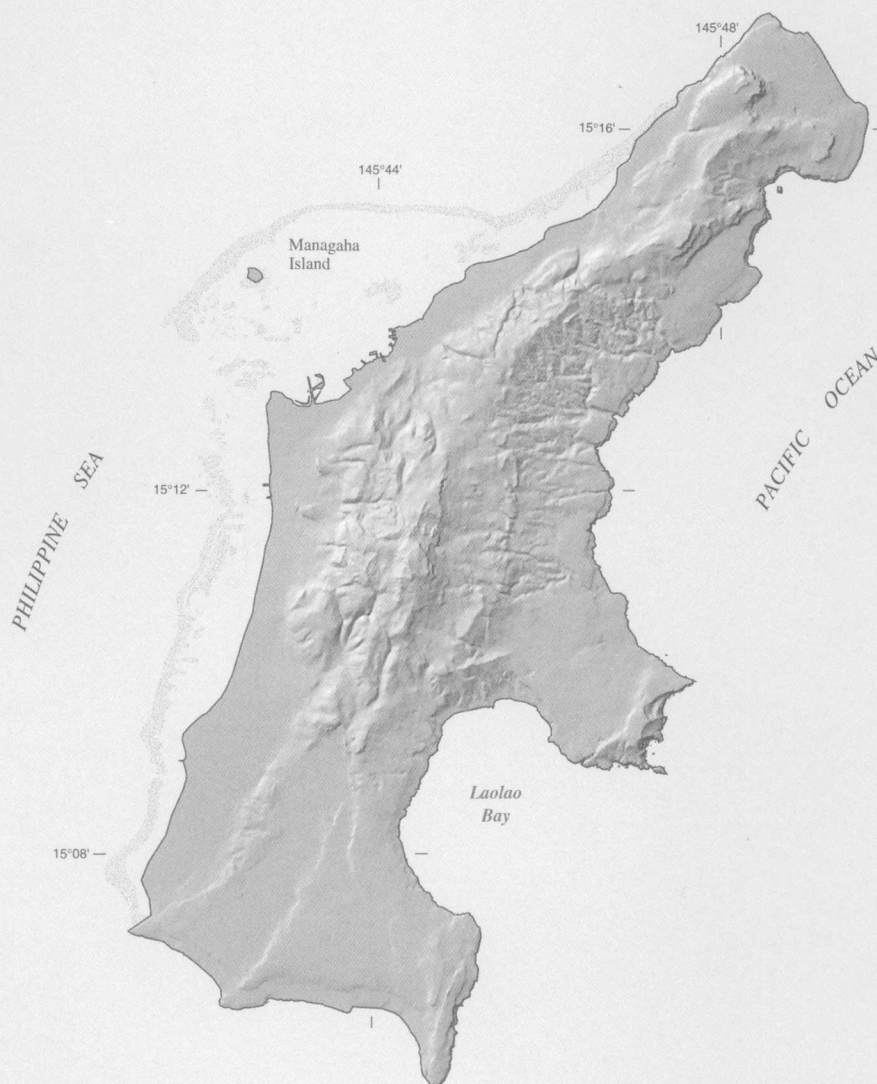


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Summary of Hydrologic Data for 1998, Saipan, Commonwealth of the Northern Mariana Islands

U.S. GEOLOGICAL SURVEY
Open-File Report 00-301



Prepared in cooperation with the
COMMONWEALTH UTILITIES CORPORATION,
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

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By Robert L. Carruth

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Honolulu, Hawaii
2000

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary



U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

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PLATE

1. Map showing municipal wells, well fields, and developed springs, Saipan, 1998 (in pocket)

CONVERSION FACTORS

Multiply	By	To obtain
mile (mi)	1.609	kilometer
square mile (mi ²)	2.590	square kilometer
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
gallon per minute (gal/min)	0.06309	liter per second
gallon per day (gal/d)	0.003785	cubic meter per day
million gallons per day (Mgal/d)	0.04381	cubic meter per second
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second

Abbreviations used in water quality descriptions:

mg/L, milligrams per liter

μS/cm, microsiemen per centimeter at 25° Celsius

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Abstract

Hydrologic data for 1998 were collected and compiled for the island of Saipan as part of the cooperative program between the Commonwealth Utilities Corporation and the U.S. Geological Survey. A hydrologic data network consisting of rain gages, monitor wells, and surface-water stage and discharge measurement sites is operated and maintained. Sea-level data from the Saipan sea-level station were obtained from the University of Hawaii Sea Level Center. Ground-water data consist of pumpage, water levels, chloride-ion concentrations, and specific conductance. Surface-water data consist of periodic discharge measurements at developed springs and South Fork Talufofo Stream, and stage at Lake Susupe. Most data are from production wells and monitor wells because ground water makes up about 95 percent of the water supply for the island.

Rainfall on Saipan in 1998 varied seasonally with greater rainfall during the period of July through November. Total rainfall at Saipan stations in 1998 ranged from 34.18 to 53.04 inches. Mean annual rainfall on Saipan is 80.27 inches. Ground-water production on Saipan in October 1998 was 11.15 million gallons per day from 127 wells. Well fields in southern Saipan accounted for about 57 percent of the total ground-water production. Ground-water levels were less than 5 feet above mean sea level for all monitoring sites except for Kagman monitor well 1 and Akgak monitor well 1,

where water levels ranged from about 11 to 15 and 380 to 410 feet above mean sea level, respectively. The volume-weighted chloride-ion concentrations from all well fields in October 1998 ranged from a low of 63 milligrams per liter in the Akgak and Capital Hill well fields, to a high of 2,853 milligrams per liter in the Maui IV well field.

INTRODUCTION

Saipan, the largest of 14 small islands that make up the Commonwealth of the Northern Mariana Islands (CNMI), is located in the western Pacific Ocean at latitude 15°12' N. and longitude 145°45' E. (fig. 1). The island is about 12 mi long, ranges in width from 2 to 6 mi and has an area of 48 mi². Saipan is elongated in the northeast-southwest direction and Mt. Tagpochau is the highest point on the island at 1,555 ft. The population of Saipan is about 65,000 and the population density and commerce are greatest along the western coast region. The central uplands and eastern side of Saipan remain more rural.

The island consists of a volcanic core overlain by younger limestones. From axial uplands in the middle three-fourths of the island, the land steps down to the sea in a succession of nearly horizontal limestone terraces that are separated by steep scarps (Cloud and others, 1956). Ground water is pumped from limestone aquifers throughout the island and pumping is concentrated in southern Saipan.

Municipal water on Saipan is supplied by the Commonwealth Utilities Corporation (CUC). In 1998, the CUC served most of the population with water from 127



Figure 1. Rain gages, ground-water monitoring sites, sea-level station, and surface-water monitoring sites used in the water-resources management program, Saipan, 1998.

production wells, 3 developed springs, and a rain-water catchment system at the airport. About an equal number of privately owned wells are scattered throughout Saipan for light industries, irrigation, and tourist-related businesses such as resorts and golf courses. The average permitted pumping rate for a private well is 30 gal/min (Joe Kaipat, Commonwealth Department of Environmental Quality, oral commun., 1998).

In 1988, CUC began a cooperative project with the U.S. Geological Survey (USGS) to study and describe the water resources on Saipan and to develop and maintain a hydrologic data network. Operation of the hydrologic data network includes the collection and compilation of rainfall, ground-water, sea-level, and surface-water data.

Purpose and Scope

This report presents the 1998 rainfall, ground-water, sea-level, and surface-water data that were collected and compiled for Saipan. The report contains the following:

Rainfall

- monthly rainfall at 8 stations
- monthly mean rainfall of all stations and departure from mean monthly rainfall

Ground Water

- daily mean ground-water levels at 6 monitoring wells with digital recorders
- monthly ground-water levels at 6 monitoring wells measured monthly
- vertical profiles of chloride-ion concentration at four deep-profiling monitor wells
- ground-water production from 127 municipal production wells in October 1998
- mean daily chloride-ion concentration by well field in October 1998
- quarterly chloride-ion concentration from 127 production wells

Sea Level

- daily and monthly mean sea level at the Saipan sea port

Partial-Record Surface-Water Stations and Springs

- intermittent discharge measurements at South Fork Talufofo Stream
- intermittent discharge measurements at Donni, Achugao, and Tanapag Springs
- intermittent stage measurements at Lake Susupe

Acknowledgments

Data were compiled from the following agencies:

Commonwealth Utilities Corporation (CUC);
Commonwealth Ports Authority (CPA);
Commonwealth Emergency Management
Office (EMO); and the
University of Hawaii Sea Level Center (UHSLC).

Assistance from these agencies in support of the hydrologic data program is gratefully acknowledged. Field support from the staff of CUC is appreciated.

RAINFALL

Records of rainfall on Saipan indicate a seasonal distribution and a mean annual rainfall of 80.27 in. (van der Brug, 1985). The dry season usually is from about January through May and droughts are frequent. A wet season occurs from about July through November and June and December are transitional months. Heavy and prolonged rainfall usually are associated with tropical depressions and typhoons that pass near or over the island.

Rainfall data are compiled from 8 rain gages located throughout Saipan (fig. 1). The gages are owned and operated by the EMO, CPA, or the USGS. Monthly rainfall on Saipan for all stations in 1998 are displayed in table 1 and in figure 2. Monthly mean rainfall for Saipan (determined by averaging the monthly rainfall from all stations) and departures from mean monthly rainfall (van der Brug, 1985) are shown in table 1 and in figure 3.

Total rainfall at Saipan stations in 1998 ranged from a low of 34.18 in. at the CPA Tower rain gage to a high of 53.04 in. at the EMO Base gage. Departure from the mean annual rainfall at Saipan stations ranged from about -27 to -44 in. (table 1). Seasonal rainfall in 1998 was evident with all stations showing increased rainfall

Table 1. Monthly and annual rainfall at Saipan stations, 1998

[Values in inches; nd, no data; n/a, not applicable]

Rainfall station location, name																			
Laderan		Saddok		Capital Hill,		Mt.		Kagman,		Susupe,		Isley Field,		Isley Field,		Long-term		Departure	
Year	Month	Towers	Tasi,	EMO Base ¹	Tagpochau,	EMO Tower	Agriculture	Station	Mt. Carmel	Reservoir	CPA Tower ²	Monthly mean	mean monthly ³	from mean monthly					
1998	January	nd	2.00	1.85	0.20	0.70	0.20	0.10	0.99	0.86	3.91	-3.05							
	February	nd	1.40	1.70	2.20	2.30	1.30	1.70	1.11	1.67	3.34	-1.67							
	March	nd	1.50	2.21	2.70	2.60	1.60	2.00	1.96	2.08	3.23	-1.15							
	April	nd	2.10	2.10	2.40	2.20	1.80	1.90	1.51	2.00	3.12	-1.12							
	May	nd	2.00	4.15	2.40	2.30	2.00	2.40	2.62	2.55	3.50	-0.95							
	June	1.94	0.82	0.83	1.30	1.00	nd	1.10	0.91	1.13	4.93	-3.80							
	July	5.50	7.40	8.21	3.10	5.80	5.60	6.50	5.89	6.00	9.50	-3.50							
	August	6.30	8.00	8.72	6.10	5.20	5.80	5.70	5.46	6.41	12.45	-6.04							
	September	9.10	8.50	8.65	8.40	9.60	4.20	4.70	4.89	7.26	13.43	-6.18							
	October	6.70	6.10	6.52	5.20	6.80	7.30	6.60	4.68	6.24	10.60	-4.36							
	November	3.00	3.60	5.24	3.50	3.50	3.20	2.80	2.95	3.47	7.46	-3.99							
	December	2.30	2.28	2.86	3.20	2.20	2.30	0.72	1.21	2.13	4.80	-2.67							
Total		n/a	45.70	53.04	40.70	44.20	n/a	36.22	34.18	41.81	80.27	-38.46							

¹ Data from Commonwealth Emergency Management Office

² Data from Commonwealth Ports Authority

³ Calculated from 50 years of rainfall data collected between 1901 and 1983 at five stations that have been discontinued (van der Brug, 1985)

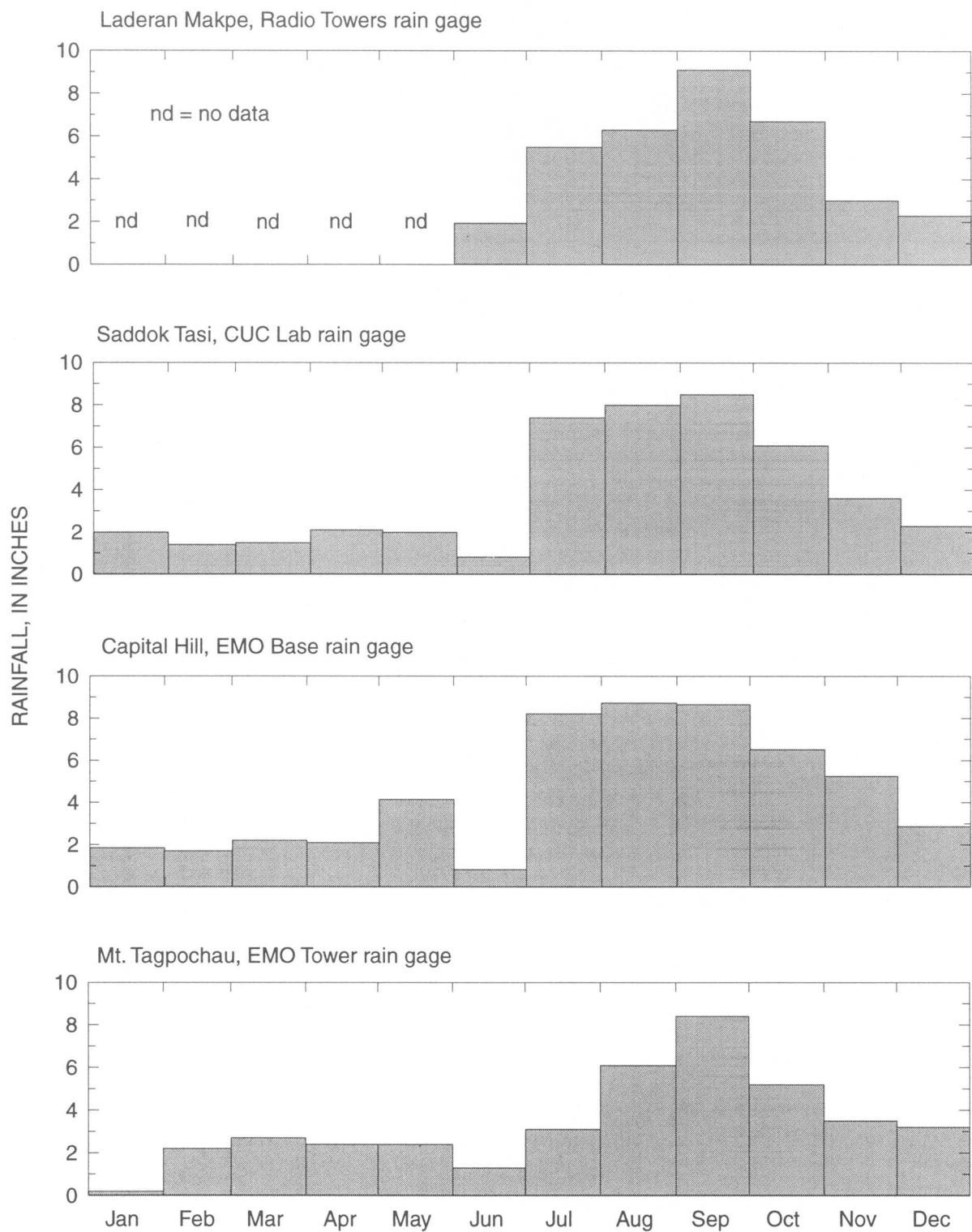


Figure 2. Monthly rainfall at Saipan stations, 1998.

