



**FEDERATED
STATES
OF
MICRONESIA
WATER
RESOURCES
STUDIES
BIBLIOGRAPHY**

by

Stephen J. Winter



WERI

WATER AND ENERGY RESEARCH INSTITUTE
OF THE WESTERN PACIFIC
UNIVERSITY OF GUAM

Technical Report 74
July 1993

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Abstract

A bibliography of water resources studies in the Federated States of Micronesia (FSM) was created from a computerized data base. The bibliography includes all studies included in the data base. It lists some or all of the following information for each report. Author(s), Title, Publisher, Place of Publication, Date of Publication, Series Title, Series Volume, Number of Pages, Report Identification Number, Notes, Abstract, Descriptors, Storage Location, and Call Number. The bibliography was created by first sorting the data base chronologically and then by searching descriptors for reports dealing with each of the four states of the FSM and then for reports dealing with the entire FSM. The Water and Energy Research Institute is capable of performing custom searches of the data base to produce other bibliographies.

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Introduction

Numerous studies of water resources have taken place in the Federated States of Micronesia (FSM), especially in the past 20 years. Unfortunately, because of changes in political status, changes in administration, and other reasons, present administrators are often unaware of the existence and/or contents of the reports that resulted from these studies. In some cases, reports may have actually become lost or at least are not available in the office that might be able to make the most use of them. Before undertaking future studies of water resources in the FSM, it makes sense to have access to the results of previous studies. Unfortunately, due to the situation described above, this is often difficult or impossible. In recognition of this problem, the FSM Advisory Council to the Water and Energy Research Institute (WERI) identified the creation of a data base of recent water resources studies as its highest priority project area. Such a project was implemented and was funded under the first grant to WERI from the U. S. Geological Survey for water studies and training programs in the FSM. The result of the project is a computerized data base. This bibliography was produced from the data base (and contains every report in the data base at the time the bibliography was printed).

In addition to water-related reports, the data base also includes reports dealing with geology and soils. These will be of specific interest to persons interested in groundwater research and development.

As the locations of reports in various offices throughout the FSM often changes, it was deemed wise to also attempt to create a library of hard copies of as many reports in the data base as possible. Thus, there would be a single location that a person could go to, to access these reports. The location of this library is WERI.

The data base was created by means of personal visits to all offices in the FSM and Guam that might contain water-related reports. During these visits, pertinent information was taken from the reports and entered into a computerized cataloging system. If possible, copies of the reports were also made for storage in the WERI library.

The data base is not complete. It is certain that a number of existing reports have not been included. Likewise, the library of hard copies of WERI is far from complete as it does not even include all the reports referenced in the data base. However, the data base will be updated on a continuing basis both by adding recently written reports as well as by adding previously written reports as they become available. It is anticipated that this bibliography will be reprinted from time to time as more reports are added to the data base.

Some "reports" have not been included in the data base as the information contained in them is not likely to be of permanent value. These include:

- Annual reports and quarterly reports
- Specifications for capital improvement projects
- Contract documents for capital improvement projects
- Proposals for capital improvement projects
- Cost estimates for capital improvement projects.

Use of the Bibliography

Each report included in the data base has entries under a number of categories. The categories are listed below and grouped in the manner in which they appear in this bibliography:

Author(s)

Title

Publisher

Place of publication

Date of publication

Series title

Series volume

Number of pages

Report identification number

Notes

Abstract

Descriptors

Storage location

Call number

Following is a further explanation of some of the foregoing categories whose function might not be clear.

Author. No "Author" is given for reports written by an engineering company or government agency unless a specific individual is identified as the "Author." the company or agency name is identified as the "Publisher".

Title. The title of the report is in italics.

Series title. An example of a series title is "technical report".

Series volume. This is the number of the volume in the series.

Number of pages. This number often excludes pages in an appendix.

Report identification number. If a contract number or other identifying number has been assigned to the project or the resulting report, it is given here.

Notes. This entry might include information describing appendices or annexes, a summary of the report if one was given in the report, a copy of the table of contents, or other information that will elaborate on the contents of the report.

Abstract. If the report contains an abstract, it is included here. Abstracts have not been written for reports that do not include one.

Descriptors. These are key words that can be used to access the report. With the exception of place and river names (e.g., Chuuk, Kolonia, Nanpil, etc.), all descriptors are taken from the Water Resources Thesaurus, third edition, 1980, U. S. Department of the Interior, Office of Water Research and Technology, Washington, D. C. 20240. In cases where an "old" place name (e.g., Truk) is used in the title of a report, it is used as a descriptor

Each citation includes one or more descriptors giving the name(s) of the state(s) that the report deals with. In cases where a report deals with all states of the FSM or where it deals with tropical islands in general, "FSM" is used as a descriptor (and individual state names are not used).

Storage location. This is the physical location where the report is stored. Often a report is stored at more than one location.

Often an abbreviation is used to describe a storage location. The following abbreviations have been used for storage locations and may appear elsewhere in the data base.

WERI - Water and Energy Research Institute, University of Guam, Guam

MARC - Micronesian Area Research Center, University of Guam, Guam

WRRC - Water Resources Research Center, University of Guam, Guam

Marine Lab - Marine Laboratory, University of Guam, Guam

USGS - United States Geological Survey, Guam

FSMOPS - FSM Office of Planning and Statistics, Palikir, Guam

Barrett - Barrett Consulting Group, Guam

Tenorio - Juan C. Tenorio & Associates, Guam

Pobuk - Pobuk Engineering, Pohnpei

FSM - Federated States of Micronesia

TTPI - Trust Territory of the Pacific Islands
UOG - University of Guam
OWRT - Office of Water Research and Technology, U. S. Department of
Interior

Technical reports produced by WERI are stored in many locations throughout the FSM. However, WERI is the only storage location listed for these reports. Likewise, a few technical reports by the University of Guam Marine Laboratory are also stored in many locations throughout the FSM. WERI and the Marine Laboratory are the only storage locations listed for these reports.

If the storage location is a state office, the name of the office is given followed by the name of the state. The word "and" is used to connect a series of offices within one state (e.g, Public Works and Environmental Protection, Kosrae State). The symbol "&" is used within the name of a state office (e.g., Planning & Statistics and Environmental Protection, Kosrae State).

Storage locations in different states are separated by a semicolon (e.g. Environmental Protection, Kosrae State, WERI; Public Works, Chuuk State).

This printed bibliography was created by first sorting the data base so that entries are in chronological order. Then the descriptor fields were searched for each of the four state names and for "FSM". Thus, the bibliography consists of a chronological listing of reports dealing with each state followed by a chronological listing of reports dealing with all states in the FSM. Reports that deal with more than one state (have more than one state name as a descriptor), but do not deal with all states of the FSM, are listed under all the states they deal with. Such multiple listings only occur in a few cases.

As the data base is constantly being updated, this bibliography may not necessarily include all entries in the data base. Upon request, WERI will search the data base for a word or words listed in the previously given categories. The most common categories to search are author, title, or descriptors. Persons interested in such a search should contact WERI for further details.

Chuuk Bibliography

1. *Task Force Report on Point and Non-Point Sources of Pollution in the Trust Territory of the Pacific Islands.*

Environmental Protection Board, Trust Territory of the Pacific Islands. Saipan, Mariana Islands.

84 pages.

Descriptors: Palau/Yap/Truk/Ponape/Chuuk/Pohnpei/Coastal Waters/Water pollution sources/Nonpoint pollution sources/Water quality.

Storage Location: Environmental Protection Agency, Yap State; WERI; FSMOPS.

2. *A Collection of Reports Dealing with Water Supply on Moen, Truk.*

100 (approx) pages.

Note: This is a collection of reports and portions of reports dealing with water supply on Moen, Truk. These documents include the following:

Water Resources Development Plan for Moen Island, Truk, ECI

The Ralph M. Parsons Company and Austin, Tsutsumi & Associates, Inc.

April, 1980

This is a partial report.

Summary of Previous Plans and Studies

This may be a part of the previous report.

Record of Ground-Water Exploration and Development, 1975-76, on Moen, Truk Islands, Eastern Caroline Islands

Dan A. Davis

Updating Report for Water Supply System for Island of
Moen, Truk District, Caroline Islands, Trust Territory of
the Pacific Islands
Austin, Tsutsumi & Associates, Inc.

Groundwater in Moen, Truk District
John Mink

Moen Water System - Truk, Eastern Caroline Islands,
Operation and Maintenance Standards

Descriptors: Truk/Chuuk/Moen/Weno/Groundwater potential/
Surface water/Surface water availability/Water Supply/
Groundwater/Maintenance/Water conveyance.

Storage Location: WERI.

3. Clayshulte, Russell N. *Limited Bathymetric and Water
Circulation Surveys in Etal Atoll Lagoon, Truk State.*

WERI, UOG. Mangilao, Guam.

Information Report 5, 15 pages.

Descriptors: Truk/Chuuk/Etal/Coastal waters/Bathymetry/
Water currents.

Storage Location: WERI.

4. *Climatology of Truk.*

26 pages.

Note: The report also contains approximately 50 pages of
climatological data.

Descriptors: Truk/Chuuk/Climatology/Temperature/Rainfall/
Humidity/Wind/Wind velocity.

Storage Location: USGS.

5. *Truk Gaebert Wastewater Treatment Plant Operations.*

200 - 300 pages.

Note: This appears to be the original copy of the document.

Descriptors: Truk/Chuuk/Wastewater treatment/Wastewater facilities/Maintenance/Operating policies.

Storage Location: FSMOPS.

6. Stark, John T., James E. Paseur, Richard L. Hay, Harold G. May, and Elmer D. Patterson. *Military Geology of Truk Islands, Caroline Islands.*

Intelligence Division, Office of the Engineer,
Headquarters United States Army Pacific. July, 1958.

207 pages.

Note: Report also contains 36 color maps.

Descriptors: Truk/Chuuk/Geology/Maps/Geologic mapping/
Subsurface mapping/Topographic mapping.

Storage Location: USGS.

7. Valenciano, Santos, and Kiyoshi J. Takasaki. *Military Geology of Truk Islands, Caroline Islands, Water Resources Supplement.*

Intelligence Division, Office of the Engineer,
Headquarters United States Army Pacific. September, 1959.

81 pages.

Note: Report also contains 8 color maps indicating surface water and groundwater resources of Truk.

Descriptors: Truk/Chuuk/Surface water/Surface water availability/Groundwater/Groundwater availability/Groundwater potential/Maps.

Storage Location: USGS.

8. Stark, J. T., and R. L. Hay. *Geology and Petrography of Volcanic Rocks of the Truk Islands, East Caroline Islands.*

U. S. Department of the Interior. Washington, D.C. 1963.

40 pages.

Geological Survey Paper 409.

Note: The report contains two geological maps (in color) of the high islands within the Truk Lagoon.

Abstract: The Truk Islands are a near-atoll in the North Pacific Ocean at about 7 degrees, 20 minutes north latitude and 151 degrees east longitude. They consist of 12 volcanic islands and many low coral reef islands in a lagoon approximately 30 to 40 miles, enclosed by a coral reef. The volcanic islands range from 5 to 2 miles to islands less than a quarter of a mile in diameter. Several peaks on the volcanic islands rise more than 1,000 feet; the highest altitude is 1,453 feet, on Tol. Dense, jungle vegetation covers slopes and crests of the volcanic islands and many of the reef islands.

The Truk Islands are remnants of a large shield volcano, now inactive, which has been partly submerged. Lava flows predominate although pyroclastic deposits are fully imbedded with the flows. The Truk volcano extended about

16,000 feet from the ocean floor to the surface. No evidence of crater walls now exists, but geologic evidence indicates a central crater once erupted large volumes of pyroclastic ejecta. Most of the lavas issued from fissure vents now represented by dikes and dike swarms.

The petrography of the volcanic rocks of Truk is relatively simple except for breccia blocks in the pyroclastic deposits of the central islands. The lava flows and dikes consist of olivine-rich basalt, melilite-nepheline and nepheline basalt, nepheline-basanite, andesite, and trachyte. The breccias of central Udot and Eot consist of angular fragments of rock in a fine-grained tuff matrix of crystal and rock fragments. Andesite, trachyte, and basalt rocks predominate in the breccias. Phaneritic blocks of gabbro are locally common, and blocks of hornfelsic, recrystallized gabbro, basalt, and breccia contain veins of fine-grained monzonite and quartz monzonite. Several blocks of monzonite have been found. Gabbro blocks contain dikes of andesite and basalt and inclusions of recrystallized basalt. A small number of limestone xenoliths were found.

The lavas of the Truk volcano clearly represent the alkalic-olivine-basalt-trachyte association common in the Pacific Ocean basin east of the andesite line. The undersaturated lavas of Hawaii are similar to those of Truk, but hypersthene-bearing tholeiitic lavas of Hawaii have no visible counterpart on Truk, either as lavas or pyroclastic ejecta. Unlike Hawaii, quartz trachyte occurs on the central islands of Truk. Most lavas and dikes of the central islands have been hydrothermally altered to some extent. Secondary chlorite and albite partly or entirely replace primary mafic minerals and plagioclase, respectively, and quartz and pyrite have been introduced into some of the rock.

Ejecta from the central crater include a number of rock types not found otherwise at the surface and supply information about rock types and processes at depth in the interior of the volcano. Gabbro was probably emplaced in the volcano, possibly as a stock. The gabbro is undersaturated and fundamentally similar to the basalt flows at the surface and was probably derived from the same magma. Monzonite and quartz monzonite form veins in the gabbro blocks and occur as individual xenoliths. The monzonite crystallized from a hydrous magma, apparently at temperature high enough to melt and assimilate adjacent gabbro. The quartz monzonite may be the hypabyssal equivalent of the quartz trachyte which assimilated some gabbroic material during intrusion.

Foraminifera in limestone fragments from the central crater indicate a late Tertiary e age with a slight possibility that they could be early Tertiary f. In terms of the standard time scale, these Foraminifera are very likely early Miocene. Consideration of several factors suggests that this limestone was deposited when the volcano had grown approximately to sea level, prior to the development of the subaerial shield volcano of large size. After the growth of the shield volcano, erosion dissected the cone, and several flows of nepheline-bearing lavas were extruded. After these last eruptions the volcano subsided sufficiently to submerge most of the dissected subaerial shield. A barrier reef subsided relative to sea level as the volcano subsided and formed a lagoon enclosing unsubmerged remnants of the Truk shield volcano.

Descriptors: Truk/Chuuk/Geology/Petrography/Mapping/Geologic mapping/Subsurface mapping/Topographic mapping.

Storage Location: WERI; USGS.

9. *Trust Territory of the Pacific Islands, Engineering Report Covering a Master Planned Water Supply and Distribution System for the Island of Moen together with a Sewer Outfall Study at South Point, Moen, Truk Islands, Caroline Islands.*

Austin Smith and Associates, Inc. Honolulu, Hawaii.
January, 1967.

63 pages.

Descriptors: Truk/Chuuk/Planning/Future planning/Water conveyance/Water supply/Surface water availability/Groundwater availability/Outfall sewers/Water currents.

Storage Location: Environmental Health, Chuuk State; WERI; USGS; FSMOPS.

10. *Engineering Report Covering a Sewerage System for the Island of Moen Supplementing the Truk Report of January, 1967.*

Austin, Smith & Associates, Inc. Agana, Guam. November, 1967.

25 pages.

Descriptors: Truk/Chuuk/Moen/Weno/Sewer systems/Wastewater facilities/Sewage Systems/Outfall sewers/Wastewater outfall/Outfall/Water currents.

Storage Location: Barrett; FSMOPS.

11. Mink, John F. *Groundwater Development in the Trust Territory.*

The Earth Sciences Group, Inc. Washington, D.C. 1969.

71 pages.

Descriptors: Yap/Truk/Chuuk/Groundwater/Geology/Groundwater potential/Geohydrology.

Storage Location: MARC; WERI; Tenorio.

MARC: TD 124 P3 M4

12. *ToI Master Plan.*

Hawaii Architects & Engineers, Inc. Honolulu, Hawaii. 1970.

50 pages.

Note: The only water-related material in this report is in

the appendix. This includes preliminary designs for water supply and for wastewater treatment and disposal for a sub-district center to have been located in Tol.

Descriptors: Truk/Chuuk/Tol/Ton/Water supply/Surface water/Dams/Water conveyance/Water storage/Storage tanks/Water tanks/Wastewater facilities/Wastewater disposal/Wastewater treatment.

Storage Location: Barrett.

13. Rollo, Frank O., and E. C. Winterhalder. *Geophysical Exploration, Ground-Water Studies, Moen, Truk.*

Harding, Miller, Lawson & Associates. San Rafael, California. May, 1971.

34 pages.

HML&A Job No. 372,001.07.

Descriptors: Truk/Chuuk/Moen/Weno/Groundwater/Groundwater potential/Groundwater availability/Geophysics/Electrical studies/Resistivity.

Storage Location: WERI; USGS; Tenorio.

14. *Engineering Report Covering the Dublon Island Water System.*

Austin, Tsutsumi & Associates, Inc. Honolulu, Hawaii. October, 1972.

14 pages.

Descriptors: Truk/Chuuk/Dublon/Tonoas/Water supply/Water conveyance.

Storage Location: FSMOPS.

15. Tsuda, Roy T., Steven S. Amesbury, Steven C. Moras, and Parks P. Beeman. *Limited Current and Underwater Biological Survey at the Point Gabert Wastewater Outfall on Moen, Truk.*

Marine Lab, UOG. Mangilao, Guam. May, 1975.

Technical Report 20, 39 pages.

Trust Territory Contract No. 175-62.

Descriptors: Truk/Chuuk/Moen/Weno/Outfall sewers/
Wastewater outfall/Outfall/Water currents.

Storage Location: WERI; Marine Lab.

16. *Micronesia Survey, 1975-76.*

Minerals Exploration Company. La Jolla, California.
December, 1976.

30 pages.

Note: Report also containing 45 figures which are profiles
of atoll lagoon geology.

Descriptors: Ponape/Truk/Yap/Chuuk/Pohnpei/Geology/
Minerals/Marine geology.

Storage Location: WERI; USGS.

17. Amesbury, Steven S., James A. Marsh, Richard H. Randall, and Jeanine O. Stojkovich. *Limited Current and Underwater Biological Survey of the Proposed Tuna Fishery Complex, Dublon Island, Truk.*

Marine Lab, UOG. Mangilao, Guam. June, 1977.

Technical Report 36, 49 pages.

Trust Territory Contract No. 77-72.

Descriptors: Truk/Chuuk/Dublon/Outfall/Water currents/Dye releases/Dye dispersion/Canneries/Fish handling facilities/Outfall sewers/Wastewater outfall.

Storage Location: WERI; Marine Lab.

18. *Truk District Sewerage Facility Plan, First Phase.*

Austin, Tsutsumi & Associates, Inc. Agana, Guam. August, 1977.

35 pages.

Note: Report also contains 7 appendices.

Descriptors: Truk/Chuuk/Moen/Weno/Planning/Wastewater facilities/Sewer systems/Wastewater treatment/Main sewers/Sewers.

Storage Location: Planning & Statistics and Public Works, Chuuk State; WERI.

19. Davis, Dan A. *Record of Ground-Water Exploration and Development, 1975-76, Moen, Truk, Eastern Caroline Islands.*

U.S. Geological Survey. September, 1977.

358 pages.

Open-File Report 77-739.

Note: SUMMARY

The ground-water exploration and development program consisted of the drilling and testing of 22 test holes on the island of Moen and the conversion of 8 of the holes into producing wells. Records compiled in this report on the work include running descriptions of the drilling and testing of the test holes and details of the construction and testing of the finished wells. All test holes and wells were drilled in volcanic rock and weathered products of volcanic rock.

Depths of the test holes ranged from 53 to 200 feet. Yields of water ranged from zero to about 60 gal/min (gallons per minute). Typically, drawdown of water level was large in the holes. In most, the specific capacities were 1 gal/min/ft (gallons per minute per foot) or less. The highest specific capacity was 8 gal/min/ft at a pumping rate of 48 gal/min.

Pumping-test rates among the completed wells ranged from 15 to 60 gal/min, and specific capacities ranged from 3/4 gal/min/ft at a rate of 35 gal/min to 6 gal/min/ft at 60 gal/min. The chloride concentration in water from one well was 120 milligrams per liter and less than 50 milligrams per liter in the other 7 wells.

Descriptors: Chuuk/Truk/Moen/Weno/Wells/Test wells/Deep wells/Well capacity/Water supply development/Well drilling/Well yield/Groundwater potential/Water quality/Chlorides.

Storage Location: Planning & Statistics, Chuuk State; WERI; USGS; FSMOPS.

20. *Environmental Assessments for Truk District Capital Improvements Program Infrastructure Including*

1. *Moen Water System*
2. *Dublon Water System*
3. *Moen Roadway and Causway.*

Austin, Tsutsumi & Associates, Inc. Honolulu, Hawaii.
December, 1977.

17 pages.

Note: This report also includes a number of appendices each of which may be considered to be a separate report

1. Updating Report for Water Supply System for Island of Moen, Truk District, Caroline Islands, Trust Territory of the Pacific Islands
2. Pou River Water Treatment Plant, Basis of Design
3. Wichen River Water Treatment Plant, Basis of design
4. Engineering report Covering the Dublon Island Water System

Descriptors: Chuuk/Truk/Dublon/Tonoas/Moen/Weno/
Environmental Impact Statement.

Storage Location: FSMOPS.

