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mk

BASIS OF DESIGN

HAGATNA TREATMENT PLANT OUTFALL EXTENSION

TUMON BAY INFRASTRUCTURE AND BEAUTIFICATION PROJECT

Prepared for:
Guam Waterworks Authority
and
Department of Public Works

AUGUST 2001

GM
ASSOCIATES, INC.

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SECTION 1

SECTION 1

PROJECT

1.1 HAGATNA WASTEWATER TREATMENT PLANT

The plant was built on a 500-by-700-foot island in West Agana Bay. It is located at the edge of the Agana Reef Flat and forms the western boundary of a recreational boat basin.

The service area is the central district of Guam, which includes the villages of Hagatna, Agana Heights, Asan Piti, Tamuning, Mongmong-Toto-Maiti, Senajana, Chalan Pago-Ordot, Yona, Mangelao, portion of Barregada, and Tumon.

The plant is designed to provide primary treatment for an average daily flow of 12 mgd with peak hydraulic capacity at 21 mgd. Unit operations consist of primary clarification, aerobic digestion, and centrifuge dewatering. Comminution and grit removal occur in an upstream pump station.

1.2 EXISTING OUTFALL

Plant effluent is discharged 870 feet away from the reef flat at a depth of 85 feet into the Philippine Sea via a 36 inch-diameter reinforced concrete pipe running south to north offshore. Six vertical users capped with 90° elbows are installed along the last 40 feet of pipeline at

an average depth of 80 feet with three elbows orientated east and three west. An underwater video survey and inspection by E.K. Noda and Associates determined that the first three users inshore are buried while the pipeline endplate is gone. Most of the effluent flows through the end, which causes a boil to appear at the surface. The outfall has been subjected to storm damage from Typhoon Pamela in 1976, when most of the protective covering cracked and fell away from the pipeline; and from Typhoon Roy in January 1988, when the pipeline broke approximately 300 feet from the reef flat. Outfall repairs were completed by January 1989.

1.3 PROPOSED OUTFALL

Section 301(h) of the Clean Water Act allows the USEA administrator to issue National Pollution Discharge Elimination System (NPDES) permits for the discharge of less than secondary treated effluent by a publicly owned treatment works (POTW) to marine waters. The plant has received a 301(h) modified permit, and in March 1998 Guam Waterworks Authority applied for its renewal. This application included the intent to construct a new outfall with a discharge further offshore. The new pipeline would

be installed under the seafloor by horizontal directional drilling (HDD). This construction method has shown to provide superior protection from storm surge and to be more cost effective than cut and cover placement, as evidenced by outfall installed at Tipalao Point in 1996.

SECTION 2

SECTION 2

OUTFALL PERFORMANCE REQUIREMENTS

The design begins with determination of required hydraulic capacity and initial dilution.

2.1 HYDRAULIC CAPACITY

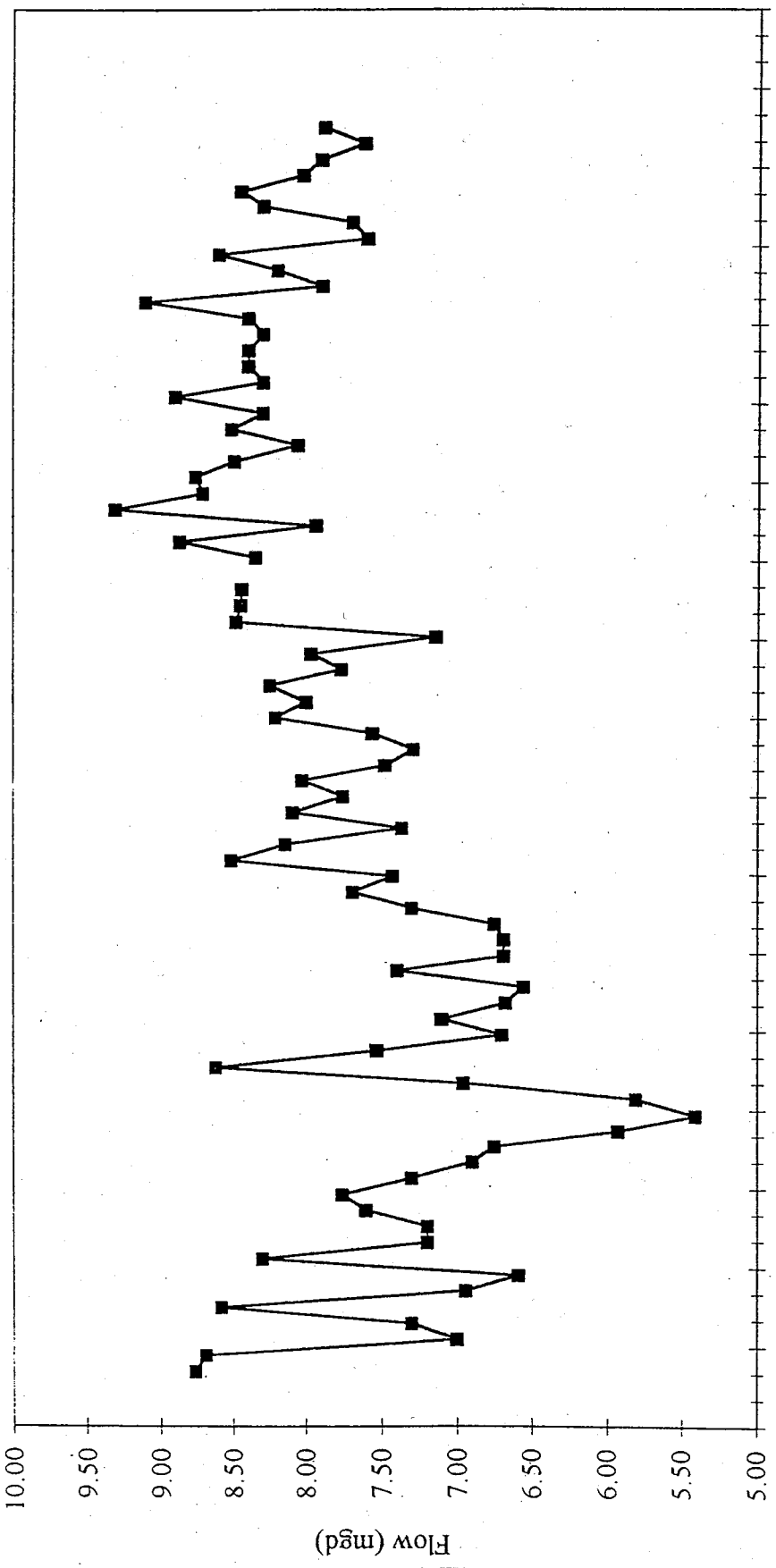
Plant flow records were analyzed from January 19892 to November 1998. The initial date was selected because the first significant diversion of sewage collected in the northern Tumon service area from the Agana to Northern District plant occurred in late 1991. This analysis examined:

1) Maximum, average, and minimum daily flows;
2) Seasonal variations in daily flows against corresponding rainfall data; and
3) Diurnal flow cycles on weekdays and weekends.

Figure 2.1 shows the average monthly flow over a six-year span while Figure 2.2 shows the maximum monthly flow. Over the term, average flow is observed to initially decrease because of the aforementioned sewer diversion, and then gradually increase with growth in the service area. Though the maximum flow varies considerably from month to month, an increasing trend with time is not observed nor was a significant correlation observed with rainfall. These observations indicate that inflow and infiltration

Agana Ave STP Cht

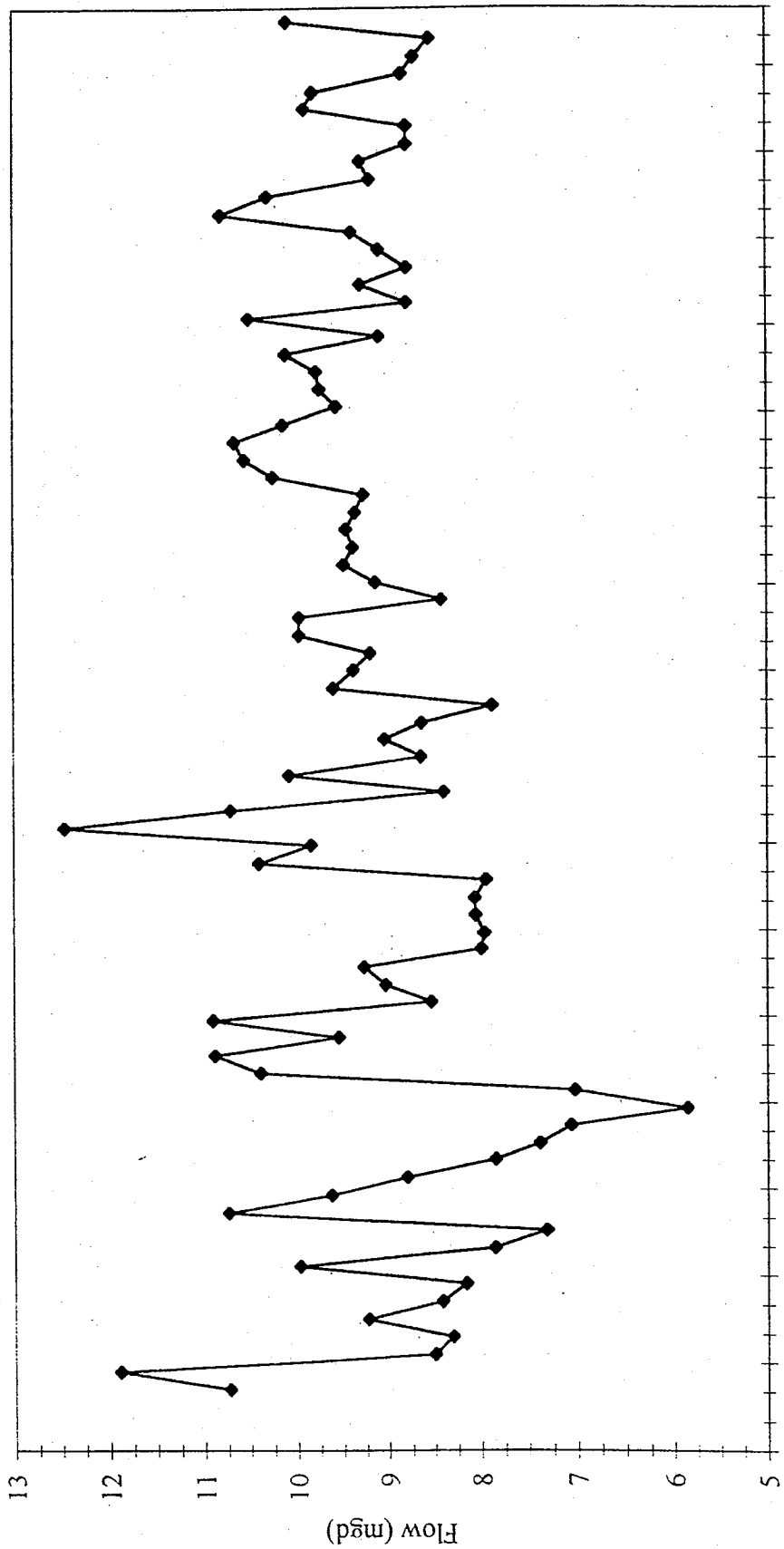
Figure 2.1
Agana Wastewater Treatment Plant Monthly Flow Over a Six Year Span



AGA 2743

Agana Max STP Cht

Figure 2.2
Agana Wastewater Treatment Plant Monthly Flow Over a Six Year Span



AGA 2744

TABLE 2.1

FLOWRATE SUMMARY FOR AGANA WWTP

Classification	Flow (mgd)	Occurrence
Annual		
Average Daily	8.27	
Maximum Daily	11.2	Sept. 1998
Minimum Daily	5.19	Dec. 1998
Peak Hour	15	08/29/97
Wet Season		
Average Daily	8.33	
Maximum Daily	11.2	Sept. 1998
Minimum Daily	5.19	Dec. 1997
Dry Season:		
Average Daily	8.22	
Maximum Daily	10.5	Feb. 1997
Minimum Daily	6.19	Jan. 1998
Projected (2014)		
Average Daily	11.6	
Peak Hour	34.1	
Design		
Average Daily	12	
Peak Hour	21	

contributions to the collection system were stable during the observation period, which included two super typhoons, Omar in August 1992 and Paka in December 1997, as well as a significant earthquake at 7.6 on the Richter Scale in August 1993.

An average peaking factor of 1.34 was observed for diurnal flow, which is quite less than the peaking factor of 2 typically associated with an average daily flow of 8 mgd.[1] This condition likely occurs because of the significant commercial activity in the service area.

Table 2.1 summarizes the daily average, maximum, and minimum flows on an annual and seasonal basis. No significant seasonal variation is observed. The average daily and peak hourly flows set in the plant design and the same flows projected for 2014 in the 1994 Guam Islandwide Wastewater Facilities Plan[2] are also presented. The peak flow of 34.1 mgd is selected for design purposes to provide an adequate factor of safety.

2.2 INITIAL DILUTION

The initial required dilution for a specific compound or indicator is a function of water quality standard for the receiving water, ambient concentration in the receiving water, and the concentration in the wastewater treatment plant effluent.

2.2.1 Water Quality Standards

The water quality standards applicable to Agana Bay are established by the Revised Guam Water Quality Standards adopted on January 2, 1992. These standards have undergone a triennial review resulting in a draft final revision. Final adoption is subject to the approval of the Guam EPA Board of Directors, Attorney General, Governor, Senate, and USEPA. Both the adopted standards and draft final revision were consulted for this analysis.

The outfall will discharge into marine waters classified as M-2, Good.

> Water in this category must be of sufficient quality to allow for the propagation and survival of marine organisms, particularly shellfish and other similarly harvested aquatic organisms, corals and other reef related resources, and whole body contact recreation. Other important and intended uses include mariculture activities, aesthetic enjoyment and related activities.[3]

The numerical criteria for those water quality standards that are likely to be impacted by sewage effluent are listed in Table 2.2.

2.2.1 Receiving Water Condition

A water quality survey was conducted on September 21 at the four corners of the mixing zone for the proposed outfall site. Water samples were taken at surface, mid-depth and bottom. The analytical results are tabulated in Appendix A, while values averaged over depth and four locations are

listed in Table 2.2. Water quality is consistent with the standards for M-2 waters.

2.2.2 Wastewater Effluent Concentrations

The plant effluent is routinely analyzed for the following constituents to comply with the monthly reporting requirements of its discharge permit:

a) Suspended Solids (SS)

b) Biochemical Oxygen Demand (BOD)

c) Settable Solids

d) Oil & Grease

e) pH

A composite effluent sample was taken on March 10, 1998 and subjected to a priority toxic pollutant scan. Six pollutants out of a possible 126 were detected and are listed in Table 2.2. Five additional chemical constituents that are not yet regulated were also detected in the parts per billion range.

Analysis of Entercocci, orthophosphate, ammonia and sulfide in the effluent were not available. Analytical data of primary effluent from several WWTP's located on Oahu, Hawaii, were substituted in Table 1.2.

2.2.4 Required Dilution

Required dilution is the volume ratio of ambient seawater plus wastewater effluent to wastewater effluent that will not allow exceedance of the water quality standard for that particular constituent. Generally, the required dilution is calculated with the expression taken from USEPA (1994)[4]:

$$Sa = (Ce-Ca) / (Cs-Ce)$$

Where Ce = effluent concentration
Cs = water quality standard
Ca = receiving water concentration
Sa = dilution

Values for the three parameters and resulting dilution are listed in Table 2.1 for the constituents found in the wastewater effluent.

The indicator bacteria "Entercocci" requires the largest dilution of 8000. However, this dilution is beyond the performance of an outfall that could be constructed at reasonable cost. The second highest required dilution is for the nutrient orthophosphate at 100 and closely followed by suspended solids at 90. The design criterion for initial dilution is selected at 100.

OP: no Sample from discharge eff.

Table 2.2

Required Dilution Calculation for Hagatna Wastewater Treatment Plant Outfall

Constituent Regulated by Guam Water Quality Standards	Unit	Water Quality Std	Ambient Conc.	Effluent Conc.	Required Dilution
Enterococci	***#/100ml***	104	0	***830000***	7,981
pH		6.5 to 8.5	8.2	7.2	10
Orthophosphate	***ug/l***	50	7	***4240***	98
Nitrate-Nitrogen	***ug/l***	200	5	29	0
Dissolved Oxygen	***mg/l***	4.6	6	0	6
Salinity	***ppt***	10%+ambient	31.74	0.8	0
Suspended Solids	***ug/l***	20000	18140	184000	89
Turbidity	***NTU***	1+ambient	0.27		
Temperature	°C	1+ambient	29.7	29.7	0
Priority Toxic Pollutants					
p-Dichlorobenzene	***ug/l***	2600	0	1.2	0
Toluene	***ug/l***	5000	0	1.2	0
Tetrachloroethylene	***ug/l***	450	0	2	0
Chloroform	***ug/l***	470	0	1.8	0
Copper	***ug/l***	3.1	0	37	12
Silver	***ug/l***	2.3	0	10	4
Zinc	***ug/l***	86	0	87	1
Additional Toxic Pollutants					
Ammonia	***ug/l***	20	0	***1045***	52
Sulfide	***ug/l***	5	0	***110***	22
Nonregulated Chemical Constituents					
Acetone	***ug/l***	-	-	120	-
4-Methylphenol	***ug/l***	-	-	50	-
2-Ethylhexyl Phthalate	***ug/l***	-	-	23	-
Benzyl Alcohol	***ug/l***	-	-	13	-
Benzoic Acid	***ug/l***	-	-	100	-

*Effluent Values in bold Itatics are estimated from analyses of primary effluent form Oahu wastewater treatment plants.
**Ammonia and orthophosphate are averaged from grab samples
*Application factor of 0.05 applied to total NH3 conc. of 20.9 mg/l.
*Sulfide conc. Is from an inplant survey at Sand Is. WWTP.
*Enterococci is from a five plant survey of primary effluent.
*Effluent suspended solids conc. is the highest value recorded from July 1997 to September 1998.
*Required Dilution for dissolved oxygen assumes 3mg/l immediate demand.

SECTION 3

SECTION 3

OUTFALL DESIGN

3.1 ALIGNMENT AND TERMINUS

The outfall terminus or discharge location is determined by three factors. First, a seafloor slope of 10% but not more than 15% is needed for constructability of the diffuser. Second, the terminus shall be beyond the near shore waster -- i.e. beyond 10 fathom depth (60 ft., 18.3 m) in West Agana Bay. Third, the depth at the diffuser shall provide the required initial dilution.

Examination of bathymetric/topographic maps for West Agana Bay shows that the seafloor bottom is steeply sloped after approximately 50-ft. depth and does not receded to less than 20% until 250 feet.

E.K. Noda & Associates used two models, UMERGE and Point Plume, to estimate initial dilutions in West Agana Bay at depths from 225 to 325 feet, effluent flowrate at 34.1 mgd, and seawater densities as measured in their November 1998 survey. The results are shown in Table 3.1. Initial dilutions vary inversely to flow, i.e. increasing with decreasing flow. Two hundred and seventy-five feet is selected as the terminus depth.

Table 3.1

INITIAL DILUTION CALCULATIONS

Discharge Depth (ft.)	UMERGE[1] Calculation	Point Plume[2] Calculation
225	86- 91	81
250	99-105	97
275	111-120	113
300	124-135	131
325	136-151	150

[1]UMERGE model used the actual density profiles measured in the November 1998 survey.

[2]Point Plume model used the average density of the aforementioned profiles.

The alignment selected for the new outfall is 7.5° NNE from the Hagatna wastewater treatment plan and approximately 407 feet east of the existing outfall. This alignment removes construction away from existing operations and provides an adequate staging area for the contractor.

3.2 DIFFUSER DESIGN

A single point diffuser is selected because this configuration provides the required dilution at depth while minimizing the construction cost. The terminal depth is twice the limit OSHA allows diving with air and will require decompression with mixed gases significantly increasing underwater construction cost. The diffuser will be designed for pre-assembly on the surface with minimum construction underwater. The effectiveness of multiple ports, i.e. four

to eight on a single riser, to enhance dilution will be studied. However, a practical limit exists as the separate buoyant plumes widen and combine while travelling to the surface.

SECTION 4

SECTION 4

CONSTRUCTION METHODOLOGY

4.1 OUTFALL PIPELINE

The selected construction method is horizontal directional drilling (HDD). The selection is based upon:

1) The pipeline length and diameter are within the capability of this method, i.e. up to 6000 feet and 48-inch pipe diameter.
2) The method minimizes underwater construction.
3) The method has proven successful in similar consolidated limestone strata found at Tipalao Point.
4) The method is compatible with the severe seafloor bathymetry in West Agana Bay. Conversely, pipeline installation by cut and cover would be difficult and may require additional anchoring.
5) The method provides adequate cover and protection from storm surge.
6) The method has proven to be more economical than the cut and cover method.
7) The method causes less impact to the marine environment during construction.

Construction begins with drilling a 12-inch diameter pilot hole from the Hagatna treatment plant. This hole should exit within a 30-foot square of the proposed location at the 275-foot depth. The cutting head is directed by manipulating its orientation relative to the drill string. Cutting head location is monitored continuously by measuring the magnetic field to determine latitude and longitude and inclination to determine depth.

Upon exiting, the cutting head and drill string are retrieved by a barge onstation. The pilot hole is then reamed to seceding larger diameters until suitably sized for the pipeline. This operation is accomplished by replacing the cutting head with a reamer and pulling the reamer and additional drill string back to the treatment plant.

After the hole is sufficiently enlarged, the pipeline is pulled through it. The pipeline is prefabricated at the sewage treatment plant and pulled through the hole by the drill string to the barge onstation. In all three operations, large quantities of bentonite slurry are used to maintain hole integrity, remove cuttings, and drive the cutting head motors.

The pipeline profile is determined by the entry angle, radius of curvature, and exit angle. Initially, a shallow 15° entry angle has been selected to clear the embankment at the treatment plant and to provide adequate cover at the reef flat. The entrance angle can be increased

up to 20° to minimize travel through sand and sandy silt. The radius of curvature is 4200 feet to accommodate a 42-inch diameter pipe. A shallow exit angle of 6° at the exit is used to clear the seafloor.

4.2 PIPELINE SIZE AND MATERIAL

High-density polyethylene (HDPE) is selected because:

1) It is impervious to seawater environment,
2) Strength and flexibility properties are suited to construction method, and
3) It is cost competitive to epoxy-coated steel pipe.

A 42-inch diameter pipe with an SDR=17 (standard ratio of pipe diameter to wall thickness) is selected to accommodate the peak hourly flow of 34.1 mgd.

4.3 DIFFUSER

To date, the diffuser has been modeled as a single point discharge. The use of multiple ports on a single user to improve initial dilution will be further enhanced. Dr. Koh, a consultant to E.K. Noda and Associates, has researched and published work in this area.[5] Whatever the final configuration, the diffuser will be designed as an

integral unit, pre-assembled on the surface, and lowered into place. Underwater work will be to connect to the outfall pipe. This assembly will have sufficient mass to resist current forces by gravity.

REFERENCES

REFERENCES

1. Tchobanoglous, G., *Wastewater Engineering, Collection & Pumping of Wastewater,* McGraw-Hill, Fig. 3.4 (1981).

2. Duenas & Associates & CH2MHill, *Guam Island Wastewater Facilities Plan, Vol. I,* Public Utility Agency of Guam (Dec. 1994).

3. Guam Water Quality Standards (Final Draft Revision) (Dec. 1999).

4. Office and Coastal Protection Division (4504F), Office of Wetlands, Oceans and Watersheds, *Amended Section 301(h) Technical Document,* EPA 842-B-94-007 (Sept. 1994).

5. Isaacson, I.S., Koh, R.C.Y., Brooks, N.H., "Plume Dilution for Diffusers with Multiport Risers," *Journal of Hydraulic Engineering,* Vol. 109 (Feb. 1983).

APPENDIX A

WATER QUALITY SURVEY

WEST AGANA BAY

APPENDIX A

WATER QUALITY SURVEY

A-1 Purpose

The water quality survey conducted on September 20, 2000 provided a baseline condition prior to construction and set the ambient conditions for the required dilution calculations.

A-2 Procedure

Video inspection and record of the bottom community structure was conducted simultaneously with the water sampling. A panoramic view was recorded at the center of the mixing zone, i.e outfall discharge, and along 25m transects at the four cornors. Generally, the camera and light assembly was held 24 to 15 inches off the seafloor. Vessel was navigated by GPS.

