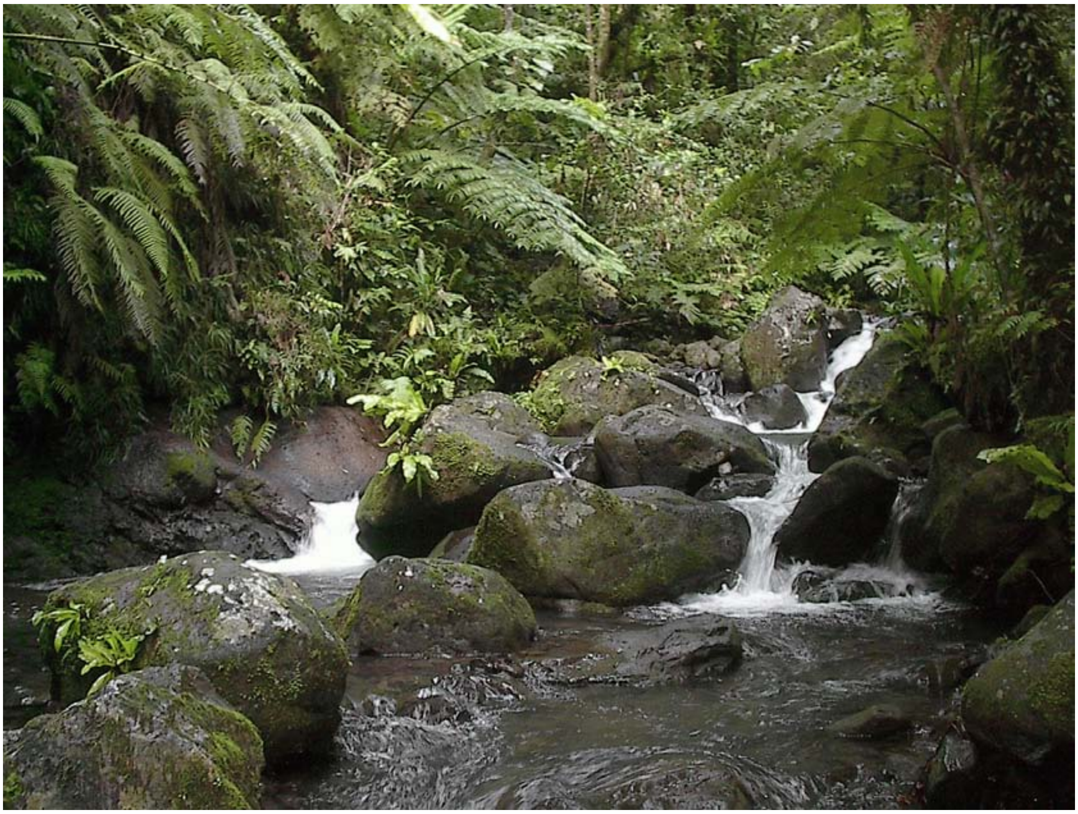
ASEPA Stream Monitoring: Results from Year 1 and Preliminary Interpretation



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ABSTRACT

Tutuila, the largest island of American Samoa, is the location of the majority of American Samoa's perennial stream ecosystems. These systems are poorly understood and currently under threat by the Territory's growing human population. The American Samoa Environmental Protection Agency (ASEPA) monitors local streams using a modified probabilistic design. To select streams for monitoring, all perennial streams on Tutuila are pooled in to four classes, representing levels of anthropogenic disturbance (pristine, minimal, intermediate, extensive) within island watersheds. These classes are determined from watershed population density. In 2003, eight (8) streams, 2 from each watershed class, were selected randomly for monthly monitoring. In addition, a habitat assessment was conducted for each stream during the initial visit. The data show that there is a general gradient of decreasing habitat scores with increasing level of human disturbance as predicted by population density. Furthermore, many of the measured stream variables (temperature, nutrients, etc.) also varied predictably along the watershed disturbance gradient. This monitoring protocol captured in Year 1 the range of variability in these tropical stream ecosystems, and future monitoring will further refine our understanding of these tropical ecosystems and human impacts on them.

INTRODUCTION

Tutuila, the largest island of American Samoa, is the location of the majority of American Samoa's perennial stream ecosystems. These systems are poorly understood and currently under threat by Tutuila's burgeoning human population. Serious modifications in channel structure, flow regimes, and nutrient dynamics have already occurred (DiDonato *in press*), and this will likely continue as human pressures for land and household water increases.

The ASEPA stream monitoring program was designed to assist with the agency's mandate to assess the natural waters of the Territory. The Clean Water Act (section 305(b)) requires that all States and Territories submit to Congress an assessment of jurisdictional waters; waters that are found to be impaired are then promulgated to the 303(d) list. Up until 2003, the Agency had participated in some stream monitoring efforts or conducted limited stream sampling; however, this was typically done for short periods or very infrequently.

The current ASEPA stream monitoring program utilizes a modified probabilistic design. A small number of streams (8 in 2003-2004) are selected from a pool of all perennial streams, and these streams are visited at monthly or near-monthly frequencies for 1 year. These data are used to assess and evaluate the stream's condition or designated use, and then a new population of streams is selected. After several iterations, the data can be pooled for a comprehensive assessment.

METHODS

Eight (8) streams were selected randomly for monthly monitoring. Of these 8 ecosystems, two (2) were selected from each watershed class (pristine, minimal, intermediate, extensive). Classifications for each watershed of American Samoa and the criteria used in that determination are presented in Table 1; for a full description of the classification scheme, see DiDonato (2004). Physical characteristics of the selected streams (e.g., total length, stream order, etc.) are representative of Tutuila streams (Table 2). Furthermore, the streams are distributed across the island (Figure 1). Five streams were located on Tutuila's south shore; 3, the less populated north shore.

Each stream was reconnoitered and surveyed for regular sampling sites. Between 1 and 3 sites were located on each stream (specific locations given in Appendix B, Figures 1-8); site selection was determined by accessibility and cooperation of nearby land owners. Once visited, the field team conducted a habitat assessment at each site using methods based on the US EPA's Rapid Bioassessment Protocols (Barbour et al. 1999). The following characters were evaluated at each site: epifaunal substrate/available cover, embeddedness, sediment deposition, channel flow status, channel alteration, and riparian vegetative zone width (Barbour et al. 1999). These characters were evaluated with a ordinal scoring system of 7, 5, 3, and 1 (7 being the highest, 1 the lowest). The values for each character at each site were summed and divided by 42 (the highest possible score), indicating in terms of % of maximum score the quality of stream and adjacent habitat at each site. Sites within streams were averaged for an overall stream score.

After site selection and habitat assessment, the following data were collected at monthly or near-monthly intervals. Hydrographic data (temperature, specific conductivity, pH, dissolved oxygen, percent dissolved oxygen saturation, and turbidity) were collected using a calibrated YSI data sonde. These data were recorded at each site. In addition to hydrographic parameters, water samples were collected for bacterial analysis and water chemistry. Bacterial analysis used Enterolert® to enumerate *Enterococcus* as a potential indicator of animal waste contamination. Single bacterial samples were collected in sterile 100 mL bottles, and 1:10 dilutions in the laboratory were routinely done for enumeration. In cases where a duplicate was collected, samples were averaged to generate a mean site estimate of bacterial load. Stream water was also collected in 125 mL plastic bottles and frozen within 4 hours. Frozen water samples were sent to a commercial laboratory (AECOS, Hawaii) and analyzed for total nitrogen (TN), total phosphorus (TP), nitrate+nitrite (NO_3^-+NO_2^-), and ammonium (NH_4^+).

Flow rates were measured at one station for each stream. In most cases, field teams measured flow using a Marsh-McBirney FloMeter2000 following standard methods (Gore 1996); discharge was calculated using field data. In some of the more remote locations where using the flow meter was impracticable, or in some of the streams with extremely low water levels, discharge was measured when possible by volumetric method.

In cases where water level at particular sites was too low to collect some or all of the required data, those data are missing.

Data Summary and Statistical Analyses

Since the unit of interest for this study was the entire stream, all site values for a given month were averaged together. In some cases, stream averages were used to evaluate the condition of the stream by comparing stream data to the American Samoa Water Quality Standards (ASWQS). In cases where there is no standard (e.g., Enterococcus, NH_4^+, NO_3^-+NO_2^-, specific conductivity), monthly averages were used to evaluate stream dynamics.

All statistical analyses used monthly stream averages. One major question about these stream data was whether there were statistical differences between watershed classes for the measured parameters. To examine potential class differences, both streams within each class were pooled. Stream classes were then compared using one-way analysis of variance (ANOVA), with class (i.e., pristine, minimal, intermediate, extensive) as the treatment factor. Prior to testing with ANOVA, the assumption of homoscedasticity was evaluated with a Bartlett's test. If variances were found to be heteroscedastic, data were log-transformed. If transformed data satisfied the assumption of homoscedasticity, then data were tested with ANOVA and followed with a Tukey HSD comparison. Data that did not demonstrate equal variances were examined with the nonparametric Kruskal-Wallis test. The z-value calculated from the Kruskal-Wallis test was used to point out the relationship of individual class data compared to the overall median for all the data. This was used as a proximate indicator of watershed class differences.

RESULTS

Sampled Streams

Streams sampled during the 2003-4 annual period are shown in Figure 1, and detailed watershed maps are presented in Appendix B. The general physical characteristics of the study streams are presented in Table 2. Short descriptions of the stream and the surrounding environs are presented below.

Fagalii1 Stream (names of all streams follow Burger and Maciolek 1981), in Fagalii watershed (#2), is a 1st order stream (Figure B1). This stream is approximately 720 meters long and drains a land area of approximately 0.12 km^2. The average gradient of the stream is 18%, but the section below the road is much steeper than the segment above the road. Two sample locations were selected for this stream. The upstream site was approximately 100 meters above the road crossing, while the downstream site was approximately the same distance below the road. The watershed is predominantly forested, with small plantation clearings. However, during the survey period, the steep stream banks in the upstream section were cleared for agriculture. The cleared vegetation was tossed into the stream channel, where it choked the small stream and caused pooling. Because of the clearing and the difficult access created by the discarded vegetation, the upstream sample station was relocated to just above the road for the remaining months.

Malota Stream in Malota watershed (#3), a 3rd order stream with a length of 7.30 km, drains 2.67 km^2 of relatively intact forest (Figure B2). There is one family living in this watershed. The disturbed locations associated with residential structures are relatively discrete and concentrated in the area below the road to the west of the stream channel. There is some disturbance above the road near another house. Three sites were selected for this stream. The downstream site was approximately 150 meters below the road. The midstream site was 500 meters upstream from the road, and the upstream site was 500 meters further. The upstream site was a short 5 minute walk from the first waterfall on this stream.

Fagatuitui1 Stream (Figure B3) is the 2nd westernmost stream in the Fagatuitui watershed (#9). This stream is a 1st order stream approximately 600 meters in length. It drains an area of 0.13 km^2, and the average gradient is 38%. There were three stations on this stream, spread across approximately 300 meters. The downstream site was just above the short falls leading to the beach and Fagatuitui cove, and the midstream and upstream sites were spaced about 150 meters apart. This stream flows entirely within the National Park of American Samoa (NPSA); the watershed is largely intact forest with minimal disturbance.

Auvaiola Stream in Amouli watershed (#20) is a short (410 m) 1st order stream in the western part of the watershed (Figure B4). It drains a small area (0.08 km^2) of steep (31%) terrain. Initially, two sampling stations were selected, one approximately 75 meters above the road crossing, the other about 30 meters below the road crossing. The downstream site was abandoned after 4 visits; the local residents dump refuse from coconut husks to glass near the access point, and this made for very unsafe hiking conditions.

Figure B5 shows Nuu Stream, a short (620 m) 2nd order stream which flows entirely within the village of Alofau in the Fagaitua watershed (#21). It drains 0.1 km^2, and the gradient is very gentle (16%). There were 2 sites selected on this stream. The downstream site is just below the confluence of the 2 1st order channels. This section of the stream is highly channelized. The upstream site is on the southern most tributary. This site is above the houses in the village in a mixed forest/plantation region adjacent to the pulenuu's house. Sites were approximately 150 meters apart.

Alega Stream (Figure B6) drains 0.67 km^2 of Alega watershed (#22). This stream is 2.3 km long, with a gentle average gradient (15%); however, there are several steep waterfalls in the lower section of this stream. Two sites were sampled on Alega Stream. The first was adjacent to the Posala house approximately 100 m from where the highway crosses the stream. The second site was at the base of the first waterfall, over 200 m upstream from the downstream site.

Vailoa Stream (Figure B7) in the Pago Pago watershed (#24) is a 2nd order stream that flows through the village of Utulei. The majority of the stream channel is within the village and behind the American Samoa Government Executive Office Building. This stream is 0.98 km long and drains 0.23 km^2. The average gradient is gentle (17%), but the upstream section is very steep. Three sites were chosen along a 400 m stretch of this stream. The downstream site was behind the EPA building, and the midstream site was 250 meters from that in the middle of the village. The upstream site was an addition 150 meters, above the last house in the village and adjacent to plantation and mixed forest area.

Mataalii Stream (Figure B8) in Nuuuli Pala watershed (#27) is a 1.46 km 2nd order stream draining 0.48 km^2. This stream is generally low gradient (17%). The headwaters begin above the village of Nuuuli, but much of the stream is within the village and has been extensively modified and channelized. Three sites over approximately 700 meters were chosen within this stream. The downstream site is just below the Faoa house on the pala side, approximately 150 meters below the road. The midstream site is over 200 meters upstream from the road, in the area behind FLY, Inc. The upstream site is 250 m further upstream, above the last house on the stream and adjacent to a small plantation area.

Habitat Assessment

Habitat assessments were conducted upon initial visits in February, 2003. The maximum possible habitat assessment score at each site was 42, and individual site scores were calculated as a percentage of that maximum. Habitat scores for the entire stream were calculated by averaging individual site scores. The data show that there is a trend of decreasing habitat scores with increasing level of human disturbance as estimated by population density (Figure 2). Both Fagatuitui1 and Malota Streams scored very high in the habitat assessment, with Fagatuitui1 and Malota averaging 100% and 98%, respectively, across all sites. There is a trend to lower scores across the remaining streams. Nuu Stream in Fagaitua watershed had the lowest average score (57%) of all streams. The low score reflects the extensive channelization and loss of riparian zone, as well as evidence of sediment deposition and poor habitat quality, at the downstream site. In the most densely populated watersheds (Nuuuli Pala and Pago Pago), study streams showed impacted habitats. The scores, however, are weighted by the poor condition of the downstream or village sites, where stream segments are extensively modified by channelization and riparian loss. In both cases, the stream segments above the villages demonstrated better habitat quality.

Water Quality

The 8 streams were monitored beginning in March, 2003, until February, 2004. All streams were visited at least 9 times, and several streams were visited every month. In general all streams followed the predictable longitudinal gradient typically exhibited by streams. For instance, specific conductivity generally increased as the stream flowed downstream towards the ocean, indicating that solute concentrations increase as the stream picks up more materials from the watershed. Summarized data for all parameters for each stream are presented in Table 3 and graphically summarized in Figures 3-5. Raw data are presented in Appendix A (Tables A1-A8).

Stream water temperature increased significantly across the gradient of impacted watersheds (ANOVA $F_{3,82}$=9.95, $p<0.001$). The average temperature of the streams from each watershed class was 25.0 °C, 25.4 °C, 26.1 °C, and 26.5 °C for pristine, minimal, intermediate, and extensive watersheds, respectively. The increase in temperature with increased population density more than likely reflects the removal of the riparian zone along much of the stream. Without the shading from adjacent trees, stream water temperatures increase.

Most streams demonstrated high dissolved oxygen (DO) and DO saturation levels exceeding the American Samoa Water Quality Standards (ASWQS) for fresh surface waters (Table 3, Figure 3). Of all the streams, only Nuu Stream demonstrated persistently low dissolved oxygen (DO), with an average percent saturation of 66.6%, and violated the standard (not less than 75%). There was a significant difference between stream DO across watershed class (K-W test, H=27.09, $p<0.001$), and this reflects the lower median DO levels in the streams sampled from intermediate watersheds (including Nuu Stream). Pristine streams had the highest overall DO concentration, but there was little difference between those streams from minimal and extensive watersheds (Table 4).

All streams satisfied the ASWQS for pH, which specifies that the pH range of fresh surface waters shall be between 6.5 and 8.6. There was a significant decrease in pH across a gradient of watersheds demonstrating increased human population density (ANOVA $F_{3,82}$=6.51, p=0.001). The exact reason for this decrease is unclear.