21. *Environmental Consultants, Inc. Baseline Water Quality Survey of Sewage Treatment Plant Facilities and Marine Outfall Sites on Moen and Dublon Islands, Truk Atoll.*

Austin, Tsutsumi & Associates. Honolulu, Hawaii. June, 1978.

76 pages.

Descriptors: Truk/Chuuk/Surveys/Wastewater treatment/Water quality/Wastewater discharge/Wastewater disposal/Wastewater outfall/Outfall.

Storage Location: Planning & Statistics, Chuuk State;
WERI.

22. Clayshulte, Russell N., James A. Marsh, Richard H. Randall, Jeanine O. Stojkovich, and Michael E. Molina. *Limited Current and Biological Survey at the Proposed Fishery Complex Site on Tol Island, Truk.*

Marine Lab, UOG. Mangilao, Guam. August, 1978.

Technical Report 50, 122 pages.

Trust Territory Contract No. B 78-18 .

Descriptors: Truk/Chuuk/Tol/Outfall/Water currents/Dye releases/Dye dispersion/Canneries/Fish handling facilities/Outfall sewers/Wastewater outfall.

Storage Location: WERI; Marine Lab.

23. *Wastewater Management Facilities Plan for the Truk District, Eastern Caroline Islands, Trust Territory of the Pacific Islands, Volume I.*

Austin, Tsutsumi & Associates. Honolulu, Hawaii.
November, 1978.

268 pages.

Descriptors: Truk/Chuuk/Wastewater facilities/Wastewater treatment/Rural Areas/Sewer systems.

Storage Location: Environmental Health, Chuuk State;
FSMOPS .

24. *Wastewater Management Facilities Plan for the Truk District, Eastern Caroline Islands, Trust Territory of the Pacific Islands, Volume II, Appendices 1 - 12.*

Austin, Tsutsumi & Associates. Honolulu, Hawaii.
November, 1978.

268 pages.

Descriptors: Truk/Chuuk/Wastewater facilities/Wastewater treatment/Rural Areas/Sewer systems.

Storage Location: Environmental Health, Chuuk State;
FSMOPS .

25. Clayshulte, Russell N., William J. Zolan, and Stephen J. Winter. *Air, Noise, and Water Quality Monitoring Program, Airport Construction Site, Moen Island, Truk District, Trust Territory of the Pacific Islands, Part A, Pre-Construction.*

WRRRC, UOG. Mangilao, Guam. March 1979.

Technical Report 7, 44 pages.

Contract No. N62742-78-0029, Part A, Department of the Navy, Pacific Division, Naval Facilities Engineering Command.

Descriptors: Moen/Weno/Truk/Chuuk/Surface runoff/Marine sediments/Water quality/Coastal waters.

Storage Location: WERI.

26. *Task Force Report on Point and Non-Point Sources of Pollution in the Outer Islands (Palau, Yap, Truk, Ponape) of the Trust Territory of the Pacific Islands.*

Environmental Protection Board, Trust Territory of the Pacific Islands. Saipan, Mariana Islands. September, 1979.

58 pages.

Descriptors: Palau/Yap/Truk/Ponape/Chuuk/Pohnpei/Coastal Waters/Water pollution sources/Nonpoint pollution sources/Water quality.

Storage Location: Environmental Protection Agency, Yap State; Environmental Protection & Sanitation, Pohnpei State; Environmental Health, Chuuk State; WERI.

27. Keating, B. *Preliminary Report of Geologic Studies in the Caroline Islands.*

Hawaii Institute of Geophysics, University of Hawaii. Honolulu, Hawaii. March, 1980.

15 pages.

Note: Report also includes 3 appendices.

Descriptors: Chuuk/Geologic history/Geology/Geological surveys/Geologic time/Rocks/Geophysics/Magnetic studies.

Storage Location: Planning Office, Pohnpei State; WERI.

28. *Water Resources Development Plan for Moen Island, Truk, E.C.I.*

Austin, Tsutsumi & Associates, Inc. Honolulu, Hawaii.
April, 1980.

103 pages.

NAVFAC CONTRACT NO. N62742-77-C-0001.

Note: The report also contains 3 appendices.

Descriptors: Chuuk/Truk/Moen/Weno/Water resources development/Planning/Future planning/Water supply development/Water demand/Water conveyance/Water management.

Storage Location: Planning & Statistics, Chuuk State; WERI; USGS; Tenorio; FSMOPS.

29. *Moen, Truk, Wastewater System, Plan of Operation.*

June, 1980.

200 - 300 pages.

Descriptors: Truk/Chuuk/Moen/Weno/Wastewater treatment/Wastewater facilities/Operating policies/Maintenance.

Storage Location: FSMOPS.

30. Clayshulte, Russell N., and William J. Zolan. *Well Water Quality on Moen Island, Truk.*

WRRC, UOG. Mangilao, Guam. September, 1980.

Technical Report 13, 36 pages.

Descriptors: Chuuk/Truk/Moen/Weno/Water quality/
Groundwater pollution/Deep wells.

Storage Location: WERI.

31. Winter, Stephen J., and Rebecca A. Stephenson. *The Development of a Village Water Supply System on Truk.*

WERI, UOG. Mangilao, Guam. July 1981.

Technical Report 28, 45 pages.

OWRT Project No. B-003-Guam.

Abstract: The village of Nemwan on Moen Island, Truk, was selected as the site for a pilot project that would lead to improvements in the village water supply system. Prior to the project, each household had to provide for its own water supply from rooftop rainwater catchments or shallow wells. During the dry season, it was often necessary to travel great distances to obtain a supply of potable water.

Since Nemwan is a fairly traditional village, a strong effort was made to consider cultural factors in the planning and design of the water system. In spite of this effort, misunderstandings of these cultural factors were largely responsible for the failure to complete the project. These factors included permission to use the land on which the water source to be developed was located, as well as attitudes toward physical labor and money. In addition, in hindsight, it was recognized that the water system, as planned, may have been too complex to be operated and maintained on the village level. Also, funding had not been identified that would be sufficient to complete all phases of the project.

The portions of the project that are expected to be completed are a long concrete-lined trench for collection of shallow groundwater and a sand filter. These will improve both the quantity and quality of water available for consumption. Facilities for water storage and distribution are not expected to be completed.

Descriptors: Truk/Chuuk/Moen/Weno/Rural areas/Social aspects/Water supply/Water supply systems.

Storage Location: WERI.

32. *Preliminary Cost Analysis (Water, Sewer, Road, and Catchment), Moen Island for Truk State, Federated States of Micronesia.*

Arizala, Arizala & Associates. Agana, Guam. September, 1982.

47 pages.

Note: The report also contains 4 appendices.

Descriptors: Chuuk/Truk/Moen/Weno/Cost analysis/Catchment areas/Water supply/Water supply development/Water conveyance/Wastewater facilities/Wastewater disposal/Outfall sewers/Wastewater outfall/Sewers.

Storage Location: Planning & Statistics, Chuuk State; Tenorio.

33. Clayshulte, Russell N., and William J. Zolan. *Water Quality Monitoring Program, Airport Construction site, Moen Island, Truk, Trust Territory of the Pacific Islands, Part B, Construction.*

WERI, UOG. Mangilao, Guam. October, 1982.

Technical Report 35, 43 pages.

Contract No. N62742-78-C-0029, Part B, Department of the Navy, Pacific Division, Naval Facilities Engineering Command.

Descriptors: Chuuk/Truk/Water Quality/Marine sediments/Coastal waters/Monitoring.

Storage Location: WERI.

34. *Preliminary Cost Analysis (Water, Sewer, Road, and Catchment), Dublon Island for Truk State, Federated States of Micronesia.*

Arizala, Arizala & Associates. Agana, Guam. December, 1982.

91 pages.

Note: The report also contains 4 appendices.

Descriptors: Chuuk/Truk/Dublon/Tonoas/Cost analysis/Water supply/Water supply development/Water conveyance/Water storage/Reservoir storage/Water treatment facilities/Wastewater facilities/Wastewater treatment/Wastewater disposal/Outfall sewers/Wastewater outfall/Sewers.

Storage Location: Planning & Statistics, Chuuk State; Barrett.

35. van der Brug, Otto. *Water Resources of the Truk Islands.*

Geological Survey. Honolulu, Hawaii. 1983.

223 pages.

U. S. Geological Survey, Water-Resources Investigations Report 82-4082.

Abstract: The Truk Islands consist of 19 volcanic islands and about 65 coral islets. The volcanic islands and some of the coral islets are scattered in an 820-square-mile lagoon enclosed by a 125-mile long barrier reef. Moen, although not the largest, is by far the most developed island and is the administrative, commercial, educational, and transportation center of the islands.

This report summarizes all hydrologic data collected and provides interpretations that can be used for development of the water resources.

Monthly rainfall records are available for most years since 1903, although they were not collected on the same island. On Moen, the average annual rainfall is 144 inches and rainfall-runoff comparisons show that about half of this runs off as surface water into Truk lagoon.

Flow characteristics of the major streams, based on more than 11 years of record, are provided and the application of data for permissible use in the design of reservoirs and rain catchments is included.

Historical and present development of all water sources are given. Virtually all water produced in the Truk islands comes from the Administration area on Moen, where a 90-acre catchment and the only known large aquifer in the islands are located. Runoff from the catchment area ranges from 15,000 to 150,000 gallons per day depending on the amount of rainfall, and production of ground water ranges from 500,000 to 800,000 gallons per day depending on the number of wells in operation and their pumping rates. The chemical analyses of surface and ground water on Moen, with the exception of water from well 9, indicate that the quality of water is good.

Descriptors: Truk/Chuuk/Surface water/Water records/Streamflow/High flow/Low flow/Flow duration/Water quality/Dissolved solids/Rainfall-runoff relationships/Rainfall/Geology/Geohydrology/Geologic formations/Geologic units/Geologic mapping/Groundwater/Groundwater potential/Wells/Well drilling/Well yield/Deep wells/Shallow wells.

Storage Location: Planning & Statistics, Kosrae State; Environmental Health and Planning & Statistics, Chuuk State; WERI; USGS; Barrett; FSMOPS.

36. Laird, William E. *Soil Survey of Islands of Truk, Federated States of Micronesia.*

Soil Conservation Service, United States Department of Agriculture. January, 1983.

65 pages.

Note: Report includes 16 soil maps.

Descriptors: Truk/Chuuk/Soil surveys/Soil types/Soil physical properties/Soil management/Soil genesis.

Storage Location: Environmental Health, Chuuk State; WERI; USGS; FSMOPS.

37. Ayers, Jerry F., and Russell N. Clayshulte. *Water Well and Taro Patch Water Quality, Moch Island.*

WERI, UOG. Mangilao, Guam. June, 1983.

Information Report 3, 9 pages.

Descriptors: Chuuk/Moch/Water quality/Well water/Saline water intrusion/Groundwater/Conductivity/Chlorides/Shallow wells/Geohydrology.

Storage Location: Office of Planning & Budget, Yap State; Environmental Health, Chuuk State; WERI.

38. Ayers, Jerry F., and Russell N. Clayshulte. *Water Well and Taro Patch Water Quality, Satawan Island.*

WERI, UOG. Mangilao, Guam. June, 1983.

Information Report 4, 9 pages.

Descriptors: Chuuk/Satawan/Water quality/Well water/Saline water intrusion/Groundwater/Conductivity/Chlorides/Shallow wells/Geohydrology.

Storage Location: Environmental Health, Chuuk State; Office of Planning & Budget, Yap State; WERI.

39. Winter, Stephen J., Larry D. McCleary, and Robert D. Watters.
The WERI Well on Truk: A Solar Photovoltaic Pumping Project.

WERI, UOG. Mangilao, Guam. September, 1983.

Technical Report 39, 27 pages.

Descriptors: Chuuk/Truk/Solar Energy/Shallow wells/Dug wells/Pumps/Pump wells/Pumping.

Storage Location: WERI.

40. *Water System Improvements to Serve the Proposed Fisheries Complex, Dublon Island, State of Truk, Federated States of Micronesia.*

Barrett, Harris & Associates, Inc. Tamuning, Guam.
September, 1983.

64 pages.

Descriptors: Truk/Chuuk/Dublon/Fisheries/Marine fisheries/Canneries/Water supply/Potential water supply/Water supply development/Groundwater potential/Surface water availability.

Storage Location: Planning & Statistics, Chuuk State.

41. Stephenson, Rebecca A., and Hiro Kurashina. *A Comparison of Water Catchment and Storage Systems in Two Micronesian Atoll Communities: Laura and Nama.*

WERI, UOG. Mangilao, Guam. September, 1983.

Technical Report 50, 73 pages.

OWRT Project No. A-021-Guam, Grant Agreement Nos. 14-34-0001-0112, 1112.

Abstract: This technical report focuses on a discussion of freshwater catchment and storage systems in Micronesia. Particular attention is paid to the conditions within two small Micronesian atoll environments, the village of Laura on Majuro atoll and the village community of Nama, a small Carolinian island lying outside of Truk lagoon. Both of the study areas lie within American jurisdiction in the western Pacific.

Fieldwork at Laura in August 1981 revealed that a paradox exists between abundant availability of freshwater occurring as rainwater and groundwater on one hand, and frequent shortages on the other. Fieldwork on Nama in August 1982 revealed similar abundant availability of rainwater, but freshwater shortages were rarely reported.

It is suggested that different levels of individual initiative and community response to the need for freshwater are apparent in the two island communities being studied. Particular variables such as access to the district center, availability of construction materials and supplies, community level planning and leadership or lack of the same, and time perspectives may be called upon to help explain variations between freshwater catchment and storage systems found at Laura and Nama.

Descriptors: Truk/Chuuk/Nama/Marshall Islands/Majuro/Laura/Catchment areas/Water tanks/Water storage/Storage tanks/Shallow wells/Dug wells/Rural sociology/Rural areas/Social aspects/Social values/Water use/Water consumption/Consumptive use/Nonconsumptive use.

Storage Location: WERI.

42. Clayshulte, Russell N. *Water Quality Monitoring Program, Airport Construction Site, Moen Island, Truk, Trust Territory of the Pacific Islands, Part C, Post-Construction.*

WERI, UOG. Mangilao, Guam. October 1983.

Technical Report 43, 32 pages.

Contract No. N62742-78-C-0029, Department of the Navy, Pacific Division, Naval Facilities Engineering Command.

Descriptors: Chuuk/Truk/Water quality/Coastal waters/Monitoring/Marine sediments.

Storage Location: WERI.

43. Winter, Stephen J., and Robert D. Watters. *Solar Pumping for Village Water Supply Systems on Truk.*

WERI, UOG. Mangilao, Guam. February, 1984.

Technical Report 49, 16 pages.

Descriptors: Chuuk/Truk/Solar Energy/Dug wells/Pumps/Pump wells/Pumping.

Storage Location: WERI.

44. Winter, Stephen J., and Larry D. McCleary. *Solar-Powered Wells for Atoll Island Water Supplies - Part I.*

WERI, UOG. Mangilao, Guam. June 1985.

Technical Report 60, 13 pages.

USGS Project No. 06, Grant No. G-837 and Project No.02, Grant No. 14-08-0001-901.

Abstract: This report describes the design, installation, and testing of a solar photovoltaic pumping system on the atoll island on Pis-Moen in Truk State, Federated States of Micronesia. The system uses twelve thirty-watt photovoltaic modules connected directly to a centrifugal pump. The pump draws groundwater from a horizontal well consisting of a length of perforated and screened PVC pipe, twenty feet long. During a noon test at full sun, at five feet head, the pump delivered approximately eighteen gpm. One major problem was encountered during the installation. This was the occurrence of reef rock at the water table at the first site selected. A second site proved to be satisfactory. Test holes should always be dug prior to siting wells on atoll islands.

Descriptors: Pis-Moen/Truk/Chuuk/Pumps/Pumping/Pump wells/Solar energy/Horizontal wells.

Storage Location: WERI.

45. Ayers, Jerry F., and Russell N. Clayshulte. *Reconnaissance Level Investigation of Salt-Water Intrusion on Kuttu Island, Satawan Atoll, Truk State.*

WERI, UOG. Mangilao, Guam. November, 1985.

Technical Report 48, 67 pages.

TTPI Contract No. CT310016.

Descriptors: Chuuk/Truk/Satawan/Saline water intrusion/Geophysics/Electrical studies/Seismology/Water quality/Shallow wells/Salinity/Chlorides/Specific conductivity.

Storage Location: WERI.

46. Heitz, Leroy F. *Development of a Computerized Distribution System Model of the Moen Island Water Distribution System.*

WERI, UOG. Mangilao, Guam. January, 1986.

Technical Report 62, 39 pages.

USGS Project No. 04, Grant No. 14-08-002-G1012.

Abstract: The purpose of this project was to develop a model of the water distribution system for Moen Island in Truk Lagoon. The water distribution system on Moen Island is one that has been plagued with operating problems for years. Even though there appears to be an adequate supply of water, the system is not operated on a 24 hour a day basis and there are also problems with leakage, over use and back flows into the system.

System data was gathered and two models were developed for the distribution system. The first model was of the Southfield area on the south end of the island. This model is a comprehensive model and can be used to study individual rates and the operation of an adequately constructed system. The second model is of the entire island water distribution system, but all of the individual services have not been identified. Although this second model is not as comprehensive as the Southfield model, it is still valuable in that various operating schemes can be investigated to optimize the coordination of available supplies, storage and demands. A complete listing of raw and annotated data for each model is contained in the appendices to this report.

Development of a water distribution model is only the first phase of solving the many problems with the Moen Island water distribution system. This report describes in detail a series of five follow up studies that will use the system models. These follow up studies should be useful in determining solutions that are both sound in engineering concepts and also feasible in both a political and social sense.

Descriptors: Chuuk/Truk/Moen/Computer models/Network design/Pipelines/Pipes/Water conveyance/Hydraulic models.

Storage Location: WERI.

47. *Leak Dection Survey on Water System of Moen Island, Truk State, F.S.M.*

Asanuma Gumi Co., Ltd. August, 1986.

19 pages.

Note: SUMMARY

LEAK DECTION SURVEY ON WATER SUPPLY SYSTEM OF MOEN ISLAND was conducted and examined between March 12 and April 4, 1986 as a part of contract: DUBLON AND MOEN WATER SUPPLY IMPROVEMENTS, CHANGE ORDER NUMBER 1.

It is concluded that no substantial water leakage was detected on most of the main water pipes on Moen Island. It is considered that poor maintenance of facilities such as valves and fire hydrants along water lines and especially almost continuous discharging of water from many private service pipes are making the present water system impossible to supply enough water to each houses despite the fact that Moen Island has enough water for its needs.

This report also suggests that management method of the water system by the government of Truk need to be reconsidered in order to have sufficient water supply in the near future.

The report contains detailed leakage reports as an attachment.

Descriptors: Chuuk/Truk/Moen/Weno/Water conveyance/ Leakage/Water loss.

Storage Location: Planning & Statistics, Chuuk State; WERI.

48. Stock, Daniel A. *Operation and Maintenance Management Plan, Moen Water System, Public Works, Truk State, FSM.*

November, 1986.

42 pages.

Note: Report also contains 3 appendices.

Descriptors: Truk/Chuuk/Moen/Weno/Maintenance/Water conveyance/Management planning/Training/Water storage/Water supply/Operating policies/Monitoring/Budgeting.

Storage Location: Planning & Statistics and Public Works, Chuuk State; WERI; Tenorio; FSMOPS.

49. *Hydraulic Analysis Report, Moen Island Water System.*

Barrett Consulting Group, Inc. Moen, Truk. December, 1987.

51 pages.

Note: This report is supplemented by two additional volumes of computer output.

Descriptors: Truk/Chuuk/Moen/Weno/Water conveyance/Computers/Computer models/Hydraulics/Pipe flow.

Storage Location: Planning & Statistics, Chuuk State; WERI; Tenorio.

50. Moravcik, Philip S. *A Further Investigation into Potential Contamination of Water Resources on Moen, Truk Islands, Federated States of Micronesia.*

School of Public Health, University of Hawaii. Honolulu, Hawaii. 1989.

64 pages.

Note: Objectives. Little is known about the capacity of the soils commonly found in Micronesia to prevent the passage of contaminants from the surface and latrine pits (many of which penetrate the water table) to sources of groundwater supply. The research objectives of the present project were therefore to examine waste disposal practices and sanitary conditions in select communities in Truk and assess the impact of these practices and conditions on the quality of shallow groundwater in the areas. A further objective was to examine rainwater catchment practices and to assess the bacteriological quality of water in rain storage tanks. As this water represents the principal source of drinking water for many if not most Micronesians it is important to determine the effect that collection and storage practices have under the unique environmental and social conditions that exist in Micronesia.

Descriptors: Truk/Chuuk/groundwater pollution/Coliforms/Feces/Wastewater disposal/Water storage/Water tanks/Storage tanks.

Storage Location: Environmental Health, Chuuk State; WERI.

51. Takasaki, Kiyoshi J. *Ground-Water Resources of Selected High Islands of Truk with Emphasis on Small Village Supplies.*

U.S. Geological Survey. Honolulu, Hawaii. April, 1989.

60 pages.

Abstract: The Truk Lagoon, about 800 square miles, is roughly the size of a volcano that once occupied it. The

volcano was eroded and also sank with time. The 19 volcanic islands now visible in the lagoon are remnant peaks of this partly eroded and sunken volcano. Coral atolls form the periphery of the lagoon.