At each outfall corner, water samples were taken at the surface, med depth and near the bottom with a vertical polycarbonate sampler. The temperature, pH and dissolved oxygen were measured onboard with portable instruments. Remaining water sample was poured into the appropriate sampling bottles, kept at 4°C and shipped to

Pace Analytical Services, Inc., Long Beach, California for analysis.

A-3 Results

The analytical results are listed in table A.1 along with the coordinates, date, time, and depth of sampling. All values are lower than the water quality standards except one exceedance by a fecal coliform sample taken at the surface and at the closet position to the existing outfall. See figure A.1 for sampling locations.

The suspended solids data reported by the laboratory was approximately two orders of magnitude too large and contradicted both turbidity measurements and visual observations. Since this discrepancy could not be resolved with the laboratory, the area will be resampled.

The priority pollutant scan report on a composite sample of treatment plant effluent is also enclosed a reference to the types and methods of analyses.

Figure A.1

WATER QUALITY DATA FOR THE PROPOSED HAGATNA OUTFALL

LOCATION	DESCRIPTION OF SITE & WATER QUALITY PARAMETERS												
HAGATNA:	GPS Coordinates	Date	Time of day	Depth ft	Turbidity NTU	Fecal Col. MPN	Temp. F	pH	D.O.	Salinity mg/L	P mg/L	Nitrate-N mg/L	O & G mg/L
HA-1	N: 13 29.271	21-Sep-00	11:10 AM	3	0.37	<10	30.2	8.15	6.02	32,000	ND	0.11	ND
HA-2	E: 144 44.862	21-Sep-00	11:00 AM	150	0.19	41	29.7	8.15	5.53	31,000	ND	0.059	ND
HA-3		21-Sep-00	11:00 AM	287	0.6	<10	29.6	8.18	6.27	32,000	ND	ND	ND
HB-1	N: 13 29.270	21-Sep-00	12:50 PM	3	0.24	<10	29.9	8.13	5.96	31,000	ND	ND	ND
HB-2	E: 144 44.966	21-Sep-00	12:40 PM	140	0.22	<10	29.6	8.18	6.07	32,000	ND	0.065	ND
HB-3		21-Sep-00	12:07 PM	280	0.21	10.1	29.4	8.15	6.01	32,000	ND	0.059	ND
HC-1	N: 13 29.169	21-Sep-00	1:52 PM	3	0.24	<10	29.8	8.18	6.36	31,000	ND	ND	ND
HC-2	E: 144 45.000	21-Sep-00	1:45 PM	80	0.19	85	29.7	8.15	5.94	31,000	ND	ND	ND
HC-3		21-Sep-00	1:30 PM	160	0.31	10	29.6	8.13	5.65	32,000	ND	ND	ND
HD-1	N: 13 29.186	21-Sep-00	2:43 PM	3	0.32	19,862	29.9	8.16	6.03	31,000	ND	ND	ND
HD-2	E: 144 44.864	21-Sep-00	12:35 PM	90	0.16	<10	29.7	8.12	6.45	31,000	ND	ND	ND
HD-3		21-Sep-00	2:30 PM	170	0.22	63	29.6	8.14	5.92	31,000	ND	ND	ND

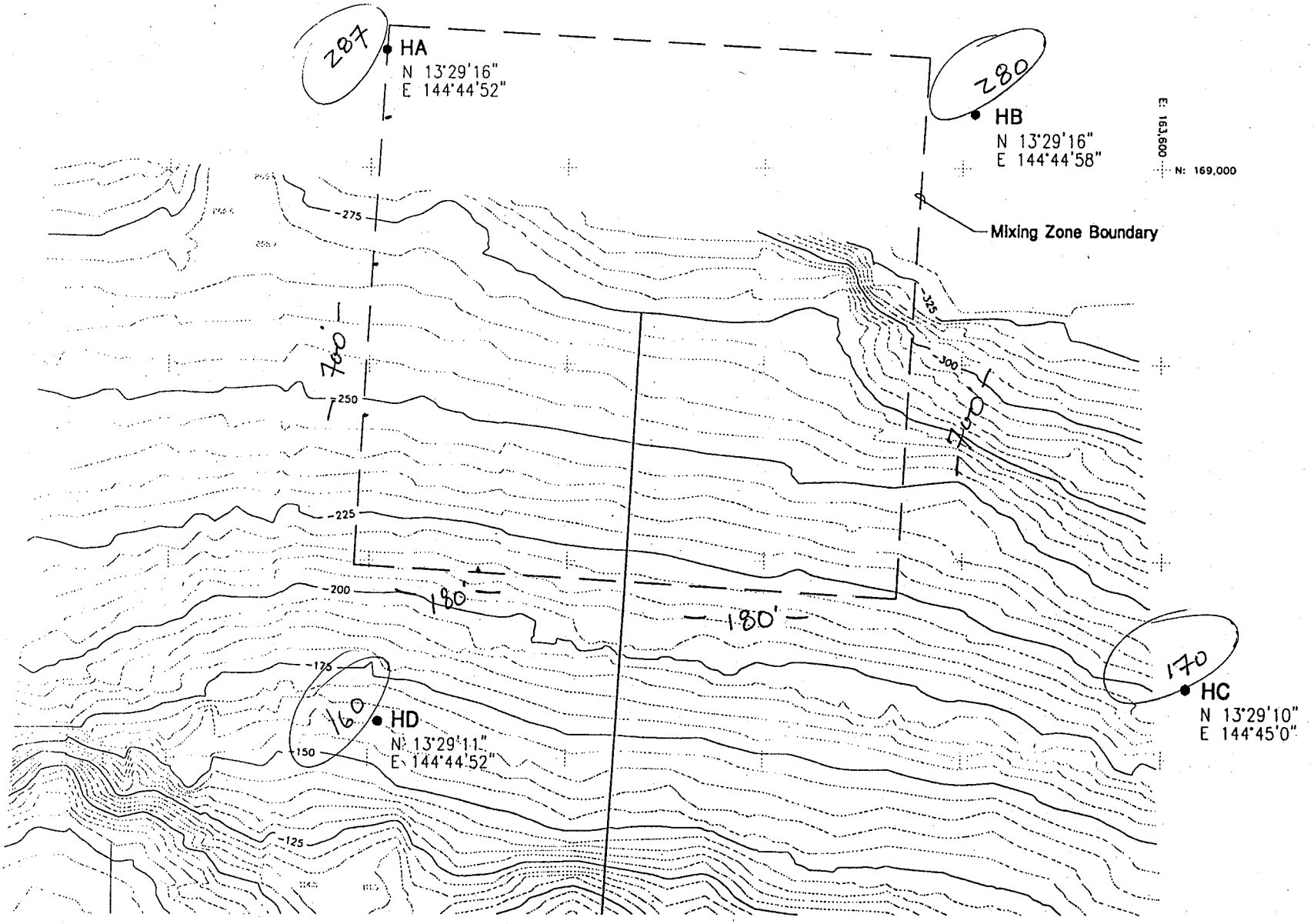


Figure A-1 WATER QUALITY SURVEY SAMPLING LOCATIONS

GRAPHIC SCALE:
100' 0 100' 200'

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 568 LABS (1 800 568 5227)

Laboratory
Report
#41239

Guam Water Authority
Carmen Sian-Denton
Government of Guam
P.O.Box 3010
Agana, GUAM , USA 96910

Samples Received
11-mar-1998 10:44:10

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
OMP12 AGANA STP (980311001) Sampled on 03/10/98								
03/13/98	03/16/98	74594	(S3113B/E200.9)	Arsenic, Total, GF	ND	mg/l	0.005	1
	03/11/98		(ML/EPA 100.1)	Asbestos by TEM	<1.9	MFL	1.9	1
03/19/98	03/20/98	74822	(E335.2/E335.3)	Cyanide by manual distillation	ND	mg/l	0.005	1
03/13/98	03/13/98	74456	(EPA/ML 245.1)	Mercury	ND	ug/l	0.20	1
03/13/98	03/16/98	74596	(S3113B/200.9)	Lead, Total, GF	ND	mg/l	0.002	1
03/13/98	03/18/98	74598	(S3113B/E200.9)	Selenium, Total, GF	ND	mg/l	0.005	1
03/23/98	03/25/98	75332	(SUBCONTRACTED)	2,3,7,8-TCDD	ND	ng/l	7.3	1
03/13/98	03/16/98	74597	(ML/EPA 279.2)	Thallium, Total, GF	ND	mg/l	0.005	1
				BNA Extractable				
03/12/98	03/16/98	74668	(ML/EPA 625)	1,2,4-Trichlorobenzene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	1,2-Diphenylhydrazine	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4,5-Trichlorophenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4,6-Trichlorophenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dichlorophenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dimethylphenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dinitrophenol	ND	ug/l	100	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dinitrotoluene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2,6-Dinitrotoluene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Chloronaphthalene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Chlorophenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Methylnaphthalene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Methylphenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Nitroaniline	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Nitrophenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	3,3'-Dichlorobenzidine	ND	ug/l	100	2
03/12/98	03/16/98	74668	(ML/EPA 625)	3-Nitroaniline	ND	ug/l	40	2
03/12/98	03/16/98	74668	(ML/EPA 625)	4,6-Dinitro-o-cresol	ND	ug/l	100	2

MONTGOMERY WATSON LABORATORIES

555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory Report #41239

Guam Water Authority
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Bromophenylphenylether	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Chloroaniline	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Chlorophenylphenylether	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Methylphenol	50	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Nitroaniline	ND	ug/l	40	2
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Nitrophenol	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Acenaphthene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Acenaphthylene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Aniline	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Anthracene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(a)anthracene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(a)pyrene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(b)fluoranthene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(g,h,i)perylene	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(k)fluoranthene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	bis(2-Chloroethyl)ether	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	bis(2-Chloroethoxy)methane	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	bis(2-Chloroisopropyl)ether	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Di(2-Ethylhexyl)phthalate	23(B)	ug/l	8.0	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Butylbenzylphthalate	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzidine	ND	ug/l	100	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzoic Acid	100	ug/l	100	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzyl Alcohol	13	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Chrysene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Dibenzo(a,h)anthracene	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Dibenzofuran	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Diethylphthalate	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Dimethylphthalate	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Di-n-butylphthalate	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Di-n-octylphthalate	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Fluoranthene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Fluorene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachlorobenzene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachlorobutadiene	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachlorocyclopentadiene	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachloroethane	ND	ug/l	10	2

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Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
03/12/98	03/16/98	74668	(ML/EPA 625)	Indeno(1,2,3-c,d)pyrene	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Isophorone	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Naphthalene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Nitrobenzene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	N-Nitrosodimethylamine	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	N-Nitrosodi-N-propylamine	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	N-Nitrosodiphenylamine	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	p-Chloro-m-cresol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Pentachlorophenol	ND	ug/l	20	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Phenanthrene	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Phenol	ND	ug/l	10	2
03/12/98	03/16/98	74668	(ML/EPA 625)	Pyrene	ND	ug/l	10	2
			(Surrogate)	2,4,6-Tribromophenol	89	% Rec		
			(Surrogate)	2-Fluorobiphenyl	86	% Rec		
			(Surrogate)	2-Fluorophenol	77	% Rec		
			(Surrogate)	Nitrobenzene-d5	89	% Rec		
			(Surrogate)	Phenol-d5	148	% Rec		
			(Surrogate)	Terphenyl-d14	34	% Rec		
			Pesticides/PCBs					
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1016 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1221 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1232 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1242 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1248 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1254 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1260 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Alpha-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Aldrin	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Beta-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Chlordane	ND	ug/l	2.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Delta-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	p,p' DDD	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	p,p' DDE	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	p,p' DDT	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Dieldrin	ND	ug/l	0.20	10

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Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
03/14/98	03/24/98	74999	(ML/EPA 608)	Endrin Aldehyde	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endrin	ND	ug/l	0.10	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endosulfan I (alpha)	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endosulfan II (beta)	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endosulfan sulfate	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Gamma-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Heptachlor	ND	ug/l	0.10	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Heptachlor Epoxide	ND	ug/l	0.10	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Methoxychlor	ND	ug/l	2.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Toxaphene	ND	ug/l	5.0	10
			(Surrogate)	Dibutyl Chlorendate	40	% Rec		
Priority Pollutant Metals - IC								
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Silver, Total, ICAP	0.01	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Beryllium, Total, ICAP	ND	mg/l	0.0010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Cadmium, Total, ICAP	ND	mg/l	0.005	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Chromium, Total, ICAP	ND	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Copper, Total, ICAP	0.037	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Nickel, Total, ICAP	ND	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Antimony, Total, ICAP	ND	mg/l	0.050	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Zinc, Total, ICAP	0.087	mg/l	0.020	1
Volatile Organics HSL								
	03/17/98	74720	(ML/EPA 624)	1,1,2-Trichloroethane (1,1,2-T	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	1,1-Dichloroethylene (1,1DCE)	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	1,1-Dichloroethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	1,2-Dichloroethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	1,2-Dichloropropane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	p-Dichlorobenzene (1,4-DCB)	1.2	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	2-Butanone (MEK)	ND	ug/l	10	1
	03/17/98	74720	(ML/EPA 624)	2-Hexanone	ND	ug/l	10	1
	03/17/98	74720	(ML/EPA 624)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	10	1
	03/17/98	74720	(ML/EPA 624)	Acetone	120	ug/l	10	1
	03/17/98	74720	(ML/EPA 624)	Acrolein	ND	ug/l	200	1

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Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
	03/17/98	74720	(ML/EPA 624)	Acrylonitrile	ND	ug/l	50	1
	03/17/98	74720	(ML/EPA 624)	Benzene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	cis-1,2-Dichloroethene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Chlorobenzene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Bromoform	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Chloroform (Trichloromethane)	1.8	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Chloroethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Carbon disulfide	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Carbon Tetrachloride	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Dibromochloromethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Dichlorobromomethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Ethyl benzene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Methyl Bromide	ND	ug/l	1.0	1
	03/17/98	74720	(ML/EPA 624)	Methyl Chloride	ND	ug/l	1.0	1
	03/17/98	74720	(ML/EPA 624)	Methylene Chloride	ND	ug/l	3.0	1
	03/17/98	74720	(ML/EPA 624)	m,p-Xylenes	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	o-Xylene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Tetrachloroethylene (PCE)	2.0	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Styrene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	trans-1,2-Dichloroethene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Trichlorofluoromethane	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Tetrahydrofuran	ND	ug/l	10	1
	03/17/98	74720	(ML/EPA 624)	Toluene	1.2	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Vinyl Chloride (VC)	ND	ug/l	0.50	1
	03/17/98	74720	(ML/EPA 624)	Vinyl Acetate	ND	ug/l	10	1
			(Surrogate)	1,2-Dichloroethane-d4	117	% Rec		
			(Surrogate)	4-Bromofluorobenzene	93	% Rec		
			(Surrogate)	Toluene-d8	99	% Rec		

APPENDIX B

OCEAN DENSITY, DISSOLVED OXYGEN, AND CURRENT SURVEYS

APPENDIX B

OCEAN DENSITY, DISSOLVED OXYGEN AND CURRENT SURVEYS

B-1 DENSITY PROFILE

Density profiles are calculated from the salinity-temperature-depth (S-T-D) data collected during the November 6-13, 1998 field survey and compared to profiles estimated from historical data. The field data indicates that the water column is uniform in density to the 70 m. depth (maximum extent of profiling), which is usual in Pacific waters where the upper mixed layer is usually 100 m. deep. The historical density data indicates a lower near surface density profile.

B-2 DISSOLVED OXYGEN PROFILE

Profile ranges from 95 to 105% saturation, which is in conformity with historical data showing near 100% saturation.

B.3 CURRENT

The predominant current directions during the field survey were east (12% occurrence) and west (16%) occurrence. Current speed varied from 0 to 0.8 fps with an average value of .2 fps.

Water temperature measured concurrently proved to be uniform at 84.7°F.

AGA WWTP DIFFUSER SITE DENSITY DATA

MONTH	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
1	0	1.02140	28.8	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX
1	3	1.02150	28.5	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX
1	0	1.02137	28.9	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX1
1	3	1.02150	28.5	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX1
1	6	1.02154	28.4	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX1
1	0	1.02137	28.9	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX2
1	3	1.02150	28.5	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX2
1	6	1.02154	28.4	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX2
1	0	1.02154	28.4	34.0	7	86	Gov. of Guam, Water Quality Data	AGMX
1	10	1.02154	28.4	34.0	7	86	Gov. of Guam, Water Quality Data	AGMX
1	20	1.02191	28.4	34.5	7	86	Gov. of Guam, Water Quality Data	AGMX
2	0	1.02215	26.5	34.0	4	82	Gov. of Guam, Water Quality Data	AGMX
2	3	1.02290	26.5	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX
2	6	1.02296	26.3	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX
2	0	1.02218	26.4	34.0	4	82	Gov. of Guam, Water Quality Data	AGMX1
2	3	1.02293	26.4	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX1
2	6	1.02293	26.4	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX1
2	0	1.02293	26.4	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX2
2	3	1.02293	26.4	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX2
2	6	1.02221	26.3	34.0	4	82	Gov. of Guam, Water Quality Data	AGMX2
2	0	1.02290	26.5	35.0	1	83	Gov. of Guam, Water Quality Data	AGMX
2	3	1.02290	26.5	35.0	1	83	Gov. of Guam, Water Quality Data	AGMX
2	6	1.02290	26.5	35.0	1	83	Gov. of Guam, Water Quality Data	AGMX
3	0	1.02183	27.5	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX
3	3	1.02023	27.8	32.0	5	81	Gov. of Guam, Water Quality Data	AGMX
3	6	1.02020	27.9	32.0	5	81	Gov. of Guam, Water Quality Data	AGMX
3	0	1.02180	27.6	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX2
3	3	1.02186	27.4	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX2
3	6	1.02196	27.1	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX2
3	0	1.02167	28.0	34.0	4	82	Gov. of Guam, Water Quality Data	AGMX
3	3	1.02248	27.8	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX
3	6	1.02173	27.8	34.0	4	82	Gov. of Guam, Water Quality Data	AGMX
3	0	1.02235	28.2	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX1
3	3	1.02258	27.5	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX1
3	6	1.02258	27.5	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX1
3	0	1.02242	28.0	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX2
3	3	1.02245	27.9	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX2
3	6	1.02252	27.7	35.0	4	82	Gov. of Guam, Water Quality Data	AGMX2
3	0	1.02274	27.0	35.0	1	83	Gov. of Guam, Water Quality Data	AGMX
3	3	1.02281	26.8	35.0	1	83	Gov. of Guam, Water Quality Data	AGMX
3	6	1.02281	26.8	35.0	1	83	Gov. of Guam, Water Quality Data	AGMX
4	0	1.02180	27.6	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX
4	3	1.02258	27.5	35.0	8	81	Gov. of Guam, Water Quality Data	AGMX
4	6	1.02258	27.5	35.0	8	81	Gov. of Guam, Water Quality Data	AGMX
4	0	1.02183	27.5	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX1
4	3	1.02183	27.5	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX1
4	6	1.02274	27.0	35.0	8	81	Gov. of Guam, Water Quality Data	AGMX1
4	0	1.02177	27.7	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX2

MONTH	DEPTH (meters)	DENSITY gm/cm^3	TEMP C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
4	3	1.02258	27.5	35.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
4	6	1.02274	27.0	35.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
4	0	1.02242	28.0	35.0	13	82	Gov. of Guam, Water Quality Data	AGMX
4	3	1.02248	27.8	35.0	13	82	Gov. of Guam, Water Quality Data	AGMX
4	6	1.02258	27.5	35.0	13	82	Gov. of Guam, Water Quality Data	AGMX
4	0	1.02170	27.9	34.0	13	82	Gov. of Guam, Water Quality Data	AGMX1
4	3	1.02255	27.6	35.0	13	82	Gov. of Guam, Water Quality Data	AGMX1
4	6	1.02255	27.6	35.0	13	82	Gov. of Guam, Water Quality Data	AGMX1
4	0	1.02248	27.8	35.0	13	82	Gov. of Guam, Water Quality Data	AGMX2
4	3	1.02255	27.6	35.0	13	82	Gov. of Guam, Water Quality Data	AGMX2
4	6	1.02180	27.6	34.0	13	82	Gov. of Guam, Water Quality Data	AGMX2
4	0	1.02281	26.8	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX1
4	3	1.02281	26.8	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX1
4	6	1.02281	26.8	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX1
4	0	1.02281	26.8	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX2
4	3	1.02281	26.8	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX2
4	6	1.02281	26.8	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX2
4	0	1.02258	27.5	35.0	4	85	Gov. of Guam, Water Quality Data	AGMX
4	10	1.02258	27.5	35.0	4	85	Gov. of Guam, Water Quality Data	AGMX
4	20	1.02258	27.5	35.0	4	85	Gov. of Guam, Water Quality Data	AGMX
4	0	1.02185	28.6	34.5	3	86	Gov. of Guam, Water Quality Data	AGMX
4	10	1.02171	29.0	34.5	3	86	Gov. of Guam, Water Quality Data	AGMX
4	20	1.02171	29.0	34.5	3	86	Gov. of Guam, Water Quality Data	AGMX
4	0	1.02175	28.9	34.5	3	86	Gov. of Guam, Water Quality Data	AGMX1
4	10	1.02175	28.9	34.5	3	86	Gov. of Guam, Water Quality Data	AGMX1
4	20	1.02175	28.9	34.5	3	86	Gov. of Guam, Water Quality Data	AGMX1
4	0	1.02212	28.9	35.0	3	86	Gov. of Guam, Water Quality Data	AGMX2
4	10	1.02212	28.9	35.0	3	86	Gov. of Guam, Water Quality Data	AGMX2
4	20	1.02212	28.9	35.0	3	86	Gov. of Guam, Water Quality Data	AGMX2
4	0	1.02173	27.8	34.0	9	87	Gov. of Guam, Water Quality Data	AGMX
4	10	1.02167	28.0	34.0	9	87	Gov. of Guam, Water Quality Data	AGMX
4	20	1.02167	28.0	34.0	9	87	Gov. of Guam, Water Quality Data	AGMX
4	0	1.02000	28.5	32.0	6	89	Gov. of Guam, Water Quality Data	AGMX
4	10	1.02225	28.5	35.0	6	89	Gov. of Guam, Water Quality Data	AGMX
4	20	1.02225	28.5	35.0	6	89	Gov. of Guam, Water Quality Data	AGMX
4	0	1.02225	28.5	35.0	6	89	Gov. of Guam, Water Quality Data	AGMX1
4	10	1.02225	28.5	35.0	6	89	Gov. of Guam, Water Quality Data	AGMX1
4	20	1.02225	28.5	35.0	6	89	Gov. of Guam, Water Quality Data	AGMX1
4	0	1.02155	27.2	33.5	25	89	Matson, A.E. (1990)	E
4	5	1.02151	27.1	33.4	25	89	Matson, A.E. (1990)	E
4	10	1.02136	27.1	33.2	25	89	Matson, A.E. (1990)	E
4	0	1.02169	27.0	33.6	25	89	Matson, A.E. (1990)	F
4	5	1.02161	27.0	33.5	25	89	Matson, A.E. (1990)	F
4	10	1.02157	26.9	33.4	25	89	Matson, A.E. (1990)	F
4	0	1.02183	27.5	34.0	5	90	Gov. of Guam, Water Quality Data	AGMX
4	10	1.02183	27.5	34.0	5	90	Gov. of Guam, Water Quality Data	AGMX
4	20	1.02183	27.5	34.0	5	90	Gov. of Guam, Water Quality Data	AGMX
5	0	1.02160	28.2	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX
5	3	1.02167	28.0	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX
5	6	1.02167	28.0	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX

