, peak discharges, their time of occurrence and corresponding stage, are listed for all peaks above a selected base discharge. Time is expressed in 24-hour local standard time. Daily discharges are not given in this report but are published in the annual U.S. Geological Survey report "Water Resources Data for Hawaii and other Pacific Areas" for water years 1968 to 1982. Daily discharges for Denni Spring for 1952 to 1954 were published in "Surface Water Supply of Mariana, Caroline and Samoa Islands through June 1960" (U.S. Geological Survey, 1962).

Partial-record stations are sites where discharge measurements are made on a systematic basis over a period of years usually during a period of low flow where streamflow is primarily from ground-water storage. When these measurements are correlated with the simultaneous discharge of a nearby stream for which continuous record is available, the low-flow potential can be predicted. On Saipan, the only correlations made were between Hasngot and Middle Fork Talufofo Streams and between Talufofo and Middle Fork Talufofo Streams.

A comparison of monthly yield from the gaged streams and Denni Spring is shown in table 5. The difference in percentages between the stations is caused by the amount of retention of rainfall in the basins. For the same reason, the flow-duration curves show different shapes. (See fig. 6.)

Discharge measurements made at sites not included in the partial-record program are called measurements at miscellaneous sites. For the flooding of August 12, 1978, three determinations of peak flow were made at miscellaneous sites.

As a means of identification, station numbers have been assigned to each of the gaging stations, partial-record stations, and the lake level-station. On Saipan, station numbers were assigned in counterclockwise sequence beginning at Denni Spring.

All records were collected in English (and American) units of length, area, and volume, and are published as such. Surface-water data are published by water year, the year beginning on October 1 and ending on September 30.

Drainage areas and the locations (latitude, longitude, and altitude) of all stations differ from those used in "Water Resources Data of Hawaii and other Pacific Areas, 1968-81" (U.S. Geological Survey, 1968-74, 1975-76, 1977-80, 1981). These were based on the 1953 U.S. Army Map Service W843 maps with a scale of 1:25,000 (International Spheroid), whereas the revised figures are based on the 1981 U.S. Geological Survey maps with 1:10,000 scale (Clarke Spheroid of 1866).

Table 5. Average monthly and annual mean discharge in cubic feet per second and in percentage of total

Number of years ---------	South Fork Talufofo Stream 14		Middle Fork Talufofo Stream 12-15		Denni Spring 13-14	
	Mean	Per-cent	Mean	Per-cent	Mean	Per-cent
October	2.37	14.0	1.04	11.8	1.03	13.5
November	3.32	19.6	1.45	16.5	1.00	13.1
December	.79	4.7	.64	7.3	.73	9.5
January	.53	3.1	.46	5.2	.57	7.5
February	.43	2.6	.43	4.9	.49	6.4
March	.29	1.7	.33	3.7	.41	5.4
April	.17	1.0	.37	4.2	.33	4.3
May	.55	3.3	.33	3.7	.34	4.4
June	.12	.7	.29	3.3	.25	3.3
July	1.08	6.4	.62	7.0	.34	4.4
August	4.76	28.2	1.64	18.6	1.16	15.2
September	2.49	14.7	1.21	13.7	.99	13.0
Annual total	--	100	--	100	--	100
Mean of monthly means.	1.41	--	0.73	--	0.64	--

Streamflow characteristics

Runoff-rainfall comparison.--No complete rainfall record is available for a rain gage during the period that streamflow record is available and rainfall totals from several stations had to be used for the runoff-rainfall comparison. In 1972 and 1973, no rainfall was recorded on any rain gage and no annual total could be determined. The U.S. Coast Guard Loran Station rainfall totals were used for 1969-70 and 1974-75 and Hakmang Communication Center totals for 1971, 1976-78. For 1979-81 more than one annual total was available and the average rainfall was used.

Records for South Fork Talufofo Stream for October 1968 to March 1971 were collected at a site where some of the flow was lost to the ground via seepage through the channel bottom, and the mean runoff at this location is not comparable to records collected at the present site. For 1971, 1974-79, complete records are available for both Talufofo Stream stations and the average annual runoff is 40 percent of rainfall for each (table 6). Although the average is the same, the annual percentage of runoff differs considerably for 1978-79, between the two stations. A possible explanation for this is that in the Middle Fork Talufofo basin more rainfall infiltrates and is subsequently released over a period of time. For the wet year of 1978, the percentage of runoff at South Fork Talufofo Stream was higher than at Middle Fork Talufofo Stream. The following year, a dry year, the opposite was true.

Flow-duration curves.--A flow-duration curve is a cumulative frequency curve showing the percentage of time within the total period of record that a specified daily discharge was equaled or exceeded. It combines in one curve the flow characteristics of a stream throughout the range of discharge without regard to the sequence of occurrence. The general shape of such a curve is influenced by many factors, such as basin slope and cover, ground-water contributions, precipitation, and diversion.

The curve is plotted from a flow-duration table, which tabulates the distribution of daily discharges by different class limits in increasing order to magnitude. Discharge in cubic feet per second is plotted on the ordinate and percentage-of-time equaled or exceeded is plotted on the abscissa. The flow-duration tables in this report are based on distribution of the daily discharges.

For comparison for different streams, data covering the same period should be used to avoid including an extremely dry or wet year in one set and not in the other.

Figure 6 compares the flow duration curves for South and Middle Fork Talufofo Stream and Denni Spring for the period 1972-79. The curves show there is considerable retention of rainfall in the Middle Fork Talufofo Stream basin in contrast to the South Fork Talufofo Stream basin. The curves of Middle Fork Talufofo Stream and Denni Spring are similar for discharges less than 1.5 ft^3/s. This indicates that during low flow, the ground water release for Middle Fork Talufofo Stream is similar to the springflow of Denni Spring.

Table 6. Runoff-rainfall comparison

[Loran, U.S. Coast Guard Loran station; HCC, Hakmang Communication Center station; Isley, U.S. Geological Survey Isley Field station; 9 Mgal, U.S. Geological Survey 9-Mgal Reservoir station].

Calendar year	Rainfall (inches)	Source of record	South Fork Talufofo Stream Runoff		Middle Fork Talufofo Stream Runoff	
			Inches	Percent of rainfall	Inches	Percent of rainfall
1969	61.21	Loran	--	--	26.18	43
1970	63.99	do.	--	--	28.12	44
1971	60.30	HCC	32.45	54	33.45	55
1972	--	--	26.72	--	27.63	--
1973	--	--	5.30	--	11.15	--
1974	89.02	Loran	26.51	30	20.36	23
1975	80.29	do.	29.69	37	30.45	38
1976	85.57	11 months Loran, 1 month HCC.	31.60	37	32.48	38
1977	73.36	HCC	20.57	28	20.36	28
1978	145.07	do.	93.11	64	77.08	53
1979	60.04	Isley, HCC	16.12	27	26.18	44
1980	78.36	9 Mgal, Isley, HCC.	32.66	42	--	--
1981	80.00	do.	38.39	48	--	--
Mean (1971, 1974-79).	85		--	40	--	40

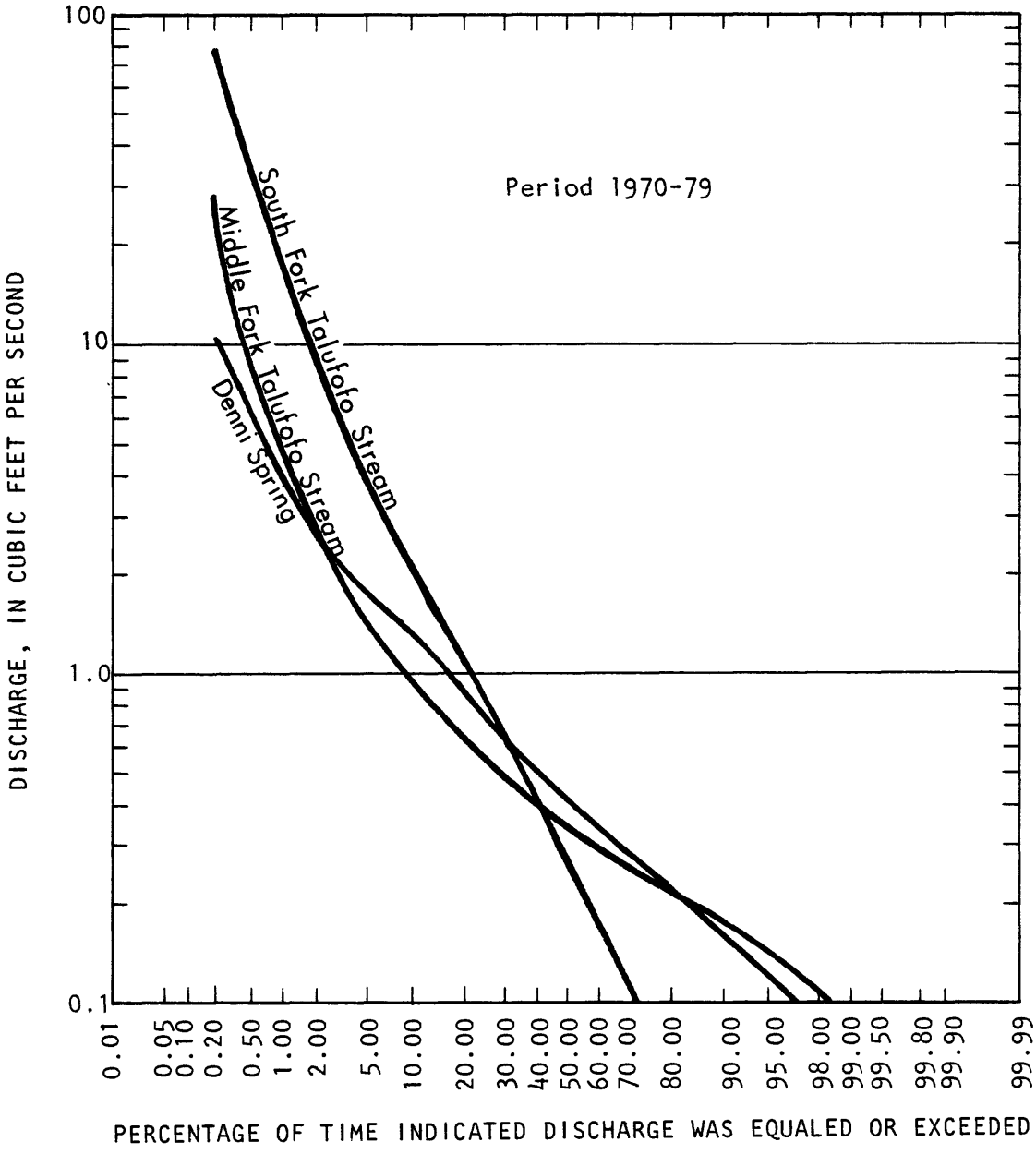


Figure 6. Flow-duration curves for continuous-record stations.

Low-flow frequency curves.--Low-flow frequency curves show the lowest mean discharge for certain periods of consecutive days. Figures 7-9 show the curves for a number of consecutive days ranging from one day to 120 days for the gaging stations at Denni Spring and on South and Middle Fork Talufofo Streams.

High-flow frequency curves.--High-flow frequency curves show the maximum mean discharge for certain periods of consecutive days and its likelihood of occurrence and also the instantaneous annual peak discharge. Figures 10 and 11 show high-flow frequency curves for South and Middle Fork Talufofo Streams.

High-flow frequency curves provide information needed to determine the size of reservoirs and diversion structures.

Correlation between partial record and continuous record.--The purpose of operating a low-flow partial-record station is to determine the low-flow characteristics of the stream through correlation with concurrent discharges at continuous-record stations. Because of the limited surface runoff on Saipan and, consequently, the lack of streams on the island, only two correlations have been made. These are shown in table 7. By use of the relationships derived in figures 12 and 13, reliable estimates of low-flow discharge at the partial-record stations can be obtained from the known discharge at the nearby gaging station.

Lake Susupe

In 1905, H. H. L. W. Costenoble mentioned two lakes with brackish water on Saipan (Cloud, 1956, p. 12), presumably Lake Susupe and, what is now, a marsh near Muchot Point. (See fig. 5.) Lake Susupe has not changed since 1921 as shown by a Japanese map (M1-6, U.S. Geological Survey files, Honolulu, Hawaii). The size and the depth of the lake varies with the rainfall. Normally, the size of the lake is about 45 acres with an additional 372 acres of surrounding marsh, and the greatest depth is 5.5 ft below mean sea level. The lake receives the runoff from a 2,520 acre basin (Huxel, C. J., U.S. Geological Survey, written commun., 1978) and, as there is no outflow, loses the water only through percolation and evaporation. During periods of extremely heavy rainfall, this will cause flooding of the surrounding areas as happened on Aug. 10-12, 1978, when the lake level rose to 7.6 feet above mean sea level (5.4 ft above the average lake level).

Water from the lake was used during the Japanese Administration for cane washing at the nearby sugar mill in Chalan Kanoa and after the end of World War II for showers, toilet flushing, and fire fighting by American Forces (Davis, 1958).

Chloride concentration in the lake water has ranged from 261 mg/L (milligram per liter), 4 months after the flood of Aug. 10-12, 1978, to 4,800 mg/L in 1983 and normally is much too high for consumption (table 8). On Jan. 23, 1981, the U.S. Geological Survey established a lake-level recording station on the lake. The mean daily maximums and minimums for each month are given in table 9 and the water-level graph in combination with a bar graph of rainfall at Isley Field is shown in figure 14.

For chemical analyses of the lake water see table 10.

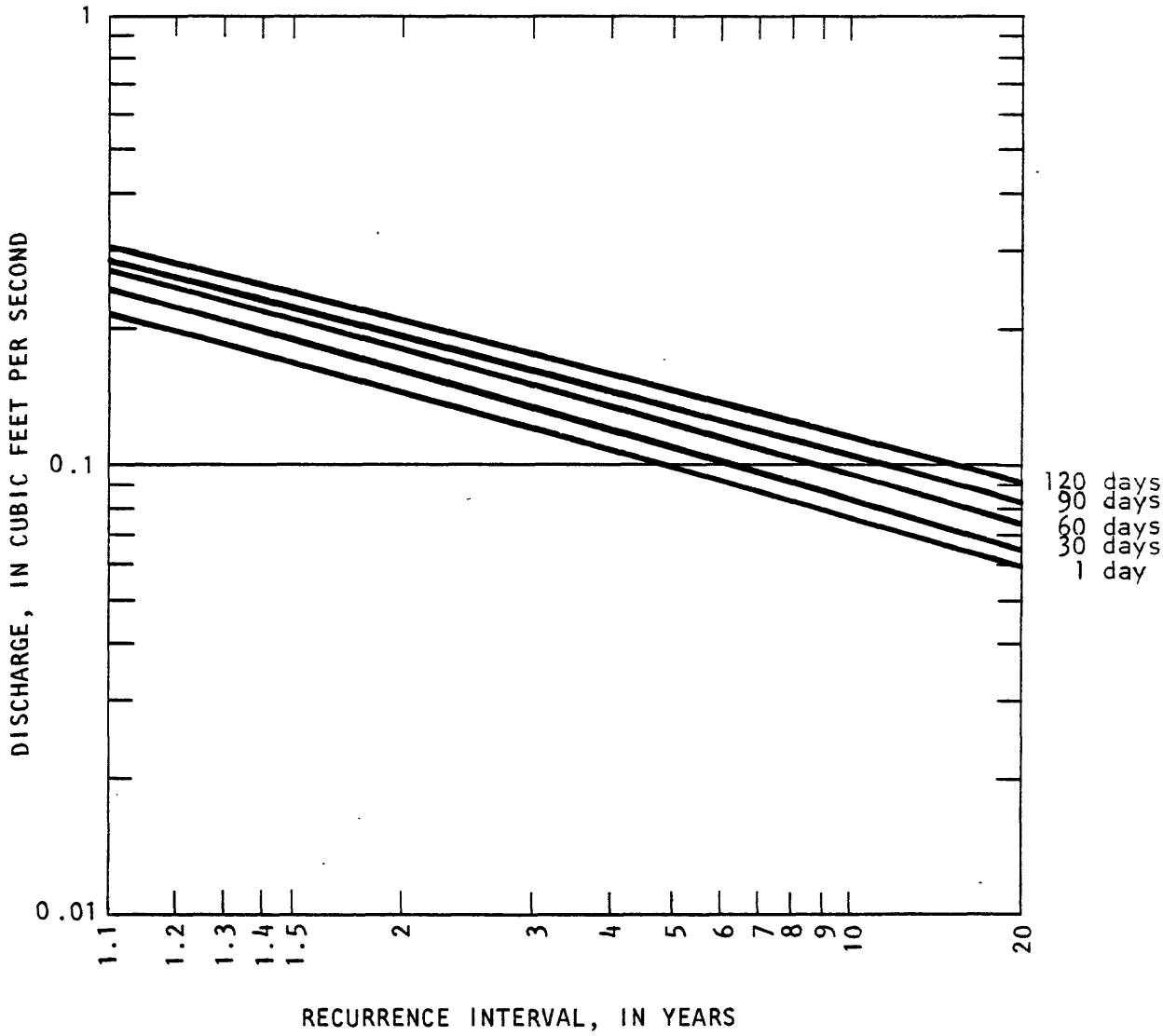


Figure 7. Magnitude and frequency of lowest mean discharges for duration indicated for Denni Spring, 1972-79.

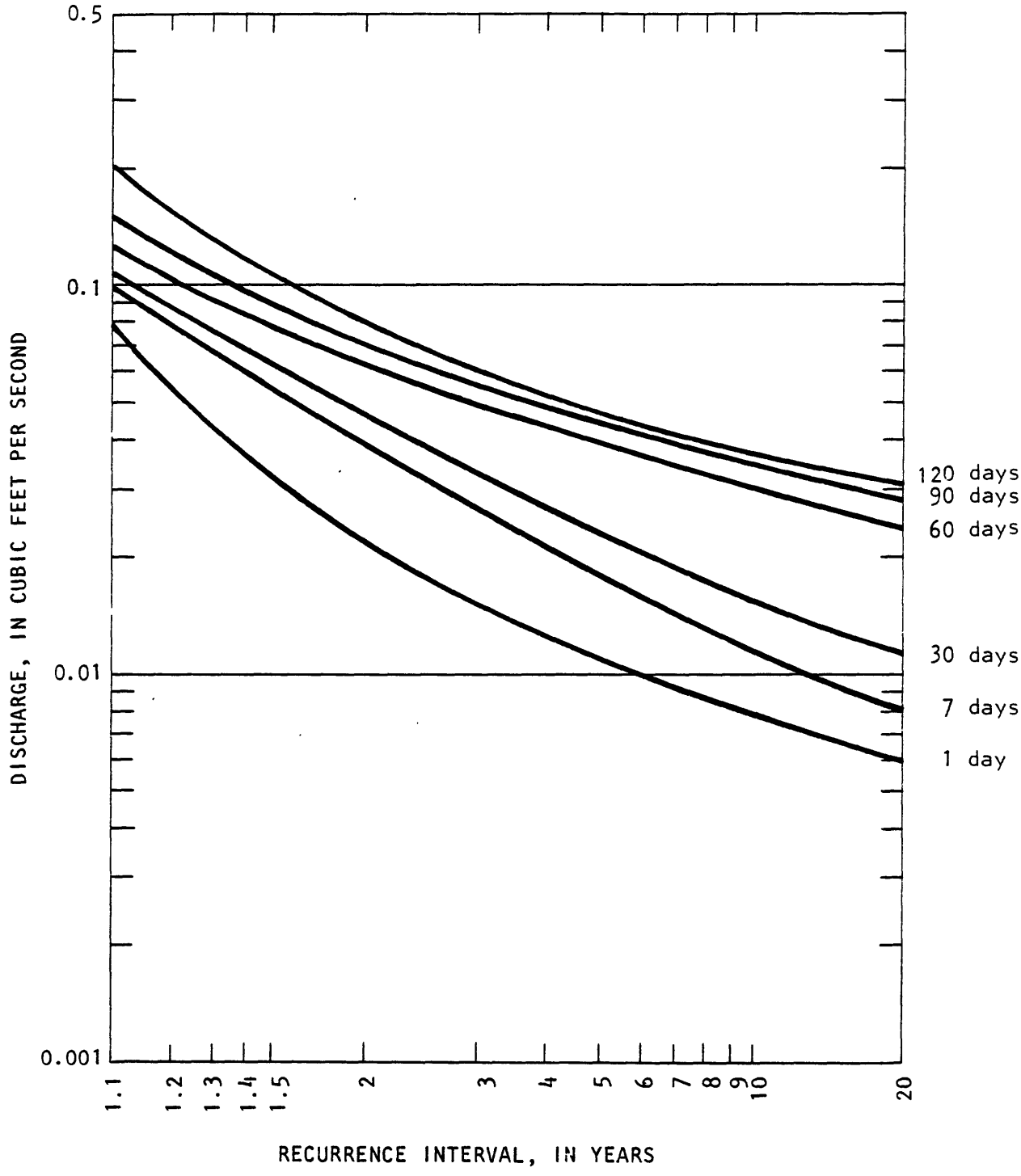


Figure 8. Magnitude and frequency of lowest mean discharges for duration indicated for South Fork Talufofo Stream, 1972-79.

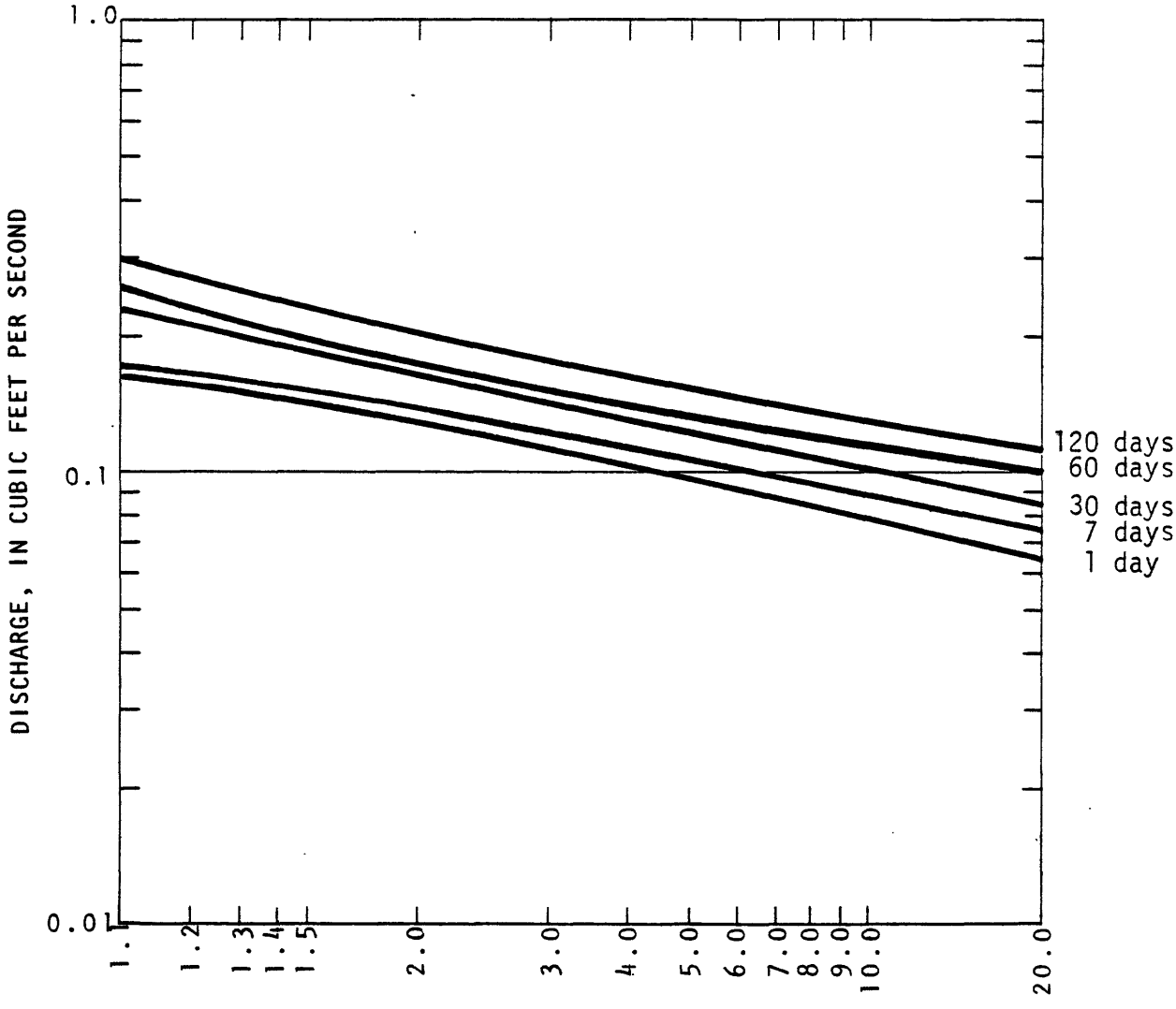


Figure 9. Magnitude and frequency of lowest mean discharges for duration indicated for Middle Fork Talufofo Stream, 1972-79.

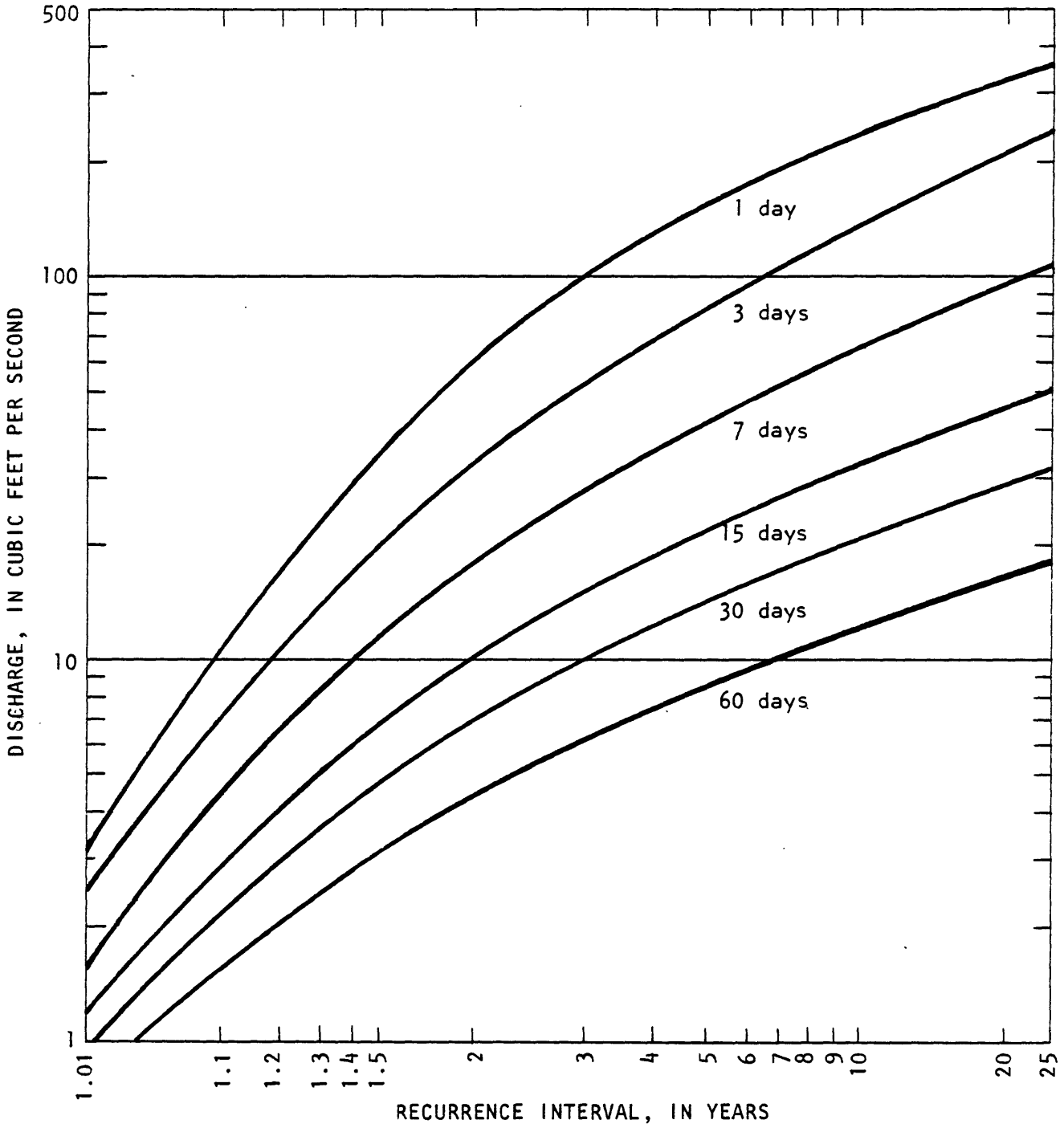


Figure 10. Magnitude and frequency of highest mean discharges for duration indicated for South Fork Talufofo Stream, 1972-79.

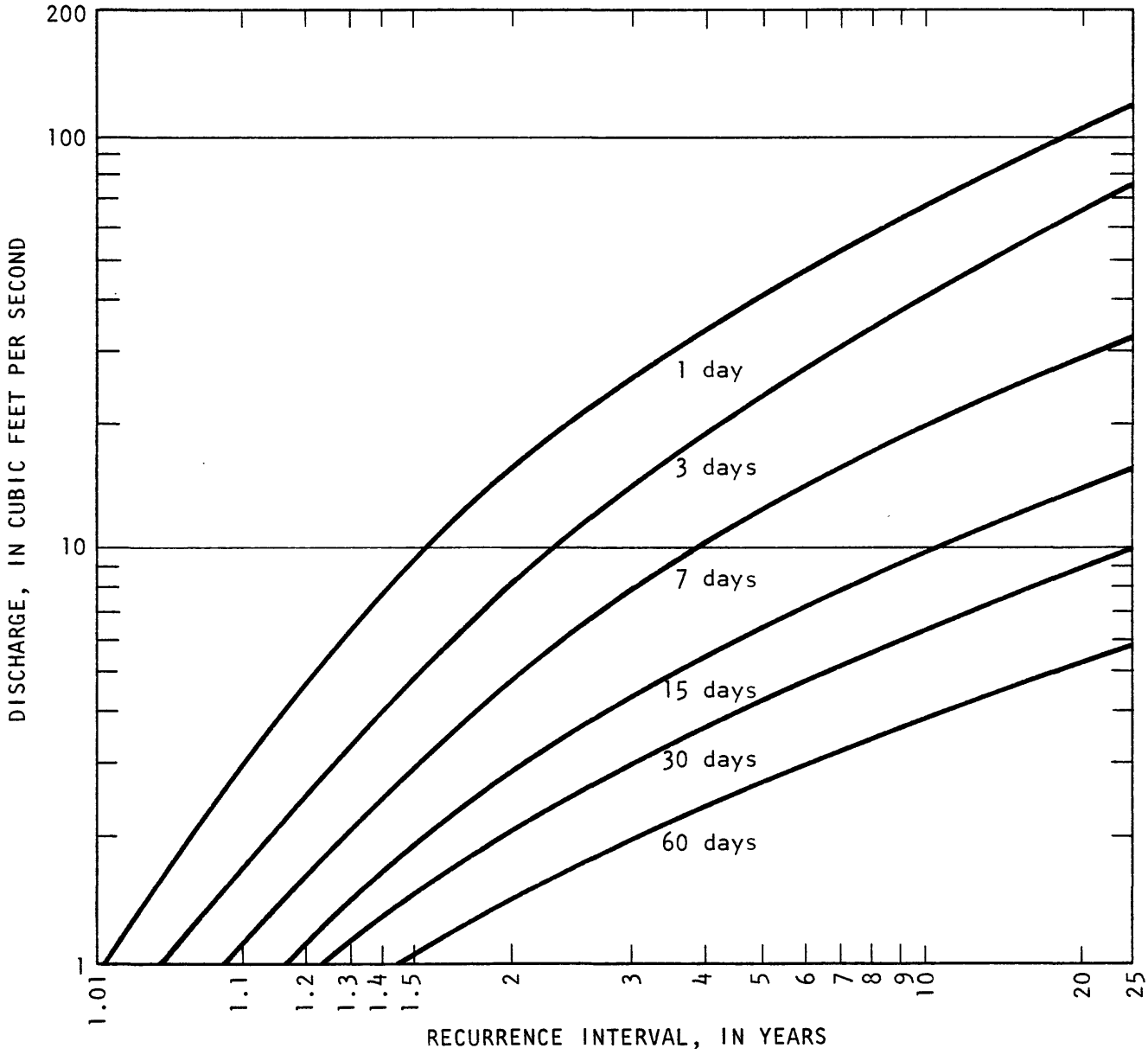


Figure 11. Magnitude and frequency of highest mean discharges for duration indicated for Middle Fork Talufofo Stream, 1972-79.

Table 7. Correlation between discharges at low-flow partial-record and continuous-record stations

[Y, discharge at partial-record station; X, discharge at continuous-record station]

Partial record station	Drainage area (mi^2)	Continuous record station	Drainage area (mi^2)	Number of observations	Correlation coefficient	Standard error (percent)	Regression
Hasngot Stream.	0.45	Middle Fork Talufofo Stream.	0.28	68	0.93	0.14	$Y=0.448X^{1.260}$
Talufofo Stream.	1.43	Middle Fork Talufofo Stream.	.28	60	.90	.33	$Y=2.128X^{2.358}$

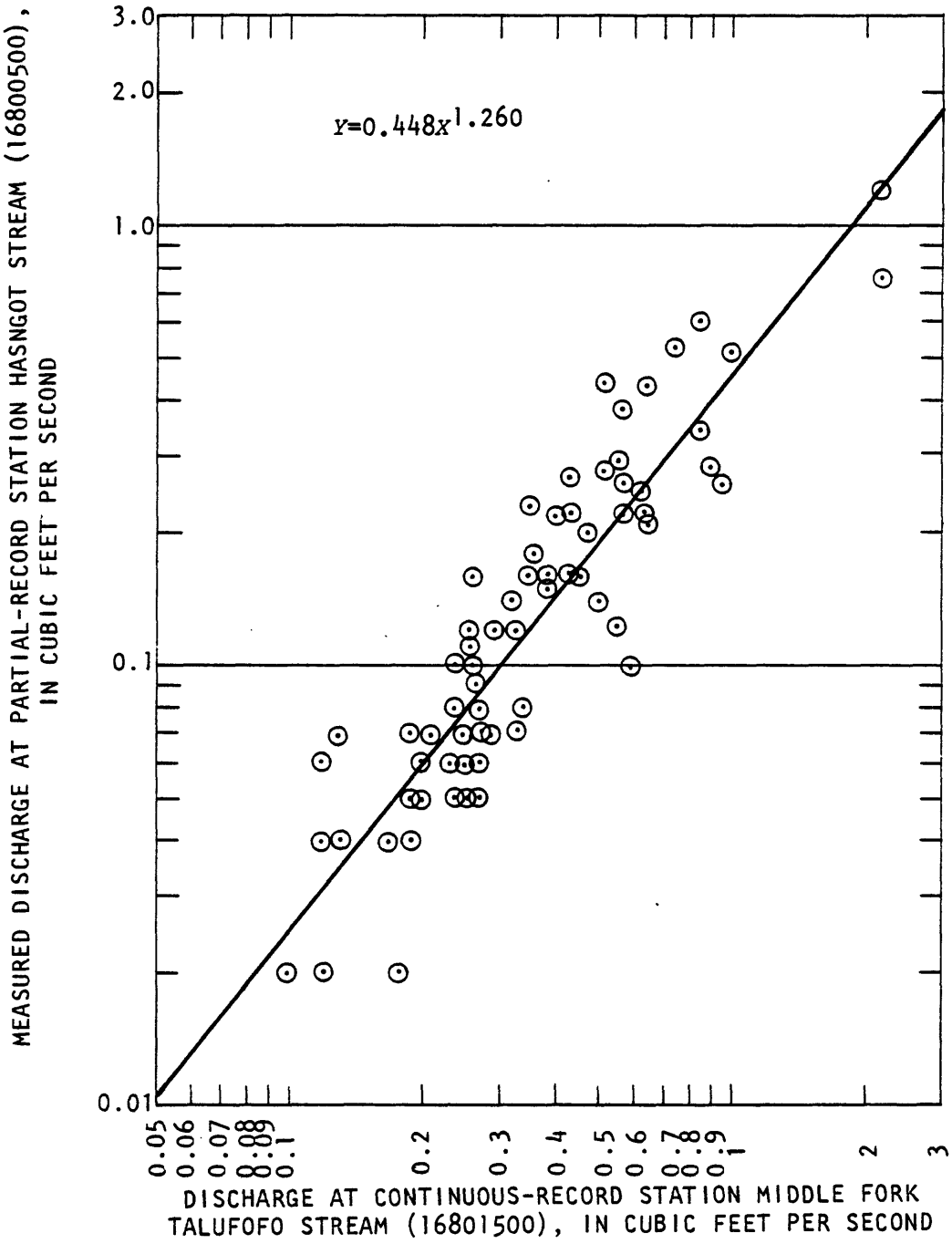


Figure 12. Correlation between discharges at Hasngot Stream and Middle Fork Talufofo Stream.

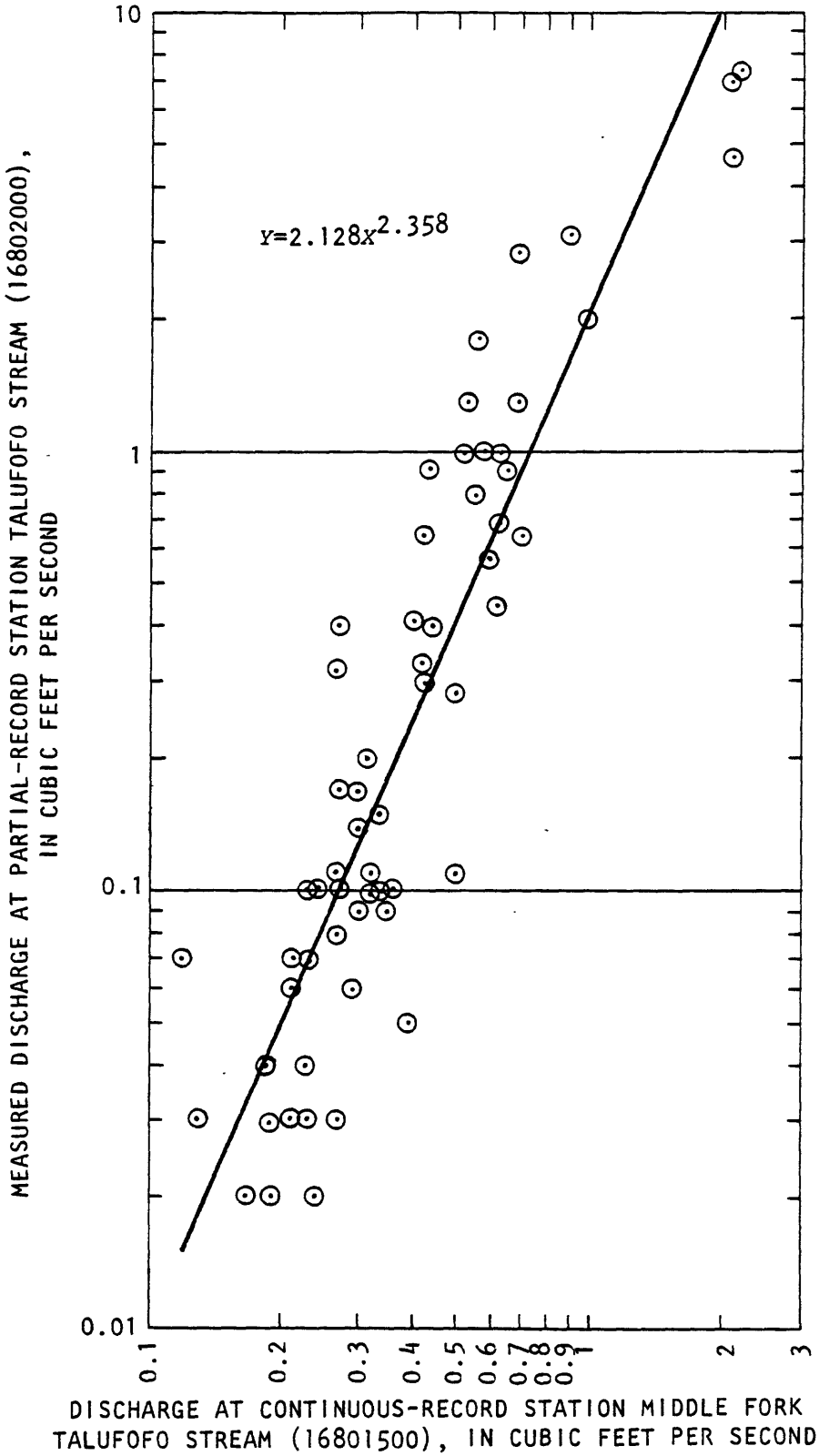


Figure 13. Correlation between discharges at Talufofo Stream and Middle Fork Talufofo Stream.

Table 8. Chloride concentration and specific conductance of water from Lake Susupe

[ppm, parts per million; mg/L, milligrams per liter; µmho, micromho per centimeter at 25° Celsius]

Date	Time	Chloride (ppm or mg/L)	Specific conductance (µmho)	Remarks
Aug. 19, 1944	--	821	--	Water leading from lake to the sugar mill after heavy rain (H. T. Stearns, written commun., Sept. 9, 1944).
July 7, 1956	1400	4,676	--	At pier on west side of lake (Cox, 1956).
1967	--	1,715	--	Austin, Smith and Associates, 1972.
September 1976	--	924-941	--	Shallenberg and Ford, 1978.
September to November 1976.	--	--	2,180-2,900.	12 samples, excluding one sample of 600 µmho (Shallenberg and Ford, 1978).
Dec. 17-22, 1978	--	[1/] 261-316	--	pH 7.6-8.6 (U.S. Army Corps of Engineers, 1981).
June 20, 1980	--	3,400	10,200	U.S. Geological Survey.
May 21, 1981	1000-1300.	2,033-2,144.	--	U.S. Army Corps of Engineers, 1981.
Aug. 28, 1981	0930	1,200	3,500	U.S. Geological Survey.
Aug. 19, 1982	0920	1,900	6,180	Do.
Nov. 19, 1982	1000	760	2,600	Do.
July 1, 1983	1545	4,600	14,000	Do.
Sept. 9, 1983	1250	4,800	14,800	Do.

[1/] Four months after August 1978 flood. Three samples each at surface, at 3-ft depth, and at bottom taken at 0630, 1200, and 1730 hours.

Lake Susupe Lake-level Recording Station

Location: Lat 15°09'15" N., long 145°42'42" E., on west side of lake.

Period of record: February 1981 to December 1983.

Gage: Water-level recorder. Zero of gage is mean sea level.

Remarks: Records good.

Extremes for period of record: Maximum gage height, 4.61 ft, Oct. 19, 1982; minimum, 0.70 ft, June 13, 1983.

Extremes outside the period of record: Stage of 7.6 ft above mean sea level on Aug. 12, 1978, was highest level in memory of local residents.

Table 9. Monthly and annual maximum, minimum, and mean water levels of Lake Susupe, in feet above mean sea level

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1981													
Max.	--	2.18	1.89	1.60	1.47	1.28	2.73	4.37	3.55	2.71	3.07	2.76	--
Min.	--	1.84	1.55	1.45	1.22	1.20	1.25	3.02	2.62	2.46	2.39	2.46	--
Mean	--	2.05	1.74	1.51	1.36	1.24	1.59	3.69	2.85	2.61	2.65	2.59	--
1982													
Max.	2.75	2.69	2.30	2.23	1.85	2.38	3.14	3.10	2.56	4.55	2.75	2.11	4.55
Min.	2.30	2.24	2.08	1.85	1.65	1.50	2.28	2.53	2.20	2.18	2.08	1.74	1.50
Mean	2.55	2.45	2.17	2.04	1.73	1.74	2.48	2.71	2.38	3.14	2.39	1.93	2.31
1983													
Max.	1.73	*1.32	1.15	.94	.87	.79	1.12	2.35	2.28	2.66	2.61	2.37	2.66
Min.	1.33	*1.02	.90	.86	.75	.71	.80	1.07	2.12	2.24	2.38	2.15	.71
Mean	1.50	*1.14	*1.02	.89	.80	.74	.97	1.90	2.18	2.47	2.48	2.23	1.53

* About.

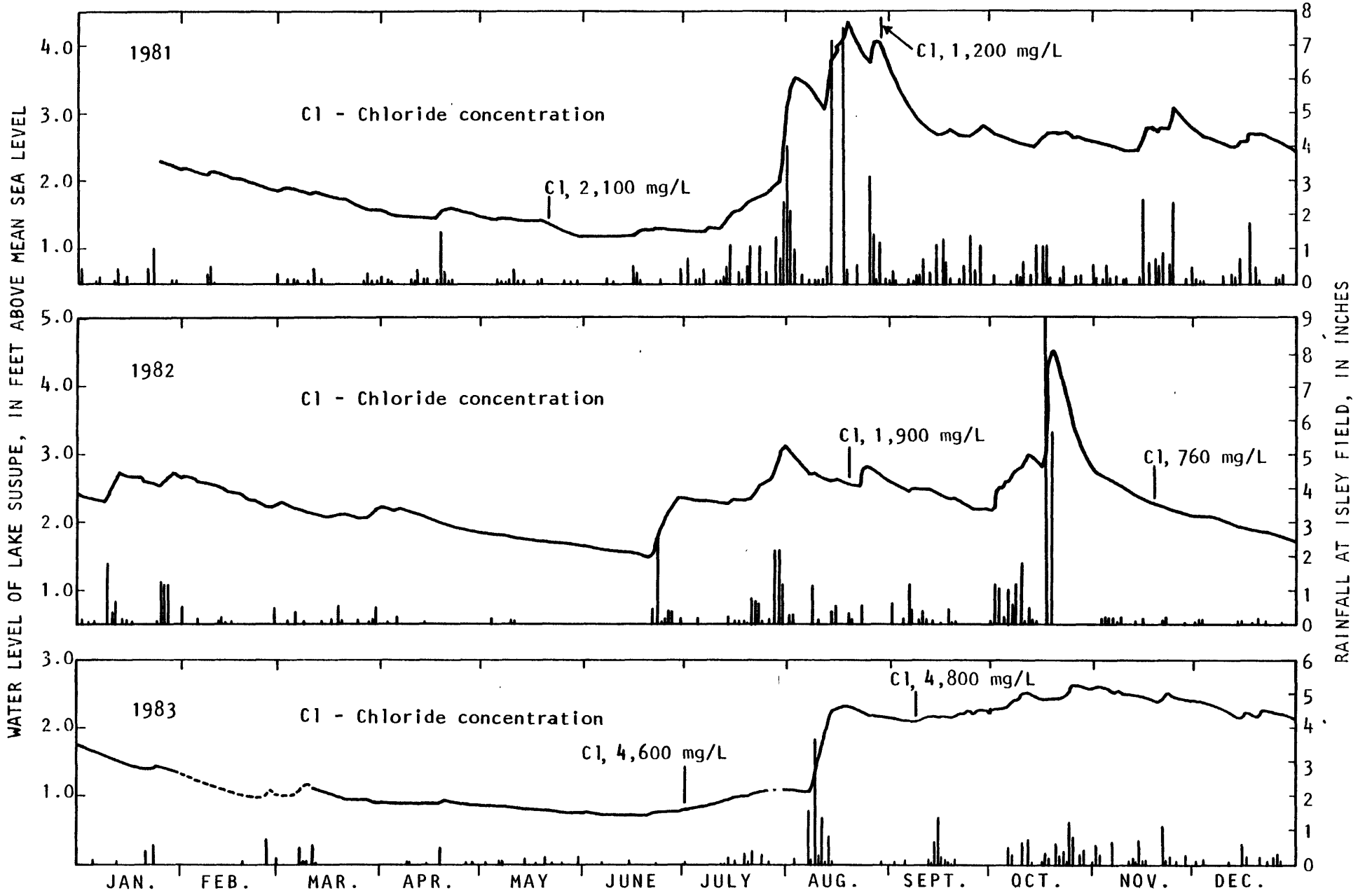


Figure 14. Water level of Lake Susupe and rainfall at Isley Field (1981-83).

Table 10. Chemical analyses of water from Lake Susupe

[µmho, micromhos per centimeter at 25° Celsius; NTU, nephelometric turbidity units; mg/L, milligrams per liter; µg/L, micrograms per liter]

Constituent			Date	1967	8-28-81	11-19-82
			Time	--	0930	1000
			Analyses by	1/	USGS 2/	USGS 2/
Specific conductance	µmho			--	3,500	2,600
pH	--			8.6	7.8	7.8
Temperature, water	°C			25	28.0	28.0
Turbidity	NTU			20	1.8	--
Hardness as $CaCO_3$	mg/L			3/ 728	480	350
Noncarbonate hardness	mg/L			--	380	230
Calcium, dissolved (Ca)	mg/L			104	70	55
Magnesium, dissolved (Mg)	mg/L			113	75	51
Sodium, dissolved (Na)	mg/L			--	630	410
Percent sodium	percent			--	73	71
Sodium adsorption ratio	--			--	12	10
Potassium, dissolved (K)	mg/L			--	27	14
Alkalinity, total as $CaCO_3$	mg/L			4/ 180	100	116
Sulfate, dissolved (SO_4)	mg/L			--	70	85
Chloride, dissolved (Cl)	mg/L			1,715	1,200	760
Fluoride, dissolved (F)	mg/L			--	.1	<.1
Silica, dissolved (SiO_2)	mg/L			--	7.2	4.7
Solids, dissolved, sum of constituents	mg/L			3,745	2,140	1,450
Nitrogen, dissolved (NO_2+ NO_3)	mg/L			--	.01	<.1
Iron, dissolved (Fe)	µg/L			133	60	20
Manganese, dissolved (Mn)	µg/L			--	80	10

1/ Reported in Austin, Smith and Associates, 1972. Date and laboratory not given.

2/ U.S. Geological Survey Laboratory, Denver, Colorado.

3/ Total hardness as $CaCO_3$.

4/ Methyl orange alkalinity.

Springs

There are many perennial springs on Saipan but not all were significant enough to warrant development (table 11 and fig. 15). During the Japanese Administration and after the occupation of the island by U.S. Forces, many of the springs were in use but at present only water from Denni Spring and the Tanapag Springs is utilized. The springs on Saipan can be placed in three groups:

1. Springs on the east flank of Mount Takpochau; they issue from limestone or limestone-volcanic sediment lying on a less permeable layer of rock (Mink, 1977).
2. Springs originating in the dissected volcanic upland south of Mount Achugao; an area of high-level ground water with springs on the west and the east flanks.
3. Basal springs.

Springs located on the east flank of Mount Takpochao are Denni Spring, Natural Bridge Springs, and Nicholson Spring. The largest high-level spring (altitude, 261 ft) on the island is Denni Spring which was a major source of water during the Japanese Administration and is still an important source today. A concrete chute leads the water from the spring area which is enclosed by a low concrete wall and covered by a shed, to a 6,000 gallon sump. From here, the water is pumped to the main line on Capitol Hill. The U.S. Geological Survey has recorded the yield of the spring during 1952-54 and 1968-82. Daily spring flow has averaged 0.65 ft^3/s during the 14 years of complete record (1953, 1970-82). The minimum daily discharge during the periods of record was 0.02 ft^3/s on Sept. 16, 17, 1969. Monthly and annual discharges are given in table 63 in the Hydrologic Data section.

About 2,000 feet northwest of Denni Spring is a small spring, called Denni Spring No. 2, at an altitude of about 350 ft. This spring was never developed and goes dry during the dry season.

The Natural Bridge Springs are located south of the road to Denni Spring. Spring No. 1, at altitude 390 ft, was never developed and its capacity was estimated at 5,000-10,000 gal/d (Glander, 1946). Spring No. 2, at altitude of 420 ft, was only used in 1946 as a source of raw water in the U.S. Marine camp nearby. Ted Arnow (written communication to High Commissioner, Nov. 3, 1952) estimated a minimum dry season yield of 3,000 gal/d.

Nicholson Spring, a small high-level spring along the south side of the Cross Island Highway at the Hakmang road intersection at an altitude of 540 feet, is too small to be developed. The water was used locally during the Japanese era and in 1944-45 to supply U.S. troops. Chloride was reported as 40 ppm (parts per million) and pH as 7.0-7.2 (Glander, 1946). Use of the springwater was discontinued in 1945 when the water was no longer needed.

Most of the springs on Saipan issue from the volcanics and limestone of northern Saipan. On the east flank flow two small springs which were never used (Radio Hill Springs No. 3 and 4), and East Achugao Spring. East Achugao Spring was developed by American Forces and the discharge was measured as 0.05 ft^3/s on July 2, 1956 (Cox, 1956). Between 1965 and 1974, the Geological Survey made 68 discharge measurements of the East Achugao springflow. (See table 67.) The measurements range from 0 to 0.85 ft^3/s and average 0.125 ft^3/s.

Table 11. List of the major springs on Saipan

Name of spring	Location			Aquifer	Remarks
	Latitude north	Longitude east	Altitude (ft)		
Nicholson Spring (Bobo Papago).	15°10'58"	145°45'15"	540	Limestone	Developed during Japanese Administration and used during 1944-45.
Natural Bridge Spring No. 1. (Bobo As Teo No. 1).	15°11'30"	145°45'35"	425	do.	Never developed.
Natural Bridge Spring No. 2. (Bobo As Teo No. 2).	15°11'27"	145°45'36"	395	do.	Not developed, used for raw water during 1945 by U.S. Marines.
Denni Spring (Bobo I Denne).	15°11'48"	145°45'32"	261	Limestone on sedimentary rock.	Major water source since Japanese Administration.
Denni Spring No. 2	15°11'59"	145°45'38"	475	do.	Never developed.
Radio Hill Spring No. 1	15°13'25"	145°45'16"	500	Volcanic sediment	Developed during Japanese Administration.
Radio Hill Spring No. 2	15°13'57"	145°45'45"	350	do.	Enclosed in concrete cistern.
Radio Hill Spring No. 3	15°13'47"	145°46'11"	575	do.	Never developed.
Radio Hill Spring No. 4	15°13'44"	145°46'06"	400	do.	Do.
East Achugao Spring (Bobo Achugao Hava).	15°13'54"	145°46'32"	320	Limestone	Enclosed in concrete cistern.
West Achugao Spring (Bobo Achugao Lagu).	15°14'11"	145°45'51"	270	Sandy marl	Do.
Tanapag Spring No. 1 (Bobo Agatan).	15°13'49"	145°45'10"	115	Andesite lava	Do.
Tanapag Spring No. 2 (Bobo Mames).	15°13'59"	145°45'15"	60	do.	Do.
Starch Factory Springs	15°13'29" 15°13'28"	145°44'13" 145°44'16"	5 5	Limestone	Water not potable due to high salinity.

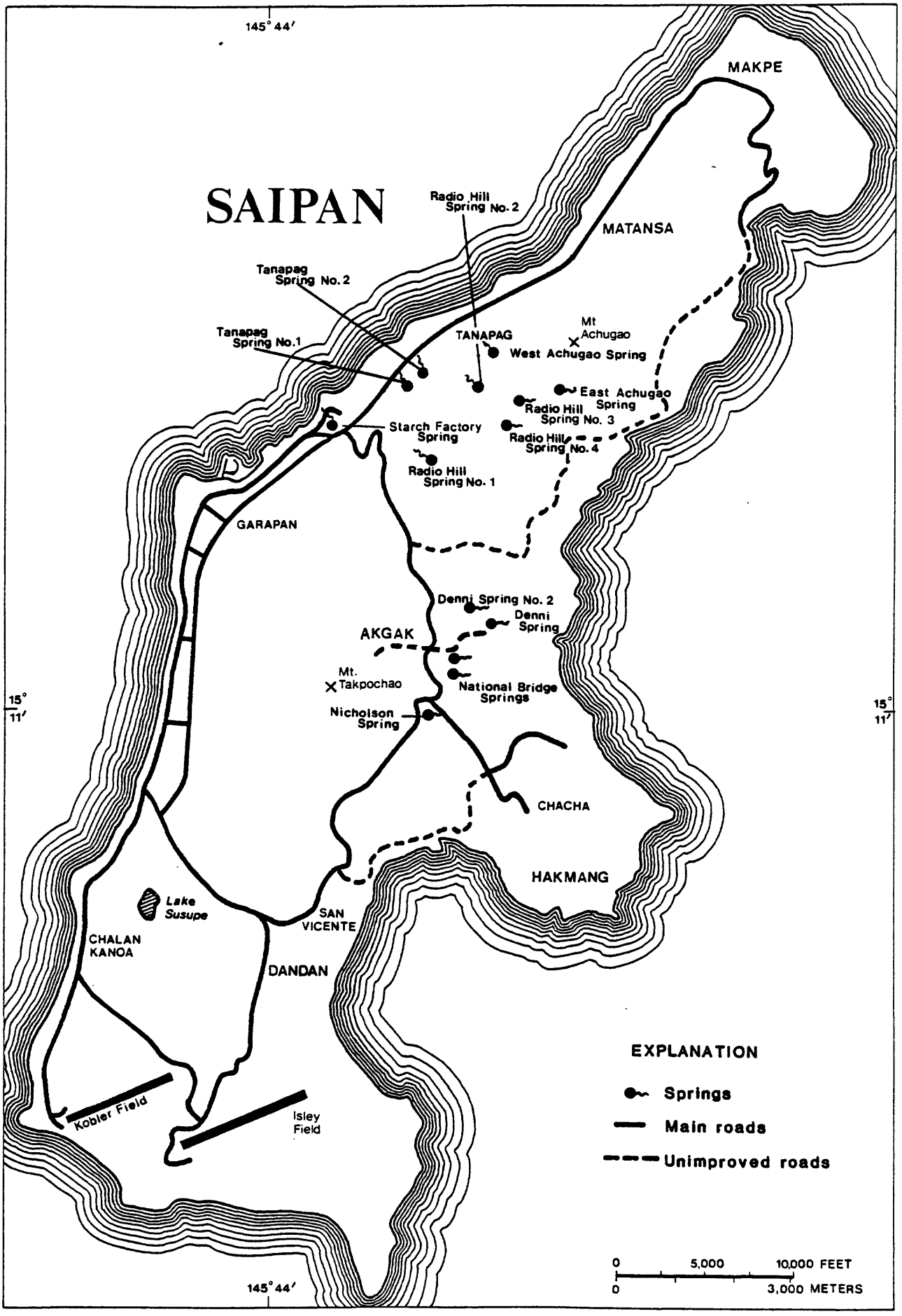


Figure 15. Location of major springs.

On the west flank several springs occur. The largest are Tanapag Springs No. 1 and 2, which continue to contribute to the water-supply system. Prior to the drilling of wells 8a and 8b, the yield of Spring No. 2 was measured on July 20, 1944, as 54,000 gal/d and of Spring No. 1 on Aug. 18, 1944, as 36,000 gal/d. Spring No. 1 (Mink, 1977, calls it Spring No. 2) now is mostly artesian water flowing from old well 8a since the well was drilled in the spring in September 1944. Piper (1946-47) estimated the flow from the springs to be 40,000 to 100,000 gal/d. The spring water is pumped to the 200,000 gallon As Mahettok (Tanapag or Tasa) reservoir at altitude 225 ft.

The water of West Achugao Spring, at altitude 265 ft, was stored in a 20,000 gallon reservoir at altitude 233 ft before entering the central water system. Between 1967 and 1972, the Geological Survey made 57 discharge measurements of the spring yield. The measurements varied from a low of 0.01 ft^3/s on Sept. 19, 1969 to a high of 0.43 ft^3/s on Feb. 6, 1970. (See table 68.) Mean of measurements made during the 1969 water year was 0.05 ft^3/s; during 1970, 0.15 ft^3/s; and during 1972, 0.18 ft^3/s. Mean of all measurements was 0.14 ft^3/s and the median 0.09 ft^3/s. The spring water is no longer used.

Also on the west flank two minor spring occur, Radio Hill Spring No. 1 and 2. Spring No. 1 was used during the Japanese Administration and Spring No. 2 during the early years of the American Administration. Maximum yield of each spring was estimated at 30,000 gal/d (Piper, 1946-47).

The only significant basal springs on Saipan are the Starch Factory Springs. The yield of the springs has never been measured as the springs discharge at several places and only slightly above sea level in a swampy area. During the Japanese Administration, some of the spring water was piped to a starch factory in an industrial area where the Tanapag docks are now located. The water has not been used since because of the high chloride concentration of the water: 1,200 ppm, June 16, 1980 and Sept. 27, 1982 (discharge about 2 Mgal/d, Nance, 1982).

For more data of the springs, see the Hydrologic Data section.

Ground Water

General

In "Military Geology of Saipan, Mariana Islands, Volume II, Water Resources", Dan A. Davis (1959) describes the occurrence of ground water as follows:

> In an island of uniform and favorable permeability, some of the rain water moves downward to the water table and accumulates as basal ground water forming a buoyant though not static mass floating on the sea water in the rocks below sea level. Ideally this fresh-water body has the shape of a double-convex lens, the edge approximating the shoreline of the island. The upper surface of the water is only slightly above sea level but the lower surface extends below sea level several times the height of the upper surface above sea level. Recharge of fresh water from rainfall takes place uniformly over the top surface of the lens; discharge occurs only in a relatively narrow zone around the shore.

If the rate of recharge were constant the height of a lens above sea level, the thickness, and the rate of discharge would be constant except for variation caused by sea-level fluctuations. An increase in recharge rate would cause a rise in head, or height, followed by increases in thickness of the lens and rate of discharge. If the rate of recharge should drop, head, thickness, and discharge rate also would drop to new conditions of stability. If recharge should cease, discharge would continue at a diminishing rate and the lens would decay. Actually, the rate of recharge fluctuates with variations in rainfall; consequently, a basal lens is never at rest, and head, thickness, and discharge continually react to changes in the rate of recharge.

Tidal fluctuations in sea level and fluctuations in the thickness of a lens cause movement and mixing at the interface between fresh and salt waters and the formation of a brackish transition zone. The thickness of the zone depends, to a considerable degree, on the permeability of the rock. For example, in highly permeable material, even though fluctuations are moderate, the zone of transition may grow until it extends throughout the thickness of the lens, making the entire 'fresh water' lens brackish.

In Saipan rock permeability is far from uniform. The volcanic rocks and the sedimentary rocks derived from them, which form the bulk of the island, have generally low permeability but variations are common. Limestones, the most widespread rocks on the surface, have generally high permeabilities, but permeabilities vary greatly in short distances. In places, sandstone and tuffaceous members and limestone facies of low permeability act as confining members rather than aquifers.

Because of their low permeability the volcanic rocks and associated sedimentary rocks, as a whole, are not good water-bearing materials even though they probably contain large quantities of high-level ground water in small pores and cracks. In places the volcanic rocks supply springs, seeps, and a few wells, but in general little water is available to any single installation. These rocks, in one locality, act as a perching member under permeable limestone and hold up a considerable quantity of recoverable high-level ground water.

Large quantities of ground water occur as basal water in limestones that extend below sea level. The quality of the water is variable, however, and much of it is too saline for human consumption. The best quality water is in rubbly unconsolidated limestone which transmits water equally well in all directions. In dense consolidated limestones the principal openings transmitting water are solution channels or fissures which are large compared with intergranular openings in the rubbly rocks. The length of these openings is usually many times greater than the width and many of them are so deep that they form conduits through which considerable sea water can move laterally and upward in response to small head differences.

Ocean tides apparently are felt throughout the basal ground-water bodies in the limestone, and, because of high permeabilities, these tidal fluctuations have produced wide zones of transition between fresh and salt waters. In limestone having deep fissures, the transition zone commonly extends throughout the basal-water body, and water at the top of the lens is generally too salty for drinking although it may be considerably less salty than sea water. In much of the rubbly limestone the zone of mixing does not extend as high and ordinarily the water at and near the top is of fair to good quality.

Areal and vertical variations in permeability in the limestones, and accompanying variations of sea-water intrusion, produce irregular and usually unpredictable patterns of salinity in the basal-water bodies of Saipan. Probably the most nearly consistent feature is a generally increasing freshness of water with distance inland from the shore; however this is not invariable and in places may consist only of a change from highly saline to slightly less saline water.

In the Chacha area of east central Saipan dipping permeable limestone beds are overlain above and below sea level by less permeable facies of the same formation. The confining effect of the beds of low permeability has produced artesian conditions, and because the escape of water from the permeable rock is retarded, the basal-water body has greater height above and depth below sea level than the basal water in unconfined rocks.

Near the shore of the island, beaches and coastal flats are underlain by calcareous sands and detrital deposits which generally have moderate to high and rather uniform permeabilities. These materials contain basal ground water, but generally of high salinity.

When undisturbed by removal of water from wells and tunnels, the basal ground-water bodies are in a state of dynamic equilibrium with prevailing conditions of recharge, permeability, and sea-level fluctuation. When pumping begins, the effect is equivalent to a decrease in the rate of recharge and the lens tends to adjust itself to the new set of conditions. If the artificial removal of water could be uniform over the surface of the basal water, the adjustment would consist of generally uniform reduction in head and thickness of the fresh-water body and decline in rate of natural discharge. In practice however, much of the disturbance created by pumping is concentrated in a relatively small area at the well or tunnel, and, although general adaptation to new conditions takes place, local changes in the flow pattern of the water are the major problem. It is these local changes that cause the rapid and sometimes ruinous encroachment of sea water into wells and tunnels.

Experience has shown that, for a given rate of pumping, the most rapid and intense salt-water encroachment occurs when the pumping is concentrated at a point such as a drilled well. Encroachment is least serious when the removal of water is spread over a wide area by means of tunnels having inverts just below the water table.

Wells

About 75 percent of Saipan is covered by limestone (Mink, 1969), where a basal lens of freshwater floats on ocean water near sea level. Of the wells drilled on the island most try to obtain water from this lens without drawing in the ocean water. On Saipan the height of the water table in the basal lens is less than 2 feet above sea level (Mink, 1977), thus the freshwater is easily contaminated by the underlying seawater. The chloride in one percent of seawater mixed with the freshwater, will be sufficient to reach the upper limit of the desirable range of chloride in drinking water.

As far as known, no wells were drilled on Saipan during the Japanese Administration. Although the island was an agricultural and light commercial center and supported a fairly large Japanese population (in excess of 20,000) besides the much smaller original population (about 4,000), the water supply depended on water from springs, rain catchments, and shallow dug wells. Tayama (1939) listed 1,125 shallow wells, most of them supplying individual homes. The chloride concentration of many wells exceeded 1,000 mg/L.

Two large dug wells, As Gonna A and B, were continued in use by U.S. Forces at first, but only As Gonna B was used for any length of time, contributing water to the Isley Reservoir until about 1950.

After the military occupation of the island by American Forces, more than 70 wells were drilled in 1944-45 to supply water for a large number of American troops stationed on Saipan. The majority of these wells were drilled in limestone aquifers to tap the basal lens; only two of these were still in use in 1956 and both were still in use in 1983 (Maui I and IV). Some wells encountered impermeable rock and were not completed and some were abandoned when no longer needed for their specific use. Often, the wells were pumped until the chloride concentration of the water rose to unacceptable levels after which the wells were abandoned. The main exception was the Akgak well field where high-level water of good quality was found. (See fig. 23.) This well field is still being used today although the old wells were replaced by new ones of the same designation in 1969-71, and most of these, in turn, were replaced in 1977.

Maui I and IV were the two most successful wells on Saipan. Maui-type wells consist of a shaft with infiltration tunnels at the base. Water from the tunnels drain into a sump at the base of the shaft.

During 1945-46, U.S. Military Forces constructed four of these Maui wells. Of the four wells, Maui I and IV have been in use since they were constructed although Maui I was dry during January to June 1983. Maui II was dug trying to intercept the Starch Factory Spring source before the water mixed with saltwater. The well was used from October 1945 until March 1950 when the tunnel caved in. The chloride concentration averaged about 400 mg/L. Maui III was constructed to intercept artesian flow in the Hakmang area, but no water was encountered and the shaft was abandoned before the tunnels were dug.

Maui I has yielded up to 1 Mgal/d at times but the high pumping rate caused a steep increase in chloride concentration of the water. In the early 1950's, Maui I and IV supplied almost all the water for the island. The production of the two wells averaged 430,000 gal/d in 1952, 502,000 gal/d in 1953, and 437,000 gal/d in 1954, with Maui I supplying about 75 percent of the total. The production of Maui IV has been decreased during the last few years to reduce the chloride concentration of the water. Both wells have structural problems and may have to be abandoned in the near future. Beginning in July 1982, the water level in Maui I began to drop until at the end of 1982 the level had dropped about 2 feet, the infiltration tunnels had dried up, and the well could no longer be used.

This was the first time Maui I dried up and it was assumed at the time this was caused by pumping of the nearby new Isley well field. There, since July 1982, the wells have produced at least 800,000 gal/d. However, at the end of the dry season in July 1983, the water level in Maui I rose a foot and pumping could be resumed. Apparently, the changes in water level were caused by differences in ocean levels.

Results of chemical analyses of Maui wells are given in table 75 in the Hydrologic Data section. For the location of the wells see figures 19 (Maui I), 26 (Maui III), and 31 (Maui II, IV).

Between 1946 and 1969, only four wells were completed but since then, about 100 additional wells have been drilled to keep up with the rapidly growing demand for domestic water. Many wells have duplicate numbering, and some are known by more than one number. Usually, the well drilling was done by contracts and was, therefore, done during certain periods. The wells can thus be grouped by these periods, which are: 1956-62, 1969-71, 1977, 1979-80, and 1981-83. The well drilling was also concentrated in certain areas and it was preferred to group the wells by area rather than by period. In section II of this report, all available information including drilling logs, water-quality data, water levels, and pumping tests of all wells on Saipan, are given by the areas shown on figure 16.

Continuous water-level records have been collected by the U.S. Geological Survey at well 45 (1981), well 31 (1982) and well 78 (1981-82), and hydrographs of these records are given with the data for those wells.

The division of the island into subareas is not based on a geologic basis but solely on the basis of water-producing areas (fig. 16). Wells drilled in parts of the island not included in these areas (with one exception, only wells drilled in 1944-45) are listed under miscellaneous sites. To ease confusion in the numbering of wells, the Saipan Division of Environmental Quality started in 1982 to assign a three-digit number to new wells placed in production, with the first two digits designating the area.

To facilitate locating well data in this report, the following tables (12 to 17) list all wells by the period when they were completed.

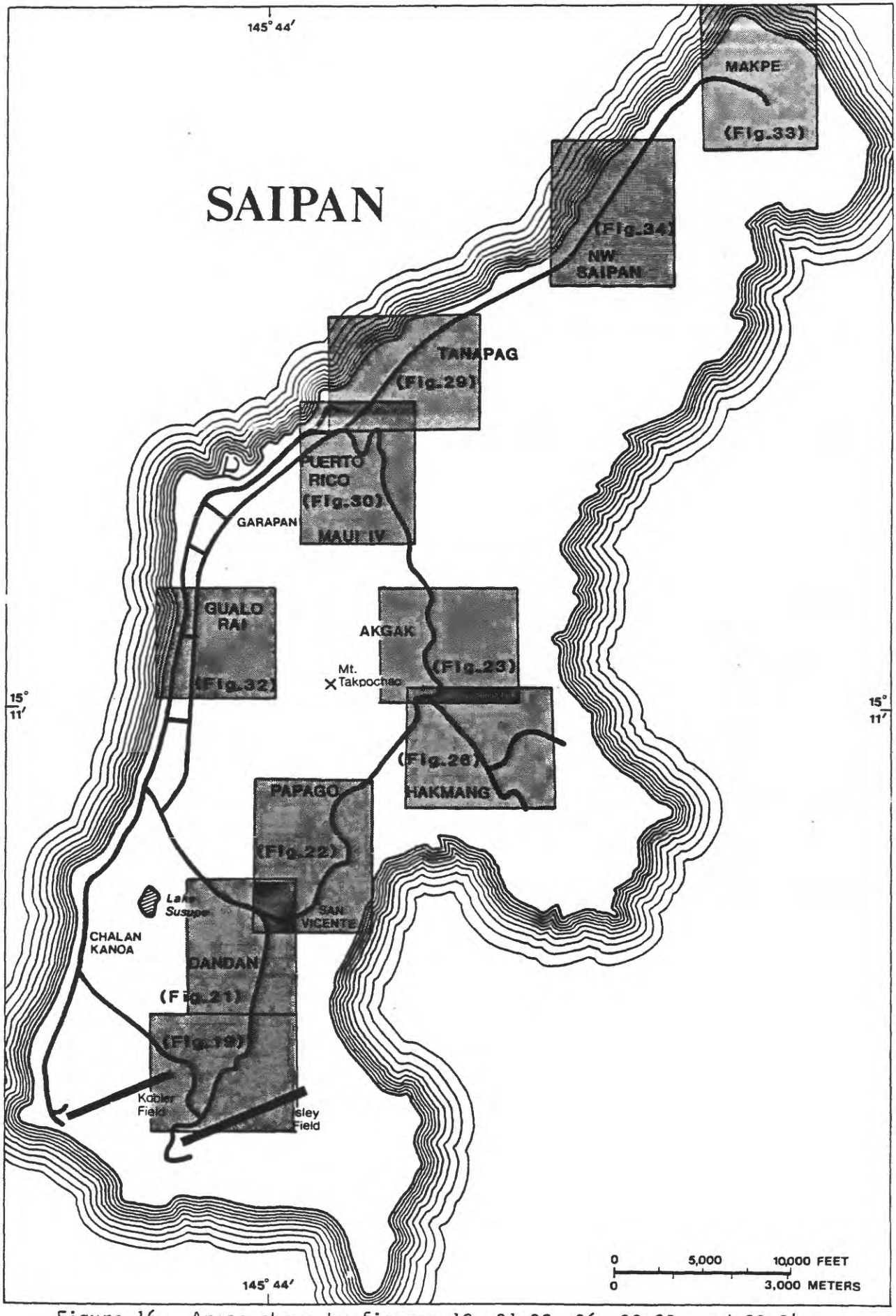


Figure 16. Areas shown by figures 19, 21-23, 26, 29-30, and 32-34.

Table 12. Summary of wells drilled during 1944-45

Well No.	Area listing	Page No.	Remarks
1	Kobler Field	142	Well contaminated with oil.
2	do.	143	Brackish water.
3	Dandan	204	Near hospital.
4	Miscellaneous	479	Near Lake Susupe. High salinity.
5	Hakmang	319	Still in use in 1949.
6	Northwest Saipan	453	At Matansa, N.W. Saipan.
7	Miscellaneous	477	At Kiya, near Lake Susupe.
8A	Tanapag	350	Drilled in Tanapag Spring No. 1.
8B	do.	351	At Tanapag Spring No. 1.
9	Puerto Rico	358	At As Rapugao. Well went dry.
10	do.	359	Production well.
11A	do.	360	Casing broke.
11B	do.	361	High salinity.
12	do.	362	Do.
13	Hakmang	321	Low yield.
14A	Dandan	205	Drill stem lost.
14B	do.	206	Very low yield.
15	Isley Field	75	Production well.
16	Miscellaneous (Garapan).	465	High salinity.
17	do.	466	Salinity increasing when pumped.
18	Hakmang	323	No well log.
19A	Miscellaneous (Garapan).	467	High salinity.
19B	do.	467	Do.
19C	do.	468	Do.
20	Dandan	207	North of hospital well 3.
21	Hakmang	324	Artesian basal water.
22	Isley Field	76	Low yield.
23A	Maui IV area	397	Well bailed dry.
23B	do.	398	Low yield.
24	Hakmang	326	Artesian basal water.
25	do.	327	Do.
26	Makpe	449	Near Makpe (Marpi) Field. High salinity.
27	Northwest Saipan	454	At Matansa. High salinity.
28	Tanapag	352	Well pumped dry.
29	do.	352	Do.
30	Maui IV area	399	Near well Maui IV.
31	Akgak	257	Called old well 31.
32	Makpe	450	Near Makpe (Marpi) Field. Brackish water.
33	Northwest Saipan	454	At Matansa. Well went dry.
34	Miscellaneous	472	At Radio Hill Spring 1, Capitol Hill. Low yield.
35A	do.	471	At Talufofo Hill.
35B	do.	472	Do.
36	do.	473	At Capitol Hill.

Table 12. Summary of wells drilled during 1944-45--Continued

Well No.	Area listing	Page No.	Remarks
37	Tanapag	353	At Tanapag town.
38	Miscellaneous	470	At Kalabera, only well drilled in northeast Saipan.
39	do.	475	North of Mount Takpochao.
42	Akgak	259	Low yield.
43	Miscellaneous	473	At Capitol Hill.
44	San Vicente	234	At Papago, north of San Vicente.
45	Akgak	260	Called old well 45.
46	Kobler Field	144	In use in 1946.
47	Miscellaneous	472	At Talufofo Hill.
48	Akgak	262	Low yield.
49	Kobler Field	145	In use in 1946.
50	Akgak	263	Called old well 50.
51	Maui IV area.	400	--
52	Kobler Field	146	Used short time only.
53	Isley Field	77	No equipment to operate (1946).
54	Kobler Field	147	In use in 1946.
55	do.	148	No equipment to operate (1946).
56	do.	149	Used short time only.
57	do.	149	No equipment to operate (1946).
58	Miscellaneous	474	At Talufofo Stream. Low yield.
59	Isley Field	78	No equipment to operate (1946).
60	Makpe	450	Near Makpe (Marpi) Field. High salinity.
61	do.	451	Do.
62	do.	451	Do.
63	do.	452	Do.
64	Hakmang	329	Used for 3 months till Marines left.
65	Miscellaneous	474	East of Denni Spring. Well was contaminated.
66	Chacha	330	Used for 3 months till Marines left.
67	do.	330	Do.
68A	Puerto Rico	363	At quarry, As Rapugao.
68B	do.	363	Do.
68C	do.	364	Do.
68D	do.	364	Do.
70	Miscellaneous	476	At Chalan Pupulo.
71	do.	476	Southwest of Mount Takpochao.
PW	Northwest Saipan	455	High salinity.
Maui I	Kobler Field	150	Infiltration tunnel.
Maui II	Tanapag	365	Do.
Maui III	Hakmang	331	Do.
Maui IV	Maui IV area	401	Do.

Note: Wells As Gonna A and B, near Kobler Field, are wells dug during the Japanese Administration.
Wells 40, 41, and 69 were never drilled.

Table 13. Summary of wells drilled during 1956-62

Well No.	Year completed	1982 No.	Location (area)	Page No.	Remarks
3 New	1962	3	Dandan	208	Near hospital.
75 Old	1956	--	Akgak	264	--
76	1956	76	Hakmang	332	--
78	1956	--	do.	334	Continuous water-level record 1973-75, 1978, 1981-82.

Table 14. Summary of testholes and wells drilled during 1969-71

Well or testhole No.	1982 No.	Location (area)	Page No.	Remarks
TH Maui-IV-1	--	Maui IV area	406	Converted to well Maui IV-1.
W Maui-IV-1	141	do.	408	--
W Maui-IV-2	142	do.	413	--
W Maui-IV-3	143	do.	417	--
W Maui-IV-4	144	do.	421	--
W Hawaiian Rock	--	Northwest Saipan	456	--
W Austin-Smith	--	Puerto Rico	365	Also called Tanapag well 1.
W 1	--	Isley	78	--
W 5	--	Dandan	211	High salinity.
W 6	6	do.	214	--
W 7	7	do.	217	--
W 8	--	do.	220	Abandoned; colored water.
W 9	9	Kobler Field	154	--
W 10	10	do.	158	--
W 11	11	do.	162	--
W 31 New	--	Akgak	265	Continuous water-level record in 1983.
W 45 New	--	do.	267	Continuous water-level record in 1981-82.
W 50 New	50	do.	273	--
W 75 New	--	do.	279	--
W Agriculture Station	--	Hakmang	336	Supplies Agriculture Station.

Table 15. Summary of testholes and wells drilled during 1977

Well or testhole No.		1982 No.	Location (area)	Page No.	Remarks
TH	IR-1	--	Isley Field	79	Converted to well IR-1.
W	IR-1	IR-1	do.	82	
TH	IR-2	--	do.	85	Converted to well IR-2.
W	IR-2	IR-2	do.	90	
TH	IR-3	--	do.	92	Abandoned.
TH	12	--	Kobler Field	165	Abandoned; cave-in.
TH	12A	--	do.	166	Abandoned; well filled with gummy clay.
TH	15	--	do.	167	Converted to well 15.
W	15	15	do.	169	
TH	16	--	do.	173	Converted to well 16.
W	16	16	do.	175	
TH	17A	--	do.	178	Abandoned; dry hole.
TH	17B	--	do.	179	Converted to well 17B.
W	17B	--	do.	181	Abandoned; conductor casing stuck.
W	17BB	17	do.	181	Called well 17.
TH	17D	--	do.	183	Abandoned; high salinity.
TH	17	--	do.	184	Do.
TH	18	--	do.	185	Abandoned; dry hole.
W	20	--	Dandan	224	Abandoned; hole could not be kept open.
W	20A	--	do.	227	Do.
W	20B	--	do.	227	Do.
TH	21	--	do.	229	Abandoned; small yield.
TH	22	--	do.	230	Converted to well 22.
W	22	--	do.	232	
W	70	70	Akgak	282	
TH	71	--	do.	286	Abandoned; low yield.
W	72	72	do.	288	
W	73	73	do.	290	
TH	Denni Spring	--	do.	294	Abandoned; dry hole.
TH	Capitol Hill	--	do.	295	Do.

Table 16. Summary of testholes and wells drilled during 1979-80

Well or testhole No.	1982 No.	Location (area)	Page No.	Remarks
TH 1	--	San Vicente	236	Abandoned in 1980.
TH 2	--	Isley Field	93	Do.
TH 3	--	do.	95	Converted to well 3 (103).
W 3C	103	do.	97	Placed in production in 1982.
TH 4	--	do.	101	Converted to well 4 (104).
W 4C	104	do.	103	Placed in production in 1982.
TH 5	--	San Vicente	237	Near quarry. Abandoned in 1980.
TH 6	--	do.	238	At school. Abandoned in 1980.
TH 7	--	do.	241	At reservoir. Abandoned in 1980.
TH 8	--	do.	243	Converted to well 8.
W 8	--	do.	245	Also called San Vicente-1.
TH 9	--	do.	248	Abandoned in 1980.
TH 10	--	Akgak	296	Converted to well 10.
W 10C	121	do.	299	Placed in production in 1982.
TH 11	--	Hakmang	338	Abandoned in 1980.
TH 12	--	do.	341	Do.
TH 13	--	San Vicente	249	Do.
TH 14	--	do.	250	Do.
TH 15	--	Isley Field	106	Converted to well 15 (105).
W 15C	105	do.	108	Placed in production in 1982.
TH 16	--	do.	112	Abandoned in 1982.
TH 17	--	Miscellaneous	480	At Talufofo. Abandoned in 1980.
Disposal well 1		Tanapag	354	At Tanapag School.
Disposal well 2		do.	354	Do.
Disposal well 3		do.	355	Do.
Makpe golf course 1.		Northwest Saipan.	458	For watering golf course.
Makpe golf course 2.		Northwest Saipan.	458	Do.

Table 17. Summary of exploratory holes and wells drilled during 1981-83

Exploratory hole or well No.	1982 No.	Location (area)	Page No.	Remarks
Exh 1	--	Akgak	302	
Exh 2	--	do.	303	Well 123 drilled 2 feet from Exh 2.
Exh 3	--	Isley Field	114	Abandoned; cave-in.
Exh 3A	--	do.	115	--
Exh 4	--	Akgak	305	--
Exh 6	--	do.	307	--
Exh 7	--	do.	308	--
Exh 8	--	do.	309	--
W 101	101	Isley Field	116	--
W 102	102	do.	120	--
W 106	106	do.	125	--
W 107	107	do.	128	--
W 108	108	do.	132	--
W 109	109	do.	136	--
W 111	111	Kobler Field	186	--
W 112	--	do.	190	--
W 113	113	do.	192	--
W 116	--	do.	194	No water found.
W 116A	116	do.	197	Next to well 116.
W 122	--	Akgak	311	Abandoned; dry hole.
W 123	--	do.	312	Next to Exh 2.
W 124	--	do.	313	Abandoned; cave-in.
W M and E	131	Hakmang	342	Well dry. In 1982 deepened to 345 ft.
W 145	145	Maui IV area	424	At first called 141.
W 146	146	do.	431	--
W 147	147	do.	432	--
W 148	148	Puerto Rico	379	Near quarry.
W 149	149	do.	388	Do.
W 150	150	do.	391	Do.
W 151	151	Gualo Rai	436	--
W 152	--	do.	438	Abandoned; dry hole.
W 153	--	do.	439	Do.
W 154A	--	do.	440	Abandoned; cave-in.
W 154B	154	do.	442	10 feet from 154A.
W 161	161	Miscellaneous (Garapan).	469	At Navy Hill. Salinity is high.
W 162	--	Puerto Rico	368	Abandoned; cave-in.
W 162A	162	do.	369	--
W 163	163	do.	372	--
W 164	164	do.	376	--
W 171	171	Northwest Saipan	459	--
W 172	172	do.	460	--

Water Quality

Except for chloride concentrations of wells in the western coastal area given by Tayama (1939), no record of analyses of water from Saipan prior to the American Administration have been found. During the period 1944-46, when large numbers of American Forces were on the island, much attention was paid to the water supply. The only chemical analyses available for some of the small springs and old wells date from this period. Although the units are now normally given in milligrams per liter, for these analyses they are presented as reported. Parts per million can be considered to be the same as milligrams per liter where the density is 1.000. Normally water has a density of 1.0. Table 18 lists the analyses of spring, lake, stream, and ground water presented in this publication, and figure 17 shows the location of the sampling sites. Results of the analyses are given in the respective section.

All major springs except the Starch Factory Springs, are high-level springs with water of good quality although the level of dissolved iron and bicarbonate are fairly high. Dissolved iron varied from 310 to 492 µg/L (microgram per liter). The World Health Organization (1971) recommends a desirable level of 100 µg/L and a maximum permissible level of 1,000 µg/L (table 19). Iron is a minor element in water but can cause problems where the concentration exceeds 300 µg/L. It can affect the taste, color, turbidity and can sustain the growth of iron bacteria. A high level of bicarbonate normally is caused by contact with limestone and then shows also high levels of calcium.

Starch Factory Springs are basal springs and the spring water has a high chloride concentration which makes the water unfit for consumption. Although they are the largest springs on the island, the water is not used.

Ground water from the basal lens also tends to have a high concentration of chloride. This concentration often depends on the pumping. Heavy pumping leads to a steep increase in chloride concentration which often causes wells to be abandoned. In contrast, water from high-level perched sources normally is of good quality as there is no underlying saline water which can be drawn in.

The specific conductance of water from the basal lens on Saipan generally is high, at times in excess of 5,000 µmho at some wells. Specific conductance is expressed in micromhos per centimeter at 25°C. It is a measure of the ability of water to transmit an electric current and is used as an indicator of the concentration of dissolved solids in water; the more dissolved solids, the greater the conductance. The high specific conductance of most well-water samples was mainly caused by the high chloride concentration.

pH is a measure of acidity or basicity, and depends on hydrogen-ion concentration. Generally the pH values for ground water on Saipan ranged between 7 and 8, within the recommended range for public water supply (World Health Organization, 1971).

The most important chemical constituent of the ground water on Saipan is chloride. It is the chloride concentration of the water which limits the production and the use of ground water. As chloride concentration depends on the amount of pumpage and varies by area, it is discussed in the sections on Water Production and Ground Water Production Areas.

Table 18. Summary of chemical analyses of spring, ground, and surface water

[18 MGL, 18th Medical General Laboratory, Saipan; Tokyo, To Laboratories for Medical Sciences, Tokyo; USGS, U.S. Geological Survey, Salt Lake City Laboratory; Layne, Layne International Laboratory, Guam; HBWS, Honolulu Board of Water Supply; LFE, LFE Environmental Analysis Laboratory, Richmond, Calif.]

Location	Analyses by	Date	Remarks	Table
Springs				
Denni Spring	18 MGL	9-8-44		65
	Tokyo	3-23-50		65
	USGS	5-8-52		65
	Layne	7-20-67		65
	LFE	Nov. 1977	Metals and pesticides.	66
Radio Hill Spring No. 1	18MGL	12-1-44		69
West Achugao Spring	18MGL	12-1-44		69
	18MGL	12-5-44		69
East Achugao Spring	18MGL	12-1-44		69
	18MGL	12-5-44		69
Tanapag Spring No. 1	18MGL	12-1-44		69
Tanapag Spring No. 2	18MGL	12-5-44		69
Starch Factory Spring	HBWS	Sept. 1945		69
Wells				
Well 1	18MGL	12-1-44		70
Well 3, 5, 6 (old), As Gonna B.	18MGL	9-8-44		70
Well 31	Tokyo	3-27-50		70
Well 57	USGS	5-8-52		70
Well 6, 16, 50, Maui IV	LFE	Nov. 1977	Metals and pesticides.	74
Maui I, IV	Tokyo	3-23-50		71
	USGS	5-8-52		71
	Layne	7-20-67		71
Maui II	HBWS	9-14-45		71
Well 3, 31 (old), 76	--	1967 [1/]		72
Coast Guard well	USGS	7-25-71		73
Well 8	USGS	3-27-72	See page 221	--
Well 103, 111	USGS	11-18-82		75
Well 171	USGS	6-30-83		76
Well 76, 144, 164	USGS	7-1-83		76
Well 150	USGS	4-23-83		77
Well 148, 149, 150	USGS	7-1-83		77

Table 18. Summary of chemical analyses of spring, ground, and surface water--Continued

Location	Analyses by	Date	Remarks	Table
Surface water				
Lake Susupe	--	[1/] 1967		10
	USGS	8-28-81		10
	USGS	11-19-82		10
South Fork Talufofo Stream.	USGS	11-19-82		58
Middle Fork Talufofo Stream.	USGS	11-19-82		58

[1/] From Austin, Smith and Associates, 1972. Date and laboratory not given.

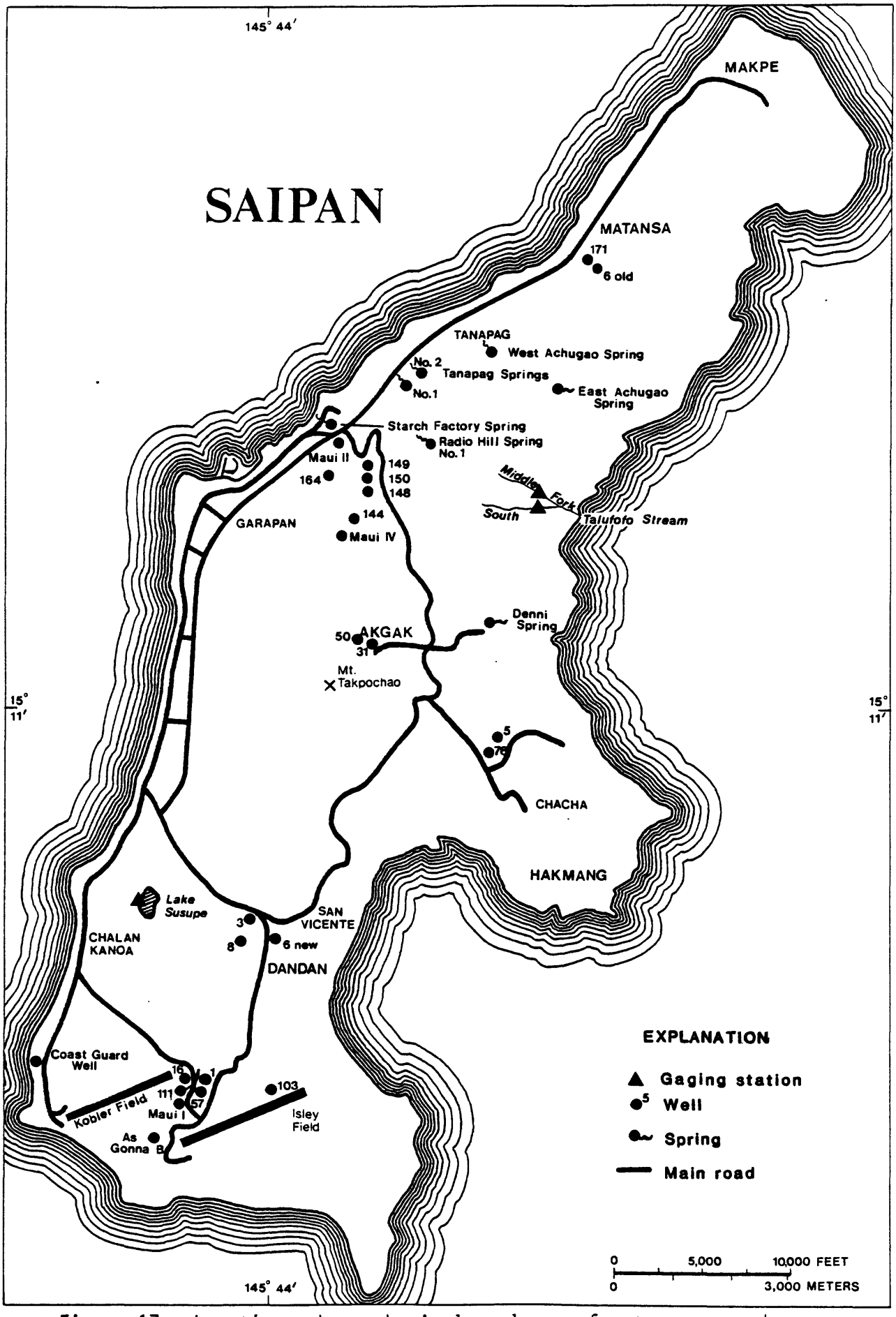


Figure 17. Locations where chemical analyses of water were made.

Table 19. World Health Organization drinking-water standards

[NTU, nephelometric turbidity units; mg/L, milligrams per liter; µg/L, micrograms per liter]

Constituent	Units	Highest desirable	Maximum permissible
pH	--	7.0-8.5	6.5-9.2
Turbidity	NTU	5	25
Hardness as $CaCO_3$	mg/L	100	500
Calcium, dissolved (Ca)	mg/L	75	200
Magnesium, dissolved (Mg)	mg/L	30	150
Sulfate, dissolved (SO_4)	mg/L	200	400
Chloride, dissolved (Cl)	mg/L	200	600
Fluoride, dissolved (F)	mg/L	1/	1/
Solids, total dissolved	mg/L	500	1,500
Iron, dissolved (Fe)	µg/L	100	1,000
Manganese, dissolved (Mn)	µg/L	50	500

1/ 1.4-2.4 mg/L, depending on ambient temperature.

WATER PRODUCTION

After the end of World War II, when most of the U.S. troops had departed, approximately 20,000 military personnel and dependents in addition to about 5,000 local people remained on the island. Water production was about 2.6 Mgal/d, with 2.3 Mgal/d coming from ground-water sources (Glander, 1946). During 1948, water production averaged 2.2 Mgal/d and supplied a population of only about 6,500 people. However, it was estimated that as much as two-thirds of the water was being lost (Curione, 1949).

In 1951, production had dropped to 463,000 gal/d and in 1952 to 384,000 gal/d, all from ground water sources. After the U.S. Navy took over the administration of the Northern Mariana Islands from the Department of the Interior on Jan. 1, 1953, production was boosted to 851,000 gal/d. Most of this water came from Maui I.

In 1956, production had dropped to 700,000 gal/d with 600,000 gal/d from ground water sources, mainly Maui I and IV and Akgak well field (Cox, 1956). Leakage had been reduced through replacement of some old pipe lines and wooden tanks, but was still considered to be a problem.

Between 1956 and 1978, ground-water production increased to 2.4 Mgal/d due to the drilling of new wells in 1956, 1962, 1969-71 and 1977. Although more wells were drilled in 1979-80, production did not increase until 1982 when many more wells were placed in production. In 1982, the amount of ground water produced almost doubled from that of 1980 while the mean weighted chloride concentration remained about the same (690 mg/L). The sharp increase in the chloride concentration of water from the Maui IV area, mainly due to the increased pumping of Maui IV and well 145, was offset by lower chloride water from the new Isley Field wells (table 20). With the increased springflow during the wet season, total water production reached a peak of 4.6 Mgal/d in August 1982. Ground-water production dropped to 3-1/4 Mgal/d in January 1983 due to the closing of Maui I and the reduction of pumpage of Maui IV. In mid 1983, Maui I could be placed back in operation and the new wells 148-150 started to produce more than 300 gal/min. Ground-water production reached 4.1 Mgal/d in September 1983. However, owing to minimal recharge of the aquifers during the prolonged 1983 dry season, the average chloride concentration of the produced ground water increased by more than 25 percent between August 1982 and September 1983.

Table 20. Pumping rates and chloride concentrations of the water from production wells

[Pumping rate in gallons per minute, chloride concentration in milligrams per liter]

Area and well	May 31, 1978		Mar. 18, 1980		June 17, 1980		Aug. 18, 1982		Sept. 7-9, 1983	
	Pumping rate	Chloride	Pumping rate	Chloride	Pumping rate	Chloride	[1] Pumping rate	Chloride	Pumping rate	Chloride
Isley Field										
Well 101-109	--	[2] --	--	--	--	--	580	[2] 205	557	344
IR-1	47	[2] 660	0	--	0	--	28	[2] 660	[1] 0	--
IR-2	57	660	0	--	0	--	28	[2] 660	[1] 38	[2] 660
Subtotal -----	104		0		0		636		595	
Average (weighted)	----------		----------		----------		----------	245	----------	364
Kobler Field										
Maui I	600	1,700	353	1,200	324	1,200	300	1,500	[1] 250	1,400
9	71	220	70	275	70	300	57	260	[1] 50	680
10	50	1,200	0	--	15	720	44	1,400	[1] 50	1,600
11	73	450	73	370	73	610	40	850	34	1.600
15	0	--	[1] 70	720	0	--	76	900	[1] 50	1,200
16	70	730	[1] 75	1,000	75	1,100	72	1,100	[3] 77	1,400
17	71	810	70	275	83	1,100	45	920	[1] 50	1,300
111	--	--	--	--	--	--	67	880	[1] 60	1,200
113	--	--	--	--	--	--	70	[2] 180	91	300
116	--	--	--	--	--	--	--	--	31	1,200
Subtotal -----	935		711		640		771		743	
Average (weighted)	---- 1,300			860		1,000		1,065		1,195
Dandan										
3 (Hospital)	--	--	57	740	[1] 57	700	50	700	[1] 62	610
6	--	--	52	2,100	[1] 42	2,600	28	--	[1] 28	[4] 2,600
7	--	--	28	850	22	900	45	--	53	[4] 900
Subtotal ----------			137		121		123		143	
Average (weighted)	----------		----------	1,280		1,400		[4] 1,400		1,107
San Vicente										
8 (SV-1 or 17)	--	--	60	1,300	62	1,200	55	[4] 1,200	68	[4] 1,200
Akgak										
50	158	--	207	--	[1] 103	[5] 29	80	--	[1] 120	[4] 21
70	75	--	[1] 0	--	72	[5] 20	80	--	[2] 60	[4] 20
72	0	--	[1] 180	--	72	[5] 20	80	--	--	--
73	100	--	[1] 60	--	97	[5] 20	72	--	[1] 55	25
75	62	--	[1] 48	40	72	[5] 20	0	--	0	--
121 (10)	--	--	--	--	--	--	50	--	0	--
Subtotal -----	395		495		416		362		235	
Average (weighted)	----- [2] 40			[2] 40		22		[4] 22		21
Hakmang										
76	[1] 50	125	50	92	35	72	35	[4] 72	67	75

Table 20. Pumping rates and chloride concentrations of the water from production wells--Continued

Area and well	May 31, 1978		Mar. 18, 1980		June 17, 1980		[1] Aug. 18, 1982		Sept. 7-9, 1983	
	Pumping rate	Chloride	Pumping rate	Chloride	Pumping rate	Chloride	Pumping rate	Chloride	Pumping rate	Chloride
Maui IV area										
Maui IV	116	750	70	280	70	480	250	[2] 1,100	[1] 240	[2] 2,000
141	--	--	--	--	--	--	31	[2] 1,000	[1] 28	[2] 1,000
142	0	--	0	--	--	--	27	[2] 1,000	54	1,200
143	30	1,100	0	--	31	500	50	650	[1] 50	2,000
144	70	1,800	48	600	36	750	43	700	[1] 50	1,100
145	--	--	--	--	--	--	65	1,400	65	3,400
Subtotal	216		118		137		466		487	
Average (weighted)		1,100		410		560		1,050		1,948
Gualo Rai										
151	--	--	--	--	--	--	51	260	45	270
154	--	--	--	--	--	--	41	800	40	1,000
Subtotal							92		85	
Average (weighted)								500		614
Puerto Rico										
162	--	--	--	--	--	--	[3] 80	--	75	1,600
163	--	--	--	--	--	--	[3] 90	--	0	--
148	--	--	--	--	--	--	--	--	50	60
149	--	--	--	--	--	--	--	--	60	34
150	--	--	--	--	--	--	--	--	222	21
Subtotal							170		407	
Average (weighted)								580		319
Total (gal/min)	1,700		1,521		1,411		2,710		2,830	
Total (Mgal/d)	2.4		2.2		2.0		3.9		4.1	
Average (weighted)						689		686		878

[1] From Department of Public Works, Commonwealth of the Northern Mariana Islands.

[2] Estimated.

[3] Determination on June 30, 1983.

[4] Assumed unchanged from June 17, 1980.

[5] From Ronimus, 1981.

Production wells

* Not operating in November 1983 because of high salinity or low yield.

RESERVOIRS

The water storage reservoirs on Saipan are listed in table 21 and their location shown in figure 18. The Isley Field reservoir, the As Mahettok reservoirs and the Fleet tanks were constructed during the Japanese Administration. The first two are still in use today.

Isley Field Reservoir - The two adjacent underground concrete reservoirs were built by the Japanese to store runoff from their airfield (Piper, 1946-47). Originally they had wooden roofs which were removed sometime between 1949 and 1956, and were replaced at a later date by concrete roofs. The capacity of the reservoirs is 500,000 gallons each and they are connected by dual 15-inch transite pipes. The maximum water level is at altitude 193.4 ft and the bottom is at altitude 183.4 ft (Curione, 1949).

As Mahettok Reservoirs - The Japanese constructed two underground concrete reservoirs at Tanapag. The upper reservoir was used as a sedimentation basin and has a capacity of about 100,000 gallons; the lower, where the water was chlorinated, has a 200,000 gallon capacity. Altitude of the maximum water level of the upper reservoir is 207 ft, and the bottom altitude is 196.1 ft. The lower reservoir has a concrete roof, a maximum water-level altitude of 185 ft, and a bottom altitude of 174.8 ft (Curione, 1949). In 1945, the upper reservoir received water from Tanapag Springs and well 10 for treatment and filtration, after which the water was stored in the lower reservoir combined with already treated water from the Hakmang wells (5, 21, 24, 25) and Denni Spring (Boniface, 1945). The supply of water of well 10 to the reservoir was discontinued in 1946 (Glander, 1946). At that time, the reservoirs were receiving water from Tanapag Springs, Radio Hill Spring No. 1, some of the flow of the Akgak wells (31, 45, 75), and Denni Spring (Cox, 1956). In 1967, the upper reservoir and filtration units located between the reservoirs were still in use, but they have since been abandoned. The upper reservoir appears to be still in good condition although the corrugated iron roof is rusting away. The lower reservoir now receives water from Tanapag Springs and, by gravity, water from the Maui IV area, which includes water from Denni Spring and excess Akgak-well-field water from Capitol Hill.

Fleet Tanks - The Japanese built three circular concrete underground tanks of about 9-Mgal capacity each with wooden roofs supported by steel H beams. In 1970, the most northern reservoir was cleaned and used to store excess water and to collect water from an adjacent small catchment area. The diameter of this reservoir is 216 ft and the depth from the top of the concrete walls to the invert of the outlet is 33 ft. The invert is 26 inches above the concrete bottom. Altitude of the bottom is 20.2 ft (Curione, 1949). Near this reservoir is a 3-Mgal-capacity, underground tank with steel plate walls and concrete bottom and roof. The diameter is 131 ft and the depth is 31.2 ft from the top of the walls to the invert of the outlet pipe 20 inches above the bottom of the tank. Altitude of the bottom of the tank is also 20.2 ft (Curione, 1949). In 1949, the 3-Mgal reservoir was used to store water from Maui IV well but by 1956 the reservoir was no longer in service. At present, none of the Fleet Tanks (so called because they supplied water to the ships) are in use.

Table 21. Summary of water storage reservoirs

Reservoir name	Location: Latitude north	Location: Longitude east	Altitude (ft): Top	Altitude (ft): Bottom	Type	Capacity (Mgal)	Supply source	Remarks
Isley Field	15°07'24"	145°43'18"	196	183	Concrete	1.0	Maui 1, wells 101, 103, 104.	2 underground tanks of Japanese construction. Concrete roof.
Hospital tower	15°09'05"	145°43'14"	250	238	Steel	.05	Well 3	Elevated.
Hospital tank	15°09'07"	145°43'11"	182	142	do.	1.0	Tower overflow, wells 102, 106-108.	Diameter 66 ft.
San Vicente	15°09'04"	145°44'04"	352	320	do.	.5	do. Dandan and San Vicente wells.	Diameter 52 ft.
Hakmang	15°10'47"	145°45'38"	370	355	Concrete	.05	Well 76	25 x 25 ft, built in 1956.
Akgak	15°11'31"	145°44'01"	626	609	do.	.1	Akgak field	Diameter 35.5 ft.
Capitol Hill	15°12'18"	145°44'49"	890	870	do.	1.0	do.	Diameter 101 ft.
As Mahettok								
Upper	15°13'31"	145°44'49"	207	196	Concrete	.1	--	Not in use.
Lower	15°13'31"	145°44'47"	1/ 185	1/ 175	do.	.2	Tanapag Springs, Maui IV area.	Japanese construction; concrete roof.
Achugao	15°14'12"	145°45'49"	233	227	do.	.02	Achugao Spring	Not in use. Old steel tank at lat 15°14'14" N., long 145°45'45" E.
Fleet tanks								
9 Mgal	15°13'20"	145°44'07"	55	20	do.	9	Not used	Japanese construction.
3 Mgal	15°13'18"	145°44'15"	53	20	do.	3	Not used	Do.
Calhoun 2/	15°12'18"	145°44'08"	561	541	do.	.5	Maui IV area	Diameter 72 ft.
Gualo Rai	15°11'20"	145°43'27"	327	303	Steel	.2	Gualo Rai field	Diameter 38.5 ft.
Maui IV	15°12'44"	145°44'20"	250	240	Concrete	.05	Denni Spring, Akgak field, Maui IV area.	22 x 30 ft.
Puerto Rico	15°13'15"	145°44'16"	190	150	Steel	1.0	Denni Spring, Akgak field.	Diameter 66 ft.

1/ Listed as 225 and 213 ft by GK[2], Inc./CE Maguire, Inc., 1982.

2/ An old steel tank, also called "Calhoun", was located about 100 ft from the concrete reservoir.

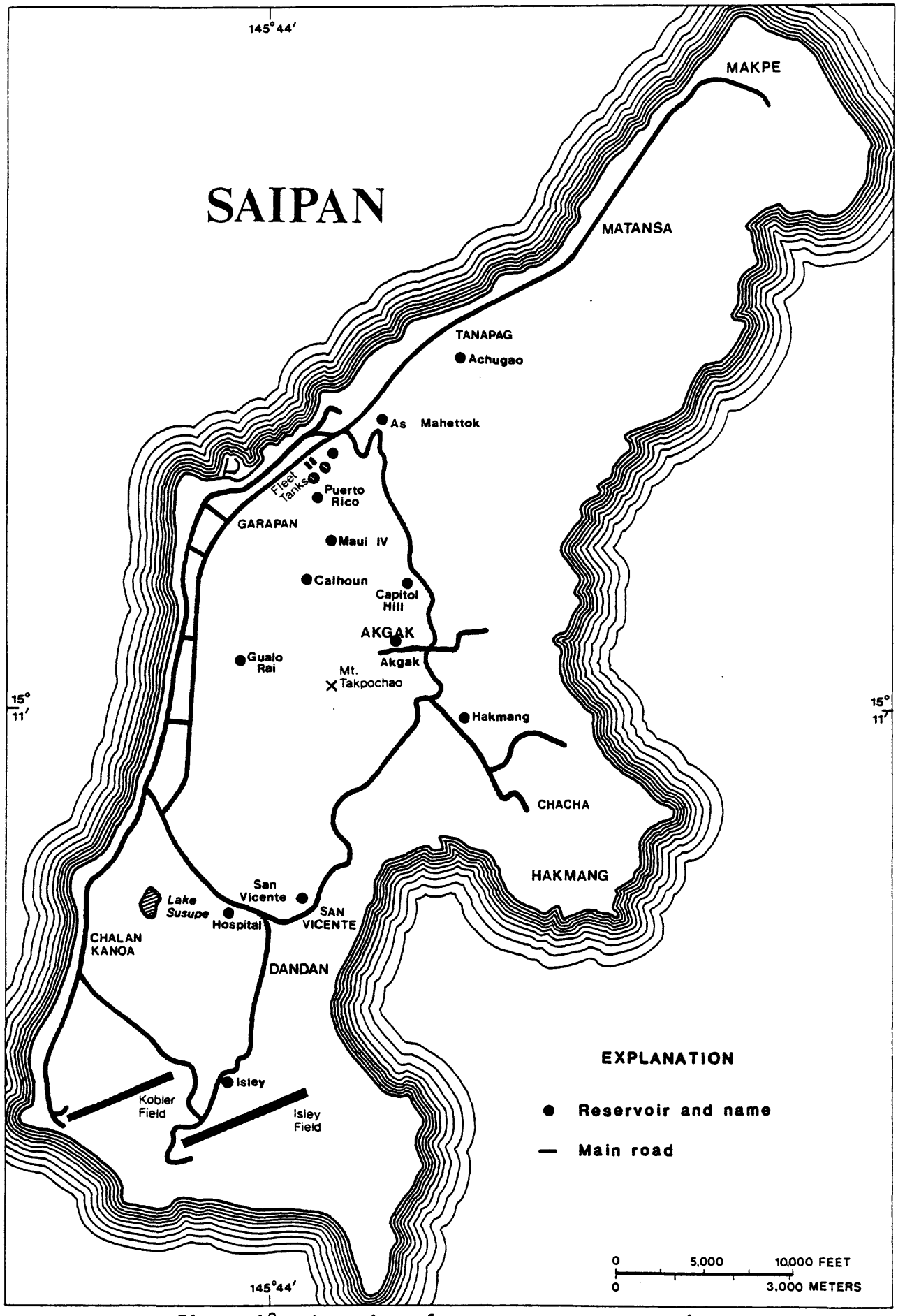


Figure 18. Location of water storage reservoirs.