The bulk of the islands consists of tight massive lavas and cemented rock fragments. Although the rocks are saturated, they yield little water to springs or to wells tapping them. Weathering of these rocks causes some increase in permeability and where weathering is deepest, as in valleys and in the flatter slopes, the material in the valleys underlying the flatter slopes comprise the main groundwater reservoirs. Although mostly small and discontinuous, these aquifers store limited quantities of ground water for development.

Rainfall averages around 140 inches per year and generally is sufficiently persistent to provide water for drinking and cooking from very small rain catchments, springs, and seeps with small storage. This situation is not satisfactory because with rainless periods, even short ones, springs, seeps, and rain barrels quickly go dry.

Water supplies in the villages can quickly be made more dependable by increasing the size of rain catchments and storage. Another alternative, where costs are too high to make these changes immediately, is to dig wells to supply water for only bathing, washing and flushing of toilets. A design for a simple well, to provide drinking and cooking water for long rainless periods, is illustrated.

The water-supply problems in the volcanic islands of Dublon, Uman, Fefan and the Faichuk islands during the 1882-83 drought were generally similar. Ground water occurs in Pis Island, a coral island, on the north end of the lagoon in a freshwater lens floating on seawater.

The water from wells tapping the freshwater lens had some increase in chloride concentration during the 1982-83 drought.

The day-to-day rain-dependent supply of water was totally inadequate during the 1982-83 drought. During this drought, rain barrels went dry, most streams and springs ceased to flow, and many shallow wells went dry. Fortunately, some dug wells in flat coastal areas still had water and these wells provided the only water available for the villages.

Descriptors: Chuuk/Truk/Groundwater/Wells/Dug wells/Shallow wells/Drought/Water shortage/Rural areas.

Storage Location: Public Works, Chuuk State; WERI; USGS.

52. *Plan of Action, Operations and Maintenance Improvement Program, State of Chuuk, Federated States of Micronesia.*

Louis Berger International, Inc. and Barrett Consulting Group, Inc. December, 1990.

52 pages.

Note: This report also contains 6 annexes.

Descriptors: Chuuk/Operating policies/Maintenance/Water conveyance/Sewer systems/Wastewater treatment/Water treatment.

Storage Location: Public Works, Chuuk State.

53. *Engineering Design and Hydraulic Analysis for Weno Island Water System.*

Juan C. Tenorio & Associates, Inc. Agana, Guam. 1991.

23 pages.

Note: The report also contains approximately 200 pages of computer printout and 4 appendices as follows:

- A. Aquifer test data
- B. Well drawdown curves
- C. Wells' horsepower calculations
- D. Engineering design calculations: booster pump station

Descriptors: Chuuk/Weno/Water conveyance/Water mains/Pipelines/Storage tanks/Deep wells/Pumps/Hydraulic design/Computer models/Model studies.

Storage Location: WERI; Tenorio.

54. *Basis of Design, Weno Island Water System Improvement.*

Juan C. Tenorio & Associates, Inc. Agana, Guam. April, 1991.

26 pages.

Descriptors: Chuuk/Weno/Water conveyance/Water mains/Pipelines/Storage tanks/Water supply/Surface water availability/Groundwater availability/Maintenance.

Storage Location: Planning & Statistics, Chuuk State; WERI; USGS.

55. *Second Year Review, Operations and Maintenance Improvement Program, OMIP Team's Field Report, State of Chuuk, Federated States of Micronesia.*

Louis Berger International, Inc. and Barrett Consulting Group, Inc. June, 1991.

22 pages.

Note: This report also contains 1 annex.

Descriptors: Chuuk/Operating policies/Maintenance/Water conveyance/Sewer systems/Wastewater treatment/Water treatment.

Storage Location: Public Works, Chuuk State.

56. *Wastewater Facilities Assessment Report, Weno, Chuuk.*

Barrett Consulting Group. Agana, Guam. 1992.

46 pages.

Descriptors: Chuuk/Weno/Wastewater facilities/Wastewater treatment/Assessments.

Storage Location: Environmental Health and Planning & Statistics, Chuuk State.

57. Hoffman, John P. *Chuuk Trip and Data Report, April 8-13, 1992.*

Geological Survey (unpublished). April, 1992.

100 pages (approx).

Note: Most of this report consists of data from a survey of the wells on Weno during the 1992 drought.

Descriptors: Chuuk/Weno/Drought/Rainfall/Wells/Deep wells/Conductivity/Specific conductivity/Chlorides/Pumping/Water level/Groundwater level/Water table/Water table fluctuations/Water level fluctuations.

Storage Location: WERI; USGS.

58. *Weno Island Master Plan, Water Supply Development, 1993-2002.*

Chuuk State Government. Weno, Chuuk. April, 1993.

96 pages.

Prepared under the FSM/UN Water Resources Assessment and Development Project.

Note: The report contains 14 appendices.

Descriptors: Chuuk/Weno/Planning/Future planning/Surface water/Surface water availability/Groundwater/Groundwater availability/Water demand/Population dynamics/Water conveyance/Water supply development/Cost analysis/Costs/Estimated costs.

Storage Location: Public Works, Chuuk State.

Kosrae Bibliography

1. *Kosrae Wastewater Facilities, Project No. T-616 (Phase II - Utwe & Tafunsak), Kosrae State, FSM.*

Division of Construction and Engineering, O.P. & B, Kosrae State. Kosrae, FSM.

64 pages.

Note: Table of Contents

Introduction
 Sewage disposal system
 Number of household & building classification
 Individual tank design criteria
 Septic tank design criteria
 Construction and location of septic tanks
 Technical data in determining the volume of the septic tank
 Topography mapping
 Ground water and subsurface condition
 Leaching field
 Leaching well
 Bill of materials for individual sanitary core unit and plumbing
 Waste sludge lagoon, basis of design
 Preliminary cost estimates
 Implementation
 Organization structure
 Implementation schedule

Report also contains 3 annexes, 10 figures, and 4 tables.

Abstract:

Descriptors: Kosrae/Oxidation ponds/Wastewater treatment/Sludge/Septic sludge/Septic tanks/Wastewater/Septic wastewater/Sludge disposal/Sludge digestion/Stabilization ponds/Biological treatment/Leachates.

Storage Location: Construction & Engineering, Kosrae State; WERI.

2. *Hydroelectric Power Feasibility Study, Kosrae District, Trust Territory of the Pacific Islands.*

PAE International. Los Angeles, California. April, 1976.

65 pages.

Note: The report also contains 5 appendices.

Appendix I (Flow curves; Flow duration curves; Flow diversion calculations; Kosrae Island map; Hourly wage rates; List of manufacturers; Diesel generator burn rates; Turbine gate opening vs. efficiency, CFS, and KW output curves; Impulse turbine vs. efficiency curve)

Appendix II (Tofol site calculations; Tofol detailed cost estimate; Tofol dam cost estimate)

Appendix III (Malem site calculations; Malem dam cost estimate)

Appendix IV (Mutunte site calculations; Mutunte dam cost estimate)

Appendix V (Okat River - preliminary layout, tube turbine)

Abstract: This study has analyzed four prospective hydroelectric sites on the island of Kosrae, Eastern Caroline islands, Trust Territory of the Pacific Islands, in terms of engineering suitability and economic viability. Comparisons have been made between new hydrostations versus new and existing diesel stations to determine cost effectiveness. As a result of these comparisons, we have determined the following:

The Okat site has a relatively low output and much higher first cost and is not feasible.

A summary of costs for the other sites compared to new diesel are tabulated below.

Site	Annual Cost	Expected Yearly Output	Cost Ratio New Diesel/Hydro
Tofol	77,758	420,000 kW hours	.7835
Malem	70,250	575,500 kW hours	1.02
Mutunte	70,175	417,000 kW hours	.866

A hydroelectric station at the Malem River offers cost advantages over a new diesel generating station in the

100-150 kW range. However, the power from this source has to be limited only to meet either nonpeaking loads in the 35-40 kW range or to provide backup capacity (100-150 kW range) for peaking loads of a diesel-generated source.

Hydroelectric stations at the Tofol and Mutante Rivers do not compare favorably to diesel power plants.

However, load growth and the continuing increase in diesel fuel prices will make these hydroelectric sites both attractive and practical within the next ten to fifteen years.

Descriptors: Kosrae/Hydroelectric plants/Powerplants/
Surface water/Feasibility studies/Financial feasibility/
Economic aspects/Flow duration/On-site investigations.

Storage Location: Planning & Statistics, Kosrae State;
WERI.

3. *Determination, Headwaters of Streams.*

R. M. Towill Corporation. Honolulu, Hawaii. September, 1978.

34 pages.

Descriptors: Ponape/Pohnpei/Kosrae/Streams/Headwaters.

Storage Location: WERI.

4. *Wastewater Facilities Plan for Kosrae District, Trust Territory of the Pacific Islands.*

PAE International. Agana, Guam. December, 1978.

413 pages .

Contract No. N62742-77-C-0003, Department of the Navy,
Naval Facilities Engineering Command.

Note: The report also contains approximately 200 pages of

appendices.

Descriptors: Kosrae/Wastewater/Wastewater disposal/Wastewater treatment/Water transport/Wastewater facilities/Domestic wastes/Rural areas/Costs/Cost analysis/Environmental Effects/Environmental impact statement.

Storage Location: Barrett; FSMOPS.

5. Chun, Michael J., Clifford Furukado, Estelle Shiroma, and Reginald H. F. Young. *Water Quality Survey, Okat, Kosrae, Trust Territory of the Pacific Islands.*

Water Resources Research Center. Honolulu, Hawaii.
November, 1979.

34 pages.

Contract No. N62742-78-C-0067, Naval Facilities Engineering Command, Pearl Harbor, Hawaii.

Descriptors: Kosrae/Coastal Waters/Water quality/Baseline studies/Turbidity/Oxygen demand/Phosphorus/Nitrogen/Hydrogen ion concentration.

Storage Location: MARC; FSMOPS.

MARC: TD 324 K87 C48

6. *An Engineering Evaluation of Wastewater Treatment Ponds, Kosrae District, Trust Territory of the Pacific Islands.*

Barrett, Harris & Associates, Inc. Tamuning, Guam.
December, 1979.

53 pages.

Note: Report also contains 4 appendices.

Descriptors: Kosrae/Wastewater treatment/Oxidation process/Aeration/Wastewater oxidation.

Storage Location: Pobuk, Environmental Protection & Sanitation, Pohnpei State; WERI; FSMOPS.

7. *Kosrae Hydropower Reconnaissance Report.*

U. S. Army Corps of Engineers. Honolulu, Hawaii.
December, 1981.

14 pages.

Note: Summary and Conclusions. This reconnaissance report investigated the hydropower potential at four sites: the Mutante, Pukusruk Wan, Malem, and Finkel Wan Rivers. Based on the conceptual run-of-the-river hydropower plans, the design nameplate capacities varied from 121 KW on the Finkel Wan River to 140 KW on the Pukusruk Wan River. The average annual energy output is approximately 200,000 kilowatt hours at each site. The cost and financial feasibility analysis indicated that none of the sites are financially feasible based on an outside contractor to do the work. The most significant cost items are the access roads and mobilization/demobilization costs. These items typically represent about one million dollars of the first cost. The remoteness of Kosrae from centers of construction and manufacturing industries and the rugged terrain of the rivers contribute to these high costs.

Hydropower on Kosrae is not feasible if an outside contractor is hired to perform all phases of plant construction. However, hydropower should not be written off as an impossible accomplishment. Hydropower on Kosrae may be feasible if the local community can work together to build their own system independent of outside contractors. Hydropower development is very similar to the existing water supply system that was constructed as a self-help style project. The hydropower system could use the same water supply dams and the penstock would be placed next to the water supply lines. The majority of this work could be accomplished by local villages with professional supervision. However, the Finkel Wan site does not appear to be feasible even as a self-help project because of the difficult access and penstock costs. Cost breakdowns are specifically shown in tables 8 to 11 to aid in formulating alternative development plans.

Recommendations. The government of Kosrae should determine if hydropower facilities can be constructed as a self-help project. If the people are willing to build their own system, then a detailed feasibility study should be prepared for the Mutante, Malem, and Pukusruk Wan sites. The feasibility report would outline how the projects would be built and would show specific detailed costs associated with the projects.

Descriptors: Kosrae/Hydroelectric plants/Hydroelectric power/Powerplants/Flow duration/Surface water/Feasibility studies/Financial feasibility/Economic feasibility/Environmental effects/Environmental impact statement.

Storage Location: Planning & Statistics, Kosrae State; WERI.

8. Harder, John. *F.S.M. Micro-Hydro Analysis.*

Architectural Energy Systems. Kapaa, Kauai, Hawaii. March, 1982.

48 pages.

Descriptors: Kosrae/Ponape/Pohnpei/Hydroelectric plants/Powerplants/Flow duration/Surface water/Feasibility studies/Financial feasibility/Economic feasibility.

Storage Location: WERI; Planning & Statistics, Kosrae State.

9. Kvandal, Scott C., and Frank H. Barrett. *Development of Design Criteria for Waste Stabilization Ponds in the Western Pacific Islands.*

August, 1982.

23 pages.

Pan American Congress on Environmental Engineering, UPADI-

82, San Juan, Puerto Rico.

Abstract: The need to develop and maintain wastewater collection, treatment, and disposal facilities is of paramount importance to any society. The majority of the tropical islands comprising Micronesia are without adequate wastewater disposal facilities. In many instances no wastewater facilities exist, resulting in uncontrolled discharge of raw wastes to land and water areas. In recent years, mechanical treatment facilities have been constructed and operated in many of the more populated islands, but with limited success. Some of the problems encountered with mechanical systems include special maintenance problems associated with the tropical environment, lack of adequately trained personnel, lack of reliable power sources and difficulty in obtaining replacement parts. For these reasons, the use of stabilization ponds has recently been encouraged.

Design criteria for construction of stabilization ponds in the Western Pacific differ from those normally employed in the continental United States because of the contrasting climatic characteristics. To develop criteria for use throughout the western Pacific, the performance of an existing stabilization pond was evaluated. The facility is located in the Village of Tofol, State of Kosrae, Federated States of Micronesia, and is believed to be the only facultative stabilization pond system serving a community in Micronesia. The evaluation included an extensive field sampling and analysis program. The results of the evaluation provide insight into the various design parameters for use in optimizing the performance of wastewater treatment pond systems throughout the Western Pacific Islands.

Descriptors: Kosrae/Wastewater treatment/Oxidation ponds/Stabilization ponds/Wastewater oxidation/Biological wastewater treatment.

Storage Location: Construction & Engineering, Kosrae State; WERI.

10. Heitz, Leroy F. *Hydropower Development in Micronesia*.
University of Idaho. Moscow, Idaho. August, 1982.
17 pages.

Descriptors: Pohnpei/Kosrae/Hydroelectric plants/
Hydroelectric power/Flow duration/Surface water.

Storage Location: WERI.

11. Laird, William E. *Soil Survey of Island of Kosrae, Federated States of Micronesia*.
Soil Conservation Service, United States Department of
Agriculture. March, 1983.
67 pages.

Note: Report includes 11 soil maps.

Descriptors: Kosrae/Soil surveys/Soil types/Soil physical
properties/Soil management/Soil genesis.

Storage Location: WERI; USGS; FSMOPS.

12. Videnov, Todor, and Russell G. Ludwig. *Kosrae, Plan Design Proposal for Sanitary and Wastewater Disposal Facilities*.
World Health Organization. Suva, Fiji. March, 1983.
66 pages.

Note: Report also includes 27 annexes containing designs,
materials lists, and other information for wastewater
facilities.

Descriptors: Kosrae/Sludge/Septic sludge/Septic tanks/Wastewater/Wastewater disposal/Wastewater collection/Wastewater treatment/Septic wastewater/Sludge disposal/Sludge digestion/Leachates/Outfall/Outfall sewers/Rural areas.

Storage Location: Barrett, Guam; Pobuk, Pohnpei.

13. Dillaha, Theo A., and William J. Zolan. *An Investigation of the Water Quality of Rooftop Rainwater Catchment Systems in Micronesia* .

WERI, UOG. Mangilao, Guam. November, 1983.

Technical Report 45, 39 pages.

OWRT Project No. A-029-Guam.

Abstract: This research involved an investigation of rainwater catchment system (RWCS) characteristics and water quality in Micronesia. The objectives of the research were to determine the bacteriological state of existing RWCS waters by analyses of fecal and total coliform bacteria and to try and identify those catchment characteristics and maintenance practices which affect water quality.

A total of 203 different RWCS were sampled in Kosrae, Ponape, Yap, and Palau. Seventy-one percent of the RWCS sampled had no fecal coliforms per 100ml and 37 percent had no total coliforms per 100ml. Eighty-five and 70 percent had 5 or less fecal and total coliforms respectively per 100ml. Cleaning the catchment tank, roof, and gutters were not found to affect RWCS water quality significantly. Total coliforms counts were significantly affected by screening the tank inlet and by the type of catchment tank.

In general, screens and tank coverings improved water quality. The newer ferrocement tanks had the best quality while metal barrels had the poorest.

Catchment tanks were the largest and most popular source of water in Yap where water was less plentiful. Catchment tanks were also popular in areas with other sources of

water. Even in areas with treated piped public water supplies, catchment systems appeared to be preferred for drinking purposes because of objections to chlorine taste and mistrust of public water.

Descriptors: Kosrae/Yap/Ponape/Pohnpei/Palau/Water quality/Catchment areas/Storage tanks/Water tanks.

Storage Location: WERI.

14. *Engineering Report, Malem Hydroelectric Project Design Review.*

Barrett, Harris & Associates, Inc. Honolulu, Hawaii.
November, 1983.

21 pages.

Note: Report also contains a section on specifications and an appendix amounting to over 100 pages.

Descriptors: Kosrae/Hydraulic design/Hydroelectric power/Hydroelectric plants/Powerplants.

Storage Location: Barrett.

15. van der Brug, Otto. *Water Resources of Kosrae, Caroline Islands.*

Geological Survey. Honolulu, Hawaii. March, 1984.

143 pages.

U. S. Geological Survey, Water-Resources Investigations Report 83-4161.

Abstract: Kosrae is a volcanic island about 43 square miles in area and is the easternmost of the Caroline Islands. Mount Finkel (Mt. Crozer), at 2,065 feet, is the highest point of the island. Mountainous ridges descend sharply to narrow coastal strips that support a population of 5,500 people. Many streams, some quite large relative

to the size of the island, drain radially from the interior. The average discharge of surface water amounts to 7 million gallons per square mile per day.

Annual rainfall for coastal areas on Kosrae averages around 200 inches and is similar to the rainfall for coastal areas on the island of Ponape, about 340 statute miles to the northwest. Rainfall in the interior was estimated at 225 inches per year, of which about two thirds runs off as streamflow.

Surface-water quality is very good as shown by 42 chemical analyses of water from 12 streams.

This report summarizes in one volume the hydrologic data collected and provides interpretations that can be used by planning and public works officials as a basis for making decisions on the development and management of their water resources.

Descriptors: Kosrae/Surface water/Water records/
Streamflow/High flow/Low flow/Flow duration/Water quality/
Dissolved solids/Rainfall-runoff relationships/Rainfall.

Storage Location: Planning & Statistics, Kosrae State;
Office of Planning & Budget, Yap State; WERI; USGS.

16. Clayshulte, Russell N. *Limited Current and Bathymetric Surveys at the Marine Outfall in Lelu Harbor and Reconnaissance Surveys of Effluent Disposal Sites at Malem and Utwe, Kosrae.*

WERI, UOG. Mangilao, Guam. July 1984.

Technical Report 55, 33 pages.

TTPI Contract No. 410046.

Descriptors: Kosrae/Coastal waters/Effluents/Wastewater disposal/Bathymetry/Water currents.

Storage Location: WERI.

17. Stock, Daniel A. *Kosrae Wastewater System Operation and Maintenance Management Plan.*

May, 1985.

60 pages.

Descriptors: Kosrae/Wastewater treatment/Treatment plants/Wastewater facilities/Sewer systems/Maintenance/Pumps/Pumping.

Storage Location: FSMOPS.

18. Clayshulte, Russell N., and William J. Zolan. *Environmental Mercury in Marine Water and Fish from Kosrae State, FSM.*

WERI, UOG. Mangilao, Guam. June 1985.

Technical Report 58, 47 pages.

Contract No. 410074, TTPI.

Descriptors: Kosrae/Coastal waters/Water quality/Mercury/Fish/Fish toxins.

Storage Location: WERI.

19. *Reconnaissance Study of Kosrae Water Resource Development Potential.*

U. S. Army Corps of Engineers. Honolulu, Hawaii.
September, 1985.

70 pages.

Abstract: This is a reconnaissance report of water resource (specifically water supply and hydropower) projects for consideration in the capital improvement program of Kosrae State, Federated States of Micronesia. The information presented on potential development needs is intended to highlight the more attractive projects which should be further refined in detailed engineering investigations. A sequence and funding level is proposed for three, five-year periods beginning in 1986.

The report contains seven chapters, ten appendices, and three plates. The main report introduces the physical, environmental, and socioeconomic characteristics of the island to the reader with particular emphasis on those facets effecting water resources development. The existing water supply and electrical energy systems are described, and problems and opportunities for future development are noted. A set of criteria are proposed to evaluate the needs and quantify the size of capital improvement projects. Future water resource development projects are identified based on this evaluation. Recommended short range projects include additional private water catchments, system storage, fire protection, and distribution line upgrades, and well field transmission facilities. Medium to long range improvements include additional treatment facilities and possibly hydropower developments.