The ASWQS sets 5.0 Nephalometric Turbidity Units (NTU) as the turbidity standard for fresh surface waters in American Samoa. Four streams satisfied the ASWQS, but turbidity exceeded the standard in Fagalii1, Auvaiola, Nuu, and Vailoa Streams (Table 3). In most cases, this reflects localized sedimentation. In some cases, however, it indicates pig waste or household grey water being disposed in the stream. There was a significant difference (K-W test, H=30.5, p<0.001) in stream turbidity across watershed classes. Pristine streams had the lowest median turbidity (3.0 NTU) followed by minimal streams (4.2 NTU). Streams in extensively disturbed watersheds demonstrated higher turbidities (4.9 NTU), while the intermediate streams were the most turbid (27.5 NTU).

Enterococci numbers were high in most streams, but a few streams stood apart as having relatively low numbers of this bacterial indicator (Table 3). Malota Stream had the lowest median concentration of *Enterococcus* [141 colony forming units(CFU)/100 ml] of all the streams, and Alega Stream was next with 947 CFU/100 ml. All other streams, including Fagatuitui1 in the National Park, exhibited higher bacterial levels. In many cases, the elevated levels likely signal inputs of animal waste (either human or pig). In other cases, within the National Park for instance, it may reflect indigenous bacteria in soils. Analyzing the bacterial data with a Kruskal-Wallis test demonstrated a significant difference in median bacteria counts between the watershed classes

(H=27.15, p<0.001). Streams in pristine and minimally impacted watersheds had the lowest bacterial numbers (433 and 1493 CFU/100mL, respectively). The streams in extensively disturbed watersheds had the next highest bacteria numbers (2250 CFU/100mL). The streams in intermediate watersheds had the highest numbers of Enterococci (7940 CFU/100mL). This high number was heavily influenced by the downstream site of Nuu Stream. This site was located just downstream of a piggery; the consistent presence of the indicator *Enterococcus* in this case likely indicates actual animal waste.

There was significantly more NH_4^+ in streams located in watersheds with higher population density (K-W test, H=18.5, p<0.001) than in watersheds with lower population density. The streams from pristine or minimal watersheds had very little NH_4^+ present, while the more impacted streams often had residual NH_4^+ present (Table 3). In fact Nuu Stream had the highest median NH_4^+ concentration (0.186 mg NH_4^+/L; Figure 4), and this was likely due to direct input of pig waste (high in NH_4^+) nearby.

Stream NO_3^-+NO_2^- also demonstrated significant differences between watershed classes (K-W test, H=49.61, p<0.001, Table 3). Highest NO_3^-+NO_2^- levels were found in streams from extensive watersheds (Figure 4), and minimal watersheds were next highest. Pristine watershed streams had the lowest levels of NO_3^-+NO_2^-.

Total nitrogen (TN) differed across watershed class (K-W test, H=32.95, p<0.001), with streams in pristine and minimal watersheds exhibiting the lowest TN and streams in the intermediate and extensive watersheds showing the highest TN (Table 3). Fagalii1 Stream (minimal) actually violated the ASWQS during this annual period (Figure 4), which limits the amount of TN in fresh surface water to 0.300 mg/L. Total phosphorus (TP) also demonstrated a significant increase with increasing watershed disturbance (K-W test, H=27.47, $P<0.001$). In the case of TP, however, the only streams that satisfied the ASWQS (0.150 mg/L) were the two pristine streams (Figure 4). TP in streams from other watershed classes was largely indistinguishable across classes.

The coefficient of variation (CV) reflects the within-stream level of variability in particular parameters. I examined specifically the CV for TN and TP. A significant increase in the CV would reflect a strong longitudinal gradient along the stream, exactly what you expect when a stream flows from the relatively undisturbed high elevation headwaters down through a village. Like other parameters, I expect that the CV will increase with increasing level of watershed population density. In fact, this appears to be the case. Log-transformed CV values for TN demonstrated significant differences across watershed classes (ANOVA $F_{3,63}=25.69$, $p<0.001$), with minimal and pristine watersheds demonstrating less than 10% CV while intermediate and extensive watersheds had >70% CV (Figure 5). The results for the significance test for the CV of TP demonstrated a significant difference across watershed classes (K-W test, H=32.42, $p<0.001$). For TP CV, minimal, pristine, and extensive watersheds demonstrated 3.7%, 11.5%, and 18.1% CV (Figure 5), while the intermediate watershed class had a much higher CV (69.7%).

Measured discharge from these streams ranged over close to 3 orders of magnitude. Auvaiola and Fagalii1 Streams had the lowest median discharge, estimated at 0.1 L/s, while Alega and Malota Streams had the highest median discharge (Table 3).

An overall summary of the statistical analyses is presented in Table 4. This table shows the results of each statistical test, with the watershed classes arranged in order of increasing value for each parameter. Where possible, subscripts indicate the results of the Tukey's HSD comparisons. If a Kruskal-Wallis test was used, a bar indicates where the z value changes from negative (class scores below the overall median score) to positive (class scores above the overall median score).

In general, Table 4 shows that there was a consistent gradient for each parameter that runs from streams in less impacted classes (i.e., pristine and minimal) to streams in more disturbed watersheds (i.e., intermediate and extensive). At this point, the discriminant power of these analyses is low; with only 2 streams from each class, there is not much statistical power to say with confidence that there are differences between specific classes. However, the fact that there are consistent differences between streams that show little human influence (pristine and minimal streams) and ones that have been modified (intermediate and extensive) suggests that these watershed classes reflect the condition of the stream ecosystems within them.

<u>305b Assessment</u>

The habitat assessment data and conventional water quality data were used to assess these fresh surface waters of Tutuila, American Samoa. The habitat data were considered to demonstrate Data Quality Level 1, while the physical and chemical data were considered Data Quality Level 2. Of the 8 streams assessed, three streams (Malota, Fagatuitui1, and Alega) were considered fully supporting of their aquatic life designated use. The other 5 streams (Fagalii1, Auvaiola, Nuu, Vailoa, and Mataalii) were deemed to be not supporting. The summaries of these assessments and the rationale for the designated use determination are given in Appendix C.

DISCUSSION

The first year of the ASEPA Stream Monitoring Program revealed some interesting information concerning the fundamental design of the stream monitoring program, as well as some insight into Tutuila streams and their general condition.

Previous stream monitoring efforts undertaken on this island (e.g., M&E Pacific 1979, CH2MHill 1984) have yielded some useful information on the range of water quality in selected island streams. For instance, M&E Pacific (1979) reported stream water quality data from 12 streams across the island which were sampled over 2 short periods within one year. This study had nice spatial coverage, but did not delve into the temporal dynamics exhibited by tropical streams. CH2MHill (1984) summarized water quality data from selected streams in the Pago Pago harbor region. This work gives a concise picture of stream contributions to the harbor during a carefully defined temporal window. Later efforts by ASEPA staff sampled some of these streams again, and sampled them for several years. However, each stream might have been sampled from once to many times within an annual period. The primary shortcoming of these data is that the collected information does not provide a comprehensive picture of stream condition in the Territory (DiDonato *in press*).

The ASEPA stream monitoring program was designed to address our agency's requirement to survey, assess, and evaluate streams with respect to the ASWQS. We needed to develop a program that would provide quantitative data that could be used for assessment and also for comparison with other island streams. For this we selected a modified probabilistic approach that allowed us to select streams at random from watersheds classified according to their potential anthropogenic disturbance. In effect, this stratified the pool of over 140 perennial streams on Tutuila into 4 classes and allowed us to block for one potentially large source of between-stream variability; that is, the density of people living around that stream.

One of the main goals of Year 1 is to evaluate how useful and appropriate that classification scheme is by evaluating how stream hydrography, nutrients, and chemistry change across the watershed gradient. These data demonstrate that watershed class (i.e., human impact) correlated across the gradient of streams for a variety of parameters. This is summarized in Table 4. Not only do the averages of the different parameters rank in the expected order (e.g., increasing temperature, nutrients) but statistical analyses show that there are differences across those groups. For instance, water temperature showed an increasing gradient from the most pristine to the most disturbed streams. Tukey analysis revealed that there were several statistical breakpoints along that gradient, and that the pristine streams showed significantly lower water temperatures over the course of a year than streams in extensively disturbed watersheds. That is also true for pH. For analyses where we could only employ the nonparametric K-W test, there were no post tests that could distinguish groups. However, the z scores, which show the group median in relation to the overall median (i.e., z scores are negative when a group median is below the overall median and positive then the group median is above the overall median), suggest that there were differences between the least and most impacted watershed streams.

Note that there is not a perfect correspondence between watershed class and particular parameters. For instance, the pristine and intermediate streams had the lowest NO_3^-+NO_2^- levels, while the minimal and extensive streams had the highest NO_3^-+NO_2^- levels. In general, however, the ordering and the presence of breaks in the data between the least and most impacted watershed streams suggests that the classification stratifies the stream ecosystems across a consistent and real source of variability. Continued monitoring using a different population of streams (already selected for the current 2004-2005 year) will provide more data and may provide a more rigorous indication of island streams along the suspected watershed gradient.

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Table 1. Information and classification for watersheds of American Samoa.

Watershed	Number	Watershed Area (mi^2)	Population[1]	Pop'n Density ($mi.^{-2}$)	Classification[3]
Poloa	1	0.42	203	483	minimal
Fagalii	2	0.80	259	324	minimal
Maloata	3	1.08	17	16	pristine
Fagamalo	4	1.30	39	30	pristine
Aoloau Sisifo	5	0.62	0	0	pristine
Aoloau Sasae	6	2.05	nd[2]	--	pristine
Aasu	7	3.27	1142	349	minimal
Fagasa	8	1.35	900	667	intermediate
Fagatuitui	9	2.00	0	0	pristine
Vatia	10	1.89	648	343	minimal
Afono	11	1.29	530	411	minimal
Masefau	12	1.42	435	306	minimal
Masausi	13	0.60	192	320	minimal
Sailele	14	0.26	100	385	minimal
Aoa	15	0.85	507	596	intermediate
Onenoa	16	0.30	153	510	intermediate
Tula	17	0.60	413	688	intermediate
Alao	18	0.52	528	1015	extensive
Auasi	19	0.40	189	473	minimal
Amouli	20	0.80	520	650	intermediate
Fagaitua	21	1.88	1460	777	intermediate
Alega	22	0.51	111	218	minimal
Laulii-Aumi	23	0.70	1186	1694	extensive
Pago Pago	24	4.00	10586	2647	extensive
Fagaalu	25	0.96	1006	1048	extensive
Matuu	26	1.00	671	671	intermediate
Nuuuli Pala	27	6.70	8344	1245	extensive
Tafuna Plain	28	5.50	17256	3137	extensive
Fagatele-Larso	29	1.23	nd	--	pristine
Leone	30	5.67	6600	1164	extensive
Afao-Asili	31	1.07	438	409	minimal
Nua-Seetaga	32	1.20	694	578	intermediate
Amanave	33	0.40	287	718	intermediate
Aunuu Sisifo	34	0.38	476	1253	extensive
Aunuu Sasae	35	0.22	0	0	pristine
Ofu Saute	36	1.78	289	162	minimal
Ofu Matu	37	1.06	10	9	pristine
Olosega Sisifo	38	0.80	216	270	minimal
Olosega Sasae	39	1.20	0	0	pristine
Tau Matu	40	14.20	873	61	pristine
Tau Saute	41	3.3	0	0	pristine

[1]population data are taken from the US 2000 Census

[2]no data

[3]disturbance classification based on numeric criteria: density <100 mi^{-2}, pristine; 101<density<500 mi^{-2}, minimal; 501<density<1000 mi^{-2}, intermediate; >1001 mi^{-2}, extensive

Table 2. Stream name and geographical characteristics for streams selected for sampling in the 2003-04 sampling period. Stream names and physical characteristics were based on USGS maps and/or collected from unpublished survey reports.

Stream	Classification	Order	Drainage Area (km2)	Total Length (km)	Linear Distance (km)	Elevation (m)	Gradient
Fagatuitui1	Pristine	1	0.13	0.60	0.6	227	0.38
Malota	Pristine	3	2.67	7.30	2.6	338	0.13
Alega	Minimal	3	0.67	2.31	1.8	269	0.15
Fagalii1	Minimal	1	0.12	0.72	0.7	126	0.18
Auvaiola	Intermediate	1	0.08	0.41	0.4	122	0.31
Nuu	Intermediate	2	0.10	0.62	0.3	49	0.16
Mataalii	Extensive	2	0.48	1.46	1.5	246	0.16
Vailoa	Extensive	2	0.23	0.98	0.8	137	0.17

Table 3. Hydrographic and water chemistry data for 8 streams sampled from March, 2003 to February, 2004. For all water quality parameters, the tabulated number is the median monthly average across all sampled sites. The number in parentheses is the number of monthly samples.

Stream[1]	Classification	Temp (°C)	Sp. Cond. (mS/cm)	DO (mg/L)	DO (%sat)	pH	Turbidity (NTU)	Enterococci (MPN)	NH_4^+ (mg/L)	$NO_3^-+NO_2^-$ (mg/L)	TN (mg/L)	TP (mg/L)	Discharge[2] (L/s)
Fagatuitui1	Pristine	25.23	0.145	7.95	96.9	7.89	1.5	1054	0.000	0.056	0.172	0.094	0.7
		(7)	(7)	(6)	(5)	(7)	(7)	(8)	(8)	(8)	(8)	(8)	(2)
Malota	Pristine	25.13	0.076	8.65	106.4	7.39	3.6	141	0.000	0.012	0.083	0.089	79.2
		(11)	(11)	(11)	(10)	(11)	(11)	(12)	(10)	(10)	(10)	(10)	(6)
Alega	Minimal	25.58	0.121	8.41	103.9	7.36	2.9	947	0.000	0.148	0.241	0.222	30.7
		(12)	(12)	(12)	(12)	(12)	(12)	(12)	(10)	(10)	(10)	(10)	(6)
Fagalii1	Minimal	25.74	0.083	7.30	85.0	6.94	11.3	2275	0.001	0.225	0.367	0.189	0.1
		(11)	(11)	(11)	(10)	(11)	(11)	(12)	(10)	(10)	(10)	(10)	(5)
Auvaiola	Intermediate	25.59	0.186	6.82	83.3	7.42	30.3	4133	0.003	0.061	0.409	0.239	0.1
		(12)	(12)	(12)	(12)	(12)	(12)	(12)	(10)	(10)	(10)	(10)	(4)
Nuu	Intermediate	26.87	0.233	5.26	66.6	7.15	24.1	9195	0.186	0.044	1.088	0.286	4.0
		(12)	(12)	(12)	(12)	(12)	(12)	(12)	(10)	(10)	(10)	(10)	(6)
Mataalii	Extensive	26.17	0.120	8.00	101.0	7.12	2.2	1321	0.000	0.260	0.376	0.152	8.0
		(10)	(10)	(9)	(9)	(10)	(10)	(12)	(10)	(10)	(10)	(10)	(5)
Vailoa	Extensive	26.77	0.137	7.86	98.9	7.14	7.1	3295	0.011	0.307	0.486	0.224	11.0
		(11)	(11)	(10)	(10)	(11)	(11)	(12)	(10)	(10)	(10)	(10)	(6)