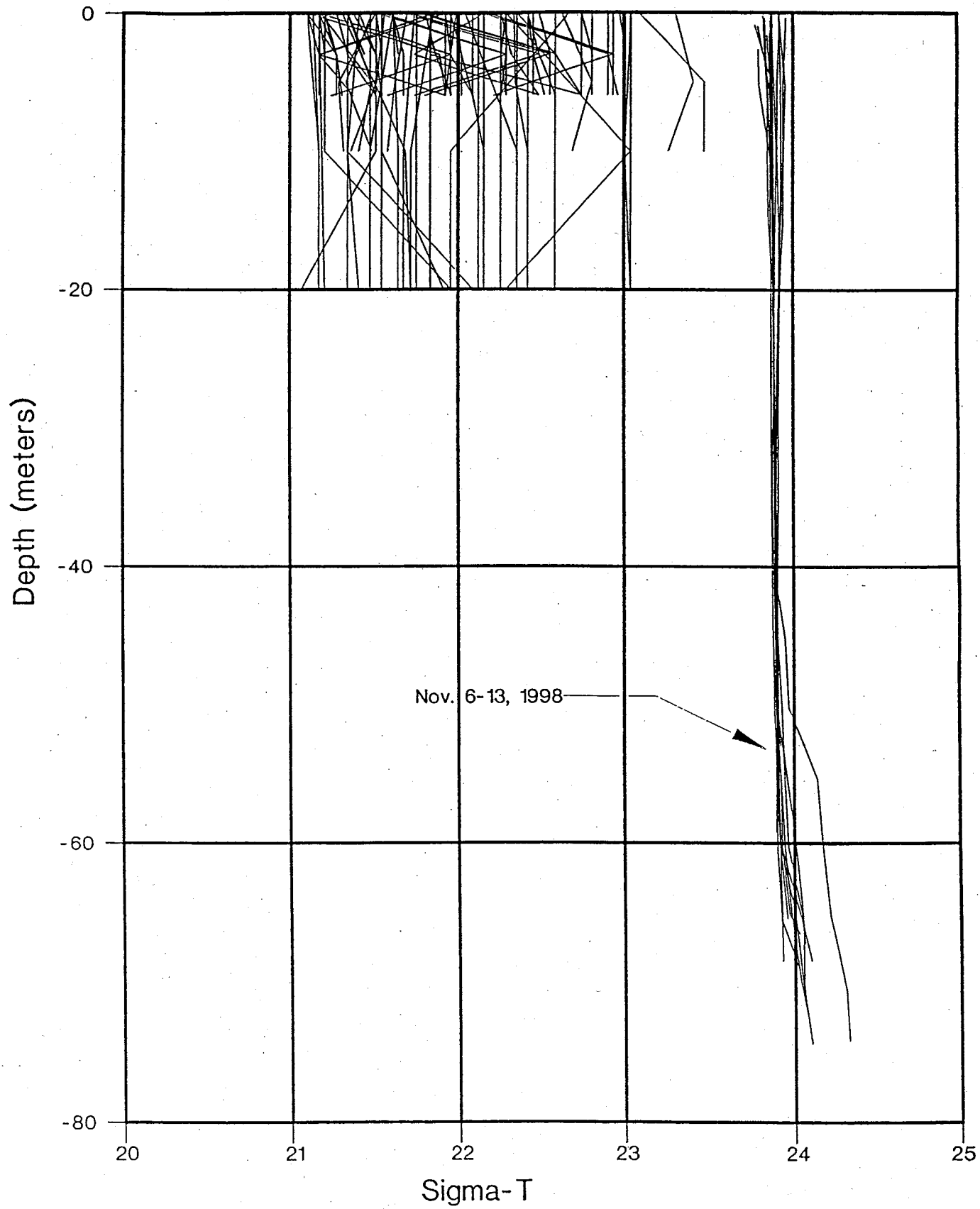
MONTH	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
5	0	1.02160	28.2	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX1
5	3	1.02164	28.1	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX1
5	0	1.02225	28.5	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX
5	3	1.02232	28.3	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX
5	6	1.02248	27.8	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX
5	0	1.02274	27.0	35.0	5	83	Gov. of Guam, Water Quality Data	AGMX
5	3	1.02274	27.0	35.0	5	83	Gov. of Guam, Water Quality Data	AGMX
5	6	1.02274	27.0	35.0	5	83	Gov. of Guam, Water Quality Data	AGMX
5	0	1.02242	28.0	35.0	9	85	Gov. of Guam, Water Quality Data	AGMX
5	10	1.02242	28.0	35.0	9	85	Gov. of Guam, Water Quality Data	AGMX
5	20	1.02242	28.0	35.0	9	85	Gov. of Guam, Water Quality Data	AGMX
5	0	1.02204	28.0	34.5	1	86	Gov. of Guam, Water Quality Data	AGMX
5	10	1.02235	28.2	35.0	1	86	Gov. of Guam, Water Quality Data	AGMX
5	20	1.02235	28.2	35.0	1	86	Gov. of Guam, Water Quality Data	AGMX
5	0	1.02229	28.4	35.0	4	89	Gov. of Guam, Water Quality Data	AGMX
5	10	1.02304	28.4	36.0	4	89	Gov. of Guam, Water Quality Data	AGMX
5	20	1.02229	28.4	35.0	4	89	Gov. of Guam, Water Quality Data	AGMX
5	0	1.02304	28.4	36.0	4	89	Gov. of Guam, Water Quality Data	AGMX1
5	10	1.02301	28.5	36.0	4	89	Gov. of Guam, Water Quality Data	AGMX1
5	20	1.02304	28.4	36.0	4	89	Gov. of Guam, Water Quality Data	AGMX1
5	0	1.02304	28.4	36.0	4	89	Gov. of Guam, Water Quality Data	AGMX2
5	10	1.02304	28.4	36.0	4	89	Gov. of Guam, Water Quality Data	AGMX2
5	20	1.02304	28.4	36.0	4	89	Gov. of Guam, Water Quality Data	AGMX2
5	0	1.02160	28.2	34.0	3	90	Gov. of Guam, Water Quality Data	AGMX
5	10	1.02164	28.1	34.0	3	90	Gov. of Guam, Water Quality Data	AGMX
5	20	1.02164	28.1	34.0	3	90	Gov. of Guam, Water Quality Data	AGMX
5	0	1.02154	28.4	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX
5	10	1.02154	28.4	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX
5	20	1.02154	28.4	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX
5	0	1.02160	28.2	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX1
5	10	1.02147	28.6	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX1
5	0	1.02140	28.8	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX2
5	10	1.02134	29.0	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX2
5	20	1.02140	28.8	34.0	21	97	Gov. of Guam, Water Drogue Study	AGMX2
6	0	1.02154	28.4	34.0	4	81	Gov. of Guam, Water Quality Data	AGMX
6	3	1.02229	28.4	35.0	4	81	Gov. of Guam, Water Quality Data	AGMX
6	6	1.02225	28.5	35.0	4	81	Gov. of Guam, Water Quality Data	AGMX
6	0	1.02150	28.5	34.0	4	81	Gov. of Guam, Water Quality Data	AGMX1
6	3	1.02154	28.4	34.0	4	81	Gov. of Guam, Water Quality Data	AGMX1
6	6	1.02154	28.4	34.0	4	81	Gov. of Guam, Water Quality Data	AGMX1
6	0	1.02150	28.5	34.0	4	81	Gov. of Guam, Water Quality Data	AGMX2
6	3	1.02229	28.4	35.0	4	81	Gov. of Guam, Water Quality Data	AGMX2
6	6	1.02157	28.3	34.0	4	81	Gov. of Guam, Water Quality Data	AGMX2
6	0	1.02242	28.0	35.0	8	82	Gov. of Guam, Water Quality Data	AGMX
6	3	1.02242	28.0	35.0	8	82	Gov. of Guam, Water Quality Data	AGMX
6	6	1.02242	28.0	35.0	8	82	Gov. of Guam, Water Quality Data	AGMX
6	0	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX
6	3	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX
6	6	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX
6	0	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX1

MONTH	DEPTH (meters)	DENSITY gm/cm^3	TP C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
6	3	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX1
6	6	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX1
6	0	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX2
6	3	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX2
6	6	1.02245	27.9	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX2
6	0	1.02267	29.5	36.0	12	86	Gov. of Guam, Water Quality Data	AGMX
6	10	1.02195	29.4	35.0	12	86	Gov. of Guam, Water Quality Data	AGMX
6	20	1.02195	29.4	35.0	12	86	Gov. of Guam, Water Quality Data	AGMX
6	0	1.02235	28.2	35.0	4	87	Gov. of Guam, Water Quality Data	AGMX
6	10	1.02235	28.2	35.0	4	87	Gov. of Guam, Water Quality Data	AGMX
6	20	1.02235	28.2	35.0	4	87	Gov. of Guam, Water Quality Data	AGMX
6	0	1.02330	27.6	36.0	13	89	Matson, A.E. (1990)	E
6	5	1.02341	27.5	36.1	13	89	Matson, A.E. (1990)	E
6	10	1.02326	27.5	35.9	13	89	Matson, A.E. (1990)	E
6	0	1.02309	27.8	35.8	13	89	Matson, A.E. (1990)	F
6	5	1.02347	27.3	36.1	13	89	Matson, A.E. (1990)	F
6	10	1.02347	27.3	36.1	13	89	Matson, A.E. (1990)	F
7	0	1.02185	29.7	35.0	9	81	Gov. of Guam, Water Quality Data	AGMX
7	3	1.02117	29.5	34.0	9	81	Gov. of Guam, Water Quality Data	AGMX
7	6	1.02192	29.5	35.0	9	81	Gov. of Guam, Water Quality Data	AGMX
7	0	1.02192	29.5	35.0	9	81	Gov. of Guam, Water Quality Data	AGMX1
7	3	1.02117	29.5	34.0	9	81	Gov. of Guam, Water Quality Data	AGMX1
7	0	1.02110	29.7	34.0	9	81	Gov. of Guam, Water Quality Data	AGMX2
7	3	1.02189	29.6	35.0	9	81	Gov. of Guam, Water Quality Data	AGMX2
7	6	1.02192	29.5	35.0	9	81	Gov. of Guam, Water Quality Data	AGMX2
7	0	1.02229	28.4	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX
7	3	1.02229	28.4	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX
7	6	1.02229	28.4	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX
7	0	1.02229	28.4	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX1
7	3	1.02225	28.5	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX1
7	6	1.02229	28.4	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX1
7	0	1.02229	28.4	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX2
7	3	1.02225	28.5	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX2
7	6	1.02229	28.4	35.0	6	82	Gov. of Guam, Water Quality Data	AGMX2
7	0	1.02225	28.5	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX
7	3	1.02225	28.5	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX
7	6	1.02225	28.5	35.0	7	83	Gov. of Guam, Water Quality Data	AGMX
8	0	1.02117	29.5	34.0	6	81	Gov. of Guam, Water Quality Data	AGMX
8	3	1.02120	29.4	34.0	6	81	Gov. of Guam, Water Quality Data	AGMX
8	6	1.02120	29.4	34.0	6	81	Gov. of Guam, Water Quality Data	AGMX
8	0	1.02117	29.5	34.0	6	81	Gov. of Guam, Water Quality Data	AGMX1
8	3	1.02120	29.4	34.0	6	81	Gov. of Guam, Water Quality Data	AGMX1
8	0	1.02117	29.5	34.0	6	81	Gov. of Guam, Water Quality Data	AGMX2
8	3	1.02195	29.4	35.0	6	81	Gov. of Guam, Water Quality Data	AGMX2
8	6	1.02124	29.3	34.0	6	81	Gov. of Guam, Water Quality Data	AGMX2
8	0	1.02297	28.6	36.0	5	82	Gov. of Guam, Water Quality Data	AGMX
8	3	1.02301	28.5	36.0	5	82	Gov. of Guam, Water Quality Data	AGMX
8	6	1.02301	28.5	36.0	5	82	Gov. of Guam, Water Quality Data	AGMX
8	0	1.02199	29.3	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX
8	3	1.02195	29.4	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX

MONTH	DEPTH (meters)	DENSITY gm/cm^3	TMP (C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
8	6	1.02209	29.0	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX
8	0	1.02199	29.3	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX1
8	3	1.02202	29.2	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX1
8	6	1.02209	29.0	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX1
8	0	1.02195	29.4	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX2
8	3	1.02202	29.2	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX2
8	6	1.02202	29.2	35.0	2	83	Gov. of Guam, Water Quality Data	AGMX2
8	0	1.02192	29.5	35.0	7	84	Gov. of Guam, Water Quality Data	AGMX
8	3	1.02195	29.4	35.0	7	84	Gov. of Guam, Water Quality Data	AGMX
8	6	1.02195	29.4	35.0	7	84	Gov. of Guam, Water Quality Data	AGMX
8	0	1.02130	29.1	34.0	5	86	Gov. of Guam, Water Quality Data	AGMX
8	10	1.02168	29.1	34.5	5	86	Gov. of Guam, Water Quality Data	AGMX
8	20	1.02171	29.0	34.5	5	86	Gov. of Guam, Water Quality Data	AGMX
8	10	1.02209	29.0	35.0	4	87	Gov. of Guam, Water Quality Data	AGMX
8	20	1.02134	29.0	34.0	4	87	Gov. of Guam, Water Quality Data	AGMX
8	10	1.02209	29.0	35.0	4	87	Gov. of Guam, Water Quality Data	AGMX1
8	20	1.02182	29.8	35.0	4	87	Gov. of Guam, Water Quality Data	AGMX1
8	0	1.02134	29.0	34.0	4	87	Gov. of Guam, Water Quality Data	AGMX2
8	10	1.02134	29.0	34.0	4	87	Gov. of Guam, Water Quality Data	AGMX2
8	20	1.02209	29.0	35.0	4	87	Gov. of Guam, Water Quality Data	AGMX2
8	0	1.01954	29.9	32.0	31	98	Gov. of Guam, Water Drogue Study	AGMX
8	10	1.01961	29.7	32.0	31	98	Gov. of Guam, Water Drogue Study	AGMX
8	20	1.02114	29.6	34.0	31	98	Gov. of Guam, Water Drogue Study	AGMX
8	0	1.01957	29.8	32.0	31	98	Gov. of Guam, Water Drogue Study	AGMX1
8	10	1.02107	29.8	34.0	31	98	Gov. of Guam, Water Drogue Study	AGMX1
8	0	1.01855	30.6	31.0	31	98	Gov. of Guam, Water Drogue Study	AGMX2
8	5	1.01944	30.2	32.0	31	98	Gov. of Guam, Water Drogue Study	AGMX2
8	10	1.01957	29.8	32.0	31	98	Gov. of Guam, Water Drogue Study	AGMX2
9	0	1.02117	29.5	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX
9	3	1.02127	29.2	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX
9	6	1.02130	29.1	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX
9	0	1.02120	29.4	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX1
9	2	1.02124	29.3	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX1
9	3	1.02127	29.2	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX1
9	0	1.02120	29.4	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
9	3	1.02127	29.2	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
9	6	1.02130	29.1	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
9	0	1.02225	28.5	35.0	9	82	Gov. of Guam, Water Quality Data	AGMX
9	3	1.02225	28.5	35.0	9	82	Gov. of Guam, Water Quality Data	AGMX
9	6	1.02225	28.5	35.0	9	82	Gov. of Guam, Water Quality Data	AGMX
9	0	1.02192	29.5	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX
9	3	1.02192	29.5	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX
9	6	1.02192	29.5	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX
9	0	1.02192	29.5	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX1
9	3	1.02192	29.5	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX1
9	6	1.02192	29.5	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX1
9	0	1.02195	29.4	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX2
9	3	1.02195	29.4	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX2
9	6	1.02192	29.5	35.0	6	83	Gov. of Guam, Water Quality Data	AGMX2

MONTH	DEPTH (meters)	DENSITY gm/cm^3	TEMP C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
9	0	1.02114	29.6	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX
9	10	1.02117	29.5	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX
9	20	1.02117	29.5	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX
9	0	1.02117	29.5	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX1
9	20	1.02120	29.4	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX1
9	0	1.02110	29.7	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX2
9	10	1.02117	29.5	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX2
9	20	1.02117	29.5	34.0	5	85	Gov. of Guam, Water Quality Data	AGMX2
9	0	1.02234	29.6	35.6	21	89	Matson, A.E. (1990)	E
9	5	1.02234	29.8	35.7	21	89	Matson, A.E. (1990)	E
9	10	1.02242	29.8	35.8	21	89	Matson, A.E. (1990)	E
9	0	1.02262	29.2	35.8	21	89	Matson, A.E. (1990)	F
9	5	1.02281	29.1	36.0	21	89	Matson, A.E. (1990)	F
9	10	1.02269	29.0	35.8	21	89	Matson, A.E. (1990)	F
10	0	1.02110	29.7	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX
10	3	1.02127	29.2	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX
10	6	1.02127	29.2	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX
10	0	1.02110	29.7	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
10	3	1.02117	29.5	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
10	6	1.02117	29.5	34.0	8	81	Gov. of Guam, Water Quality Data	AGMX2
10	3	1.02117	29.5	34.0	9	81	Gov. of Guam, Water Quality Data	AGMX1
10	6	1.02117	29.5	34.0	9	81	Gov. of Guam, Water Quality Data	AGMX1
10	0	1.02229	28.4	35.0	26	82	Gov. of Guam, Water Quality Data	AGMX
10	3	1.02229	28.4	35.0	26	82	Gov. of Guam, Water Quality Data	AGMX
10	6	1.02229	28.4	35.0	26	82	Gov. of Guam, Water Quality Data	AGMX
10	0	1.02225	28.5	35.0	7	86	Gov. of Guam, Water Quality Data	AGMX
10	10	1.02225	28.5	35.0	7	86	Gov. of Guam, Water Quality Data	AGMX
10	20	1.02225	28.5	35.0	7	86	Gov. of Guam, Water Quality Data	AGMX
10	0	1.02120	29.4	34.0	6	87	Gov. of Guam, Water Quality Data	AGMX
10	10	1.02120	29.4	34.0	6	87	Gov. of Guam, Water Quality Data	AGMX
10	20	1.02195	29.4	35.0	6	87	Gov. of Guam, Water Quality Data	AGMX
11	0	1.02134	29.0	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX
11	6	1.02150	28.5	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX
11	0	1.02134	29.0	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX1
11	3	1.02144	28.7	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX1
11	0	1.02127	29.2	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX2
11	3	1.02134	29.0	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX2
11	6	1.02150	28.5	34.0	5	81	Gov. of Guam, Water Quality Data	AGMX2
11	0	1.02215	28.8	35.0	10	86	Gov. of Guam, Water Quality Data	AGMX
11	10	1.02215	28.8	35.0	10	86	Gov. of Guam, Water Quality Data	AGMX
11	20	1.02215	28.8	35.0	10	86	Gov. of Guam, Water Quality Data	AGMX
11	0	1.02134	29.0	34.0	9	89	Gov. of Guam, Water Quality Data	AGMX
11	10	1.02134	29.0	34.0	9	89	Gov. of Guam, Water Quality Data	AGMX
11	20	1.02134	29.0	34.0	9	89	Gov. of Guam, Water Quality Data	AGMX
12	0	1.02117	29.5	34.0	3	81	Gov. of Guam, Water Quality Data	AGMX
12	3	1.02117	29.5	34.0	3	81	Gov. of Guam, Water Quality Data	AGMX
12	6	1.02137	28.9	34.0	3	81	Gov. of Guam, Water Quality Data	AGMX
12	0	1.02215	28.8	35.0	7	82	Gov. of Guam, Water Quality Data	AGMX
12	3	1.02173	27.8	34.0	7	82	Gov. of Guam, Water Quality Data	AGMX
12	6	1.02248	27.8	35.0	7	82	Gov. of Guam, Water Quality Data	AGMX

MONTH	DEPTH (meters)	DENSITY gm/cm^3	TEMP C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
12	0	1.02209	29.0	35.0	5	83	Gov. of Guam, Water Quality Data	AGMX
12	3	1.02209	29.0	35.0	5	83	Gov. of Guam, Water Quality Data	AGMX
12	6	1.02209	29.0	35.0	5	83	Gov. of Guam, Water Quality Data	AGMX
12	10	1.02215	28.8	35.0	3	87	Gov. of Guam, Water Quality Data	AGMX
12	20	1.02215	28.8	35.0	3	87	Gov. of Guam, Water Quality Data	AGMX
12	0	1.02150	28.5	34.0	7	89	Gov. of Guam, Water Quality Data	AGMX
12	10	1.02150	28.5	34.0	7	89	Gov. of Guam, Water Quality Data	AGMX
12	20	1.02107	29.8	34.0	7	89	Gov. of Guam, Water Quality Data	AGMX
12	0	1.02147	28.6	34.0	7	89	Gov. of Guam, Water Quality Data	AGMX1
12	20	1.02147	28.6	34.0	7	89	Gov. of Guam, Water Quality Data	AGMX1
12	0	1.02118	31.0	34.7	12	89	Matson, A.E. (1990)	D
12	5	1.02148	31.0	35.1	12	89	Matson, A.E. (1990)	D
12	10	1.02140	31.0	35.0	12	89	Matson, A.E. (1990)	D
12	0	1.02148	31.0	35.1	12	89	Matson, A.E. (1990)	E
12	5	1.02133	31.0	34.9	12	89	Matson, A.E. (1990)	E
12	10	1.02148	31.0	35.1	12	89	Matson, A.E. (1990)	E
12	0	1.02150	30.5	34.9	12	89	Matson, A.E. (1990)	F
12	5	1.02128	30.7	34.7	12	89	Matson, A.E. (1990)	F
12	10	1.02131	30.4	34.6	12	89	Matson, A.E. (1990)	F



AGA 2782

Edward K. Noda and Associates, Inc.	AGANA SEWAGE TREATMENT PLANT OUTFALL EXTENSION	Agana STP Historic Sigma-T Profiles	FIGURE

AGANA WW. DENSITY PROFILE DATA OBTAINED DURING NOV. 6-13, 1998 BY EDWARD K. NODA AND ASSOCIATES, INC. (Lat. and Long. in WGS 83)