An executive summary and list of recommendations is contained in Section VII for readers desiring only a brief overview of the report. The report recommends that the State government continue to use a flexible strategy to provide water to island residents. This approach relies on private as well as public means of providing water, developing multiple sources for supply using appropriate scale technology for water and hydropower developments, and encouraging conservation and wise use of these resources.

Descriptors: Kosrae/Surface water/Water supply/Water conveyance/Water treatment/Water treatment facilities/Hydrology/Water resources development/Flow duration/Hydroelectric power/Financial feasibility/Economic aspects/Planning.

Storage Location: Planning & Statistics, Kosrae State; WERI; Barrett; FSMOPS.

20. Jackson, Bard. *Kosrae: Design and Implementation of the Malem Micro-Hydropower Project.*

National Rural Electric Cooperative Association, Small Centralized Hydropower Program, International Programs Division. Washington, DC. November, 1985.

43 pages.

Note: This report is essentially a design of the hydropower project. The appendix contains specifications.

Descriptors: Kosrae/Malem/Powerplants/Hydroelectric plants/Hydroelectric power/Hydraulic design/Electrical equipment/Turbines/Penstocks.

Storage Location: Planning & Statistics, Kosrae State; WERI.

21. Nance, Tom. *Results of Exploratory Drilling on Kosrae Island, Federated States of Micronesia.*

Belt, Collins & Associates. January, 1986.

9 pages.

Note: Contents

Introduction

Conduct of the Drilling and Pump Testing

Summary of Results in Tafunsak

Summary of Results in Innem and Tofol

Appendix

A. Drilling Logs, Well Dimensions, and Pump Test Results at Tafunsak

B. Drilling Logs, Well Dimensions, and Pump Test Results at Innem-Tofol

Descriptors: Kosrae/Groundwater/Groundwater potential/Wells/Deep wells/Test wells/Well logs/Well capacity/

Drilling/Water supply development/Well yield/Safe yield/
Pumping tests.

Storage Location: Planning & Statistics, Kosrae State;
WERI; FSMOPS.

22. Stock, Daniel A. *Operation and Maintenance Management Plan, Lelu-Tofol Water System, Public Utilities, Kosrae State, FSM.*

OMI, Inc. September, 1986.

39 pages.

Note: Contents

Summary of Plan

Introduction

Purpose

Scope

Plan Organization

Background Information

Statement of Major Problems

Existing Facilities

Introduction

Sources and Treatment

Distribution and Storage

Reliability

Condition of Facilities

Safety

Summary and Recommendations

Operating Procedures

Introduction

Normal Operations

Maintenance Practices

Emergency Operational Procedures

Safety Practices

O&M Manual

Summary and Recommendations

Monitoring and Reporting

Introduction

Routine Reports

Laboratory Testing

Flow Measurement

Summary and Recommendations

Facility Staffing Requirements

Introduction

Staffing Requirements

Recommended Staffing
 Training Needs
 Summary
 Operating Costs and Revenue
 Introduction
 Operating Budget
 Estimated Unit Operating Costs
 Revenues
 Summary and Recommendations
 Contract Operations
 Introduction
 What is "Contract Operations"
 Why use Contract Operations
 Concern and Responsibilities of the Utility
 How to Decide if Contract Operations is the Best
 Solution
 How to Select a Firm and Negotiate a Contract
 How to Monitor Performance and Renegotiate a Contract

 Report also contains 3 appendices.

Descriptors: Kosrae/Maintenance/Water conveyance/
 Management planning/Training/Water storage/Water supply/
 Operating policies/Monitoring/Budgeting.

Storage Location: Planning & Statistics, Kosrae State;
 WERI.

23. *Sludge Oxidation Ponds, Basis of Design.*

Construction and Engineering, Bureau of Planning and
 Statistics, Office of Planning and Budget, Kosrae State.
 Kosrae, FSM. 1992.

21 pages.

Note: Table of Contents

Executive Summary

Rationale

 Background

 Maintenance of Septic Tanks

Project Description

 Methods of Sludge/Septage Disposal

 Locations of Sludge Disposal Systems

 Improvement of the Tofol Oxidation Ponds

Malem-Utwe Sludge Pond/Drying Bed
 Frequency of Septage Collection
 Specifications of Sludge Tank Truck
 Inlet Chamber Station
 Strategy of Implementation
 Phases of Implementation
 Implementation of Phase I
 Phase II implementation
 Estimated Cost
 Phase I
 Phase II
 Environmental Impact Assessment
 Operation and Maintenance

Descriptors: Kosrae/Oxidation ponds/Wastewater treatment/
 Sludge/Septic sludge/Septic tanks/Wastewater/Septic
 wastewater/Sludge disposal/Sludge digestion/Leachates.

Storage Location: Construction & Engineering, Kosrae
 State; WERI.

24. *Utwe Wastewater Facilities Project, Basis of Design.*

Construction and Engineering, Office of Budget and
 Planning, Bureau of Planning and Statistics, Kosrae state.
 Kosrae, FSM. September, 1992.

10 pages.

Note: Table of Contents

Executive Summary
 Introduction
 Island of Kosrae
 Kosrae Wastewater Facilities
 Project Description
 Physical and Environmental Characteristics of the
 Service Area
 Service Area Population
 Wastewater Loads
 Soil Characteristics
 The Proposed System
 Sanitary Core Units
 Septic Tank w/ Leaching Chambers
 Estimated Project Cost
 Strategy of Implementation

Environmental Impact Assessment

The report also contains 6 figures and 3 annexes.

Descriptors: Kosrae/Wastewater treatment/Sludge/Septic sludge/Septic tanks/Wastewater/Septic wastewater/Sludge disposal/Sludge digestion/Leachates.

Storage Location: Construction & Engineering, Kosrae State; WERI.

25. *Kosrae Wastewater Facilities, Operation and Maintenance Manual.*

Construction and Engineering, Bureau of Planning and Statistics, Office of Planning and Budget, Kosrae state. Kosrae, FSM. September, 1992.

115 pages.

Descriptors: Kosrae/Stabilization ponds/Oxidation ponds/Wastewater treatment/Sludge/Septic sludge/Septic tanks/Wastewater/Septic wastewater/Sludge disposal/Sludge digestion/Wastewater facilities/Maintenance/Pumps/Operating policies/Chemical analysis/Safety.

Storage Location: Construction & Engineering, Kosrae State.

26. *Kosrae State Master Plan: Water Supply Development, 1993-2002.*

Office of Planning and Statistics, Kosrae State. Kosrae State, FSM. October, 1992.

97 pages.

Prepared under the FSM/UN Water Resources Assessment and Development Project.

Note: The report also contains 12 appendices.

Descriptors: Kosrae/ Planning/Water resources development/
Water supply development/Surface water/Groundwater/Water
requirements/Dams/Diversion dams/Water treatment
facilities/Water treatment/Filtration/Disinfection/Water
storage/Pipelines/Water conveyance.

Storage Location: Public Works and Planning & Statistics,
Kosrae state.

Pohnpei Bibliography

1. *First State Development Plan, 1987-1991, Pohnpei State, Federated States of Micronesia.*

Division of Planning, Office of Planning, Budget, and Statistics, Pohnpei State. Pohnpei State, FSM.

224 pages.

Descriptors: Pohnpei/Water supply/Water quality/Wastewater/Wastewater treatment/Wastewater disposal/Planning/Future planning.

Storage Location: Planning Office, Pohnpei State.

2. *Task Force Report on Point and Non-Point Sources of Pollution in the Trust Territory of the Pacific Islands.*

Environmental Protection Board, Trust Territory of the Pacific Islands. Saipan, Mariana Islands.

84 pages.

Descriptors: Palau/Yap/Truk/Ponape/Chuuk/Pohnpei/Coastal Waters/Water pollution sources/Nonpoint pollution sources/Water quality.

Storage Location: Environmental Protection Agency, Yap State; WERI; FSMOPS.

3. *Economics of Hydroelectric generation, Ponape Island, E.C.I., Ponape District, Trust Territory of the Pacific Islands.*

Juan C. Tenorio & Associates, Inc. and Thomas J. Davis, Inc. Tamuning, Guam.

21 pages.

Descriptors: Ponape/Pohnpei/Hydroelectric plants/Powerplants/Surface water/Feasibility studies/Financial feasibility/Economic feasibility.

Storage Location: WERI.

4. *Background Paper on Hydroelectric Power Generation on Ponape Island, Ponape District, Trust Territory of the Pacific Islands.*

Juan C. Tenorio & Associates, Inc. and Thomas J. Davis, Inc. Tamuning, Guam.

30 pages.

Naval Facilities Engineering Command, Contract No. N62742-77-C-0002.

Descriptors: Ponape/Pohnpei/Hydroelectric plants/Powerplants/Flow duration/Surface water/Feasibility studies.

Storage Location: Pobuk, Pohnpei; WERI, Guam.

5. Pennaz, James. *Nanpil River Hydropower Project, Pohnpei, Federated States of Micronesia.*

10 pages.

Abstract: The US Army Corps of Engineers is actively engaged in developing small-scale hydropower on Pacific islands. Most of the islands are entirely dependent on oil-fired generation for their power needs. These high kilowatt-hour costs result in attractive benefits for alternative energy development.

The Nanpil River Hydropower Project is a 1600 KW run-of-the-river hydropower project located on the tropical island of Pohnpei, Federated States of Micronesia. The hydropower project will consist of an intake located at an existing water supply dam, a 4,600-foot penstock buried under the access roadway, a powerhouse, a switchyard, and a 2-mile transmission line. The construction contract includes one year of contractor operation and maintenance, with simultaneous training of local operators. The project is fully funded and should be under construction in late-1985.

The US Army Corps of Engineers planned and designed the hydropower facility on a reimbursable basis for the State of Pohnpei. Interesting design challenges included assessing environmental impacts and designing facilities for a minimum of operation and maintenance requirements. This paper will deal primarily with the planning and design of this small scale hydropower facility and will discuss some of the problems encountered in dealing with an island culture located in a remote part of the world.

Descriptors: Ponape/Pohnpei/Hydroelectric plants/Powerplants/Flow duration/Surface water/Feasibility studies/Hydraulic design/Electrical equipment/Turbines/Penstocks.

Storage Location: WERI.

6. *Kolonia Hydrological Study, Ponape, E.C.I., Ponape District, Trust Territory of the Pacific Islands.*

Juan C. Tenorio & Associates, Inc. and Thomas J. Davis, Inc.

10 pages.

Contract N62742-77-C-0002.

Note: Introduction

The following report outlines the results of a short-term, semi-in-depth study of rainfall in Ponape. The principal purpose of the study was to assess the magnitude of storm run-off so that adequately sized drainage structures would be provided as part of the road improvements within the municipality of Kolonia.

Report also contains 2 appendices entitled:

- A. Frequency Series, Ponape Rainfall Data (12 pages)
- B. Design Calculations, Ponape Storm Drainage Facilities (36 pages)

Descriptors: Ponape/Pohnpei/Rainfall/Rainfall distribution.

Storage Location: Pobuk.

7. *Trust Territory of the Pacific Islands, Engineering Report Covering a Master Planned Water Supply and Distribution System as well as a Sewerage System for the Kolonia Area of Ponape Island, Eastern Caroline Islands.*

Austin Smith and Associates, Inc. Agana, Guam. April, 1968.

42 pages.

Note: Report also contains 5 "Exhibits".

Descriptors: Ponape/Pohnpei/Kolonia/Planning/Water

conveyance/Water supply/Surface water availability/Outfall
sewers/Water currents/Human population/Population
dynamics/Rainfall/Wastewater treatment/Sewer systems/
Rainfall distribution.

Storage Location: Pobuk; FSMOPS.

8. Mangold, Arthur. *Kolonia Town Environment and Sanitation, Preliminary Report.*

District Department of Public Works and the Environmental Health Division of the District Department of Health Services, Ponape District. Ponape, TTPI. September, 1972.

27 pages.

Descriptors: Pohnpei/Ponape/Kolonia/Sanitation/Wastewater/
Wastewater disposal/Raw wastewater/Rodents/Insects.

Storage Location: Planning Office, Pohnpei State; WERI.

9. Tsuda, Roy T., Richard H. Randall, and Jennifer A. Chase. *Limited Current and Biological Survey in the Taunmokot Channel, Ponape.*

Marine Lab, UOG. Mangilao, Guam. October, 1974.

Technical Report 15, 58 pages.

Trust Territory Contract No. 175-5.

Descriptors: Ponape/Pohnpei/Outfall sewers/Wastewater
outfall/Outfall/Water currents.

Storage Location: WERI; Marine Lab.

10. *Micronesia Survey, 1975-76.*

Minerals Exploration Company. La Jolla, California.
December, 1976.

30 pages.

Note: Report also containing 45 figures which are profiles of atoll lagoon geology.

Descriptors: Ponape/Truk/Yap/Chuuk/Pohnpei/Geology/Minerals/Marine geology.

Storage Location: WERI; USGS.

11. *Water System Study, Town of Kolonia on Ponape Island, Ponape District, Trust Territory of the Pacific Islands.*

Juan C. Tenorio & Associates, Inc. and Thomas J. Davis, Inc. 1977.

26 pages.

Contract N62742-77-C-0002.

Note: Report also contains 10 plates and 18 exhibits (pressure records from fire hydrants).

Descriptors: Ponape/Pohnpei/Kolonia/Pipes/Steel pipes/Water conveyance/Water supply/Water demand/Water storage/Water treatment/Water treatment facilities.

Storage Location: WERI, Tenorio, Guam; Pobuk, Pohnpei.

12. Facilities Plan for the District of Ponape.

Juan C. Tenorio & Associates, Inc. and Thomas J. Davis, Inc. August, 1978.

200 pages (approx).

Note: Purpose and Scope

The facility plan is a districtwide wastewater study covering the District of Ponape. Because of varied conditions of population distribution, geology, and terrain of the islands and atolls, which are spread throughout an ocean area of approximately 170,000 square miles, this facility plan will consider each priority area as a separate study. A detailed study, however, has been made of the populated areas of Kolonia and Sokehs. The outlying areas and the atolls are sparsely populated and have no immediate need for wastewater facilities. These areas are covered in the report by "typical" conditions for treatment and disposal.

The purposes of this facility plan are as follows:

1. To evaluate and assess the newly-constructed Kolonia sewerage system;
2. To study alternative wastewater management plans, as necessary, to accommodate future flows;
3. To assess the environmental impact of the alternative plans; and
4. To develop a plan that will best meet the desired public health, environmental, and water quality goals.

Descriptors: Ponape/Pohnpei/Wastewater/Wastewater disposal/Wastewater treatment/Water transport/Wastewater facilities/Domestic wastes/Rural areas/Environmental effects/Environmental impact statement.

Storage Location: WERI; Barrett; Tenorio; FSMOPS.

13. *Determination, Headwaters of Streams.*

R. M. Towill Corporation. Honolulu, Hawaii. September, 1978.

34 pages.

Descriptors: Ponape/Pohnpei/Kosrae/Streams/Headwaters.

Storage Location: WERI.

14. *Task Force Report on Point and Non-Point Sources of Pollution in the Outer Islands (Palau, Yap, Truk, Ponape) of the Trust Territory of the Pacific Islands.*

Environmental Protection Board, Trust Territory of the Pacific Islands. Saipan, Mariana Islands. September, 1979.

58 pages.

Descriptors: Palau/Yap/Truk/Ponape/Chuuk/Pohnpei/Coastal Waters/Water pollution sources/Nonpoint pollution sources/Water quality.

Storage Location: Environmental Protection Agency, Yap State; Environmental Protection & Sanitation, Pohnpei State; Environmental Health, Chuuk State; WERI.

15. *Water Resources Study, Ponape, E. Caroline Islands.*

Juan C. Tenorio & Associates, Inc. and Thomas J. Davis, Inc. Tamuning, Guam. July, 1980.

47 pages.

Note: Conclusions

1. The water system has been well planned and its layout is quite adequate to meet the immediate needs of the people. Good quality water is being produced largely due to the quality of the water drawn from the source.

2. The system is operated in a less than desirable manner and is poorly maintained. Large amounts of water are lost through leakage and outright waste by consumers. Inadequate water levels are maintained in the storage tanks.

There is a prevalent lack of concern and resources for maintaining the various components of the system.

Localized water outages and insufficient production often result due to facility maintenance problems. The capacity of the system as a whole is also reduced whenever a particular component fails due to lack of maintenance.

3. Population growth appears to be exceeding projections in 1968. The current rate of growth in Kolonia is approximately 10% per year. Migration to Kolonia appears to be a large contributor to the rate of growth.

4. Improvements of various facilities will be necessary if present demands, as well as those 10 and 20 years from now, are to be met.

An appendix contains executive summaries of prior plans and studies relating to the Ponape District water system.

Descriptors: Ponape/Pohnpei/Kolonia/Water conveyance/Water supply/Water demand/Water storage/Water treatment/Water treatment facilities.

Storage Location: WERI; Barrett; FSMOPS.

16. Japan Consulting Institute. *Report on the Feasibility of Nanpil Hydropower Project in the State of Ponape, Federated States of Micronesia.*

December, 1980.

46 pages.

Descriptors: Ponape/Pohnpei/Hydroelectric plants/
Hydroelectric power/Powerplants/Flow duration/Surface
water/Feasibility studies/Financial feasibility/Economic
feasibility.

Storage Location: Barrett.

17. *An Economic Analysis of Hydro-Electric Generation at the Nanpil River, State of Ponape, Ponape Island, Federated States of Micronesia, Eastern Caroline Islands.*

Trust Territory of the Pacific Islands, Office of Planning
and Statistics. Saipan, Northern Mariana Islands.
January, 1981.

46 pages.

Descriptors: Ponape/Pohnpei/Hydroelectric plants/
Powerplants/Surface water/Feasibility studies/Financial
feasibility/Economic feasibility.

Storage Location: WERI.

18. *Kolonia, Ponape, Wastewater System, Plan of Operation.*

March, 1981.

200 - 300 pages.

Descriptors: Ponape/Pohnpei/Kolonia/Wastewater facilities/
Wastewater treatment/Operating policies/Maintenance.

Storage Location: FSMOPS.

19. *Design Modifications, Wone Water System, Ponape District.*

Barrett, Harris & Associates, Inc. Tamuning, Guam. April,
1981.

26 pages.

Note: The report also contains around 25 pages of
calculations and design details.

Descriptors: Ponape/Pohnpei/Wone/Hydraulic design/Surface
water/Water supply/Water conveyance/Water supply
development/Water treatment/Rural areas/Water storage/
Dams/Water tanks/Storage tanks.

Storage Location: Barrett.

20. *Ponape Hydropower Reconnaissance Report.*

U. S. Army Corps of Engineers. Fort Shafter, Hawaii.
June, 1981.

16 pages.

Descriptors: Ponape/Pohnpei/Lehnmasi/Senpen/Hydroelectric plants/Powerplants/Flow duration/Surface water.

Storage Location: Pohnpei Utilities Corp., Pohnpei State; WERI; Barrett.

21. *Engineering Report, Wastewater Disposal Facilities for Proposed Capital Complex for the Federated States of Micronesia.*

Barrett, Harris & Associates, Inc. Tamuning, Guam.
November, 1981.

52 pages.

Note: From Executive Summary

Several methods for treatment and disposal of wastewater were considered, including onsite systems such as composting toilets, pit privies, and septic tank-leach field systems. Centralized treatment systems were also evaluated and included the use of stabilization ponds in combination with other process units such as intermittent sand filters, aquaculture systems and disinfection. Disposal alternatives included ocean discharge, surface water discharge, mangrove swamp discharge and percolation basins.

Field investigations were conducted to evaluate the ability of the areas soil structure to assimilate wastewater effluent. The results of numerous soil percolation tests were dissapointing in that the percolation through the subsurface soils was virtually non-existent and, therefore, the use of percolation basins and septic tank-leach field systems were determined to be infeasible. Composting toilets were eliminated from further consideration because of the sophisticated operation and control requirements. The use of pit privies may be adapted for interim use in the Government Center housing, however, it was assumed that the long-term use of pit privies would not be acceptable to the people residing in the Palikir area.

Three alternatives were reviewed in more detail, including:

- 1: Collection system with centralized treatment followed by disposal of effluent through an ocean outfall
- 2: Collection system with centralized treatment followed by overland flow and ultimate discharge to the mangrove swamps
- 3: Collection system with centralized treatment followed by discharge to the Kirictilang River

Abstract:

Descriptors: Ponape/Pohnpei/Palikir/Wastewater treatment/Wastewater disposal/Land disposal/Sewage disposal/Outfall/Wastewater outfall.

Storage Location: Pobuk; FSMOPS.

22. Laird, William E. *Soil Survey of Island of Ponape, Federated States of Micronesia.*

Soil Conservation Service, United States Department of Agriculture. January, 1982.

81 pages.

Note: Report includes 43 soil maps.

Descriptors: Pohnpei/Ponape/Soil surveys/Soil types/Soil physical properties/Soil management/Soil genesis.

Storage Location: Environmental Protection & Sanitation and Planning Office, Pohnpei State; WERI; USGS; Barrett; FSMOPS.

23. Harder, John. *F.S.M. Micro-Hydro Analysis.*

Architectural Energy Systems. Kapaa, Kauai, Hawaii. March, 1982.

48 pages.

Descriptors: Kosrae/Ponape/Pohnpei/Hydroelectric plants/
Powerplants/Flow duration/Surface water/Feasibility
studies/Financial feasibility/Economic feasibility.

Storage Location: WERI; Planning & Statistics, Kosrae
State.