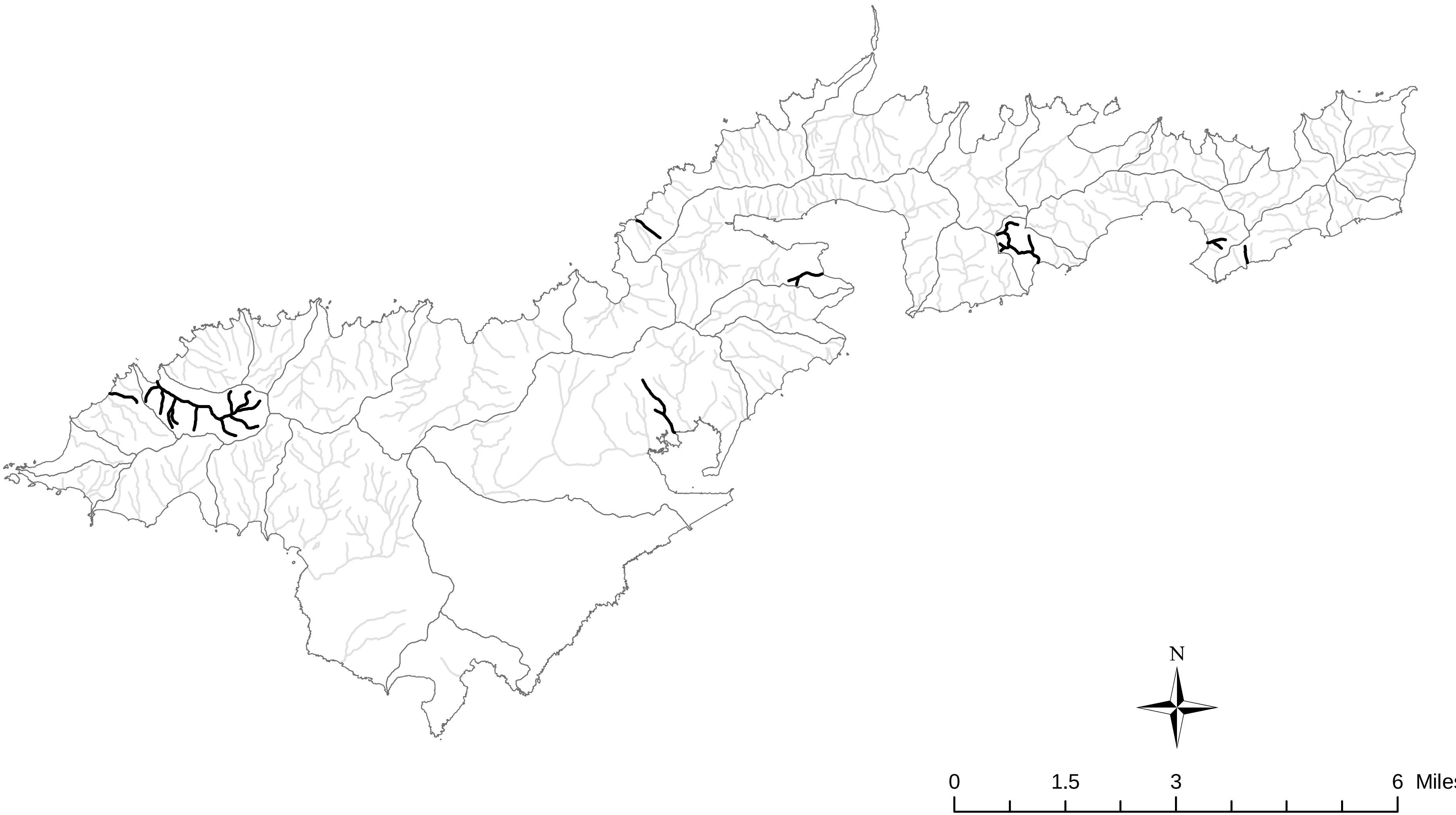
[1]Stream names follow Burger and Maciolek (1981)

[2]Discharge calculated from flow measurement made at one station along the stream

Table 4. Results of the ANOVA (with Tukey HSD post test) or the Kruskal-Wallis test examining differences between watershed classes for different stream parameters.

Variable	increasing averages →				
Temperature	P^{a}	M^{a,b}	I^{b,c}	E^{c}	ANOVA
Dissolved Oxygen	I ‖	E	M	P	K-W
pH	E^{a}	M^{a,b}	I^{a,b}	P^{b}	ANOVA
Turbidity	P	M	E ‖	I	K-W
Enterococcus	P	M	E ‖	I	K-W
NH_4^+	P	M ‖	E	I	K-W
NO_3^-+NO_2^-	P	I ‖	M	E	K-W
TN	P	M ‖	E	I	K-W
TP	P ‖	M	E	I	K-W
Coefficient of Variation (log_{10} TN)	M^{a}	P^{a}	I^{b}	E^{b}	ANOVA
Coefficient of Variation (TP)	M	P ‖	E	I	K-W

List of Figures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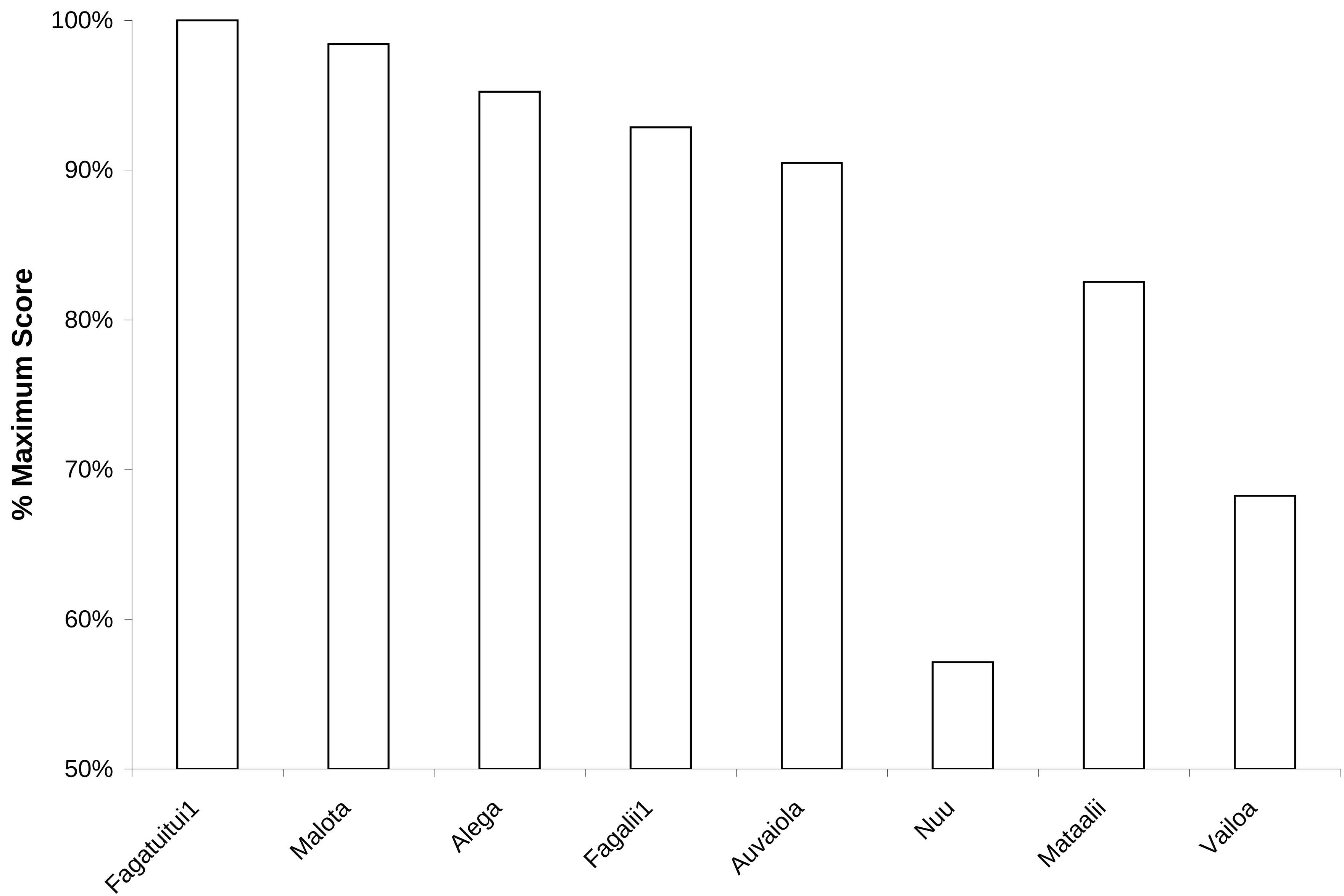
0
1.5
3
6 Miles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100%
90%
80%
70%
60%
50%
Fagatuitui1
Malota
Alega
Fagalii1
Auvaiola
Nuu
Mataalii
Vailoa

Fig 3

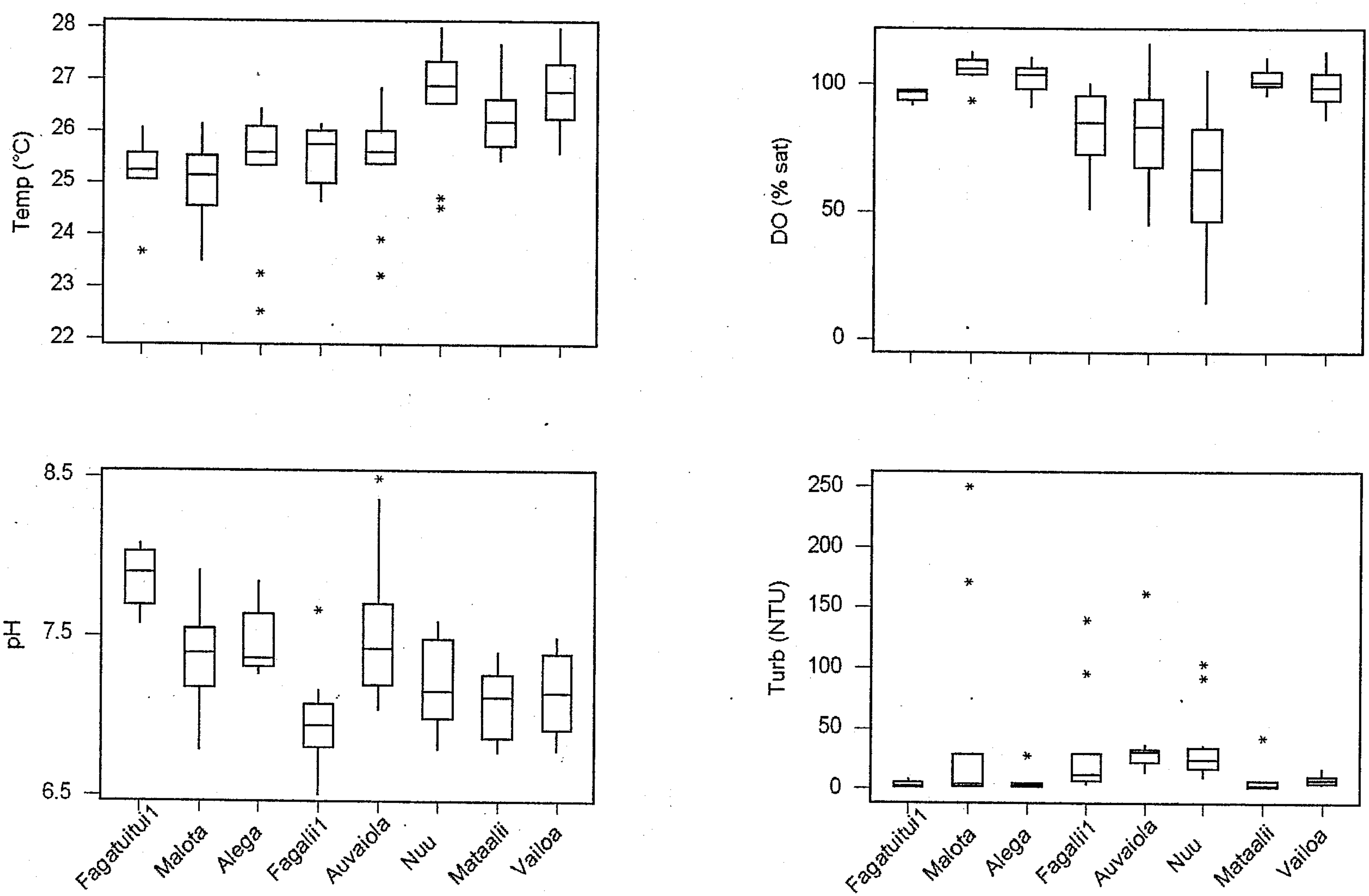
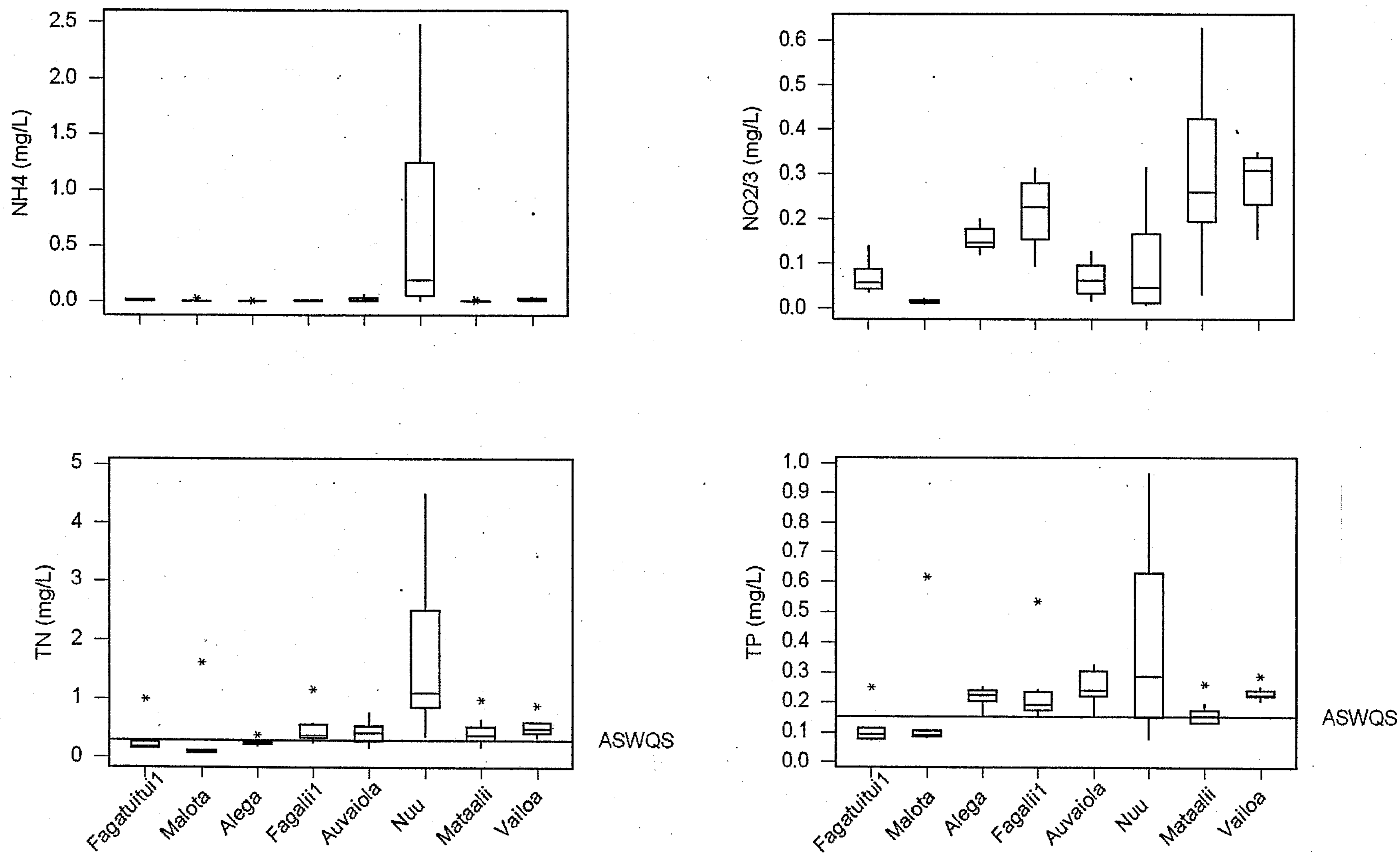
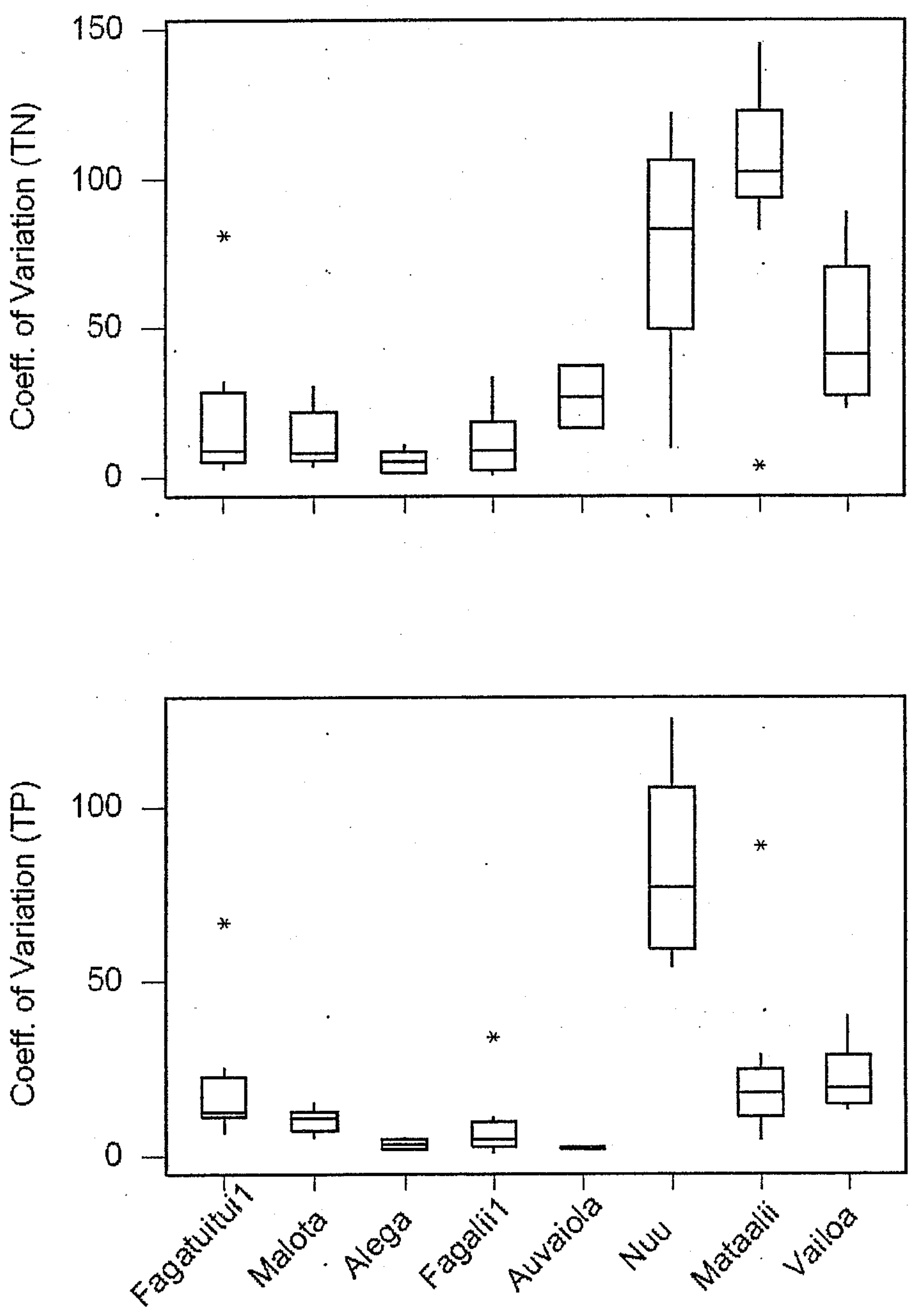