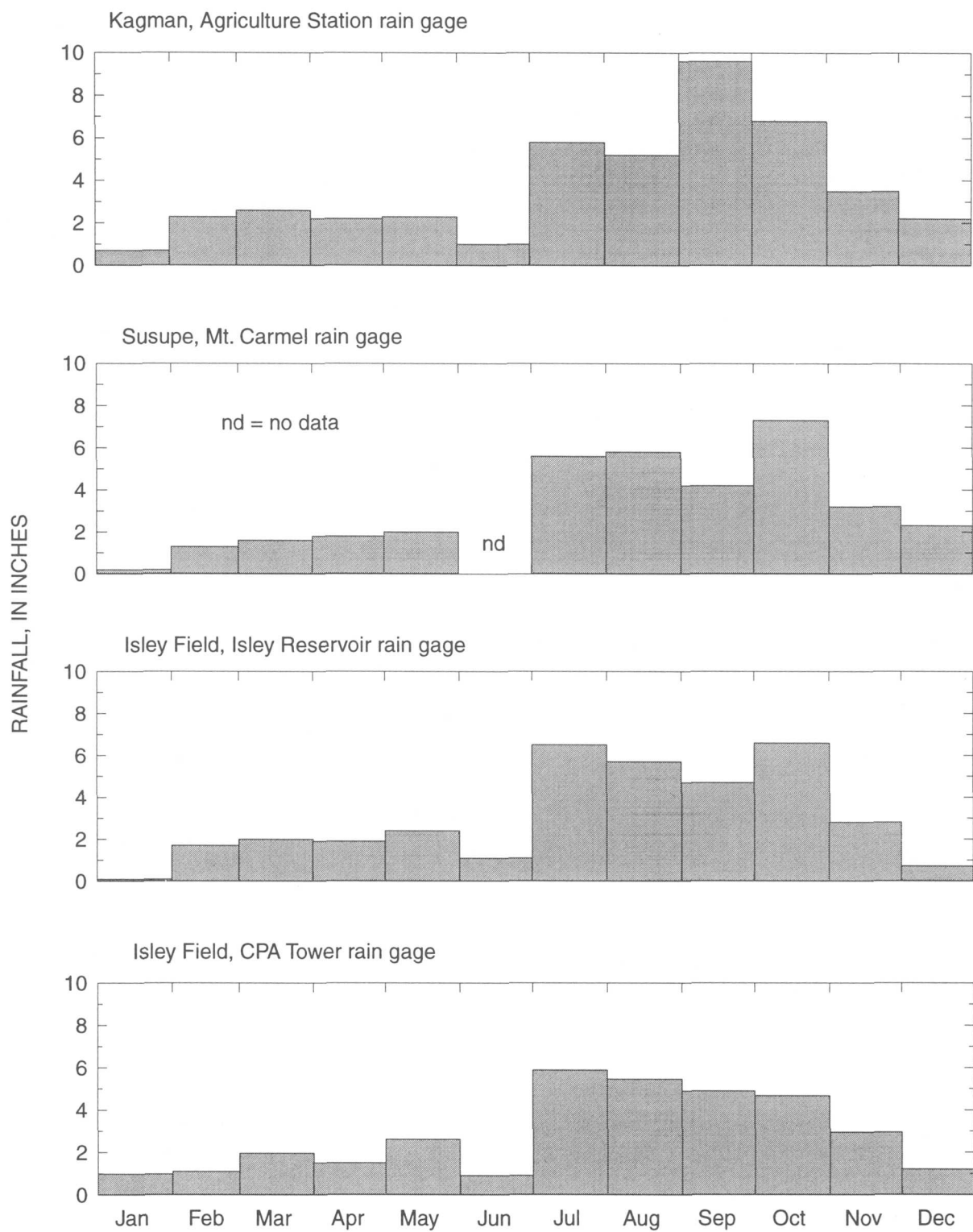


Figure 2. Monthly rainfall at Saipan stations, 1998--Continued.

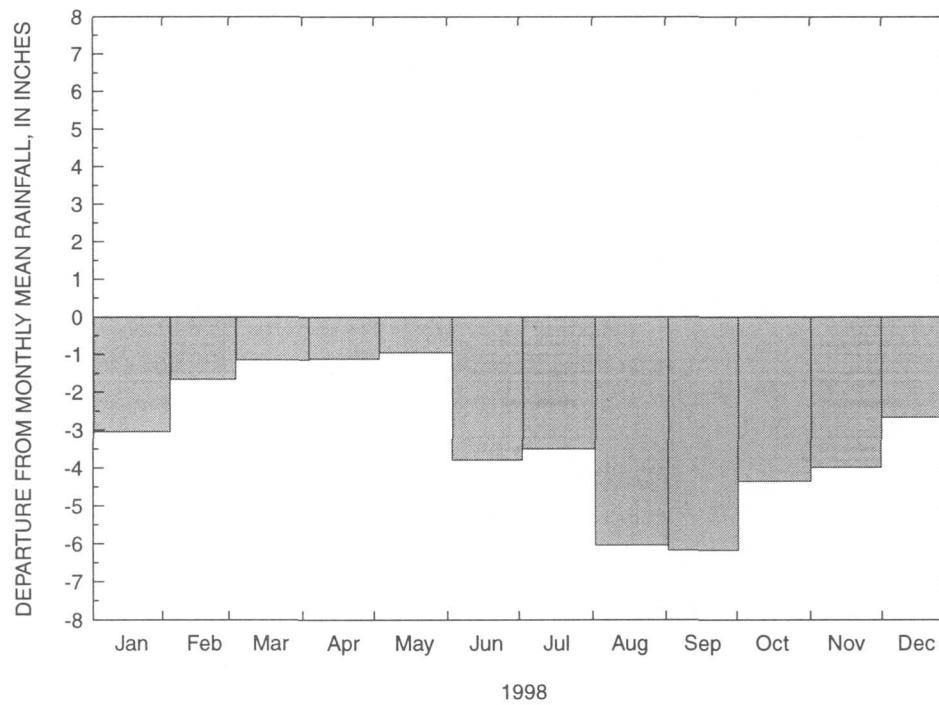
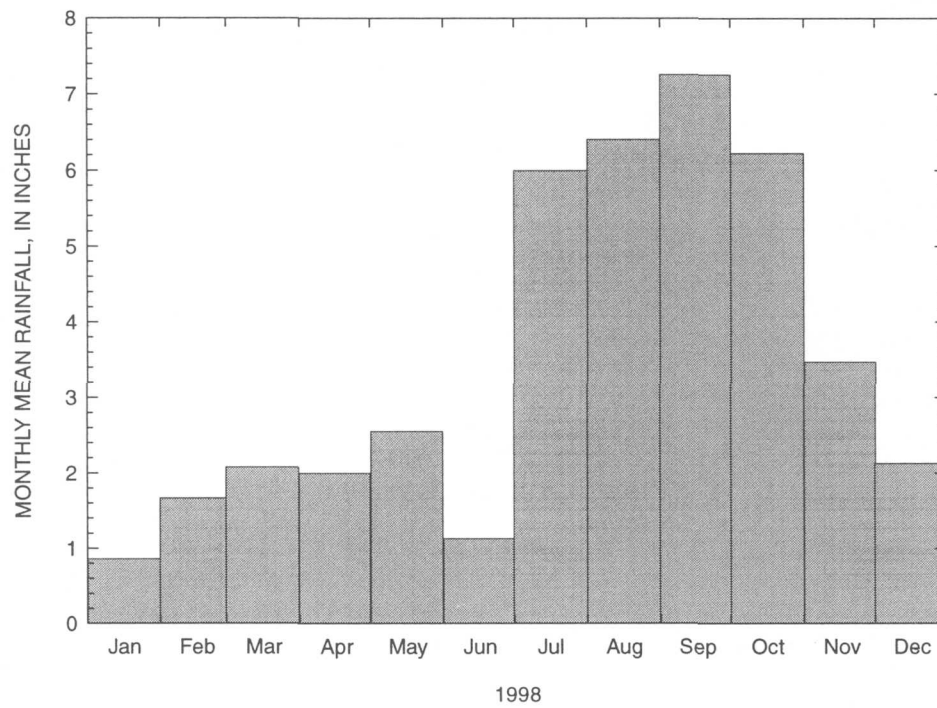


Figure 3. Monthly mean rainfall of all Saipan stations and departure from long-term mean monthly rainfall, Saipan, 1998.

during the wet season months of July through November. About 70 percent of the total rainfall occurred during the wet season months.

GROUND WATER

Ground-water data include pumpage, water levels, and chloride-ion concentrations. Saipan has 127 production wells that are unequally divided into 15 well fields (plate 1). Present (1998) names and status of Saipan municipal wells and developed springs; and previously used well names and identification numbers are shown in table 2. Ground-water production data are from October 1998. Ground-water level data are from six continuously recording monitor wells and from six wells that are measured monthly. Production wells are sampled and analyzed quarterly for chloride-ion concentration.

Pumpage

Water for the municipal supply is pumped and distributed by the CUC. About 95 percent of the water supply for the island comes from ground water. In 1998, 127 production wells were active continuously. Municipal well fields on Saipan are grouped into three regions, referred to as the southern, central, and northern well fields (plate 1). Ground-water pumpage data for October 1998 are shown in tables 3, 4, and 5. Pumpage data are shown by individual well and by well field. Daily production at each well was determined by multiplying the instantaneous meter reading in gallons per minute by 1,440 minutes per day; this method of estimating daily pumpage is considered reasonable over short time periods because all production wells are operated continuously. A summary of daily ground-water production is shown in table 6. Municipal ground-water pumpage in early October 1998 for the entire island was about 11.15 Mgal/d. Pumpage from the southern Saipan well fields accounted for about 57 percent of the total municipal ground-water production.

Water Levels

Ground-water levels are measured by the USGS at six monitoring wells equipped with digital recorders (fig. 1). The recorders measure water levels to the nearest 0.01 ft at 30-minute intervals. Daily mean ground-

water levels at the recording monitor wells are shown in figure 4. An additional six monitoring wells are measured about monthly (fig. 1). Monthly ground-water data and levels are shown in figure 5. Ground-water levels were 0.5 to 5 ft above mean sea level at wells OB-MW1, IF-MW1-5, KG-MW2, KG-MW3, and AM-MW1 (figs. 4 and 5). Ground-water levels ranged from about 11 to 15 ft at KG-MW1 and from about 380 to 410 ft at AG-MW1 (fig. 4). Water levels at KG-MW1 and AG-MW1 were highest in January and February.

Chloride-Ion Concentrations

Chloride-ion concentration data are reported for production wells and monitor wells. In this report, chloride-ion concentration is used as a quantitative measure of salinity. A chloride-ion concentration of 250 mg/L is the secondary maximum contaminant level (SMCL) under secondary drinking-water standards (U.S. Environmental Protection Agency, 1991). Secondary standards are not enforceable limits, but instead establish goals for constituents that may affect the aesthetic qualities of drinking water, such as taste or color. For comparison, the chloride-ion concentration in seawater is about 19,200 mg/L.

Chloride-ion concentrations of water from production wells are analyzed quarterly by the CUC (table 7). Chloride-ion concentration data for October 1998 are shown with production-well data from the same time period in tables 3, 4, and 5. A summary of mean daily volume-weighted chloride-ion concentration at municipal well fields in early October 1998 is shown in table 6. The mean daily volume-weighted chloride-ion concentrations are calculated by adding the products of daily pumpage and chloride-ion concentration for every sampled well in the well field, and then dividing that sum by the total daily pumpage for those wells. The volume-weighted chloride-ion concentrations account for pumpage and weights chloride-ion concentrations from those wells which pump more or less water.

The mean daily volume-weighted chloride-ion concentrations from all well fields in early October 1998 ranged from a low of 63 mg/L in the Akgak and Capital Hill well fields, to a high of 2,853 mg/L in the Maui IV well field (table 6). The volume-weighted chloride-ion concentration of water from all well fields except Akgak and Capital Hill (table 6) exceeded the 250 mg/L SMCL.

Table 2. Present names and status of municipal wells and developed springs, and previously used names and identification numbers, Saipan
[--, none]

Well field name	Present well or spring name	Previously used well name(s)	Previously used well identification number	Present status
Isley Field	IF-1	Isley 212	10-21	production well
	IF-2	Isley 214B	--	production well
	IF-3	--	--	production well
	IF-4	--	--	production well
	IF-5	--	--	production well
	IF-6	Isley 206B	--	production well
	IF-7	--	--	production well
	IF-8	--	--	production well
	IF-9	--	--	off line pending completion
	IF-10	--	--	off line pending completion
	IF-11	Isley 107, W 107	10-07	production well
	IF-12	--	--	production well
	IF-13	Isley 203B	--	production well
	IF-14	--	--	off line pending completion
	IF-15	--	--	production well
	IF-16	Dan Dan 9	--	production well
	IF-17	--	--	production well
	IF-18	--	--	production well
	IF-19	--	--	production well
	IF-20	--	--	production well
	IF-21	--	--	production well
	IF-22	--	--	production well
	IF-23	Isley 103, TH 3, W 3C	10-03	production well
	IF-24	--	--	production well
	IF-25	Isley 109, W 109	10-09	production well
	IF-26	--	--	off line pending completion
	IF-27	--	--	off line pending completion
	IF-28	Isley 210	--	production well
	Isley 101	W 101A, W 101B	10-01	production well
	Isley 102	W 102	10-02	production well
	Isley 104	TH 4, W 4C	10-04	abandoned and sealed, 7/98
	Isley 105	TH 15, W 15	10-05	production well
	Isley 106	W 106 (103)	10-06	production well
	Isley 108	W 108	10-08	production well
	Isley 201	--	10-10	production well
	Isley 202	--	10-11	production well
	Isley 203	--	10-12	abandoned and sealed, 10/95
	Isley 204	--	10-13	production well
	Isley 205	--	10-14	production well
	Isley 206	--	10-15	abandoned and sealed, 3/96
	Isley 207	--	10-17	abandoned and sealed, 7/98
	Isley 208	--	10-16	off line, 7/98 (used intermittently by airport fire station)
	Isley 211	--	10-20	production well
	Isley 213	--	10-22	abandoned and sealed, 7/98
	Isley 214	--	10-23	abandoned and sealed, 3/96
	Isley 215	--	10-24	abandoned and sealed, 7/98
	Isley 216	--	10-25	abandoned and sealed, 7/98
	Isley 217	--	10-26	production well
	Isley 218	--	10-27	abandoned and sealed, 7/98
	Isley 219	--	10-28	abandoned and sealed, 7/98
	Isley 220	--	10-29	production well
	Isley 221	--	10-30	abandoned and sealed, 7/98
	IF-MW1	--	10-32	monitor well
	IF-MW2	--	10-00	monitor well
	IF-MW3	--	10-01X	monitor well
	IF-MW4	DD-10	--	monitor well
	IF-MW5	--	--	monitor well

Table 2. Present names and status of municipal wells and developed springs, and previously used names and identification numbers, Saipan--Continued
[--, none]

Well field name	Present well or spring name	Previously used well name(s)	Previously used well identification number	Present status
Obyan	OB-1	--	--	production well
	OB-2	--	--	production well
	OB-3	--	--	production well
	OB-4	--	--	production well
	OB-5	--	--	production well
	OB-6	--	--	production well
	OB-7	--	--	production well
	OB-8	--	--	production well
	OB-9	--	--	production well
	OB-10	--	--	production well
	OB-11	--	--	production well
	OB-12	--	--	production well
	OB-13	--	--	production well
	OB-MW1	--	10-03X	monitor well
Koblerville	KV-9	Kobler Field W-9	11-09	production well
	KV-10	Kobler Field W-10	11-10	off line (CUC lab analysis indicates high chloride-ion concentration)
	KV-11	Kobler Field W-11	11-11	production well
	KV-12	Kobler Field W-12	11-12	production well
	KV-13	Kobler Field W-13	11-03	production well
	KV-15	Kobler Field W-15	11-15	production well
	KV-16	Kobler Field W-16	11-16	production well
	KV-17	Kobler Field W-17, W 17BB	11-17	production well
	KV-18	Kobler Field W-18	11-18	off line (private lab analysis indicates presence of trichloro-ethylene)
	KV-19	Kobler Field W-19	11-19	production well
	KV-20	Kobler Field W-20	11-20	production well
	KV-21	Kobler Field W-21	11-21	production well
	KV-22	--	--	production well
	KV-23	--	--	production well
	KV-24	--	--	production well
	KV-25	--	--	production well
	KV-111	Kobler Field W-111	11-01	production well
	KV-113	Kobler Field W-113	11-13	off line (CUC lab analysis indicates high nitrate concentration)
	KV-116	Kobler Field W-116, W 116A	11-06	production well
	Mafnas	--	--	production well
	Kumoi 3	--	--	production well
	Maui 1	--	11-99	production well
	KV-MW1	--	--	monitor well pending completion
Dan Dan	DD-3	Old hospital well	20-03	production well
	DD-4	--	--	production well
	DD-7	--	20-07	production well
	DD-8	--	20-08, 10-02X	production well
	Apatang	--	--	production well
	D. Torres	--	--	production well
	DD-MW1	--	--	monitor well
San Vincente	SV-1	W-8, TH-8	20-04	production well
	SV-2	--	--	production well
	SV-6	--	--	production well
	SV-7	--	--	production well