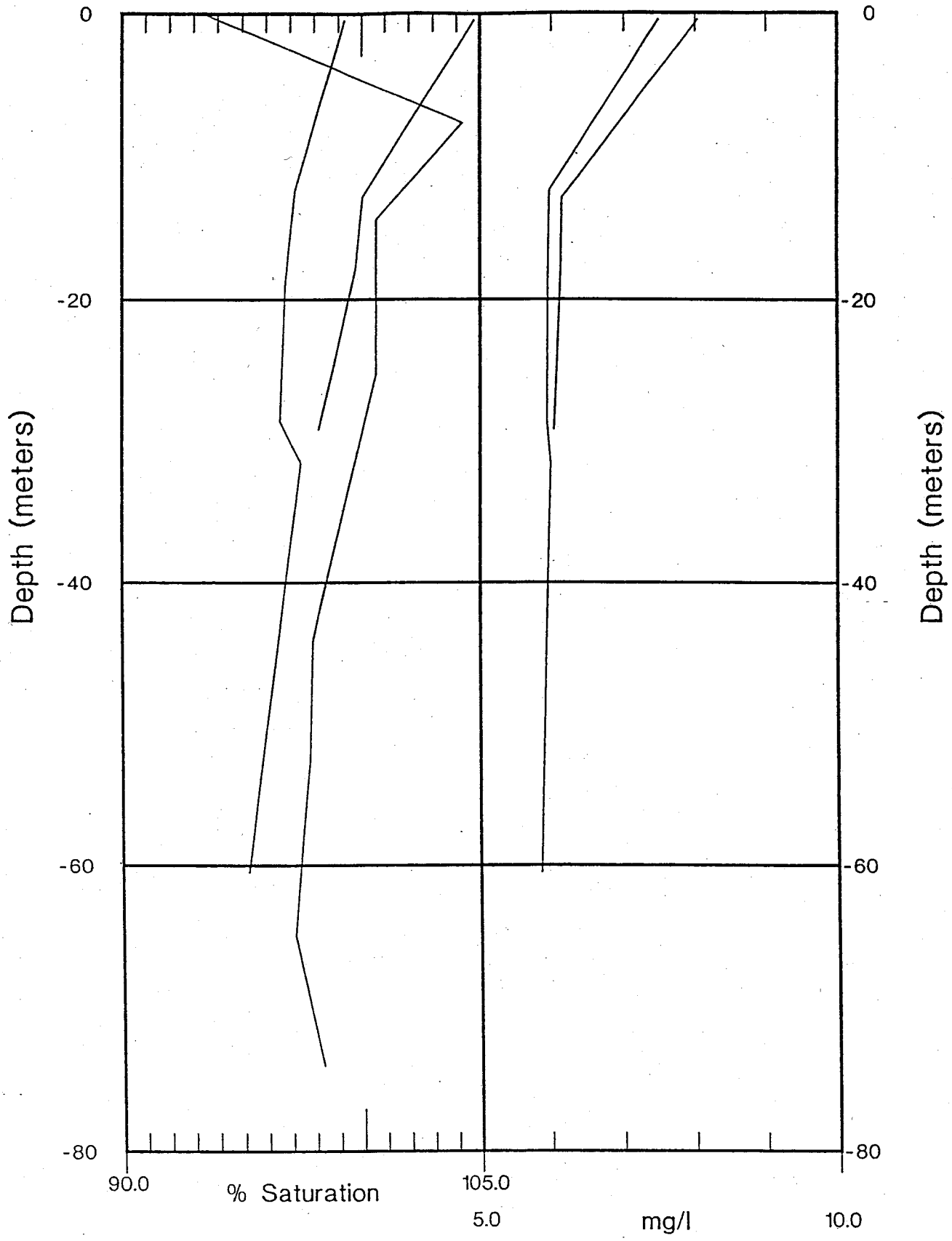
MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	Lat.	Long.
11	6	98	0.07	1.02392	29.34	37.62	13 29 15.10N	144 44 40.14E
11	6	98	5.04	1.02391	29.19	37.53	13 29 15.10N	144 44 40.14E
11	6	98	10.42	1.02391	29.15	37.52	13 29 15.10N	144 44 40.14E
11	6	98	15.30	1.02392	29.14	37.53	13 29 15.10N	144 44 40.14E
11	6	98	20.44	1.02391	29.13	37.52	13 29 15.10N	144 44 40.14E
11	6	98	25.22	1.02391	29.13	37.51	13 29 15.10N	144 44 40.14E
11	6	98	30.20	1.02390	29.12	37.49	13 29 15.10N	144 44 40.14E
11	6	98	35.19	1.02390	29.11	37.48	13 29 15.10N	144 44 40.14E
11	6	98	40.37	1.02389	29.10	37.47	13 29 15.10N	144 44 40.14E
11	6	98	45.23	1.02395	28.83	37.43	13 29 15.10N	144 44 40.14E
11	6	98	50.22	1.02397	28.59	37.35	13 29 15.10N	144 44 40.14E
11	6	98	55.31	1.02414	28.35	37.47	13 29 15.10N	144 44 40.14E
11	6	98	60.10	1.02417	28.21	37.45	13 29 15.10N	144 44 40.14E
11	6	98	65.30	1.02422	28.05	37.44	13 29 15.10N	144 44 40.14E
11	6	98	70.60	1.02431	27.87	37.49	13 29 15.10N	144 44 40.14E
11	6	98	74.26	1.02433	27.82	37.49	13 29 15.10N	144 44 40.14E
11	8	98	0.07	1.02392	29.05	37.48	13 29 11.05N	144 44 48.75E
11	8	98	5.35	1.02393	29.05	37.50	13 29 11.05N	144 44 48.75E
11	8	98	10.48	1.02393	29.05	37.51	13 29 11.05N	144 44 48.75E
11	8	98	15.56	1.02392	29.05	37.50	13 29 11.05N	144 44 48.75E
11	8	98	20.75	1.02392	29.05	37.49	13 29 11.05N	144 44 48.75E
11	8	98	25.22	1.02391	29.04	37.48	13 29 11.05N	144 44 48.75E
11	8	98	30.20	1.02391	29.03	37.47	13 29 11.05N	144 44 48.75E
11	8	98	35.09	1.02391	29.03	37.47	13 29 11.05N	144 44 48.75E
11	8	98	40.68	1.02391	29.02	37.46	13 29 11.05N	144 44 48.75E
11	8	98	45.54	1.02390	29.02	37.45	13 29 11.05N	144 44 48.75E
11	8	98	50.55	1.02390	29.02	37.44	13 29 11.05N	144 44 48.75E
11	8	98	55.41	1.02389	29.02	37.44	13 29 11.05N	144 44 48.75E
11	8	98	59.17	1.02389	29.02	37.44	13 29 11.05N	144 44 48.75E
11	8	98	0.07	1.02387	29.06	37.42	13 29 13.07N	144 44 45.08E
11	8	98	5.55	1.02388	29.04	37.43	13 29 13.07N	144 44 45.08E
11	8	98	10.12	1.02388	29.04	37.43	13 29 13.07N	144 44 45.08E
11	8	98	15.30	1.02388	29.04	37.43	13 29 13.07N	144 44 45.08E
11	8	98	20.48	1.02388	29.04	37.43	13 29 13.07N	144 44 45.08E
11	8	98	25.45	1.02389	29.04	37.44	13 29 13.07N	144 44 45.08E
11	8	98	30.38	1.02389	29.04	37.44	13 29 13.07N	144 44 45.08E
11	8	98	35.36	1.02389	29.03	37.44	13 29 13.07N	144 44 45.08E
11	8	98	40.15	1.02389	29.03	37.44	13 29 13.07N	144 44 45.08E
11	8	98	45.54	1.02389	29.02	37.44	13 29 13.07N	144 44 45.08E
11	8	98	50.12	1.02390	29.01	37.44	13 29 13.07N	144 44 45.08E
11	8	98	55.41	1.02391	28.99	37.44	13 29 13.07N	144 44 45.08E
11	8	98	60.09	1.02392	28.79	37.37	13 29 13.07N	144 44 45.08E
11	8	98	65.09	1.02403	28.63	37.45	13 29 13.07N	144 44 45.08E
11	8	98	68.55	1.02410	28.57	37.52	13 29 13.07N	144 44 45.08E
11	8	98	0.07	1.02388	29.06	37.43	13 29 13.80N	144 44 43.87E
11	8	98	5.25	1.02388	29.05	37.43	13 29 13.80N	144 44 43.87E
11	8	98	10.48	1.02388	29.04	37.43	13 29 13.80N	144 44 43.87E
11	8	98	15.06	1.02388	29.04	37.43	13 29 13.80N	144 44 43.87E
11	8	98	20.24	1.02389	29.04	37.44	13 29 13.80N	144 44 43.87E
11	8	98	25.35	1.02389	29.04	37.44	13 29 13.80N	144 44 43.87E
11	8	98	30.20	1.02389	29.04	37.45	13 29 13.80N	144 44 43.87E
11	8	98	35.09	1.02389	29.03	37.44	13 29 13.80N	144 44 43.87E
11	8	98	40.57	1.02389	29.03	37.44	13 29 13.80N	144 44 43.87E

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	Lat.	Long.
11	8	98	45.26	1.02390	29.03	37.45	13 29 13.80N	144 44 43.87E
11	8	98	50.53	1.02390	29.03	37.45	13 29 13.80N	144 44 43.87E
11	8	98	55.21	1.02389	29.03	37.45	13 29 13.80N	144 44 43.87E
11	8	98	60.61	1.02390	29.02	37.45	13 29 13.80N	144 44 43.87E
11	8	98	65.60	1.02392	28.89	37.42	13 29 13.80N	144 44 43.87E
11	8	98	68.86	1.02402	28.72	37.47	13 29 13.80N	144 44 43.87E
11	9	98	0.07	1.02387	29.08	37.44	13 29 12.76N	144 44 53.96E
11	9	98	5.25	1.02389	29.13	37.48	13 29 12.76N	144 44 53.96E
11	9	98	10.02	1.02390	29.12	37.50	13 29 12.76N	144 44 53.96E
11	9	98	15.16	1.02390	29.11	37.48	13 29 12.76N	144 44 53.96E
11	9	98	20.14	1.02389	29.11	37.48	13 29 12.76N	144 44 53.96E
11	9	98	25.12	1.02389	29.11	37.47	13 29 12.76N	144 44 53.96E
11	9	98	30.20	1.02388	29.11	37.46	13 29 12.76N	144 44 53.96E
11	9	98	35.29	1.02387	29.09	37.45	13 29 12.76N	144 44 53.96E
11	9	98	40.17	1.02388	29.08	37.45	13 29 12.76N	144 44 53.96E
11	9	98	45.03	1.02389	29.05	37.45	13 29 12.76N	144 44 53.96E
11	9	98	50.33	1.02390	28.99	37.44	13 29 12.76N	144 44 53.96E
11	9	98	55.21	1.02396	28.86	37.45	13 29 12.76N	144 44 53.96E
11	9	98	60.29	1.02401	28.71	37.46	13 29 12.76N	144 44 53.96E
11	9	98	65.28	1.02405	28.60	37.46	13 29 12.76N	144 44 53.96E
11	9	98	70.19	1.02405	28.59	37.46	13 29 12.76N	144 44 53.96E
11	9	98	71.71	1.02406	28.57	37.47	13 29 12.76N	144 44 53.96E
11	9	98	0.21	1.02382	29.10	37.38	13 29 13.18N	144 44 53.95E
11	9	98	5.04	1.02385	29.13	37.43	13 29 13.18N	144 44 53.95E
11	9	98	10.22	1.02386	29.12	37.44	13 29 13.18N	144 44 53.95E
11	9	98	15.40	1.02387	29.12	37.45	13 29 13.18N	144 44 53.95E
11	9	98	20.14	1.02387	29.11	37.45	13 29 13.18N	144 44 53.95E
11	9	98	25.12	1.02387	29.11	37.45	13 29 13.18N	144 44 53.95E
11	9	98	30.10	1.02387	29.11	37.44	13 29 13.18N	144 44 53.95E
11	9	98	35.19	1.02387	29.11	37.45	13 29 13.18N	144 44 53.95E
11	9	98	40.15	1.02387	29.09	37.44	13 29 13.18N	144 44 53.95E
11	9	98	45.13	1.02388	29.07	37.45	13 29 13.18N	144 44 53.95E
11	9	98	50.02	1.02389	29.04	37.45	13 29 13.18N	144 44 53.95E
11	9	98	55.31	1.02392	28.96	37.45	13 29 13.18N	144 44 53.95E
11	9	98	60.20	1.02394	28.90	37.45	13 29 13.18N	144 44 53.95E
11	9	98	65.39	1.02398	28.76	37.44	13 29 13.18N	144 44 53.95E
11	9	98	70.09	1.02404	28.64	37.46	13 29 13.18N	144 44 53.95E
11	9	98	72.12	1.02407	28.58	37.48	13 29 13.18N	144 44 53.95E
11	9	98	0.57	1.02383	29.10	37.38	13 29 13.60N	144 44 53.91E
11	9	98	5.14	1.02385	29.13	37.43	13 29 13.60N	144 44 53.91E
11	9	98	10.32	1.02386	29.12	37.45	13 29 13.60N	144 44 53.91E
11	9	98	15.16	1.02387	29.12	37.45	13 29 13.60N	144 44 53.91E
11	9	98	20.07	1.02387	29.11	37.45	13 29 13.60N	144 44 53.91E
11	9	98	25.02	1.02387	29.11	37.45	13 29 13.60N	144 44 53.91E
11	9	98	30.20	1.02387	29.11	37.45	13 29 13.60N	144 44 53.91E
11	9	98	35.39	1.02387	29.10	37.45	13 29 13.60N	144 44 53.91E
11	9	98	40.05	1.02387	29.09	37.44	13 29 13.60N	144 44 53.91E
11	9	98	45.23	1.02387	29.09	37.45	13 29 13.60N	144 44 53.91E
11	9	98	50.02	1.02388	29.07	37.45	13 29 13.60N	144 44 53.91E
11	9	98	55.21	1.02390	29.03	37.45	13 29 13.60N	144 44 53.91E
11	9	98	60.00	1.02391	28.98	37.45	13 29 13.60N	144 44 53.91E
11	9	98	65.30	1.02401	28.71	37.45	13 29 13.60N	144 44 53.91E
11	9	98	70.28	1.02405	28.61	37.47	13 29 13.60N	144 44 53.91E
11	9	98	74.46	1.02410	28.50	37.49	13 29 13.60N	144 44 53.91E
11	11	98	1.58	1.02384	29.11	37.41	13 29 10.91N	144 44 43.57E
11	11	98	5.11	1.02386	29.09	37.43	13 29 10.91N	144 44 43.57E
11	11	98	10.02	1.02388	29.05	37.44	13 29 10.91N	144 44 43.57E

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	c.	Long.
11	11	98	15.36	1.02389	29.03	37.44	13 29 10.91N	144 44 43.57E
11	11	98	20.17	1.02389	29.03	37.44	13 29 10.91N	144 44 43.57E
11	11	98	25.32	1.02389	29.03	37.44	13 29 10.91N	144 44 43.57E
11	11	98	30.20	1.02389	29.02	37.44	13 29 10.91N	144 44 43.57E
11	11	98	35.06	1.02389	29.02	37.44	13 29 10.91N	144 44 43.57E
11	11	98	40.25	1.02390	29.01	37.44	13 29 10.91N	144 44 43.57E
11	11	98	45.13	1.02390	29.01	37.44	13 29 10.91N	144 44 43.57E
11	11	98	50.02	1.02390	29.00	37.44	13 29 10.91N	144 44 43.57E
11	11	98	55.11	1.02391	28.99	37.45	13 29 10.91N	144 44 43.57E
11	11	98	56.43	1.02391	28.98	37.45	13 29 10.91N	144 44 43.57E
11	11	98	2.63	1.02379	29.21	37.39	13 29 11.82N	144 44 47.62E
11	11	98	5.25	1.02380	29.20	37.40	13 29 11.82N	144 44 47.62E
11	11	98	10.42	1.02386	29.09	37.43	13 29 11.82N	144 44 47.62E
11	11	98	15.06	1.02388	29.06	37.44	13 29 11.82N	144 44 47.62E
11	11	98	20.44	1.02389	29.04	37.44	13 29 11.82N	144 44 47.62E
11	11	98	25.12	1.02389	29.04	37.44	13 29 11.82N	144 44 47.62E
11	11	98	30.20	1.02389	29.03	37.44	13 29 11.82N	144 44 47.62E
11	11	98	35.19	1.02389	29.03	37.44	13 29 11.82N	144 44 47.62E
11	11	98	40.27	1.02389	29.02	37.44	13 29 11.82N	144 44 47.62E
11	11	98	45.36	1.02391	28.99	37.44	13 29 11.82N	144 44 47.62E
11	11	98	50.04	1.02391	28.98	37.44	13 29 11.82N	144 44 47.62E
11	11	98	55.21	1.02391	28.98	37.44	13 29 11.82N	144 44 47.62E
11	11	98	60.10	1.02391	28.97	37.45	13 29 11.82N	144 44 47.62E
11	11	98	65.28	1.02392	28.96	37.45	13 29 11.82N	144 44 47.62E
11	11	98	0.37	1.02396	29.12	37.57	13 29 12.41N	144 44 47.94E
11	11	98	5.04	1.02394	29.09	37.53	13 29 12.41N	144 44 47.94E
11	11	98	10.18	1.02394	29.06	37.52	13 29 12.41N	144 44 47.94E
11	11	98	15.30	1.02394	29.05	37.52	13 29 12.41N	144 44 47.94E
11	11	98	20.04	1.02392	29.05	37.49	13 29 12.41N	144 44 47.94E
11	11	98	25.32	1.02391	29.04	37.47	13 29 12.41N	144 44 47.94E
11	11	98	30.00	1.02391	29.04	37.47	13 29 12.41N	144 44 47.94E
11	11	98	35.16	1.02390	29.03	37.45	13 29 12.41N	144 44 47.94E
11	11	98	40.17	1.02390	29.00	37.45	13 29 12.41N	144 44 47.94E
11	11	98	45.23	1.02391	28.99	37.45	13 29 12.41N	144 44 47.94E
11	11	98	50.02	1.02393	28.95	37.45	13 29 12.41N	144 44 47.94E
11	11	98	55.31	1.02394	28.90	37.45	13 29 12.41N	144 44 47.94E
11	11	98	60.31	1.02396	28.84	37.45	13 29 12.41N	144 44 47.94E
11	11	98	65.08	1.02404	28.62	37.46	13 29 12.41N	144 44 47.94E
11	11	98	67.33	1.02406	28.56	37.46	13 29 12.41N	144 44 47.94E
11	11	98	0.98	1.02379	29.26	37.41	13 29 12.56N	144 44 50.47E
11	11	98	5.35	1.02386	29.10	37.43	13 29 12.56N	144 44 50.47E
11	11	98	10.02	1.02388	29.07	37.45	13 29 12.56N	144 44 50.47E
11	11	98	15.30	1.02389	29.05	37.45	13 29 12.56N	144 44 50.47E
11	11	98	20.14	1.02389	29.05	37.44	13 29 12.56N	144 44 50.47E
11	11	98	25.32	1.02389	29.04	37.44	13 29 12.56N	144 44 50.47E
11	11	98	30.00	1.02389	29.04	37.44	13 29 12.56N	144 44 50.47E
11	11	98	35.29	1.02389	29.02	37.44	13 29 12.56N	144 44 50.47E
11	11	98	40.27	1.02389	29.01	37.44	13 29 12.56N	144 44 50.47E
11	11	98	45.03	1.02390	29.01	37.44	13 29 12.56N	144 44 50.47E
11	11	98	50.33	1.02390	29.00	37.44	13 29 12.56N	144 44 50.47E
11	11	98	55.21	1.02390	28.99	37.44	13 29 12.56N	144 44 50.47E
11	11	98	60.09	1.02392	28.97	37.45	13 29 12.56N	144 44 50.47E
11	11	98	65.20	1.02392	28.95	37.45	13 29 12.56N	144 44 50.47E
11	11	98	68.55	1.02393	28.95	37.45	13 29 12.56N	144 44 50.47E
11	11	98	0.82	1.02382	29.13	37.40	13 29 12.62N	144 44 42.69E
11	11	98	5.25	1.02384	29.13	37.42	13 29 12.62N	144 44 42.69E
11	11	98	10.18	1.02387	29.06	37.43	13 29 12.62N	144 44 42.69E

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	Lat.	Long.
11	11	98	15.26	1.02388	29.05	37.43	13 29 12.62N	144 44 42.69E
11	11	98	20.38	1.02388	29.05	37.44	13 29 12.62N	144 44 42.69E
11	11	98	25.35	1.02388	29.05	37.44	13 29 12.62N	144 44 42.69E
11	11	98	30.20	1.02389	29.04	37.44	13 29 12.62N	144 44 42.69E
11	11	98	35.26	1.02388	29.04	37.44	13 29 12.62N	144 44 42.69E
11	11	98	40.27	1.02389	29.03	37.44	13 29 12.62N	144 44 42.69E
11	11	98	45.13	1.02389	29.03	37.44	13 29 12.62N	144 44 42.69E
11	11	98	50.02	1.02390	29.01	37.44	13 29 12.62N	144 44 42.69E
11	11	98	55.01	1.02392	28.96	37.45	13 29 12.62N	144 44 42.69E
11	11	98	60.20	1.02393	28.94	37.45	13 29 12.62N	144 44 42.69E
11	11	98	65.20	1.02397	28.84	37.46	13 29 12.62N	144 44 42.69E
11	11	98	66.61	1.02403	28.76	37.51	13 29 12.62N	144 44 42.69E
11	11	98	0.37	1.02383	29.15	37.42	13 29 12.85N	144 44 39.03E
11	11	98	5.35	1.02385	29.14	37.43	13 29 12.85N	144 44 39.03E
11	11	98	10.28	1.02385	29.13	37.43	13 29 12.85N	144 44 39.03E
11	11	98	15.20	1.02385	29.10	37.42	13 29 12.85N	144 44 39.03E
11	11	98	20.14	1.02388	29.05	37.44	13 29 12.85N	144 44 39.03E
11	11	98	25.32	1.02389	29.05	37.44	13 29 12.85N	144 44 39.03E
11	11	98	30.20	1.02389	29.04	37.44	13 29 12.85N	144 44 39.03E
11	11	98	35.06	1.02389	29.03	37.44	13 29 12.85N	144 44 39.03E
11	11	98	40.35	1.02389	29.03	37.44	13 29 12.85N	144 44 39.03E
11	11	98	45.03	1.02389	29.03	37.44	13 29 12.85N	144 44 39.03E
11	11	98	50.33	1.02390	29.00	37.44	13 29 12.85N	144 44 39.03E
11	11	98	55.01	1.02391	28.98	37.44	13 29 12.85N	144 44 39.03E
11	11	98	60.10	1.02392	28.96	37.44	13 29 12.85N	144 44 39.03E
11	11	98	65.49	1.02396	28.88	37.46	13 29 12.85N	144 44 39.03E
11	12	98	0.57	1.02392	29.13	37.52	13 29 13.57N	144 44 36.20E
11	12	98	5.35	1.02395	29.06	37.54	13 29 13.57N	144 44 36.20E
11	12	98	10.12	1.02394	29.04	37.52	13 29 13.57N	144 44 36.20E
11	12	98	15.06	1.02393	29.04	37.49	13 29 13.57N	144 44 36.20E
11	12	98	20.24	1.02391	29.03	37.47	13 29 13.57N	144 44 36.20E
11	12	98	25.22	1.02390	29.03	37.46	13 29 13.57N	144 44 36.20E
11	12	98	30.00	1.02390	29.02	37.45	13 29 13.57N	144 44 36.20E
11	12	98	35.19	1.02389	29.02	37.44	13 29 13.57N	144 44 36.20E
11	12	98	40.05	1.02389	29.02	37.44	13 29 13.57N	144 44 36.20E
11	12	98	45.16	1.02389	29.02	37.44	13 29 13.57N	144 44 36.20E
11	12	98	46.88	1.02389	29.02	37.44	13 29 13.57N	144 44 36.20E
11	12	98	0.88	1.02377	29.20	37.36	13 29 15.53N	144 44 43.73E
11	12	98	5.45	1.02388	29.05	37.43	13 29 15.53N	144 44 43.73E
11	12	98	10.42	1.02388	29.04	37.43	13 29 15.53N	144 44 43.73E
11	12	98	15.50	1.02388	29.03	37.44	13 29 15.53N	144 44 43.73E
11	12	98	20.17	1.02389	29.03	37.44	13 29 15.53N	144 44 43.73E
11	12	98	25.25	1.02389	29.03	37.44	13 29 15.53N	144 44 43.73E
11	12	98	30.20	1.02389	29.02	37.44	13 29 15.53N	144 44 43.73E
11	12	98	35.16	1.02389	29.01	37.43	13 29 15.53N	144 44 43.73E
11	12	98	40.07	1.02389	29.01	37.43	13 29 15.53N	144 44 43.73E
11	12	98	45.23	1.02390	29.00	37.44	13 29 15.53N	144 44 43.73E
11	12	98	50.12	1.02390	29.01	37.44	13 29 15.53N	144 44 43.73E
11	12	98	53.06	1.02392	28.96	37.45	13 29 15.53N	144 44 43.73E
11	13	98	0.57	1.02386	29.02	37.40	13 29 13.51N	144 44 54.85E
11	13	98	5.04	1.02387	29.01	37.40	13 29 13.51N	144 44 54.85E
11	13	98	10.18	1.02388	28.99	37.40	13 29 13.51N	144 44 54.85E
11	13	98	15.36	1.02388	28.97	37.40	13 29 13.51N	144 44 54.85E
11	13	98	20.04	1.02388	28.98	37.41	13 29 13.51N	144 44 54.85E
11	13	98	25.12	1.02389	29.00	37.43	13 29 13.51N	144 44 54.85E
11	13	98	30.10	1.02389	29.00	37.43	13 29 13.51N	144 44 54.85E
11	13	98	35.39	1.02389	29.00	37.43	13 29 13.51N	144 44 54.85E

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	Lat.	Long.
11	13	98	40.17	1.02389	29.01	37.43	13 29 13.51N	144 44 54.85E
11	13	98	43.21	1.02389	29.01	37.43	13 29 13.51N	144 44 54.85E
11	13	98	1.48	1.02386	29.02	37.39	13 29 13.60N	144 44 50.56E
11	13	98	5.14	1.02386	29.01	37.40	13 29 13.60N	144 44 50.56E
11	13	98	10.12	1.02387	28.99	37.39	13 29 13.60N	144 44 50.56E
11	13	98	15.20	1.02388	28.98	37.40	13 29 13.60N	144 44 50.56E
11	13	98	20.14	1.02388	28.99	37.41	13 29 13.60N	144 44 50.56E
11	13	98	25.12	1.02389	29.01	37.43	13 29 13.60N	144 44 50.56E
11	13	98	30.00	1.02389	29.01	37.44	13 29 13.60N	144 44 50.56E
11	13	98	35.09	1.02389	29.01	37.44	13 29 13.60N	144 44 50.56E
11	13	98	40.07	1.02389	29.02	37.44	13 29 13.60N	144 44 50.56E
11	13	98	44.73	1.02389	29.01	37.44	13 29 13.60N	144 44 50.56E