24. Contractor, Dinshaw N., and Stephen J. Winter. *Assessment of Low Head Micro Hydroelectric Equipment for Use on Small Tropical Islands.*

WERI, UOG. Mangilao, Guam. April 1982.

Technical Report 33, 8 pages.

OWRT Project No. A-024-Guam.

Abstract: This project points out the suitability of micro hydroelectric equipment for application on undeveloped tropical islands. Two potential sites on the island of Ponape were investigated. Manufacturers of hydro equipment suitable for installation at these sites were identified and price quotations obtained.

Descriptors: Ponape/Pohnpei/Hydroelectric power.

Storage Location: WERI.

25. Cowan, Peter A. *The Influence of Modern Water Supply and Wastewater Treatment Systems on Water Quality in Micronesia.*

WERI, UOG. Mangilao, Guam. August, 1982.

Technical Report 36, 87 pages.

OWRT Project No. A-020-Guam .

Abstract: The near shore environment surrounding the district centers of Koror (Palau) and Kolonia (Ponape) was evaluated with respect to selected physical and

bacteriological parameters. The baseline data measured in this study will serve to quantify ambient (natural background level) conditions for the expressed purpose of: A) acting as a basis of comparison against which future data may be judged; B) identifying areas of poor water quality, areas which could improve in quality given complete implementation of a fully operational wastewater collection/treatment/disposal system. In Koror, those areas immediately east and west of T-Dock and the small bay adjoining the Community Club could experience such improvements. In Kolonia, all near shore marine areas should be positively impacted. The waters surrounding Ponape, a high island, will continue to suffer from turbidities during sustained rainfall events; areas of concern are those impacted by freshwater (stream) inputs.

Since the highest priority water quality monitoring program in the Micronesian trust territories is the continuous evaluation of the public water supply system (PWS), a concurrent study was performed on the distribution systems in these two district centers (limited data from the Colonia (Yap) system were included in the PWS evaluation). Numerous drinking water standard violations were measured in each system: Colonia - excessive turbidities and coliform densities accompanied by negligible free residual chlorine (FRC) levels at distribution points; Koror - turbidity and coliform violations; Kolonia - coliform violations. The systems in Colonia and Koror are operated on an intermittent basis and, as such, patrons should boil PWS water prior to culinary uses. The service in Kolonia is continuous; however, until improved chlorination practices at the water treatment plant (WTP) are effected, the boiling precaution should be mandatory until district center PWS coliform densities are consistently negligible.

Descriptors: Koror/Palau/Kolonia/Ponape/Pohnpei/Colonia/Yap/Water quality/Coastal waters/Water distribution/Wastewater treatment/Water supply/Water supply systems.

Storage Location: WERI.

26. Heitz, Leroy F. *Hydropower Development in Micronesia.*

University of Idaho. Moscow, Idaho. August, 1982.

17 pages.

Descriptors: Pohnpei/Kosrae/Hydroelectric plants/
Hydroelectric power/Flow duration/Surface water.

Storage Location: WERI.

27. Ayers, Jerry F., and Russell N. Clayshulte. *Water Well Quality, Ngatik Atoll.*

WERI, UOG. Mangilao, Guam. May, 1983.

5 pages.

Descriptors: Pohnpei/Ngatik/Water quality/Well water/
Saline water intrusion/Groundwater/Conductivity/Chlorides/
Shallow wells/Geohydrology.

Storage Location: Office of Planning & Budget, Yap State;
Planning Office, Pohnpei State; WERI.

28. Ayers, Jerry F., and Russell N. Clayshulte. *Investigations of Salt-Water Intrusion Problems on Nukuro, Nukuro Atoll, Ponape State.*

WERI, UOG. Mangilao, Guam. May, 1983.

59 pages.

Descriptors: Pohnpei/Ponape/Nukuoro/Saline water
intrusion/Specific conductivity/Chlorides/Salinity/
Geophysics/Water quality/Electrical studies/Seismology.

Storage Location: WERI.

29. *Implementation Plan, Water Service Connection, Rehabilitation and Metering Program, for the Department of Public Works, State of Ponape.*

Barrett, Harris & Associates, Inc. Honolulu, Hawaii.
October, 1983.

20 pages.

Descriptors: Pohnpei/Ponape/Water conveyance/Leakage/Water loss/Water costs/User charges.

Storage Location: Barrett.

30. Dillaha, Theo A., and William J. Zolan. *An Investigation of the Water Quality of Rooftop Rainwater Catchment Systems in Micronesia* .

WERI, UOG. Mangilao, Guam. November, 1983.

Technical Report 45, 39 pages.

OWRT Project No. A-029-Guam.

Abstract: This research involved an investigation of rainwater catchment system (RWCS) characteristics and water quality in Micronesia. The objectives of the research were to determine the bacteriological state of existing RWCS waters by analyses of fecal and total coliform bacteria and to try and identify those catchment characteristics and maintenance practices which affect water quality.

A total of 203 different RWCS were sampled in Kosrae, Ponape, Yap, and Palau. Seventy-one percent of the RWCS sampled had no fecal coliforms per 100ml and 37 percent had no total coliforms per 100ml. Eighty-five and 70 percent had 5 or less fecal and total coliforms respectively per 100ml. Cleaning the catchment tank,

roof, and gutters were not found to affect RWCS water quality significantly. Total coliforms counts were significantly affected by screening the tank inlet and by the type of catchment tank.

In general, screens and tank coverings improved water quality. The newer ferrocement tanks had the best quality while metal barrels had the poorest.

Catchment tanks were the largest and most popular source of water in Yap where water was less plentiful. Catchment tanks were also popular in areas with other sources of water. Even in areas with treated piped public water supplies, catchment systems appeared to be preferred for drinking purposes because of objections to chlorine taste and mistrust of public water.

Descriptors: Kosrae/Yap/Ponape/Pohnpei/Palau/Water quality/Catchment areas/Storage tanks/Water tanks.

Storage Location: WERI.

31. *Engineering Report, Leak Detection Services, Kolonia Water Distribution System.*

Barrett, Harris & Associates, Inc. Honolulu, Hawaii.
December, 1983.

67 pages.

Note: Report contains an appendix describing an Implementation Plan for Water Service Connection, Rehabilitation and Metering Program.

Descriptors: Ponape/Pohnpei/Kolonia/Water conveyance/Leakage/Water loss.

Storage Location: Water, Sewer & Solid Waste, Pohnpei State; WERI; FSMOPS.

32. van der Brug, Otto. *Water Resources of Pohnpei, Caroline Islands.*

Geological Survey. Honolulu, Hawaii. March, 1984.

171 pages.

U. S. Geological Survey, Water-Resources Investigations Report 83-4139.

Abstract: Pohnpei is the third largest island in the western Pacific, with a land area of 129 square miles. The island is volcanic, nearly circular in shape, and covered with lush tropical vegetation. The mountainous interior has the highest peaks in the western Pacific.

Mean annual rainfall at Kolonia and other coastal areas is 191 inches. Inland at higher elevations, annual rainfall is considerably higher. The upper Nanpil River basin averages about 340 inches annually.

Runoff-to-rainfall ratios for Pohnpeian streams show that about two thirds of the rain falling on the island runs off. Flow-duration curves show the similarity of the geology, vegetation, and rainfall of the drainage basins and indicate little sustained ground-water contribution to surface runoff.

Surface-water quality is excellent as shown by 53 chemical analyses of water from 19 streams. Water of the Nanpil River, the source of water for the central system, is especially low in dissolved solids.

This report summarizes in one volume all the hydrologic data collected and provides analyses that may be used by planning and public works officials as a basis for making decisions on the development and management of the water resources.

Descriptors: Pohnpei/Surface water/Water records/Streamflow/High flow/Low flow/Flow duration/Water quality/Dissolved solids/Rainfall-runoff relationships/Rainfall.

Storage Location: Conservation & Resource Surveillance and Planning Office, Pohnpei State; Office of Planning & Budget, Yap State; WERI; USGS; FSMOPS.

35. *Study of Roadside Drainage Facilities, Ponape Capital Improvement Program, Ponape State, Federated States of Micronesia.*

Tenorio, Duenas & Associates. March, 1984.

40 pages.

Naval Facilities Engineering Comand, Contract No. N62742-77-C-0002.

Note: Purpose and Scope of Study

The purpose of the study is to investigate the as-built condition of roadside drainage facilities constructed under certain increments of the Ponape Capital Improvement Program, identify problems associated with the adequacy of the facilities to handle storm runoff as well as hazards posed to pedestrian and vehicular traffic, and to develop alternative solutions for a review by approving authorities.

Descriptors: Ponape/Pohnpei.

Storage Location: Pobuk, Pohnpei; FSMOPS.

36. *Ponape Water Supply Reconnaissance Report.*

U. S. Army Corps of Engineers. Honolulu, Hawaii. April, 1984.

5 pages.

Note: Report also contains 1 appendix and 5 plates.

Descriptors: Ponape/Pohnpei/Lehnmasi/Surface water/Water supply/Water conveyance/Water treatment/Water treatment facilities/Hydrology/Water resorces development/Flow duration.

Storage Location: Water, Sewer & Solid Waste and Pohnpei

Utilities Corp., Pohnpei State; WERI.

37. Jackson, Bard, and Paul Clark. *Ponape: Recommendations for small-hydropower activities.*

National Rural Electric Cooperative Association, Small Centralized Hydropower Program. Washington, DC. July, 1984.

72 pages.

Descriptors: Pohnpei/Ponape/Mand/Powerplants/Hydroelectric plants.

Storage Location: Planning Office, Pohnpei State; WERI.

38. Ayers, Jerry F., H. Len Vacher, Russell N. Clayshulte, David Strout, and Richard Stebnisky. *Hydrogeology of Deke Island, Pingelap Atoll, Eastern Caroline Islands.*

WERI, UOG. Mangilao, Guam. July, 1984.

Technical Report 52, 366 pages.

TTPI Contract No. CT410036, USGS Project No. G837-02.

Abstract: An extensive hydrogeological investigation was conducted on Deke Island located on Pingelap Atoll, Ponape State. Field work included installation of observation wells, water-level monitoring, installation of a tidal gage, core drilling, surface geological and topographic mapping, geophysical surveys, and water-quality analysis. Results from the work indicate a number of previously unknown aspects of atoll island hydrology. The most significant of these is the confinement of the fresh-water lens system beneath the leeward extension of the reef-flat plate. Where the plate is absent, water-table conditions are prevalent. The plate acts as a leaky confining layer which allows some rainwater to enter the flow system by downward movement under gravity. Approximately 2/3 of

Deke overlies the reef-flat plate; the remainder overlies sediments deposited behind the reef-flat depositional environment.

In addition to the documentation of hydraulic conditions within the lens system, the behavior of the ground-water resource was studied and a method of reducing observed water levels in wells to actual sea level was developed. Also, several subsurface hydrogeologic units were indentified and their roles within the overall hydrology of Deke were defined. In general, the size and extent of the lens was mapped. Based on the interpretation of the study results an atoll island hydrologic (conceptual) model is presented. Finally, some practical implications of the study findings are discussed and recommendations for further work are made.

Descriptors: Pohnpei/Pingelap/Deke/Geohydrology/
Groundwater hydrology/Observation wells/Tides/Groundwater level/Monitoring/Core drilling/Geohydrologic units/
Geohydrologic boundries/Geologic units/Geologic formations/Topographic mapping/Geophysics/Electrical studies/Seismology/Water quality/Shallow wells/Chlorides/Specific conductivity/Confined aquifers/Coastal aquifers/Leaky aquifers.

Storage Location: WERI.

39. Mink, John F., and Donald S. Austin. *Report on Groundwater Development, FSM Capital Complex, Palikir, Ponape, ECI.*

Austin, Tsutsumi & Associates, Inc. Honolulu, Hawaii.
August, 1984.

15 pages.

Note: Appendix contains location map, lithology logs, description of general hydrogeology, pump test data, graphs of recoveries, graphs of drawdowns, and water quality test data.

Descriptors: Ponape/Pohnpei/Palikir/Groundwater/
Groundwater potential/Wells/Deep wells/Test wells/Well logs/Well capacity/Drilling/Water supply development/Well yield/Safe yield/Pumping tests.

Storage Location: Water, Sewer & Solid Waste, Pohnpei State; WERI; USGS; FSMOPS.

40. Mink, John F. *Groundwater Supply for Kolonia, Ponape, Site Selection, Initial Well.*

October, 1984.

5 pages.

Descriptors: Pohnpei/Groundwater/Groundwater potential/Wells/Deep wells/Geology/Geohydrology.

Storage Location: WERI; USGS.

41. Stock, Daniel A. *Pohnpei Wastewater System Operation and Maintenance Management Plan.*

November, 1984.

50 (approximate) pages.

Descriptors: Pohnpei/Wastewater treatment/Treatment plants/Wastewater facilities/Sewer systems/Maintenance/Pumps/Pumping.

Storage Location: Pohnpei Utilities Corp., Pohnpei State; WERI; FSMOPS.

42. *Kolonia Sewer System Evaluation Survey, Phases I and II.*

Duenas & Swavely, Inc. and CH2M Hill. January, 1985.

68 pages.

Naval Facilities Engineering Command, Contract No. N67742-77-C-0002, Amendment 0035.

Note: From Summary

A physical survey and rainfall simulation test were conducted on sewerlines installed in Kolonia, Pohnpei under construction contracts administered by the US Navy's Officer In Charge of Construction (OICC). The investigation was authorized by the US Navy's OICC and conducted by Duenas & Swavely, Incorporated in association with CH2M Hill. The purpose of the investigation was to identify sources and estimate volumes of inflow/infiltration (I/I) flow in these lines, construction deficiencies to determine a need for further investigations and to develop a program of rehabilitation based on a cost analysis of I/I removal. As a result of consultation and information provided by CH2M Hill, the effort was expanded to consider the impact of I/I removal with regard to wastewater treatment and transportation costs.

Descriptors: Pohnpei/Kolonia/Simulated rainfall/
Infiltration/Sewer infiltration/Influent seepage/Sewer
systems/Sewers.

Storage Location: Pobuk.

43. Winter, Stephen J., and Larry D. McCleary. *A Ram Pump Demonstration.*

WERI, UOG. Mangilao, Guam. June 1985.

Technical Report 59, 19 pages.

Contract No. C50176, Office of Capital Improvement Programs, TTPI.

Descriptors: Pohnpei/Pumping/Pumps/Water supply/Rural areas.

Storage Location: WERI.

44. Mink, John F. *Groundwater Development, Kolonia, Pohnpei, Federated States of Micronesia.*

September, 1985.

16 pages.

Note: Report also includes appendices containing location, lithology, completion data, pump test data, tables and drawings for Kolonia wells K-1, K-2, and K-3.

Descriptors: Pohnpei/Groundwater/Groundwater potential/Wells/Deep wells/Test wells/Well logs/Well capacity/Drilling/Water supply development/Well yield/Safe yield/Pumping tests.

Storage Location: Water, Sewer & Solid Waste and Environmental Protection & Sanitation, Pohnpei State; WERI; USGS.

45. Ayers, Jerry F., and Russell N. Clayshulte. *A Preliminary Investigation of Salt-Water Intrusion on Nukuro Island, Nukuro Atoll, Ponape State.*

WERI, UOG. Mangilao, Guam. November, 1985.

Technical Report 44, 168 pages.

TTPI Contract No. CT310016.

Descriptors: Pohnpei/Ponape/Nukuoro/Saline water intrusion/Specific conductivity/Chlorides/Salinity/Geophysics/Water quality/Electrical studies/Seismology.

Storage Location: WERI.

46. Mink, John F. *Groundwater Development, Kolonia, Pohnpei, Federated States of Micronesia, Phase II, Wells K-5, K-7, K-8, K-9, and K-10* .

December, 1986.

8 pages.

Note: Report also contains appendices including location map, basic information about construction and performance of the wells, pump test results, lithology logs, aquifer parameters, table of distances between wells, and recommended pump sizes.

Descriptors: Pohnpei/Groundwater/Groundwater potential/Wells/Deep wells/Test wells/Well logs/ Well capacity/Drilling/Water supply development/Well yield/Safe yield/Pumping tests.

Storage Location: Water, Sewer & Solid Waste and Planning Office, Pohnpei State; WERI.

47. Stock, Daniel A. *Operation and Maintenance Management Plan, Kolonia Pohnpei Water System.*

December, 1986.

45 pages.

Note: Report also contains 3 appendices.

Descriptors: Pohnpei/Kolonia/Maintenance/Water conveyance/Management planning/Training/Water storage/Water supply/Operating policies/Monitoring/Budgeting.

Storage Location: Water, Sewer & Solid Waste, Pohnpei State; WERI; FSMOPS.

48. *Federated States of Micronesia Request for Japanese Grant-Aid on Immediate Reinforcement Project for Pohnpei Water Supply.*

Department of Public Works, Pohnpei State. Pohnpei State, FSM. December, 1986.

16 pages.

Descriptors: Pohnpei/Water supply/Water conveyance/Water supply development/Water treatment facilities/Pipelines/Conveyance structures/Financing.

Storage Location: Office of Construction Management, Pohnpei State; WERI.

49. Khosrowpanah, Shahram. *Improving the Water Distribution System at Kolonia, Pohnpei State, through use of a Digital Water Distribution Model.*

WERI, UOG. Mangilao, Guam. May, 1987.

Technical Report 66, 39 pages.

Abstract: In spite of adequate input water to the modern water distribution system of Kolonia, Pohnpei, substandard water is available to consumers for only a few hours per day. The implementation and continuation of water hours in a place where rain pours, often all day long, and where streams gush with the resulting runoff, frustrates not only the government but the people as well. Previous studies indicate certain technical flaws in the system, such as system leakage, nonefficient operation of the system and inappropriate consumer behavior and attitudes toward water use.

A hydraulic model of the Kolonia, Pohnpei, water system was developed. This model summarizes the geometry of the system as well as the existing operation of the system. From this model the best system operation, as well as the

pressure and flow in each pipe of the system, can be determined. Also, this model can be used as a tool for leak detection and prediction of flow and pressure towards additional pipes.

Development of a water distribution model is only the first phase of solving many problems with the Pohnpei distribution system. Future studies for improving the water distribution system are required, such as: 1) a training program for all levels at the Department of Public Works 2) a metering program, and counting the legal and illegal connections in Kolonia which determine the actual consumer usage and required water for the Pohnpei system 3) repair and maintenance of the leakage in the system 4) providing additional sources of water 5) a public education program about the water system.

Descriptors: Pohnpei/Kolonia/Water conveyance/Model studies/Computer models/Hydraulic models/Leakage/Water loss/Water supply.

Storage Location: WERI.

50. *Pohnpei Island, Surface Water Resources Study, A Planning Report for Hydropower Addition to the Nanpil River Project.*

U. S. Army Corps of Engineers. Honolulu, Hawaii. March, 1988.

9 pages.

Note: Report also contains 5 plates and 2 appendices.

Descriptors: Pohnpei/Nanpil/Hydroelectric plants/Surface water/Hydrology/Flow duration.

Storage Location: Office of Construction Management and Conservation & Resource Surveillance, Pohnpei State; WERI.

51. Dale, W. R. *Report on a Partial Survey of Some Aspects of the Freshwater Resources of Northern Nikalap Areu Island, Ant Atoll, Pohnpei State.*

South Pacific Commission. Noumea, New Caledonia. July, 1988.

18 pages.

Descriptors: Pohnpei/Ant/Groundwater/Geophysics/Electrical studies/Water supply/Water supply development/Well development/Potential water supply/Saline water intrusion/Saline-freshwater interfaces.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; WERI.

52. *Mini Hydro-Electric Power Study (5kW-300kW), Pohnpei State Government.*

KRTA Limited. Auckland, New Zealand. September, 1988.

44 pages.

Note: Lengthy appendices include:

- A. Site data sheets, catchment maps, site plans and photographs
- B. Assumptions made in economic analyses and details of cash flows
- C. Scope of work

Descriptors: Pohnpei/Nanpil/Senipehn/Nankewi/Mahnd/Pahlap/Pohnahtik/Kidar/Hydroelectric plants/Powerplants/Surface water/Feasibility studies/Financial feasibility/Economic aspects/Flow duration.

Storage Location: Office of Construction Management, Pohnpei State; WERI.

53. Anthony, Stephen S. *Ground-Water Resources of Mwoakilloa and Pingelap Atolls, Pohnpei State: Preliminary Findings.*

U. S. Geological Survey. Honolulu, Hawaii. October, 1989.

25 pages.

Abstract: This report provides the Pohnpei State government with preliminary findings on the ground-water resources of Mwoakilloa and Pingelap atolls. A hydrologic monitoring network constructed on Kahlap island, Mwoakilloa, and Pingelap island, Pingelap, defines the thickness and extent of the freshwater lens beneath each of these atoll islands. Storage of potable freshwater in these lenses is estimated to be 2.5 and 16 million gallons on Mwoakilloa and Pingelap, respectively. These small lenses can be important sources of freshwater for both drinking and sanitation purposes. The freshwater lens of Pingelap is significantly larger than that on Kahlap, because of the greater island-width and the leeward position of Pingelap on the atoll.

Hydrologic monitoring over the next year will examine: (1) the potential for water quality problems which may result from seawater intrusion and (or) ground-water contamination, and (2) the sustainable yield, which is defined as the amount of water that can be pumped from the lens on a long-term basis without producing an undesired result. Data collected from the hydrologic monitoring network will identify changes in rainfall, ground-water recharge rates, and salinity distribution. The resulting changes in the shape and size of the freshwater lens will be used to estimate sustainable yield.