Table 2. Present names and status of municipal wells and developed springs, and previously used names and identification numbers, Saipan--Continued
[--, none]

Well field name	Present well or spring name	Previously used well name(s)	Previously used well identification number	Present status
Chalan Kiya	V. Duenas	--	--	production well
	E. Torres	--	--	production well
Kagman	KG-2	K-2	13-04	production well
	KG-3	K-3	13-05	production well
	KG-4	K-4	13-06	production well
	KG-5	K-5	--	abandoned and sealed, 11/98
	KG-6	K-6	13-02X	production well
	KG-7	--	--	production well
	KG-8	--	--	production well
	KG-9	--	--	production well
	KG-10	--	--	production well
	KG-11	--	--	production well
	KG-12	--	--	production well
	KG-13	--	--	production well
	KG-14	--	--	production well
	KG-15	--	--	production well
	KG-16	--	--	off line pending completion
	KG-17	--	--	off line pending completion
	KG-18	--	--	leased by Kagman Agriculture Station
	KG-19	--	--	production well
	KG-20	--	--	leased by Kagman Agriculture Station
	KG-76	--	13-76	off line (CUC lab analysis indicates high chloride-ion concentration)
	KG-131	M & E well	13-01	production well
	KAS-1	--	--	production well
	KAS-2	--	--	off line pending completion
	KAS-3	Agriculture well	13-03	off line pending completion
	KG-MW1	--	13-78	monitor well
	KG-MW2	--	13-T2b	monitor well
	KG-MW3	--	13-T4	monitor well
Sablan Quarry	SQ-4	Sablan Quarry TH-4X	18-04	production well
	SQ-5	Sablan Quarry TH-5X	18-05	production well
	SQ-6	Sablan Quarry TH-6X	18-06	production well
	SQ-7	Sablan Quarry TH-7X	18-07	production well
	SQ-9	Sablan Quarry TH-9X	18-09	production well
	SQ-10	--	--	production well
	SQ-11	--	--	production well
	SQ-12	--	--	production well
	SQ-148	Sablan Quarry W-148	18-48	production well
	SQ-149	Sablan Quarry W-149	18-49	production well
	SQ-150	Sablan Quarry W-150	18-50	production well
Akgak	AG-45	Akgak W-45	12-45	production well
	AG-50	Akgak W-50	12-50	production well
	AG-70	Akgak W-70	12-70	production well
	AG-72	Akgak W-72	12-72	production well
	AG-73	Akgak W-73	12-73	production well
	AG-121	Akgak W-121, W 10C	--	production well
	AG-MW1	old well 31	--	monitor well

Table 2. Present names and status of municipal wells and developed springs, and previously used names and identification numbers, Saipan--Continued
[--, none]

Well field name	Present well or spring name	Previously used well name(s)	Previously used well identification number	Present status
Capital Hill	CH-1	Capital Hill 1	12-02X	production well
	CH-2	Capital Hill 2	12-01X	production well
	CH-3	--	--	production well
Calhoun (Navy Hill)	NH-1	Oblender Well	--	abandoned and sealed, 6/95
	NH-2	--	--	abandoned and sealed, 11/98
	CL-1	Calhoun, W-1	19-01	abandoned and sealed, 6/95
	CL-2	Calhoun, W-2	19-02	production well
	CL-3	--	--	production well
Maui IV	Maui IV	M-4	14-99	production well
	MA-144	As Rapugau W-144, Maui IV-4	14-04	production well
	MA-145	As Rapugau W-145	14-05	production well
Puerto Rico	PR-161	--	--	abandoned and sealed, 12/98
	PR-162	Puerto Rico W-162, W-162A	16-02	production well
	PR-163	Puerto Rico W-163	16-03	abandoned and sealed, 12/98
	PR-163B	--	--	production well
	ST-MW1	--	--	monitor well
Gualo Rai	GR-151	Gualo Rai W-151	15-01	production well
	GR-154	Gualo Rai W-154	15-04	production well
Marpi Quarry (As Matuis)	MQ-1	MQ-1X	--	production well
	MQ-2	MQ-2X	--	abandoned and sealed, 12/98
	MQ-3	MQ-3X	--	production well
	MQ-5	--	--	production well
	AM-MW1	MQ-4	--	monitor well
Developed springs	Donni	--	--	developed spring
	Achugao	--	--	developed spring
	Tanapag I	--	--	developed spring
	Tanapag II	--	--	developed spring

Table 3. Ground-water production and chloride-ion concentration at municipal production wells in southern Saipan, October 1998

[gal/min, gallons per minute; gal/d, gallons per day; mg/L, milligrams per liter; --, no data]

Well field name	Well name	Discharge ¹ (gal/min)	Date discharge measured	Daily production ² (gal/d)	Chloride-ion concentration ¹ (mg/L)	Date of sampling for chloride analysis
Isley Field	IF-1	30	09/02/1998	43,200	612	10/01/1998
	IF-2	40	10/01/1998	57,600	1,053	10/01/1998
	IF-3	50	10/01/1998	72,000	1,274	10/01/1998
	IF-4	50	10/01/1998	72,000	1,323	10/01/1998
	IF-5	70	10/01/1998	100,800	485	10/09/1998
	IF-6	55	10/01/1998	79,200	367	10/01/1998
	IF-7	50	10/01/1998	72,000	1,176	09/30/1998
	IF-8	50	09/30/1998	72,000	392	09/30/1998
	IF-9	--	--	--	--	--
	IF-10	--	--	--	--	--
	IF-11	60	09/30/1998	86,400	637	09/30/1998
	IF-12	48	09/30/1998	69,120	784	09/30/1998
	IF-13	55	10/01/1998	79,200	465	10/01/1998
	IF-14	--	--	--	--	--
	IF-15	33	10/01/1998	47,520	906	10/01/1998
	IF-16	51	09/01/1998	73,440	661	10/01/1998
	IF-17	40	10/01/1998	57,600	1,666	10/01/1998
	IF-18	58	10/01/1998	83,520	1,470	10/01/1998
	IF-19	40	09/30/1998	57,600	1,102	09/30/1998
	IF-20	44	09/02/1998	63,360	294	09/30/1998
	IF-21	50	09/30/1998	72,000	294	09/30/1998
	IF-22	45	09/30/1998	64,800	318	09/30/1998
	IF-23	45	09/30/1998	64,800	196	09/30/1998
	IF-24	35	09/30/1998	50,400	196	09/30/1998
	IF-25	63	09/30/1998	90,720	74	09/30/1998
	IF-26	--	--	--	--	--
	IF-27	--	--	--	--	--
	IF-28	65	09/30/1998	93,600	343	09/30/1998
	Isley 101	62	09/02/1998	89,280	1,151	09/30/1998
	Isley 102	64	09/02/1998	92,160	759	09/30/1998
	Isley 104	--	--	--	--	--
	Isley 105	35	09/02/1998	50,400	882	10/01/1998
	Isley 106	67	09/30/1998	96,480	1,519	09/30/1998
	Isley 108	45	09/30/1998	64,800	563	09/30/1998
	Isley 201	50	09/30/1998	72,000	1,715	09/30/1998
	Isley 202	55	09/02/1998	79,200	686	10/01/1998
	Isley 203	--	--	--	--	--
	Isley 204	65	09/02/1998	93,600	1,984	10/01/1998
	Isley 205	50	10/01/1998	72,000	1,372	10/01/1998
	Isley 206	--	--	--	--	--
	Isley 207	--	--	--	--	--
	Isley 208	--	--	--	--	--
	Isley 211	60	09/02/1998	86,400	686	10/01/1998
	Isley 213	--	--	--	--	--
	Isley 214	--	--	--	--	--
	Isley 215	--	--	--	--	--
	Isley 216	--	--	--	--	--
	Isley 217	50	10/01/1998	72,000	1,004	10/01/1998
	Isley 218	--	--	--	--	--
	Isley 219	--	--	--	--	--
	Isley 220	30	09/02/1998	43,200	1,200	10/01/1998
	Isley 221	--	--	--	--	--
Subtotal	35	1,760		2,534,400	849 ³	

Table 3. Ground-water production and chloride-ion concentration at municipal production wells in southern Saipan, October 1998--Continued

[gal/min, gallons per minute; gal/d, gallons per day; mg/L, milligrams per liter; --, no data]

Well field name	Well name	Discharge ¹ (gal/min)	Date discharge measured	Daily production ² (gal/d)	Chloride-ion concentration ¹ (mg/L)	Date of sampling for chloride analysis
Obyan	OB-1	50	10/01/1998	72,000	367	10/01/1998
	OB-2	45	10/01/1998	64,800	343	10/01/1998
	OB-3	50	10/01/1998	72,000	172	10/01/1998
	OB-4	50	10/01/1998	72,000	122	10/01/1998
	OB-5	45	10/01/1998	64,800	74	10/01/1998
	OB-6	50	10/01/1998	72,000	98	10/01/1998
	OB-7	50	10/01/1998	72,000	147	10/01/1998
	OB-8	45	10/01/1998	64,800	147	10/01/1998
	OB-9	50	10/01/1998	72,000	686	10/01/1998
	OB-10	50	10/01/1998	72,000	588	10/01/1998
	OB-11	50	10/01/1998	72,000	294	10/01/1998
	OB-12	50	09/30/1998	72,000	367	09/30/1998
	OB-13	50	09/30/1998	72,000	416	09/30/1998
Subtotal	13	635		914,400	296 ³	
Koblerville	KV-9	60	09/02/1998	86,400	906	09/30/1998
	KV-10	--	--	--	--	--
	KV-11	65	09/30/1998	93,600	1,347	09/30/1998
	KV-12	70	09/30/1998	100,800	2,915	09/30/1998
	KV-13	72	09/02/1998	103,680	3,038	09/30/1998
	KV-15	83	09/02/1998	119,520	1,029	09/30/1998
	KV-16	60	09/30/1998	86,400	1,200	09/30/1998
	KV-17	86	09/02/1998	123,840	833	06/25/1998
	KV-18	--	--	--	--	--
	KV-19	40	09/30/1998	57,600	1,568	09/30/1998
	KV-20	54	09/02/1998	77,760	1,151	09/30/1998
	KV-21	60	09/30/1998	86,400	1,323	09/30/1998
	KV-22	65	09/30/1998	93,600	1,176	09/30/1998
	KV-23	60	09/02/1998	86,400	1,445	09/30/1998
	KV-24	60	09/30/1998	86,400	1,372	09/30/1998
	KV-25	60	09/02/1998	86,400	1,323	09/30/1998
	KV-111	60	09/30/1998	86,400	906	09/30/1998
	KV-113	55	09/30/1998	79,200	392	09/30/1998
	KV-116	70	09/30/1998	100,800	1,470	09/30/1998
	Mafnas	15	09/02/1998	21,600	833	09/30/1998
	Kumoi 3	62	10/09/1998	89,280	2,766	10/09/1998
	Maui 1	320	10/13/1998	460,800	1,310	10/13/1998
Subtotal	20	1,477		2,126,880	1,425 ³	
Dan Dan	DD-3	55	10/01/1998	79,200	661	10/01/1998
	DD-4	25	10/01/1998	36,000	563	10/01/1998
	DD-7	60	10/01/1998	86,400	1,127	10/01/1998
	DD-8	75	10/01/1998	108,000	490	10/01/1998
	Apatang	43	09/30/1998	61,920	490	09/30/1998
	D. Torres	30	10/01/1998	43,200	955	10/01/1998
Subtotal	6	288		414,720	710 ³	

Table 3. Ground-water production and chloride-ion concentration at municipal production wells in southern Saipan, October 1998--Continued

[gal/min, gallons per minute; gal/d, gallons per day; mg/L, milligrams per liter; --, no data]

Well field name	Well name	Discharge ¹ (gal/min)	Date discharge measured	Daily production ² (gal/d)	Chloride-ion concentration ¹ (mg/L)	Date of sampling for chloride analysis
San Vicente	SV-1	65	10/01/1998	93,600	808	10/01/1998
	SV-2	70	10/01/1998	100,800	1,225	10/01/1998
	SV-6	40	09/02/1998	57,600	1,837	10/01/1998
	SV-7	43	10/01/1998	61,920	735	10/01/1998
Subtotal	4	218		313,920	1,116 ³	
Chalan Kiya	V. Duenas	60	09/02/1998	86,400	2,474	10/01/1998
	E. Torres	20	09/02/1998	28,800	539	10/01/1998
Subtotal	2	80		115,200	1,990 ³	
Total	80	4,458		6,419,520	985 ⁴	

¹ Data from the Commonwealth Utilities Corporation

² Daily well production determined by multiplying the well discharge in gal/min by 1,440 minutes/day

³ Value is an estimate of daily volume-weighted chloride-ion concentration for the well field in early October 1998

⁴ Value is an estimate of daily volume-weighted chloride-ion concentration for all southern well fields in early October 1998

Table 4. Ground-water production and chloride-ion concentration at municipal production wells in central Saipan, October 1998
[gal/min, gallons per minute; gal/d, gallons per day; mg/L, milligrams per liter; --, no data]

Well field name	Well or spring name	Discharge ¹ (gal/min)	Date discharge measured	Daily production ² (gal/d)	Chloride-ion concentration ¹ (mg/L)	Date of sampling for chloride analysis
Kagman	KG-2	40	10/01/1998	57,600	147	10/01/1998
	KG-3	55	10/01/1998	79,200	1,788	10/01/1998
	KG-4	55	10/01/1998	79,200	2,646	10/01/1998
	KG-5	--	--	--	--	--
	KG-6	60	10/01/1998	86,400	416	10/01/1998
	KG-7	30	10/01/1998	43,200	245	10/01/1998
	KG-8	30	10/01/1998	43,200	539	10/01/1998
	KG-9	30	11/23/1998	43,200	293	06/25/1998
	KG-10	30	10/01/1998	43,200	122	10/01/1998
	KG-11	30	10/01/1998	43,200	1,029	10/01/1998
	KG-12	28	10/01/1998	40,320	98	06/25/1998
	KG-13	30	10/01/1998	43,200	71	06/25/1998
	KG-14	38	10/01/1998	54,720	172	10/01/1998
	KG-15	28	10/01/1998	40,320	367	10/01/1998
	KG-16	--	--	--	--	--
	KG-17	--	--	--	--	--
	KG-18	--	--	--	--	--
	KG-19	--	--	--	--	--
	KG-20	--	--	--	--	--
	KG-76	--	--	--	--	--
	KG-131	170	10/01/1998	244,800	1,886	10/01/1998
	KAS-1	90	09/02/1998	129,600	809	06/26/1998
	KAS-2	--	--	--	--	--
	KAS-3	--	--	--	--	--
Subtotal	15	744		1,071,360	1,017 ³	
Sablan Quarry	SQ-4	50	09/02/1998	72,000	534	10/01/1998
	SQ-5	42	10/02/1998	60,480	243	10/02/1998
	SQ-6	40	10/02/1998	57,600	1,262	10/02/1998
	SQ-7	52	10/02/1998	74,880	752	10/02/1998
	SQ-9	53	10/02/1998	76,320	243	10/02/1998
	SQ-10	35	10/02/1998	50,400	485	10/02/1998
	SQ-11	10	10/02/1998	14,400	170	10/02/1998
	SQ-12	40	09/02/1998	57,600	121	10/02/1998
	SQ-148	50	09/03/1998	72,000	146	10/01/1998
	SQ-149	50	09/03/1998	43,200	485	10/02/1998
	SQ-150	179	10/01/1998	257,760	776	10/01/1998
Subtotal	11	601		836,640	557 ³	
Akgak	AG-45	30	10/01/1998	43,200	24	10/02/1998
	AG-50	33	10/01/1998	47,520	73	10/02/1998
	AG-70	68	10/01/1998	97,920	70	estimate
	AG-72	127	10/01/1998	182,880	70	estimate
	AG-73	56	10/01/1998	80,640	73	10/02/1998
	AG-121	73	09/01/1998	105,120	48	10/13/1998
Subtotal	6	387		557,280	63 ³	
Capitol Hill	CH-1	62	10/01/1998	89,280	73	10/01/1998
	CH-2	107	10/02/1998	154,080	49	10/02/1998
	CH-3	97	10/02/1998	139,680	73	10/02/1998
Subtotal	3	266		383,040	63 ³	