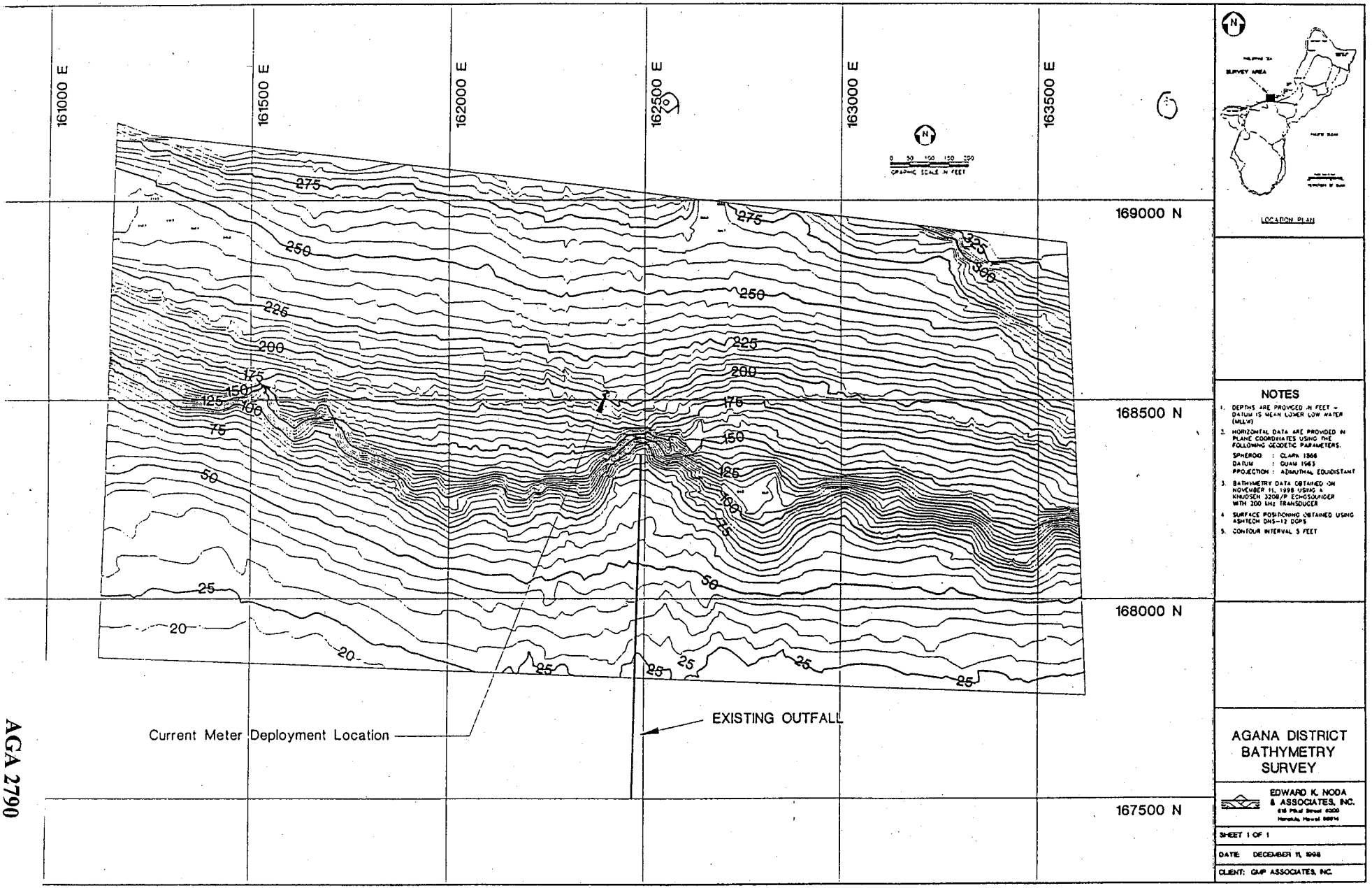
DISSOLVED OXYGEN

AGA 2788

Edward K. Noda and Associates, Inc.	AGANA SEWAGE TREATMENT PLANT OUTFALL EXTENSION	Agana STP Dissolved Oxygen Profiles Measured During Nov. 6-13, 1998	FIGURE

AGANA WWTP DISSOLVED OXYGEN(DO) PROFILE DATA OBTAINED DURING NOV. 6-13, 1998 BY EDWARD K. NODA AND ASSOCIATES, INC. (Lat. and Long. in WGS 83)

MONTH	DAY	YEAR	DEPTH (meters)	DO Pct Sat	DO mg/l	TEMP (C)	Cond mS/cm	Turb NTUs	pH	ORP mV	Lat.	Long.
11	6	98	0.10	93.5	0.00	30.33	0.71	3	7.10	290	13 29 14.72N	144 44 41.14E
11	6	98	7.62	104.2	0.00	29.18	1.18	0	8.23	348	13 29 14.72N	144 44 41.14E
11	6	98	14.36	100.6	0.00	29.12	1.10	0	8.24	333	13 29 14.72N	144 44 41.14E
11	6	98	25.30	100.6	0.00	29.09	1.10	0	8.25	327	13 29 14.72N	144 44 41.14E
11	6	98	37.72	98.8	0.00	28.80	1.02	0	8.25	324	13 29 14.72N	144 44 41.14E
11	6	98	44.12	97.9	0.00	28.76	1.06	0	8.25	323	13 29 14.72N	144 44 41.14E
11	6	98	52.68	97.8	0.00	28.69	1.10	0	8.25	322	13 29 14.72N	144 44 41.14E
11	6	98	58.33	97.5	0.00	28.69	1.10	0	8.25	321	13 29 14.72N	144 44 41.14E
11	6	98	64.96	97.1	0.00	28.64	0.78	0	8.25	321	13 29 14.72N	144 44 41.14E
11	6	98	74.13	98.3	0.00	28.29	1.05	0	8.25	320	13 29 14.72N	144 44 41.14E
11	12	98	0.40	104.8	8.04	28.36	0.00	0	7.94	252	13 29 14.19N	144 44 43.04E
11	12	98	12.81	100.0	6.15	29.08	2.76	0	8.16	208	13 29 14.19N	144 44 43.04E
11	12	98	17.84	99.7	6.13	29.07	2.73	0	8.17	213	13 29 14.19N	144 44 43.04E
11	12	98	29.24	98.2	6.04	29.06	2.78	0	8.17	234	13 29 14.19N	144 44 43.04E
11	13	98	0.41	99.3	7.50	28.36	4.92	10	7.86	283	13 29 13.51N	144 44 54.85E
11	13	98	12.30	97.2	5.98	29.07	2.80	0	8.18	247	13 29 13.51N	144 44 54.85E
11	13	98	18.96	96.8	5.95	29.05	2.79	0	8.18	251	13 29 13.51N	144 44 54.85E
11	13	98	28.59	96.5	5.94	29.05	2.80	0	8.18	254	13 29 13.51N	144 44 54.85E
11	13	98	31.59	97.4	5.99	29.05	2.80	0	8.18	258	13 29 13.51N	144 44 54.85E
11	13	98	60.55	95.2	5.86	29.04	2.80	0	8.18	266	13 29 13.51N	144 44 54.85E


161000 E
161500 E
162000 E
162500 E
163000 E
163500 E
169000 N
168500 N
168000 N
167500 N
275
250
225
200
175
150
125
100
75
50
25
20
Current Meter Deployment Location
EXISTING OUTFALL
SURVEY AREA
LOCATION PLAN
NOTES
1. DEPTHS ARE PROVIDED IN FEET - DATUM IS MEAN LOWER LOW WATER (MLLW)
2. HORIZONTAL DATA ARE PROVIDED IN PLANE COORDINATES USING THE FOLLOWING GEODETIC PARAMETERS.
SPHEROID : CLARK 1866
DATUM : GUAM 1963
PROJECTION : AZIMUTHAL EQUIDISTANT
3. BATHYMETRY DATA OBTAINED ON NOVEMBER 11, 1998 USING A KNUDSEN 320B/P ECHOSOUNDER WITH 200 kHz TRANSDUCER
4. SURFACE POSITIONING OBTAINED USING ASHTECH DNS-12 DGPS
5. CONTOUR INTERVAL 5 FEET
AGANA DISTRICT BATHYMETRY SURVEY
EDWARD K. NODA & ASSOCIATES, INC.
SHEET 1 OF 1
DATE: DECEMBER 11, 1998
CLIENT: GMP ASSOCIATES, INC.

AGA 2790

GUAM AGANA WWTP DIFFUSER CURRENTS -- 1

CURRENT METER S/N -- 0705

METER POSITION ----- 1

DATA ACQUISITION
   DEPLOYMENT DATE(GST) - NOV. 7 ,1998
   DEPLOYMENT TIME(GST) - 1545

   RETRIEVAL DATE(GST) --- NOV. 13,1998
   RETRIEVAL TIME(GST) --- 1205

MOORING LOCATION
   LATITUDE -------- 13-29.09N
   LONGITUDE ------- 144-44.65E

SENSOR DEPTH(M) ---- 33

BOTTOM DEPTH(M) ---- 61

MAGNETIC DECLINATION(DEGREES) -- 1.8

DATA ANALYSIS
   START DATE(GST) - NOV. 7 ,1998
   START TIME(GST) - 1545

   ENDING DATE(GST) - NOV. 13,1998
   ENDING TIME(GST) - 1215

TIME INTERVAL(MIN) - 10.00

DISTRIBUTION FREQUENCY

.17 HOUR AVERAGES

DEPLOYMENT 1 METER POSITION 1

FROM 1545 7 NOV 1998 TO 1215 13 NOV 1998

DIRECTION	33 METERS DEPTH									
DEGREES TRUE										
0- 15	8	0	0	0	0	0	0	0	0	0
15- 30	2	0	0	0	0	0	0	0	0	0
30- 45	2	1	0	0	0	0	0	0	0	0
45- 60	3	1	0	0	0	0	0	0	0	0
60- 75	5	2	0	0	0	0	0	0	0	0
75- 90	11	10	7	3	3	0	0	0	0	0
90-105	25	48	33	17	6	0	0	0	0	0
105-120	35	46	30	1	0	0	0	0	0	0
120-135	43	24	1	0	0	0	0	0	0	0
135-150	35	5	0	0	0	0	0	0	0	0
150-165	42	2	0	0	0	0	0	0	0	0
165-180	28	1	0	0	0	0	0	0	0	0
180-195	44	0	0	0	0	0	0	0	0	0
195-210	22	0	0	0	0	0	0	0	0	0
210-225	29	3	0	0	0	0	0	0	0	0
225-240	39	8	0	0	0	0	0	0	0	0
240-255	21	41	10	0	0	0	0	0	0	0
255-270	25	42	17	8	0	0	0	0	0	0
270-285	16	13	6	1	0	0	0	0	0	0
285-300	7	3	0	0	0	0	0	0	0	0
300-315	3	0	0	0	0	0	0	0	0	0
315-330	2	0	0	0	0	0	0	0	0	0
330-345	2	0	0	0	0	0	0	0	0	0
345-360	2	0	0	0	0	0	0	0	0	0
SPEED	0	5	10	15	20	25	30	35	40	45
CM/SEC	|	|	|	|	|	|	|	|	|	|
	5	10	15	20	25	30	35	40	45	50

0- 15	0	0	0	0	0	0	0	0	0	0	0
15- 30	0	0	0	0	0	0	0	0	0	0	0
30- 45	0	0	0	0	0	0	0	0	0	0	0
45- 60	0	0	0	0	0	0	0	0	0	0	0
60- 75	0	0	0	0	0	0	0	0	0	0	0
75- 90	0	0	0	0	0	0	0	0	0	0	0
90-105	0	0	0	0	0	0	0	0	0	0	0
105-120	0	0	0	0	0	0	0	0	0	0	0
120-135	0	0	0	0	0	0	0	0	0	0	0
135-150	0	0	0	0	0	0	0	0	0	0	0
150-165	0	0	0	0	0	0	0	0	0	0	0
165-180	0	0	0	0	0	0	0	0	0	0	0
180-195	0	0	0	0	0	0	0	0	0	0	0
195-210	0	0	0	0	0	0	0	0	0	0	0
210-225	0	0	0	0	0	0	0	0	0	0	0
225-240	0	0	0	0	0	0	0	0	0	0	0
240-255	0	0	0	0	0	0	0	0	0	0	0
255-270	0	0	0	0	0	0	0	0	0	0	0
270-285	0	0	0	0	0	0	0	0	0	0	0
285-300	0	0	0	0	0	0	0	0	0	0	0
300-315	0	0	0	0	0	0	0	0	0	0	0
315-330	0	0	0	0	0	0	0	0	0	0	0
330-345	0	0	0	0	0	0	0	0	0	0	0
345-360	0	0	0	0	0	0	0	0	0	0	0
SPEED	50	55	60	65	70	75	80	85	90	95	
CM/SEC	|	|	|	|	|	|	|	|	|	|	>100
	55	60	65	70	75	80	85	90	95	100	

AGA 2792

SUMMARY STATISTICS
DEPLOYMENT 1 METER POSITION 1
FROM 1545 7 NOV 1998 TO 1215 13 NOV 1998

DIRECTION(DEGREES TRUE)	TOTAL OBSERVATIONS	PERCENT
0 TO 15	8	.95
15 TO 30	2	.24
30 TO 45	3	.36
45 TO 60	4	.47
60 TO 75	7	.83
75 TO 90	34	4.03
90 TO 105	129	15.28
105 TO 120	112	13.27
120 TO 135	68	8.06
135 TO 150	40	4.74
150 TO 165	44	5.21
165 TO 180	29	3.44
180 TO 195	44	5.21
195 TO 210	22	2.61
210 TO 225	32	3.79
225 TO 240	47	5.57
240 TO 255	72	8.53
255 TO 270	92	10.90
270 TO 285	36	4.27
285 TO 300	10	1.18
300 TO 315	3	.36
315 TO 330	2	.24
330 TO 345	2	.24
345 TO 360	2	.24

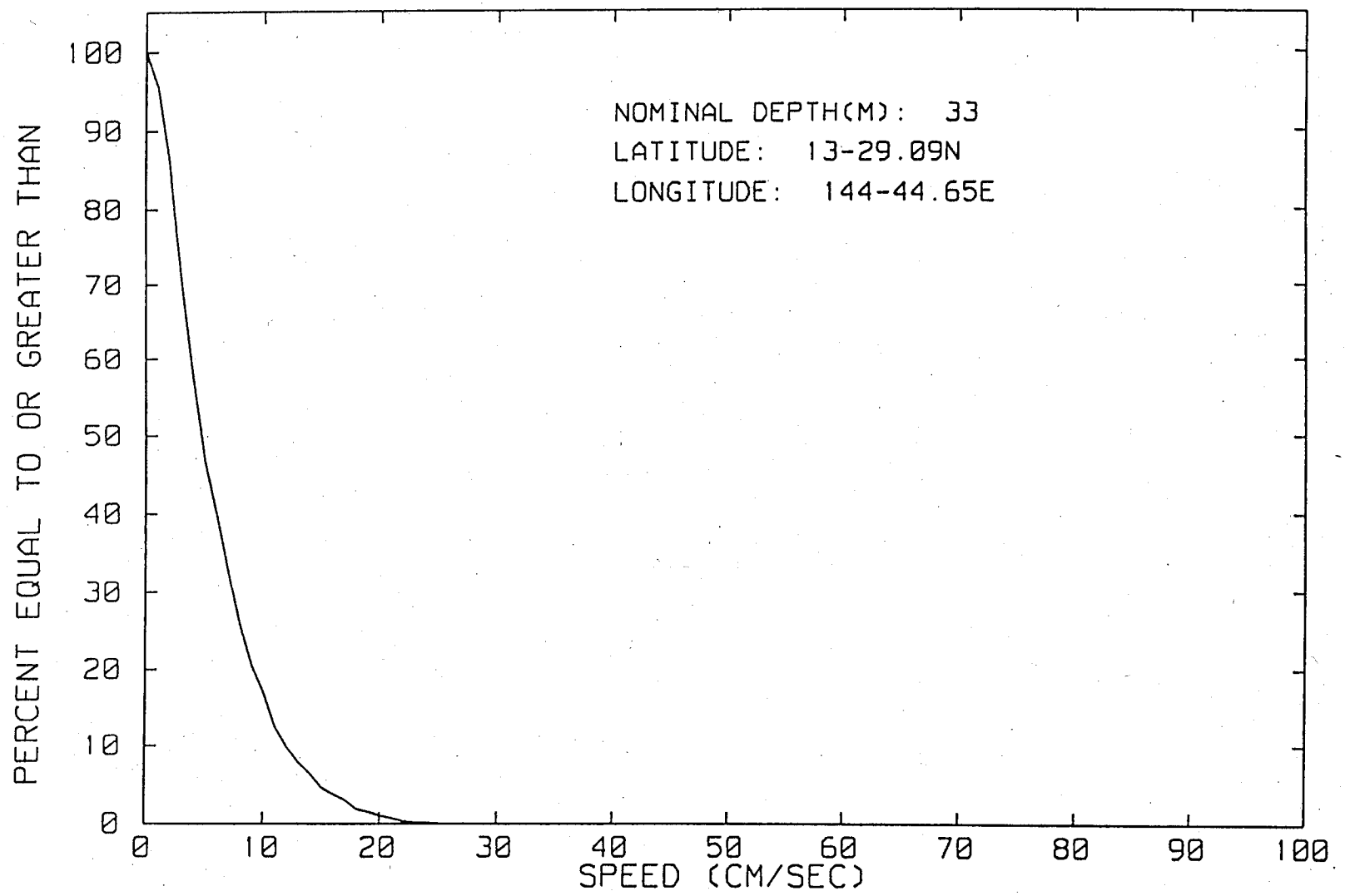
SPEED(CM/SEC)	TOTAL OBSERVATIONS	PERCENT
0.0 TO 5.0	451	53.44
5.0 TO 10.0	250	29.62
10.0 TO 15.0	104	12.32
15.0 TO 20.0	30	3.55
20.0 TO 25.0	9	1.07
25.0 TO 30.0	0	0.00
30.0 TO 35.0	0	0.00
35.0 TO 40.0	0	0.00
40.0 TO 45.0	0	0.00
45.0 TO 50.0	0	0.00
50.0 TO 55.0	0	0.00
55.0 TO 60.0	0	0.00
60.0 TO 65.0	0	0.00
65.0 TO 70.0	0	0.00
70.0 TO 75.0	0	0.00
75.0 TO 80.0	0	0.00
80.0 TO 85.0	0	0.00
85.0 TO 90.0	0	0.00
90.0 TO 95.0	0	0.00
95.0 TO 100.0	0	0.00
ABOVE 100	0	0.00

TOTAL NUMBER OF POINTS READ = 844
TOTAL NUMBER OF OBSERVATIONS USED IN THE DISTRIBUTIONS = 844
MEAN SPEED = 5.90 CM/SEC
STANDARD DEVIATION = 4.36 CM/SEC
MAXIMUM SPEED = 24.20 CM/SEC
MINIMUM SPEED = 0.00 CM/SEC
RANGE = 24.20 CM/SEC

LATITUDE: 13-29.09N
LONGITUDE: 144-44.65E
NOMINAL DEPTH(METERS): 33
TIME SPAN(GST): 1545 NOV 7 1998 TO 1215 NOV 13 1998

CUMULATIVE OCCURENCE OF CURRENT SPEEDS

SPEED (CM/SEC)	PERCENT EQUAL TO OR GREATER THAN
0	100.000
3	70.616
6	39.929
9	20.498
12	9.834
15	4.621
18	1.896
21	.711
24	.118
27	0.000



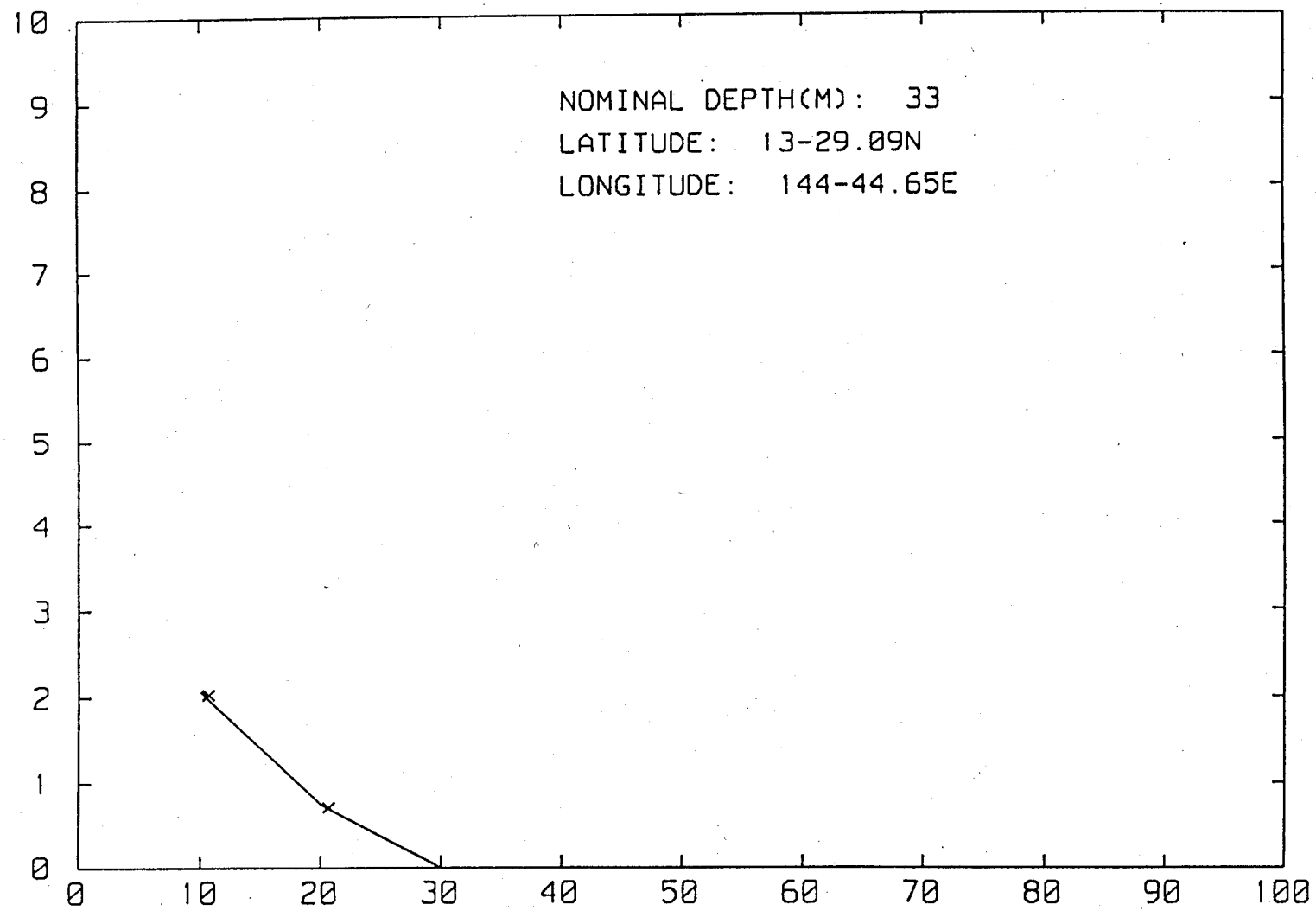
CUMULATIVE OCCURENCE OF CURRENT SPEEDS
(GST) 1545 NOV 7 1998 TO 1215 NOV 13 1998