Temp (°C)
28
27
26
25
24
23
22
DO (% sat)
100
50
0
pH
8.5
7.5
6.5
Turb (NTU)
250
200
150
100
50
0
Fagatuitui1
Malota
Alega
Fagalii1
Auvaiola
Nuu
Mataalii
Vailoa

Fig 4



NH4 (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
NO2/3 (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
TN (mg/L)
0
1
2
3
4
5
ASWQS
TP (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
ASWQS
Fagatuitui1
Malota
Alega
Fagalii1
Auvaiola
Nuu
Mataalii
Vailoa

Fig 5



150
100
50
0
Coeff. of Variation (TN)
100
50
0
Coeff. of Variation (TP)
Fagatuitui1
Malota
Alega
Fagalii1
Auvaiola
Nuu
Mataalii
Vailoa

Appendix A

Table A1. Raw data collected at near-monthly intervals from 3 sites on Fagatuitui1 Stream (Watershed #9), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Fagatuitui 1 Stream, FG1 (upstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March															
April	4/4/2003	12:50	25.50	0.144	0.00	8.38		8.01	5.0						
May															
June	6/24/2003	10:07								7068	0	0.037	0.146	0.065	
July	7/21/2003	11:50	24.78	0.121	0.06			8.08	5.3	4611	0	0.049	0.203	0.093	
August	8/28/2003	10:30	23.40	0.115	0.05	7.93	93.2	8.00	7.0	1274	0	0.017	0.150	0.082	
September	9/15/2003	11:44	24.88	0.135	0.05	6.98	84.3	7.56	1.7	669	0.005	0.038	0.179	0.084	
October	10/28/2003	11:39	25.06	0.136	0.06	7.32	88.7	7.46	2.3	2118	0.006	0.060	0.312	0.113	
November															
December	12/18/2003	13:30	26.40	0.112	0.05	7.42	92.1	7.59	1.8	959	0	0.024	0.150	0.060	
January	1/21/2004	11:09	25.79	0.124	0.06	7.70	94.3	7.69	0.8	954	0	0.029	0.161	0.090	
February	2/26/2004	10:55								14136	0	0.140	0.890	0.217	

Fagatuitui 1 Stream, FG2 (midstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March															
April	4/4/2003	12:06	25.40	0.136	0.00	8.49		7.83	5.0						
May															
June	6/24/2003									1396	0	0.071	0.128	0.073	
July	7/21/2003	11:07	25.10	0.162	0.08			8.11	1.9	24192	0	0.084	0.171	0.082	
August	8/28/2003	10:09	23.96	0.154	0.07	8.17	97.0	8.05	3.5	122	0	0.051	0.154	0.078	
September	9/15/2003	11:09	25.16	0.187	0.09	7.87	95.4	7.78	0.2	316	0	0.068	0.151	0.086	
October	10/28/2003	10:52	25.25	0.190	0.09	7.96	96.7	7.56	0.9	168	0.004	0.088	0.223	0.100	
November															
December	12/18/2003	13:03	25.74	0.147	0.07	8.03	98.3	7.66	1.4	156	0	0.058	0.157	0.074	
January	1/21/2004	10:38	25.46	0.158	0.07	7.96	97.1	7.87	0.1	565	0	0.039	0.148	0.104	
February	2/26/2004	10:20								24192	0.06	0.166	1.860	0.431	

Fagatuitui 1 Stream, FG3 (downstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March															
April	4/4/2003	11:16	25.20	0.118	0.00	7.30		7.91	13.0						
May															
June	6/24/2003									413	0	0.064	0.148	0.081	
July	7/21/2003	10:25	25.29	0.153	0.07			8.05	0.7	1024	0	0.085	0.190	0.089	
August	8/28/2003	9:39	23.64	0.144	0.07	8.52	100.6	8.03	4.4	2332	0	0.031	0.156	0.099	
September	9/15/2003	10:15	25.15	0.185	0.09	7.82	95.0	7.71	0.2	413	0.026	0.057	0.274	0.128	0.4
October	10/28/2003	10:10	25.38	0.177	0.08	8.23	100.4	7.67	0.5	257	0.002	0.121	0.295	0.125	1
November															
December	12/18/2003	12:34	26.04	0.147	0.07	8.41	103.7	7.81	1.3	218	0	0.053	0.161	0.079	
January	1/21/2004	9:58	25.40	0.157	0.07	8.19	99.9	8.12	0.1	1076	0	0.048	0.137	0.114	
February	2/26/2004	9:30								1112	0	0.110	0.244	0.102	
															0.7

Fagatuitui 1 Stream, average

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)
March														
April	4/4/2003		25.37	0.133	0.00	8.06		7.92	7.67					
May														
June	6/24/2003									2959	0	0.057	0.141	0.073
July	7/21/2003		25.06	0.145	0.07			8.08	2.63	9942	0	0.073	0.188	0.088
August	8/28/2003		23.67	0.138	0.06	8.21	96.9	8.03	4.97	1243	0	0.033	0.153	0.086
September	9/15/2003		25.06	0.169	0.08	7.56	91.6	7.68	0.70	466	0.010	0.054	0.201	0.099
October	10/28/2003		25.23	0.168	0.08	7.84	95.3	7.56	1.23	848	0.004	0.090	0.277	0.113
November														
December	12/18/2003		26.06	0.135	0.06	7.95	98.0	7.69	1.50	444	0	0.045	0.156	0.071
January	1/21/2004		25.55	0.146	0.07	7.95	97.1	7.89	0.33	865	0	0.039	0.149	0.103
February	2/26/2004									13147	0.020	0.139	0.998	0.250
			25.23	0.145	0.07	7.95	96.9	7.89	1.5	1054	0.000	0.056	0.172	0.094
			7	7	7	6	5	7	7	8	8	8	8	8

Table A2. Raw data collected at monthly intervals from 3 sites on Malota Stream (Watershed #3), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Malota Stream, MA1 (upstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/26/2003	10:57	25.40	0.053	0.02	8.21	100.4	7.70	88.4	2187					
April	4/23/2003	11:19	25.20	0.060	0.00	11.57		7.40	8.0	359					
May	5/22/2003	11:02	25.15	0.063	0.03	7.53	92.2	7.44	3.9	122	0	0.014	0.062	0.071	
June	6/17/2003									41	0	0.012	0.048	0.073	
July	7/28/2003														
August	8/18/2003	11:41	23.88	0.068	0.03	9.49	112.3	7.67	3.6	52	0	0.009	0.074	0.081	
September	9/24/2003	10:13	23.31	0.074	0.03	9.12	109.8	7.23	3.1	74	0	0.014	0.082	0.092	
October	10/24/2003	11:02	25.12	0.083	0.04	8.47	102.9	7.38	2.4	94	0	0.018	0.133	0.101	
November	11/24/2003	10:53	24.75	0.070	0.03	8.66	104.4	7.24	5.0	249	0	0.009	0.061	0.079	
December	12/22/2003	10:33	25.00	0.072	0.03	8.40	102.2	7.20	1.7	52	0	0.010	0.084	0.083	
January	1/29/2004	11:45	25.78	0.072	0.03	8.24	101.5	6.85	1.2	0	0	0.006	0.074	0.087	
February	2/19/2004	11:33	25.35	0.075	0.03	8.51	103.9	7.18	1.7	20	0	0.007	0.090	0.074	

Malota Stream, MA2 (midstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/26/2003	10:27	25.51	0.054	0.02	8.65	106.2	7.88	228.3	6820					
April	4/23/2003	11:00	25.10	0.062	0.00	11.59		7.08	64.0	285					
May	5/22/2003	10:37	25.08	0.066	0.03	7.78	95.3	7.37	4.6	185	0	0.015	0.058	0.079	
June	6/17/2003									63	0	0.012	0.051	0.077	
July	7/28/2003	12:01	24.53	0.043	0.02	8.61	103.4	7.20	226.0	10831	0.012	0.009	1.480	0.567	
August	8/18/2003	11:04	23.71	0.071	0.03	9.61	113.5	7.79	3.6	135	0	0.010	0.068	0.082	
September	9/24/2003	9:52	23.34	0.080	0.04	8.89	107.5	7.28	2.9	74	0	0.014	0.096	0.105	
October	10/24/2003	10:42	25.22	0.087	0.04	9.27	114.7	7.50	2.5	41	0	0.022	0.120	0.111	
November	11/24/2003	10:34	24.76	0.074	0.03	8.87	107.2	7.37	5.2	199	0	0.010	0.063	0.088	
December	12/22/2003	10:18	25.19	0.077	0.03	8.64	105.6	7.42	1.3	97	0	0.012	0.093	0.088	
January	1/29/2004	11:21	26.09	0.077	0.03	8.83	110.0	7.18	1.4	148	0	0.011	0.075	0.098	
February	2/19/2004	11:16	25.56	0.074	0.03	8.68	106.7	7.30	1.9	158	0	0.007	0.098	0.083	

Malota Stream, MA3 (downstream site below road)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/26/2003	9:53	25.63	0.065	0.03	8.58	106.0	8.14	195.7	15531					
April	4/23/2003	10:20	25.10	0.072	0.00	11.56		7.04	13.0	240					
May	5/22/2003	10:06	25.08	0.073	0.03	7.57	92.8	7.76	5.9	776	0	0.018	0.090	0.092	
June	6/17/2003									327	0	0.014	0.049	0.085	
July	7/28/2003	11:51	24.57	0.047	0.02	8.60	103.3	7.53	274.6	15531	0.035	0.015	1.760	0.665	
August	8/18/2003	10:13	23.84	0.078	0.04	9.53	113.0	7.94	3.6	230	0	0.011	0.073	0.089	
September	9/24/2003	9:18	23.77	0.091	0.04	9.22	110.8	7.43	3.8	169	0	0.020	0.097	0.111	68.0
October	10/24/2003	10:02	25.48	0.096	0.04	9.01	111.6	7.75	1.5	68	0	0.023	0.128	0.117	44.7
November	11/24/2003	10:02	24.92	0.084	0.04	9.23	112.8	7.56	8.3	816	0	0.017	0.101	0.106	304.0
December	12/22/2003	9:51	25.71	0.085	0.04	8.91	112.3	7.81	1.0	266	0	0.015	0.086	0.091	74.4
January	1/29/2004	10:42	26.57	0.087	0.04	8.56	106.7	6.30	0.7	0	0	0.004	0.083	0.110	84.0
February	2/19/2004	10:47	25.96	0.084	0.04	8.72	107.4	6.69	1.4	185	0	0.013	0.130	0.094	102.0
															79.2
															6

Malota Stream, average

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)
March	3/26/2003		25.51	0.057	0.02	8.48	104.2	7.91	170.8	8179				
April	4/23/2003		25.13	0.065	0.00	11.57		7.17	28.3	295				
May	5/22/2003		25.10	0.067	0.03	7.63	93.4	7.52	4.8	361	0	0.016	0.070	0.081
June	6/17/2003									144	0	0.013	0.049	0.078
July	7/28/2003		24.55	0.045	0.02	8.61	103.4	7.37	250.3	13181	0.02	0.012	1.620	0.616
August	8/18/2003		23.81	0.072	0.03	9.54	112.9	7.80	3.6	139	0	0.010	0.072	0.084
September	9/24/2003		23.47	0.082	0.04	9.08	109.4	7.31	3.3	106	0	0.016	0.092	0.103
October	10/24/2003		25.27	0.089	0.04	8.92	109.7	7.54	2.1	68	0	0.021	0.127	0.110
November	11/24/2003		24.81	0.076	0.03	8.92	108.1	7.39	6.2	421	0	0.012	0.075	0.091
December	12/22/2003		25.30	0.078	0.03	8.65	106.7	7.48	1.3	138	0	0.012	0.088	0.087
January	1/29/2004		26.15	0.079	0.03	8.54	106.1	6.78	1.1	49	0	0.007	0.077	0.098
February	2/19/2004		25.62	0.078	0.03	8.64	106.0	7.06	1.7	121	0	0.009	0.106	0.084
			25.13	0.076	0.03	8.65	106.4	7.39	3.6	141	0.000	0.012	0.083	0.089
			11	11	11	11	10	11	11	12	10	10	10	10

Table A3. Raw data collected at monthly intervals from 2 sites on Alega Stream (Watershed #22), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Alega Stream, AL1 (upstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/19/2003	10:47	25.22	0.117	0.05	7.94	97.2	7.49	5.1	3076					
April	4/21/2003	11:34	25.65	0.099	0.05	7.89	97.1	7.31	35.8	4740					
May	5/15/2003	11:45	26.18	0.128	0.06	7.12	90.4	7.37	3.5	418	0	0.134	0.243	0.240	
June	6/23/2003	14:46	22.36	0.122	0.06	8.61	99.5	7.68	1.1	448	0	0.170	0.238	0.213	
July	7/23/2003	14:41	25.36	0.131	0.06	8.13	99.1	7.55	4.0	894	0	0.152	0.223	0.244	
August	8/27/2003	12:11	23.18	0.113	0.05	9.25	108.2	7.82	3.2	275	0	0.126	0.205	0.205	
Septembei	9/16/2003	13:07	25.43	0.128	0.06	8.25	101.0	7.69	2.0	161	0	0.143	0.217	0.243	
October	10/22/2003	11:48	25.83	0.137	0.06	8.87	110.7	7.47	1.8	1112	0.006	0.127	0.260	0.262	
November	11/25/2003	12:25	25.25	0.103	0.05	9.25	113.3	7.38	4.8	203	0	0.199	0.292	0.148	
December	12/29/2003	11:11	26.07	0.119	0.05	8.34	104.3	7.41	1.9	121	0	0.134	0.257	0.196	
January	1/28/2004	12:52	26.36	0.116	0.05	8.10	101.0	7.29	1.7	814	0	0.109	0.184	0.217	
February	2/18/2004	13:28	25.95	0.109	0.05	8.13	100.2	7.14	4.9	1671	0	0.185	0.401	0.240	