Table 4. Ground-water production and chloride-ion concentration at municipal production wells in central Saipan, October 1998
--Continued
[gal/min, gallons per minute; gal/d, gallons per day; mg/L, milligrams per liter; --, no data]

Well field name	Well or spring name	Discharge ¹ (gal/min)	Date discharge measured	Daily production ² (gal/d)	Chloride-ion concentration ¹ (mg/L)	Date of sampling for chloride analysis
Calhoun (Navy Hill)	NH-1	--	--	--	--	--
	NH-2	--	--	--	--	--
	CL-1	--	--	--	--	--
	CL-2	120	09/01/1998	172,800	1,176	10/01/1998
	CL-3	120	09/01/1998	172,800	1,666	10/01/1998
Subtotal	2	240		345,600	1,421 ³	
Maui IV	Maui IV	270	10/01/1998	172,800	2,645	10/01/1998
	MA-144	48	10/01/1998	69,120	2,863	10/01/1998
	MA-145	32	09/03/1998	46,080	3,616	10/01/1998
	Subtotal	3		288,000	2,853 ³	
Puerto Rico	PR-161	--	--	--	--	--
	PR-162	55	10/01/1998	79,200	1,176	10/01/1998
	PR-163	--	--	--	--	--
	PR-163B	70	09/02/1998	100,800	3,184	10/01/1998
Subtotal	2	125		180,000	2,300 ³	
Gualo Rai	GR-151	30	09/02/1998	43,200	441	10/01/1998
	GR-154	35	10/01/1998	50,400	1,617	10/01/1998
Subtotal	2	65		93,600	1,074 ³	
Developed springs	Donni	250	09/03/1998	360,000	73	07/16/1998
Subtotal	1	250		360,000	73	
Total	44	3,028		4,115,520	843 ⁴	

¹ Data from the Commonwealth Utilities Corporation

² Daily well production determined by multiplying the well discharge in gal/min by 1,440 minutes/day

³ Value is an estimate of daily volume-weighted chloride-ion concentration for the well field in early October 1998

⁴ Value is an estimate of daily volume-weighted chloride-ion concentration for all southern well fields in early October 1998

Table 5. Ground-water production and chloride-ion concentration at municipal production wells in northern Saipan, October 1998

[gal/min, gallons per minute; gal/d, gallons per day; mg/L, milligrams per liter; --, no data]

Well field name	Well or spring name	Discharge ¹ (gal/min)	Date discharge measured	Daily production ² (gal/d)	Chloride-ion concentration ¹ (mg/L)	Date of sampling for chloride analysis
Marpi Quarry (As Matuis)	MQ-1	115	10/01/1998	165,600	1,407	10/01/1998
	MQ-2	--	--	--	--	--
	MQ-3	90	09/01/1998	129,600	1,116	10/01/1998
	MQ-5	72	10/01/1998	103,680	4,222	10/01/1998
Subtotal	3	277		398,880	2,044 ³	
Developed springs	Achugao	25	09/03/1998	36,000	70	estimate
	Tanapag I	115	09/03/1998	165,600	98	07/16/1998
	Tanapag II	15	09/03/1998	21,600	73	07/16/1998
Subtotal	3	155		223,200	913	
Total	3	155		622,080	1,343 ⁴	

¹ Data from the Commonwealth Utilities Corporation² Daily well production determined by multiplying the well discharge in gal/min by 1,440 minutes/day³ Value is an estimate of daily volume-weighted chloride-ion concentration for the well field in early October 1998⁴ Value is an estimate of daily volume-weighted chloride-ion concentration for all southern well fields in early October 1998**Table 6.** Summary of daily ground-water production and mean daily volume-weighted chloride-ion concentration at municipal well fields, Saipan, October 1998

[Mgal/d, million gallons per day; mg/L, milligrams per liter; --, none]

Well field location	Well field name	Number of pumped wells	Pumpage ¹ (Mgal/d)	Volume-weighted chloride-ion concentration ² (mg/L)
Southern Saipan	Isley Field	35	2.53	849
	Obyan	13	0.91	296
	Koblerville	20	2.13	1,425
	Dan Dan	6	0.41	710
	San Vincente	4	0.31	1,116
	Chalan Kiya	2	0.12	1,990
Subtotal		80	6.41	985
Central Saipan	Kagman	15	1.07	1,017
	Sablan Quarry	11	0.84	557
	Akgak	6	0.56	63
	Capital Hill	3	0.38	63
	Calhoun (Navy Hill)	2	0.35	1,421
	Maui IV area	3	0.29	2,853
	Puerto Rico	2	0.18	2,300
	Gualo Rai	2	0.09	1,074
	Donni Springs	--	0.36	73
Subtotal		44	4.12	843
Northern Saipan	Marpi Quarry (As Matuis)	3	0.40	2,044
	Tanapag I and II Springs and Achugao Spring	--	0.22	91
Subtotal		3	0.62	1,343
Total		127	11.15	953

¹ Daily well-field production determined by multiplying the cumulative well discharge in gal/min by 1,440 minutes/day; the method is considered reasonable because all wells are operated continuously² Calculated with chloride and pumpage data from Commonwealth Utilities Corporation laboratory

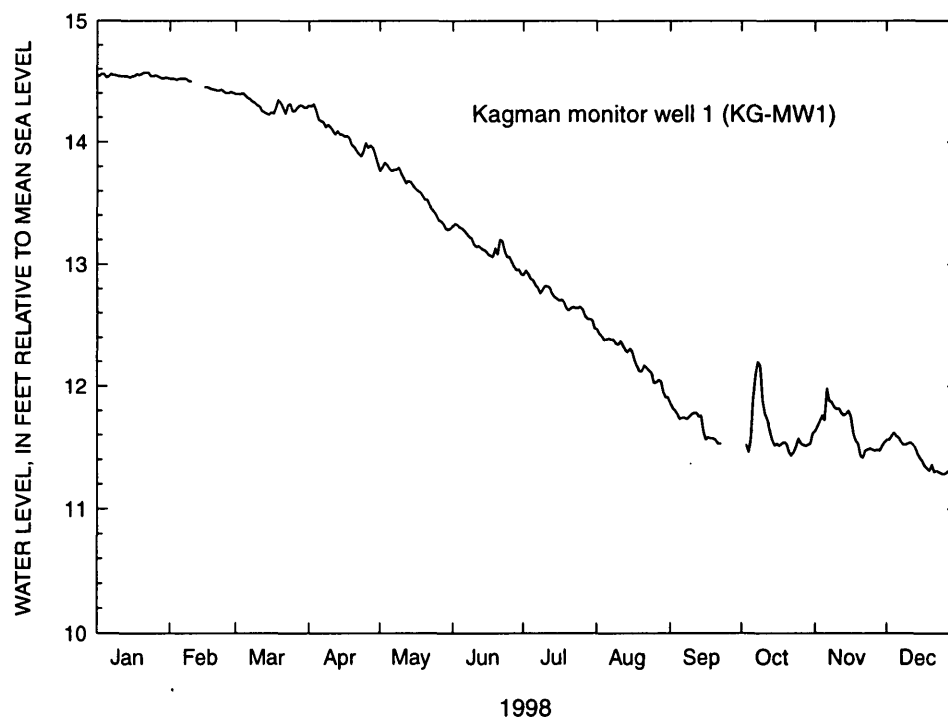
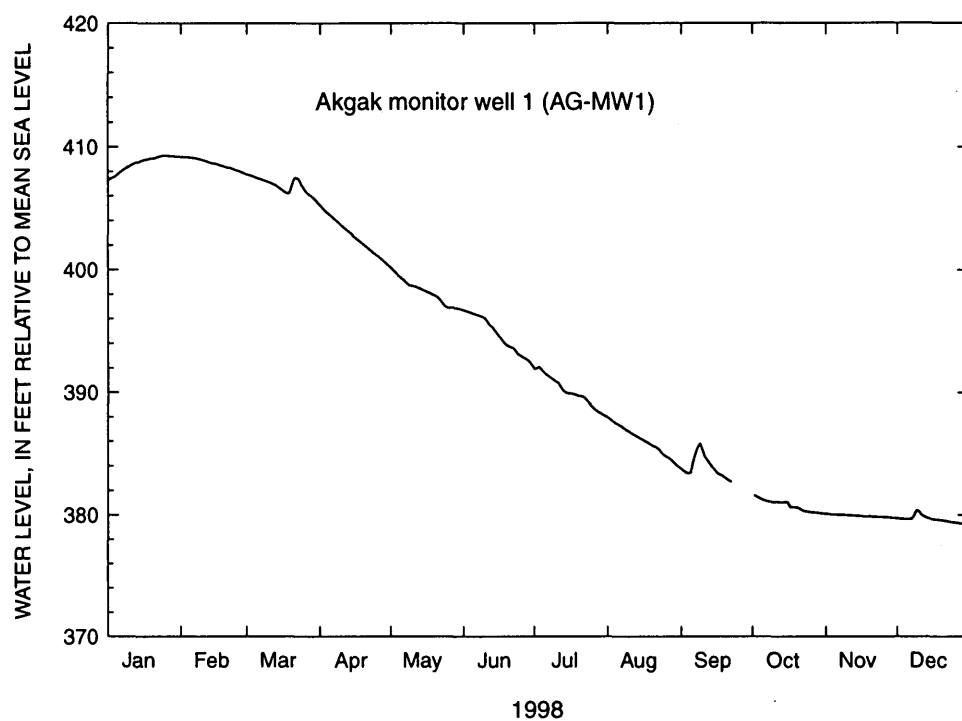


Figure 4. Daily mean ground-water levels at recording monitor wells, Saipan, 1998.

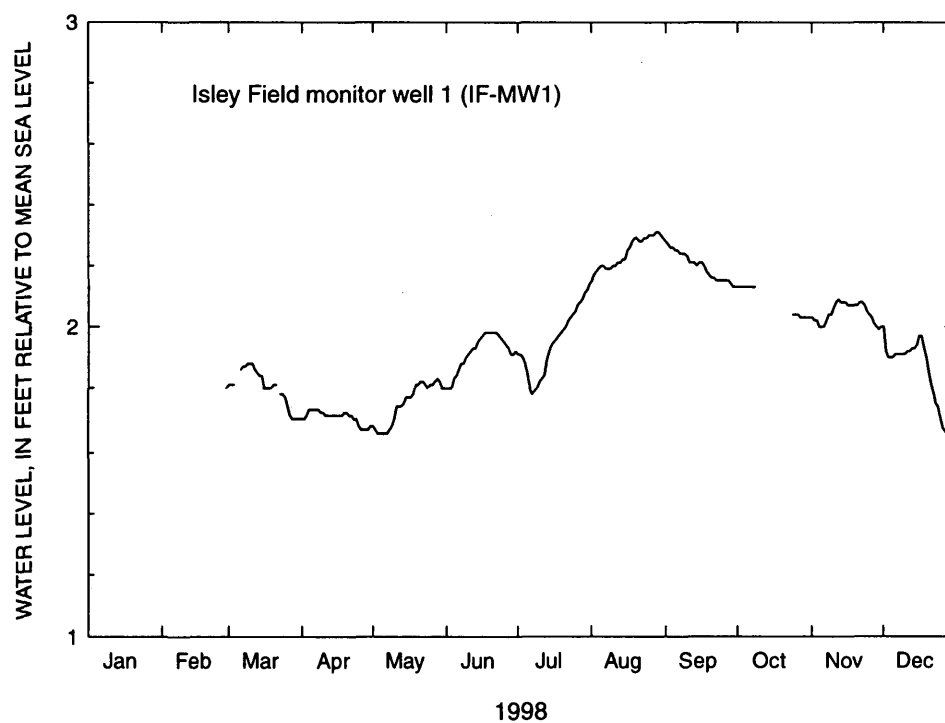
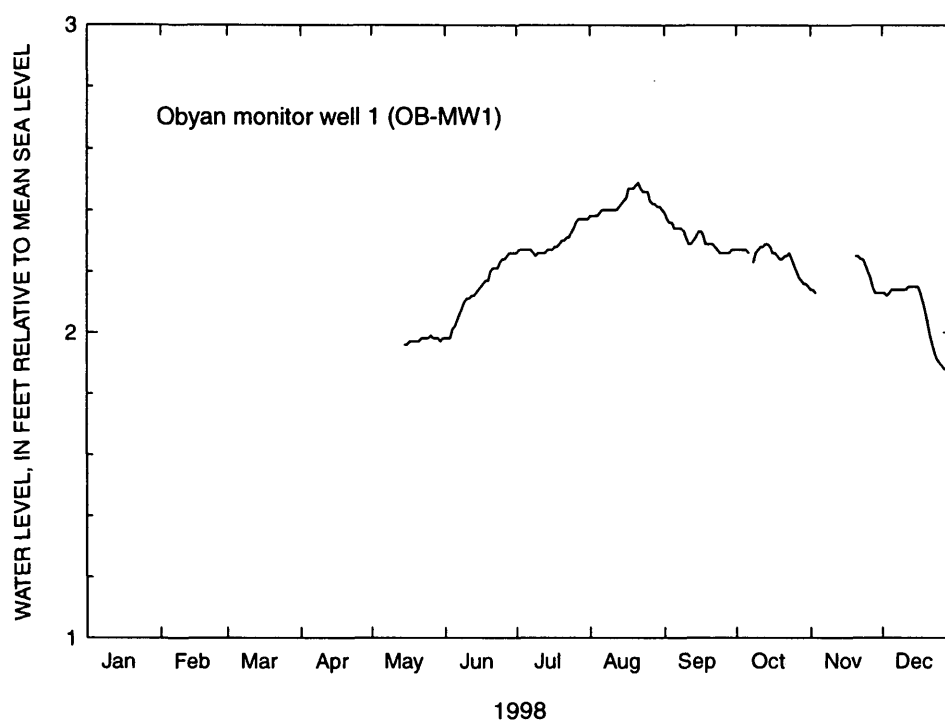


Figure 4. Daily mean ground-water levels at recording monitor wells, Saipan, 1998--Continued.