AGA 2797

LATITUDE: 13-29.09N
LONGITUDE: 144-44.65E
NOMINAL DEPTH(METERS): 33
TIME SPAN(GST): 1545 NOV 7 1998 TO 1215 NOV 13 1998

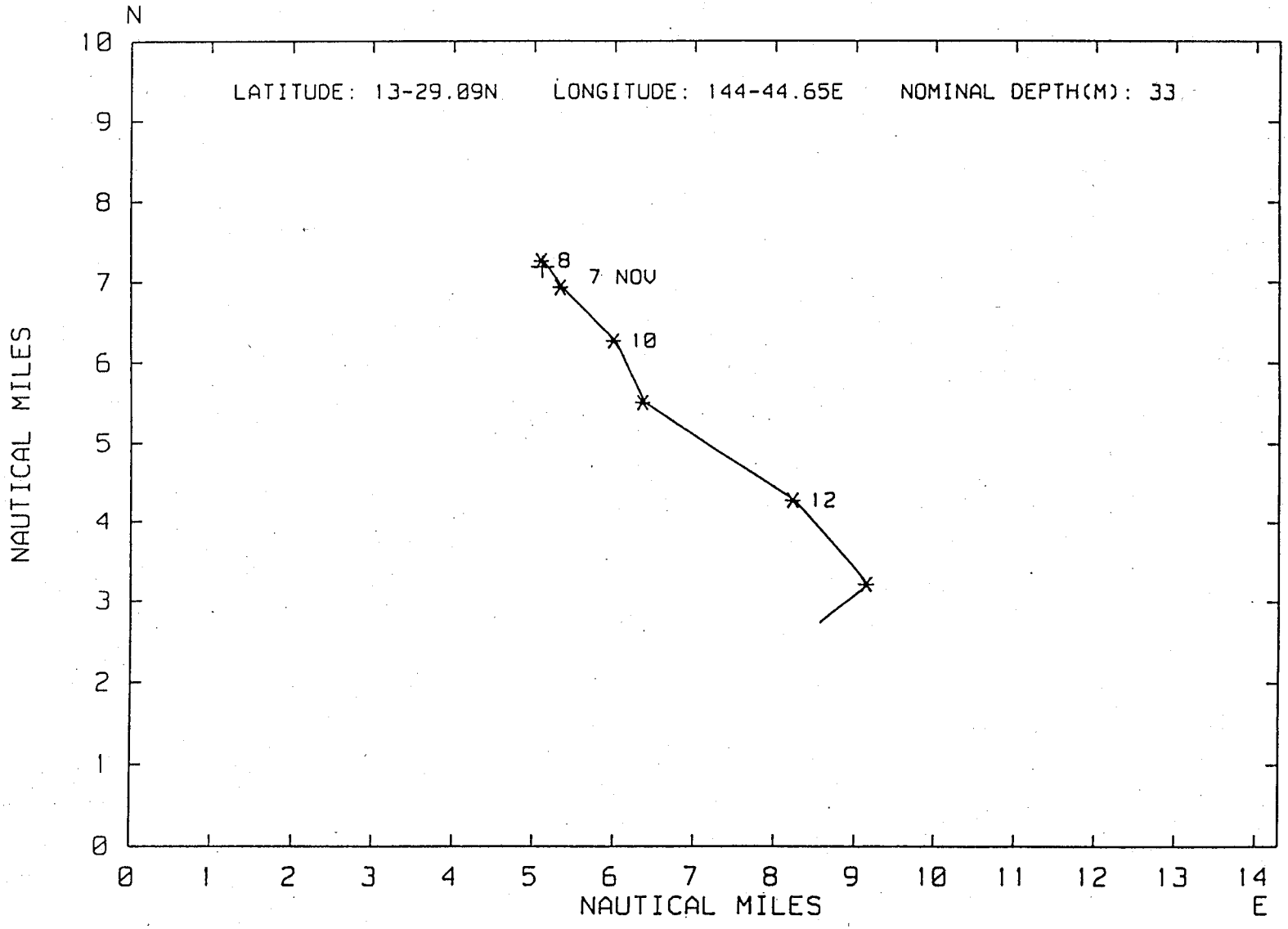
PERSISTENCE OF CURRENT SPEEDS

SPEED (CM/SEC)	MAXIMUM DURATION (HOURS)
10	2.06
20	.74
30	0.00



PERSISTENCE OF CURRENT SPEED FROM:
(GST) 1545 NOV 7 1998 TO 1215 NOV 13 1998

AGA 2799



PROGRESSIVE VECTOR DIAGRAM OF CURRENTS
(GST) 1545 NOV 7 1998 TO 1215 NOV 13 1998

AGA 2800

TEMPERATURE STATISTICS

DEPLOYMENT 1 METER POSITION 1
FROM 1545 7 NOV 1998 TO 1215 13 NOV 1998

TEMPERATURE(CENTIGRADE)	TOTAL OBSERVATIONS	PERCENT
0 TO 1	0	0.00
1 TO 2	0	0.00
2 TO 3	0	0.00
3 TO 4	0	0.00
4 TO 5	0	0.00
5 TO 6	0	0.00
6 TO 7	0	0.00
7 TO 8	0	0.00
8 TO 9	0	0.00
9 TO 10	0	0.00
10 TO 11	0	0.00
11 TO 12	0	0.00
12 TO 13	0	0.00
13 TO 14	0	0.00
14 TO 15	0	0.00
15 TO 16	0	0.00
16 TO 17	0	0.00
17 TO 18	0	0.00
18 TO 19	0	0.00
19 TO 20	0	0.00
20 TO 21	0	0.00
21 TO 22	0	0.00
22 TO 23	0	0.00
23 TO 24	0	0.00
24 TO 25	0	0.00
25 TO 26	0	0.00
26 TO 27	0	0.00
27 TO 28	0	0.00
28 TO 29	0	0.00
29 TO 30	844	100.00

TOTAL NUMBER OF POINTS READ = 844
TOTAL NUMBER OF OBSERVATION USED IN THE DISTRIBUTION = 844
MEAN TEMPERATURE = 29.3 DEGREES CENTIGRADE
STANDARD DEVIATION = 0.0 DEGREES CENTIGRADE
MAXIMUM TEMPERATURE = 29.4 DEGREES CENTIGRADE
MINIMUM TEMPERATURE = 29.2 DEGREES CENTIGRADE
RANGE = .2 DEGREES CENTIGRADE

Guam Agana WWTP Diffuser Monthly Current-Temperature Statistics

DEPLOYMENT LOCATION: 1

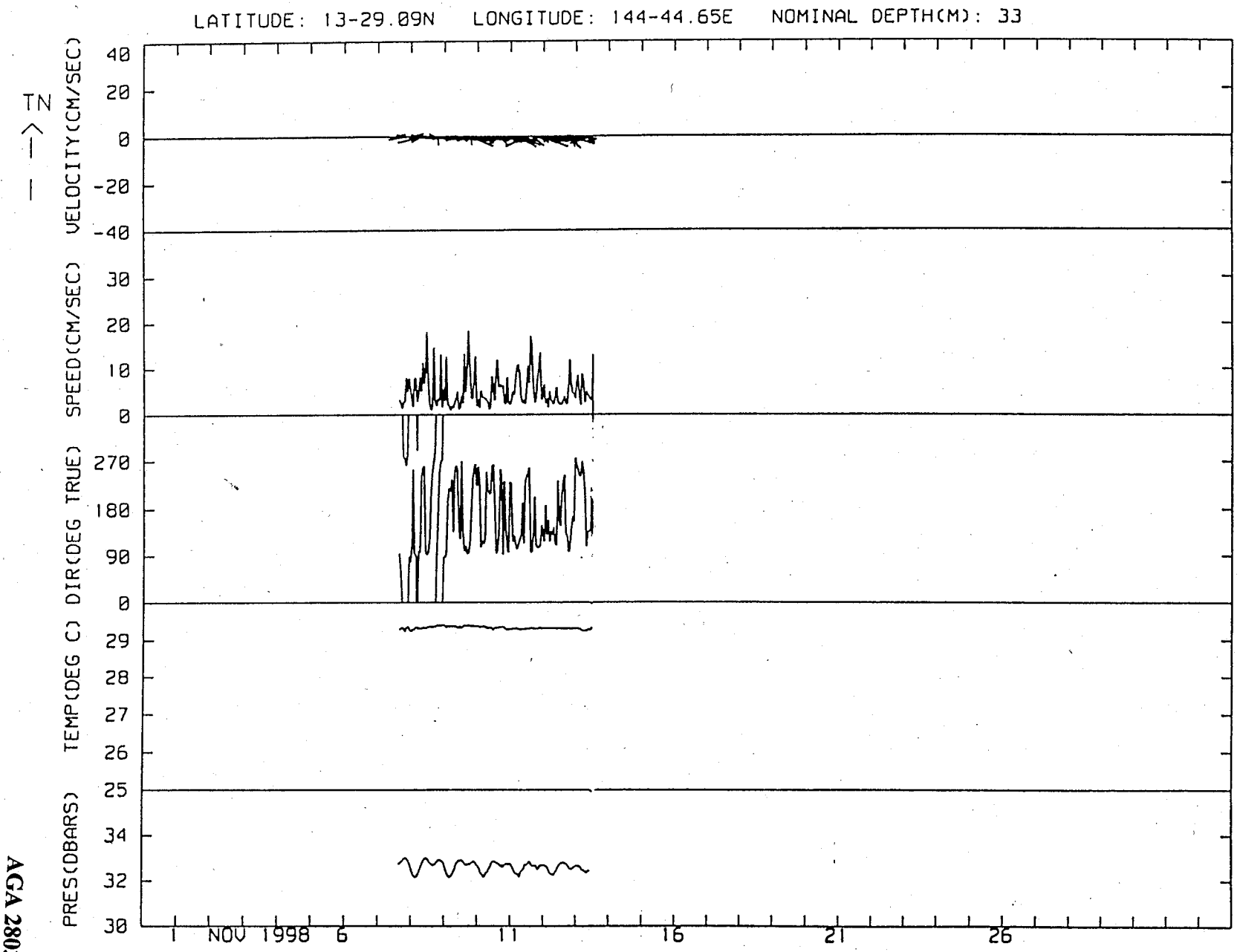
Latitude: 13-29.09N Longitude: 144-44.65E
Meter Depth(m): 33.0 Bottom Depth(m): 61.0

Period: NOVEMBER 1998

Mean Speed(cm/sec): 5.90
Maximum Speed(cm/sec): 24.20
Standard Deviation: 4.36
Average North Vector Component(cm/sec): -1.63
Average East Vector Component(cm/sec): 1.25
Resultant Magnitude(cm/sec): 2.05
Resultant Direction(°T): 143

Minimum Temperature(°C): 29.2
Maximum Temperature(°C): 29.4
Mean Temperature(°C): 29.3
Standard Deviation: 0.0

Day	Maximum Speed	Minimum Temperature	Maximum Temperature
7	17.00	29.2	29.4
8	24.20	29.2	29.4
9	20.20	29.2	29.4
10	17.00	29.3	29.4
11	22.80	29.3	29.3
12	14.90	29.3	29.3
13	14.10	29.2	29.3


LATITUDE: 13-29.09N LONGITUDE: 144-44.65E NOMINAL DEPTH(M): 33
TN
VELOCITY(CM/SEC)
40
20
0
-20
-40
SPEED(CM/SEC)
30
20
10
0
DIR(DEG TRUE)
270
180
90
0
TEMP(DEG C)
29
28
27
26
25
PRES(DBARS)
34
32
30
1 NOV 1998
6
11
16
21
26

AGA 2803

APPENDIX C

SEDIMENT ANALYSES

APPENDIX C

SEDIMENT ANALYSIS

C-1 Introduction

Sediment samples were collected at three locations shown in figure C.1 on September 20, 2001. Generally, these locations are in the center, and then east and west of the mixing zone. The previous video survey of community structure on September 21, 2000 had shown the sea floor to be mostly bare substrate with occasional pockets of sediment or sand. Therefore, an underwater video camera and lights were mounted on an articulating arm so that potential sampling locations could be inspected before activating the sampler. A video record of searching and sampling was made. The severe bathymetry in the outfall area limited sampling to three general areas. in the vicinity of the proposed outfall mixing zone as

C-2 Purpose

Samples were taken for four general classes of analysis; 1) Physical, Infauna, Sediment Chemistry, and Sediment Biochemical Oxygen Demand (SOD). These four classes can be further broken into;

Physical

Grain Size

Sediment Chemistry

Total Organic Carbon
Volatiles
Total Kjeldahl Nitrogen
Sulfide
Total Phosphorous
ICP Metals
Cyanide
Semivolatile Organics
Mercury
Asbestos
Organochlorine Pesticides
PCB's
Dioxin

Infauna

Polychaetes
Mollusks

C-3 Sampling Procedure

Grab samples were taken with a Van Veen sampler, model No 214 WA, as manufactured by Kahl Scientific Instrument Corporation[1]. The sampler was outfitted with a video camera and light mounted on an articulating arm.

The survey boat was navigated by GPS to the general sampling area which had been chosen for its moderate slope.

[1] Kahlsico International Corporation
P.O. Box 947
El Cajon, California 92022

On-station, the Van Veen sampler and camera assembly were lowered until the sea floor became visible- i.e 24 to 15 from the bottom. Upon finding a potential site, the sampler was quickly dropped. Location and depth were immediately recorded. The samples was hoisted on deck and placed in a plastic basin. Sample was then inspected of suitable according to the criteria of:

a) fairly flat surface with overlying seawater
b) sides are not heavily sloped nor humped along midline
c) minimum sample depth at midline is 2 in (5cm) with 2 ¼ to 4 in. (7 to 10 cm) preferred as measured with a plastic ruler.

Physical characteristics were noted and recorded;

a) Composition - coarse sand, fine sand, silt/clay, gravel, or mixed shell hash
b) Color - brown, black, grey, olive, green or red
c) Odor - petroleum, hydrogen sulfide, other or none.

If sample was judged acceptable, infauna sample for polychaetes were taken with a PVC core sampler 7.6 cm dia. By 10 cm deep. Sample was transferred to a 500 ml wide mouth nalgene bottle with buffered formalin stained with rose bengal, additional formalin was added to insure penetration and coverage of sample. Second infauna sample

for mollusks was taken with a 5 cm dia by 5 cm deep PVC core sampler and transferred to a 125 ml wide mouth nalgenc bottle with de-ionized water. The remaining sediment chemistry, grain size and SOD samples were taken with plastic scoops and transferred to the appropriate storage bottles with de-ionized water. Samples for ICP metals were taken at least 1 cm away from the sides and bottom of the sampler. All samples except the infauna samples preserved in formalin were stored at 4°C. Van Veen sampler and holding basin were washed before the next grab. Four successfully grabs were needed to fill all containers. Two and one half liters of seawater was also taken from near the seafloor with a vertical polycarbonate water samples to provide dilution water.

Samples were transferred with the appropriate chain of custody documents to

a) Geo Engineering & Testing for grain size;

b) Water Resources Research center, University of Hawaii at Manoa for infauna analysis

c) Oceanic analytical Laboratory, Inc. in Aiea, Hawaii for the sediment chemistry and SOD analysis

C-4 Analytical Procedures

The analytical procedures for the infauna[1] and sediment chemistry analysis[2] had been previously documented.

Measurement of SOD insitu is impractical given the 275 ft depth at the outfall location. SOD was measured in standard incubation bottles with the standard methodology modified as follows;

1) Incubation bottles were calibrated for their cross-sectional areas at the level corresponding to a volume of 55 ml and tared empty
2) 55 ml of wet sediment is carefully added to each bottle, allowed to settle and weighed
3) Saturated seawater is carefully added to minimize disturbance of sediment
4) Bottles are incubated in the dark at 29 C

1. Baily-Brock, J.H. ''Defination of Indicator Species for Pollution Monitoring in Mamala Bay, Oahu, Hawaii''. *Project MB-9, Mamala Bay Study Final Report, vol 2,* (1996)

2. USEPA ''Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)

5) Bottles are opened consecutively on a schedule prorated as to D.O. depletion in the previous interval until the D.O in the saturation water has been depleted by 50% or incubation period has reached five days. Resuspended SOD is measured in the same manner except the sediment sample is reduced to 25 ml and the sediment is keep suspended during incubation with a platform shaker.

C-4 Results

Under sediment chemistry, only three compounds were detected as listed in table C.1, all other analysis were not detected at the reporting limit. The laboratory report for the samples taken in the middle of mixing are attached to reference analytical methods and their respective reporting limits.

Table C.1

Sediment Chemistry

Analysis	Sample ID		
	A-SE	A-SW	A-NE
Total Organic Carbon (mg/kg)	7730	4410	7430
Total Phosphorous (mg/kg)	118	148	153
Acetone mg/kg (dry)	0.469	0.00992	0.281
Moisture (%)	36.6	36.7	36.3
Oxygen Sediment Demand g O_2/m^2.day	0.116	0.233	0.355
Oxygen Resuspended Sediment Demand g O_2/g.day	0.011	0.019	0.054

The classification and identification of infauna species is scheduled for completion in November 2001.

Results for grain size are pending at the time of this report.

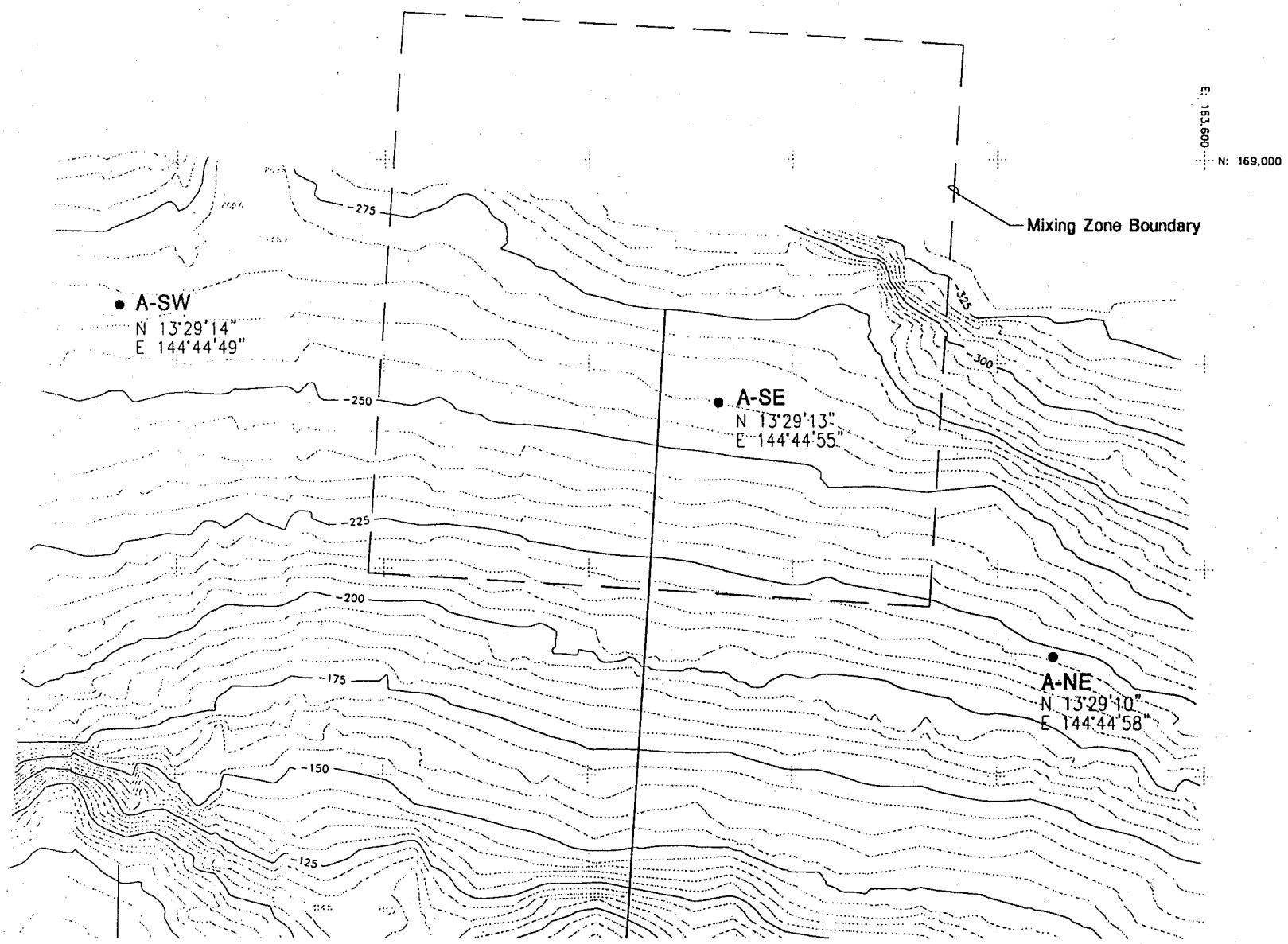


Figure C-1 SEDIMENT GRAB LOCATIONS

GRAPHIC SCALE:
100' 0 100' 200'

Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04A	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual	Notes
CYANIDE, TOTAL			**SW9010**							
Cyanide	ND	0.431	mg/Kg	1	8/2/2001	8/2/2001	1H02042	SUB		
ORGANIC CARBON, TOTAL			**SW9060**							
Total Organic Carbon	***7730***	1000	mg/Kg	1	7/30/2001	7/30/2001	1G27028	SUB		
PHOSPHOROUS, TOTAL			**SW6010B**							
Phosphorus, Total (As P)	***118***	7.87	mg/Kg	1	8/2/2001	8/6/2001	1H02028	SUB		

Qualifiers

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04B	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual	Notes
ICP METALS, TOTAL			**SW6010A**							
Antimony	ND	15.8	mg/Kg-dry	1	7/30/2001	7/30/2001	4147	TKL		
Arsenic	ND	7.89	mg/Kg-dry	1						
Beryllium	ND	0.789	mg/Kg-dry	1						
Cadmium	ND	3.15	mg/Kg-dry	1						
Chromium	ND	7.89	mg/Kg-dry	1						
Copper	ND	15.8	mg/Kg-dry	1						
Lead	ND	31.5	mg/Kg-dry	1						
Nickel	ND	15.8	mg/Kg-dry	1						
Selenium	ND	31.5	mg/Kg-dry	1						
Silver	ND	7.89	mg/Kg-dry	1						
Thallium	ND	31.5	mg/Kg-dry	1						
Zinc	ND	15.8	mg/Kg-dry	1						
MERCURY, TOTAL			**SW7471**							
Mercury	ND	0.315	mg/Kg-dry	1	8/6/2001	8/6/2001	4181	MFB		
ORGANOCHLORINE PESTICIDES			**SW8081**							
4,4'-DDD	ND	0.00515	mg/Kg-dry	1	8/3/2001	8/4/2001	4174	EDF		
4,4'-DDE	ND	0.00515	mg/Kg-dry	1						
4,4'-DDT	ND	0.00515	mg/Kg-dry	1						
Aldrin	ND	0.00265	mg/Kg-dry	1						
alpha-BHC	ND	0.00265	mg/Kg-dry	1						
beta-BHC	ND	0.00265	mg/Kg-dry	1						
Chlordane	ND	0.0515	mg/Kg-dry	1						
delta-BHC	ND	0.00265	mg/Kg-dry	1						
Dieldrin	ND	0.00515	mg/Kg-dry	1						
Endosulfan I	ND	0.00265	mg/Kg-dry	1						
Endosulfan II	ND	0.00515	mg/Kg-dry	1						
Endosulfan sulfate	ND	0.00515	mg/Kg-dry	1						
Endrin	ND	0.00515	mg/Kg-dry	1						
Endrin aldehyde	ND	0.00515	mg/Kg-dry	1						
gamma-BHC	ND	0.00265	mg/Kg-dry	1						
Heptachlor	ND	0.00265	mg/Kg-dry	1						
Heptachlor epoxide	ND	0.00265	mg/Kg-dry	1						
Methoxychlor	ND	0.0265	mg/Kg-dry	1						
Toxaphene	ND	0.265	mg/Kg-dry	1						
Surr: Decachlorobiphenyl	86.8	50-150	%REC	1						
Surr: Tetrachloro-m-xylene	79.2	50-150	%REC	1						

Qualifiers

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J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
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R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04B	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual	Notes
PCBS IN SOIL OR SOLID WASTE		**SW8082**								
Aroclor 1016	ND	0.0521	mg/Kg-dry	1	8/3/2001	8/6/2001	4173	RTK		
Aroclor 1221	ND	0.104	mg/Kg-dry	1						
Aroclor 1232	ND	0.0521	mg/Kg-dry	1						
Aroclor 1242	ND	0.0521	mg/Kg-dry	1						
Aroclor 1248	ND	0.0521	mg/Kg-dry	1						
Aroclor 1254	ND	0.0521	mg/Kg-dry	1						
Aroclor 1260	ND	0.0521	mg/Kg-dry	1						
Surr: Decachlorobiphenyl	108	50-150	%REC	1						
Surr: Tetrachloro-m-xylene	93.2	50-150	%REC	1						
PERCENT MOISTURE		**ILMO4.0**								
Percent Moisture	36.6	0.100	wt%	1	7/30/2001	7/31/2001	R11023	MFB		