Alega Stream, AL2 (downstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/19/2003	10:38	25.61	0.124	0.06	7.93	97.7	7.48	3.7	4106					
April	4/21/2003	11:27	25.66	0.108	0.05	8.02	97.1	7.30	19.6	2481					
May	5/15/2003	11:38	26.12	0.134	0.06	7.34	91.5	7.30	2.3	1354	0	0.153	0.237	0.223	
June	6/23/2003	14:40	22.68	0.127	0.06	9.23	108.1	7.68	1.1	550	0	0.183	0.251	0.209	
July	7/23/2003	14:36	25.43	0.134	0.06	8.82	108.7	7.58	1.7	2932	0	0.169	0.254	0.239	
August	8/27/2003	12:05	23.30	0.118	0.05	9.08	106.4	7.85	2.7	413	0	0.149	0.222	0.202	
Septembei	9/16/2003	12:49	25.57	0.130	0.06	8.37	102.4	7.61	1.6	358	0	0.160	0.242	0.235	7.7
October	10/22/2003	11:31	25.55	0.141	0.07	8.78	108.5	7.04	0.9	905	0	0.136	0.224	0.244	22.2
November	11/25/2003	12:12	25.35	0.112	0.05	8.90	108.5	7.23	2.9	297	0	0.203	0.288	0.156	56.1
December	12/29/2003	11:01	25.96	0.125	0.06	8.46	105.0	7.33	1.0	246	0	0.147	0.256	0.191	36.5
January	1/28/2004	12:38	26.52	0.121	0.06	8.05	100.4	7.40	0.6	1353	0	0.127	0.183	0.206	24.8
February	2/18/2004	13:17	26.24	0.117	0.05	8.70	108.1	7.41	3.5	1354	0	0.171	0.367	0.226	41.4
															30.7
															6

Alega Stream, average

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)
March	3/19/2003		25.42	0.121	0.06	7.94	97.5	7.49	4.4	3591				
April	4/21/2003		25.66	0.104	0.05	7.96	97.1	7.31	27.7	3611				
May	5/15/2003		26.15	0.131	0.06	7.23	91.0	7.34	2.9	886	0	0.144	0.240	0.232
June	6/23/2003		22.52	0.125	0.06	8.92	103.8	7.68	1.1	499	0	0.177	0.245	0.211
July	7/23/2003		25.40	0.133	0.06	8.48	103.9	7.57	2.9	1913	0	0.161	0.239	0.242
August	8/27/2003		23.24	0.116	0.05	9.17	107.3	7.84	3.0	344	0	0.138	0.214	0.204
Septembei	9/16/2003		25.50	0.129	0.06	8.31	101.7	7.65	1.8	260	0	0.152	0.230	0.239
October	10/22/2003		25.69	0.139	0.07	8.83	109.6	7.26	1.4	1009	0.003	0.132	0.242	0.253
November	11/25/2003		25.30	0.108	0.05	9.08	110.9	7.31	3.9	250	0	0.201	0.290	0.152
December	12/29/2003		26.02	0.122	0.06	8.40	104.7	7.37	1.5	184	0	0.141	0.257	0.194
January	1/28/2004		26.44	0.119	0.06	8.08	100.7	7.35	1.2	1084	0	0.118	0.184	0.212
February	2/18/2004		26.10	0.113	0.05	8.42	104.2	7.28	4.2	1513	0	0.178	0.384	0.233
			25.58	0.121	0.06	8.41	103.9	7.36	2.9	947	0.000	0.148	0.241	0.222
			12	12	12	12	12	12	12	12	10	10	10	10

Table A4. Raw data collected at monthly intervals from 2 sites on Fagalii1 Stream (Watershed #2), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Fagalii 1 Stream, Fa1 (upstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/31/2003	9:05	25.61	0.068	0.03	7.91	97.5	6.73	104.4	4748					
April	4/23/2003	9:28	25.30	0.062	0	10.31		6.47	30.0	6867					
May	5/22/2003	11:55	26.19	0.069	0.03	6.90	85.8	6.94	19.8	1664	0	0.132	0.266	0.159	
June	6/18/2003									1483	0.004	0.183	0.348	0.178	
July	7/28/2003	12:29	24.63	0.047	0.02	8.33	100.2	6.70	134.9	7766	0.005	0.297	0.947	0.408	
August	8/28/2003	14:15	25.20	0.082	0.04	4.59	55.9	7.50	12.9	677	0.004	0.222	0.365	0.201	
September	9/24/2003	11:35	24.88	0.079	0.04	6.50	84.3	6.62	12.6	307	0.010	0.302	0.561	0.203	
October	10/24/2003														
November	11/24/2003	11:53	25.47	0.077	0.03	7.21	88.8	6.91	25.6	805	0	0.193	0.363	0.231	
December	12/22/2003	11:22	26.11	0.085	0.04	3.57	46.2	6.79	4.7	712	0.019	0.128	0.31	0.152	
January	1/29/2004	10:22	26.21	0.082	0.04	4.75	61.2	6.29	7.5	624	0	0.251	0.318	0.178	
February	2/19/2004	10:31	26.16	0.085	0.04	4.35	57.2	6.90	7.9	256	0	0.260	0.423	0.196	

Fagalii 1 Stream, Fa2 (downstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/31/2003	8:51	25.86	0.072	0.03	8.24	101.6	7.15	87.3	5475					
April	4/23/2003	9:09	25.30	0.068	0	10.56		7.14	28.0	1664					
May	5/22/2003	11:47	26.01	0.077	0.03	7.73	90.3	7.20	14.8	1281	0	0.201	0.303	0.169	
June	6/18/2003									12997	0	0.266	0.392	0.171	
July	7/28/2003	12:22	24.68	0.048	0.02	8.35	100.6	6.90	144.2	24192	0.008	0.320	1.380	0.665	
August	8/28/2003	14:05	24.77	0.083	0.04	7.60	91.7	7.82	9.3	4352	0	0.228	0.349	0.185	
September	9/24/2003	11:23	24.36	0.087	0.04	8.10	101.2	6.96	10.0	243	0.009	0.323	0.591	0.237	0.1
October	10/24/2003	12:02	25.95	0.098	0.05	3.88	50.7	6.92	2.7	41	0	0.113	0.535	0.244	
November	11/24/2003	11:47	25.48	0.080	0.04	8.16	99.8	7.14	23.9	3208	0	0.198	0.364	0.233	2.6
December	12/22/2003	11:13	25.89	0.089	0.04	7.10	88.7	7.13	2.5	4352	0	0.057	0.192	0.149	0.1
January	1/29/2004	10:15	25.64	0.090	0.04	8.25	102.5	6.64	5.6	3448	0	0.245	0.365	0.189	0.3
February	2/19/2004	10:22	26.11	0.090	0.04	8.10	101.0	7.43	4.8	1547	0	0.280	0.426	0.175	0.1
															0.1
															5

Fagalii 1 Stream, average

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)
March	3/31/2003		25.74	0.070	0.03	8.08	99.6	6.94	95.9	5111				
April	4/23/2003		25.30	0.065	0.00	10.44		6.81	29.0	4266				
May	5/22/2003		26.10	0.073	0.03	7.32	88.1	7.07	17.3	1473	0	0.167	0.285	0.164
June	6/18/2003									7240	0.002	0.225	0.370	0.175
July	7/28/2003		24.66	0.048	0.02	8.34	100.4	6.80	139.6	15979	0.007	0.309	1.164	0.537
August	8/28/2003		24.99	0.083	0.04	6.10	73.8	7.66	11.1	2515	0.002	0.225	0.357	0.193
September	9/24/2003		24.62	0.083	0.04	7.30	92.8	6.79	11.3	275	0.010	0.313	0.576	0.220
October	10/24/2003		25.95	0.098	0.05	3.88	50.7	6.92	2.7	41	0	0.113	0.535	0.244
November	11/24/2003		25.48	0.079	0.04	7.69	94.3	7.03	24.8	2007	0	0.196	0.364	0.232
December	12/22/2003		26.00	0.087	0.04	5.34	67.5	6.96	3.6	2532	0.010	0.093	0.251	0.151
January	1/29/2004		25.93	0.086	0.04	6.50	81.9	6.47	6.6	2036	0	0.248	0.342	0.184
February	2/19/2004		26.14	0.088	0.04	6.23	79.1	7.17	6.4	902	0	0.270	0.425	0.186
			25.74	0.08	0.04	7.30	84.95	6.94	11.30	2275.25	0.00	0.22	0.37	0.19
			11	11	11	11	10	11	11	12	10	10	10	10

Table A5. Raw data collected at monthly intervals from 2 sites on Auvaiola Stream (Watershed #20), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Auvaiola Stream, Au1 (upstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/19/2003	9:30	26.06	0.184	0.09	6.40	79.2	7.48	34.1	9208					
April	4/21/2003	10:30	25.66	0.119	0.06	7.32	90.5	7.25	193.1	8164					
May	5/15/2003	10:40	26.06	0.193	0.09	5.02	62.5	7.37	33.1	4884	0	0.064	0.410	0.260	
June	6/23/2003	13:37	23.19	0.185	0.09	7.01	82.6	7.55	17.0	1274	0.028	0.061	0.295	0.233	
July	7/23/2003	13:40	25.33	0.226	0.11	3.65	44.5	7.18	31.2	19863	0.055	0.089	0.577	0.326	
August	8/27/2003	11:10	23.20	0.175	0.08	6.96	81.6	7.73	30.4	1814	0	0.046	0.275	0.231	
September	9/16/2003	11:04	25.44	0.198	0.09	4.36	53.4	7.18	21.8	4611	0.017	0.077	0.503	0.318	0.02
October	10/22/2003	10:53	25.51	0.176	0.08	6.55	81.6	7.47	30.1	8665	0.060	0.058	0.759	0.301	
November	11/25/2003	11:13	25.47	0.185	0.09	9.31	116.1	7.03	13.7	1137	0	0.014	0.154	0.146	
December	12/29/2003	9:52	25.73	0.175	0.06	7.61	94.6	7.23	13.2	9208	0.006	0.032	0.281	0.183	0.03
January	1/28/2004	11:20	26.84	0.186	0.09	6.67	84.9	8.36	22.3	2993	0	0.064	0.420	0.242	0.1
February	2/18/2004	12:06	25.66	0.163	0.08	8.46	104.8	8.49	23.8	3654	0	0.030	0.349	0.231	0.4
															0.065
															4

Auvaiola Stream, Au2 (downstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/19/2003	9:18	26.71	0.263	0.12	6.6	82.8	7.66	27.5	3591					
April	4/21/2003	10:17	25.97	0.211	0.10	7.7	95.6	7.43	129.6	10462					
May	5/15/2003	10:29								496	0	0.191	0.514	0.254	
June	6/23/2003	13:24	24.61	0.286	0.14	8.7	102.7	7.63	56.0	265	0.010	0.159	0.502	0.240	
July	7/23/2003														
August	8/27/2003														
September	9/16/2003														
October	10/22/2003														
November	11/25/2003														
December	12/29/2003														
January	1/28/2004														
February	2/18/2004														

Auvaiola Stream, average

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/19/2003		26.39	0.224	0.11	6.51	81.0	7.57	30.8	6400					
April	4/21/2003		25.82	0.165	0.08	7.51	93.1	7.34	161.4	9313					
May	5/15/2003		26.06	0.193	0.09	5.02	62.5	7.37	33.1	2690	0	0.128	0.462	0.257	
June	6/23/2003		23.90	0.236	0.12	7.86	92.7	7.59	36.5	770	0.019	0.110	0.399	0.237	
July	7/23/2003		25.33	0.226	0.11	3.65	44.5	7.18	31.2	19863	0.055	0.089	0.577	0.326	
August	8/27/2003		23.20	0.175	0.08	6.96	81.6	7.73	30.4	1814	0	0.046	0.275	0.231	
September	9/16/2003		25.44	0.198	0.09	4.36	53.4	7.18	21.8	4611	0.017	0.077	0.503	0.318	
October	10/22/2003		25.51	0.176	0.08	6.55	81.6	7.47	30.1	8665	0.060	0.058	0.759	0.301	
November	11/25/2003		25.47	0.185	0.09	9.31	116.1	7.03	13.7	1137	0	0.014	0.154	0.146	
December	12/29/2003		25.73	0.175	0.06	7.61	94.6	7.23	13.2	9208	0.006	0.032	0.281	0.183	
January	1/28/2004		26.84	0.186	0.09	6.67	84.9	8.36	22.3	2993	0	0.064	0.420	0.242	
February	2/18/2004		25.66	0.163	0.08	8.46	104.8	8.49	23.8	3654	0	0.030	0.349	0.231	
			25.59	0.186	0.09	6.82	83.3	7.42	30.3	4133	0.003	0.061	0.409	0.239	
			12	12	12	12	12	12	12	12	10	10	10	10	

Table A6. Raw data collected at monthly intervals from 2 sites on Nuu Stream (Watershed #21), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Nuu Stream, Nu1 (east trib site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/19/2003	9:56	26.81	0.900	0.44	6.09	76.5	7.09	13.6	24192					
April	4/21/2003	10:57	26.44	0.127	0.06	7.32	90.8	6.92	109.7	19863					
May	5/15/2003	11:06	27.02	0.422	0.20	5.61	71.8	7.10	23.4	1935	0	0.013	0.393	0.046	
June	6/23/2003	14:02	24.08	0.175	0.08	5.16	64.2	7.53	35.7	1012	0.020	0.021	0.151	0.087	
July	7/23/2003														
August	8/27/2003	11:34	24.19	0.121	0.06	8.58	102.3	7.80	48.6	3873	0	0.030	0.269	0.073	
September	9/16/2003														
October	10/29/2003	11:16	26.49	0.151	0.07	7.55	94.3	7.50	61.1	226	0.021	0.022	1.000	0.250	
November	11/25/2003	11:43	26.59	0.116	0.05	9.13	114.6	7.40	35.1	393	0	0.009	0.236	0.063	
December	12/29/2003	10:27	26.51	0.124	0.06	6.81	85.4	7.21	28.2	1935	0	0.000	0.265	0.054	
January	1/28/2004	11:51	27.39	0.138	0.06	6.53	84.8	7.80	35.3	3654	0.043	0.122	0.554	0.104	
February	2/18/2004	12:40	27.40	0.110	0.05	8.72	111.1	7.65	148.5	24192	0.007	0.035	1.010	0.048	

Nuu Stream, Nu3 (main channel near road)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/19/2003	9:49	26.86	0.315	0.15	3.00	40.2	6.91	4.3	17329					
April	4/21/2003	10:51	26.61	0.107	0.04	6.20	78.8	6.91	74.7	15531					
May	5/15/2003	10:59	27.76	0.479	0.23	1.34	18.3	6.85	10.6	16430	2.110	0.011	2.950	0.738	
June	6/23/2003	13:54	25.37	0.311	0.15	2.87	36.2	7.15	6.6	19863	0	0.019	2.040	0.671	
July	7/23/2003	13:56	27.03	0.556	0.27	1.78	22.4	6.78	16.0	24192	1.790	0.006	2.860	0.942	
August	8/27/2003	11:27	24.88	0.238	0.11	4.02	48.8	7.25	10.4	7701	0.254	0.439	1.050	0.259	
September	9/16/2003	11:48	26.91	0.566	0.27	1.09	13.8	7.12	12.8	9208	2.480	0.007	4.500	0.964	5.8
October	10/29/2003	11:03	27.99	0.538	0.26	3.41	45.2	7.04	10.2	3476	1.920	0.023	3.770	0.799	0.8
November	11/25/2003	11:31	26.56	0.158	0.07	7.70	97.0	6.96	21.0	4106	0	0.121	0.450	0.147	27.8
December	12/29/2003	10:13	27.14	0.228	0.11	3.27	41.6	7.04	25.8	14136	0.276	0.258	1.530	0.269	2.2
January	1/28/2004	11:40	29.03	0.306	0.14	4.86	64.4	7.34	5.5	12033	0.423	0.508	1.455	0.283	2.0
February	2/18/2004	12:28	28.01	0.169	0.08	6.59	84.9	7.53	59.0	24192	0.121	0.252	1.150	0.106	23.6
															4.0
															6

Nuu Stream, average

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)
March	3/19/2003		26.84	0.608	0.30	4.55	58.4	7.00	9.0	20761				
April	4/21/2003		26.53	0.117	0.05	6.76	84.8	6.92	92.2	17697				
May	5/15/2003		27.39	0.451	0.22	3.48	45.0	6.98	17.0	9182	1.055	0.012	1.672	0.392
June	6/23/2003		24.73	0.243	0.12	4.02	50.2	7.34	21.2	10437	0.010	0.020	1.096	0.379
July	7/23/2003		27.03	0.556	0.27	1.78	22.4	6.78	16.0	24192	1.790	0.006	2.860	0.942
August	8/27/2003		24.54	0.180	0.09	6.30	75.6	7.53	29.5	5787	0.127	0.235	0.660	0.166
September	9/16/2003		26.91	0.566	0.27	1.09	13.8	7.12	12.8	9208	2.480	0.007	4.500	0.964
October	10/29/2003		27.24	0.345	0.17	5.48	69.8	7.27	35.7	1851	0.971	0.023	2.385	0.525
November	11/25/2003		26.58	0.137	0.06	8.42	105.8	7.18	28.1	2250	0	0.065	0.343	0.105
December	12/29/2003		26.83	0.176	0.09	5.04	63.5	7.13	27.0	8036	0.138	0.129	0.898	0.162
January	1/28/2004		28.21	0.222	0.10	5.70	74.6	7.57	20.4	7844	0.233	0.315	1.005	0.194
February	2/18/2004		27.71	0.140	0.07	7.66	98.0	7.59	103.8	24192	0.064	0.144	1.080	0.077
			26.87	0.233	0.11	5.26	66.6	7.15	24.1	9195	0.186	0.044	1.088	0.286
			12	12	12	12	12	12	12	12	10	10	10	10