During the first year after the occupation of Saipan by U.S. Forces, a large number of wooden and steel tanks were constructed, but after the troops left, almost all were abandoned. The Calhoun tank, a bolted steel tank on a concrete slab at altitude 555 ft with a capacity of 425,000 gallons (Nettleman, 1953), was constructed in about 1948. Ted Arnow (written communication to D. A. Davis, May 11, 1953) reported in 1953 that the tank was badly rusted and leaking at the bottom and was only supplying the powerplant. In 1956, the steel tank was replaced by a 0.5-Mgal concrete tank located about a hundred feet from the old tank. The tank at present receives the water from Maui IV well field, which includes water from Akgak well field and Denni Spring, for distribution in Garapan and to the 12-inch west-coast pipeline.

Other concrete reservoirs constructed in 1956 were the 1-Mgal tank on Capitol Hill, the 100,000-gallon tank near well 31 in Akgak, the 50,000-gallon Hakmang tank, and a 20,000-gallon tank at Achugao Spring. About 1970, 1-Mgal steel tanks were constructed at the Hospital and at Puerto Rico, and a 0.5-Mgal steel tank at San Vicente.

At present (1984) the total useable reservoir storage on Saipan is 5.65 Mgal.

Chloride concentrations of water of some of the reservoirs during April to October 1983, are given in table 22.

WATER DISTRIBUTION

Prior to the Japanese Administration, the local population depended mainly on rainwater caught from trees and roofs and water from some shallow wells for its water supply.

The large influx of Japanese with their agriculture and light industry necessitated a better supply. Springs were developed, concrete cisterns to hold rainwater were constructed, more than 1,100 shallow wells were dug, and a rain catchment at Isley Field was built. Storage was provided by Isley and As Mahettok reservoirs and by large underground concrete storage tanks of 3- and 9-Mgal capacity, called the Fleet tanks.

After the American occupation of Saipan in 1944, more than 70 wells were drilled and in 1946, a water distribution system was built which distributed well and spring water island wide. Owing to broken lines and the increased salinity of most of the wells, the system had been reduced to two sections by 1953, supplied only with water from Maui I and IV. Water from Maui I was pumped to the Isley Field reservoir which supplied the southern end of the island. Two miles of 12-inch steel pipe brought water from the reservoir to the west coast with a 1-1/2-mile-long, 6-inch line going south to the Coast Guard LORAN station and a 2-mile long, 8-inch line going north to the Public Works area.

Water from Maui IV was pumped to As Mahettok reservoir, the Fleet tanks and the Calhoun tank, and distributed through a 12-inch transite pipeline of about 3,500 feet length.

Table 22. Chloride concentrations, in milligrams per liter, of water from reservoirs

[Source: Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Reservoir	1983									
	3-14	4-6	4-25	5-10	5-23	6-6	6-27	9-14	10-3	10-25
Isley Field -1	344	338	369	365	368	379	365	897	951	980
Isley Field -2	635	719	641	655	658	615	670	895	942	960
Hospital tower	484	528	557	585	478	--	515	--	871	570
Hospital tank	487	659	669	655	496	515	535	609	878	580
As Mahettok	1,500	1,570	713	1,700	30	30	35	37	39	43
Calhoun		--	1,550	1,550	1,220	1,150	--	2,170	1,790	1,740
Puerto Rico	763	1,150	1,400	1,140	1,480	1,220	1,170	1,610	1,950	580

In February 1953, leakage was calculated to be 296,000 gal/d out of a production of 572,000 gal/d (52 percent) for the Maui I system, and 25,000 gal/d out of a production of 192,000 gal/d (13 percent) for the Maui IV system (Nettleman, 1953).

Shortly after 1953, water from Denni Spring and the Akgak well field (wells 31, 45, 50) was again included in the water distribution system. The average yield of Denni Spring during 13 years of continuous record (1970-82) was 400,000 gal/d, and the production of wells 31, 45, and 50 during 41 weeks from April 1947 to February 1948 ranged between 135,000-225,000 gal/d.

The main lines of the present distribution system are described in the sections dealing with the separate water-producing areas and are shown in figures 19, 21-23, 26, 29, 30 and 32. Basically, it is a West Coast distribution system receiving water from Kobler Field and part of Isley Field, from Akgak and Denni Spring by way of Capitol Hill, and from West Coast sources contributing directly to the system. Water from part of Isley Field and from Dandan serves the San Vicente-Dandan areas and well 76 serves the Hakmang area.

CONCLUSIONS

Water production almost doubled from 1980 to 1982. This was accomplished through the drilling of new wells, reactivating some previously drilled wells, and pumping the wells to near the maximum which the aquifer could sustain. In August 1982, 4.6 Mgal/d was produced, about 300 gallons per person per day, three times the demand which normally can be expected. As much as two-thirds of the produced water is wasted through leakage of the distribution pipes and by users. Efforts have been made to keep the water distribution system in operation around the clock rather than restricting the operation to a few hours a day as was the common practice until 1982. It will be difficult to continue this service as long as the waste of water continues. Although new wells are being drilled, the population is growing at a rate of 3-4 percent annually and more tourists are being attracted to the island. Thus, the need for water keeps increasing. The mean chloride concentration of all pumped ground water was 686 mg/L in August 1982 and 879 mg/L in September 1983. The chloride concentration of water produced in some areas has exceeded 1,000 mg/L. Water levels in the Akgak area have been declining. This means that the amount of low-chloride water is limited.

In August 1982, the production total included 670,000 gal/d from Denni Spring. The yield of the spring decreases to 150,000 gal/d or less during the dry season.

It is, therefore, essential that leakage and waste are reduced and new wells are drilled to replace wells of which the water has become brackish. Development of surface water appears uneconomical due to the small supply during periods of greatest need for water and limited storage potential.

WELL DATA

Drilling logs, water quality data, water levels, and pumping tests of wells located in the following areas:

Southern Saipan Area

This area, consisting of Isley Field and Kobler Field (As Gonna) has been and is one of the most productive ground-water producing areas on the island (fig. 19). Although the Japanese relied principally on spring water for their military and governmental needs, and on shallow dug wells and rain catchments for domestic needs, the Isley-Kobler area was an exception. In addition to rain water caught on the airstrip (where Isley Field is now located) and collected in the Isley reservoir (still in use today), the two large Japanese wells, As Gonna A and B, were located south of Kobler Field. Both air fields, Kobler and Isley, were built immediately after the occupation of the island by U.S. Forces in 1944.

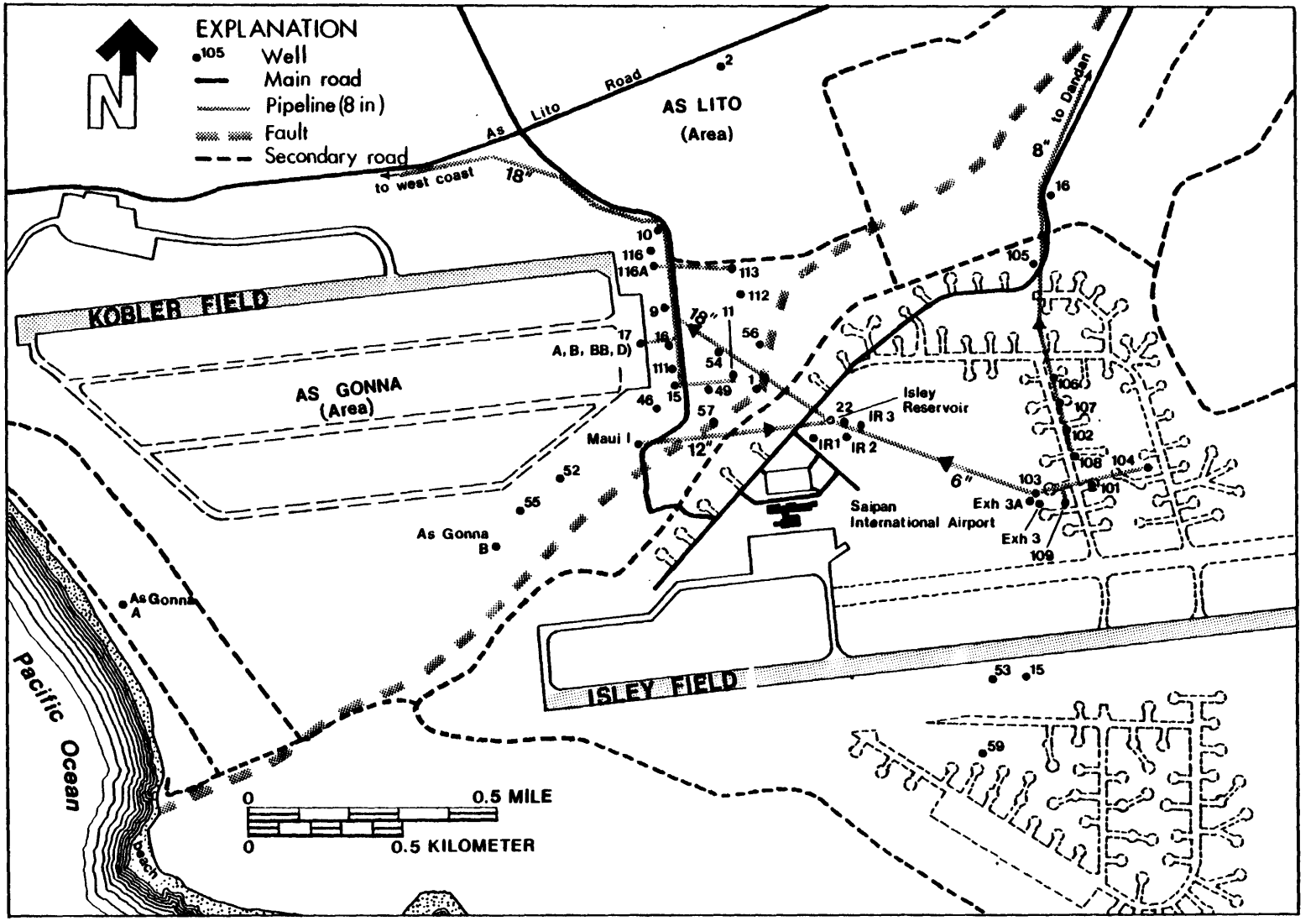
To supply water for the large number of U.S. troops stationed on the island during 1944-45, more than 70 wells were drilled on the island, three of them at Isley Field and 10 at Kobler Field. One of these wells is known as Maui I, a Maui-type infiltration gallery. Maui I has been the largest ground-water producer on Saipan and was pumped at almost 1 Mgal/d during 1947-50 and at least half that rate most of the time from then until 1982.

No new wells were drilled in the Isley-Kobler Field area until 1970, when one well was drilled at Isley Field (well 1, at uncertain location) and three wells at Kobler Field (wells 9, 10, and 11, still in operation today).

Because the demand for water grew rapidly during the 1970's due to the increase in population and economic development, a large number of wells have been drilled since 1977. Many of these wells are located at the southern end of the island. Simultaneously, a heavier demand was placed on existing wells with the result that the chloride concentration of water from many wells has reached the limits of potability. Recent chemical analyses of water from the Kobler well field have shown the chloride concentration of all wells, with the exception of wells 9 and 113, exceeding 1,000 mg/L (fig. 20). Combined with this increase in chloride ions, the water table in the Maui I infiltration galleries has receded from its normal level. On September 28, 1982, about one third of both tunnels were dry and the weirs to the pumping sump had been lowered to prevent the sump from being pumped dry. When the water table continued to drop, the well was closed at the end of 1982. Pumping could be resumed on July 5, 1983, at a reduced rate (about 250 gal/min) after a small rise in the water level of the well. Part of the drop in water level can be attributed to a drop in ocean levels during this period.

The northeast-southwest fault line in southern Saipan runs just east of Maui I and separates the Isley and Kobler well fields (Cloud and others, 1956, plate 1). Water levels at Isley Field generally are a foot higher than at Kobler Field (Nance, 1982).

At Isley Field, wells 101-108 have been pumped continuously beginning in July 1982 and production has remained fairly constant. The chloride of the water at Isley Field is relatively low, although chloride concentrations have risen 50 percent during the first year of operation of the wells (table 23). At Kobler Field, the average chloride concentration has increased to about 1,200 mg/L (table 24). To lessen the chloride concentration, salty water from Kobler Field and Dandan is mixed with water from Isley Field.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 19. Location of wells at Isley and Kobler Fields.

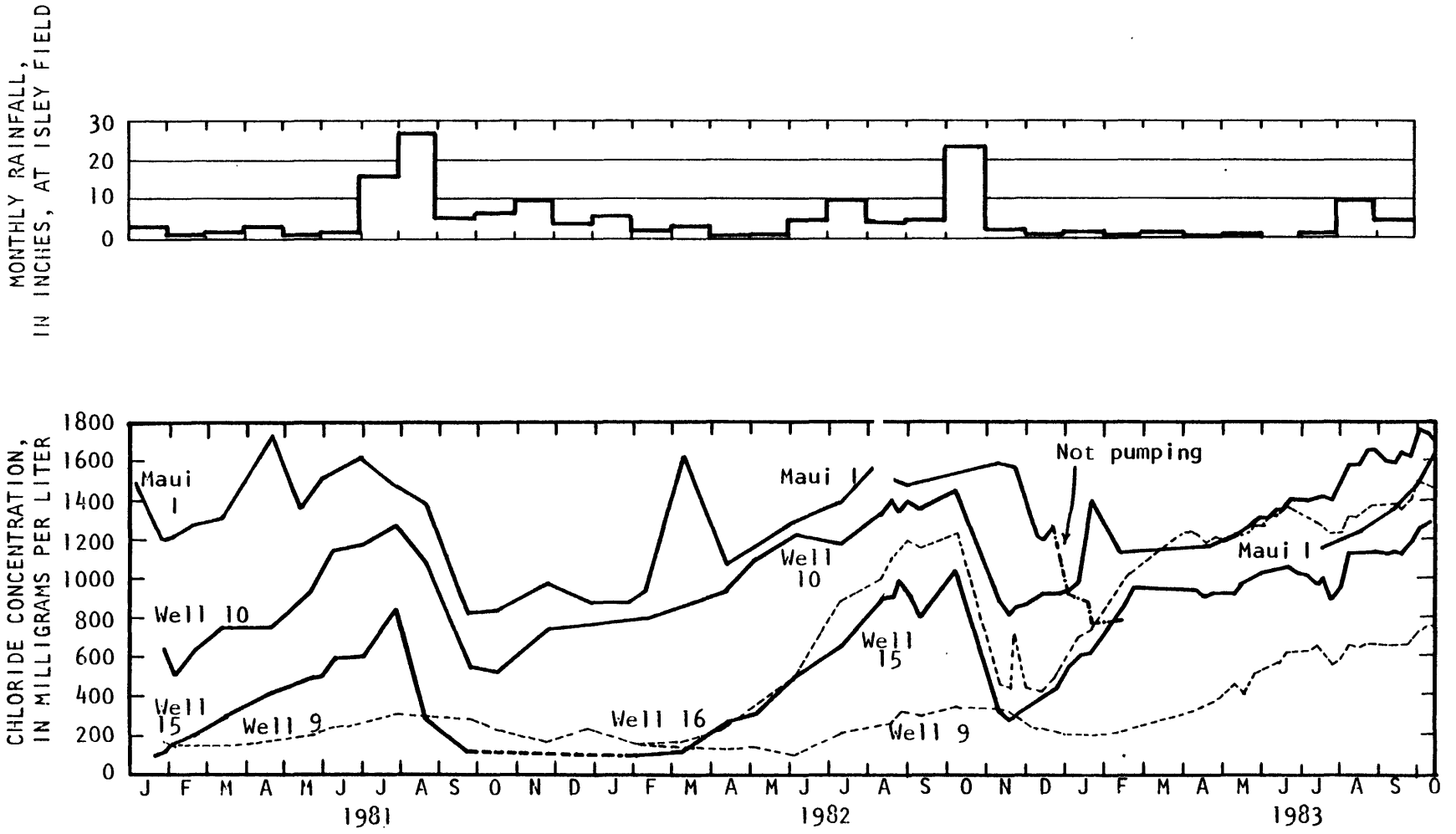


Figure 20. Chloride concentration of wells at Kobler Field and rainfall at Isley Field.

Table 23. Pumping rates and chloride concentrations of Isley Field wells

[U.S. Geological Survey]

Well No.	Aug. 18, 1982		Nov. 18, 1982		Jan. 14, 1982		Mar. 2, 1983		June 30, 1983		Sept. 8, 1983	
	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	[1/] Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)
IR-1	28	[2/]660	--	--	--	--	--	--	--	--	--	--
IR-2	28	[2/]660	[2/]25	[2/]660	[2/]25	[2/]660	[2/]25	660	--	--	[2/]38	[2/]660
101	70	180	70	190	65	254	65	300	70	370	70	430
102	73	130	80	180	77	221	75	260	75	320	57	350
103	76	110	70	[2/]110	70	119	70	120	69	120	70	130
104	70	330	90	310	86	358	70	360	69	380	70	380
105	76	310	[2/]75	320	[2/]75	335	[2/]75	360	[2/]75	370	47	400
106	73	300	60	340	55	340	60	360	55	400	55	430
107	73	170	60	190	59	213	60	240	54	260	53	260
108	69	110	75	190	74	233	75	260	60	320	70	340
109	--	--	--	--	65	[2/]400	65	410	65	400	65	400
Total	636	--	605	--	651	--	640	--	592	--	595	--
Weighted average		245	--	248	--	290	--	310	--	327	--	364

[1/] Determined on January 19, 1983 by Water Quality Laboratory, Commonwealth of the Northern Mariana Islands.

[2/] Estimated.

The only storage facility in the area is the 1-Mgal Isley Reservoir, a concrete underground storage of pre-World War II construction with post-war concrete roofing. The reservoir receives the production of Maui I, (when pumped) and wells IR-2, 101, 103, 104, 109 and delivers the water through an 18-inch cast-iron pipe (installed in 1962) by way of the Kobler well field to the populated west coast of Saipan. The remaining Isley wells deliver their water to the San Vicente and Hospital reservoirs. (See chapter covering the Dandan-San Vicente-Papago areas.)

All test holes and wells drilled at Isley Field are listed in table 25; those drilled at Kobler Field in table 26 (p. 138) preceding the data of the Kobler wells.

Table 24. Pumping rates and chloride concentrations of Kobler Field wells

[U.S. Geological Survey]

Well No.	Aug. 18, 1982		Nov. 18, 1982		Mar. 2, 1983		June 30, 1983		Sept. 8, 1983	
	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)	Pumping rate (gal/min)	Chloride (mg/L)
Maui I	300	1,500	[1/]300	1,400	--	--	--	--	[2/]250	1,400
9	57	260	[1/]57	320	[1/]57	260	[1/]57	620	[2/]50	680
10	44	1,400	[1/]44	800	[1/]44	[3/]1,110	--	--	[2/]50	1,600
11	40	850	[1/]40	920	[1/]40	1,100	--	--	34	1,600
15	76	900	50	270	[1/]76	[3/]955	[1/]76	1,000	[2/]50	1,200
16	72	1,100	50	430	[1/]72	1,060	[1/]72	1,300	[4/]77	1,400
17	45	920	70	200	70	980	77	1,200	[2/]50	1,300
111	67	880	67	880	70	1,000	42	1,200	[2/]60	1,200
113	70	[5/]180	--	--	90	180	91	300	91	[4/]400
116	--	--	--	--	--	--	38	1,200	31	[5/]1,500
Total	771	--	678	--	519	--	453	--	743	--
Weighted average	--	1,065	--	912	--	793	--	929	--	1,195

[1/] Assumed unchanged from August 18, 1982.

[2/] Estimated by Department of Public Works, Commonwealth of the Northern Mariana Islands.

[3/] Determined on February 25, 1983 by Commonwealth Water Quality Laboratory.

[4/] Determined on June 30, 1983.

[5/] Estimated.

Table 25. Testholes and wells drilled at Isley Field

Testhole and well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
W 15	15°07'03"	145°43'46"	Nov. 6, 1944	202	234	
W 22	15°07'24"	145°43'19"	Dec. 15, 1944	198	237	Abandoned. Low yield.
W 53	15°07'02"	145°43'42"	May 15, 1945	202.0	225	No equipment to operate well.
W 59	15°06'54"	145°43'44"	May 23, 1945	200.4	225	Do.
			1969-71			
W 1	--	--	June 8, 1970	204.5	225	Not located.
			1977			
TH IR-1	15°07'22"	145°43'16"	June 27, 1977	199.57	260	Converted to well IR-1.
W IR-1	do.	do.	Oct. 4, 1977	199.57	261.5	
TH IR-2	15°07'23"	145°43'20"	July 6, 1977	197.95	260	Converted to well IR-2.
W IR-2	do.	do.	Oct. 20, 1977	197.95	261.4	
TH IR-3	15°07'24"	145°43'22"	July 16, 1977	200	255	Abandoned. Low yield, high salinity.
			1979-80			
TH 2	--	--	Mar. 20, 1979	1/200.5	220	Not located.
TH 3	15°07'22"	145°43'41"	Apr. 2, 1979	1/205.32	225	Converted to well 3C.
W 3C	do.	do.	Aug. 13, 1979	205.32	227	Called well 103 in 1982.
TH 4	15°07'28"	145°43'52"	Apr. 18, 1979	1/185.04	225	Converted to well 4C.
W 4C	do.	do.	Aug. 25, 1979	185.04	216	Called well 104 in 1982.
TH 15	15°07'46"	145°43'34"	Feb. 25, 1980	1/177.44	192	Converted to well 15.
W 15	do.	do.	Mar. 5, 1980	177.44	191	Called well 105 in 1982.
TH 16	15°07'53"	145°43'34"	Mar. 28, 1980	175	191	
			1981-82			
EXH-3	15°07'21"	145°43'42"	May 1981	1/205	--	Abandoned before completion.
EXH-3A	15°07'21"	145°43'41"	do.	1/204.92	257	Exploratory hole.
W 101A	15°07'25"	145°43'47"	Feb. 17, 1982	201.5	240	Converted to well 101B
W 101B	15°07'25"	145°43'47"	May 1982	1/202.49	235	Called well 101.
W 102	15°07'30"	145°43'43"	Mar. 5, 1982	1/190.68	230	
W 106	15°07'35"	145°43'40"	Mar. 8, 1982	1/180.08	220	
W 107	15°07'32"	145°43'41"	Apr. 24, 1982	1/184.33	208	
W 108	15°07'27"	145°43'44"	Apr. 18, 1982	1/199.00	227	
W 109	15°07'19"	145°43'45"	Sept. 30, 1982	201.41	220	

1/ Altitude of well plate, levels of October 4-5, 1982.

WELL 15

Location: About lat 15°07'03" N., long 145°43'46" E., Isley Field.
Drilled: Oct. 24 to Nov. 6, 1944 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 202 ft. Depth: 234 ft.
Casing: 6 in. to 234 ft with bottom 20 ft perforated.
Aquifer: Limestone.
Remarks: Static water level before pumping, 200.5 ft. Well sprung with 100 lb TNT at bottom 15 ft.
Chloride: 30 ppm, at completion (log).
50-70 ppm (Glander, 1946).
99 ppm, July 1953 (Davis, 1958).
Pumpage: 245,000 gal/d at completion (log).
190,000 gal/d (Boniface, 1945).
90,000 gal/d decreasing to 50,000 gal/d (Stock).
50,000-100,000 gal/d (Glander, 1946).
30,000 gal/d from weekly pumping records over 42 weeks during March 1947 to February 1948 (maximum, 53,000 gal/d, minimum, 23,000 gal/d).
40,000-50,000 gal/d, 4-5 hours per day (Curione, 1949)
pH: 7.6-7.8 (Glander, 1946).

1/ Written communication from T. S. Stock to Commanding Officer, Nov. 7, 1945.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
White lime	0-207
White sand	207-234

WELL 22

Location: About lat 15°07'24" N., long 145°43'19" E., at Isley Reservoir.

Drilled: Dec. 8-15, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 198 ft. Depth: 237 ft.

Casing: 6 in. to 237 ft.

Aquifer: Shale, lime, and sand.

Remarks: Static water level before pumping, 191 ft.

Chloride: 40 ppm, at completion (log).

Pumpage: Pumped dry when pumped at rate of 6,000 gal/d (Piper, 1946-47).

Well was abandoned because of low yield.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Lime and sand	0-9
Chalky lime	9-20
Hard lime rock	20-28
Beach sand	28-33
Hard lime and sand	33-36
Hard lime and chalky lime	46-84
Hard lime	84-125
Hard and chalky lime	125-130
Sticky clay and lime	130-145
Chalky and hard lime and a little clay	145-155
Hard lime, clay, and sand	155-160
Lime and sand	160-175
Shale and sand	175-180
Clay, lime, and sand	180-195
Sand, clay, and mud	195-205
Chalky lime, sand, and gray shale	205-222
Chalky lime, clay, and sand	222-225
Gray shale, chalky lime, and sand (water struck in this formation)	225-237

WELL 53

Location: About lat 15°07'02" N., long 145°43'42" E., at Isley Field.
Drilled: May 7-15, 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 202.0 ft. Depth: 225 ft.
Casing: 6 in. to 225 ft with lower 30 ft perforated (1/4-in. holes, 20 per ft).
Aquifer: Limestone.
Remarks: Water was found at 202 ft. Static water level, 199 ft.

No equipment available to operate the well (Glander, 1946).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Yellow coral	0-23
Hard coral	23-28
Soft, white coral	28-60
Hard, white coral	60-80
Soft, yellow coral	80-100
Hard, white coral	100-115
Soft, white coral	115-140
Yellow coral	140-202
Gravel and white sand	202-225

WELL 59

Location: About lat 15°06'54" N., long 145°43'44" E., at Isley Field.
Drilled: Completed May 23, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 200.4 ft. Depth: 225 ft.
Casing: 6 in. to 225 ft.
Aquifer: Limestone.

No equipment available to operate the well (Glander, 1946).

WELL 1

Location: Isley Field.
Drilled: May 25 to June 8, 1970 by Layne International, Guam.
Altitude: 204.5 ft. Depth: 225 ft.
Diameter of open hole: 12 in.
Casing: 8 in. to 215 ft with 10 ft 8-in. stainless steel screen at bottom.
Gravel pack and grout: June 6, 1970, 15 bags of 3/16 in. gravel and 2 yd of cement grout to 180 ft.
Source of record: Driller.
Remarks: Chloride: 94-100 mg/L, June 2, 1970, after 7 hours of pumping at rate of 110 gal/min.
110 mg/L, May 11, 1971, after 40 minutes of pumping at rate of 85 gal/min.
Pumpage: 100 gal/min per foot of drawdown, initially.

TEST HOLE IR-1

Location: Lat 15°07'22" N., long 145°43'16" E., at Isley Reservoir.

Drilled: June 22-27, 1977 by International Bridge Corporation.

Altitude: 199.57 ft (levels of Oct. 28, 1977). Depth: 260 ft.

Diameter of open hole: 6-3/4 in.

Casing: None.

Source of record: Driller.

Pumping test: June 28, 1977,: Drawdown 9.03 ft in 10 hours at pumping rate of 51-56 gal/min; recovery, to 0.47 ft of initial water level in 10 minutes; chloride, 500 mg/L. See pumping test record.

Testhole was converted to Well IR-1, Oct. 4, 1977.

CHLORIDE CONCENTRATIONS

Date	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1977				
June 25 ----	196.42	15	110	Hole 220 ft deep; pumped to clean out well; drawdown, 11.6 ft.
June 26 ----	196.60	56	525	Hole 260 ft deep; drawdown, 9.5 ft.
June 28 ----	1/ 199.20	54	500	Hole 260 ft deep; drawdown, 9.03 ft.

1/ Static depth to water, measured from 2.60 ft above ground surface.

TEST HOLE IR-1

LOG

Description of material	Depth (ft)
Top soil, brown clay	0-10
Medium hard, coralline limestone, white	10-120
Light brown, medium hard limestone	120-125
Dark brown, very hard, dry clay	125-145
Light brown, very hard, dry clay	145-150
Dark brown, very hard sandstone	150-170
Light brown, very hard sandstone	170-195
Medium hard, gray, sandy limestone	195-200
Medium hard, gray sandstone with brown clay (water level at about 190 ft below ground surface; pumped water from hole via 7-1/2 HP 75-gal/min submersible pump at 220 ft; suction broken after brief period)	200-220
Medium hard, gray sandstone with brown clay	220-225
Black sand with very hard, dry, brown clay	225-230
Very hard, dry, brown clay	230-250
Black sand with hard, dry, brown clay	250-260

PUMPING TEST

Date: June 28, 1977.
Reference point: 2.60 ft above ground surface (top of drill mast table).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0655	--	199.20	--	--	Static depth to water before start of pumping.
0700	0	199.20	--	--	Start of test.
0705	5	206.52	51	--	
0715	15	207.23	51	--	
0720	20	207.43	52	500	
0725	25	207.54	52	--	
0730	30	207.68	54	--	
0745	45	207.74	53	--	
0800	60	207.85	52	--	
0815	75	207.89	53	--	
0830	90	207.94	52	500	
0845	105	208.33	56	--	Increased pumping
0900	120	208.30	56	--	rate due to in-
0930	150	208.43	56	500	creased generator
1000	180	208.45	56	--	engine revolution.

TEST HOLE IR-1

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1030	210	208.45	56	500	
1100	240	208.49	56	--	
1130	270	208.33	56	500	
1200	300	208.43	56	--	
1230	330	207.72	56	--	
1300	360	208.22	56	500	
1330	390	208.25	56	--	
1400	420	208.33	56	500	
1430	450	208.23	56	--	
1500	480	208.23	56	500	End of pumping test.
Recovery					
1502	0	--			Start of recovery test.
1503	1	202.46			Water level recovered
1504	2	201.64			to within 3.26 ft of
1505	3	201.40			initial static depth
1506	4	201.16			to water in 1 minute.
1507	5	201.00			
1508	6	200.85			
1509	7	200.45			
1510	8	200.28			
1511	9	199.93			
1512	10	199.87			Water level recovered
1517	15	199.67			to within 47/100 ft
1522	20	199.60			of initial static depth
1527	25	199.60			to water in 10 minutes.
1532	30	199.60			
1537	35	199.58			
1542	40	199.58			
1552	50	199.63			
1602	60	199.58			
1612	70	199.55			
1622	80	199.52			
1632	90	199.53			
1642	100	199.53			Last measurement. Water level recovered to within 33/100 ft of initial static depth to water in 100 minutes.

WELL IR-1

Location: Same as test hole IR-1, Isley Field.

Reamed: Sept. 30 to Oct. 4, 1977 by International Bridge Corporation.

Altitude: 199.57 ft (levels of Oct. 28, 1977).

Depth: 266.6 ft, backfilled to 261.5 ft.

Diameter of open hole: 14-3/4 in.

Casing: 8-in. steel casing and 8-in. stainless steel screen to 261.45 ft.

Gravel pack and grout: Gravel around 8-in. casing and screen to 190 ft.
Used 175 bags of cement to grout.

Source of record: Driller.

Pumping test: Oct. 11, 1977, 1600-1700: Depth to water, 208.28 ft from top of casing; pumping rate, 62 gal/min; chloride, 460 mg/L.

Oct. 12, 1977, Hole acidized with three barrels HCL at 10-percent concentration.

Oct. 14, 1977: Drawdown, 9.87 ft in 8 hours at pumping rate of 62 gal/min; chloride, 530-850 mg/L; recovery, to 1.56 ft of starting depth to water in 10 minutes and to within 0.4 ft in 100 minutes. See pumping test record.

WELL IR-1

PUMPING TEST

Date: October 14, 1977.
Reference point: top of casing, 3.5 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0750	--	200.24	--	840	Static depth to water.
0800	0	--	--	850	Start of test.
0801	1	206.40	--	--	
0802	2	206.80	--	--	
0803	3	207.20	--	--	
0804	4	207.24	--	--	
0805	5	207.26	--	--	
0806	6	208.16	--	--	
0807	7	208.40	--	--	
0808	8	208.50	--	--	
0809	9	208.60	--	--	
0810	10	208.70	--	--	
0815	15	208.85	62	--	
0820	20	209.15	62	--	
0825	25	209.30	62	800	
0830	30	209.40	62	--	
0835	35	209.50	62	780	
0840	40	209.55	62	--	
0845	45	209.60	62	--	
0850	50	219.65	62	--	
0855	55	209.72	62	--	
0900	60	209.72	62	740	
0905	65	209.82	62	--	
0910	70	209.83	62	--	
0940	100	209.90	62	680	
1010	130	210.00	62	640	
1040	160	210.08	62	630	
1110	190	210.12	62	630	
1140	220	210.12	62	580	
1210	250	210.15	62	590	
1240	280	210.00	62	560	
1310	310	210.00	62	560	
1340	340	210.00	62	570	
1410	370	210.13	62	550	
1440	400	210.11	62	530	
1510	430	210.10	62	550	
1540	460	210.08	62	540	
1610	490	210.11	62	550	End of pumping test.

WELL IR-1

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
Recovery					
1610	0	210.11			Start of recovery test.
1611	1	204.70			
1612	2	203.60			
1613	3	203.12			
1614	4	202.80			
1615	5	202.53			
1616	6	202.35			
1617	7	202.18			
1618	8	202.08			
1619	9	201.90			
1620	10	201.80			
1625	15	201.50			
1630	20	201.32			
1635	25	201.17			
1640	30	201.08			
1645	35	201.04			
1700	50	200.85			
1710	60	200.81			
1720	70	200.75			
1730	80	200.70			
1740	70	200.70			
1750	100	200.64			End of test.

TEST HOLE IR-2

Location: Lat 15°07'23" N., long 145°43'20" E., at Isley Reservoir.
Drilled: June 30 to July 6, 1977 by International Bridge Corporation.
Altitude: 197.95 ft. (levels of Oct. 25, 1977). Depth: 260 ft.
Diameter of open hole: 6-3/4 in.
Casing: None.
Source of record: Driller.
Pumping tests: July 1, 1977: Drawdown 11.68 ft in 1-1/2 hours; chloride, 400-435 mg/L.

July 2, 1977: Drawdown, 20.87 ft in 8 hours at pumping rate of 57 gal/min; chloride, 400 mg/L; recovery, to 2.66 ft of initial depth to water in 10 minutes, to 1.7 ft in 100 minutes. See pumping test record.

July 6, 1977: Drawdown, 22.57 ft in 8 hours at pumping rate of 59 gal/min; chloride, 375 mg/L; recovery, to 3.42 ft of initial depth to water in 10 minutes, to 2.18 ft in 90 minutes. See pumping test record.

LOG

Description of material	Depth (ft)
Top soil	0-5
Medium hard, light brown coral limestone	5-20
Medium hard, brown and white coral limestone	20-50
Medium hard, white coral limestone	50-100
Medium hard, brown and white coral limestone	100-120
Medium hard, light brown coral limestone	120-130
Brown clay with white coral limestone	130-135
Sandy, light brown limestone with brown clay	135-145
Hard, dry, light brown clay	145-210
Hard, dry, sandy brown clay (depth to water, 194.85 ft below ground surface, pumped)	210-220
Sandy, hard, brown clay	220-230
Hard, dry, light brown clay	230-250
On July 5, hole deepened to 260 ft:	
Sandy, hard, brown clay	250-260

TEST HOLE IR-2

PUMPING TEST

Date: July 1 and 2, 1977.
Reference point: 3.15 ft above ground surface (top of drilling mast table).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
July 1, 1977					
1000	0	194.85	--	435	Chloride at 1040.
1130	90	--	42	400	Chloride at 1110. Drawdown 11.68 ft.
July 2, 1977					
1125	--	197.98	--	--	Static depth to water.
1130	0	197.98	--	--	Start of test.
1135	5	218.62	57	--	
1140	10	218.73	57	--	
1145	15	218.60	57	--	
1150	20	218.66	57	--	
1155	25	218.55	57	--	
1200	30	218.48	57	400	
1215	45	217.92	57	--	
1230	60	217.65	56	--	
1245	75	217.68	56	--	
1300	90	217.70	57	400	
1315	105	217.65	57	--	
1330	120	217.65	57	--	
1400	150	217.70	57	400	
1430	180	217.66	57	--	
1500	210	218.00	57	--	
1530	240	217.33	57	--	
1600	300	218.24	57	--	
1630	300	218.24	57	--	
1700	330	218.51	57	--	
1730	360	218.57	57	--	
1800	390	218.27	57	--	
1830	420	218.31	57	400	
1900	450	218.90	57	--	
1930	480	218.85	57	--	End of pumping test.
Recovery					
1930	0	--			Start of recovery test.
1931	1	203.95			Elapsed time since pumping stopped measured with stopwatch.
1932	2	201.95			
1933	3	201.45			
1934	4	201.10			
1935	5	201.04			

TEST HOLE IR-2

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1936	6	200.85			
1937	7	200.78			
1938	8	200.74			
1939	9	200.68			
1940	10	200.64			
1945	15	200.52			
1950	20	200.38			
1955	25	200.32			
2000	30	200.27			
2005	35	200.18			
2010	40	200.12			
2020	50	200.00			
2030	60	199.92			
2040	70	199.88			
2050	80	199.82			
2100	90	199.75			
2110	100	199.68			Last measurement. Recovered to within 1.7 ft of initial depth to water.

TEST HOLE IR-2

PUMPING TEST

Date: July 6, 1977.
Test hole was deepened from 250 to 260 feet on July 5, 1977.
Reference point: 2.70 ft above ground surface (top of drilling mast table).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0817	--	197.48	--	--	Static depth to water.
0830	0	197.48	--	--	Start of test.
0835	5	214.56	58	--	
0840	10	215.12	59	375	
0845	15	215.60	59	--	
0850	20	215.93	59	--	
0855	25	216.06	59	--	
0900	30	216.07	59	375	
0915	45	216.31	59	--	
0930	60	216.80	59	--	
0945	75	217.11	59	--	
1000	90	217.42	59	375	
1015	105	217.92	59	--	
1030	120	217.93	59	--	
1100	150	218.29	59	375	
1130	180	218.59	59	--	
1200	210	218.43	59	--	
1230	240	218.40	59	--	
1300	270	219.02	59	--	
1330	300	218.97	59	--	
1400	330	218.56	59	--	
1430	360	219.54	59	375	
1500	390	219.64	59	--	
1530	420	219.64	59	--	
1600	450	219.75	59	375	
1630	480	220.05	59	375	End of pumping test.
Recovery					
1630	0	--			Start of recovery test.
1631	1	204.37			
1632	2	202.25			
1633	3	201.75			
1634	4	201.50			
1635	5	201.32			
1636	6	201.23			
1637	7	201.18			
1638	8	201.04			
1639	9	200.96			
1640	10	200.90			

TEST HOLE IR-2

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1645	15	200.68			
1650	20	200.52			
1655	25	200.38			
1700	30	200.30			
1705	35	200.18			
1710	40	200.11			
1720	50	199.98			
1720	60	199.88			
1740	70	199.77			
1750	80	199.70			
1800	90	199.66			Last measurement. Recovered to within 2.18 ft of initial depth to water.

WELL IR-2

Location: Same as test hole IR-2 at Isley Reservoir.
Reamed: Oct. 16-20, 1977 by International Bridge Corporation.
Altitude: 197.95 ft (levels of Oct. 25, 1977).
Depth: 262 ft, backfilled to 261.4 ft, from top of conductor pipe.
Diameter of open hole: 14-3/4 in.
Casing: 8-in. steel casing and 8-in. stainless steel screen to 261 ft.
Gravel pack and grout: Gravel around 8-in. casing and screen to 190 ft, sealed with 4 in. of sand. Used 166 bags of cement to grout.
Source of record: Driller.
Pumping test: Oct. 27, 1977: Drawdown, 20.88 ft in 8 hours at pumping rate of 61 gal/min; chloride, 340-400 mg/L; recovery, to within 4.33 ft of starting depth to water in 10 minutes and to within 2.48 ft in 100 minutes. See pumping test record.

PUMPING TEST

Date: October 27, 1977.
Reference point: 4.11 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0800	--	199.48	--	--	Static depth to water.
0805	0	--	--	--	Start of test.
0806	1	201.92	--	340	
0807	2	211.42	--	--	
0808	3	212.22	--	--	
0809	4	213.50	--	--	
0810	5	213.70	--	--	
0811	6	213.95	--	--	
0812	7	214.17	--	--	
0813	8	214.30	--	--	
0814	9	214.48	--	--	
0815	10	214.54	--	--	
0820	15	215.00	61	340	
0825	20	215.55	61	--	
0830	25	215.55	61	--	
0835	30	215.77	61	--	
0840	35	215.96	61	350	
0845	40	216.09	61	--	

WELL IR-2

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0850	45	216.27	61	--	
0855	50	216.44	61	--	
0900	55	216.64	61	--	
0905	60	216.72	61	--	
0910	65	216.75	61	--	
0915	70	216.40	61	--	
0945	100	216.38	61	365	
1015	130	216.68	61	--	
1045	160	217.95	61	400	
1115	190	218.29	61	--	
1145	220	218.47	61	400	
1215	250	218.28	61	--	
1245	280	218.87	61	--	
1315	310	218.97	61	--	
1345	340	219.25	61	400	
1415	370	219.48	61	--	
1445	400	219.70	61	400	
1515	430	220.00	61	--	
1545	460	220.16	61	390	
1605	480	220.36	61	--	End of pumping test.
Recovery					
1605	0	--			Start of recovery test.
1606	1	209.40			
1607	2	206.32			
1608	3	205.32			
1609	4	204.78			
1610	5	204.45			
1611	6	204.28			
1612	7	204.13			
1613	8	204.02			
1614	9	203.90			
1615	10	203.81			
1620	15	203.54			
1625	20	203.28			
1630	25	203.10			
1635	30	202.95			
1640	35	202.82			
1645	40	202.70			
1655	50	202.55			
1705	60	202.39			
1715	70	202.26			
1725	80	202.15			
1735	90	202.08			
1745	100	201.96			End of test.

TEST HOLE IR-3

Location: About lat 15°07'24" N., long 145°43'22" E., at Isley Reservoir.
Drilled: July 14-16, 1977 by International Bridge Corporation.
Altitude: About 200 ft. Depth: 255 ft.
Diameter of open hole: 6-3/4 in.
Source of record: Driller.
Pumping test: July 15, 1977, well 215 ft deep: Little water, pumping level at 210.12 ft below ground surface.
July 18, 1977, well 255 ft deep: No suction after 30 minutes of pumping; stopped pump for 35 minutes; depth to water, 201.1 ft below top of drill mast table (2.85 ft above ground surface); depth to water after 40 seconds of pumping, 242.45 ft below reference point; chloride, 700 mg/L.
Remarks: Site abandoned.

LOG

Description of material	Depth (ft)
Top soil	0-5
Medium hard, grayish white limestone	5-25
Hard, white and light brown limestone	25-30
Hard, clayey, light brown limestone	30-50
Medium hard, grayish white coral limestone	50-90
Medium hard, light brown coral limestone	90-160
Medium hard, white coral limestone with clay	160-165
Medium hard, white and red coral limestone	165-180
Hard, brown shale with limestone fragments	180-215
Hard, light brown shale with coral limestone	215-245
Hard, black and brown shale	245-255

TEST HOLE 2

Location: Isley Field. Exact location not determined.

Drilled: Mar. 16-20, 1979 by Ted Lund Drilling and Supply.

Altitude: 200.5 ft. Depth: 220 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping tests: Mar. 23, 1979: Pumped intermittently for 1 hour at rate of 50-55 gal/min; chloride, 118 mg/L.

Mar. 27, 1979: Pumped for 8 hours at rate of 50-57 gal/min; chloride, 112-150 mg/L. See pumping test record.

Hole abandoned and sealed, May 12, 1980.

LOG

Description of material	Depth (ft)
Dark, soft fill	0-1
White, hard coral	1-11
Gray, medium hard coral	11-18
White, extremely hard coral	18-21
White, very hard coral	21-24
White, medium hard coral with hard layers	24-135
White, medium hard coral	135-155
White, hard coral	155-174
White, very hard coral	174-197
White, medium hard coral	197-198
White, very hard coral	198-201
White, medium hard coral	201-202
White, very hard coral	202-206
White, medium hard coral	206-217
Brown, stiff clay	217-220

TEST HOLE 2

PUMPING TEST

Date: March 27, 1979.
Measuring point: Ground surface near well.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1400	--	198.62	--	--	Static depth to water.
1406	0	--	--	--	Start of test.
1408	2	--	57	--	
1409	3	--	--	125	
1415	9	--	--	--	Pump drawing air.
1418	12	--	54	--	
1420	14	--	--	125	
1430	24	--	52	125	
1500	54	--	51	125	
1517	71	--	52	--	
1600	114	--	--	125	
1625	139	--	51	--	
1630	144	--	--	150	
1700	174	--	50	125	
1730	204	--	50	125	
1830	264	--	51	116	
1900	294	--	50	116	
1930	324	--	50	116	
2000	384	--	50	119	
2030	384	--	50	112	
2100	414	--	50	112	
2130	444	--	50	112	
2200	474	--	50	112	
2206	480	--	--	--	End of test.

TEST HOLE 3

Location: Lat 15°07'22" N., long 145°43'41" E., at Isley Field.

Drilled: Mar. 30 to Apr. 2, 1979 by Ted Lund Drilling and Supply.

Altitude: 205 ft. (See well 3C). Depth: 225 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping tests: Apr. 4, 1979: Drawdown, 0.1 ft in 6-1/2 hours at pumping rate of 84-86 gal/min; chloride, 75-87 mg/L. See pumping test record.

Apr. 12, 1979: Drawdown, 0.1 ft in 8 hours at pumping rate 80 gal/min. See pumping test record.

Remarks: Chloride: Apr. 19, 1979, 1000, 106 mg/L; 1200, 121 mg/L; 1300, 134 mg/L.

LOG

Description of material	Depth (ft)
Fill	0-1
White and brown medium hard coral	1-8
White, hard coral	8-12
White, medium hard coral	12-28
White, hard with very hard layers	28-42
White, medium hard with hard layers	42-57
White, rough, hard drilling coral	57-61
White, hard with medium hard layers	61-71
White, hard coral	71-74
White, very hard layers	74-80
Hard and rough drilling	80-82
Very hard layers	82-88
Hard and rough drilling	88-90
Very hard layers	90-141
Hard and smooth drilling	141-150
White, very hard and smooth drilling	150-163
Hard with medium hard layers	163-197
White, stiff coral clay	197-208
White coral with yellow stained coral and small showing of dark brown volcanic clay	208-225

TEST HOLE 3

PUMPING TEST

Date: April 4 and 12, 1979.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
		April 4, 1982			
0830	0	205.7	--	--	Start of test. Static depth to water.
0832	2	205.8	84	--	
0835	5	205.8	86	87	
0840	10	205.8	84	--	
0900	30	205.8	86	75	
0915	45	205.8	86	--	Same reading at 0930 and 0945.
1000	90	205.8	88	--	
1030	120	205.8	86	75	
1100	150	205.8	86	--	
1130	180	205.8	86	81	
1200	210	205.8	86	--	Same reading at 1230 and 1300.
1310	280				End of test (motor failed).
1330	300	205.6	--	--	
		April 12, 1982			
0805	0	205.8	--		Start of test. Static depth to water.
0810	5	--	--		
0811	6	--	81		
0815	10	205.9	79		
0820	15	205.9	81		Same reading at 0825, 0830, 0840, 0850.
0900	55	205.9	81		
0930	85	205.9	82		
1000	115	205.9	81		Same reading at 1030 and 1100.
1130	205	205.9	82		
1200	235	205.9	82		
1230	265	205.9	81		
1300	295	205.9	79		
1330	325	205.9	81		Same reading at 1400.
1430	385	205.8	80		
1500	415	205.9	81		Same reading at 1530 and 1600.
1610	485	--	--		End of test.

WELL 3C. Called well 103 (1982)

Location: Same as test hole 3, lat 15°07'22" N., long 145°43'41" E., at Isley Field.

Drilled: Aug. 11-13, 1979 reamed from 7-7/8 to 12-1/2 in. by Ted Lund Drilling and Supply.

Altitude: Top of concrete pedestal, 205.22 ft; top of well plate, 205.32 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).

Depth: 227 ft.

Diameter of open hole: 12-1/2 inches.

Casing: 207 ft of 8-in. steel casing from surface to 207 ft.

Screen: 16 ft of 8-in. stainless steel screen from 207 to 223 ft.

Gravel pack and grout: 65 gallons of gravel from 170 to 223 ft sealed with 90 bags of cement to ground surface.

Source of record: Driller.

Pumping test: Aug. 16, 1979: Drawdown, 0.5 ft in 8 hours at pumping rate of 99 gal/min. See pumping test record.

Jan. 28, 1982: Maximum drawdown, 0.3 ft during 7-3/4 hours at pumping rate of 55 gal/min; chloride, 67-73 mg/L. See pumping test record.

Remarks: Depth to water can be measured through hole for power cord in well plate.

See table 75 for chemical analyses of Nov. 18, 1981.

Date well brought in production: June 7, 1982.

WELL 3C. Called well 103 (1982).

Depth to water, in feet

[Source: Northern Marianas Division of Environmental Quality]
Altitude of measuring point, 205.32 ft (top of well plate)

Date	Depth to water	Date	Depth to water	Date	Depth to water
11-21-80 --	204.54	5-4-81 ---	204.84	8-12-81 ---	203.56
12-3-80 ---	203.25	5-4-81 ---	204.78	8-19-81 ---	203.62
12-10-80 --	204.39	5-7-81 ---	204.73	9-9-81 ----	204.04
1-5-81 ----	204.66	5-11-81 --	204.69	9-16-81 ---	204.64
1-26-81 ---	203.22	5-20-81 --	204.67	10-21-81 --	203.46
2-5-81 ----	203.38	5-26-81 --	204.69	10-27-81 --	202.72
2-10-81 ---	203.42	6-9-81 ---	204.79	11-25-81 --	204.60
2-19-81 ---	202.99	6-23-81 --	204.59	12-3-81 ---	204.36
3-9-81 ----	203.18	6-29-81 --	204.59	12-11-81 --	204.43
3-18-81 ---	203.18	7-14-81 --	204.75	12-16-81 --	203.99
3-18-81 ---	204.96	7-24-81 --	204.78	1-6-82 ----	204.13
3-27-81 ---	204.84	7-28-81 --	204.71	1-27-82 ---	204.48

Well not in production during this period.

WELL 3C. Called well 103 (1982).

PUMPING TEST

Date: August 16, 1979.
Measuring point: 3.5 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0755	0	205.6	99	Static depth to water.
0800	5	--	99	Start of test.
0801	6	206.1	99	
0805	10	206.1	99	Same reading every 5 minutes 0810-0830, every 15 minutes 0845-0900, and every 30 minutes 0930-1530.
1600	485	206.1	99	
1603	488	--	--	End of test.

Date: January 28, 1982.

Time	Elapsed time (min)	Drawdown (in.)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1310	0	--	--	66.6	Start of test.
1312	2	2	55	--	
1322	12	2	55	67.2	
1357	47	2	55	--	
1512	122	4	55	68.2	
1548	158	1	55	70.2	
1841	331	1	55	70.9	
1900	350	2	55	73.3	
2000	410	2	55	70.7	
2035	445	2	55	72.7	
2055	465	2	55	72.1	End of test.

WELL 103 (Previously well 3C, 1979-81)

Chemical analyses of water from well 103

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)[3]
7-9-82	99.8	508	920	7.3	265	--
8-10-82	111	--	886	7.2	262	--
8-17-82	113	--	--	--	--	--
8-18-82[1/]	110	--	870	--	--	--
8-24-82	113	--	--	--	--	--
8-31-82	115	--	--	--	--	--
9-8-82	113	510	925	7.3	261	--
9-13-82	110	--	--	--	--	--
9-14-82	111	--	--	--	--	--
9-15-82	109	--	--	--	--	--
9-16-82	129	--	--	--	--	--
9-17-82	114	--	--	--	--	--
10-7-82	113	--	--	--	--	--
11-10-82	112	--	886	7.6	261	--
11-18-82[1/]	112	--	870	--	--	--
12-7-82	116	--	903	7.7	264	--
1-19-83	119	--	880	7.5	259	--
2-25-83	116	--	931	7.1	259	--
3-2-83[1/]	120	--	940	--	--	--
4-21-83	120	--	967	7.0	253	328
6-21-83	124	--	973	7.8	232	--
7-18-83	131	--	972	7.5	253	331
8-15-83	120	--	959	--	252	348
9-8-83	130	--	1,020	--	263	--
10-14-83	134	--	982	7.6	242	231

[1/] By U.S. Geological Survey.

TEST HOLE 4

Location: Lat 15°07'28" N., long 145°43'52" E., at Isley Field.

Drilled: April 16-18, 1979 by Ted Lund Drilling and Supply.

Altitude: 185 ft (See well 4c). Depth: 225 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping test: Apr. 19, 1979: Drawdown, 0.3 ft in 8 hours at pumping rate of 82 gal/min. See pumping test record.

LOG

Description of material	Depth (ft)
Brown clay with hard coral	0-9
White, very hard, broken coral	9-22
Medium hard with hard layers	22-41
Hard with very hard layers	41-54
Very hard, rough drilling	54-58
Hard	58-60
Hard with thin medium hard layers	60-69
Hard with very hard layers	69-106
Hard with medium hard layers	106-131
Medium hard, rough drilling	131-147
Hard rough drilling	147-206
Medium hard, rough drilling	206-223
Medium hard	223-225

Note: When drill bit was pulled out of hole, bit showed stiff white clay.

TEST HOLE 4

PUMPING TEST

Date: April 19, 1979.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1225	--	185.3	--	Static depth to water.
1230	0	--	--	Start of test.
1233	3	185.6	79	
1237	7	185.6	82	Same reading at 1245.
1300	30	185.6	82	Same reading every 30 minutes 1330-2000.
2030	480	185.6	82	End of test.

Water appeared fresh and good tasting.

WELL 4C. Called well 104 (1982).

Location: Same as test hole 4, lat 15°07'28" N., 145°43'52" E., at Isley Field.

Drilled: Aug. 24-25, 1979 reamed from 7-7/8 to 12-1/2 in. by Ted Lund Drilling and Supply.

Altitude: Top of concrete pedestal, 184.95 ft; top well plate, 185.04 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).

Depth: 216 ft.

Diameter of open hole: 12-1/2 in.

Casing: 193 ft of 8-in. steel casing from surface to 192 ft.

Screen: 24 feet of 8-in. stainless screen from 192 to 216 ft.

Gravel pack and grout: 225 gallons of gravel from 170 to 216 ft and 94 bags of cement to 15 ft below surface.

Source of record: Driller.

Pumping test: Aug. 28, 1979: Drawdown, 0.4 ft in 8 hours at pumping rate of 100 gal/min. See pumping test record.

Remarks: Water levels can be measured through hole for power cord in well plate.

Date well brought in production: June 7, 1982.

Chloride concentration and specific conductance of water from well 104

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1540	330	1,630	--	70
11-18-82	1125	310	1,580	28.2	90
3-2-83	1410	360	1,760	27.5	--
6-30-83	1712	380	1,800	28.5	68
9-8-83	0825	380	1,830	28.5	70

WELL 4C. Called well 104 (1982).

PUMPING TEST

Date: August 28, 1979.
Measuring point: 1 ft above ground surface (top of 8-in. casing).

Time	Elapsed time (min)	Depth to water[1/] (ft)	Pumping rate (gal/min)	Remarks
1058	--	393.2	--	Static depth to water.
1100	0	--	--	Start of test.
1101	1	393.6	104	
1103	3	--	99	
1105	5	--	104	Same reading at 1110, 1115.
1130	30	--	104	Same readings every 30 minutes 1200-1830.
1900	480	393.6	99	
1902	482	--	--	End of test.

[1/] Unknown amount to be subtracted from "Depth to water" readings.

Depth to water, in feet

[Source: Northern Marianas Division of Environmental Quality]
Altitude of measuring point: 185.04 ft (top of well plate)

Date	Depth to water	Date	Depth to water	Date	Depth to water
11-21-80 --	182.22	5-4-81 ---	182.27	8-19-81 ---	182.71
12-3-80 ---	181.94	5-7-81 ---	182.19	9-9-81 ----	185.57
12-10-80 --	182.16	5-11-81 --	182.17	9-16-81 ---	186.08
1-5-81 ----	182.31	5-20-81 --	182.09	10-21-81 --	181.74
1-16-81 ---	181.53	5-26-81 --	182.12	10-27-81 --	180.12
1-26-81 ---	181.18	6-9-81 ---	182.24	11-25-81 --	183.45
2-10-81 ---	181.66	6-23-81 --	182.04	12-3-81 ---	181.19
2-19-81 ---	181.58	6-29-81 --	182.27	12-11-81 --	183.21
3-9-81 ----	181.62	7-14-81 --	182.29	12-16-81 --	180.88
3-18-81 ---	182.97	7-28-81 --	182.29	1-6-82 ----	180.75
3-27-81 ---	183.24	8-12-81 --	182.68		

WELL 104 (Previously well 4C, 1979-81)

Chemical analyses of water from well 104

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
8-10-82	318	--	1,620	7.5	271	--
8-17-82	328	--	--	--	--	--
8-24-82	326	--	--	--	--	--
8-31-82	327	--	--	--	--	--
9-8-82	328	882	1,690	7.5	267	--
9-13-82	326	--	--	--	--	--
9-14-82	327	--	--	--	--	--
9-15-82	330	--	--	--	--	--
9-16-82	328	--	--	--	--	--
9-17-82	338	--	--	--	--	--
10-7-82	346	--	--	--	--	--
11-10-82	277	--	1,420	7.8	270	--
12-7-82	327	--	1,680	7.9	273	--
1-19-83	358	--	1,750	7.5	267	--
2-25-83	340	--	1,750	7.3	266	--
4-21-83	365	--	1,750	7.1	262	416
6-20-83	376	--	1,830	7.3	245	--
7-18-83	386	--	1,880	7.3	262	412
8-15-83	375	--	1,880	--	267	425
9-8-83	390	--	1,620	--	276	--
10-14-83	390	--	1,890	7.7	259	--

TEST HOLE 15

Location: Lat 15°07'46" N., long 145°43'34" E., at Isley Field.

Drilled: Feb. 21-25, 1980 by Ted Lund Drilling and Supply.

Altitude: 177 ft (See well 15C). Depth: 192 ft.

Diameter of open hole: 7-7/8 inches.

Casing: None.

Source of record: Driller.

Pumping test: Feb. 26, 1980: Drawdown, 1.1 ft in 16 hours at pumping rate of 94 gal/min.; chloride, 125-154 mg/L. See pumping test record.

LOG

Description of material	Depth (ft)
Black clay	0-9
White coral, medium hard	2-10
White, hard coral	10-18
White, medium hard coral	18-39
Yellow brown coral	39-50
White coral with brown and pink clay intermixed	50-105
White coral with some brown and pink clay	105-148
Coral with brown clay	148-170
White, medium hard coral	170-185
Note: Tried to pump well but no water produced	
White, medium hard coral	185-188
White, hard cavernous coral	188-190
White, hard coral	190-192
Note: Good water encountered at 188-190 ft	

TEST HOLE 15

PUMPING TEST

Date: February 26, 1980.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0755	--	176.4	--	--	Static depth to water.
0800	0	--	--	--	Start of test.
0801	1	177.4	--	150	
0802	2	177.5	94	140	
0810	10	177.55	94	130	
0815	15	177.55	94	--	
0830	30	177.55	94	130	
0900	60	177.55	94	130	
0930	90	177.53	94	125	
1000	120	177.50	94	125	
1030	150	177.49	94	130	
1100	180	177.52	94	130	
1130	210	177.52	94	135	
1200	240	177.50	94	137	
1230	270	177.50	94	134	
1300	300	177.50	94	137	
1330	330	177.51	94	134	
1400	360	177.50	94	137	
1430	390	177.51	94	137	
1500	420	177.50	94	140	
1530	450	177.51	94	137	
1600	480	177.51	94	137	
1630	510	177.52	94	133	
1700	540	177.51	94	137	
1730	570	177.51	94	135	
1800	600	177.50	94	137	
1830	630	177.51	94	140	
1900	660	177.51	94	143	
1930	690	177.50	94	134	
2000	720	177.53	94	141	
2030	750	177.50	94	136	
2100	780	177.50	94	141	
2130	810	177.52	94	141	
2200	840	177.52	94	147	
2230	870	177.53	94	149	
2300	930	177.52	94	154	
2400	960	177.53	94	152	End of test.

WELL 15C. Called well 105 (1982)

Location: Same as test hole 15, lat 15°07'46" N., long 145°43'34" E., at Isley Field.

Drilled: Mar. 4-5, 1980 reamed from 7-7/8 to 14-1/2 in. by Ted Lund Drilling and Supply.

Altitude: Concrete pedestal, 177.39 ft; well plate, 177.44 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).

Depth: 191 ft.

Diameter of open hole: 14-1/2 in.

Casing: 10-in. steel casing, solid to 174 ft.

Screen: 16 ft of 10-in. stainless steel screen from 174 to 190 ft.

Gravel pack and grout: Used 200 gallons of gravel from 150 to 190 ft. Gravel sealed with four sacks of cement.

Source of record: Driller.

Pumping tests: Mar. 9, 1980: Pumped hole to clear of cuttings. Water clear and drawdown 12-1/2 ft at pumping rate of 100 gal/min.

Mar. 10, 1980: Drawdown, 1.1 ft in 7 hours at pumping rate of 94 gal/min.; chloride, 150-160 mg/L; recovery none in 8 minutes.

See pumping test record.

Depth to water, in feet

[Source: Northern Marianas Division of Environmental Quality]
Altitude of measuring point: 177.44 ft (top of well plate)

Date	Depth to water	Date	Depth to water	
11-21-80 ---	173.98	5-26-81 ----	175.07	
12-3-80 ----	173.91	6-9-81 -----	175.15	
12-10-80 ---	174.03	6-23-81 ----	175.08	
1-21-81 ----	173.96	6-29-81 ----	174.28	
1-26-81 ----	173.79	7-14-81 ----	174.31	
2-5-81 -----	173.84	7-24-81 ----	174.29	
2-10-81 ----	173.80	7-28-81 ----	174.24	
2-19-81 ----	173.87	8-12-81 ----	173.43	
3-9-81 -----	173.61	8-19-81 ----	172.95	
3-18-81 ----	174.83	9-9-81 -----	174.05	
3-27-81 ----	174.86	10-9-81 ----	173.79	Total depth, 188.81.
5-4-81 -----	174.31	10-21-81 ---	173.52	
5-7-81 -----	174.33	10-27-81 ---	172.97	
5-11-81 ----	174.23	12-3-81 ----	173.00	
5-20-81 ----	175.04			

WELL 15C. Called well 105 (1982)

PUMPING TEST

Date: March 10, 1980.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride[1/] (mg/L)	Remarks
0828	--	176.4	--	--	Static depth to water.
0830	0	177.85	--	--	Start of test.
0831	1	177.88	--	--	
0832	2	177.90	94	--	
0833	3	177.89	--	--	
0834	4	177.90	--	--	
0835	5	177.92	94	--	
0840	10	177.96	94	160	
0900	30	177.98	94	--	
0930	60	177.99	94	160	
1000	90	177.97	94	--	
1030	120	177.95	94	--	
1100	150	177.85	94	155	
1130	180	177.70	94	--	
1200	210	177.55	94	150	
1230	240	177.70	94	--	
1300	270	177.55	94	150	
1330	300	177.50	--	--	
1400	330	177.50	94	158	
1430	360	177.60	94	160	
1500	390	177.50	94	160	
1526	416	177.50	94	160	
1530	420				End of pumping test.
Recovery					
1530	0	--			Start of recovery test.
1531:00	1	177.45			
1531:15	1-1/4	177.55			
1531:30	1-1/2	177.53			
1531:45	1-3/4	177.55			
1532	2	177.54			
1533	3	177.52			
1534	4	177.52			
1535	5	177.50			
1536	6	177.50			
1537	7	177.50			
1538	8	177.51			End of test.

[1/] Chloride readings by D. A. Davis, U.S. Geological Survey.

WELL 105 (Previously well 15C, 1980-81)

Chemical analyses of water from well 105

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
12-3-81	116	--	--	--	--	--
12-9-81	190	--	--	--	--	--
12-14-81	219	--	--	--	--	--
12-28-81	281	806	1,610	7.3	0.28	--
1-14-82	291	--	--	--	--	--
1-18-81	306	--	--	--	--	--
1-27-81	281	766	1,410	7.8	.39	--
2-1-81	298	--	--	--	--	--
2-16-82	306	--	--	--	--	--
2-8-82	292	900	1,640	7.9	.28	--
2-22-82	307	--	--	--	--	--
3-1-82	319	--	--	--	--	--
3-5-82	316	--	--	--	--	--
3-8-82	307	930	1,650	7.5	.13	--
3-12-82	319	--	--	--	--	--
4-5-82	321	--	--	--	--	--
4-26-82	329	--	--	--	--	--
4-12-82	319	910	1,670	7.3	.22	--
5-3-82	322	998	1,710	7.4	.23	--
5-10-82	328	--	--	--	--	--
5-17-82	336	--	--	--	--	--
6-4-82	361	--	--	7.4	--	231
6-7-82	342	--	--	--	--	--
6-14-82	326	--	--	--	--	--
6-28-82	421	--	--	--	--	--
7-6-82	303	--	--	--	--	--
7-7-82	306	--	--	--	--	--
7-8-82	300	--	--	--	--	--
8-10-82	305	--	1,620	7.4	--	270
8-17-82	328	--	--	--	--	--
8-24-82	318	--	--	--	--	--
9-8-82	308	852	1,630	7.7	--	269
9-14-82	294	--	--	--	--	--
9-15-82	305	--	--	--	--	--
9-16-82	303	--	--	--	--	--
9-17-82	295	--	--	--	--	--
10-7-82	318	--	--	--	--	--
11-10-82	311	--	1,580	7.9	--	271
12-7-82	323	--	1,690	8.0	--	271
1-19-83	335	--	1,670	7.8	--	263
2-25-83	333	--	1,730	7.6	--	266

WELL 105 (Previously well 15C, 1980-81)

Chemical analyses of water from well 105--Continued

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
4-12-83[1/]	350	--	1,750	7.3	--	263
6-20-83	359	--	1,840	7.4	--	241
7-18-83	377	--	1,870	7.5	--	266
8-15-83[2/]	378	--	1,880	--	--	265
9-8-83	380	--	1,880	--	--	271
10-14-83	402	--	1,980	7.8	--	259

[1/] Hardness as $CaCO_3$, 412 mg/L.
[2/] Hardness as $CaCO_3$, 415 mg/L.

Chloride concentration and specific conductance of water from well 105

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1545	310	1,580	29.0	76
11-18-82	1140	320	1,620	28.2	--
3-2-83	1415	360	1,730	28.0	--
6-30-83	1130	370	1,790	29.0	--
9-8-83	0820	400	1,880	29.0	--

TEST HOLE 16

Location: Lat 15°07'53" N., long 145°43'34" E., north of Isley Field.
Drilled: Mar. 26-28, 1980 by Ted Lund Drilling and Supply.
Altitude: 175 ft (from topographic map). Depth: 191 ft.
Diameter of open hole: 7-7/8 in.
Casing: None.
Source of record: Driller.
Pumping tests: Apr. 7, 1980: Well producing 25 gal/min clear water; chloride, 320 mg/L increasing to 340 mg/L.
Apr. 8, 1980: Drawdown, more than 5.75 ft in 8 hours at pumping rate of 33 gal/min; chloride, 355-390 mg/L; recovery, 5.9 ft in 9-1/2 minutes. See pumping test record.
Hole abandoned and sealed, May 12, 1980.

LOG

Description of material	Depth (ft)
Black clay	0-3
White coral	3-9
White coral with yellow clay	9-18
White and pink coral	18-23
White and pink, hard coral	23-32
White coral with red clay layers	32-91
Medium hard coral with soft, chalky layers	91-148
Medium hard, cavernous coral	148-165
Medium soft, chalky coral	165-178
White, soft, chalky coral	178-191

TEST HOLE 16

PUMPING TEST

Date: April 8, 1980.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1145	--	171.55	--	--	Static depth to water (by electric sounder).
1200	0	--	--	--	Start of test.
1201	1	--	33	355	Pump drawing air.
1205	5	--	33	--	
1210	10	--	33	--	
1215	30	--	33	360	
1300	60	--	33	360	
1330	90	--	33	--	
1400	120	--	33	370	
1430	150	--	33	370	
1500	180	--	33	370	
1530	210	--	30	--	
1600	240	--	33	--	
1630	270	--	33	370	
1700	300	--	33	--	
1730	330	--	33	--	
1800	360	--	33	--	
1830	390	--	33	390	
1900	420	--	33	--	
1930	450	--	33	385	
2000	480	--	33	390	End of test.
Recovery					
2000	0	--			Start of recovery test.
2001	1	171.3			
2003	3	171.6			
2005	5	171.5			
2008	8	171.7			
2009	9	171.7			
2010	10	171.7			End of test.

EXPLORATORY HOLE 3 (EXH-3)

Location: Lat 15°07'21" N., long 145°43'42" E., near well 103, Isley Field.

Drilled: May 1981 by Geo-Engineering and Testing.

Altitude: About 205 ft.

Depth: Abandoned at 160-170 ft.

LOG

Description of material	Depth (ft)
Yellow-brown limestone, weak to moderately hard with solution tubes and cavities	0-15
Coring started at 15 ft	
Yellow-brown coralline limestone with abundant solution tubes, cavities and coral gravel	15-30
Yellow-white limestone, moderately hard	30-56
Lost circulation at 35 ft. Core stuck at 56 ft	
Yellow-light gray-white coralline limestone	56-75
White limestone, porous, very poor recovery	75-100
No recovery 100-160 ft. Core stuck at 160-170 ft and could not be pulled out. Hole abandoned.	

EXPLORATORY HOLE 3A (EXH-3A)

Location: Lat 15°07'21" N., long 145°43'41" E., about 40 ft from well 103, Isley Field.

Drilled: May 1981 by Geo-Engineering and Testing.

Altitude: Top of casing, 204.92 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).

Depth: 257 ft.

Depth to water, in feet

[Source: Northern Marianas Division of Environmental Quality]
Altitude of measuring point: 204.92 ft (top of casing)

Date	Depth to water	Date	Depth to water	Date	Depth to water
4-29-81 ---	204.21	6-9-81 ---	204.06	10-27-81 --	201.90
5-4-81 ----	204.17	6-23-81 --	203.381	1-25-81 ---	201.76
5-7-81 ----	204.11	6-29-81 --	203.51	12-3-81 ---	200.62
5-11-81 ---	203.94	7-14-81 --	203.49	12-11-81 --	200.27
5-20-81 ---	203.91	7-27-81 --	203.49	12-16-81 --	200.07
5-26-81 ---	203.89	8-12-81 --	201.90	1-6-82 ----	199.87

LOG

Description of material	Depth (ft)
Brown, silty, sandy gravel, moderately dense	0-1
Red brown clayey silt, moderately stiff	1-3
Light brown limestone, moderately hard	3-10
Light brown limestone, hard	10-20
Light brown-white limestone, hard	20-60
Lost circulation at 35 ft	
Light brown-white limestone, moderately hard	60-140
Medium hard limestone	140-235
Color blue-gray and clayey	235-239
Red brown-dark gray volcanic rock (Donni sandstone)	239-256
Dark blue-gray volcanic rock (hard drilling)	256-257

WELL 101A

Location: Lat 15°07'25" N., long 145°43'47" E., at Isley Field.

Drilled: Feb. 17, 1982 by Geo-Engineering and Testing.

Altitude: 201.50 ft. Depth: 240 ft.

Diameter of open hole: 8 in.

Casing: None.

Source of record: Driller.

Pumping test: Feb. 25, 1982: Drawdown, 0.4 ft in 4-1/2 hours at pumping rate of 45 gal/min. See pumping test record.

LOG

Description of material	Depth (ft)
Limestone base with boulders	0-3
White to light brown, hard limestone	3-20
Yellow-brown, hard to moderately hard limestone	20-37
Dark yellow, hard to moderately hard limestone	37-45
Light brown, moderately hard limestone	45-50
White, hard limestone	50-68
Yellow, moderately hard limestone	68-75
White limestone	75-90
Moderately hard limestone	90-240

PUMPING TEST

Date: February 25, 1982.
Static depth to water, 199.6 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1155	0	199.6	--	Start of test.
1200	5	199.9	45	
1205	10	200.0	45	Same reading every 5 minutes. 1210-1255, every 10 minutes. 1305-1355, and every 30 minutes. 1355-1555.
1625	270	200.0	--	End of test.

WELL 101B. (Called well 101)

Location: Same as well 101A, lat 15°07'25" N., long 145°43'47" E., at Isley Field.

Reamed: May 1982 by Geo-Engineering and Testing.

Altitude: Concrete pedestal, 202.44 ft; well plate, 202.40 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).

Depth: 235 ft.

Diameter of open hole: 12 in.

Casing: Solid 8-in. casing to 209 ft with 26 ft screen below.

Source of record: Drillers log.

Pumping test: May 19-20, 1982: Drawdown, 0.5 ft in 12 hours at pumping rate of 106-110 gal/min. See pumping test record.

Static depth to water: 200.57 ft, Apr. 5, 1983 (USGS).

Date well brought in production: June 16, 1982.

LOG

Description of material	Depth (ft)
Yellow brown clay silt with abundant clay silt boulders ------	10-40
Yellow brown, moderately hard limestone ----------	40-76
Yellow white, moderately hard limestone ----------	70-130
White, hard limestone ----------	130-235

WELL 101. (Previously well 101B)

Chemical analyses of water from well 101

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
6-30-82	122	--	--	--	--	--
7-1-82	123	--	--	--	--	--
7-2-82	128	--	--	--	--	--
7-6-82	134	--	--	--	--	--
7-7-82	129	--	--	--	--	--
7-8-82	136	--	--	--	--	--
7-9-82	137	612	1,040	7.4	0.10	269
8-10-82	179	--	1,170	7.3	--	264
8-17-82	185	--	--	--	--	--
8-24-82	204	--	1,160	--	--	--
8-31-82	195	--	--	--	--	--
9-8-82	204	686	1,230	7.3	--	262
9-13-82	199	--	--	--	--	--
9-14-82	205	--	--	--	--	--
9-15-82	199	--	--	--	--	--
9-16-82	207	--	--	--	--	--
9-17-82	208	--	--	--	--	--
10-7-82	228	--	--	--	--	--
11-10-82	192	--	1,080	7.5	--	220
12-7-82	216	--	1,300	7.6	--	268
1-19-83	254	--	1,430	7.5	--	254
2-25-83	280	--	1,520	7.3	--	262
4-21-83	315	--	1,590	7.1	--	256
7-18-83	392	--	1,870	7.3	--	257
8-15-83	381	--	1,970	--	--	259
9-8-83	410	--	1,800	--	--	259
10-14-83	433	--	1,980	7.5	--	220

Hardness as $CaCO_3$: 4-21-83, 412 mg/L; 7-18-83, 435 mg/L; 8-15-83, 447 mg/L.

WELL 101B. (Called well 101)

Chloride concentration and specific conductance of water from well 101

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1530	180	1,160	--	70
11-18-82	1105	190	1,160	28.1	70
3-2-83	1400	300	1,490	28.5	65
6-30-83	1655	370	1,790	28.5	70
9-8-83	0900	430	--	28.5	70

PUMPING TEST

Date: May 19-20, 1982.
Static depth to water, 199.0 ft; pump intake at 216 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
May 19				
1243	0	199.0	--	Start of test.
1248	5	199.8	110	Same reading every 5 minutes. 1248-1313.
1328	45	199.8	106	Same reading every 45 minutes. 1328-1443 and every 30 minutes. 1443-1913.
1943	420	199.5	106	Same reading every 30 minutes. 1943-0043.
May 20				
0043	720	199.5	--	End of test.

WELL 102

Location: Lat 15°07'30" N., long 145°43'43" E., at Isley Field.

Drilled: Mar. 1-5, 1982; reamed May 1982 by Geo-Engineering and Testing.

Altitude: Concrete pedestal, 190.63 ft; well plate, 190.68 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).

Depth: 230 ft.

Diameter of open hole: 8-in. pilot, reamed to 12 in.

Casing: Solid 8-in. casing to 190 ft with 30 ft screen below.

Source of record: Driller.

Pumping tests: Mar. 5, 1982: Drawdown, 0.1 ft in 5 hours at pumping rate of 45 gal/min; chloride, 200-239 mg/L; recovery immediately. See pumping test record.

May 12-13, 1982: Drawdown, 0.1 ft in 24 hours at pumping rate of 106 gal/min; chloride, 112 mg/L. See pumping test record.

Date well brought in production: June 26, 1982.

WELL 102

Chemical analyses of water from well 102

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
7-1-82	77.0	--	--	--	--	--
7-2-82	87.3	--	--	--	--	--
7-6-82	98.7	--	--	--	--	--
7-7-82	88.7	--	--	--	--	--
7-8-82	105	--	--	--	--	--
7-9-82	105	496	922	7.4	272	--
8-10-82	127	--	999	7.4	274	--
8-17-82	133	--	--	--	--	--
8-24-82	143	--	--	--	--	--
8-31-82	144	--	--	--	--	--
9-8-82	145	570	1,050	7.3	272	--
9-13-82	147	--	--	--	--	--
9-14-82	149	--	--	--	--	--
9-15-82	148	--	--	--	--	--
9-16-82	131	--	--	--	--	--
9-17-82	150	--	--	--	--	--
10-7-82	175	--	--	--	--	--
11-10-82	178	--	1,100	7.56	267	--
12-7-82	186	--	1,190	7.8	275	--
1-19-83	221	--	1,310	7.4	266	--
2-25-83	245	--	1,420	7.2	266	--
4-21-83	285	--	1,540	7.0	259	392
6-20-83	323	--	1,660	8.0	260	--
7-18-83	323	--	1,630	7.2	257	396
8-15-83	324	--	1,690	--	266	403
9-8-83	340	--	1,700	--	263	--
10-14-83	321	--	1,650	7.5	254	361

WELL 102

Chloride concentration and specific conductance of water from well 102

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1525	130	980	29.0	73
11-18-82	1055	180	1,120	--	80
3-2-83	1335	260	1,420	27.5	75
6-30-83	1608	320	1,640	28.5	75
9-8-83	0850	350	1,700	28.5	57

LOG

Description of material	Depth (ft)
Base coarse limestone gravel	0-2
Dark brown, clayey silt, medium stiff with limestone boulders	2-3
Yellow brown, hard limestone with massive recrystalized boulders	3-30
Yellow brown, moderately hard limestone	30-35
Yellow brown, hard limestone	35-65
Lost circulation 45-55 ft	
Yellow brown, moderately hard limestone	65-80
White limestone	80-90
White limestone with occasional recrystalized fragments	90-185
Hard limestone	185-205
Very hard limestone	205-215
Moderately hard limestone with occasional boulders	215-230

WELL 102

PUMPING TEST

Date: March 5, 1982.
Static depth to water, 186.7 ft; pump intake at 213 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1055	0	186.7	--	--	Start of test.
1100	5	186.8	45	233	
1105	10	186.8	45	232	Same depth to water and pumping rate 1110, 1115, 1120.
1125	30	186.8	45	--	Same depth to water and pumping rate
1130	35	--	--	239	every 15 minutes 1140-1255 and every 30 minutes 1325-1555.
1200	65	--	--	225	
1230	95	--	--	200	
1300	125	--	--	207	
1430	215	--	--	204	
1600	305	--	--	--	End of pumping test.
Recovery					
1600	0	186.7	--	202	Start of recovery test.
1615	15	186.7	--	--	End of test.

WELL 102

PUMPING TEST

Date: May 12-13, 1982.
Static depth to water, 186.7 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
May 12					
1150	0	186.7	--	--	Start of test.
1152	2	--	106	--	
1220	30	186.8	106	--	Same reading at 1250, 1350, 1620.
1850	420	186.8	106	112	
2110	560	186.8	106	--	
2340	710	186.8	106	--	
May 13					
0210	860	186.8	106	--	Same reading at 0440, 0710.
0940	1310	186.8	106	--	
1150	1440	186.8	106	--	End of test.

WELL 106 (At first called well 103)

Location: Lat 15°07'35" N., long 145°43'40" E., at Isley Field.

Drilled: Mar. 8, 1982; reamed May 1982 by Geo-Engineering and Testing.

Altitude: Concrete pedestal, 180.04 ft; well plate, 180.08 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).

Depth: 220 ft.

Diameter of open hole: 8-in. pilot, reamed to 12 in.

Casing: Solid 8-in. casing to 182 ft with 30 ft of screen below.

Source of record: Driller.

Date well bought in production: June 26, 1982.

Chloride concentration and specific conductance of water from well 106

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1515	300	1,540	29.0	73
11-18-82	1135	340	1,680	28.2	60
3-2-83	1320	360	1,680	28.5	60
4-5-83	--	--	1,720	--	--
6-30-83	1550	400	1,880	29.0	55
9-8-83	0830	430	1,980	28.5	55

WELL 106

Chemical analyses of water from well 106

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
7-01-82	241	--	--	--	--	--
7-02-82	246	--	--	--	--	--
7-06-82	257	--	--	--	--	--
7-07-82	257	--	--	--	--	--
7-08-82	261	--	--	--	--	--
7-09-82	263	--	--	--	--	--
8-10-82	297	--	1,560	7.3	271	--
8-17-82	309	--	--	--	--	--
8-24-82	309	--	--	--	--	--
8-31-82	310	--	--	--	--	--
9-08-82	310	916	1,620	7.5	268	--
9-13-82	303	--	--	--	--	--
9-14-82	310	--	--	--	--	--
9-15-82	318	--	--	--	--	--
9-16-82	313	--	--	--	--	--
9-17-82	316	--	--	--	--	--
10-7-82	331	--	--	--	--	--
11-10-82	335	--	1,670	7.7	271	--
12-7-82	336	--	1,700	8.0	273	--
1-19-83	340	--	1,750	7.6	267	--
2-25-83	305	--	1,780	7.4	266	--
4-21-83	365	--	1,850	7.1	259	424
6-20-83	258	--	1,470	7.8	257	--
7-18-83	402	--	1,950	7.3	257	423
8-15-83	410	--	1,960	--	261	435
9-8-83	420	--	1,960	--	266	--
10-14-83	437	--	2,060	7.6	259	--

WELL 106

LOG

8-inch diameter pilot hole.

Description of material	Depth (ft)
Base coarse	0-2
Dark brown, clayey silt (stiff)	2-4
Yellowish brown limestone, hard to very hard with recrystalized boulders	4-10
Light brown limestone, moderately hard to hard (lost circulation at 15 ft)	10-30
Yellow, hard limestone (regained circulation at 41 ft)	30-50
Moderately hard limestone	50-65
Hard limestone with recrystalized boulders	65-85
Light brown to white limestone, moderately hard (penetration rate 1 1/2 min/foot)	85-140
Color light brown to white, moderately hard	140-220

PUMPING TEST

Date: May 3-4, 1982.
Static depth to water, 176.2 ft; pump intake at 193 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
May 3				
1640	0	176.2	--	Start of 24-hour test.
1645	5	176.3	114	Same reading every 5 minutes 1650-1710, every 15 minutes. 1725-1840, and every 30 minutes, 1910 (May 3) to 1610 (May 4).
May 4				
1640	1440	176.3	114	End of 24-hour test.

WELL 107

Location: Lat 15°07'32" N., long 145°43'41" E., at Isley Field.
Drilled: Apr. 23-24, 1982 by Pacific Drilling Inc.
Altitude: Concrete pedestal, 184.28 ft; well plate 184.33 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).
Depth: 208 ft.
Diameter of open hole: 12 in.
Casing: Solid 8-in. casing to 171 ft with 32 ft of screen below.
Gravel pack and grout: Gravel at lower 48 ft.
Source of record: Driller.
Pumping test: Apr. 26, 1982: Drawdown, 0.2 ft in 5 hours at pumping rate of 73-85 gal/min; recovery within 1 minute. See pumping record.
June 29, 1982: Drawdown, 0.1 ft in 6 hours at pumping rate of 65-80 gal/min; chloride, 105-118 mg/L. See pumping test record.
Static depth to water: 182.79 ft, Apr. 5, 1983 (USGS).
Date well bought in production: June 27, 1982.

Chloride concentration and specific conductance of water from well 107

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1520	170	1,120	29.0	73
11-18-82	1130	190	1,180	28.2	60
3-2-83	1330	240	1,370	26.5	60
4-5-83	--	--	1,350	--	--
6-30-83	1601	260	1,450	29.0	54
9-8-83	0835	260	1,450	28.5	53

WELL 107

Chemical analyses of water from well 107

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
6-28-82 (Pump test)	104	--	--	--	--	--
6-29-82 (12 samples during pump test)	105-118	--	--	--	--	--
6-30-82 (7 samples during pump test)	117-123	--	--	--	--	--
7-1-82	123	--	--	--	--	--
8-10-82	173	--	1,170	7.5	276	--
8-17-82	175	--	--	--	--	--
8-24-82	181	--	1,120	--	--	--
8-31-82	184	--	--	--	--	--
9-8-82	185	628	1,190	7.6	272	--
9-13-82	180	--	--	--	--	--
9-14-82	182	--	--	--	--	--
9-15-82	183	--	--	--	--	--
9-16-82	184	--	--	--	--	--
9-17-82	187	--	--	--	--	--
10-7-82	198	--	--	--	--	--
11-10-82	190	--	1,110	7.8	275	--
12-7-82	198	--	1,240	7.9	274	--
1-19-83	213	--	1,300	7.6	268	--
2-25-83	279	--	1,360	7.5	270	--
4-21-83	250	--	1,410	7.0	262	380
6-20-83	258	--	1,470	7.8	257	--
7-18-83	262	--	1,490	7.3	266	384
8-15-83	260	--	1,500	--	265	389
9-8-83	270	--	1,450	--	265	--
10-14-83	264	--	1,430	7.5	263	--

WELL 107

LOG

Description of material	Depth (ft)
Asphalt	0-0.2
White, coral gravel fill	0.2-1.5
Reddish brown clay with occasional coral gravel	1.5-5
Tan-white corraline limestone (dense to very dense)	5-7
Color tan	7-8
Color white	8-30
Color tan	30-38
Color brown	38-50
Color white	50-190
Color tan	190-195
Color white	195-208

Water at depth of 182.0 ft.

PUMPING TEST

Date: April 26, 1982.
Static depth to water, 182.0 ft; pump intake at 202.5 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1424	0	182.0	--	Start of test.
1425	1	182.8	--	
1426	2	182.4	--	
1427	3	182.2	--	
1428	4	182.4	--	
1429	5	182.2	--	
1430	6	182.3	--	
1431	7	182.2	--	
1432	8	182.2	82.5	
1434	10	182.2	85	
1450	26	--	0	Pumping air. Stopped pump 1453-1455.
1504	40	182.2	79	Same reading at 1514, 1524, 1554, 1624, 1654.
1724	180	182.2	73	
1754	210	182.2	73	
1754	210	182.2	79	Same reading at 1824, 1854.
1924	300	182.2	--	End of pumping test.
Recovery				
1924	0	182.2	--	Start of recovery test.
1925	1	182.0	--	
1929	5	182.0	--	End of test.

WELL 107

PUMPING TEST

Date: June 29, 1982.
Static depth to water, 180.5 ft; pump at 192 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0930	0	180.5	--	Start of test.
0933	3	--	65	
0945	15	180.5	70	
1010	40	--	78	
1020	50	180.7	--	
1035	65	180.7	80	
1100	90	180.7	80	
1115	105	180.6	80	Same reading every 15 minutes 1115-1200 and every 30 minutes 1200-1500.
1530	360	180.6	80	End of test.

Note: 12 chloride analyses made during test, 105-118 mg/L.

WELL 108

Location: Lat 15°07'27" N., long 145°43'44" E., at Isley Field.
Drilled: Apr. 16-18, 1982 by Pacific Drilling Inc.
Altitude: Concrete pedestal, 198.95 ft; well plate, 199.00 ft (levels from TAM 14 by Tom Nance, Oct. 4-5, 1982).
Depth: 227 ft.
Diameter of open hole: 12 in.
Casing: Solid 8-in casing to 193 ft with 32 ft of screen below.
Gravel and pack grout: Gravel at lower 58 ft, sealed with grout.
Source of record: Driller.
Pumping test: Apr. 21, 1982: Drawdown, 0.1 ft in 5 hours at pumping rate of 69-72 gal/min; chloride, 127 mg/L; recovery immediately, with chloride 130 mg/L at end of recovery. See pumping test record.

June 26-27, 1982: Drawdown, 1.0 ft in almost 10 hours at pumping rate of 65-70 gal/min; chloride, 87.3-104 mg/L. See pumping test record.

Chloride concentration and specific conductance of water from well 108

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
11-18-82	1100	190	1,160	28.2	75
3-2-83	1340	260	1,420	27.5	--
6-30-83	1635	320	1,600	28.5	60
9-8-83	0855	340	1,680	28.5	70

WELL 108

Chemical analyses of water from well 108

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
7-9-82	121	--	--	--	--	--
8-31-82	131	--	--	--	--	--
9-8-82	144	572	999	7.5	266	--
9-13-82	159	--	--	--	--	--
9-14-82	155	--	--	--	--	--
9-15-82	159	--	--	--	--	--
9-16-82	158	--	--	--	--	--
9-17-82	162	--	--	--	--	--
10-7-82	169	--	--	--	--	--
11-10-82	194	--	1,100	--	--	--
12-7-82	202	--	1,210	--	--	--
1-19-83	233	--	1,320	--	--	--
2-25-83	245	--	1,390	--	--	--
3-23-83	261	--	1,460	--	--	--
4-21-83	285	--	1,480	7.0	256	392
6-20-83	304	--	1,560	7.7	262	--
7-18-83	303	--	1,620	7.4	257	396
8-15-83	322	--	1,640	--	261	405
9-8-83	340	--	1,670	--	267	--
10-14-83	338	--	1,720	7.5	259	--

LOG

Description of material	Depth (ft)
Asphalt	0-0.2
Reddish-brown clay silt with occasional dense limestone	0.2
Tan-white corraline limestone (dense to very dense)	-8
Color white	8-23
Color tan	23-25
Color tan-brown	35-40
Reddish-brown clay silt with tan corraline limestone	40-60
White corraline limestone (dense)	60-230
Cave-in	218-225
Very hard drilling	228-230

WELL 108

PUMPING TEST

Date: April 21, 1982.
Static depth to water, 196.6 ft; pump intake at 223 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1014	0	196.6	--	--	Start of test.
1015	1	196.8	--	--	Same reading at 1016, 1017.
1018	4	196.6	--	--	
1019	5	196.8	--	--	Same reading at 1020, 1021.
1022	8	197.0	--	--	
1023	9	196.8	--	--	
1024	10	196.8	70	--	
1034	20	196.9	70	--	
1044	30	196.8	72	--	Same reading at 1054, 1104.
1114	60	196.8	70	--	
1144	90	196.8	72	--	Same reading at 1214.
1244	150	196.7	70	--	Same reading at 1314, 1344.
1414	240	196.7	69	--	
1514	300	196.7	--	--	End of pumping test.
Recovery					
1514	0	196.7	--	--	Start of recovery test.
1515	1	196.6	--	--	
1519	5	196.6	--	130	End of test.

Note: Pump not operating from 1311 to 1320.

WELL 108

PUMPING TEST

Date: June 26-27, 1982.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1712	0	196.4	--	Static depth to water. Start of test.
1715	3	197.1	65	
1742	30	197.0	--	
1753	41	197.2	65	
1805	53	197.4	--	
1815	63	--	70	
1827	75	197.5	--	
1920	128	197.4	70	Same readings at 2020, 2040, 2130, 2205, 2235, 2300, and every hour till 0300 June 27, 1982.
0300	588	197.4	--	End of test.

Note: 23 chloride analyses made during test, 87.3-104 mg/L.

WELL 109

Location: Lat 15°07'19" N., long 145°43'45" E., at Isley Field.

Drilled: Sept. 28-30, 1982 by Geo-Engineering and Testing.

Altitude: About 201.41 ft. Depth: 220 ft.

Diameter of open hole: 7 in. pilot.

Casing: None.

Pumping test: Oct. 1, 1982: Drawdown, 0.8 ft in 3 hours at pumping rate of 87-94 gal/min. See pumping test record.

Chemical analyses of water from well 109

[Sources: Water Quality Laboratory, Commonwealth of the Northern Mariana Islands, and the U.S. Geological Survey*]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Temperature (°C)	Hardness as $CaCO_3$ (mg/L)	Pumping rate (gal/min)
2-25-83	406	1,870	7.4	--	--	--	--
3-2-83*	410	1,890	--	--	28.0	--	65
3-23-83	401	1,900	--	--	--	--	--
4-5-83*	--	1,860	--	--	28.5	--	65
4-21-83	400	1,880	7.1	250	--	444	--
6-20-83	408	1,910	8.0	249	--	--	--
6-30-83*	400	1,870	--		25.9	--	65
7-18-83	407	1,870	7.2	250	--	400	--
8-15-83	398	1,880	--	250	--	445	--
9-8-83	400	1,790	--	259	--	--	--
10-14-83	406	1,910	7.5	250	--	--	--

WELL 109

LOG

Description of material	Depth (ft)
Asphalt concrete	0-2
White limestone	2-27
Light brown - white limestone	27-52
Light yellow-brown limestone	52-53
White limestone	53-62
Light brown-white limestone	62-88
White limestone	88-220

Note: All drilling was moderately hard.

PUMPING TEST

Date: October 12, 1982.
Static depth to water, 201.8 ft; pump intake at 210 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1318	0			Start of test.
1319	1	202.7	94	
1321	3	202.8	94	
1323	5	202.6	94	
1325	7	202.6	94	Same reading every 5 minutes 1325-1400.
1405	47	202.6	92	Same reading every 5 minutes 1405-1440.
1450	92	202.6	87	
1500	102	202.6	89	Same reading every 10 minutes 1500-1610.
1620	182			End of test.

Table 26. Testholes and wells drilled at Kobler Field (As Gonna)

Testhole and well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			Prior to 1944			
W As Gonna A.	--	--	--	36.15	40	Well dug during Japanese Administration.
W As Gonna B.	15°07'01"	145°42'46"	--	97	113	Do.
			1944-45			
W 1	15°07'27"	145°43'09"	July 11, 1944	106.39	127	Contaminated with spilled gasoline.
W 2	15°07'56"	145°42'55"	July 17, 1944	88.84	124	Brackish water.
W 46	15°07'20"	145°42'59"	Mar. 28, 1945	100.44	110	Abandoned (broken pump shaft).
W 49	15°07'23"	145°43'04"	Apr. 17, 1945	102.42	112	Abandoned in 1948 (broken pump shaft).
W 52	15°07'10"	145°42'51"	May 1, 1945	97.06	110	
W 54	15°07'27"	145°43'04"	Apr. 25, 1945	94	105	
W 55	15°07'06"	145°42'48"	May 7, 1945	99.46	115	No equipment to operate well.
W 56	15°07'29"	145°43'08"	May 3, 1945	101.1	110	Abandoned in 1947.
W 57	15°07'20"	145°43'05"	May 10, 1945	128.8	135	Abandoned in 1952.
Maui I	15°07'16"	145°42'58"	July 1945	99.7	107.7	
			1971			
W 9	15°07'30"	145°42'58"	May 1971	1/ 101.40	120	
W 10	15°07'37"	145°42'54"	June 3, 1971	1/ 105.61	127	
W 11	15°07'24"	145°43'07"	July 1971	1/ 100.58	120	
			1977			
TH 12	--	--	Feb. 2, 1977	92	150	Hole caved in.
TH 12A	--	--	Apr. 25, 1977	92.13	120	
TH 15	15°07'23"	145°43'00"	Jan. 31, 1977	105.98	146	
W 15	do.	do.	May 2, 1977	1/ 107.75	135	
TH 16	15°07'28"	145°42'59"	May 14, 1977	103.36	126	
W 16	do.	do.	May 19, 1977	1/ 104.39	126	
TH 17A	--	--	Feb. 15, 1977	105.13	125	No water found.
TH 17B	15°07'26"	145°42'55"	June 7, 1977	105	150	
W 17B	do.	do.	June 10, 1977	105	150	Could not remove conductor casing.
W 17BB	do.	do.	June 16, 1977	1/ 106.48	140	Ten feet from TH 17B.
TH 17D	--	--	July 9, 1977	105	130	
TH 17	--	--	July 13, 1977	105	130	
TH 18	--	--	Feb. 19, 1977	--	116	No water found.

Table 26. Testholes and wells drilled at Kobler Field (As Gonna)--Continued

Testhole and well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1982			
W 111	15°07'24"	145°43'00"	Mar. 10, 1982	1/ 107.12	127	
W 112	15°07'33"	145°43'04"	Mar. 30, 1982	1/ 130.97	170	
W 113	15°07'36"	145°43'02"	Mar. 26, 1982	1/ 92.65	130	
			1983			
W 116	15°07'34"	145°42'54"	February 1983	107.71	147	Abandoned; low yield.
W 116A	15°07'36"	145°42'53"	do.	108.45	131	Later called well 116.

1/ Altitude of well plate, levels of October 4-5, 1982.

WELL As Gonna A

Location: Agingan, S. W. Saipan.
Drilled: Well is a 15 x 20-ft rectangular pit dug in coral by the Japanese prior to 1944.
Altitude: 36.15 ft. Depth: 40 ft.
Source of record: Glander (1946).
Remarks: Chloride: 300 ppm, July 2, 1944 (Stearns, 1944).
370 ppm (Glander, 1946).
Pumpage: 100,000 gal/d, Sept. 6, 1944 (Stearns, 1944).
50,000 gal/d (Glander, 1946).
pH: 7.4-7.6.

Well was connected by a 4-inch transite pipe to As Gonna B well.
Well was not used by the Japanese prior to the American invasion because of high salinity (Piper, 1946-47, from Stearns, 1944, citing a Japanese map dated March 1944).
Well was not used by U.S. Forces because of high bacterial count (Glander, 1946).

WELL As Gonna B

Location: Lat 15°07'01" N., long 145°42'46" E., between Kobler and Isley Field.

Drilled: Well was dug by the Japanese prior to 1944.

Altitude: 97 ft. Depth: 113 ft.

Casing: 24-in. wood stave.

Source of record: Glander (1946).

Remarks: Chloride: 40 ppm, July 2, 1944, during pumping (Stearns, 1944).
70 ppm, September 1944 (Stearns, 1944).
1,170 ppm, May 8, 1952 at 1045 (field notes Ted Arnow).
1,320 ppm, Aug. 13, 1952 at 1610.[1/]

Pumpage: 72,800 gal/d, Sept. 6, 1944 (Stearns, 1944).
70,000-160,000 gal/d (Glander, 1946).

For chemical analysis, see table 70.

Well was still in use in 1949 (Curione, 1949) and was removed from system in October 1952 (field notes Ted Arnow).

[1/] Written communication, Ted Arnow to Commander Naval Forces Marianas, Jan. 22, 1953.

WELL 1

Location: Lat 15°07'27" N., long 145°43'09" E., at Kobler Field (As Gonna). Drilled to supply water for Isley Field and to determine extent of As Gonna basin.

Drilled: July 3-11, 1944 by U.S. Marine Corps, 7th Field Depot.

Altitude: 106.39 ft. Depth: 127 ft.

Casing: 8 in. to 125 ft.

Aquifer: Limestone.

Remarks: Water was found at depth of 105.18 ft.

Chloride: 15 ppm, at completion.
14 ppm, Aug. 2, 1944, before and after pumping (Stearns, 1944).
15 ppm, Sept. 2, 1944 (Stearns, 1944).
30 ppm, (Glander, 1946).

Pumpage: 150,000 gal/d, at completion (log).
158,400 gal/d, Sept. 6, 1944 (Stearns, 1944).
100,000-150,000 gal/d (Brown, 1944[1/]).
180,000 gal/d, some gasoline odor (Boniface, 1945).
50,000 gal/d (Stock, 1945[2/]).
40,000-60,000 gal/d (Glander, 1946).

For chemical analysis, see table 70.

In 1944 or 1945, well was contaminated with gasoline spilled nearby; thereafter water was not used for drinking. Well was abandoned in 1947 (written communication W. A. Ross to Public Works Officer, Dec. 17, 1948).

1/ Supplemental report on well drilling, unpublished memorandum, 1944, 3 p.

2/ Written communication, T. S. Stock to Commanding Officer, Nov. 7, 1945.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Limestone	0-127

WELL 2

Location: About lat 15°07'56" N., long 145°42'55" E., 3,100 ft northeast of well 1, at old 7th Field Depot, Kobler Field.

Drilled: July 13-17, 1944 by U.S. Marine Corps, 7th Field Depot.

Altitude: 88.84 ft. Depth: 124 ft.

Diameter of open hole: 7 in.

Casing: 6 in. to 114 ft.

Aquifer: Limestone.

Source of record: H. T. Stearns (1944) and others.

Remarks: Water was found at depth of 108 ft. Hole had 35 ft of water when completed (Stearns, 1944).

Chloride: 245 ppm, July 19, 1944 after 1/2 hour of pumping at rate of 72,000 gal/d (Stearns, 1944).

270 ppm, Aug. 21, 1944, after one month of light pumping (Stearns, 1944) at rate of 72,000 gal/d (Glander, 1946).

Well reported abandoned after 1 month of use because of high salinity; well continued to be brackish even after heavy rains (Stearns, 1944).

LOG
[Source: H. T. Stearns]

Description of material	Depth (ft)
Reddish brown soil	0-20
Limestone	20-50
Broken limestone and red mud	50-60
Clean white limestone	60-95
Volcanic gravel and limestone (struck water at 108 ft)	95-110
Volcanic sand and limestone	110-120
White limestone	120-124

WELL 46

Location: Lat 15°07'20" N., long 145°42'59" E., at Kobler Field (As Gonna).
Drilled: Mar. 24-28, 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 100.44 ft. Depth: 110 ft.
Casing: 6 in. to 110 ft with lower 20 ft perforated.
Aquifer: Limestone.
Remarks: Water was found at depth of 101 ft. Depth to water before pumping, 97.5 ft.
Well was shot with 25 lb TNT between 101 and 104.5 ft and with 100 lb TNT between 100 and 106.5 ft.
Chloride: 40 ppm (Glander, 1946).
Pumpage: 200,000 gal/d, at completion (log).
185,000 gal/d (Boniface, 1945).
60,000 gal/d (Glander, 1946).
22,000 gal/d (Davis, 1948).
pH: 7.0-7.2 (Glander, 1946).

Well abandoned in 1948 because of broken pump shaft (written communication, W. A. Ross to Public Works Officer, Dec. 17, 1948).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Surface soil	0-2
Hard coral	2-30
White lime rock	30-38
Yellow clay and gravel	38-52
Hard coral	52-65
Soft white coral	65-95
Hard yellow coral (struck water at 101 ft)	95-101
Fine yellow coral	101-110

WELL 49

Location: Lat 15°07'23" N., long 145°43'04" E., at Kobler Field (As Gonna).
Drilled: Apr. 8-17, 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 102.42 ft. Depth: 112 ft.
Casing: 6 in. to 112 ft with lower 20 ft perforated.
Aquifer: Limestone.
Remarks: Water was found at depth of 105 ft.
Water level before pumping, 102 ft.
Well shot with 25 lb and 125 lb TNT.
Chloride: 40 ppm (Glander, 1946).
30-40 ppm (Piper, 1946-47).
Pumpage: 240,000 gal/d, at completion (log).
185,000 gal/d (Boniface, 1945).
60,000-70,000 gal/d (Glander, 1946).
pH: 7.0-7.2 (Glander, 1946).

Pump broke during operation in mid 1948 and was not operating in December 1948 (written communication, W. A. Ross to Public Works Officer, Dec. 17, 1948).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Top soil (clay)	0-3
Yellow broken coral	3-18
Hard white coral	18-27
Yellow coral	27-47
Yellow clay	47-63
Hard white coral	63-70
Yellow coral	70-102
White coral	102-112

WELL 52

Location: Lat 15°07'10" N., long 145°42'51" E., at Kobler Field (As Gonna).
Drilled: Apr. 20 to May 1, 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 97.06 ft. Depth: 110 ft.
Casing: 6 in. to 110 ft with lower 20 ft perforated.
Aquifer: Limestone.
Remarks: Water was found at depth of 99.6 ft.
Depth to water before pumping, 96.6 ft.
Chloride: 40 ppm (Glander, 1946).
Pumpage: 185,000 gal/d (Boniface, 1945).
50,000 gal/d (Glander, 1946).

Well had been abandoned in 1946 (Glander, 1946). In 1945, a jeep motor was used to drive the pump (Boniface, 1945).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Top soil	0-3
Broken yellow coral	3-14
Hard white coral	14-35
Soft white coral	35-40
Coral and yellow clay	40-57
Hard white coral	57-63
Soft white coral	63-88
White coral	88-96
Soft coral (struck water at 99 ft)	96-101
Hard white coral	101-110

WELL 54

Location: Lat 15°07'27" N., long 145°43'04" E., at Kobler Field (As Gonna).

Drilled: Completed Apr. 25, 1945 (Glander, 1946), May 25, 1945 (Boniface, 1945) by 2807th U.S. Naval Construction Battalion.

Altitude: 94 ft. Depth: 105 ft.

Casing: 6 in. to 105 ft.

Aquifer: Porous white coral.

Source of record: Glander (1946).

Remarks: Depth to water before pumping, 93 ft.
Chloride: 30 ppm (Glander, 1946).
Pumpage: 60,000-70,000 gal/d (Glander, 1946).
65,000 gal/d, pumped 8 hours per day (Ross, 1948).
pH: 7.0-7.2 (Glander, 1946).

The well was still in use in 1949 (Curione, 1949), but presumably abandoned not long afterwards.

WELL 55

Location: Lat 15°07'06" N., long 145°42'48" E., at Kobler Field (As Gonna).
Drilled: May 2-7, 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 99.46 ft. Depth: 115 ft.
Casing: 6 in. to 115 ft with lower 20 ft perforated; cave catcher at 95 ft.
Aquifer: Limestone.
Remarks: Water was found at depth of 99.6 ft.
Water level before pumping, 96 ft.

No equipment available to operate the well (Glander, 1946). Apparently the well was never used.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Top soil	0-3
Broken yellow coral	3-14
Hard white coral	14-35
Soft white coral	35-40
Coral and yellow clay	40-57
Hard white coral	57-63
Soft white coral	63-88
White coral	88-96
Soft yellow coral (struck water at 99 ft)	96-101
Broken yellow coral and gravel	101-115

WELL 56

Location: Lat 15°07'29" N., long 145°43'08" E., at Kobler Field (As Gonna).
Drilled: Completed May 3, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 101.1 ft Depth: 110 ft.
Casing: 6 in. to 110 ft.
Aquifer: Porous coral.
Source of record: Glander (1946).
Remarks: Chloride: 30 ppm.
Pumpage: 60,000-70,000 gal/d.

Well was abandoned in 1947 (written communication, W. A. Ross to Public Works Officer, Dec. 17, 1948).

WELL 57

Location: Lat 15°07'20" N., long 145°43'05" E., at Kobler Field (As Gonna).
Drilled: Completed May 10, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 128.8 ft. Depth: 135 ft.
Casing: 6 in. to 135 ft.
Aquifer: Porous coral.
Source of record: Glander (1946).
Remarks: Well not used at first as no equipment was available.
Chloride: 2,600 ppm, May 8, 1952 at 1000; pumped 24 hours per day at rate of 350-400 gal/min (field notes Ted Arnow).
3,080 ppm, Aug. 13, 1952 at 1610 (Arnow, 1952).
For chemical analysis, see table 70.