Two hand pump stations were constructed on both Mwoakilloa and Pingelap atolls. These stations tap the freshwater portion of the lens and are accessible to all members of the community. The pumps produce approximately five gallons per minute and develop water from a two-inch driven well. The pumps are mounted on a concrete pad that is surrounded by a cobble drain. This design offers a significant improvement to the traditional open dug well as it keeps out surface-water contamination, insects, and wildlife.

Development alternatives, such as hand pumps, solar pumps, and windmill pumps, as well as a monitoring program

designed to help manage development of the ground-water resources will be discussed in the final report.

Descriptors: Pohnpei/Kahlap/Mwoakilloa/Pingelap/
Groundwater/Geohydrology/Groundwater availability/
Groundwater potential/Shallow wells/Saline water
intrusion/Saline-freshwater interfaces/Monitoring/Safe
yield/Wells/Water supply development/Well yield/Well
capacity/Test wells/Geophysics/Electrical studies/
Chlorides.

Storage Location: Water, Sewer & Solid Waste and
Conservation & Resource Surveillance, Pohnpei State.

54. Pobuk, Jack R. *Review of Proposed Wastewater Facilities for the F.S.M. Capital Complex and C.C.M. Campus in Palikir.*

Jack R. Pobuk. Kolonia, Pohnpei. July, 1990.

9 pages.

Note: Report also contains appendices giving cost estimates and calculations.

Descriptors: Pohnpei/Palikir/Wastewater treatment/
Wastewater facilities/Leachates/Wastewater disposal/
Environmental effects/Environmental protection.

Storage Location: FSMOPS.

55. *Plan of Action, Operations and Maintenance Improvement Program, State of Pohnpei, Federated States of Micronesia.*

Louis Berger International, Inc. and Barrett Consulting Group, Inc. December, 1990.

51 pages.

Note: This report also contains 6 annexes.

Descriptors: Pohnpei/Operating policies/Maintenance/Water conveyance/Sewer systems/Wastewater treatment/Water treatment.

Storage Location: Office of Construction Management and Planning Office, Pohnpei State; WERI.

56. Anthony, Stephen S. *Hydrogeology and Ground-Water Resources of Pingelap Island, Pingelap Atoll, Pohnpei State, Federated States of Micronesia.*

U. S. Geological Survey. Honolulu, Hawaii. 1991.

38 pages.

U. S. Geological Water Resources Investigations Report 91-XXXX (Provisional Draft).

Note: The report also contains two appendices.

Abstract: The demand for water on Pingelap, Pingelap Atoll, is increasing as a result of a desire to construct sanitary facilities such as showers, flush toilets, and laundry facilities. Water supplies on Pingelap are obtained from individual and community rainwater catchment systems and from shallow dug wells yielding fresh to brackish groundwater. During extended dry periods the demand for potable water commonly exceeds the supply. One way to alleviate the chronic water-supply shortage is to further develop ground-water resources. Study of the ground-water resources of Pingelap involved a survey of existing wells, installation of monitoring wells, a surface geophysical survey, and collection of rainfall, water level, and water-quality data.

The lens of freshwater beneath Pingelap contains about 384 million gallons of potable water. Recharge to the lens is estimated to be 230,000 gallons per day, based on an average annual rainfall of 160 inches. The long term average sustainable yield is estimated to be about 69,000 gallons per day. Shallow vertical tube wells or horizontal infiltration wells would be appropriate to develop the lens. The impact of development on the lens can be determined by monitoring the salinity with a network of monitoring wells.

The ground-water resource can be used conjunctively with individual rainwater catchment systems; rainwater can be used for drinking and cooking and ground water for sanitary uses. During extended dry periods, when

rainwater catchment systems fail, ground water would be available to meet the total demand.

Descriptors: Pohnpei/Pingelap/Groundwater/Geohydrology/
Groundwater availability/Groundwater potential/Shallow
wells/Saline water intrusion/Saline-freshwater interfaces/
Monitoring/Safe yield/Wells/Water supply development/Well
yield/Well capacity/Test wells/Geophysics/Electrical
studies/Chlorides.

Storage Location: Conservation & Resource Surveillance,
Pohnpei State.

57. Anthony, Stephen S. *Hydrogeology and Ground-Water Resources of Kahlap Island, Mwoakilloa Atoll, Pohnpei State, Federated States of Micronesia.*

U. S. Geological Survey. Honolulu, Hawaii. 1991.

39 pages.

U. S. Geological Water Resources Investigations Report 91-XXXX (Provisional Draft).

Note: The report also contains three appendices.

Abstract: The demand for water on Kahlap, Mwoakilloa Atoll, is increasing as a result of a desire to construct sanitary facilities such as showers, flush toilets, and laundry facilities. Water supplies on Kahlap are obtained from individual and community rainwater catchment systems and from shallow dug wells yielding fresh to brackish groundwater. During extended dry periods the demand for potable water commonly exceeds the supply. One way to alleviate the chronic water-supply shortage is to further develop ground-water resources. Study of the ground-water resources of Kahlap involved a survey of existing wells, installation of monitoring wells, a surface geophysical survey, and collection of rainfall, water level, and water-quality data.

The lens of freshwater beneath Kahlap contains about 21.3 million gallons of potable water. Recharge to the lens is estimated to be 125,000 gallons per day, based on an average annual rainfall of 120 inches. The long term average sustainable yield is estimated to be about 17,300 gallons per day. Shallow vertical tube wells or horizontal infiltration wells would be appropriate to develop the lens. The impact of development on the lens can be determined by monitoring the salinity with a

network of monitoring wells.

The ground-water resource can be used conjunctively with individual rainwater catchment systems; rainwater can be used for drinking and cooking and ground water for sanitary uses. During extended dry periods, when rainwater catchment systems fail, ground water would be available to meet the total demand.

Descriptors: Pohnpei/Kahlap/Groundwater/Geohydrology/
Groundwater availability/Groundwater potential/Shallow
wells/Saline water intrusion/Saline-freshwater interfaces/
Monitoring/Safe yield/Wells/Water supply development/Well
yield/Well capacity/Test wells/Geophysics/Electrical
studies/Chlorides.

Storage Location: Conservation and Resource Surveillance,
Pohnpei State.

58. Anthony, Stephen S. *Ground-Water Resources of Kahlap Island, Mwoakilloa Atoll, Pohnpei State, Federated States of Micronesia.*

U. S. Geological Survey. Honolulu, Hawaii. 1991.

65 pages.

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Abstract: The demand for water on Kahlap, Mwoakilloa Atoll, is increasing as a result of a desire to construct sanitary facilities such as showers, flush toilets, and laundry facilities. Water supplies on Kahlap are obtained from individual and community rainwater catchment systems and from shallow dug wells yielding fresh to brackish groundwater. During extended dry periods the demand for potable water commonly exceeds the supply. One way to alleviate the chronic water-supply shortage is to further develop ground-water resources. Study of the ground-water resources of Kahlap involved a survey of existing wells, installation of monitoring wells, a surface geophysical survey, and collection of rainfall, water level, and water-quality data.

The lens of freshwater beneath Kahlap contains about 21.3 million gallons of potable water. Recharge to the lens is estimated to be 125,000 gallons per day, based on an

average annual rainfall of 120 inches. The long term average sustainable yield is estimated to be about 17,200 gallons per day. Shallow vertical tube wells or horizontal infiltration wells would be appropriate to develop the lens. The impact of development on the lens can be determined by monitoring the salinity with a network of monitoring wells.

The ground-water resource can be used conjunctively with individual rainwater catchment systems; rainwater can be used for drinking and cooking and ground water for sanitary uses. During extended dry periods, when rainwater catchment systems fail, ground-water will be available to meet the demand.

Descriptors: Pohnpei/Kahlap/Groundwater/Geohydrology/Groundwater availability/Groundwater potential/Shallow wells/Saline water intrusion/Saline-freshwater interfaces/Monitoring/Safe yield/Wells/Water supply development/Well yield/Well capacity/Test wells/Geophysics/Electrical studies/Chlorides.

Storage Location: Conservation and Resource Surveillance, Pohnpei State.

59. *Second Year Review, Operations and Maintenance Improvement Program, OMIP Team's Field Report, State of Pohnpei, Federated States of Micronesia.*

Louis Berger International, Inc. and Barrett Consulting Group, Inc. June, 1991.

31 pages.

Note: This report also contains 2 annexes.

Descriptors: Pohnpei/Operating policies/Maintenance/Water conveyance/Sewer systems/Wastewater treatment/Water treatment.

Storage Location: Water, Sewer & Solid Waste and Planning, Pohnpei State; WERI; FSMOPS.

60. Anthony, Stephen S., and Steven R. Spengler. *Hydrogeologic Reconnaissance of Lenger Island, Pohnpei State, Federated States of Micronesia.*

U. S. Geological Survey. Honolulu, Hawaii. 1992.

26 pages.

U. S. Geological Water Resources Investigations Report 92-XXXX (Provisional Draft).

Abstract: Lenger is a small volcanic island located within the lagoon of Pohnpei island, Pohnpei State, Federated States of Micronesia. Ground water on Lenger moves as shallow subsurface flow through weathered bedrock slopes into low lying areas near the coast prior to discharging into the surrounding lagoon. Recharge to the island from rainfall is estimated to be 506,000 gallons per day on the basis of a mean annual rainfall of 140 inches. The basal part of Lenger is composed of a relatively impermeable post-shield building lava flow. This flow is overlain by a conglomerate of stream deposits which is in turn overlain by a relatively impermeable columnar jointed lava flow. The limited land mass and relatively impermeable lava flows that comprise the bedrock of Lenger are not favorable to the formation of well-defined drainage basins or large basal ground-water bodies.

Numerous springs and seeps discharge shallow subsurface flow at the contact between water-bearing weathered bedrock and underlying less permeable bedrock. Because the amount of water stored in these shallow subsurface ground-water bodies is small, spring and seep flow rates are directly related to rainfall. Barbosa pond, the largest water body on Lenger, contained 162,000 gallons of water on June 19, 1991. On June 20, 1991, spring flow to the pond increased from 0.6 gallons per minute during base flow conditions to 16 gallons per minute during a 0.062 ft rainfall event of 4 hours duration. The water from Barbosa pond contains iron and manganese in concentrations that may cause problems in a water supply system.

Small-scale development of ground water, such as done by the Japanese, is possible by exploiting water stored in colluvial talus deposits that flank the base of Mosher hill. The source of water in these deposits is seeps and springs that have low base flows; however, additional quantities of water can be obtained from these deposits by widening or deepening the capture area of wells used to develop these deposits. If sufficient storage facilities

are built, water from these deposits would be available during drought conditions.

Descriptors: Pohnpei/Lenger/Groundwater/Geohydrology/Groundwater availability/Groundwater potential/Shallow wells/Safe yield/Wells/Water supply development/Well yield/Well capacity/Seeps/Springs/Seepage springs/Rainfall/Evapotranspiration.

Storage Location: Conservation & Resource Surveillance, Pohnpei State.

61. Barrett Consulting Group. *Nanpil Hydropower Expansion Project Feasibility Study, Prefinal Report.*

U. S. Army Corps of Engineers. Honolulu, Hawaii. June, 1992.

45 pages.

Contract No. DACW83-91-0016.

Note: Report contains voluminous appendices, approximately 100 additional pages.

Descriptors: Pohnpei/Nanpil/Powerplants/Hydroelectric power/Surface water/Diversion/Flow duration/Environmental effects/Environmental impact statement.

Storage Location: PUC, Pohnpei State.

Yap Bibliography

1. *Task Force Report on Point and Non-Point Sources of Pollution in the Trust Territory of the Pacific Islands.*

Environmental Protection Board, Trust Territory of the Pacific Islands. Saipan, Mariana Islands.

84 pages.

Descriptors: Palau/Yap/Truk/Ponape/Chuuk/Pohnpei/Coastal Waters/Water pollution sources/Nonpoint pollution sources/Water quality.

Storage Location: Environmental Protection Agency, Yap State; WERI; FSMOPS.

2. Clayshulte, Russell N. *Limited Water Quality Survey, Ulithi Atoll, Yap State, Federated States of Micronesia.*

WERI, UOG. Mangilao, Guam.

Information Report 6, 12 pages.

Descriptors: Yap/Ulithi/Water quality/Well water/Groundwater/Conductivity/Chlorides/Hardness/Alkalinity/Hydrogen ion concentration/Shallow wells/Geohydrology.

Storage Location: Office of Planning & Budget, Yap State; WERI; FSMOPS.

3. Arnow, Ted. *The Hydrology of Ifalik Atoll, Western Caroline Islands* .

The Pacific Science Board, National Academy of Sciences,
National Research Council. Washington, D.C. August 1955.

15 pages.

Paper no. 44 in Atoll Research Bulletin.

Descriptors: Yap/Ifalik/Rainfall/Tides/Groundwater/
Observation wells/Shallow wells/Dug wells/Hydrographs/
Chlorides/Hardness/Saline-water intrusion/Coastal
aquifers/Saline-freshwater interfaces/Hydrology/
Geohydrology.

Storage Location: WERI; USGS.

4. Mink, John F. *Groundwater Development in the Trust Territory*.

The Earth Sciences Group, Inc. Washington, D.C. 1969.

71 pages.

Descriptors: Yap/Truk/Chuuk/Groundwater/Geology/
Groundwater potential/Geohydrology.

Storage Location: MARC; WERI; Tenorio.

MARC: TD 124 P3 M4

5. *Preliminary Engineering Report for Developing a Domestic Water Supply Using Streams of Island of Yap, Trust Territory of the Pacific Islands.*

Sun, Low, Tom & Hara, Inc. Honolulu, Hawaii. December, 1970.

19 pages.

Note: The report also contains approximately 15 pages of plates, charts, and appendix.

Descriptors: Yap/Water supply development/Water resources development/Dams/Damsites/Domestic water.

Storage Location: Office of Planning & Budget, Yap State; WERI; Tenorio; FSMOPS.

6. *Soils Investigation, Proposed Municipal Water and Sewerage System, Yap Island, Western Caroline Islands, Trust Territory of the Pacific Islands.*

Dames & Moore. Honolulu, Hawaii. March, 1971.

26 pages.

Note: Report also contains numerous plates and appendix.

Descriptors: Yap/Soil engineering/Soil mechanics/Soil physical properties/Soil properties/Soil strength/Soil structure/Soil types.

Storage Location: FSMOPS.

7. *Feasibility Studies for the Installation of Communal Water Facilities in the Populated Areas of Tomil, Gagil, and Kanikay.*

Sunn, Low, Tom & Hara, Inc. Honolulu, Hawaii. June, 1971.

24 pages.

Note: Contents

Introduction
 Description of Study Area
 Considerations in Planning Water Systems
 Groundwater Studies
 Water Supply Schemes
 Conclusions and Recommendations

Descriptors: Yap/Tomil/Gagil/Kanikay/Groundwater potential/Surface water/Groundwater/Surface water availability/Water supply/Potential water supply/Water conveyance.

Storage Location: FSMOPS.

8. Amesbury, Steven S., Roy T. Tsuda, Richard H. Randall, Charles E. Birkeland, and Frank A. Cushing. *Limited Current and Underwater Biological Survey of the Donitish Island Sewer Outfall Site, Yap, Western Caroline Islands.*

Marine Lab, UOG. Mangilao, Guam. April, 1976.

Technical Report 24, 49 pages.

Trust Territory Contract No. 176-40.

Descriptors: Yap/Outfall sewers/Wastewater outfall/Outfall/Water currents/Dye releases/Dye dispersion.

Storage Location: WERI; Marine Lab.

9. *Micronesia Survey, 1975-76.*

Minerals Exploration Company. La Jolla, California.
December, 1976.

30 pages.

Note: Report also containing 45 figures which are profiles of atoll lagoon geology.

Descriptors: Ponape/Truk/Yap/Chuuk/Pohnpei/Geology/
Minerals/Marine geology.

Storage Location: WERI; USGS.

10. *Trust Territory of the Pacific Islands, Yap State, Caroline Islands, Capital Improvement Program, Water and Sewer Projects, Design Analysis - 100% Submittal.*

Lyon Associates. Honolulu, Hawaii. March, 1978.

22 Pages.

Contract No. N62766-77-C-0217, Pacific Division, Naval Facilities Engineering Command.

Descriptors: Yap/Water conveyance/Water treatment facilities/Sewer systems.

Storage Location: Office of Planning & Budget, Yap State.

11. *Wastewater Facilities Plan, Yap District, Trust Territory of the Pacific Islands.*

Lyon Associates, Inc. Honolulu, Hawaii. October, 1978.

247 pages .

Contract No. N62742-76-C-0152, Department of the Navy, Naval Facilities Engineering Command.

Note: The report also contains approximately 200 pages of appendices.

Descriptors: Yap/Wastewater/Wastewater disposal/Wastewater treatment/Water transport/Wastewater facilities/Domestic wastes/Rural areas/Costs/Cost analysis/Environmental Effects/Environmental impact statement.

Storage Location: Office of Planning & Budget, Yap State; WERI; Barrett.

12. *Task Force Report on Point and Non-Point Sources of Pollution in the Outer Islands (Palau, Yap, Truk, Ponape) of the Trust Territory of the Pacific Islands.*

Environmental Protection Board, Trust Territory of the Pacific Islands. Saipan, Mariana Islands. September, 1979.

58 pages.

Descriptors: Palau/Yap/Truk/Ponape/Chuuk/Pohnpei/Coastal Waters/Water pollution sources/Nonpoint pollution sources/Water quality.

Storage Location: Environmental Protection Agency, Yap State; Environmental Protection & Sanitation, Pohnpei State; Environmental Health, Chuuk State; WERI.

13. Nance, Tom. *Yap Islands Groundwater Exploration, April to August 1979.*

Lyon Associates, Inc. Honolulu, Hawaii. October, 1979.

70 pages.

Note: Contents

Introduction
Overview of Yap's water resources
Exploratory drilling
Springs, seeps, and dug wells
Water development recommendations
Appendix

The appendix also contains 61 pages of drilling logs and pump test data.

Descriptors: Yap/Groundwater/Groundwater potential/Wells/Deep wells/Test wells/Well logs/Well capacity/Drilling/Water supply development/Well yield/Safe yield/Pumping tests/Dug wells/Seeps/Springs.

Storage Location: Public Utilities & Contracts, Yap State; WERI; FSMOPS.

14. *Conceptual Water Development Plans for the Colonia, Tomil-Gagil, and Southern Yap Areas of Yap Sate.*

Lyon Associates, Inc. Honolulu, Hawaii. April, 1980.

87 pages.

Note: The report also contains 5 appendices.

Descriptors: Yap/Water resources development/Water demand/Water treatment/Water conveyance/Pipelines.

Storage Location: Office of Planning & Budget, Yap State; WERI; Barrett.

15. *Evaluation of Yap Water Treatment Plant, Colonia, Yap State.*

Lyon Associates, Inc. Honolulu, Hawaii. October, 1981.

40 pages.

Note: The report also contains 5 appendices containing approximately 150 pages.

Descriptors: Yap/Water treatment facilities/Water treatment.

Storage Location: Office of Planning & Budget, Yap State; Barrett; FSMOPS.

16. Nance, Tom. *Yap Island Water Well Development, January to March 1982.*

Lyon Associates, Inc. Honolulu, Hawaii. March, 1982.

48 pages.

Note: Contents

Introduction
 Contractual basis of the well drilling
 Well design, drilling methods, and development techniques
 Wells in central Tomil
 Wells in the airport aquifer
 Magaf, Dalipebinau well
 Recommended pump settings
 References cited

Descriptors: Yap/Groundwater/Groundwater potential/Wells/Deep wells/Test wells/Well logs/Well capacity/Drilling/Water supply development/Well yield/Safe yield/Pumping tests.

Storage Location: Public Utilities & Contracts, Yap State; WERI.

17. *Trust Territory of the Pacific Islands, Yap State, Caroline Islands, Capital Improvement Program, Gagil Tomil Water System, Environmental Impact Assessment.*

Lyon Associates. Honolulu, Hawaii. April, 1982.

9 Pages.

Contract No. N62766-80-C-0259, Pacific Division, Naval Facilities Engineering Command.

Descriptors: Yap/Environmental Impact Statement.

Storage Location: Office of Planning & Budget, Yap State.

18. *Trust Territory of the Pacific Islands, Yap State, Capital Improvement Program, Gagil-Tomil Water System, Electrical Design Analysis, 100% Submittal.*

Lyon Associates. Honolulu, Hawaii. April, 1982.

15 Pages.

Contract No. N62766-80-C-0259, Pacific Division, Naval Facilities Engineering Command.

Descriptors: Yap/Electrical equipment/Electrical engineering.

Storage Location: Office of Planning & Budget, Yap State.

19. *Trust Territory of the Pacific Islands, Yap State, Caroline Islands, Capital Improvement Program, Gagil-Tomil Water System, Structural Design Analysis - 100% Submittal.*

Lyon Associates. Honolulu, Hawaii. April, 1982.

66 Pages.

Contract No. N62766-80-C-0259, Pacific Division, Naval

Facilities Engineering Command.

Note: This report consists of engineering calculations.

Descriptors: Yap/Water conveyance/Structural engineering.

Storage Location: Office of Planning & Budget, Yap State.

20. *Trust Territory of the Pacific Islands, Yap State, Caroline Islands, Capital Improvement Program, Gagil-Tomil Water System, Civil Design Analysis - 100% Submittal.*

Lyon Associates. Honolulu, Hawaii. April, 1982.