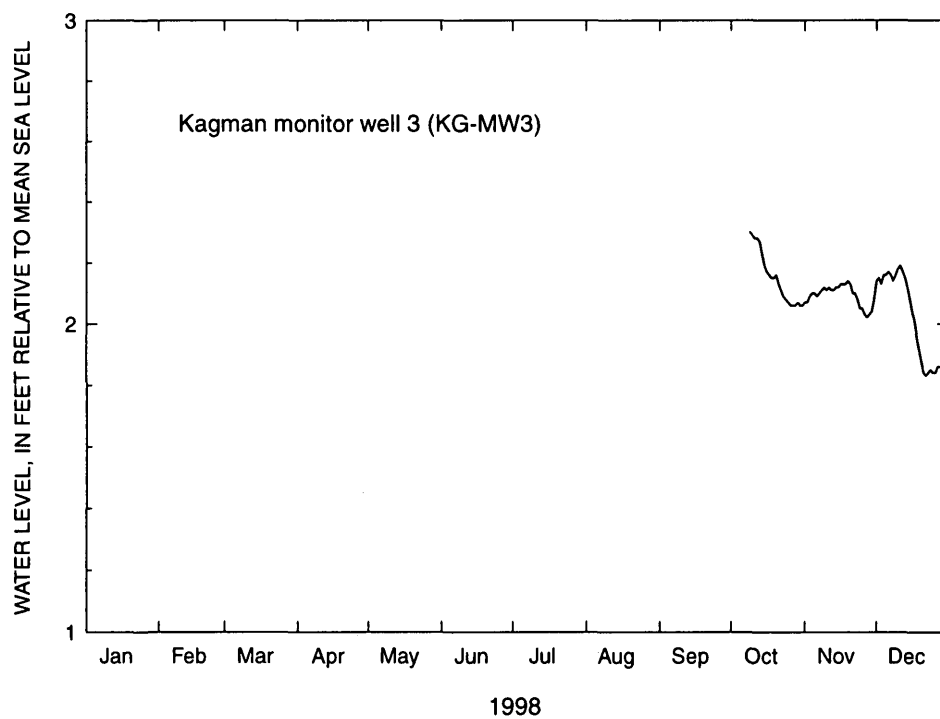
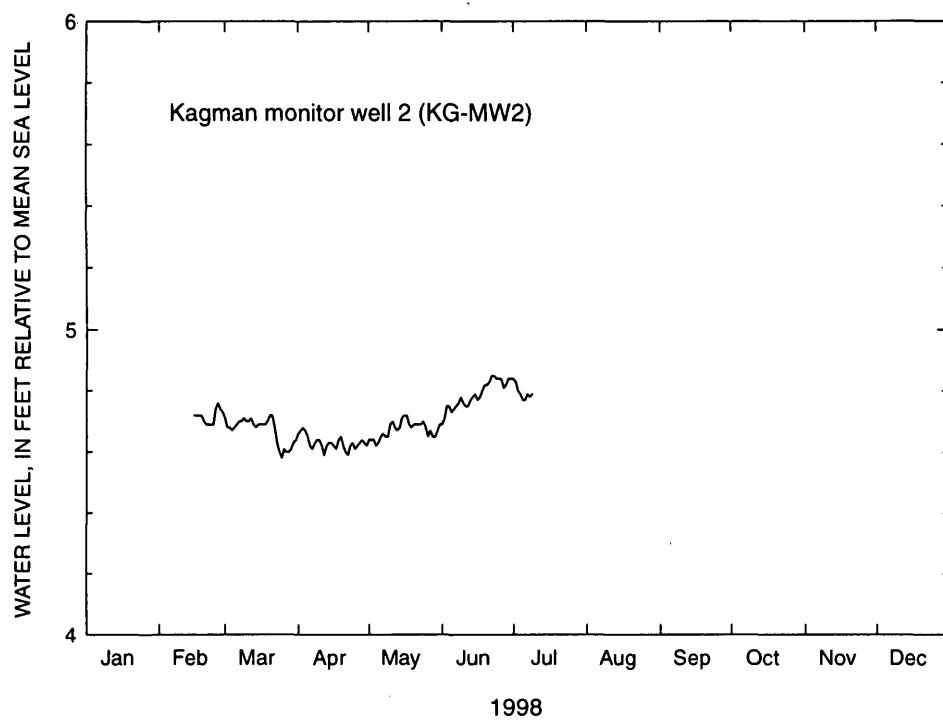


Figure 4. Daily mean ground-water levels at recording monitor wells, Saipan, 1998--Continued.

Isley Field monitor well 2 (IF-MW2)				
Date	Time	Measuring point elevation (feet)	Depth to water (feet)	Water level altitude (feet)
01/20/98	1415	184.84	183.04	1.80
03/16/98	1350	184.84	183.22	1.62
04/23/98	1245	184.84	183.95	0.89
05/12/98	1450	184.84	183.15	1.69
06/18/98	1145	184.84	183.03	1.81
08/04/98	1410	185.75	183.72	2.03
09/08/98	1400	185.75	183.77	1.98
10/20/98	1443	185.75	183.89	1.86
11/09/98	1105	185.75	183.85	1.90

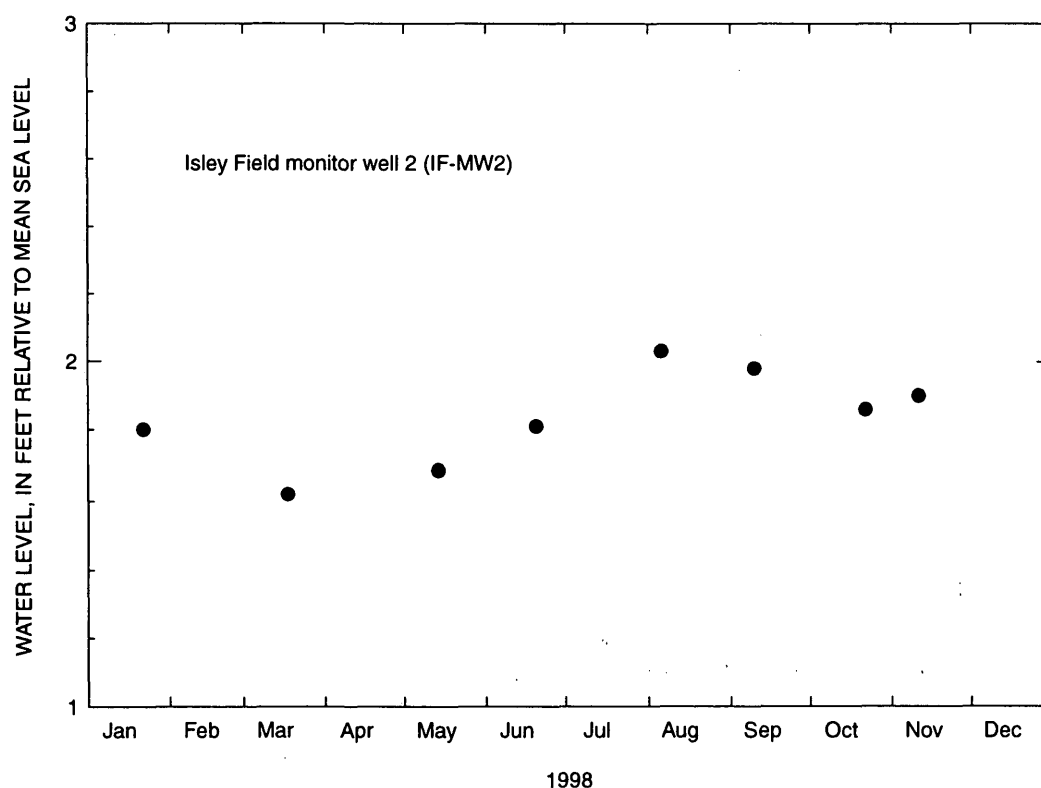


Figure 5. Ground-water data and water level at monitor wells measured approximately monthly, Saipan, 1998.

Isley Field monitor well 3 (IF-MW3)				
Date	Time	Measuring point elevation (feet)	Depth to water (feet)	Water level altitude (feet)
01/20/98	1430	209.22	205.19	4.03
03/16/98	1330	209.22	205.08	4.14
04/23/98	1255	209.22	205.18	4.04
05/12/98	1505	209.22	205.24	3.98
06/18/98	1137	209.22	205.25	3.97
08/04/98	1410	209.22	205.05	4.17
09/08/98	1330	209.22	205.03	4.19
10/20/98	1515	209.22	205.20	4.02
11/16/98	1130	209.22	205.30	3.92

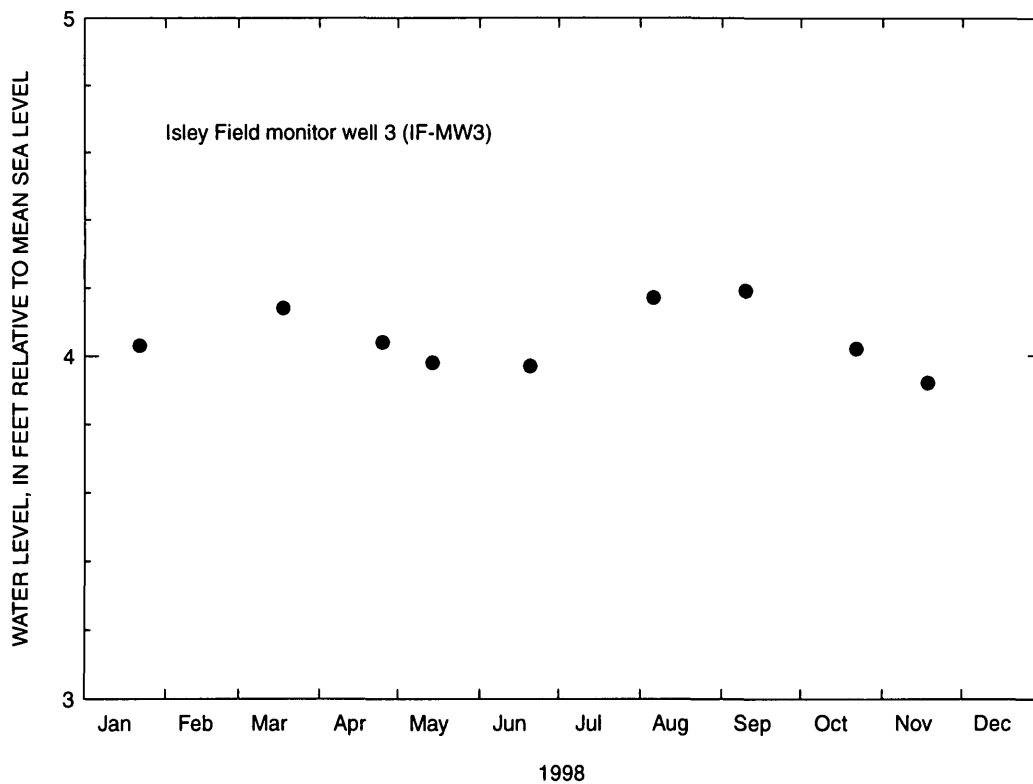


Figure 5. Ground-water data and water level at monitor wells measured approximately monthly, Saipan, 1998--Continued.

Isley Field monitor well 4 (IF-MW4)				
Date	Time	Measuring point elevation (feet)	Depth to water (feet)	Water level altitude (feet)
01/20/98	1255	196.56	194.90	1.66
03/16/98	1300	196.56	195.00	1.56
04/23/98	1145	196.56	194.89	1.67
05/12/98	1345	196.56	194.89	1.67
06/18/98	0930	196.56	194.32	2.24
08/04/98	1700	197.00	195.02	1.98
09/08/98	1215	197.00	194.83	2.17
10/21/98	1230	197.00	194.99	2.01
11/16/98	0820	197.00	194.90	2.10

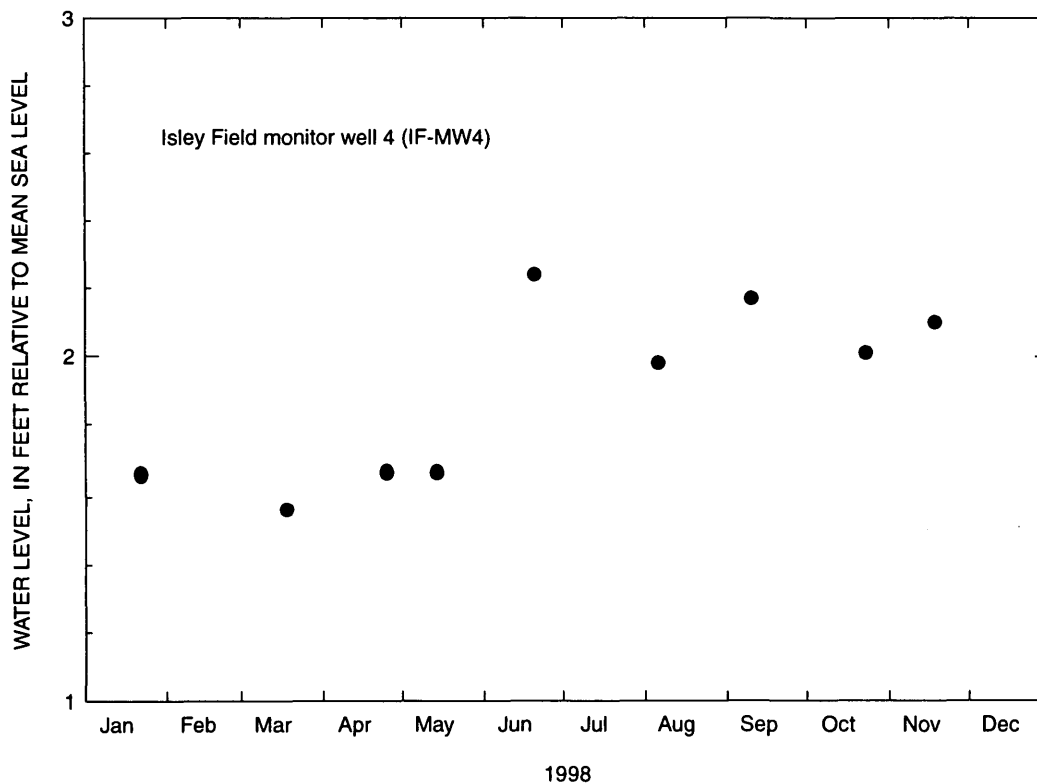


Figure 5. Ground-water data and water level at monitor wells measured approximately monthly, Saipan, 1998--Continued.

Isley Field monitor well 5 (IF-MW5)				
Date	Time	Measuring point elevation (feet)	Depth to water (feet)	Water level altitude (feet)
09/11/98	800	192.08	190.11	1.97
10/20/98	1045	192.08	190.31	1.77
11/16/98	1335	192.08	189.98	2.10

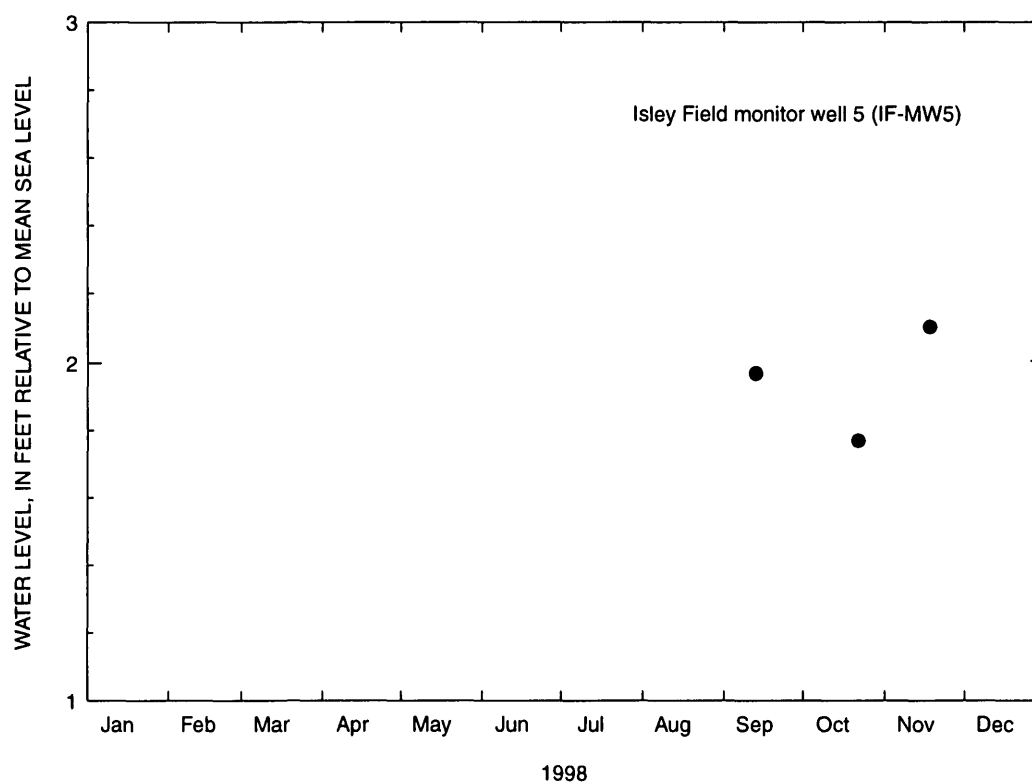


Figure 5. Ground-water data and water level at monitor wells measured approximately monthly, Saipan, 1998--Continued.