Table A7. Raw data collected at monthly intervals from 3 sites on Mataalii Stream (Watershed #27), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Mataalii Stream, MT1 (upstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/27/2003	12:27	26.40	0.089	0.04	8.84	111.8	7.24	1.9	199					
April	4/29/2003	11:22	25.78	0.100	0.05	9.40	116.7	7.23	1.3	212					
May	5/21/2003	9:27	24.79	0.072	0.03			7.00	115.4	2063	0	0.050	0.815	0.531	
June	6/18/2003									373	0	0.058	0.112	0.168	
July	7/31/2003	12:10	24.49	0.082	0.04	9.44	114.8	7.20	2.4	341	0	0.064	0.114	0.151	
August	8/21/2003	13:17	24.91	0.087	0.04	9.43	114.2	7.17	1.3	97	0	0.053	0.109	0.155	
Septembe	9/24/2003	12:55	24.90	0.089	0.04	9.18	115.5	6.96	1.0	266	0	0.062	0.129	0.175	1.7
October	10/16/2003	9:01	25.73	0.105	0.05	7.96	99.3	7.15	0.6	1850	0	0.313	0.382	0.180	8.7
November	11/20/2003	14:50								108	0	0.034	0.093	0.135	
December	12/23/2003	9:34	25.18	0.074	0.03	8.38	102.9	7.05	5.2	374	0	0.034	0.142	0.128	82.6
January	1/26/2004	9:52	26.29	0.091	0.04	8.75	108.8	6.80	0.1	410	0	0.008	0.070	0.167	1.6
February	2/12/2004	10:06	25.59	0.085	0.04	9.00	111.1	7.18	0.9	374	0	0.037	0.123	0.158	8.0
															8.0
															5

Mataalii Stream, MT2 (midstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/27/2003	12:18	27.35	0.087	0.04	8.82	112.9	7.90	2.2	831					
April	4/29/2003	11:13	26.17	0.101	0.05	8.50	105.3	7.15	1.7	4884					
May	5/21/2003	9:15	24.85	0.075	0.03			7.15	9.6	14136	0	0.053	0.127	0.136	
June	6/18/2003									145	0	0.061	0.133	0.118	
July	7/31/2003	12:01	25.86	0.095	0.04	7.97	99.4	7.15	3.5	789	0	0.046	0.138	0.123	
August	8/21/2003	13:03	26.24	0.097	0.04	8.37	103.8	7.31	3.2	1053	0	0.057	0.103	0.113	
Septembe	9/24/2003	12:44	25.83	0.097	0.04	8.10	102.7	7.05	6.7	368	0	0.042	0.130	0.137	
October	10/16/2003	8:46	26.26	0.104	0.05	8.01	102.6	7.65	11.7	2481	0.041	0.080	0.364	0.210	
November	11/20/2003	14:41								121	0	0.069	0.116	0.102	
December	12/23/2003	9:22	25.27	0.075	0.03	8.58	106.4	6.99	16.6	1326	0	0.037	0.187	0.176	
January	1/26/2004	9:39	26.45	0.097	0.04	8.01	100.4	6.90	4.1	1515	0	0.049	0.266	0.158	
February	2/12/2004	9:56	26.63	0.091	0.04	8.29	104.0	7.26	4.7	1326	0	0.058	0.141	0.123	

Mataalii Stream, MT3 (downstream site below road)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/27/2003	12:08	29.33	0.187	0.09	5.59	73.9	6.55	1.2	1899					
April	4/29/2003														
May	5/21/2003	8:57	26.58	0.208	0.10			6.88	1.6	1884	0	1.780	2.010	0.119	
June	6/18/2003									402	0	0.579	0.663	0.097	
July	7/31/2003	11:53	26.61	0.225	0.11	5.77	72.4	6.77	0.8	2909	0	1.070	1.160	0.130	
August	8/21/2003	12:53	28.67	0.226	0.11	7.74	100.1	7.12	0.0	1374	0	0.440	0.554	0.125	
Septembe	9/24/2003	12:30	28.31	0.251	0.12	6.71	86.2	6.29	0.9	3255	0	0.755	0.853	0.165	
October	10/16/2003														
November	11/20/2003	14:25								924	0	1.440	1.710	0.157	20.4
December	12/23/2003	9:09	26.73	0.19	0.09	7.09	89.5	6.55	0.0	6510	0.004	0.600	0.805	0.130	
January	1/26/2004														
February	2/12/2003	9:46	27.61	0.222	0.10	6.43	83.6	7.55	0.0	6510	0	0.847	1.040	0.197	

Mataalii Stream, average

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)
March	3/27/2003		27.69	0.121	0.06	7.75	99.5	7.23	1.8	976				
April	4/29/2003		25.98	0.101	0.05	8.95	111.0	7.19	1.5	2548				
May	5/21/2003		25.41	0.118	0.05			7.01	42.2	6028	0	0.628	0.984	0.262
June	6/18/2003									307	0	0.233	0.303	0.128
July	7/31/2003		25.65	0.134	0.06	7.73	95.5	7.04	2.2	1346	0	0.393	0.471	0.135
August	8/21/2003		26.61	0.137	0.06	8.51	106.0	7.20	1.5	841	0	0.183	0.255	0.131
Septembe	9/24/2003		26.35	0.146	0.07	8.00	101.5	6.77	2.9	1296	0	0.286	0.371	0.159
October	10/16/2003		26.00	0.105	0.05	7.99	101.0	7.40	6.2	2166	0.021	0.197	0.373	0.195
November	11/20/2003									384	0	0.514	0.640	0.131
December	12/23/2003		25.73	0.113	0.05	8.02	99.6	6.86	7.3	2737	0.001	0.224	0.378	0.145
January	1/26/2004		26.37	0.094	0.04	8.38	104.6	6.85	2.1	962	0	0.029	0.168	0.163
February	2/12/2003		26.61	0.133	0.06	7.91	99.6	7.33	1.9	2737	0	0.314	0.435	0.159
			26.17	0.120	0.06	8.00	101.0	7.12	2.2	1321	0.000	0.260	0.376	0.152
			10	10	10	9	9	10	10	12	10	10	10	10

Table A8. Raw data collected at monthly intervals from 3 sites on Vailoa Stream (Watershed #24), American Samoa. Monthly averages across all sampled sites are shown at the bottom.

Vailoa Stream, VA1 (upstream site)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/27/2003	10:30	26.56	0.115	0.05	7.75	97.1	6.87	4.3	1747					
April	4/29/2003	10:22	26.13	0.120	0.06	10.70	126.5	7.22	2.8	156					
May	5/21/2003	10:34	26.15	0.098	0.05			6.71	11.8	2489	0	0.127	0.237	0.179	
June	6/18/2003									388	0	0.164	0.264	0.197	
July	7/31/2003	10:49	24.92	0.109	0.05	9.18	111.7	7.38	7.7	512	0	0.236	0.353	0.183	
August	8/21/2003	12:22	25.63	0.111	0.05	9.07	111.4	7.42	5.3	250	0	0.123	0.230	0.177	
Septembei	9/24/2003	14:09	25.36	0.122	0.06	9.72	122.4	6.95	3.6	108	0.005	0.076	0.325	0.193	
October	10/16/2003	10:30	26.19	0.132	0.06	8.06	101.6	7.90	4.1	1500	0.016	0.021	0.181	0.175	
November	11/20/2003	9:39	25.80	0.107	0.05	8.97	110.6	6.98	5.6	313	0	0.071	0.171	0.152	
December	12/23/2003	8:36	25.37	0.094	0.04	8.32	102.1	6.83	15.0	1710	0	0.082	0.281	0.160	
January	1/26/2004	9:04	26.24	0.118	0.05	8.32	104.2	6.79	1.3	290	0	0.083	0.170	0.181	
February	2/12/2004	11:02	26.45	0.116	0.05	8.50	107.7	6.77	2.5	1710	0	0.269	0.425	0.191	

Vailoa Stream, VA2 (midstream site by bridge)

Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/27/2003	10:19	27.50	0.129	0.06	7.23	92.0	6.91	8.3	3448					
April	4/29/2003	10:13	27.28	0.148	0.07	7.62	97.9	7.15	6.8	2143					
May	5/21/2003	10:25	26.20	0.105	0.05			6.79	14.4	2666	0	0.238	0.352	0.234	
June	6/18/2003									1211	0	0.392	0.533	0.252	
July	7/31/2003	10:40	25.44	0.115	0.05	8.24	101.1	7.36	10.8	3448	0	0.338	0.465	0.253	
August	8/21/2003	12:12	26.28	0.124	0.06	7.90	98.1	7.34	4.9	1313	0	0.423	0.708	0.268	
Septembei	9/24/2003	14:00	25.81	0.142	0.07	7.20	94.0	7.11	1.8	2382	0	0.314	0.512	0.256	
October	10/16/2003	10:21	26.78	0.197	0.09	5.92	78.0	7.30	2.2	8164	0.027	0.230	0.541	0.339	
November	11/20/2003	9:29	26.12	0.115	0.05	9.29	116.7	7.12	8.9	784	0	0.272	0.383	0.240	
December	12/23/2003	8:27	25.79	0.104	0.05	8.21	102.4	7.35	18.0	3214	0	0.303	0.599	0.234	
January	1/26/2004	8:50	26.75	0.133	0.06	7.37	92.7	6.85	3.4	8164	0	0.494	0.758	0.273	
February	2/12/2004	10:50	26.75	0.125	0.06	8.47	106.9	6.94	4.9	3214	0	0.372	0.569	0.257	

Vailoa Stream, VA3 (downstream site behind lot)

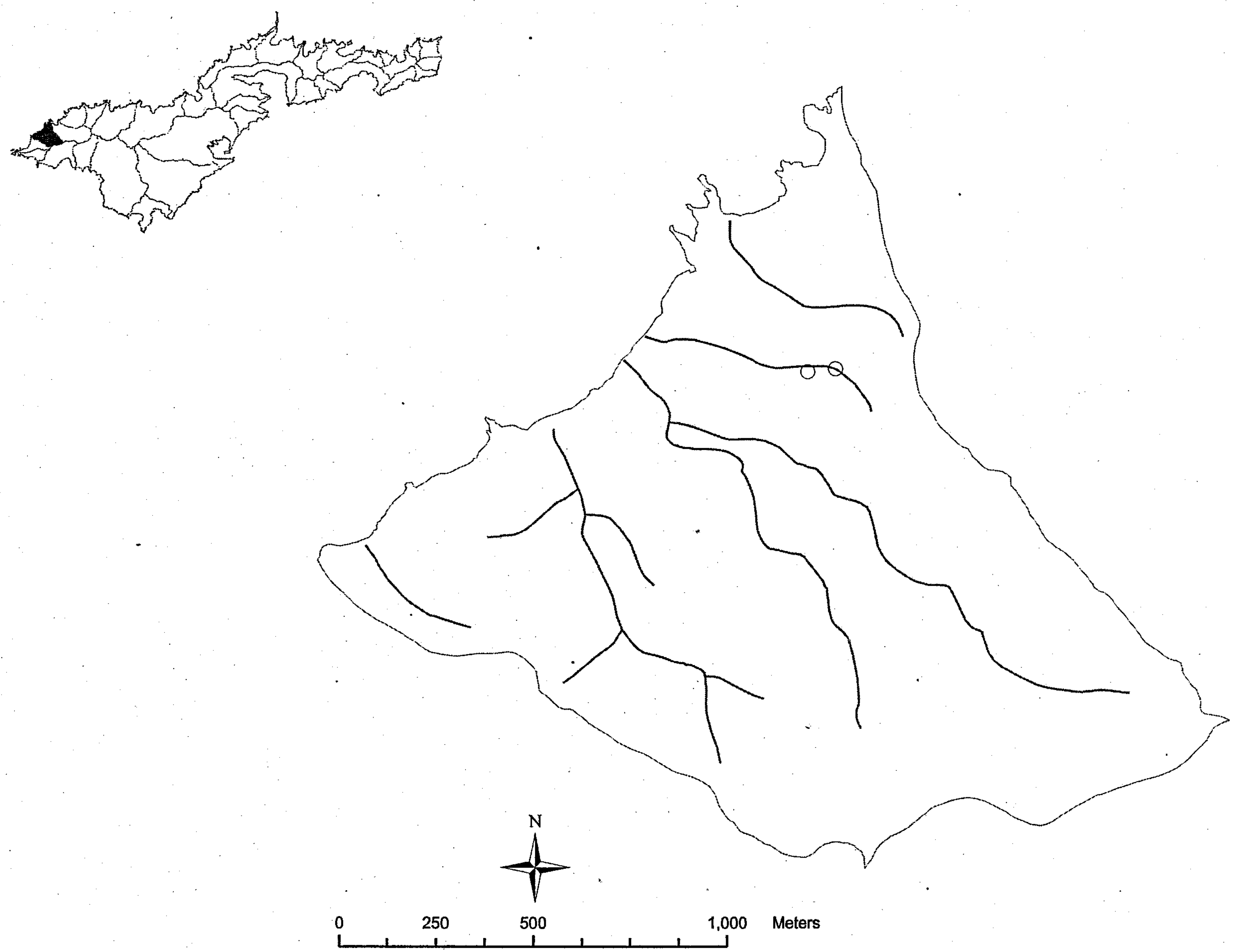
Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)	Discharge (L/s)
March	3/27/2003	10:07	27.85	0.164	0.08	5.32	69.3	6.96	10.8	743					
April	4/29/2003	10:02	30.96	0.207	0.10	8.51	115.5	7.51	11.6	9450					
May	5/21/2003	10:13	27.66	0.138	0.06			6.83	13.2	1850	0	0.287	0.404	0.193	
June	6/18/2003									1782	0.004	0.307	0.440	0.216	
July	7/31/2003	10:31	26.29	0.152	0.07	6.20	76.9	7.74	11.8	11199	0.024	0.348	0.563	0.252	
August	8/21/2003	12:01	30.21	0.201	0.09	7.30	97.2	7.40	4.6	1607	0.007	0.376	0.562	0.223	
Septembei	9/24/2003	13:49	29.13	0.299	0.14	6.63	87.8	6.86	2.8	1153	0.029	0.322	0.577	0.216	4.0
October	10/16/2003	10:04	27.67	0.523	0.25	8.20	108.2	7.16	9.0	3102	0.016	0.214	0.493	0.242	0.4
November	11/20/2003	9:13	26.81	0.165	0.08	8.44	108.9	7.48	13.1	9804	0.097	0.605	1.110	0.246	31.7
December	12/23/2003	8:11	26.44	0.185	0.09	7.38	92.3	7.24	18.7	4962	0.079	0.659	1.770	0.280	52.6
January	1/26/2004	8:32	27.00	0.208	0.10	5.14	66.7	7.34	6.3	7270	0.130	0.424	0.912	0.408	6.8
February	2/12/2004	10:38	27.28	0.169	0.08	6.41	82.2	6.91	5.8	4962	0.032	0.405	0.742	0.252	15.1
															11.0
															6