Well was last used May 8, 1952 and was abandoned at end of 1952 (written communication, Ted Arnow to Commander Naval Forces Marianas, Jan. 22, 1953).

WELL Maui I (Isley Field infiltration tunnel), As Gonna.

Location: Lat 15°07'16" N., 145°42'58" E., between Isley and Kobler Fields.
Drilled: Completed in July 1945.
Altitude: 99.7 ft. Depth: 107.7 ft.
Diameter of hole: Shaft is 8 x 8 ft, vertical, timbered. Two 200-ft supply tunnels with inverts at +1.6 ft, draining into a 12 x 12 x 8 ft concrete-lined pump sump (bottom, -7.5 ft).
Source of record: Glander, 1946.
Pumping tests: June 5, 1945, 0900-1300: Pumped at rate of 1,700 gal/min, chloride increased from 20 to 50 ppm.
June 5, 1945, 1500-June 6, 1945, 1500: Pumped at rate of 1,700 gal/min, chloride increased from 20 to 90 ppm. (Written communication, W. H. Boniface to Island Commander, June 16, 1945).
Maximum drawdown, 4.8 in. after continuous pumping for 43 hours at rate of 700 gal/min (Glander, 1946).
Production: 962,000 gal/d average over 45 weeks during July 24, 1947 to Feb. 5, 1948 (from tabulated figures).
670,000 gal/d average during 1964 (1/ Miller).
600,000-930,000 gal/d during January to August, 1965 (1/ Miller).
650,000 gal/d average during 1974.
640,000 gal/d average during 1975.
630,000 gal/d average during 1976.
620,000 gal/d average during 1977.
Remarks: June 10, 1972: Hardness, 344 ppm.
June 26, 1974, analyses by W. B. Brewer, Health Services T. T., using Hach kit: pH, 7.4.
Sulfate, 250 ppm.
Alkalinity as $CaCO_3$, 240 ppm.
Hardness, 868 ppm.

For chemical analyses, see table 71.

1/ Written communication M. M. Miller and Ted Arnow to Office of the High Commissioner U.S. Trust Territory of the Pacific Islands, 1965.

WELL Maui I

Pumping rate and chloride concentration of water from Maui I

Date	Hour	Pumping rate (gal/d)	Chloride (mg/L)	Remarks	Source
1945	--	322,000	40	Average for 4 months after completion.	1/ Arnow.
12/21/45-1/9/46.	--	300,000	40	Average of 10 hrs daily pumping.	Glander, 1946.
March 1947-Feb. 5, 1948.	--	962,000	--	Average from 45 weekly totals.	
1948-50	--	950,000	--	Pumped for 2 years at average rate of 950,000 gal/d.	2/ Arnow.
Mar. 23, 1950		*600,000	614		3/Arnow.
May 8, 1952	1005	--	177	Dipped sample (field notes Ted Arnow).	
Aug. 13, 1952	1600	--	640	Pumped sample (field notes Ted Arnow).	
Oct. 21, 1952	1335	*200,000	292	do.	4/Arnow.
Oct. 21, 1952	1340	--	196	From sump	Do.
Oct. 21, 1952	1340	--	124	From gallery	Do.
Jan. 19, 1953	1600	*200,000	212	Pumped sample	Do.
January 1953	--	*590,000	--	U.S. Navy increased pumpage (Navy estimate).	Do.
Mar. 3, 1953	--	*590,000	260	Estimate	Nettleman, 1953.
Apr. 7, 1953	1130	--	357	Pumped sample	3/Arnow.
July 6, 1953	1330	*590,000	584	do.	Do.
Dec. 16, 1953	1610	--	570	do.	Do.
June 23, 1954	--	*308,000	820	do.	5/Bishop.
July 6, 1956	1030	--	380	SW tunnel	6/Cox, 1956.
Do.	1030	--	280	SE tunnel	Do.
Do.	1615	--	792	After 15 min. pumping	Do.
Do.	2100	--	772	After 5 hrs pumping	Do.
Sept. 14, 1965	--	763,000	370		7/Miller.
Dec. 21, 1966	--	900,000	994		Ronimus, 1980.

WELL Maui I

Pumping rate and chloride concentration of water from Maui I--Continued

Date	Hour	Pumping rate (gal/d)	Chloride (mg/L)	Remarks	Source
Sept. 20, 1967	--	792,000	1,150		Do.
Sept. 16, 1974	--	677,000	1,750		Do.
February 1982	--	430,000	1,500		GK[2], Inc. 1982.

*Average pumping rate for the month.

Note: The pumping decreased after the U.S. Department of the Interior took over the Trust Territory administration on July 1, 1951. The U.S. Navy resumed control in January 1953 and increased the pumping rate.

1/ Written communication Ted Arnow to ComNavMar, Jan. 26, 1953.
2/ Written communication, Ted Arnow to D. A. Davis, May 11, 1953.
3/ Written communication, Ted Arnow to ComNavMar, Dec. 23, 1953.
4/ Written communication, Ted Arnow to ComNavMar, July 13, 1953.
5/ Written communication, E. W. Bishop to ComNavMar, July 19, 1954.
6/ Collected by D. C. Cox, analyzed by P. E. Ward.
7/ Written communication, M. M. Miller and Ted Arnow, to Office of the High Commissioner of the U.S. Trust Territory of the Pacific Islands, 1965.

Chloride concentration and specific conductance of water from Maui I

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	1,700	--	--	600
3-18-80	--	1,200	--	--	353
6-17-80	--	1,200	--	--	323
6-20-80	--	1,300	4,660	25.4	--
8-18-82	1505	1,500	5,200	28.0	300
11-18-82	--	1,400	5,150	28.2	--
9-8-83	0925	1,400	4,980	28.0	--

WELL Maui 1

Chemical analyses of water from Maui 1

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-7-81	1,490	3,000	--	8.0	0.80	--
1-27-81	1,190	2,430	4,030	7.4	.48	--
2-4-81	1,200	2,790	4,000	7.8	.40	--
2-18-81	1,260	2,800	4,790	7.1	.14	--
3-13-81	1,290	2,992	5,070	7.4	.17	--
4-22-81	1,730	3,750	6,088	7.3	.27	--
5-14-81	1,340	2,710	4,470	7.6	.15	--
5-29-81	1,520	3,350	5,360	7.1	.38	--
6-10-81	1,500	3,324	4,370	7.6	.18	--
7-1-81	1,620	3,090	5,810	7.5	.32	--
7-28-81	1,470	2,990	5,330	7.6	.46	--
8-20-81	1,380	2,950	4,900	7.6	.49	--
9-23-81	817	1,850	2,780	7.2	.55	--
10-16-81	832	1,880	3,250	7.2	.38	--
11-25-81	975	2,160	4,200	7.0	.32	--
12-28-81	872	2,000	3,380	7.3	.47	--
1-27-82	844	1,864	3,370	7.8	.57	--
2-8-82	922	2,172	3,270	7.8	.41	--
3-8-82	1,630	3,466	5,629	7.1	.64	--
4-12-82	1,070	2,430	4,150	7.2	.24	--
5-3-82	1,160	2,570	4,440	7.3	.14	--
6-4-82	1,290	--	--	7.8	--	333
7-9-82	1,390	2,740	5,310	7.7	.17	256
8-10-82	1,610	--	5,860	7.7	--	253
8-17-82	1,490	--	--	--	--	--
8-31-82	1,370	--	--	--	--	--
11-10-82	1,590	--	--	--	--	--
11-22-82	1,470	--	--	--	--	--
12-7-82	1,210	--	3,750	7.8	--	257
12-13-82	1,190	--	--	--	--	--
12-20-82	1,270	--	--	--	--	--
1-3-83	913	--	--	--	--	--
1-17-83	871	--	--	--	--	--
1-19-83	777	--	--	--	--	--
2-14-83	787	--	--	--	--	--
2-22-83	787	--	--	--	--	--
2-25-83	786	--	3,260	7.7	--	232
7-18-83	1,170	--	4,620	7.5	--	253
8-15-83	1,240	--	3,630	--	--	250
9-8-83	1,330	--	4,470	--	--	259
10-14-83	1,630	--	5,640	7.7	--	252

Note: No pumpage January to June 1983.
Hardness as $CaCo_3$: 7-18-83, 692 mg/L; 8-15-83, 757 mg/L.

WELL 9

Location: Lat 15°07'30" N., long 145°42'58" E., near Maui I, Kobler Field, As Gonna.

Drilled: May 1971.

Altitude: Concrete pedestal, 101.32 ft; well plate, 101.40 ft (levels from TAM 11 by Tom Nance, Oct. 4-5, 1982).

Depth: 120 ft.

Remarks: Chloride: 105 ppm, at completion.
50 ppm, June 19, 1971.
105 ppm, June 20, 1971.
105 ppm, June 21, 1971.
900 ppm, July 26, 1971.
864 ppm, July 27, 1971.
80 ppm, Dec. 7, 1972.
120 ppm, Mar. 22, 1973.
400 ppm, June 26, 1974*.
115 mg/L, average of 8 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
280 mg/L, June 6, 1980 at pumping rate of 68 gal/min (Ronimus, 1981).

Hardness: 220 ppm, June 10, 1972.
320 ppm, June 26, 1974.

Specific conductance: 1,400 µmho, June 20, 1980.

Pumpage: 72,000 gal/d, at completion.
86,000 gal/d, Mar. 19, 1973 (USGS).

Depth to water: 107.95 ft while pumping; after pumping stopped, recovery in 18 minutes to 100.03 ft, Mar. 19, 1973 (USGS).
100.18 ft, static depth, Apr. 5, 1983 (USGS).

June 26, 1974*: pH, 7.4.
Sulfate, 10 ppm.
Alkalinity (as $CaCO_3$), 220 ppm.
No fecal or total coliform per 100 mL.

---

* Analyses by W. B. Brewer, Health Services T. T., using Hach kit.

WELL 9

Chemical analyses of water from well 9

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-7-81	84.1	342	--	8.0	0.20	--
1-27-81	170	572	1,000	7.3	.25	--
2-4-81	160	615	1,020	7.5	.50	--
2-18-81	156	584	1,040	7.3	.16	--
3-13-81	146	574	1,220	7.6	.30	--
4-22-81	172	598	1,090	7.4	.14	--
5-14-81	197	650	1,190	7.8	.24	--
5-29-81	219	750	1,250	7.2	.12	--
6-10-81	241	778	1,260	7.6	.29	--
7-1-81	265	750	1,410	7.5	.21	--
7-28-81	312	836	1,510	7.7	.15	--
8-20-81	297	854	1,430	7.6	.33	--
9-23-81	285	838	1,440	7.4	.31	--
10-16-81	230	688	1,250	7.2	.34	--
11-25-81	164	538	1,040	7.1	.50	--
12-28-81	240	658	1,380	7.6	.38	--
2-4-82	148	--	--	--	--	--
2-8-82	154	556	1,040	8.8	.31	--
2-9-82	146	--	--	--	--	--
3-8-82	141	564	1,010	7.2	.11	--
4-12-82	128	504	996	7.2	.24	--
5-3-82	136	560	1,030	6.8	.11	--
6-4-82	148	--	--	7.5	--	229
7-9-82	204	620	1,220	7.4	.09	228
8-10-82	245	--	1,380	7.6	--	238
8-17-82	261	--	--	--	--	--
8-24-82	277	--	--	--	--	--
9-8-82	297	852	1,500	7.2	--	--
10-7-82	345	--	--	--	--	--
11-10-82	339	--	1,620	7.6	--	221
11-22-82	286	--	--	--	--	--
11-29-82	255	--	--	--	--	--
12-7-82	230	--	1,290	7.8	--	229
12-13-82	234	--	--	--	--	--
12-20-82	225	--	--	--	--	--
1-3-82	202	--	--	--	--	--
1-11-83	200	--	--	--	--	--
1-17-83	207	--	--	--	--	--
1-19-83	198	--	1,180	7.6	--	226
2-14-83	219	--	--	--	--	--
2-25-83	240	--	1,320	7.5	--	228
4-21-83	375	--	--	7.1	--	220

WELL 9

Chemical analyses of water from well 9--Continued

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
5-2-83	419	--	--	--	--	--
5-10-83	460	--	--	--	--	--
5-16-83	420	--	--	--	--	--
5-23-83	516	--	--	--	--	--
5-31-83	529	--	--	--	--	--
6-6-83	560	--	--	--	--	--
6-13-83	576	--	--	--	--	--
6-20-83	619	--	2,570	7.4	--	207
6-27-83	630	--	--	--	--	--
7-5-83	630	--	--	--	--	--
7-11-83	665	--	--	--	--	--
7-18-83	633	--	2,670	7.3	--	219
7-25-83	565	--	--	--	--	--
8-1-83	585	--	--	--	--	--
8-8-83	667	--	--	--	--	--
8-15-83	658	--	2,670	--	--	219
8-22-83	677	--	--	--	--	--
8-29-83	660	--	--	--	--	--
9-8-83	660	--	2,640	--	--	231
9-14-83	664	--	--	--	--	--
9-19-83	663	--	--	--	--	--
10-3-83	739	--	--	--	--	--
10-11-83	760	--	--	--	--	--
10-14-83	749	--	3,020	7.7	--	225

Hardness as $CaCO_3$: 4-21-83, 400 mg/L; 7-18-83, 474 mg/L; 8-15-83, 500 mg/L.

WELL 9

Chloride concentration and specific conductance of water from well 9

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	220	--	--	71
3-18-80	--	275	--	--	70
6-17-80	--	300	--	--	70
6-20-80	--	300	1,400	25.5	68
8-18-82	1430	260	1,350	28.0	57
11-18-82	1210	320	1,520	28.2	--
3-2-83	1453	260	1,350	27.0	--
4-9-83	--	--	1,660	29.0	--
6-30-83	1755	620	2,510	28.0	--
9-8-83	0955	680	2,730	28.5	--

LOG

Description of material	Depth (ft)
Top soil (clay)	0-3
Yellow broken coral	3-18
Hard white coral	18-27
Yellow coral	27-47
Yellow clay	47-63
Hard white coral	63-70
White coral	70-102
White coral	102-120

Note: This log is identical to the log provided for well 10.

WELL 10

Location: Lat 15°07'37" N., long 145°42'54" E., near Maui I, Kobler Field, As Gonna.

Drilled: June 3, 1971.

Altitude: Concrete pedestal, 105.54 ft; well plate, 105.61 ft (levels from TAM 11 by Tom Nance, Oct. 4-5, 1982).

Depth: 127 ft.

Remarks: Chloride: 105 ppm, July 3, 1971.
615 ppm, Dec. 7, 1972.
830 ppm, Mar. 8, 1973.
720 ppm, Mar. 22, 1973.
1,950 ppm, June 26, 1974*.
550 mg/L, June 6, 1980 at pumping rate of 16 gal/min (Ronimus, 1981).

Hardness: 210 ppm, June 10, 1972.
930 ppm, June 26, 1972*.

Specific conductance: 2,280 µmho, June 20, 1980.

Pumpage: 72,000 gal/d, at completion.
108,000 gal/d, Mar. 20, 1974.

Static depth to water: 103.26 ft, Apr. 5, 1983 (USGS).

June 26, 1974*: pH, 7.7.
Sulfate, 210 ppm.
Alkalinity (as $CaCO_3$), 210 ppm.
No fecal or total coliform per 100 mL.

Depth to water: Feb. 9 and 15, 1983, 107.0 ft; Feb. 17, 19, 20, 1983, 107.7 ft.

---

* Analyses by W. B. Brewer, Health Services T. T., using Hach kit.

WELL 10

Chemical analyses of water from well 10

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
2-4-81	518	1,220	--	8.2	0.20	--
2-18-81	634	1,560	2,650	7.3	.08	--
3-13-81	744	--	2,990	7.5	.19	--
4-22-81	751	1,756	2,780	7.2	.64	--
5-14-81	929	2,050	3,640	7.6	.21	--
6-10-81	1,140	2,590	3,990	7.5	.35	--
7-1-81	1,160	2,430	3,410	7.5	.43	--
7-28-81	1,270	2,460	4,570	7.8	.35	--
8-20-81	1,090	2,390	3,120	7.6	.15	--
9-23-81	562	1,320	2,240	7.4	.39	--
10-16-81	515	1,250	2,240	7.3	.27	--
11-25-81	737	1,640	2,870	7.0	.53	--
2-4-82	782	--	--	--	--	--
2-8-82	767	1,410	2,950	7.9	.29	--
2-9-82	780	--	--	--	--	--
3-8-82	859	2,050	2,890	7.1	.69	--
4-12-82	934	2,040	3,440	7.2	.33	--
5-3-82	1,090	2,464	3,810	6.9	.80	--
6-4-82	1,220	--	--	7.3	--	214
7-9-82	1,170	2,390	4,370	7.3	.17	210
8-10-82	1,330	--	4,930	7.5	--	208
8-17-82	1,350	--	--	--	--	--
8-24-82	1,350	--	--	--	--	--
8-31-82	1,390	--	--	--	--	--
9-8-82	1,360	2,840	5,110	7.7	--	207
10-7-82	1,440	--	--	--	--	--
11-10-82	868	--	3,400	7.8	--	213
11-22-82	834	--	--	--	--	--
11-29-82	852	--	--	--	--	--
12-13-82	900	--	--	--	--	--
12-20-82	901	--	--	--	--	--
1-3-83	925	--	--	--	--	--
1-11-83	974	--	--	--	--	--
1-19-83	1,400	--	3,840	7.8	--	210
2-14-83	1,120	--	--	--	--	--
2-22-83	1,130	--	--	--	--	--
2-25-83	1,110	--	3,560	7.5	--	209
4-21-83	1,170	--	4,050	7.4	--	205
5-2-83	1,210	--	--	--	--	--
5-10-83	1,210	--	--	--	--	--
5-16-83	1,100	--	--	--	--	--
5-23-83	1,270	--	--	--	--	--

WELL 10

Chemical analyses of water from well 10--Continued

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
5-31-83	1,310	--	--	--	--	--
6-6-83	1,310	--	--	--	--	--
6-13-83	1,350	--	--	--	--	--
6-20-83	1,360	--	4,870	7.9	--	190
6-27-83	1,400	--	--	--	--	--
7-5-83	1,400	--	--	--	--	--
7-11-83	1,410	--	--	--	--	--
7-18-83	1,420	--	5,200	7.3	--	203
7-25-83	1,400	--	--	--	--	--
8-1-83	1,470	--	--	--	--	--
8-8-83	1,580	--	--	--	--	--
8-15-83	1,580	--	5,080	--	--	204
8-22-83	1,660	--	--	--	--	--
8-29-83	1,660	--	--	--	--	--
9-8-83	1,610	--	5,150	--	--	208
9-14-83	1,590	--	--	--	--	--
9-19-83	1,630	--	--	--	--	--
9-26-83	1,620	--	--	--	--	--
10-3-83	1,760	--	--	--	--	--
10-11-83	1,740	--	--	--	--	--
10-14-83	1,690	--	6,230	7.6	--	201

1/ Hardness as $CaCO_3$: 4-21-83, 354 mg/L; 7-18-83, 796 mg/L; 8-15-83, 853 mg/L.

Chloride concentration and specific conductance of water from well 10

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	1,200	--	--	50
6-17-80	--	700	--	--	16
6-20-80	--	540	2,280	25.3	--
8-18-82	1420	1,400	4,710	28.0	44
11-18-82	1215	800	3,170	28.2	--
9-8-83	1000	1,600	5,820	28.0	--

WELL 10

LOG

Description of material	Depth (ft)
Top soil (clay)	0-3
Yellow broken coral	3-18
Hard white coral	18-27
Yellow coral	27-47
Yellow clay	47-63
Hard white coral	63-70
Yellow coral	70-102
White coral	102-127

RECOVERY TEST

[U.S. Geological Survey, March 20, 1973]

Time	Depth to water (ft)	Remarks
1045	108.15	Pumping at 75 gal/min.
1051	--	Pump off.
1052	104.10	
1055	104.00	
1059	103.80	
1103	103.69	
1109	103.59	

WELL 11

Location: Lat 15°07'24" N., long 145°43'07" E., near Maui I, Kobler Field, As Gonna.

Drilled: July 1971.

Altitude: Concrete pedestal, 100.53 ft; well plate, 100.58 ft (levels from TAM 11 by Tom Nance, Oct. 4-5, 1982).

Depth: 120 ft.

Casing: Steel.

Remarks: Chloride: 105 ppm, at completion.
136 ppm, July 15, 1971.
217 ppm, July 16, 1971.
232 ppm, July 20, 1971.
280 ppm, Dec. 7, 1972.
280 ppm, Mar. 8, 1973.
260 ppm, Mar. 22, 1973.
500 ppm, June 26, 1974*.

Hardness: 200 ppm, July 18, 1972.
360 ppm, June 26, 1974*.

Pumpage: 72,000 gal/d, at completion.

Depth to water: 99.33 ft while pumping; after pumping stopped, recovery in 5 minutes to 99.20 ft below measuring point, Mar. 19, 1973 (USGS).
99.13 ft, while pump is off, 6-30-83 (USGS).

June 26, 1974*: pH, 7.9.
Sulfate, 28 ppm.
Alkalinity (as $CaCO_3$), 220 ppm.
No fecal or total coliform per 100 mL.

---

* Analyses by W. B. Brewer, Health Services Trust Territory, using Hach kit.

WELL 11

Chemical analyses of water from well 11

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
2-5-82	656	--	--	--	--	--
2-8-82	960	2,160	3,680	7.8	0.26	--
2-9-82	889	--	--	--	--	--
3-8-82	648	1,700	2,590	7.7	.19	--
4-12-82	739	1,530	2,940	7.2	.22	--
6-4-82	663	--	--	7.4	--	230
7-9-82	714	1,700	2,910	7.5	.10	229
8-10-82	799	--	3,230	7.3	--	230
8-17-82	838	--	--	--	--	--
8-24-82	866	--	--	--	--	--
8-31-82	894	--	--	--	--	--
9-8-82	933	1,890	3,650	7.6	--	231
10-7-82	1,060	--	--	--	--	--
11-10-82	928	--	3,590	7.6	--	200
11-22-82	932	--	--	--	--	--
11-29-82	946	--	--	--	--	--
12-13-82	943	--	--	--	--	--
12-20-82	949	--	--	--	--	--
1-3-83	950	--	--	--	--	--
1-11-83	943	--	--	--	--	--
1-19-83	939	--	3,660	7.7	--	229
2-25-83	1,060	2,270	4,160	7.4	--	232
4-21-83	1,300	--	4,710	7.1	--	231
6-20-83	1,430	--	5,160	8.1	--	241
8-15-83	1,580	--	5,510	--	--	237
9-8-83	1,580	--	5,080	--	--	240
10-14-83	1,690	--	5,930	7.7	--	235

Hardness as $CaCO_3$: 4-21-83, 732 mg/L; 8-15-83, 842 mg/L.

Chloride concentrations: 4-6-83, 1,220 mg/L; 4-11-83, 1,260 mg/L; 4-18-83, 1,270 mg/L; 4-25-83, 1,310 mg/L; 5-2-83 and 5-10-83, 1,330 mg/L; 5-16-83, 1,160 mg/L; 5-23-83, 1,360 mg/L; 5-31-83, 1,380 mg/L; 6-6-83, 1,400 mg/L; 6-13-83, 1,410 mg/L; 6-27-83, 1,430 mg/L; 7-5-83 and 7-25-83, 1,600 mg/L; 8-1-83, 1,580 mg/L; 8-8-83, 1,740 mg/L; 8-22-83, 1,620 mg/L; 8-29-83, 1,630 mg/L; 9-14-83, 1,640 mg/L; 9-19-83, 1,610 mg/L; 9-26-83, 1,600 mg/L; 10-3-83, 1,660 mg/L; 10-11-83, 1,640 mg/L.

WELL 11

Chloride concentration and specific conductance of water from well 11

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	450	--	--	73
3-18-80	--	370	--	--	73
6-17-80	--	610	--	--	73
6-20-80	--	580	2,340	25.4	--
8-18-82	1458	850	3,170	28	40
11-18-82	1155	920	3,510	28.2	--
3-2-83	1425	1,100	4,055	26.5	--
9-8-83	0930	1,600	5,780	28.0	--
10-19-82	0915	--	--	--	34

LOG

Log provided is identical to log for well 9.

RECOVERY TEST

[U.S. Geological Survey, March 19, 1973]

Time	Depth to water (ft)	Remarks
1509	99.33	Pumping.
1512	--	Pump off.
1514	99.18	
1517	99.20	

TEST HOLE 12

Location: Kobler Field (As Gonna). Site not known.

Drilled: Feb. 2, 1977 by International Bridge Corporation.

Altitude: 92 ft. Depth: 150 ft.

Diameter of open hole: 6-3/4 in.

Casing: None.

Source of record: Driller.

Remarks: Feb. 8, 1977, 1245: Chloride concentration, 300 mg/L (USGS).
Feb. 12, 1977: Water level at 92 ft.
Apr. 23, 1977: Well acidized with 65 gallons 15 percent hydrochloric acid solution.
Apr. 23, 1977: Hole caved in at bottom and was abandoned.

LOG

Description of material	Depth (ft)
(Source: Inspector's daily report)	
Top soil, reddish	0-8
Hard, broken rocks	8-110
Clayey	110-143
Hard, solid formation	143-150
(Source: Driller's daily report)	
Surface	0-5
Medium soft, white coral	5-70
Hard, white coral	70-85
Medium soft, white coral	85-95
Medium hard, red clay	95-110
Gummy, dark brown clay	110-145
Soft, white coral	145-150

TEST HOLE 12A

Location: Kobler Field (As Gonna), 10 ft from abandoned test hole 12.

Drilled: Apr. 25, 1977 by International Bridge Corporation.

Altitude: 92.13 ft. Depth: 120 ft.

Diameter of open hole: 6-3/4 in.

Casing: None.

Source of record: Driller.

Remarks: No log kept of drilling as site is only 10 feet east from well 12.
Apr. 26, 1977: Well acidized (4 hours). Pumped turbid water at rate of 28 gal/min; chloride, over 5,000 mg/L.
Apr. 27, 1977: Water still turbid. Lower part of hole kept filling up with dark gummy clay. Hole was drilled to 146 ft but was open only to 119 ft. Site was abandoned.

TEST HOLE 15

Location: Lat 15°07'23" N., long 145°43'00" E., at Kobler Field (As Gonna).
Drilled: Jan. 25-31, 1977 by International Bridge Corporation.
Altitude: 105.98 ft (levels of May 14, 1977). Depth: 146 ft.
Diameter of open hole: 8 in. After cave-in redrilled as 6-3/4 in. open hole on Feb. 4, 1977 and top 20 feet reamed to 12-1/4 in. on Feb. 5, 1977.
Casing: Temporary 9-5/8 in. (outside diameter) steel pipe for top 20 ft.
Source of record: Driller.
Pumping tests: Apr. 27, 1977: Depth to water before pumping, 105 ft. No drawdown in 50 minutes at pumping rate of 64 gal/min.
Apr. 28, 1977: Drawdown, 0.03 ft in 8 hours at pumping rate of 60 gal/min; chloride, 82.5-100 mg/L; recovery to 0.04 ft above initial water level in 3 minutes. See pumping test record.
Remarks: Feb. 8, 1977, 1355: Chloride concentration, 450 mg/L (USGS).

LOG

Description of material	Depth (ft)
Hard and broken coral (circulation lost)	0-23
Old coral bed	23-25
White coral, medium hard	25-128
Brown clay with white coral	128-143
Hard, white coral	143-146
While reaming the 6-3/4-in. pilot hole to 14-3/4 in.:	
Soft limestone formation	118-123
Clay	123-135

TEST HOLE 15

PUMPING TEST

Date: April 28, 1977.
Reference point: 3.2 ft above ground surface (top of drilling mast table).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0820	--	107.55	--	--	Static depth to water.
0830	0	107.58	60	100	Start of test.
0835	5	107.58	60	--	Same reading at 0840, 0845.
0850	20	107.54	60	--	
0855	25	107.55	60	--	
0900	30	107.54	60	100	
0915	45	107.55	60	--	Same reading at 0930.
0945	75	107.58	60	--	
1000	90	107.55	59	--	
1015	105	107.53	60	--	
1030	120	107.55	60	87.5	
1100	150	107.54	60	--	Same reading at 1130, 1200.
1230	240	107.53	60	87.5	
1300	270	107.54	60	--	
1330	300	107.55	59	--	
1400	330	107.53	60	--	
1430	360	107.55	59	--	
1500[1/]	390	107.55	60	82.5	
1530	420	107.54	60	--	
1600	450	107.50	60	--	
1630	480	107.58	60	--	
					End of pumping test.
Recovery					
1630	0	--	--	--	Start of recovery test.
1631	1	107.58	--	--	Elapsed time measured with stopwatch.
1633	3	107.51	--	--	Same reading every minute, 1634-1638.
1639	9	107.50	--	--	
1640	10	107.50	--	82.5	End of test.

[1/] Pump broke suction: clogged up with clay for 15 minutes; restarted after backwashing; clay possibly from hole cave-in.

WELL 15

Location: Same as test hole 15.

Reamed: Apr. 30 to May 2, 1977 by International Bridge Corporation.

Altitude: 105.98 ft (levels of May 14, 1977). Well plate, 107.75 ft (levels from TAM 11 by Tom Nance, Oct. 4, 5, 1982).

Depth: 135 ft.

Diameter of open hole: 14-3/4 in.

Casing: 12-in. conductor casing placed on May 2, with bottom at 126 ft below ground surface.

8-in. solid steel casing to 131.5 ft placed May 7.

12-in. casing removed on May 9, except for 55 ft length stuck in grout and cut off at surface.

Screen: 8-in. stainless steel with steel plug at bottom at 128.2 ft below ground surface.

Gravel pack and grout: Gravel around steel screen from 127.1 to 95.9 ft below ground surface (42-1/2 ft^3). Sand seal above gravel pack. Grout to ground surface.

Source of record: Driller.

Pumping tests: Apr. 28, 1977: Drawdown not more than 0.2 ft during 8 hours at pumping rate of 60 gal/min; chloride at end of test, 82.5 mg/L.

May 7, 1977: Depth to water before pumping, 105.04 ft. Drawdown, 0.3 ft in 15 minutes at pumping rate of 60 gal/min.

May 9, 1977: Depth to water before pumping, 104.89 ft. Drawdown, 0.2 ft in 30 minutes at pumping rate of 60 gal/min.

May 11, 1977: Depth to water before pumping, 108.02 ft. Maximum drawdown, 0.14 ft during 8 hours at pumping rate of 57 gal/min; chloride, 110-160 mg/L; recovery immediate. See pumping test record.

Remarks: May 10, 1977: Well acidized with two barrels of 15 percent concentration of hydrochloric acid solution.

Chloride: 170 mg/L, May 5, 1977 at 0935 (150 mg/L at 0945).

199 mg/L average of 14 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).

WELL 15

Chemical analyses of water from well 15

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-7-81	84.1	332	--	7.6	1.10	--
1-27-81	108	492	826	7.3	.11	--
2-4-81	146	387	769	8.2	.10	--
2-18-81	189	642	1,140	7.5	.08	--
3-13-81	292	876	1,540	7.5	.37	--
4-22-81	420	1,200	2,000	7.6	.23	--
5-14-81	486	1,190	2,100	7.8	.38	--
5-29-81	487	1,300	2,170	7.2	.30	--
6-10-81	591	1,420	2,250	7.6	.48	--
7-1-81	585	1,330	2,320	7.6	.59	--
7-28-81	849	1,740	3,220	7.8	.35	--
8-20-81	278	786	1,360	7.8	.60	--
9-23-81	104	452	803	7.4	.43	--
2-4-82	84.7	--	--	--	--	--
2-8-82	84.0	446	791	7.8	.34	--
2-9-82	77.0	--	--	--	--	--
3-8-82	109	458	843	7.6	.17	--
4-12-82	264	700	1,250	7.5	.22	--
5-3-82	309	904	1,600	7.0	.12	--
6-4-82	497	--	--	7.6	--	233
7-9-82	644	1,480	2,670	7.6	.11	233
8-10-82	994	--	3,900	7.6	--	241
11-10-82	321	--	1,540	7.6	--	220
1-19-83	621	--	2,580	7.6	--	230
2-25-83	955	--	3,810	7.5	--	240
4-21-83	915	--	3,500	7.3	--	235
6-20-83	1,050	--	4,100	8.2	--	245
7-18-83	1,020	--	3,880	7.4	--	236
8-15-83	1,140	--	4,170	--	--	244
9-8-83	1,130	--	3,980	--	--	244
10-14-83	1,320	--	4,740	7.6	--	244

Hardness as $CaCO_3$: 4-21-83, 568 mg/L; 7-18-83, 602 mg/L; 8-15-83, 653 mg/L.

Chloride concentrations: 8-17-82, 891 mg/L; 8-24-82, 988 mg/L; 8-31-82, 923 mg/L; 9-8-82, 898 mg/L; 11-7-82, 1,050 mg/L; 11-22-82, 305 mg/L; 12-20-82, 422 mg/L; 1-3-83, 560 mg/L; 1-11-83, 604 mg/L; 1-17-83, 607 mg/L; 2-14-83, 849 mg/L; 2-22-83, 938 mg/L; 4-6-83, 938 mg/L; 4-11-83, 941 mg/L; 4-18-83, 905 mg/L; 4-25-83, 928 mg/L; 5-2-83, 931 mg/L; 5-10-83, 930 mg/L; 5-16-83, 981 mg/L; 5-23-83, 999 mg/L; 5-31-83, 1,020 mg/L; 6-6-83, 1,030 mg/L; 6-13-83, 1,040 mg/L. 6-27-83, 1,030 mg/L; 7-5-83, 1,020 mg/L; 7-11-83, 975 mg/L; 7-25-83, 890 mg/L; 8-1-83, 950 mg/L; 8-8-83, 8-29-83 and 9-14-83, 1,140 mg/L; 9-19-83, 1,130 mg/L; 9-26-83, 1,190 mg/L; 10-3-83, 1,270 mg/L; 10-11-83, 1,300 mg/L.

WELL 15

PUMPING TEST

Date: May 11, 1977.
Reference point: 3.15 ft above ground surface (top of 8-inch casing).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1330	0	108.02	--	--	Static depth to water before start of pumping; start of test.
1331	1	108.03	--	--	
1332	2	108.03	--	--	
1333	4	108.06	--	--	
1335	5	108.01	--	--	
1336	6	108.02	--	--	
1337	7	108.07	--	--	
1338	8	108.07	--	--	
1339	9	108.10	--	--	
1340	10	108.16	--	160	Maximum drawdown.
1345	15	108.09	56	--	
1350	20	108.11	56	--	
1355	25	108.12	56	--	
1400	30	108.04	57	150	
1405	35	108.06	57	--	
1410	40	108.08	57	--	
1415	45	108.05	58	--	
1420	50	108.04	58	--	
1425	55	108.06	58	--	
1430	60	108.03	58	150	
1500	90	108.00	57	--	
1530	120	108.04	58	140	
1600	150	108.14	58	--	
1630	180	108.14	58	--	
1700	210	108.09	58	--	
1730	240	108.03	58	125	
1800	270	108.02	58	--	
1830	300	108.12	58	115	
1900	330	108.05	58	--	
1930	360	108.03	57	110	
2000	390	108.05	57	--	
2030	420	108.05	57	110	
2100	450	108.05	57	--	
2130	480	108.05	--	110	End of pumping test.
Recovery					
2130	0	--			Start of recovery test.
2131	1	108.00			Elapsed time since
2132	2	107.98			pumping stopped meas-
2133	3	107.98			ured with stopwatch.

WELL 15

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
2134	4	107.98			
2135	5	107.98			
2136	6	107.98			
2137	7	107.98			
2138	8	107.98			
2139	9	107.98			
2140	10	107.98		110	End of test.

Chloride concentration and specific conductance of water from well 15

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
3-18-80	--	720	--	--	70
6-20-80	--	1,200	4,300	25.7	--
8-18-82	1455	900	3,370	28.0	76
11-18-82	1150	270	1,360	28.2	--
6-30-83	1246	1,000	3,670	28.0	--
9-8-83	0935	1,200	4,350	28.0	--

TEST HOLE 16

Location: Lat 15°07'28" N., long 145°42'59" E., at Kobler Field (As Gonna), 350 ft north of well 15.

Drilled: May 12-14, 1977 by International Bridge Corporation.

Altitude: Ground surface, 103.36 ft (levels of May 28, 1977).

Depth: 126 ft.

Diameter of open hole: 6-3/4 in.

Casing: None.

Source of record: Driller.

Pumping test: May 13, 1977: Water pumped from hole at rate of 60 gal/min for 35 minutes. Depth to water almost constant; chloride, 185 mg/L.

May 14, 1977: Maximum drawdown during 8 hours of pumping rate of 70 gal/min, 0.07 ft, 5 minutes after pump was started; chloride, 125-140 mg/L; recovery to 0.01 ft of initial water level in 1 minute. See pumping test record.

LOG

Description of material	Depth (ft)
Top soil and white coral	0-5
Medium hard, white coral with brown clay	5-15
Medium hard, white coral	15-25
Medium hard, pale yellow coral	25-30
Medium hard, coral with yellow clay	30-40
Hard, white coral	40-45
Medium hard, yellow and white coral	45-50
Medium hard, white coral	50-70
Medium hard, pale yellow coral	70-85
Hard, white and pale yellow coral	85-110
Hard, pale yellow and light brown coral	110-118
Hard, light brown coral with brown clay	118-127

TEST HOLE 16

PUMPING TEST

Date: May 14, 1977.
Reference point: 0.92 ft above ground surface (top of conductor casing).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1150	--	102.50	--	--	Static depth to water (using electric sounder).
1200	0	102.53	71	--	Start of test.
1205	5	102.57	69	--	
1210	10	102.57	71	--	
1215	15	102.57	69	--	
1220	20	102.54	69	--	
1225	25	102.51	69	--	
1230	30	102.53	71	--	
1245	45	102.54	69	--	
1300	60	102.53	68	140	
1315	75	102.54	66	--	
1330	90	102.54	71	--	
1345	105	102.55	71	--	
1400	120	102.54	71	--	
1430	150	102.55	69	--	
1500	180	102.54	71	140	
1530	210	102.53	69	--	
1600	240	102.54	69	--	
1630	270	102.52	69	--	
1700	300	102.53	71	140	
1730	330	102.52	69	--	
1800	360	102.55	71	130	
1830	390	102.52	69	--	
1900	420	102.52	71	130	
1930	450	102.54	71	--	
2000	480	102.54	72	125	End of pumping test.
Recovery					
2000	0	--			Start of recovery test.
2001	1	102.53			
2002	2	102.51			Recovery within 0.01 ft after one minute.
2003	3	102.51			
2004	4	102.51			Same reading every minute 2005-2009.
2010	10	102.51			End of test.

WELL 16

Location: Same as test hole 16.

Reamed: May 17-19, 1977 by International Bridge Corporation.

Altitude: Concrete pedestal, 104.31 ft; well plate, 104.39 ft (levels from TAM 11 by Tom Nance, Oct. 4-5, 1982).

Depth: 126 ft.

Diameter of open hole: 14-3/4 in.

Casing: 8-in. steel casing with 20 ft of 8-in. stainless steel at bottom.

Gravel pack and grout: Silica gravel pack (24 ft^3) to 98.7 ft below ground surface. Sealed with 6 in. of screened crushed coral, 6 in. of drill cuttings, and 12 in. of beach sand. Cement grout from top of sand seal to ground level.

Source of record: Driller.

Pumping test: May 25, 1977: Drawdown, 0.21 ft in 8 hours at pumping rate of 69 gal/min; chloride, 150-320 mg/L; recovery to initial water level within one minute. See pumping test record.

Remarks: Chloride: 225 mg/L, average of 13 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).

For chemical analysis, see table 74.

Chloride concentration and specific conductance of water from well 16

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	730	--	--	1/ 70
3-18-80	--	1,000	--	--	1/ 75
6-17-80	--	1,100	--	--	77
6-20-80	--	1,000	3,770	25.5	--
8-18-82	1440	1,100	4,020	28.0	72
11-18-82	1205	430	1,870	28.2	--
6-30-83	1305	1,300	5,150	28.0	--
9-8-83	0935	1,400	5,040	28.5	--

1/ Estimated.

WELL 16

Chemical analyses of water from well 16

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
6-6-80	1,200	--	--	--	--	--
2-4-82	151	--	--	--	--	--
2-8-82	141	562	975	7.8	0.18	--
2-9-82	140	--	--	--	--	--
3-8-82	165	616	1,090	7.4	.20	--
4-12-82	240	734	1,380	7.5	.25	--
5-3-82	347	1,010	1,710	7.1	.14	--
6-4-82	650	--	--	7.7	--	241
7-9-82	884	2,040	3,500	7.7	.14	243
8-10-82	994	--	3,900	7.6	--	241
8-17-82	1,100	--	--	--	--	--
8-24-82	1,150	--	--	--	--	--
8-31-82	1,190	--	--	--	--	--
9-8-82	1,150	2,360	4,480	7.6	--	244
10-7-82	1,220	--	--	--	--	--
11-10-82	460	--	2,080	7.6	--	223
11-22-82	737	--	--	--	--	--
11-29-82	433	--	--	--	--	--
12-7-82	429	--	1,960	7.9	--	235
12-13-82	412	--	--	--	--	--
12-20-82	477	--	--	--	--	--
1-19-83	730	--	2,970	7.6	--	236
2-25-83	1,060	2,280	4,210	7.5	--	243
4-21-83	1,200	--	4,220	7.4	--	243
6-20-83	1,370	--	4,710	7.9	--	249
7-18-83	1,320	--	4,920	7.3	--	241
8-16-83	1,320	--	4,740	--	--	250
9-8-83	1,340	--	4,120	--	--	254
10-14-83	1,500	--	5,210	7.6	--	250

Hardness as $CaCO_3$: 4-21-83, 672 mg/L; 7-18-83, 717 mg/L; 8-16-83, 733 mg/L.

Chloride concentrations: 1-3-83, 636 mg/L; 1-11-83, 700 mg/L; 1-17-83, 724 mg/L; 2-22-83, 1,030 mg/L; 4-6-83, 1,240 mg/L; 4-11-83, 1,220 mg/L; 4-18-83, 1,180 mg/L; 4-25-83, 1,210 mg/L; 5-2-83, 1,190 mg/L; 5-10-83, 1,210 mg/L; 5-16-83, 1,070 mg/L; 5-23-83, 1,260 mg/L; 5-31-83, 1,280 mg/L; 6-6-83, 1,310 mg/L; 6-13-83, 1,330 mg/L; 6-27-83, 1,340 mg/L; 7-5-83, 1,310 mg/L; 7-11-83, 1,290 mg/L; 7-25-83 and 8-1-83, 1,230 mg/L; 8-8-83, 1,320 mg/L; 8-22-83, 1,350 mg/L; 8-29-83, 1,370 mg/L; 9-14-83, 1,380 mg/L; 9-19-83, 1,340 mg/L; 9-26-83, 1,400 mg/L; 10-3-83, 1,500 mg/L; 10-11-83, 1,470 mg/L.

WELL 16

PUMPING TEST

Date: May 25, 1977.
Reference point: 3.0 ft above ground surface (top of 8-in. casing).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0805	--	104.88	--	--	Static depth to water before start of pumping.
0810	0	105.07	--	--	Start of test.
0811	1	105.08	--	--	
0812	2	105.10	--	--	
0813	3	105.08	--	--	
0814	4	105.09	--	--	
0815	5	105.10	--	--	
0816	6	105.09	--	--	Same reading every minute 0817-0820.
0825	15	105.09	69	320	
0830	20	105.09	68	--	
0835	25	105.09	69	--	Same reading every 5 minutes 0840-0905.
0910	60	105.09	69	250	
0940	90	105.09	69	235	
1010	120	105.10	69	--	
1040	150	105.09	69	--	Same reading at 1110.
1140	210	105.09	69	195	
1210	240	105.09	69	--	Same reading at 1240.
1310	300	105.10	69	175	
1340	330	105.09	70	--	
1410	360	105.09	70	170	
1440	390	105.09	69	--	
1510	420	105.09	69	150	
1540	450	105.09	69	--	
1610	480	105.09	69	150	
1615					End of pumping test.
Recovery					
1615	0				Start of recovery test.
1616	1	104.87			Same reading every minute 1617-1624.
1625	10	104.87			End of test.

TEST HOLE 17A

Location: Kobler Field (As Gonna), between well 17 and well 9.
Drilled: Feb. 14-15, 1977 by International Bridge Corporation.
Altitude: 105.13 ft.
Diameter of open hole: 6-3/4 in. Depth: 125 ft.

No water in hole. Checked again July 12, 1977: no water.

LOG (incomplete)

Description of material	Depth (ft)
White coral fill	0-2
White limestone	2-25
Red limestone	25-40
Red clay	40-50
White limestone	50-105
Red limestone	105-115
Red clay	115-125

TEST HOLE 17B

Location: Near test hole 17A, Kobler Field (As Gonna).

Drilled: June 7, 1977 by International Bridge Corporation.

Altitude: About 105 ft. Depth: 150 ft.

Diameter of open hole: 6-3/4 in.

Source of record: Driller.

Pumping test: June 9, 1977: Drawdown, 0.1 ft in 8 hours at pumping rate of 63 gal/min; chloride, 155-160 mg/L; recovery immediately. See pumping test record.

LOG (incomplete)

Description of material	Depth (ft)
Top soil	0-5
Medium hard, white coral	5-10
Medium hard, brown coral	10-20
Medium hard, coral with clay	30-35
Hard, brown coral	35-55
Hard, white coral	55-105
Hard, brown coral	105-115
Hard, brown coral with clay	115-125
Brown clay with limestone fragments	125-130

TEST HOLE 17B

PUMPING TEST

Date: June 9, 1977.
Static depth to water, 106.92 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0810	0	106.92	--	--	Start of test.
0815	5	107.05	69	--	
0820	10	107.03	63	--	
0825	15	107.02	64	--	
0830	20	107.03	62	160	
0835	25	107.03	63	--	
0840	30	107.03	63	--	
0855	45	107.02	63	160	
0910	60	107.02	63	--	
0925	75	107.03	63	160	
0940	90	107.02	63	--	
0955	105	107.01	63	--	
1010	120	107.00	63	155	Same readings every 30 minutes, 1010-1310.
1340	330	106.98	63	155	
1410	360	106.93	63	--	
1440	390	107.06	63	--	
1510	420	107.00	63	--	
1540	450	106.95	63	155	
1610	480	107.02	63	--	End of pumping test.
Recovery test					
1615	0	--			Start of recovery test.
1616	1	106.84			
1625	10	106.84			End of test.

WELL 17B

Location: Same as test hole 17B.
Reamed: June 10, 1977 by International Bridge Corporation.
Altitude: About 105 ft. Depth: 150 ft.
Diameter of open hole: Reamed to 14-3/4 in.
Casing: 12-in. conductor casing. Could not be removed and new pilot hole was drilled 10 ft from well 17B (17BB).

WELL 17BB (later called well 17)

Location: 10 feet from 17B. Lat 15°07'26" N., long 145°42'55" E., at Kobler Field (As Gonna).
Drilled: June 16, 1977 by International Bridge Corporation.
Altitude: Concrete pedestal, 106.42 ft; well plate, 106.48 ft (levels from TAM 11 by Tom Nance, Oct. 4-5, 1982).
Depth: 140 ft, backfilled to 126 ft.
Diameter of open hole: 6-1/4 in., reamed to 14-3/4 in.
Casing: 8-in. steel casing with 8-in. stainless steel screen to 126.5 ft.
Gravel pack and grout: Silica gravel pack to 96.1 ft, grout to surface.
Source of record: Driller.
Remarks: Chloride, 487 mg/L, average of 7 samples June to September 1977 (M and E Pacific, 1978).

Chloride concentration and specific conductance of water from well 17

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1435	920	3,460	28.0	45
11-18-82	1205	200	1,220	28.2	70
3-2-83	1435	980	3,600	27.0	--
6-30-83	1745	1,200	4,470	28.0	77
9-8-83	0952	1,300	4,740	28.0	--

WELL 17BB

Chemical analyses of water from well 17BB

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
2-4-82	105	--	--	--	--	--
2-8-82	125	520	930	7.8	0.30	--
2-9-82	127	--	--	--	--	--
3-8-82	179	642	1,110	7.5	.37	--
4-12-82	288	832	1,600	7.4	.20	--
5-3-82	382	1,100	1,890	7.2	.16	--
6-4-82	589	--	--	7.7	--	244
7-9-82	763	1,720	3,080	7.6	.21	246
8-10-82	820	--	3,340	7.6	--	242
8-17-82	1,020	--	--	--	--	--
8-24-82	1,000	--	--	--	--	--
8-31-82	964	--	--	--	--	--
10-7-82	1,070	--	--	--	--	--
11-10-82	222	--	1,290	7.6	--	249
11-22-82	226	--	--	--	--	--
11-29-82	305	--	--	--	--	--
12-7-82	394	--	1,860	7.9	--	245
12-13-82	450	--	--	--	--	--
12-20-82	513	--	--	--	--	--
1-19-83	722	--	3,010	7.7	--	241
2-25-83	928	--	3,770	7.5	--	242
4-21-83	1,020	--	4,110	7.2	--	241
6-20-83	1,230	--	4,320	7.9	--	249
7-18-83	1,220	--	4,630	7.3	--	245
8-15-83	1,220	--	4,630	--	--	246
9-8-83	1,260	--	4,270	--	--	250
10-14-83	1,390	--	4,860	7.7	--	244

Hardness as $CaCO_3$: 4-21-83, 680 mg/L; 7-18-83, 682 mg/L; 8-15-83, 698 mg/L.

Chloride concentrations: 1-3-83, 653 mg/L; 1-11-83, 687 mg/L; 1-17-83, 711 mg/L; 2-22-83, 931 mg/L; 4-6-83, 1,020 mg/L; 4-11-83, 1,140 mg/L; 4-18-83, 1,050 mg/L; 4-25-83, 1,090 mg/L; 5-2-83, 1,100 mg/L; 5-10-83, 1,070 mg/L; 5-16-83, 966 mg/L; 5-23-83, 1,150 mg/L; 5-31-83, 1,180 mg/L; 6-6-83, 1,200 mg/L; 6-13-83, 1,220 mg/L 6-27-83, 1,210 mg/L; 7-5-83, 1,230 mg/L; 7-11-83, 1,210 mg/L; 7-25-83, 1,140 mg/L 8-1-83, 1,150 mg/L; 8-8-83, 1,230 mg/L; 8-22-83 and 8-29-83, 1,280 mg/L; 9-14-83, 1,300 mg/L; 9-19-83, 1,320 mg/L; 9-26-83, 1,300 mg/L; 10-3-83 and 10-11-83, 1,360 mg/L.

TEST HOLE 17D

Location: Kobler Field (As Gonna).

Drilled: July 9, 1977 by International Bridge Corporation.

Altitude: About 105 ft. Depth: 130 ft.

Diameter of open hole: 6-3/4 in.

Source of record: Driller.

Pumping test: July 11, 1977: Initial static depth to water, 107.68 ft below top of drilling mast table (2.55 ft above ground surface). Maximum drawdown, 0.07 ft in 8 hours at average pumping rate of 65 gal/min; chloride concentration at end of test, 1,175 mg/L; recovery to within 0.03 ft in 10 minutes.

LOG

Description of material	Depth (ft)
Top soil	0-5
Medium hard, light brown coral limestone	5-40
Hard, brown clayey coral limestone	40-60
Medium hard, grayish white coral limestone	60-80
Hard, pale gray white coral limestone	80-115
Hard, coral limestone with brown clay	115-120
Medium hard, brown clay	120-130

TEST HOLE 17

Location: Kobler Field (As Gonna).

Drilled: July 13, 1977 by International Bridge Corporation.

Altitude: About 105 ft. Depth: 130 ft.

Diameter of open hole: 6-3/4 in.

Source of record: Driller.

Pumping test: July 13, 1977: Pumped for two hours at approximate rate of 64 gal/min; chloride concentration, 2,365 mg/L.

July 14, 1977: Static depth to water, 107.93 ft; pumped for 45 minutes; chloride concentration, 2,440 mg/L.

LOG

Description of material	Depth (ft)
Top soil	0-5
Medium hard, light brown coral limestone	5-40
Medium hard, clayey brown coral limestone	40-55
Medium hard, light brown and white limestone	55-60
Medium hard, grayish white limestone	60-105
Medium hard, light brown limestone	105-115
Hard, brown clayey limestone	115-130

TEST HOLE 18

Location: Kobler Field (As Gonna).

Drilled: Feb. 16-19, 1977 by International Bridge Corporation.

Altitude: Exact location not known. Depth: 116 ft.

Diameter of open hole: 6-1/4 in.

Source of record: Driller.

Remarks: July 14, 1977: Still no water in test hole.

LOG

Description of material	Depth (ft)
White coralline limestone	0-10
Medium hard, white limestone	10-50
Rubbly coralline limestone	50-55
Limestone, probably cavernous, poor return of cuttings	55-78
Dense, hard, pale yellow limestone	78-87
Pale buff rubbly and clayey limestone	87-93
Pale brown clay	93-101
Hard, clayey limestone and dark brown clay	101-105
Pale brown clay	105-116

WELL 111

Location: Lat 15°07'24" N., long 145°43'00" E., at As Gonna (Kobler Field).

Drilled: Mar. 10, 1982 by Geo-Engineering and Testing, Inc.

Altitude: Concrete pedestal, 107.09 ft; well plate, 107.12 ft (levels from TAM 11 by Tom Nance, Oct. 4-5, 1982).

Depth: Pilot hole, 140 ft, reamed to 127 ft.

Diameter of open hole: 15 in. to 127 ft.

Casing: Solid 8-in. casing with 16 ft of screen below.

Pumping tests: Initial test, Mar. 10, 1982: No drawdown in 4 hours at pumping rate of 73 gal/min.

Final test, date not given: No drawdown in 24 hours at pumping rate of 80 gal/min.

Mar. 24-25, 1982: No drawdown at pumping rate of 55 gal/min for 24 hours; chloride 321-147 mg/L. See pumping test record.

Remarks: Chloride: 172 mg/L Mar. 10, 1982 at 0610.
198 mg/L Mar. 10, 1982 at 1746.

See table 75 for chemical analysis on Nov. 18, 1982.

Date well brought in production: Apr. 30, 1982.

Chloride concentration and specific conductance of water from well 111

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	1450	880	3,420	28.0	67
3-2-83	1430	1,000	3,760	26.5	--
6-30-83	1738	1,200	4,040	28.0	42
9-8-83	0945	1,200	4,450	28.5	37

WELL 111

Chemical analyses of water from well 111

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (unit)	Turbidity (NTU)	Alkalinity (mg/L)
3-25-82	147	--	--	--	--	--
9-7-82	662	1,530	2,810	7.4	0.17	238
8-10-82	706	--	2,930	7.3	--	236
8-17-82	806	--	--	--	--	--
8-24-82	1,000	--	--	--	--	--
8-31-82	1,000	--	--	--	--	--
9-8-82	888	--	--	--	--	--
10-7-82	1,070	--	--	--	--	--
11-10-82	311	--	1,510	7.6	--	222
11-22-82	247	--	--	--	--	--
11-29-82	248	--	--	--	--	--
12-7-82	255	--	1,340	7.6	--	222
12-13-82	254	--	--	--	--	--
12-20-82	272	--	--	--	--	--
1-3-83	401	--	--	--	--	--
1-11-83	452	--	--	--	--	--
1-19-83	487	--	2,150	7.7	--	227
2-14-83	723	--	--	--	--	--
2-22-83	910	--	--	--	--	--
2-25-83	914	--	3,750	7.4	--	240
4-21-83	895	--	2,580	7.2	--	235
6-20-83	1,130	--	4,320	8.3	--	236
7-18-83	1,070	--	4,080	7.3	--	241
8-16-83	1,180	--	4,250	--	--	242
9-8-83	1,170	--	3,900	--	--	250
10-14-83	1,390	--	4,830	7.5	--	246

Hardness as $CaCO_3$: 4-21-83, 590 mg/L; 7-18-83, 631 mg/L; 8-15-83, 678 mg/L.

Chloride concentrations: 4-6-83, 968 mg/L; 4-11-83, 979 mg/L; 4-18-83, 913 mg/L; 4-25-83, 900 mg/L; 5-2-83, 900 mg/L; 5-10-83, 940 mg/L; 5-16-83, 853 mg/L; 5-23-83, 1,050 mg/L; 5-31-83, 1,070 mg/L; 6-6-83, 1,090 mg/L; 6-13-83, 1,110 mg/L; 6-27-83, 1,130 mg/L; 7-5-83, 1,100 mg/L; 7-11-83, 970 mg/L; 7-25-83, 900 mg/L; 8-1-83, 915 mg/L; 8-8-83, 1,100 mg/L; 8-22-83, 1,220 mg/L; 8-29-83, 1,180 mg/L; 9-14-83, 1,390 mg/L; 9-19-83, 1,360 mg/L; 9-26-83, 1,310 mg/L; 10-3-83, 1,330 mg/L; 10-11-83, 1,360 mg/L.

WELL 111

LOG

Description of material	Depth (ft)
Dark brown clayey silt, medium stiff	0-3
Yellow-brown limestone, hard	3-27
Red brown clayey silt, medium stiff	27-30
Yellow-white limestone, moderately hard	30-35
Color light brown-white	35-115
Dark brown silty clay, medium stiff to soft	115-125
Hole collapsed several times during drilling	125-130
Clay, very stiff	130-140

Note: Water level at 104.5 ft.
Hole reamed to 15 inches only to 127 ft.

PUMPING TEST

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
Date: March 10, 1982. Initial pumping test, pump intake at 114 ft.				
1410	0	104.1	--	Start of test.
1415	5	104.1	73	Same reading every 5 minutes 1420-1455 and every 30 minutes 1425-1755.
1810	240	104.1	73	End of test.
Date: Not given. Final pumping test, pump intake at 115 ft.				
0825	0	104.3	--	Start of 24-hr test.
0830	5	104.3	80	Same reading every 5 minutes 0835-0855, every 15 minutes 0925-1055, every 30 minutes 1125-1625, every hour 1725-0725.
0825	1440	104.3	80	End of 24-hr test.

WELL 111

PUMPING TEST

Date: March 24-25, 1982.

Time	Elapsed time (min)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
March 24				
0835	0	55	321	Start of 24-hr test.
0935	60	--	220	
1035	120	--	190	
1135	180	--	183	
1235	240	--	177	
1435	360	--	169	
1635	480	--	158	
1835	600	--	160	
2035	720	--	151	
2235	840	--	154	
March 25				
0035	960	--	148	
0235	1080	--	142	
0435	1200	--	145	
0635	1320	--	148	
0834	1440	--	147	End of 24-hr test.

Note: No drawdown during pumping test.

WELL 112

Location: Lat 15°07'33" N., long 145°43'04" at As Gonna (Kobler Field).

Drilled: March 30, 1982 by Geo-Engineering and Testing.

Altitude: 130.97 ft. Depth: 170 ft.

Diameter of open hole: 12 in.

Casing: Could not case.

Pumping test: Mar. 30, 1982: Drawdown, 6.6 ft in 5 hours at pumping rate of 122 gal/min. See pumping test record.

Hole was abandoned because of cave-in.

LOG

Description of material	Depth (ft)
White sandy limestone gravel backfill	0-1
Brown clayey gravel	1-2
Light brown limestone	2-30
Dark brown clay, stiff	30-75
Water infiltration at 43 ft	
Several cavings at 50 ft	
Mixed clayey limestone	
Several cavings at 70 ft	
Several large boulders between 70 and 100 feet	
(No samples recovered)	75-115
Light brown limestone, medium hard	115-120
White limestone, hard	120-162
Red brown clay	162-165
(Not recorded)	165-170

WELL 112

PUMPING TEST

Date: March 30, 1982.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1330	0	--	--	--	Start of test.
1335	5	128.7	15	--	
1340	10	129.6	60	--	
1345	15	132.9	47	324	
1350	20	132.2	47	298	
1355	25	132.6	47	--	
1400	30	131.5	47	272	
1415	45	136.3	100	--	
1421	51	--	--	266	
1430	60	135.3	118	--	
1445	75	135.3	127	221	
1500	90	135.3	122	--	
1515	105	135.3	122	--	
1530	120	135.3	122	--	
1545	135	--	--	271	
1600	150	135.3	122	--	
1630	180	135.3	122	--	
1700	210	135.3	122	--	
1730	240	135.3	122	--	
1745	255	--	--	273	
1800	270	135.3	122	--	
1830	300	135.3	122	--	End of test.

Note: Pump screen was partially blocked with clay and cleaned at 30-45-minute intervals.

WELL 113

Location: Lat 15°07'36" N., long 145°43'02" E., at As Gonna (Kobler Field).

Drilled: Mar. 26, 1982 by Geo-Engineering and Testing.

Altitude: Concrete pedestal, 92.58 ft; well plate, 92.65 ft; (levels from TAM 11 by Tom Nance, Oct. 4-5, 1982).

Depth: 130 ft.

Diameter of open hole: 12 in.

Gravel pack and grout: 40 ft of gravel around casing from 81 to 121 ft below ground surface. Concrete pack to ground surface.

Pumping tests: Apr. 28, 1982: Drawdown, 0.4 ft in 5 hours at pumping rate of 143 gal/min; chloride, 90-139 mg/L.

Apr. 30 to May 1, 1982: Drawdown, 0.3 ft in 24 hours at pumping rate of 143 gal/min.

Remarks: Apr. 5, 1983, specific conductance, 1,100 µmho; pumping rate, 90 gal/min; static depth to water, 91.48 ft (USGS).

June 30, 1983, specific conductance, 1,450 µmho; chloride, 300 mg/L; pumping rate, 91 gal/min (USGS).

LOG

Description of material	Depth (ft)
White limestone gravel, fill material	0-1
Red brown clayey silt with limestone boulders	1-2
Yellowish white limestone, moderately hard	2-5
Yellowish white limestone with large boulders and hard	5-15
Yellow-brown limestone, moderately hard	15-20
Color yellow-white	20-35
Light brown-white limestone, weak	35-55
Color yellow-white, weak	55-100
Color light brown-white, moderately hard	100-110
Brown silty clay with limestone boulders	110-125
Brown silty clay with limestone boulders, medium stiff	125-130

WELL 113

PUMPING TEST

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
		Initial pumping test, April 28, 1982			
1040	0	89.7	--	--	Start of test. Static depth to water.
1041	1	90.2	143	90	
1045	5	90.2	143	--	Same reading every 5 minutes 1050-1110.
1125	45	90.1	143	--	
1140	60	90.1	143	--	
1155	75	90.1	143	139	
1210	90	90.1	143	--	Same reading at 1225, 1240 and every 30 minutes 1310-1510.
1540	300	90.1	143	--	End of test.
		Final pumping test April 30 to May 1, 1982			
April 30					
1020	0	89.7	--	--	Start of 24-hr test. Static depth to water.
1025	5	90.1	143	--	Same reading every 5 minutes 1030-1050 and every 15 minutes 1105-1220.
1250	150	90.0	143	--	Same reading every 30 minutes 1320-1010, May 1.
May 1					
1040	1460	90.0	143	--	End of 24-hr test.

WELL 116

Location: Lat 15°07'34" N., long 145°42'54" E., at Kobler Field, As Gonna.

Drilled: Feb. 7-10, 1983, by Geo-Engineering and Testing.

Altitude: 107.71 ft (Department of Public Works). Depth: 147 ft.

Pumping test: Feb. 10, 1983: Chloride concentration during almost 9 hours of pumping dropped from 1,120 mg/L to 202 mg/L.

Feb. 11, 1983: Maximum drawdown during 8 hours at pumping rate of 30-110 gal/min, 17.8 ft. See pumping test record.

Feb. 14, 1983: Maximum drawdown during almost 6 hours at pumping rate of 22-150 gal/min, 20.6 ft; chloride, 124-706 mg/L. See pumping test record.

Feb. 15, 1983: Well was pumped dry twice after pumping for a few minutes at a rate of 65-70 gal/min.

Remarks: Chloride: Feb. 15, 1983, 157-189 mg/L.

Hole abandoned because of low yield.

LOG

Description of material	Depth (ft)
Light yellow-brown limestone	0-4
Light yellow limestone	4-11
Yellow-brown limestone	11-15
Yellow-white limestone	15-17
Yellowish-white limestone	17-39
Yellowish-brown limestone with brown clay particles	39-51
Yellowish-brown limestone	51-56
Yellowish-white limestone	56-73
Lost air circulation, no cuttings or foam	73-147
Static depth to water, 105.4 ft on Feb. 11, 1983.	

WELL 116

PUMPING TEST

Date: February 11, 1983.
Static depth to water, 105.4 ft; pump at 137 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1005	0	105.4	110	Start of test.
1015	10	119.6	34	
1030	25	121.1	30	
1100	55	121.1	30	
1105	60	122.1	30	
1115	70	122.9	30	
1120	75	122.6	30	Same reading at 1145.
1200	115	122.6	32	
1230	145	107.2	31	
1300	175	106.7	30	
1330	205	120.3	110	
1400	235	112.7	59	
1430	265	125.3	36	Pump raised to 127 ft at 1440.
1500	295	113.8	43	
1530	325	112.2	43	
1600	355	123.2	41	End of test.

WELL 116

PUMPING TEST

Date: February 14, 1983.
Static depth to water, 105.4 ft; pump at 127 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1244	0	105.4	91	--	Start of test.
1245	1	118.6	150	361	
1300	16	124.6	94	--	
1315	31	117.4	132	--	
1330	46	--	--	--	Pump stopped. Water level recovered 3 ft.
1345	61	124.5	122	--	
1400	76	124.3	35	431	Same reading at 1415.
1423	99	119.3	34	--	
1430	106	--	--	--	Pump lowered to 128 ft.
1530	166	--	30	430	
1537	173	126.0	--	706	
1547	183	111.2	--	--	
1600	196	107.2	27	460	
1611	207	107.2	30	--	
1617	213	106.5	22	--	
1624	220	108.3	34	146	
1630	226	110.4	35	--	
1641	237	107.2	34	--	
1700	256	106.0	34	143	
1715	271	106.9	36	--	
1730	286	107.0	34	124	
1745	301	107.2	33	--	
1800	316	119.8	91	164	
1815	331	124.2	89	--	
1830	346	126.0	113	147	End of test.

WELL 116A. Later called well 116.

Location: Lat 15°07'36" N., long 145°42'53" E., about 80 ft from well 116 at Kobler Field (As Gonna).

Drilled: Feb. 16-23, 1983, by Geo-Engineering and Testing.

Altitude: 108.45 ft, ground surface (Department of Public Works).

Depth: 131 ft (8-in. pilot hole to 139 ft, deepened to 154 ft on Feb. 23. About 23 ft of cuttings at bottom).

Diameter of open hole: 8 in., reamed to 12 in.

Casing: 110 ft solid stainless steel 8 in. casing with 20 ft screen below.

Source of record: Driller's log.

Gravel pack: Gravel to 69 ft below ground surface.

Pumping test: Well 139 ft deep: Feb. 17, 1983: No drawdown in 2-1/2 hours at pumping rate of 55-60 gal/min; chloride, 18 samples between 1152 and 1830, 35.9-45.1 mg/L.

Feb. 19-20, 1983: Maximum drawdown, 7.5 ft during 24 hours at pumping rate of 33-57 gal/min; chloride, 24 samples between 1425 (Feb. 19) and 1430 (Feb. 20), 57.3-204 mg/L. See pumping test record.

Feb. 22, 1983: Practically no drawdown in 4 hours at pumping at rate of about 40 gal/min; chloride, 15 samples, 42.7-181 mg/L.

Well 154 ft deep: Feb. 24, 1983: Drawdown, 4.6 ft in 2 hours at pumping rate of 29-62 gal/min; recovery to static depth of water (106.2 ft) in 22 seconds; chloride, 5 samples, 799-1,770 mg/L.

Feb. 28 to Mar. 1, 1983: Drawdown, 12 ft in 24 hours at pumping rate of 23-51 gal/min; chloride, 26 samples, 739-1,680 mg/L. See pumping test record.

Remarks: Apr. 5, 1983, static depth to water, 108.80 ft (USGS). Measuring point, top of steel plate on concrete pad, 10 inches (0.83 ft) above ground surface.

WELL 116A

LOG

Description of material	Depth (ft)
Yellowish-brown limestone with brown clay	0-6
Yellowish-brown limestone with pockets of brown clay (moderately hard)	6-12
Yellowish-brown limestone (hard drilling)	12-25
Yellowish-brown limestone	25-27
Yellowish-white limestone	27-45
Yellowish-brown limestone	45-56
Yellowish-brown-white limestone	56-80
Yellowish-white limestone	80-117
Yellowish-white limestone with stiff brown clay	117-129
Not listed	129-130
Brownish particles of clay	134-140
Not listed	140-154

PUMPING TEST

Date: February 19-20, 1983.
Static depth to water, 106.2 ft; pump at 113 ft, lowered to 115 ft at 1435.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1415	0	106.2	--	--	Start of test.
1420	5	109.2	57	538	
1425	10	110.8	56	204	
1430	15	110.8	53	101	
1435	20	110.8	51	101	Pump lowered to 115 ft.
1440	25	110.8	51	77.4	
1445	30	110.3	40	--	
1450	35	110.0	39	70.8	
1500	45	110.0	39	60.9	
1515	60	110.0	38	--	
1530	75	110.0	36	182	
1545	90	109.0	35	--	
1600	105	108.6	35	71.5	Same reading at 1615.
1630	135	108.6	36	68.1	
1645	150	108.6	37	--	
1700	165	108.6	37	63.5	
1730	195	108.3	37	--	Same reading every 30 minutes 1800-1930.
2000	345	108.6	36	63.8	

WELL 116A

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
2030	375	108.6	37	--	
2100	405	108.6	35	60.8	
2130	435	110.8	34	--	
2200	465	110.1	35	58.6	
2230	495	108.9	35	--	Same reading every 30 minutes 2300-0130.
0200	705	109.0	34	61.4	February 20, 1983.
0230	735	109.0	34	--	Same reading at 0300.
0330	795	108.9	34	--	Same reading every 30 minutes 0400-0600.
0630	975	108.9	33	--	Same reading at 0700.
0730	1,035	110.9	49	--	
0800	1,065	110.9	43	57.3	
0830	1,095	110.0	43	--	
0900	1,125	112.8	49	--	
0930	1,155	112.0	49	--	
1000	1,185	113.7	49	61.8	Maximum drawdown.
1030	1,215	111.7	49	--	
1100	1,245	113.5	49	--	Same reading at 1130.
1200	1,305	111.7	49	60.9	
1230	1,335	113.2	49	--	
1300	1,365	110.8	49	--	Same reading at 1330, 1400.
1430	1,455	110.8	--	69.1	End of test.

Water level recovered to static depth to water in 45 seconds.

Date: February 28 to March 1, 1983.
Static depth to water: 106.2 ft; pump intake at 128 ft, raised to 123 ft at 0900 on March 1.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1545	0	106.2	--	--	Start of test.
1552	7	111.5	30	1,680	Chloride at 1555.
1600	15	--	--	1,400	Shut off pump to clean screen.
1605	20	112.8	28	1,170	Chloride at 1610.
1614	29	113.0	23	--	

WELL 116A

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1617	32	--	--	--	Shut off pump to clean screen.
1620	35	112.2	43	739	
1625	40	112.5	40	--	
1630	45	113.2	35	1,150	Same reading at 1635.
1640	55	112.9	45	1,010	
1645	60	113.3	40	--	
1650	65	113.2	39	958	
1655	70	114.0	37	--	Same reading at 1700.
1715	90	115.0	35	--	
1730	105	113.8	45	767	
1745	120	114.4	44	--	Same reading at 1800; chloride 1,080 mg/L.
1815	150	114.7	51	--	
1830	165	120.0	43	1,220	
1845	180	115.0	44	--	
1900	195	113.9	43	1,230	
1930	205	120.0	42	1,190	
2000	255	121.2	44	1,200	Maximum drawdown.
2030	285	119.2	42	--	
2100	315	121.2	42	1,210	
2130	345	119.2	42	--	
2200	375	119.5	42	1,190	Same reading at 2230.
2300	435	119.9	43	1,220	Same reading at 2330 and 2400.
March 1					
0030	525	119.9	43-45	--	Same reading every half hour 0100-0530.
0600	855	118.8	43	1,220	
0630	885	118.5	43	--	
0700	915	118.4	113	--	Same reading every half hour 0730-0930. Chloride, 1,240 mg/L at 0800 and 1,270 mg/L at 0918.
1000	1,095	118.4	41	--	
1030	1,125	118.3	40	--	
1100	1,155	118.2	42	--	Same reading every half hour 1130-1530. Chloride, 1,200 mg/L at 1200.
1545	1,440	118.2	42	1,210	
1548	1,443	--	--	--	End of test.

Dandan and San Vicente-Papago Areas

Dandan is the area immediately north of Isley Field (fig. 21). The San Vicente-Papago area lies north of Dandan. Until 1979, only a few wells had been drilled in these areas. Of the four wells drilled in the Dandan area in 1944 (3, 14A and B, 20), only (old) well 3 was productive and supplied water for the 4,000 men of the nearby Navy camp (Irving, L. F., to Acting Public Works Officer, written commun., July 26, 1967). After a cave-in, well 3 had to be abandoned and was replaced in 1962 with a new well 3, 300 feet south of the old well. Since then, (new) well 3 has supplied the nearby hospital with water having an average chloride concentration of 700 mg/L. A 6-inch waterline carries the well water to the elevated 50,000-gallon tank at the hospital.

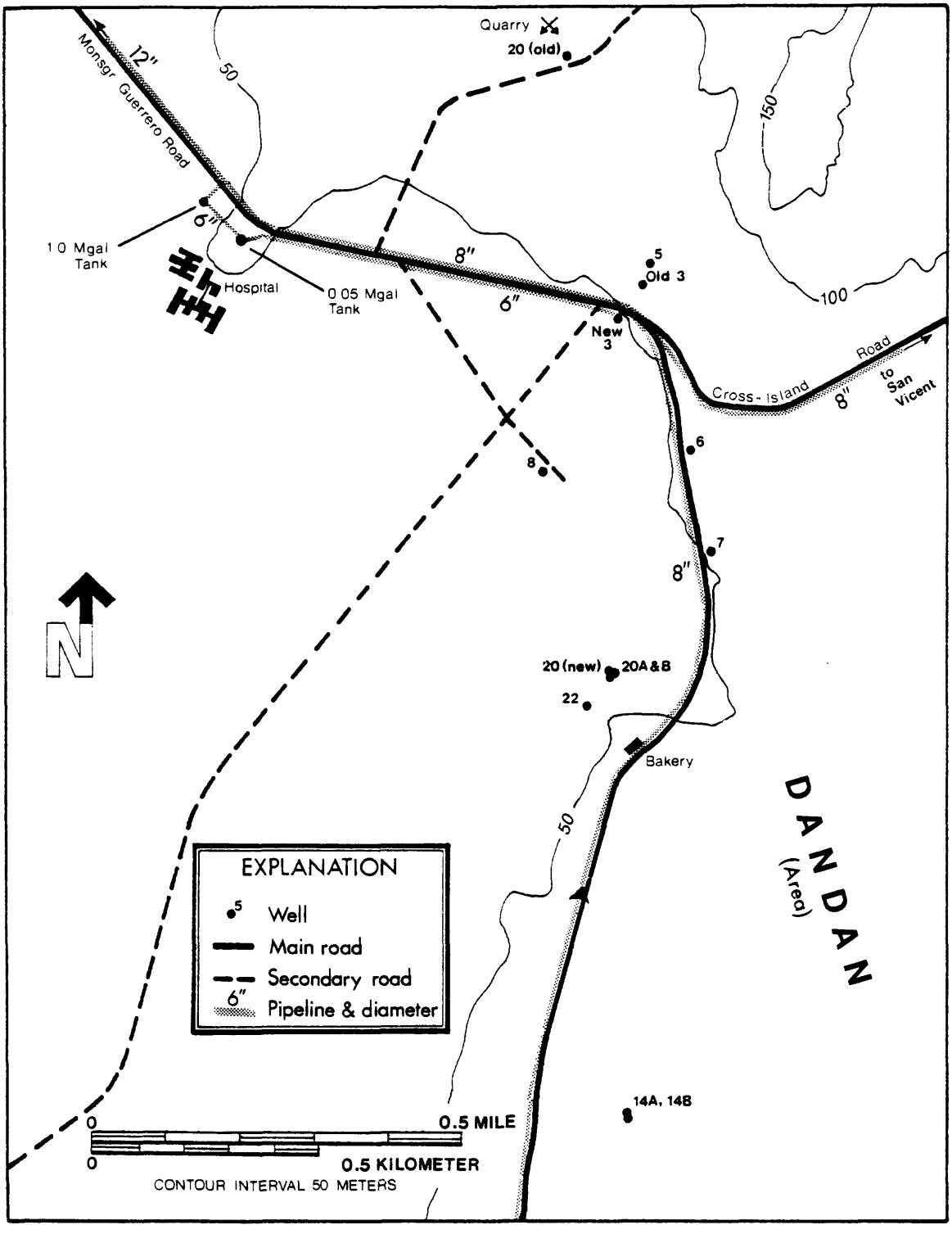
Between July 1970 and January 1971, four new wells (5-8) were completed in the Dandan area (table 27). Well 5, drilled near the location of old well 3, was abandoned because of high chloride concentrations similar to (old) well 20 which had been drilled about 1,500 feet to the north 25 years earlier. Wells 6 and 7 are still in production at present, although the chloride concentration is high and well 8 was taken out of production after 1 year because the water was stained. Chemical analyses of water from this well showed a very high iron concentration when the pump was just started and a much lower concentration 5 minutes later. This indicated that the well casing may have been corroding.

Of the test holes drilled in 1977 near Guerrero's Bakery, wells 20 and 22 were completed but were abandoned shortly thereafter because of low yield.

Until 1979, only well 44 had been drilled (in 1945) in the San Vicente-Papago area. Of the eight test holes drilled in 1979, only test hole 8 was developed as well 8, also known as well San Vicente-1. (See table 28 and figure 22, pages 234, 235 in the San Vicente-Papago area section.)

The water from wells 6 and 7 enters the 8-inch pipeline which carries the water from wells 102, 106-108 at Isley Field to the 8-inch line along Monsigneur Guerrero Road (Cross Island Road). This 8-inch line connects the 0.5 Mgal reservoir at San Vicente with the 1.0 Mgal reservoir at the Hospital. The San Vicente reservoir also receives the water from well 8. Water from well 3 is pumped to a 50,000-gallon tank at the Hospital with the overflow flowing into the adjacent 1.0-Mgal Hospital reservoir.

The chloride concentration of water from all wells in Dandan and San Vicente is high, averaging about 1,000 mg/L. By mixing this water with water of lower chloride concentration from Isley Field, the blended water can be used for domestic consumption.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 21. Location of wells in Dandan area.

Table 27. Testholes and wells drilled in Dandan area

Testhole and well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944			
W 3 (old)	15°09'01"	145°43'40"	July 27, 1944	175.59	186	Abandoned after cave-in.
W 14A	15°08'02"	145°43'40"	November 1944	172	--	Drill stem lost in hole.
W 14B	do.	do.	do.	172	197	Practically no water. Abandoned.
W 20 (old)	15°09'17"	145°43'36"	Dec. 7, 1944	220	235	Low yield, high chloride. Abandoned.
			1962			
W 3 (new)	15°08'59"	145°43'41"	1962	165	180	Hospital well.
			1970-71			
W 5	15°09'03"	145°43'43"	July 25, 1970	184.4	230	
W 6	15°08'50"	145°43'46"	Oct. 10, 1970	183	210	
W 7	15°08'43"	145°43'47"	Oct. 9, 1970	174	190	
W 8	15°08'49"	145°43'35"	January 1971	126.36	146	Water discolored. Discontinued in 1972.
			1977			
W 20	15°08'34"	145°43'40"	Feb. 21, 1977	130	150	Hole caving in. Abandoned.
W 20A	do.	do.	Mar. 7, 1977	130	150	30 ft from W 20. Abandoned.
W 20B	do.	do.	Mar. 26, 1977	130	150	20 ft from W 20A.
TH 21	Adjacent to well 20B, location not known		Apr. 19, 1977	108.36	130	Little water. Abandoned.
TH 22	15°08'32"	145°43'38"	May 27, 1977	111	131	
W 22	do.	do.	June 5, 1977	111	140	

WELL 3 (old)

Location: Lat 15°09'01" N., long 143°43'40" E., near Saipan Hospital, 300 ft north of present well 3, Dandan.

Drilled: July 21-27, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 175.59 ft. Depth: 186 ft.

Casing: 6 in. to 185 ft with 16 ft at bottom perforated.

Aquifer: Limestone.

Source of record: H. T. Stearns (1944) and others.

Remarks: Water was encountered at depth of 174 ft.

Chloride: 49 ppm, at completion. Increased to 83 ppm after 15,000 gallons were pumped in 2 hrs (Stearns, 1944).
320 ppm, when pumped 12 hrs per day (Boniface, 1945, and Curione, 1949).
270 ppm (Glander, 1946).

Pumpage: 200,000 gal/d, at completion (log).
230,400 gal/d, Sept. 6, 1944 (Stearns, 1944).
215,000 gal/d (Boniface, 1945).
78,000 gal/d, on 10-hr/d schedule[1/].
70,000-100,000 gal/d (Glander, 1946).
76,000-110,000 gal/d (from weekly pumpage records March 1947 to February 1948).
70,000-100,000 gal/d (Glander, 1946).
76,000-110,000 gal/d (from weekly pumpage records March 1947 to February 1948).
80,000 gal/d, on 10-hr/d schedule (Curione, 1949).

pH: 7.0-7.2 (Glander, 1946).

For chemical analysis, see table 76.

Well was abandoned after cave-in[2/].

1/ Written communication T.S. Stock to Commanding Officer, Nov. 7, 1945.

2/ Written communication, L. F. Irving to Acting Public Works Officer, July 28, 1967.

WELL 3 (old)

LOG
[Source: H. T. Stearns]

Description of material	Depth (ft)
Clay and sand	0-10
Sticky clay and sandy limestone	10-40
Hard limestone	40-45
Hard limestone with volcanic grains	45-65
White limestone	65-135
Brown shale	135-149
Mixed limestone and clay	149-152
Volcanic and lime sand	152-160
Hard limestone and reddish clay containing volcanic grains	160-175
Hard limestone and white sand	175-179
White lime sand	179-186

WELL 14A

Location: Lat 15°08'02" N., long 145°43'40" E., Dandan, at old asphalt plant No. 1.

Drilled: November 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 172 ft. Depth: Not reported.

Drill stem lost in hole and hole was abandoned (Supplemental report on well drilling, memorandum by Desloge Brown to Commanding Officer, Nov. 29, 1944, 3p.)

WELL 14B

Location: Next to well 14A.

Drilled: November 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 172 ft. Depth: 197 ft.

Casing: Pulled when abandoned.

Aquifer: Sand.

Remarks: Well sprung with 125 lbs TNT at 192 ft.
Chloride: 30 ppm, at completion (Brown[1/]).

Practically no water recovered by pumping and well was abandoned.

[1/] Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Rock and sandy gravel	0-12
Lime and clay	12-20
Hard lime	20-35
Clay	35-40
Sand and gravel	40-43
Lime and sand	43-51
Sand	51-53
Sand and chalky lime	53-56
Chalky lime	56-91
Chalky lime and sand	91-94
Hard lime	94-113
Chalky lime and hard lime	113-126
Hard lime	126-142
Chalky lime and lime	142-152
Beach sand	152-154
Clay and soft chalky lime	154-155
Sand and clay	155-160
Sand and chalky lime	160-179
Lime rock and clay	179-192
Chalky lime and clay	192-197

WELL 20 (old)

Location: Lat 15°09'17" N., long 145°43'36" E., 1,200 ft north of (old) well 3, Dandan.

Drilled: Nov. 25 to Dec. 7, 1944 by 1397th Engineers Construction Battalion, U.S. Army.

Altitude: 220 ft. Depth: 235 ft.

Casing: 6 in. to 235 ft.

Aquifer: Limestone.

Source of record: Driller and Glander (1946).

Remarks: Well sprung with 100 lb TNT at depth of 230 ft. Depth to water before pumping, 227.5 ft (Glander, 1946).

Chloride: 470 ppm, at completion (log). Increasing daily due to pumping, 600 ppm when abandoned (Glander, 1946).

Pumpage: 63,000 gal/d, at completion (log).
5,000-10,000 gal/d (Glander, 1946).

Well was abandoned because of low yield (Glander, 1946).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Hard limestone	0-28
Limestone	28-218
No record	218-235

WELL 3 (Hospital)

Location: Lat 15°08'59" N., long 145°43'41" E., 300 ft south of old well 3 (1944), near Saipan Hospital.

Drilled: 1962 by Brown, Pacific Maxon for U.S. Navy[1/].

Altitude: 165 ft (from topographic map). Depth: 180 ft.

Remarks: Chloride: 430 ppm, Sept. 14, 1965[1/] at pumping rate of 20 gal/min.
458 ppm, Dec. 21, 1966 at pumping rate of 7 gal/min (Ronimus, 1981).
560 ppm, Sept. 20, 1967 (Ronimus, 1981).
900 ppm, June 26, 1974[2/].
1,175 ppm, Sept. 14, 1974 (Ronimus, 1981).
632 mg/L, average of 7 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
730 mg/L, June 6, 1980 at pumping rate of 56 gal/min (Ronimus, 1981).

Hardness: 330 ppm, Sept. 23, 1971.
510 ppm, June 26, 1974[2/].

Pumpage: 160 gal/min at completion.
115 gal/min, Sept. 14, 1965, pumping intermittently[1/].
Total for 1974, 30,498,400 gal.
1975, 29,230,270 gal.
1976, 24,776,810 gal.
1977, 28,098,490 gal.

Analysis of June 26, 1974[2/]: pH 7.2;
Sulfate, 73 ppm;
Alkalinity (as $CaCO_3$), 310 ppm;
Fecal coliform, 0 per 100 mL;
Total coliform, 64 per 100 mL.

For chemical analysis, see table 72.

[1/] Written communication, L. F. Irving to Acting Director Public Works, July 28, 1967.

[2/] Analyzed by W. B. Brewer, Health Services Trust Territory, using Hach kit.

WELL 3 (Hospital)

LOG

Description of material	Depth (ft)
Clay and coral fill	0-10
Sticky clay and sandy limestone	10-40
Hard limestone with volcanic grains	40-65
White limestone	65-135
Mixed limestone and clay, brown	135-155
Limestone mixed with volcanic and lime sand, reddish clay	155-175
Hard limestone, clear	175-180

Chloride concentration and specific conductance of water from well 3

[Source: U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)	Remarks
3-18-80	--	740	--	--	57	Field determination.
6-17-80	--	700	--	--	57	Do.
6-20-80	--	720	2,910	25.6	--	
8-18-82	1555	700	2,720	29.0	--	Meter broken.
11-18-82	1635	850	3,420	28.3	--	Do.
9-8-83	0810	610	2,670	29.0	--	

WELL 3 (Hospital)

Chemical analyses of water from well 3

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-27-81	790	1,860	3,170	7.1	0.07	--
2-4-81	795	1,970	3,330	7.5	.12	--
3-13-81	763	1,880	3,220	7.4	.14	--
5-14-81	741	1,740	3,090	7.6	.17	--
5-29-81	721	1,850	3,130	7.0	.13	--
6-10-81	710	1,790	2,730	7.6	.38	--
7-1-81	659	1,570	2,990	7.4	.36	--
7-28-81	700	1,520	2,240	7.8	.25	--
8-20-81	918	2,020	3,550	7.6	.42	--
9-23-81	795	1,900	3,120	7.1	.36	--
10-16-81	734	1,750	3,160	7.4	.42	--
11-25-81	742	1,710	3,000	7.0	.37	--
3-8-82	719	1,790	2,890	7.0	.12	--
4-12-82	708	1,630	2,950	7.2	.29	--
5-3-82	696	1,684	3,021	6.9	.22	--
6-4-82	665	--	--	7.2	--	333
7-9-82	641	1,470	2,740	7.6	.16	335
8-10-82	720	--	3,020	7.5	--	325
8-17-82	640	--	--	--	--	--
8-24-82	618	--	--	--	--	--
8-31-82	721	--	--	--	--	--
9-8-82	759	--	--	--	--	--
10-7-82	695	--	--	--	--	--
11-10-82	866	--	3,460	7.6	--	--
12-7-82	760	--	3,060	8.1	--	--
1-19-83	732	--	3,140	7.6	--	--
2-25-83	707	--	2,570	7.6	--	--
3-23-83	671	--	2,960	--	--	--
4-21-83	665	--	2,810	7.0	--	315
6-20-83	597	--	2,710	7.5	--	300
7-18-83	611	--	2,730	7.6	--	317
8-15-83	595	--	2,540	--	--	318
9-8-83	660	--	2,570	--	--	326
10-14-83	628	--	2,780	7.8	--	318

Hardness as $CaCO_3$: 4-21-83, 536 mg/L; 7-18-83, 531 mg/L; 8-15-83, 520 mg/L.

WELL 5

Location: Lat 15°09'03" N., long 145°43'43" E., at Dandan.

Drilled: July 7-25, 1970 by Asia Wells, Inc.

Altitude: 184.4 ft. Depth: 230 ft.

Casing: 12-in. steel. Gravel pack and grout, from 200 to 210 ft.

Source of record: Driller.

Pumping tests: Sept. 9-10, 1970: Drawdown, 0.3 ft in 32 hours at pumping rate of 47-62 gal/min; chloride, 1,090-1,120 ppm. See pumping test record.

Sept. 21, 1970: Drawdown, 0.45 ft in 16 hours at pumping rate of 23-50 gal/min; chloride, 940-1,330 ppm. See pumping test record.

Remarks: Well re-acidized after plugging with cement and gravel. Initial chloride concentration decreased from about 1,000 to 260 ppm; yield, 15 gal/min.

LOG

Description of material	Depth (ft)
Top soil	0-31
Dark red clay with limestone ledges	31-98
Fractured limestone	98-110
Limestone small amount clay	110-120
Fractured limestone	120-137
Limestone with channels	137-150
Hard limestone	150-170
Broken limestone	170-219
Broken limestone (water)	219-230

First water at 219 ft. Static depth to water 180 ft.
At 200 ft, bailed 240 gallons in 5 minutes with 1 ft drawdown.

WELL 5

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 184.4 ft (top of casing).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
3-20-73	181.80	1-4-74	181.29	3-14-75	181.35	12-2-76	180.47
3-28-73	181.93	1-17-74	181.42	3-31-75	181.58	12-16-76	180.47
4-19-73	181.65	1-31-74	181.57	4-10-75	181.38	1-3-77	180.24
5-4-73	181.41	2-14-74	181.50	4-25-75	181.56	1-14-77	181.30
5-11-73	181.58	2-24-74	181.50	5-9-75	181.50	1-27-77	181.54
5-24-73	181.52	3-21-74	181.45	5-22-75	181.55	2-11-77	181.84
6-7-73	181.83	4-2-74	181.73	6-5-75	181.55	2-26-77	181.60
6-14-73	181.23	4-26-74	181.54	6-20-75	181.58	3-11-77	181.60
6-21-73	181.24	5-9-74	180.53	7-2-75	181.55	5-6-77	181.52
6-28-73	181.22	5-24-74	181.50	7-17-75	181.16	6-2-77	181.51
7-5-73	180.16	6-20-74	181.00	8-28-75	180.50	6-20-77	181.66
7-31-73	181.01	7-5-74	180.13	9-11-75	180.47	7-1-77	181.68
8-9-73	181.04	7-22-74	180.76	9-25-75	180.63	7-28-77	181.74
8-30-73	180.77	8-1-74	181.09	10-9-75	180.65	8-25-77	179.26
9-13-73	181.04	8-19-74	181.00	10-28-75	180.60	9-8-77	179.26
9-27-73	181.23	10-10-74	180.08	11-6-75	180.00	9-22-77	179.26
10-11-73	181.00	10-29-74	180.00	12-19-75	179.42	12-16-77	181.51
10-25-73	181.00	1-15-75	178.95	1-1-76	180.57	1-15-78	181.57
11-8-73	181.15	1-30-75	182.87	1-16-76	180.00	2-13-78	181.64
11-26-73	181.47	2-7-75	181.00	1-30-76	180.76	2-27-78	181.06
12-6-73	181.56	2-21-75	181.57	2-12-76	181.00	4-10-78	182.52
12-20-73	181.45	3-3-75	181.00	11-18-76	180.48		

WELL 5

PUMPING TEST

Date: September 9-10, 1970.
Static depth to water, 180.8 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
1350	0	--	--	--	Start of test.
1450	60	180.9	48	--	
1550	120	180.9	55	--	
1650	180	180.8	50	--	
1750	240	181.1	48	--	
1850	300	181.0	48	--	
1950	360	181.0	47	--	
2050	420	181.1	48	--	
2150	480	181.2	55	--	
2250	540	181.2	57	--	
2350	600	181.1	53	--	
0050	660	181.0	60	--	Sept. 10, 1970.
0150	720	181.2	60	--	
0250	780	181.2	57	--	
0350	780	181.2	57	--	
0450	900	181.1	60	--	
0550	960	181.0	57	--	
0650	1,020	181.1	62	1,120	
0750	1,080	181.1	62	1,120	
0850	1,140	181.1	53	1,120	
0950	1,200	181.1	57	1,120	
1050	1,260	181.1	57	1,100	
1150	1,320	181.1	53	1,100	
1250	1,380	181.1	52	1,090	
1350	1,440	181.1	52	1,090	
1450	1,500	181.1	52	1,090	
1550	1,560	181.1	55	1,090	
1650	1,620	181.1	55	1,090	
1750	1,680	181.1	57	1,090	
1850	1,740	181.1	48	1,090	
1950	1,800	181.1	53	1,090	
2050	1,860	181.1	48	1,090	
2150	1,920	181.1	60	1,090	End of test.

WELL 5

PUMPING TEST

Date: September 21, 1970.
Static depth to water, 180.8 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
0800	0	--	--	--	Start of test.
0910	70	181.1	35	1,240	
1000	120	181.1	32	1,330	
1100	180	181.2	28	1,300	
1200	240	181.2	28	1,220	
1300	300	181.2	28	1,210	
1400	360	181.2	30	1,060	
1500	420	181.25	28	1,100	
1600	480	181.25	30	1,120	
1700	540	181.25	25	1,050	
1800	600	181.25	30	1,050	
1900	660	181.25	25	1,050	
2000	720	181.2	23	970	
2100	780	181.25	45	960	
2200	840	181.25	50	940	
2300	900	181.25	48	960	
2400	960	181.25	48	1,090	End of test.

WELL 6

Location: Lat 15°08'50" N., long 145°43'46" E., at Dandan.
Drilled: Oct. 6-10, 1970 by Asia Wells, Inc.
Altitude: 183 ft (187.65 ft at measuring point, USGS). Depth: 210 ft.
Casing: 8-in. steel.
Source of record: Driller.
Pumping test: Oct. 14, 1970: Drawdown, 4 ft in 4-1/2 hours at pumping rate of 17-50 gal/min; chloride, 121-151 ppm. See pumping test record.
Remarks: Chloride: 2,640 mg/L, June 10, 1980.
2,600 mg/L, June 17, 1980 (USGS). Pumping rate, 42 gal/min (Public Works estimate).
2,700 mg/L, June 20, 1980; specific conductance, 8,820 µmho (USGS).
For chemical analysis, see table 74.

WELL 6

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 187.65 ft, (top of casing, 0.70 ft above concrete well pad).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
3-19-73 --	183.17	12-20-73 -	182.76	2-21-75 --	182.62	2-12-76 --	181.50
3-29-73 --	183.32	1-3-74 ---	182.49	3-3-75 ---	182.00	11-18-76 -	179.65
4-5-73 ---	183.03	1-17-74 --	182.67	3-14-75 --	182.63	12-2-76 --	182.65
4-19-73 --	183.05	1-31-74 --	182.77	3-31-75 --	182.78	12-16-76 -	182.74
5-4-73 ---	182.77	2-14-74 --	182.80	4-10-75 --	182.65	1-3-77 ---	182.70
5-11-73 --	182.80	2-28-74 --	182.76	4-25-75 --	182.76	1-14-77 --	182.64
5-24-73 --	182.00	3-21-74 --	182.77	5-9-75 ---	182.76	1-27-77 --	182.66
6-7-73 ---	182.64	4-2-74 ---	182.86	5-22-75 --	182.82	2-11-77 --	182.55
6-14-73 --	181.76	4-26-74 --	182.86	6-5-75 ---	182.50	2-26-77 --	182.54
6-21-73 --	182.65	5-9-74 ---	182.75	6-20-75 --	182.50	3-11-77 --	182.49
6-28-73 --	182.57	5-24-74 --	182.74	7-2-75 ---	182.50	5-6-77 ---	182.55
7-5-73 ---	182.52	6-20-74 --	181.05	7-17-75 --	182.47	6-2-77 ---	182.65
7-31-73 --	182.43	7-5-74 ---	182.75	8-28-75 --	181.79	6-20-77 --	182.69
8-9-73 ---	182.42	7-22-74 --	182.80	9-11-75 --	181.10	7-28-77 --	181.72
8-30-73 --	182.41	7-25-74 --	182.85	9-25-75 --	181.96	8-25-77 --	182.58
9-13-73 --	182.36	8-1-74 ---	183.00	10-9-75 --	182.00	9-8-77 ---	182.58
9-27-73 --	182.56	8-19-74 --	182.75	10-28-75 -	182.00	9-22-77 --	182.49
10-11-73 -	182.65	10-10-74 -	181.75	11-6-75 --	182.23	12-16-77 -	182.65
10-25-73 -	182.46	10-29-74 -	181.78	12-19-75 -	181.48	1-15-78 --	181.60
11-8-73 --	182.49	1-15-75 --	182.85	1-1-76 ---	181.55	2-13-78 --	181.60
11-26-73 -	182.66	1-30-75 --	181.56	1-16-76 --	181.35	2-27-78 --	181.54
12-6-73 --	182.76	2-7-75 ---	180.54	1-30-76 --	181.43	4-10-78 --	182.52

WELL 6

LOG

Description of material	Depth (ft)
Hard fractured limestone	0-40
Buff colored, soft, fractured limestone	40-78
Light brown soft limestone	78-84
Limestone and brown clay	84-98
Light brown, soft, shattered limestone	98-135
Buff colored limestone	135-153
Red clay and limestone	153-184
Buff colored limestone	184-210

Static depth to water, 181 ft

PUMPING TEST

Date: October 14, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
1130	0	187.0	--	--	Start of test.
1200	30	191.5	17	121	
1230	60	192.0	--	121	
1300	90	194.0	20	121	
1305	95	--	50	--	Increased pumping rate to 50 gal/min and broke suction.
1335	120	--	30	--	Restarted pump at 30 gal/min.
1400	150	195.0	--	151	
1430	180	195.0	--	151	
1500	210	195.0	35	151	
1530	240	195.0	--	151	
1600	270	191.0	21	151	End of test.

WELL 7

Location: Lat 15°08'43" N., long 145°43'47" E., at Dandan.
Drilled: Oct. 7-9, 1970 by Asia Wells, Inc.
Altitude: 174 ft. Depth: 190 ft.
Casing: 8-in. steel.
Source of record: Driller.
Pumping tests: Oct. 10, 1970: Drawdown, 1.2 ft in 4 hours at pumping rate of 33-50 gal/min; chloride, 670-730 ppm. See pumping test record.
Oct. 10-12, 1970: Drawdown, 0.7 ft in 32 hours at pumping rate of 41-56 gal/min; chloride, 910-950 ppm. See pumping test record.
Remarks: Chloride: 710 ppm, at completion.
950 ppm, Dec. 7, 1972.
505 ppm, Mar. 8, 1972.
960 ppm, Mar. 22, 1973.
1,650 ppm, June 26, 1974*.
1,236 mg/L, average of 7 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
900 mg/L, June 17, 1980 at pumping rate of 22 gal/min (USGS).
900 mg/L, June 23, 1980; specific conductance, 3,490 µmho (USGS).
Hardness: 590 ppm, Mar. 3, 1971.
700 ppm, June 26, 1974*.
Pumpage: 72,000 gal/d, at completion.
76,000 gal/d, Oct. 19, 1983 (USGS).
June 26, 1974*: pH, 7.5.;
iron, 1.5 ppm;
alkalinity (as $CaCO_3$), 300 ppm.
no fecal or total coliform per 100 mL.

* Analyses by W. B. Brewer, Health Services Trust Territory, using Hach kit.

WELL 7

LOG

Description of material	Depth (ft)
Red clay	0-32
Clay and limestone	32-65
Fractured limestone, buff colored, traces of clay	65-125
Limestone, white colored, medium hard	126-175
Fractured limestone, buff colored, traces of clay	175-190

Water first encountered at 182 ft
Static depth to water, 173 ft

PUMPING TEST

Date: October 10-12, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
		4-hour test			
October 10					
1830	0	173.0	--	--	Begin of 4-hr test. Meter reading, 271,800.
1900	30	174.2	40	730	
1930	60	174.0	40	700	
2000	90	174.2	33	700	
2030	120	174.2	50	730	
2100	150	174.2	50	670	
2130	180	174.2	50	730	
2200	210	174.2	50	730	
2230	240	174.2	50	730	End of 4-hr test.
		32-hour test			
October 10-12					
2235	0	173.8	--	--	Beginning of 32-hr test.
2335	60	174.2	50	910	
0035	120	174.2	48	910	October 11.
0135	180	174.2	50	910	
0235	240	174.2	48	910	
0335	300	174.1	50	910	
0435	360	174.1	50	950	
0535	420	174.1	48	910	

WELL 7

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
0635	480	174.1	50	910	
0735	540	174.1	50	950	
0835	600	174.1	41	910	
0935	660	174.1	50	910	
1035	720	174.1	50	910	
1135	780	174.1	50	950	
1235	840	174.1	48	950	
1335	900	174.1	50	950	
1435	960	174.1	56	950	
1535	1,020	174.1	45	--	
1635	1,080	174.1	46	910	
1735	1,140	174.1	45	910	
1835	1,200	174.1	48	910	
1935	1,260	174.1	43	910	
2035	1,320	174.1	50	910	
2135	1,380	174.9	45	910	
2235	1,440	174.9	45	910	
2335	1,500	174.9	45	910	
0035	1,560	174.9	45	910	October 12.
0135	1,620	174.9	45	910	
0235	1,680	174.9	45	910	
0335	1,740	174.9	45	910	
0435	1,800	174.9	45	910	
0535	1,860	174.9	45	910	
0635	1,920	--	--	--	End of 32-hr test. Meter reading, 373,200.

WELL 8

Location: Lat 15°08'49" N., long 145°43'35" E., at Dandan.
Drilled: January 1971 by Asia Wells, Inc.
Altitude: 126.36 ft (originally reported as 136.36 ft).
Casing: 8-in. steel.
Depth: 146 ft (on Sept. 27, 1982: 145.9 ft).
Screen: Top of screen at 136 ft.
Gravel pack and grout: Top of gravel at 105 ft.
Pumping test: Jan. 26, 1971: Almost no drawdown in 6-1/2 hours at pumping rate of 58-59 gal/min; chloride, 390-420+ ppm. See pumping test record.

Well water was corroding the casing and pump and causing discoloration of the water. Well was no longer used at the beginning of 1972 and pump was removed on Mar. 20, 1973.

WELL 8

Chemical analyses of water from well 8

First sample collected during first 5 seconds after pump was started; second sample, 5 minutes later. Samples analyzed by U.S. Geological Survey Laboratory in Salt Lake City

[µmho, micromhos per centimeter at 25° Celsius; mg/L, milligrams per liter; µg, micrograms per liter]

Constituent	Unit	March 27, 1972 at 1030	March 27, 1972 at 1035
Specific conductance	µmho	1,520	1,840
pH	--	8.0	7.7
Hardness as $CaCO_3$	mg/L	210	387
Noncarbonate hardness	mg/L	36	82
Calcium, dissolved (Ca)	mg/L	38	104
Magnesium, dissolved (Mg)	mg/L	28	31
Sodium, dissolved (Na)	mg/L	222	228
Potassium, dissolved (K)	mg/L	12	12
Bicarbonate (HCO_3)	mg/L	213	373
Carbonate (CO_3)	mg/L	0	0
Sulfate, dissolved (SO_4)	mg/L	4.0	47
Chloride, dissolved (Cl)	mg/L	375	390
Fluoride, dissolved (F)	mg/L	.1	.1
Silica, dissolved (SiO_2)	mg/L	2.4	6.7
Solids, dissolved, sum of constituents	mg/L	787	1,000
Iron, dissolved (as Fe)	µg/L	2,200	120
Manganese, dissolved (Mn)	µg/L	100	100

WELL 8

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 126.36 ft, (top of casing, 0.70 ft above concrete well pad).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
3-20-73 --	126.38	4-26-74 --	126.08	10-28-75 --	125.20	9-19-80 --	129.73
4-5-73 ---	126.42	5-9-74 ---	126.03	11-6-75 ---	125.36	9-29-80 --	123.88
4-19-73 --	126.52	5-24-74 --	126.00	12-19-75 --	126.07	10-3-80 --	123.98
5-4-73 ---	126.61	6-20-74 --	126.15	1-1-76 ----	126.19	10-10-80 -	123.91
5-11-73 --	126.02	7-5-74 ---	126.12	1-16-76 ---	125.77	10-17-80 -	125.5
5-24-73 --	126.05	7-22-74 --	126.28	1-30-76 ---	125.82	10-27-80 -	125.0
6-7-73 ---	125.88	8-1-74 ---	127.26	2-12-76 ---	126.38	11-10-80 -	123.70
6-14-73 --	125.85	8-19-74 --	127.05	11-18-76 --	125.76	11-14-80 -	125.62
6-21-73 --	125.86	10-10-74 -	125.89	12-2-76 ---	125.62	11-21-80 -	125.84
6-28-73 --	125.74	10-29-74 -	125.82	1-3-77 ----	125.84	11-28-80 -	125.86
7-5-73 ---	125.75	1-15-75 --	126.01	1-14-77 ---	125.55	12-3-80 --	125.53
7-31-73 --	125.61	1-30-75 --	126.01	1-27-77 ---	125.62	12-10-80 -	125.62
8-9-73 ---	125.63	2-7-75 ---	127.85	2-11-77 ---	125.74	1-5-81 ---	125.94
8-30-73 --	125.56	2-21-75 --	126.54	2-26-77 ---	125.78	1-16-81 --	125.16
9-13-73 --	125.58	3-3-75 ---	182.00	3-11-77 ---	125.59	1-26-81 --	124.86
9-27-73 --	125.77	3-14-75 --	125.85	5-6-77 ----	126.63	2-5-81 ---	124.88
10-11-73 -	125.81	3-31-75 --	126.01	6-2-77 ----	125.60	2-10-81 --	124.41
10-25-73 -	125.73	4-10-75 --	125.43	6-20-77 ---	125.60	2-19-81 --	124.40
11-8-73 --	125.66	4-25-75 --	125.75	7-1-77 ----	126.45	3-19-81 --	123.39
11-26-73 -	182.66	5-9-75 ---	125.78	7-28-77 ---	125.84	4-18-81 --	125.17
12-6-73 --	125.88	5-22-75 --	126.29	8-25-77 ---	126.03	5-11-81 --	124.21
12-20-73 -	125.87	6-5-75 ---	125.71	9-8-77 ----	126.00	5-20-81 --	124.31
1-4-74 ---	125.80	6-20-75 --	125.71	9-22-77 ---	125.86	5-26-81 --	124.26
1-17-74 --	125.78	7-2-75 ---	125.71	12-16-77 --	126.08	6-29-81 --	124.48
1-31-74 --	126.04	7-17-75 --	125.69	1-15-78 ---	126.00	7-14-81 --	124.35
2-14-74 --	126.07	8-28-75 --	124.83	2-13-78 ---	125.98	8-12-81 --	124.32
2-28-74 --	126.07	9-11-75 --	125.14	2-27-78 ---	126.00	9-27-82 --	125.5
3-21-74 --	125.88	9-25-75 --	125.01	4-10-78 ---	125.77		
4-2-74 ---	126.08	10-9-75 --	125.17	9-5-80 ----	125.62		

WELL 8

LOG

Description of material	Depth (ft)
Top soil and coral fill	0-10
Buff colored limestone with traces of clay	10-40
Light colored medium hard limestone	40-80
Buff colored clear limestone	80-146

PUMPING TEST

Date: January 26, 1971.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
1000	0	126.8	58	390	Start of test.
1100	60	126.9	58	390	At 1020: pumping rate, 59 gal/min.
1200	120	126.9	58	390	
1300	180	126.9	58	390	
1400	240	126.9	58	390	
1500	300	126.9	58	420	
1600	360	126.9	58	420	
1700	420	126.9	58	390+	
1800	480	126.9	58	420+	
1815	495	126.9	--	--	End of test.

Recovery of 0.1 ft, too fast to record.

WELL 20

Location: Lat 15°08'34" N., long 145°43'40" E., behind Guerrero's Bakery in Dandan.

Drilled: Feb. 19-21, 1977 by International Bridge Corporation.

Altitude: 130 ft (from topographic map). Depth: 150 ft.