Qualifiers

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R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04B	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual	Notes
SEMIVOLATILE ORGANICS		**SW8270A**								
1,2,4,5-Tetrachlorobenzene	ND	0.507	mg/Kg-dry	1	7/31/2001	8/7/2001	4152	EDF		
1,2,4-Trichlorobenzene	ND	0.507	mg/Kg-dry	1						
1,2-Dichlorobenzene	ND	0.507	mg/Kg-dry	1						
1,3-Dichlorobenzene	ND	0.507	mg/Kg-dry	1						
1,4-Dichlorobenzene	ND	0.507	mg/Kg-dry	1						
1-Chloronaphthalene	ND	0.507	mg/Kg-dry	1						
1-Naphthylamine	ND	0.507	mg/Kg-dry	1						
2,3,4,6-Tetrachlorophenol	ND	0.507	mg/Kg-dry	1						
2,4,5-Trichlorophenol	ND	0.507	mg/Kg-dry	1						
2,4,6-Trichlorophenol	ND	0.507	mg/Kg-dry	1						
2,4-Dichlorophenol	ND	0.507	mg/Kg-dry	1						
2,4-Dimethylphenol	ND	0.507	mg/Kg-dry	1						
2,4-Dinitrophenol	ND	2.61	mg/Kg-dry	1						
2,4-Dinitrotoluene	ND	0.507	mg/Kg-dry	1						
2,6-Dichlorophenol	ND	0.507	mg/Kg-dry	1						
2,6-Dinitrotoluene	ND	0.507	mg/Kg-dry	1						
2-Chloronaphthalene	ND	0.507	mg/Kg-dry	1						
2-Chlorophenol	ND	0.507	mg/Kg-dry	1						
2-Methylnaphthalene	ND	0.507	mg/Kg-dry	1						
2-Methylphenol	ND	0.507	mg/Kg-dry	1						
2-Naphthylamine	ND	0.507	mg/Kg-dry	1						
2-Nitroaniline	ND	2.61	mg/Kg-dry	1						
2-Nitrophenol	ND	0.507	mg/Kg-dry	1						
2-Picoline	ND	0.507	mg/Kg-dry	1						
3,3'-Dichlorobenzidine	ND	0.507	mg/Kg-dry	1						
3-Methylcholanthrene	ND	0.507	mg/Kg-dry	1						
3-Nitroaniline	ND	2.61	mg/Kg-dry	1						
4,6-Dinitro-2-methylphenol	ND	2.61	mg/Kg-dry	1						
4-Aminobiphenyl	ND	0.507	mg/Kg-dry	1						
4-Bromophenyl phenyl ether	ND	0.507	mg/Kg-dry	1						
4-Chloro-3-methylphenol	ND	0.507	mg/Kg-dry	1						
4-Chloroaniline	ND	0.507	mg/Kg-dry	1						
4-Chlorophenyl phenyl ether	ND	0.507	mg/Kg-dry	1						
4-Methylphenol	ND	0.507	mg/Kg-dry	1						
4-Nitroaniline	ND	0.507	mg/Kg-dry	1						
4-Nitrophenol	ND	2.61	mg/Kg-dry	1						
7,12-Dimethylbenz(a)anthracene	ND	0.507	mg/Kg-dry	1						
a,a-Dimethylphenethylamine	ND	2.61	mg/Kg-dry	1						
Acenaphthene	ND	0.507	mg/Kg-dry	1						
Acenaphthylene	ND	0.507	mg/Kg-dry	1						

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Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04B	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual	Notes
Acetophenone	ND	0.507	mg/Kg-dry	1						
Aniline	ND	0.507	mg/Kg-dry	1						
Anthracene	ND	0.507	mg/Kg-dry	1						
Azobenzene	ND	0.507	mg/Kg-dry	1						
Benz(a)anthracene	ND	0.507	mg/Kg-dry	1						
Benzidine	ND	2.61	mg/Kg-dry	1						
Benzo(a)pyrene	ND	0.507	mg/Kg-dry	1						
Benzo(b)fluoranthene	ND	0.507	mg/Kg-dry	1						
Benzo(g,h,i)perylene	ND	0.507	mg/Kg-dry	1						
Benzo(k)fluoranthene	ND	0.507	mg/Kg-dry	1						
Benzoic acid	ND	2.61	mg/Kg-dry	1						
Benzyl alcohol	ND	0.507	mg/Kg-dry	1						
Bis(2-chloroethoxy)methane	ND	0.507	mg/Kg-dry	1						
Bis(2-chloroethyl)ether	ND	0.507	mg/Kg-dry	1						
Bis(2-chloroisopropyl)ether	ND	0.507	mg/Kg-dry	1						
Bis(2-ethylhexyl)phthalate	ND	0.507	mg/Kg-dry	1						
Butyl benzyl phthalate	ND	0.507	mg/Kg-dry	1						
Chrysene	ND	0.507	mg/Kg-dry	1						
Di-n-butyl phthalate	ND	0.507	mg/Kg-dry	1						
Di-n-octyl phthalate	ND	0.507	mg/Kg-dry	1						
Dibenz(a,h)anthracene	ND	0.507	mg/Kg-dry	1						
Dibenz(a,j)acridine	ND	0.507	mg/Kg-dry	1						
Dibenzofuran	ND	0.507	mg/Kg-dry	1						
Diethyl phthalate	ND	0.507	mg/Kg-dry	1						
Dimethyl phthalate	ND	0.507	mg/Kg-dry	1						
Ethyl methanesulfonate	ND	0.507	mg/Kg-dry	1						
Fluoranthene	ND	0.507	mg/Kg-dry	1						
Fluorene	ND	0.507	mg/Kg-dry	1						
Hexachlorobenzene	ND	0.507	mg/Kg-dry	1						
Hexachlorobutadiene	ND	0.507	mg/Kg-dry	1						
Hexachlorocyclopentadiene	ND	0.507	mg/Kg-dry	1						
Hexachloroethane	ND	0.507	mg/Kg-dry	1						
Indeno(1,2,3-cd)pyrene	ND	0.507	mg/Kg-dry	1						
Isophorone	ND	0.507	mg/Kg-dry	1						
Methyl methanesulfonate	ND	0.507	mg/Kg-dry	1						
N-Nitroso-di-n-butylamine	ND	0.507	mg/Kg-dry	1						
N-Nitrosodi-n-propylamine	ND	0.507	mg/Kg-dry	1						
N-Nitrosodimethylamine	ND	0.507	mg/Kg-dry	1						
N-Nitrosodiphenylamine	ND	0.507	mg/Kg-dry	1						
N-Nitrosopiperidine	ND	0.507	mg/Kg-dry	1						
Naphthalene	ND	0.507	mg/Kg-dry	1						

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E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04B	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual Notes
Nitrobenzene	ND	0.507	mg/Kg-dry	1					
p-Dimethylaminoazobenzene	ND	0.507	mg/Kg-dry	1					
Pentachloronitrobenzene	ND	0.507	mg/Kg-dry	1					
Pentachlorophenol	ND	2.61	mg/Kg-dry	1					
Phenacetin	ND	0.507	mg/Kg-dry	1					
Phenanthrene	ND	0.507	mg/Kg-dry	1					
Phenol	ND	0.507	mg/Kg-dry	1					
Pronamide	ND	0.507	mg/Kg-dry	1					
Pyrene	ND	0.507	mg/Kg-dry	1					
Pyridine	ND	0.507	mg/Kg-dry	1					
Surr: 2,4,6-Tribromophenol	104	43.2-139	%REC	1					
Surr: 2-Fluorobiphenyl	68.6	43.6-137	%REC	1					
Surr: 2-Fluorophenol	62.8	20.5-124	%REC	1					
Surr: 4-Terphenyl-d14	100	53.9-131	%REC	1					
Surr: Nitrobenzene-d5	58.7	51.1-108	%REC	1					
Surr: Phenol-d6	78.8	23.9-132	%REC	1					
SULFIDE		**SW9030**							
Sulfide	ND	15.8	mg/Kg-dry	1	8/1/2001	8/1/2001	R11082	MFB	
TOTAL KJELDAHL NITROGEN		**E351.2**							
Nitrogen, Kjeldahl, Total	ND	394	mg/Kg-dry	1	7/25/2001	7/25/2001	R10930	JYD	

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R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04C	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual	Notes
VOLATILES BY GC/MS			**SW8260A**							
1,1,1,2-Tetrachloroethane	ND	0.0158	mg/Kg-dry	1	8/2/2001	8/2/2001	R11085	KAL		
1,1,1-Trichloroethane	ND	0.0158	mg/Kg-dry	1						
1,1,2,2-Tetrachloroethane	ND	0.0158	mg/Kg-dry	1						
1,1,2-Trichloroethane	ND	0.0158	mg/Kg-dry	1						
1,1-Dichloroethane	ND	0.0789	mg/Kg-dry	1						
1,1-Dichloroethene	ND	0.0158	mg/Kg-dry	1						
1,1-Dichloropropene	ND	0.0158	mg/Kg-dry	1						
1,2,3-Trichlorobenzene	ND	0.0158	mg/Kg-dry	1						
1,2,3-Trichloropropane	ND	0.0158	mg/Kg-dry	1						
1,2,4-Trichlorobenzene	ND	0.0789	mg/Kg-dry	1						
1,2,4-Trimethylbenzene	ND	0.0158	mg/Kg-dry	1						
1,2-Dibromo-3-chloropropane	ND	0.0158	mg/Kg-dry	1						
1,2-Dibromoethane	ND	0.0158	mg/Kg-dry	1						
1,2-Dichlorobenzene	ND	0.0789	mg/Kg-dry	1						
1,2-Dichloroethane	ND	0.0789	mg/Kg-dry	1						
1,2-Dichloropropane	ND	0.0158	mg/Kg-dry	1						
1,3,5-Trimethylbenzene	ND	0.0158	mg/Kg-dry	1						
1,3-Dichlorobenzene	ND	0.0789	mg/Kg-dry	1						
1,3-Dichloropropane	ND	0.0158	mg/Kg-dry	1						
1,4-Dichlorobenzene	ND	0.0789	mg/Kg-dry	1						
2,2-Dichloropropane	ND	0.0158	mg/Kg-dry	1						
2-Butanone	ND	0.0789	mg/Kg-dry	1						
2-Chlorotoluene	ND	0.0158	mg/Kg-dry	1						
2-Hexanone	ND	0.0789	mg/Kg-dry	1						
4-Chlorotoluene	ND	0.0158	mg/Kg-dry	1						
4-Isopropyltoluene	ND	0.0158	mg/Kg-dry	1						
4-Methyl-2-pentanone	ND	0.0789	mg/Kg-dry	1						
Acetone	*0.469*	0.0789	mg/Kg-dry	1						
Acrylonitrile	ND	0.0789	mg/Kg-dry	1						
Benzene	ND	0.0158	mg/Kg-dry	1						
Bromobenzene	ND	0.0158	mg/Kg-dry	1						
Bromochloromethane	ND	0.0789	mg/Kg-dry	1						
Bromodichloromethane	ND	0.0158	mg/Kg-dry	1						
Bromoform	ND	0.0158	mg/Kg-dry	1						
Bromomethane	ND	0.0789	mg/Kg-dry	1						
Carbon disulfide	ND	0.0158	mg/Kg-dry	1						
Carbon tetrachloride	ND	0.0158	mg/Kg-dry	1						
Chlorobenzene	ND	0.0158	mg/Kg-dry	1						
Chloroethane	ND	0.0789	mg/Kg-dry	1						
Chloroform	ND	0.0158	mg/Kg-dry	1						

Qualifiers

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 16, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	A-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/20/2001 9:00
Lab ID:	0107159-04C	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepare	Date Analyze	Batch ID	Analyst	Qual	Notes
Chloromethane	ND	0.0789	mg/Kg-dry	1						
cis-1,2-Dichloroethene	ND	0.0158	mg/Kg-dry	1						
cis-1,3-Dichloropropene	ND	0.0158	mg/Kg-dry	1						
Dibromochloromethane	ND	0.0158	mg/Kg-dry	1						
Dibromomethane	ND	0.0158	mg/Kg-dry	1						
Dichlorodifluoromethane	ND	0.0789	mg/Kg-dry	1						
Ethylbenzene	ND	0.0158	mg/Kg-dry	1						
Hexachlorobutadiene	ND	0.0789	mg/Kg-dry	1						
Iodomethane	ND	0.0789	mg/Kg-dry	1						
Isopropylbenzene	ND	0.0158	mg/Kg-dry	1						
m,p-Xylene	ND	0.0158	mg/Kg-dry	1						
Methyl tert-butyl ether	ND	0.0158	mg/Kg-dry	1						
Methylene chloride	ND	0.0789	mg/Kg-dry	1						
n-Butylbenzene	ND	0.0158	mg/Kg-dry	1						
n-Propylbenzene	ND	0.0158	mg/Kg-dry	1						
Naphthalene	ND	0.0789	mg/Kg-dry	1						
o-Xylene	ND	0.0158	mg/Kg-dry	1						
sec-Butylbenzene	ND	0.0158	mg/Kg-dry	1						
Styrene	ND	0.0158	mg/Kg-dry	1						
tert-Butylbenzene	ND	0.0158	mg/Kg-dry	1						
Tetrachloroethene	ND	0.0158	mg/Kg-dry	1						
Toluene	ND	0.0158	mg/Kg-dry	1						
trans-1,2-Dichloroethene	ND	0.0158	mg/Kg-dry	1						
trans-1,3-Dichloropropene	ND	0.0158	mg/Kg-dry	1						
trans-1,4-Dichloro-2-butene	ND	0.0789	mg/Kg-dry	1						
Trichloroethene	ND	0.0158	mg/Kg-dry	1						
Trichlorofluoromethane	ND	0.0158	mg/Kg-dry	1						
Vinyl acetate	ND	0.0789	mg/Kg-dry	1						
Vinyl chloride	ND	0.0789	mg/Kg-dry	1						
Surr: 1,2-Dichloroethane-d4	124	81.6-153	%REC	1						
Surr: 4-Bromofluorobenzene	111	80-120	%REC	1						
Surr: Dibromofluoromethane	115	81.8-137	%REC	1						
Surr: Toluene-d8	87.3	70.7-129	%REC	1						

Qualifiers

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

APPENDIX D

GEOTECHNICAL SURVEY

REPORT

GEOTECHNICAL INVESTIGATION
NORTHERN DISTRICT SEWER OUTFALL EXTENSION
and AGANA SEWAGE TREATMENT PLANT OUTFALL EXTENSION
DEDEDO and HAGATNA, GUAM

Prepared for

GMP ASSOCIATES, INC.
ITC BUILDING, 3rd FLOOR
MARINE DRIVE
TAMUNING, GUAM 96931

By

GEO-ENGINEERING & TESTING, INC.
POST OFFICE BOX 8170
TAMUNING, GUAM 96931

18 AUGUST 2001

353.21(B)

INTRODUCTION

This report presents the results of the geotechnical investigation we performed for the Northern District Sewer Outfall Extension and the Agana Sewage Treatment Plant Sewer Outfall Extension.

The Northern District Outfall Extension Pipe Line will be constructed from the existing manhole at Tanguisson Point which is at Elevation +22 feet (Mean Lower Low Water = 0.00 feet), crossing the beach and reef flat directly in front and into the deep sea floor to discharge at approximately Elev. -150 feet deep below the sea will serve the nearby Northern District Sewage Treatment Plant. The total length of the outfall pipeline is approximately 2000 feet.

The Agana (or Hagatna) site will be an extension of the Agana Sewage Treatment Plant Outfall Line, for a total length of approximately 2200 linear feet. The new pipe line surface elevations will be from approximately Elevation +12.00 at the treatment plant site to Elevation –275 feet.

The purpose of our investigation was to perform limited subsurface exploration along the two new pipe lines, so as to provide discussion, opinions and recommendations concerning the two pipe lines, generally as follows:

1. General subsurface soil and rock conditions along the two new, pipe lines, as interpreted from the subsurface conditions found from the new test borings.

2. Feasibility of horizontal directional drilling method of installing the new pipe lines, from geotechnical engineering stand point.

3. Possible difficulties, from geotechnical engineering view point, concerning the installation of the new pipe lines; such as unsuitable

material for the horizontal directional drilling and piping, caving soils that may affect the stability of the drilling, and cavities.

SUBSURFACE EXPLORATION

We explored the subsurface conditions at both the Tanguisson and Agana sites by drilling test borings with a trailer-mounted, rotary wash drilling equipment. The drill rig was mounted on a floating support platform for the over-the-water drilling.

Our limited set-up for this investigation could not drill in the deep-water portions of the two outfall lines beyond the reef-flat due to the high wave conditions. However, the information obtained from the test borings under this investigation appears to be adequate for interpolation into or estimating the subsurface conditions for the remaining portions of the outfall lines for design and bid purposes.

At the Tanguisson outfall site, we drilled four test borings up to the edge of the reef flat. The depth of the test bored holes ranged from 18 feet at the entrance of the outfall pipe line to 60 feet below the existing sea floor. Boring 4 at the edge of the reef-flat area could not drill deeper due to existence of hard coralline limestone and crashing waves. However, all the four test borings penetrated significant depths in to the hard to very hard, underlying coralline limestone rock formation which is judged to extend at least several hundred feet beneath the sea floor.

At the Agana Sewage Treatment Plant outfall site, we also drilled four test borings with the same equipment set-up. The boring depth ranged from 32 to 90 feet below the existing surface (Boring 1) and the shallow sea floor (remaining bored holes). All the four test borings penetrated significantly into the underlying coralline limestone rock formation.

During the drilling of the test borings, we logged the subsurface conditions encountered in the test bored holes and obtained subsurface soil and rock samples for visual examination, classification, and laboratory testing. The test boring locations and the logs of the test borings are presented in Appendix A for the Tanguisson outfall site and in Appendix B for the Agana outfall site.

While obtaining the subsurface soil and rock samples, we also performed the standard penetration test or obtaining the N-values. The N-value is defined as the number of blows required to drive a 2.0-inch diameter, split spoon soil sampler 12 inches deep into the underlying soil or rock with a 140-pound drop weight free falling 30 inches per each blow. The collected N-values are shown on the boring logs at their respective depths. The N-values are commonly used for empirically estimating the unconfined compressive strength and consistency of soils and rocks.

In addition to the above, we performed rock coring in Borings 2, 3 and 4 at the Tanguisson site and Boring 4 at the Agana site. The rock cores were conducted with a Nx series core barrel having 3.0-inch outside diameter and 5 feet in length. Due to the nature of coralline limestone formations, the rock core recoveries ranged from zero to the 61 percent. The rock core depths and

recoveries, as well as rock quality RQD are shown on the boring logs at their respective depths. Plate 6 in the Appendix A presents the Unified Soil Classification System that is commonly used for describing soils.

LABORATORY TESTING

In our testing laboratory, we re-examined the subsurface soil and rock samples obtained from the test bored holes and tested selected samples. The tests we performed included in-situ moisture content and dry density (unit weight), particle size distribution (sieve analysis), specific gravity and absorption and unconfined compressive strength of rock cored samples. The test results are shown on the boring logs at the depths where the tested samples were obtained. The test name abbreviations are explained on a Key to Test Data shown on Plate 6 of the Appendix A.

SUBSURFACE CONDITIONS

Tanguisson Outfall Site

The Tanguisson outfall pipe line is essentially underlain with near-surface to shallow coralline limestone rock formation. Boring 1 at the entrance of the pipe line and beach area encountered approximately 5-1/2 feet thick of loose to medium dense, light color gravelly sand of beach deposits overlying very dense to hard coral fingers and cobbles to approximately 14 feet deep, and hard

coralline limestone formation beneath 14 feet. The remaining three test borings encountered hard coralline limestone formation from the sea floor to the full depths of the test borings (30 to 60 feet deep). Laboratory unconfined compressive strength test results on the rock core samples from these test bored holes ranged from 1038 pounds per square inch (psi) to as high as 3148 psi, which are equivalent to masonry block strength to regular 3000 psi ready-mixed concrete. These strengths are considered relatively high for coralline limestone and an indication of existence of relatively hard rock. The coralline limestone formation should extend to at least several hundred feet to more than a thousand feet before reaching the basaltic basement rock.

Agana Outfall Site

Boring 1 at the entrance of the pipe line inside the treatment plant compound encountered several inches of silty topsoil and very dense to hard limestone gravel and cobble rock fill material to approximately 13 feet deep, overlying approximately 5 feet thick of very dense, formerly beach deposit of gravelly sand. Hard coralline limestone formation exists below approximately 14 feet deep in this bored hole. Ground water in Boring 1 was gauged at 11.3 feet deep; it could fluctuated with tidal changes.

Boring 2 at this site encountered approximately 8 feet thick of loose, relatively fine-grained beach sand, overlying approximately 8 more feet thick of medium dense sandy coral gravel and loose to dense gravelly sand to approximately 33 feet deep. Moderately hard to hard coralline limestone exists

below 33 feet deep to the 50-foot depth of this bored hole. It is expected that the limestone would be hard below 50 feet.

Boring 3 and 3A further out on the reef flat encountered moderately hard to hard coralline limestone; but Boring 3 is also underlain with approximately 28 feet thick of dense to very dense sand which could have been a pocket within the irregular surface of the reef flat.

In general, the coralline limestone formation at the Agana Sewage Treatment Plant outfall site is moderately hard in the upper few to several feet and becomes hard with increasing depth.

DISCUSSION AND OPINIONS

The results of our investigation indicate that both the Tanguisson and the Agana sewer outfall pipe line sites are underlain with favorable, generally shallow and relatively hard coralline limestone rock formation, particularly within the depth range of the proposed pipe lines. However, the entrance points of the pipe lines at the beach area and the treatment plant site are underlain with beach sand and gravelly soil but should not have significant effect on the over-all pipe line installation by horizontal, directional drilling.

We did not encounter caverns or cavities of noticeable sizes, and the limestone in the test bored holes appear to be consistent and relatively uniform. Therefore, although existence of under-surface, significant size cavities and even caverns can not be completely ruled out, the chance of such occurrence within

the two outfall project sites should be very unlikely or remote. It is also possible that there may be sand pocket(s) existing within the upper 50 or 60 feet or so; but any such sand pockets would likely be dense to very dense and could hold together (by its adhesion or light cementation effects) even if it is encountered in the underground directional drilling.

Based on our findings and the above discussion, it is our opinion that the proposed horizontal, directional drilling for the installation of the new sewer outfall pipe lines is feasible and is superior over the conventional cut-and-fill method of installing sewer outfall pipe lines.

The following appendices complete our preliminary report for the geotechnical investigation performed for the Tanguisson and Agana sewer outfall pipeline project.

APPENDIX A - Tanguisson Outfall Site

Plate 1	-	Test Boring Location
Plates 2 through 5	-	Logs of Borings 1 through 4
Plate 6	-	Soil Classification Chart and Key to Test Data
Plate 7	-	Summary of Laboratory Test Data

APPENDIX B - Agana Outfall Site

Plate 1	-	Test Boring Location
Plates 2 through 5	-	Logs of Borings 1, 2, 3 and 3A
Plate 6	-	Soil Classification Chart and Key to Test Data
Plate 7	-	Particle Size Distribution
Plate 8	-	Summary of Test Data

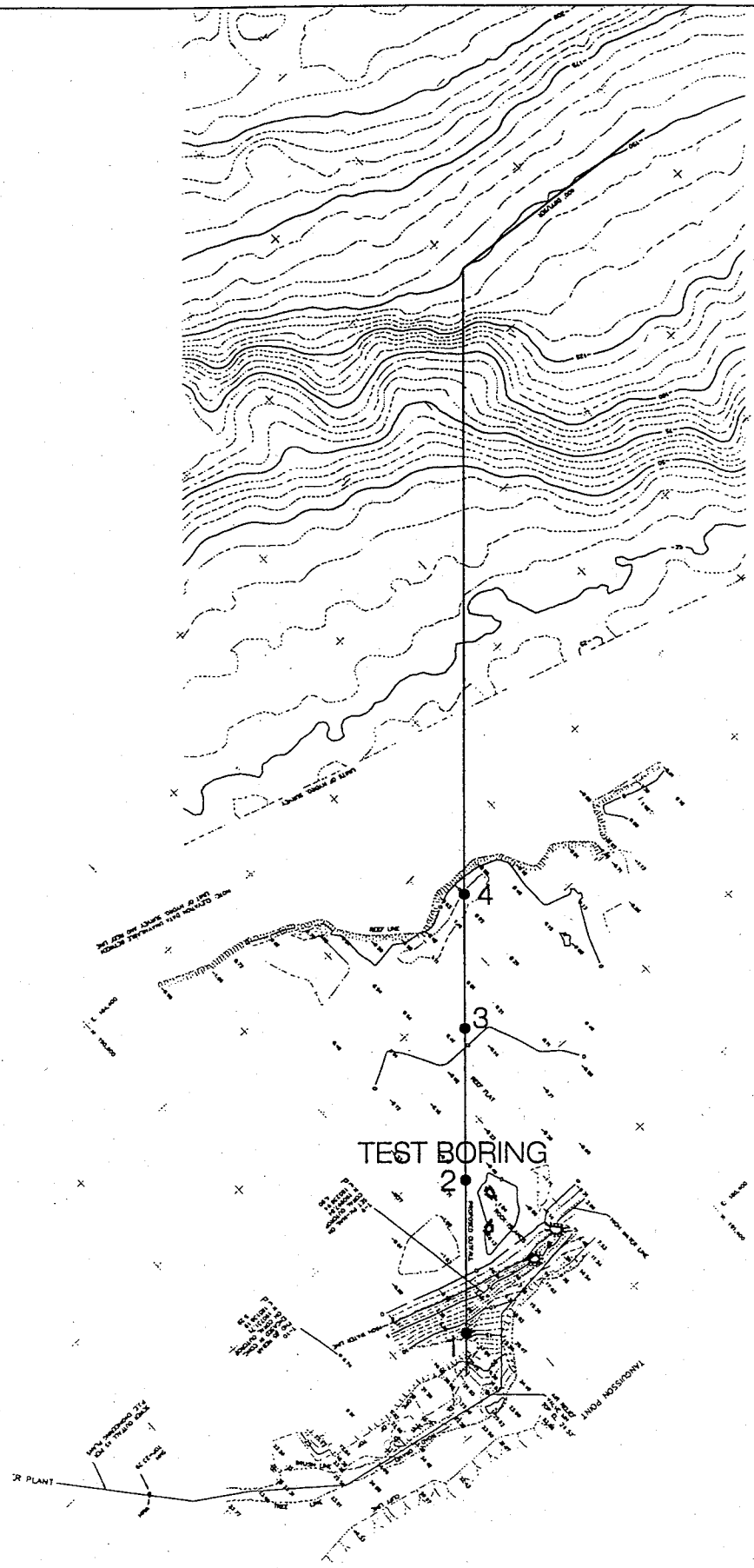
Respectfully submitted,

GEO-ENGINEERING & TESTING, INC.