Vailoa Stream, average

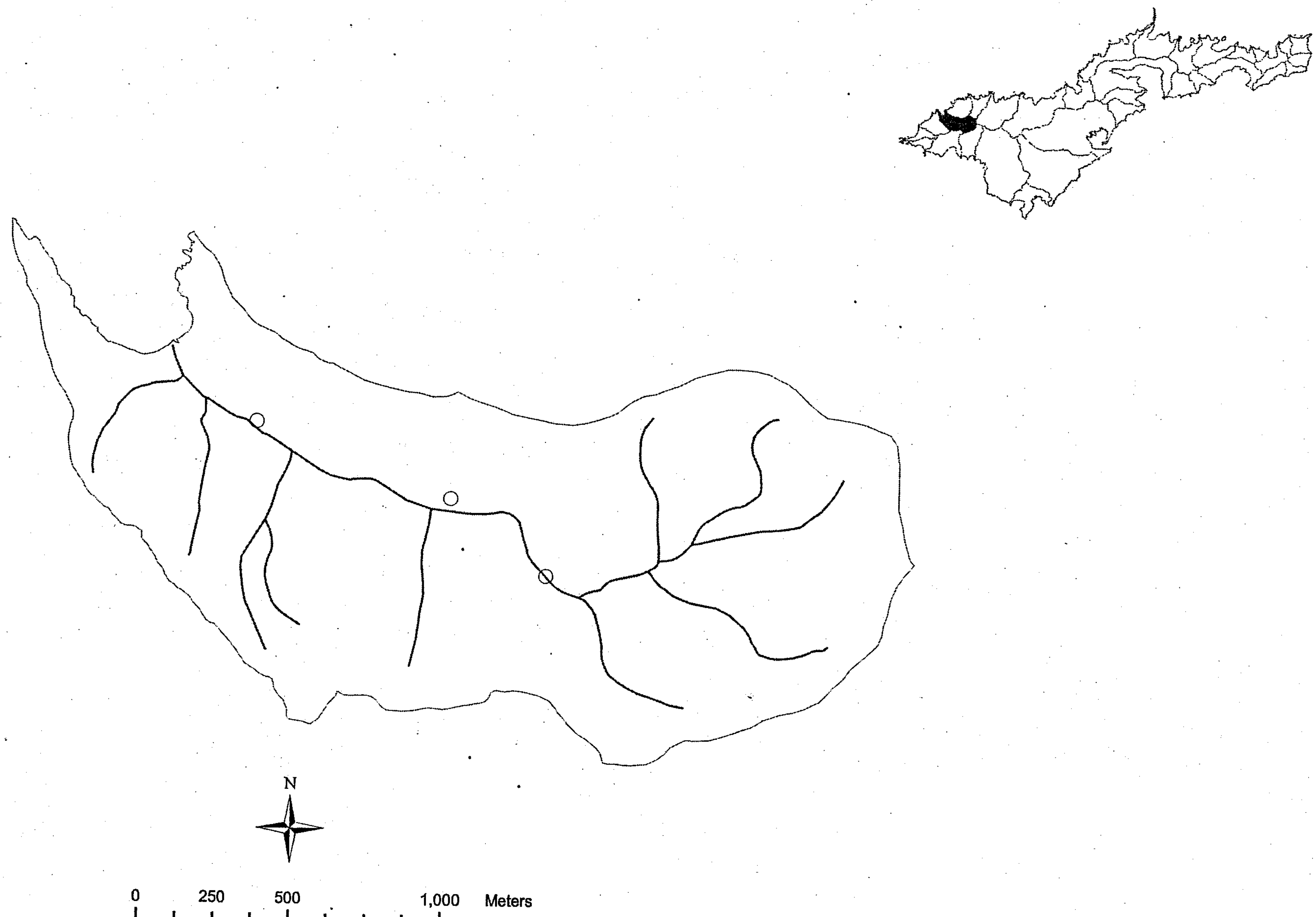
Month	Date	Time	Temp (°C)	SpCond (mS/cm)	Sal (ppt)	DO (mg/L)	DO (% sat)	pH	Turb (NTU)	Bacti (MPN)	NH4 (mg/L)	NO2/3 (mg/L)	TN (mg/L)	TP (mg/L)
March	3/27/2003		27.30	0.136	0.06	6.77	86.1	6.91	7.8	1979				
April	4/29/2003		28.12	0.158	0.08	8.94	113.3	7.29	7.1	3916				
May	5/21/2003		26.67	0.114	0.05			6.78	13.1	2335	0	0.217	0.331	0.202
June	6/18/2003									1127	0.001	0.288	0.412	0.222
July	7/31/2003		25.55	0.125	0.06	7.87	96.6	7.49	10.1	5053	0.008	0.307	0.460	0.229
August	8/21/2003		27.37	0.145	0.07	8.09	102.2	7.39	4.9	1057	0.002	0.307	0.500	0.223
Septembei	9/24/2003		26.77	0.188	0.09	7.85	101.4	6.97	2.7	1214	0.011	0.237	0.471	0.222
October	10/16/2003		26.88	0.284	0.13	7.39	95.9	7.45	5.1	4255	0.020	0.155	0.405	0.252
November	11/20/2003		26.24	0.129	0.06	8.90	112.1	7.19	9.2	3634	0.032	0.316	0.555	0.213
December	12/23/2003		25.87	0.128	0.06	7.97	98.9	7.14	17.2	3295	0.026	0.348	0.883	0.225
January	1/26/2004		26.66	0.153	0.07	6.94	87.9	6.99	3.7	5241	0.043	0.334	0.613	0.287
February	2/12/2004		26.83	0.137	0.06	7.79	98.9	6.87	4.4	3295	0.011	0.349	0.579	0.233
			26.77	0.14	0.06	7.86	98.93	7.14	7.07	3295.33	0.01	0.31	0.49	0.22
			11	11	11	10	10	11	11	12	10	10	10	10

Appendix B

B1



B2



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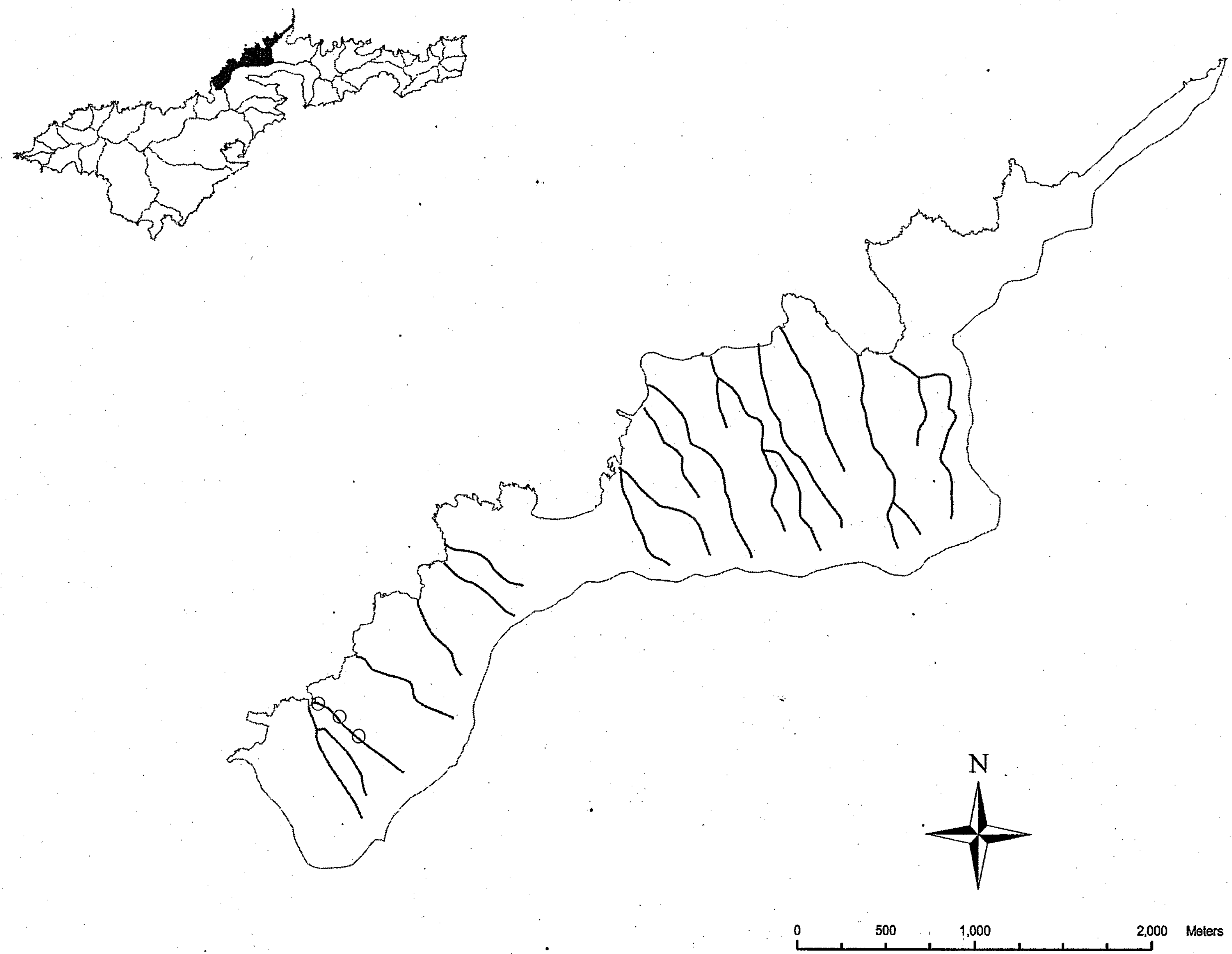

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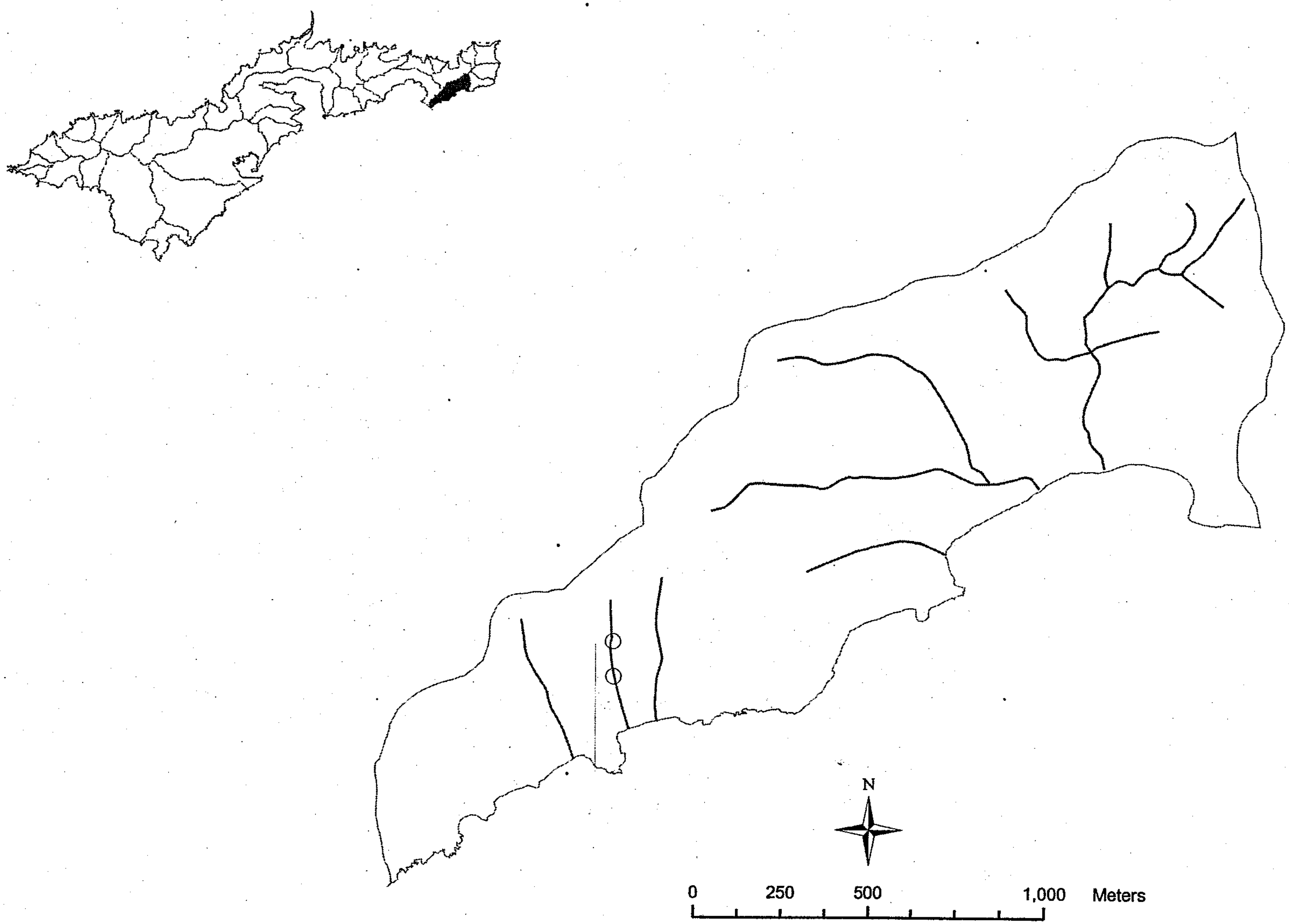

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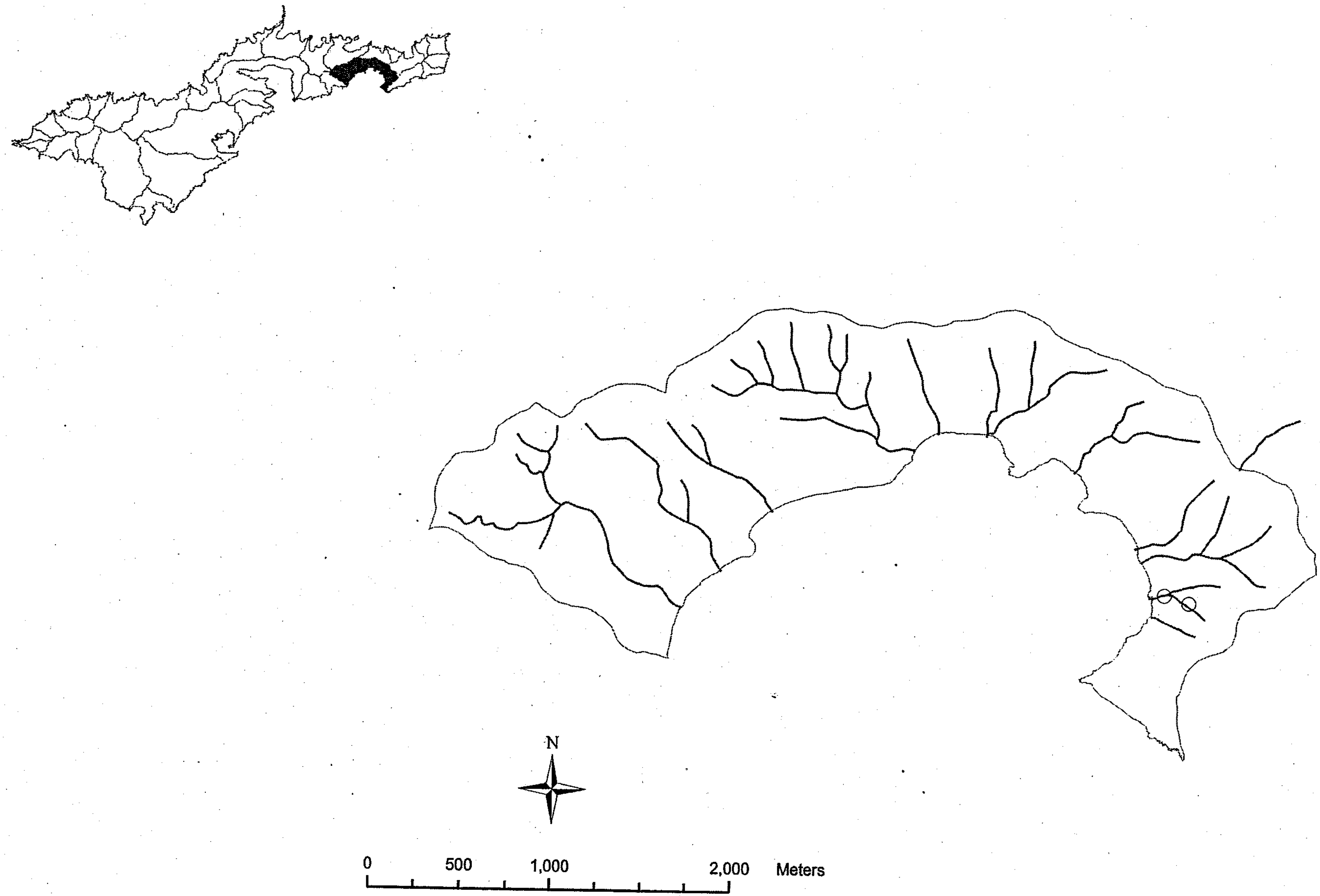