Diameter of open hole: 6-1/2 in.; reamed to 12-1/4 in. Feb. 25-26, 1977.

Casing: 8-5/8 in. steel casing with 20 ft of 8-5/8 in. perforated screen at bottom. Casing removed when blocked at 118 ft.

Source of record: Driller.

Pumping test: Feb. 23, 1977: Drawdown, 5.35 ft in 8 hours at pumping rate of 53-54 gal/min; chloride, 405-430 mg/L; recovery to within 0.3 ft in 36 minutes. See pumping test record.

Remarks: Chloride: 415 mg/L, Feb. 22, 1977, after completion of drilling, at pumping rate of 6.7 gal/min.
410 mg/L, Feb. 23, 1977, after pumping at rate of 53 gal/min; water temperature, 28.5°C.

Note: Hole kept closing at about 50 ft below ground surface by loose clay and was abandoned on Mar. 4, 1977.

WELL 20

LOG

Description of material	Depth (ft)
Top soil	0-7
Brown clay	7-10
Soft red clay	10-20
Hard red clay	20-21
Hard red clay with limestone	21-23
Brown clay with traces of limestone	23-33
Hard red clay with limestone	33-40
Hard brown clay with limestone	40-50
Medium hard limestone with brown clay	50-52
Medium hard limestone with red clay	52-56
Medium hard limestone with brown clay	56-68
Medium hard limestone	68-80
Fractured limestone	80-110
Medium hard limestone	110-125
Hard limestone	125-150

PUMPING TEST

Date: February 23, 1977.
Static depth to water, 111.77 ft (tape), 112.02 ft (electric sounder).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1021	--	112.02	--	--	Static depth to water.
1100	0	--			Start of test.
1107	7	117.23	53	415	
1110	10	117.25	54	--	
1115	15	117.32	54	--	
1120	20	117.42	54	--	
1125	25	117.01	54	--	
1130	30	117.10	53	430	
1145	45	117.25	53	--	
1200	60	117.28	53	420	
1215	75	117.34	53	--	
1230	90	117.35	53	410	
1245	105	117.42	53	--	
1300	120	117.34	53	410	
1330	150	117.27	51	--	
1400	180	117.40	54	415	
1430	210	117.40	54	420	

WELL 20

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1500	240	117.14	54	415	
1530	270	117.16	54	420	
1600	300	117.25	54	417	
1630	330	117.27	54	425	
1700	360	117.24	54	415	
1730	390	117.26	54	405	
1800	420	117.31	54	410	
1830	450	117.38	54	422	
1900	480	117.37	54	402	End of test.
Recovery					
1900	0	117.37			Prior to stopping pump.
1900	0	112.59			Immediately after stopping pump.
1901	1	112.70			
1902	2	112.69			
1903	3	112.66			
1904	4	112.65			
1905	5	112.63			
1906	6	112.62			
1907	7	112.61			
1908	8	112.59			
1909	9	112.57			
1912	12	112.53			
1915	15	112.50			
1918	18	112.49			
1924	24	112.42			
1930	30	112.41			
1936	36	112.38			End of test.

WELL 20A

Location: Dandan, about 30 ft from hole 20.
Drilled: Mar. 7, 1977 by International Bridge Corporation.
Altitude: 130 ft (from topographic map). Depth: 150 ft.
Diameter of open hole: 6-1/4 in., reamed to 12-1/4 in. Mar. 8-9, 1977.
Casing: 8-in. steel casing and screen to 135 ft. Bottom filled with cement plug to 137.5 ft; 14 ft of 12-in. casing was placed around 8-inch casing and space outside 12-in. pipe backfilled. Space outside 8-inch casing could not be kept open for gravel fill at bottom.
Remarks: Hole abandoned on Mar. 25, 1977.

WELL 20B

Location: 20 ft from 20A. No drilling log taken.
Drilled: Mar. 26, 1977 by International Bridge Corporation.
Altitude: 130 ft (from topographic map). Depth: 150 ft.
Diameter of open hole: 6-1/4 in., reamed to 15 in. Hole was constricted at 33 ft, used 12-in. steel pipe to 38 ft for conductor casing. Hole bridged at 115 ft, possibly by loose clay pushed down by conductor casing.
Casing: 8-in. steel casing and screen.
Gravel pack and grout: Silica gravel in space between 12-in. and 8-in. casings to 108.5 ft. Removed 12-in. casing. Placed sand seal on top of gravel. Placed 104 sacks of cement while pulling out 12-in. conductor casing. Cement plug at 135.35 ft and depth to water at 111.35 ft below top of casing.
Acidized hole; surging and pumping for several days.
Pumping test: Apr. 18, 1977, 0950-1940: Final pumping and recovery test. No results available.

WELL 20A, assumed same for 20B.

LOG

Description of material	Depth (ft)
Surface	0-7
Brown clay	7-28
Yellow clay	28-36
Red clay	36-39
Light brown clay	39-49
Black-white coral	49-65
White limestone	65-90
Fractured limestone	90-100
Medium hard limestone	100-125
Fractured limestone	125-130
Medium hard limestone	130-150

WELL 20B

Depth to water, in feet

[Source: Northern Marianas Division of Environmental Quality]

Altitude of measuring point: 130 ft (from topographic map).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
9-5-80	113.39	11-10-80	113.65	1-16-81	110.79	3-27-81	111.38
9-19-80	111.10	11-14-80	112.78	1-26-81	110.55	5-4-81	113.62
9-29-80	111.36	11-21-80	113.48	2-5-81	110.79	5-7-81	113.58
10-3-80	111.80	11-28-80	111.11	2-10-81	110.88	5-11-81	113.54
10-10-80	111.39	12-10-80	111.24	2-19-81	110.86	5-20-81	112.97
10-17-80	114.6	12-18-80	113.51	3-9-81	110.92	5-26-81	112.97
10-27-80	112.8	1-5-81	111.33	3-18-81	111.35	6-9-81	113.00

TEST HOLE 21

Location: Dandan, adjacent to well 20B. Exact location not known.

Drilled: Apr. 19, 1977 by International Bridge Corporation.

Altitude: 108.36 ft. Depth: 130 ft.

Diameter of open hole: 6-3/4 in.

Casing: None.

Source of record: Driller.

Remarks: Apr. 19, 1977: Static depth to water, 105.3 ft.

Apr. 20, 1977, 0945: Depth to water, 108 ft from top of mast table.

0945-1215, 1315-1430: Pumped off and on at rate of 8.7 gal/min.

1430-1445: Water level, 123.45 ft when pump motor at no load. Average pumpage rate, 10.9 gal/min.

1630: Depth to water, 105.7 ft below ground surface; chloride, 160 mg/L. Yield of water was very small.

June 6, 1977: Depth of hole, 125 ft below ground surface; depth to water, 105.5 ft. Pumped water, but no continuous flow as there was little water in the hole.

LOG

Description of material	Depth (ft)
Top soil	0-10
Brown clay	10-50
Brown clay with medium hard coral	50-60
Corraline limestone with brown clay	60-75
Medium hard limestone and red clay	75-95
Medium hard limestone	95-105
Hard limestone	105-130

TEST HOLE 22

Location: Lat 15°08'32" N., long 145°43'38" E., at Dandan on H. R. Guerrero farmland.

Drilled: May 26-27, 1977 by International Bridge Corporation.

Altitude: 111 ft. Depth: 131 ft.

Diameter of open hole: 6-3/4 in.

Casing: None.

Source of record: Driller.

Pumping test: May 27, 1977: Drawdown, 1.32 ft in 8 hours at pumping rate of 68-69 gal/min; chloride during test, 500 mg/L; recovery to 0.17 ft of initial depth to water in 8 seconds. See pumping test record.

LOG

Description of material	Depth (ft)
Top soil	0-5
Soft brown clay	5-28
Soft yellow clay	28-30
Soft red clay	30-31
Soft yellow clay	31-50
Red clay with medium hard limestone	50-65
Hard limestone with red clay	65-75
Hard limestone with yellow clay	75-105
Hard coral with yellow clay	105-131

TEST HOLE 22

PUMPING TEST

Date: May 27, 1977.
Reference point: 2.5 ft above ground surface (top of drill mast table).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1333	--	109.78	--	500	Static depth to water before start of pumping.
1335	0	109.78	68	--	Start of test.
1340	5	111.43	68	--	
1345	10	111.46	68	--	
1350	15	111.46	68	--	
1355	20	111.48	68	--	
1400	25	111.48	68	--	
1405	30	111.47	68	500	
1420	45	111.48	68	--	
1435	60	111.49	68	500	
1450	75	111.48	68	--	
1505	90	111.50	68	500	
1520	105	111.52	68	--	
1535	120	111.51	68	--	
1605	150	111.50	69	500	
1635	180	111.40	69	--	
1705	210	111.25	69	500	
1735	240	111.30	69	--	
1805	270	111.22	69	500	
1835	300	111.20	69	--	
1905	330	111.18	69	500	
1935	360	111.10	69	--	
2005	390	111.12	69	500	
2035	420	111.10	69	--	
2105	450	111.10	69	--	
2135	480	111.10	69	500	End of test; pumping stopped.
Recovery					
2135	0	--			Start of recovery test.
2136	1	109.67			Elapsed time since pumping stopped was measured with stopwatch.
2137	2	109.67			
2138	3	109.65			
2139	4	109.67			
2140	5	109.61			
2141	6	109.61			
2142	7	109.64			
2143	8	109.61			
2144	9	109.61			
2145	10	109.61			Last measurement.

WELL 22

Location: Same as test hole 22.

Drilled: May 29 to June 5, 1977 by International Bridge Corporation.

Altitude: Same as test hole 22. Depth: 140 ft.

Diameter of open hole: 14-3/4 in. (reamed).

Casing: 8-in. solid casing with 8-in. screen at bottom to 137 ft.

Gravel pack and grout: Silica gravel pack around screen to 102.9 ft below ground surface. Sealed with 2 ft of sand. Cement grout to 1 ft below ground surface.

Source of record: Driller.

Pumping test: June 3, 1977: Drawdown, 3.69 ft in 8 hours at pumping rate of 62-63 gal/min; chloride during test, 500 mg/L; recovery to 0.06 ft of initial water level in 8 minutes. See pumping test record.

Remarks: Well acidized with 110 gallons 30 percent hydrochloric acid. On Sept. 27, 1982, depth was 95-1/2 ft; casing was in poor condition.

PUMPING TEST

Date: June 3, 1977.
Reference point: 4.0 ft above ground surface (top of 8-inch casing).

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0915	--	111.31	--	--	Static depth to water before start of pumping.
0926	0	115.75	62	500	Start of test.
0927	1	115.53	--	--	
0928	2	115.54	--	--	
0929	3	115.53	--	--	
0930	4	115.43	--	--	
0931	5	115.46	--	--	
0932	6	115.43	--	--	
0933	7	115.40	--	--	
0934	8	115.38	--	--	
0935	9	115.41	--	--	
0936	10	115.60	--	--	
0941	15	115.43	62	--	
0946	20	115.38	62	--	
0951	25	115.34	62	--	

WELL 22

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0956	30	115.34	62	--	
1001	35	115.24	62	--	
1006	40	115.26	62	--	
1011	45	115.23	62	--	
1016	50	115.23	62	--	
1021	55	115.22	62	--	
1026	60	115.26	62	500	
1056	90	115.19	62	--	
1126	120	115.19	62	500	
1156	150	115.04	63	--	
1226	180	115.09	63	500	
1256	210	115.10	63	--	
1326	240	115.15	63	--	
1356	270	115.12	63	--	
1426	300	115.10	62	--	
1456	330	115.10	62	--	
1526	360	115.16	63	500	
1556	390	115.00	62	--	
1626	420	115.00	62	500	
1656	450	115.00	62	--	
1726	480	115.00	62	--	End of pumping test.
Recovery					
1729	0	--			Start of recovery test.
1730	1	111.52			Elapsed time since
1731	2	111.44			pumping stopped meas-
1732	3	111.44			ured with stopwatch.
1733	4	111.44			
1734	5	111.43			
1735	6	111.42			
1736	7	111.39			
1737	8	111.37			
1738	9	111.37			
1739	10	111.37			End of test.

Table 28. Testholes and wells drilled at San Vicente-Papago area

Testhole and well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
W 44	15°10'39"	145°44'49"	1945	660	--	Abandoned; low yield.
			1979-80			
TH 1	15°10'13"	145°44'37"	Feb. 24, 1979	630	498	Abandoned in 1980.
TH 5	15°09'03"	145°43'43"	Apr. 30, 1979	280	315	Do.
TH 6	15°09'11"	145°44'13"	May 6, 1979	270	290	Do.
TH 7	15°09'05"	145°44'04"	May 18, 1979	325	335	Do.
TH 8	15°09'19"	145°44'11"	May 25, 1979	317.45	335	Converted into well 8.
W 8	do.	do.	Sept. 19, 1979	317.45	335	Also called San Vicente-1.
TH 9	15°09'19"	145°44'01"	June 8, 1979	420	433	Location approximate.
TH 13	15°09'30"	145°44'31"	Dec. 6, 1979	269.33	190	Abandoned in 1980.
TH 14	15°09'50"	145°44'20"	Dec. 17, 1979	459.38	380	Do.

WELL 44

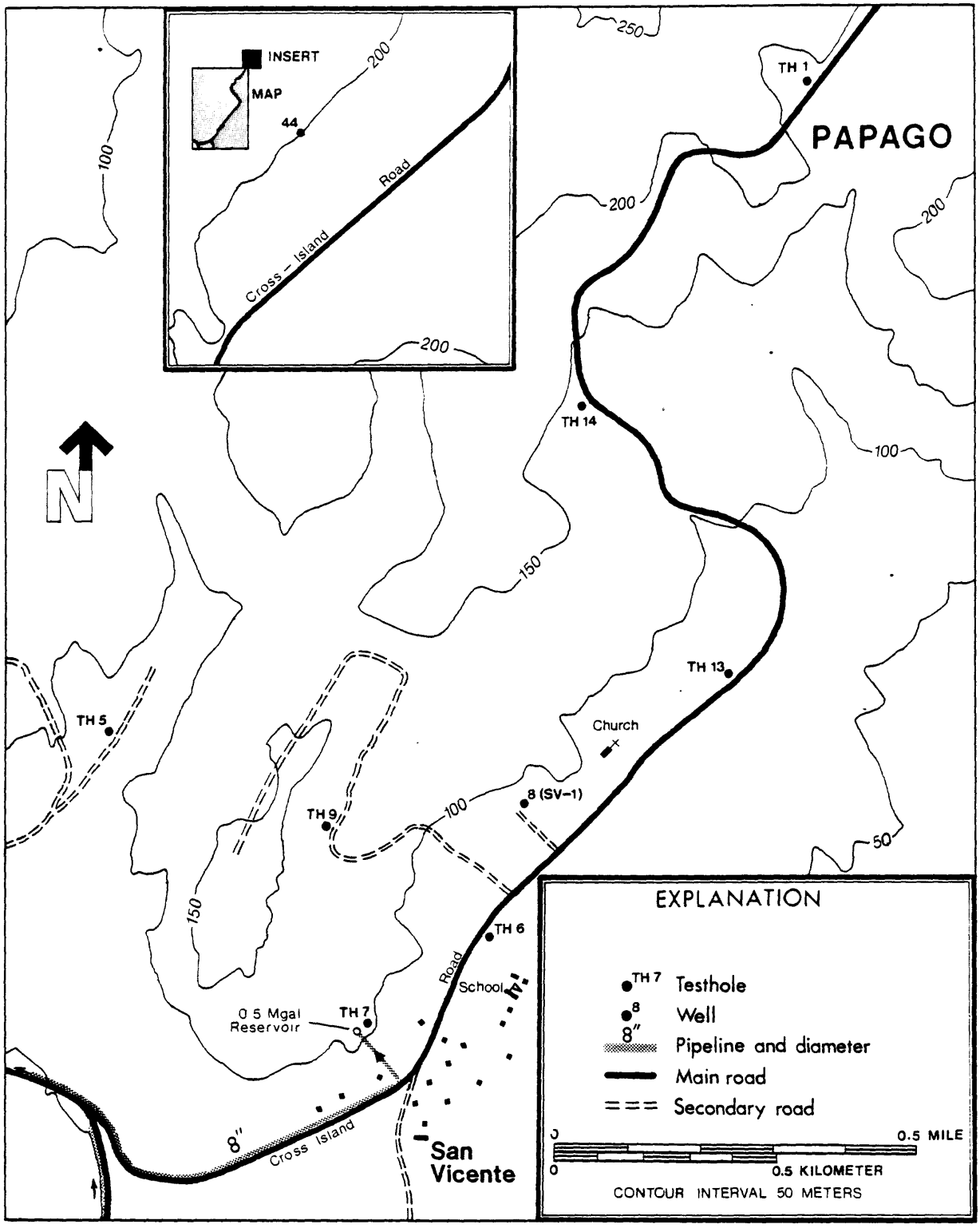
Location: About 15°10'39" N., long 145°44'49" E., at Papago, north of San Vicente.

Drilled: 1945 by 2807th U.S. Naval Construction Battalion.

Altitude: 660 ft. Depth: Not reported.

Source of record: Glander (1946); driller's log missing.

Well was abandoned because of low yield although the salinity was low.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 22. Location of wells in San Vicente-Papago area.

TEST HOLE 1

Location: Lat 15°10'13" N., long 145°44'37" E., 1.5 mi. north of San Vicente on Pinaula property.

Drilled: Feb. 17-24, 1979 by Ted Lund Drilling and Supply.

Altitude: 630 ft (from topographic map). Depth: 498 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Remarks: Feb. 20, 1979: First water encountered at 325 ft.
Feb. 24, 1979, 0900: Depth to water 420 ft. After bailing, recovery of about 6 ft/hr.
May 7, 1979, 1625: Chloride, 91 mg/L.
May 8, 1979, 0900: Chloride, 115 mg/L.
1215: Chloride, 215 mg/L.
1700: Chloride, 290 mg/L.

Hole abandoned and sealed May 13, 1980.

LOG

Description of material	Depth (ft)
White soft fill	0-2
Red soft clay	2-4
White soft to hard coral	4-16
White medium hard with very hard layers	16-52
White hard coral	52-86
White medium hard coral	86-87
White hard coral with very hard layer	87-134
White medium hard coral	134-137
White very hard coral	137-141
White medium hard coral with very hard layers	141-188
Pink soft clay	188-190
White medium hard coral with very hard layers	190-237
White medium hard coral with hard layers	237-280
White very hard coral with hard layers	280-292
White hard coral	292-327
White very hard coral	327-340
White medium hard coral	340-390
White hard coral with very hard and rough layers	390-450
White hard coral	450-484
Red clay and coral, turning clay at 498	484-498

TEST HOLE 5

Location: Lat 15°09'03" N., long 145°43'43" E., 0.5 mi north of Hospital well 3, 0.7 mi northwest of San Vicente.

Drilled: April 25-30, 1979 by Ted Lund Drilling and Supply.

Altitude: 280 ft (from topographic map). Depth: 315 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Remarks: May 1, 1979: Well bailed to 295 ft.

May 2, 1979: Water level at 260 ft, still recovering. Acidized well with 30 gallons 98 percent sulfuric acid and 110 gallons water.

May 3, 1979: Water level at 230 ft. Bailed to 295 ft, water thick with mud. No improvement.

Hole abandoned and sealed May 12, 1980.

LOG

Description of material	Depth (ft)
White, very hard; rough drilling	0-22
Hard, not so rough	22-25
Hard, rough drilling	25-45
Medium hard with hard layers	45-60
Hard with medium hard layers	60-95
Soft, open; rough drilling	95-99
Hard coral with very hard layers rough drilling at 130 ft	99-142
Very soft; rough drilling	142-145
Medium hard with hard layers	145-205
Hard	205-215
Medium hard with hard layers	215-234
Hard with medium hard layers	234-252
Medium hard	252-285
Hard	285-291
Medium soft	291-292
Medium hard	292-315

Note: Clay layers at 70-74, 87-92, 167-170, 182-185; stiff clay at 210-215; very stiff clay at 298-301 ft.
When drill bit was pulled out of the hole, sample showed coral and some clay around bit.

TEST HOLE 6

Location: Lat 15°09'11" N., long 145°44'13" E., at San Vicente School.

Drilled: May 4-6, 1979 by Ted Lund Drilling and Supply.

Altitude: 270 ft (from topographic map). Depth: 290 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping tests: May 8, 1979: Drawdown, 6.33 ft in 8 hours at pumping rate of 52 gal/min; chloride, 152-330 mg/L. See pumping test record.

May 9, 1979: Drawdown, 2.08 ft in 8 hours at pumping rate of 23-24 gal/min; chloride, 300-337 mg/L. See pumping test record.

Hole abandoned and sealed May 12, 1980.

LOG

Description of material	Depth (ft)
Red, medium hard clay	0-2
Hard to very hard coral	2-20
Hard with very hard layers; rough hard drilling	20-32
Very hard	32-35
Hard with medium hard rough drilling	35-50
Medium soft; smooth drilling	50-55
Medium hard with hard rough drilling	55-110
Hard; smooth drilling	110-129
Medium hard with soft and hard rough drilling	129-162
Hard smooth drilling	162-180
Medium hard with hard layers	180-188
Medium soft with hard rough drilling	188-227
Medium soft; smooth drilling	227-239
Medium hard with hard layers	239-265
Medium soft; mud level in hole dropped	265-274
Hard	274-275
Medium soft; smooth drilling	275-288
Medium hard; smooth drilling	288-290

TEST HOLE 6

PUMPING TEST

Date: May 8, 1979.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water[1/] (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0845	--	273.27	--	--	Static depth to water.
0900	0	--	--	--	Start of test.
0904	5	279.9	51	--	
0905	5	279.9	51	152	
0910	10	280.0	52	--	
0915	15	279.9	52	--	
0920	20	280.2	52	--	
0925	25	280.2	52	--	
0930	30	280.1	52	162	
0945	45	280.7	52	--	
1000	60	280.8	52	175	
1015	75	280.8	52	177	
1030	90	280.8	52	197	
1045	105	280.8	52	202	
1100	120	--	--	--	Line found tangled. Correction applied.
1130	150	280.8	52	222	
1200	180	280.9	52	247	
1230	210	280.8	52	262	
1300	240	280.8	52	272	
1330	270	280.8	52	300	
1400	300	280.8	52	290	
1430	330	280.8	52	300	
1500	360	280.9	52	300	
1530	390	280.9	52	312	
1600	420	279.6	52	315	
1630	450	279.6	52	325	
1700	480	279.6	52	330	End of test.

[1/] Depth to water might not be accurate due to line hanging up.

TEST HOLE 6

PUMPING TEST

Date: May 9, 1979.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0805	--	273.27	--	--	Static depth to water.
0810	0	--	--	--	Start of test.
0811	1	--	--	337	
0824	14	275.25	23	--	
0830	20	275.3	24	312	
0845	35	275.25	23	307	
0900	50	275.3	24	--	
0915	65	275.3	24	300	
0930	80	275.25	24	--	
0945	95	--	23	300	
1000	110	275.25	23	--	
1020	130	275.15	23	300	
1030	140	275.2	23	--	
1100	170	275.25	23	312	
1130	200	275.35	23	307	
1200	230	275.35	23	312	
1230	260	275.35	23	312	
1300	290	275.35	23	312	
1330	320	275.25	23	312	
1400	350	275.25	24	317	
1430	380	275.25	23	317	
1500	410	275.25	23	317	
1530	440	275.35	23	322	
1600	470	275.4	24	322	
1610	480	275.35	24	--	End of test.

TEST HOLE 7

Location: Lat 15°09'05" N., long 145°44'04" N., at San Vicente reservoir.

Drilled: May 10-18, 1979 by Ted Lund Drilling and Supply.

Altitude: 325 ft (from topographic map). Depth: 335 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping tests: May 19, 1979, 1525: Pumped at rate of 28 gal/min.

May 20, 1979, 0900-1245: Development test, seven times surging with water and air.

May 21, 1979: Drawdown, 5.15 ft in 8 hours at pumping rate of 47-60 gal/min; chloride, 280-348 mg/L. See pumping test record.

LOG

Description of material	Depth (ft)
Red stiff clay	0-4
White hard coral, rough drilling	4-17
White hard rough coral	17-24
White medium hard with hard layers	24-96
Very hard coral	96-104
Medium hard	104-105
Medium hard with hard layers	105-123
Very hard with clay pockets	123-126
Hard with very hard layers/clay	126-142
Smooth drilling in clay	142-143
Medium hard with hard layers and clay pockets	143-166
Medium hard, smooth drilling	166-193
Medium hard, slightly rough	191-201
Medium soft, slightly rough	201-285
Medium soft/clay pockets	285-287
Medium hard	287-308
Hard smooth drilling	308-312
Medium hard and "cleaner"	312-313
Medium hard, slightly rough drilling (lost mud between 313 and 315 ft)	313-327
Medium soft, slightly rough drilling	327-335

TEST HOLE 7

PUMPING TEST

Date: May 21, 1979.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water[1/] (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1200	0	318.35	--	--	Static depth to water. Start of test.
1208	8	--	47	--	
1210	10	322.3	51	--	
1213	13	--	52	--	
1215	15	--	50	--	
1217	17	--	54	--	
1219	19	--	60	280	
1221	21	324.0	58	--	
1232	32	323.7	57	--	
1235	35	--	58	--	
1240	40	323.95	57	290	
1245	45	324.1	55	--	
1300	60	323.75	56	300	
1315	75	323.95	57	300	
1330	90	323.96	57	--	
1400	120	323.95	56	315	
1430	150	323.96	56	317	
1500	180	324.0	55	325	
1530	210	324.0	55	330	
1600	240	323.95	57	320	
1630	270	323.85	57	330	
1640	280	323.92	--	--	
1700	300	323.85	57	327	Water temperature 29.2°C.
1730	330	323.85	57	335	
1800	360	323.80	57	327	
1830	390	323.20	57	--	
1900	420	323.60	55	337	
1930	420	323.60	54	342	
2000	480	323.50	55	348	End of test.

[1/] Determined by U.S. Geological Survey.

TEST HOLE 8

Location: Lat 15°09'19" N., long 145°44'11" E., at goat farm, San Vicente.

Drilled: May 22-25, 1979 by Ted Lund Drilling and Supply.

Altitude: 317.45 ft. Depth: 335 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping test: May 26, 1973: Drawdown, 0.47 ft in 8 hours at pumping rate of 73-76 gal/min; chloride, 55-56 mg/L; recovery, 0.11 ft in 6-1/2 minutes and to within 0.02 ft in 14 hours. See pumping test record.

Remarks: Chloride: 1,240 mg/L, June 10, 1980 (Ronimus, 1981).
1,220 mg/L, June 17, 1980 (USGS). Pumping rate, 62 gal/min.
1,200 mg/L, June 20, 1980 (USGS).
Specific conductance: 4,460 µmho, June 20, 1980.

LOG

Description of material	Depth (ft)
Red, medium hard clay	0-3
White, extremely hard coral	3-13
White, very hard	13-24
Medium hard with hard layers	24-34
Soft	34-42
Very hard	42-48
Medium hard, smooth drilling	48-81
Medium hard with rough hard layers	81-129
Medium hard with hard cavity filled with clay	129-148
Medium hard with hard layers	148-169
Medium hard with hard layers with clay in pockets	169-280
Hard with very hard layers	280-310
Soft to open, lost mud in hole	310-313
Medium hard	313-315
Very soft to open	315-320
Medium hard, smooth drilling	320-335

TEST HOLE 8

PUMPING TEST

Date: May 26, 1979.
Measuring point: 4 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1055	--	316.33	--	--	Static depth to water.
1100	--	--	--	--	Start of test.
1105	5	316.43	76	55	
1115	15	316.43	76	--	
1130	30	316.43	73	--	
1200	60	316.47	73	--	
1230	90	316.45	73	--	
1300	120	--	--	56	
1330	150	316.55	73	--	
1400	180	316.67	76	--	
1430	210	316.60	73	--	
1500	240	316.65	73	--	
1535	275	316.64	73	--	
1600	300	316.72	73	--	
1630	330	316.77	76	--	
1700	360	316.80	73	--	
1730	390	316.78	73	--	
1800	420	316.71	73	--	
1830	450	316.78	73	--	
1900	480	316.80	73	--	End of pumping test.
Recovery					
1900	0	316.76			Start of recovery test.
1901:30	1-1/2	316.76			
1902:30	2-1/2	316.64			
1903:30	3-1/2	316.63			
1904:30	4-1/2	316.65			
1905:30	5-1/2	316.62			
1906:30	6-1/2	316.65			
May 27					
0805	785	316.35			13 hrs 5 minutes.
May 28					
1410	2,590	316.60			43 hrs 10 minutes. End of test.

WELL 8 (also called well SV-1)

Location: Same as test hole 8, lat 15°09'19" N., long 145°44'11" E., at goat farm, San Vicente.

Drilled: Sept. 17-19, 1979, reamed from 7 7/8 to 12 1/2 in. by Ted Lund Drilling and Supply.

Altitude: 317.45 ft. Depth: 335 ft.

Diameter of open hole: 12-1/2 in.

Casing: 8-in. steel casing from surface to 313 ft.

Screen: 20 ft 8-in. stainless steel screen from 313 to 333 ft.

Gravel pack and grout: Gravel pack from 288 to 335 ft and 166 bags of cement from surface to 288 ft.

Source of record: Driller.

Pumping test: Sept. 22, 1979: Drawdown, 0.17 ft in 8 hours at pumping rate of 71-76 gal/min. See pumping test record.

Remarks: Chloride: 1,300 mg/L, Mar. 18, 1980; pumping rate, 60 gal/min (USGS).
1,220 mg/L, June 17, 1980; pumping rate, 62 gal/min (USGS).
1,200 mg/L, June 20, 1980; specific conductance, 4,460 µmho (USGS).

WELL 8 (SV-1)

Chemical analyses of water from well 8 (SV-1)

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)
1-7-81	914	1,960	--	7.8	1.7
1-27-81	1,030	2,220	3,850	7.2	.34
2-4-81	1,090	2,390	4,080	8.0	.41
2-18-81	1,160	2,500	4,570	7.1	.65
3-13-81	1,180	2,700	4,600	7.5	.32
4-22-81	1,160	2,610	4,120	7.3	.32
5-14-81	1,210	2,550	4,430	7.8	.18
5-29-81	1,240	2,850	4,760	7.0	.29
6-10-81	1,320	2,860	4,470	7.6	.30
7-1-81	1,190	2,490	3,810	7.5	.24
7-28-81	1,270	2,640	3,960	7.9	.22
8-20-81	[1/] 51.3	[1/] 270	[1/] 612	7.6	.15
9-23-81	417	1,020	1,960	7.0	.30
10-16-81	640	1,470	2,670	7.4	.24
11-25-81	191	458	1,170	7.2	[1/] 4.0
12-28-81	536	1,310	2,200	7.2	.24
1-27-82	641	1,500	2,670	8.0	.26
3-8-82	764	1,800	2,990	7.2	.24
4-12-82	881	1,910	3,210	7.0	.22
5-3-82	956	2,110	4,010	6.9	.22

[1/] Appears doubtful.

WELL 8 (SV-1)

PUMPING TEST

Date: September 22, 1979.
Measuring point: 2.5 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0850	--	316.32	--	Static depth to water.
0900	0	--	--	Start of test.
0901	1	316.42	--	
0902	2	--	73	
0905	5	316.46	73	
0910	10	316.45	76	
0915	15	316.45	73	
0930	30	316.46	73	
1000	90	316.46	73	
1030	90	316.46	73	
1100	120	316.45	73	
1130	150	316.43	73	
1200	180	316.43	73	
1230	210	316.44	71	
1300	240	316.45	73	
1330	270	316.44	73	
1400	300	316.45	73	
1430	330	316.46	71	
1500	360	316.48	71	
1530	390	316.46	73	
1600	420	316.48	71	
1630	450	316.50	71	
1700	480	316.49	71	End of test.

TEST HOLE 9

Location: About 15°09'19" N., long 145°44'01" E., in Upper San Vicente.

Drilled: June 5-8, 1979 by Ted Lund Drilling and Supply.

Altitude: About 420 ft. Depth: 433 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping tests: June 9, 1979: Well producing only 11 gal/min.

June 10, 1979: After surging for 4 hours, no improvement. Water was clear and chloride low.

Hole abandoned and sealed May 13, 1980.

LOG

Description of material	Depth (ft)
Red clay	0-4
Very hard coral	4-26
Hard coral	26-43
Medium hard with some hard layers	43-103
Soft to stiff clay	103-111
Medium hard clay and coral rubble	110-117
Hard rough coral	117-122
Medium hard clay and coral rubble	122-156
Very hard coral with pockets of clay	156-179
Hard coral with medium hard layers. Not as much clay as before	179-199
Soft	199-204
Medium hard	204-229
Medium hard with hard rough layers	223-256
Medium hard with soft to stiff clay	256-273
Open	273-276
Medium hard coral	276-280
Medium hard with clay pockets	280-292
Medium hard less clay	292-306
Open	306-318
Soft	318-325
Medium soft to medium hard with clay	325-342
Medium hard with clay becoming quite stiff	342-373
Medium hard with clay	373-376
Sticky clay	376-383
Medium hard less sticky	383-393
Sticky clay	393-411
Slightly less sticky volcanic clay	411-422
Sticky clay, hard to drill as bit balls up	422-430
Slightly less sticky clay	430-433

TEST HOLE 13

Location: Lat 15°09'30" N., long 145°44'31" E., 0.6 mile north of San Vicente (in front of house of Ben Reyes).

Drilled: Dec. 5-6, 1979 by Ted Lund Drilling and Supply.

Altitude: 269.33 ft. Depth: 190 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Hole abandoned and sealed May 13, 1980.

LOG

Description of material	Depth (ft)
(Not given)	0-13
Very hard white coral	13-34
Medium hard white coral	34-54
White medium hard and red clay	54-57
White medium hard coral	57-94
Medium hard with hard layers under pockets of clay	94-140
Hard coral with pockets of brown clay	140-161
Hard coral with dark gray clay	161-175
Becoming more dark gray	175-180
Becoming black rock and very hard at 185-190 ft	180-190

TEST HOLE 14

Location: Lat 15°09'50" N., long 145°44'20" E., one mile north of San Vicente on property of Joaquin Cepeda.

Drilled: Dec. 14-17, 1979 by Ted Lund Drilling and Supply.

Altitude: 459.38 ft. Depth: 380 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Hole abandoned and sealed May 13, 1980.

LOG

Description of material	Depth (ft)
Very hard, white coral	0-15
Very hard coral	15-28
Medium hard with pockets of clay	28-34
Very hard with hard layers	34-42
Medium hard with pockets of clay	42-58
Clay	58-60
Hard with very hard layers. Occasional clay pockets	60-113
Very stiff pink clay	113-121
Hard with very hard layers. Occasional clay pockets	121-155
Hard coral with clay pockets and stiff clay layers	155-168
Hard with very hard red coral	168-197
Hard and medium hard coral and clay layers	197-230
Medium hard coral with green and brown weathered volcanic hard clay	230-255
Hard coral, less volcanics	255-260
White, hard coral with very hard layers, some brown clay pockets. Hard bouncy drilling	260-380

Notes: No foam returns at 28-35, 98-116, 117-131 ft.
Clay layers at 78-81, 95-98 ft.
Poor foam return from 155-205 ft.
Hole caved in, drill collar stuck and hole was abandoned.

Akgak

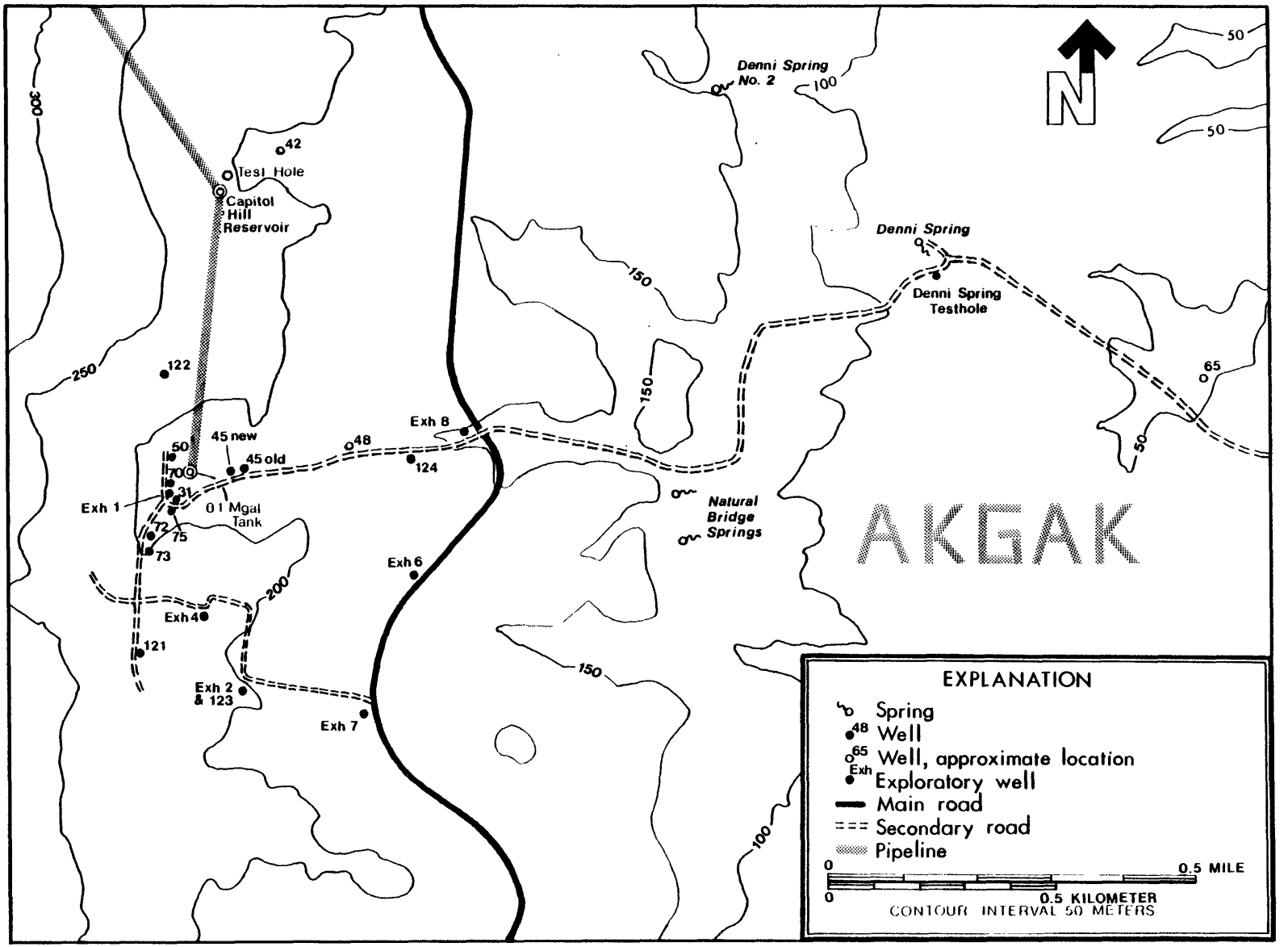
The area of perched ground water at Akgak has yielded large amounts of excellent quality water since the first wells were drilled there in 1945 (fig. 23). Weekly production figures for March 11, 1947 to February 5, 1948, show an average daily production of 225,000 gal/d during this period from wells 31, 45, and 50. Glander (1946) reported that well 31 alone produced 225,000 gal/d with an additional 130,000 gal/d from the other two wells. The wells were used up to 1950-51 (Davis, 1958); pumping apparently was stopped when water levels dropped down to the pump strainers (Cox, 1956). In a short typewritten report by Ted Arnow to the High Commissioner dated November 3, 1952, wells 31, 45, and 50 were mentioned as not being in use, and in April 1955, the only sources used to supply water for the island were Maui I and IV (Public Works Officer to E. A. Bishop, written commun., April 4, 1955). In 1956, a new well (75) was drilled near well 31 but little information of the use and production of this well is available. In 1969, wells 31 and 75 were still in production (Mink, 1969) and it can be assumed that these wells were in operation from 1956 to 1969. At the end of 1969, two new wells were drilled to replace old wells 45 and 50 and were named New 45 and New 50. A year later, well 75 was replaced by New 75, and the following year New 31 replaced 31. Well New 31 was drilled 100 feet deeper in 1978 to increase its yield. After three new wells (70, 72, and 73) had been completed in 1977, only New 50 of the older wells remained in use. In 1982, well 10C, drilled in 1979, was developed as well 121, and well 123 was drilled a few feet from exploratory hole 2, one of six exploratory holes (Exh 1, 2, 4, 6-8) drilled during 1981 to determine the boundaries of the aquifer (Ayers, 1981). Well 122 was drilled outside this boundary and did not yield water (table 29).

Beginning in 1946, water from wells 31, 45 and 50 was pumped north to a 0.5-Mgal steel tank on Capitol Hill and then through a 6-inch line south to the Dandan area (Curione, 1949). The southern line was broken in 1949 and abandoned. In 1956, a 0.1-Mgal tank was built at well 31 and the 0.5-Mgal steel tank on Capitol Hill was replaced by a 1-Mgal concrete reservoir. At present, water from the Akgak well field is pumped from the 0.1-Mgal tank near well 31 to the Capitol Hill reservoir for use on Capitol Hill with the overflow going to Calhoun and Tanapag reservoirs by way of the Maui IV tank. (See fig. 30.)

The chloride concentration of water from Akgak well field is very low (less than 50 mg/L), making the field the most desired source of ground water on the island. Because of continuous pumping at an average rate of 75 gal/min per well, the water level in the well field has been declining. Ayers (1981) estimated the decline in well 45 to average 1.25 ft per year since 1973.

Since January 1981, the Geological Survey has operated a continous water-level recorder in the Akgak well field. The recorder was located on Old well 45 until April 24, 1981, and for 1 year on New well 45 (fig. 24). Since December 1982, the recorder is located on New well 31 (fig. 25).

Ground water in the Akgak well field responds quickly to rainfall and the water level may rise 30 ft in a short period of time. However, without more rain, the water level will drop to a low level again in a few weeks. At well 45, the water level will drop sharply to about 420 ft above mean sea level, but only gradually below 420 ft.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 23. Location of wells in Akgak area.

Table 29. Testholes and wells drilled at Akgak area

Testhole and well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
W 31 Old	15°11'30"	145°44'59"	Jan. 22, 1945	613.78	220	Well was dry during much of 1973-76.
W 42[1/]	15°11'55"	145°45'05"	Apr. 16, 1945	620	490	Abandoned; low yield.
W 45 Old	15°11'32"	145°45'04"	Mar. 28, 1945	580.45	185	50 feet from new well 45.
W 48[1/]	15°11'34"	145°45'12"	Apr. 29, 1945	526.24	150	Abandoned; low yield.
W 50 Old	15°11'33"	145°44'57"	May 9, 1945	643.43	249	30 feet from new well 50.
			1956-62			
W 75 Old	15°11'29"	145°44'58"	1956	624.97	253	Near new well 75.
			1969-71			
W 31 New	15°11'30"	145°44'59"	October 1971	615.37	223	A few feet from old well 31. Deepened to 325 ft in 1978.
W 45 New	15°11'32"	145°45'03"	Nov. 4, 1969	582.70	195	Measuring point 1969-77, 585.6 ft.
W 50 New	15°11'33"	145°44'57"	Dec. 18, 1969	646.55	350	
W 75 New	15°11'29"	145°44'58"	November 1970	622.88	249	
			1977			
W 70	15°11'31"	145°44'57"	July 27, 1977	633.03	325	
TH 71	--	--	Aug. 8, 1977	--	290	Testhole not located.
W 72	15°11'27"	145°44'57"	Aug. 15, 1977	653.34	350	
W 73	15°11'24"	145°44'56"	Sept. 1, 1977	680.79	375	
TH Denni Spring.	15°11'47"	145°45'55"	Aug. 27, 1977	270	175	
TH Capitol Hill[1/].	15°11'52"	145°45'02"	Sept. 27, 1977	700	325	No water found.
			1979-80			
TH 10	15°11'19"	145°44'56"	June 20, 1979	694.43	356	
W 10C	do.	do.	July 28, 1979	do.	do.	Now called well 121.

Table 29. Testholes and wells drilled at Akgak area--Continued

Testhole and well No.	Location		Completion date	Altitude (ft)	Depth (ft)	Remarks
	Latitude north	Longitude east				
			1982			
Exh 1	15°11'30"	145°44'58"	Begin 1982	625	350	
Exh 2	15°11'17"	145°45'04"	February 1982	649.96	322	
Exh 4	15°11'22"	145°45'01"	Dec. 31, 1981	683.50	380	
Exh 6	15°11'25"	145°45'16"	Feb. 28, 1982	545.21	200	
Exh 7	15°11'15"	145°45'13"	Mar. 15, 1982	585.62	135	
Exh 8	15°11'35"	145°45'20"	Mar. 12, 1982	493.10	192	
W 122	15°11'39"	145°44'57"	Mar. 25, 1982	739.08	345	Well was dry.
W 123	15°11'17"	145°45'04"	Mar. 30, 1982	649.95	306	3 feet from Exh 2.
W 124	15°11'33"	145°45'16"	Apr. 5, 1982	570	180	Abandoned because of cave-in.

1/ Location approximate.

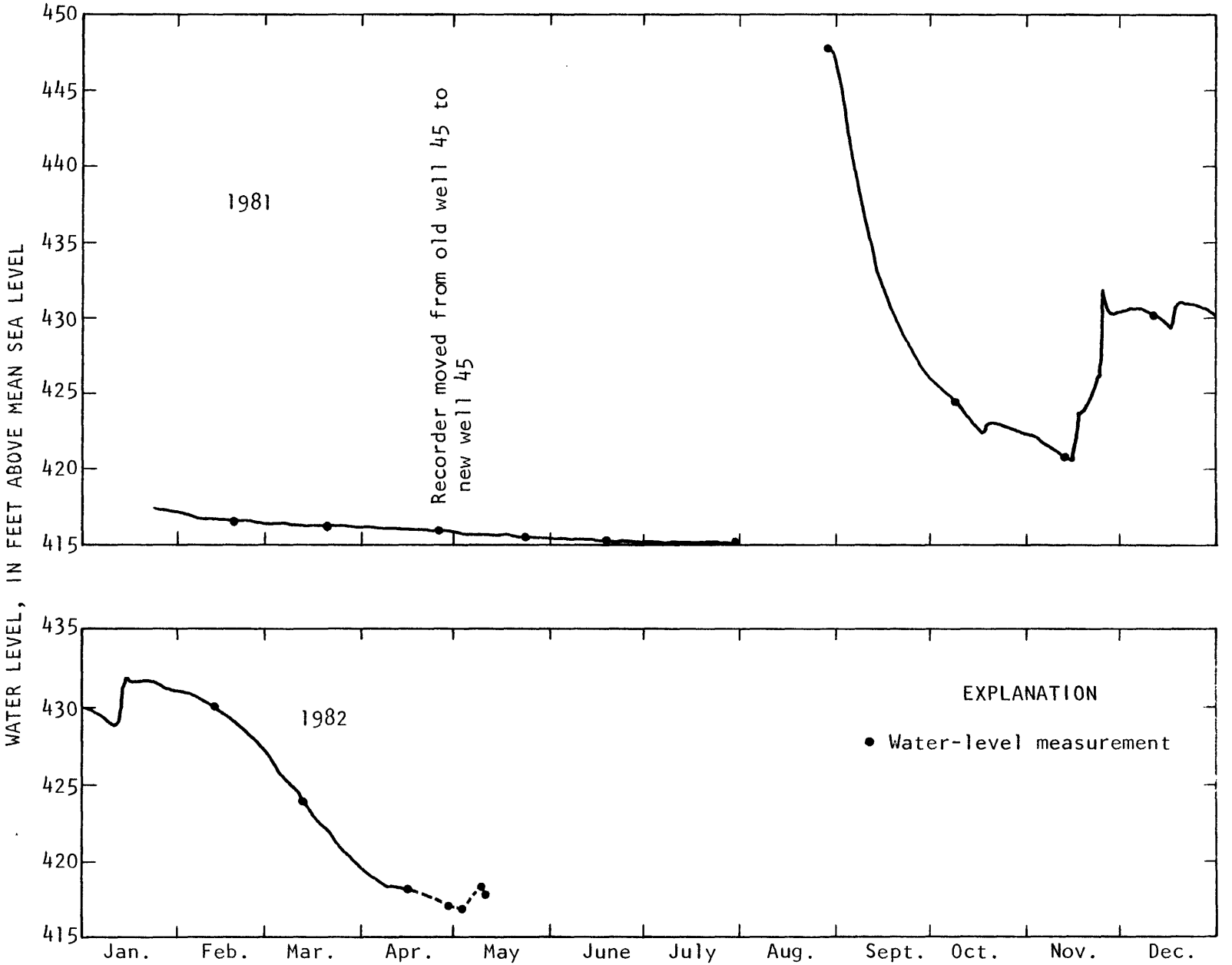


Figure 24. Water levels in well 45, January 1981 to April 1982.

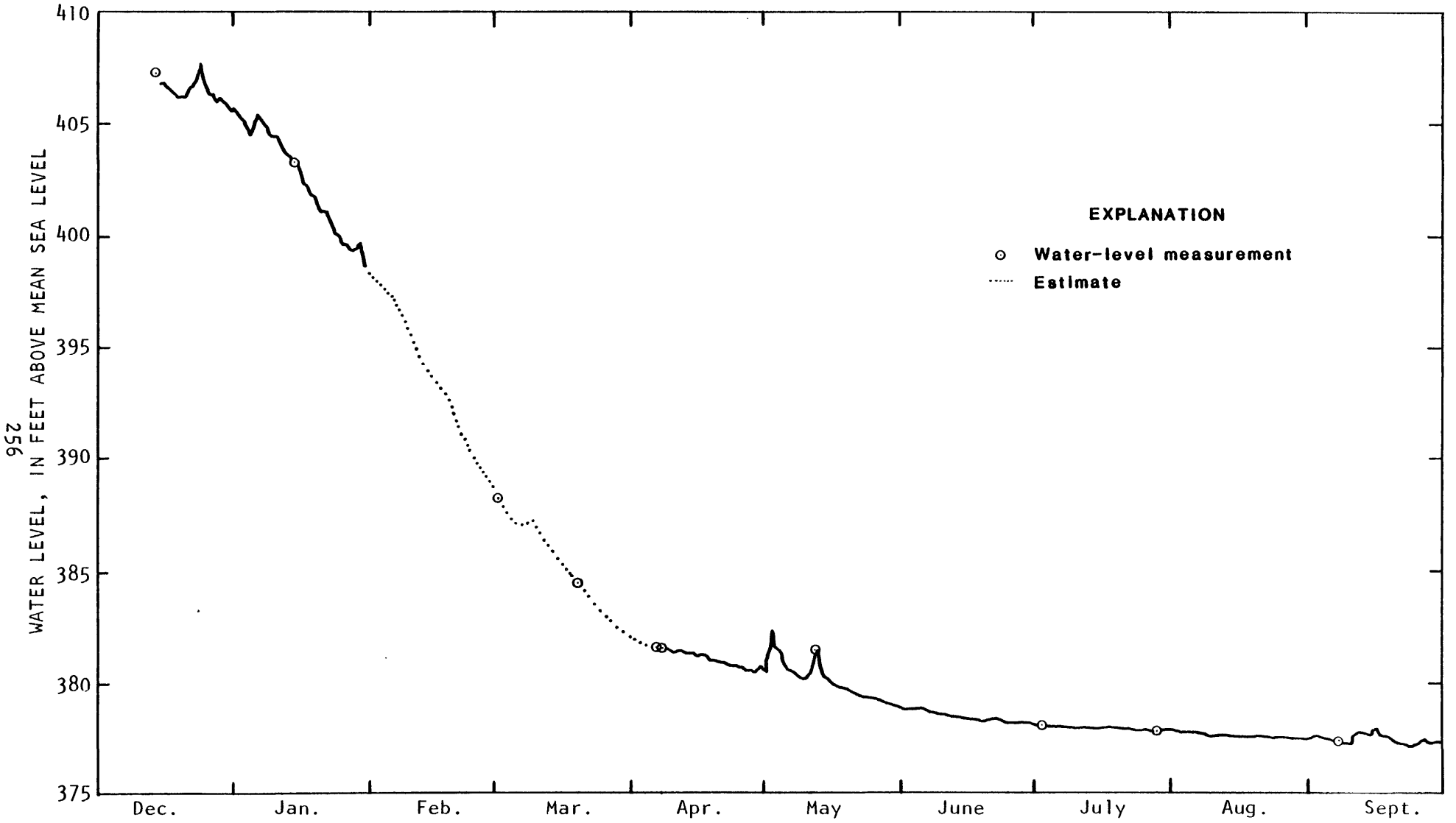


Figure 25. Water levels in well 31, December 1982 to September 1983.

WELL 31 (Old)

Location: Lat 15°11'30" N., long 145°44'59" E., at Akgak.

Drilled: Jan. 6-22, 1945 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 615.5 ft. (613.78 ft, "x" on concrete slab, levels of Oct. 8, 1974 by Gilbert and Davis).

Depth: 220 ft (212 ft in 1974).

Casing: 6 in. to 220 ft with lower 60 ft perforated.

Aquifer: Limestone.

Remarks: Water was found at depth of 165 ft.

Depth to water before pumping, 160 ft.

Chloride: 10 ppm, at completion (log).
50 ppm (Glander, 1946).

Pumpage: 300,000 gal/d, at completion (log).
215,000 gal/d (Boniface, 1945).
230,000-240,000 gal/d (Glander, 1946).
185,000-240,000 gal/d (Piper, 1946-47).
130,000 gal/d, from weekly production figures in March 1947.
225,000 gal/d, average of 41 weeks during April 1947 to February 1948, combined with production of wells 45 and 50 (maximum, 320,000 gal/d, minimum, 135,000 gal/d), from weekly production figures.

pH: 7.0-7.2 (Glander, 1946).

For chemical analyses, see tables 70, 72.

WELL 31 (Old)

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 613.78 ft, (top of concrete slab, levels of 10-8-74, USGS).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
3-19-73 --	183.17	11-8-73 --	--	8-1-74 ---	--	12-16-76 -	--
3-29-73 --	192.78	11-26-73 -	--	8-20-74 --	--	1-3-77 ---	--
4-5-73 ---	192.04	12-6-73 --	--	6-6-75 ---	--	1-14-77 --	--
4-19-73 --	196.59	12-20-73 -	--	6-19-75 --	--	2-11-77---	188.85
5-4-73 ---	199.42	1-3-74 ---	--	7-2-75 ---	--	5-6-77 ---	--
5-24-73 --	--	1-18-74 --	--	7-17-75 --	--	6-2-77 ---	--
6-7-73 ---	--	2-14-74 --	--	8-29-75 --	--	6-20-77 --	--
6-14-73 --	--	2-28-74 --	--	9-11-75 --	--	7-1-77 ---	--
6-21-73 --	--	3-21-74 --	--	9-25-75 --	--	7-28-77 --	--
6-28-73 --	--	4-2-74 ---	--	10-9-75 --	--	8-25-77 --	--
7-5-73 ---	--	4-26-74 --	--	10-28-75 -	--	9-8-77 ---	--
7-31-73 --	--	5-6-74 ---	--	11-7-75 --	--	9-22-77 --	--
8-9-73 ---	--	5-8-75 ---	--	12-19-75 -	--	12-16-77 -	--
8-30-73 --	--	5-9-74 ---	--	1-15-76 --	--	1-15-78 --	--
9-13-73 --	--	5-24-74 --	--	1-16-76 --	--	2-13-78 --	--
9-27-73 --	--	6-20-74 --	--	1-30-76 --	--	2-27-78 --	--
10-11-73 -	--	7-5-74 ---	--	11-18-76 -	--	4-10-78 --	--
10-25-73 -	--	7-22-74 --	--	12-2-76 --	--	5-6-78 ---	225.23

Dash (--) indicates dry well.

RECOVERY TEST

Date: March 21, 1973.
Altitude of measuring point: 613.78 ft.

Time	Altitude of water level	Remarks
1402	422.1	New well 31 pumping.
1422	--	New well 31 pump off.
1432	424.7	Recovery.

WELL 31 (Old)

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Hard lime	0-15
Chalky lime	15-25
Hard lime	25-53
White beach sand	53-55
Hard lime	55-90
Hard and chalky lime	90-125
Hard lime	125-135
Hard and chalky lime (struck water at 165 ft)	135-167
White and gray sand	167-170
Hard and chalky lime	170-190
Sand and chalky lime	190-192
Hard and chalky lime	192-197
Beach sand	197-201
Sand and chalky lime	201-212
Beach sand	212-220

WELL 42

Location: About lat 15°11'55" N., long 145°45'05" E., North of Akgak well field.

Drilled: Completed Apr. 16, 1945 by 17th U.S. Naval Construction Battalion.

Altitude: About 620 ft (from topographic map). Depth: 490 ft.

Casing: 6 in. to 250 ft.

Aquifer: Sand.

Source of record: Glander (1946).

Well was drilled through clay, clay and yellow coral, gray clay, clay and sand, blue clay and sand, and blue clay.

Well was abandoned because of low yield (no yield, reported by Boniface, 1945).

WELL 45 (Old)

Location: Lat 15°11'32" N., long 145°45'04" E., at Akgak.
Drilled: Mar. 23-28, 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 580.45 ft; was reported as 550 ft by Davis, 1958.
Depth: 185 ft.
Casing: 6 in. to 185 ft with lower 60 ft perforated.
Aquifer: Limestone.
Remarks: Water was encountered at depth of 125 ft.
Chloride: 30 ppm, at completion (log).
Pumpage: 150,000 gal/d, at completion (log).
110,000 gal/d (Boniface, 1945).
100,000-110,000 gal/d (Glander, 1946).
90,000-130,000 gal/d (Piper, 1946-47).
115,000 gal/d, March 1947, from weekly production figures.
225,000 gal/d, average of 41 weeks during April 1947 to February 1948, combined with production of wells 31 and 50 (maximum, 320,000 gal/d, minimum, 135,000 gal/d), from weekly production figures.
pH: 7.0-7.2 (Glander, 1946).

Continuous water-level recorder (USGS) Jan. 23 to Apr. 24, 1981.

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 580.45 ft (top of casing).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
10-31-72	(1125) ---	146.24 (pumping)				9-25-75 --	160.18
	(1258) ---	(pump off)		9-17-74 --	162.0	10-9-75 --	158.23
	(1300) ---	143.73		9-18-74 --	161.35	10-28-75 -	158.60
	(1309) ---	141.12		9-20-74 --	155.85	11-7-75 --	158.43
11-1-72 --	147.52	10-11-73 -	164.70	9-23-74 --	156.19	12-19-75 -	151.10
12-7-72 --	146.80	10-25-73 -	164.87	9-27-74 --	155.87	1-15-76 --	160.53
1-23-73 --	148.65	11-8-73 --	164.78	9-30-74 --	182.05	1-30-76 --	149.10
3-2-73 ---	141.50	11-26-73 -	164.88	10-2-74 --	151.89	2-12-76 --	152.40
3-8-73 ---	147.98	12-6-73 --	165.00	10-4-74 --	151.74	5-7-76 ---	157.50

WELL 45 (Old)

Depth to water, in feet--Continued

Altitude of measuring point: 580.45 ft (top of casing).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
3-20-73 --	147.58	12-20-73 -	165.26	10-9-74 --	151.19	11-18-76 -	160.57
3-28-73 --	149.58	1-3-74 ---	166.00	10-30-74 -	153.74	12-2-76 --	150.08
4-4-73 ---	150.88	1-14-74 --	165.62	1-15-75 --	152.43	12-16-76 -	160.60
4-19-73 --	153.32	1-18-74 --	165.62	1-30-75 --	153.90	1-3-77 ---	160.52
5-4-73 ---	154.17	1-31-74 --	165.72	2-7-75 ---	154.60	1-14-77 --	160.52
5-11-73 --	156.88	2-14-74 --	165.60	2-21-75 --	155.63	1-27-77 --	153.59
5-24-73 --	159.16	2-28-74 --	165.76	2-28-75 --	155.72	2-11-77 --	155.27
6-4-73 ---	160.56	4-2-74 ---	166.00	3-14-75 --	155.51	2-26-77 --	156.58
6-7-73 ---	161.52	4-26-74 --	166.02	3-31-75 --	159.00	3-11-77 --	157.13
6-14-73 --	161.47	5-10-74 --	165.47	4-11-75 --	154.79	5-6-77 ---	161.67
6-21-73 --	161.84	5-24-74 --	166.05	4-25-75 --	161.24	6-2-77 ---	161.47
6-28-73 --	164.35	6-20-74 --	166.10	5-9-75 ---	162.19	6-20-77 --	164.55
7-5-73 ---	162.73	7-5-74 ---	163.40	5-23-75 --	162.57	7-1-77 ---	165.43
7-31-73 --	163.64	7-22-74 --	165.23	6-6-75 ---	162.37	7-28-77 --	162.62
8-9-73 ---	164.02	7-31-74 --	165.63	6-19-75 --	163.11	8-25-77 --	164.26
8-30-73 --	164.30	8-1-74 ---	165.28	7-3-75 ---	163.50	12-16-77 -	160.54
9-13-73 --	164.58	8-20-74 --	163.50	7-17-75 --	163.82	2-13-78 --	163.57
9-27-73 --	163.51	9-9-74 ---	160.75	8-29-75 --	159.31	4-10-78 --	167.29
10-11-73 -	164.70	9-13-74 --	162.45	9-11-75 --	157.46	1-14-83 --	167.00

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Top soil and broken coral	0-7
Medium coral	7-17
Hard coral	17-19
Medium coral	19-30
White medium coral, crevice at 60 ft, lost water	30-62
Soft coral	62-67
Hard lime	67-85
Hard chalky lime	85-105
Hard lime (struck water at 125 ft)	105-128
Hard lime and sharps	128-150
Clay and sand	150-153
Coarse water sand	153-155
Fine water sand	155-160
Soft clay formation coral	160-171
Clay and sand	171-179
Red clay	179-185

WELL 48

Location: About lat 15°11'34" N., long 145°45'12" E., Akgak.
Drilled: Apr. 9-29, 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 526.24 ft. Depth: 150 ft.
Casing: None.
Aquifer: Clay (Glander, 1946). Sand and limestone (Davis, 1958).
Remarks: Water was found at 55 ft and at 120 ft. Water was lost between 55 and 120 ft.
Pumpage: 4,300 gal/d, at completion (log).

Well was abandoned because of low yield (Boniface, 1945; Glander, 1946).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Top soil and broken coral, crevice at 12 ft, lost water	0-15
Broken coral	15-28
Sandy coral	28-30
Hard sandy coral	30-50
Clay	50-55
Coarse sand	55-60
Coral sand	60-64
Dark clay	64-70
Yellow clay	70-77
Hard clay	77-79
Blue and yellow clay	79-95
Blue clay	95-118
Hard coral shell; lost water 55 to 120 ft (struck water at 120 ft)	118-121
Sandy blue clay	121-150

WELL 50 (Old)

Location: Lat 15°11'33" N., long 145°44'57" E., at Akgak, 30 feet from new well 50.

Drilled: May 1-9, 1945 by 101st U.S. Naval Construction Battalion.

Altitude: 643.43 ft. Depth: 249 ft.

Casing: 6 in. to 249 ft with lower 50 ft perforated.

Aquifer: Limestone.

Remarks: Water was found at depth of 202 ft.
Water level before pumping, 189 ft.
Chloride: 50 ppm (Glander, 1946).
Pumpage: 30,000-50,000 gal/d (Glander, 1946).
100,000 gal/d March 1947, from weekly production figures.
225,000 gal/d, average of 41 weeks during April 1947 to February 1948, combined with production of wells 31 and 45 (maximum, 320,000 gal/d, minimum, 135,000 gal/d), from weekly production figures.
pH: 7.0-7.2 (Glander, 1946).

Water level recorder on the well in 1956 but float lost in well (Cox, 1956).

WELL 50 (Old)

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Top soil and broken coral	0-7
Yellow sandy coral	7-20
Hard and pink lime mix	20-45
Hard lime	45-58
Chalky lime	58-65
Hard lime	65-78
Pink lime	78-84
Hard coral	84-98
Beach sand	98-102
Chalky lime	102-111
Hard lime	111-118
Sandy coral	118-129
Hard lime	129-152
Soft chalky lime	152-160
Medium chalky lime	160-184
Hard lime	184-190
Medium chalky lime (struck water at 202 ft)	190-204
Soft lime	204-220
Hard lime	220-232
Sand and hard lime	232-237
Beach sand	237-241
Hard lime	241-249

WELL 75 (Old)

Location: Lat 15°11'29" N., long 145°44'58" E., near present well 75 (new), Akgak.

Drilled: 1956 by Brown-Pacific-Maxon.

Altitude: 625 ft (Cox, 1956); 624.97 ft (Ayers, 1981); top of casing, 624 ft (USGS).

Depth: 253 ft.

Remarks: Water level, 437 ft, Mar. 21, 1973, pump off for 9 minutes. Safe yield estimate at 140,000 gal/d (Cox, 1956).

WELL 31 (New)

Location: Lat 15°11'30" N., long 145°44'59" E., at Akgak.

Drilled: October 1971 by Layne International, Guam. Hole deepened Apr. 26 to May 4, 1978 by International Bridge Corporation.

Altitude: 614.39 ft (on concrete slab, levels of Oct. 8, 1974 by Gilbert and Davis); 615.37 ft (top of casing, levels of Jan. 8, 1981, Ayers).

Depth: 223 ft in 1971, deepened to 325 ft in 1978.

Diameter of open hole: 6-3/4 in., reamed to 9-7/8 in.

Pumping tests: May 10, 1978: After 3 minutes of pumping at rate of 59 gal/min, hole ran dry.

May 11, 1978, 0830: After 13 minutes of pumping at rate of 24 gal/min, hole ran dry.

1000: Same, after 10 minutes of pumping at 50 gal/min. Water level recovered to 235 ft in 5 minutes.

Remarks: Chloride: 50 mg/L, at completion (1971).
40 mg/L, Mar. 22, 1973.
50 mg/L, 3 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).

Hardness: 250 mg/L, at completion.

Pumpage: 290,000 gal/d, at completion.

Prior to September 1974, pump removed because of low water level.

Aug. 20, 1977: Depth to water, 206.55 ft below top of well casing. Well acidized with 55 gallons of 30 percent hydrochloric acid.

Continuous water-level record (USGS) since December 1982.

WELL 31 (New)

Depth to water, in feet

[U.S. Geological Survey to May 1978, Northern Mariana Islands Division of Environmental Quality thereafter]

Altitude of measuring point: 614.45 ft (top of base plate of pump discharge) to May 1978; 615.37 ft (top of casing) thereafter.

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
3-21-73 --	203.64	9-20-74 --	213.2	5-6-78 ---	225.23	1-16-81 --	217.26
8-1-74 ---	222.30	9-23-74 --	212.6	8-3-80 ---	235.54	1-26-81 --	217.31
9-9-74 ---	214.3	9-25-74 --	212.2	9-5-80 ---	235.33	1-29-81 --	217.96
9-11-74 --	213.9	9-27-74 --	211.8	11-18-80 -	224.47	2-5-81 ---	217.28
9-12-74 --	214.0	9-30-74 --	211.0	11-21-80 -	224.75	2-10-81 --	217.04
9-13-74 --	214.02	10-2-74 --	210.4	11-26-80 -	217.88	2-16-81 --	216.79
9-16-74 --	213.7	10-4-74 --	209.9	12-3-80 --	222.14	5-13-81 --	215.79
9-17-74 --	213.7	10-9-74 --	208.5	12-10-80 -	217.14	6-4-81 ---	216.84
9-18-74 --	213.6	8-20-77 --	206.55	1-7-81 ---	217.87		

Note: Depth to water Sept. 12 to Oct. 9, 1974 read with an electric sounder with a correction based on comparison with steel tape measurement.

LOG

No log available 0-225 ft, drilled in October 1971.
Well deepened from 225 to 325 ft, April 26 to May 4, 1978.

Description of material	Depth (ft)
White and pink limestone	225-230
White and light pink limestone	230-240
White, light pink, and gray limestone	240-255
Gray and light brown limestone	255-275
Gray and pink limestone	275-305
Gray limestone	305-310
Gray limestone and hard brown clay	310-315
Gray and light brown limestone with hard dark brown clay	315-325
End of drilling due to presence of clay	

WELL 45 (New)

Location: Lat 15°11'32" N., long 145°45'03" E., at Akgak.
Drilled: Oct. 8 to Nov. 4, 1969 by Layne International, Guam.
Altitude: 582.70 ft (top of casing).
Depth: 195 ft.
Diameter of open hole: 12 in.
Casing: 8 in. to 155 ft.
Screen: Shutter, 155-195 ft.
Gravel pack and grout: 3.5 cubic feet cement grout (top at 90 ft); 4 bags of cement grout, poured.
Source of record: Driller.
Pumping test: Oct. 22-24, 1969: Drawdown, 38.45 ft in 36-1/2 hours at pumping rate of 235-370 gal/min; recovery to 14.05 ft in 1 minute, to within 1.5 ft in 6 hours. See pumping test record.
Oct. 24, 1969: Drawdown, 30.55 ft in 10 minutes at pumping rate of 250-255 gal/min. See pumping test record.
May 6, 1970: Drawdown, 40.05 ft in 6 hours at pumping rate of 180-200 gal/min; recovery to 7.05 ft in 1 minute, to 1.25 ft in 8 hours, and to initial depth to water in 48 hours. See pumping test record.
Remarks: Not in operation until May 4, 1970, awaiting new pump.
Chloride: 50 ppm, at completion.
40 ppm, Mar. 5, 1973.
50 mg/L, 6 samples May 18 to Sept. 8, 1977 (M and E, Pacific, 1978).
Hardness: 240 ppm, at completion.
Pumpage: 290,000 gal/d, at completion.

Continuous water-level record (USGS) Apr. 24, 1981 to Apr. 14, 1982. (See fig. 24.)

WELL 45 (New)

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 585.6 ft (1/2-in. airline, 2.93 ft above concrete well pad); after pump was removed in 1977, measuring point, 582.70 ft (top of casing).

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
10-31-72	144.30	6-28-73	164.15	9-27-74	157.48	4-11-75	161.77
3-20-73	151.77	7-5-73	164.58	9-30-74	153.90	4-25-75	162.27
3-28-73	151.31	7-31-73	165.52	10-2-74	153.69	5-8-75	164.59
4-4-73	154.58	8-9-73	165.44	10-4-74	153.53	5-23-75	164.36
4-19-73	155.35	8-30-73	160.73	10-9-74	152.99	6-6-75	164.72
5-4-73	157.58	9-27-73	165.67	1-15-75	154.18	6-19-75	165.05
5-11-73	158.61	10-11-73	166.85	1-30-75	155.63	7-3-75	165.48
5-24-73	160.85	10-25-73	167.00	2-7-75	156.38	7-17-75	165.70
6-4-73	162.25	11-8-73	166.88	2-21-75	157.33	8-29-75	167.36
6-7-73	162.00	9-11-74	161.5	2-28-75	157.45	9-11-75	159.09
6-14-73	163.18	9-12-74	161.75	3-14-75	158.85	4-10-78	167.29
6-21-73	163.62	9-13-74	[1/] 165.4	3-31-75	160.75		

[1/] Pumping rate, 8.5 gal/min.

WELL 45 (New)

LOG

Description of material	Depth (ft)
Brown medium soft clay	0-5
White medium hard clay	5-15
White hard coral	15-23
White medium hard coral with soft layers	23-26
White medium hard coral	26-98
White hard coral	98-118
White very hard coral	118-123
White medium hard coral	123-133
White hard coral	133-142
White medium hard coral	142-152
White very hard coral (lots of chatter)	152-162
White medium hard coral (164-168, lots of chatter)	162-168
White very hard coral (severe chatter, felt like crevice)	168-176
White medium hard coral	176-182
White hard coral	182-192
Red hard sticky clay	192-193
Red sticky clay	193-195

WELL 45 (New)

PUMPING TEST

Date: October 22-24, 1969.
Altitude of measuring point, 585.6 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1900	0	121.75	--	Static depth to water. Start of test.
1901	1	138.8	--	
1902	2	143.8	--	
1903	3	145.8	250	
1904	4	146.3	250	
1905	5	146.8	--	
1905-2300	--	--	--	Pumped 230-240 gal/min. Surged well twice.
2300	240	156.8	240	
2330	270	157.3	235	
2400	300	157.8	230	
0100	360	158.3	--	Oct. 23, 1969.
0400	540	158.8	--	
0630	690	159.3	--	
0700	720	159.6	--	0705-0706, surged well.
0730	750	159.0	235	
0800	780	159.5	235	
1130	990	159.7	240	
1600	1,260	160.0	225	
1630	1,290	160.2	230	
1645	1,305	160.5		
2200	1,620	161.2	360	
2330	1,710	161.5	370	
0710	2,170	160.6	235	Oct. 24, 1969.
0730	2,190	160.2	--	End of pumping test.
Recovery test				
0740	0	160.2		Start of recovery test.
0740:30	0.5	135.8		
0741	1	132.8		
0742	2	132.0		
0743	3	131.5		
0744	4	131.2		
0745	5	131.0		
0750	10	128.8		
0820	40	125.8		
1000	140	124.6		
1200	260	123.8		
1345	365	123.2		End of test.

No change in nearby wells 31 and 75 during recovery test.

WELL 45 (New)

PUMPING TEST

Date: October 24, 1969.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1355	0	121.75	--	Start of test.
1356	1	143.2	--	
1357	2	147.2	--	
1358	3	149.2	255	
1359	4	149.7	--	
1400	5	150.2	--	
1403	8	151.7	250	
1405	10	152.3	--	End of test.

Date: May 6-8, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0800	0	121.75	--	Static depth to water. Start of test.
0800:30	0.5	142.8	--	
0801	1.0	146.8	--	
0801:30	1.5	149.8	--	
0802	2.0	151.8	200	
0802:30	2.5	152.8	--	
0803	3.0	153.3	--	
0803:30	3.5	153.8	198	
0804	4.0	154.0	--	
0804:30	4.5	154.5	--	
0805	5.0	154.8	--	
0805:30	5.5	155.2	--	
0806	6.0	155.6	--	
0806:30	6.5	155.7	160	
0806:30	6.5	155.7	160	
0807	7.0	155.8	--	
0807:30	7.5	156.0	--	
0808	8.0	156.5	--	
0808:30	8.5	156.7	--	
0809	9.0	156.8	195	
0809:30	9.5	157.0	--	
0810	10	157.5	--	

WELL 45 (New)

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0815	15	158.0	180	
0818	18	156.8	--	
0821	21	157.0	180	
0825	25	157.6	180	
0830	30	157.8	180	
0845	45	158.8	180	
0900	60	159.5	180	
1000	120	160.6	180	
1100	180	161.2	181	
1200	240	161.8	180	End of pumping test.
Recovery				
1200	0	161.8		Start of recovery test.
1200:15	.25	146.8		
1200:30	.50	134.8		
:45	.75	129.8		
1201:00	1.00	128.8		
.15	1.25	128.3		
:30	1.50	127.8		
:45	1.75	127.7		
1202:00	2.00	126.9		
:15	2.25	127.2		
:30	2.50	127.0		
:45	2.75	126.8		
1203:00	3.00	126.7		
:15	3.25	126.6		
:30	3.50	126.5		
:45	3.75	126.3		
1204	4.00	126.0		
1205	5	125.6		
1206	6	125.2		
1207	7	124.9		
1210	10	124.6		
1215	15	124.2		
1220	20	123.8		
1320	80	123.7		
1800	480	123.0		
5/7/70 1000	1,320	122.2		
5/8/70 1200	2,880	121.8		End of test.

WELL 50 (New)

Location: Lat 15°11'33" N., long 145°44'57" E., at Akgak, 30 ft from old well 50.
Drilled: Nov. 12 to Dec. 18, 1969 by Layne International, Guam.
Altitude: "0" on NE corner of concrete base, 646.55 ft levels of Oct. 8, 1974, USGS).
Depth: 350 ft.
Diameter of open hole: 12 in.
Casing: 8 in. to 290 ft.
Screen: Shutter, 290-345 ft.
Gravel pack and grout: 52 bags gravel and 3.5 cubic yard cement grout. Top at 165 ft depth.
Source of record: Driller.
Pumping tests: Dec. 11, 1969: Maximum drawdown, 15.1 ft during 11 hours at pumping rate of 207-297 gal/min.
Dec. 16-17, 1969: Maximum drawdown, 20 ft during 17 hours at pumping rate of 240-273 gal/min. See pumping test record.
May 5, 1970: Maximum drawdown, 24.8 ft during 4-1/2 hours at pumping rate of 168-172 gal/min; recovery in 1/2 minute. See pumping test record.
Remarks: Not in operation until May 4, 1970, awaiting new pump.
Chloride: 50 ppm, at completion.
50 ppm, Mar. 22, 1973.
150 ppm, June 26, 1974*.
100 ppm, Sept. 25, 1974.
50 mg/L, 5 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
22 mg/L, June 6, 1980.
29 mg/L, June 17, 1980 (USGS) at pumping rate of 103 gal/min.
25 mg/L, June 20, 1980; specific conductance, 541 µmho (USGS).
Hardness: 240 ppm, Nov. 11, 1971.
250 ppm, June 26, 1974*.
240 ppm, Sept. 25, 1974.
Pumpage: 290,000 gal/d, at completion.
216,000 gal/d, May 5, 1980.
June 26, 1974*: pH, 7.4.
Sulfate, 12 ppm.
Alkalinity (as $CaCO_3$), 240 ppm.
No fecal or total coliform per 100 mL.
Sept. 25, 1974 (1325): pH, 7.2
Iron, < 1 ppm
Manganese, < 1 ppm

For metals and pesticides analyses, see table 74.

* Analyses by W. B. Brewer, Health Services Trust Territory, using Hach kit.

WELL 50 (New)

OBSERVATIONS

Altitude of measuring point: 647.5 ft (bolt hole in metal plate, 0.08 ft above concrete casing which is 0.84 ft above concrete well pad).

Date	Time	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1974				
Sept. 9	1415	--	240	
Sept. 11	--	275.4	180	Steel tape measurement.
Sept. 13	1025	--	250	Meter: 21559700 gal.
Sept. 16	1410	--	177	Meter: 22639400 gal.
Sept. 17	0950	--	250	Meter: 22930600 gal.
Sept. 18	0845	--	250	From 1025 hrs, Sept. 13, to 0845, Sept. 18, well produced 1.713 Mgal or an average of about 240 gal/min, or about 0.34 Mgal per 24 hour day.
Sept. 20	0845	--	250	Meter: 23960400 gal.
Sept. 23	1340	--	250	Meter: 25090400 gal.
Sept. 25	1317	--	250	Meter: 25796100 gal.
Sept. 27	0850	--	250	Meter: 26427000 gal.
	1445	--	250	Meter: 26519000 gal.
Sept. 30	0830	--	250	Meter: 27489200 gal.
Oct. 2	1330	--	250	Meter: 28293300 gal.
	1335		176	Pumping to main tank only.
Oct. 4	1000	--	250	Meter: 28932400 gal.
Oct. 9	0815	--	250	Meter: 30698300 gal.
Sept. 23	--	--	--	Well idle. No measurements, until Sept. 27.
Sept. 27	1345	--	--	Completed pulling of pump.
	1400	157.48	--	Steel tape measurement.
Sept. 30	0845	153.90	--	Do.
Oct. 2	1352	153.69	--	Do.
Oct. 4	1005	153.53	--	Do.
Oct. 9	0850	153.0	--	Do.

Sept. 13 (1025) to Oct. 9 (0850), 1974: 9,138,600 gallons or 245 gal/min (352,800 gal/d).

WELL 50 (New)

LOG

Description of material	Depth (ft)
White very hard limestone	0-15
Pink limestone with medium hard streaks clay	15-16
Pink hard limestone	16-25
White and pink hard limestone	25-30
White and pink hard limestone	30-33
Pink hard limestone	33-35
Pink limestone with hard streaks	35-39
Pink hard limestone	39-42
White very hard limestone	42-44
White and pink very hard limestone	44-52
Very hard limestone	52-63
Hard limestone	63-68
Very hard limestone	68-74
Hard limestone	74-84
Medium hard limestone	84-106
Hard limestone	106-112
Very hard limestone	112-118
Hard limestone	118-120
Very hard limestone	120-132
Medium hard softer limestone	132-134
Medium hard limestone	134-142
Hard limestone	142-145
Medium hard limestone	145-152
Hard limestone	152-158
Very hard limestone	158-168
Very hard limestone	168-172
Hard limestone	172-178
Medium hard limestone	178-195
Hard limestone	195-202
Medium hard limestone	202-214
Hard limestone	214-217
Very hard limestone	217-233
Hard limestone	233-236
Medium hard limestone	236-239
Very hard limestone	239-243
Hard limestone	243-247
Medium hard limestone	247-251
Very hard limestone	251-256
Very hard limestone	256-261
Very hard limestone	261-267
Hard limestone	267-274
Medium hard softer limestone	274-276
Hard limestone	276-335
Hard limestone with soft streaks	335-340
Feels like clay, blue clay on bit	340-350

WELL 50 (New)

Chemical analyses of water from well 50

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
4-21-83	25.4	414	7.2	235	224
10-14-83	24.6	690	7.7	216	--

PUMPING TEST

Date: December 11, 1969.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0800	0	192.5	--	Start of test.
0830	30	207.5	226	
0900	60	222.3	297	
0930	90	207.5	240	
1000	120	207.5	240	
1030	150	207.6	240	Maximum drawdown.
1100	180	207.6	240	
1130	210	207.5	240	
1200	240	207.5	240	
1230	270	207.5	240	
1300	300	207.5	240	
1330	330	206.5	240	
1400	360	205.3	222	
1430	390	205.3	207	
1500	420	206.5	226	
1530	450	207.0	240	
1600	480	206.7	231	
1630	510	207.0	235	
1700	540	207.0	235	End of test.

Well recovered 3 ft and showed no change after that.

WELL 50 (New)

PUMPING TEST

Date: December 16-17, 1969.

This test was run after casing, gravel packing and acidizing the well. For the first 2 hours the well was pumped and surged to clear of spent acid and increase capacity of the well. At the start of pumping, the pump drew air at a pumping rate of 250 GPM. The well was surged every 10 minutes until 1300 hr when the airline registered 1.50 ft, at which time pump test records were started and the surge rate was decreased to once every 15 minutes until 12-16-69 at 1700 hr. From 12-16-69, 1700 to 2400 the well was surged every 30 minutes; on 12-17-69 from 0000 to 0600 the well was not surged.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1300	--	192	--	Static depth to water.
1300	0	193.5	250	Start of test.
1315	15	194	250	
1330	30	194	250	
1345	45	194.2	240	
1400	60	194	250	
1415	75	194.5	261	
1430	90	194.5	261	
1445	105	194	261	
1500	120	194	261	
1515	135	202.5	273	
1530	150	202.5	261	
1545	165	202.2	261	
1600	180	203.5	261	
1615	195	203.2	261	
1630	210	211.2	250	
1645	225	210	250	
1700	240	210.5	240	
1730	270	207	240	
1800	300	210	240	
1830	330	209	240	
1900	360	211	261	
1930	390	212	261	Maximum drawdown.
2000	420	209	250	
2030	450	210	250	
2100	480	210	273	
2130	510	210	273	
2200	540	210	261	
2230	570	210	273	
2300	600	210	261	
2330	630	211	261	
2400	660	211	250	
0030	690	210.5	261	Dec. 17, 1969.
0130	750	209	250	

WELL 50 (New)

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0230	810	209	240	
0300	840	208.5	250	
0400	900	208	--	
0430	930	--	240	
0530	990	207.5	--	
0600	1020	207	--	Generator failed, pump stopped.

Date: May 5, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0800	0	192	--	Start of test.
0800:30	0.5	210	--	
0801	1.0	216	--	
0801:30	1.5	216.5	--	
0802	2.0	216.8	170	Maximum drawdown. Same reading every 30 seconds, 0802-0805.
0810	10	216.8	170	
0815	15	216.8	172	
0820	20	216.8	170	
0825	25	216.8	172	
0830	30	216.6	170	
0835	35	216.5	171	
0845	45	216.4	170	
0900	60	216.1	170	Same reading at 0930 and 1000.
1100	180	216.0	171	
1130	210	215.9	170	
1200	240	215.9	168	End of pumping test.
Recovery				
1225:00	0	215.9		Start of recovery test.
:20	.3	193		
:30	.5	192		
:40	.7	191.75		Remaining the same until 1235. End of test.

WELL 75 (New)

Location: Lat 15°11'29" N., long 145°44'58" E., at Akgak.

Drilled: November 1970.

Altitude: 622.88 ft ("x" on concrete slab), 624.00 ft (top of concrete pump base), levels of Oct. 8, 1974.

Depth: 249 ft.

Remarks: Chloride: 40 ppm, at completion.
40 ppm, Mar. 22, 1973.
100 ppm, Sept. 25, 1974.
48 mg/L, average of 6 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
20 ppm, June 1980, at pumping rate of 48 gal/min (Ronimus, 1981).

Hardness: 280 ppm, at completion.
240 ppm, Sept. 25, 1974.

Pumpage: 200 gal/min, at completion.
48 gal/min, June 17, 1980 (estimate by Public Works).

Sept. 25, 1974: pH, 7.5-7.6.
iron, < 1 ppm.
manganese, < 1 ppm.

WELL 75

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 624.07 ft (bolt hole in pump base, 0.07 ft above concrete of pump base). Altitude of concrete pump base from USGS levels of 10-8-74.

Date	Depth to water	Pumping rate (gal/min)
3-21-73 --------	200.51	170
3-21-73 --------	197.11	Pump off for 9 min.
9-11-74 --------	227.03	--
9-12-74 --------	227.16	55
9-13-74 --------	226.56	52
9-16-74 --------	226.0	52
9-17-74 --------	225.98	52
9-18-74 --------	225.88	53
9-20-74 --------	225.04	52
9-23-74 --------	224.06	49
9-25-74 --------	223.27	50
9-27-74 --------	222.36	48
9-30-74 --------	221.36	45
10-2-74 --------	220.44	45
10-4-74 --------	219.03	51
10-9-74 --------	218.27	51
10-29-74 -------	206.02	
8-20-80 --------	246.02	
1-7-81 ---------	275.52	
4-24-81 --------	233.61	
1-14-83 --------	220.74	No pump.

Note: Total production Sept. 13 (0930) to Oct. 9 (0830), 1974: 1,827,500 gallons or 49 gal/min.

WELL 75

Chemical analyses of water from well 75

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)
1-27-81	12.0	400	588	7.2	0.79
2-4-81	24.5	390	588	8.1	.13
2-18-81	24.3	329	617	7.1	.06
3-15-81	23.2	338	613	7.4	.12
5-14-81	30.0	304	566	7.6	.15
5-29-81	24.1	334	588	7.1	.20
6-10-81	23.8	316	561	8.0	.26
7-1-81	24.3	306	584	7.7	.21
7-28-81	23.4	242	413	7.7	.24
8-20-81	24.5	272	605	7.6	.30
9-23-81	23.2	310	607	7.2	.13
10-16-81	27.8	292	562	7.2	.27
12-28-81	25.5	284	600	7.1	.37

LOG

Description of material	Depth (ft)
Top soil and broken coral	0-7
Yellow sandy coral	7-20
Hard and pink lime mix	20-58
Chalky lime	58-65
Hard lime	65-78
Pink lime	78-84
Hard coral	84-98
Beach sand	98-102
Chalky lime	102-111
Hard lime	111-118
Sandy coral	118-129
Hard lime	129-152
Soft chalky lime	152-160
Medium chalky lime	160-184
Hard lime	184-190
Medium, chalky lime (water at 202 ft)	190-204
Soft lime	204-220
Hard lime	220-232
Sand and hard lime	232-237
Beach sand	237-241
Hard lime	241-249

WELL 70

Location: Lat 15°11'31" N., long 145°44'57" E., at Akgak.

Drilled: July 23-27, 1977 to 275 ft, Nov. 8, 1977 to 325 ft, reamed Jan. 20-25, 1978 by International Bridge Corporation.

Altitude: 633.03 ft. Depth: 325 ft.

Diameter of open hole: 9-7/8 in. reamed to 14-3/4 in.

Casing: 8-in. steel casing with 20 ft 8-in. stainless steel screen to bottom of well.

Gravel pack and grout: Gravel to depth of 212.20 ft. Grouted with 259 bags of cement.

Source of record: Drillers log.

Pumping test: July 30, 1977: Hole is 275 ft deep. Maximum drawdown, 11.89 ft in 8 hours at pumping rate of 212 gal/min; recovery to within 0.6 ft of starting water level in 90 min.

Feb. 11, 1978: Depth to water, 227.05; drawdown, 0.30 ft in 45 minutes pumping.

Feb. 11, 1978: Drawdown, 31.05 ft in 8 hours at pumping rate of 212 gal/min; recovery to within 1.38 ft of static water level in 10 minutes and to 0.92 ft in 100 minutes. See pumping test record.

Feb. 12, 1978, 0900-1030: Pump suction at 278 ft; depth to water, 229.05 ft; drawdown, 24.15 ft after 10 minutes.

Remarks: Chloride: 20 mg/L, June 1980, at pumping rate of 72 gal/min (Ronimus, 1981).

Pumpage: 130,000 gal/d, May 5, 1980.

WELL 70

Chemical analyses of water from well 70

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-7-81	25.0	222	--	7.0	0.21	--
1-27-81	12.6	347	549	7.3	.18	--
2-4-81	23.5	310	526	7.9	.13	--
2-18-81	23.3	317	575	7.3	.12	--
3-13-81	22.2	312	562	7.5	.12	--
4-22-81	24.0	325	605	7.2	.28	--
5-14-81	24.0	286	537	7.6	.19	--
6-10-81	24.2	324	583	7.8	.25	--
7-10-81	21.7	282	520	7.6	.18	--
7-28-81	23.2	252	429	7.7	.23	--
8-20-81	23.0	234	514	7.6	.12	--
9-23-81	23.3	296	557	7.3	.23	--
10-16-81	25.8	235	399	7.2	.47	--
12-28-81	30.6	242	567	7.5	.27	--
7-9-82	26.3	260	501	7.6	.17	221
8-10-82	27.6	217	521	7.5	--	217
8-17-82	23.2	--	--	--	--	--
8-24-82	23.2	--	--	--	--	--
8-31-82	23.2	--	--	--	--	--
10-7-82	22.7	--	--	--	--	--
11-10-82	22.9	--	412	7.7	--	217
12-7-82	23.1	--	528	7.8	--	225
2-25-83	23.4	--	518	7.4	--	211
4-21-83	24.9	--	508	7.6	--	208
6-20-83	28.6	--	494	7.8	--	173
7-18-83	21.1	--	510	7.3	--	207
8-15-83	22.3	--	497	--	--	204
10-14-83	20.3	--	507	7.7	--	218

Hardness as $CaCO_3$: 4-21-83, 228 mg/L; 7-18-83, 212 mg/L; 8-15-83, 186 mg/L.

WELL 70

LOG

Description of material	Depth (ft)
Top soil	0-5
Hard, clayey brown coral limestone	5-10
Hard, pink and white coral limestone	10-50
Hard, light brown-white coral limestone	50-65
Very hard, light brown coral limestone	65-80
Very hard, pink coral limestone	80-85
Very hard, pinkish white coral limestone	85-115
Very hard, brownish white coral limestone	115-130
Very hard, pink and white coral limestone	130-145
Very hard, light brown and white coral limestone	145-170
Very hard, white coral limestone with brown traces	170-220
Very hard, pink and white coral limestone	220-260
Very hard, pink coral limestone	260-275
Continued drilling, Nov. 8, 1977	
Very hard, pink and white limestone	275-310
Very hard, pink limestone and gray adobe rock	310-325

PUMPING TEST

Date: February 11, 1978. Measuring point: top of table, 2.6 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1200	--	228.50	--	Static depth to water.
1200	0	--	--	Start of test.
1201	1	256.30	--	
1202	2	257.98	--	
1203	3	259.05	--	
1204	4	259.65	--	
1205	5	259.65	--	
1206	6	259.65	--	
1207	7	259.60	--	
1208	8	259.60	--	
1209	9	259.60	--	
1210	10	259.60	--	
1215	15	259.55	212	
1220	20	259.50	212	
1225	25	259.50	212	
1230	30	249.48	212	
1235	35	259.48	212	
1240	40	259.47	212	

WELL 70

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1245	45	259.55	212	
1250	50	259.50	212	
1255	55	259.55	212	
1300	60	259.55	212	
1305	65	259.55	212	
1310	70	259.55	212	
1340	100	259.50	212	
1410	130	259.55	212	
1440	160	259.60	212	
1510	190	259.51	212	
1540	220	259.58	212	
1610	250	259.60	212	
1640	280	259.57	212	
1710	310	259.57	212	
1740	340	259.58	212	
1810	370	259.50	212	
1840	400	259.53	212	
1910	430	259.55	212	
1940	460	259.50	212	
2010	490	259.55	212	End of pumping test.
Recovery				
2010	0	--		Start of recovery test.
2011	1	230.90		
2012	2	230.28		
2013	3	230.18		
2014	4	230.13		
2015	5	230.08		
2016	6	230.04		
2017	7	230.00		
2018	8	229.95		
2019	9	229.95		
2020	10	229.88		
2025	15	229.85		
2030	20	229.79		
2035	25	229.72		
2040	30	229.70		
2045	35	229.67		
2050	40	229.62		
2100	50	229.58		
2110	60	229.53		
2120	70	229.50		
2130	80	229.49		
2140	90	229.46		
2150	100	229.42		End of test.

TEST HOLE 71

Location: Akgak.

Drilled: Aug. 3-8, 1977 by International Bridge Corporation.

Altitude: Well not located. Depth: 290 ft.

Diameter of open hole: 9-7/8 in.

Pumping test: Well 245 ft deep, pump suction at approximate 236 ft below ground level, about 36 ft below water level, Aug. 8, 1977: Pump sucking air in 10-15 seconds after starting.

Well 290 ft deep, pump suction at 255 ft below ground level and 55 ft below water surface, Aug. 9, 1977: Pump sucking air in 70 seconds after starting. Initial rate of pumping, 308 gal/min.

Aug. 10, 1977: Pumped at rate of 23 gal/min, drawdown about 20 ft. Pumped at rate of 29 gal/min, pump sucking air.

Hole abandoned Aug. 11, 1977.

TEST HOLE 71

LOG

Description of material	Depth (ft)
Dark brown clay with limestone	0-5
Brown clay with limestone	5-10
White limestone with traces of brown clay	10-15
Buff limestone	15-20
Tan limestone	20-25
Buff limestone	25-45
Off-white limestone	45-50
Buff limestone	50-55
Buff to off-white limestone	55-65
Buff limestone	65-70
White limestone with traces of buff	70-85
Off-white limestone with traces of buff	85-90
Off-white to buff limestone	90-95
Buff limestone	95-100
Off-white to buff limestone	100-105
Off-white limestone	105-115
Off-white to buff limestone	115-125
Buff limestone	125-130
Off-white to buff limestone	130-145
Buff limestone	135-150
Off-white to buff limestone	150-190
Off-white limestone	190-195
Buff limestone	195-200
Buff to pink limestone	200-210
Off-white to pink limestone	210-225
Buff limestone with traces of pink	225-230
Buff to tan limestone	230-245
Tan limestone with traces of brittle gray fine grained formation	245-250
Tan limestone and gray formation	250-265
Gray formation	265-275
Gray formation with traces of tan coral	275-280
Liquified red clay. No solids cuttings; sampling not possible	280-290

WELL 72

Location: Lat 15°11'27" N., long 145°44'57" E., at Akgak, 600 ft south of of well 70.

Drilled: Aug. 12-15, 1977, Dec. 28, 1977; reamed Dec. 29, 1977 to Jan. 5, 1978 by International Bridge Corporation.

Altitude: 653.34 ft. Depth: 350 ft.

Diameter of open hole: 9-7/8 in. reamed to 14-3/4 in.

Casing: 8-in. steel casing with 30 ft stainless steel screen to 352.7 ft.

Gravel pack and grout: Gravel to depth of 234.9 ft, sealed with sand. Grouted with 298 bags of cement.

Pumping test: Aug. 16, 1977: Static depth to water, 243.51 ft; pump suction at 278 ft; depth to water, 244.75 ft after 30 minutes pumping at rate of 220 gal/min.

Aug. 17, 1977: Static depth to water, 244.24 ft; maximum drawdown, 0.95 ft in 8 hours of pumping at rate of 205 gal/min; recovery to within 0.37 ft of static water level in 60 minutes, to within 0.21 ft in 25 minutes.

Jan. 18, 1978: Drawdown, about 1-1/2 ft in 8 hours.

Remarks: Jan. 6, 1978: Static depth to water, 239 ft.

WELL 72

LOG

Description of material	Depth (ft)
Buff to pink limestone and brown clay	0-5
Buff limestone	5-10
Buff to tan limestone	10-15
Buff limestone	15-30
Tan limestone and red clay	30-35
Tan limestone	35-45
Buff to tan limestone	40-70
Tan limestone with traces of pink	70-80
Tan limestone	80-95
Tan limestone with sandy grains	95-100
Flakey buff to tan limestone	100-110
Buff to tan limestone with traces of pink	110-120
Pinkish buff limestone	120-140
Mixed pink and buff limestone	140-145
Buff to tan limestone	145-160
Buff limestone	160-185
Buff to tan limestone	185-195
Chalky limestone, cream with traces of tan	195-220
Chalky limestone, cream to off-white	220-260
Chalky limestone, cream	260-275
Limestone, cream with traces of tan	275-280
Limestone, cream to buff	280-285
Buff limestone	285-300
Continued drilling, Dec. 28, 1977	
White limestone	300-305
Light brown limestone	305-335
Light brown and gray limestone	335-350

WELL 73

Location: Lat 15°11'24" N., long 145°44'56" E., at Akgak.

Drilled: Aug. 30 to Sept. 1, 1977, Feb. 15, 1978; reamed Feb. 16 to Mar. 12, 1978 by International Bridge Corporation.

Altitude: 680.79 ft. Depth: 375 ft.

Diameter of open hole: 9-7/8 in. reamed to 14-3/4 in.

Casing: 8-in. steel casing with 20 ft 8-in. stainless steel screen to bottom of well.

Gravel pack and grout: Gravel to depth of 259.38 ft, sealed with 1.1 ft of sand. Grouted with 348 bags of cement.

Pumping test: Sept. 3, 1977: Static depth to water, 273.80 ft; drawdown 3.44 ft in 45 minutes at pumping rate of 190 gal/min.

Sept. 5, 1977: Maximum drawdown, 3.35 ft in 8 hours at average pumping rate of 199 gal/min; recovery to within 0.4 ft of static level after 60 minutes.

Mar. 29, 1978: Drawdown, 2.75 ft in 8 hours at pumping rate of 212 gal/min; chloride, 35 mg/L; recovery to within 0.83 ft of starting depth to water in 10 minutes and to within 0.63 ft in one hour. See pumping test record.

Remarks: Chloride, 20 mg/L, June 1980, at pumping rate of 97 gal/min (Ronimus, 1981).

WELL 73

Chemical analyses of water from well 73

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
9-23-81	23.2	310	607	7.2	0.13	--
10-16-81	27.8	292	562	7.2	.27	--
12-28-81	25.5	284	600	7.1	.37	--
2-3-82	25.0	238	508	7.6	.49	--
3-8-82	22.6	354	533	7.3	.15	--
4-12-82	21.8	254	524	7.3	.27	--
5-3-82	22.9	352	600	7.2	.10	--
6-4-82	23.0	--	--	7.4	--	251
7-9-82	28.4	302	591	7.6	.12	241
8-10-82	24.7	--	586	7.6	--	238
8-17-82	24.6	--	--	--	--	--
8-24-82	24.7	--	--	--	--	--
8-31-82	24.3	--	--	--	--	--
9-8-82	23.5	304	572	7.7	--	243
10-7-82	24.7	--	--	--	--	--
11-10-82	24.1	--	465	7.9	--	255
12-7-82	22.9	--	589	7.6	--	260
1-19-83	22.0	--	545	7.8	--	240
2-25-83	22.8	--	561	7.4	--	237
4-21-83	26.9	--	495	7.5	--	229
6-20-83	26.5	--	544	7.5	--	181
7-18-83	22.6	--	536	7.4	--	219
8-15-83	26.1	--	526	--	--	246
9-8-83	22.5	--	531	--	--	227
10-14-83	23.1	--	558	7.7	--	216

Hardness as $CaCO_3$: 4-21-83, 248 mg/L; 7-18-83, 235 mg/L; 8-15-83, 196 mg/L.

WELL 73

LOG

Description of material	Depth (ft)
Buff limestone to 3/8 inch and brown clay	0-10
Buff limestone to 1/4 inch with traces of clay	10-20
Buff limestone to 1/4 inch with traces of tan	20-90
Buff limestone with traces of reddish clay	90-100
Off-white to buff limestone	100-120
Buff to tan limestone	120-145
Cream limestone to 3/16 inch with traces of tan	145-175
Fine, cream limestone	175-195
Cream limestone to 3/16 inch	195-300
No circulation	300-325
Continued drilling Feb. 15, 1978	
No circulation	325-375

PUMPING TEST

Date: March 29, 1978.
Reference point: top of casing, 2 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0815	--	284.50	--	--	Static depth to water.
0830	0	--	--	--	Start of test.
0831	1	286.15	212	--	
0832	2	286.25	212	--	
0833	3	286.41	--	--	
0834	4	286.47	--	--	
0835	5	286.35	--	--	
0836	6	286.40	--	--	
0837	7	286.38	--	--	
0838	8	286.42	--	--	
0839	9	286.39	--	--	
0840	10	286.41	212	--	
0845	15	286.43	212	--	
0850	20	286.47	212	35	
0855	35	286.51	212	--	
0900	30	286.56	212	--	
0905	35	286.59	212	--	
0910	40	286.64	212	--	
0915	45	286.64	212	--	
0920	50	286.60	212	--	

WELL 73

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0925	55	286.63	212	--	
0930	60	286.64	212	--	
0935	65	286.66	212	--	
0940	70	286.66	212	--	
1010	100	286.72	212	--	
1040	130	286.80	212	35	
1110	160	286.80	212	--	
1140	190	286.85	212	--	
1210	220	286.89	212	--	
1240	250	286.93	212	--	
1310	280	286.99	212	--	
1340	310	287.04	212	--	
1410	340	287.05	212	--	
1440	370	287.05	212	--	
1510	400	287.14	212	--	
1540	430	287.20	212	35	
1610	460	287.21	212	--	
1640	490	287.25	212	--	End of pumping test.
Recovery					
1640	0	--			Start of recovery test.
1641	1	286.47			
1642	2	285.46			
1643	3	285.46			
1644	4	285.41			
1645	5	285.42			
1646	6	285.37			
1647	7	285.38			
1648	8	285.35			
1649	9	285.34			
1650	10	285.33			
1655	15	285.26			
1700	20	285.26			
1705	25	285.25			
1710	30	285.20			
1715	35	285.16			
1720	40	285.18			
1730	50	285.14			
1740	60	285.13			End of test.

TEST HOLE Denni Spring

Location: Lat 15°11'47" N., long 145°45'55" on road at Denni Spring.

Drilled: Aug. 23-27, 1977 by International Bridge Corporation.

Altitude: 270 ft (from topographic map). Depth: 175 ft.

Diameter of open hole: 9-7/8 in.

Casing: None.

Remarks: No appreciable water. Hole abandoned Aug. 27, 1977.

LOG

Description of material	Depth (ft)
Buff limestone, sand to 3/8 inch, some brown clay	0-5
Mixed buff limestone and brown sandstone to 3/8 inch	5-10
Buff clay with sandy limestone	10-15
Brown clay with limestone to 1/4 inch	15-25
Brown clay and sandstone	25-30
Coarse sandstone with some limestone to 1/4 inch	30-35
Limestone, sandy to 1/4 inch, with some sandstone	35-40
Coarse sandstone with limestone to 1/4 inch	40-45
Mixed limestone, sandstone, and dark gray volcanic rock chips	45-50
Dark gray to black volcanic rock with traces of sandstone and limestone	50-55
Dark gray volcanic rock with sandstone and limestone	55-70
Dark gray volcanic rock with traces of sandstone and limestone	70-80
Dark gray volcanic rock with fine limestone and sandstone	80-85
Fine dark gray volcanic rock with trace of limestone	85-90
Dark gray volcanic rock to 5/16 inch	90-115
Dark gray volcanic rock with some to 1/4 inch	115-120
Fine dark volcanic rock with some to 1/4 inch	120-150
Dark gray volcanic rock to 3/16 inch	150-175

TEST HOLE Capitol Hill

Location: About lat 15°11'52" N., long 145°45'02" E., at Akgak.
Drilled: Sept. 20-27, 1977 by International Bridge Corporation.
Altitude: About 700 ft (from topographic map). Depth: 325 ft.
Diameter of open hole: 9-7/8 in.
Casing: None.

No water found, hole abandoned.

LOG

Description of material	Depth (ft)
Clay and fine tan limestone flakes to 3/16 inch	0-5
Fine tan limestone flakes to 3/16 inch	5-15
Fine tan and some dark tan limestone flakes to 3/16 inch	15-25
Fine tan limestone flakes to 1/8 inch	25-40
Tan limestone to 1/8 inch	40-140
Tan limestone to 1/4 inch	140-150
Mixed tan and gray limestone to 1/4 inch	150-165
Mixed tan and gray limestone and red brown clay	165-175
Red brown clay with some tan and gray limestone	175-180
Mixed tan and gray limestone to 1/8 inch with brown clay	180-195
Conglomerate: multi-colored clays, black-shale and tan limestone	195-270
Multi-colored clays, tan limestone, and gray black andesite	270-280
Gray black andesite with traces of clay	280-290
Gray black andesite to 3/16 inch	290-325

TEST HOLE 10

Location: Lat 15°11'19" N., long 145°44'56" E., at Akgak (same as well 121).
Drilled: June 12-20, 1979 by Ted Lund Drilling and Supply.
Altitude: 694.43 ft. Depth: 356 ft.
Diameter of open hole: 7-7/8 inches.
Casing: None.
Source of record: Driller.
Pumping tests: June 20, 1979: Pumped to clear well. Depth to water before pumping, 244.55 ft; drawdown, 3.25 ft in 45 minutes at pumping rate of 82 gal/min; recovery after three minutes to 244.50 ft.
June 21, 1979: Drawdown, 2.79 ft in 8 hours at pumping rate of 90 gal/min. See pumping test record.

TEST HOLE 10

LOG

Description of material	Depth (ft)
Fill	0-3
White, medium hard coral	3-37
Brown, medium soft clay	37-39
White, medium hard coral	39-49
Brown, medium soft clay	49-51
White, clay coral rubble with hard rough layers	51-88
Medium hard, clay coral rubble	88-90
Very hard	90-92
Extremely hard coral (20 minutes per foot)	92-96
Very hard	96-115
Very hard, severe drill collar chatter	115-122
Very hard, smooth drilling (pulled out drill bit because of slow drilling-40 min/ft-found dense white coral on teeth of bit)	122-130
Very hard	130-135
Medium hard with drill collar chatter	135-158
Hard with very hard layer	158-175
Hard clay coral rubble	175-182
Hard with medium hard layers and less clay	182-198
Hard with medium hard coral	198-208
Medium hard with hard layers	208-262
Hard, rough drilling	262-266
Medium hard with hard layers	266-298
Hard	298-305
Medium hard	305-319
Hard	319-328
Hard clean coral with some medium hard layers	328-343
Hard, bouncy drilling	343-346
Medium soft with medium hard layer	349-352
Becoming sticky	349-352
Hard and rough drilling becoming very hard at 356 (volcanic black rock on bit)	352-356

TEST HOLE 10

PUMPING TEST

Date: June 21, 1979.
Measuring point: 3 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0750	--	247.65	--	Static depth to water.
0800	0	--	--	Start of test.
0801	1	250.18	90	
0803	3	250.27	90	
0805	5	250.35	90	
0807	7	250.37	90	
0810	10	250.25	90	
0815	15	250.28	90	
0820	20	250.31	90	
0825	25	250.33	90	
0830	30	250.35	90	
0845	45	250.37	90	
0900	60	250.39	90	
0930	90	250.38	90	
1000	120	250.42	90	
1030	150	250.46	90	
1100	180	250.50	90	
1130	210	250.50	90	
1200	240	250.50	90	
1230	270	250.50	90	
1300	300	250.50	90	
1330	330	250.40	90	
1400	360	250.40	88	
1430	390	250.40	86	
1450	410	--	--	Stopped pump for one minute to backwash pump screen.
1500	420	250.44	90	
1530	450	250.45	90	
1600	480	250.44	90	
1601	481	--	--	End of test.

WELL 10C. Called well 121 (1982)

Location: Same as test hole 10, lat 15°11'19" N., long 145°44'56" E., at Akgak.

Drilled: July 21-28, 1979 reamed from 7 7/8 to 14 1/2 inches by Ted Lund Drilling and Supply.

Altitude: 694.43 ft. Depth: 356 ft.

Diameter of open hole: 14-1/2 in.