50 Pages.

Contract No. N62766-80-C-0259, Pacific Division, Naval Facilities Engineering Command.

Note: This report consists primarily of engineering calculations.

Descriptors: Yap/Water conveyance/Civil engineering/
Hydraulic engineering/Hydraulic design.

Storage Location: Office of Planning & Budget, Yap State;
FSMOPS.

21. *Colonia, Yap, Wastewater System, Operation and Maintenance Manual.*

June, 1982.

200 -300 pages.

Descriptors: Yap/Colonia/Wastewater treatment/Wastewater facilities/Operating policies/Maintenance.

Storage Location: FSMOPS.

22. Cowan, Peter A. *The Influence of Modern Water Supply and Wastewater Treatment Systems on Water Quality in Micronesia.*

WERI, UOG. Mangilao, Guam. August, 1982.

Technical Report 36, 87 pages.

OWRT Project No. A-020-Guam .

Abstract: The near shore environment surrounding the district centers of Koror (Palau) and Kolonia (Ponape) was evaluated with respect to selected physical and bacteriological parameters. The baseline data measured in this study will serve to quantify ambient (natural background level) conditions for the expressed purpose of: A) acting as a basis of comparison against which future data may be judged; B) identifying areas of poor water quality, areas which could improve in quality given complete implementation of a fully operational wastewater collection/treatment/disposal system. In Koror, those areas immediately east and west of T-Dock and the small bay adjoining the Community Club could experience such improvements. In Kolonia, all near shore marine areas should be positively impacted. The waters surrounding Ponape, a high island, will continue to suffer from turbidities during sustained rainfall events; areas of concern are those impacted by freshwater (stream) inputs.

Since the highest priority water quality monitoring program in the Micronesian trust territories is the continuous evaluation of the public water supply system (PWS), a concurrent study was performed on the distribution systems in these two district centers (limited data from the Colonia (Yap) system were included in the PWS evaluation). Numerous drinking water standard violations were measured in each system: Colonia - excessive turbidities and coliform densities accompanied by negligible free residual chlorine (FRC) levels at distribution points; Koror - turbidity and coliform violations; Kolonia - coliform violations. The systems in Colonia and Koror are operated on an intermittent basis and, as such, patrons should boil PWS water prior to culinary uses. The service in Kolonia is continuous; however, until improved chlorination practices at the water treatment plant (WTP) are effected, the boiling precaution should be mandatory until district center PWS

coliform densities are consistently negligible.

Descriptors: Koror/Palau/Kolonia/Ponape/Pohnpei/Colonia/
Yap/Water quality/Coastal waters/Water distribution/
Wastewater treatment/Water supply/Water supply systems.

Storage Location: WERI.

23. van der Brug, Otto. *Water Resources of the Yap Islands.*

Geological Survey. Honolulu, Hawaii. 1983.

187 pages.

U. S. Geological Survey, Water-Resources Investigations
Report 82-357.

Abstract: The Yap Islands consist of four major islands, Yap, Gagil-Tamil, Maap, and Rumung. Of these, Yap has more than half the total land area, most of the population, and almost all the economic development. The islands of Mapp and Rumung together compose only 15 percent of the land area and population.

Average annual rainfall over the Yap islands amounts to 122 inches. Rainfall-runoff comparisons indicate that about half of the annual rainfall runs off to the ocean on Yap island and Gagil-Tamil. Streams on Gagil-Tamil are perennial but streams on Yap are dry an average of 3 months per year due to geologic differences.

Analyses of water samples from 23 sources show the good quality and the chemical similarity of surface and ground water.

This report summarizes the hydrologic data collected and provides interpretations that can be used by the planning and public works officials of Yap to make decisions concerning development and management of their water resources.

Descriptors: Yap/Surface water/Water records/Streamflow/
High flow/Low flow/Flow duration/Water quality/Dissolved
solids/Rainfall-runoff relationships/Rainfall/Geology/
Geohydrology/Geologic formations/Geologic units/Geologic
mapping/Groundwater/Groundwater potential/Wells/Well
drilling/Well yield/Deep wells/Shallow wells.

Storage Location: Contracts Div. and Office of Planning & Budget, Yap State; Planning & Statistics, Kosrae State; WERI; USGS; FSMOPS.

24. Smith, Christopher W. *Soil Survey of Islands of Yap, Federated States of Micronesia.*

Soil Conservation Service, United States Department of Agriculture. March, 1983.

90 pages.

Note: Report includes 18 soil maps.

Descriptors: Yap/Soil Surveys/Soil Types/Soil Physical Properties/Soil Management/Soil Genesis.

Storage Location: Planning & Statistics, Chuuk State; FSMOPS.

25. Dillaha, Theo A., and William J. Zolan. *An Investigation of the Water Quality of Rooftop Rainwater Catchment Systems in Micronesia .*

WERI, UOG. Mangilao, Guam. November, 1983.

Technical Report 45, 39 pages.

OWRT Project No. A-029-Guam.

Abstract: This research involved an investigation of rainwater catchment system (RWCS) characteristics and water quality in Micronesia. The objectives of the research were to determine the bacteriological state of existing RWCS waters by analyses of fecal and total coliform bacteria and to try and identify those catchment characteristics and maintenance practices which affect water quality.

A total of 203 different RWCS were sampled in Kosrae, Ponape, Yap, and Palau. Seventy-one percent of the RWCS sampled had no fecal coliforms per 100ml and 37 percent

had no total coliforms per 100ml. Eighty-five and 70 percent had 5 or less fecal and total coliforms respectively per 100ml. Cleaning the catchment tank, roof, and gutters were not found to affect RWCS water quality significantly. Total coliforms counts were significantly affected by screening the tank inlet and by the type of catchment tank.

In general, screens and tank coverings improved water quality. The newer ferrocement tanks had the best quality while metal barrels had the poorest.

Catchment tanks were the largest and most popular source of water in Yap where water was less plentiful. Catchment tanks were also popular in areas with other sources of water. Even in areas with treated piped public water supplies, catchment systems appeared to be preferred for drinking purposes because of objections to chlorine taste and mistrust of public water.

Descriptors: Kosrae/Yap/Ponape/Pohnpei/Palau/Water quality/Catchment areas/Storage tanks/Water tanks.

Storage Location: WERI.

26. Stephenson, Rebecca A. *A Comparison of Freshwater Use Customs on Ulithi Atoll with those of Selected Other Micronesian Atolls.*

WERI, UOG. Mangilao, Guam. August, 1984.

Technical Report 51, 27 pages.

USGS Project No. G-837-03.

Abstract: Freshwater catchment, storage, and distribution systems, along with freshwater use customs, in particular areas of Micronesia are discussed. Special attention is paid to Ulithi Atoll in the Western Caroline Islands.

The average annual rainfall on atoll islands in Micronesia is high (over 100 inches). There are also significant groundwater resources. However, severe water shortages are often experienced, especially during the dry season. Water use customs that differ from those of Western nations often account for these difficulties.

The field work was undertaken at a time of drought

conditions on Ulithi, at the end of the dry season in June, 1983. True freshwater shortages were apparent, but Ulithians carried out a variety of coping strategies that made the impact of the drought less severe. These included a strong sense of community spirit, with the sharing of community resources as an everyday way of life. In this way, Ulithi differed from the communities of Nama and Laura studied earlier by the same research team.

In communities in developing countries, it is important to attempt to understand the human dynamics that govern the use of scarce resources. Similar studies must be conducted in several locations in order to begin to make generalizations. By gaining an understanding of water use customs, it is more probable that engineering solutions to water supply problems will be successful.

Descriptors: Yap/Ulithi/Catchment areas/Water tanks/Water storage/Storage tanks/Shallow wells/Dug wells/Rural sociology/Rural areas/Social aspects/Social values/Water use/Consumptive use/Nonconsumptive use/Water consumption.

Storage Location: WERI.

27. Hunter-Anderson, Rosalind L. *Indigenous Fresh Water Management Technology of the Yap Islands, Micronesia.*

WERI, UOG. Mangilao, Guam. June 1986.

Technical Report 63, 51 pages.

USGS Project No. 02, Grant No. 14-08-0001-G1012.

Abstract: Recent investigations in Yap, Federated States of Micronesia, undertaken to document ancient fresh water management practices and their manifestations, are reported. Project findings include an indigenous technological tradition of fresh water management designed to provide fresh water for domestic uses and to prevent erosion and minimize soil loss from agricultural plots under variable climatic conditions. The fresh water management system consisted of household catchments, remote seeps, springs and streams, taro patch wells, and a complete series of diversion canals and drainage ditches. Although the field work was focused on Map Island in northern Yap, the spatial extent of this system is co-extensive with the entire Yap island complex of ca. 30 sq. mi, encompassing both upland and lowland topography.

Customary practices involving differential status ranking regulated individual access to fresh water sources. A conservation ethic prevailed with regard to agricultural soils and fresh water. Present use structures resemble those of the prehistoric past; however, access now is less strictly regulated and the physical system has deteriorated markedly due to inadequate labor force for maintenance and repair. This lack is due to dramatic population losses after European contact early in the 19th century and subsequent colonial occupations through the second world war. Current and future demands on traditional fresh water for domestic consumption appear not to threaten traditional agricultural practices but modernization of water delivery systems is encouraging higher usage rates in households.

Descriptors: Map/Yap/Water conveyance/Irrigation canals/Irrigation practices/Erosion control/Rural areas/Farming/Drainage practices.

Storage Location: WERI.

28. Stock, Daniel A. *Operation and Maintenance Management Plan, Colonia Water System, Public Utilities and Contracts, Yap State, FSM.*

November, 1986.

39 pages.

Note: Report also contains 3 appendices.

Descriptors: Yap/Colonia/Maintenance/Water conveyance/Management planning/Training/Water storage/Water supply/Operating policies/Monitoring/Budgeting.

Storage Location: Public Utilities & Contracts and Environmental Protection Agency, Yap State; WERI.

29. *Water Well Design Memorandum, Yap State, F.S.M.*

U. S. Army, Engineer District Far East, Corps of Engineers. San Fransisco. October, 1989.

Descriptors: Yap/Groundwater/Groundwater potential/Wells/Deep wells/Test wells/Well logs/Well capacity/Drilling/Water supply development/Well yield/Safe yield/Pumping tests.

Storage Location: Contracts Div., Yap State; WERI.

30. *Plan of Action, Operations and Maintenance Improvement Program, State of Yap, Federated States of Micronesia.*

Louis Berger International, Inc. and Barrett Consulting Group, Inc. December, 1990.

56 pages.

Note: This report also contains 6 annexes.

Descriptors: Yap/Operating policies/Maintenance/Water conveyance/Sewer systems/Wastewater treatment/Water treatment.

Storage Location: Office of Planning & Budget, Yap State.

31. *Second Year Review, Operations and Maintenance Improvement Program, OMIP Team's Field Report, State of Yap, Federated States of Micronesia.*

Louis Berger International, Inc. and Barrett Consulting Group, Inc. June, 1991.

26 pages.

Descriptors: Yap/Operating policies/Maintenance/Water conveyance/Sewer systems/Wastewater treatment/Water treatment.

Storage Location: Environmental Protection Agency, Yap State; FSMOPS.

32. Shade, Patricia J., Stephen S. Anthony, and Kiyoshi J. Takasaki. *Ground-Water Resources Reconnaissance of the Yap Main Islands, Federated States of Micronesia.*

U. S. Geological Survey. Honolulu, Hawaii. 1992.

71 pages.

U. S. Geological Water Resources Investigations Report 90-4074.

Abstract: At present, water shortages occur on the four main islands of Yap every year during the dry season, and especially during extended drought periods such as in 1983. Shortages occur primarily because of inadequate storage and substantial transmission loss. The Yap government intends to eliminate these shortages by establishing centralized water systems that will supply 24-hour per day service to the populated areas, and by improving village-scale water systems in the remote areas.

The projected water demand by the population of the four main islands of Yap in the year 2,000 is 507,000 gallons per day. This demand can be met by increasing the storage and surface area of established rainwater-catchment and spring-fed village-scale systems, and by increasing

ground-water development in the volcanic formations found in the old airport area on Yap, on the southern Yap plateau, and on Gagil-Tamil island. Existing wells in the volcanic formations have yields of 25 to 50 gallons per minute. Proposed exploratory wells in these areas will better define sustainable yield, extent, and water-bearing characteristics of the principal aquifers.

Wells completed in the aquifer at the old airport had a combined yield of 77 gallons per minute in 1986. The proposed exploratory wells in the old airport area could lead to increased development from this aquifer and reduce natural losses due to drainage to surrounding gulches and evaporation from pond surfaces.

Exploratory wells sited along the southern Yap plateau, in the volcanic formation, will provide data that could facilitate better description of the geology and water-bearing characteristics of the aquifer. The proposed drill sites could tap a thicker, more productive, volcanic formation than was found during previous exploration. The new wells along the plateau could be able to supply the area population.

The Gagil-Tamil aquifer is the most promising source, with a 1986 combined well yield of 200 gallons per minute. Water balance calculations and streamflow analyses in the Eyeb and Mukong Stream basins indicate that more than 0.5 million gallons per day are recharging the ground-water reservoir in both of these basins. The proposed exploratory wells in these basins and elsewhere will develop some part of this water, and will better define the water-bearing characteristics of the volcanic formation and the coral limestone that lie beneath the volcanics in a small part of the Mukong Stream basin.

The largest water demand is in the Colonis area, the state capital. This area is underlain by schist that is impermeable, as compared with the volcanic formation, and is not a productive aquifer material. Wells drilled previously into this material had small yields, about 10 gallons per minute. The schist formation underlies most of the island of Yap and large parts of the other islands. Therefore, although it is not expected that exploratory wells drilled into this formation will produce more than about 10 gallons per minute, the hydrologic information gained from the exploration is transferrable and valuable. The Colonia water demand can be met by increasing development from the old airport and/or Gagil-Tamil aquifers. Indications are that, although the ground-water supply is limited, there is enough to meet the present demand and that projected for the year 2,000.

Descriptors: Yap/Groundwater/Geohydrology/Geology/
Groundwater availability/Groundwater potential/Deep wells/
Wells/Drilling/Monitoring/Safe yield/Wells/Water supply
development/Well yield/Well capacity/Test wells.

Storage Location: Contracts Div. and Office of Planning &
Budget, Yap State; Sanitation and Public Works, Kosrae
State; WERI; Barrett.

33. Senyange, Kayora V. *A Field Trip Report to the Outer
Islands, Yap State.*

April, 1992.

30 pages.

Project No. MIC/89/203.

Note: Objective and Methodology

The objective was to see and assess the water situation in the outer islands. By visual inspection, the major task we did was to make inventory of the water facilities they have, and to get approximate data for the water demand by interviewing the Chiefs. We could assess the physical quality of the water by smell vision, and interviewing the users. My counterpart, Mr. Godfrey Chochol helped me to take tape measurements, and he ws always the Coordinator between me and the public. The Field Trip Officer all the time introduced us to the Chiefs and the community so as to get good response during our data findings.

Descriptors: Yap/Sorol/Eauripik/Satawal/Lamotrek/Elato/
Fachalop/Ifalik/Woleai/Water demand/Rural areas/Water
supply/Wells/Shallow wells/Dug wells/Catchment areas/Water
tanks.

Storage Location: FSMOPS.

FSM Bibliography

1. *Sanitary Survey Reference Manual for Sanitarians of Micronesia.*

U. S. Environmental Protection Agency. Washington, DC.

202 pages.

EPA 570-9-87-005.

Note: This is the text that accompanied a training course for sanitarians. It includes copies of transparencies used in the training as well as textual material.

Descriptors: FSM/Sanitation/Water supply/Training/Water treatment/Water distribution/Water storage/Pumps/Monitoring/Wells/Springs/Surface water.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; WERI.

2. *Micronesian Sanitarian's Handbook.*

Environmental Protection Board, TTPI. Saipan, Mariana Islands.

98 pages.

Descriptors: FSM/TTPI/Plumbing/Bacteria/Viruses/Chemical analysis/Water treatment/Hydrology/Construction methods.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; Environmental Health, Chuuk State; WERI.

3. *Water Quality Management Plan for the Trust Territory of the Pacific Islands.*

Office of Planning and Statistics, TTPI. Saipan, Mariana Islands.

341 pages.

Descriptors: FSM/TTPI/Water quality/Pollution/Water pollution/Nonpoint pollution sources/Water supply/Water conveyance/Wastewater disposal/Wastewater treatment/Sewer systems/Planning.

Storage Location: Sanitation, Kosrae State; Environmental Protection & Sanitation, Pohnpei State; Planning & Statistics, Chuuk State; WERI; Tenorio; FSMOPS.

4. Environmental Protection Board. *House Sewer Connection Program.*

Environmental Protection Board and Bureau of Public Works, TTPI. Saipan, Mariana Islands.

42 pages.

Descriptors: FSM/TTPI/Wastewater disposal/Wastewater/Sewer systems/Domestic wastes.

Storage Location: Public Utilities & Contracts, Yap State; Sanitation, Kosrae State; Environmental Protection & Sanitation, Pohnpei State; Environmental Health and Public Works, Chuuk State; WERI.

5. van der Brug, Otto. *Water Resources data for the Trust Territory of the Pacific Islands, 1968-70 Surface-Water Records.*

U. S. Geological Survey. Honolulu, Hawaii.

92 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Gaging stations.

Storage Location: WERI; Barrett; Tenorio; FSMOPS.

6. Dale, W. R., B. C. Waterhouse, G. F. Risk, and D. R. Petty. *Coral Island Hydrology, A Training Guide for Field Practice.*

Commonwealth Science Council, Commonwealth Secretariat. London.

108 pages.

CSC Technical Publication Series No. 214, CSC(86) WMR-8.

Descriptors: FSM/Hydrology/Geohydrology/Training/Groundwater/Groundwater availability/Groundwater potential/Resistivity/Conductivity/Pumping tests/Recharge/Safe yield.

Storage Location: Environmental Protection Agency, Yap State; WERI.

7. *WERI WELL.*

WERI, UOG. Mangilao, Guam.

25 pages.

Note: This is a simplified construction manual for a dug well that utilizes solar pumping. The instructions are presented in a humorous manner making use of numerous illustrations.

Descriptors: FSM/Dug wells/Shallow wells/Construction methods/Solar energy/Pumping/Pumps.

Storage Location: Office of Planning & Budget, Yap State; WERI.

8. *Surface Water Supply of Mariana, Caroline and Samoa Islands through June 1960.*

U. S. Department of the Interior, Geological Survey.
Washington, D.C. 1962.

107 pages.

Geological Survey Water-Supply Paper 1751 .

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Gaging stations.

Storage Location: WERI; USGS.

9. 1967, *Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1968.

267 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

10. 1968, *Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1970.

296 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS.

11. Siren, Nachsa, and Donna L. Scheuring. *Murkey Waters of Micronesia, A Bacteriological Water Pollution Survey of Micronesia.*

Trust Territory of the Pacific Islands. Saipan, Mariana Islands. 1970.

50 pages (approx).

Descriptors: TTPI/FSM/Bacteria/Bacterial analysis/Feces/Coliforms/Water pollution sources/Outfall/Outfall sewers/Wastewater outfall/Coastal waters/Wastewater disposal/Domestic wastes.

Storage Location: MARC.

MARC: TD 425 S4

12. Keagy, Donald M., and Richard A. Coddington. *A Report on Environmental Health in the Trust Territory of the Pacific Islands.*

Environmental Control Administration, Environmental Health Service, Department of Health, Education and Welfare. February, 1970.

37 pages.

Descriptors: FSM/TTPI/Water supply/Sanitation/Environment/Water quality.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; WERI.

13. 1969, *Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1971.

289 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

14. *Surface Water Supply of the United States, 1960-65, Part 16, Hawaii and Other Pacific Areas.*

U. S. Department of the Interior, Geological Survey.
Washington, D.C. 1971.

710 pages.

Geological Survey Water-Supply Paper 1937.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Gaging stations.

Storage Location: FSMOPS.

15. *Trust Territory-Wide Water and Sewerage Systems.*

Design and Engineering Division, Department of Public Works, Trust Territory of the Pacific Islands. Saipan, Mariana Islands. July, 1971.

67 Pages.

Descriptors: FSM/TTPI/Water Supply/Water conveyance/Sewerage systems/Potential water supply/Water supply development.

Storage Location: Environmental Protection & Sanitation, Pobuk, and Planning Office, Pohnpei State; WERI; USGS; Barrett; Tenorio.

16. *1970, Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1972.

299 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

17. Tenorio, Pedro A. *Trust Territory-Wide Water and Sewerage Systems: Planning and Financing of Municipal Water and Sewerage Works.*

Design and Engineering Division, Department of Public Works, Trust Territory of the Pacific Islands. Saipan, Mariana Islands. August, 1972.

48 pages.

Descriptors: FSM/TTPI/Sewer systems/Water supply/Water conveyance/Planning/Financing.

Storage Location: Office of Planning & Budget, Yap State; Conservation & Resource Surveillance, Pobuk, and Planning Office, Pohnpei State; WERI; Barrett; Tenorio.

18. Floherschultz, Frederick A., and Bill F. Pearson. *A Report on Sanitation Facilities in the Trust Territory of the Pacific Islands.*

U. S. Department of Health, Education and Welfare, Public Health Service. November, 1972.

37 pages.

Descriptors: FSM/TTPI/Water conveyance/Water supply/Wastewater treatment/Sewer systems/Wastewater disposal.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; WERI.