As Matus monitor well 1 (AM-MW1)				
Date	Time	Measuring point elevation (feet)	Depth to water (feet)	Water level altitude (feet)
01/20/98	0935	397.16	395.74	1.91
03/16/98	0855	397.16	395.55	2.10
04/23/98	0740	397.16	395.38	2.27
05/14/98	1409	397.16	395.37	2.28
06/17/98	1305	397.16	395.45	2.20
08/03/98	0752	397.16	395.10	2.55
09/08/98	0845	397.16	395.15	2.50
10/20/98	0930	397.16	394.87	2.29
11/09/98	0830	397.16	395.41	1.75

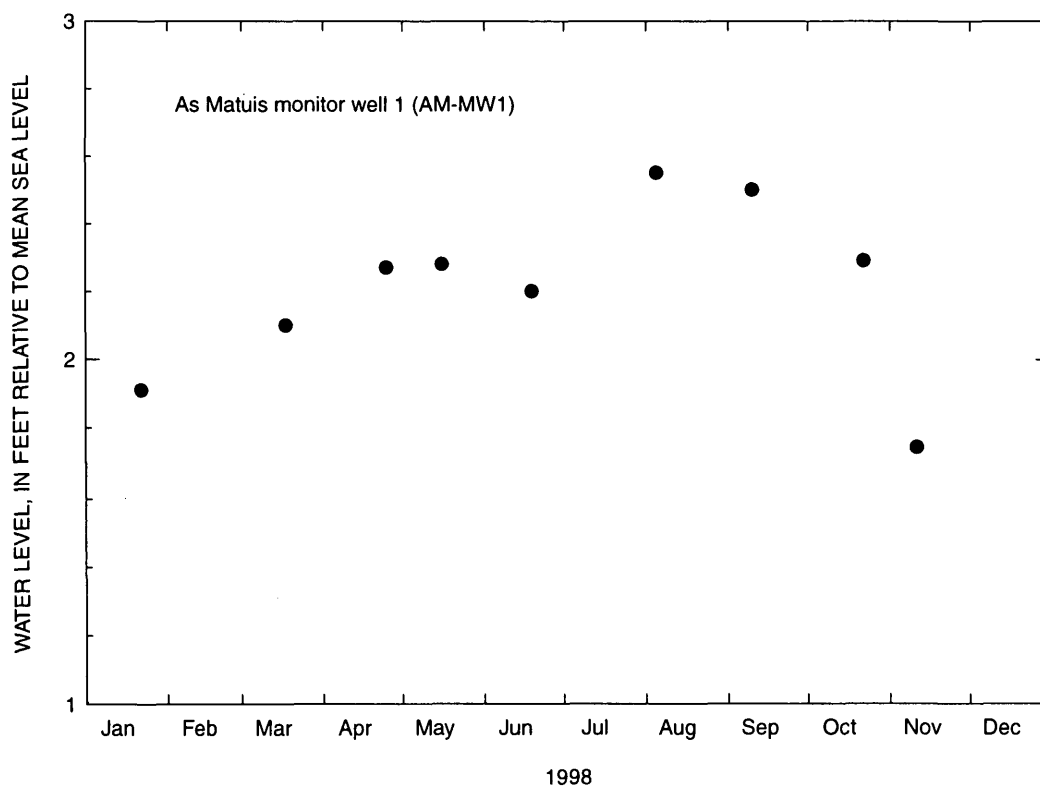


Figure 5. Ground-water data and water level at monitor wells measured approximately monthly, Saipan, 1998--Continued.

Kagman monitor well 2 (KG-MW2)				
Date	Time	Measuring point elevation (feet)	Depth to water (feet)	Water level altitude (feet)
2/23/98	1017	233.30	228.53	4.77
2/27/98	1015	233.30	228.59	4.71
3/16/98	1015	233.30	228.63	4.67
4/23/98	0957	233.30	228.69	4.61
5/13/98	1040	233.30	228.59	4.71
6/19/98	1038	233.30	228.45	4.85
7/8/98	1227	233.30	228.45	4.85
8/3/98	1342	233.30	228.80	4.50
9/9/98	0910	233.30	228.47	4.83
10/21/98	1020	233.30	228.71	4.59
11/17/98	1345	233.30	228.63	4.67

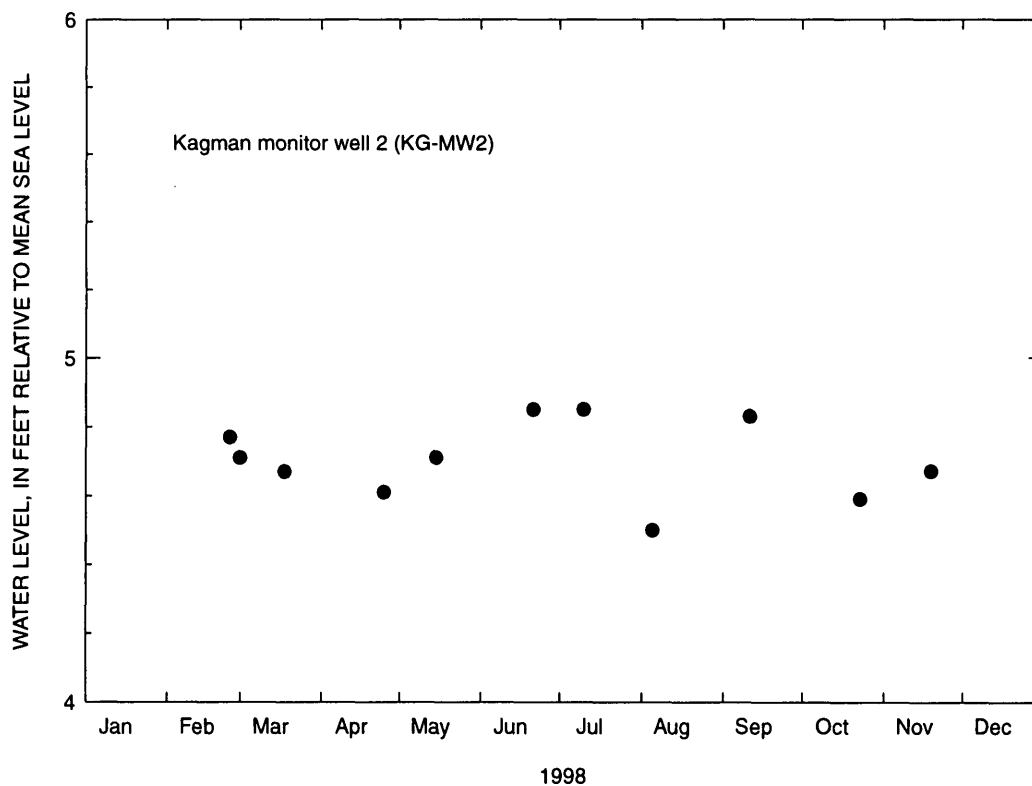


Figure 5. Ground-water data and water level at monitor wells measured approximately monthly, Saipan, 1998--Continued.

Table 7. Chloride-ion concentration of water from municipal production wells, Saipan, 1998

[Data from the Commonwealth Utilities Corporation laboratory; mg/L, milligrams per liter; --, no data or not applicable]

Well field	Well name	Chloride-ion concentration (mg/L)				Number of analyses	Maximum (mg/L)	Minimum (mg/L)	Mean (mg/L)
		Quarter 1	Quarter 2	Quarter 3	Quarter 4				
Isley Field	IF-1	767	784	612	829	4	829	612	748
	IF-2	--	931	1,053	1,122	3	1,122	931	1,035
	IF-3	1,238	1,274	1,274	1,244	4	1,274	1,238	1,258
	IF-4	619	1,152	1,323	1,290	4	1,323	619	1,096
	IF-5	322	466	485	536	4	536	322	452
	IF-6	619	735	367	951	4	951	367	668
	IF-7	891	343	1,176	1,268	4	1,268	343	920
	IF-8	322	980	392	414	4	980	322	527
	IF-9	--	--	--	--	0	--	--	--
	IF-10	--	--	--	--	0	--	--	--
	IF-11	495	588	637	658	4	658	495	595
	IF-12	495	637			2	637	495	566
	IF-13	446	441	465	512	4	512	441	466
	IF-14	--	--	--	--	0	--	--	--
	IF-15	792	931	906	951	4	951	951	895
	IF-16	569	710	661	780	4	780	661	680
	IF-17	1,089	1,005	1,666	439	4	1,666	439	1,050
	IF-18	1,040	588	1,470	1,512	4	1,512	588	1,153
	IF-19	1,040	980	1,102	1,048	4	1,102	980	1,043
	IF-20	446	833	294	926	4	926	294	625
	IF-21	248	294	294	293	4	294	248	282
	IF-22	297	343	318	317	4	343	297	319
	IF-23	173	221	196	185	4	221	173	194
	IF-24	149	196	196	161	4	196	149	176
	IF-25	99	98	74	102	4	102	74	93
	IF-26	--	--	--	--	0	--	--	--
	IF-27	--	--	--	--	0	--	--	--
	IF-28	248	294	343	341	4	343	248	307
	Isley 101	866	1,054	1,151	1,048	4	1,151	866	1,030
	Isley 102	668	760	759	805	4	805	668	748
	Isley 105	792	858	882	902	4	902	792	859
	Isley 106	1,163	1,372	1,519	1,609	4	1,609	1,163	1,416
	Isley 108	--	588	563	561	3	588	561	571
	Isley 201	1,608	1,519	1,715	1,829	4	1,829	1,519	1,668
	Isley 202	1,608	933	686	1,195	4	1,608	686	1,106
	Isley 204	1,807	12,008	1,984	2,121	4	12,008	1,984	4,480
	Isley 205	1,287	1,323	1,372	1,390	4	1,390	1,287	1,343
	Isley 208	173	245	--	134	3	245	134	184
	Isley 211	718	637	686	731	4	731	637	693
	Isley 217	1,015	980	1,004	1,000	4	1,015	980	1,000
	Isley 220	1,114	1,225	1,200	1,244	4	1,244	1,114	1,196
Obyan	OB-1	297	368	367	414	4	414	297	362
	OB-2	322	368	343	341	4	368	322	344
	OB-3	149	196	172	161	4	196	149	170
	OB-4	99	123	122	93	4	123	93	109
	OB-5	99	98	74	83	4	99	74	89
	OB-6	99	123	98	68	4	123	68	97
	OB-7	99	123	147	132	4	147	99	125
	OB-8	99	147	147	112	4	147	99	126
	OB-9	124	564	686	732	4	732	124	527
	OB-10	347	539	588	683	4	683	347	539
	OB-11	223	270	294	341	4	341	223	282
	OB-12	347	368	367	366	4	368	347	362
	OB-13	396	441	416	488	4	488	396	435

Table 7. Chloride-ion concentration of water from municipal production wells, Saipan, 1998--Continued

[Data from the Commonwealth Utilities Corporation laboratory; mg/L, milligrams per liter; --, no data or not applicable]

Well field	Well name	Chloride-ion concentration (mg/L)				Number of analyses	Maximum (mg/L)	Minimum (mg/L)	Mean (mg/L)
		Quarter 1	Quarter 2	Quarter 3	Quarter 4				
Koblerville	KV-9	371	368	906	366	4	906	366	503
	KV-10	5,717	7,914	--	8,412	3	8,412	5,717	7,348
	KV-11	990	1,078	1,347	1,463	4	1,463	990	1,220
	KV-12	1,930	2,646	2,915	3,170	4	3,170	1,930	2,665
	KV-13	1,980	2,499	3,038	2,121	4	3,038	1,980	2,410
	KV-15	--	686	1,029	780	3	1,029	686	832
	KV-16	272	784	1,200	951	4	1,200	272	802
	KV-17	520	833	--	--	2	833	520	677
	KV-18	1,584	--	--	--	1	--	--	--
	KV-19	1,411	1,519	1,568	1,560	4	1,568	1,411	1,515
	KV-20	842	882	1,151	1,268	4	1,268	842	1,036
	KV-21	743	980	1,323	1,170	4	1,323	743	1,054
	KV-22	941	1,078	1,176	1,414	4	1,414	941	1,152
	KV-23	767	882	1,445	1,512	4	1,512	767	1,152
	KV-24	965	1,176	1,372	1,560	4	1,560	965	1,268
	KV-25	990	1,127	1,323	1,714	4	1,714	990	1,289
	KV-111	--	637	906	732	3	906	637	514
	KV-113	347	392	392	439	4	439	347	393
	KV-116	842	1,225	1,470	1,170	4	1,470	842	1,177
	Mafnas	495	686	833	926	4	926	495	735
	Kumoi 3	2,772	2,940	2,766	2,828	4	2,940	2,766	2,827
	Maui 1	1,163	1,176	1,310	2,268	4	2,268	1,163	1,479
Dan Dan	DD-3	668	686	661	707	4	707	661	681
	DD-4	520	539	563	536	4	563	520	540
	DD-7	842	1,152	1,127	1,122	4	1,152	842	1,061
	DD-8	446	--	490	561	3	561	446	499
	Apatang	272	466	490	536	4	536	272	441
	D. Torres	668	662	955	951	4	955	662	809
San Vincente	SV-1	1,040	1,125	808	--	3	1,125	808	991
	SV-2	792	833	1,225	780	4	1,225	780	908
	SV-6	1,757	665	1,837	1,804	4	1,837	665	1,516
	SV-7	767	883	735	829	4	883	735	804
Chalan Kiya	V. Duenas	2,104	2,279	2,474	2,609	4	2,609	2,104	2,367
	E. Torres	322	270	539	512	4	539	270	411
Kagman	KG-2	99	172	147	134	4	172	99	138
	KG-3	1,114	1,421	1,788	2,170	4	2,170	1,114	1,623
	KG-4	--	2,254	2,646	2,877	3	2,877	2,254	2,592
	KG-6	99	441	416	405	4	441	99	340
	KG-7	545	392	245	344	4	545	245	382
	KG-8	545	539	539	585	4	585	539	552
	KG-9	--	--	--	363	1	--	--	--
	KG-10	--	--	--	85	1	--	--	--
	KG-11	--	--	--	1,268	1	--	--	--
	KG-12	--	--	--	217	1	--	--	--
	KG-13	--	--	--	129	1	--	--	--
	KG-14	--	--	--	146	1	--	--	--
	KG-15	--	--	--	393	1	--	--	--
	KG-16	--	--	--	95	1	--	--	--
	KG-17	--	--	--	--	0	--	--	--
	KG-18	--	--	--	--	0	--	--	--

Table 7. Chloride-ion concentration of water from municipal production wells, Saipan, 1998--Continued

[Data from the Commonwealth Utilities Corporation laboratory; mg/L, milligrams per liter; --, no data or not applicable]

Well field	Well name	Chloride-ion concentration (mg/L)				Number of analyses	Maximum (mg/L)	Minimum (mg/L)	Mean (mg/L)
		Quarter 1	Quarter 2	Quarter 3	Quarter 4				
	KG-19	--	--	--	--	0	--	--	--
	KG-20	--	--	--	--	0	--	--	--
	KG-76	2,795	3,969	--	951	3	3,969	951	2,572
	KG-131	619	1,127	1,886	1,756	4	1,886	619	1,347
	KAS-1	--	809	--	--	1	--	--	--
	KAS-2	--	--	--	--	0	--	--	--
	KAS-3	--	--	--	--	0	--	--	--
Sablan Quarry	SQ-4	421	441	534	414	4	534	414	453
	SQ-5	248	294	243	251	4	294	243	259
	SQ-6	1,015	1,176	1,262	1,341	4	1,341	1,015	1,199
	SQ-7	297	637	752	1,024	4	1,024	297	678
	SQ-9	297	294	243	127	4	297	127	240
	SQ-10	347	392	485	463	4	485	347	422
	SQ-11	248	196	170	900	4	900	170	379
	SQ-12	767	1,225	121	1,512	4	1,512	121	906
	SQ-148	173	147	146	122	4	173	122	147
	SQ-149	421	466	485	336	4	485	336	427
	SQ-150	668	710	776	780	4	780	668	734
Akgak	AG-45	74	74	24	390	4	390	24	141
	AG-50	74	49	73	340	4	340	49	134
	Ag-70	--	--	--	440	1	--	--	--
	AG-72	no sample port				0	--	--	--
	AG-73	--	--	73	37	2	73	37	55
	AG-121	50	74	48	340	4	340	48	128
Capital Hill	CH-1	123	49	73	440	4	440	49	171
	CH-2	74	74	49	420	4	420	49	154
	CH-3	74	73	73	390	4	390	73	153
Calhoun (Navy Hill)	CL-2	718	980	1,176	1,170	4	1,176	718	1,011
	CL-3	866	1,348	1,666	1,512	4	1,666	866	1,797
Maui IV	Maui 4 Shaft		2,842	2,645	1,463	3	2,842	1,463	2,317
	MA-144	371	2,450	2,863	3,072	4	3,072	371	2,189
	MA-145	2,549	2,891	3,616	3,901	4	3,901	2,549	3,239
Puerto Rico	PR-162	1,088	1,029	1,176	1,219	4	1,219	1,029	1,128
	PR-163B	2,945	3,209	3,184	3,487	4	3,487	2,945	3,206
Gualo Rai	GR-151	445	466	441	463	4	466	441	454
	GR-154	1,510	1,789	1,617	1,780	4	1,789	1,510	1,674
Marpi Quarry (As Matuis)	MQ-1	990	1,299	1,407	1,365	4	1,407	990	1,265
	MQ-3	940	956	1,116	1,390	4	1,390	940	1,101
	MQ-5	3,218	3,871	4,222	1,682	4	4,222	1,682	3,248

Specific conductance was measured by the USGS throughout the water column in four deep-profiling monitor wells (fig. 1) using a down-the-hole sampler. The samples were analyzed for chloride-ion concentration by the CUC laboratory. Vertical chloride-ion concentration profiles of the deep-profiling monitor wells are shown in figures 6 through 10.