Casing: 10-in. steel casing, solid to 288 ft, perforated 288 to 316 ft.

Screen: 32 ft 10-in. stainless steel screen from 316 to 348 ft.

Gravel pack and grout: 640 gallons of gravel from 220 to 348 ft (used four bags of cement to seal top of gravel).

Source of record: Driller.

Pumping tests: Aug. 3, 1979: No change in water level during pumping at 86 gal/min.

Aug. 23, 1979: Drawdown, 4.66 ft in 7-1/2 hours at pumping rate of 82-86 gal/min. See pumping test record.

Feb. 11, 1982: Drawdown, 1 ft in about 8 hours at pumping rate of 49-55 gal/min; chloride, 21-23 mg/L. See pumping test record.

Depth to water, in feet

[Source: Ayers, 1981]

Date	Depth to water	Date	Depth to water	Date	Depth to water
11-18-80	290.47	1-26-81	290.97	2-28-81	290.69
11-19-80	dry	1-29-81	291.24	3-5-81	296.20
11-21-80	297.22	2-5-81	290.84	3-9-81	292.26
12-10-80	297.62	2-10-81	292.75	4-14-81	299.95
1-16-81	290.74	2-16-81	293.13	5-13-81	298.09

WELL 10C. Called well 121 (1982).

PUMPING TEST

Date: August 23, 1979.
Measuring point: One foot above ground surface (top of casing).

Time	Elapsed time (min)	Drawdown (ft)	Pumping rate (gal/min)	Remarks
0725	--	0	--	Static depth to water.
0730	0	--	--	Start of test.
0731	1	3.78	86	
0732	2	3.80	--	
0733	3	3.92	--	
0734	4	3.97	--	
0735	5	4.02	86	
0740	10	4.01	86	
0745	15	4.06	86	
0750	20	4.08	84	
0800	30	4.13	82	
0815	45	4.19	82	
0830	60	4.24	84	
0845	75	4.27	86	
0900	90	4.23	86	
0930	120	4.40	84	
1000	150	4.45	82	
1030	180	4.47	86	
1100	210	4.49	86	
1130	240	4.47	82	
1200	270	4.45	82	
1230	300	4.50	82	
1300	330	4.50	86	
1330	360	4.55	82	
1400	390	4.55	82	
1430	420	4.60	86	
1500	450	4.66	82	
1504	454	--	--	End of test.

WELL 10C. Called well 121 (1982).

PUMPING TEST

Date: February 11, 1982.
Static depth to water, 275.67 ft; pump intake at 285.38 ft.

Time	Elapsed time (min)	Drawdown (ft)	Pumping rate (gal/min)	Remarks
1045	0	--	55	Start of test.
1048	3	0	52	
1050	5	1.3	52	
1054	9	3.1	52	
1059	14	2.2	52	
1103	18	1.0	--	Same reading at 1106, 1125, 1140, 1220.
1230	105	1.0	49	Same reading at 1300, 1400, 1515, 1600, 1700, 1730, 1800, 1838.
1838	473	1.0	49	End of test.

Note: Nine determinations of chloride concentration made during pump test, 20.9-22.9 mg/L (Water Quality Laboratory Commonwealth of the Northern Mariana Islands).

EXPLORATORY HOLE 1 (EXH 1)

Location: Lat 15°11'30" N., long 145°44'58" E., at Akgak.
Drilled: Begin 1982 by Geo-Engineering and Testing.
Altitude: 625 ft (from topographic map). Depth: 350 ft.
Diameter of open hole: 5 in., opened to 7-7/8 in. to 215 ft.
Source of record: Driller.

LOG

Description of material	Depth (ft)
Red brown clayey gravely silt, moderately stiff	0-7
Light brown limestone, weak to moderately hard	7-41
Color white, moderately hard to hard and occasionaly very hard	41-70
Moderately hard	70-215
Yellow white limestone, moderately hard	215-260
Blue gray sandstone, weak, weathered	260-313
Red brown calcified clay	313-315
Rotary drill was used from 315-350 ft; no samples	

Note: For log of chip and core samples, see Ayers, 1981.

Depth to water, in feet

[Source: Northern Mariana Islands Division of Environmental Quality]

Altitude of measuring point: 625 ft (from topographic map).

Date	Depth to water	Date	Depth to water
5-5-81	226.07	6-23-81	225.49
5-13-81	225.02	7-14-81	225.93
5-27-81	224.75	4-12-82	225.94
6-4-81	225.02	1-14-83[1/]	213.81

[1/] By U.S. Geological Survey.

EXPLORATORY HOLE 2 (EXH 2)

Location: Lat 15°11'17" N., long 145°45'04" E., at Akgak.
Drilled: February 1982 by Geo-Engineering and Testing.
Altitude: 649.96 ft (Ayers, 1981). Depth: 322 ft.
Diameter of open hole: 5 in.
Source of record: Driller.

LOG

Description of material	Depth (ft)
Red-brown clayey gravely silt	0-2
Yellow-white limestone, hard	2-8
White limestone, moderately hard	8-20
Hard	20-40
Moderately hard	40-65
Moderately hard to weak	65-80
Hard (partially lost circulation at 125 ft)	80-130
Yellow-white, moderately hard	130-195
Grayish color	195-203
Color yellow-brown	203-207
Color blue gray with clay	207-210
Color white (with gray from 218 to 218.5 ft)	210-224
Red-brown clay (stiff, from 228-242)	224-242
Yellow-brown clayey limestone, moderately hard (color white from 267 to 268 ft)	242-298
Blue gray-dark brown clay, stiff	298-322

Note: For log of chip and core samples, see Ayers, 1981.

EXPLORATORY HOLE 2 (EXH 2)

Depth to water, in feet

[Sources: Northern Mariana Islands Division of Environmental Quality and Ayers, 1981 (*)]

Altitude of measuring point, 649.96 ft.

Date	Depth to water	Date	Depth to water
2-25-81	231.85	5-27-81	220.29
2-28-81	231.69	6-4-81	221.89
3-25-81	220.36*	6-23-81	221.93
4-25-81	220.80*	7-14-81	220.12
5-5-81	220.29	8-12-81	219.40
5-13-81	220.12	8-24-81	211.48

EXPLORATORY HOLE 4 (EXH 4)

Location: Lat 15°11'22" N., long 145°45'01" E., at Akgak.
Drilled: Dec. 11-31, 1981 by Geo-Engineering and Testing.
Altitude: 683.50 ft (Ayers, 1981). Depth: 380 ft.
Diameter of open hole: 6 in. to 280 ft, 5-1/2 in. to 369 ft, and 5 in. to 380 ft.
Source of record: Driller.

LOG

Description of material	Depth (ft)
Red brown clayey limestone gravel	0-8
Light brown-yellow limestone, moderately hard	8-10
White limestone, hard (weak from 90 to 95 ft)	10-130
Weak	130-135
Moderately hard	135-280
Yellow-brown limestone, weak to moderately hard	280-320
Color gray and white	320-324
Color yellow-brown	324-339
Color pinkish yellow	339-344
Blue-gray tuffaceous sandstone	344-356
Clayey	356-360
Color dark green	360-364
Red brown calcified clay	364-366
Mottled red-brown-gray white silty clay, stiff	366-380

Note: For log of chip and core samples, see Ayers, 1981.

EXPLORATORY HOLE 4 (EXH 4)

Depth to water, in feet

[Sources: Northern Mariana Islands Division of Environmental Quality and Ayers, 1981 (*)]

Altitude of measuring point, 683.50 ft.

Date	Depth to water	Date	Depth to water
1-7-81	270.61*	4-14-81	283.36*
1-16-81	270.31	4-25-81	284.80*
1-26-81	276.32	5-5-81	274.96
1-29-81	276.52	5-13-81	275.03
2-5-81	274.87	5-27-81	277.64
2-10-81	274.72	6-4-81	279.83
2-16-81	275.87	6-23-81	280.36
2-24-81	274.58	7-14-81	280.34
3-5-81	278.81*	4-12-82	280.34
3-9-81	274.31		

EXPLORATORY HOLE 6 (EXH 6)

Location: Lat 15°11'25" N., long 145°45'16" E., at Akgak.
Drilled: Feb. 24-28, 1982 by Geo-Engineering and Testing.
Altitude: 545.21 ft (Ayers, 1981). Depth: 200 ft.
Diameter of open hole: 6 in.
Source of record: Driller.

LOG

Description of material	Depth (ft)
Orange-brown clay, stiff	0-5
Yellow-white limestone, hard (cavity at 35 ft, lost circulation)	5-37
Limestone boulders	37-45
Clay, color unknown, very stiff	45-57
Brown-white slightly clayey limestone (hard to very hard at times)	57-95
Weak zone	95-97
Very hard	91-130
Clay, stiff (no recovery 145-150 ft, 50-70 percent recovery 150-156 ft)	130-156
Blue-gray-black clay, stiff, with occasional shells and shell fragments	156-170
Yellow-brown clayey limestone, moderately hard	170-193
Dark gray-black basalt	193-200

Note: For log of chip and bore samples, see Ayers, 1981.

Depth to water, in feet

[Source: Northern Mariana Islands Division of Environmental Quality]

Altitude of measuring point, 545.21 ft.

Date	Depth to water	Date	Depth to water
5-5-81	96.60	6-23-81	95.67
5-13-81	96.76	7-14-81	93.90
5-27-81	96.53	4-12-82	95.23
6-4-81	95.00		

EXPLORATORY HOLE 7 (EXH 7)

Location: Lat 15°11'15" N., long 145°45'13" E., at Akgak.
Drilled: Mar. 14-15, 1982 by Geo-Engineering and Testing.
Altitude: 585.62 ft (Ayers, 1981). Depth: 135 ft.
Diameter of open hole: 6 in.
Source of record: Driller.

LOG

Description of material	Depth (ft)
Yellow-brown limestone, hard	0-11
Color darker and clayish	11-13
Color yellow-white, moderately hard	13-35
Moderately hard to hard	35-51
Yellow-brown tuffaceous limestone clay	51-61
Black-blue conglomerate with black manganese deposits	61-66
Yellow-white limestone, moderately hard	66-75
Dark gray-black-yellow-green conglomerate, moderately hard	75-90
Yellow-brown clayey limestone	90-125
Yellow-red-brown limestone with clay	125-130
Dark gray-blue with white specks of clay	130-135
Very little water in hole	

Note: For log of chip and core samples, see Ayers, 1981.

Depth to water, in feet

[Source: Northern Mariana Islands Division of Environmental Quality]

Altitude of measuring point, 585.62 ft.

Date	Depth to water	Date	Depth to water
4-25-81	106.05	5-27-81	107.00
5-5-81	106.48	6-4-81	104.66
5-13-81	107.04	4-12-82	106.48

EXPLORATORY HOLE 8 (EXH 8)

Location: Lat 15°11'35" N., long 145°45'20" E., at Akgak.
Drilled: Mar. 2-12, 1982 by Geo-Engineering and Testing.
Altitude: 493.10 ft (Ayers, 1981). Depth: 192 ft.
Diameter of open hole: 6 in.
Source of record: Driller.

LOG

Description of material	Depth (ft)
Red-brown-yellow white silty clay and large limestone boulders	0-2
Yellow-brown-white limestone, hard (small cavity at 15 ft; lost circulation at 37 ft)	2-50
Clayey	50-51
Yellow-white limestone, hard	51-63
Gray clayey limestone	63-71
Yellow-brown clayey limestone	71-72
Yellow limestone, moderately hard, fractioned with layers	72-80
Yellow-white limestone with recrystalization	80-118
Gray silty clay, medium stiff	118-123
Clay and limestone mixed (very poor recovery)	123-148
Yellow-white recrystalized limestone, moderately hard to hard (recovery 80 percent)	148-155
Yellow-brown limestone, medium hard	155-165
Blue-gray stone with calcified deposits	165-178
Blue-black basalt	178-182
Bottom of hole at 192 ft. Drilling becoming harder with depth	182-192

Note: For log of chip and core samples, see Ayers, 1981.

EXPLORATORY HOLE 8 (EXH 8)

Depth to water, in feet

[Source: Northern Mariana Islands Division of Environmental Quality]

Altitude of measuring point, 493.10 ft.

Date	Depth to water	Date	Depth to water
4-25-81	65.00	6-23-81	67.47
5-5-81	68.80	7-14-81	70.47
5-13-81	69.05	8-12-81	65.33
5-27-81	69.74	8-24-81	51.52
6-4-81	67.40	4-12-82	58.34

WELL 122

Location: Lat 15°11'39" N., long 145°44'57" E., at Akgak.

Drilled: Mar. 22-25, 1982 by Pacific Drilling Inc.

Altitude: 739.08 ft. Depth: 345 ft.

Source of record: Driller.

Remarks: Well was drilled outside basin boundary and was dry.

WELL 122

LOG

Description of material	Depth (ft)
White-light gray coral gravel	4
White corraline limestone (very dense):	
Color to white yellow	8
Color to white	10
Color to tan	17
Color to pinkish white	18
Color to white	19
Color to white yellow	24
Color to white	25
Color to white yellow	30
Color to white	31
Color to tan	35
Color to white	37
Color to pinkish tan	38
Color to pinkish white	44
Color to yellow white	48
Color to tan	49
Color to yellow white	51
Color to white	52
Color to pinkish white	57
Color to white	60
Drilling hard, color to yellow white	62
Tan corraline limestone	78-80
Pinkish corraline limestone	80-81
Color to white	82.5
Color to pinkish white	91
Color to yellow white	94
Color to white, hard	94.5
Color to yellow white	106
Color to white	117
Lost circulation	122
Regained circulation	125
Color to yellow white	150
Color to white	155
Drills very slowly (very dense)	170
4-inch cave in	311-31
Drills very hard	345
Drilling terminated at 345, no water found	

WELL 123

Location: Lat 15°11'17" N., long 145°45'04" E., at Akgak (3 ft from exploratory hole 2).

Drilled: Mar. 26-30, 1982 by Pacific Drilling Inc.

Altitude: 649.95 ft. Depth: 306 ft.

Source of record: Driller.

Remarks: Depth to water, 435.05 ft.

LOG

Description of material	Depth (ft)
Brown clay silt, soft	0-2
White coralline limestone, dense	2-141
Lost circulation at 71 ft	
Drilling slow (dense) at 77 ft	
Regain circulation at 95 ft	
Color to pinkish white	141-143
Color to white	143-160
Color to yellow white	160-162
Color to pinkish white	162-165
Color to yellow white	165-186
Color to pinkish white	186-189
Gray cement with tan coralline limestone	189-194
Color to grayish white (cavity, 195-196)	194-196
Color to yellow white	196-200
Color to grayish white	200-205
Color to yellow white	205-208
Color to grayish white	208-209
Color to white	209-210
Color to yellow white	210-210.5
Color to white	210.5-212
Color to pinkish white	212-215
Color to white	215-234
Reddish brown clay silt with coralline limestone	234-244
Color to white	244-245
Color to pinkish white	245
White coralline limestone (dense)	245-250
Color to yellow white (cave-in, 245-280 ft)	250-280
Color to reddish brown	280-285
Color to pinkish white	285-300
Color to grayish white	300-306

WELL 124

Location: Lat 15°11'33" N., long 145°45'16" E., at Akgak.
Drilled: Apr. 1-5, 1982 by Pacific Drilling Inc.
Altitude: 570 ft. Depth: 180 ft.
Source of record: Driller.

Well abandoned due to subsurface conditions.

LOG

Description of material	Depth (ft)
White-tan coralline limestone (dense)	0-20
Color to yellow white	at 20
Color to tan	at 40
Reddish brown clay silt (soft) with tan coralline limestone (dense)	45-50
Color to light gray	at 50
Color to yellow white	at 51
White-tan coralline limestone (very dense)	51-55
Gray-light gray volcanic silt stone (loose-dense)	at 55
Tan volcanic rock (silt stone)	67-70
Gray volcanic rock (silt stone)	at 70
Gray clay silt with gray volcanic rock (silt stone), soft	75-79
Gray volcanic rock (silt stone)	at 79
White-tan coralline limestone (very dense)	at 85
Color to grayish white	at 104
Cave-in	105-120
Color to grayish tan	at 165
Cave-in	170-180
Drilling terminated at 180 ft. Hole abandoned.	

Hakmang (Kagman) area

Limestone in the Hakmang area is underlain by a layer of impermeable sandstone, much of it below sea level. Wells not drilled through this layer tend to be dry but water rises to 15 feet above sea level when the layer is punctured (Cox, 1956).

During 1944-45, nine wells were drilled and the Maui III shaft dug in the Hakmang area, most of them near the present well 76 (fig. 26). Maui III was never completed, as the shaft failed to find water but, instead, hit impermeable rock. Wells 64, 66, and 67, drilled by the U.S. Marines to supply water for their camp, were sealed when they left 3 months later.

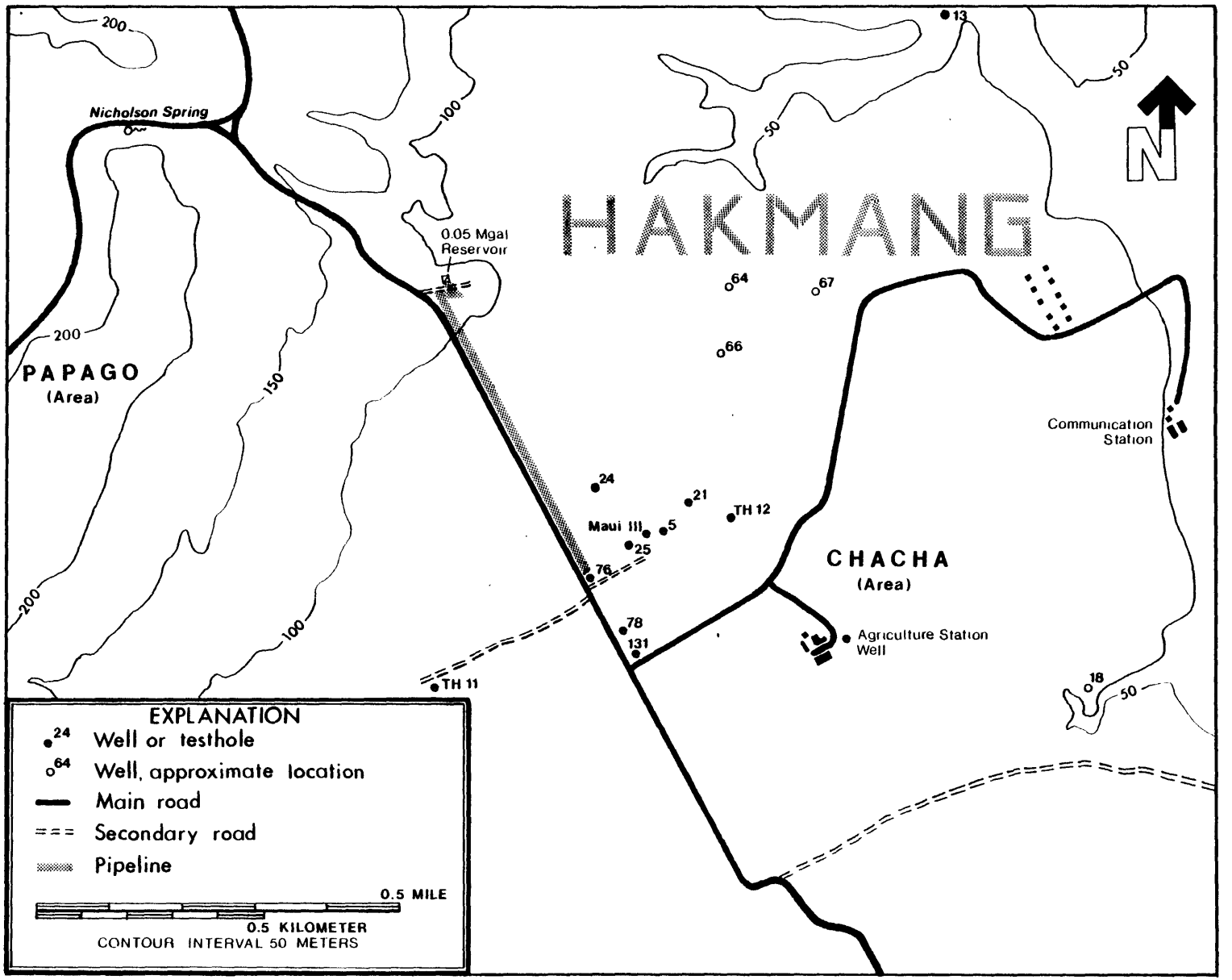
Beginning in 1945, water from wells 5, 24, and 25 was pumped to Denni Spring and together with the Denni Spring water, pumped by way of a Capitol Hill reservoir to the west coast. In 1949, the Hakmang well field and the pipeline to Denni Spring were abandoned. In 1956, two new wells, 76 and 78, were drilled and a 50,000-gallon concrete tank was constructed half a mile north of well 76. Presently, water from well 76 is pumped to this reservoir for local distribution.

In 1976, a well was dug at the Agriculture Station and this well is still supplying the water for the Station. Test holes 11 and 12, drilled in 1979, were never developed. Although the result of a pump test of test hole 11 was promising, the water was not needed locally at that time. In 1981, well 131 (also called M and E well) was drilled. The yield was small and in 1982 the well was deepened by 73 feet to tap the artesian aquifer. During a pump test prior to the deepening, the water level dropped 60 feet in 30 minutes; during the pump test after deepening, there was practically no drawdown in more than 23 hours of pumping.

The Geological Survey has collected water-level data at well 78 since 1973. For much of that time, water levels have been recorded continuously (fig. 27, 28). Recorder charts shows that the water level is affected by the tides but not by the pumping of nearby well 76.

Wells 5, 21, 24, 25, drilled in 1944-45, and wells 76, 78, drilled in 1956, penetrated the artesian aquifer below sea level. After penetration, the water level rose to an average height of 20 ft above mean sea level. Salinity of the water was low and the yield satisfactory. At present (1983), only well 76 is in operation and being pumped at a rate of 35 gal/min. This water, with a chloride concentration of less than 100 mg/L, is stored in the 50,000 gallon reservoir and provides all the water needed in the area. As the Hakmang area is not integrated in the island-wide water distribution system, there has been little incentive to develop additional wells.

All wells drilled in the Hakmang area are listed in table 30.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 26. Location of wells in Hakmang area.

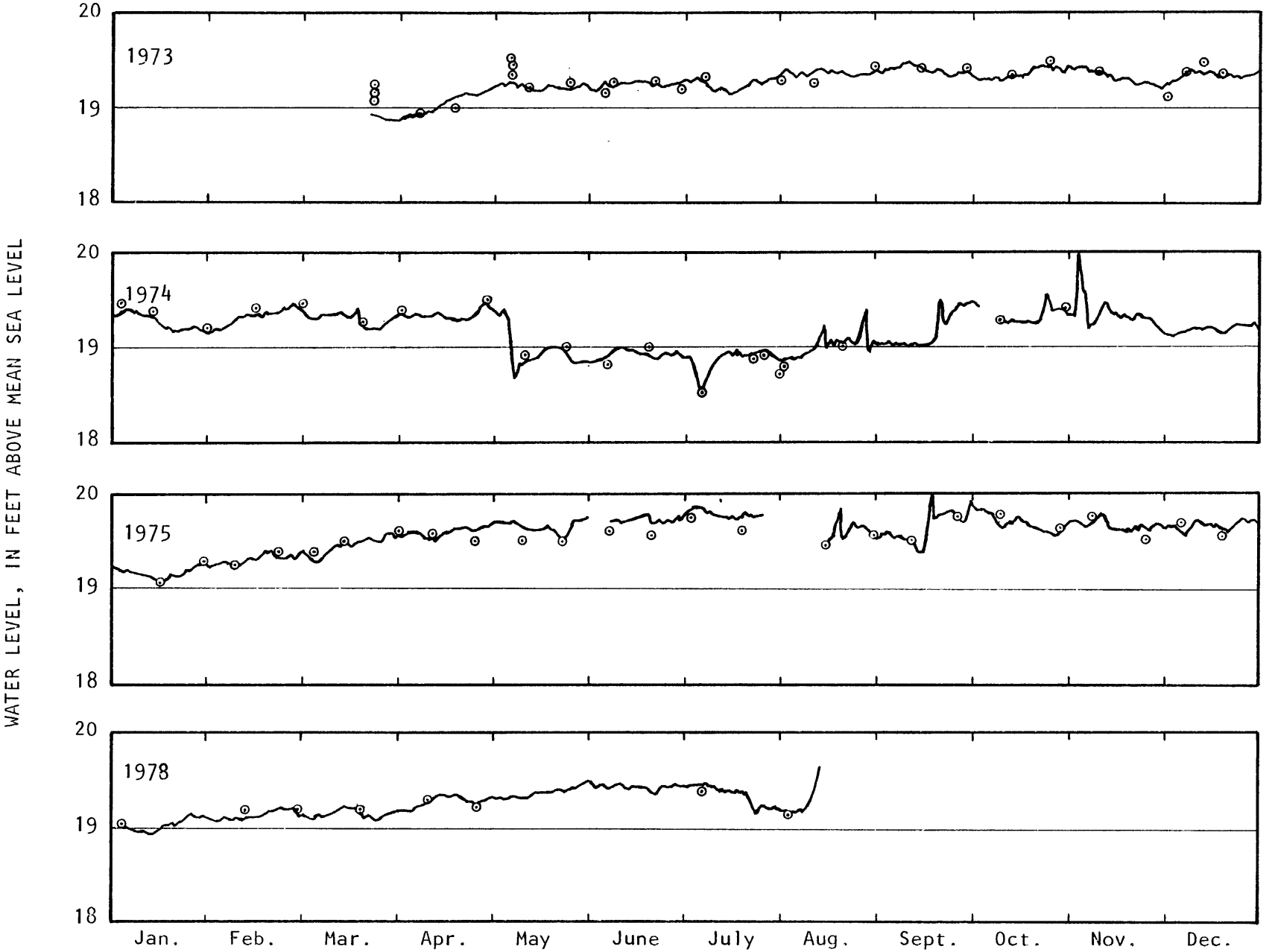


Figure 27. Water level in well 78, 1973-75, 1978.

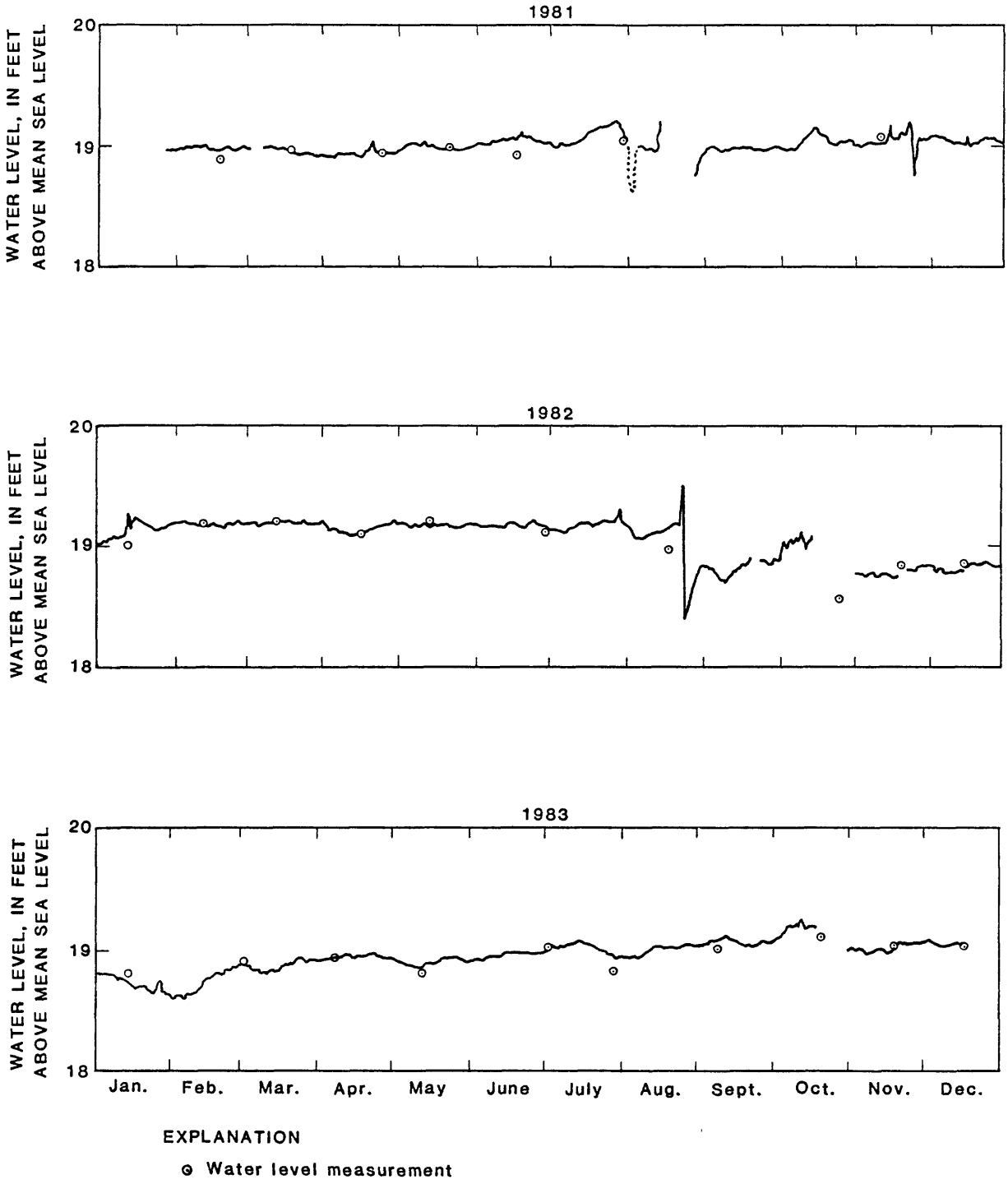


Figure 28. Water level in well 78, 1981-83.

Table 30. Testholes and wells drilled at Hakmang (Kagman) area

Testhole and well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
W 5	15°10'29"	145°45'54"	Aug. 15, 1944	223.15	349	Still in use in 1949.
W 13	15°11'06"	145°46'15"	Oct. 9, 1944	117.5	330	At bottom of ravine. Abandoned; low yield.
W 18[1/]	15°10'18"	145°46'26"	1944	175	190	Abandoned after 10 months use.
W 21	15°10'31"	145°45'56"	Dec. 6, 1944	217	394	
W 24	15°10'32"	145°45'50"	Dec. 21, 1944	233	400	Tapped artesian basal water.
W 25	15°10'27"	145°45'52"	Jan. 5, 1945	225	400	Do.
W 64[1/]	15°10'47"	145°45'59"	June 1945	214	258	Abandoned after 3 months.
W 66[1/]	15°10'41"	145°45'58"	June 27, 1945	213	275	Do.
W 67[1/]	15°10'46"	145°46'06"	July 10, 1945	220	265	Do.
Maui III	15°10'28"	145°45'53"	July 13, 1945	224	258	Abandoned before completion.
			1956-62			
W 76	15°10'26"	145°45'49"	1956	230		
W 78	15°10'22"	145°45'51"	1956	228	364	
			1969-71			
W Agriculture Station.	15°10'21"	145°46'08"	June 8, 1970	204.5	225	
			1979-80			
TH 11	15°10'18"	145°45'38"	June 29, 1979	245	276	
TH 12	15°10'30"	145°45'59"	July 5, 1979	210	223	
			1981-82			
W 131	15°10'20"	145°45'52"	Nov. 4, 1981	227	297	Also called M and E well, deepened to 370 ft in October 1982.

[1/] Location approximate.

WELL 5

Location: Lat 15°10'29" N., long 145°45'54" E., 0.3 mi northwest of Hakmang Agriculture Station.

Drilled: July 31 to Aug. 15, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 223.15 ft. Depth: 349 ft.

Casing: 6 in. to 132 ft.

Aquifer: Limestone.

Source of record: H. T. Stearns (1944) and others.

Remarks: Water encountered at depth of 349 ft (126 ft below sea level) and rose to 206.8 ft before pumping (Stearns, 1944).

Chloride: 26 ppm, at completion, before and after pumping 3,000 gallons at pumping rate of 70,000 gal/d (Stearns, 1944).
70-90 ppm (Glander, 1946).
70-200 ppm (Piper, 1946-47).

Pumpage: 72,000 gal/d, Sept. 6, 1944 (Stearns, 1944).
135,000 gal/d (Boniface, 1945).
70,000-130,000 gal/d (Glander, 1946).
60,000 gal/d (anonymous report, March 1947).

pH: 6.8-7.0 (Glander, 1946).

For chemical analysis, see table 70.

Well was reported in use in 1949 (Curione, 1949).

Well tapped artesian basal water in aquifer below sea level.

WELL 5

LOG
[Source: H. T. Stearns, 1944]

Description of material	Depth (ft)
Brown soil	0-10
Brown clay and manganese oxide pellets	10-20
Clay and limestone	30-35
Dirty limestone	30-35
Clean white limestone	35-60
Limestone (no samples)	60-134
Limestone, fragments of tan shale and manganese pellets	134-137
Thin bedded tuffaceous shales, gray, red, green and lavender, containing Globigerina fossils	137-173
Sandy tuffaceous shale	173-188
Marly tuffaceous shale	188-225
Sandy tuffaceous shale	225-230
Shale with 1/4-inch fragments of volcanic rock alternating with sandy shales	230-255
White limestone with thin layers containing volcanic grains (struck water at 349 ft)	255-349

WELL 13

Location: Lat 15°11'06" N., long 145°46'15" E., Hakmang, near bottom of ravine (to reduce drilling distance[1/]).

Drilled: Sept 30 to Oct. 9, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 117.5 ft Depth: 330 ft.

Casing: 6 in. to 298 ft with bottom 18 ft perforated.

Aquifer: Limestone and sand.

Source of record: Driller.

Remarks: Water encountered from 15 ft to total depth but in small quantity. When sand was reached at 295 ft, water level dropped 15 ft to 30 ft below surface[1/].

Pumpage: 43,000 gal/d, at completion (log).

60,000-70,000 gal/d for several days, no decrease in flow and taste remained sweet.

Well abandoned, presumably because of low yield (Glander, 1946).

[1/] Supplemental report on well drilling, memorandum from Desloge Brown to Commanding Officer, Nov. 29, 1944, 3p.

WELL 13

LOG

Description of material	Depth (ft)
Sandy clay	0-45
Sand	45-50
Sand, shale and clay	50-65
Shale and sand	65-75
Clay and sand	75-90
Sand and shale	90-110
Shale and clay	110-130
Sand and sticky clay	130-140
Shale and clay	140-150
Sticky clay and sand	150-160
Clay and some lava rock	160-170
Sticky clay and sand	170-230
Sticky clay	230-242
Sticky clay and sand	242-278
Sticky clay and shale	278-287
Lime rock and clay	287-295
Sand	295-300
Sand and shale	300-310
Sand	310-315
Lime and sand	315-320
Lime and lava rock	320-325
Lava rock	325-330

WELL 18

Location: About lat 15°10'18" N., long 145°46'26" E., about 0.4 mi east of Hakmang Agriculture Station.

Drilled: 1944 by U.S. Marine Corps.

Altitude: 175 ft. Depth: 190 ft.

Casing: 6 in. to 190 ft.

Aquifer: Limestone (Davis, 1958).

Source of record: Glander (1946), Piper (1946-47). Driller's log missing.

Remarks: Water encountered at depth of 190 ft (bottom of hole).

Chloride: 30 ppm (Glander, 1946).
30-190 ppm (Piper, 1946-47).

Pumpage: 30,000-40,000 gal/d (Glander, 1946).
30,000 gal/d (Piper, 1946-47).

pH: 7.0-7.2 (Glander, 1946).

Well was in use for about 10 months and then abandoned (Glander, 1946).

WELL 21

Location: Lat 15°10'31" N., long 145°45'56" E., 500 ft north of well 5, Hakmang.

Drilled: Nov. 27 to Dec. 6, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 217 ft. Depth: 394 ft.

Casing: 6 in. to 251 ft.

Aquifer: Limestone and sand.

Remarks: Depth to water before pumping, 194 ft.

Chloride: 30 ppm, at completion (log).
90 ppm (Glander, 1946).
90-150 ppm (Piper, 1946-47).

Pumpage: 94,000 gal/d at completion (log).
105,000 gal/d (Boniface, 1945).
85,000-95,000 gal/d (Glander, 1946).
97,000 gal/d (anonymous report, 1947).

pH: 6.8-7.0 (Glander, 1946).

Well tapped artesian basal water in aquifer below sea level.

Well could not be located in 1956 (Cox, 1956).

WELL 21

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Sticky clay	0-40
Clay and sand	40-47
Chalky lime and sand	47-60
Sand and lime	60-65
Sandy clay and lime	65-75
Sticky clay	75-86
Lavender shale, chalky lime and clay	86-100
Clay and sandy gravel	100-115
Sticky clay and chalky lime	115-120
Sandy clay and chalky lime	120-125
Blue sandy shale and clay	125-130
Blue shale, chalky lime and sand	130-152
Blue and gray shale and lime	152-155
Blue shale	155-165
Sandy clay and blue shale	165-175
Sand and sand rock gravel	175-220
Sand and sandy clay	220-229
Blue and gray shale	229-250
Lavender shale, sand and lime	250-265
Chalky lime and sand	265-300
Lime rock and clay	300-320
Chalky lime with alternating fragments of blue shale, sandy shale, and sand	320-366
Sand	366-372
Lavender shale, chalky lime and sand	372-394

WELL 24

Location: Lat 15°10'32" N., long 145°45'50" E., 0.4 mi northwest of Hakmang Agriculture Station.

Drilled: Dec. 15-21, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 233 ft. Depth: 400 ft.

Casing: 6 in. to 250 ft.

Aquifer: Shale and chalky lime (Glander, 1946); limestone (Davis, 1958).

Remarks: Depth to water before pumping, 212 ft.

Chloride: 50 ppm, at completion (Curione, 1949).
80-120 ppm (Glander, 1946).

Pumpage: 94,000 gal/d, at completion (log).
100,000 gal/d (Boniface, 1945).
130,000-140,000 gal/d (Glander, 1946).
120,000-145,000 gal/d (Piper, 1946-47).
145,000 gal/d (anonymous report, 1947).

pH: 6.8-7.0 (Glander, 1946).

Reported not in use because the pump was stuck (Cox, 1956).

Well tapped artesian basal water in aquifer below sea level (Davis, 1958).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Sandy shale and red clay	0-125
Lavender shale and sand	125-145
Sandy clay, lavender shale, and chalky lime	145-155
Chalky lime and hard lime	155-164
Hard lime and sand	164-220
Chalky and hard lime	220-225
Chalky lime and sand	225-230
Gray sand, chalky lime, and sand	230-245
Chalky lime	245-270
Hard lime and sandy shale	270-310
Gray sand and little lime	310-325
Lavender shale, chalky lime, and sand	325-330
Lava rock and lime	330-345
Shale, lime, and sand	345-363
Lavender shale, mud, and gray shale	363-375
Lavender shale and chalky lime	375-400

WELL 25

Location: Lat 15°10'27" N., long 145°45'52" E., about 400 ft northeast of well 76, Hakmang.

Drilled: Dec. 22, 1944 to Jan. 5, 1945 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 225 ft. Depth: 400 ft.

Casing: 6 in. to 257 ft.

Aquifer: Sand and limestone.

Remarks: Water encountered at depth of 224 ft.
Depth to water before pumping, 208 ft.
Chloride: 40 ppm, at completion (log).
100 ppm (Glander, 1946).
Pumpage: 120,000 gal/d, at completion (log).
160,000 gal/d (Boniface, 1945).
150,000-170,000 gal/d (Glander, 1946).
90,000-120,000 gal/d (Piper, 1946-47).
173,000 gal/d (anonymous report, 1947).
pH: 6.8-7.0 (Glander, 1946).

Well reported "open" in 1956 (Cox, 1956).
Well tapped artesian basal water in aquifer below sea level (Davis, 1958).

WELL 25

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Mud and clay	0-25
Red clay	25-42
Clay and lime	42-65
Blue clay, shale, and chalky lime	65-75
Chalky lime and hard lime	75-95
Hard lime and clay	95-159
Hard lime, shale, and clay	159-170
Hard lime, lava rock, shale, and clay	170-180
Gray clay and sand	180-200
Lime, mud, and shale	200-210
Chalky lime, lavender shale, and red clay	210-215
Hard and chalky lime and gray shale	215-220
Lime, shale, and beach sand	220-225
Hard lime and lava rock	225-230
Chalky lime	230-260
Chalky lime and hard lime	260-287
Chalky lime	287-290
Chalky lime and clay	290-295
Chalky lime	295-315
Hard lime	315-329
Hard lime and chalky lime	329-380
Chalky lime and sand	380-400

WELL 64

Location: About lat 15°10'47" N., long 145°45'59" E., 0.5 mi north of Hakmang Agriculture Station.
Drilled: June 1945 by U.S. Marine Corps.
Altitude: 214 ft. Depth: 258 ft.
Casing: 6 in. to 248 ft.
Aquifer: Limestone.
Source of record: Glander (1946).
Remarks: Chloride: 30 ppm, at completion.
Pumpage: 15,000-20,000 gal/d, June to September 1945.
pH: 7.0-7.2.

Well was used about 3 months and when the Marines left, they pulled all equipment and capped the well (Glander, 1946). Well could not be located by Cox (1956).

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Varicolored clay and shale	0-247
Hard coral	247-258

WELL 66

Location: About lat 15°10'41" N., long 145°45'58" E., about 0.1 mi south of well 64, Hakmang.
Drilled: Completed June 27, 1945 by U.S. Marine Corps.
Altitude: 213 ft. Depth: 275 ft.
Casing: 6 in. to 262 ft.
Aquifer: Limestone.
Source of record: Glander (1946).
Remarks: Chloride: 30 ppm, at completion.
Pumpage: 20,000-25,000 gal/d.
pH: 7.0-7.2.

Well was drilled in varicolored clay, sandy clay, shale, and sandy shale with some coral (Davis, 1958).
Well was used about 3 months and when the Marines left, they pulled all equipment and capped the well (Glander, 1946).

WELL 67

Location: About lat 15°10'46" N., long 145°46'06" E., about 0.1 mi east of well 64, Hakmang.
Drilled: July 10, 1945 by U.S. Marine Corps.
Altitude: 220 ft.
Depth: 265 ft.
Casing: 6-in. steel.
Aquifer: Clay, shale, and limestone.
Source of record: Glander (1946).
Remarks: Chloride: 30 ppm, at completion.
Pumpage: 30,000-35,000 gal/d.
pH: 7.0-7.2.

Well was drilled in varicolored clay, sandy clay, shale and sandy shale with some coral (Davis, 1958).
Well was used about 3 months and when the Marines left, they pulled all equipment and capped the well (Glander, 1946).

WELL Maui III

Location: Lat 15°10'28" N., long 145°45'53" E., 0.1 mi northeast of well 76, Hakmang.

Drilled: Excavation stopped July 13, 1945.

Altitude: 224 ft. Depth: 258 ft.

Diameter of hole: 8 x 8 ft, vertical, timbered.

Source of record: Glander, 1946.

Remarks: No tunnels dug.

Shaft penetrated formation of clay, coral, coral gravel, slate or mud rock, sandstone, grey shale, and hard limestone.

Well was abandoned and sealed because shaft ended in impermeable rock and no usable water was found (Davis, 1958).

WELL 76

Location: Lat 15°10'26" N., long 145°45'49" E., along main road in Hakmang, 0.3 mi northwest of Hakmang Agriculture Station.

Drilled: 1956 by Brown-Pacific-Maxon. Well had not been tested in July 1956 (Cox, 1956).

Altitude: 230 ft (Cox, 1956, and from topographic map).

Depth: Not known.

Remarks: Safe yield estimated at 35,000 gal/d (Cox, 1956).

Chloride: 62 ppm, Sept. 14, 1965, at pumping rate of 30 gal/min.[1/]
97 mg/L, average of 7 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
92 mg/L, Mar. 18, 1980 (USGS).
72 mg/L, June 17, 1980 (USGS).
75 mg/L, Sept. 8, 1983 (USGS).

Drawdown and salinity test June 20-25, 1966: In 5 days, 179,000 gal pumped at 25 gal/min and no drawdown. Salinity remained constant at 74-78 ppm.[2/]

Pumpage: 35 gal/min, June 17, 1980 and Aug. 18, 1982.
65 gal/min, Apr. 27, 1983.
67 gal/min, Sept. 8, 1983.

Well provides water for the Hakmang area. For chemical analyses, see tables 72 and 76.

1/ Written communication M. M. Miller and Ted Arnow to High Commissioner of the Trust Territory of the Pacific Islands, 1965.

2/ Written communication L. F. Irving to District Director Public Works, June 30, 1966.

WELL 76

Chemical analyses of water from well 76

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-7-81	67.7	406	--	7.7	0.63	--
1-27-81	33.9	552	769	7.6	.15	--
2-4-81	65.6	486	833	8.0	.48	--
2-18-81	66.0	481	875	7.4	.06	--
3-13-81	68.2	494	843	7.6	.10	--
4-22-81	85.3	518	917	7.7	.10	--
1-29-82	65.3	356	727	7.5	1.3	--
3-8-82	62.9	510	810	7.4	.87	--
4-12-82	66.3	468	843	7.1	.30	--
5-3-82	66.0	534	852	7.1	.19	--
7-9-82	74.6	532	913	7.3	.19	326
8-10-82	71.3	--	800	7.1	--	325
8-17-82	68.8	--	--	--	--	--
8-24-82	67.9	--	--	--	--	--
8-31-82	69.7	--	--	--	--	--
9-8-82	71.6	468	877	7.5	--	320
10-7-82	70.1	--	--	--	--	--
11-10-82	64.0	--	684	7.8	--	321
1-19-83	66.7	--	840	7.5	--	320
2-25-83	68.0	--	878	7.3	--	323
4-21-83	66.0	--	859	7.1	--	322
6-20-83	71.4	--	863	7.6	--	287
7-18-83	68.5	--	884	7.2	--	317
8-15-83	81.2	--	884	--	--	318
9-8-83	70.0	--	841	--	--	326
10-14-83	84.8	--	896	7.5	--	316

Hardness as $CaCO_3$: 4-21-83, 354 mg/L; 7-18-83, 357 mg/L; 8-15-83, 348 mg/L.

WELL 78

Location: Lat 15°10'22" N., long 145°45'51" E., along main road in Hakmang, about 200 ft south of well 76.

Drilled: 1956 by Brown-Pacific-Maxon. (Well had not yet been tested in July 1956 (Cox, 1956).

Altitude: 228 ft (from topographic map).

Depth: 364 ft (Oct. 7, 1981).

Casing: 12-in. steel.

Remarks: July 2, 1983: Specific conductance, 883 µmho (USGS).
Continuous water-level record (USGS) in 1973-75, 1978, 1981-82. (See figs. 27, 28).

WELL 78

Depth to water, in feet

[U.S. Geological Survey]

Altitude of measuring point: 230 ft (top of casing), from topographic map.

Date	Depth to water	Date	Depth to water	Date	Depth to water	Date	Depth to water
3-20-73	211.02	2-14-74	210.61	5-22-75	210.48	1-15-78	211.06
3-29-73	211.06	2-28-74	210.58	6-6-75	210.40	2-13-78	210.81
4-5-73	211.05	3-21-74	210.75	6-20-75	210.43	2-27-78	210.80
4-19-73	211.01	4-2-74	210.62	7-2-75	210.27	3-1-78	210.80
5-4-73	210.67	4-29-74	210.53	7-17-75	210.40	3-21-78	210.79
5-11-73	210.83	5-9-74	211.06	8-29-75	210.42	4-10-78	210.68
5-24-73	210.75	5-24-74	211.00	9-11-75	210.47	4-26-78	210.77
6-4-73	210.87	6-6-74	211.21	9-26-75	210.27	7-6-78	210.64
6-7-73	210.74	6-20-74	211.10	10-9-75	210.23	9-2-78	210.88
6-14-73	210.62	7-5-74	211.46	10-28-75	210.38	2-18-81	211.01
6-21-73	210.72	7-22-74	211.12	11-7-75	210.27	3-18-81	211.05
6-28-73	210.81	7-25-74	211.08	11-21-75	210.48	4-24-81	211.17
7-5-73	210.71	7-31-74	211.28	12-5-75	210.33	5-21-81	211.02
7-31-73	210.72	8-1-74	211.15	12-19-75	210.45	6-17-81	211.09
8-9-73	210.73	8-20-74	211.00	1-1-76	206.47	7-30-81	210.97
8-30-73	210.61	10-9-74	210.71	1-16-76	210.24	8-28-81	211.29
9-13-73	210.62	10-10-74	210.72	1-30-76	210.25	9-25-81	211.00
9-27-73	210.61	10-29-74	210.63	11-18-76	210.75	10-7-81	211.13
10-11-73	210.65	1-15-75	210.95	12-2-76	210.72	11-12-81	210.94
10-25-73	210.55	1-30-75	210.72	12-16-76	210.73	12-10-81	210.96
11-8-73	210.65	2-7-75	210.75	1-3-77	210.66	1-12-82	210.99
12-1-73	210.89	2-21-75	210.60	1-14-77	209.75	2-11-82	210.80
12-6-73	210.68	3-3-75	210.62	1-28-77	210.60	3-12-82	210.82
12-20-73	210.66	3-14-75	210.49	2-11-77	210.39	4-15-82	210.90
1-3-74	210.57	3-31-75	210.40	2-26-77	210.42	5-13-82	210.80
1-14-74	210.63	4-11-75	210.44	3-11-77	210.33	6-29-82	210.89
1-17-74	210.66	4-25-75	210.52	5-6-77	210.13	8-17-82	211.04
1-31-74	210.80	5-9-75	210.50	1-2-78	210.96		

WELL at Agriculture Station

Location: Lat 15°10'21" N., long 145°46'08" E., at Agriculture Station, Hakmang.

Drilled: May 22 to June 8, 1970 by Layne International, Guam.

Altitude: 204.5 ft. Depth: 225 ft.

Diameter of open hole: 12 in.

Casing: 8-in. to 215 ft. with 10 ft 8-in. stainless steel, louvered screen at bottom.

Gravel pack and grout: June 6, 1970, 15 bags of 3/16 inch gravel and 2 cubic yards of cement grout to 180 ft.

Source of record: Driller.

Remarks: Chloride: 94-100 ppm, June 2, 1970, after 7 hours of pumping at average rate of 110 gal/min. Pump at 224 ft.
110 ppm, May 11, 1971, after 40 min. of pumping at average rate of 85 gal/min.
180 ppm, Mar. 8, 1973.
70 mg/L, June 10, 1980, at pumping rate of 35 gal/min (Ronimus, 1981).
72 mg/L, June 17, 1980 (USGS).
75 mg/L, June 20, 1980; specific conductance, 826 µmho (USGS).

Pumpage: 100 gal/min per foot of drawdown, initially.

Depth to water: 208.90 ft, Mar. 20, 1973 (USGS).

WELL at Agriculture Station

LOG

Description of material	Depth (ft)
Hard, sticky clay	0-35
Black and brown, medium soft clay with silt	35-45
White, hard coral with some clay	45-59
Black and brown, medium hard clay with silt	59-66
White, medium hard coral	66-84
White, medium soft coral	84-95
White, medium soft coral with medium hard layers	95-155
White, medium hard coral (losing some mud)	155-172
White, medium soft coral (losing some mud)	172-200
White, medium soft coral becoming medium hard to hard	200-207
White, hard coral with some thin layers of medium hard	207-218
White, medium hard coral (slight chatter and bounce)	218-220
White, medium hard coral with some thin soft layers	220-225

June 1, 1970: Pumped and surged well for 1 1/2 hours. Capacity increased from 50 gal/min to 150 gal/min.

Chemical analyses of water from well at Agriculture Station

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
6-6-83	517	--	--	--	--
6-13-83	532	--	--	--	--
6-20-83	550	2,460	7.8	283	--
6-27-83	440	--	--	--	--
7-6-83	520	--	--	--	--
7-11-83	545	--	--	--	--
7-18-83	550	2,480	7.5	300	502
8-1-83	545	--	--	--	--
8-29-83	381	--	--	--	--
9-8-83	330	1,680	--	293	--
9-14-83	400	--	--	--	--

TEST HOLE 11

Location: Lat 15°10'18" N., long 145°45'38" E., 0.5 mi west of Agriculture Station, Hakmang, on property of Calistro Cabrera.

Drilled: June 27-29, 1979 to 250 ft, Jan. 13, 1980 to 276 ft by Ted Lund Drilling and Supply.

Altitude: 245 ft (from topographic map). Depth: 276 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping tests: Hole is 250 ft deep.

June 29, 1979, 1710: After completion of drilling, mud level in well is at about 150 ft.

June 30, 1979, 1000-1100: Pumped at rate of 11 gal/min; recovery is very slow.

1200-1530: Pumped at rate from 11 gal/min reducing to 8 gal/min.

1700: Static depth to water, 230.5 ft.

Hole is 276 ft deep.

Jan. 14, 1980: Pumped well to clear cuttings. Well producing 50-60 gal/min; chloride, 15 mg/L.

Jan. 15, 1980: Drawdown, at least 36 ft in 8 hours at pumping rate of 52 gal/min; chloride, 17-18 mg/L; recovery, 4.3 ft in 11 minutes. See pumping test record.

Hole abandoned and sealed May 12, 1980.

TEST HOLE 11

LOG

Description of material	Depth (ft)
Brown medium soft clay	0-6
Coral with some clay	6-23
Medium hard coral	23-46
Becoming more clay with very stiff clay at 65-70	46-71
Medium hard with hard layers with some silt or clay	71-148
Medium hard. Cleaner than above	148-163
Medium hard clean coral with some hard layers	163-191
Medium soft	191-192
Medium hard	192-202
Medium soft	202-203
Medium hard sticky drilling	203-217
Harder and less sticky	217-222
Medium hard with hard layers. Sticky drilling	222-231
Medium hard, seems cleaner than above. Drill collar chatter at 234	231-240
Becoming harder and rougher drilling	240-246
Becoming very hard and rough drilling (Found some gray volcanic clay and black rock on bit)	246-250
Drilling continued on Jan. 13, 1980:	
Brown hard rough volcanic	250-253
White hard coral	253-269
Dark brown weathered volcanics, medium hard at the top becoming hard black basalt rock at 273 ft	269-275
Very hard black basalt rock	275-276

Notes: At 269 ft foam became very dark brown and gradually lightened until at 276 ft foam was almost clear again.
Drilling very slow and rough from 275 to 276: 25 minutes for first 6 inches, 45 minutes for last 6 inches.

TEST HOLE 11

PUMPING TEST

Date: January 15, 1980.
Measuring point: 2.9 ft above ground surface.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0750	--	233.8	--	--	Static depth to water.
0800	0	--	--	--	Start of test.
0802	2	270	54	--	Drawdown is to level of
0810	10	--	54	17.5	pump intake at 270 ft
0815	15	--	54	--	and remains there
0830	30	--	52	--	during the test.
0900	60	--	52	--	
0930	90	--	52	--	
1000	120	--	52	--	
1030	150	--	52	170	
1100	180	--	52	--	
1130	210	--	52	--	
1200	240	--	52	--	
1230	270	--	52	--	
1300	300	--	52	17.5	
1330	330	--	52	--	
1400	360	--	52	--	
1430	390	--	52	--	
1500	420	--	52	18.0	
1530	450	--	52	--	
1600	480	--	52	17.5	End of pumping test.
Recovery					
1600	0	--			Start of recovery test.
1601	1	229.4			
1602	2	232.0			
1603	3	233.0			
1604	4	233.4			
1605	5	233.5			
1606	6	233.6			
1607	7	233.6			
1608	8	233.61			
1609	9	233.63			
1610	10	233.65			
1612	12	233.70			End of test.

TEST HOLE 12

Location: Lat 15°10'30" N., long 145°45'59" E., about 0.2 mi northwest of Agriculture Station, Hakmang.

Drilled: June 27 to July 5, 1979 by Ted Lund Drilling and Supply.

Altitude: 210 ft (from topographic map). Depth: 223 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Hole abandoned and sealed May 12, 1980.

LOG

Description of material	Depth (ft)
Brown, medium soft clay	0-3
Red, medium hard clay	3-9
Gray, medium hard clay	9-27
Gray-green, hard volcanics	27-46
Brown, hard rock	46-48
Medium hard becoming hard, brown rock	48-58
Hard with some hard layers	58-62
Medium hard with hard layer	62-68
Hard, bouncy drilling	68-76
Medium hard with hard layers	76-93
Medium hard, gray rock	93-105
Medium hard, muddy gray rock	105-142
Brown, medium soft clay	142-146
Gray, hard rock. Rough drilling	146-151
Gray, medium hard, muddy rock	151-155
White, hard coral	155-167
White, medium hard coral with hard layers	167-215
Black, very hard. Rough drilling	215-218
Brown, medium hard clay	218-221
Brown, extremely hard rock (from 221 to 222 ft, drilling time over 45 minutes)	221-223

Note: No water showing in foam returns.

WELL 131. Also called M and E well

Location: Lat 15°10'20" N., long 145°45'52" E., 100 ft south of well 78, Hakmang.

Drilled: Nov. 4, 1981 by Geo-Engineering and Testing (suggested by M and E Pacific, Inc). Deepened Nov. 4, 1982.

Altitude: 227 ft.

Diameter of open hole: 8 in.

Depth: 297 ft. Well deepened to 370 ft in November 1982.

Source of record: Driller.

Pumping test: Nov. 3, 1981, 0800, pump at 254 ft: Pump sucking air in two minutes.

0955, pump at 256 ft: Pump sucking air in 20 seconds at pumping rate of about 50 gal/min.

Nov. 4, 1981, pump at 290 ft: Drawdown, 63 ft in 8 hours at pumping rate of 55 gal/min. See pumping test record.

Nov. 5, 1981: Drawdown, 2 ft in 9-1/2 hours at pumping rate of 55 gal/min. See pumping test record.

Nov. 6, 1981: Drawdown, 2 ft in 4 hours at pumping rate of 55 gal/min; chloride, 60 mg/L. See pumping test record.

After deepening of well:

Nov. 24-25, 1982: Drawdown, 0.3 ft in 24 hours at pumping rate of 39-41 gal/min. See pumping test record.

WELL 131. Also called M and E well.

LOG

Description of material	Depth (ft)
November 4, 1981	
Dark brown clay	0-10
Limestone, moderately hard	10-215
Dark brown clay with limestone	215-218
Limestone	218-235
Limestone with some clay	235-290
Brown clay with limestone	290-294
Limestone with clay	294-297
November 4, 1982	
Light yellow brown limestone with stiff brown clay pocket (moderately hard drilling)	295-300
Light yellow-white limestone (moderately hard)	300-310
Light yellow-brown limestone (moderately hard)	310-320
Light yellow-white limestone with coral fragments (moderately hard)	325-362
Light yellow-brown limestone with some coral fragments with brown clay (moderately hard drilling)	362-370

PUMPING TEST

Date: November 4-6, 1981. Static water level, 210 ft; pump intake at 290 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
November 4				
1500	0	210	--	Start of test.
1505	5	240	55	
1510	10	250	55	
1515	15	260	55	
1520	20	268	55	
1525	25	269	55	
1530	30	270	55	
1535	35	271	55	
1540	40	272	55	Same reading every 5 minutes 1545-1600; every 15 minutes 1615-1700.

WELL 131

PUMPING TEST--Continued

Date: November 4-6, 1981. Static water level, 210 ft; pump intake at 290 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1730	150	272	55	
1800	180	272	55	
1830	210	272	55	
1900	240	273	55	Same reading every 30 minutes 1930-2230.
2300	480	273	--	End of test.
November 5, 1981 Water level not yet recovered from pumping the night before.				
0730	0	270	55	Start of test.
0800	30	271	55	
0830	60	272	55	Same reading every 30 minutes 0900-1630.
1700	570	272	--	End of test.
November 6, 1981 Water level not yet recovered.				
0930	0	270	55	Start of test.
1000	30	272	55	Same reading every 30 minutes 1030-1300.
1330	240	272	55	End of test.

WELL 131

PUMPING TEST

Date: November 24-25, 1982, after well had been deepened to 370 ft.
Static depth to water, 207.2 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
November 24				
1440	0	207.2	39	Start of test.
1442	2	206.9	40	
1505	25	206.9	41	Same reading every 5 minutes 1510-1600, every 10 minutes 1610-1700, every 30 minutes 1730-2400.
November 25				
0100	620	206.9	41	Same reading every hour 0200-1300.
1400	1440	206.9	--	End of test.

West Coast Areas

On the west side of the island are four areas which presently contribute to the water supply of Saipan; they are from north to south: Tanapag, Puerto Rico, Maui IV, and Gualo Rai.

Tanapag. See table 31 and figure 29.

The two Tanapag springs have supplied water since the Japanese Administration. The Japanese pumped water from these springs, combined with water from West Achugao Spring, to a 100,000-gallon reservoir, used as a sedimentation basin, and by way of a filtration plant to a nearby underground 200,000-gallon reservoir. These reservoirs are known as Tasa, As Mahettok, or Tanapag reservoirs. Water from Denni Spring, on the east coast of the island, was also pumped to these reservoirs by the Japanese and the 200,000-gallon reservoir was connected to a 3-Mgal underground reservoir at Puerto Rico.

The same system was used during the early days of the American Administration; with the addition of water from Maui IV piped to the As Mahettok reservoir. In 1967, both reservoirs and the filtration system were still in use but not the 3-Mgal reservoir. At present, the water from the Tanapag Springs is pumped only to the 200,000-gallon reservoir with water from the Maui IV well field supplementing the supply. The quality of the spring water is excellent; dissolved solids average 356 mg/L (tables 64-66).

During 1944-45, five wells were drilled in the Tanapag area. To increase the yield of Tanapag Spring No. 1, well 8A was drilled in the spring and well 8B was drilled nearby. Well 8B was never used and it is not sure whether well 8A did increase the yield of the spring after the initial increase (10 gal/min) reported by Stearns (1944). The other three wells (28, 29, 37) were abandoned because they either went dry after a short period (28, 29) or because of high salinity (37).

During February 1980, three wells were drilled at the Tanapag School for storm drainage.

Puerto Rico area. See table 32 and figure 30.

During 1944-45, nine wells were drilled and Maui II was dug in this area. To find a location for a basal water tunnel, four exploratory holes (68 A-D) were drilled around a sinkhole. The other five wells (9, 10, 11 A and B, and 12) were abandoned because of high salinity of the water or low yield. Maui II was dug to intercept the flow of Starch Factory Spring (Cox, 1956) but was abandoned when the portal section caved in (March 1950).

The new Puerto Rico well field (wells 162A, 163, 164) is located west of the old wells 9-12. The wells were placed in production in 1982 and contribute water to the nearby 1-Mgal reservoir. This reservoir also receives water from the Maui IV system. Although the chloride concentration of water from the Puerto Rico wells was not high initially, the average chloride concentration was 1,300 mg/L in February 1983, and more than 2,600 mg/L on July 1, 1983. Well 164 was shut down after the chloride concentration of the water had reached 4,500 mg/L in September 1983.

Located in this same area are the Fleet Tanks, so-called because they were constructed by the Japanese to provide water for their ships. These consist of an underground 3-Mgal reservoir and three 9-Mgal underground tanks. Only the northernmost of the 9-Mgal tanks has been cleaned for water storage but its use has been minimal.

In 1983, three wells (148-150) were drilled near the site of the old exploratory holes 68 A-D at the quarry. These wells were drilled east of the north-south fault line which run almost parallel to and a short distance from the road to Maui IV. In November 1983, the three wells were producing a total of 340 gal/min with a mean chloride concentration of less than 50 mg/L.

Maui IV area. See table 33 and figure 30.

Maui IV, located two-thirds of a mile south of the Puerto Rico wells, has been a major producer of water since 1945. Previous pumpage ran as high as 864,000 gal/d but production has been curtailed to 100,000 gal/d during most of the last few years to present a further increase in the chloride concentration of the water. Nevertheless, the chloride concentration exceeded 1,000 mg/L in August 1982 and reached 2,000 mg/L in September 1983 (fig. 31).

Four other wells drilled nearby in 1944-45 (23A and B, 30, 51) were used only for a short time. The four wells drilled during 1970-71 (141-144) are still in production today. During 1982, three more wells were completed (145-147). However, the chloride concentration of the water from all wells exceeds 1,000 mg/L. Pumping of well 147 was halted after the chloride concentration of the water reached 5,770 mg/L in October 1983.

Water from the wells, combined with overflow from the Capitol Hill reservoir (Akgak-well-field water) and with water from Denni Spring, is distributed from this area by gravity to the As Mahettok reservoir, almost a mile to the north, and by pumping to the Calhoun reservoir, half a mile to the south.

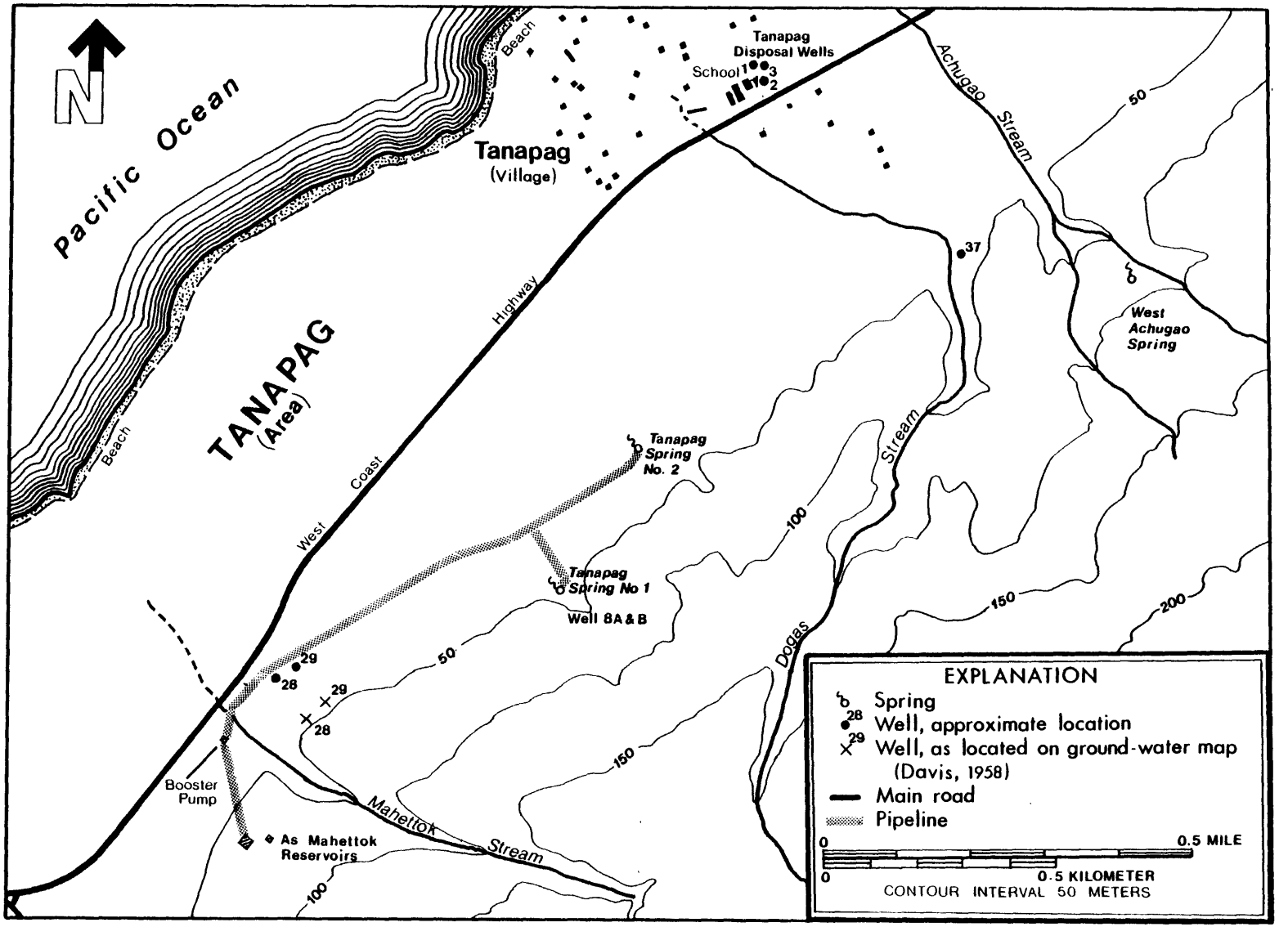
Gualo Rai area. See table 34 and figure 32.

In 1981-82, five wells were drilled in the Gualo Rai area on the west flank of Mount Takpochau in an area where no wells had been drilled previously. Two of these wells (152, 153) were dry, one caved in (154 A) and two are being used (151, 154). Water from these wells is stored in a nearby 200,000-gallon reservoir for domestic use in the area and contributes to the main west coast distribution system. Chloride concentrations of water from the wells were 260 (well 151) and 800 mg/L (well 154) in August 1982, were unchanged in March 1983, and only slightly higher in July 1983.

Table 31. Wells drilled at Tanapag (fig. 29)

Well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
W 8A	15°13'49"	145°45'10"	Sept. 9, 1944	115	77	Drilled in Tanapag Spring No. 1.
W 8B	15°13'49"	145°45'10"	Sept. 21, 1944	120	89	Drilled 15 ft from the spring.
W 28[1/]	15°13'43"	145°44'49"	Dec. 31, 1944	23	50	Well went dry after short period.
W 29[1/]	15°13'44"	145°44'51"	Jan. 12, 1945	27	51	Do.
W 37[1/]	15°14'13"	145°45'38"	Mar. 29, 1945	103	121	High salinity.
			1980			
DW 1	15°14'35"	145°45'31"	February 1980	35	65	Disposal well at Tanapag School.
DW 2	Do.	do.	do.	35	70	Do.
DW 3	Do.	do.	do.	35	68	Do.

[1/] Location approximate.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 29. Location of wells in Tanapag area.

WELL 8A

Location: Lat 15°13'49" N., long 145°45'10" E., drilled in Tanapag Spring No. 1 to tap source of spring water.

Drilled: Aug. 24 to Sept. 9, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 115 ft, from topographic map (100 ft by Stearns, 1944, and Davis, 1958).

Depth: 77 ft (depth measured Sept. 26, 1982: 67.3 ft to soft bottom).

Casing: 8 in. to 18 ft (inside diameter 6-7/8 in.).

Aquifer: Volcanic rock.

Remarks: At 35 ft depth, yield was about 25 gal/min and did not increase between 35 and 62 ft. A flow measurement at outlet of spring showed an increase of 10 gal/min in the yield of the spring after well was completed (Stearns, 1944).

Chloride: 10 ppm, Sept. 6, 1944 (Stearns, 1944).
20 ppm, (Brown[1/], Davis, 1958).

Pumpage: 100,000 gal/d, at completion (log).
At 100,000 gal/d pumpage, drawdown is 25 ft. An additional 20,000 gal/d from fissures at well (Brown[1/]).
100,000 gal/d (Glander, 1946).

Well reported abandoned because of low yield (Davis, 1958).

[1/] Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG

[Source: Driller's log]

Description of material	Depth (ft)
Lava rock	0-7
Lava rock and hard lime	7-25
Lava rock	25-45
Hard lime and hard shale	54-56
Lava rock and blue shale	56-68
Lava rock	68-77

Due to hardness of the rock, only 2-5 feet drilled per 8 hours (Stearns, 1944).

WELL 8B

Location: 15 ft from well 8A, Tanapag, lat 15°13'49" N., long 145°45'10" E.
Drilled: Sept. 12-21, 1944 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 120 ft (from topographic map). Depth: 89 ft.
Diameter of open hole: 8 in.
Casing: None.
Aquifer: Volcanic rock.
Remarks: Water encountered from 34-48 ft.
Chloride: 20 ppm, (Brown[1/], Davis, 1958).

Yield was small and hole was abandoned.

[1/] Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG

[Source: Driller's log]

Description of material	Depth (ft)
Lava rock and sand	0-9
Lava rock	9-14
Lava rock and sand	14-22
Lava rock	22-48
Lava rock and lime	48-56
Lava rock	56-65
Lava rock and lime	65-68
Lava rock	68-89

WELL 28

Location: About lat 15°13'43" N., long 145°44'49" E., at Tanapag.
Drilled: Dec. 31, 1944 to Jan. 5, 1945 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 23 ft. Depth: 50 ft.
Casing: 6 in. to 50 ft with lower 20 ft perforated.
Aquifer: Volcanic rock.
Source of record: Driller.
Remarks: Depth to water before pumping, 20 ft.
Chloride: 40 ppm, at completion (log).
Pumpage: 15,000 gal/d, at completion (log).

Well went dry after short period of pumping (Glander, 1946).

LOG

Description of material	Depth (ft)
Shale and clay	0-20
Volcanic rock	20-50

WELL 29

Location: About lat 15°13'44" N., long 145°44'51" E., at Tanapag.
Drilled: Jan. 7-12, 1945 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 27 ft. Depth: 51 ft.
Casing: 6 in. to 51 ft with lower 20 ft perforated.
Aquifer: Volcanic rock.
Source of record: Driller.
Remarks: Depth to water before pumping, 24 ft.
Chloride: 40 ppm, at completion (log).
Pumpage: 7,200 gal/d, at completion (log).

Well went dry after short period of pumping (Glander, 1946).

WELL 29

LOG

Description of material	Depth (ft)
Red clay and sand	0-12
Shale	12-20
Decomposed lava rock with clay	20-40
Lava rock	40-51

WELL 37

Location: About lat 15° 14'13" N., long 145°45'38" E., 0.4 mi southeast of Tanapag School.

Drilled: Mar. 29, 1945 by 51st U.S. Naval Construction Battalion.

Altitude: 103 ft. Depth: 121 ft[1/].

Casing: 6 in. to 121 ft.

Aquifer: Porous coral.

Source of record: Glander (1946).

Remarks: Water level at about sea level.
Chloride: Water highly saline.

[1/] Piper (1946-47) reports a depth of 275 ft.

LOG

[Source: Driller's log]

Description of material	Depth (ft)
Coral	0-12
Varicolored clay and sandy clay	12-121

DISPOSAL WELL 1, Tanapag School

Location: Lat 15°14'35" N., long 145°45'31" E., at Tanapag School.
Drilled: February 1980 by Ted Lund Drilling and Supply.
Altitude: 35 ft (from topograhic map). Depth: 65 ft.
Diameter of open hole: 12 in.
Casing: 0-60 ft.
Gravel pack: 0-65 ft.
Source of record: Driller.
Remarks: Infiltration test: inflow rate, 37.5 gal/min for 20 minutes. Water returned to static level one minute after flow was stopped.

LOG

Description of material	Depth (ft)
Coral fill	0-6
Red clay	6-21
Red and black clay	21-27
Yellow clay and coral	27-57
Cavernous coral	57-64
Coral	64-65

DISPOSAL WELL 2, Tanapag School

Location: Lat 15°14'35" N., long 145°45'31" E., at Tanapag School.
Drilled: February 1980 by Ted Lund Drilling and Supply.
Altitude: 35 ft (from topographic map). Depth: 70 ft.
Diameter of open hole: 12 in.
Casing: 0-60 ft.
Gravel pack: 0-70 ft.
Source of record: Driller.
Remarks: Infiltration test: inflow rate, 37.5 gal/min for 15 minutes. Water returned to static level one minute after flow was stopped.

DISPOSAL WELL 2, Tanapag School

LOG

Description of material	Depth (ft)
Coral fill	0-6
Red clay	6-21
Yellow clay and coral	21-43
Medium hard coral	43-65
(Not recorded)	65-70

DISPOSAL WELL 3, Tanapag School

Location: Lat 15°14'35" N., long 145°45'31" E., at Tanapag School.

Drilled: February 1980 by Ted Lund Drilling and Supply.

Altitude: 35 ft (from topographic map). Depth: 68 ft.

Diameter of open hole: 12 in.

Casing: 0-60 ft.

Gravel pack: 0-68 ft.

Source of record: Driller.

Remarks: Infiltration test: inflow rate, 37.5 gal/min for 10 minutes. Water returned to static level one minute after flow was stopped.

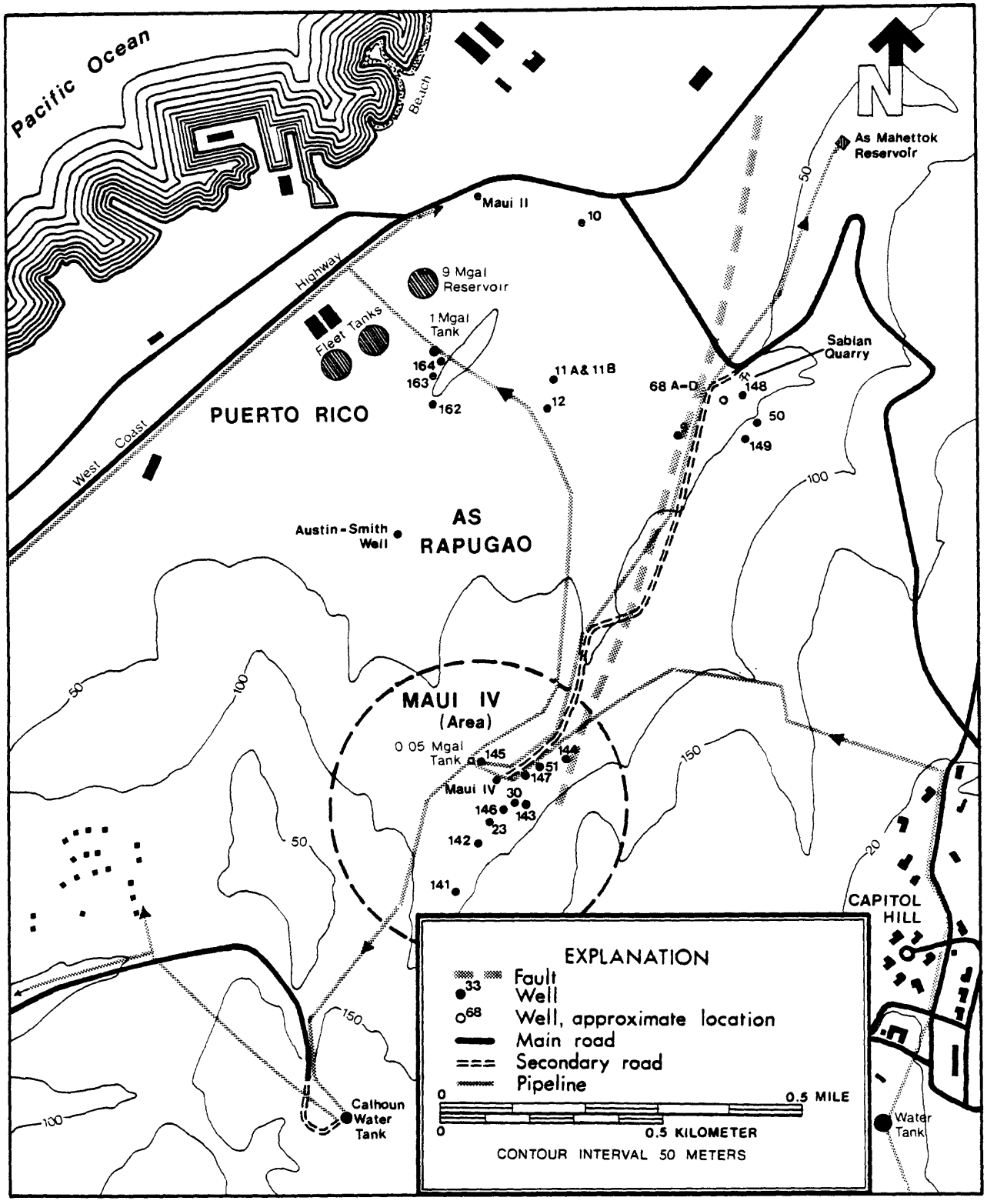
LOG

Description of material	Depth (ft)
Coral fill	0-6
Red clay	6-27
Yellow clay and coral	27-39
Medium hard coral	39-54
Hard coral	54-59
Medium hard coral	59-68

Table 32. Wells drilled in Puerto Rico area (fig. 30)

Well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
9[1]	15°13'09"	145°44'34"	Sept. 11, 1944	100	119	Well went dry after one month.
10[1]	15°13'25"	145°44'26"	Sept. 23, 1944	45	66	Discontinued for domestic water in 1946.
11A[1]	15°13'13"	145°44'25"	Oct. 7, 1944	54	172	Abandoned when casing broke.
11B[1]	10 ft from well 11A.		Nov. 15, 1944	54	65	Abandoned because salinity rose rapidly when pumped.
12[1]	15°13'11"	145°44'24"	Oct. 18, 1944	51	80	Do.
68A	At quarry, As Rapugao.		June 4, 1945	138.7	143	Abandoned because of bacterial contamination.
68B	Do.		June 9, 1945	136.4	141	Do.
68C	Do.		June 14, 1945	130.2	135	Do.
68D	Do.		June 20, 1945	117.8	122	Do.
Maui II	About 500 ft east of Starch Factory Springs.		Oct. 30, 1945	11	--	Inclined tunnel. Abandoned after cave-in.
			1969-71			
Austin Smith well[1].	15°13'01"	145°44'12"	July 1969	64.36	98	Also called Well Tanapag-1.
			1982-83			
162	15°13'12"	145°44'15"	June 1982	140.34	210	Abandoned. Replaced by 162A.
162A	15°13'12"	145°44'15"	July 12, 1982	148	180	Later called 162.
163	15°13'14"	145°44'15"	June 2, 1982	149.09	210	
164	15°13'15"	145°44'16"	July 12, 1982	154.84	190	
148	15°13'12"	145°44'39"	March 3-13, 1983	143.94	190	At quarry.
149	15°13'08"	145°44'39"	March 24-26, 1983	194.00	227	Do.
150	15°13'09"	145°44'40"	April 7-14, 1983	194.5	375	Do.

[1] Location approximate.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 30. Location of wells in Puerto Rico and Maui IV areas.

WELL 9

Location: About lat 15°13'09" N., long 145°44'34" E., at As Rapugao.

Drilled: Aug. 24 to Sept. 11, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 100 ft (from topographic map). Depth: 119 ft.

Casing: 8 in. to 20 ft, 6 in. to 113.5 ft, bottom 20 ft perforated.

Aquifer: Limestone.

Remarks: Water was encountered at depth of 119 ft.
On Sept. 6, 1944 at depth of 109 ft, water could be lowered 20 ft by bailing (Stearns, 1944).
Chloride: 7 ppm, Sept. 6, 1944 (Stearns, 1944).
Pumpage: 20,000-30,000 gal/d, at completion (log).
15,000-20,000 gal/d, estimated (Brown[1/]).

Well went dry after pumping 20,000-30,000 gal/d for one month and was abandoned (Glander, 1946).

1/ Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Red clay	0-16
Hard limestone	16-119

WELL 10

Location: About lat 15°13'25" N., long 145°44'26" E., near Starch Factory Springs, Tanapag.

Drilled: Sept. 18-23, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 45 ft (from topographic map). Depth: 66 ft.

Casing: 6 in. to 66 ft with bottom 20 ft perforated.

Aquifer: Limestone.

Remarks: Water encountered at depth of 57 ft.

Chloride: 320 ppm (Boniface, 1945).
460 ppm (Glander, 1946).
335-475 ppm (Piper, 1945-46).

Pumpage: 72,000 gal/d, steadily (Brown[1/]).
85,000 gal/d (Boniface, 1945).
6,000-72,000 gal/d (Glander, 1946).
6,000 gal/d, average (anonymous report, March 1947).
6,000-42,000 gal/d (Piper, 1946-47).

pH: 7.4-7.6 (Glander, 1946).

In 1946, the well water was used only for the Army Engineers concrete plant and discontinued as a supply for As Mahettok Reservoir (Glander, 1946).

[1/] Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Red clay	0-8
Hard limestone	8-66

WELL 11A

Location: About lat 15°13'13" N., long 145°44'25" E., at Puerto Rico.
Drilled: Sept. 28 to Oct. 7, 1944 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 54 ft. Depth: 172 ft, plugged back to 132 ft.
Casing: 6 in. to 138 ft with bottom 65 ft perforated.
Aquifer: Limestone.
Remarks: Water encountered at depth of 51 ft.
Salinity: 0.3 percent, at completion.
3 percent after several days of pumping at rate of 200,000 gal/d (Brown[1/]).

Well was backfilled with concrete to 132 ft. When trying to clear concrete adhering to the casing which was preventing entry of the pump, the casing broke and the well was abandoned (Brown[1/]).

[1/] Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Red clay	0-8
Limestone	8-28
Cavity	28-35
Red clay and limestone	35-39
Hard limestone	39-172

WELL 11B

Location: About lat 15°13'13" N., long 145°44'25" E., at Puerto Rico, about 10 ft from well 11A (Brown[1/]).

Drilled: Nov. 11-15, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 54 ft. Depth: 65 ft.

Casing: 6 in. to 65 ft.

Aquifer: Limestone.

Remarks: Water was found at depth of 51 ft. At completion, water was potable (Glander, 1946) and pumped at rate of 72,000 gal/d. Well was sprung with TNT at 60 ft.

Chloride: 360 ppm (Brown[1/]).

When pumped at unknown rate, the salinity increased rapidly and the well was abandoned (Glander, 1946).

[1/] Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Brown clay and limestone	0-53
Limestone	53-65

WELL 12

Location: About lat 15°13'11" N., long 145°44'24" E., at Puerto Rico.
Drilled: Oct. 13-18, 1944 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 51 ft. Depth: 80 ft.
Casing: 6 in. to 80 ft with bottom 20 ft perforated.
Aquifer: Limestone.
Remarks: Water was found at 65 ft.
Bottom of hole was spring with 75 lb TNT (Brown[1/]) (95 lb, Glander, 1946).
Chloride: 360 ppm (Brown[1/]).
Salinity increasing after pumping (Boniface, 1945).

Salinity increasing rapidly at pumping rate of about 290,000 gal/d and well was abandoned (Glander, 1946).

1/ Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Red clay and limestone	0-18
Hard limestone	18-80

WELL 68A

Location: One of four wells, spaced 100 ft apart around a large sinkhole, to test for a location of Maui Well IV. At quarry at As Rapugao.
Drilled: Completed June 4, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 138.7 ft. Depth: 143 ft.
Casing: None.
Aquifer: Porous coral.
Source of record: Glander (1946).
Remarks: Depth to water before pumping, 133 ft.
Chloride: 20 ppm.
pH: 7.2.

Well was abandoned because of excessive bacteriological contamination.

WELL 68B

Location: See 68A.
Drilled: Completed June 9, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 136.4 ft. Depth: 141 ft.
Casing: None.
Aquifer: Porous coral.
Source of record: Glander (1946).
Remarks: Depth to water before pumping, 134 ft.
Chloride: 20 ppm.
pH: 7.5.

Well was abandoned because of excessive bacteriological contamination.

WELL 68C

Location: See 68A.
Drilled: Completed June 14, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 130.2 ft. Depth: 135 ft.
Casing: None.
Aquifer: Porous coral.
Source of record: Glander (1946).
Remarks: Depth to water before pumping, 128 ft.
Chloride: 30 ppm.
pH: 6.9.

Well was abandoned because of excessive bacteriological contamination.

WELL 68D

Location: See 68A.
Drilled: Completed June 20, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 117.8 ft. Depth: 122 ft.
Casing: None.
Aquifer: Porous coral.
Source of record: Glander (1946).
Remarks: Depth to water before pumping, 116 ft.
Chloride: 90 ppm.
pH: 7.0.

Well was abandoned because of excessive bacteriological contamination.

WELL 69 (Was never drilled)

Site was considered as site for Maui IV well, but a site near well 30 was selected.

WELL Maui II (Starch Factory infiltration tunnel)

Location: About 500 ft east of Starch Factory springs, Tanapag.
Drilled: Completed Oct. 30, 1945.
Altitude: 11 ft.
Diameter of open hole: 6 x 8 ft, 100 ft long shaft on gentle incline with one 752 ft long main tunnel and one 220 ft long lateral tunnel.
Casing: First 338 ft of main tunnel was timbered 6 x 8 ft.
Source of record: Glander, 1946.
Remarks: First 338 ft of main tunnel was coralline rubble, remainder was consolidated limestone with numerous caverns.
Chloride: 280 ppm, during construction, at foot of inclined portal section; 400 ppm in main tunnel near portal section, 800-1,000 ppm in pools in cavernous section.
380-420 ppm, Nov. 21, 1945 to Jan. 16, 1946, from daily readings.
Pumpage: 162,000 gal/d, average during Nov. 21, 1945 to Jan. 16, 1946, from daily readings.
For chemical analysis, see table 71.

Well was abandoned after tunnel caved in near the foot of portal section in March 1950.

WELL Austin Smith well (Sometimes called Tanapag 1)

Location: Tanapag, about lat 15°13'01" N., long 145°44'12" E., downgradient from Maui IV shaft at sinkhole.
Drilled: July 1969 by Layne International, Guam.
Altitude: 64.36 ft. Depth: 98 ft.
Diameter of open hole: 7-1/8 in.
Casing: None.
Source of record: Driller.
Remarks: Chloride: Increasing from 207 to 438 ppm, July 25-26, 1969, at a pumping rate decreasing from 50 to 29 gal/min. See pumping test record.
513-536 ppm, July 28, 1969, at pumping rate of 42 gal/min. See pumping test record.

WELL Austin Smith well (Sometimes called Tanapag 1)

LOG

Description of material	Depth (ft)
Soft brown clay	0-2
White hard coral	2-4
White to pink medium soft coral	4-7
White medium hard coral	7-13
Yellow soft clay	13-14
White to pink medium hard coral (lost circulation at 16 ft)	14-16
White to brown hard coral	16-19
Soft clay	19-34
Coral boulder in medium soft clay	34-35
Soft clay with acc. small boulders	35-48
Medium hard coral	48-50
Medium hard stiff brown clay	50-58
Soft brown clay (could be soft limestone)	58-60
Red sticky clay	60-73
Yellow brown clay, medium soft drilling	73-78
Extremely hard coral; appears white and brown for sample on bit	78-82
Final depth at altitude-33.64 ft	98

PUMPING TEST

Date: July 25-26, 1969.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0800	0	--	47	--	Start of test.
0815	15	88.3	48	207.5	
0900	60	88.7	50	249.0	
1000	120	90.1	49	259.5	
1005	125	87.1	45	--	Pump drawing air.
1100	180	87.2	45	269.0	
1200	240	87.0	44	280.0	
1300	300	86.9	43	276.5	
1400	360	87.8	46	274.0	
1500	420	87.6	45	278.0	
1600	480	87.6	45	304.5	
1700	540	88.6	45	332.5	
1800	600	88.5	45	365.0	
1900	660	88.6	45	374.5	
2000	720	88.5	45	381.0	
2100	780	88.8	45	388.0	

WELL Austin Smith well

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
2200	840	88.6	45	398.5	
2300	900	88.8	45	412.0	
2400	960	88.8	45	416.5	
0100	1020	88.7	45	418.0	July 26, 1969.
0200	1080	88.3	45	418.5	
0300	1140	88.8	45	419.5	
0400	1200	88.5	46	421.0	
0500	1260	87.7	45	423.5	
0600	1320	88.2	45	425.0	
0700	1380	87.8	45	429.0	
0800	1440	88.6	45	432.0	
0830	1470	88.4	45	434.0	
0835	1475	--	35	--	Pumping rate reduced from 45 to 35 gal/min.
0900	1500	78.3	35	430.0	
1000	1560	78.2	35	430.5	
1100	1620	78.2	35	432.0	
1200	1680	78.2	35	430.5	
1300	1740	78.2	36	436.0	
1305	1745	--	30	--	Pumping rate reduced from 35 to 30 gal/min.
1400	1800	71.6	30	432	
1500	1860	71.6	31	435.5	
1600	1920	71.7	29	438.5	End of test.

July 28, 1969

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0900	0	84.0	42	513.5	Start of test.
1000	60	84.0	42	513.5	
1100	120	84.0	42	516.0	
1200	180	84.1	42	519.5	
1300	240	84.0	42	522.0	
1400	300	84.0	42	526.0	
1500	360	84.1	42	528.5	
1600	420	84.0	42	531.5	
1700	480	84.1	42	534.5	
1800	540	84.1	42	536.0	End of test.

WELL 162

Location: Lat 15°13'12" N., long 145°44'15" E., at Puerto Rico.

Drilled: June 1982 by Pacific Drilling Inc.

Altitude: 140.34 ft. Depth: 210 ft.

Diameter of open hole: 8-in. pilot hole.

Source of record: Driller.

Pumping test: June 21, 1982, preliminary test: Drawdown, 53 in. in 4 hours 10 minutes at pumping rate of 38-64 gal/min. See pumping test record.

Hole abandoned and new hole, 162A, drilled nearby.

LOG

Description of material	Depth (ft)
Fill	0-4
Hard limestone	at 20
Clay streaks	at 35
Limestone, half brown, half white	at 40
Limestone, 90 percent brown	at 60
Lost circulation	90-97
Sandy streaks with limestone	at 110
Lost circulation	120-124
Very hard limestone	124-150
Course red cuttings, fractured limestone	at 155
Limestone with clay streaks	at 180
Water	180-185
Stopped drilling	210

WELL 162

PUMPING TEST

Date: June 21, 1982.
Static depth to water, 147.6 ft; pump intake at 169.5 ft.

Time	Elapsed time (min)	Drawdown (in.)	Pumping rate (gal/min)	Remarks
1425	0	--	--	Start of test.
1434	9	44	80	
1435	10	38	45	
1438	13	38	--	
1445	20	36	73	
1447	22	42	73	
1457	32	64	73	Same readings at 1500, 1503, 1516, 1530, 1538.
1548	83	55	60	
1610	105	53	60	
1630	125	45	35	Pump stopped for 5 minutes (plugged).
1700	155	57	60	
1730	185	53	60	
1800	215	53	60	
1820	235	53	65	
1835	250	53	65	End of test.

WELL 162A. Later called 162.

Location: Lat 15°13'12" N., long 145°44'15" E., at well 162, Puerto Rico.
Drilled: July 11, 12, 1982 by Geo-Engineering and Testing.
Altitude: 148 ft. Depth: 180 ft.
Diameter of open hole: 12 in.
Casing: 145 ft of solid 8-in. steel casing with 30 ft 8-in. stainless steel screen below.
Gravel pack and grout: Gravel at lower 56 ft, sealed with grout.
Source of record: Driller.
Pumping test: July 13-14, 1982, after reaming of the well: Drawdown, 3.9 ft in almost 23 hours at pumping rate of 84-90 gal/min; chloride, 400-693 mg/L. See pumping test record.
Date well brought in production: July 15, 1982.
Remarks: Pumping rate, 71 gal/min on Jan. 14, 1983 (USGS); 70 gal/min on Apr. 25, 1983 (USGS); 72 gal/min on July 1, 1983 (USGS).

WELL 162A. Later called 162.

Chemical analyses of water from well 162A

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
7-13-82	400-653 (pump test)		--	--	--	--
12-7-82	692	--	2,820	7.7	242	--
1-19-82	1,160	--	4,480	7.7	288	--
2-25-83	1,260	2,620	4,820	7.4	288	--
4-21-83	1,510	--	5,640	7.4	285	860
6-20-83	1,780	--	6,280	7.9	257	--
7-1-83	1,600	--	6,420	--	--	--
7-18-83	1,510	--	5,280	7.4	287	823
8-15-83	1,640	--	5,480	--	288	891
9-8-83	1,560	--	5,540	--	293	--
10-14-83[1/]	1,750	--	6,080	7.7	293	--

[1/] By U.S. Geological Survey.

LOG

Description of material	Depth (ft)
White-light brown limestone, hard	0-3
Yellowish brown limestone, hard	3-6
Yellowish white limestone, hard	6-10
White limestone, hard	10-30
Yellow-light brown limestone, hard	30-40
Yellow-white limestone, hard	40-65
(Lost air circulation, 45-63 ft)	
Yellow-light brown limestone, moderately hard	65-75
White-yellow-light brown limestone, moderately hard	75-90
Yellow-light brown limestone, moderately hard	90-110
Yellow-light brown limestone, moderately hard	110-170
Light brown-white limestone	170-180

WELL 162(A)

PUMPING TEST (after reaming)

Date: July 13-14, 1982.
Static depth to water, 147.8 ft; pump intake at 171 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
July 13				
1240	0	147.8	--	Start of test.
1242	2	--	85	
1309	29	--	85	Water connected to main line.
1310	30	149.0	90	Same reading at 1315.
1320	40	149.2	90	Same reading at 1325, 1330, and 1335.
1340	60	149.3	90	
1345	65	149.3	88	Same reading at 1350, 1355, 1400.
1420	100	149.4	88	Same reading at 1430, 1440, 1450, and 1500.
1530	170	149.4	88	Cut water from main line, gravel packed.
1600	200	149.6	88	
1630	230	150.3		
1730	290	150.7	88	Same reading at 1830.
1930	410	151.2	88	Same reading at 2030, 2130.
2230	590	151.5	88	
2330	650	151.4	--	At 1140; water clear, connected to main line.
July 14				
0030	710	151.5	88	Same reading at 0130, 0230.
0330	890	151.6	88	
0430	950	151.6	85	Same reading 0530, 0630, 0730.
0830	1190	151.6	84	
0930	1250	151.7	84	Same reading at 1030, 1130.
1135	1375	--	--	End of test because of pump malfunction.

Note: Chloride concentration, 22 determinations: Starting at 653 mg/L, ending at 403 mg/L.

WELL 163

Location: Lat 15°13'14" N., long 145°44'15" E., at Puerto Rico.

Drilled: June 1-2, 1982 by Geo-Engineering and Testing.

Altitude: 149.09 ft. Depth: 210 ft.

Diameter of open hole: 12 in.

Casing: 175 ft of solid 8-in. casing with 30 ft of 8-in. screen below.

Source of record: Driller.

Pumping tests: July 3, 1982: Drawdown, 15.1 ft in almost 5 hours at pumping rate of 55 gal/min; chloride, 401-415 mg/L. See pumping test record.

July 9-10, 1982: Drawdown, 16.5 ft in 21 hours at pumping rate of 87-94 gal/min; chloride 587 mg/L. See pumping test record.

Date well brought in production: July 15, 1982.

Remarks: Pumping rate, 85 gal/min on Jan. 14, 1983 (USGS); 87 gal/min on Apr. 25, 1983 (USGS); 89 gal/min on July 1, 1983 (USGS).

LOG

Description of material	Depth (ft)
Yellow-brown-white limestone, hard	0-5
Yellow-white limestone, hard	5-30
Yellow-brown limestone, hard	30-35
Yellow-white limestone, hard	35-60
Yellow-brown-white limestone, hard	60-70
Yellowish brown limestone, moderately hard	70-90
Yellow-white limestone, moderately hard	90-100
Yellowish light brown limestone, moderately hard	100-115
Yellow-white limestone, moderately hard	115-130
Yellow-light brown limestone, moderately hard	130-140
Yellowish light brown limestone, moderately hard	140-155
Yellow-white limestone, moderately hard	155-180
Yellowish brown-white limestone, moderately hard	180-195
Yellowish white limestone, moderately hard	195-204
(Not reported)	204-210

WELL 163

Chemical analyses of water from well 163

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)
7-3-82	401-415 (pump test)		--	--	--
7-7-82	441-480 (pump test)		--	--	--
7-10-82	587 (pump test)		--	--	--
1-19-83	1,640	--	6,000	7.6	274
2-25-83	1,230	2,590	4,790	7.4	288
4-21-83[1/]	1,740	--	6,350	7.3	279
7-1-83[2/]	2,300	--	7,540	--	--
10-14-83	2,840	--	9,400	7.8	273

[1/] Hardness as $CaCO_3$, 920 mg/L.

[2/] By U.S. Geological Survey.

WELL 163

PUMPING TEST

Date: July 3, 1982.
Static depth to water, 159.4 ft; pump intake at 175 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1035	0	159.4	--	--	Start of test.
1036	1	--	63	401	
1050	15	--	55	--	
1115	40	174.7	--	--	
1150	75	174.7	--	--	
1220	105	172.6	--	--	
1223	108	166.2	55	--	Did pump stop?
1226	111	166.2	--	--	
1228	113	172.7	55	--	
1231	116	173.6	55	--	
1234	119	173.3	55	--	
1236	121	174.2	--	--	
1239	124	174.5	55	--	
1245	130	174.5	55	--	Same reading 1315, 1330, 1335.
1405	210	174.5	55	415	
1435	240	174.5	55	--	
1530	295	174.5	55	--	End of test.

WELL 163

PUMPING TEST

Date: July 9-10, 1982.
Static depth to water, 159.0 ft; pump intake at 191 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
July 9					
1510	0	159.0	--	--	Start of test.
1511	1	172.0	30	--	Shut off pump.
1513	3	--	22	--	Turn on pump again. Low yield.
1520	10	172.7	--	--	
1550	40	--	--	--	Shut off pump.
1558	48	169.0	94	--	Turn on pump again. Water is brown.
1610	60	176.5	94	--	Same reading at 1625.
1640	90	175.7	94	--	Same reading at 1655.
1710	120	175.2	94	--	Same reading at 1740.
1810	180	176.5	94	--	Same reading every 30 minutes 1840-2040.
2110	360	175.5	94	--	Same reading every 30 minutes 2140-0740.
July 10					
0810	1020	172.8	87	--	Placed gravel in the hole.
0840	1050	175.5	87	587	
0910	1080	175.5	87	--	Same reading every 30 minutes 0940-1210.
1210	1260	--	--	--	End of test.

WELL 164

Location: Lat 15°13'15" N., 145°44'16" E., at Puerto Rico.
Drilled: July 12, 1982 by Geo-Engineering and Testing.
Altitude: 154.84 ft. Depth: 190 ft.
Diameter of open hole: 12 in.
Casing: 160 ft of solid 8-in. casing with 30 ft of 8-in. stainless steel screen below.
Source of record: Driller.
Pumping test: July 14, 1982: Drawdown, 8.4 ft in 5 hours at pumping rate of 94-103 gal/min; water level recovered to original level in 20 minutes; chloride, 284-300 mg/L. See pumping test record.
July 16, 1982: Drawdown, 7.2 ft in 2 hours 15 minutes at pumping rate of 94-108 gal/min; chloride, 242-322 mg/L. See pumping test record.
Date well brought into production: July 9, 1982.
Remarks: Pumping rate, 86 gal/min on Jan. 14, 1983; 65 gal/min on Apr. 25, 1983; 72 gal/min on July 1, 1983; 71 gal/min on Sept. 9, 1983 (USGS).

For chemical analyses of water, see table 76.

Pump removed from well in October 1983 due to high chloride concentration of the water. Static depth to water, Oct. 19, 1983, 160.71 ft (USGS).

LOG

Description of material	Depth (ft)
Light brown limestone, hard	0-15
Yellow-white limestone, moderately hard	15-50
Yellowish brown-white limestone, moderately hard	50-105
Yellow-white limestone, moderately hard	105-140
(Lost air circulation at 125 ft)	140-190

WELL 164

Chemical analyses of water from well 164

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
7-14-82	284-300 (pump test)		--	--	--	--
7-16-82	242-322 (pump test)		--	--	--	--
1-19-83	1,050	--	4,170	7.7	289	--
2-25-83	1,420	2,890	5,320	7.4	276	--
4-21-83	2,950	--	10,200	7.3	257	1,440
6-20-83	3,020	--	10,100	7.7	253	--
7-1-83[1/]	--	--	9,400	--	--	--
7-18-83	3,730	--	12,200	7.4	249	1,690
8-15-83	4,090	--	11,800	--	258	1,810
9-8-83[1/]	4,500	--	13,800	--	--	--

[1/] By U.S. Geological Survey.

WELL 164

PUMPING TEST

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
July 14, 1982				
		Static depth to water, 157.4 ft.		
1515	0	157.4	--	Start of test.
1520	5	164.2	94	
1525	10	163.8	--	
1540	25	157.5	--	
1600	45	165.6	103	
1630	75	165.8	103	
1815	180	165.8	103	
2015	300	165.8	103	End of test.
Depth to water 20 minutes after electric generator shut off, 157.4 ft. Chloride concentration of water during test, 284-300 mg/L.				
July 16, 1982				
		Static depth to water, 157.5 ft; pump intake at 179.0 ft.		
1030	0	157.5	--	Start of test.
1033	3	162.6	108	
1035	5	162.4	--	
1138	8	--	97	
1045	15	162.6	--	Same reading at 1050.
1055	25	162.7	94	Same reading every 10 min. 1100-1130.
1200	90	163.0	94	
1215	105	163.2	94	
1230	120	163.3	94	
1245	135	164.7	--	Shut off pump as hose came loose of the pipe. End of test.
Chloride concentration of water during test, 242-322 mg/L.				

WELL 148

Location: Lat 15°13'12" N., long 145°44'39" E., near quarry at As Rapugao.
Drilled: Mar. 3-13, 1983 by Geo-Engineering and Testing.
Altitude: 143.94 ft (top of reinforcing steel bar at edge of concrete pad).
Depth: 190 ft.
Diameter of open hole: 8-in. pilot hole, reamed to 12 in.
Casing: 8-in. solid casing to 135 ft with 30 ft stainless steel screen below.
Source of record: Driller.
Pumping test: Mar. 7, 1983: Drawdown, 11.1 ft in almost 6 hours at pumping rate of 29-38 gal/min. See pumping test record.
Mar. 9, 1983: Maximum drawdown, 13.6 ft during 8 hours at pumping rate of 34-35 gal/min; recovery in 5 minutes. See pumping test record.
Mar. 11, 1983: Drawdown, 12 ft in 1 hour at pumping rate of 49-114 gal/min. See pumping test record.
Mar. 14, 1983: Drawdown, 21.7 ft in 3 hours at pumping rate of 64-118 gal/min; recovery in 13 minutes. See pumping test record.
Mar. 16, 1983: Maximum drawdown, 32.3 ft during 8 hours of pumping at rate of 44-110 gal/min. See pumping test record.
Mar. 21, 1983: Maximum drawdown, 21.7 ft during 2 hours of pumping at rate of 49-110 gal/min. See pumping test record.
April 14-21, 1983: Drawdown, 18.11 ft in almost 7 days at pumping rate of 66-70 gal/min; chloride, 48.6 mg/L. See pumping test record.
Remarks: Pumping rate, 75 gal/min, Apr. 27, 1983 (USGS).
60 gal/min, Nov. 4, 1983 (USGS).

For chemical analyses of July 1, 1983 see table 77.

WELL 148

Chemical analyses of water from well 148

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
4-21-83	45	952	7.2	258	292
6-6-83	42	694	--	--	--
6-20-83	46	694	7.9	249	--
7-18-83	48	748	7.4	253	298
8-15-83	54	779	--	263	230
9-8-83	54	767	--	301	--
10-14-83	60	799	7.7	276	--

Chloride concentrations: 7-5-83, 45 mg/L; Aug. 1, 1983, 51 mg/L; 8-29-83, 54 mg/L; 9-19-83, 60 mg/L; 10-11-83, 59 mg/L; 10-25-83, 63 mg/L.

WELL 148

Depth to water and pumping rate of well 148

[U.S. Geological Survey]

Altitude of measuring point, 144.71 ft (bolt hole in pump plate, 0.07 ft above concrete pedestal which is 0.70 ft above concrete pad).

Date	Time	Static depth to water (ft)	Pumping depth to water (ft)	Pumping rate (gal/min)
4-6-83	1337	139.01	--	--
4-12-83	1515	138.99	--	--
4-13-83	1811	139.08	--	--
4-14-83	0752	139.02	--	--
4-15-83	0644	--	156.25	68
4-17-83	1220	--	158.69	70
4-18-83	0854	--	156.33	68
4-19-83	0830	--	157.08	70
4-20-83	1750	--	156.52	66
4-21-83	0700	--	157.13	70
5-20-83	0833	140.72	--	--
5-21-83	1815	--	152.59	54
5-22-83	0650	--	152.65	55
5-27-83	1255	--	148.77	40
5-29-83	1056	--	153.28	54
6-6-83	1605	--	152.73	51
6-21-83	1530	141.45	--	--
6-23-83	1154	--	148.88	41
7-1-83	1013	--	149.11	39

WELL 148

LOG

Description of material	Depth (ft)
Light brown limestone	0-4
Yellowish-white limestone	4-64
Yellowish-brown limestone	64-73
Yellowish-white limestone	73-100
(No drilling log)	100-190

PUMPING TEST

Date: March 7, 1983.
Well 165 ft deep (8-in. pilot hole). Pump at 147.4 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0949	--	137.4	--	Static depth to water.
0950	0	143.7	38	Start of test.
0951	1	146.4	31	
1000	10	147.2	31	Same reading at 1015.
1016	26	--	--	Surge for 2 minutes.
1018	28	147.2	33	Same reading at 1025.
1115	70	146.2	29	Same reading at 1130, 1145, 1200.
1343	233	146.2	30	Same reading at 1400, 1430, 1500.
1515	325	--	--	Shut off pump. Water level recovered in 6 minutes.
1525	335	--	25	Start pump again. Water is dirty.
1535	345	145.2	29	
1539	349	148.5	--	
1540	350	--	--	End of test.

Depth to water next day at 0959, 137.6 ft.