Ukrit Siriprusanan
Civil Engineer - 360

APPENDIX A

TANGUISSON OUTFALL SITE



GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	**TEST BORING LOCATION** TANGUISSON SEWER OUTFALL	PLATE 1A
Job No. 353.21(B) Appr. US/ Date 8/10/01	TANGUISSON GUAM	

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AGA 2832

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT) SAMPLE SYMBOL	
					0	LIGHT BROWN-WHITE GRAVELLY SAND (SP) - loose to medium dense, slightly moist, with coral cobbles, boulders and short grass on surface
		13				
					5	LIGHT BROWN-WHITE CORAL FINGERS AND COBBLES (GP) - very dense, saturated
		10/0"				
					10	
		39/3"				
					15	LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard
						(Bottom of hole at 18')
					20	
					25	
					30	
					35	
					40	

LOG OF BORING 1

EQUIPMENT 8" Hollow Stem Auger

DATE 6/22/00

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 1
TANGUISSON SEWER OUT FALL
TANGUISSON GUAM

PLATE **2A**

AGA 2833

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT) SAMPLE SYMBOL	
						LOG OF BORING 2
						EQUIPMENT 3-7/8" Dia. Rotary Wash
						DATE 6/27/00
						Approximate depth of water = 4'
					0	LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard
						(Nx rock coring at 2' - 7'; Recovery = 36"; RQD = 23%)
						(Nx rock coring at 7' - 12'; Recovery = 36"; RQD = 12%)
					10	(Nx rock coring at12' - 17'; Recovery = 56"; RQD = 27%)
UC = 1906 psi						(Nx rock coring at17' - 22'; Recovery = 24"; RQD = 7%)
Gs					20	
UC = 1038 psi						(Nx rock coring at 22' - 27; Recovery = 51"; RQD = 45%)
UC = 1387 psi						(Nx rock coring at 27' - 32'; Recovery = 54"; RQD = 77%)
					30	(Rotary wash at 32' - 42')
					40	(Nx rock coring at 42' - 47'; Recovery = 49"; RQD = 67%)
						(Rotary wash at 47' - 57')
					50	
						(Nx rock coring at 57' - 62'; Recovery = 58%; RQD = 98%)
UC = 3148 psi						
Gs					60	
UC = 2629 psi						(Nx rock coring at 62' - 64'; Recovery = 20%; RQD = 48%)
						(Bottom of hole at 64')
					70	
					80	

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 2
TANGUISSON SEWER OUTFALL
TANGUISSON GUAM

PLATE
3A

AGA 2834

LOG OF BORING 3

EQUIPMENT 3-7/8" Dia. Rotary wash

DATE 6/30/00

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	
					0		LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard
							(Nx rock coring at 2' - 7'; Recovery = 58"; RQD = 36%)
							(Nx rock coring at 7' - 12'; Recovery = 60"; RQD = 33%)
UC = 2830 psi Gs UC = 1942 psi					10		(Nx rock coring at 12' - 17'; Recovery = 39"; RQD = 22%)
							(Nx rock coring at 17' - 22'; Recovery = 41"; RQD = 20%)
					20		(Rotary wash at 22' - 27')
							(Nx rock coring at 27' - 32'; Recovery = 37"; RQD = 8%)
					30		(Rotary wash at 32' - 37')
UC = 1144 psi UC = 1579 psi Gs							(Nx rock coring at 37' - 42'; Recovery = 35"; RQD = 20%)
					40		(Rotary wash at 42' - 47')
UC = 2656 psi UC = 1447 psi							(Nx rock coring at 47' - 52'; Recovery = 31"; RQD = 0%)
					50		(Rotary wash at 52' - 62')
UC = 2723 psi Gs					60		(Nx rock coring at 62' -67'; Recovery = 58'; RQD = 8%)
							(Bottom of hole at 67')
					70		
					80		

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 352.21 Appr. US/ Date 8/10/01

LOG OF BORING 3
TANGUISSON SEWER OUTFALL
TANGUISSON GUAM

PLATE **4A**

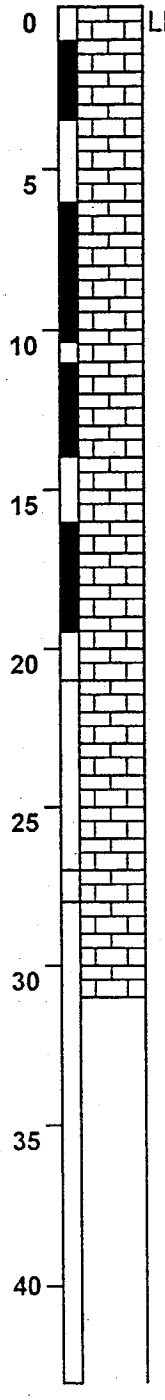
AGA 2835

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL

LOG OF BORING 4

EQUIPMENT 3-7/8" Dia. Rotary Wash

DATE 7/4/00



Approximate depth of water = 5'

LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard

(Nx rock coring at 1' - 6'; Recovery = 30"; RQD =28%)

(Nx rock coring at 6' - 11'; Recovery = 51"; RQD =44%)

(Nx rock coring at 11' - 16'; Recovery = 37"; RQD =10%)

(Nx rock coring at 16' - 21'; Recovery = 41"; RQD = 8%)

(Bottom of hole at 31')

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 4
TANGUISSON SEWER OUTFALL
TANGUISSON GUAM

PLATE
5A

AGA 2836

MAJOR DIVISIONS			SYMBOL		TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAT # 200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12 % FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12 % FINES	SM		SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN # 200 SIE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILT WITH SLIGHTLY PLASTICITY
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

SA	=	Sieve Analysis
UC	=	Unconfined Compressive Strength
Gs	=	Specific Gravity

■ "UNDISTURBED SAMPLE ☒ DISTURBED SAMPLE

KEY TO TEST DATA

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	**SOIL CLASSIFICATION CHART AND KEY TO TEST DATA** TANGUISSON SEWER OUTFALL	PLATE **6A**
Job No. 353.21 Appr. US/ Date: 8/10/01	TANGUISSON GUA	

AGA 2837

SPECIFIC GRAVITY AND ABSORPTION
(ASTM C-127)

Sample No.	Boring No.	Depth (ft)	Bulk Sp. Gr. Dry	Bulk Sp. Gr. (SSD)*	Apparent Sp. Gr.	Absorption (%)
1	2	17	2.06	2.21	2.42	7.26
2	2	57	2.26	2.33	2.44	3.29
3	3	12	2.18	2.32	2.54	6.40
4	3	37	2.35	2.43	2.54	3.16
5	3	62	2.34	2.41	2.52	3.07

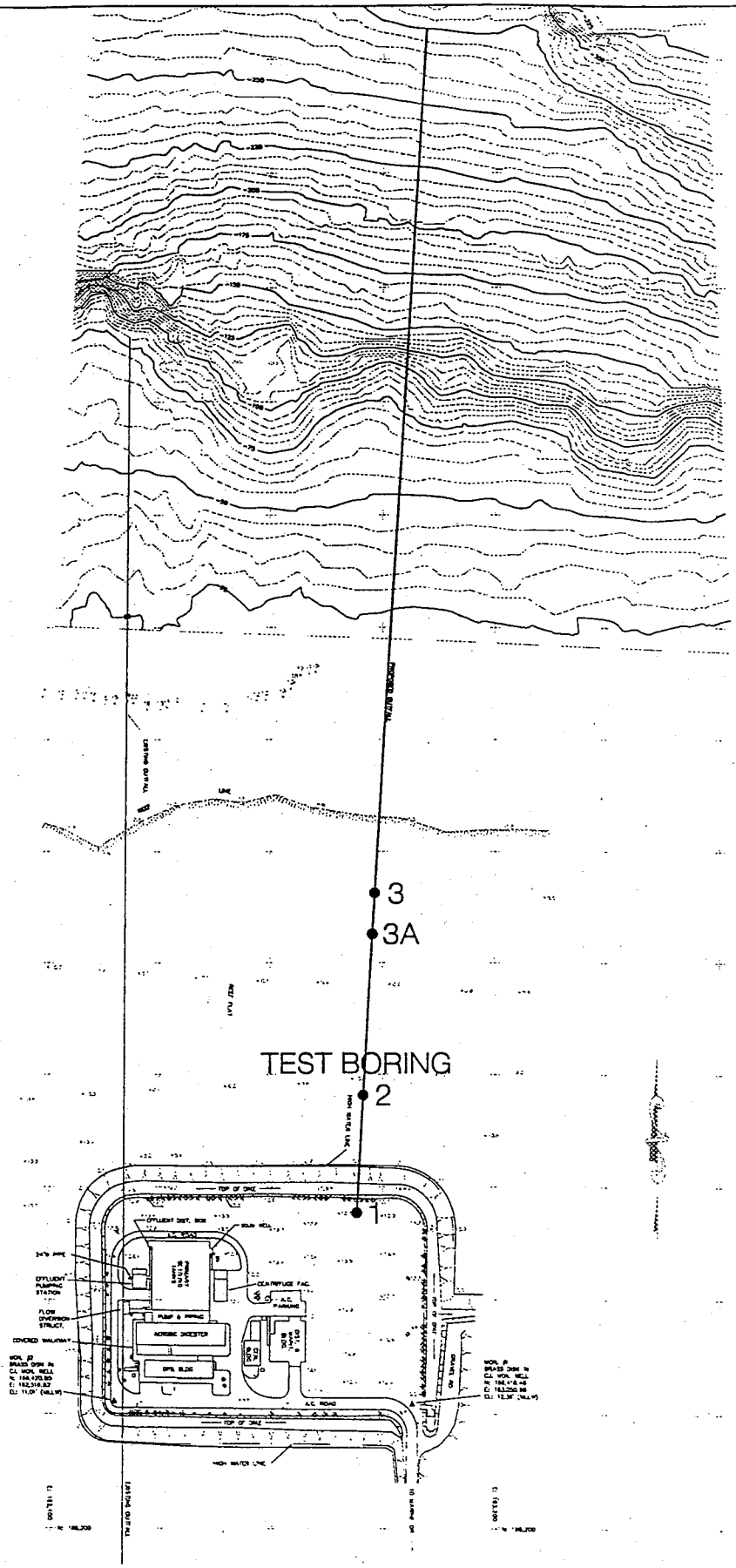
* SSD = Saturated Surface Dry

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	SUMMARY OF TEST DATA TANGUISSON SEWER OUTFALL	PLATE 7A
Job No. 353.21 Appr. Date	TANGUISSON GUAM	

AGA 2838

APPENDIX B

AGANA OUTFALL SITE



GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	TEST BORING LOCATION AGANA SEWER OUTFALL	PLATE 1B
Job No. 353.21(A) Appr. US/ Date	AGANA GUAM	

SC3250AD 08/23/01 13:29

AGA 2840

LOG OF BORING 1

EQUIPMENT 8" Hollow Stem Auger

DATE 8/2/00

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	
		17/0"			0		DARK BROWN CLAYEY SANDY SILT (MH) - soft, slightly moist
							LIGHT BROWN-WHITE SANDY LIMESTONE GRAVEL/ COBBLES (GP) - very dense to hard, moist
		40/4"			5		
					10		water level at 11.3'; 1:17 pm; 8/2/2000
SA		96/9"	12.9	117			
					15		LIGHT BROWN-WHITE GRAVELLY SAND (SP) - very dense, saturated, with fragments of sea shells
SA		61/6"	13.3	115			
					20		LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard
		20/1					
					25		
		10/0"					
					30		
		14/0.5"					(Bottom of hole at 32')
					35		
					40		

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Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 1
AGANA SEWER OUTFALL
AGANA GUAM

PLATE **2B**

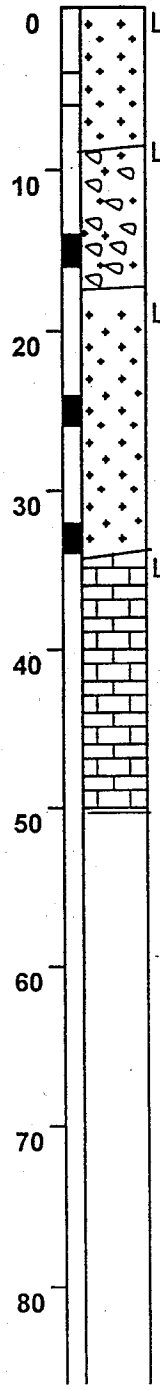
AGA 2841

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT) SAMPLE SYMBOL

LOG OF BORING 2

EQUIPMENT 3-7/8" Dia. Rotary Wash

DATE 8/2/00



Approximate depth of water = 5'

0 — LIGHT GREYISH WHITE FINE SAND (SP) - loose, saturated

10 — LIGHT BROWN-WHITE SANDY CORAL GRAVEL (GP) - loose to medium dense, saturated

19

20 — LIGHT BROWN-WHITE GRAVELLY SAND (SP) - loose saturated, with fragments of sea shells

7

dense from 28'.

30

30 — LIGHT BROWN-WHITE CORALLINE LIMESTONE - moderately hard , highly fractured, with sand pockets (Nx rock coring at 37' - 47', no recovery)

40

hard from 48'

10/0"

50 — (Bottom of hole at 50')

60

70

80

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LOG OF BORING 2
AGANA SEWER OUTFALL
AGANA GUAM

PLATE
3B

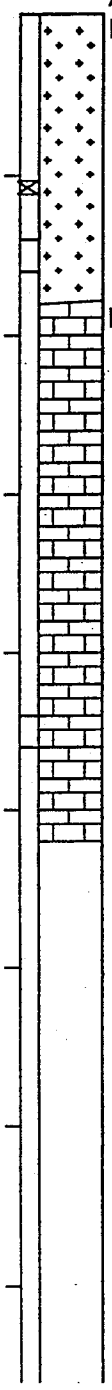
AGA 2842

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL

LOG OF BORING 3

EQUIPMENT 8" Hollow Stem Auger

DATE 8/3/01



Approximate depth of water = 5'

LIGHT BROWN-WHITE SAND (SP) - dense to very dense, saturated

39

LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard

10/0.5"

20/0"

(Nx rock coring at 37' - 47', no recovery)

(Bottom of hole at 52')

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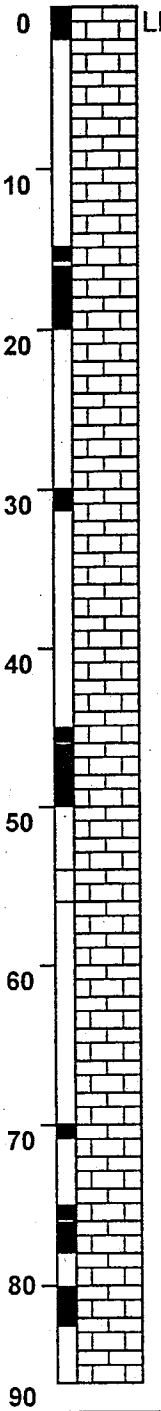
LOG OF BORING 3
AGANA SEWER OUTFALL
AGANA GUAM

PLATE 4B

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	
							LOG OF BORING 3A
							EQUIPMENT 3-7/8" Dia. Rotary Wash
							DATE 8/9/00

Approximate depth of water = 5'



LIGHT BROWN-WHITE CORALLINE LIMESTONE - moderately hard to hard

(Nx rock coring at 0' - 5'; Recovery = 2'-2"; RQD =17%)

(Rotary wash from 5' - 15')
hard from 10'

Gs

(Nx rock coring at 15' - 20'; Recovery =60"; RQD = 48%)

(Rotary wash from 20' - 30')

(Nx rock coring at 30' - 35'; Recovery = 18"; RQD = 0%)

(Rotary wash at 35' - 45')

UC = 3960psi
Gs

(Nx rock coring at 45' - 50'; Recovery =33"; RQD = 27%

(Rotary wash at 50' - 60')

(Nx rock coring at 60' - 70'; No recovery)

(Nx rock coring at 70' - 75' ; Recovery = 12", RQD= 0%)

(Nx rock coring at 75' - 80', Recovery = 36"; RQD = 25%)

UC = 1690 psi
Gs

(Nx rock coring at 80' - 85', Recovery = 28"; RQD = 14%)

(Nx rock coring at 85' - 90', No recovery)
(Bottom of hole at 90')

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Geotechnical & Material Testing Engineers

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LOG OF BORING 3A
AGANA SEWER OUTFALL
AGANA GUAM

PLATE
5B

AGA 2844

MAJOR DIVISIONS			SYMBOL		TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAT # 200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12 % FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12 % FINES	SM		SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN # 200 SIE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILT WITH SLIGHTLY PLASTICITY
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

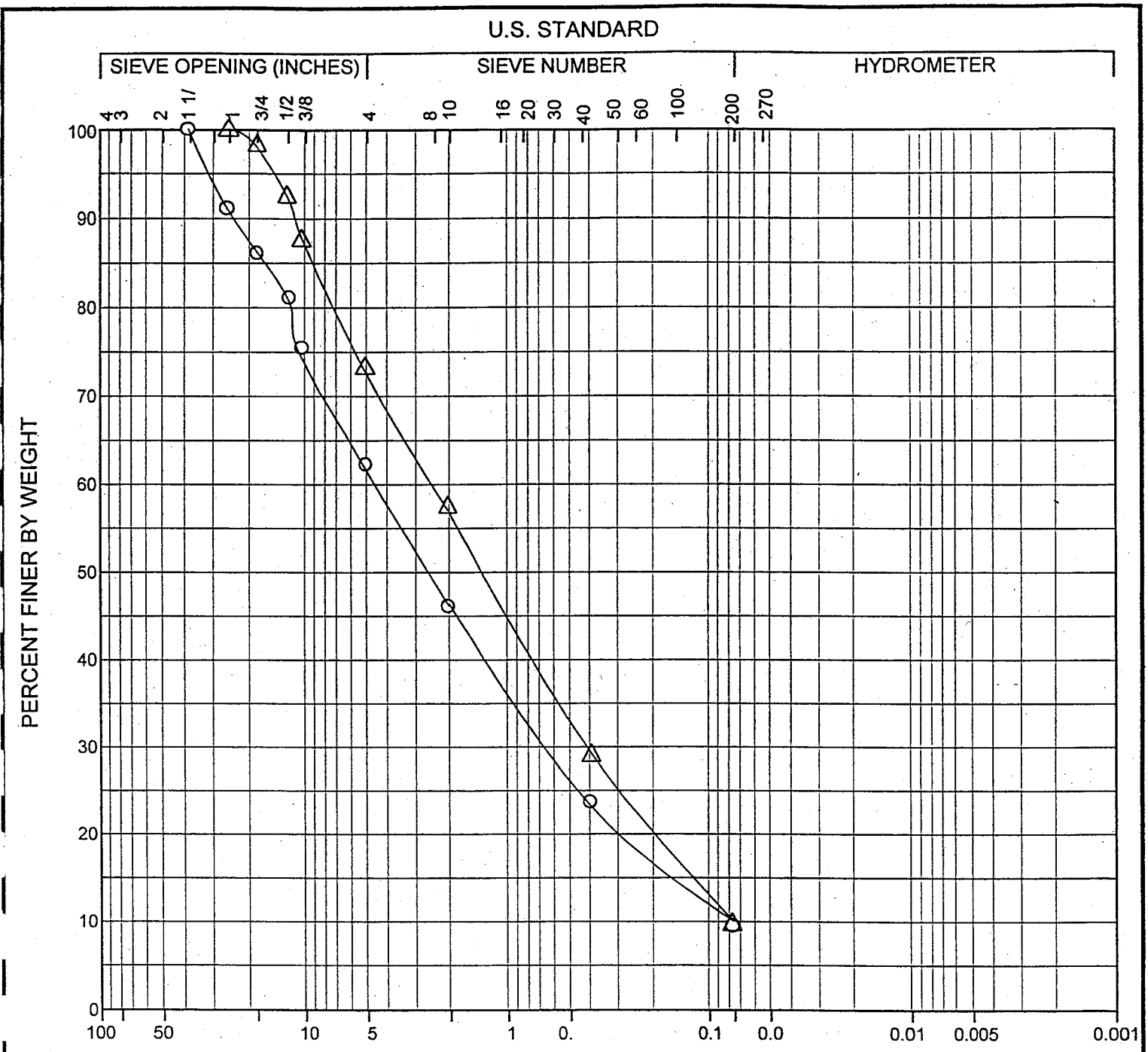
SA	=	Sieve Analysis
UC	=	Unconfined Compressive Strength
Gs	=	Specific Gravity
RQD	=	Rock Quality Designation

■ "UNDISTURBED SAMPLE ☒ DISTURBED SAMPLE

KEY TO TEST DATA

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	**SOIL CLASSIFICATION CHART AND KEY TO TEST DATA** AGANA SEWER OUTFALL	PLATE **6B**
Job No. 353.21 Appr. US/ Date: 8/10/01	AGANA GU	

AGA 2845



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	SAMPLE SOURCE	CLASSIFICATION
○	B-1 @ 12'	LIGHT BROWN-WHITE SANDY LIMESTONE GRAVEL (GP)
△	B-1 @ 17.5'	LIGHT BROWN-WHITE GRAVELLY SAND (SP)

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. S/ Date

PARTICLE SIZE DISTRIBUTION
AGANA SEWER OUTFALL

AGANA GUAM

PLATE **7B**

AGA 2846

SPECIFIC GRAVITY AND ABSORPTION
(ASTM C-127)

Sample No.	Boring No.	Depth (ft)	Bulk Sp. Gr. Dry	Bulk Sp. Gr. (SSD)*	Apparent Sp. Gr.	Absorption (%)
1	3A	15	2.17	2.37	2.73	9.49
2	3A	45	2.11	2.34	2.73	10.7
3	3A	55'	2.13	2.31	2.59	8.48

* SSD = Saturated Surface Dry

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	SUMMARY OF TEST DATA AGANA SEWER OUTFALL	PLATE 8B
Job No. 353.21 Appr. Date	AGANA GUAM	

Preliminary

Construction Cost Estimate

Hagatna Treatment Plant

Outfall Extension

CONSTRUCTION COST MODEL for OUTFALL EXTENSION
Hagatna Treatment Plant

Horizontal Directional Drilling Component

Description of Item	Quantity	Labor	Material	Total	Unit Cost
Mobilization Mtrls & Eqt	LS	$ 575,000		$ 575,000	
Site Preparation & Setup	LS	$ 153,000		$ 153,000	
42" HDPE Pipe	2200		$ 103	$ 226,600	$ 103
Drill Pilot Hole	2200	$ 233	$ 57	$ 638,000	$ 290
Ream pilot hole	2200	$ 373	$ 90	$ 1,018,129	$ 463
42" HDPE Installation	2200	$ 307	$ 60	$ 807,400	$ 367
Pig Laucher	1	$ 133,000	$ 73,695	$ 206,695	
Permits & Insurance	LS	$ 45,000			
Site Clean-Up/Restore	LS	$ 48,000	$ 12,000	$ 60,000	
Demobilization	LS	$ 193,000		$ 193,000	
Admin & Misc	LS	$ 85,000		$ 85,000	
Subtotal				$ 3,962,824	

Diffuser Component

Description of Item	Quantity	Labor	Material	Total
Point diffuser at 275 ft fsw depth				
Diffuser Assembly	LS			$ 30,000
Dive Cost @ 250ft per day	16	$ 9,630		$ 154,080
Mob/Demob Dive Crew		$ 33,400		$ 33,400
(per EKNA memo 1/11/99)				
Work Platform onsite per day	19	$ 6,600		$ 125,400
(per Tipalao schedule of values)				
Tremie Concrete	26		$ 216	$ 5,619
(per Tipalao schedule of values)				
Diesel Fuel	760		$ 2	$ 1,581
(per Tipalao schedule of values)				
Subtotal				$ 350,080
Total				**$ 4,312,903**

AGA 2849