19. 1971, *Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1973.

333 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS.

20. 1973, *Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1974.

264 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

21. 1972, *Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1974.

280 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

22. 1974, *Water Resources Data for Hawaii and other Pacific Areas, Part 1. Surface Water Records, Part 2. Water Quality Records.*

U. S. Geological Survey. Honolulu, Hawaii. 1975.

277 pages.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

23. Davis, Dan. *Notes on Water Resources in the Trust Territory of the Pacific Islands.*

Geological Survey (unpublished report). 1976.

48 pages.

Descriptors: TTPI/FSM/Water resources/Water supply/
Groundwater/Groundwater potential/Surface water/Surface
water availability.

Storage Location: WERI; USGS.

24. *Water Resources Data for Hawaii and other Pacific Areas,
Water Year 1975.*

U. S. Geological Survey. Honolulu, Hawaii. 1976.

401 pages.

U. S. Geological Survey Water-Data Report HI-75-1.

Descriptors: FSM/Hydrologic data/Hydrologic data
collections/Water quality/Stream discharge/Surface water/
Surface water records/Groundwater/Monitoring/Wells/Deep
wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

25. Irving, Louis F. *Training Manual, Waste Water Treatment
Plant Operators Course, Operations and Maintenance
Procedures, Moen, Truk - E.C.I.*

Operation and Maintenance Division, Department of Public
Works, Headquarters, Trust Territory of the Pacific
Islands. Saipan, Mariana Islands. 1976.

194 pages.

Descriptors: FSM/Wastewater facilities/Wastewater treatment/Maintenance/Training/Operating policies.

Storage Location: FSMOPS.

26. van de Graaff, J. W. E. *Report to the Congress of Micronesia on Mineral Resources.*

Center of Natural Resources, Energy, and Transport, United Nations. New York, New York. February, 1976.

16 pages.

Descriptors: FSM/TTPI/Minerals/Mineral industry.

Storage Location: Planning Office, Pohnpei State; WERI.

27. Finlanson, George. *Report to the Congress of Micronesia on Water Resources.*

ESCAP. Bangkok, Thailand. April, 1976.

60 pages.

Descriptors: FSM/TTPI/Water supply/Water supply development/Groundwater/Surface water/Surface water availability/Groundwater potential.

Storage Location: WERI.

28. *Water Resources Data for Hawaii and other Pacific Areas, Water Year 1976.*

U. S. Geological Survey. Honolulu, Hawaii. 1977.

445 pages.

U. S. Geological Survey Water-Data Report HI-76-1.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: WERI; USGS; FSMOPS.

29. *Surface Water Supply of the United States, 1966-70, Part 16, Hawaii and Other Pacific Areas.*

U. S. Department of the Interior, Geological Survey. Washington, D.C. 1977.

750 pages.

Geological Survey Water-Supply Paper 2137.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Gaging stations.

Storage Location: FSMOPS.

30. Young, Marvin W. H., Darryl E. Wong, Michael J. Chun, and Reginald H. F. Young. *Sanitary Survey of Major Municipal Water Systems, Trust Territory of the Pacific Islands.*

University of Hawaii. Honolulu, Hawaii. April, 1977.

82 pages.

Descriptors: FSM/TTPI/Water conveyance/Water supply/Sanitation/Water quality/Municipal water.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; WERI; FSMOPS.

31. *Water Resources Data for Hawaii and other Pacific Areas, Water Year 1977, Volume 2, Trust Territory of the Pacific Islands, Guam, American Samoa, and Northern Mariana Islands.*

U. S. Geological Survey. Honolulu, Hawaii. 1978.

90 pages.

U. S. Geological Survey Water-Data Report HI-77-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: Conservation & Resource Surveillance, Pohnpei State; WERI; USGS; FSMOPS.

32. Lee, Reuben, Santos Valenciano, Iwao Matsuoka, Otto van der Brug, Charles J. Huxel, Rose M. Maruoka, and Akiko K. Tanaka. *Water Resources Data for Hawaii and other Pacific Areas, Water Year 1978, Volume 2, Trust Territory of the Pacific Islands, Guam, American Samoa, and Northern Mariana Islands.*

U. S. Geological Survey. Honolulu, Hawaii. 1979.

108 pages.

U. S. Geological Survey Water-Data Report HI-78-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: Planning & Statistics, Kosrae State; WERI; USGS; FSMOPS.

33. Lee, Reuben, Santos Valenciano, Iwao Matsuoka, Johnson J. S. Yee, Otto van der Brug, David A. Bech, Charles J. Huxel, Rose M. Maruoka, and Akiko K. Tanaka. *Water Resources Data for Hawaii and other Pacific Areas, Water Year 1979, Volume 2, Trust Territory of the Pacific Islands, Guam, American Samoa, and Northern Mariana Islands.*

U. S. Geological Survey. Honolulu, Hawaii. 1980.

126 pages.

U. S. Geological Survey Water-Data Report HI-79-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: EPA, Yap State; C & RS, Pohnpei State; Planning & Statistics, Chuuk State; WERI; USGS; FSMOPS.

34. Cowan, Peter A., and Russell N. Clayshulte. *Marine Baseline Water Quality of the Trust Territory of the Pacific Islands.*

WRRG, UOG. Mangilao, Guam. March, 1980.

Technical Report 14, 98 pages.

Contract No. B910-240, TTPI Environmental Protection Board.

Descriptors: FSM/TTPI/Water quality/Coastal waters.

Storage Location: WERI.

35. Cowan, Peter A. *Future Water Quality Monitoring Priorities for the Trust Territory of the Pacific Islands.*

WRRG, UOG. Mangilao, Guam. June 1980.

Technical Report 16, 61 pages.

OWRT Project No. A-020-Guam.

Abstract: Implementation of a comprehensive water quality monitoring program is not possible at the present time in the Trust Territory of the Pacific Islands (TTPI). Due to the remoteness of these islands, any routine monitoring must be accomplished by local district sanitation officers. Formulation of monitoring strategies must satisfy objectives which are realistically attainable based on the constraints of manpower, time, and finances.

The highest priority monitoring strategy is the one that must be developed for the public water system (PWS). Total Coliform (TC), Free Residual Chlorine (FRC), and Turbidity analyses must be performed at least twice per month on water samples representative of the entire PWS in order to insure the delivery of safe drinking water to the public served by these systems. It is imperative that FRC be checked daily; any violations of standards must be

reported to the Environmental Protection Board (EPB) within 48 hours. The PWS data should be reported to the EPB once per month.

A second monitoring scheme must evaluate the marine environments surrounding the various district centers. Fecal Coliform (FC), FRC, and Turbidity should be monitored at representative sites at least twice per month. The marine water quality results should be reported to the EPB once per month.

Descriptors: FSM/TTPI/Coastal waters/Water quality/Monitoring/Water supply systems.

Storage Location: WERI.

36. *Trust Territory of the Pacific Islands, Environmental Country Report for the South Pacific Regional Environment Program, South Pacific Commission.*

Environmental Protection Board, TTPI. Saipan, Mariana Islands. June, 1980.

109 pages.

Descriptors: FSM/TTPI/Environment/Water supply/Sanitation/Wastewater disposal/Sewage disposal/Sewer systems/Water conveyance/Legislation/Environmental control/Governmental interrelations.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; WERI.

37. Lee, Reuben, Santos Valenciano, Iwao Matsuoka, Johnson J. S. Yee, Otto van der Brug, David A. Beck, Isao Yamashiro, Charles J. Huxel, Rose M. Maruoka, and Akiko K. Tanaka. *Water Resources Data for Hawaii and other Pacific Areas, Water Year 1980, Volume 2, Trust Territory of the Pacific Islands, Guam, American Samoa, and Northern Mariana Islands.*

U. S. Geological Survey. Honolulu, Hawaii. 1981.

159 pages.

U. S. Geological Survey Water-Data Report HI-80-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: Planning & Statistics, Kosrae State; Office of Planning & Budget, Yap State; WERI; USGS; Tenorio; FSMOPS.

38. Lee, R., V. Santos, S. S. Chinn, J. J. S. Yee, C. J. Huxel, O. van der Brug, D. A. Beck, I. Yamashiro, G. A. Tateishi, R. A. Maruoka, and A. K. Tanaka. *Water Resources Data, Hawaii - other Pacific Areas, Water Year 1981, Volume 2, Guam, Northern Mariana Islands, Federated States of Micronesia, Palau Islands, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1982.

148 pages.

U. S. Geological Survey Water-Data Report HI-81-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: Planning & Statistics, Kosrae State; Planning & Statistics, Chuuk State; Office of Planning & Budget, Yap State; WERI; USGS; Tenorio; FSMOPS.

39. *Ground Water in the Pacific Region.*

United Nations. New York, New York. 1983.

Department of Technical Co-operation for Development,
Natural Resources/Water Series 12, 289 pages.

Note: Sixteen pages of this report deal with the TTPI.

Descriptors: FSM/TTPI/Groundwater/Geohydrology/Climates/
Marine climates/Geology.

Storage Location: Conservation & Resource Surveillance,
Pohnpei State.

40. Chinn, Salwyn S., Grace A. Tateishi, and Johnson J. S. Yee.
*Water Resources Data, Hawaii and other Pacific Areas,
Water Year 1982, Volume 2, Guam, Northern Mariana Islands,
Federated States of Micronesia, Palau, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1983.

146 pages.

U. S. Geological Survey Water-Data Report HI-82-2.

Descriptors: FSM/Hydrologic data/Hydrologic data
collections/Water quality/Stream discharge/Surface water/
Surface water records/Groundwater/Monitoring/Wells/Deep
wells/Gaging stations.

Storage Location: Contracts Div. and Public Utilities and
Contracts, Yap State; Conservation & Resource
Surveillance, Pohnpei State; Planning & Statistics, Chuuk
State; WERI; USGS; Tenorio; FSMOPS.

41. Hogge, Ralph L. *Construction of a Water Storage Tank for Micronesia.*

Guam Community College. Mangilao, Guam. March, 1983.

41 pages.

Descriptors: FSM/Water storage/Water tanks/Storage tanks/Construction methods.

Storage Location: Environmental Protection & Sanitation, Pohnpei State; Environmental Health, Chuuk State; WERI; FSMOPS.

42. Chinn, Salwyn S., Grace A. Tateishi, and Johnson J. S. Yee. *Water Resources Data, Hawaii and other Pacific Areas, Water Year 1983, Volume 2, Guam, Northern Mariana Islands, Federated States of Micronesia, Palau, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1984.

162 pages.

U. S. Geological Survey Water-Data Report HI-83-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: Conservation & Resource Surveillance, Pohnpei State; Planning & Statistics, Chuuk State; WERI; USGS; FSMOPS.

43. Winter, Stephen J., and Larry D. McCleary. *Some Improvements in the Design of the WERI Well.*

WERI, UOG. Mangilao, Guam. September, 1984.

Technical Report 54, 29 pages.

Descriptors: FSM/Solar Energy/Shallow wells/Dug wells/Pumps/Pump wells/Pumping.

Storage Location: WERI.

44. Silverman, Gary P. *Inventory of Existing Water Systems, Trust Territory of the Pacific Islands.*

U. S. Environmental Protection Agency, Region 9. San Francisco, California. December, 1984.

51 pages.

Note: Overview

The following is a compilation of the existing written information regarding the water supply systems in the Trust Territory of the Pacific Islands (TTPI). Since 1977, there has been a good number of reports on the topic, however, they are either outdated, incomplete or limited in scope. This report hopes to pull together the bits and pieces from existing materials, keeping in mind that situations are ever changing, and arrive at a comprehensive characterization of the present water supply systems in this area.

This report has been organized by district, with a separate section for each of the 6 districts of Palau, Yap, Truk, Ponape, Kosrae, and the Marshall Islands. Figure 1 is a map of the TTPI. Within each district, the major water systems of the district and/or population centers have been described in as much detail and as currently as information will allow. There were, for example, references to projects in planning or design stages that no record of them having been completed was

found.

The outer islands and rural regions of these districts have been handled slightly differently. When reports of recent changes or programs were found, they were described within. However, for characterization of existing systems, the reader is referred to either summary tables found in the appendices of this document or to outside reference materials. One report in particular, the 1978 Sanitary Survey of Outer Island Water Systems, done for the Environmental Protection Board (TTEPB) does an excellent job of describing the outer island water systems. Although this survey is several years old, it is doubtful that conditions have changed appreciably in that time. Also many of the districts have recently conducted municipal surveys and inventories, the data from which are contained in the 1984 Quarterly Reports from each district.

Descriptors: FSM/TTPI/Water supply/Water conveyance.

Storage Location: Sanitation, Kosrae State; WERI.

45. Chinn, Salwyn S., Grace A. Tateishi, and Johnson J. S. Yee. *Water Resources Data, Hawaii and other Pacific Areas, Water Year 1984, Volume 2, Guam, Northern Mariana Islands, Federated States of Micronesia, Palau, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1985.

150 pages.

U. S. Geological Survey Water-Data Report HI-84-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: Planning and Statistics, Kosrae State; Conservation & Resource Surveillance, Pohnpei State; Planning & Statistics, Chuuk State; WERI; USGS; FSMOPS.

46. van der Brug, Otto. *The 1983 Drought in the Western Pacific.*

U. S. Geological Survey. Honolulu, Hawaii. 1986.

89 pages.

U. S. Geological Survey, Open-File Report 85-418.

Abstract: A severe drought, from late 1982 until mid-1983, on many islands in the Western Pacific Ocean is attributed to the El Nino effect, a change in oceanic circulation that is typically associated with the Eastern South Pacific Ocean. Because of the lessening trade winds, warm Western Pacific seawater flowed abnormally to the west coast of the Americas, inducing an El Nino effect that was possibly the strongest in 100 years. Of the values for total monthly rainfall recorded January through May 1983 at long-term rainfall stations in the Western Pacific, half were the lowest on record. West of longitude 155 degrees E., total rainfall for the five-month period was 28 percent of normal; east of this longitude, 13 percent of normal. In islands of the Carolines and the Marshall groups, recurrence interval of the drought is estimated at 125 years for Koror (Palau Islands), Yap Island, and Majuro (Marshall Islands); and at 250 years for Pohnpei and Kosrae. For most streams in the Caroline Islands, average monthly streamflow for January through May 1983 was the lowest of record each month. On Pohnpei, the streamflow for January through May was 4 to 7 percent of normal; on Moen (Truk Islands), 8 percent; on Kosrae for January through April, 3 to 7 percent of normal. On Moen, the average chloride concentration of ground water (the main source of water for the island) increased from 78 milligrams per liter on February 10 to 410 milligrams per liter on April 20, 1983. On Saipan, chloride concentration increased by a third, to a value of 878 milligrams per liter.

Water-conservation measures were imposed on islands affected by the drought. On Guam, conservation was voluntary; on Majuro, water was available for only one hour every third day; and on Jaluit Atoll (Marshall Islands), one gallon per person per day was allowed. Losses of staple food crops (taro, coconut, and breadfruit) were severe, especially on Pohnpei, Kosrae, and in the Marshall Islands. At least half the population of the Caroline and Marshall Islands received U. S. Department of Agriculture food supplements.

Descriptors: FSM/Surface water/Water records/Streamflow/

Groundwater/Deep wells/Chlorides/Drought/Weather/Weather patterns/Water quality/Rainfall.

Storage Location: MARC (uncataloged); WERI.

47. Mink, John F. *Trust Territory of the Pacific Islands, Water Supply Initiative, Groundwater Resources and Development.*

August, 1986.

40 pages.

Note: The main body of the report includes 5 illustrations dealing with volcanic islands and 5 illustrations dealing with atoll islands. The report also includes the following appendices:

1. Shape of the Fresh Water Lens
2. Derivation of the Ghyben-Herzberg ratio
3. Heads in a Ghyben-Herzberg System
4. Dual Lithology Lens
5. Sustainable Yield of Dug Wells, Galleries

Finally, the report also includes a detailed description of groundwater resources and development for each of the following island groups:

Marshall Islands, 13 pages
Kosrae, 16 pages
Pohnpei, 15 pages
Truk, 24 pages
Yap, 19 pages
Belau, 25 pages

Descriptors: FSM/TTPI/Groundwater/Geohydrology/Geology/Groundwater potential/Aquifers/Coastal aquifers/Saline-freshwater interfaces/Wells/Deep wells/Water quality/Groundwater pollution.

Storage Location: Planning & Statistics, Kosrae State; Environmental Health and Public Works, Chuuk State; Contracts Div., Yap State; WERI; Tenorio.

48. Winter, Stephen J. *The Development of a Ferrocement Well for use in Rural Areas of Micronesia.*

Appropriate Technology Enterprises. Chuuk, FSM.
November, 1986.

Technical Report 3, 11 pages.

Abstract: A design is presented for a well that is suitable for use in the rural areas of Micronesia. It utilizes the ferrocement construction technique and incorporates a number of desirable features, including low cost, simple construction procedures, and use of local materials. Water can be hand-dipped from the well or drawn by means of a hand or small electric pump. A number of prototype wells have been successfully installed.

Descriptors: FSM/Wells/Shallow wells/Dug wells/Rural areas/Construction methods.

Storage Location: Environmental Protection Agency, Yap State; WERI.

49. Chinn, Salwyn S., Grace A. Tateishi, and Johnson J. S. Yee. *Water Resources Data, Hawaii and other Pacific Areas, Water Year 1985, Volume 2, Guam, Northern Mariana Islands, Federated States of Micronesia, Palau, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1987.

140 pages.

U. S. Geological Survey Water-Data Report HI-85-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells/Gaging stations.

Storage Location: Contracts Div. and Office of Planning & Budget, Yap State; Public Works, Kosrae State; Conservation & Resource Surveillance, Pohnpei State;

Planning & Statistics, Chuuk State; WERI; USGS; FSMOPS.

50. Winter, Stephen J. *Construction Manual for a Ferrocement Well.*

Appropriate Technology Enterprises. Chuuk, FSM. April, 1987.

43 pages.

Descriptors: FSM/Wells/Shallow wells/Dug wells/Rural areas/Construction methods.

Storage Location: Environmental Protection Agency, Yap State; WERI.

51. Northern Islands Company. *Comprehensive Groundwater Protection Strategy for the Federated States of Micronesia.*

Trust Territory Environmental Protection Board. Saipan, Mariana Islands. July, 1987.

87 pages.

Note: The report also contains extensive appendices.

Descriptors: FSM/Groundwater/Geohydrology/Potential Water Supply/Groundwater Pollution/Groundwater Management/Well Regulations/.

Storage Location: Environmental Protection Agency, Yap State; Planning & Statistics, Kosrae State; Planning Office, Pohnpei State; WERI; FSMOPS.

52. Chinn, Salwyn S., Grace A. Tateishi, and Johnson J. S. Yee.
*Water Resources Data, Hawaii and other Pacific Areas,
Water Year 1986, Volume 2, Guam, Northern Mariana Islands,
Federated States of Micronesia, Palau, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1988.

126 pages.

U. S. Geological Survey Water-Data Report HI-86-2.

Descriptors: FSM/Hydrologic data/Hydrologic data
collections/Water quality/Stream discharge/Surface water/
Surface water records/Groundwater/Monitoring/Wells/Deep
wells/Gaging stations.

Storage Location: Public Works and Construction &
Engineering, Kosrae State; Conservation & Resource
Surveillance, Pohnpei State; Contracts Div. and Office of
Planning & Budget, Yap State; WERI; USGS; FSMOPS.

53. Chinn, Salwyn S., Grace A. Tateishi, and Johnson J. S. Yee.
*Water Resources Data, Hawaii and other Pacific Areas,
Water Year 1987, Volume 2, Guam, Northern Mariana Islands,
Federated States of Micronesia, Palau, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1988.

108 pages.

U. S. Geological Survey Water-Data Report HI-87-2.

Descriptors: FSM/Hydrologic data/Hydrologic data
collections/Water quality/Stream discharge/Surface water/
Surface water records/Groundwater/Monitoring/Wells/Deep
wells/Gaging stations.

Storage Location: Public Works, Construction &
Engineering, and Planning & Statistics, Kosrae State;
Conservation & Resource Surveillance, Pohnpei State;
Contracts Div., Yap State; WERI; USGS; FSMOPS.

54. Mosley, Barnabas. *Planning and Management of Water Resources in Small Islands (South Pacific)*

Alternate title: Water Resources Assessment & Planning in Pacific Islands.

UNDP. Suva, Fiji. March, 1989.

24 Pages.

Descriptors: FSM/Water supply/Water conveyance/Planning/Long-term planning/Short-term planning/Management planning.

Storage Location: Office of Construction Management, Pohnpei State; Planning & Statistics, Chuuk state; WERI.

55. Nakahara, R. H., J. J. S. Yee, I. Yamashiro, G. A. Tateishi, and J. A. Domingo. *Water Resources Data, Hawaii and other Pacific Areas, Water Year 1988, Volume 2, Guam, Northern Mariana Islands, Federated States of Micronesia, Palau, and American Samoa.*

U. S. Geological Survey. Honolulu, Hawaii. 1990.

136 pages.

U. S. Geological Survey Water-Data Report HI-88-2.

Descriptors: FSM/Hydrologic data/Hydrologic data collections/Water quality/Stream discharge/Surface water/Surface water records/Groundwater/Monitoring/Wells/Deep wells.

Storage Location: Planning & Statistics, Public Works and Construction & Engineering, Kosrae State; Conservation & Resource Surveillance, Pohnpei State; Public Utilities &