WELL 148

PUMPING TEST

Date: March 9, 1983.
Well 165 ft deep (8-in. pilot hole). Pump at 152 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1045	--	137.6	--	Static depth to water.
1055	0	--	--	Start of test.
1057	2	144.0	45	
1100	5	148.3	41	
1105	10	149.2	40	Same reading at 1110.
1120	25	149.6	40	Same reading at 1125, 1130, 1140.
1150	55	149.6	39	Same reading at 1200, 1210, 1220.
1230	95	149.4	39	
1245	110	148.7	34	At 1250 surged for 2 minutes.
1300	125	149.1	43	
1315	140	151.2	--	Pump lowered to 154 ft.
1330	155	151.2	41	Maximum drawdown.
1400	185	150.3	38	
1500	245	149.2	38	
1530	275	148.9	37	Same reading at 1545, 1600, 1615.
1630	335	149.0	37	Same reading at 1645, 1700, 1715.
1730	395	146.6	37	
1800	425	147.1	37	Same reading until end of test.
1855	480	147.1	--	End of test.

Recovery to static level in 5 minutes.

WELL 148

PUMPING TEST

Date: March 11, 1983.
Well 175 ft deep (8-in. pilot hole). Pump at 160 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1155	--	137.6	--	Static depth to water.
1200	0	145.6	65	Start of test.
1205	5	149.2	63	Same reading at 1215.
1220	20	149.5	54	
1225	25	144.2	49	
1233	33	139.9	114	Surged for 2 minutes.
1235	35	149.4	87	
1255	55	149.6	65	Same reading at 1300, 1305, 1310.

No information until end of test at 1515.

Date: March 14, 1983.
Well 175 ft deep (reamed to 12 in.). Pump at 160 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1410	--	137.6	118	Static depth to water.
1423	0	147.6	--	Start of test.
1425	2	--	--	Water dirty and very slow.
1428	5	--	114	Surged for total of 6 minutes.
1434	11	147.6	114	
1442	19	157.0	70	
1451	28	159.0	66	Same reading at 1456, 1502, 1508, 1520, 1525.
1535	72	159.3	64-65	Same reading at 1545 and every 15 minutes 1600-1730.
1730	187	159.3	64	End of test.

Recovery to static water level in 13 minutes.

WELL 148

PUMPING TEST

Date: March 16, 1983.
Well 190 ft deep. Pump at 170 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1239	--	137.6	--	Static depth to water.
1240	0	--	--	Start of test.
1245	5	151.2	110	
1250	10	159.0	103	Surged 1 minute 1257-1258.
1300	20	159.0	103	
1305	25	161.3	103	
1310	30	165.9	103	
1320	40	169.2	82	Same reading at 1330.
1345	65	159.0	89	Pump at 171 ft.
1400	80	153.7	56	
1415	95	155.0	97	
1430	110	153.3	50	
1439	119	147.6	106	
1455	135	169.9	103	Maximum drawdown.
1500	190	169.9	85	Same reading every 5 minutes 1505-1540.
1550	190	167.1	100	
1605	205	162.2	62	
1630	230	150.9	44	
1700	260	151.6	53	
1730	290	152.2	55	No change until end of test at 2100.
2100	500	152.2	--	End of test.

WELL 148

PUMPING TEST

Date: March 21, 1983.
Well 190 ft deep. Pump at 170 ft. Final test before backfilling.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1145	--	138.7	--	Static depth to water.
1150	0	--	--	Start of test.
1151	1	156.1	110	
1153	3	156.9	106	
1156	6	158.2	106	
1159	9	160.4	79	Maximum drawdown.
1202	12	152.9	63	
1207	17	150.0	49	
1210	20	148.9	49	
1212	22	149.3	54	
1217	27	149.7	54	
1230	40	149.9	53	
1240	50	150.7	54-55	Same reading to end of test.
1400	130	150.7	--	End of test.

WELL 148

PUMPING TEST

Date: April 14-21, 1983.
Static depth to water, 139.79 ft. Well completed.

Time	Elapsed time (min)	Depth to water (ft)	Draw-down (ft)	Pumping rate (gal/min)	Remarks
0752	--	139.79	--	--	April 14. Meter reading 001232.
0830	0	--	0	--	Start of test.
0831	1	147.70	7.91	--	
0833	3	151.30	11.51	--	
0838	8	--	--	70	
0840	10	155.93	16.14	--	
0910	40	156.70	16.91	70	
1246	276	157.41	17.62	70	
1752	562	157.83	18.04	70	
0644	1,334	157.02	17.23	68	April 18. Meter reading 092200.
1530	1,860	156.98	17.19	68	
1224	3,114	157.83	18.04	65	April 16.
1220	4,550	159.46	19.67	70	April 17. Meter reading 312000.
0854	5,784	157.10	17.31	68	April 18. Chloride, 48.6 mg/L.
0830	7,200	157.85	18.06	70	April 19. Meter reading 493100.
1750	9,200	157.29	17.50	66	April 20.
0700	9,990	157.90	18.11	70	Meter reading 673800. End of test.

WELL 149

Location: Lat 15°13'08" N., long 145°44'39" E., near quarry at As Rapugao.
Drilled: Mar. 24-26 by Geo-Engineering and Testing.
Altitude: 194.00 ft (top of reinforcing steel bar, 8 ft from well).
Depth: 227 ft (220.8 ft measured inside casing and screen on Apr. 22, 1983).
Diameter of open hole: 8-in pilot hole, reamed to 12 in.
Casing: 8-in. solid casing to 187 ft with 40 ft stainless steel screen below.
Source of record: Driller.
Pumping test: Mar. 28, 1980: Drawdown, 4.2 ft in 7-1/2 hours at pumping rate of 57-94 gal/min; chloride, 30-40 mg/L. See pumping test record.
Apr. 6, 1983: Drawdown, 3 ft in almost 13 hours at pumping rate of 92 gal/min; recovery to static level in 7 minutes; chloride (21 readings), from 52.5 to 29.2 mg/L. See pumping test record.
Remarks: Apr. 21, 1983: With nearby well 150 pumping at rate of 87-92 gal/min for more than 8 hours, the water level in well 149 dropped 0.25 ft; recovery to within 0.11 ft in 3-1/2 hours, to within 0.02 ft in 16 hours.

For chemical analysis of July 1, 1983, see table 77.

LOG

Description of material	Depth (ft)
Brownish-white limestone, very hard drilling	0-27
White limestone	27-68
Yellowish-white limestone	68-82
Brownish-white limestone with traces of light brown clay particles	82-96
Yellowish-white limestone	96-102
Brown-white limestone with traces of light brown clay	102-112
Brown-white limestone	112-128
Yellowish-white limestone	128-178
Brown-yellow limestone	178-193
Brown-yellow-white limestone	193-197
Yellowish-brown limestone	197-200
Yellowish-white limestone	200-225
(No drilling log)	225-227

Note: Drilling moderately hard from 27 to 225 ft.

WELL 149

Chemical analyses of water from well 149

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)
6-6-83	28	587	--	--
6-20-83	30	592	7.9	236
6-27-83	27	--	--	--
10-19-83	42	--	--	--
10-25-83	43	--	--	--

Depth to water and pumping rate of well 149

[U.S. Geological Survey]

Altitude of measuring point, 195.25 ft, April 14-21, 1983 (top of casing, 1.25 ft above ground surface); 195.05 ft, since May 1983 (access hole in pump plate, 1.05 ft above ground surface).

Date	Time	Static depth to water (ft)	Pumping depth to water (ft)	Pumping rate (gal/min)
4-12-83	1350	188.19	--	--
4-13-83	0800	188.19	--	--
4-13-83	1830	188.30	--	--
4-14-83	0720	188.24	--	--
4-21-83	1135	188.57	--	--
5-14-83	1003	--	192.40	66
5-20-83	0930	189.94	--	--
5-21-83	1740	--	191.82	58
5-22-83	0748	--	192.03	58
5-27-83	1330	--	192.29	54
5-29-83	1146	--	192.44	58
6-6-83	1653	--	192.73	58
6-23-83	1140	--	191.91	55
7-1-83	1056	--	192.55	58
9-8-83	1145	--	193.64	60

WELL 149

PUMPING TEST

Date: March 28, 1983.
Well 225 ft deep (8-in. pilot hole). Pump at 213 ft.

Time	Elapsed time (min)	Depth to water (ft)	Draw-down (ft)	Pumping rate (gal/min)	Remarks
0830	--	187.0	--	--	Static depth to water.
0831	0	187.0	92	--	Start of test.
0834	3	189.7	92	40	
0837	6	189.0	57	--	
0838	7	191.0	92	30	
0847	16	189.8	80	--	
0900	29	189.0	61	--	
0901	30	--	--	--	Surged for 4 minutes.
0905	34	189.8	94	--	Same reading at 0913, 0926.
0930	59	191.2	94	--	No change until end of test at 1600.
1600	449	191.2	--	--	End of test.

Date: April 6, 1983.
Well 227 ft deep. Pump at 211 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1052	--	187.0	--		Static depth to water.
1055	0	191.8	92	52.5	Start of test.
1100	5	190.4	92	1/	Same reading every 15 minutes 1115-1430.
1439	224	--	--		Surged the well.
1443	228	189.9	92		Same reading at 1450.
1454	239	190.0	92		Same reading every 15 minutes 1545-1700 and every 30 minutes 1730-2300.
2345	770	190.0	92		End of test.

Recovery to static level in 7 minutes.

1/ 1100-1145, 20 chloride concentration readings, 45.8-29.2 mg/L.

WELL 150

Location: Lat 15°13'09" N., long 145°44'40" E., near quarry at As Rapugao.
Drilled: Apr. 7-14, 1983 by Geo-Engineering and Testing.
Altitude: About 194.5 ft. Depth: 375 ft.
Casing: 8-in. solid casing to 225 ft with 150 ft of stainless steel screen below.
Source of record: Driller.
Pumping test: Apr. 14-15, 1983: Drawdown, 16.29 ft in almost 26 hours at pumping rate of 60-70 gal/min. See pumping test record.
Apr. 21-22, 1983: Drawdown, 1.30 ft in 8 hours 20 minutes at pumping rate of 82-92 gal/min; recovery immediately and water level 1 ft higher than original level in 1 minute; chloride, (19 readings) 29-31 mg/L; specific conductance, 598-630 µmho. See pumping test record.

For chemical analyses of Apr. 23, 1983 and July 1, 1983, see table 77.

Depth to water and pumping rate of well 150

[U.S. Geological Survey]

Altitude of measuring point, about 197.5 ft, April 21, 1983 (edge of drilling table, 3 ft above ground surface); about 195.65 ft since May 1983 (access hole in pump plate, 1.15 ft above ground surface).

Date	Time	Static depth to water (ft)	Pumping depth to water (ft)	Pumping rate (gal/min)
4-21-83	1440	188.86	--	--
4-21-83	1532	--	193.43	82
5-19-83	1906	190.22	--	220
5-20-83	0723	--	197.30	220
5-27-83	1316	--	196.96	215
5-29-83	1124	--	197.15	225
6-23-83	1130	--	196.90	--
7-1-83	--	--	196.59	215
9-8-83	1025	--	197.90	222

WELL 150

LOG

Description of material	Depth (ft)
(No drilling log)	0-275
White-yellow limestone and very small clay particles. Hard drilling	275-285
Yellow-white limestone	285-290
At 286 ft color of foam changes to light tan	
At 287 ft color of foam changes to white	
Yellow-light brown-white limestone	290-295
At 292 ft color of foam changes to gray	
At 293 ft color of foam changes to white	
Yellow-brownish-white limestone. Soft drilling	295-300
At 298 color of foam changes to light yellow	
At 299 color of foam changes to white	
White-yellow limestone	300-305
White-yellow limestone. Hard drilling	305-310
At 308 color of foam changes to white	
Yellow-white limestone. Soft drilling	310-325
White-yellow limestone with little clay	325-350
(No drilling log)	350-375

Chemical analyses of water from well 150

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)
6-27-83	26	--	--	--
9-8-83[1/]	34	611	--	--
9-12-83	34	--	--	--
9-19-83	34	--	--	--
10-3-83	36	--	--	--
10-11-83	36	--	--	--
10-14-83	37	649	7.8	259
10-25-83	39	--	--	--

[1/] By U.S. Geological Survey.

WELL 150

PUMPING TEST

Date: April 14-15, 1983.
Well is 325 ft deep.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0752	--	138.76	--	Static depth to water.
0830	0	--	70	Start of test.
0831	1	154.53	--	
0833	3	150.93	--	
0840	10	153.70	--	
0843	13	153.68	--	
0848	15	153.90	--	
0850	20	154.19	--	
0902	32	154.39	--	
0910	40	154.47	70	
0934	64	154.66	60	
0945	75	154.64	--	Same reading at 0951, 1000, 1012.
1017	107	154.84	--	
1031	121	155.16	--	
1319	289	155.27	70	
0644	1,334	154.79	68	April 15.
1020	1,550	155.05	--	End of test.

WELL 150

PUMPING TEST

Date: April 21-22, 1983.
Well is 375 ft deep.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1440	--	191.86	--	--	Static depth to water.
1444	0	--	--	--	Start of test.
1445	1	192.21	--	--	
1446	2	192.11	--	28.9	
1450	6	192.36	--	--	
1453	9	192.68	92	--	
1500	16	193.00	--	--	
1508	24	193.32	92	--	
1540	56	193.40	82	--	
1604	80	193.39	--	--	Specific conductance, 630 µmho.
1620	96	193.37	82	--	Same reading at 1638, 1702, 1724.
2010	326	193.25	87	--	Specific conductance, 598 µmho.
2130	406	193.19	--	30.7	Specififc conductance, 598 µmho.
2226	462	193.17	--	29.8	
2259	495	193.16	87	--	Specific conductance, 620 µmho.
2306	502	193.16	--	--	End of pumping test.
Recovery:					
2306	0	193.16			
2307	1	190.81			Start of recovery test.
2308	2	190.74			
2309	3	190.69			
2312	6	190.60			
2332	26	190.50			
2356	50	190.45			
1525	979	190.25			End of test.

Table 33. Wells drilled near Maui IV (fig. 30)

Well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
23A	15°12'40"	145°44'19"	Dec. 26, 1944	241	225	Well was bailed dry.
23B	do.	do.	Jan. 15, 1945	241	250	Abandoned; low yield.
30	15°12'42"	145°44'20"	Jan. 22, 1945	220	290	
51	15°12'44"	145°44'23"	Sept. 1, 1945	210	248	
Maui IV	15°12'44"	145°44'20"	1945-46	224.62	225.7	
			1969-70			
TH Maui IV-1.	15°12'35"	145°44'16"	Mar. 5, 1970	285.76	308	Converted to well 141.
141	do.	do.	Nov. 16, 1970	290.37	304	Prior to 1982 called Maui IV-1.
142	15°12'39"	145°44'18"	Sept. 26, 1970	261.66	281	Prior to 1982 called Maui IV-2.
143	15°12'42"	145°44'22"	Nov. 25, 1970	239.35	251	Prior to 1982 called Maui IV-3.
144	15°12'45"	145°44'25"	January 1971	214.61	232	Prior to 1982 called Maui IV-4.
			1982			
145	15°12'45"	145°44'18"	Mar. 11, 1982	242.23	300	
146	15°12'41"	145°44'20"	August 1982	223.12	300	
147	15°12'44"	145°44'22"	Aug. 20, 1982	210	280	

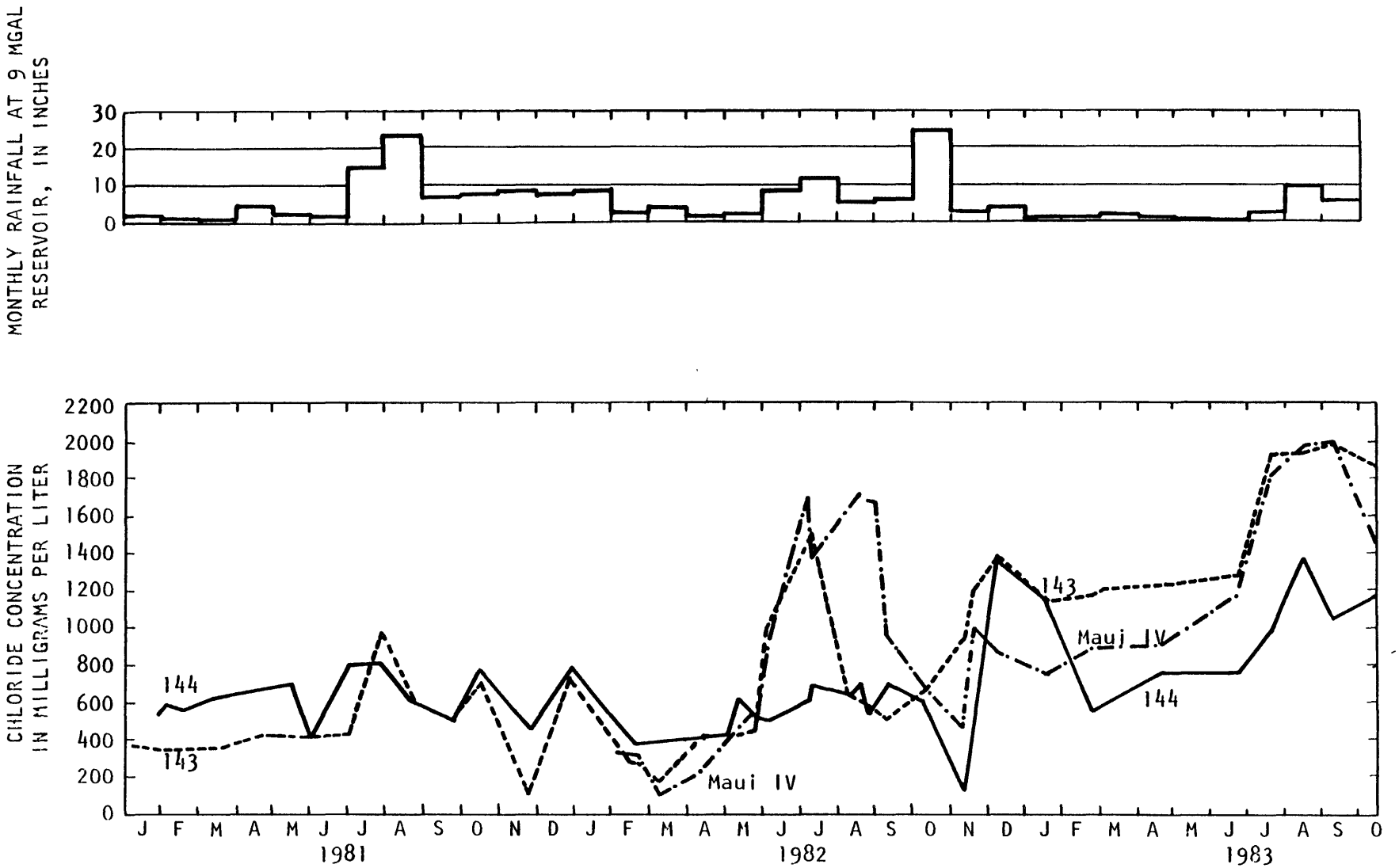


Figure 31. Chloride concentration of wells in the Maui IV area and rainfall at the 9-Mgal reservoir.

WELL 23A (called 23B by Piper, 1946-47)

Location: Lat 15°12'40" N., long 145°44'19" E., near Maui IV.
Drilled: Dec. 11-26, 1944 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 241 ft. Depth: 225 ft.
Casing: None.
Aquifer: Red clay and sand.
Source of record: Driller.
Remarks: Water was found at depth of 208 ft.
Chloride: 20 ppm, at completion (log).

Well was bailed dry. Well was plugged and abandoned.

LOG

Description of material	Depth (ft)
Clay and limestone	0-26
Limestone	26-100
Limestone and red clay	100-155
Red clay and sand (struck water at 208 ft, bailed dry)	155-225

WELL 23B (called 23A by Piper, 1946-47)

Location: At well 23A, lat 15°12'40" N., long 145°44'19" E., near Maui IV.

Drilled: Dec. 24, 1944 to Jan. 15, 1945 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 241 ft. Depth: 250 ft.

Casing: 6 in. to 245 ft with lower 40 ft perforated.

Aquifer: Red clay and sand (Glander, 1946); limestone and red clay (Davis, 1958).

Source of record: Driller.

Remarks: Water was found at depth of 195 ft.
Depth to water before pumping, 195 ft.
Chloride: 20 ppm, at completion (log).
Pumpage: less than 15,000 gal/d at completion (log).
15,000 gal/d (Glander, 1946).

Well was abandoned because of low yield.

LOG

Description of material	Depth (ft)
Limestone	0-47
Red clay	47-50
Limestone	50-114
Shale	114-115
Limestone	115-135
Shale	135-136
Limestone	136-160
Limestone and red clay	160-206
Red clay and sand	206-210
Red clay	210-237
Red clay and sand	237-250

WELL 30

Location: Lat 15°12'42" N., long 145°44'20" E., near Maui IV.
Drilled: Jan. 6-22, 1945 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 220 ft. Depth: 290 ft.
Casing: 6 in. to 255 ft with lower 40 ft perforated.
Aquifer: Limestone.
Remarks: Depth to water before pumping, 213 ft.
Chloride: 40 ppm, at completion (log).
40-100 ppm (Glander, 1946).
30-100 ppm (Piper, 1946-47).
Pumpage: 200,000 gal/d, at completion (log).
85,000 gal/d (Boniface, 1945).
40,000-60,000 gal/d (Glander, 1946).
pH: 7.0-7.2 (Glander, 1946).

LOG

Description of material	Depth (ft)
Hard lime	0-95
Brown clay	95-115
Limestone and brown clay	115-135
Limestone	135-147
Hard lime and sand clay	147-157
Hard lime and brown clay	157-175
Very hard lime	175-187
Hard lime	187-290

WELL 51

Location: Lat 15°12'44" N., long 145°44'23" E., near Maui IV.
Drilled: Completed Sept. 1, 1945 by 117th U.S. Naval Construction Battalion.
Altitude: 210 ft. Depth: 248 ft.
Casing: 6 in. to 248 ft with bottom 45 ft perforated.
Aquifer: Limestone and clay.
Source of record: Glander (1946).
Remarks: Chloride: 40-80 ppm (Glander, 1946).
30-85 ppm (Piper, 1946-47)
Pumpage: 45,000-75,000 gal/d (Glander, 1946).
pH: 7.2-7.4 (Glander, 1946).

Well was abandoned in 1947 or 1948.

WELL Maui IV (Tanapag infiltration tunnel)

Location: Lat 15°12'44" N., long 145°44'20" E.
Drilled: September 1945 to April 1946.
Altitude: 224.62 ft. Depth: 225.7 ft.
Diameter of hole: Shaft is 8 x 8 ft, vertical, timbered. Two main tunnels, each with one lateral, draining into a 12 x 12 x 8 ft concrete lined pump sump. Total length is 1,100 ft.
Source of record: Glander (1946).
Remarks: June 26, 1974: Analyses by W. B. Brewer, Health Services Trust Territory, using Hach kit:

Chloride, 650 ppm.
pH, 7.6.
Sulfate, 60 ppm.
Alkalinity as $CaCO_3$, 240 ppm.
Hardness, 390 ppm.
No fecal or total coliform per 100 mL.

Production: 230,000 gal/d, average during 1964[1/].
270,000-470,000 gal/d, during January to August, 1965[1/].
114,000 gal/d, average during 1974.
143,000 gal/d, average during 1975.
143,000 gal/d, average during 1976.
152,000 gal/d, average during 1977.

Well reported dry on Dec. 9, 1953 (Field notes Ted Arnow).
For chemical analyses, see tables 71, 74.

[1/] Written communication M. M. Miller and Ted Arnow to High Commissioner of the Trust Territory of the Pacific Islands, 1965.

WELL Maui IV

Pumping rate and chloride concentrations of Maui IV

Date	Time	Pumping rate (gal/d)	Chloride (mg/L)	Source	Remarks
1946	--	--	50	Arnow[1/]	After construction.
July 1947 to Feb. 1948	--	315,000	--	Pumpage records	Average of 45 weekly totals.
March 1950	--	300,000	838	Arnow[2/]	Pumping rate increased to 300,000 gal/d during 1946-50.
May 8, 1952	--	170,000	330	Field notes Arnow	
Aug. 13, 1952	1430	--	280	do.	
Oct. 21, 1952	1500	170,000	588	Arnow[3/]	Pumped water.
Do.	1515	--	336	do.	From sump.
Do.	1515	--	332	do.	From gallery.
Jan. 19, 1953	1500	170,000	520	do.[1/]	
Mar. 3, 1953	--	643,000	1,150	do. [4/]	
Apr. 7, 1953	1030	--	685	do. [2/]	
July 6, 1953	1105	--	1,275	do.	
Dec. 16, 1953	1315	--	1,440	do.	
June 23, 1954	--	--	780	Bishop[5/]	Pumping was decreased to reduce salinity.
July 6, 1956	1545	--	1,200	Cox (1956)[6/]	After 15 minutes of pumping.
July 7, 1956	0200	--	1,160	do.	After 2-1/2 hours of pumping.
September 1965	--	--	540	Ronimus (1980)	
Dec. 21, 1966	--	864,000	600	do.	
January 1967	--	--	427	do.	
Sept. 20, 1967	--	--	620	do.	
June 26, 1974	--	--	650		Ronimus (1980).
Sept. 14, 1974	--	177,000	1,030		Do.

Note: The pumping decreased after the U.S. Dept. of the Interior took over the Trust Territory administration on July 1, 1951. The U.S. Navy resumed control in January 1953 and increased the pumping rate.

1/ Written communication Ted Arnow to ComNavMar, Jan. 22, 1953.

2/ Written communication Ted Arnow to ComNavMar, Dec. 23, 1953.

3/ Written communication Ted Arnow to ComNavMar, July 13, 1953.

4/ Written communication Ted Arnow to D. A. Davis, May 11, 1953.

5/ Written communication, E. W. Bishop to ComNavMar, July 19, 1954.

6/ Collected by D. C. Cox, analyzed by P. E. Ward.

WELL Maui IV

Chloride concentration and specific conductance of water from Maui IV

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	790	--	--	116
3-18-80	--	280	--	--	70
6-17-80	--	480	--	--	70
6-20-80	--	520	2,200	25.6	--
8-18-82	1635	1,100	4,130	28.5	250
11-18-82	--	1,000	3,980	28.2	--
7-1-83	--	1,500	5,500	32.5	--
9-8-83	1400	2,000	6,930	27.5	--

WELL Maui IV

Chemical analyses of water from Maui IV

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
2-17-82	306	--	--	--	--	--
2-3-82	329	880	1,630	7.7	0.32	--
2-22-82	297	--	--	--	--	--
3-8-82	147	594	1,010	7.2	.68	--
4-12-82	222	656	1,270	7.5	.20	--
5-3-82	403	1,110	2,000	7.0	.20	--
5-14-82	536	--	2,370	--	--	251
5-24-82	527	--	--	--	--	--
6-4-82	886	--	--	7.2	--	260
7-6-82	1,700	--	--	--	1.3	--
7-9-82	1,360	2,760	5,280	7.4	.18	254
8-10-82	1,640	--	5,870	7.5	--	258
8-17-82	1,712	--	--	--	--	--
8-24-82	1,670	--	--	--	--	--
8-31-82	1,660	--	--	--	--	--
9-9-82	970	259	3,760	7.5	--	259
10-7-82	686	--	--	--	--	--
11-10-82	450	--	2,000	7.8	--	262
12-7-82	854	--	3,350	7.7	--	257
1-19-83	744	--	3,060	7.7	--	252
2-25-83	880	--	3,590	7.5	--	251
4-21-83	910	--	3,510	7.3	--	250
6-20-83	1,180	--	4,500	7.9	--	249
7-18-83	1,830	--	6,560	7.5	--	241
8-15-83	1,880	--	5,990	--	--	246
9-8-83	2,000	--	6,710	--	--	248
10-14-83	1,430	--	4,940	--	--	--

Hardness as $CaCO_3$: 4-21-83, 615 mg/L; 7-18-83, 892 mg/L; 8-15-83, 876 mg/L.

WELL Maui IV

LOG

Date	Remarks
Sept. 7, 1945	Clearing operation at shaft portal.
Sept. 23	Depth of shaft, 50 ft.
Oct. 8	Depth of shaft, 102 ft.
Nov. 4	Depth of shaft, 208 ft. Began excavation of pump chamber.
Nov. 11	Began excavation of tunnels, tunnel A in easterly direction, tunnel B in westerly direction.
Nov. 15	Length of tunnel A, 14 ft; tunnel B, 14 ft. Jan. 1, 1946: Length of tunnel A, 355 ft.
Jan. 20	Tunnel A completed, length 575 ft.
Jan. 21	Began taking up bottom in tunnel A, beginning at heading and working toward shaft. Invert of finished tunnel, about 1.5 ft below water level at heading and 3.5 ft below water level at pump sump.
Feb. 3	Take up of bottom in tunnel A, 345 ft from heading. Started excavating tunnel C in southerly direction from A at 221 from shaft.
Feb. 8	Resumed excavation in tunnel B.
Feb. 13	Length of tunnel B, 40 ft. Length of tunnel C, 100 ft.
Feb. 18	Length of tunnel C, 155 ft. Small cave with pool of water at 155 ft. Length of tunnel B, 76 ft.
Feb. 19	Test made on pool in tunnel C; pumped at 316,800 gal/d for 1/2 hour; drawdown, 0.2 ft, chloride, 30 ppm.
Feb. 28	Length of tunnel B, 135 ft. Tunnel C completed at 256 ft.

TEST HOLE Maui IV well 1

Location: Lat 15°12'35" N., long 145°44'16" E., at Maui IV.

Drilled: Feb. 25 to Mar. 5, 1970; reamed Mar. 6-20, 1970 by Layne International, Guam.

Altitude: 285.76 ft. Depth: 308 ft.

Diameter of open hole: 10 in.

Source of record: Driller.

Pumping test: At completion, yield less than 50 gal/min during 24-hour pump test; chloride, more than 200 mg/L.

Remarks: Chloride: 390 mg/L, February 1970.

Chloride determinations, April 23, 1970

Hour	Elapsed time (min)	Pumping rate (gal/min)	Chloride (mg/L)	
1200	--	--	--	Start test.
1220	2	18	150	
1300	60	19	150	
1400	120	21	170	
1500	180	21	--	
1600	240	21	170	End of test.

TEST HOLE Maui IV well 1

LOG

Description of material	Depth (ft)
Brown medium hard clay	0-5
Brown soft clay	5-14
Dark brown medium soft clay	14-18
Brown medium soft clay	18-30
Brown hard	30-35
Brown medium hard	35-39
Brown hard	39-42
Brown very hard	42-47
Brown medium soft	47-49
Brown medium hard (51-55 open)	49-75
Brown hard	75-86
Very hard coral (chatter)	86-90
Very hard	90-95
Medium hard	95-106
Medium soft, clay mixed with coral	106-110
Soft	110-135
Hard coral	135-140
Very hard	140-155
Hard clay	155-159
Very hard coral	159-181'3 1/2"
Very hard coral	181'3 1/2"-223
Hard	223-229'8 1/2"
Very hard	229'8 1/2"-265
Open	265-268
Medium soft	268-272
Medium hard	272-276
Medium soft	276-283
Hard (Static depth to water 284.25 ft)	283-286
Medium hard	286-305'8 1/2"
End of drilling	308

WELL Maui IV well 1. Called 141 (1982)

Location: Same as testhole Maui IV well 1, lat 15°12'35" N., long 145°44'16" E., 0.2 mi south of Maui IV.

Drilled: Nov. 11-16, 1970 by Asia Wells, Inc.

Altitude: 290.37 ft (Sablan, Takai and Assoc., April 1982).

Depth: 304 ft.

Casing: 8-in. steel with 10 ft 8-in. stainless steel screen at bottom.

Gravel pack and grout: Gravel from 275 ft to bottom, grout from ground surface to gravel.

Source of record: Driller.

Pumping test: Nov. 21, 1970, before acidizing: No drawdown in 4-1/2 hours at pumping rate of 12-30 gal/min; chloride, 185-390 ppm; hardness, 240-290 ppm. See pumping test record.

Nov. 23-24, 1970, after acidizing: Drawdown, 1.4 ft in 28 hours at pumping rate of 20-50 gal/min; chloride, 315-480 ppm. See pumping test record.

Mar. 20, 1982: Drawdown, 3.3 ft in 4 hours at pumping rate of 32 gal/min; recovery to original water level in one minute; pump was sucking air during the test. See pumping test record.

Remarks: Chloride: 690 ppm, Nov. 13, 1970.
390 ppm, Dec. 22, 1970.
450 ppm, Jan. 7, 1971.
160 ppm, Dec. 7, 1972.
375 ppm, Dec. 14, 1972.
295 ppm, Mar. 8, 1972.
219 mg/L, Feb. 22, 1982.

Hardness: 344 ppm, at completion.

Pumpage: 76,300 gal/d, Mar. 21, 1973 (USGS).
No water, May 5, 1980.

WELL Maui IV well 1. Called 141 (1982)

Depth to water, in feet

[Source: Northern Mariana Islands Division of Environmental Quality]

Altitude of measuring point, 290.37 ft.

Date	Depth to water	Date	Depth to water	Date	Depth to water
9-27-71	285.78[1/]	1-16-81	285.22	6-2-81	286.36
3-21-73	286.54[1/]	1-26-81	285.97	6-19-81	286.92
9-5-80	286.82	2-4-81	285.79	6-30-81	286.86
9-19-80	280.56	2-10-81	285.32	7-14-81	286.79
9-29-80	274.96	2-16-81	285.31	8-12-81	286.91
10-3-80	285.84	3-9-81	285.27	9-9-81	286.14
11-10-80	286.12	3-12-81	285.34	10-16-81	286.80
11-28-80	285.51	5-7-81	287.06	11-25-81	275.12
12-5-80	285.45	5-11-81	286.88	12-3-81	274.98
12-12-80	285.46	5-13-81	287.57	12-10-81	274.81
1-5-81	285.27	5-20-81	286.99	1-6-82	290.17

[1/] By U.S. Geological Survey.

LOG

Description of material	Depth (ft)
Hard, shattered limestone	0-8
Fairly soft limestone and clay	8-30
Hard, fractured limestone with traces of reddish brown clay	30-135
Fractured limestone, buff colored	135-240
Brown sandy clay and fractured limestone	240-245
Limestone, light buff colored	245-294
Light colored fissured limestone	294-304

Water bearing strata, 294 ft
Static depth to water 283 ft

WELL Maui IV well 1. Called 141 (1982)

PUMPING TEST

Date: November 21, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Hardness (ppm)	Remarks
0730	0	284.8	--	--	--	Static depth to water. Start of test.
0800	30	284.8	12	--	--	
0815	45	284.8	20	185	--	
0845	75	284.8	20	240	240	
0915	105	284.8	20	300	290	
0930	120	284.8	30	300	240	
1000	150	284.8	30	300	240	
1030	180	284.8	30	360	240	
1100	210	284.8	30	360	240	
1130	240	284.8	30	390	240	
1200	270	284.8	30	390	275	End of test.

WELL Maui IV well 1. Called 141 (1982)

PUMPING TEST

Date: November 23-24, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm) Field	Chloride (ppm) Layne Lab.	Hardness (ppm)	Remarks
November 23. Pump intake at 286 ft							
0815	0	--	--	--	--	--	Start of test. After acidizing.
0820	5	285.8	20	--	--	--	
0830	15	285.2	23	--	--	--	
0845	30	284.5	20	330	--	275	
0900	45	284.5	20	330	--	275	
0915	60	286.0	30	330	--	275	
0940	85	286.1	30	360	--	275	
1020	125	286.1	30	390	315	275	
1120	185	286.2	32	390	335	280	
1150	215	286.2	32	390	--	280	
1150-1415: Change pump setting from 286 to 291 ft							
1415	215	--	--	--	--	--	Continue test.
1430	230	291.2	40	390	--	275	
1515	275	286.0	40	390	350	275	
1530	290	286.5	50	390	--	275	
1630	350	287.2	50	420	--	375	
1730	410	287.2	50	420	375	--	
1830	470	287.2	50	420	380	--	
1930	530	287.2	50	450	385	--	
2030	590	287.2	50	450	395	--	
2130	650	287.2	50	450	405	--	
2230	710	287.2	50	450	415	--	
2330	770	287.2	50	450	425	--	
November 24							
0030	830	287.2	50	450	420	--	
0130	890	287.2	50	450	430	--	
0230	950	287.2	50	450	435	--	
0330	1,010	287.2	50	450	440	--	
0430	1,070	287.2	50	450	450	--	
0530	1,130	287.2	50	480	435	--	
0630	1,190	287.2	50	480	440	--	
0730	1,250	287.2	50	480	450	--	
0830	1,310	287.2	50	480	440	--	

WELL Maui IV well 1. Called 141 (1982)

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm) Field	Chloride (ppm) Layne Lab.	Hardness (ppm)	Remarks
0930	1,370	287.2	50	480	450	--	
1030	1,430	287.2	50	480	450	--	
1130	1,490	287.2	50	480	440	--	
1215	1,535	287.2	--	--	450	--	pH 7.7; alkalinity ($CaCO_3$), 210 ppm
1230	1,550	287.2	50	480	--	--	End of 28-hour test.

Date: March 20, 1982.

Static depth to water 286.0 ft; pump intake at 289.4 ft.

Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0	286.0	--	Start of test.
5	289.0	32	
10	289.2	32	
20	289.3	32	
40	289.3	32	
60	289.3	32	
120	289.3	32	
240	289.3	31	End of test.

100 percent recovery in one minute.

WELL Maui IV well 2 (B). Called 142 (1982)

Location: Lat 15°12'39" N., long 145°44'18" E., 0.1 mi south of at Maui IV.
Drilled: Aug. 19 to Sept. 26, 1970 by Asia Wells, Inc.
Altitude: 261.66 ft (Sablan, Takai, and Assoc., April 1982).
Depth: 281 ft.
Casing: 8-in. steel.
Source of record: Driller.
Pumping tests: Initial test: Drawdown, 0.1 ft at pumping rate of 30 gal/min; chloride, 400-650 mg/L.
Oct. 5, 1970: Drawdown, 4.8 ft in 4 hours at pumping rate of 28-58 gal/min; chloride, 300-315 mg/L. See pumping test record.
Oct. 5-7, 1970: No drawdown, in 32 hours at pumping rate of 47-58 gal/min; chloride, 275-315 mg/L. See pumping test record.
Remarks: Chloride: 275-315 ppm, Oct. 5-6, 1970.
330 ppm, Dec. 21, 1970.
945 ppm, Dec. 14, 1973.
1,600 ppm, June 26, 1974.*
Hardness: 440 ppm, Sept. 23, 1971.
680 ppm, June 26, 1974.*
Pumpage: 250 gal/min, May 5, 1980.
27 gal/min, Aug. 18, 1982 (USGS).
55 gal/min, Apr. 27, 1983 (USGS).
53 gal/min, July 1, 1983 (USGS).
June 26, 1974*: pH, 6.9.
sulfate, 175 ppm.
alkalinity (as $CaCo_3$), 210 ppm.
no fecal or total coliform per 100 mL.

* Analysis by W. B. Brewer, Health Services Trust Territory, using Hach kit.

WELL Maui IV well 2. Called 142 (1982)

Chemical analyses of water from well 142

[Sources: Water Quality Laboratory, Commonwealth of the Northern Mariana Islands, and U.S. Geological Survey(*)]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
4-21-83	855	3,870	7.2	545	249
9-8-83*	1,200	4,280	--	--	--
10-14-83	1,430	4,000	7.8	246	--

LOG

Description of material	Depth (ft)
Clay and limestone	0-2
Limestone	2-4
Clay and soft limestone	4-28
Hard limestone	28-32
Soft limestone	32-34
Limestone, open channel	34-42
Broken limestone and clay, soft	42-60
Broken limestone, some clay, soft	60-85
Red clay with sand and gravel, soft	85-140
Shattered limestone, buff colored, traces of clay	140-170
Shattered limestone and layer of dark brown clay	170-180
Fractured limestone, buff colored, traces of clay	180-254
Limestone, buff colored, very hard	254-258
Fractured limestone, buff colored, traces of clay	258-281

Water bearing formation at 258 ft
Static depth to water, 255 ft

WELL Maui IV well 2. Called 142 (1982)

Depth to water, in feet

[Source: Ayers, 1981]

Date	Depth to water	Date	Depth to water	Date	Depth to water
9-10-71[1/] -	256.99	10-27-80 --	256.15	12-12-80 --	257.57
9-27-71[1/] --	257.18	11-10-80 --	256.52	1-5-81 ----	257.04
9-5-80 ----	257.30	11-14-80 --	257.30	1-16-81 ---	256.88
9-19-80 ---	257.43	11-18-80 --	257.38	1-26-81 ---	257.04
9-29-80 ---	256.52	11-19-80 --	257.98	2-4-81 ----	257.27
10-3-80 ---	256.31	11-21-80 --	257.96	2-16-81 ---	256.80
10-10-80 --	255.97	11-28-80 --	256.36		
10-17-80 --	255.78	12-5-80 ---	257.95		

[1/] By U.S. Geological Survey.

PUMPING TEST

Date: October 5-7, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
	4-hour test				
1330	0	260.2	28	315	Start of test. Meter reading 157,300.
1430	60	260.2	28	315	
1530	120	260.2	28	300	
1535	125	263.5	--	300	
1630	180	263.5	37	300	
1635	185	265.0	--	300	
1700	210	265.0	--	315	
1730	240	265.0	58	300	End of 4-hour test. Meter reading 166,800.

WELL Maui IV well 2. Called 142 (1982)

PUMPING TEST--Continued

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
	32-hour test				
1800	0	264.7	55	275	Continuation of test.
1900	60	265.0	56	275	
2000	120	265.0	55	275	
2100	180	264.8	53	255	
2200	240	264.7	56	275	
2300	300	264.8	56	275	
2400	360	264.8	56	275	
0100	420	264.8	56	275	Oct. 6, 1970.
0200	480	264.8	58	275	
0300	540	264.8	58	275	
0400	600	264.8	55	275	
0500	660	264.8	55	275	
0600	720	264.8	55	275	
0700	780	264.8	55	275	
0800	840	264.8	53	275	
0900	900	264.8	55	275	
1000	960	264.8	51	275	
1100	1,020	264.8	51	300	
1200	1,080	264.8	55	315	
1300	1,140	264.7	45	300	
1400	1,200	264.8	55	275	
1500	1,260	264.7	55	275	
1600	1,320	264.8	51	275	
1700	1,380	264.8	55	275	
1800	1,440	264.8	55	275	
1900	1,500	264.8	53	275	
2000	1,560	264.8	53	275	
2100	1,620	264.8	51	275	
2200	1,680	264.7	51	275	
2300	1,740	264.7	47	275	
2400	1,800	264.7	50	275	
0100	1,860	264.7	50	275	Oct. 7, 1970.
0200	1,920	264.7	52	275	End of 32-hour test.

WELL Maui IV well 3. Called 143 (1982)

Location: Lat 15°12'42" N., long 145°44'22" E., 0.05 mi southeast of Maui IV.
Drilled: Completed Nov. 25, 1970 by Asia Wells, Inc.
Altitude: 239.35 ft (Sablan, Takai and Assoc., April 1982).
Depth: 251 ft.
Casing: 8-in. steel.
Source of record: Driller.
Pumping test: Nov. 13, 1970: Drawdown, 0.1 ft in 2 hours at pumping rate of 20-32 gal/min; chloride, 210-690 ppm. See pumping test record.
Remarks: Chloride: 690 ppm, Nov. 17, 1970.
840 ppm, Dec. 17, 1970.
220 ppm, Sept. 23, 1971; hardness 330 ppm.
480 ppm, Dec. 14, 1972.
200 ppm, Mar. 8, 1973.
950 ppm, June 26, 1974; hardness 510 ppm.*
1,236 mg/L, average of 7 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
Depth to water: 235.11 ft (not pumping), Sept. 27, 1971; 241.95 ft (pumping), Mar. 21, 1973 (USGS).
Pumpage: 72,000 gal/d, initially.
June 26, 1974*: pH, 7.4.
sulfate, 92 ppm.
alkalinity (as $CaCO_3$), 240 ppm.
no fecal or total coliform per 100 mL.

* Analysis by W. B. Brewer, Health Services Trust Territory, using Hach kit.

WELL Maui IV well 3. Called 143 (1982)

Chemical analyses of water from well 143

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-7-81	377	1,000	--	7.8	0.11	--
1-27-81	357	944	1,670	7.2	.30	--
2-4-81	357	1,050	1,720	7.7	.30	--
2-18-81	361	992	1,800	7.3	.29	--
3-13-81	364	1,050	1,850	7.5	.33	--
4-22-81	429	1,070	1,920	7.7	.58	--
5-29-81	414	1,100	2,000	7.1	.59	--
6-10-81	429	1,120	2,020	7.7	.29	--
7-1-81	437	1,100	2,010	7.6	.35	--
7-28-81	978	1,680	3,120	7.8	.16	--
8-20-81	600	1,340	2,450	7.7	.28	--
9-23-81	500	1,240	2,240	7.4	.53	--
10-16-81	758	1,680	3,070	7.5	.31	--
11-25-81	114	498	896	7.5	.25	--
12-28-81	724	1,660	3,000	7.5	.22	--
2-17-82	275	804	1,450	7.8	.19	--
2-22-82	262	--	--	--	--	--
3-8-82	179	618	1,110	7.3	.58	--
4-12-82	412	1,010	2,020	7.4	.22	--
5-3-82	365	1,150	1,790	7.1	.34	--
5-24-82	544	--	--	--	--	--
6-4-82	991	--	--	7.5	--	265
7-6-82	1,450	--	--	--	.29	--
7-9-82	1,510	3,050	5,589	7.4	.14	255
8-10-82	621	--	2,760	7.3	--	272
8-17-82	584	--	--	--	--	--
8-24-82	586	--	--	--	--	--
9-8-82	595	1,380	2,610	7.5	--	268
10-7-82	639	--	--	--	--	--
11-10-82	952	--	3,680	7.7	--	262
12-7-82	1,360	--	4,850	8.1	--	266
1-19-83	1,130	--	4,380	7.6	--	264
2-25-83	1,170	2,460	4,540	7.7	--	262
4-21-83	1,230	--	4,720	7.4	--	256
6-20-83	1,280	--	4,830	7.9	--	253
7-18-83	1,930	--	6,330	7.5	--	253
8-15-83	1,940	--	6,170	--	--	254
9-8-83	1,990	--	5,160	--	--	257
10-14-83	1,860	--	6,310	7.8	--	259

Hardness as $CaCO_3$: 4-21-83, 635 mg/L; 7-18-83, 898 mg/L; 8-15-83, 901 mg/L.

WELL Maui IV well 3. Called 143 (1982)

Chloride concentration and specific conductance of water from well 143

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	1,100	--	--	30
6-17-80	--	500	--	--	31
6-20-80	--	520	2,210	25.5	--
8-18-82	1645	650	2,840	28.0	50
11-18-82	1425	1,200	4,340	28.2	--
3-2-83	1545	1,200	4,360	27.5	--
7-1-83	1230	1,600	5,670	28.0	--
9-8-83	1410	2,000	7,010	27.0	--

LOG

Description of material	Depth (ft)
Clay and coral fill	0-4
Clay and limestone, soft	4-20
Traces of clay, alternating hard and soft	20-60
Fractured limestone, medium hard, traces of clay	60-100
Fractured limestone, buff colored, traces of clay	100-140
Fractured limestone, medium hard, traces of clay	140-200
Fractured limestone, hard, traces of clay	200-230
Fractured limestone, hard, clean	230-251

WELL Maui IV well 3. (Called 143 (1982)

PUMPING TEST

Date: November 13, 1970.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
0750	0	--	--	--	Meter reading, 438,880
0755	5	234.1	20	210	
0805	15	234.1	--	420	
0820	30	234.1	--	540	
0835	45	234.1	--	600	
0850	60	234.1	23	630	
0905	75	234.1	--	630	
0920	90	234.1	--	630	
0935	105	234.2	32	660	
0950	120	234.2	--	690	Meter reading, 442,700

WELL Maui IV well 4. Called 144 (1982)

Location: Lat 15°12'45" N., long 145°44'25" E., 0.1 mi northeast of Maui IV.

Drilled: January 1971 by Asia Wells, Inc.

Altitude: 214.61 ft (Sablan, Takai and Assoc., April 1982). (212.94 ft at measuring point, USGS).

Depth: 232 ft.

Casing: 8-in. steel casing with 10 ft 8-in. stainless steel screen at bottom.

Gravel pack and grout: Silica gravel to 204 ft, grout to ground level.

Source of record: Driller.

Remarks: Chloride: 90 ppm, at completion.
450 ppm, Jan. 15, 1971.
375 ppm, Jan. 27, 1971.
375 ppm, Feb. 10, 1971.
480 ppm, Dec. 14, 1972.
380 ppm, Mar. 8, 1973.
1,850 ppm, June 26, 1974.*
1,404 mg/L, average of 6 samples May 18 to Sept. 8, 1977 (M and E Pacific, 1978).
738 mg/L, June 10, 1980.

Hardness: 470 ppm, Sept. 23, 1971.
730 ppm, June 26, 1974.*

Water level: + 1.69 ft, Mar. 21, 1971 at 0939. Pump off at 0935 (USGS).
+ 3.06 ft, Sept. 27, 1971 at 1811 (USGS).
+ 3.04 ft, Sept. 28, 1971 at 0824 (USGS).
+ 3.00 ft, Sept. 29, 1971 at 1000 (USGS).

Pumpage: 72,000 gal/d, initially.

June 26, 1974*: pH 7.3.
sulfate, 250 ppm.
alkalinity (as $CaCO_3$), 220 ppm.
fecal coliform, 0 per 100 mL.
total coliform, 20 per 100 mL.

For chemical analyses of July 1, 1983, see table 76.

* Analysis by W. B. Brewer, Health Services Trust Territory, using Hach kit.

WELL Maui IV well 4. Called 144 (1982)

Chemical analyses of water from well 144

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
1-27-81	540	1,390	2,310	7.2	2.3	
2-4-81	594	1,410	2,170	7.7	1.5	--
2-18-81	579	1,450	2,580	7.3	1.3	--
3-13-81	620	1,570	2,670	7.4	.75	--
5-14-81	700	1,620	2,830	7.5	.16	--
5-29-81	415	1,170	2,000	7.1	.70	--
6-10-81	797	1,750	2,670	7.6	.50	--
7-1-81	800	1,760	2,740	7.5	.48	--
7-28-81	809	1,780	2,300	7.8	.23	--
8-20-81	608	1,390	2,490	7.6	.22	--
9-23-81	500	1,270	2,260	7.3	.84	--
10-16-81	773	1,710	3,160	7.5	.40	--
11-25-81	446	1,140	2,870	7.0	3.0	--
12-28-81	786	1,800	3,230	7.3	.22	--
2-17-82	371	996	1,810	7.7	.26	--
2-22-82	369	--	--	--	--	--
3-8-82	377	1,090	1,930	7.2	.22	--
4-12-82	405	1,020	1,980	7.4	.23	--
5-3-82	413	1,050	2,000	7.1	.22	--
5-24-82	530	--	--	--	--	--
6-4-82	495	--	--	7.7	--	271
7-6-82	595	--	--	--	.20	--
7-9-82	687	1,530	2,870	7.6	.13	265
8-10-82	625	--	2,680	7.5	--	271
8-17-82	595	--	2,850	--	--	--
8-24-82	584	--	--	--	--	--
9-8-82	697	1,530	2,900	7.4	--	257
10-7-82	594	--	--	--	--	--
11-10-82	121	--	853	7.8	--	264
12-7-82	1,360	--	4,850	7.8	--	264
1-19-83	1,130	--	4,390	7.7	--	262
2-25-83	540	--	2,470	7.4	--	263
4-21-83	760	--	3,170	7.4	--	263
6-20-83	753	--	3,140	7.9	--	262
7-18-83	969	--	3,750	7.5	--	262
8-15-83	1,380	--	4,720	--	--	263
9-8-83	1,050	--	4,190	--	--	267
10-14-83	1,180	--	4,340	7.7	--	267

Hardness as $CaCO_3$: 4-21-83, 580 mg/L; 7-18-83, 598 mg/L; 8-15-83, 728 mg/L.

WELL Maui IV well 4. Called 144 (1982)

Chloride concentration and specific conductance of water from well 144

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
5-31-78	--	1,800	--	--	70
3-18-80	--	600	--	--	48
6-17-80	--	750	--	--	36
6-20-80	--	750	2,950	25.6	--
8-18-82	1650	700	2,850	28	43
11-18-82	1350	460	2,110	28.2	--
9-8-83	1345	1,100	4,030	27.5	--

LOG

Description of material	Depth (ft)
Clay and coral fill	0-4
Clay and limestone	4-30
Limestone, slightly fractured, medium hard	30-40
Traces of clay, limestone, medium hard	40-60
Fractured limestone, medium hard	60-80
Fractured limestone, medium hard, traces of clay	80-120
Fractured limestone, hard, traces of clay	120-160
Clean limestone, fractured, buff colored	160-232

WELL 145 (At first called 141)

Location: Lat 15°12'45" N., long 145°44'18" E., at Maui IV.
Drilled: Mar. 4-11, 1982 by Pacific Drilling Inc.
Altitude: 242.23 ft (Sablan, Takai and Assoc., April 1982).
Depth: 300 ft.
Casing: 260 ft solid 8-in. casing with 32 ft stainless steel screen below.
Gravel pack and grout: Gravel at lower 58 ft; 10 bags cement used.
Source of record: Driller.
Pumping test: Mar. 12, 1982: Maximum drawdown, 50 inches during 5 hours at pumping rate of 22-55 gal/min; chloride, about 400 mg/L. See pumping test record.

May 25-26, 1982: Drawdown, 6.2 ft in almost 19 hours at pumping rate of 36-55 gal/min. See pumping test record.

June 8, 1982: Maximum drawdown, 11.8 ft during 1-1/2 hours at pumping rate of 50 gal/min; recovery to static level in less than 10 minutes. Test interrupted by malfunction. See pumping test record.

June 9, 1982: Maximum drawdown, 10.6 ft during 8-1/3 hours at pumping rate of 60-70 gal/min; chloride, 347-389 mg/L. See pumping test record.

WELL 145

Chemical analyses of water from well 145

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
6-16-82	368	--	--	--	--	--
6-17-82	400	--	--	--	--	--
7-6-82	591	--	--	--	0.18	--
7-9-82	691	1,610	2,950	7.6	.09	272
8-10-82	1,240	--	4,690	7.5	--	246
8-17-82	1,330	--	--	--	--	--
8-24-82	1,400	--	--	--	--	--
9-8-82	1,520	3,080	5,590	7.4	--	242
10-7-82	1,700	--	--	--	--	--
12-7-82	1,420	--	5,040	7.4	--	257
1-19-83	1,840	--	6,590	7.6	--	243
2-25-83	2,120	4,120	7,330	7.4	--	242
4-21-83	2,410	--	8,340	7.3	--	237
6-20-83	2,830	--	9,410	7.8	--	232
7-18-83	2,920	--	8,730	7.4	--	228
8-15-83	3,120	--	8,810	--	--	--
9-8-83	3,270	--	10,800	--	--	233
10-14-83	3,520	--	10,500	7.6	--	229

Hardness as $CaCO_3$: 4-21-83, 1,270 mg/L; 7-18-83, 1,460 mg/L; 8-15-83, 1,560 mg/L.

Chloride concentration and specific conductance of water from well 145

[U.S. Geological Survey]

Time	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	--	1,400	4,730	--	--
11-18-82	--	1,300	4,690	28.2	65
1-14-83	0900	--	--	--	65
3-2-83	1535	2,200	7,350	28.5	--
7-1-83	1200	2,900	9,450	28.0	--
9-8-83	1350	3,400	10,600	28.5	--

WELL 145

LOG

Description of material	Depth (ft)
White silty sandy coral gravel (dense to very dense)	5
Color to tan white	35
Color to light brown	40
Brown silty clayey with coralline limestone (dense)	55
White coralline limestone (dense)	60
Lost circulation	65
Regained circulation	85
Drills very hard	190
Blue-green volcanic rock (medium dense)	200
Loose drilling	205
Reddish volcanic rock (dense)	210
Limestone	224-226
Lost circulation	235
Regained circulation	245
Drills very hard	250
White limestone; occasional reddish brown	275
Cave-in	278-280
Volcanic rock	280
Color to pinkish white	290
Color to white	295
Boring terminated	300

WELL 145

PUMPING TEST

Date: March 12, 1982.
Static depth to water, 239.7 ft; pump intake at 273 ft.

Time	Elapsed time (min)	Drawdown (in.)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1410	0	--	--	--	Start of test.
1411	1	8	55	--	
1412	2	15	55	--	
1413	3	18	55	--	
1414	4	26	55	--	
1415	5	30	55	--	
1416	6	30	55	--	
1417	7	30	55	--	
1418	8	30	55	--	
1419	9	30	55	--	
1420	10	30	55	--	
1430	20	31	55	--	
1440	30	33	55	--	
1450	40	36	55	--	
1500	40	36	55	--	
1510	60	49	42	--	
1520	70	49	42	--	
1530	80	50	42	--	
1540	90	50	42	--	
1610	120	50	38	--	
1640	150	50	38	--	
1710	180	--	36	--	
1740	210	--	24	*400	
1810	240	--	22	--	
1840	270	--	23	--	
1910	300	--	23	--	End of test.

* About.

WELL 145

PUMPING TEST

Date: May 25-26, 1982.
Static depth to water, 228.0 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1308	0	228.0	--	Start of test.
1309	1	228.9	55	
1310	2	229.3	55	
1311	3	229.5	55	
1312	4	230.0	55	
1313	5	230.5	55	
1314	6	230.7	50	Same reading at 1315.
1316	8	230.8	50	
1328	20	230.8	48	
1338	30	230.8	28	
1353	45	230.9	28	
1408	60	231.0	18	
1429	80	231.1	18	Same reading at 1448.
1508	120	231.4	18	Same reading a 1538.
1608	180	231.6	16	
1620	192	--	--	Stopped pump; lowered pump 8 ft.
1635	207	--	--	Started pump.
1648	220	229.0	55	
1658	230	230.0	55	
1713	245	230.2	55	
1808	300	230.5	55	Same reading at 1823.
1918	370	230.7	55	
1953	405	231.7	50	
2053	465	233.0	38	
2153	525	232.7	50	
2253	585	233.5	50	Same reading at 2353.
0053	705	234.0	50	May 26, 1982.
0153	765	234.2	50	
0253	825	234.2	45	
0353	885	234.2	36	
0453	945	234.2	36	
0553	1,005	234.2	46	
0653	1,065	234.2	48	
0753	1,125	234.2	50	End of test.

WELL 145

PUMPING TEST

Date: June 8, 1982.
Static depth to water, 238.7 ft; pump intake at 275 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0941	0	238.7	--	Start of test.
0944	3	249.7	55	
0951	10	250.5	50	
0958	17	248.9	--	
1000	19	--	55	
1007	26	--	--	Turned off pump for repairs.
1020	39	238.7	--	Resumed pumping.
1021	40	247.4	50	
1023	42	247.2	--	
1025	44	248.9	50	Same reading at 1030 and 1035.
1040	59	248.8	50	
1046	65	248.7	50	
1051	70	249.2	50	
1057	76	249.6	45	
1103	82	--	--	Lost suction, shut off pump to allow back flow to clean pump.
1107	86	238.7	--	End of test because of pump troubles.

WELL 145

PUMPING TEST

Date: June 9, 1982.
Static depth to water, 238.7 ft; pump intake at 275 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0940	0	238.7	--	Start of test.
1008	28	--	60	
1022	42	247.2	60	
1037	57	249.2	60	
1043	63	--	65	
1047	67	249.3	--	
1150	130	249.3	70	
1300	200	249.1	70	
1420	280	249.1	70	
1509	329	249.0	70	
1545	365	249.2	70	
1625	405	249.0	70	
1715	455	248.8	70	
1800	500	248.8	70	End of test.

Note: Chloride during test, 347-389 mg/L.

WELL 146

Location: Lat 15°12'41" N., long 145°44'20" E., at Maui IV.

Drilled: August 1982 by Geo-Engineering and Testing.

Altitude: 223.12 ft. Depth: 300 ft.

Diameter of open hole: 12 in.

Casing: 8-in. steel.

Source of record: Driller.

Remarks: Well is not used.

LOG

Description of material	Depth (ft)
Light brown limestone fill	0-2
Red brown silty clay, soft	2-11
Yellowish white limestone, hard	11-20
Yellowish light brown limestone, hard	20-30
Yellowish white limestone, hard	30-50
Yellowish brown limestone, moderately hard	50-70
Yellowish green-brown clayey limestone, moderately hard	70-130
Yellowish green-brown clayey limestone, hard	130-150
Yellow-white limestone, hard	150-170
Yellow-green-brown clayey limestone, hard	170-180
Yellow-brown slightly clayey limestone, moderately hard	180-190
Yellow-white limestone, moderately hard	190-230
White limestone, hard	230-300

WELL 147

Location: Lat 15°12'44" N., long 145°44'22" E., at Maui IV.

Drilled: Aug. 20, 1982 by Geo-Engineering and Testing.

Altitude: About 210 ft. Depth: 280 ft.

Diameter of open hole: 8-in. pilot hole.

Source of record: Driller.

Pumping test: Aug. 25, 1982: Maximum drawdown, 16.4 ft in 5 hours at pumping rate of 66-80 gal/min; recovery to initial level in 5 minutes. See pumping test record.

Sept. 3, 1982: Drawdown, 21 ft in 1 hour; chloride, 272-790 mg/L (6 samples). See pumping test record.

Pumpage: 55-58 gal/min January to April 1983 (USGS).

Chemical analyses of water from well 147

[Sources: Water Quality Laboratory, Commonwealth of the Northern Mariana Islands, and U.S. Geological Survey(*)]

Date	Chloride (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
9-4-82	736	--	--	--	--
2-25-83[1/]	3,790	12,000	7.5	244	--
3-2-83*	4,100	12,400	--	--	--
3-23-83	4,210	13,600	--	--	--
4-18-83	4,610	--	--	--	--
4-21-83	4,660	14,900	7.4	234	1,820
6-20-83	--	16,200	7.8	228	--
7-1-83*	5,400	16,000	--	--	--
7-18-83	5,370	15,700	7.4	224	2,050
8-15-83	5,500	15,700	--	229	2,100
9-8-83	5,500	13,900	--	231	--
10-14-83	5,770	16,300	7.7	229	--

[1/] Total dissolved solids, 7,200 mg/L.

WELL 147

LOG

Description of material	Depth (ft)
White limestone, backfill	0-3
Yellowish light brown limestone, hard	3-12
Yellowish white limestone, hard	12-14
Yellowish brown limestone, hard	14-20
Yellowish white limestone, moderately hard	20-30
Yellowish brown limestone, moderately hard	30-70
Yellow brown clayey limestone, moderately hard	70-80
Yellowish light brown limestone, moderately hard	80-90
Yellow white limestone, moderately hard	90-120
Yellowish white limestone, moderately hard	120-180
Yellowish brown slightly clayey limestone, moderately hard	180-230
Yellowish white limestone, moderately hard with occasional clay pockets	230-280

PUMPING TEST

Date: August 25, 1982.
Static depth to water, 208.0 ft; pump intake at 170 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
0808	0	208.0	--	Start of test.
0809	1	224.4	80	
0814	6	224.2	--	
0819	11	224.3	73	
0825	17	224.3	73	Same reading at 0830, 0835, 0840.
0845	37	224.3	69	Same reading every 5 minutes 0850-0910.
0920	72	224.3	67	Same reading every 15 minutes 0930-1030.
1045	157	224.2	66	
1100	172	224.2	66	
1120	192	224.2	66	Same readings every 20 minutes 1140-1240.
1305	297	224.2	66	
1315	307	224.2	--	End of test.

Recovery to static depth to water in 5 minutes.

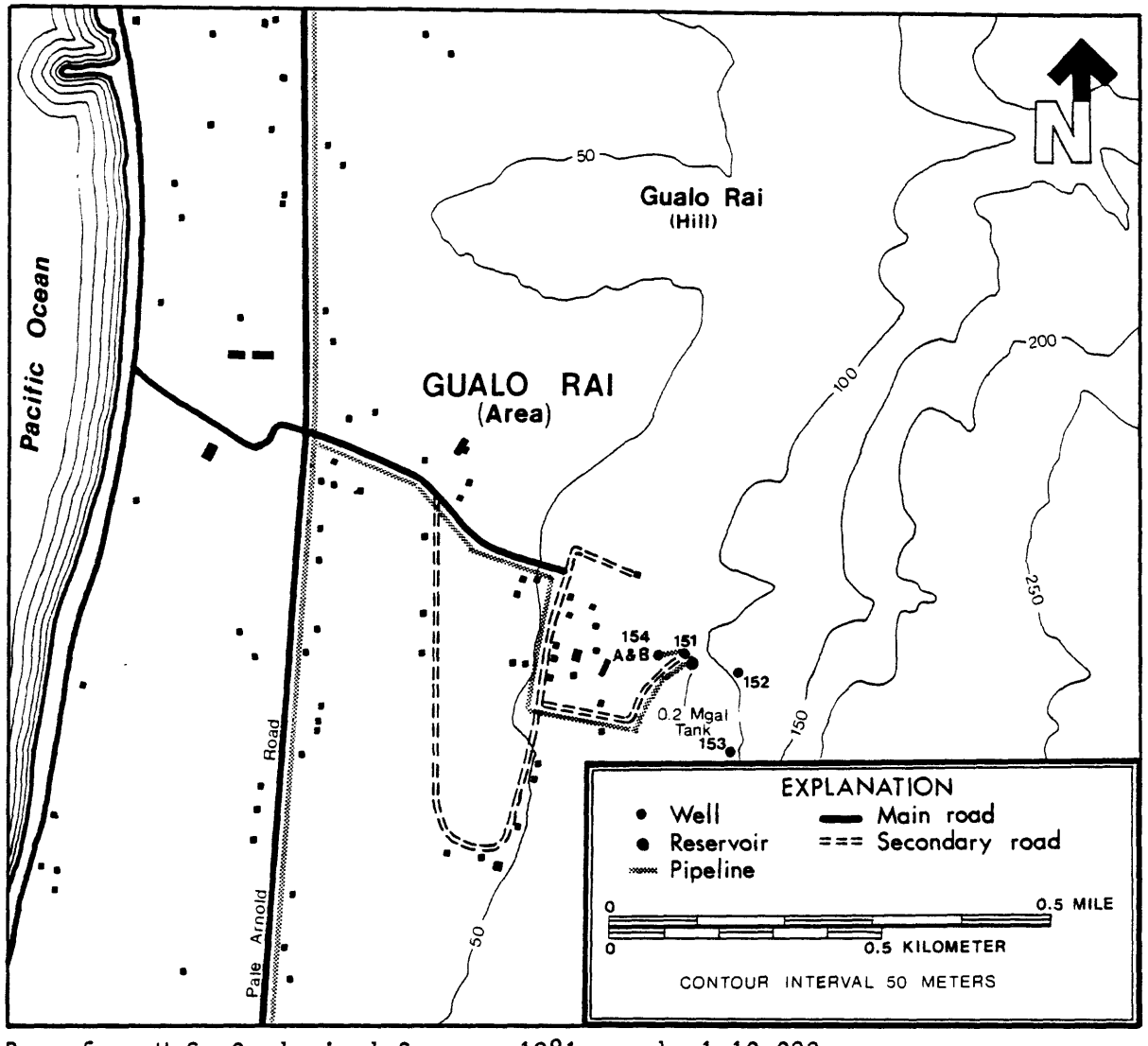
WELL 147

Date: September 3, 1982.
Static depth to water 208.0 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1430	0	208.0	82	272	Start of test.
1441	11	--	--	--	Stopped pump. No water.
1445	15	224.0	47		Turn pump on. Water dirty.
1455	25	--	--	--	Turn off pump.
1505	35	--	73	661	Turn pump on.
1511	41	--	--	--	Turn off pump. Little water.
1530	60	229.0	73	756	Turn on pump.
1537	67	--	--	--	Turn off water. Pump defective.

Table 34. Wells drilled at Gualo Rai area (fig. 32)

Well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1981-82			
151	15°11'20"	145°43'27"	September 1981	304.65	317	
152	15°11'19"	145°43'31"	April 1982	341.53	425	Well was dry and was abandoned.
153	15°11'14"	145°43'30"	April 1982	312.97	360	Do.
154A	15°11'19"	145°43'23"	June 6, 1982	260.69	330	Hole caved in and was abandoned.
154B	do.	do.	June 12, 1982	260.69	330	Called 154.



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 32. Location of wells in Gualo Rai area.

WELL 151

Location: Lat 15°11'20" N., long 145°43'27" E., at Gualo Rai.
Drilled: Reaming completed September 1981 by Pacific Drilling Inc.
Altitude: 304.65 ft (Sablan, Takai and Assoc., April 1982).
Depth: 6-in. pilot hole to 325 ft, reamed to 12 in. to 317 ft.
Diameter of open hole: 12 in.
Casing: 8-in. steel with stainless steel screen below to 315 ft.
Gravel pack and grout: Gravel packing from 280 to 317 ft and concrete from 0 to 280 ft.
Source of record: Driller.
Pumping test: 6-in. pilot hole, July 13, 1981: Drawdown, 0.4 ft in 9 hours of pumping at rate of 42-82 gal/min; chloride, 175-184 mg/L.

Chloride concentration and specific conductance of water from well 151

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)
8-18-82	--	260	1,350	--
3-2-83	1600	270	1,400	29.0
7-1-83	1015	300	1,470	29.0
9-8-83	1315	270	1,410	29.0

WELL 151

Chemical analyses of water from well 151

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
9-23-81	200	638	1,170	7.5	0.30	--
10-16-81	244	738	1,330	7.7	.28	--
11-25-81	259	721	1,420	7.1	.20	--
12-28-81	153	530	1,010	7.5	.28	--
2-4-82	250	726	1,370	8.1	.26	--
2-8-82	242	736	1,330	7.8	.24	--
3-8-82	253	730	1,410	7.2	.16	--
4-12-82	262	706	1,420	7.2	.24	--
5-3-82	266	804	1,440	6.9	.17	--
6-4-82	274	--	--	7.5	--	243
7-9-82	279	670	1,460	7.7	.12	190
8-10-82	257	--	1,460	7.6	--	238
8-17-82	267	--	--	--	--	--
8-24-82	256	--	--	--	--	--
8-31-82	258	--	--	--	--	--
9-8-82	265	--	--	--	--	--
10-7-82	273	--	--	--	--	--
11-10-82	230	--	1,200	7.8	--	236
12-7-82	211	--	1,210	7.8	--	240
1-19-83	229	--	1,260	7.6	--	229
2-25-83	260	--	1,410	7.5	--	260
4-21-83	250	--	1,420	7.4	--	227
6-20-83	297	--	1,480	7.6	--	198
7-18-83	293	--	1,480	7.4	--	224
8-15-83	286	--	1,450	--	--	229
9-8-83	270	--	1,520	--	--	231
10-14-83	301	--	1,440	7.8	--	231

Hardness as $CaCO_3$: 4-21-83, 312 mg/L; 7-18-83, 325 mg/L; 8-15-83, 309 mg/L.

Chloride concentrations: 10-5-81, 228 mg/L; 10-8-81, 237 mg/L; 10-13-81, 245 mg/L; 10-20-81, 240 mg/L; 10-26-81, 11-2-81, and 11-9-81, 250 mg/L; 12-1-81, 249 mg/L; 12-9-81, 239 mg/L; 1-14-81, 230 mg/L; 1-18-82, 250 mg/L; 2-1-82, 257 mg/L; 2-16-82, 255 mg/L; 2-22-82 and 3-1-82, 250 mg/L; 3-15-82, 251 mg/L; 4-5-82, 246 mg/L; 4-26-83, 253 mg/L; 5-10-82, 256 mg/L; 5-17-82, 265 mg/L; 5-24-82, 263 mg/L; 6-7-82, 279 mg/L; 6-14-82, 263 mg/L; 6-21-82, 273 mg/L; 7-6-82, 269 mg/L.

WELL 152

Location: Lat 15°11'19" N., long 145°43'31" E., at Gualo Rai.

Drilled: April 1982 by Geo-Engineering and Testing.

Altitude: 341.53 ft (Sablan, Takai and Assoc., April 1982).

Depth: 425 ft.

Diameter of open hole: 8 in.

Source of record: Driller.

Well was dry and was abandoned.

LOG

Description of material	Depth (ft)
Brown-red clayey silt with abundant limestone gravel	0-2
Dark yellow-brown limestone, moderately hard	2-5
Color light yellow-light brown	5-65
Color dark yellow-brown limestone with some clay particles	65-70
Color light brown-white, moderately hard	70-110
Color white with coralline limestone gravel and shell fragments	110-140
Color yellow-brown with clay particles	140-180
Lost circulation from 150-180 ft	
Color yellow-brown-white, hard, with recrystalized fragments	180-220
Light gray-yellow brown, slightly clayey limestone, moderately	220-240
Light brown limestone, hard	240-250
Light gray-yellow-brown clayey limestone	250-260
Light brown-white-gray limestone	260-285
Slightly clayish	285-290
Brown-yellow slightly clayey limestone	290-300
Gray-yellow clayey limestone with weathered sandstone gravel	300-310
Red-brown clay with occasional sandstone gravel	310-355
Abundant sandstone gravel	355-365
Occasional sandstone gravel	365-370
Light-brown-yellow-white limestone with abundant sandstone gravel	370-380
Brown-gray weathered sandstone with limestone boulders	370-425
More abundant sandstone 405-410 ft	

WELL 153

Location: Lat 15°11'14" N., long 145°43'30" E., at Gualo Rai.

Drilled: April 1982 by Geo-Engineering and Testing.

Altitude: 312.97 ft (Sablan, Takai and Assoc., April 1982). Concrete monument.

Depth: 360 ft.

Diameter of open hole: 8 in.

Source of record: Driller.

Well was dry and was abandoned.

LOG

Description of material	Depth (ft)
Light red brown clay and gravel	0-2
Yellowish white limestone, moderately hard	2-5
White limestone, hard	5-10
Yellowish white limestone, hard	10-30
Yellowish brown limestone, moderately hard	30-50
Yellowish white limestone, hard	50-100
Lost air circulation, 60-90 ft	
Yellowish brown limestone, moderately hard	100-190
Lost air circulation, 110-130 ft	
Yellowish white limestone, moderately hard	190-220
Yellowish brown limestone, hard to very hard	220-230
Yellowish white limestone	230-240
Yellowish brown limestone	240-290
Dark yellow-brown limestone, hard	290-320
Yellowish brown limestone	320-330
Light brown-white limestone	330-360

Note: No water found.

WELL 154A

Location: Lat 15°11'19" N., long 145°43'23" E., at Gualo Rai.
Drilled: June 3-6, 1982 by Geo-Engineering and Testing.
Altitude: 260.69 ft. Depth: 330 ft.
Diameter of open hole: 8 in.
Pumping test: Initial test June 6, 1982: Drawdown, 7.2 ft in 5 hours at pumping rate of 69-73 gal/min. See pumping test record.
Source of record: Driller.

Hole caved and was abandoned.

LOG

Description of material	Depth (ft)
Dark brown clay, moderately stiff	0-3
Yellow-brown limestone, moderately hard, slightly clayish	3-20
Light brown limestone, weak to moderately hard	20-30
Yellowish brown limestone, weak to moderately hard	30-40
Color light brown-white, weak to moderately hard	40-50
Yellow-white limestone, hard	50-60
Yellow-white limestone, moderately hard	60-150
Light brown-white limestone, moderately hard	150-170
Light brown-yellow limestone, moderately hard	170-210
Light brown-white limestone, moderately hard	210-260
Lost air circulation at 215 ft.	
Limestone, hard	260-290
Limestone, moderately hard	290-330

WELL 154A

PUMPING TEST

Date: June 6, 1982.
Static depth to water 261.8 ft; pump intake at 285 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Remarks
1415	0	261.8	--	Start of test.
1420	5	263.6	69	
1425	10	264.0	--	
1430	15	264.2	--	
1435	20	265.0	--	
1440	25	265.2	--	
1445	30	266.0	73	Same reading at 1500, 1515, 1530.
1545	90	267.0	73	
1600	105	268.0	73	
1645	150	269.0	73	Same reading every 30 minutes 1715-1845.
			--	
1915	300	269.0	--	End of test.

WELL 154B. Called well 154.

Location: Lat 15°11'19" N., long 145°43'23" E., at Gualo Rai, 10 feet from well 154A.

Drilled: June 12, 1982 by Geo-Engineering and Testing.

Altitude: 260.69 ft. Depth: 330 ft.

Diameter of open hole: 12 inches.

Casing: Solid 8-in. casing to 280 ft with 30 ft of 8-in. screen at bottom.

Source of record: Driller.

Pumping test: June 24, 1982: Maximum drawdown, 14.7 ft in 4-1/2 hours at pumping rate of 67-69 gal/min; chloride, 890-990 mg/L. See pumping test record.

July 6-7, 1982: Maximum drawdown, 13.5 ft in 29-1/2 hours at pumping rate of 41-60 gal/min; chloride, 800-990 mg/L. See pumping test record.

Date well brought into production: July 16, 1982.

Remarks: Apr. 21, 1983[1/]: Chloride, 795 mg/L.
Specific conductance, 3,220 µmho.
pH, 7.4.
Alkalinity, 229 mg/L.
Total hardness (as $CaCO_3$), 484 mg/L.

Oct. 14, 1983[1/]: Chloride, 950 mg/L.
Specific conductance, 3,560 µmho.
pH, 7.8.
Alkalinity, 227 mg/L.
Turbidity, 6.9 NTU.

1/ By Water Quality Laboratory, Commonwealth of the Northern Mariana Islands.

WELL 154 (B)

Chloride concentration and specific conductance of water from well 154

[U.S. Geological Survey]

Date	Time	Chloride (mg/L)	Specific conductance (µmho)	Temperature (°C)	Pumping rate (gal/min)
8-18-82	--	800	3,090	--	--
11-18-82	--	700	2,780	--	--
3-2-83	1600	780	2,910	29.0	--
4-25-83	1435	--	--	--	43
7-1-83	1015	820	3,140	30.5	39
9-8-83	1305	1,000	3,820	30.5	--

PUMPING TEST

Date: June 24, 1982.
Static depth to water, 260.8 ft; pump intake at 288 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1000	0	260.8	--	990	Start of test.
1005	5	267.8	69	--	
1010	10	275.5	69	--	
1015	15	275.0	69	--	
1020	20	274.8	69	--	
1025	25	274.1	69	--	Same reading at 1030.
1100	60	274.0	--	--	
1115	75	273.5	67	--	Same reading at 1130, 1145, 1200.
1230	150	273.7	67	--	Same reading at 1300, 1330.
1400	240	273.6	67	890	
1430	270	273.6	67	--	End of test.

WELL 154 (B)

PUMPING TEST

Date: July 6-7, 1982.
Static depth to water, 262 ft; pump intake at 285 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
July 6					
0850	0	262	--	--	Start of test.
0851	1	--	--	800	
0855	5	267	60	--	
0900	10	272	60	--	
0905	15	279.5	60	--	Same reading every 5 minutes 0910-0925.
0950	60	279.5	60	990	
1005	75	278.5	--	--	Same reading at 1020.
1035	105	277.5	53	--	
1050	120	277.5	47	--	Same reading at 1120, 1150, 1220.
1250	240	276.2	44	--	
1650	480	276.1	44	--	Same reading at 1720, 1750.
1820	570	276.1	43	--	Same reading at 1850.
1920	630	276.2	43	--	
1950	660	276.2	41	--	Same reading every 30 minutes 2020-0050.
July 7					
0120	930	276.0	41	--	Same reading every 30 minutes 0150-1250.
1420	1830	274.3	41	--	End of test.

Northern Saipan

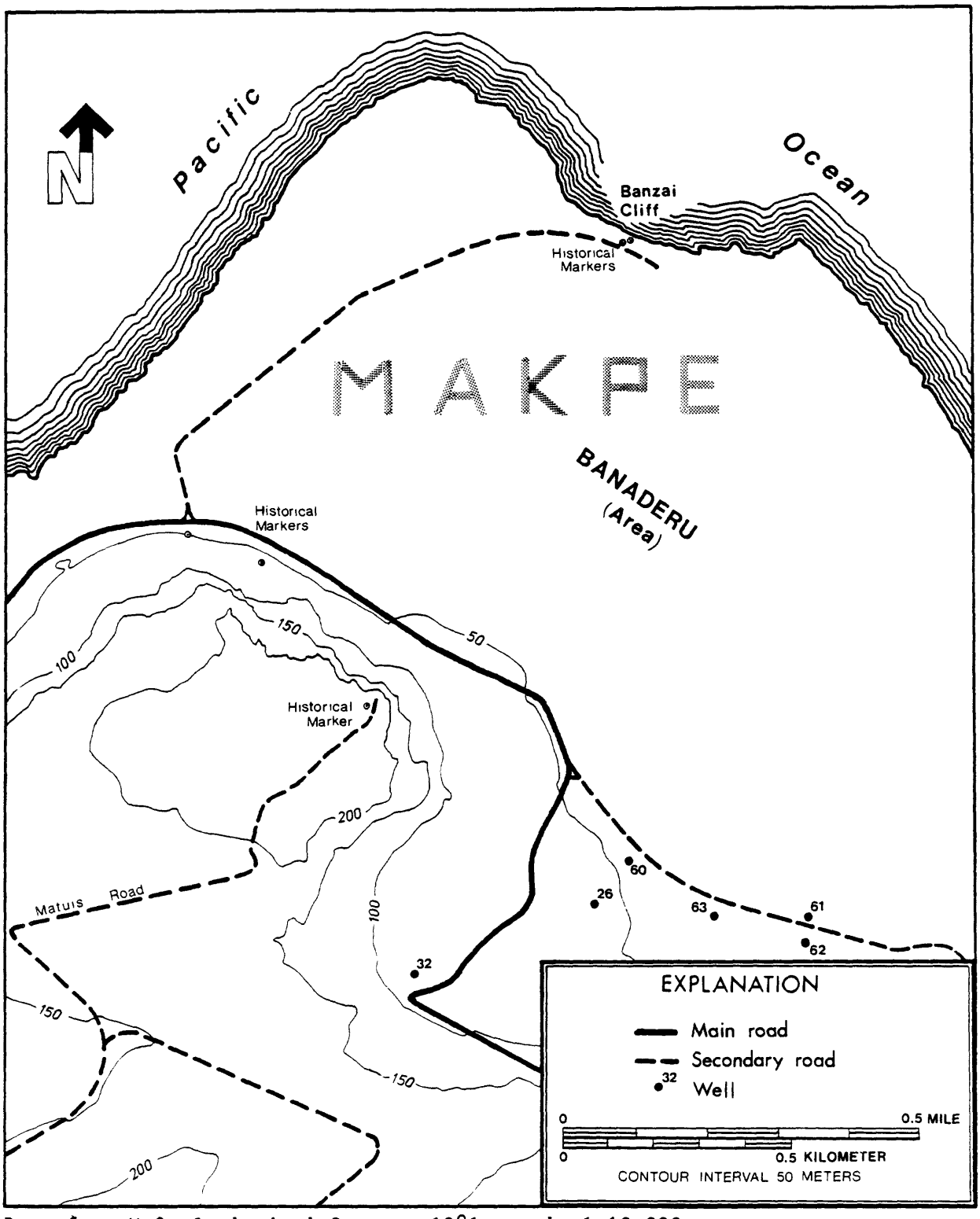
The water from all wells drilled in Northern Saipan, with the possible exception of well 6, show a high chloride concentration. It appears doubtful that potable ground water can be obtained in this area. No information is available for well 6 beyond the initial low chloride concentration and good yield. It is not known if the well was used for any length of time. The wells drilled in the area are listed in table 35 and their location is shown in figure 33 (Marpi Point) and figure 34 (Northwest Saipan).

Table 35. Wells drilled in Northern Saipan

Well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			At Marpi (Makpe) Point			
			1944-45			
26	15°16'18"	145°48'40"	Jan. 1, 1945	176	185	Abandoned; high salinity.
32	15°16'13"	145°48'25"	January 1945	293.3	302	Brackish water and porous strata.
60	15°16'22"	145°48'43"	Apr. 21, 1945	149.8	230	Abandoned; high salinity and low yield.
61	15°16'21"	145°48'50"	Apr. 19, 1945	134.8	144.5	High salinity.
62	15°16'17"	145°48'51"	May 4, 1945	126.3	141.2	Do.
63	15°16'19"	145°48'46"	May 7, 1945	141.5	154.5	Do.
			At Northwest coast			
			1944-45			
6	15°15'09"	145°46'56"	Aug. 10, 1944	167	173	
27	15°15'38"	145°47'18"	May 21, 1945	385	405	Abandoned; high salinity.
33	15°14'51"	145°46'48"	January 1945	200	--	Well went dry in 1946.
PW	15°14'45"	145°46'26"	May 1945	80	--	High salinity.
			1969-71			
Hawaiian Rock Quarry	15°15'21"	145°46'56"	July 11, 1969	110	170	High salinity.

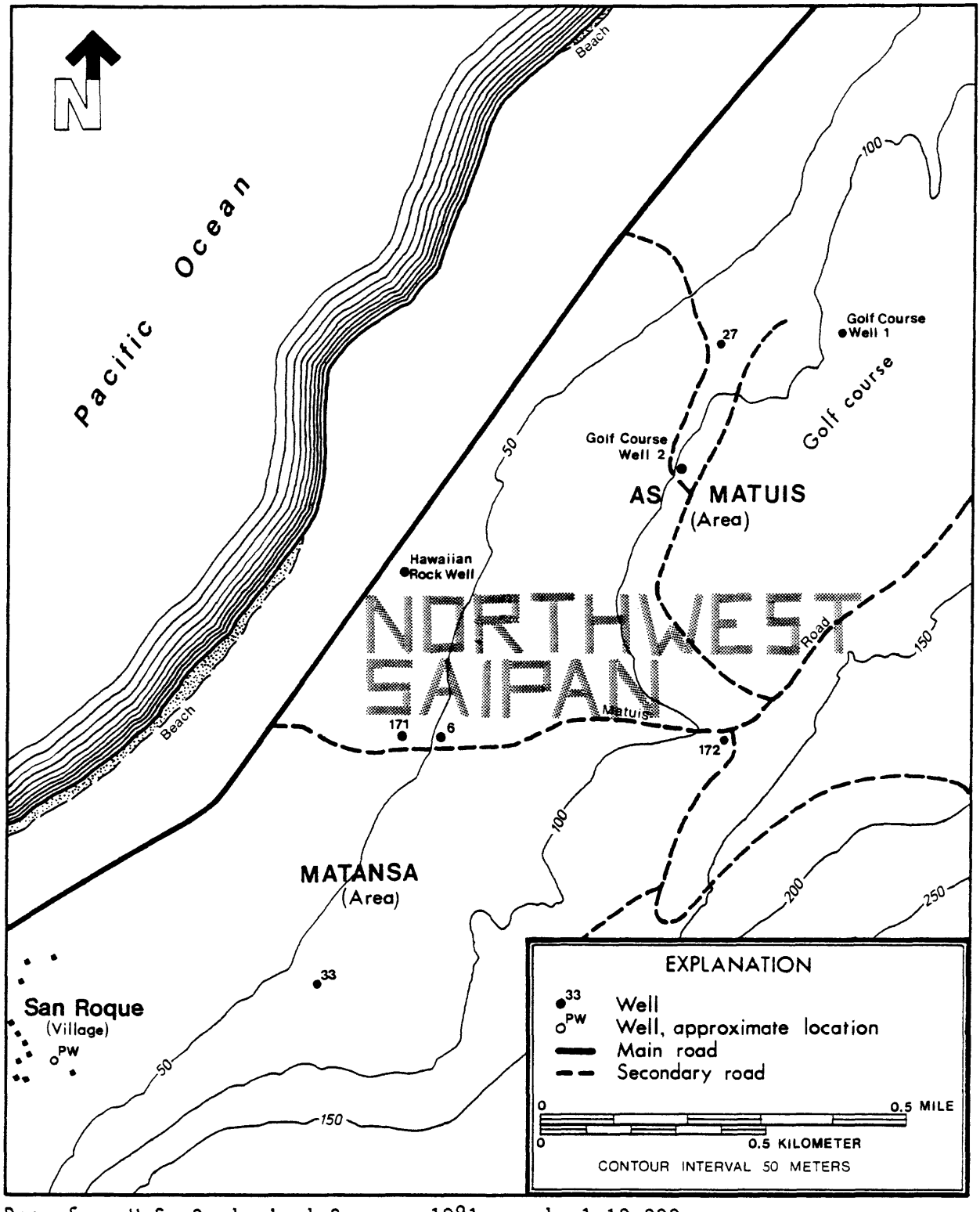
Table 35. Wells drilled in Northern Saipan--Continued

Well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1979-80			
Makpe golf course well 1	15°15'38"	145°47'27"	--	360	--	For watering the golf course.
Makpe golf course well 2	15°15'28"	145°47'15"	--	335	366.3	Do.
			1981-82			
171	15°15'08"	145°46'53"	May 25, 1982	149.18	200	
172	15°15'08"	145°47'18"	May 30, 1982	339.49	390	



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 33. Location of wells at Marpi Point (Makpe).



Base from U.S. Geological Survey, 1981, scale 1:10,000.

Figure 34. Location of wells in Northwest Saipan.

WELL 26

Location: About lat 15°16'18" N., long 145°48'40" E., near abandoned Marpi Airfield.

Drilled: Dec. 26, 1944 to Jan. 1, 1945 by 101 U.S. Naval Construction Battalion.

Altitude: 176 ft. Depth: 185 ft.

Casing: 6 in. to 185 ft with lower 20 ft perforated.

Aquifer: Limestone.

Remarks: Water was found at depth of 180 ft.
Depth to water before pumping, 171.5 ft.
Chloride: 880 ppm (Glander, 1946).
825 ppm (Piper, 1946-47).
Pumpage: 72,000 gal/d, at completion (log).
40,000-50,000 gal/d (Glander, 1946).
25,000-50,000 gal/d (Piper, 1946-47).
pH: 7.2-7.4 (Glander, 1946).

Well abandoned because of high salinity.

LOG

Description of material	Depth (ft)
Top soil	0-7
Broken coral	7-19
Solid coral	19-59
Soft coral	59-80
Hard coral	80-99
Medium coral	99-107
Pink coral	107-117
White medium coral	117-133
Yellow medium coral	133-182
Snow white coral	182-185

WELL 32

Location: About lat 15°16'13" N., long 145°48'25" E., at Marpi (Makpe), near base of cliff.
Drilled: January 1945 by 51st U.S. Naval Construction Battalion.
Altitude: 293.3 ft. Depth: 302 ft.
Casing: 6 in. to 224 ft.
Source of record: Glander (1946).

Well yielded a small amount of brackish water and was abandoned.

Well was drilled through coral and limestone with occasional streaks of clay or sand. At 300 ft, porous strata was encountered and the brackish water disappeared.

WELL 60

Location: About lat 15°16'22" N., long 145°48'43" E., at abandoned Marpi Airfield.
Drilled: Completed Apr. 21, 1945 by 51st U.S. Naval Construction Battalion.
Altitude: 149.8 ft. Depth: 230 ft.
Casing: 6 in. to 224 ft.
Aquifer: Limestone.
Source of record: Glander (1946).
Remarks: Chloride: 1,000 ppm.

Well abandoned because of high salinity and low yield.

LOG

Description of material	Depth (ft)
Limestone	0-60
Sandy clay and clayey limestone	60-140
Limestone	140-200
Sand and sandy clay	200-220
Limestone containing brackish water	220-230

WELL 61

Location: About lat 15°16'21" N., long 145°48'50" E., at abandoned Marpi Airfield.
Drilled: Completed Apr. 19, 1945 by 57st U.S. Naval Construction Battalion.
Altitude: 134.8 ft. Depth: 144.5 ft.
Casing: 6 in.
Aquifer: Sandy limestone.
Source of record: Glander (1946).
Remarks: Chloride: 800-1,000 ppm.
Pumpage: 50,000-60,000 gal/d.
pH: 7.4-7.6.

Water not potable because of high salinity.

WELL 62

Location: About lat 15°16'17" N., long 145°48'51" E., at abandoned Marpi Airfield.
Drilled: Completed May 4, 1945 by 51st U.S. Naval Construction Battalion.
Altitude: 126.3 ft. Depth: 141.2 ft.
Casing: 6 in. to 141 ft.
Aquifer: Gravelly clay.
Source of record: Glander (1946).
Remarks: Chloride: 1,000 ppm.
Pumpage: 40,000 gal/d.
pH: 7.4-7.6.

Water not potable because of high salinity.

WELL 63

Location: About lat 15°16'19" N., long 145°48'46" E., at abandoned Marpi Airfield.
Drilled: Completed May 7, 1945 by 51st U.S. Naval Construction Battalion.
Altitude: 141.5 ft. Depth: 154.5 ft.
Casing: 6 in. to 154.5 ft.
Aquifer: Sandy limestone.
Source of record: Glander (1946).
Remarks: Water level at sea level.
Chloride: 1,000 ppm.
Pumpage: 40,000 gal/d.
pH: 7.4-7.6.

Water not potable because of high salinity.

WELL 6

Location: About lat 15°15'09" N., long 145°46'56" E., along Matuis road, at Matansa.

Drilled: Aug. 5-10, 1944 by U.S. Marine Corps.

Altitude: 167 ft. Depth: 173 ft.

Casing: 6 in. to 173 ft, with bottom 6 ft slotted.

Aquifer: Limestone.

Source of record: H. T. Stearns (1944) and Glander (1946).

Remarks: Water was found at depth of 167 ft. Depth to water before pumping, 166 ft.

Chloride: 73 ppm, at completion prior to pumping (Stearns, 1944).
125 ppm, Aug. 10, 1944 after pumping 1,000 gallons (Stearns, 1944).
166 ppm, Aug. 22, 1944 after pumping 8,500 gallons for 12 days (Stearns, 1944).
100-250 ppm (Glander, 1946).

Pumpage: 50,400 gal/d, Sept. 6, 1944 (Stearns, 1944).
12,000-45,000 gal/d (Glander, 1946).

pH: 7.4-7.6 (Glander, 1946).

For chemical analysis of the water, see table 70.

LOG

Description of material	Depth (ft)
Clean white sandstone	0-173

WELL 27

Location: About lat 15°15'38" N., long 145°47'18" E., near golf course (NW Saipan).
Drilled: Completed May 21, 1945 by 11th Service Marines, U.S. Marines Corps.
Altitude: 385 ft. Depth: 405 ft.
Casing: 6 in. to 405 ft with lower 10 ft perforated.
Aquifer: Limestone.
Source of record: Glander (1946).
Remarks: Drilling penetrated hard coral, coral with gray streaks, and sandy coral.
Well shot at 395 ft with 104 lbs of TNT.

Salinity increased rapidly when pumped and well was abandoned.

WELL 33

Location: About lat 15°14'51" N., long 145°46'48" E., at Matansa (NW Saipan).
Drilled: January 1945 by 101st U.S. Naval Construction Battalion.
Altitude: 200 ft. Depth: Not reported.
Casing: 6 in.
Source of record: Glander (1946).
Remarks: Chloride: 350 ppm (Glander, 1946).
375 ppm (Piper, 1946-47).
Pumpage: 20,000-40,000 gal/d, 1945 (Piper, 1946-47).

Well went dry in 1946.

WELL PW

Location: About lat 15°14'45" N., long 145°46'26" E., at San Roque village.
Drilled: May 1945 by U.S. Marine Corps.
Altitude: 80 ft. Depth: Not reported.
Source of record: Glander (1946).
Remarks: Chloride: 680 ppm.
Pumpage: 25,000-35,000 gal/d.
pH: 7.2-7.4.

Water not potable due to high salinity.

WELL Hawaiian Rock Quarry (Also called Dillingham well)

Location: About lat 15°15'21" N., long 145°46'56" E., at quarry, Makpe (Marpi).

Drilled: June 24 to July 11, 1969 by Layne International, Guam.

Altitude: About 110 ft. Depth: 170 ft.

Diameter of open hole: 12 in.

Casing: 8 in. to 110 ft with 20 ft 8-in. screen at bottom.

Gravel pack and grout: 1-1/2 cubic yard cement, 1-1/4 cubic yard gravel. Top altitude of gravel pack is 90 ft.

Source of record: Driller.

Pumping test: July 8, 1969: No drawdown in 10 hours at pumping rate of 225-250 gal/min; chloride, 620 ppm.

Remarks: Nov. 11, 1971: Motor broke off when pump was pulled; new pump and motor installed.
Chloride: 800 ppm, at completion.

LOG

Description of material	Depth (ft)
White land fill	0-3
Red soft clay	3-11
White medium hard coral	11-22
White very hard coral	22-26
Medium hard	26-32
Medium soft	32-53
Medium hard	53-102
Very hard	102-111
Soft, hole caving	111-116
Hard	116-122
Soft, hole caving	122-129
Medium hard	129-150
Medium hard, hole caving	150-170

Hole caving badly at 170 ft

WELL Hawaiian Rock Quarry (Also called Dillingham well)

Chemical analyses of water from Hawaiian Rock quarry well

[Analyses by Layne International, Guam.
Psi, pound per square inch]

Constituent	Time -------	July 8, 1969			July 28, 1969
		0815	1400	1600	1700
Specific conductance -	µmho	2,510	2,560	2,590	2,950
pH ----------	--	7.4	7.5	7.6	7.8
Temperature (water) --	°C	23	23	23	29
Total hardness -------	mg/L	505	505	505	520
Calcium hardness -----	mg/L	315	320	325	340
Bicarbonate (HCO_3) ---	mg/L	325	320	325	--
Methol Alkalinity, as $CaCo_3$ ----------	mg/L	266	268	266	260
Chloride (Cl) --------	mg/L	725	730	740	810
Total dissolved solids	mg/L	1,506	1,536	1,554	--

Time -------		Sept. 3, 1969						
		0840	0940	1040	1140	1240	1340	1440
Water pressure -----	psi	105	105	110	107	105	105	105
Water temperature --	°C	30	30	30	30	30	30	30
Chloride (Cl) ------	mg/L	830	830	830	830	840	830	830

WELL Makpe golf course 1

Location: Lat 15°15'38" N., long 145°47'27" E., at pond on golf course.
Altitude: About 360 ft (from topographic map). Depth: Not reported.
Remarks: Chloride: 785 mg/L at depth of 325 ft, June 23, 1981.
314 mg/L at depth of 314 ft, July 2, 1981.

WELL Makpe golf course 2

Location: Lat 15°15'28" N., long 145°47'15" E., along road to golf course.
Altitude: About 335 ft (from topographic map). Depth: 366.3 ft.
Remarks: Chloride: 695 mg/L, at depth of 344 ft, June 19, 1981.
821 mg/L, at depth of 355 ft, June 23, 1981.
2,780 mg/L, at depth of 365 ft, June 23, 1981.

Chemical analyses of water from Makpe golf course wells

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Total solids (mg/L)	Specific conductance (µmho)	pH (units)	Alkalinity (mg/L)	Hardness as $CaCO_3$ (mg/L)
			Makpe golf course 1			
Feb. 25, 1981	900	2,070	3,680	7.8	0.54	> 2400
			Makpe golf course 2			
Feb. 25, 1981	1,800	3,925	6,830	7.1	3.0	> 2400

WELL 171

Location: Lat 15°15'08" N., long 145°46'53" E., along Matuis Road.

Drilled: May 24-25, 1982 by Geo-Engineering and Testing.

Altitude: 149.18 ft. Depth: 200 ft.

Diameter of open hole: 8 in.

Pumping test: May 26, 1982: No drawdown in 75 minutes at pumping rate of 118 gal/min; chloride 2,780-6,990 mg/L. See pumping test record.

Source of record: Driller.

Remarks: Depth to water, 147.69 ft June 1, 1982, (T. Camacho, using home made sampler).

For chemical analysis of June 30, 1983, see table 76.

LOG

Description of material	Depth (ft)
Dark brown clayey silt with abundant limestone boulders	0-3
Light brown-red with abundant limestone boulders	3-15
Yellow-brown limestone, moderately hard	15-20
Light brown-reddish limestone with silt pocket	20-25
Yellow-brown limestone, moderately hard	25-35
Yellow-white limestone, moderately hard	35-45
Color white, hard	45-55
Yellowish white, medium hard	55-60
Reddish white, medium hard	60-70
Yellowish white, medium hard	70-90
White limestone, moderately hard	90-110
Color yellowish white, moderately hard	110-120
White limestone, moderately hard	120-140
Brownish white limestone, moderately hard	140-150
Yellow-white limestone, weak	150-200

WELL 171

PUMPING TEST

Date: May 26, 1982.
Static depth to water, 148.0 ft; pump intake at 165 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (ppm)	Remarks
1640	0	148.0	--	--	Start of test.
1642	2	148.0	--	2,780	
1645	5	148.3	118	--	
1650	10	148.3	118	--	
1655	15	148.3	118	--	
1700	20	148.3	118	--	
1705	25	148.3	118	--	
1710	30	148.3	118	--	
1725	45	148.0	118	--	
1740	60	148.0	118	6,990	
1755	75	148.0	--	--	End of test.

WELL 172

Location: Lat 15°15'08" N., long 145°47'18" E., along Matuis Road.

Drilled: May 28-30, 1982 by Geo-Engineering and Testing.

Altitude: 339.49 ft. Depth: 390 ft.

Diameter of open hole: 8 in.

Pumping test: June 1, 1982: Drawdown 0.3 ft in about 7 hrs at pumping rate of 55 gal/min; chloride, 821-3,210 mg/L. See pumping test record.

Source of record: Driller.

WELL 172

LOG

Description of material	Depth (ft)
Red-brown clayey silt, medium stiff with limestone gravel	0-3
Yellow-brown limestone, moderately hard	3-10
Color yellow-white, moderately hard	10-20
Color yellow-brown, moderately hard	20-40
Color light brown-white, moderately hard	40-60
Color yellow-brown, moderately hard	60-72
Clay pocket	72-74
Color light brown-white, moderately hard	74-90
Color yellow-white, moderately hard	90-108
Brown clayey limestone, weak	108-112
Light brown-red-grey clay, 20 ft	112-124
Yellow-brown limestone, moderately hard	124-150
Yellow-white limestone, moderately hard	150-160
Color light brown-yellow, moderately hard	160-180
Color yellow-white, moderately hard	180-260
Color white, moderately hard	260-270
Color yellow-white, moderately hard	270-288
Light brown-white, slightly clayey limestone	280-320
Light brown-yellow-white limestone, moderately hard	320-350
Color yellow-white, moderately hard to weak	350-380
Yellow-white limestone, moderately hard	380-390

PUMPING TEST

Date: June 1, 1982.
Static depth to water, 339.0 ft.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
0945	0	339.0	--	--	Start of test.
0947	2	339.0	--	821	
0950	5	339.2	55	--	Same reading every 5 minutes 0955-1010.
1015	30	339.3	55	--	Same reading at 1030, 1045, 1100.
1115	90	339.4	55	--	Same reading at 1130, 1145, 1215.
1245	180	339.7	--	--	Same reading 1315, 1345, 1415.
1445	300	339.6	--	--	Same reading at 1515, 1545, 1615.
1645	420	339.5	--	3,210	
1650	425	339.3	--	--	End of test.

Miscellaneous sites

During 1944-45, wells were drilled in many places on the island in hopes of finding water. As potable water in sufficient quantity was not found in most areas, further miscellaneous exploration has not been done. The only wells listed under miscellaneous sites that were drilled after 1945 are test hole 17, drilled in 1980 along the road to Talufofo Stream near the site of well 36, and well 161, drilled at Navy Hill in 1982. Testhole 17 was not developed because of low yield and well 161 was abandoned because the chloride concentration of the water exceeded 2,000 mg/L.

Six of the wells drilled near Garapan are listed separately in table 36 and the remaining wells are listed under miscellaneous sites in table 37. The locations of the wells are shown in figure 35.

Table 36. Wells drilled at Garapan

Well No.	Location: Latitude north	Location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
16	15°12'06"	145°43'26"	Nov. 2, 1944	121	173	Abandoned; high salinity.
17	15°11'55"	145°43'28"	Nov. 10, 1944	156.45	170	
19A	15°12'18"	145°43'32"	Feb. 10, 1945	240	248	Abandoned; high salinity.
19B	15°12'19"	145°43'35"	Feb. 15, 1945	240	370	Do.
19C	15°12'20"	145°43'43"	February 1945	320	430	Do.
			1982			
161	15°13'35"	145°44'31"	May 21, 1982	170	215	At Navy Hill. See figure 32.

Note: Locations of wells 16-19C are approximate.

Table 37. Wells drilled at miscellaneous sites

Well No.	Approximate location: Latitude north	Approximate location: Longitude east	Completion date	Altitude (ft)	Depth (ft)	Remarks
			1944-45			
			Listed from North to South			
38	15°14'09"	145°47'21"	Feb. 21, 1945	224.5	220	Abandoned; low yield.
35A	15°13'31"	145°46'16"	Feb. 4, 1945	201.65	200	Had been abandoned in 1946.
35B	do.	do.	1945	200	(140)	Hole caved in at depth of 140 ft.
47	15°13'32"	145°45'51"	April 1945	433	190	Abandoned; low yield.
34	15°13'17"	145°45'22"	1945	650	--	Do.
43	15°12'42"	145°45'30"	Mar. 15, 1945	556.4	67	Abandoned; contaminated.
36	15°12'29"	145°45'22"	February 1945	604	300	Well went dry after 20 min. pumping.
58	15°12'22"	145°46'07"	Apr. 28, 1945	161.6	224	Abandoned; low yield.
65	15°11'38"	145°46'13"	June 20, 1945	150	171	Abandoned; contaminated.
39	15°11'59"	145°44'20"	March 1945	721	535	No water found.
70	15°10'35"	145°43'05"	Sept. 20, 1945	42	50	Abandoned; high salinity.
71	15°10'10"	145°43'15"	Oct. 25, 1945	178	189	Do.
7	15°09'49"	145°43'05"	Aug. 21, 1944	50	481	Do.
4	15°09'06"	145°43'00"	July 31, 1944	65.9	80	Do.
			1980			
TH17	15°12'24" at Talufofo.	145°45'18"	May 7, 1980	615	335	Abandoned; low yield.

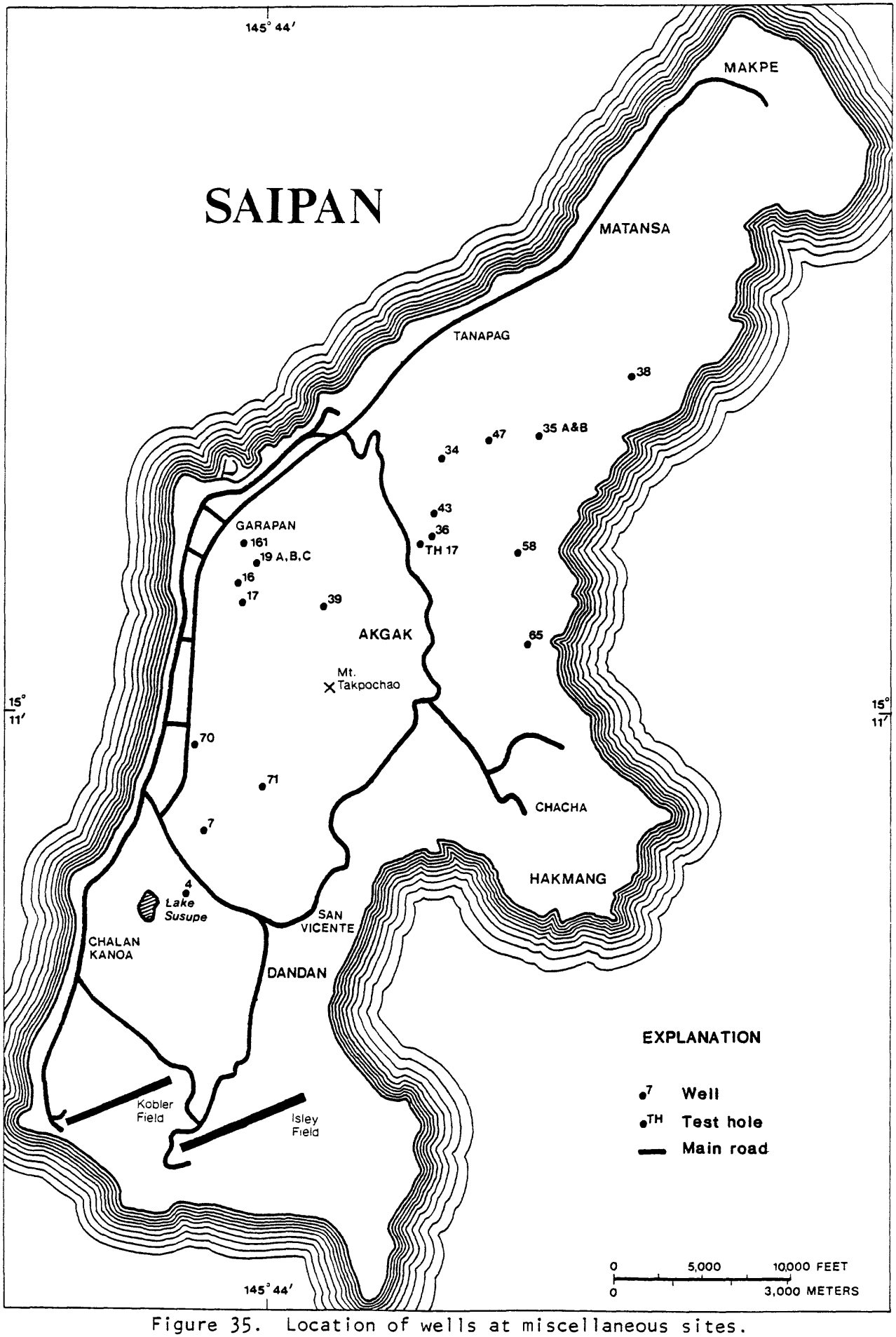


Figure 35. Location of wells at miscellaneous sites.