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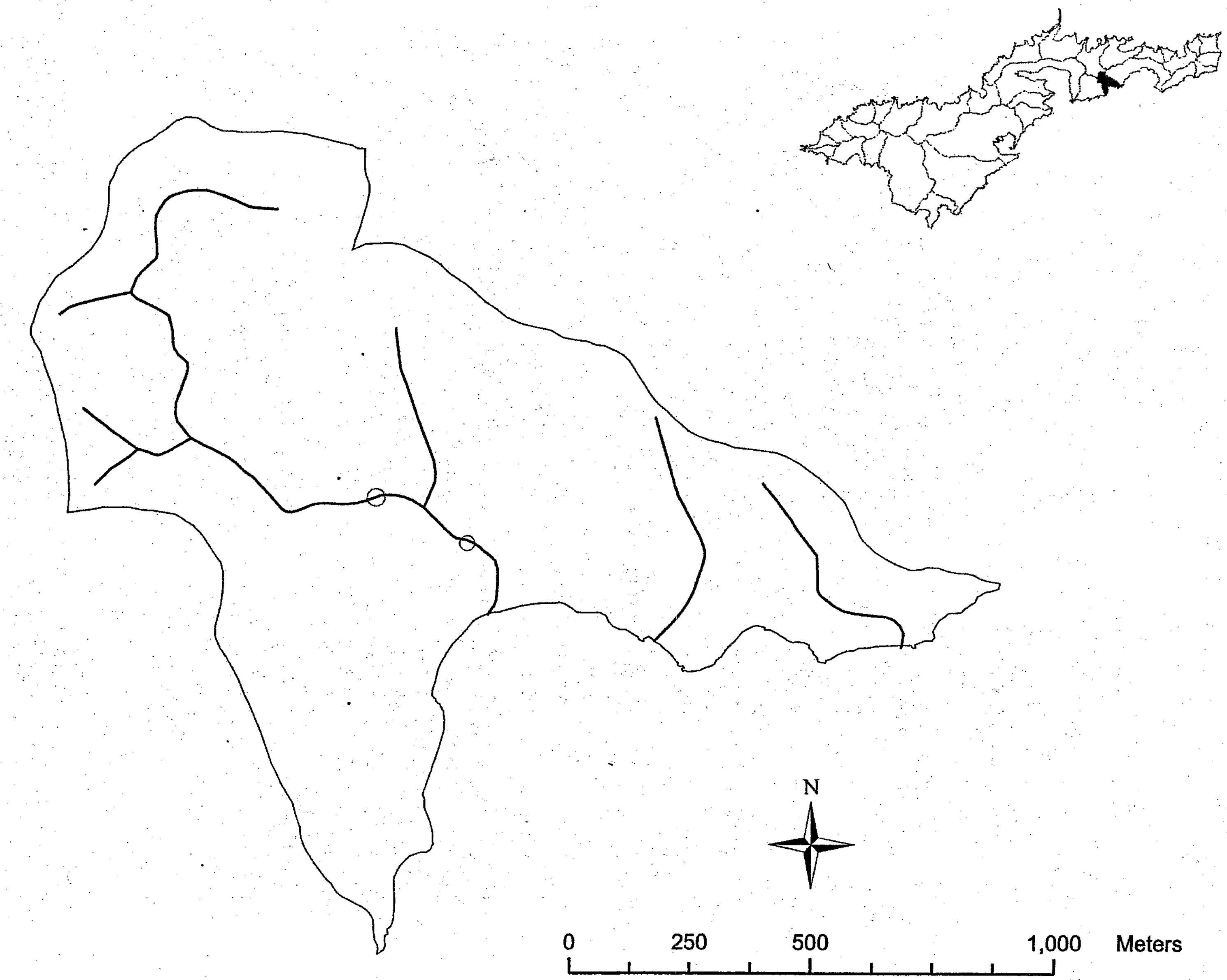

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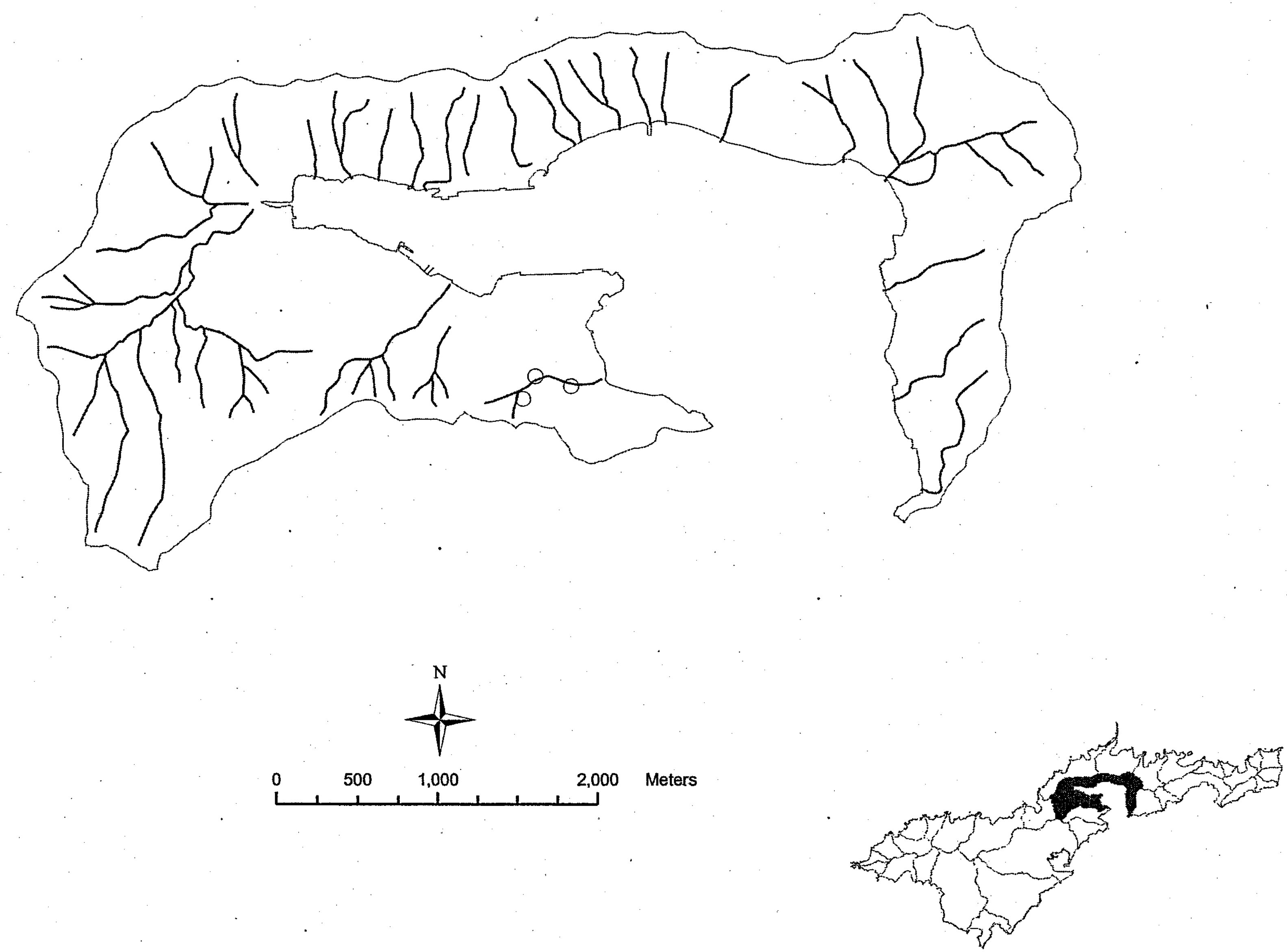

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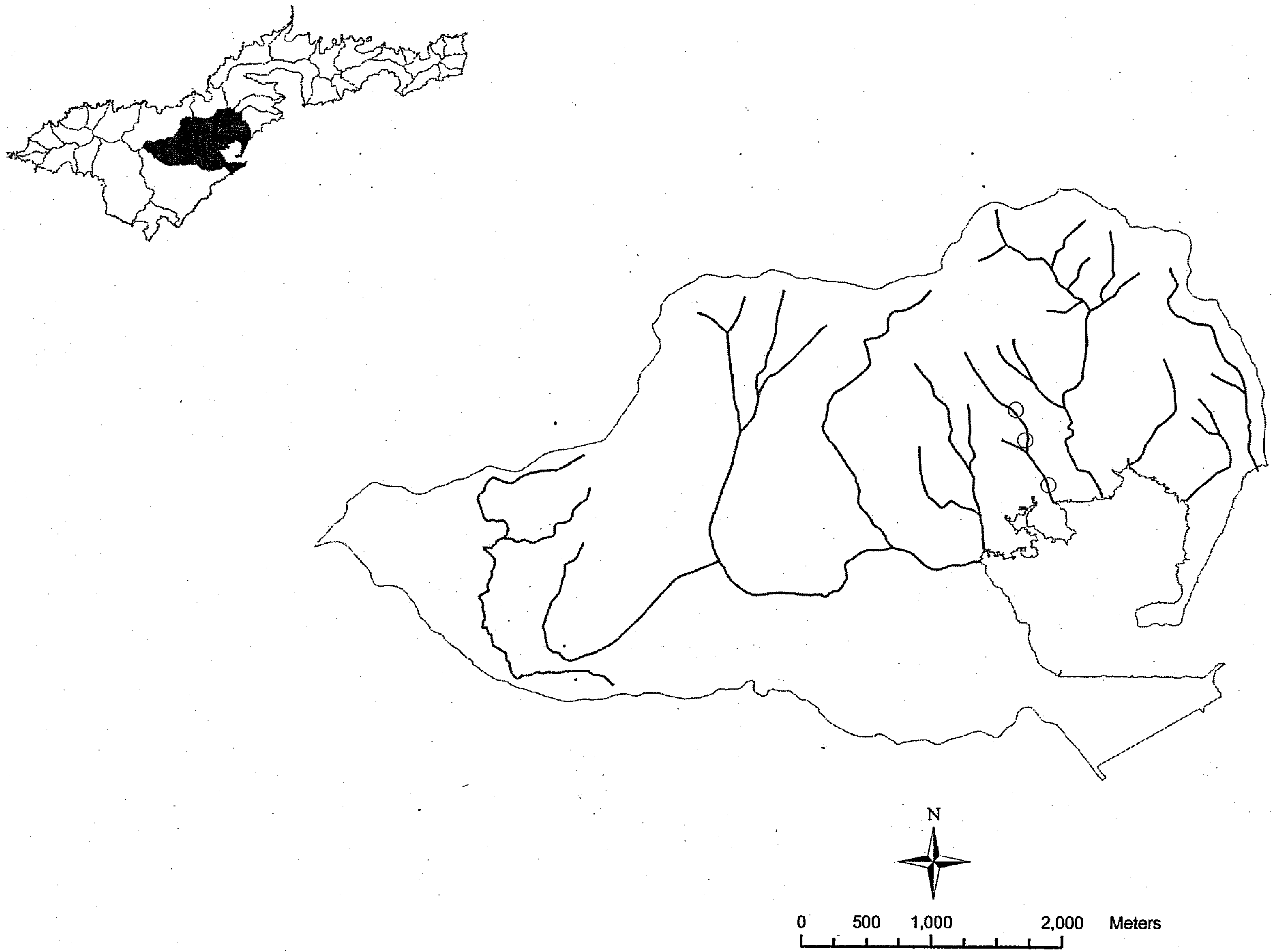

Appendix C

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Fagalii 1 Stream / FY2004
WATERSHED: Fagali'i (2)
REACH SIZE:
STRESSORS: other habitat alterations, nutrients, organic enrichment/low DO, turbidity
SITES MONITORED: 1

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: D. Vargo, ASCC Stream Survey; ASEPA Stream Monitoring Program

ASSESSMENT FINDINGS				
FULLY SUP. FULLY SUP. (THREAT)				
Threshold for attainment				
PARTIALLY SUP. NOT SUP.		X		X
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: Several instances of low DO, and most samples exceeded nutrient (TN/TP) ASWQS. Turbidity also exceeds WQS. Recent clearing for agriculture has reduced ALUS habitat determination.

RESULT = Not supporting; monitored data.

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Malota Stream / FY2004
WATERSHED: Malota (3)
REACH SIZE:
STRESSORS: turbidity
SITES MONITORED: 3

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: D. Vargo, ASCC Stream Survey; ASEPA Stream Monitoring Program; World Wildlife Fund research project

ASSESSMENT FINDINGS				
FULLY SUP.		X		X
FULLY SUP. (THREAT)				
Threshold for attainment				
PARTIALLY SUP.				
NOT SUP.				
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: Turbidity exceeded ASWQS on 4 separate occasions, but overall median value is within ASWQS.

RESULT = Fully supporting; monitored data.

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Fagatuitui 1 Stream / FY2004
WATERSHED: Fagatuitui (9)
REACH SIZE:
STRESSORS: turbidity
SITES MONITORED: 3

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: ASEPA Stream Monitoring Program

ASSESSMENT FINDINGS				
FULLY SUP.		X		X
FULLY SUP. (THREAT)				
Threshold for attainment				
PARTIALLY SUP.				
NOT SUP.				
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: One instance where turbidity value exceeded ASWQS, but median value is well within the ASWQS.

RESULT = Fully supporting; monitored data.

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Auvaiola Stream / FY2004
WATERSHED: Amouli (20)
REACH SIZE:
STRESSORS: nutrients, turbidity
SITES MONITORED: 1

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: ASEPA Stream Monitoring Program

ASSESSMENT FINDINGS				
FULLY SUP. FULLY SUP. (THREAT)		X		
Threshold for attainment				
PARTIALLY SUP. NOT SUP.				X
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: Total nitrogen (TN) and total phosphorus (TP) routinely exceed ASWQS. Turbidity does not comply with WQS.

RESULT = Not supporting; monitored data.

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Nuu Stream / FY2004
WATERSHED: Faga'itua (21)
REACH SIZE:
STRESSORS: nutrients, organic enrichment/low DO, turbidity
SITES MONITORED: 3

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: ASEPA Stream Monitoring Program

ASSESSMENT FINDINGS				
FULLY SUP. FULLY SUP. (THREAT)		X		
Threshold for attainment				
PARTIALLY SUP. NOT SUP.				X
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: The habitat assessment showed that the impacted segment was primarily in the short segment by the road. DO, turbidity, TN, and TP routinely violate the ASWQS at 1 of the two sites, and the stream medians for those conventional parameters also exceed the ASWQS.

RESULT = Not supporting; monitored data.

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Alega Stream / FY2004
WATERSHED: Alega (22)
REACH SIZE: 2.8
STRESSORS: nutrients
SITES MONITORED: 2

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: D. Vargo, ASCC Stream Survey, ASEPA Stream Monitoring Program

ASSESSMENT FINDINGS				
FULLY SUP.		X		
FULLY SUP. (THREAT)				X
Threshold for attainment				
PARTIALLY SUP.				
NOT SUP.				
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: Habitat assessment showed habitat to be in excellent condition, but total phosphorus (TP) routinely exceeded ASWQS. This is likely the background level of TP, as there are no obvious sources.

RESULT = Fully supporting (threatened); monitored data.

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Vailoa Stream / FY2004
WATERSHED: Pago Pago (24)
REACH SIZE:
STRESSORS: habitat modification, pH, nutrients, organic enrichment/low DO, turbidity
SITES MONITORED: 3

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: D. Vargo, ASCC Stream Survey, ASEPA Stream Monitoring Program, CH2MHill harbor monitoring

ASSESSMENT FINDINGS				
FULLY SUP.				
FULLY SUP. (THREAT)				
Threshold for attainment				
PARTIALLY SUP.		X		
NOT SUP.				X
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: Habitat assessment shows degraded habitat and extensive channelization in this stream. Total nitrogen (TN) and total phosphorus (TP) routinely exceed ASWQS, and the annual value also exceeds ASWQS. Turbidity also exceeds ASWQS. There are many instances of DO below the WQS at specific sites, but overall stream value complies with WQS.

RESULT = Not supporting; monitored data.

USE SUPPORT – AQUATIC LIFE

____STREAM____
Waterbody Type

WATERBODY DESCRIPTION
NAME/YEAR: Mataalii Stream / FY2003
WATERSHED: Nuuuli (27)
REACH SIZE:
STRESSORS: habitat modification, nutrients, turbidity
SITES MONITORED: 3

ASSESSMENT QUALITY					
DATA TYPE	LEVEL 1	2	3	4	DESCRIPTION
BIOLOGICAL					
HABITAT	X				ASEPA Stream Monitoring Program
TOXICITY					
P/CHEMICAL		X			Conventional parameters: ASEPA Stream Monitoring Program

ASSESSMENT FINDINGS				
FULLY SUP. FULLY SUP. (THREAT)				
Threshold for attainment				
PARTIALLY SUP. NOT SUP.		X		X
	BIO.	HAB.	TOX.	P/CHEM.

SUMMARY: Habitat assessment showed degraded habitat, extensive channelization, and interrupted flow in this stream. Total nitrogen (TN) routinely exceeded ASWQS, and total phosphorus (TP) often did as well. Turbidity exceeded ASWQS on several occasions, but median value is below the standard.

RESULT = Not supporting; monitored data.