SEA LEVEL

The sea-level station at the Saipan sea port in Tanapag Harbor is operated by the UHSLC (fig. 1). Sea level is measured in millimeters at 15-minute intervals using a digital recorder. The sea-level data collected by the UHSLC are referenced to an arbitrary datum located at the station tide staff zero. The datum is linked to a local network of fixed benchmarks in the vicinity of the station. In May 1999, a leveling survey was conducted between USGS benchmark TAM1 and UHSLC benchmark UH1. In this report, the UHSLC sea-level data are referenced to the mean sea level established by the USGS in 1969 from 29 days of tidal observations (T.A. Moyer, 1969, unpublished data from files in USGS Saipan field office).

Ocean tides at Saipan are semidiurnal, meaning that there are two high tides and two low tides each day. The mean tidal range is about 2.3 ft (T.A. Moyer, 1969, unpublished data from files in USGS Saipan field office). Daily and monthly sea levels at the Saipan sea port are shown in figure 11 and in table 8. The highest monthly mean sea level of 1.43 ft relative to mean sea level occurred in August. The lowest monthly mean sea level of 0.69 ft relative to mean sea level occurred in January. The highest daily mean sea level of 1.61 ft occurred on August 13. The lowest daily mean sea level of 0.56 ft occurred on January 5 and also on March 22 and 23.

PARTIAL-RECORD SURFACE-WATER STATIONS AND SPRINGS

Surface-water data collected during 1998 include intermittent discharge measurements at South Fork Talufofo Stream, Donni Spring, Achugao Spring, and

Tanapag I and II Springs, and periodic stage measurements at Lake Susupe (fig. 1 and tables 9 and 10). Measurements of streamflow at the South Fork of Talufofo Stream ranged from 0.02 ft³/s on June 23 at 9:10 a.m. to 0.26 ft³/s on May 21 at 1:20 p.m. The average discharge at a streamflow gaging station at the same location on the South Fork of Talufofo Stream (USGS station number 16801000) for the period between 1971 and 1987 was 1.36 ft³/s (Izuka and Ewart, 1995).

Discharge measurements at Donni Spring ranged from 0.16 ft³/s on May 21 at 12:15 p.m., to 0.43 ft³/s on September 16 at 10:20 a.m. (table 9). Three discharge measurements at Achugao Spring were made in 1998 (table 9). Six discharge measurements at Tanapag I and II Springs were made in 1998 (table 9). Discharge measurements at Tanapag Springs ranged from a low of 0.13 ft³/s on June 29 at 8:20 a.m. to a high of 0.31 ft³/s on August 6 at 8:00 a.m. Flow from Tanapag I and II Springs are combined by the CUC into one outlet pipe; thus, the discharge measurements are a sum of flow at the two springs. Stage measurements were made 10 times in 1998 at Lake Susupe (table 10). The stage at Lake Susupe ranged from 0.77 ft above mean sea level on June 8 at 9:54 a.m. to 2.45 ft above mean sea level on October 26 at 11:00 a.m.

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- Izuka, S.K., and Ewart, C.J., 1995, *Geology, streamflow, and water chemistry of the Talufofo Stream basin, Saipan, Northern Mariana Islands*: U.S. Geological Survey Water-Resources Investigations Report 95-4183, 26 p.
- U.S. Environmental Protection Agency, 1991, *Secondary maximum contaminant levels (section 143.3 of part 143, National secondary drinking water regulations)*: U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised through July 1, 1991.
- Van der Brug, Otto, 1985, *Compilation of water resources development and hydrologic data of Saipan, Mariana Islands*: U.S. Geological Survey Water-Resources Investigations Report 84-4121, 578 p.

Isley Field monitor well 2 (IF-MW2)					
Static water level about 2.0 feet relative to mean sea level					
Time	Sample number	Depth below water surface (feet)	Elevation (feet)	Specific conductance (microsiemens per centimeter)	Chloride-ion concentration ¹ (milligrams per liter)
0840	1	2	0	976	196
0855	2	6	-4	1,000	196
0910	3	11	-9	1,005	196
0920	4	16	-14	1,215	196
0930	5	21	-19	1,090	196
0940	6	26	-24	1,026	196
0950	7	31	-29	1,522	220
1000	8	36	-34	6,920	245
1010	9	41	-39	2,900	367
1020	10	43	-41	7,180	1,347
1030	11	49	-47	12,850	2,058
1040	12	59	-57	22,000	2,303
1050	13	69	-67	38,000	13,007
1100	14	85	-83	42,700	16,412
1110	15	100	-98	44,500	17,637

¹ Data from the Commonwealth Utilities Corporation laboratory

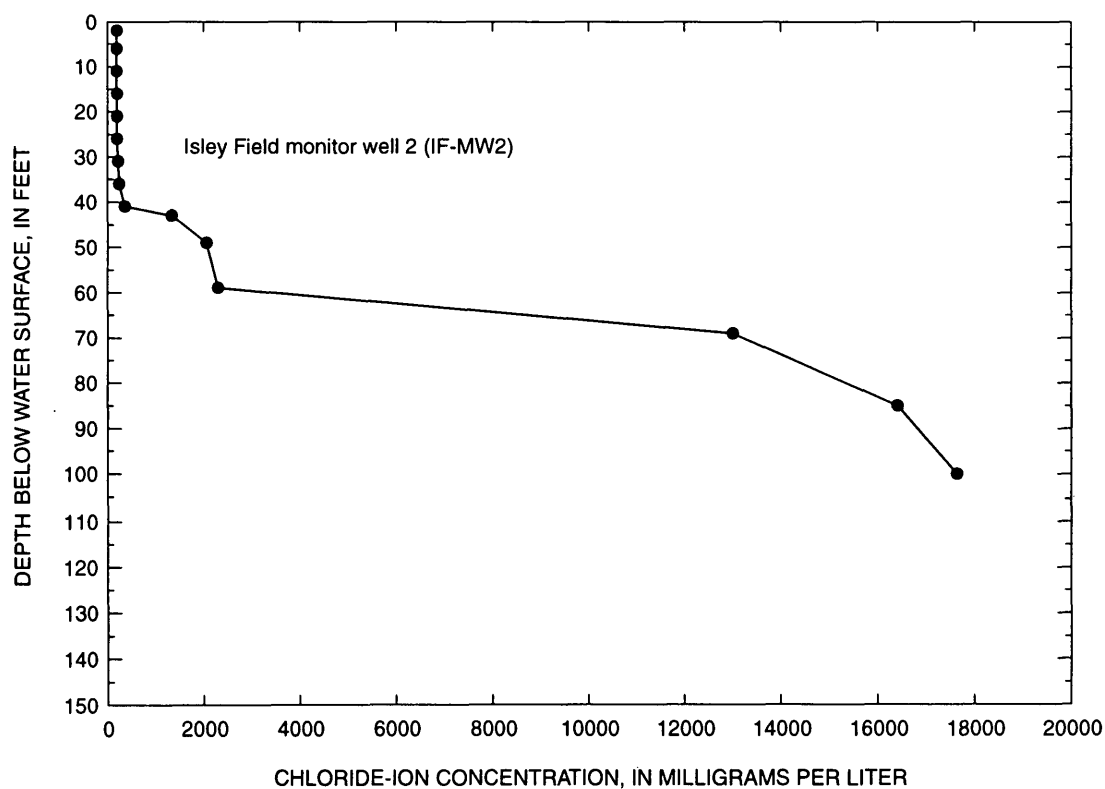


Figure 6. Chloride-ion concentration data and profile at Isley Field monitor well 2, September 28, 1998.

Obyan monitor well 1 (OB-MW1)					
Static water level about 2.0 feet relative to mean sea level					
Time	Sample number	Depth below water surface (feet)	Elevation (feet)	Specific conductance (microsiemens per centimeter)	Chloride-ion concentration ¹ (milligrams per liter)
1015	1	1	1	689	74
1035	2	4	-2	672	98
1040	3	8	-6	670	98
1055	4	13	-11	667	98
1105	5	18	-16	670	74
1120	6	23	-21	670	74
1130	7	28	-26	670	98
1145	8	33	-31	668	98
1155	9	38	-36	681	98
1210	10	43	-41	993	196
1220	11	48	-46	2,290	588
1230	12	52	-50	24,400	8,231

¹ Data from the Commonwealth Utilities Corporation laboratory

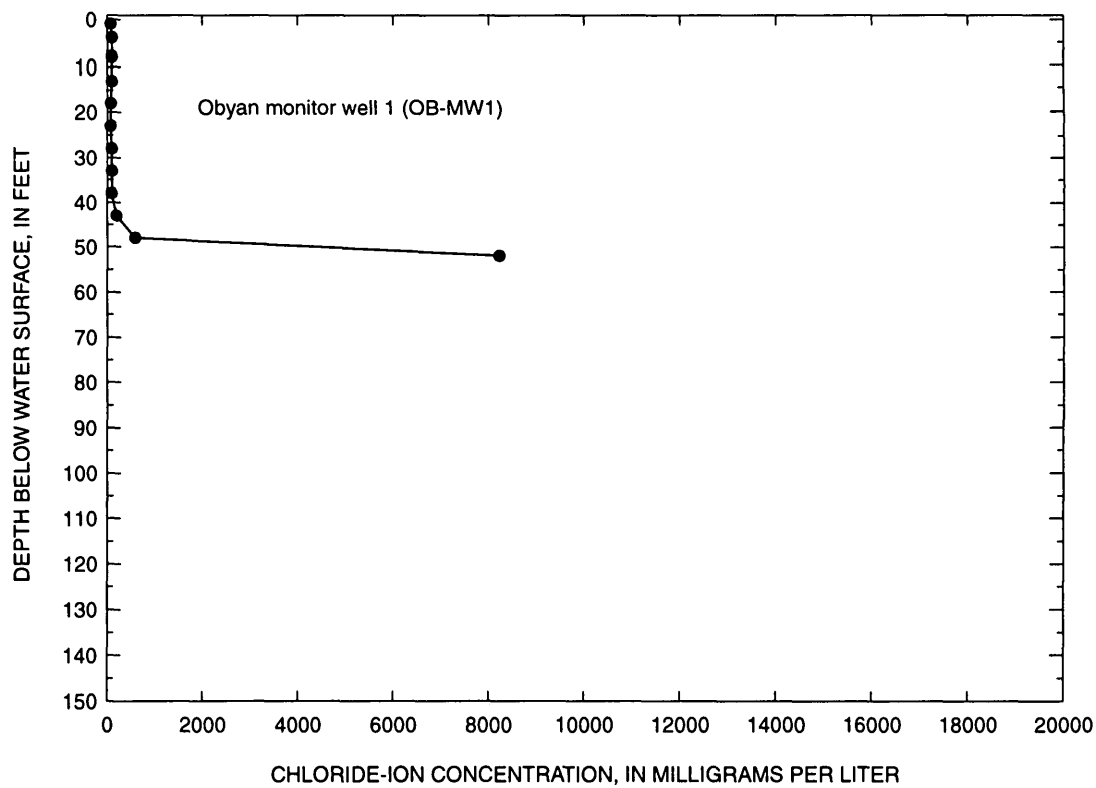


Figure 7. Chloride-ion concentration data and profile at Obyan monitor well 1, October 5, 1998.

Kagman monitor well 1 (KG-MW1)					
Static water level about 11.5 feet relative to mean sea level					
Time	Sample number	Depth below water surface (feet)	Elevation (feet)	Specific conductance (microsiemens per centimeter)	Chloride-ion concentration ¹ (milligrams per liter)
1030	1	4	7.5	890	200
1050	2	9	2.5	879	200
1100	3	14	-2.5	875	200
1110	4	19	-7.5	873	200
1120	5	24	-12.5	875	200
1130	6	29	-17.5	877	200
1138	7	34	-22.5	880	200
1145	8	39	-27.5	880	200
1155	9	44	-32.5	882	200
1200	10	49	-37.5	882	200
1210	11	56	-44.5	889	200
1225	12	61	-49.5	880	200
1235	13	66	-54.5	887	200
1245	14	76	-64.5	882	200
1300	15	86	-74.5	884	200
1315	16	96	-84.5	882	200
1330	17	138	-126.5	882	200

¹ Data from the Commonwealth Utilities Corporation laboratory

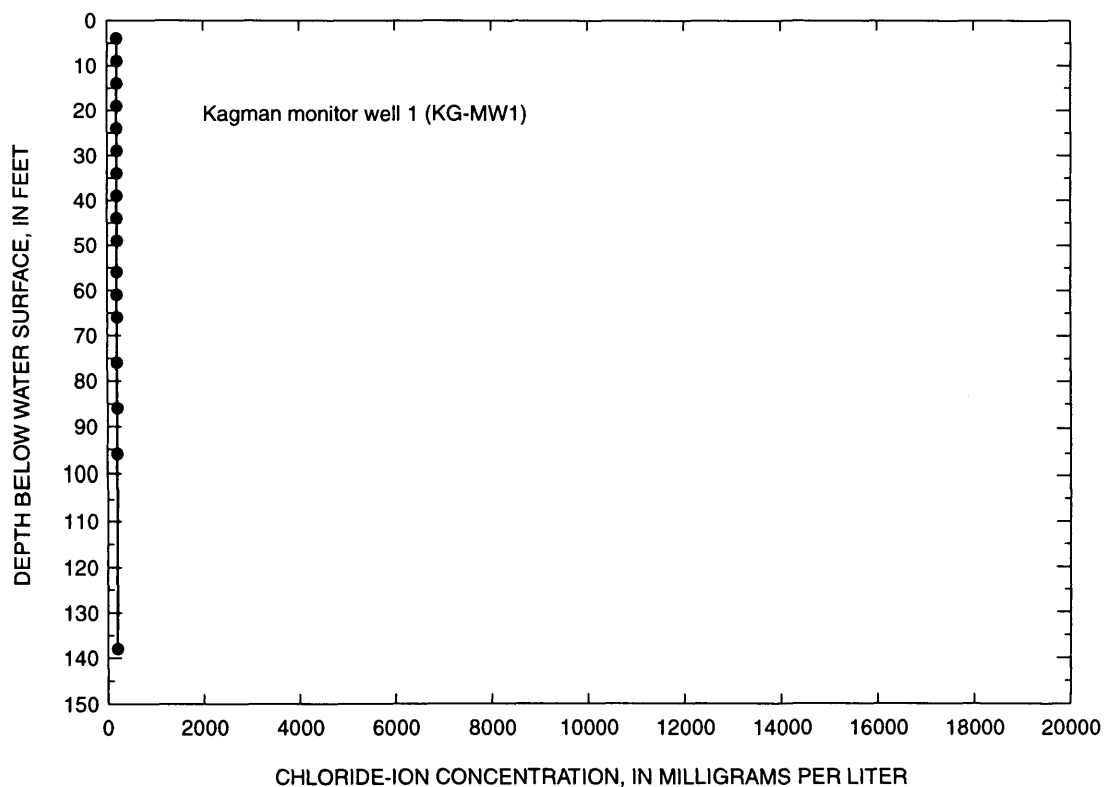


Figure 8. Chloride-ion concentration data and profile at Kagman monitor well 1, September 25, 1998.