WELL 16

Location: About lat 15°12'06" N., long 145°43'26" E., near Garapan.
Drilled: Oct. 31 to Nov. 2, 1944 by 17th Navy Construction Battalion.
Altitude: 121 ft. Depth: 173 ft.
Casing: 6 in. to 160 ft.
Aquifer: Soft coral and shale (Glander, 1946); limestone (Davis, 1958).
Source of record: Driller.
Remarks: Water was found at depth of 121 ft.
Depth to water before pumping, 121 ft (at sea level).
Chloride: 400-500 ppm, Nov. 3, 1944 during 24-hour pump test at pumping rate of 20 gal/min.

For chemical analysis of the water, see table 74.

Salinity increased steadily and well was abandoned.

LOG

Description of material	Depth (ft)
(Source: Driller's log)	
Top soil	0-4
Soft coral with hard streaks	4-156
Soft shale	156-168
Blue gumbo	168-173
(Source: Written communication Lt. Col. H. M. Arnold to H. T. Stearns, Dec. 2, 1944)	
Top soil	0-4
Soft coral with hard streaks	4-121
Soft shale	121-156
Blue gumbo	156-161
Not given	161-173

WELL 17

Location: About lat 15°11'55" N., long 145°43'28" E., near Garapan, 1,000 ft south of well 16.

Drilled: Nov. 7-10, 1944 by 17th U.S. Navy Construction Battalion.

Altitude: 156.45 ft. Depth: 170 ft.

Casing: 6 in. to 158 ft.

Aquifer: Hard coral (Glander, 1946); limestone (Davis, 1958).

Remarks: Water was found at 156 ft.

Well sprung with 24 lbs TNT at depth of 153 ft.

Chloride: 30 ppm, Nov. 28, 1944. Pumping at rate of 30 gal/min, chloride increased from 30 to 550 ppm (Glander, 1946).

575 ppm (Piper, 1946-47).

Pumpage: 30,000 gal/d, at completion (log).

43,000 gal/d (Brown[1/]).

30,000-40,000 gal/d (Glander, 1946).

pH: 7.4-7.6 (Glander, 1946).

[1/] Supplemental report on well drilling, memorandum Desloge Brown to Commanding Officer, Nov. 29, 1944, 3 p.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Loose coral	0-40
Medium coral	40-120
Hard coral	120-170

WELL 19A

Location: About lat 15°12'18" N., long 145°43'32" E., about 3/4 mile east of Garapan town.
Drilled: Feb. 10, 1945 by 117th U.S. Navy Construction Battalion.
Altitude: 240 ft. Depth: 248 ft.
Casing: None.
Aquifer: No record, probably limestone (Davis, 1958).
Source of record: Glander (1946). Driller's log is missing.

Chloride concentration was high and well was abandoned.

WELL 19B

Location: About lat 15°12'19" N., long 145°43'35" E., near Garapan, 400 ft east of well 19A.
Drilled: Feb. 15, 1945 by 117th U.S. Navy Construction Battalion.
Altitude: 240 ft. Depth: 370 ft.
Casing: None.
Aquifer: No record, probably limestone (Davis, 1958).
Source of record: Glander (1946). Driller's log is missing.

Chloride concentration was high and well was abandoned.

WELL 19C

Location: About lat 15°12'20" N., long 145°43'43" E., near Garapan, east of well 19B.

Drilled: February 1945 by 117th U.S. Navy Construction Battalion.

Altitude: 320 ft. Depth: 430 ft.

Casing: 6 in.

Aquifer: No record, probably limestone (Davis, 1958).

Source of record: Glander (1946). Driller's log is missing.

Remarks: Chloride 3,000 ppm.
Pumpage: 20,000 gal/d.
pH: 7.6-7.8.

Because of high salinity, water was used in 117th Construction Battalion camp for shower and wash water only.

WELL 161

Location: Lat 15°13'35" N., long 145°44'31" E., at Navy Hill.

Drilled: May 20-21, 1982 by Geo-Engineering and Testing.

Altitude: 170 ft (from topographic map). Depth: 215 ft.

Diameter of open hole: 8 in.

Source of record: Driller.

Pumping test: May 21, 1982: Drawdown, 23.2 ft in 4 hours at pumping rate of 106-110 gal/min; chloride, 2,170-3,210 mg/L. See pumping test record.

LOG

Description of material	Depth (ft)
Dark brown clayey silt, moderately stiff	0-1.5
Yellow-white limestone, moderately hard	1.5-5
Light brown-white limestone, hard	5-20
Color pinkish	20-25
Color light pink-white	25-30
Color pink, moderately hard	30-35
Color pink, weak	35-45
Moderately hard, slightly clayish	45-50
Pink clayey limestone, moderately hard	50-60
Light brown limestone, moderately hard	60-100
Lost circulation at 80 ft	
Moderately hard to weak limestone	100-125
Moderately hard limestone	125-145
Hard limestone	145-155
Moderately hard limestone	155-215

WELL 161

PUMPING TEST

Date: May 21, 1982.

Time	Elapsed time (min)	Depth to water (ft)	Pumping rate (gal/min)	Chloride (mg/L)	Remarks
1540	0	143.2	--	--	Start of test.
1542	2	--	--	2,170	
1545	5	146.1	106	--	
1550	10	146.6	106	--	
1555	15	147.2	106	--	Same reading at 1600, 1605, 1610, 1625, and 1640.
1655	75	148.4	106	--	
1710	90	151.8	106	--	
1725	105	156.5	106	--	
1740	120	161.2	110	--	
1810	150	163.8	110	--	
1840	180	165.6	110	--	
1910	210	166.6	110	--	
1940	240	166.4	110	3,210	End of test.

Next day, recovery to 163.0 ft.

WELL 38

Location: About lat 15°14'09" N., long 145°47'21" E., at Kalabera, N. E. Saipan.

Drilled: Completed Feb. 21, 1945 by 51st U.S. Naval Construction Battalion.

Altitude: 224.5 ft. Depth: 220 ft.

Casing: None.

Aquifer: Volcanic sediments.

Source of record: Glander (1946).

Remarks: Water level, + 20 ft (Piper, 1946-47).

Well was abandoned because of low yield.

WELL 35A

Location: About lat 15°13'31" N., long 145°46'16" E., at Talufofo.

Drilled: Jan. 22 to Feb. 4, 1945 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 201.65 ft. Depth: 200 ft.

Casing: 6 in. to 142 ft with lower 107 ft perforated.

Aquifer: Volcanic rock.

Remarks: Depth to water before pumping, 191.7 ft.
Chloride: 50 ppm (Glander, 1946).
Pumpage: 43,000 gal/d, at completion (log).
27,000 gal/d (Stock, 1945[1/]).
6,000-27,000 gal/d (Glander, 1946).
27,000 gal/d (Curione, 1947).
pH: 6.8-7.0 (Glander, 1946).

Well had been abandoned in February 1946.

[1/] Written communication T. S. Stock to Commanding Officer, Nov. 7, 1945.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Clay	0-4
Sand and clay	4-40
Blue clay and volcanic ash	40-50
Shale and sand	50-53
Volcanic ash and shale	53-75
Shale, clay, and sand	75-95
Lime and sand	95-100
Lava rock and sand	100-105
Shale, lava rock, and sand	105-120
Lime and sand	120-126
Lava, ash, and sand	126-152
Lime, sand, and clay	150-170
Lime, sand, clay, and lava rock	170-200

WELL 35B

Location: 500 ft from well 35A, Talufofo.
Drilled: 1945 by 2807th U.S. Naval Construction Battalion Detachment.
Altitude: About 200 ft. Depth: 140 ft.

Hole began to cave in at 140 ft and was abandoned after attempt to install casing failed (Glander, 1946).

WELL 47

Location: About lat 15°13'32" N., long 145°45'51" E., at Talufofo Hill.
Drilled: April 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 433 ft. Depth: 190 ft.
Casing: 6 in. to 170 ft.
Source of record: Glander (1946).
Aquifer: Sandy, porous coral.
Remarks: Chloride: "low".
Pumpage: 3,000 gal/d, at completion.

Well was abandoned because of low yield.

WELL 34

Location: About lat 15°13'17" N., long 145°45'22" E., near Radio Hill Spring No. 1.
Drilled: 1945 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 650 ft. Depth: Not reported.
Source of record: No driller's log available.

Well was reported abandoned because of low yield and excessive contamination (Piper, 1946-47).

WELL 43

Location: About lat 15°12'42" N., long 145°45'30" E., at Capitol Hill.
Drilled: Completed Mar. 15, 1945 by 2807th U.S. Naval Construction Battalion.
Altitude: 556.4 ft. Depth: 67 ft.
Casing: 6 in. to 55 ft.
Aquifer: Sandstone and clay.
Source of record: Glander (1946).
Remarks: Water level at altitude 530 ft.

Well reported capable of producing 108,000 gal/d, but was abandoned because of excessive contamination.

WELL 36

Location: About lat 15°12'29" N., long 145°45'22" at old booster pumping station, Capitol Hill, along road to Talufofo Stream (Glander, 1946).
Drilled: February 1945 by 1397th Engineer Construction Battalion, U.S. Army.
Altitude: 604 ft. Depth: 300 ft.
Casing: 6 in. to 252 ft with lower 100 ft perforated.
Aquifer: Volcanic rock.
Source of record: Glander (1946) and Piper (1946-47).
Remarks: Depth to water before pumping, 484 ft.

Well went dry after 20 minutes pumping at 30 gal/min and was abandoned (Piper, 1946-47).

WELL 58

Location: About lat 15°12'22" N., long 145°46'07" E., along road to Talufofo Stream.
Drilled: Completed Apr. 28, 1945 by U.S. Marine Corps.
Altitude: 161.6 ft. Depth: 224 ft.
Casing: 6 in. to 217 ft.
Aquifer: Coral and sand.
Source of record: Glander (1946).
Remarks: Water level before pumping, 57 ft.
Well shot at 205 ft with 85 pounds TNT.

Well abandoned because of low yield.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Clay	0-55
Coral with some sand	55-218
Lava rock	218-224

WELL 65

Location: About lat 15°11'38" N., long 145°46'13" E., east of Denni Spring.
Drilled: Completed June 20, 1945 by U.S. Marine Corps.
Altitude: 150 ft. Depth: 171 ft.
Casing: 6 in. to 170 ft.
Aquifer: Limestone.
Source of record: Glander (1946).
Remarks: Chloride: 60 ppm, at completion.
Pumpage: 15,000-20,000 gal/d.
pH: 7.0-7.2.

Well was used only a short time and capped because of bacteriological contamination. Well could not be located by Cox (1956).

WELL 65

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Clay and coral	0-50
Yellow clay and coral	50-150
White coral	150-163
No record	163-171

WELL 39

Location: About lat 15°11'59" N., long 145°44'20" E., 6,000 ft north of Mount Takpochau (Glander, 1946).

Drilled: March 1945 by 17th U.S. Naval Construction Battalion.

Altitude: 721 ft. Depth: 535 ft.

Casing: None.

Source of record: Glander (1946).

Remarks: No water-bearing beds found.
Well was drilled through coral, clay, sand, and several crevices and caverns.

Well was abandoned because of absence of water.

WELL 70

Location: About lat 15°10'35" N., long 145°43'05" E., at Chalan Pupulu.
Drilled: Completed Sept. 20, 1945 by 117th U.S. Naval Construction Battalion.
Altitude: 42 ft. Depth: 50 ft.
Casing: None.
Aquifer: Hard coral with streaks of clay.
Source of record: Glander (1946).
Remarks: Water was found at depth of 43 ft (1 ft below sea level).
Chloride: 1,100 ppm from bailer sample.
pH: 7.4-7.6.

Well was abandoned because of high salinity.

WELL 71

Location: About lat 15°10'10" N., long 145°43'15" E., east of Chalan Laolao.
Drilled: Completed Oct. 25, 1945 by 117th U.S. Naval Construction Battalion.
Altitude: 178 ft. Depth: 189 ft.
Casing: None.
Aquifer: Coral.
Source of record: Glander (1946).
Remarks: Water was found at 179 ft.
Chloride: 1,100 ppm, from bailer sample.
pH: 7.4-7.6.

Well was abandoned because of high salinity.

WELL 7

Location: About lat 15°09'49" N., long 145°43'05" E., at Kiya near Lake Susupe.

Drilled: Aug. 9-21, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 50.29 ft (51.6 ft by Glander, 1946). Depth: 481 ft.

Diameter of open hole: 8 in.

Aquifer: Limestone.

Casing: None.

Source of record: Stearns (1944).

Remarks: Drilled in existing dug well, which was 3 ft in diameter and 50 ft deep, to explore for artesian water. Dug well contained 28 in. of water, yielded 14,400 gal/d with chloride concentration of 40 ppm (Stearns, 1944); 50 ppm, Glander (1946).

No water was found between bottom of dug well and 479 ft. Bailer sample contained 3,210 ppm of chloride.

Well was abandoned Aug. 21, 1944 (Stearns, 1944).

WELL 7

LOG
[Source: Stearns, 1944]

Description of material	Depth (ft)
Soil (dug)	0-12
Very open limestone (dug)	12-50
Brown clay	50-55
Coarse lime sand and clay	55-60
Fine lime sand and clay	60-75
Coarse lime fragments and clay	75-80
Brown clay	80-85
Lime sand (Foraminifera)	85-95
Red clay	95-125
Alternating red, gray, green, and lavender Globigernia tuffaceous shales	125-175
Marly shale	175-185
Coarse sandy Globigernia shale with manganese pellets	185-205
Marly shale	205-220
Brown shale with sandy layers	220-255
Shale with 1/4 inch pebbles	255-265
Brown shale with some marl	265-280
Sandy and pebbly shale	280-315
Sandy and pebbly shale with lime granules	315-350
White marl	350-370
Tuffaceous marl	370-415
Lavender marl	415-419
Tuffaceous marl	419-440
Fine-grained marl	440-445
Pink and lavender marl	445-475
White marl	475-480
Caving marl	480-481

WELL 4

Location: About lat 15°09'06" N., long 145°43'00" E., east of Lake Susupe.

Drilled: July 1-31, 1944 by 1397th Engineer Construction Battalion, U.S. Army.

Altitude: 65.9 ft. Depth: 80 ft.

Diameter of open hole: 8 in.

Casing: 6 in., could not be driven beyond 80 ft.

Aquifer: Limestone.

Source of record: Stearns (1944).

Remarks: July 23, 1944, hole 22 ft deep: Chloride, 280 ppm, after pumping at rate of 25 gal/min for 15 minutes. At 80 ft, bailer sample showed chloride concentration of 1,740 ppm.

Well was abandoned on Aug. 1, 1944.

LOG
[Source: Driller's log]

Description of material	Depth (ft)
Lump coral	0-20
Sandy coral and limestone	20-40
Hard lime and coral	40-60
Hard sand and limestone	60-70
Hard lime and coral	70-74
Mud and salt water	74-76
Coral rock and salt water	76-80

Note: Hole caved badly below 20 ft (Stearns, 1944).

TEST HOLE 17

Location: Lat 15°12'24" N., long 145°45'18" E., 100 ft south of road to Talufofo, at Denni Spring pipeline crossing.

Drilled: Apr. 16 to May 7, 1980 by Ted Lund Drilling and Supply.

Altitude: 615 ft (from topographic map). Depth: 335 ft.

Diameter of open hole: 7-7/8 in.

Casing: None.

Source of record: Driller.

Pumping tests: Apr. 17, 1980, pumping test when well was 83 ft deep: Well producing 20 gal/min.

Apr. 18, 1980, pumping test when well was 103 ft deep: Pumping rate dropped from 42 gal/min to less than 20 gal/min in less than one hour; recovery very slow. See pumping test record.

Apr. 19, 1980, pumping test when well was 205 ft deep: Pumped for two hours; results about the same as test of April 18. See pumping test record.

May 8, 1980, pumping test when well was 335 ft deep: Pumping rate dropped from 48 to 16 gal/min in less than 3-1/2 hours. Recovery very slow. See pumping test record.

Well was abandoned and sealed May 13, 1980.

TEST HOLE 17

LOG

Description of material	Depth (ft)
Brown clay	0-8
Brown, hard coral	8-23
White, hard coral	23-48
Red clay	48-50
White, hard coral (foam becoming wet)	50-56
Red clay	56-58
Beige, hard coral-rough drilling	58-71
Brown clay	71-72
Brown clay and coral	72-75
Black, soft weathered rock	75-83
Gray soft sandstone (tuff), becoming sticky at bottom	83-103
Gray tuff with soft black rock	103-107
Black, medium hard weathered rock	107-135
Hard, black rock-rough drilling	135-143
Black, medium hard to medium soft highly weathered basalt with multicolored soft tuff	143-170
Black, medium hard, highly weathered basalt with layers of gray brown and pink soft tuff	170-205
Black, pink, gray silt and highly weathered rock	205-238
Black, medium hard rock with coral layer	238-261
Black, harder rock/less coral	261-280
White, medium hard coral layer	280-285
Black, medium hard rock with coral layers	285-310
Black, medium hard rock with less coral layers	310-355

Note: At 75 ft foam became very dark and started to lighten at 78 ft.

TEST HOLE 17

PUMPING TEST

Date: April 18, 1980.
Measuring point: 3.0 feet above ground surface; static depth to water, 35.4 ft.

Time	Elapsed time (min)	Pumping rate (gal/min)	Remarks
0800	0	--	Start of test.
0802	2	about 100	
0805	5	42	
0810	10	38	
0815	15	33	
0830	30	23	
0845	45	21	
0900	60	18	Same reading at 0915.
0930	90	17	Same reading every 15 minutes until end of test at 1030.

Recovery was very slow. One hour after end of test the water was still 5 feet below water level at start of test.

Date: April 19, 1980.
Measuring point: 3.0 feet above ground surface; static depth to water, 35.7 ft.

Time	Elapsed time (min)	Pumping rate (gal/min)	Remarks
1020	--	--	Water level still recovering from drilling with air-foam.
1025	0	--	Start pump test.
1027	2	38	Pump drawing air from 1027 till end of test.
1031	6	29	
1036	11	24	
1045	20	21	
1100	35	18	Same reading every 15 minutes 1115-1215.
1230	125	18	
1240	135	18	End of test.

TEST HOLE 17

PUMPING TEST

Date: May 8, 1980.
Measuring point: 3.0 feet above ground surface; static depth to water, 35.4 ft.

Time	Elapsed time (min)	Pumping rate (gpm)	Remarks
1028	0	--	Start of test.
1031	3	48	
1035	7	36	
1045	17	27	
1115	47	21	
1145	77	18	
1215	107	18	
1245	137	17	
1315	167	17	
1345	197	16	
1350 to 1410			Pump stopped.
1415	227	22	
1430	242	20	
1445	257	17	
1500	272	17	End of test.

Recovery was very slow. One hour after end of test, the water was still 7 feet below water level at start of test.

OTHER HYDROLOGIC DATA

Page

Springs

Chemical analyses of ground water

Rainfall data

Table 38. Monthly and annual rainfall, in inches, at Garapan from German sources (1901-12)

Location: Lat 15°12'N., long 145°43'E. at altitude 30 ft[1/].

[Source: Mitt(h)eilungen von Forschungreisenden und Gelehrten aus den deutschen Schutzgebieten; annual publication, Berlin, 1902-13 (Converted from millimeters to inches)]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1901	0.63	1.44	10.46	2.08	1.30	6.17	8.19	11.24	[2/]14.82	[2/]10.04	3.38	8.18	77.93
1902	4.60	4.82	3.74	1.16	6.97	6.93	8.11	8.83	[2/](9.33)	[2/](1.12)	2.71	1.49	[2/](59.81)
1903	1.80	1.37	1.92	2.57	1.50	2.15	9.15	8.67	12.56	13.68	8.32	8.44	72.13
1904	4.13	4.30	7.33	7.15	6.36	8.32	10.35	14.25	11.15	4.30	5.69	9.99	93.32
1905	2.44	1.26	2.24	1.73	2.20	5.79	5.31	20.94	12.40	14.76	13.62	7.40	90.09
1906	2.24	3.11	5.87	1.30	2.24	7.36	7.48	14.72	18.66	14.61	10.35	5.87	93.81
1907	2.09	3.50	1.54	5.16	2.20	7.68	10.03	19.33	10.31	9.09	9.69	4.96	85.58
1908	1.57	1.02	3.19	3.31	1.34	2.05	15.63	12.44	7.80	8.98	6.42	5.08	68.83
1909	1.30	4.76	3.23	4.29	2.28	4.21	9.06	3.62	16.14	19.65	5.31	8.90	82.75
1910	.87	3.74	1.89	3.31	7.80	4.29	13.07	12.17	10.24	13.58	6.85	1.89	79.70
1911	2.83	11.38	9.92	3.82	1.89	11.50	10.59	22.99	9.21	9.17	19.45	2.36	115.11
1912	.79	1.12	.90	.59	1.43	4.59	6.50	18.37	16.84	13.04	3.56	2.97	70.70
Mean	2.11	3.48	4.35	3.04	3.13	5.92	9.46	13.96	12.74	11.90	7.95	5.63	[3/]83.67
Percent	2.5	4.2	5.2	3.6	3.8	7.1	11.3	16.7	15.2	14.2	9.5	6.7	100

[1/] Location also published as lat 15°11'N., long 145°44'E. (Schott, 1938) and lat 15°13'N., long 145°41'E. (Taylor, 1973).

[2/] No records available for September 22 to October 14, 1902.

[3/] Total of monthly means.

Table 39. Monthly and annual rainfall, in inches, at Tanapag from Japanese sources (1926-41)

Location: Lat 15°14'N., long 145°46'E., at Mount Talufofo, at altitude 680 ft (Cox and Evans, 1956; Davis, 1958).

[Source: Japan Central Meteorological Observatory, The rainfall of Nippon, as published in Military Geology of Saipan (Davis, 1958)]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1926	--	--	--	--	--	--	--	8.15	7.95	16.98	10.91	2.80	--
1927	--	--	--	--	--	--	--	--	--	--	--	--	--
1928	4.84	7.28	3.39	2.52	7.05	4.57	15.94	7.68	24.17	24.37	5.27	6.18	113.26
1929	2.44	3.78	2.09	0.94	2.83	4.17	21.50	9.61	16.30	11.50	4.21	3.54	82.91
1930	2.95	.83	1.61	1.22	3.31	2.09	9.25	11.77	19.02	8.70	10.67	5.16	76.58
1931	3.11	2.01	2.05	2.01	4.25	2.24	6.30	13.86	8.31	8.28	9.06	4.41	65.89
1932	5.20	2.83	3.35	1.18	3.78	5.79	9.37	9.80	10.75	7.95	3.86	2.95	66.81
1933	3.27	2.01	3.03	1.30	3.50	5.43	12.24	9.92	8.86	10.32	3.19	1.81	64.88
1934	19.09	1.89	2.68	2.40	17.32	10.87	13.35	12.99	11.61	11.50	3.74	4.57	112.01
1935	10.98	9.72	5.71	5.63	2.20	11.73	9.94	16.97	29.68	10.12	12.24	9.61	134.53
1936	1.59	.79	4.88	4.04	1.33	3.68	7.21	14.55	15.91	15.75	10.30	3.40	83.43
1937	1.38	3.59	1.08	3.48	5.74	4.61	3.92	13.53	13.24	6.98	4.04	6.11	67.70
1938	6.51	1.78	.97	2.02	2.82	7.40	9.92	16.90	15.63	9.86	6.90	2.84	83.55
1939	4.66	3.21	1.77	2.72	1.35	2.64	12.55	21.99	8.05	5.87	5.23	6.93	76.97
1940	5.04	4.81	1.94	2.70	2.39	5.06	14.61	9.14	29.70	7.14	7.22	9.34	99.09
1941	3.94	2.95	3.12	2.70	2.23	3.40	12.96	14.14	9.46	5.68	2.25	2.48	65.31
Mean	5.36	3.39	2.69	2.49	4.29	5.26	11.36	13.06	15.76	10.29	6.30	4.95	1/85.20
Percent	6.3	4.0	3.2	2.9	5.0	6.2	13.3	15.3	18.5	12.1	7.4	5.8	100

1/ Total of monthly means 1928-41.

Table 40. Monthly and annual rainfall, in inches, at Garapan from Japanese sources (1927-42)

Location: Lat 15°12'N., long 145°43'E., at altitude 21 ft[1/] (Austin Smith and Associates, 1967).

[Source: Taylor, 1973]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1927	4.87	8.04	3.94	7.73	10.40	8.31	9.89	12.57	12.43	5.57	5.22	6.05	95.02
1928	4.92	5.94	5.23	2.50	3.07	4.09	16.02	7.51	23.95	25.16	5.40	6.14	109.93
1929	2.48	3.82	2.15	.85	2.46	4.79	21.57	9.74	17.26	11.96	4.37	3.74	85.19
1930	3.15	8.23	1.78	1.26	2.87	2.75	9.53	12.08	19.00	10.01	6.94	5.66	83.26
1931	3.30	2.15	2.26	2.15	4.30	2.38	6.58	13.75	7.43	9.28	9.17	4.39	67.14
1932	5.37	2.82	3.26	1.23	3.86	5.90	9.28	10.06	10.96	7.61	3.84	2.96	67.15
1933	2.76	2.27	2.73	1.31	3.74	5.44	12.03	9.98	8.71	10.24	3.16	1.74	64.11
1934	18.59	1.89	2.63	2.36	17.32	11.25	12.60	13.87	11.24	11.25	3.39	4.02	110.41
1935	10.52	9.03	6.38	5.76	2.09	10.08	9.95	16.65	30.19	9.64	12.15	9.00	131.44
1936	1.60	.77	4.39	4.37	1.37	3.76	7.22	14.35	15.43	17.08	10.00	3.50	83.84
1937	1.36	3.40	1.31	3.23	5.90	4.57	3.90	13.33	12.78	7.34	4.11	6.09	67.32
1938	6.61	1.76	1.00	2.02	2.71	7.53	10.00	16.75	15.83	9.97	6.96	--	--
1939	4.42	3.48	1.75	2.76	1.39	2.60	11.34	23.72	8.32	6.55	5.11	6.87	78.31
1940	5.30	4.65	1.80	2.80	2.35	5.11	14.85	9.13	30.26	7.08	7.04	9.55	99.92
1941	4.11	2.89	3.13	2.32	2.72	3.58	12.84	16.87	10.22	6.45	2.26	2.91	70.30
1942	14.50	3.36	3.31	2.74	6.18	3.50	14.15	14.66	9.85	10.60	5.65	4.27	82.77
Mean	5.24	4.03	2.94	2.84	4.55	5.35	11.36	13.44	15.24	10.36	5.92	5.13	[2/]86.40
Percent	6.1	4.7	3.4	3.3	5.3	6.2	13.1	15.6	17.6	12.0	6.9	5.8	100

[1/] Latitude, longitude given by Taylor is for Kobler Field. Altitude given by Cox and Evans (1956) is 10 ft.

[2/] Total of monthly means.

Note: In Schott, 1938, monthly means of rainfall for 1927-29 given for Tanapag rain gage at altitude 680 ft (called Hohenstation = High station) are the means for Garapan station.

Table 41. Monthly rainfall, in inches, at miscellaneous sites

(Source: Glander, 1946)

Location	1945 October 7-31	1945 November	1945 December	1946 January
Maui well 1, Kobler Field	5.07	5.10	2.48	2.52
Deep well 14, near Hospital	8.92	5.05	3.15	2.75
Chacha, Hakmang Field	6.74	3.16	1.65	.93
Denni Spring	6.62	2.50	2.60	2.10
Island Command Booster, Capitol Hill.	9.28	2.95	3.25	1.16
Tanapag Booster, Tanapag	8.02	3.10	2.10	2.45

(Source: Written communication W. M. Winfred and F. E. Morris to Navy Authorities)

Location: U.S. Naval Air Station, Tanapag.
January 1947 to January 1950.

	Jan.	Feb.	Mar.	Apr.	May	June
Mean of 3 years	2.99	0.98	2.14	2.09	1.79	2.85

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean of 3 years	7.68	5.86	9.13	8.03	5.42	2.07	51.23

Lowest monthly rainfall, February 1949, 0.33 inches; highest, October 1947, 14.28 inches.

Lowest annual rainfall, 47.78 inches; highest, 57.02 inches.

Table 42. Weekly rainfall, in inches, at Maui 1 (1948)

[Source: Curione, 1949]

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	--	*	*	.50	*	*	4.23	*	--	*	*	*
2	*	*	*	*	*	*	*	*	--	*	*	.30
3	*	*	*	*	*	.53	*	*	--	*	*	*
4	*	*	.68	*	*	*	*	*	--	*	8.41	*
5	*	.55	*	*	*	*	*	2.80	--	*	*	*
6	*	*	*	*	1.15	*	*	*	--	*	*	*
7	*	*	*	*	*	*	*	*	--	2.79	*	*
8	.55	*	*	1.83	*	*	.93	*	--	*	*	*
9	*	*	*	*	*	*	*	*	--	*	*	.13
10	*	*	*	*	*	2.53	*	*	--	*	*	*
11	*	*	1.60	*	*	*	*	*	--	*	.14	*
12	*	.88	*	*	*	*	*	1.77	--	*	*	*
13	*	*	*	*	0	*	*	*	--	*	*	*
14	*	*	*	*	*	*	*	*	--	.20	*	*
15	2.55	*	*	3.33	*	*	3.63	*	--	*	*	*
16	*	*	*	*	*	*	*	*	--	*	*	.54
17	*	*	*	*	*	.45	*	*	--	*	*	*
18	*	*	1.15	*	*	*	*	*	--	*	2.20	*
19	*	.05	*	*	*	*	*	.70	--	*	*	*
20	*	*	*	*	1.00	*	*	*	--	*	*	*
21	*	*	*	*	*	*	*	*	--	1.61	*	*
22	1.05	*	*	.16	*	*	.13	*	--	*	*	*
23	*	*	*	*	*	*	*	*	--	*	*	.01
24	*	*	*	*	*	.65	*	*	*	*	*	*
25	*	*	.60	*	*	*	*	*	*	*	1.25	.50
26	*	.18	*	*	*	*	*	.63	*	*	*	*
27	*	*	*	*	.95	*	*	--	*	*	*	*
28	*	*	*	*	*	*	*	--	*	4.11	*	*
29	.32	*	*	.35	*	*	1.88	--	*	*	*	*
30	*		*	*	*	*	*	--	1.18	*	*	*
31	*		*		*		*	--		*		.10

* Included in following total.
Total January 2 to August 26, 1948: 40.29 inches.

Table 43. Weekly rainfall, in inches, at well 3 (1948)

[Source: Curione, 1949]

Day	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		.10	*	--	*	--	*	--	*	*	--
2		--	.35	--	*	*	*	--	*	*	--
3		--	*	--	.55	*	*	--	*	*	--
4		--	*	--	*	*	*	--	*	9.55	--
5		*	*	--	*	*	.35	--	*	*	--
6		*	*	--	*	*	*	--	*	*	--
7		*	*	*	*	*	*	--	1.10	*	--
8		*	1.50	*	*	1.90	*	*	--	*	--
9		*	*	*	*	--	*	*	--	*	--
10		*	*	*	1.35	--	*	*	--	*	*
11		3.95	*	*	*	--	*	*	--	.65	*
12		*	*	*	*	--	1.95	*	--	--	*
13		*	*	.35	*	--	*	*	--	--	*
14		*	*	*	*	--	*	1.40	--	--	*
15		*	3.05	*	*	--	*	--	*	--	*
16		*	*	*	*	*	*	--	*	--	.40
17		*	*	*	.90	*	*	--	*	--	*
18		.55	*	*	*	*	*	--	*	--	*
19		*	*	*	*	*	2.75	--	*	*	*
20		*	*	.65	*	*	*	--	*	*	*
21		*	*	*	*	*	*	--	2.70	*	*
22		*	.45	*	*	.70	*	--	--	*	*
23		*	*	*	*	*	*	--	--	*	.70
24		*	*	*	.25	*	*	*	--	*	
25		.30	*	*	*	*	*	*	--	.90	
26		*	*	*	*	*	2.10	*	--	--	
27	*	*	*	.55	*	*	--	*	--	--	
28	*	*	*	*	*	*	--	*	--	--	
29	*	*	.25	*	*	1.40	--	*	*	--	
30		*	--	*	.70	*	--	.88	*	--	
31		*		*		*	--		*		

* Included in following total.

Table 44. Weekly rainfall, in inches, at Capitol Hill (1948)

[Source: Curione, 1949]

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		*	*	.5	*	*	1.2	--	--	--	*	*
2		*	*	*	*	*	--	--	--	--	*	1.8
3		*	*	*	*	1.2	--	--	--	--	*	*
4		*	.8	*	*	*	--	--	--	--	8.5	*
5		1.0	*	*	*	*	--	--	--	--	*	*
6		*	*	*	.7	*	--	--	--	--	*	*
7		*	*	*	*	*	--	--	--	--	*	*
8		*	*	1.8	*	*	--	--	--	--	*	*
9		*	*	*	*	*	--	--	--	--	*	3.4
10		*	*	*	*	4.7	--	--	*	--	*	*
11		*	1.8	*	*	*	--	--	*	--	.4	*
12		1.5	*	*	*	*	--	--	*	--	*	*
13		*	*	*	0	*	--	--	*	--	*	*
14		*	*	*	*	*	--	--	*	--	*	*
15		*	*	6.9	*	*	--	--	*	*	*	*
16		*	*	--	*	*	--	--	3.6	*	*	.3
17		*	*	--	*	.1	--	--	--	*	*	*
18		*	2.8	--	*	*	--	--	--	*	3.7	*
19		1.0	*	--	*	*	--	--	--	*	*	*
20		*	*	--	1.2	*	--	--	--	*	*	*
21		*	*	--	*	*	--	--	--	2.9	*	*
22		*	*	--	*	*	--	--	--	*	*	*
23		*	*	*	*	*	--	--	--	*	*	.8
24		*	*	*	*	.9	--	--	*	*	*	
25		*	1.7	*	*	*	--	--	*	*	1.3	
26		.3	*	*	*	*	--	--	*	*	*	
27		*	*	*	.4	*	--	--	*	*	*	
28		*	*	*	*	*	--	--	*	4.2	*	
29		*	*	.2	*	*	--	--	*	*	*	
30	*		*	*	*	*	--	--	.5	*	*	
31	*		*		*		--	--		*		

* Included in following total.

Table 45. Monthly and annual rainfall, in inches, from U.S. Navy (1954-63)

[Source: U.S. Weather Bureau, 1954-55, 1956-63]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
At lat 15°07'N., long 145°42'E., altitude 105 ft													
1954	1.59	3.25	3.60	1.76	2.97	1.98	2.65	13.57	17.75	8.21	--	4.64	--
1955	5.00	2.10	3.64	1.87	1.45	4.42	9.28	4.90	9.44	7.43	4.74	3.98	58.25
1956	4.06	1.12	3.65	--	3.08	--	--	10.70	10.55	9.28	5.98	2.71	--
1957	4.02	1.99	2.30	1.26	2.33	2.22	1.54	11.40	7.83	7.34	11.32	2.67	56.22
1958	3.01	1.64	2.29	1.72	1.67	11.29	13.28	7.59	9.88	6.79	5.21	3.90	68.27
1959	2.19	4.34	3.14	4.02	2.63	2.76	7.11	10.08	13.08	7.34	7.04	(1.70)	65.43
At lat 15°13'N., long 145°42'E., altitude 105 ft[1/]													
1959												1.70	
1960	2.16	2.06	1.21	2.52	3.58	4.78	4.38	28.94	16.61				
At lat 15°13'N., long 145°43'E., altitude 495 ft													
1960										19.50	9.45	7.04	--
1961	6.52	2.83	3.89	4.23	3.66	6.36	6.80	11.10	9.11	19.29	3.64	(5.27)	82.70
At lat 15°13'N., long 145°46'E., altitude 495 ft[1/]													
1961												5.27	--
1962	6.65	4.55	2.87	3.45	2.74	--	--	7.44	--	--	--	--	--
1963	3.06	3.54	2.40	13.31	4.33	5.05							
Mean	3.83	2.74	2.90	3.79	2.84	4.86	6.43	11.75	11.78	10.65	6.77	3.99	[2/]72.33
Percent	5.3	3.8	4.0	5.2	3.9	6.7	8.9	16.3	16.3	14.7	9.4	5.5	100

[1/] U.S. Weather Bureau publications do not indicate whether this is a relocation or a correction of latitude or longitude; altitude remained unchanged.

[2/] Total of monthly means.

Table 46. Monthly and annual rainfall, in inches, from U.S. Coast Guard LORAN station (1963-76)

Location: Lat 15°08'N., long 145°42'E., altitude 9 ft, at U.S. Coast Guard.

[Sources: U.S. Weather Bureau, 1963-69, and U.S. National Oceanic and Atmospheric Administration, 1970-76]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1963	--	--	--	--	--	--	9.06	8.14	16.99	9.40	3.87	9.69	--
1964	2.02	1.74	2.29	10.38	4.56	2.49	8.05	7.09	11.07	7.30	6.64	5.25	68.88
1965	9.20	3.00	1.98	1.68	4.41	2.03	15.17	3.80	19.71	7.82	4.88	8.14	81.82
1966	3.18	4.42	1.01	1.23	--	2.27	4.35	22.03	17.63	13.04	8.39	3.87	--
1967	3.17	3.98	3.55	6.62	.74	6.57	14.27	17.64	21.02	10.20	12.45	3.14	103.35
1968	3.55	1.12	3.31	--	--	8.41	11.78	12.52	17.73	11.68	22.57	1.10	--
1969	1.04	1.43	2.06	1.72	1.65	2.79	9.68	4.10	5.04	18.61	4.81	8.28	61.21
1970	11.13	4.55	2.99	1.64	1.48	5.64	10.19	8.31	4.83	5.00	2.55	5.38	63.99
1971	2.78	5.50	13.79	5.37	8.88	5.49	9.70	6.80	--	6.66	9.13	3.40	--
1972	3.74	--	--	2.13	--	6.13	--	--	--	6.95	--	2.13	--
1973	--	1.75	1.02	2.20	--	1.63	6.84	11.07	7.22	9.36	--	--	--
1974	4.04	3.78	6.24	7.93	5.31	5.76	5.83	16.00	11.98	11.96	7.43	2.76	89.02
1975	5.01	4.76	4.33	2.28	1.06	3.15	11.81	17.59	16.00	7.71	9.37	5.22	88.29
1976	8.65	3.24	1.83	2.71	--	--	--	--	10.68	4.24	6.93	2.92	--
Mean	4.79	3.27	3.70	3.82	3.51	4.36	9.73	11.26	13.32	9.28	8.25	4.71	[1]80.00
Percent	6.0	4.1	4.6	4.8	4.4	5.4	12.2	14.1	16.6	11.6	10.3	5.9	100

[1] Total of monthly means.

Agriculture Station, Hakmang
[Commonwealth of the Northern Mariana Islands]

Location: Lat 15°10'21" N., long 145°46'05" E., at Agriculture Station, Hakmang, 0.6 mile southwest from Communication Center rain gage.
Period of record: 1976-83.
Gage: Rain can read twice daily at 0730 and 1630. Altitude of gage is 205 ft (from topographic map).
Remarks: After typhoon Diana in November 1980, rain gage was moved from large open space in center of Agriculture Station buildings to an area between two of the buildings. Gage was returned to original site two years later.

Table 47. Monthly and annual rainfall, in inches, at Agriculture Station, Hakmang (1976-83)

[Source: Agriculture Station]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1976	--	--	1.30	1.92	4.66	2.60	10.00	13.70	17.33	2.45	4.88	2.05	--
1977	2.28	2.12	4.39	1.83	.72	1.39	3.45	--	22.74	14.85	12.35	1.29	--
1978	1.81	1.59	3.63	1.90	5.99	4.46	8.69	--	12.28	11.75	--	4.95	--
1979	--	--	--	--	--	--	--	--	10.90	--	3.04	--	--
1980	1.10	7.40	1.34	1.57	4.34	3.74	6.26	9.11	27.27	8.99	11.78	7.00	89.90
1981	3.57	2.03	2.45	4.23	2.25	2.84	15.57	29.70	6.82	9.20	12.02	7.06	97.74
1982	9.59	1.90	8.18	1.28	6.77	11.27	11.27	10.32	6.70	1/ 15.5	2.76	3.80	1/ 89.34
1983	2.20	2.14	1.90	1.85	1.27	1.61							
Mean	3.42	2.86	3.31	2.08	3.71	3.99	9.21	15.70	14.86	10.46	7.80	4.36	2/ 81.76
Percent	4.2	3.5	4.1	2.5	4.5	4.9	11.3	19.2	18.2	12.8	9.5	5.3	100

1/ At least as much. Rain can overflowed on October 18, 1982.
2/ Total of monthly means.

Communication Center Rain Gage, Hakmang

Location: Lat 15°10'37" N., long 145°46'32" E., in center of area between Communication Center buildings at Hakmang.

Period of record: 1968-72, 1975-83.

Gage: Eight-inch diameter rain can, read daily at 1000. Altitude of gage is 150 ft (from topographic map).

Remarks: Station is U.S. Weather Service Substation at Hakmang Communication Center. Records are not published by U.S. Weather Service.

Table 48. Monthly and annual rainfall, in inches, at Communication Center, Hakmang (1968-83)

[Source: U.S. Weather Service, Guam]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1968	--	--	--	--	--	--	--	--	--	--	1.63	--	--
1969	0.54	1.48	2.41	1.50	1.69	3.79	1.31	11.90	8.55	4.92	16.32	4.04	58.45
1970	11.23	3.38	.60	.18	.19	--	--	--	--	--	--	--	
1971	1.18	8.67	3.75	4.04	5.33	1.50	17.31	4.82	4.76	7.29	1.06	.59	60.30
1972	1.06	.54	.90	.73	.45	1.58	9.80	3.79	.93	1.45	1.15	--	--
1975	--	--	--	--	--	--	18.36	22.34	9.86	5.44	6.63	3.18	--
1976	--	--	1.48	2.23	13.24	3.61	11.71	18.31	16.52	1.98	--	1.65	--
1977	2.69	1.40	3.22	1.22	.65	2.01	7.36	3.73	20.15	16.09	13.73	1.11	73.36
1978	1.12	1.19	1.31	3.34	3.35	[1] 4.50	14.06	[2] 73.25	14.74	10.58	13.49	4.14	145.07
1979	3.66	2.04	1.65	1.53	3.24	3.13	8.69	--	--	11.86	2.75	3.47	--
1980	.88	5.90	.66	1.28	3.20	3.71	4.57	10.99	25.49	8.04	11.70	5.69	82.11
1981	3.47	1.83	2.12	3.42	3.16	2.40	11.02	24.24	5.09	5.16	8.96	5.96	76.83
1982	7.18	1.99	4.08	1.09	1.75	5.88	9.91	8.45	5.83	23.80	2.20	2.75	74.91
1983	3.06	1.91	1.43	1.94	1.17	1.32	3.29	10.31	5.24	10.71	6.08	4.52	50.98
Mean	3.28	2.76	1.97	1.88	3.12	3.04	9.78	[3] 17.47	10.65	8.94	7.14	3.37	[4] 73.40
Percent	4.5	3.8	2.7	2.6	4.2	4.1	13.3	23.8	14.5	12.2	9.7	4.6	100
Percent[5]	4.8	4.1	2.9	2.8	4.6	4.5	14.4	17.5	15.7	13.2	10.5	5.0	100

[1] No record June 30, 1978.

[2] Rainfall for Aug. 11-12, 1978: 44.5 inches with rain can overflowing both days.

[3] August mean without 1978 monthly total is 11.89 inches.

[4] Total of monthly means.

[5] August 1978 mean not included (for comparison with other rain gages where August 1978 totals were missing).

Table 49. Daily rainfall, in inches, at Communication Center (1976-83)

[Source: U.S. Weather Service, Guam]

1976

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.25	0.19	0.48	0	0.10	0	0.06	0.71	0.03	0.20	--	0
2	.08	.20	.02	.17	1.95	0	.09	.32	0	.08	--	.01
3	0	.33	0	.06	.40	0	.02	.35	0	0	--	0
4	--	.01	.05	.01	.14	.09	.03	5.49	.05	.19	--	0
5	.17	.12	0	0	.05	0	.16	3.10	1.50	.46	--	.03
6	.05	.13	0	0	.07	.01	0	2.12	2.75	.34	--	0
7	--	.08	.05	0	.30	.18	.09	.54	.20	0	--	0
8	0	.35	.07	0	0	.04	.06	.09	.99	0	--	0
9	.18	.02	0	0	0	.16	.11	.06	.14	0	--	0
10	.48	.06	0	0	0	.01	.66	0	0	0	--	0
11	.04	.03	0	.09	0	.06	0	0	.36	0	--	.02
12	.01	.01	0	0	0	0	0	0	.15	.01	--	.09
13	0	--	0	0	.23	0	.59	0	.45	0	--	.43
14	0	--	.02	0	0	.02	3.10	.27	.12	0	--	.40
15	.04	.06	0	0	.01	0	.14	.30	1.20	0	--	0
16	.07	--	0	0	0	.63	.11	.20	.80	0	--	0
17	.35	.23	0	0	0	.07	.26	.38	.35	.02	--	0
18	--	.42	0	.09	0	0	0	1.05	.25	.15	--	0
19	0	.08	0	.23	0	.17	.41	.01	.01	0	--	.01
20	.12	.03	.17	.10	1.38	0	2.10	0	.01	0	--	.01
21	.41	--	0	.46	3.45	.15	.72	1.35	.01	.02	--	.05
22	.28	--	.21	.12	4.02	.04	.45	1.42	.18	0	--	.22
23	.33	--	.06	0	.07	.35	.16	.06	1.25	0	--	.05
24	.25	--	.04	0	0	.53	.73	.06	4.40	0	--	0
25	.06	--	.11	0	0	.09	0	.19	.13	0	--	0
26	.01	--	.10	.01	.35	.13	.52	.03	.37	0	--	0
27	--	--	.06	0	.30	0	.13	.01	.19	.01	--	0
28	--	--	0	.75	.03	.53	.06	.02	0	.05	--	.20
29	.16	.14	.04	.14	.39	.11	.09	0	0	.03	--	.03
30	.84		0	0	0	.24	.85	0	.63	.17	--	.05
31	.24		0		0		.01	0		.25		.05
Total	--	--	1.48	2.23	13.24	3.61	11.71	18.13	16.52	1.98	--	1.65

Table 49. Daily rainfall, in inches, at Communication Center--Continued

1977

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.17	0	0	0.05	0	0	0.46	0.06	0	0	0	0.02
2	0	0	0	0	0	.03	0	0	.06	.38	3.64	.01
3	.20	0	.01	.12	.07	0	0	0	.14	.02	.01	.03
4	.25	0	0	0	0	0	0	.41	.04	0	.01	.09
5	0	0	0	0	.04	.37	0	0	.03	.02	.12	.04
6	0	0	.01	0	.22	0	0	0	1.20	0	.03	0
7	0	.03	.40	0	0	.72	.05	.05	1.47	.04	.25	0
8	0	0	.07	.04	0	.07	0	.08	.04	0	1.40	.37
9	.04	.04	.06	0	0	.06	.03	.02	0	.02	2.02	.03
10	0	.25	.05	0	.01	0	.02	0	0	.80	2.49	0
11	.17	.22	.02	.42	.04	.05	.02	.04	0	.86	.09	0
12	.22	0	.06	.15	.04	.08	.04	.18	.05	.07	.15	0
13	0	.04	.39	0	0	.02	.03	.07	2.85	.60	.33	0
14	0	0	0	0	0	.03	.01	.17	5.55	.10	1.05	0
15	.11	0	.73	0	0	.01	.01	.45	2.02	.40	1.87	0
16	.50	0	.01	.01	0	.05	0	0	5.06	.52	0	0
17	0	.03	.13	0	0	0	.03	0	.78	.38	0	.01
18	0	0	.02	.02	0	.12	0	.01	.20	.11	0	0
19	.22	0	.23	0	.10	.04	0	.05	.10	.27	0	.04
20	.06	.26	.02	0	0	.03	.03	.08	.11	2.02	.03	0
21	.07	.05	.22	0	0	0	.07	.01	.05	.54	.15	0
22	.03	.07	.01	.01	0	0	2.37	.09	0	1.53	0	0
23	.06	0	.17	.01	0	0	.11	0	0	7.15	0	0
24	.24	0	.29	0	0	.15	.25	0	0	.15	0	.23
25	0	.05	.22	0	0	.07	.21	.68	0	0	0	.01
26	.02	.22	0	0	0	0	.60	.31	0	0	.04	0
27	.23	.08	.02	.01	0	.05	.42	.01	0	.02	0	0
28	0	.06	.01	0	0	0	1.05	.16	.18	.05	.01	.05
29	0		0	.26	0	0	.10	.30	.17	0	.01	.09
30	.10		.03	.12	0	.06	1.40	.45	.05	.04	.03	.07
31	0		.04		.13		.05	.05		0		.02
Total	2.69	1.40	3.22	1.22	0.65	2.01	7.36	3.73	20.15	16.09	13.73	1.11

Total for 1977: 73.36 inches.

Table 49. Daily rainfall, in inches, at Communication Center--Continued

1978

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.05	0	0.10	0.08	0.03	0.46	0.41	0.01	0.15	0.59	0.80	0.20
2	0	0	0	.02	.02	0	.25	0	.07	1.28	2.60	.24
3	.02	0	0	0	.01	.05	.37	.13	.03	.09	.01	.57
4	.04	.03	.14	.01	.02	0	.92	.01	.17	.45	.03	.01
5	.01	.06	0	1.35	0	.05	1.03	.75	.03	.60	.02	0
6	0	.06	0	.01	0	.12	.02	.04	.49	.94	.02	.01
7	0	.02	.11	0	.34	.11	0	.05	.19	0	.03	.19
8	0	.01	0	.12	0	.02	.15	3.01	.05	1.40	.18	.01
9	0	.01	0	.20	.10	.11	0	5.05	.13	.20	0	.10
10	0	0	0	0	.04	.11	.80	1.30	0	.32	0	.07
11	0	0	.02	0	.01	.57	.15	22.30	.05	.01	.04	.05
12	0	0	0	0	.01	0	0	22.20	1.10	0	.19	.04
13	0	.09	0	0	.86	.18	.17	1.80	0	.31	0	.10
14	.02	0	0	0	0	.07	.89	1.00	.02	.02	.30	.02
15	.08	0	0	0	0	0	.30	1.25	.14	1.04	.86	.03
16	.01	.16	.01	.04	.05	.05	2.57	.03	.15	.06	0	.50
17	.24	.12	.01	.29	.14	.27	.45	0	.86	.07	.01	.02
18	.03	0	0	.11	.03	.16	.52	.04	.02	.02	.02	0
19	0	.03	.53	.15	0	.10	.13	.58	.06	.19	1.30	0
20	0	.04	0	.11	0	.25	1.01	.56	.04	.18	.05	0
21	0	.02	.01	.01	0	0	1.50	.38	.18	0	2.18	0
22	0	.03	0	.21	0	.03	.04	.21	.44	.02	.06	.02
23	.01	.48	.07	.02	0	0	.03	2.20	.02	.01	0	.23
24	0	.03	.01	.35	0	1.09	.02	.01	.26	.20	.07	.75
25	.30	0	0	.02	1.14	.01	.04	.08	1.74	.60	.03	.02
26	0	0	.01	.01	0	.01	.15	.05	.32	.40	0	.80
27	.01	0	0	.05	.08	.06	.29	.12	.48	.04	.36	.05
28	0	0	.07	0	0	.04	0	.16	7.50	.16	2.05	.02
29	.07		.20	0	.22	.58	.59	8.72	0	.25	2.19	.01
30	0		.02	.18	.25	--	1.22	.89	.05	.23	.09	.08
31	.23		0		0		.04	.32		.90		0
Total	1.12	1.19	1.31	3.34	3.35	4.50	14.06	73.25	14.74	10.58	13.49	4.14

Total for 1978: 145.07 inches.

Table 49. Daily rainfall, in inches, at Communication Center--Continued

1979

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0.37	0	0.02	0	0.01	0.21	--	--	0.75	0.02	0.01
2	.05	.09	0	.06	.01	0	.75	--	--	2.11	.03	.01
3	0	.01	0	.14	0	0	.36	--	--	0	.03	.01
4	0	.02	.07	.01	0	0	.19	--	--	.58	.05	.07
5	0	.04	.30	.02	0	.01	.93	--	--	.05	.06	.20
6	0	.10	.23	.10	0	0	0	--	--	.02	.03	.37
7	.05	.28	.08	.09	0	.14	.30	--	--	0	.06	.20
8	0	0	.25	0	.01	.40	.01	--	--	.45	.06	.42
9	.04	0	0	.02	0	.04	0	--	--	0	.20	.82
10	.51	.08	.01	0	0	.02	0	--	--	.80	.05	.01
11	.23	.02	.02	0	0	.03	.29	--	--	1.00	.21	.30
12	.45	0	.63	.01	0	.10	0	--	--	.29	.01	.08
13	.29	.01	.01	.02	0	.06	0	--	--	.07	0	.12
14	.08	.28	0	0	0	.40	.22	--	--	1.55	.04	.07
15	.02	.27	0	0	.03	.30	0	--	--	.15	.02	.02
16	0	.13	0	0	.01	.01	0	--	--	.02	0	.01
17	0	0	0	.10	.02	0	0	--	--	0	0	0
18	.05	0	0	.26	0	0	.06	--	--	0	.03	.13
19	0	.06	0	0	.05	.25	0	--	--	.22	.02	.27
20	.13	.03	.01	.05	0	0	.06	--	--	0	.10	.09
21	.02	.05	0	.15	.03	.03	0	--	--	0	.09	0
22	0	.20	0	.07	.06	0	1.82	--	--	2.25	.07	0
23	.04	0	.02	.04	.05	.07	0	--	--	.39	.05	0
24	.07	0	0	.11	0	.02	0	--	--	.05	.04	0
25	.09	0	0	.01	.03	.40	1.50	--	--	.80	.18	.02
26	.49	0	0	.02	1.80	.30	.97	--	--	.08	.08	.04
27	.06	0	.01	*	1.02	0	.22	--	--	.03	.12	.11
28	0	0	0	.05	.07	.15	.10	--	--	.05	1.05	.05
29	.03		.01	.06	0	.39	.05	--	--	.11	.01	.01
30	.52		0	.12	0	0	.25	--	--	.02	.04	.02
31	.44		0		.05		.40	--		.02		.01
Total	3.66	2.04	1.65	1.53	3.24	3.13	8.69	--	--	11.86	2.75	3.47

* Included in following total.

Table 49. Daily rainfall, in inches, at Communication Center--Continued

1980

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.03	0	0.03	0.03	0	0.10	0.19	0	0.05	1.30	0.60	0.10
2	.09	0	0	.10	0	.76	0	1.05	0	.02	.01	.10
3	.15	.01	0	.02	0	0	.14	.10	.07	.56	.01	.05
4	0	.05	0	.01	.01	.02	0	.75	.21	0	.01	.15
5	0	0	0	.01	0	.12	.05	.25	.36	0	.50	.01
6	0	0	.01	.18	.05	.11	.60	.44	2.30	.14	.05	.01
7	.01	.24	0	0	0	.01	.41	.01	2.90	1.40	.30	0
8	0	.01	0	.03	.69	.20	.30	0	1.21	1.94	.10	0
9	.19	.04	0	0	.04	0	.01	.02	4.10	.01	.02	0
10	0	0	0	.05	0	.03	.06	.80	1.30	.24	.04	.05
11	0	0	0	0	0	.06	.01	0	3.60	0	.03	.02
12	0	0	0	.06	0	.26	0	.02	.50	.15	.15	0
13	.06	.04	.04	0	0	.15	.09	.02	.25	0	.10	0
14	0	.15	0	0	1.14	.01	.30	.40	0	.08	.09	.10
15	0	0	0	.10	.01	0	.28	.10	0	0	.90	.50
16	.05	0	.02	.03	.06	.06	.16	.90	.09	.01	.10	0
17	0	.05	.06	.01	0	.02	.80	.19	.05	.04	.05	0
18	0	0	.08	.32	.20	0	.12	.12	.05	.20	.01	0
19	0	.10	.09	0	0	.08	.07	.20	.09	.04	.86	0
20	0	0	.01	0	.32	.24	0	.25	0	0	.79	0
21	.01	0	.22	0	.11	.02	.44	.15	0	.16	.05	.72
22	.01	0	0	.19	.04	.02	.14	.25	.45	.10	.20	2.00
23	0	2.25	0	.01	.02	.09	.02	2.30	.07	0	6.01	.60
24	.04	1.63	.05	0	0	.08	.32	2.00	.49	.15	0	.08
25	.10	.47	.02	.02	.01	0	.02	.06	.55	.05	0	.01
26	0	.49	.01	.03	.05	.10	0	.17	1.21	.75	0	.08
27	0	.20	0	0	0	.04	0	.25	4.00	.01	.20	.11
28	.01	.15	0	0	.01	.69	0	.05	.22	.01	.07	.16
29	.13	.02	.01	.04	.44	.05	0	.02	.25	.03	.05	.23
30	0		0	.04	0	.39	.03	.01	1.12	.05	.40	.61
31	0		.01		0		.01	.11		.60		0
Total	0.88	5.90	0.66	1.28	3.20	3.71	4.57	10.99	25.49	8.04	11.70	5.69

Total for 1980: 82.11 inches.

Table 49. Daily rainfall, in inches, at Communication Center--Continued

1981

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.33	0	0.70	0.03	0	0.02	0.01	5.80	0.01	0	0.10	0.39
2	*	.12	.10	0	0	.01	.10	1.05	0	.80	.25	.21
3	*	0	.11	.07	.02	.01	.16	.60	.02	0	.05	.04
4	.20	.02	.05	.10	0	0	.05	.03	0	0	.15	0
5	.01	0	.03	0	.08	.01	.04	.20	.19	.22	.49	.12
6	.06	0	.25	0	.02	0	0	.15	0	.05	.06	0
7	.05	0	.01	.02	.04	0	.05	.29	0	0	.01	0
8	.06	.11	.01	0	.05	.04	.30	0	0	.25	0	0
9	0	.90	.01	.01	.74	0	.12	.04	.02	.23	0	0
10	0	.65	0	.54	.25	.05	.10	.05	.01	.41	.18	.01
11	0	.01	.26	.43	1.45	0	.08	.02	0	.02	0	0
12	.06	0	0	0	.19	0	.47	.43	.05	.03	.08	.03
13	.02	.02	0	0	.02	.24	.42	.59	.07	.12	.11	.33
14	0	0	.02	.03	0	0	.66	2.15	.36	.18	.09	.69
15	.23	0	0	0	0	.85	.63	3.05	.19	.89	.70	.06
16	.31	0	0	0	0	.19	.14	1.05	.04	.20	2.31	.02
17	0	0	0	0	0	.12	.10	2.75	.44	.03	.17	3.10
18	0	0	0	.14	.15	.15	2.00	1.00	.85	.01	.04	.01
19	0	0	0	1.70	.02	.01	.03	.01	.04	.15	.02	.20
20	.45	0	.05	.11	0	.02	.22	.03	0	.01	1.20	.05
21	.35	0	.01	.06	0	.01	.29	.14	.12	.02	0	.08
22	0	0	0	.09	0	0	.08	.19	0	.75	.21	.02
23	.89	0	.10	.01	.04	0	.02	.09	.06	0	0	.28
24	.03	0	.16	.02	.03	.03	.02	.35	.05	.12	2.33	.02
25	.01	0	0	.01	.02	0	.05	.60	.55	.04	.01	.02
26	.06	0	0	0	0	.13	.32	3.00	.25	.43	.01	.05
27	.03	0	0	0	0	.20	.02	.22	1.00	.12	.24	.02
28	.15	0	.25	0	.03	.05	.03	.35	.76	.06	.09	.10
29	.07		0	0	0	.11	.43	0	.01	0	0	0
30	.04		0	.05	0	.15	2.78	0	0	.02	.06	.10
31	.06		0		.01		1.30	.01		0		.01
Total	3.47	1.83	2.12	3.42	3.16	2.40	11.02	24.24	5.09	5.16	8.96	5.96

* Included in following total.

Total for 1981: 76.83 inches.

Table 49. Daily rainfall, in inches, at Communication Center--Continued

1982

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0.70	0.40	0.02	0	0	0	0.21	0.01	0	0	0.07
2	.02	.21	0	.01	.01	0	0	.05	.11	.12	.10	.17
3	.50	.01	0	0	0	.15	.42	.21	.09	3.50	.25	.08
4	.01	.01	.05	0	.04	0	.25	.07	.04	.54	.12	0
5	.10	.02	0	0	.10	.02	.10	.01	.12	.05	.39	.03
6	.01	.11	0	.07	0	0	.01	0	1.30	1.00	.05	.02
7	.02	.10	.20	.15	0	.14	0	0	.03	.55	.05	0
8	.03	.10	0	.05	0	0	.07	1.20	.45	.65	.10	.34
9	.01	0	0	0	.07	.11	.01	.01	.01	.09	.20	.02
10	.04	0	0	0	.15	.03	.40	.13	.40	.19	.10	.01
11	2.40	.01	.03	0	0	0	0	0	1.05	0	0	.02
12	1.36	.01	0	.01	.03	.01	0	.09	0	.80	.03	0
13	.81	.11	.05	0	.01	0	.01	0	.04	.04	0	0
14	.01	0	0	0	.01	0	.39	.65	.15	.47	.05	.20
15	0	.13	0	0	.27	0	.31	.03	.01	.29	.02	.17
16	.02	0	0	0	.01	.03	.07	.71	0	0	0	.08
17	.04	.23	.10	.12	.35	0	.23	.16	.15	3.50	.02	0
18	.01	0	.06	0	.36	0	.05	.05	.17	8.00	.03	.98
19	0	0	1.35	0	0	0	.01	.07	1.00	2.00	0	0
20	0	0	.03	0	0	.03	1.00	.25	.01	1.75	0	.19
21	.05	.05	.07	.01	.02	0	0	.02	.02	.05	.03	.04
22	.03	.05	0	.07	0	.40	0	.05	0	.08	.40	.04
23	0	0	0	.15	0	2.80	.69	4.10	0	.02	0	.09
24	.04	0	0	0	0	.24	.05	.13	0	0	.02	0
25	.08	0	.02	0	0	.05	0	0	0	0	.02	.02
26	.02	0	.15	0	.10	.14	0	.01	0	.05	0	.01
27	1.08	.10	.02	.13	.03	.77	.02	.08	.02	.04	.05	.04
28	.05	.04	.05	0	.02	.30	3.80	.02	0	0	.08	.06
29	.03		.10	.20	.11	.14	1.46	.10	.65	0	.07	.02
30	.40		1.35	.10	.04	.52	.46	.01	0	[1/] .02	.02	0
31	.01		.05		.02		.10	.03		[1/] (0)		.05
Total	7.18	1.99	4.08	1.09	1.75	5.88	9.91	8.45	5.83	23.80	2.20	2.75

Total for 1982: 74.91 inches.

[1/] Not recorded by Communication Center personnel. Estimated.

Table 49. Daily rainfall, in inches, at Communication Center--Continued

1983

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0	0.09	0.12	0.01	0.02	0.15	0	0	0.11	0.29	0.10
2	0	.10	0	.05	.01	0	.01	.15	.12	1.17	.21	1.60
3	0	0	0	.05	.08	0	0	.40	.54	.04	.09	0
4	1.80	0	0	0	.01	0	0	.10	.03	.07	.01	.03
5	.10	0	.01	.03	0	0	0	.11	0	.09	.01	.40
6	0	0	0	.09	.10	.05	0	.02	.10	.05	.15	.37
7	0	0	0	.02	.01	.01	.01	0	.23	1.71	.06	0
8	.01	0	.32	.01	.10	.09	.01	2.60	0	.33	0	.10
9	.01	0	.09	0	.01	0	.09	2.47	.03	.10	.17	.03
10	0	.01	.02	0	.01	.02	.01	.10	0	.09	0	.02
11	.01	0	.27	.06	0	.01	.03	1.40	0	.02	.20	.08
12	.25	0	.14	0	0	.03	.03	.49	.17	.05	.16	0
13	.10	.01	0	.01	0	.10	.02	.06	.10	.44	.27	.01
14	0	.13	0	.17	.20	0	.34	0	.01	0	.22	.05
15	.03	.28	0	0	.01	.15	.70	.10	.57	.20	.90	.10
16	0	.01	0	.02	.01	.60	.08	.44	.05	.27	.28	.27
17	0	0	0	0	.05	.02	.03	.60	.30	.20	.30	.48
18	0	0	.01	.38	.05	.02	.01	.10	.20	.38	.06	0
19	.01	.57	0	.60	.07	.01	.21	.06	.02	.09	.10	.03
20	0	.03	0	.01	0	.05	.20	.57	.47	.06	0	.01
21	.13	0	.05	0	0	0	.15	.04	1.10	1.70	.90	.22
22	.40	0	0	0	.04	.03	.25	0	.05	.20	1.10	.35
23	.19	0	0	0	.02	0	.13	0	0	1.79	.20	.12
24	0	.01	.11	0	.05	.04	.06	0	.15	.50	.10	.01
25	0	0	0	0	.03	0	.01	0	.06	.17	.15	0
26	0	.75	.12	.20	.01	0	.10	.10	.20	.09	.02	.07
27	.01	0	0	.02	.03	.02	.01	.30	.50	.06	.01	.02
28	0	.01	0	.02	.05	.02	.01	0	.04	.40	.07	0
29	0		.11	.01	.20	.03	.15	0	.03	.30	.02	0
30	0		.02	.07	.01	0	.39	.07	.17	.02	.03	.05
31	.01		.07		0		.10	.03		.01		0
Total	3.06	1.91	1.43	1.94	1.17	1.32	3.29	10.31	5.24	10.71	6.08	4.52

Total for 1983: 50.98 inches.

Isley Field Rain Gage
(U.S. Geological Survey)

Location: Lat 15°07'33" N., long 145°43'00" E., at west side of covered reservoir near Isley Field.

Period of record: March 1977 to December 1983.

Gage: Eight-inch diameter rain can, continuous record of rainfall. Altitude of gage is 200 ft (from topographic map).

Table 50. Monthly and annual rainfall, in inches, at Isley Field

Year	Jan.	Feb.	Mar.	Apr.	May	June
1977	--	--	2.16	0.31	2.52	3.87
1978	0.48	0.57	.39	1.03	*	*
1979	1.41	.01	1.53	.78	3.83	2.05
1980	.13	6.01	.53	.29	2.96	2.25
1981	3.07	1.23	1.75	3.06	1.40	1.73
1982	5.89	2.01	2.85	.59	1.58	4.49
1983	1.28	1.15	1.57	.82	1.15	.23
Mean	2.04	1.83	1.54	.98	2.24	2.44
Percent	3.4	3.1	2.6	1.6	3.7	4.1

Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1977	2.96	3.75	21.41	*	(20.68)	0.27	--
1978	(16.72)	--	8.16	7.26	--	2.12	--
1979	8.19	6.31	12.58	11.16	2.41	4.11	54.37
1980	4.89	12.22	26.97	7.33	7.47	5.38	76.43
1981	15.63	26.86	5.14	6.75	9.75	4.36	80.73
1982	9.67	4.04	4.20	23.55	1.93	1.16	61.96
1983	1.80	10.06	5.33	8.76	4.67	2.11	38.93
Mean	7.19	10.54	11.97	10.80	5.25	2.79	1/ 59.61
Percent	12.1	17.7	20.1	18.1	8.8	4.7	100

* Included in following total.

1/ Total of monthly means.

Table 51. Daily rainfall, in inches, at Isley Field

1977

Day	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	1/0	0	0	0	0.01	0.08	0	0.20	*	0
2	1/0	0	0	0	0	0	0	.08	*	0
3	1/0	0	0	0	0	.17	0	0	*	0
4	1/0	0	0	0	0	.11	.68	0	*	0
5	0	0	.06	0	0	0	1.87	.90	6.94	0
6	0	0	0	.39	0	0	1.92	.04	0	0
7	.35	0	.01	.30	0	0	*	0	.13	0
8	.22	0	.01	0	0	0	.89	0	.96	.11
9	0	0	0	.71	0	.12	0	0	.90	0
10	0	.06	0	.23	0	.90	0	.44	.14	0
11	0	.12	.28	.10	0	.12	.02	0	.05	0
12	0	0	0	.08	0	.04	.56	.48	.10	0
13	.10	0	0	.28	0	0	4.96	.36	.26	0
14	.31	0	0	0	0	0	3.30	.36	.10	0
15	.16	0	0	0	0	0	4.63	.22	1.15	0
16	0	0	0	.06	0	0	.61	.47	0	0
17	.10	0	0	.52	0	.01	1.09	.01	0	0
18	0	0	0	.12	0	.83	.48	.05	0	0
19	.02	0	0	0	0	.05	.12	1.28	0	0
20	0	0	0	.06	0	.12	.02	.24	0	0
21	.32	0	0	.08	.66	0	.10	1.75	0	0
22	0	0	0	0	0	*	0	2.69	0	0
23	0	0	0	0	.04	*	.01	*	0	0
24	.38	0	.01	0	.04	*	.01	*	0	.08
25	.16	.06	0	0	.94	.52	.01	*	0	0
26	0	.05	.03	*	.02	0	0	*	.38	0
27	0	.01	0	*	.06	0	0	*	0	0
28	.04	.01	.08	*	.76	.35	0	*	0	0
29	0	0	0	*	0	.14	.03	*	0	.08
30	0	0	0	.94	.42	.19	.10	*	0	0
31	0		.04		.01	0		*		0
Total	2.16	0.31	0.52	3.87	2.96	3.75	21.41	*	20.68	0.27

Rain gage established March 5, 1977.

* Included in following total.

1/ Estimated on basis of daily rainfall readings at Communication Center.

Total for March to December 1977: 55.93 inches.

Table 51. Daily rainfall, in inches, at Isley Field--Continued

1978

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0	0	0	0.03	*	*	0	1/ 0.15	0.08	0.38	0.29
2	0	0	0	0	0	*	*	.46	1/ .05	.42	5.70	.07
3	0	0	0	0	0	*	*	.01	0	.32	--	.13
4	0	.04	0	*	0	*	*	.08	0	.24	--	0
5	0	0	0	*	0	*	*	0	0	.77	--	0
6	0	0	.07	*	0	*	4.04	0	.72	.80	--	0
7	0	.06	.01	*	.06	*	0	1.46	.05	.47	--	0
8	0	0	0	*	*	*	0	1.21	.05	.36	--	0
9	0	0	0	*	*	*	0	1.73	.02	.16	--	0
10	.02	0	0	.86	*	*	.41	2/ (12.00)	0	.01	--	0
11	.01	0	0	0	*	*	0	--	.02	0	--	0
12	.08	0	0	0	1.08	*	0	3/ (3.02)	0	.04	--	.07
13	.04	0	*	0	0	*	0	*	.31	.02	--	0
14	.01	0	*	0	0	*	.55	*	0	.29	--	.16
15	0	0	*	0	0	*	1.04	*	.10	.58	--	.18
16	.17	.06	*	0	0	*	4.14	*	.04	.48	--	.08
17	.12	.02	*	0	0	*	.02	.10	.35	.02	--	0
18	0	0	*	0	0	*	.18	.80	.23	0	--	0
19	0	0	*	0	0	*	.13	0	.07	0	--	0
20	0	0	*	0	0	*	2.36	*	.38	0	--	0
21	0	0	.31	0	0	*	.32	*	0	0	--	0
22	0	.02	0	0	0	*	.20	*	.08	.02	--	0
23	0	.36	0	.15	0	*	.07	*	.44	.31	--	.12
24	0	.01	0	.02	0	*	0	*	.22	0	--	*
25	0	0	0	0	0	*	0	*	.29	.41	--	*
26	0	0	0	0	*	*	0	*	1.54	0	--	*
27	0	0	0	0	*	*	0	*	2.88	.02	--	*
28	0	0	0	0	*	*	1.08	*	.01	.22	--	*
29	.02		0	0	*	*	.60	*	0	.23	--	*
30	.01		0	0	*	*	.28	*	.16	.49	--	*
31	0		0		*		.13	10.7		.50		4/ 1.02
Total	0.48	0.57	0.39	1.03	*	*	16.72	--	8.16	7.26	--	2.12

* Included in following total.

1/ Estimated on basis of daily rainfall readings at Communication Center.

2/ Can overflowed. Rainfall recorded from midnight to 1700 hours only.

3/ Recorder reset. Rainfall recorded from 1000 to midnight only.

4/ Estimated on basis of rainfall of 1.12 inches for period Dec. 24, 1978 to Jan. 6, 1979.

Table 51. Daily rainfall, in inches, at Isley Field--Continued

1979

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	*	0.01	0	0.02	0	0	0.04	0.53	0.80	0.22	0.05	*
2	*	0	0	0	0	0	.17	.08	.02	1.34	.04	*
3	*	0	0	0	.11	0	.12	.50	.01	.53	.01	*
4	*	0	.08	.01	0	.08	1.14	.08	0	.07	.01	*
5	*	0	.01	0	.11	0	.38	.02	0	0	.01	*
6	1/ 0.1	0	.36	.13	0	.12	0	.04	0	0	.08	*
7	0	0	.32	.01	.04	.14	0	.02	.11	.22	.26	*
8	0	0	.06	.06	.13	.07	0	1.27	.12	.02	.01	1.51
9	0	0	0	0	.10	0	0	.12	.16	*	.01	.36
10	.60	0	.22	0	0	0	0	.01	.25	*	.07	0
11	.20	0	0	0	0	.24	0	.16	.79	1.29	0	.28
12	.08	0	.48	0	0	.08	0	0	.25	0	0	.44
13	.06	0	0	*	0	.19	0	0	.11	.16	0	.16
14	.02	0	0	*	0	.13	0	0	0	1.18	0	.01
15	0	0	0	*	0	.49	.01	.04	.71	.02	.01	0
16	0	0	0	*	0	0	0	.19	.10	.23	0	0
17	0	0	0	*	0	0	.20	1.66	.46	0	0	0
18	0	0	0	*	.14	.06	0	.02	.17	.02	0	.07
19	0	0	0	*	.01	0	0	.08	.72	0	.10	.64
20	0	0	0	*	.01	0	.02	0	.18	0	0	.19
21	0	0	0	*	0	.01	.92	0	.20	0	.02	0
22	0	0	0	*	.01	0	.13	0	3.28	3.62	.24	0
23	0	0	0	*	.48	.06	0	0	.07	.05	.04	0
24	0	0	0	*	0	.22	1.68	*	.01	1.13	.16	0
25	.35	0	0	*	.94	.06	.61	*	.01	.16	.04	0
26	0	0	0	*	1.26	0	1.57	*	.10	.19	.17	.14
27	0	0	0	*	.44	0	.13	*	.59	.07	1.06	0
28	0	0	0	.55	0	0	.07	*	.30	.54	.02	.16
29	0		0	0	0	.10	.31	*	1.73	0	0	.14
30	0		0	0	0	0	.13	*	1.33	0	0	.01
31	0		0		.05		.56	1.49		.10		0
Total	1.41	0.01	1.53	0.78	3.83	2.05	8.19	6.31	12.58	11.16	2.41	4.11

* Included in following total.

1/ Estimated on basis of rainfall of 1.12 inches for period Dec. 24, 1978 to Jan. 6, 1979.

Total for 1979: 54.37 inches.

Table 51. Daily rainfall, in inches, at Isley Field--Continued

1980

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0	0	0	0	0.31	0.01	0.02	0.02	0.32	0	0.22
2	.11	0	0	.10	0	0	.04	.07	0	.26	.10	.08
3	.01	0	0	0	0	0	.05	.60	.11	.01	0	.22
4	0	0	0	0	.02	.04	0	.02	.36	.01	.18	.05
5	0	0	0	0	.14	.10	.29	0	2.48	0	.11	0
6	0	.10	0	0	0	.01	1.02	0	2.44	.31	0	0
7	0	.04	0	0	.71	.10	.06	0	.89	2.48	.13	0
8	0	0	0	.10	.11	.20	.31	0	2.45	1.42	.01	0
9	0	0	0	0	0	0	0	.18	3.18	0	0	0
10	0	0	0	0	0	.23	.12	.18	4.58	.20	.11	0
11	0	0	.02	0	0	.07	0	0	.02	0	.29	0
12	0	0	0	.02	0	.02	0	0	.23	0	.05	0
13	0	0	.16	0	.07	.08	.56	.20	0	0	.04	0
14	0	.66	0	0	.49	0	.44	.20	.02	.12	0	.47
15	0	0	0	0	0	0	.02	.32	0	0	.50	.01
16	0	0	0	0	.19	0	.44	.72	.95	0	.05	0
17	0	.01	.01	0	.13	0	.66	.26	.23	0	.02	0
18	0	0	.19	0	0	0	.11	.43	.16	0	1.56	0
19	0	.06	0	0	0	0	.04	.83	.04	.08	.24	0
20	0	0	0	0	.13	.08	.36	.43	0	.31	.02	0
21	0	0	.11	0	0	.08	.11	.08	.11	.02	.13	.53
22	0	.07	0	.07	0	.35	.11	1.21	.16	.13	.35	1.50
23	0	3.26	0	0	.02	.01	0	6.16	.24	.04	3.00	.36
24	0	.12	0	0	0	0	.14	0	.28	.11	0	0
25	.01	.53	.04	0	.01	0	0	0	.08	.01	0	.60
26	0	.32	0	0	.40	.04	0	.06	2.35	.32	0	.11
27	0	.02	0	0	0	.02	0	.10	2.17	0	.18	.14
28	0	.22	0	0	.06	.37	0	.01	.40	.01	.10	.06
29	0	.60	0	0	.48	.02	0	0	1.33	.08	.20	.90
30	0		0	0	0	.12	0	0	1.69	.23	.10	.13
31	0		0		0		0	.14		.86		0
Total	0.13	6.01	0.53	0.29	2.96	2.25	4.89	12.22	26.97	7.33	7.47	5.38

Total for 1980: 76.43 inches.

Table 51. Daily rainfall, in inches, at Isley Field--Continued

1981

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0	0.06	0	0	0	0.77	2.16	0	0.28	*	0.11
2	.47	0	0	.11	0	.02	.02	.94	0	.04	*	.05
3	.01	0	.19	.08	0	0	0	.01	0	0	*	.04
4	0	0	.02	0	0	0	.10	.22	0	0	*	0
5	0	0	.14	0	.18	0	.14	.02	0	0	*	0
6	.04	0	.07	0	.04	0	.38	.12	0	.08	*	0
7	.22	0	0	0	.04	.14	.01	0	0	.06	*	.01
8	0	.30	0	0	.13	0	0	.10	.02	.22	*	0
9	0	.48	.08	.07	.07	.04	0	.13	.06	.19	*	.20
10	0	.10	0	.06	.35	.12	.06	.04	0	.67	*	0
11	.06	0	.41	.36	.04	0	.02	.18	0	0	*	0
12	.42	0	0	0	.02	.01	.20	.41	.18	.24	1.04	.25
13	0	0	.10	.14	.08	0	.56	7.30	.32	.04	.05	.18
14	.02	0	.01	.16	0	0	1.14	*	.08	1.10	.17	.68
15	.23	0	0	0	0	.50	0	*	.04	.05	2.46	0
16	.01	0	0	0	0	.29	.01	*	.01	1.24	.04	0
17	0	0	0	.11	.04	.04	.36	8.00	1.38	.60	.58	1.76
18	0	0	0	1.50	.04	0	.17	.37	0	.20	.01	.01
19	0	0	0	.34	.14	0	.50	0	.01	.01	.67	.41
20	0	0	0	.05	0	0	1.06	.06	.06	0	.42	.12
21	.44	0	.01	.07	0	0	0	.49	.07	.12	.89	.02
22	0	0	0	0	0	0	0	.01	.01	.50	0	.04
23	1.04	0	.08	.01	0	.10	1.07	0	0	.01	.52	.05
24	0	0	.04	0	0	.04	.08	.01	1.38	0	2.34	0
25	0	0	0	0	.04	.04	.30	3.28	.38	.01	0	.17
26	0	0	.10	0	0	0	.01	1.42	1.12	.24	0	.08
27	0	0	.24	0	.11	.01	.04	.13	.02	.31	0	.18
28	.05	.35	.02	0	0	0	1.38	1.30	0	.04	.05	0
29	.06		0	0	.06	.38	.73	.01	0	0	.02	0
30	0		.05	0	0	0	2.42	.10	0	1/ 0	.49	0
31	0		.13		.02		4.10	.05		1/ .5		0
Total	3.07	1.23	1.75	3.06	1.40	1.73	15.63	26.86	5.14	6.75	9.75	4.36

* Included in following total.

1/ Estimated.

Total for 1981: 80.73 inches.

Table 51. Daily rainfall, in inches, at Isley Field--Continued

1982

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0.52	0.08	0.04	0	0.01	0.08	0.04	0.64	0.12	0.01	0.09
2	.06	0	.05	0	0	.01	0	.20	.02	1.22	0	.13
3	.10	0	.05	.11	0	0	.01	.23	*	1.13	.19	.13
4	.04	0	.08	0	.05	0	.01	.01	.19	.07	.25	0
5	.05	.04	0	.02	0	0	.18	.01	*	.12	.23	0
6	0	.22	0	.28	.23	0	.01	0	*	1.06	.19	0
7	.02	.02	.41	*	.04	0	0	0	*	.62	.07	.02
8	0	.06	.01	*	.02	0	.01	1.16	1.81	1.25	.19	.02
9	0	0	.07	*	0	.01	.01	0	.20	0	0	0
10	1.78	.04	0	*	.12	0	0	.19	.40	1.86	0	0
11	.41	0	0	*	.10	0	0	0	.19	.13	0	0
12	.66	.19	.06	*	0	0	0	.02	.01	.50	.04	0
13	.05	.24	.10	*	0	0	0	.01	.12	.24	.08	0
14	0	.05	0	.12	*	0	.20	.42	0	.11	.04	.06
15	.17	.01	0	0	*	0	.13	.54	0	.01	.13	.06
16	.12	.12	0	0	*	0	.12	.01	.07	0	0	0
17	.13	0	.18	.02	*	0	.10	0	0	9.32	.07	0
18	0	0	0	0	*	0	.12	0	.46	*	0	.04
19	0	0	.56	0	*	0	0	.34	.04	5.73	0	0
20	.01	0	.10	0	*	0	.06	.17	.05	.05	0	.20
21	0	0	0	0	*	0	.82	0	0	0	.12	0
22	0	0	0	0	*	.54	.74	.01	0	.01	.26	.12
23	0	0	0	0	*	2.50	.67	.62	0	0	0	.04
24	.01	0	.05	0	*	.10	.06	0	0	0	0	.02
25	.07	0	.14	0	*	.20	.01	.02	0	0	0	.04
26	.76	0	0	0	*	.42	.12	.01	0	0	0	.04
27	.74	0	.02	0	1/ 1.0	.44	2.27	0	0	0	0	.11
28	.67	.50	.12	0	0	.01	2.26	0	0	0	.06	.04
29	.04		.25	0	0	0	1.20	.01	0	0	0	0
30	0		.52	0	.02	.25	.01	0	0	0	0	0
31	0		0		0		.47	.02		0		0
Total	5.89	2.01	2.85	0.59	1.58	4.49	9.67	4.04	4.20	23.55	1.93	1.16

* Included in following total.

1/ Estimated on basis of daily rainfall at 9-Mgal reservoir and Communication Center.

Total for 1982: 61.96 inches.

Table 51. Daily rainfall, in inches, at Isley Field--Continued

1983

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0.02	0.14	0	0	0	0.07	0	0	*	0.60	0.06
2	0	.01	0	0	.04	0	0	.01	.12	*	.25	.01
3	0	0	0	0	0	0	0	.19	.01	*	0	0
4	.01	0	0	0	0	0	0	0	0	*	.01	.12
5	.12	0	0	0	.04	0	0	0	.12	1/ 1.0	0	.01
6	0	0	0	.01	.11	.05	0	.02	.08	.52	.65	0
7	0	0	.53	0	.10	0	0	1.60	0	.32	.01	0
8	0	0	.12	.04	.01	0	0	.25	0	.02	0	0
9	0	0	.11	.06	0	0	0	3.73	0	0	0	0
10	0	*	.01	0	0	0	0	.22	0	.71	0	.01
11	0	*	.60	0	0	0	0	1.42	0	.01	.10	.11
12	.04	*	.06	0	0	0	.02	.04	.14	.78	.16	0
13	0	*	0	0	0	0	.02	.86	.07	.06	.08	0
14	0	*	0	.04	.18	.11	.26	.11	.73	.02	.72	0
15	0	*	0	0	0	0	.02	0	1.44	0	.17	.62
16	0	*	0	0	0	0	.11	*	.26	.12	.04	.26
17	0	.24	0	0	.07	0	0	*	.18	.36	.01	0
18	0	0	0	.53	0	*	0	*	.11	.22	.01	0
19	0	.07	0	0	0	*	.32	*	.06	.04	0	0
20	0	.01	0	0	.24	*	.08	*	.11	.61	0	.24
21	.44	0	0	0	.01	*	.40	*	*	.31	1.16	.01
22	0	0	0	0	.05	.04	0	*	*	.48	.16	.01
23	.67	0	0	0	0	0	.01	*	*	.07	.22	.07
24	0	0	0	0	0	.01	.30	*	*	1.32	.01	.20
25	0	0	0	0	.07	0	.02	*	*	.79	.07	.31
26	0	.78	0	.07	0	0	.04	1.49	*	0	0	.07
27	0	0	0	0	0	0	0	0	*	.36	0	0
28	0	.02	0	.07	0	0	0	0	*	.41	.24	0
29	0		0	0	0	0	.12	.12	*	.13	0	0
30	0		0	0	.22	.02	.01	0	1/ 1.9	.02	0	0
31	0		0		.01		0	0		.08		0
Total	1.28	1.15	1.57	0.82	1.15	0.23	1.80	10.06	5.33	8.76	4.67	2.11

* Included in following total.

1/ Estimated on basis of rainfall at 9-Mgal reservoir and Communication Center.

Total for 1983: 38.93 inches.

Rain Gage at 9-Mgal Reservoir
(U.S. Geological Survey)

Location: Lat 15°13'29" N., long 145°44'28" E., on south rim of the 9 million gallon reservoir at Tanapag.

Period of record: March 1977 to December 1983.

Gage: Eight-inch diameter rain can, continuous record of rainfall. Altitude of gage is 60 ft (from topographic map).

Table 52. Monthly and annual rainfall, in inches, at 9-Mgal reservoir

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1977	--	--	1.51	1.44	0.74	1.85	3.84	4.78	22.09	*	(24.45)	0.27	--
1978	0.31	0.96	.35	1.73	*	*	(26.18)	--	9.75	8.43	27.36	3.24	--
1979	2.06	1.25	1.74	1.97	5.05	2.67	7.56	9.49	--	--	3.13	5.66	--
1980	.34	6.86	.98	.83	3.86	2.87	5.36	8.15	23.87	8.90	12.52	2.09	76.56
1981	2.15	1.74	1.54	4.55	2.51	1.79	15.38	23.60	6.75	7.20	8.28	6.94	82.43
1982	8.49	2.52	3.48	1.37	1.89	8.47	11.36	5.15	5.66	24.29	2.31	3.59	78.58
1983	.86	.90	1.62	1.14	.91	.53	2.79	10.15	6.27	10.74	5.02	3.83	44.76
Mean	2.37	2.37	1.60	1.86	2.49	3.03	7.72	10.22	12.40	11.91	9.77	3.66	1/69.40
Percent	3.4	3.4	2.3	2.7	3.5	4.4	11.1	14.7	17.9	17.2	14.1	5.3	100

* Included in following total.

1/ Total of monthly means.

Table 53. Daily rainfall, in inches, at 9-Mgal reservoir

1977

Day	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	1/ 0	0	0.01	0	0.19	0.10	0.08	0	*	0
2	1/ 0	.14	0	0	.06	0	.76	0	*	0
3	1/ 0	.07	.04	0	0	.61	.01	0	*	0
4	1/ 0	.48	.02	0	.05	0	.22	0	*	0
5	0	0	.01	.10	0	0	1.13	.07	9.50	0
6	0	0	.02	.65	0	0	1.01	.04	0	0
7	.02	0	0	.12	.14	0	*	0	.47	0
8	.04	0	0	0	0	0	1.42	0	.85	.17
9	.17	.20	0	0	0	.82	0	0	1.10	0
10	0	.38	.01	0	.14	0	0	1.62	.31	0
11	0	0	.08	0	0	.01	0	.10	.22	0
12	0	0	0	.10	0	0	1.12	.58	0	0
13	.01	0	0	.07	.03	0	6.64	.56	.35	0
14	.04	0	0	0	0	0	1/ 4.00	.35	.26	0
15	.18	0	0	*	0	.04	1/ 5.00	.46	1.81	0
16	0	0	0	*	0	0	1/ .70	.30	0	0
17	.03	0	0	*	0	0	0	.10	.05	0
18	0	.08	0	*	0	.30	0	.35	0	0
19	.07	0	0	*	.01	.46	0	1.20	0	0
20	0	.05	.46	.31	.06	0	0	.48	0	0
21	.28	0	0	0	0	0	0	1.68	0	0
22	.19	0	0	0	0	0	0	1.64	0	0
23	0	0	0	0	.71	0	0	*	0	0
24	.34	0	0	.07	.22	.36	0	*	0	0
25	.02	0	0	0	0	1.72	0	*	0	.02
26	0	0	.06	0	.13	0	0	*	0	.04
27	0	0	.02	0	.18	.01	0	*	0	0
28	.12	.04	0	0	1.08	.13	0	*	0	0
29	0	0	.01	0	0	.04	0	*	0	.04
30	0	0	0	.43	.84	.14	0	*	0	0
31	0		0		0	.04		*		0
Total	1.51	1.44	0.74	1.85	3.84	4.78	22.09	*	24.45	0.27

Rain gage established March 5, 1977.

1/ Estimated on basis of daily rainfall readings at Communication Center and Isley Field.

* Included in following total.

Total for March to December 1977: 60.97 inches.

Table 53. Daily rainfall, in inches, at 9-Mgal reservoir--Continued

1978

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0	0	0	0.01	*	*	0.02	1/ 0.15	0.47	0.53	0.61
2	0	0	0	0	0	*	*	0	1/ .05	.85	7.45	.14
3	0	0	0	0	0	*	*	0	0	.10	2/ 11.24	.83
4	0	.02	0	*	0	*	*	.16	0	.08	0	0
5	0	.05	0	*	0	*	*	.02	.17	.32	.17	0
6	0	.10	0	*	0	*	11.96	.24	.28	.98	0	0
7	0	.11	0	*	0	*	.23	.84	0	.45	0	0
8	0	.07	0	*	*	*	0	1.00	.17	.29	0	0
9	0	0	0	*	.43	*	0	2.20	.18	.35	0	.04
10	0	0	0	1.60	.10	*	.29	15.00	.18	.29	.01	.05
11	0	0	0	0	0	*	0	3/ (12.8)	.26	.04	0	.05
12	.07	0	0	0	.32	*	0	3/ (14.9)	.04	.06	0	.07
13	0	0	0	0	0	*	.10	0	.02	.06	.07	.01
14	0	0	0	0	0	*	1.63	0	0	.08	.24	.11
15	0	0	0	0	0	*	2.34	0	.18	.98	.50	.02
16	.02	.07	0	0	0	*	3.00	0	0	0	0	.16
17	.14	.10	.24	0	0	*	.26	0	.13	.06	0	0
18	0	0	.11	0	0	*	.50	1.51	.46	0	.32	.01
19	0	.02	0	0	0	*	.78	.07	.14	0	.77	0
20	0	0	0	0	0	*	.42	.60	.12	0	.36	0
21	0	0	0	.04	0	*	.86	.71	.07	0	.31	0
22	0	.04	0	0	0	*	.48	.13	.14	.01	0	*
23	0	.37	0	.01	0	*	.05	1.51	.52	.08	.12	*
24	0	0	0	.01	*	*	.05	.01	.40	.28	0	*
25	0	.01	0	.01	*	*	.10	.04	.50	.30	.02	*
26	0	0	0	0	*	*	0	.16	1.09	.05	0	*
27	0	0	0	.01	*	*	0	0	4.32	0	.44	*
28	0	0	0	.02	*	*	.01	2.46	.07	1.18	3.60	*
29	0		0	.01	*	*	.54	--	0	.19	1.21	*
30	.08		0	.02	*	*	1.26	--	.11	.53	0	*
31	0		0		*		.46	--		.35		4/ 1.14
Total	0.31	0.96	0.35	1.73	*	*	26.18	--	9.75	8.43	27.36	3.24

* Included in following total.

1/ Estimated on basis of daily rainfall readings at Communication Center.

2/ Can overflowed. Rainfall record missing one hour (0930 - 1030).

3/ Rainfall for Aug. 11 and 12 estimated at 12.8 and 14.9 inches using curves based on flow of Middle Fork Talofofo Stream (written communication Huxel); recorded rainfall on Aug. 11 from midnight to 0330, 1.64 inches and on Aug. 12 from 0900 to midnight, 5.28 inches.

4/ Rainfall for period Dec. 22, 1978 to Jan. 6, 1979 was 1.24 inches.

Table 53. Daily rainfall, in inches, at 9-Mgal reservoir--Continued

1979

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	*	0.22	0	0.31	0.12	0	0.29	0.12	2.81	*	*	0
2	*	.17	0	.01	0	0	.28	1.02	.20	*	*	0
3	*	.03	0	.06	0	0	.16	.20	.01	*	*	0
4	*	0	.14	.04	.01	0	.77	.11	.34	*	*	.11
5	*	0	.13	.02	.06	.06	.13	0	0	*	*	.80
6	1/ 0.1	.07	.18	.42	0	.04	0	.47	0	*	1/ 0.2	*
7	0	.23	.39	.26	.13	.14	.04	.07	.25	*	0	*
8	0	0	.05	0	.06	.01	0	2.29	.02	*	.17	.90
9	0	0	.01	0	.05	.10	0	.23	.06	*	.01	1.24
10	.90	.34	0	0	0	.01	0	0	1.27	*	.10	.01
11	.30	0	.01	0	0	.06	0	.22	.06	*	.01	.20
12	.19	0	.83	0	0	.10	.04	.01	.36	*	.01	.28
13	.05	0	0	0	0	.05	0	.01	.10	8.74	0	.41
14	0	0	0	0	0	.01	0	0	.01	--	.04	.02
15	.02	.10	0	.01	0	.16	0	0	.14	--	.06	.11
16	0	.07	0	0	0	0	.01	.28	.11	--	.01	.02
17	.01	.02	0	0	0	.07	.77	1.15	.02	--	.11	0
18	.01	0	0	*	0	.04	.02	.41	.14	--	0	.14
19	0	0	0	*	.05	0	.04	.29	.23	--	.13	.24
20	0	0	0	*	0	0	.08	.02	.12	--	.14	.06
21	0	0	0	*	0	0	.04	0	.06	--	.11	0
22	0	0	0	*	.13	0	.23	0	1.13	--	.30	0
23	.16	0	0	*	.01	.16	0	.07	0	--	.04	0
24	0	0	0	*	.01	.85	1.85	.34	0	--	.22	0
25	.20	0	0	*	2.12	.58	.37	*	.19	--	.05	.07
26	.02	0	0	*	1.14	.02	.43	*	.26	--	.31	.11
27	0	0	0	*	1.15	0	.35	*	1.20	--	1.06	.36
28	0	0	0	.84	.01	.07	.39	*	*	--	.05	.32
29	0		0	0	0	.14	.62	*	*	--	0	.16
30	0		0	0	0	0	.49	*	*	--	0	0
31	.10		0		0		.16	2.18		--		.10
Total	2.06	1.25	1.74	1.97	5.05	2.67	7.56	9.49	--	--	3.13	5.66

* Included in following total.

1/ Estimated on basis of daily rainfall readings at Communication Center.

Total for January to August 1979: 31.79 inches.

Table 53. Daily rainfall, in inches, at 9-Mgal reservoir--Continued

1980

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.05	0	0	0	0	1.01	0	0.01	0.17	0.42	0.61	*
2	.04	.02	0	.01	0	.01	.05	.14	.02	.82	0	*
3	0	.05	0	0	.01	.02	.28	.89	.01	.17	0	*
4	0	0	0	0	.04	0	.01	.01	.14	.14	.73	*
5	0	0	0	0	0	0	.54	0	3.38	.01	.18	*
6	0	.05	0	.07	0	0	.56	.02	2.09	1.62	.06	*
7	0	.01	0	0	.58	.32	.07	0	1.09	3.12	.02	*
8	0	.05	0	.06	.07	.01	.11	0	2.48	.01	.19	*
9	0	0	0	0	0	0	0	.01	2.96	.18	0	*
10	0	0	0	0	0	0	.19	.04	1/4.0	.17	.01	*
11	0	0	0	.13	0	.01	.05	.10	1/0	0	.24	*
12	0	.01	0	0	0	.13	.10	0	1/0	0	.22	*
13	.01	.10	.04	0	.06	0	1.03	.14	1/0	.12	.04	*
14	0	.04	.10	0	.34	0	.44	.12	0	.01	.31	*
15	0	.03	0	0	.01	0	0	.02	.04	0	.38	*
16	0	0	.20	.13	.46	0	.67	.34	.22	0	.24	*
17	0	.02	.10	0	.08	.01	.22	.67	.04	.01	.01	*
18	0	.06	.08	.25	0	0	.16	.06	0	0	.72	1/1.1
19	0	.25	.02	0	.14	.02	.01	.30	.10	.17	1.12	0
20	0	.10	.12	0	.24	.04	.43	.55	.01	.19	.04	.01
21	0	0	.04	.01	.04	.01	.13	.28	.59	.06	.01	.24
22	0	.05	0	.17	.05	.11	.01	1.58	.17	.05	.31	.53
23	0	3.83	0	0	.01	.08	.06	2.18	.04	.38	6.38	.06
24	.04	.16	0	0	.21	.01	.05	.23	.44	.01	0	0
25	.14	.95	.26	0	.07	0	0	.16	.32	.22	0	.01
26	0	.47	0	0	.29	.43	.05	.05	1.38	.01	0	0
27	0	.50	0	0	0	.11	0	.01	2.53	.11	*	0
28	.06	.11	0	0	.01	.40	0	.14	.23	0	*	0
29	0	0	0	0	0	.04	0	.02	.40	0	*	0
30	0		0	0	1.14	.10	0	0	1.02	.78	1/.7	0
31	0		.02		.01		.14	.08		.12		.14
Total	0.34	6.86	0.98	0.83	3.86	2.87	5.36	8.15	23.87	8.90	12.52	2.09

* Included in following total.

1/ Estimated on basis of daily rainfall readings for Communication Center and Isley Field.

Total for 1980: 76.63 inches.

Table 53. Daily rainfall, in inches, at 9-Mgal reservoir--Continued

1981

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.01	0.08	0	0.01	0	0	0.31	3.88	0	0.41	0.16	0.13
2	.02	.10	.02	.01	0	.14	1.01	1.48	.22	.04	.02	.14
3	0	0	.16	.41	0	0	.04	.05	0	0	.06	.01
4	.17	0	.41	.01	0	0	.04	.07	0	0	.40	0
5	0	0	.37	0	.04	0	.23	.06	0	0	.10	0
6	.01	0	0	0	.19	0	.71	.14	0	0	.04	.01
7	0	0	0	0	.07	0	*	.04	0	0	.19	.04
8	0	.12	0	0	.12	0	*	.01	.04	.16	.01	.11
9	0	.61	0	.41	.65	0	*	.01	.02	.07	.05	.02
10	0	.30	.13	.41	1.16	*	*	0	.17	.26	.12	.05
11	0	.10	.01	.58	.14	*	*	.34	.18	0	0	.01
12	0	0	.02	.01	.04	*	*	1.09	.13	.25	0	.44
13	0	0	.05	.01	0	*	*	2.68	.56	.28	0	.31
14	.26	0	0	.43	0	*	*	1.90	.30	.98	0	.55
15	.24	0	0	0	0	*	*	*	.04	.20	*	.06
16	0	0	0	0	0	*	*	*	1.31	1.50	*	.30
17	0	0	0	.38	.02	*	*	4.10	.10	1.02	*	3.02
18	.01	.23	0	1.40	0	1.13	*	.41	0	.17	*	0
19	0	0	0	.37	0	0	*	0	.14	.02	[1/] 3.5	.44
20	.19	0	0	.01	.04	0	3.03	.08	.30	.02	.01	.05
21	.41	0	0	.10	0	0	.56	.14	.13	.02	0	.40
22	0	0	0	0	0	.08	.07	0	.08	.58	0	.23
23	.66	0	.28	0	0	.20	.55	0	.06	.04	.64	.14
24	.01	0	.06	0	0	.16	1.36	0	.20	0	1.45	0
25	*	0	0	0	0	.02	.01	3.70	.55	.24	0	.04
26	*	0	0	0	0	.04	.02	2.81	2.02	.12	0	.28
27	*	0	.02	0	.01	.02	.04	.19	.07	.30	.56	.04
28	*	.20	.01	0	.01	0	0	.40	.02	.01	.38	0
29	*		0	0	0	0	.68	0	.11	0	.01	.12
30	.16		0	0	0	0	2.80	.01	0	.01	.58	0
31	0		0		.02		3.92	.01		.50		0
Total	2.15	1.74	1.54	4.55	2.51	1.79	15.38	23.60	6.75	7.20	8.28	6.94

* Included in following total.

[1/] Roof blown off by typhoon.

Total for 1981: 82.43 inches.

Table 53. Daily rainfall, in inches, at 9-Mgal reservoir--Continued

1982

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.10	0.48	0.08	0	0	0	0.01	0.06	0.10	0.05	0	0.12
2	.31	.08	.20	.01	0	.02	0	.31	0	2.46	0	.14
3	.10	0	.16	.01	0	.01	.22	.35	.23	1.55	.01	.07
4	.10	.02	0	.08	.16	0	.12	0	.02	.65	.37	0
5	.01	.12	0	.10	.02	.06	.02	0	.10	.16	.30	.05
6	0	.12	0	.25	.16	.05	.01	0	1.19	.70	.05	0
7	.04	.13	.14	.05	.02	*	0	0	.19	.07	.06	.30
8	0	.26	0	.16	.04	*	0	.79	.26	.34	.05	.02
9	0	.01	.01	0	.02	*	.10	.02	.76	.02	.02	.01
10	2.38	.06	0	.01	.23	*	.01	.37	.14	2.95	0	.02
11	.47	.02	.01	.11	.11	*	.01	0	.01	.62	0	.05
12	1.65	.06	.01	.02	.06	*	.12	.10	0	.28	.01	.02
13	0	.16	.04	0	0	*	.49	.05	.12	.76	.13	.02
14	.01	0	.06	0	.05	.24	.04	.31	.25	.22	0	.30
15	0	.02	.05	.01	.17	0	.58	.26	0	.01	0	.99
16	1.07	.24	.06	.01	.06	0	.08	.04	.19	.02	0	.02
17	.37	.01	.08	0	.62	0	.04	.12	.08	8.66	.10	.19
18	.01	0	0	.01	.06	0	.08	.01	1.14	*	0	.40
19	0	0	.62	0	0	.07	0	.17	.19	4.31	0	.04
20	.02	0	.04	0	0	.01	.02	.07	.07	.20	0	.48
21	.04	.18	.01	.01	0	.18	.56	0	.01	.13	.38	0
22	.01	0	.01	.02	0	1.80	.25	.01	0	.11	.28	.20
23	0	0	0	.12	0	3.52	.84	1.98	0	.62	0	.01
24	.04	0	.08	0	0	.10	.20	0	0	0	.31	0
25	.13	0	.04	.02	0	.54	.01	0	0	0	.06	0
26	.37	0	.01	.13	0	.64	0	.02	0	0	0	0
27	.88	0	.02	0	0	.18	1.40	0	0	0	0	.12
28	.32	.55	.05	0	.06	.08	1.65	.04	.60	0	.06	0
29	.01		.91	0	0	.01	2.99	.02	.01	0	0	.02
30	0		.79	.24	.04	.96	1.08	0	0	0	.12	0
31	.05		0		.01		.43	.05		0		0
Total	8.49	2.52	3.48	1.37	1.89	8.47	11.36	5.15	5.66	24.29	2.31	3.59

* Included in following total.

Total for 1982: 78.58 inches.

Table 53. Daily rainfall, in inches, at 9-Mgal reservoir--Continued

1983

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0.02	0.22	0.06	0.08	0	0.13	0	0.14	1.18	0.31	0.44
2	0	.02	0	0	0	0	0	.11	.20	.04	.16	.04
3	0	.01	0	0	.01	0	0	.10	0	.06	0	.01
4	.05	0	.02	0	.02	0	0	.06	0	*	0	.43
5	.01	0	0	0	0	0	0	.07	.43	.25	.07	.01
6	0	0	.22	0	.16	0	0	0	0	.60	.38	0
7	0	0	.50	0	.05	0	.02	2.34	.71	.52	.02	.04
8	0	0	0	0	0	0	.01	.20	.10	.55	0	.02
9	.02	0	.17	0	.08	0	0	2.89	0	.19	.02	.25
10	.02	*	.01	.04	0	0	.02	.43	0	.04	0	.01
11	.01	*	.40	0	0	0	.02	1.96	0	.06	.28	.13
12	.22	*	.04	0	.01	0	.19	.34	.14	.30	.08	0
13	.04	*	0	0	0	0	0	.11	.05	.22	.16	0
14	0	*	0	.13	.12	.01	.05	.01	0	0	1.02	.06
15	0	*	0	0	0	0	.11	0	.54	.24	.23	.89
16	0	*	0	0	.01	.30	.12	.80	.07	.07	.04	.19
17	0	.20	0	.06	.06	0	.12	.12	.22	.54	.46	0
18	.01	0	0	.47	0	.05	0	.04	.16	.28	.11	.08
19	.02	.12	0	.01	.01	.01	.25	0	.40	.08	.01	.02
20	0	.03	0	0	.01	0	.05	.28	.20	.53	0	.73
21	.19	0	0	0	0	.04	.46	.02	1.56	1.52	1.13	.04
22	0	0	0	0	0	.04	.29	0	.04	.88	.04	.11
23	.17	0	0	0	.10	.02	.22	0	.06	.02	.06	.07
24	.05	0	.02	.05	0	0	.34	0	.06	.66	0	.06
25	0	.02	.01	0	.02	0	.01	0	.02	.46	.07	.18
26	.05	.36	0	.30	0	0	0	0	.30	.11	0	.01
27	0	0	0	.01	.02	0	0	0	.47	.08	.12	0
28	0	.12	0	0	0	.02	.13	.05	.01	.55	.22	0
29	0		0	0	0	0	.25	.20	.38	.02	.02	0
30	0		0	.01	.14	.04	0	.02	.01	.06	.01	0
31	0		.01		.01		0	0		.13		0
Total	0.86	0.90	1.62	1.14	0.91	0.53	2.79	10.15	6.27	10.74	5.02	3.83

* Included in following total.

Total for 1983: 44.76 inches.

Gaging stations

Table 54. Streamflow records for South Fork Talufofo Stream (1680100)

Location: Lat 15°12'48" N., long 145°46'17" E., on left bank 0.4 mi upstream from confluence with Middle and North Forks, 1.4 mi south of Ogso Dogas, and 2.2 mi southeast of Tanapag.

Drainage area: 0.64 mi^2. Area at site used prior to Mar. 31, 1971, 0.73 mi^2.

Period of record: October 1968 to September 1983. Low-flow records not equivalent prior to Mar. 31, 1971, due to undetermined amount of underflow between sites.

Gage: Water-stage recorder. Concrete control since Mar. 31, 1971. Altitude of gage is 60 ft, from topographic map. Prior to Mar. 31, 1971, at site 0.2 mi downstream at different datum.

Remarks: Records fair. No diversion above station. Water-quality analysis is given in table 58.

Average discharge: 12 years (water years, 1972-83), 1.40 ft^3/s, 1,010 acre-ft/yr.

Extremes for period of record: Maximum discharge, 4,100 ft^3/s, Aug. 4, 1976, gage height, 8.15 ft, from rating curve extended above 59 ft^3/s on basis of slope-area measurements at gage heights 7.30 and 8.15 ft; no flow at times prior to Mar. 31, 1971, at site then in use, and at present site, July 16, 17, 19, 20, 1977.

A. Discharge measurements, in cubic feet per second, made prior to beginning of continuous discharge record

Date	Discharge	Date	Discharge
Feb. 13, 1968	0.10	May 31, 1968	0.08
Mar. 27, 1968	0	July 24, 1968	17
May 3, 1968	.10	Aug. 30, 1968	7.7

Table 54. Streamflow records for South Fork Talufofo Stream--Continued

B. Annual maximum discharge (*) and peak discharges above base (250 ft^3/s)

(Discharge in cubic feet per second, gage height in feet)

Date	Time	Discharge	Gage height	Date	Time	Discharge	Gage height
Oct. 23, 1968	a0330	a300	--	Sept. 13, 1977	1230	*304	4.23
Nov. 2, 1968	a1200	a1,000	1/ 8.14				
Nov. 19, 1968	1400	*1,230	7.18	Aug. 10, 1978	1230	1,640	6.37
				Aug. 12, 1978	1130	*2,720	7.30
Oct. 16, 1969	1730	*664	7.22	Aug. 29, 1978	0130	1,220	5.90
Sept. 1, 1970	1830	272	5.10				
				Nov. 2, 1978	0530	*1,270	5.96
May 7, 1971	1300	*530	4.52	Nov. 3, 1978	0400	736	5.21
July 20, 1971	0900	344	4.08	Sept. 30, 1979	2200	255	3.98
Sept. 6, 1971	2030	308	3.96				
				Oct. 14, 1979	0730	396	4.48
July 23, 1972	a0300	*924	1/ 5.24	Sept. 5, 1980	2000	308	4.19
Aug. 4, 1972	1300	454	4.36	Sept. 9, 1980	0330	*468	4.67
Aug. 6, 1972	0200	575	4.61	Sept. 10, 1980	1630	331	4.27
Aug. 10, 1972	1500	595	4.65				
				Nov. 23, 1980	0530	*1,940	6.65
Oct. 2, 1972	2230	*170	3.45	Aug. 1, 1981	0730	472	4.68
				Aug. 16, 1981	1000	408	4.52
May 4, 1974	0300	*378	4.17				
July 3, 1974	1800	278	3.86	Nov. 15, 1981	1430	416	4.54
				Aug. 23, 1982	0630	*620	5.00
Nov. 3, 1974	1300	*480	4.42				
Aug. 12, 1975	0930	386	4.19	Oct. 17, 1982	0830	*620	5.00
Aug. 18, 1975	0500	378	4.17				
Sept. 17, 1975	0800	254	3.78				
Oct. 29, 1975	0930	296	3.92				
Aug. 4, 1976	0400	*4,100	8.15				
Sept. 24, 1976	a0600	a1,500	--				

a About.

1/ From floodmark in well.

Table 54. Streamflow records for South Fork Talufofo Stream--Continued

C. Annual minimum discharge, in cubic feet per second

Water year	Date	Discharge
1969	Most of the time	[1]0
1970	Many days	[1]0
1971	Jan. 4, 29, Feb. 1-8, 1971	[1]0
1972	May 13, 15-17, 1972	.05
1973	Many days in June, July 1973	.01
1974	Several days in March 1974	.01
1975	June 6-19, 21-23, 1975	.01
1976	Apr. 26, 27, 1976	.06
1977	July 16, 17, 19, 20, 1977	0
1978	May 18, 19, 1978	.01
1979	July 17, 1979	.03
1980	July 1, 2, 4, 5, 1980	.02
1981	May 30, June 14, 1981	.01
1982	June 14-20, 1982	.04
1983	Many days in June-August, 1983	.01

[1] At lower site. Record not equivalent due to underflow between upper and lower site.

Table 54. Streamflow records for South Fork Talufofo Stream--Continued

D. Monthly and annual discharges, in cubic feet per second

Year		Calendar year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year
1968	Total	--										107.7	328.7	37.60	--
	Mean	--										3.47	11.0	1.21	--
	Max.	--										50	100	2.5	--
	Min.	--										1.0	2.5	.70	--
1969	Total	227.83	12.50	4.89	.84	0	0	0	.18	0	.38	169.60	8.54	30.90	492.79
	Mean	.62	.40	.17	.027	0	0	0	.006	0	.013	5.47	.28	1.00	1.35
	Max.	127	.60	.30	.16	0	0	0	.13	0	.38	127	.70	9.2	100
	Min.	0	.25	.14	0	0	0	0	0	0	0	0	0	0	0
1970	Total	231.30	59.35	40.63	10.62	.95	.04	1.44	1.96	45.90	37.35	14.20	12.62	6.24	407.28
	Mean	.63	1.91	1.45	.34	.032	.001	.048	.063	1.48	1.25	.46	.42	.20	1.12
	Max.	17	13	6.8	.72	.32	.04	1.0	.96	8.6	17	2.0	1.7	.70	127
	Min.	0	.76	.55	.10	0	0	0	0	0	.12	.05	.18	.01	0
1971	Total	560.21	5.58	33.74	65.32	35.52	105.94	13.50	66.93	73.22	64.17	57.45	27.86	10.98	496.98
	Mean	1.53	.18	1.21	2.11	1.18	3.42	.45	2.16	2.36	2.14	1.85	.93	.35	1.36
	Max.	22	.96	17	9.5	11	22	.96	17	11	12	9.6	2.9	.56	22
	Min.	0	0	0	.25	.40	.62	.29	.26	.78	.68	.90	.56	.23	0
1972	Total	460.76	8.12	3.29	4.21	3.09	2.89	3.98	71.75	223.30	44.57	55.31	29.32	10.93	461.49
	Mean	1.26	.26	.11	.14	.10	.093	.13	2.31	7.20	1.49	1.78	.98	.35	1.26
	Max.	83	.78	.16	.25	.29	.20	.32	20	83	5.0	6.5	4.3	.45	83
	Min.	.06	.16	.09	.08	.08	.06	.07	.11	.90	.68	.72	.45	.25	.06
1973	Total	91.44	6.41	3.86	2.74	1.95	1.37	1.01	2.60	6.74	22.78	24.41	14.55	3.02	145.02
	Mean	.25	.21	.14	.088	.065	.044	.034	.084	.22	.76	.79	.49	.097	.40
	Max.	9.3	.28	.22	.14	.10	.14	.23	.25	.81	3.7	9.3	2.9	.19	6.5
	Min.	.01	.17	.10	.06	.05	.02	.01	.01	.04	.17	.19	.17	.06	.01
1974	Total	456.92	4.55	2.10	2.57	7.01	40.75	6.74	49.52	81.87	52.89	77.76	115.59	15.57	289.98
	Mean	1.25	.15	.075	.083	.23	1.31	.22	1.60	2.64	1.76	2.51	3.85	.50	.79
	Max.	44	.76	.21	.28	4.4	26	1.2	18	12	12	17	44	.72	26
	Min.	.01	.07	.02	.01	.02	.15	.11	.28	.21	.64	.67	.72	.36	.01
1975	Total	509.25	8.39	13.39	5.43	3.30	3.15	1.22	63.53	199.7	92.54	53.00	43.22	22.38	599.57
	Mean	1.40	.27	.48	.18	.11	.10	.041	2.05	6.44	3.08	1.71	1.44	.72	1.64
	Max.	43	.54	2.9	.72	.25	.23	.19	14	43	33	14	4.5	2.0	44
	Min.	.01	.17	.21	.11	.08	.03	.01	.06	1.6	.67	.72	.80	.44	.01

Table 54. Streamflow records for South Fork Talufofo Stream--Continued

D. Monthly and annual discharges, in cubic feet per second--Continued

Year		Calendar year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year
1976	Total		14.07	16.01	5.05	3.00	71.90	10.25	55.73	215.20	114.6				624.41
		545.91										22.44	11.21	6.45	
	Mean	1.49	.45	.55	.16	.10	2.32	.34	1.80	6.94	3.82	.72	.37	.21	1.71
	Max.	100	1.5	2.3	.25	.17	33	.62	16	100	40	1.3	.64	.34	100
	Min.	.08	.25	.23	.11	.08	.08	.23	.19	.80	1.0	.42	.27	.16	.08
1977	Total		3.77	2.48	1.77	1.46	1.10	1.11	.88	.91	130.58				184.16
		355.75										127.09	70.60	14.00	
	Mean	.97	.12	.089	.057	.049	.035	.037	.028	.029	4.35	4.10	2.35	.45	.50
	Max.	59	.16	.11	.08	.10	.06	.06	.18	.06	37	59	13	.70	37
	Min.	0	.10	.06	.05	.03	.02	.01	0	.01	.02	.22	.07	.27	0
1978	Total		5.85	3.38	2.06	2.01	1.18	2.20	75.06	847.32	112.6				1,263.35
		1,601.98										79.34	409.9	61.08	
	Mean	4.39	.19	.12	.066	.067	.038	.073	2.42	27.3	3.75	2.56	13.7	1.97	3.46
	Max.	303	.27	.20	.14	.48	.07	.20	20	303	38	6.5	154	6.9	303
	Min.	.02	.16	.10	.04	.04	.02	.03	.05	.46	1.1	.94	1.4	.76	.02
1979	Total		18.12	8.81	5.36	3.39	3.41	2.27	6.52	23.17	73.36				694.73
		279.00										98.2	20.04	16.35	
	Mean	.76	.58	.31	.17	.11	.11	.076	.21	.75	2.45	3.17	.67	.53	1.90
	Max.	18	.82	.46	.30	.16	.68	.14	1.6	6.1	18	13	1.1	.88	154
	Min.	.04	.42	.20	.11	.07	.05	.05	.04	.27	.27	1.2	.46	.38	.04
1980	Total		7.05	11.44	5.26	2.29	2.03	2.13	2.78	23.57	227.72				418.86
		565.65										86.88	159.66	34.84	
	Mean	1.54	.23	.39	.17	.076	.065	.071	.090	.76	7.59	2.80	5.32	1.12	1.14
	Max.	119	.39	2.7	.27	.11	.11	.19	.36	15	41	17	119	6.0	41
	Min.	.03	.18	.14	.08	.05	.04	.03	.03	.04	.18	.88	.66	.50	.03
1981	Total		16.90	7.89	4.74	2.82	1.93	1.00	41.55	264.00	51.82				674.03
		659.76										54.16	142.10	70.85	
	Mean	1.81	.55	.28	.15	.094	.062	.033	1.34	8.52	1.73	1.75	4.74	2.29	1.85
	Max.	54	.80	.45	.22	.34	.29	.10	23	42	9.2	12	54	29	119
	Min.	.02	.35	.20	.11	.06	.04	.02	.04	.80	.82	.66	.88	.90	.02
1982	Total		59.35	19.65	10.70	5.68	3.18	5.19	29.93	62.71	20.77				484.27
		516.06										267.20	22.46	9.24	
	Mean	1.41	1.91	.70	.35	.19	.10	.17	.97	2.02	.69	8.62	.75	.30	1.33
	Max.	91	11	1.2	.80	.30	.16	1.2	9.5	40	3.1	91	1.3	.49	54
	Min.	.05	.70	.42	.24	.14	.07	.05	.14	.30	.34	.30	.46	.20	.05
1983	Total		4.45	2.36	2.01	1.30	.80	.65	.49	5.40	6.21				322.57
	Mean		.14	.084	.065	.043	.026	.022	.016	.17	.21				.88
	Max.		.20	.11	.12	.10	.04	.04	.05	1.3	1.1				91
	Min.		.10	.06	.04	.03	.02	.01	.01	.01	.05				.01

Table 55. Instantaneous discharge with water and air temperatures at South Fork Talufofo Stream

(Discharge in cubic feet per second, temperature in degrees Celsius)

Date	Time	Instantaneous discharge	Water temperature	Air temperature
Aug. 30, 1968	--	7.7	28	
Oct. 1, 1968	1400	1.2	28	
Nov. 7, 1968	0930	3.7	27	
Dec. 12, 1968	1210	1.2	26	
Jan. 15, 1969	--	.36	27	
Feb. 20, 1969	0930	.18	26	
Mar. 7, 1969	0930	.07	27	
Oct. 30, 1969	1430	.75	27	
Nov. 13, 1969	1120	.36	26	
Dec. 11, 1969	1030	.93	26	
Dec. 30, 1969	1100	.63	26	
Jan. 8, 1970	1100	1.1	26	
Jan. 22, 1970	1100	3.6	24	
Feb. 5, 1970	1030	1.1	26	
Feb. 19, 1970	1020	1.2	26	
Mar. 5, 1970	1130	.60	26	
Mar. 19, 1970	0910	.27	26	
Apr. 2, 1970	1010	.13	26	
Apr. 16, 1970	1030	.03	26	
June 18, 1970	0845	.16	26	
Aug. 6, 1970	1100	.30	25	
Aug. 20, 1970	1500	1.4	26	
Sept. 3, 1970	1015	1.6	26	
Oct. 15, 1970	1120	.10	26	
Oct. 20, 1970	0950	.63	26	
Oct. 30, 1970	1110	.60	27	
Nov. 19, 1970	1510	.28	26	
Dec. 4, 1970	0950	.20	25	
Dec. 18, 1970	1050	.18	25	
Jan. 11, 1971	1440	.29	26	
Jan. 27, 1971	1000	.08	25	
Feb. 11, 1971	1330	.08	24	
Mar. 5, 1971	1030	.30	24	
Apr. 6, 1971	1030	.82	24	
May 7, 1971	1030	3.5	26	
May 26, 1971	1410	1.5	27	
June 16, 1971	1430	.41	28	
July 14, 1971	1000	.52	25	
July 20, 1971	1000	23	25	
Aug. 5, 1971	0940	14	26	
Aug. 20, 1971	1040	1.0	25	
Sept. 13, 1971	1010	.57	25	
Oct. 8, 1971	1130	59	25	
Nov. 12, 1971	1030	.82	25	

Table 55. Instantaneous discharge with water and air temperatures at South Fork Talufofo Stream--Continued

Date	Time	Instantaneous discharge	Water temperature	Air temperature
Dec. 20, 1971	1050	0.32	25	
Jan. 27, 1972	0910	.18	25	
Feb. 25, 1972	0900	.07	25	
Mar. 10, 1972	0820	.10	25	
Mar. 24, 1972	0915	.16	25	
Apr. 12, 1972	1110	.08	25	
May 8, 1972	0900	.08	25	
June 8, 1972	0910	.06	24	
Aug. 21, 1972	1320	.89	25	
Sept. 11, 1972	1040	.38	25	
Sept. 28, 1972	0900	.34	27	
Oct. 28, 1972	0940	1.0	25	
Nov. 30, 1972	0910	.41	25	
Dec. 28, 1972	0910	.15	25	
Mar. 8, 1973	1440	.08	24	
Apr. 6, 1973	0840	.10	25	
Apr. 20, 1973	1400	.05	26	
May 11, 1973	--	.03	26	
May 25, 1973	--	.12	28	
June 20, 1973	0900	.02	25	
July 6, 1973	0940	.01	25	
Aug. 10, 1973	1010	.03	26	
Aug. 31, 1973	1330	.25	26	
Sept. 14, 1973	0910	.60	25	
Sept. 28, 1973	0930	.51	25	
Oct. 12, 1973	0950	.25	26	
Nov. 9, 1973	0830	.38	25	
Nov. 23, 1973	1150	.26	25	
Dec. 7, 1973	1010	.13	26	
Dec. 21, 1973	1000	.12	26	
Jan. 4, 1974	1435	.09	27	
Jan. 14, 1974	1525	.16	24	
Feb. 1, 1974	0955	.09	25	
Mar. 1, 1974	1440	.04	25	
Mar. 21, 1974	1035	.10	23	
Apr. 8, 1974	0930	.08	25	
May 10, 1974	1040	.43	25	
July 25, 1974	1130	.50	25	30
Oct. 1, 1974	1425	.67	24	
Nov. 11, 1974	1545	1.7	26	27
Jan. 14, 1974	1345	.11	25	
Jan. 28, 1974	1510	.16	25	27
Feb. 6, 1975	1410	.67	25	26
Feb. 28, 1975	0925	.21	24	25
Mar. 13, 1975	1325	.22	25	
May 23, 1975	0940	.14	25	
July 31, 1975	1205	1.7	26	

Table 55. Instantaneous discharge with water and air temperatures at South Fork Talufofo Stream--Continued

Date	Time	Instantaneous discharge	Water temperature	Air temperature
Nov. 6, 1975	1440	0.97	25	
Nov. 21, 1975	1350	2.0	25	
Feb. 27, 1976	--	.29	25	
Mar. 26, 1976	--	.14	25	
Apr. 22, 1976	--	.17	25	
Aug. 12, 1976	--	2.9	25	
Oct. 22, 1976	--	.46	26	
Nov. 19, 1976	--	.48	25	
Dec. 17, 1976	--	.32	25	
Jan. 13, 1977	--	.21	25	
Jan. 20, 1977	0905	.14	24	25.5
Feb. 10, 1977	0940	.15	25	
Mar. 4, 1977	1430	.05	27	
Mar. 24, 1977	0830	.13	25	
Apr. 12, 1977	1320	.06	25	
July 29, 1977	0930	.04	25	
Aug. 16, 1977	1440	.02	25	
Aug. 26, 1977	0900	.02	25	
Oct. 19, 1977	1020	.89	26	27
Nov. 6, 1977	0930	1.3	25	
Dec. 3, 1977	1430	.56	26	
Dec. 31, 1977	0950	.85	25	
Jan. 20, 1977	0920	.19	23	
Feb. 14, 1977	1100	.15	25	
Mar. 22, 1978	1530	.06	25	
Apr. 26, 1978	1240	.04	25	
July 7, 1978	0835	.09	25	
Aug. 2, 1978	1010	.60	28	26
Aug. 21, 1978	1805	2.7	26	27
Nov. 10, 1978	1445	2.7	25	
Mar. 3, 1979	1010	.22	25	
Mar. 21, 1979	1140	.14	26	28
Apr. 28, 1979	1425	.09	25	
May 2, 1979	0935	.09	25	27
June 2, 1979	1330	.09	25	
July 17, 1979	1535	.03	28.5	28
Oct. 13, 1979	1430	.89	25	
Nov. 17, 1979	1540	.69	26	
Feb. 19, 1981	1450	.23	26.5	28
Aug. 27, 1981	1600	6.4	26.5	29

Table 56. Streamflow records for Middle Fork Talufofo Stream (16801500)

Location: Lat 15°12'59" N., long 145°46'17" E., on left bank 0.2 mi upstream from confluence with South and North Forks, 2.2 mi southeast of Tanapag, and 3.7 mi east of Garapan.

Drainage area: 0.28 mi^2.

Period of record: March 1968 to June 1980, February 1981 to September 1982 (discontinued).

Gage: Water-stage recorder. Concrete control since Feb. 28, 1971. Altitude of gage is 65 ft, from topographic map.

Remarks: Records fair. No diversion above station. Water-quality analysis is given in table 58.

Average discharge: 12 years (water years, 1969-79, 1982), 0.682 ft^3/s, 494 acre-ft/yr.

Extremes for period of record: Maximum discharge, 840 ft^3/s Aug. 12, 1978, gage height, 6.58 ft, from rating curve extended above 5.3 ft^3/s on basis of slope-area measurements at gage heights 5.38 ft and 6.58 ft; minimum, 0.05 ft^3/s July 5, 6, 1977.

Discharge measurement made after the end of continuous discharge record:

Nov. 19, 1982 ---------- 0.56 ft^3/s.

Table 56. Streamflow records for Middle Fork Talufofo Stream--Continued

A. Annual maximum discharge (*) and peak discharges above base (100 ft^3/s)

(Discharge in cubic feet per second, gage height in feet)

Date	Time	Discharge	Gage height	Date	Time	Discharge	Gage height
Apr. 12, 1968	0130	69	3.23	Sept. 13, 1977	1200	*130	3.79
June 28, 1968	0730	*278	4.64				
Sept. 2, 1968	2200	171	4.07	Oct. 23, 1977	0530	107	3.61
				Aug. 10, 1978	1230	360	5.00
Oct. 23, 1968	0330	135	3.83	Aug. 12, 1978	1100	*842	6.58
Nov. 2, 1968	1200	360	5.00	Aug. 29, 1978	0200	440	5.32
Nov. 19, 1968	1430	*415	5.22	Sept. 27, 1978	1200	168	4.05
Oct. 16, 1969	1730	*282	4.66	Nov. 2, 1978	0615	*322	4.85
				Nov. 3, 1978	0445	197	4.22
Sept. 6, 1971	2100	*108	3.62				
				Oct. 14, 1979	0800	[2] *83	3.38
July 23, 1972	0300	[1] 183	4.14				
Aug. 6, 1972	0200	*256	4.53	July 31, 1981	2030	141	3.87
Aug. 10, 1972	1500	246	4.48	Aug. 1, 1981	0730	[3] *176	4.10
				Aug. 16, 1981	1000	152	3.95
Oct. 2, 1972	2300	*58	3.10				
				Nov. 15, 1981	1315	*209	4.29
May 4, 1974	0500	*74	3.29	Dec. 17, 1981	0300	111	3.64
				Aug. 23, 1982	0615	178	4.11
Nov. 3, 1974	1300	*186	4.16				
Aug. 4, 1976	0330	455	5.38				
Sept. 24, 1976	0530	*541	5.67				

[1] From floodmark in well.

[2] October 1979 to June 1980.

[3] February to September 1981.

Table 56. Streamflow records for Middle Fork Talufofo Stream--Continued

B. Annual minimum discharge, in cubic feet per second

Water year	Date	Discharge
1968[1/]	Apr. 6, 1968	0.15
1969	July 3, 1969	.08
1970	July 18, 19, 1970	.13
1971	Feb. 7, 8, 1971	.17
1972	May 7, 1972	.10
1973	July 5, 6, 1973	.07
1974	Apr. 25, 1974	.07
1975	May 26-28, 30, 1975	.08
1976	May 14-18, 1976	.10
1977	July 5, 6, 1977	.05
1978	May 22, June 2, 3, 1978	.09
1979	July 14, 15, 18, 1979	.14
1980[2/]	May 28, 29, 31, 1980	.10
1981[3/]	June 22-26, 1981	.09
1982	July 19, 1982	.16

[1/] February to September 1968.

[2/] October 1979 to June 1980.

[3/] February to September 1981.

Table 56. Streamflow records for Middle Fork Talufofo Stream--Continued

C. Monthly and annual discharges, in cubic feet per second

Year		Calendar year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year
1968	Total	--				37.15	14.48	23.16	51.49	35.96	170.10	63.31	196.4	30.61	--
	Mean	--				1.24	.47	.77	1.66	1.16	5.67	2.04	6.55	.99	--
	Max.	--				18	6.1	15	15	3.4	27	25	64	1.4	--
	Min.	--				.17	.23	.20	.31	.65	.78	.78	1.5	.81	--
1969	Total	198.76	20.01	12.15	11.31	8.66	7.70	5.51	6.90	7.30	7.76	74.40	11.87	25.19	377.62
	Mean	.54	.65	.43	.36	.29	.25	.18	.22	.24	.26	2.40	.40	.81	1.03
	Max.	49	.74	.62	.47	.50	.33	.27	1.0	.85	1.6	49	1.2	6.2	64
	Min.	.10	.52	.36	.27	.23	.19	.12	.13	.10	.13	.17	.30	.30	.10
1970	Total	213.25	36.36	24.58	16.31	11.19	9.94	11.62	9.27	27.56	30.79	14.77	11.80	9.06	289.08
	Mean	.58	1.17	.88	.53	.37	.32	.39	.30	.89	1.03	.48	.39	.29	.79
	Max.	9.4	9.4	3.5	.82	.68	.57	1.4	1.2	4.8	6.7	1.4	1.1	.75	49
	Min.	.17	.36	.52	.36	.20	.25	.25	.17	.23	.36	.27	.23	.20	.17
1971	Total	250.03	8.82	14.59	18.14	16.76	32.75	17.56	26.60	26.10	26.58	26.95	20.27	14.91	223.53
	Mean	.69	.28	.52	.59	.56	1.06	.59	.86	.84	.89	.87	.68	.48	.61
	Max.	5.2	1.0	5.2	2.1	3.4	4.4	.95	3.9	2.5	4.0	2.5	1.3	.55	5.2
	Min.	.19	.19	.19	.19	.34	.42	.46	.50	.55	.43	.60	.50	.42	.19
1972	Total	207.13	12.68	7.33	7.48	6.56	5.01	6.29	27.30	67.65	19.41	22.00	14.39	11.03	221.84
	Mean	.57	.41	.25	.24	.22	.16	.21	.88	2.18	.65	.71	.48	.36	.61
	Max.	26	.60	.28	.50	.31	.25	.42	6.6	26	1.7	2.1	1.2	.38	26
	Min.	.13	.28	.21	.19	.17	.13	.15	.19	.42	.42	.48	.38	.32	.13
1973	Total	84.16	8.97	6.55	6.55	6.07	5.31	4.31	5.62	8.47	9.46	9.35	6.99	6.51	108.73
	Mean	.23	.29	.23	.21	.20	.17	.14	.18	.27	.32	.30	.23	.21	.30
	Max.	1.7	.38	.25	.26	.29	.22	.22	.32	.89	1.2	1.7	.56	.38	2.1
	Min.	.10	.24	.22	.17	.16	.15	.12	.10	.16	.16	.18	.18	.14	.10
1974	Total	154.48	6.16	4.87	4.51	5.57	11.68	6.66	14.36	19.71	16.90	20.26	29.50	14.30	113.27
	Mean	.42	.20	.17	.15	.19	.38	.22	.46	.64	.56	.65	.98	.46	.31
	Max.	9.0	.56	.32	.24	.70	5.4	.44	3.9	1.9	1.9	2.4	9.0	.52	5.4
	Min.	.08	.14	.10	.10	.08	.16	.16	.18	.20	.35	.32	.48	.44	.08
1975	Total	229.74	11.65	11.08	9.47	7.21	5.59	6.09	25.44	54.05	30.92	25.46	25.32	17.46	225.56
	Mean	.63	.38	.40	.31	.24	.18	.20	.82	1.74	1.03	.82	.84	.56	.62
	Max.	8.3	.52	.95	.44	.26	.24	.24	4.5	8.3	6.8	3.2	2.4	.80	9.0
	Min.	.12	.29	.32	.26	.22	.12	.18	.16	.75	.56	.56	.65	.48	.12

Table 56. Streamflow records for Middle Fork Talufofo Stream--Continued

C. Monthly and annual discharges, in cubic feet per second--Continued

Year		Calendar year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year
1976	Total		15.44	12.05	8.21	6.91	24.34	11.68	27.71	59.14	40.79				274.51
		244.75										14.42	12.60	11.46	
	Mean	.67	.50	.42	.26	.23	.79	.39	.89	1.91	1.36	.47	.42	.37	.75
	Max.	22	.70	1.2	.30	.30	8.6	.50	5.3	22	14	.57	.57	.57	22
	Min.	.14	.35	.26	.23	.16	.14	.30	.26	.47	.43	.36	.36	.30	.14
1977	Total		9.13	7.53	5.30	4.36	3.42	3.00	3.44	3.53	40.61				118.80
		151.81										36.73	24.10	10.66	
	Mean	.42	.29	.27	.17	.15	.11	.10	.11	.11	1.35	1.18	.80	.34	.33
	Max.	16	.36	.33	.21	.16	.14	.15	.42	.16	10	16	3.4	.45	10
	Min.	.06	.23	.21	.14	.14	.08	.06	.06	.07	.08	.18	.41	.27	.06
1978	Total		8.29	5.57	6.87	5.88	4.96	5.39	25.20	245.99	43.67				423.31
		581.17										48.2	138.2	42.95	
	Mean	1.59	.27	.20	.22	.20	.16	.18	.81	7.94	1.46	1.55	4.61	1.39	1.16
	Max.	84	.33	.27	.30	.87	.21	.50	5.8	84	15	3.0	51	3.0	84
	Min.	.13	.24	.14	.18	.14	.13	.13	.14	.21	.45	1.1	1.1	.85	.13
1979	Total		21.67	15.51	13.07	9.97	10.12	7.71	10.89	14.08	29.97				362.34
		198.48										37.60	14.20	13.69	
	Mean	.54	.70	.55	.42	.33	.33	.26	.35	.45	1.00	1.21	.47	.44	.99
	Max.	8.1	.90	.60	.60	.41	1.3	.33	1.8	2.5	8.1	4.6	.72	.55	51
	Min.	.16	.55	.50	.30	.27	.21	.18	.16	.22	.24	.55	.40	.37	.16
1980	Total		9.09	10.43	9.03	6.20	4.98	6.33	--	--	--				--
		--										--	--	--	--
	Mean	--	.29	.36	.29	.21	.16	.21	--	--	--	--	--	--	--
	Max.	--	.33	1.8	.33	.27	.27	.30	--	--	--	--	--	--	--
	Min.	--	.24	.14	.24	.13	.10	.12	--	--	--	--	--	--	--
1981	Total		--	9.29	7.17	7.43	6.23	4.62	18.87	120.37	31.81				
		--										26.40	60.62	32.26	--
	Mean	--	--	.33	.23	.25	.20	.15	.61	3.88	1.06	.85	2.02	1.04	--
	Max.	--	--	.50	.30	.50	.68	.30	7.4	15	4.0	3.7	22	8.3	--
	Min.	--	--	.24	.18	.18	.14	.11	.16	.45	.55	.50	.55	.60	--
1982	Total		27.02	15.60	14.39	10.81	8.56	11.16	14.88	20.01	8.68				250.39
	Mean		.87	.56	.59	.37	.28	.37	.48	.65	.29				.69
	Max.		3.0	.78	.73	.50	.37	1.2	2.8	10	1.2				22
	Min.		.60	.45	.37	.30	.24	.24	.21	.24	.18				.18

Table 57. Instantaneous discharge with water and air temperatures at Middle Fork Talufofo Stream

(Discharge in cubic feet per second, temperature in degrees Celsius)

Date	Time	Instantaneous discharge	Water temperature	Air temperature
Feb. 12, 1968	1540	0.29		24
May 3, 1968	1040	.31		27
May 31, 1968	1120	.23		28
July 24, 1968	1340	5.0		26
Aug. 29, 1968	1040	.72		26
Oct. 1, 1968	1540	.94		28
Nov. 7, 1968	1140	2.3		27
Dec. 12, 1968	1330	1.0		26
Jan. 15, 1968	1230	.63		27
Feb. 20, 1968	1030	.41		26
Mar. 7, 1969	1010	.34		24
Apr. 16, 1969	1230	.27		27
May 16, 1969	1330	.18		29
June 12, 1969	1020	.24		27
July 10, 1969	1310	.15		29
Aug. 7, 1969	1330	.25		28
Sept. 4, 1969	1030	.20		27
Oct. 2, 1969	1030	.28		27
Oct. 30, 1969	1020	.56		26
Nov. 13, 1969	1030	.79		27
Dec. 11, 1969	0940	.49		26
Dec. 30, 1969	1000	.44		26
Jan. 8, 1970	1020	.50		26
Jan. 22, 1970	1010	2.4		25
Feb. 5, 1970	0940	.67		24
Feb. 19, 1970	0950	.60		26
Mar. 19, 1970	1000	.54		26
Apr. 16, 1970	1020	.42		26
May 14, 1970	1310	.29		27
June 18, 1970	0950	.29		26
July 9, 1970	0940	.39		25
Aug. 6, 1970	1030	.52		25
Sept. 3, 1970	0930	.71		27
Oct. 2, 1970	0910	.52		26
Oct. 20, 1970	1230	.39		28
Nov. 19, 1970	1410	.27		26
Dec. 18, 1970	0920	.24		25
Jan. 11, 1970	1320	.30		26
Feb. 11, 1971	0940	.22		25
Mar. 5, 1971	0950	.15		24
Apr. 6, 1971	0900	.42		24
May 7, 1971	0930	1.6		25
May 26, 1971	1320	.90		26
July 14, 1971	0900	.60		25
Aug. 5, 1971	1040	3.2		26

Table 57. Instantaneous discharge with water and air temperatures at Middle Fork Talufofo Stream--Continued

Date	Time	Instantaneous discharge	Water temperature	Air temperature
Sept. 13, 1971	0930	0.47	25	
Oct. 8, 1971	1330	14	25	
Nov. 12, 1971	0920	.67	25	
Dec. 20, 1971	1010	.41	25	
Jan. 27, 1972	1020	.31	24	
Feb. 25, 1972	1000	.23	25	
Mar. 24, 1972	1010	.22	25	
Apr. 12, 1972	0850	.18	25	
May 8, 1972	0940	.13	25	
June 8, 1972	0940	.18	24	
Aug. 21, 1972	1430	.26	25	
Sept. 28, 1972	0950	.28	27	
Oct. 28, 1972	0920	.33	25	
Nov. 30, 1972	0910	.37	25	
Dec. 28, 1972	1030	.32	25	
Jan. 23, 1972	0910	.26	23	
Feb. 8, 1973	1000	.24	24	
Mar. 8, 1973	1600	.17	24	
Apr. 6, 1973	0930	.22	25	
May 5, 1973	--	.16	25	
June 4, 1973	1000	.13	25	
July 6, 1973	0840	.13	26	
Aug. 2, 1973	0930	.28	25	
Sept. 14, 1973	0830	.26	25	
Oct. 12, 1973	0900	.22	25	
Nov. 9, 1973	0940	.23	25	
Dec. 7, 1973	0930	.14	26	
Jan. 4, 1973	1400	.16	26	
Feb. 1, 1973	1055	.20	25	
Mar. 1, 1974	1345	.14	25	
Mar. 21, 1974	0945	.12	25	
Apr. 8, 1974	1020	.12	25	
July 25, 1974	1040	.21	25	30
Oct. 1, 1974	1330	.32	25	
Nov. 11, 1974	1420	.72	26	
Jan. 14, 1975	1045	.35	25	
Jan. 28, 1975	1535	.27	25	27
Feb. 6, 1975	1320	.46	25	26
Mar. 13, 1975	1350	.30	25	
Apr. 1, 1975	0940	.36	26	
May 23, 1975	0845	.17	25	
July 3, 1975	0920	.13	25	25
July 18, 1975	1020	.36	25	25
Aug. 28, 1975	1030	.78	25	
Oct. 10, 1975	1005	.62	25	
Nov. 6, 1975	1330	.67	25	

Table 57. Instantaneous discharge with water and air temperatures at Middle Fork Talufofo Stream--Continued

Date	Time	Instantaneous discharge	Water temperature	Air temperature
Nov. 21, 1975	1440	0.86	25	
Jan. 29, 1976	1010	.32	25	
Feb. 27, 1976	1330	.27	25	
Mar. 26, 1976	1415	.29	26	
Apr. 22, 1976	1030	.24	25	
June 7, 1976	1400	.41	25	
June 23, 1976	1240	.34	25	
Aug. 31, 1976	1410	.23	25	
Oct. 22, 1976	1000	.31	26	
Nov. 19, 1976	1000	.42	25	
Dec. 17, 1976	0930	.56	25	
Jan. 20, 1977	1010	.27	24	26
Feb. 10, 1977	1050	.30	25	
Mar. 10, 1977	0930	.21	25	
Apr. 12, 1977	1400	.14	25	
May 20, 1977	1440	.11	25	
June 4, 1977	1340	.10	25	
July 2, 1977	1030	.11	25	
July 29, 1977	0840	.16	25	
Aug. 26, 1977	1000	.21	25	
Oct. 19, 1977	0900	.29	26	28
Nov. 21, 1977	0845	.94	25	
Dec. 31, 1977	0915	.55	25	
Jan. 20, 1978	0830	.28	23	23
Mar. 22, 1978	1440	.16	25	
Apr. 11, 1978	--	.19	25	
July 7, 1978	0930	.16	25	
Aug. 2, 1978	0950	.21	26	28
Aug. 21, 1978	1430	1.0	28	29
Oct. 7, 1978	1400	2.0	25	
Nov. 10, 1978	1300	1.3	25	
Dec. 2, 1978	0900	2.1	25	
Jan. 20, 1979	0950	.80	25	
Mar. 3, 1979	1045	.33	25	
Mar. 21, 1979	1030	.35	25	28
Apr. 28, 1979	1315	.25	25	
May 2, 1979	0845	.27	25	27
June 2, 1979	1400	.22	25	
July 7, 1979	1410	.24	25	
July 17, 1979	1430	.15	28	27.5
Oct. 13, 1979	1045	.50	25	
Feb. 19, 1981	1140	.31	26.5	27
Mar. 20, 1981	1000	.25	25.5	27.5
Aug. 27, 1981	1410	1.9	26.5	29
Oct. 8, 1981	1340	.48	27.5	28.5

Table 58. Chemical analyses of water from Talufofo Stream

Constituent	Date Time		South Fork 11-19-82 1300	Middle Fork 11-19-82 1145
Discharge, instantaneous		ft^3/s	0.56	0.56
Specific conductance		µmho	380	370
pH		--	8.2	8.0
Temperature (water)		°C	26.0	26.0
Hardness as $CaCO_3$		mg/L	130	120
Noncarbonate hardness		mg/L	0	0
Calcium, dissolved (Ca)		mg/L	41	37
Magnesium, dissolved (Mg)		mg/L	6.4	6.6
Sodium, dissolved (Na)		mg/L	32	31
Percent sodium		percent	35	36
Sodium adsorption ratio		--	1.3	1.3
Potassium, dissolved (K)		mg/L	1.1	1.3
Alkalinity, total as $CaCO_3$		mg/L	140	136
Sulfate, dissolved (SO_4)		mg/L	9	6
Chloride, dissolved (Cl)		mg/L	39	37
Fluoride, dissolved (F)		mg/L	.1	.1
Silica, dissolved (SiO_2)		mg/L	40	44
Solids, dissolved, sum of constituent		mg/L	253	245
Nitrogen, dissolved ($NO_2 + NO_3$)		mg/L	< .1	< .1
Iron, dissolved (Fe)		µg/L	17	31
Manganese, dissolved (Mn)		µg/L	1	2

Low-flow partial-record stations

Table 59. Discharge measurements and water temperatures at Hasngot Stream (16800500)

Location: Lat 15°12'45" N., long 145°46'21" E., 750 ft upstream from unnamed tributary, 0.5 mi upstream from mouth, and 3.4 mi east of Garapan. Altitude is 100 ft (from topographic map).

Drainage area: 0.43 mi^2.

Period of record: 1967-75, 1977 (water years).

Date	Time	Instantaneous discharge (ft^3/s)	Water temperature (°C)
July 25, 1968	1410	2.3	27.0
Aug. 29, 1968	1415	.73	26.5
Oct. 2, 1968	1120	.51	26.0
Nov. 6, 1968	1620	1.2	26.5
Jan. 15, 1969	1445	.25	26.5
Feb. 20, 1969	1210	.16	26.0
Mar. 6, 1969	1515	.12	26.0
Apr. 16, 1969	1350	.07	26.5
May 1, 1969	1210	.07	28.0
May 16, 1969	1450	.06	28.5
May 29, 1969	1130	.07	28.5
June 12, 1969	1155	.05	26.5
June 27, 1969	1430	.05	26.5
July 10, 1969	1440	.02	29.5
July 24, 1969	1115	.04	27.0
Aug. 7, 1969	1455	.07	28.5
Aug. 21, 1969	1325	.05	27.0
Sept. 4, 1969	1155	.04	26.5
Sept. 18, 1969	1200	.04	26.5
Oct. 2, 1969	1200	.08	26.5
Oct. 16, 1969	1150	.07	25.5
Oct. 30, 1969	1200	.28	26.5
Nov. 13, 1969	1130	.26	26.0
Nov. 26, 1969	1205	.16	27.0
Dec. 11, 1969	1210	.27	26.0
Dec. 30, 1969	1210	.22	25.5
Jan. 8, 1970	1215	.26	--
Jan. 22, 1970	1245	.76	24.5
Feb. 5, 1970	1200	.53	25.5
Feb. 19, 1970	1125	.38	25.5
Mar. 5, 1970	1225	.31	25.5

Table 59. Discharge measurements and water temperatures at Hasngot Stream--Continued

Date	Time	Instantaneous discharge (ft^3/s)	Water temperature (^oC)
Mar. 19, 1970	1055	0.22	25.5
Apr. 2, 1970	1050	.16	25.5
Apr. 16, 1970	1135	.10	26.0
Apr. 30, 1970	1105	.06	25.5
May 14, 1970	1410	.05	25.5
May 28, 1970	1300	.06	28.0
June 12, 1970	1040	.05	26.0
June 26, 1970	1315	.12	27.0
July 9, 1970	1040	.08	26.0
July 23, 1970	1430	.05	27.0
Aug. 6, 1970	1200	.15	25.0
Aug. 21, 1970	1355	.22	26.0
Sept. 3, 1970	1155	.06	26.0
Sept. 17, 1970	1135	.16	26.0
Oct. 2, 1970	1120	.20	27.0
Oct. 15, 1970	1150	.11	--
Oct. 29, 1970	1510	.18	27.0
Nov. 19, 1970	1545	.09	26.0
Dec. 4, 1970	1040	.08	26.0
Dec. 21, 1970	1040	.08	25.0
Jan. 12, 1971	1110	.07	26.0
Jan. 28, 1971	1020	.06	25.0
Feb. 11, 1971	1050	.07	--
Mar. 9, 1971	1100	.25	25.0
Apr. 7, 1971	1050	.22	25.0
May 10, 1971	1205	.60	27.0
May 27, 1971	1220	.12	26.0
July 14, 1971	1045	.10	26.0
Aug. 6, 1971	1130	.34	25.0
Aug. 25, 1971	1145	.21	26.0
Sept. 14, 1971	1245	.29	26.0
Oct. 8, 1971	1235	4.3	25.0
Nov. 2, 1971	1050	.26	25.0
Dec. 10, 1971	1405	.14	25.0
Mar. 10, 1972	0955	.07	25.0
Mar. 24, 1972	1050	.17	--
May 8, 1972	1100	.04	25.0
June 8, 1972	1000	.04	25.0
Aug. 21, 1972	1515	.10	25.0
Sept. 11, 1972	0900	.29	25.0
Sept. 28, 1972	1125	.14	27.0
Oct. 28, 1972	1100	.22	25.0
Nov. 30, 1972	1120	.16	25.0
Dec. 28, 1972	1430	.14	25.0

Table 59. Discharge measurements and water temperatures at Hasngot Stream--Continued

Date	Time	Instantaneous discharge (ft^3/s)	Water temperature (°C)
Jan. 23, 1973	1015	0.10	23.0
Feb. 8, 1973	1100	.10	--
Mar. 5, 1973	1310	.05	24.0
Apr. 6, 1973	1320	.06	26.0
Apr. 13, 1973	1500	.02	25.0
Apr. 26, 1973	1320	.05	--
May 18, 1973	1345	.06	25.0
May 25, 1973	1320	.05	25.0
June 15, 1973	1310	.04	26.0
June 22, 1973	1520	.02	26.0
July 6, 1973	1025	.02	25.0
Aug. 2, 1973	1325	.12	25.0
Sept. 28, 1973	1125	.23	26.0
Oct. 12, 1973	1305	.16	25.0
Nov. 9, 1973	1200	.21	25.0
Nov. 26, 1973	1130	.18	25.0
Dec. 7, 1973	1315	.21	26.0
Apr. 8, 1974	1315	.06	25.0
Jan. 30, 1975	1035	.16	25.0
Feb. 6, 1975	1000	.44	25.0
Mar. 13, 1975	1100	.12	--
July 18, 1975	1055	.19	--
Aug. 28, 1975	1405	.28	26.0
Nov. 19, 1976	1030	.18	25.0

Table 60. Discharge measurements and water temperatures at North Fork Talofofo Stream (16801800)

Location: Lat 15°13'07" N., long 145°46'41" E., 350 ft upstream from confluence with South and Middle Forks and 2.3 mi southeast of Tanapag. Altitude is 40 ft (from topographic map).

Drainage area: 0.45 mi^2.

Period of record: 1968-71.

Date	Time	Instantaneous discharge (ft^3/s)	Water temperature (°C)
July 24, 1968	1500	2.1	26.0
Aug. 30, 1968	1315	.64	26.5
Oct. 2, 1968	1035	.18	25.5
Nov. 6, 1968	1440	1.1	26.5
Dec. 12, 1968	1435	.37	26.5
Jan. 15, 1969	--	0	
Feb. 20, 1969	--	0	
Mar. 7, 1969	--	0	
Apr. 16, 1969	--	0	
May 1, 1969	--	0	
May 16, 1969	--	0	
May 29, 1969	--	0	
June 12, 1969	--	0	
July 24, 1969	--	0	
Aug. 7, 1969	--	0	
Sept. 4, 1969	--	0	
Oct. 2, 1969	--	0	
Apr. 9, 1969	--	0	
May 10, 1971	1115	.21	27.0
Aug. 5, 1971	1355	.97	25.0

Table 61. Discharge measurements and water temperatures at Talufofo Stream (16802000)

Location: Lat 15°13'05" N., long 145°46'43" E., 200 ft downstream from confluence of South, Middle, and North Forks, 0.25 mi upstream from mouth, 2.4 miles southeast of Tanapag, and 3.8 miles east of Garapan. Altitude is 30 ft (from topographic map).

Drainage area: 1.56 mi^2.

Period of record: 1968-73.

Date	Time	Instantaneous discharge (ft^3/s)	Water temperature (°C)
Feb. 9, 1968	1105	0.16	24.5
Feb. 13, 1968	0900	.15	24.5
Mar. 27, 1968	1435	.02	29.0
May 3, 1968	0925	.11	--
May 31, 1968	1200	.10	--
July 24, 1968	1530	20	26.5
Aug. 30, 1968	1245	11	--
Oct. 2, 1968	0955	2.0	25.5
Nov. 6, 1968	1525	7.4	26.5
Jan. 15, 1969	1415	.44	27.0
Feb. 20, 1969	1135	.32	26.5
Mar. 6, 1969	1450	.17	26.5
Apr. 16, 1969	1310	.08	26.5
May 1, 1969	1130	.14	28.0
May 16, 1969	1425	.03	29.5
May 29, 1969	1105	.02	29.5
June 12, 1969	--	0	--
July 10, 1969	--	0	--
Aug. 7, 1969	1420	.07	28.5
Aug. 21, 1969	1210	.01	29.5
Sept. 3, 1969	1130	.26	26.0
Sept. 4, 1969	1130	.03	28.5
Sept. 18, 1969	--	0	--
Oct. 2, 1969	1135	.10	27.0
Oct. 16, 1969	1130	.07	24.5
Oct. 30, 1969	1130	.99	26.5
Nov. 13, 1969	1205	.69	26.0
Nov. 26, 1969	1140	.10	27.0
Dec. 11, 1969	1145	.92	26.0
Dec. 30, 1969	1140	.40	25.5
Jan. 8, 1970	1150	1.0	26.0
Jan. 22, 1970	1210	4.7	24.0
Feb. 5, 1970	1115	1.3	25.5

Table 61. Discharge measurements and water temperatures at at Talufofo Stream--Continued

Date	Time	Instantaneous discharge (ft^3/s)	Water temperature (^oC)
Feb. 19, 1970	1105	1.0	25.5
Mar. 5, 1970	1200	.64	25.5
Mar. 19, 1970	1035	.28	26.5
Apr. 2, 1970	1205	.05	27.0
Apr. 16, 1970	1110	.14	26.5
Apr. 30, 1970	1055	.09	26.5
May 14, 1970	1355	.03	29.5
May 28, 1970	1110	.10	28.5
June 12, 1970	1020	.02	29.5
June 18, 1970	1030	.17	26.0
June 26, 1970	1100	.06	29.0
July 9, 1970	1020	.19	27.0
July 23, 1970	1410	.02	30.0
Aug. 6, 1970	1135	.41	25.0
Aug. 21, 1970	1545	2.2	26.0
Sept. 3, 1970	1105	2.8	25.0
Sept. 17, 1970	1105	.40	27.0
Oct. 2, 1970	1110	1.3	26.0
Oct. 15, 1970	1135	.10	29.0
Oct. 29, 1970	1430	.86	28.0
Nov. 19, 1970	1530	.11	26.0
Dec. 4, 1970	1020	.09	26.0
Dec. 18, 1970	1110	.10	25.0
Jan. 12, 1971	1100	.22	25.0
Jan. 27, 1971	1100	.03	25.0
Feb. 11, 1971	1030	.04	--
Mar. 9, 1971	1355	1.8	26.0
Apr. 6, 1971	1045	.65	26.0
May 10, 1971	1140	3.1	27.0
May 27, 1971	1200	.79	27.0
July 14, 1971	1025	.57	26.0
Aug. 5, 1971	1335	7.0	25.0
Aug. 25, 1971	1125	.91	26.0
Sept. 14, 1971	1215	.69	26.0
Oct. 8, 1971	1055	24	25.0
Dec. 20, 1971	1315	.33	26.0
Feb. 25, 1972	1040	.04	25.0
Mar. 10, 1972	0925	.06	25.0
Mar. 24, 1972	1030	.07	--
May 8, 1972	1030	.03	25.0
June 8, 1972	0945	.04	25.0
Sept. 28, 1972	1030	.11	27.0
Oct. 28, 1972	1040	.30	25.0
Nov. 30, 1972	1015	.20	25.0

Table 62. Miscellaneous discharge measurements made for flooding of August 12, 1978

Stream	Location	Drainage area (mi^2)	Discharge (ft^3/s)
Rapugao Stream	Lat 15°13'30" N., long 145°44'46" E., 50 ft upstream from Cross Island road at altitude 50 ft.	1.34	666
San Roque drainage ditch.	Lat 15°14'55" N., long 145°46'31" E., in vilage of San Roque at altitude 49 ft.	.21	300
Lake Susupe tributary.	Lat 15°15'59" N., long 145°46'51" E., a gully at altitude 65 ft draining the western hillside into Lake Susupe.	.06	285

Springs

Nicholson Spring (Bobo Papago)

(also has been called Nickelson Spring, Papako Spring and Nakada Zenko)

Location: Lat 15°10'58" N., long 145°45'15" E., along south side of the Cross Island Road at the Hakmang (Kagman) road intersection at altitude 540 ft (from topographic map).[1/]

Aquifer: Limestone resting on impermeable floor of marine shale and volcanic sediment.

Remarks: Spring is encased in concrete.

Production: 8,000-30,000 gal/d (Stearns, 1944).
11,000 gal/d measured on July 27, 1944 (Stearns, 1944).
30,000-45,000 gal/d (Glander, 1946).
20,000-35,000 gal/d (Piper, 1946-47).

Chloride: 40 ppm (Glander, 1946).
30 ppm Aug. 12, 1952 at 1500; temperature 30°C.[2/]
26 ppm Oct. 21, 1952 at 1205; temperature 26°C.[2/]

pH: 7.0-7.2 (Glander, 1946).

Springwater was used locally during the Japanese Administration. Prior to 1946, water was flowing through a 4-inch pipe to a small treatment plant. In 1946, the spring had been abandoned (Glander, 1946).

[1/] Altitude reported as 500 ft by Glander (1946) and 375 ft by Piper (1946-47).

[2/] Field notes Ted Arnow.

Natural Bridge Spring No. 1 (Bobo As Teo No. 1)

Location: Lat 15°11'30" N., long 145°45'35" N., south of the road to Denni Spring about 2,000 ft south of Denni Spring, at altitude of 425 ft (from topographic map).[1/]

Aquifer: Limestone on impermeable bed.

Remarks: Production: 5,000-10,000 gal/d.

Chloride: 50 ppm (Glander, 1946).

38 ppm, Oct. 21, 1952 at 1100; temperature 27°C.[2/]

pH: 7.0-7.2 (Glander, 1946).

Spring has not been developed.

[1/] Altitude reported as 370 ft by Glander (1946) and 300 ft by Piper (1946-47).

[2/] Field notes Ted Arnow.

Natural Bridge Spring No. 2 (Bobo As Teo No. 2)

Location: Lat 15°11'27" N., long 145°45'36" E., about 2,400 feet south of Denni Spring at altitude of 395 ft (from topographic map).[1/]

Aquifer: Limestone on impermeable bed.

Remarks: Production: 3,000-15,000 gal/d (Stearns, 1944).

7,200 gal/d measured on Aug. 1, 1944 (Stearns, 1944).

15,000-20,000 gal/d (Glander, 1946).

Chloride: 50 ppm (Glander, 1946).

46 ppm, Oct. 21, 1952 at 1115; temperature 27°C.[2/]

pH: 7.0-7.2 (Glander, 1946).

[1/] Altitude reported as 375 ft by Glander (1946) and 300 ft by Piper (1946-47).

[2/] Field notes Ted Arnow.

Gaging station

Table 63. Springflow records for Denni Spring (Bobo I Denne), 16800000 (also has been called Donnay Spring No. 1)

Location: Lat 15°11'48" N., long 145°45'52" E., 2.8 mi southeast of Tanapag, 3.1 mi east of Garapan, and 5.6 mi northeast of Chalan Kanoa.

Period of record: August 1952 to June 1954 (published as Donni Spring near Garapan), March 1968, January 1969 to September 1983.

Gage: Water-stage recorder and sharp-crested weir. Altitude of gage is 261 ft from U.S. Navy.

Remarks: Records good except those above 2 ft^3/s, which are poor. Water-quality analyses are given in tables 64-66.

Average discharge: 15 years (water years 1953, 1970-83), 0.643 ft^3/s (466 acre-ft/yr).

Extremes for period of record: Maximum daily discharge, 8.5 ft^3/s Aug. 13, 1978; minimum daily, 0.02 ft^3/s Sept. 16, 17, 1969.

Table 63. Springflow records for Denni Spring--Continued

A. Annual maximum daily discharge, in cubic feet per second

Water year	Date	Discharge
1953	Nov. 2-5, 11-13, 1952	1.8
1954[1/]	Oct. 18, 19, 1953	1.7
1969[2/]	Jan. 1, 1969	.72
1970	Oct. 19-22, 1969, Jan. 22-24, 1970	2.6
1971	May 8, 9, 1971	2.0
1972	Aug. 11-16, 1972	2.7
1973	Oct. 5-8, 1972	1.3
1974	Aug. 29-31, Sept. 4, 1974	1.6
1975	Nov. 5, 6, 1974	1.8
1976	Aug. 7-10, 1976	1.8
1977	Sept. 16-18, 1977	2.5
1978	Aug. 13, 1978	8.5
1979	Nov. 9, 10, 1979	7.0
1980	Sept. 12-14, 1980	3.5
1981	Aug. 18-21, 1981	7.0
1982	Jan. 14, 1982	1.8

[1/] October 1953 to June 1954.

[2/] January to October 1969.

Table 63. Springflow records for Denni Spring--Continued

B. Annual minimum daily discharge, in cubic feet per second

Water year	Date	Discharge
1953	Many days in July, August, 1953	0.11
1954[1/]	June 12-21, 1954	.05
1969	Sept. 16, 17, 1969	.02
1970	Oct. 1-15, 1969	.10
1971	Jan. 27 to Feb. 11, 1971	.21
1972	June 7 to July 21, 1972	.12
1973	June 24 to July 14, 1973	.06
1974	Mar. 21-31, 1974	.12
1975	July 14-21, 1975	.14
1976	May 9-17, 1976	.10
1977	Aug. 1-18, 1977	.20
1978	July 3-7, 14, 1978	.20
1979	July 25-29, 1979	.20
1980	July 1-3, 1980	.12
1981	July 8, 9, 1981	.22
1982	June 14-28, 1982	.35
1983	July 26 to Aug. 6	.08

[1/] October 1953 to June 1954.

C. Instantaneous discharge with water temperatures

(Discharge in cubic feet per second, temperature in degree Celsius)

Date	Time	Instantaneous discharge	Water temperature
Feb. 13, 1968	1340	0.19	27
Mar. 28, 1968	1000	.26	27
Oct. 2, 1969	1400	1.1	27
Sept. 13, 1971	1330	.46	26
Aug. 22, 1972	0820	.23	25
Mar. 20, 1974	1540	.12	26

Table 63. Springflow records for Denni Spring--Continued

D. Monthly and annual discharges, in cubic feet per second

Year		Calendar year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year
1952	Total										25.32				--
												38.79	48.84	26.02	
	Mean										.84	1.25	1.63	.84	--
	Max.										1.4	1.6	1.8	1.2	--
	Min.										.20	.63	1.1	.60	--
1953	Total		23.27	16.96	16.80	9.90	6.76	4.18	3.53	18.11	33.53				246.69
		207.65										32.61	18.06	23.94	
	Mean	.57	.75	.61	.54	.33	.22	.14	.11	.58	1.12	1.05	.60	.77	.68
	Max.	1.7	1.3	1.3	1.0	.36	.28	.18	.12	1.3	1.6	1.7	.76	1.4	1.8
	Min.	.11	.48	.42	.36	.28	.18	.12	.11	.11	.54	.57	.51	.42	.11
1954	Total		15.24	9.04	6.68	3.65	2.69	1.88							--
		--													
	Mean	--	.49	.32	.22	.12	.087	.063							--
	Max.	--	.60	.39	.28	.16	.10	.09							--
	Min.	--	.39	.28	.16	.10	.07	.05							--
1968	Total				8.94	--	--	--	--	--	--				--
		--										--	--	--	
	Mean	--			.29	--	--	--	--	--	--	--	--	--	--
	Max.	--			.32	--	--	--	--	--	--	--	--	--	--
	Min.	--			.26	--	--	--	--	--	--	--	--	--	--
1969	Total		16.96	11.95	9.13	5.58	3.10	2.28	1.72	2.30	2.32				--
		121.58										27.61	17.05	21.58	
	Mean	.33	.55	.43	.29	.19	.10	.076	.055	.074	.77	.89	.57	.70	--
	Max.	2.6	.72	.45	.36	.21	.10	.10	.08	.10	.28	2.6	.84	1.1	--
	Min.	.02	.45	.36	.21	.15	.10	.06	.04	.06	.02	.10	.45	.45	--
1970	Total		34.26	28.52	21.54	11.37	7.39	6.09	5.54	18.30	23.06				222.31
		195.35										15.80	12.72	10.76	
	Mean	.54	1.11	1.02	.69	.38	.24	.20	.18	.59	.77	.51	.42	.35	.61
	Max.	2.6	2.6	1.2	.84	.50	.28	.24	.36	.78	1.2	.60	.50	.40	2.6
	Min.	.12	.60	.84	.55	.28	.21	.15	.12	.28	.50	.50	.36	.28	.10
1971	Total		7.45	17.33	26.26	20.29	33.74	14.70	16.09	29.71	17.63				222.48
		243.21										26.19	18.74	15.08	
	Mean	.67	.24	.62	.85	.68	1.09	.49	.52	.96	.59	.84	.62	.49	.61
	Max.	2.0	.28	1.2	1.1	1.0	2.0	.60	.96	1.4	.90	1.2	.71	.56	2.0
	Min.	.21	.21	.21	.50	.50	.66	.40	.28	.55	.40	.66	.55	.43	.21
1972	Total		11.33	7.40	6.97	4.84	4.11	3.66	13.96	51.22	24.32				187.82
		187.05										28.17	18.00	13.07	
	Mean	.51	.37	.26	.22	.16	.13	.12	.45	1.65	.81	.91	.60	.42	.51
	Max.	2.7	.44	.31	.27	.20	.15	.13	1.5	2.7	1.2	1.3	.75	.50	2.7
	Min.	.12	.31	.21	.20	.15	.13	.12	.12	.78	.68	.65	.50	.34	.12

Table 63. Springflow records for Denni Spring--Continued

D. Monthly and annual discharges, in cubic feet per second--Continued

Year		Calendar year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year
1973	Total		8.82	5.36	3.63	3.00	2.92	2.08	2.41	3.57	6.14				97.17
		62.45										8.91	9.26	6.35	
	Mean	.17	.28	.19	.12	.10	.094	.069	.078	.12	.20	.29	.31	.20	.27
	Max.	.55	.34	.22	.14	.10	.10	.08	.10	.15	.25	.55	.47	.23	1.3
	Min.	.06	.25	.15	.10	.10	.08	.06	.06	.10	.15	.20	.24	.19	.06
1974	Total		6.29	5.03	4.42	5.32	13.47	6.58	20.93	28.95	38.31				153.82
		233.66										42.4	39.93	22.03	
	Mean	.64	.20	.18	.14	.18	.43	.22	.68	.93	1.28	1.37	1.33	.71	.42
	Max.	1.8	.23	.20	.17	.34	1.0	.26	1.1	1.6	1.6	1.7	1.8	.81	1.6
	Min.	.12	.17	.17	.12	.14	.18	.19	.20	.37	.85	1.0	.81	.65	.12
1975	Total		14.95	10.96	10.27	7.53	6.23	5.40	7.14	40.38	28.98				236.20
		204.54										31.02	22.77	18.91	
	Mean	.56	.48	.39	.33	.25	.20	.18	.23	1.30	.97	1.00	.76	.61	.65
	Max.	1.7	.61	.45	.37	.29	.23	.20	.69	1.7	1.4	1.4	.96	.69	1.8
	Min.	.14	.37	.37	.29	.23	.17	.17	.14	.81	.65	.73	.65	.53	.14
1976	Total		14.55	10.33	8.33	6.99	11.63	12.43	15.00	38.93	33.81				224.70
		219.77										29.00	20.90	17.87	
	Mean	.60	.47	.36	.27	.23	.38	.41	.48	1.26	1.13	.94	.70	.58	.61
	Max.	1.8	.53	.37	.29	.26	1.1	.65	.90	1.8	1.4	1.4	.77	.61	1.8
	Min.	.10	.37	.33	.26	.17	.10	.26	.26	.77	.81	.69	.61	.53	.10
1977	Total		14.47	10.84	10.47	8.64	8.06	7.35	7.13	6.59	27.11				168.43
		215.93										41.22	49.2	24.85	
	Mean	.59	.47	.39	.34	.29	.26	.25	.23	.21	.90	1.33	1.64	.80	.46
	Max.	4.5	.53	.41	.37	.29	.26	.26	.23	.23	2.5	4.5	2.5	1.0	2.5
	Min.	.20	.45	.33	.29	.26	.26	.23	.23	.20	.23	.49	1.1	.65	.20
1978	Total		18.07	12.96	11.15	9.20	7.61	7.14	18.05	124.87	73.8				398.12
		488.45										53.4	95.2	57.00	
	Mean	1.34	.58	.46	.36	.31	.25	.24	.58	4.03	2.46	1.72	3.17	1.84	1.09
	Max.	8.5	.61	.53	.41	.33	.29	.26	1.2	8.5	7.0	3.0	7.0	4.5	8.5
	Min.	.20	.53	.41	.33	.26	.23	.23	.20	.61	1.1	1.1	1.1	.95	.20
1979	Total		25.21	18.20	16.07	12.46	10.55	8.22	6.98	9.46	13.54				326.29
		197.39										34.72	23.39	18.59	
	Mean	.54	.81	.65	.52	.42	.34	.27	.23	.31	.45	1.12	.78	.60	.89
	Max.	1.3	.95	.73	.61	.45	.37	.29	.23	.37	.77	1.3	1.1	.65	7.0
	Min.	.20	.73	.60	.45	.37	.29	.23	.20	.23	.33	.90	.65	.57	.20
1980	Total		14.03	11.13	10.67	7.29	6.47	5.85	5.42	8.88	41.87				188.31
		217.88										44.85	30.02	31.40	
	Mean	.60	.45	.38	.34	.24	.21	.20	.17	.29	1.40	1.45	1.00	1.01	.51
	Max.	3.5	.53	.45	.45	.29	.26	.23	.23	.69	.35	2.0	1.6	1.4	3.5
	Min.	.12	.37	.33	.29	.17	.17	.14	.12	.14	.37	.91	.74	.85	.12

Table 63. Springflow records for Denni Spring--Continued

D. Monthly and annual discharges, in cubic feet per second--Continued

Year		Calendar year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Water year
1981	Total		25.67	19.44	18.17	14.60	13.42	9.54	8.99	109.1	40.11				365.31
		361.62										32.91	31.79	37.88	
	Mean	.99	.83	.69	.59	.49	.43	.32	.29	3.52	1.34	1.06	1.06	1.22	1.00
	Max.	7.0	.95	.74	.66	.55	.50	.39	.75	7.0	3.5	1.5	1.3	1.5	7.0
	Min.	.22	.74	.66	.50	.45	.39	.25	.22	1.2	.87	.87	.83	.98	.22
1982	Total		35.22	24.62	22.17	19.26	16.81	11.78	16.03	29.80	22.80				301.07
		326.93										84.81	26.32	17.31	
	Mean	.90	1.14	.88	.72	.64	.54	.39	.52	.96	.76	2.74	.88	.56	.82
	Max.	7.0	1.8	1.0	.75	.71	.59	.47	1.2	1.4	.92	7.0	1.5	.65	1.8
	Min.	.35	.87	.75	.67	.59	.47	.35	.39	.67	.59	.53	.65	.53	.35
1983	Total		13.55	8.05	7.67	6.60	4.92	3.60	3.02	6.38	8.04				190.27
	Mean		.44	.29	.25	.22	.16	.12	.097	.21	.27				.52
	Max.		.53	.33	.29	.26	.26	.12	.12	.33	.37				7.0
	Min.		.33	.26	.23	.20	.12	.12	.08	.08	.20				.08

Table 64. Chloride concentration of water from Denni Spring

Date	Time	Chloride (mg/L)	Temperature (°C)	Remarks
1946	--	50	--	pH 6.8 (Glander, 1946).
1946	--	40	--	Piper, 1946-47.
May 8, 1952	1250	45	32	Discharge, 0.25 ft^3/s.
Aug. 12, 1952	1530	35	30	
Oct. 21, 1952	1035	38	27	
Jan. 19, 1953	1430	36	26.5	
Mar. 3, 1953	--	36	--	
Apr. 7, 1953	0945	38	27	
July 6, 1953	1035	39	27	
Dec. 16, 1953	1510	35	27	Discharge, 1.3 ft^3/s.
June 22, 1954	--	35	--	Discharge, 0.10 ft^3/s.
July 12, 1955	--	40	--	
June 26, 1974	--	100	--	1/ Hardness, 310 ppm; pH 7.1; sulfate, 15 ppm; alkalinity (as $CaCO_3$), 286 ppm.
Sept. 25, 1977	--	30	--	Hardness, 275 mg/L; total dissolved solids, 350 mg/L (Mink, 1977).
June 10, 1980	--	30	--	
June 20, 1980	--	35	--	Specific conductance, 649 µmho.

1/ By W. B. Brewer, using Hach kit.

Table 65. Chemical analyses of water from Denni Spring

[Analyses by: 18 MGL, 18th Medical General Laboratory, Saipan; Tokyo, Tokyo-To Laboratories for Medical Sciences, Tokyo; USGS, U.S. Geological Survey, Salt Lake City Laboratory; Layne, Layne International Laboratory, Guam; USGS-2, U.S. Geological Survey, Denver Laboratory]

Constituent		9-8-44	3-23-50	5-8-52	7-20-67	1/	11-19-82	7-2-83
Analyses by ----		18 MGL	Tokyo	USGS	Layne	1/	USGS-2	USGS-2
Specific conductance -------	µmho	--	--	632	560	--	630	735
pH -------------------------	--	--	6.7	7.0	7.2	7.2	6.7	7.3
Temperature (water) --------	°C	--	--	--	24	25	--	27.5
Hardness as $CaCO_3$ ----------	mg/L	287	253	298	270	305	290	320
Calcium, dissolved (Ca) ----	mg/L	106	97	111	108	58	110	120
Magnesium, dissolved (Mg) --	mg/L	5.3	2.4	5.2	26.7	39	4.3	4.3
Sodium, dissolved (Na) -----	mg/L	4.9 2/	14	18	33.5	--	21	23
Potassium, dissolved (K) ---	mg/L	--	3.5	.7	--	--	.8	.7
Bicarbonate (HCO_3) ---------	mg/L	293	224	333	311	--	--	--
Alkalinity, total as $CaCO_3$--	mg/L	--	255	--	255	234	287	--
Sulfate, dissolved (SO_4) ---	mg/L	3.6	4.3	8.2	--	6	7	--
Chloride, dissolved (Cl) ---	mg/L	27	30	30	36	32	36	--
Fluoride, dissolved (F) ----	mg/L	--	--	0	--	0	< .1	< .1
Silica, dissolved (SiO_2) ---	mg/L	3.2	2.6	7.0	13	--	7.2	7.3
Solids, dissolved, sum of constituent ----------	mg/L	337	381	359	355	360	358	--
Nitrogen, dissolved (NO_2 +NO_3) -----	mg/L	20	2.2	11	--	--	2.3	2.4
Iron, dissolved (Fe) -------	µg/L	250	80	70	40	2	10	4
Manganese, dissolved (Mn) --	µg/L	0	80	--	--	--	< 1	< 1

1/ Austin Smith and Associates, 1967. Date and laboratory not given.

2/ Includes potassium expressed as sodium.

Table 65. Chemical analyses of water from Denni Spring--Continued

[Source: P. A. Mack, Water Quality Laboratory, Commonwealth of the Northern Mariana Islands]

Date	Chloride (mg/L)	Dissolved solids (mg/L)	Conductivity (µmho)	pH (units)	Turbidity (NTU)	Alkalinity (mg/L)
Feb 3, 1982	32.9	346	674	8.0	0.21	--
Mar. 8, 1982	32.3	404	562	7.4	.14	--
Apr. 12, 1982	33.7	288	553	7.6	.20	--
May 3, 1982	33.3	404	625	7.1	.19	--
June 4, 1982	36.3	--	--	7.3	--	291
July 9, 1982	36.8	314	717	7.6	.16	292
Aug. 10, 1982	33.8	--	688	7.6	--	289
Aug. 31, 1982	33.2	--	--	--	--	--
Sept. 8, 1982	30.5	--	--	--	--	--
Oct. 7, 1982	28.6	--	--	--	--	--
Nov. 10, 1982	34.0	--	513	7.8	--	281
Dec. 7, 1982	35.0	--	677	7.8	--	286
Jan. 19, 1983	33.6	--	672	7.7	--	298
Feb. 25, 1983	34.5	--	696	7.6	--	287
May 23, 1983	33.8	--	--	--	--	--
June 20, 1983	--	--	714	7.8	--	241
July 18, 1983	35.3	--	701	7.3	--	291
Aug. 15, 1983	34.4	--	566	--	--	293
Sept. 8, 1983	45.0	--	682	--	--	297
Oct. 14, 1983	31.5	--	690	7.7	--	293

Table 66. Analysis of water from Denni Spring for metals and pesticides

[Analyses by LFE Environmental Analysis Laboratory, Richmond, Calif. Date of sampling, November 1977. Date of analyses, December 1977]

Constituent	Units		Constituent	Units	
Metals			Pesticides		
Arsenic	mg/L	< 0.01	Silver	mg/L	< 0.005
Barium	mg/L	.04	Endrin	ppb	< .01
Cadmium	mg/L	.006	Lindane	ppb	< .01
Chromium	mg/L	< .05	Methoxychlor	ppb	< .01
Lead	mg/L	.058	Toxaphene	ppb	< .1
Mercury	mg/L	4.7	2, 4-D	ppb	< .01
Selenium	mg/L	< .005	2, 4, 5-TP Silvex	ppb	< .01

Denni Spring No. 2 (Bobo I Denne No. 2)
(also has been called Donnay Spring No. 2)

Location: Lat 15°11'59" N., long 145°45'38" E., 2,000 ft northwest of Denni Spring (No. 1) at altitude 475 ft (from topographic map).[1/]

Aquifer: Limestone on impermeable bed (Glander, 1946).

Remarks: Spring issues from cave in a limestone cliff.

Production: 0-2,500 gal/d (Stearns, 1944).
0 gal/d on July 8, 1944 (Stearns, 1944).
0-3,000 gal/d (Glander, 1946).

Chloride: 34 ppm, Oct. 21, 1945 at 1145; temperature 26.5 C.

Spring is too small to be developed.

[1/] Altitude reported as 350 ft by Glander (1946).

Radio Hill Spring No. 1

Location: Lat 15°13'25" N., long 145°45'16" E., 1.2 mi south of Tanapag School at altitude 500 ft (from topographic map).[1/]

Aquifer: Volcanic sediment (Stearns, 1944).

Remarks: Spring was developed during the Japanese Administration.

Production: Varies directly with rainfall: 10,000-30,000 gal/d (Stearns, 1944).
21,000 gal/d measured on Aug. 28, 1944 (Stearns, 1944).
0-20,000 gal/d (Glander, 1946).
5,000-30,000 gal/d (Piper, 1946-47).

Chloride: 40 ppm (Glander, 1946).

pH: 7.0-7.2 (Glander, 1946).

[1/] Altitude reported as 620 ft by Glander (1946) and 600 ft by Piper (1946-47).

Radio Hill Spring No. 2

Location: Lat 15°13'57" N., long 145°45'45" E., 0.7 mi southeast of Tanapag School at altitude of 350 ft (from topographic map).[1/]

Aquifer: Volcanic sediment (Glander, 1946).

Remarks: Spring enclosed in concrete masonry. Discharged by gravity through 4-in. steel main to west coast main in 1946.

Production: 10,000-20,000 gal/d (Stearns, 1944).
15,520 gal/d measured July 11, 1944 (Stearns, 1944).
15,000-30,000 gal/d (Piper, 1946-47).

Chloride: 70 ppm.

pH: 7.2-7.4.

[1/] Altitude reported by Glander (1946) as 425 ft.

Radio Hill Spring No. 3

Location: Lat 15°13'47" N., long 145°46'11" E., 0.6 mi south of Mount Achugao at altitude of 575 ft (from topographic map).[1/]

Aquifer: Volcanic sediment.

Remarks: Spring is not developed and discharges in the valley.

Production: 1,500-5,000 gal/d (Stearns, 1944).
1,500 gal/d measured Aug. 11, 1944 (Stearns, 1944).
0-5,000 gal/d (Glander, 1946).
5,000-10,000 gal/d (Piper, 1946-47).

Chloride: 30 ppm.

pH: 7.6.

[1/] Altitude reported as 300 ft by Glander (1946) and 325 ft by Piper (1946-47).

Radio Hill Spring No. 4

Location: Lat 15°13'44" N., long 145°46'06" E., 0.9 mi southwest of Mount Achugao at altitude 400 ft (from topographic map).[1/]

Aquifer: Volcanic sediment.

Remarks: Spring is not developed and discharges into the valley. Yield varies directly with rainfall, reaching 30,000 gal/d in the wet season.

Production: 5,000-10,000 gal/d (Stearns, 1944).
7,200 gal/d measured July 23, 1944 (Stearns, 1944).
5,000-30,000 gal/d (Piper, 1946-47).

[1/] Altitude reported as 200 ft by Glander (1946) and 350 ft by Piper (1946-47).

16802500 East Achugao Spring (Bobo Achugao Hava)
(also has been called Achugau Spring No. 2)

Location: Lat 15°13'54" N., long 145°46'32" E., 0.45 mi southeast of Mount Achugao at altitude 320 ft (from topographic map).[1/]

Aquifer: Limestone (Stearns, 1944).

Remarks: Spring issues from the foot of a 5-ft ledge of limestone and is encased in a concrete cistern.

Production: 30,000-60,000 gal/d (Stearns, 1944).
40,000-80,000 gal/d (Glander, 1946).

Chloride: 50 ppm (Glander, 1946).

pH: 7.2-7.4 (Glander, 1946).

For chemical analyses of spring water in December 1944, see table 69.

[1/] Altitude reported as 440 ft by Glander (1946) and 325 ft by Piper (1946-47).

Table 67. Discharge measurements and water temperatures at East Achugao Spring (16802500)

(Discharge in cubic feet per second, temperature in degrees Celsius)

Date	Time	Instantaneous discharge	Water temperature
Sept. 15, 1965	--	0.17	
Dec. 13, 1968	1020	.26	26.5
Jan. 16, 1969	1320	.11	26.5
Mar. 6, 1969	1120	.10	26.5
Apr. 17, 1969	0930	.07	26.0
May 2, 1969	1020	.06	26.5
May 17, 1969	1020	.03	26.0
May 31, 1969	0935	.05	26.5
June 13, 1969	1000	.04	26.0
June 27, 1969	1020	.05	26.0
July 12, 1969	1025	.04	25.5
July 25, 1969	1005	.03	26.0
Aug. 8, 1969	1015	.04	26.5
Aug. 22, 1969	1005	.04	26.5
Sept. 5, 1969	1010	.05	26.0
Sept. 19, 1969	1115	.02	26.5
Oct. 3, 1969	1050	.05	26.5
Oct. 18, 1969	1055	.28	25.5
Oct. 31, 1969	1035	.12	26.5
Nov. 15, 1969	1000	.12	26.5
Nov. 28, 1969	1125	.09	27.0
Dec. 12, 1969	1245	.05	26.5
Dec. 31, 1969	1105	.11	25.5
Jan. 9, 1970	1015	.12	26.0
Jan. 23, 1970	0935	.25	24.5
Feb. 6, 1970	1035	.43	25.5
Feb. 20, 1970	0915	.16	25.5
Mar. 6, 1970	0940	.10	25.5
Mar. 20, 1970	0930	.15	25.5
Apr. 3, 1970	0935	.12	26.0
Apr. 17, 1970	0845	.10	25.5
May 1, 1970	0935	.10	25.5
May 15, 1970	0930	.10	25.5
June 1, 1970	1020	.08	25.5
June 15, 1970	0935	.06	25.5
June 30, 1970	0940	.06	25.0
July 10, 1970	1010	.06	26.0
July 24, 1970	1105	.85	25.0
Aug. 7, 1970	0950	.44	25.0
Aug. 21, 1970	1005	.05	26.0
Sept. 4, 1970	1005	.15	26.0
Sept. 18, 1970	1035	.12	26.0
Oct. 5, 1970	1000	.14	27.0
Oct. 16, 1970	1020	.10	26.0

Table 67. Discharge measurements and water temperatures at East Achugao Spring--Continued

Date	Time	Instantaneous discharge	Water temperature
Nov. 2, 1970	1015	0.11	26.0
Nov. 20, 1970	1110	.12	26.0
Dec. 9, 1970	1015	.08	26.0
Dec. 21, 1970	0940	.11	26.0
Jan. 12, 1971	1010	.06	25.0
Jan. 28, 1971	0925	.06	25.0
Mar. 9, 1971	0955	.06	26.0
Apr. 7, 1971	0940	.11	26.0
May 10, 1971	1015	.21	25.0
May 27, 1971	1100	.15	26.0
July 23, 1971	1005	.10	26.0
Aug. 6, 1971	1030	.13	25.0
Aug. 25, 1971	1025	.05	26.0
Sept. 14, 1971	1025	.09	25.0
Oct. 8, 1971	0950	.31	25.0
June 9, 1972	--	0	
Aug. 22, 1972	1235	.31	25.0
Sept. 29, 1972	--	0	
Dec. 1, 1972	1035	.22	26.0
Dec. 29, 1972	0930	.12	25.0
Mar. 20, 1972	--	0	
Apr. 8, 1974	1520	.04	26.0

West Achugao Spring (Bobo Aguchao Lagu)
(also has been called Achugao Spring No. 1)

Location: Lat 15°14'16" N., long 145°46'06" E., 0.7 mi upstream from mouth of Achugao Stream and 1.3 mi east of Tanapag at altitude of 270 ft (from topographic map).[1/]

Aquifer: Sandy marl (Glander, 1946).

Remarks: Spring issues from crevices in marl beds in western slope of Talufofo basin and is enclosed in a concrete cistern.

Production: 20,000-60,000 gal/d (Stearns, 1944).
20,000-50,000 gal/d (Glander, 1946).
100,000 gal/d maximum (Curione, 1949).

Chloride: 70 ppm (Glander, 1946).

pH: 7.2-7.4 (Glander, 1946).

For chemical analyses of the spring water in December 1944, see table 69.

[1/] Altitude reported as 340 ft by Glander (1946) and 300 ft by Piper (1946-47).

Table 68. Discharge measurements and water temperatures at West Achugao Spring (16804000)

(Discharge in cubic feet per second, temperature in degrees Celsius)

Date	Time	Instantaneous discharge	Water temperature
Jan. 22, 1944	--	0.04	
Oct. 3, 1967	--	.34	
Dec. 13, 1968	1225	.28	26.5
Jan. 15, 1968	1650	.08	26.5
Feb. 19, 1969	1700	.05	26.5
Mar. 6, 1969	1335	.05	26.5
Apr. 17, 1969	1140	.03	26.5
May 1, 1969	1400	.03	26.0
May 17, 1969	1400	.02	26.5
May 29, 1969	1410	.04	26.5
June 13, 1969	1140	.02	26.0
June 27, 1969	1235	.04	26.5
July 12, 1969	1205	.02	26.0
July 25, 1969	1150	.03	26.0
Aug. 8, 1969	1210	.02	26.5
Aug. 22, 1969	1345	.02	26.5

Table 68. Discharge measurements and water temperatures at West Achugao Spring--Continued

Date	Time	Instantaneous discharge	Water temperature
Sept. 5, 1969	1200	0.02	26.0
Sept. 19, 1969	1220	.01	26.5
Oct. 3, 1969	1050	.02	26.5
Oct. 31, 1969	1155	.30	26.0
Nov. 15, 1969	1055	.15	26.0
Nov. 18, 1969	1225	.08	26.5
Dec. 12, 1969	1400	.19	26.5
Dec. 31, 1969	1200	.27	25.5
Jan. 9, 1970	1115	.29	26.0
Feb. 6, 1970	1120	.43	26.0
Feb. 20, 1970	1015	.26	25.5
Mar. 6, 1970	1040	.13	25.5
Mar. 20, 1970	1015	.14	25.5
Apr. 3, 1970	1035	.13	25.5
Apr. 10, 1970	0845	.07	26.0
Apr. 17, 1970	0940	.05	25.5
May 1, 1970	1035	.06	25.5
May 15, 1970	1025	.06	25.5
June 1, 1970	1135	.06	26.0
June 15, 1970	1040	.03	25.5
June 30, 1970	1040	.02	26.0
July 10, 1970	1105	.02	26.0
July 24, 1970	1220	.11	28.0
Aug. 21, 1970	1110	.26	25.0
Sept. 18, 1970	1145	.26	26.0
Oct. 5, 1970	1055	.24	27.0
Oct. 16, 1970	1120	.22	26.0
Nov. 2, 1970	1145	.22	26.0
Nov. 20, 1970	0910	.11	26.0
Dec. 9, 1970	1325	.10	26.0
Dec. 21, 1970	1330	.10	26.0
Jan. 12, 1971	1305	.08	26.0
Jan. 28, 1971	1330	.06	26.0
Mar. 9, 1971	1550	.40	26.0
Apr. 7, 1971	1315	.17	26.0
May 10, 1971	1410	.36	26.0
May 28, 1971	1305	.14	26.0
July 23, 1971	1335	.09	26.0
Aug. 6, 1971	1305	.40	25.0
Aug. 25, 1971	1345	.12	26.0
Oct. 12, 1971	1430	.34	26.0

Measurement at West Achugao Stream, lat 15°14'20" N., long 145°46'06" E., 0.7 mile above mouth and 1.2 miles east of Tanapag:

Aug. 30, 1968 ---------- 0.32 ft^3/s

Tanapag Spring No. 1 (Bobo Agatan)

Location: Lat 15°13'49" N., long 145°45'10" E., 0.6 mi upstream from mouth and 0.7 mi south of Tanapag School at altitude 120 ft (from topographic map).[1/]

Aquifer: Andesite lava (Stearns, 1944), volcanic lava (Piper, 1946-47).

Remarks: Spring is encased in a concrete cistern.

Production: 25,000-40,000 gal/d (Stearns, 1944).
36,000 gal/d measured Aug. 14, 1944 (Stearns, 1944).
20,000-40,000 gal/d (Glander, 1946).
144,000 gal/d (Curione, 1949).

Chloride: 30 ppm (Glander, 1946).

pH: 7.4-7.6 (Glander, 1946).

Well 8a was drilled in the spring in September 1944. The discharge was reported as artesian water flowing from the well by Mink (1977). For chemical analyses of the spring water in December 1944, see table 69.

[1/] Altitude reported as 100 ft by Glander (1946) and 300 ft by Piper (1946-47).

Tanapag Spring No. 2 (Bobo Mames)

Location: Lat 15°13'59" N., long 145°45'15" E., 0.5 mi south of Tanapag School at altitude of 60 ft (from topographic map).[1/]

Aquifer: Andesite lava (Stearns, 1944).

Remarks: Spring is encased in a concrete cistern.

Production: 25,000-80,000 gal/d (Stearns, 1944).
54,000 gal/d measured July 20, 1944 (Stearns, 1944).
20,000-60,000 gal/d (Glander, 1946).

Chloride: 30 ppm (Glander, 1946).

pH: 7.4-7.6 (Glander, 1946).

For chemical analyses of the spring water in December 1944, see table 69.

[1/] Altitude reported as 50 ft by Piper (1946-47).

Starch Factory Springs

Location: Lat 15°13'29" N., long 145°44'13" E., and lat 15°13'28" N., long 145°44'16" E., 0.2 mi southwest of Public Works buildings at altitude 5 ft (from topographic map).

Aquifer: Limestone.

Remarks: Springs flow into Tanapag Swamp and were used only for raw water because of high salinity.

Production: 1.5-2.5 Mgal (Stearns, 1944).
1-2 Mgal (Glander, 1946).
2 Mgal, with 100,000-130,000 gal/d pumped for use.

Chloride: 1,206 ppm, Aug. 22, 1944 (Stearns, 1944).
680 ppm, September 1945 (Davis, 1959).
900 ppm (Glander, 1946).
480-1,200 ppm (Piper, 1946-47).
981 ppm, May 8, 1952 at 1515; temperature, 32°C.
2,420 ppm July 2, 1956 at 0900 (low and rising tide)[1/].
1,200 ppm, June 16, 1980 (Ronimus, 1981).
1,200 mg/L, Sept. 27, 1982 (Nance, 1982).

pH: 7.4-7.6 (Glander, 1946).

Specific conductance: 4,580 µmhos, June 16, 1980 (Ronimus, 1981).

For chemical analyses of the spring water in September 1945, see table 69.

[1/] Sample collected by D. C. Cox, analyzed by P. E. Ward (Cox, 1956).

Table 69. Chemical analyses of spring water (1944)

[Source: Davis, 1958. Reported in parts per million[1/]. Analyses by: 18 MGL, 18th Medical General Laboratory, Saipan; HBWS, Honolulu Board of Water Supply]

Constituent		Achugao Spring West	Achugao Spring East	Tanapag Spring No. 1	Tanapag Spring No. 2	Starch Factory Springs	Radio Hill Spring
Sampling date --		12-1-44	12-5-44	12-1-44	12-5-44	Sept. 1945	12-1-44
Analyses by ----		18 MGL	18 MGL	18 MGL	18 MGL	HBWS	18 MGL
pH ----------	--	--	--	--	--	--	6.9
Hardness as $CaCO_3$ ----------	mg/L	269	312	170	167	465	353
Calcium, dissolved (Ca) -----	mg/L	100	112	45	42	112	131
Magnesium, dissolved (Mg) ---	mg/L	4.8	8.0	14	15	45	6.3
Sodium, dissolved (Na) ------	mg/L	[2/]26	[2/]49	[2/]32	[2/]39	355	[2/]14.5
Potassium, dissolved (K) ----	mg/L	--	--	--	--	12	--
Bicarbonate (HCO_3) ----------	mg/L	325	332	232	256	252	400
Alkalinity, total as $CaCO_3$ --	mg/L	--	--	--	--	--	328
Sulfate, dissolved (SO_4) ----	mg/L	13	23	16	8.2	86	12
Chloride, dissolved (Cl) ----	mg/L	33	69	23	23	680	30
Fluoride, dissolved (F) -----	mg/L	0	0	0	0	.6	0
Silica, dissolved (SiO_2) ----	mg/L	12	14	47	55	7.3	12
Solids, dissolved, sum of constituents ----------	mg/L	380	478	310	325	1,560	492
Nitrate, dissolved (NO_2) ----	mg/L	0	0	0	0	7.6	0
Iron, dissolved (Fe) --------	µg/L	1,800	300	800	500	200	240
Manganese, dissolved (Mn) ---	µg/L	0	0	0	0	--	200
Aluminum, dissolved (Al) ----	µg/L	--	--	--	--	--	270

[1/] Parts per million is numerically equivalent to milligrams per liter.

[2/] Includes potassium expressed as sodium.

Table 70. Chemical analyses of ground water (1944-52)

[Source: Davis, 1959. Reported in parts per million[1/]. Analyses by: 18 MGL, 18th Medical General Laboratory, Saipan; Tokyo, Tokyo-To Laboratories for Medical Science, Tokyo; USGS, U.S. Geological Survey, Salt Lake City Laboratory]

Constituent		Well						
		1	3	5	6	31	[2/]57	Asgona B
Sampling date ---		12-1-44	9-8-44	9-8-44	9-8-44	3-27-50	5-8-52	9-8-44
Analyses by -----		18 MGL	18 MGL	18 MGL	18 MGL	Tokyo	USGS	18 MGL
Specific conductance -----	µmho	--	--	--	--	--	7,770	--
pH ----------	--	7.2	7.4	8.0	8.1	6.9	7.4	--
Hardness as $CaCO_3$ --------	mg/L	252	445	360	460	220	1,150	228
Noncarbonate hardness ----	mg/L	--	--	--	--	--	942	--
Calcium, dissolved (Ca) --	mg/L	86	129	124	108	86	177	74
Magnesium, dissolved (Mg)-	mg/L	9.1	29	12	46	1.1	173	9.9
Sodium, dissolved (Na) ---	mg/L	32	212	18	335	12.9	--	31
Bicarbonate (HCO_3) -------	mg/L	295	338	361	272	205	254	206
Alkalinity, total as $CaCO_3$ ----------	mg/L	--	--	--	--	6.9	--	169
Sulfate, dissolved (SO_4)--	mg/L	9.4	57	5.3	55	3.5	315	12
Chloride, dissolved (Cl) -	mg/L	49	395	67	630	17	2,480	70
Fluoride, dissolved (F) --	mg/L	0	0	--	--	--	--	--
Silica, dissolved (SiO_2) -	mg/L	9.5	2.4	4.8	5.6	2.2	--	6.8
Solids, dissolved, sum of constituent ---------	mg/L	348	1,170	483	1,529	333	5,000	335
Nitrate, dissolved (NO_2)--	mg/L	0	16	3.6	--	1.2	--	18
Iron, dissolved (Fe) -----	µg/L	300	110	130	500	40	40	100

[1/] Parts per million is numerically equivalent to milligrams per liter.

[2/] Well 57 was being used only to maintain Isley reservoir level during Maui I breakdown. Had been pumped steadily for 3 weeks, 24 hours per day at about 350-400 gallons per hour, when sampled (field notes Ted Arnow).

Table 71. Chemical analyses of water from Maui-type wells (1945-67)

[Reported in parts per million[1/]. Analyses by Tokyo: Tokyo-To Laboratories for Medical Science, Tokyo, USGS, U.S. Geological Survey, Salt Lake City Laboratory; Layne, Layne International Laboratory, Guam; HBWS, Honolulu Board of Water Supply]

Constituent		Maui I				Maui II	Maui IV			
Sampling date ---		3-23-50	5-8-52[2/]	(3)	7-20-67	9-14-45	3-23-50	5-8-52	7-20-67	(3)
Analyses by -----		Tokyo	USGS	--	Layne	HBWS	Tokyo	USGS	Layne	--
Specific conductance --------	µmho	--	843	--	4,000	2,670	--	1,500	2,200	--
pH ----------	--	7.1	8.2	7.1	7.1	7.1	7.1	7.2	7.5	7.1
Temperature, water ----------	°C	--	--	25	24	--	--	--	24	25
Oxygen, dissolved ----------	mg/L	--	--	--	--	.7	--	--	--	--
Total hardness as $CaCO_3$ -----	mg/L	--	246	627	670	465	--	308	440	436
Noncarbonate hardness -------	mg/L	--	--	--	440	258	--	--	330	--
Calcium, dissolved (Ca) -----	mg/L	130	87	115	176	112	134	95	132	77
Magnesium, dissolved (Mg) ---	mg/L	30	7.1	82	56	45	26	17	26.7	59
Sodium, dissolved (Na) ------	mg/L	296	--	--	600	355	440	--	330	--
Potassium, dissolved (K) ----	mg/L	13	--	--	--	12	10	--	--	--
Bicarbonate (HCO_3) ----------	mg/L	175	210	--	311	252	176	--	293	--
Carbonate (CO_3) ----------	mg/L	--	10	--	--	--	--	0	--	--
Alkalinity, total as $CaCO_3$ --	mg/L	199	--	--	255	207	--	290	240	--
Sulfate, dissolved (SO_4) ----	mg/L	38	24	312	--	86	49	48	--	344
Chloride, dissolved (Cl) ----	mg/L	614	148	994	1,150	680	838	330	620	600
Fluoride, dissolved (F) -----	mg/L	--	--	0	--	6	--	--	--	0
Silica, dissolved (SiO_2) ----	mg/L	5.0	--	--	1.4	7.3	40	--	1.2	--
Solids, dissolved, sum of constituents -------	mg/L	1,508	464	1,815	2,540	1,558	1,990	849	1,440	568
Nitrate, dissolved (NO_3) ----	mg/L	.5	--	--	--	7.6	.4	--	--	--
Iron, dissolved (Fe) --------	µg/L	0	50	15	30	200	20	40	25	25
Manganese, dissolved (Mn) ---	µg/L	140	--	--	--	100	11	--	--	--

[1/] Parts per million is numerically equivalent to milligrams per liter.

[2/] Not pumping for one hour before sampling.

[3/] Austin Smith and Associates, 1967. Date and laboratory not given.

Table 72. Chemical analyses of water from wells 3, 31, 76 (1967)

[Source: Austin, Smith and Associates, 1967. Reported in parts per million]

Constituent	Units	Well 3 (new)	Well 31 (old)	Well 76
pH	--	7.3	7.5	7.1
Temperature, water	°C	25	25	25
Turbidity	NTU	2	0	0
Total hardness as $CaCO_3$	mg/L	422	270	318
Calcium (Ca)	mg/L	52	69	58
Magnesium (Mg)	mg/L	71	24	43
Carbon dioxide (CO_2)	mg/L	40	18	41
Methyl orange alkalinity	mg/L	328	234	308
Sulfate (SO_4)	mg/L	--	4.5	14
Chloride (Cl)	mg/L	458	26	64
Fluoride (F)	mg/L	0	0	0
Total solids	mg/L	1,370	317	461
Iron (Fe)	mg/L	.093	.009	.011

Parts per million is numerically equivalent to milligrams per liter.

Table 73. Chemical analysis of water from U.S Coast Guard well (1971)

[Analyses by U.S. Geological Survey, Salt Lake City Laboratory]

Constituent	Unit	July 25, 1971 at 1000
Hardness, total	mg/L	660
Calcium, dissolved (Ca)	mg/L	150
Magnesium, dissolved (Mg)	mg/L	69
Sodium, dissolved (Na)	mg/L	600
Percent sodium	percent	66
Sodium adsorption ratio	--	10
Potassium, dissolved (K)	mg/L	17
Chloride, dissolved (Cl)	mg/L	1,200
Fluoride, dissolved (F)	mg/L	0
Silica, dissolved (SiO_2)	mg/L	9.4
Nitrite and Nitrate, as dissolved N	mg/L	2.3
Iron, dissolved (Fe)	µg/L	40
Boron, dissolved	µg/L	280

Table 74. Analyses of ground water for metals and pesticides (1977)

[Analyses by LFE Environmental Analysis Laboratories, Richmond, Calif. Date of sampling, November 1977. Date of analyses, December 1977]

Constituent	Unit	Well 6	Well 16	Well 50	Well Maui IV
Metals					
Arsenic	mg/L	<0.01	<0.01	<0.01	<0.01
Barium	mg/L	.03	.04	.03	.04
Cadmium	mg/L	.004	.004	.002	.005
Chromium	mg/L	< .05	< .05	< .05	< .05
Lead	mg/L	.058	.077	.049	.072
Mercury	mg/L	4.4	.6	< .5	< .5
Selenium	mg/L	< .005	< .005	< .005	< .005
Silver	mg/L	< .005	< .005	< .005	< .005
Pesticides					
Endrin	ppb	< .01	< .01	< .01	< .01
Lindane	ppb	< .1	< .01	< .01	< .01
Methoxychlor	ppb	< .01	< .01	< .01	< .01
Toxaphene	ppb	< .1	< 1	< .1	< .1
2, 4-D	ppb	< .01	< .01	< .01	< .01
2, 4, 5-TP Silvex	ppb	< .01	< .01	< .01	< .01

ppb - parts per billion.

Table 75. Chemical analyses of water from wells 103 and 111 (1982)

Constituent		Well 103	Well 111
Date		11-18-82	11-18-82
Time		1110	1200
Specific conductance	µmho	874	1,320
pH	--	7.0	7.1
Temperature (water)	°C	28.5	28.5
Hardness as $CaCO_3$	mg/L	330	350
Noncarbonate hardness	mg/L	66	130
Calcium, dissolved (Ca)	mg/L	120	110
Magnesium, dissolved (Mg)	mg/L	6.9	18
Sodium, dissolved (Na)	mg/L	52	120
Percent sodium	percent	26	42
Sodium adsorption ration	--	1.3	2.9
Potassium, dissolved (K)	mg/L	2.0	4.7
Alkalinity, total as $CaCO_3$	mg/L	262	223
Sulfate, dissolved (SO_4)	mg/L	11	30
Chloride, dissolved (Cl)	mg/L	110	270
Fluoride, dissolved (F)	mg/L	< .1	< .1
Silica, dissolved (SiO_2)		6.5	8.8
Solids, dissolved, sum of constitutents	mg/L	484	712
Nitrogen, dissolved ($NO_2 + NO_3$)	mg/L	4.0	3.6
Iron, dissolved (Fe)	µg/L	37	28
Manganese, dissolved (Mn)	µg/L	3	3

Table 76. Chemical analyses of water from wells 76, 144, 164, 171 (1983)

[U.S. Geological Survey]

Constituent		Well 76	Well 144	Well 164	Well 171
Date		7-1-83	7-1-83	7-1-83	6-30-83
Time		1355	1250	1055	0645
Specific conductance	µmho	883	3,250	9,400	26,300
pH	--	7.3	7.4	7.6	7.6
Temperature (water)	°C	28.5	28.0	28.5	--
Hardness as $CaCO_3$	mg/L	360	560	1,300	3,200
Noncarbonate hardness	mg/L	--	380	1,100	2,700
Calcium, dissolved (Ca)	mg/L	130	140	250	330
Magnesium, dissolved (Mg)	mg/L	7.6	52	170	570
Sodium, dissolved (Na)	mg/L	42	470	1,500	5,200
Percent sodium	percent	20	64	70	77
Sodium adsorption ration	--	1.0	8.6	18	40
Potassium, dissolved (K)	mg/L	1.5	15	41	130
Alkalinity, total as $CaCO_3$	mg/L	--	180	197	500
Sulfate, dissolved (SO_4)	mg/L	--	330	360	550
Chloride, dissolved (Cl)	mg/L	--	870	2,800	9,300
Fluoride, dissolved (F)	mg/L	< .1	< .1	< .1	< .1
Silica, dissolved (SiO_2)	mg/L	26	7.6	8.2	10
Solids, dissolved, sum of constitutents	mg/L	--	2,000	5,260	16,400
Nitrogen, dissolved ($NO_2 + NO_3$)	mg/L	1.5	2.5	1.8	< .10
Iron, dissolved (Fe)	µg/L	4	40	40	160
Manganese, dissolved (Mn)	µg/L	1	10	10	5,000

Table 77. Chemical analyses of water from wells 148, 149, 150 (1983)

[U.S. Geological Survey]

Constituent		Well			
		148	149	150	
Date		7-1-83	7-1-83	4-23-83	7-1-83
Time		1021	1104	1000	1045
Specific conductance	µmho	653	560	639	577
pH	--	7.5	7.5	7.9	7.5
Temperature (water)	°C	27.5	27.0	--	27.5
Hardness as $CaCO_3$	mg/L	270	250	270	260
Noncarbonate hardness	mg/L	75	5	6	--
Calcium, dissolved (Ca)	mg/L	100	94	100	96
Magnesium, dissolved (Mg)	mg/L	4.7	4.6	4.7	4.7
Sodium, dissolved (Na)	mg/L	28	18	23	19
Percent sodium	percent	18	13	16	14
Sodium adsorption ration	--	.8	.5	.6	.5
Potassium, dissolved (K)	mg/L	2.6	.8	2.9	1.1
Alkalinity, total as $CaCO_3$	mg/L	--	249	263	--
Sulfate, dissolved (SO_4)	mg/L	7.9	6.7	8.8	--
Chloride, dissolved (Cl)	mg/L	51	29	42	--
Fluoride, dissolved (F)	mg/L	< .1	< .1	< .1	< .1
Silica, dissolved (SiO_2)	mg/L	9.1	9.2	8.6	10
Solids, dissolved, sum of constitutents	mg/L	334	326	348	--
Nitrogen, dissolved ($NO_2 + NO_3$)	mg/L	3.1	3.2	--	2.6
Iron, dissolved (Fe)	µg/L	6	10	9	3
Manganese, dissolved (Mn)	µg/L	< 1	2	2	3

REFERENCES

Arnow, Ted, 1952, Report to High Commissioner Trust Territory of the Pacific Islands: Unpublished typewritten report, 7 p.

----- 1953, Report on Island water system for Saipan: Unpublished typewritten report to U.S. Navy, 19 p.

Austin, Smith and Associates, 1967, Engineering report covering a master planned water system and sewerage system for the Island of Saipan, Mariana Islands: Honolulu, Hawaii, 50 p.

----- 1972, Engineering report covering extensions and improvements to the existing water system for the Island of Saipan, Mariana Islands.

Ayers, J. F., 1981, Evaluation of the groundwater resources of the Agag Basin, Saipan: University of Guam, Technical Report No. 31, 82 p.

Boniface, Major W. H., 1945, Report on the water system of Saipan developed by the Corps of Engineers, U.S. Army, 15 June 1944 to 1 August 1945: Unpublished typewritten report, 24 p.

Bowers, N. M., 1950, Problems of resettlement on Saipan, Tinian, and Rota, Mariana Islands: University of Hawaii, 258 p.

Bryan, E. H., Jr., 1946, A geographic summary of Micronesia and notes on the climate of Micronesia: U.S. Commercial Co., Economic Survey, v. 2-1, 102 p.

Cloud, P. E., Schmidt, R. G., and Burke, H. W., 1956, Geology of Saipan, Mariana Islands: Part 1. General Geology: Geological Survey Professional Paper 280-A, 126 p.

Cox, D. C., and Evans, T. R., 1956, Water supply, in Utilities study for Island of Saipan: Honolulu, Hawaii, Belt, Lemmon and Lo, section IV, p. 41-86.

Curione, Ensign Charles, 1949, Report on Island water system, Saipan, Mariana Islands: Unpublished typewritten report, 21 p.

Davis, D. A., 1959, Water resources, in Military geology of Saipan, Mariana Islands: Chief of Engineers U.S. Army, v. 2, 96 p.

Davis, T., Jr., 1973, Saipan Island water plan, District Administrator Mariana District, Trust Territory of the Pacific Islands, 113 p.

Glander, Lt. Raymond, 1946, Report on the water supply system of Saipan, Naval Operating Base - Public Works: Unpublished typewritten report, 61 p.

GK^2, Inc./CE Maguire, Inc., 1982, Saipan water supply system study: Saipan, 220 p.

Hawaii Architects and Engineers, Inc., 1968, Saipan: Trust Territory physical planning program, 69 p.

Knott, Norman, 1972, Groundwater Resources Saipan, Mariana Islands: Department of Resources and Development, Report of Trust Territory of the Pacific Islands.

M and E Pacific, 1978, Water management plan for Saipan, Rota and Tinian: Department of Public Works, Commonwealth of the Northern Marianas, various paging.

Mink, J. F., 1969, Ground-water development in the Trust Territory: The Earth Sciences Group, Inc., Washington D.C., 71 p.

----- 1977, Water resources and supply in the Northern Mariana Islands: Saipan, Tinian and Rota: Physical planning program for Northern Mariana Islands, 27 p.

Mitt(h)eilungen von Forschungreisenden und Gelehrten aus den deutschen Schutzgebieten [Communications from explorers and scientist from the German protectorates]: Annual publications, Berlin, 1902-13.

Nance, Tom, 1982, Status and future development of Saipan's water supply: Honolulu, Hawaii, Belt, Collins and Associates, 94 p.

Nettleman, Pete, 1953, Water supply system for Saipan: Unpublished typewritten report, 19 p.

Oliver, D. L., 1961, The Pacific Islands: The National History Library, 456 p.

Pacific Island Year Book, 1978, 13th edition: New York, 512 p.

Pacific Planning and Design Consultants, 1978, Physical development master plan for the Commonwealth of the Northern Mariana Islands, Saipan, Volume II: Office of Transitional Studies, Trust Territory of the Pacific Islands, various paging.

Piper, A. M., 1946-47, Water resources of Guam and the ex-Japanese mandated islands in the western Pacific: Unpublished typewritten report, p. 100-129.

Reyes, William, not dated, A copy of Japanese records. A translation of Japanese records covering approximately the years 1915-1937: University of Hawaii, Hamilton Library, unpublished mimeographed report, 19 p.

Ronimus, A. D., 1981, Saipan: Commonwealth of the Northern Mariana Islands, Ground water resources and their use: University of Hawaii, School of Public Health, 44 p.

Schallenberg, R. T., and Ford, J. I., 1978, Report on field trip to Guam and Saipan, 13-23 December, 1978: Unpublished processed U.S. Army Corps of Engineers report, Honolulu, Hawaii, 63 p.

Schott, Prof. Dr. G., 1938, Handbuch der Klimatologie: Band IV, Teil T, Klimakunde der Südsee Inseln, Berlin 1938, p. 114.

Spoehr, Alexander, 1954, Saipan, the ethnology of a war-devastated island: Chicago Natural History Museum, 380 p.

Stearns, H. T., 1944, Water, rock, and mineral resources of the Island of Saipan, Mariana Islands: U.S. Geological Survey, Honolulu, Hawaii, unpublished typewritten report, 28 p.

Tayama, Risaburo, 1939, Report on ground water on Saipan Island, Tropical Industry Institute, Palau Islands; Bull. No. 2, translated by M. Shimakura, 1948: Unpublished typewritten report, 13 p. and tables.

Taylor, R. C., 1973, An atlas of Pacific Island rainfall: Hawaii Institute of Geophysics Data Report No. 25, Honolulu, Hawaii, 5 p., App. A-E, various paging.

Tenorio Environmental Engineering, 1973, Evaluation of the groundwater resources at Isley Field region and other areas for planning and development. Saipan, Mariana Islands: District Administrator Marianas, Saipan, Mariana Islands, 32 p.

U.S. Army Corps of Engineers, 1981, Susupe - Chalan Kanoa flood control study, Saipan, Northern Marianas: U.S. Army Engineer District, Honolulu, p. A29-A40.

U.S. Department of the Navy, Office of the Chief of Naval Operation, 1944, Civil affairs handbook. Mandated Mariana Islands: Washington D.C., 205 p.

U.S. Geological Survey, 1962, Surface water supply of Mariana, Caroline and Samoa Islands through June 1960: Geological Survey Water-Supply Paper 1751, p. 5, 6.

----- 1968-74, Water resources data for Hawaii and other Pacific areas, water years 1968-74: U.S. Geological Survey Water-Data Reports 1968, 296 p.; 1969, 289 p.; 1970, 299 p.; 1971, 333 p.; 1972, 280 p.; 1973, 264 p.; 1974, 277 p.

----- 1975-76, Water resources data for Hawaii and other Pacific areas, water years 1975 and 1976: U.S. Geological Survey Water-Data Reports HI-75-1, 401 p.; HI-76-1, 445 p.

----- 1977, Surface water supply of the United States, 1966-70: U.S. Geological Survey Water Supply Paper 2137, p. 692-695, 735, 736.

----- 1977-80, Water resources data for Hawaii and other Pacific areas, water years 1977-80, v. 2. Trust Territory of the Pacific Islands, Guam, American Samoa, and Northern Mariana Islands: U.S. Geological Survey Water-Data Reports HI-77-2, 90 p.; HI-78-2, 108 p.; HI-79-2, 126 p.; HI-80-2, 158 p.

----- 1981-82, Water Resources Data Hawaii-other Pacific areas, water years 1981 and 1982, v. 2. Guam, Northern Mariana Islands, Federated States of Micronesia, Palau Islands, and American Samoa: U.S. Geological Survey Water-Data Reports HI-81-2, 148 p.; HI-82-2, 146 p.

U.S. National Oceanic and Atmospheric Administration, 1970-72, Climatological Data, Pacific: v. 15, no. 6-12, v. 16, 17, nos. 1-12.

----- 1973-82, Climatological Data, Hawaii and Pacific: v. 69-78, nos. 1-12.

U.S. Weather Bureau, 1954-55, Climatological Data, Hawaii: v. 50, 51, nos. 1-12.

----- 1956-70, Climatological Data, Pacific: v. 1-14, nos. 1-12, v. 15, nos. 1-5.

Von Kotzebue, Otto, 1821, A voyage of discovery into the South Sea and Bering Strait: London, v. I, p. 79.

World Health Organization, 1971, International standards for drinking water, 3rd ed., 70 p.

Young, M. W. H., Wong, D. E., Chun, M. J., and Young, R. H. F., 1977, Sanitary Survey of major municipal water systems, Trust Territory of the Pacific Islands: Unpublished typewritten report, 95 p.