Kagman monitor well 3 (KG-MW3)					
Static water level about 1.5 feet relative to mean sea level					
Time	Sample number	Depth below water surface (feet)	Elevation (feet)	Specific conductance (microsiemens per centimeter)	Chloride-ion concentration ¹ (milligrams per liter)
1410	1	2	-0.5	675	122
1415	2	5	-3.5	675	122
1422	3	10	-8.5	657	122
1430	4	15	-13.5	654	98
1438	5	20	-18.5	662	122
1444	6	25	-23.5	654	98
1452	7	30	-28.5	665	122
1501	8	35	-33.5	669	122
1510	9	40	-38.5	760	147
1519	10	45	-43.5	1,175	294
1530	11	49	-47.5	10,300	3,625

¹ Data from the Commonwealth Utilities Corporation laboratory

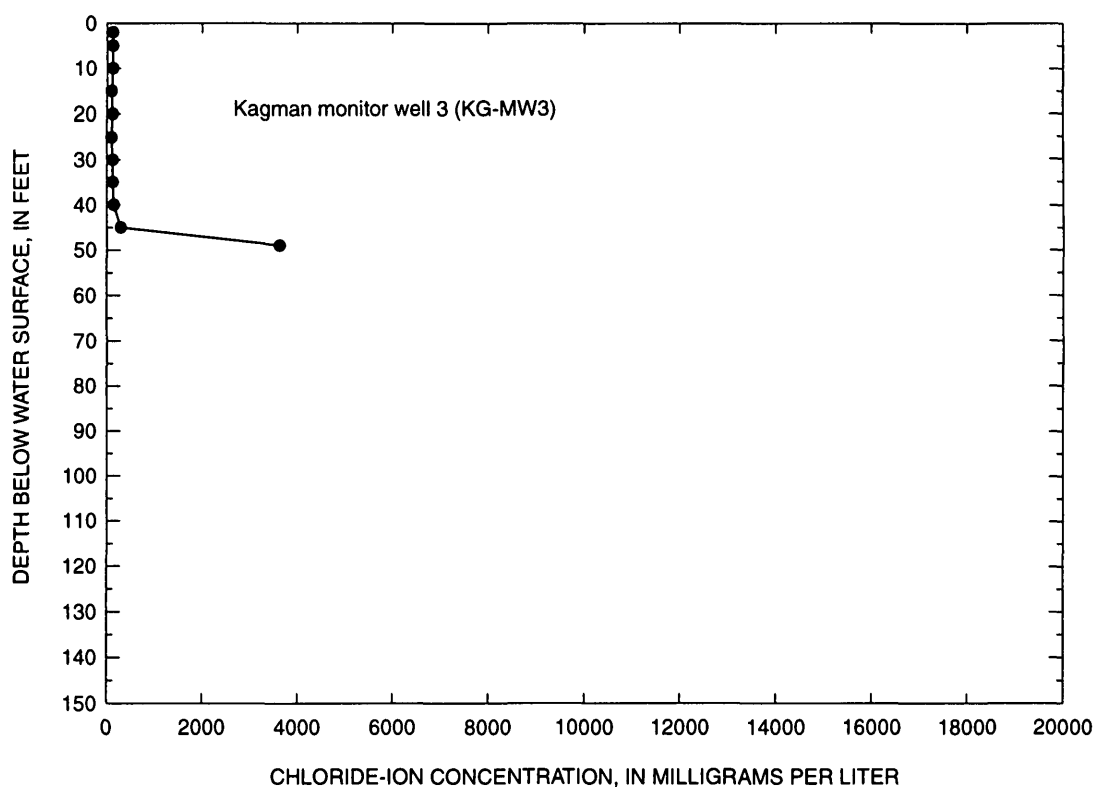


Figure 9. Chloride-ion concentration data and profile at Kagman monitor well 3, July 7, 1998.

Kagman monitor well 3 (KG-MW3)					
Static water level about 1.5 feet relative to mean sea level					
Time	Sample number	Depth below water surface (feet)	Elevation (feet)	Specific conductance (microsiemens per centimeter)	Chloride-ion concentration ¹ (milligrams per liter)
1000	1	2	-0.5	1,263	223
1015	2	6	-4.5	1,263	223
1030	3	10	-8.5	1,270	223
1042	4	15	-13.5	1,267	223
1049	5	20	-18.5	1,269	223
1055	6	25	-23.5	1,275	248
1101	7	30	-28.5	1,253	223
1108	8	35	-33.5	1,266	248
1115	9	40	-38.5	1,269	223
1122	10	45	-43.5	1,469	273
1131	11	50	-48.5	10,960	3,102
1146	12	55	-53.5	22,300	4,665
1200	13	65	-63.5	23,600	3,921
1215	14	75	-73.5	41,700	14,095
1230	15	85	-83.5	no data	no data
1245	16	95	-93.5	40,200	13,921
1300	17	125	-123.5	40,730	15,931

¹ Data from the Commonwealth Utilities Corporation laboratory

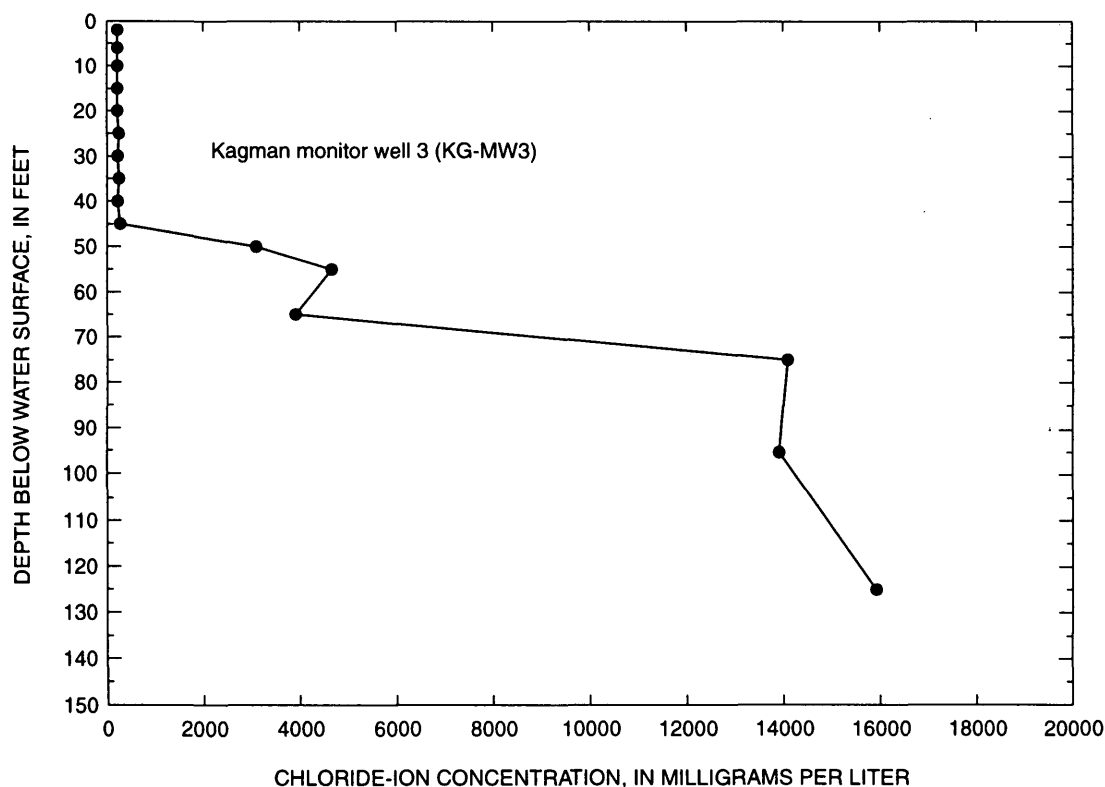


Figure 10. Chloride-ion concentration data and profile at Kagman monitor well 3, September 24, 1998.

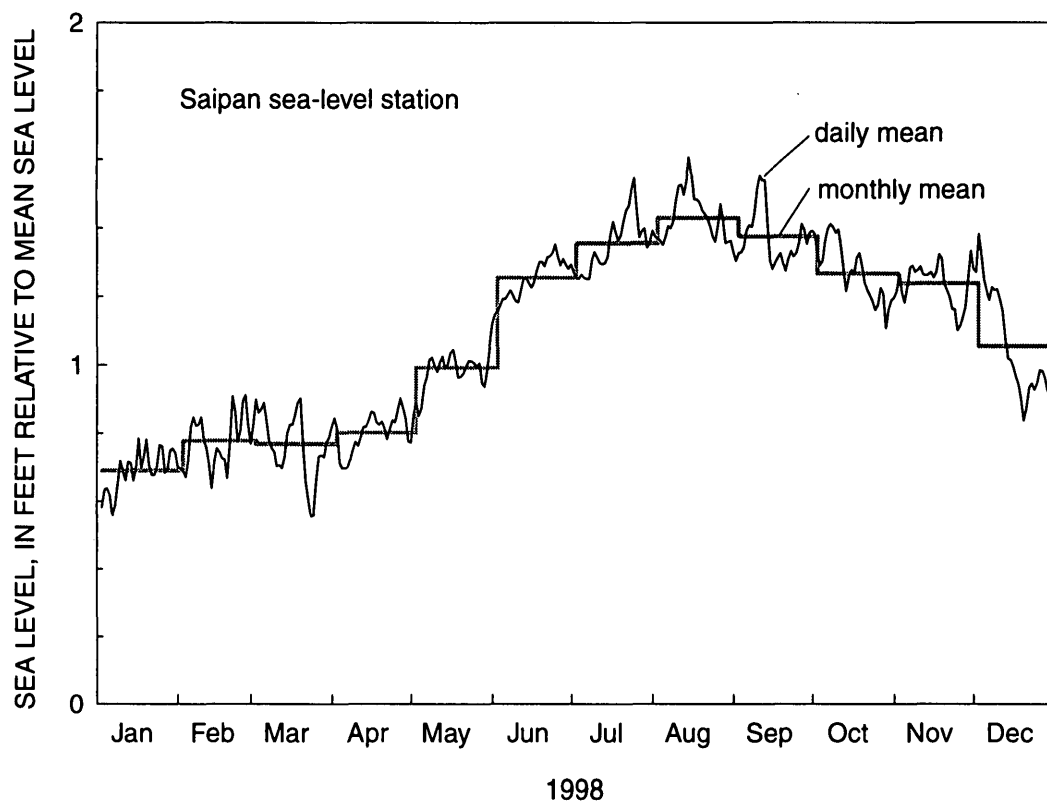


Figure 11. Daily mean and monthly mean sea level at the Saipan sea port, 1998.

Table 8. Daily mean sea levels at the Saipan sea port, 1998

[Values are in feet relative to mean sea level established by U.S. Geological Survey in 1969; --, not applicable; data from University of Hawaii Sea Level Center]

Sea levels at Saipan sea port, 1998												
DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.58	0.69	0.90	0.81	0.89	1.16	1.25	1.37	1.33	1.33	1.26	1.38
2	0.63	0.67	0.86	0.71	0.85	1.17	1.25	1.36	1.33	1.29	1.21	1.32
3	0.64	0.72	0.87	0.70	0.87	1.19	1.26	1.35	1.34	1.30	1.18	1.25
4	0.62	0.82	0.89	0.70	0.94	1.19	1.25	1.37	1.39	1.37	1.23	1.22
5	0.56	0.85	0.84	0.70	0.96	1.21	1.25	1.41	1.41	1.40	1.28	1.19
6	0.59	0.82	0.78	0.72	1.02	1.22	1.25	1.40	1.40	1.41	1.29	1.23
7	0.65	0.82	0.76	0.75	1.02	1.20	1.31	1.42	1.44	1.40	1.27	1.22
8	0.72	0.85	0.75	0.78	1.00	1.19	1.33	1.48	1.51	1.39	1.28	1.22
9	0.69	0.78	0.70	0.76	0.98	1.18	1.31	1.52	1.55	1.40	1.29	1.19
10	0.66	0.76	0.71	0.79	1.01	1.22	1.30	1.53	1.54	1.34	1.26	1.16
11	0.72	0.71	0.70	0.82	1.03	1.25	1.29	1.50	1.54	1.28	1.26	1.09
12	0.71	0.64	0.73	0.82	0.99	1.25	1.30	1.54	1.42	1.22	1.26	1.02
13	0.66	0.72	0.80	0.84	1.00	1.24	1.31	1.61	1.30	1.26	1.27	1.02
14	0.70	0.76	0.82	0.86	1.03	1.23	1.38	1.55	1.28	1.28	1.25	1.00
15	0.79	0.75	0.82	0.86	1.04	1.24	1.42	1.48	1.30	1.26	1.27	0.97
16	0.70	0.73	0.85	0.83	1.01	1.27	1.39	1.48	1.31	1.31	1.32	0.94
17	0.73	0.72	0.89	0.82	0.96	1.30	1.36	1.47	1.33	1.33	1.31	0.90
18	0.78	0.67	0.90	0.83	0.97	1.30	1.38	1.45	1.30	1.29	1.24	0.84
19	0.71	0.77	0.77	0.82	0.98	1.29	1.42	1.44	1.27	1.24	1.22	0.87
20	0.68	0.91	0.66	0.78	1.00	1.31	1.45	1.43	1.31	1.22	1.20	0.93
21	0.68	0.86	0.61	0.81	1.01	1.32	1.46	1.41	1.33	1.20	1.16	0.95
22	0.70	0.78	0.56	0.84	1.01	1.33	1.51	1.38	1.32	1.19	1.16	0.93
23	0.77	0.81	0.56	0.83	1.01	1.35	1.55	1.36	1.33	1.16	1.10	0.95
24	0.76	0.90	0.65	0.87	0.99	1.32	1.45	1.41	1.36	1.18	1.11	0.99
25	0.68	0.91	0.73	0.90	1.01	1.29	1.37	1.47	1.41	1.23	1.14	0.98
26	0.69	0.82	0.74	0.87	0.95	1.31	1.39	1.42	1.40	1.21	1.17	0.96
27	0.75	0.77	0.73	0.84	0.94	1.29	1.40	1.36	1.35	1.11	1.25	0.92
28	0.76	0.83	0.77	0.78	0.99	1.28	1.34	1.36	1.39	1.16	1.33	0.93
29	0.74	--	0.79	0.77	1.06	1.29	1.36	1.36	1.39	1.19	1.28	0.99
30	0.70	--	0.82	0.85	1.12	1.27	1.39	1.33	1.38	1.20	1.27	1.07
31	0.70	--	0.84	--	1.15	--	1.38	1.30	--	1.22	--	1.10
MEAN	0.69	0.78	0.77	0.80	0.99	1.26	1.36	1.43	1.38	1.27	1.24	1.06
MAX	0.79	0.91	0.90	0.90	1.15	1.35	1.55	1.61	1.55	1.41	1.33	1.38
MIN	0.56	0.64	0.56	0.70	0.85	1.16	1.25	1.30	1.27	1.11	1.10	0.84

Table 9. Summary of intermittent discharge measurements at South Fork Talufofo Stream and developed springs, Saipan, 1998
[ft³/s, cubic feet per second]

Date of measurement	Time of measurement	Discharge (ft ³ /s)
Discharge measurements at South Fork Talufofo Stream		
April 22	1330	0.08
May 21	1320	0.26
June 23	0910	0.02
August 5	0700	0.09
September 16	1315	0.08
October 27	0900	0.14
Discharge measurements at developed springs		
Donni Spring		
April 29	0900	0.21
May 21	1215	0.16
June 23	1345	0.22
August 5	1330	0.23
September 16	1020	0.43
October 26	1100	0.39
December 4	1330	0.29
Achugao Spring¹		
June 24	0919	0.02
September 14	1220	0.03
October 26	1000	0.06
Tanapag I and II Springs^{1,2}		
April 29	1430	0.26
May 26	1130	0.26
June 29	0820	0.13
August 6	0800	0.31
September 14	1145	0.28
October 26	0930	0.30

¹ Data are considered poor due to water loss around spring box

² Discharge is the sum of discharges at Tanapag I and Tanapag II Springs

Table 10. Summary of intermittent stage measurements at Lake Susupe, Saipan, 1998
[Stage values in feet relative to mean sea level]

Date of measurement	Time of measurement	Stage (feet)
May 11	1015	0.88
May 18	0945	0.89
May 27	1151	0.92
June 8	0954	0.77
June 17	1106	0.81
June 22	1010	0.87
July 7	1413	0.87
August 5	1245	1.46
September 15	1120	1.96
October 26	1100	2.45

