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February 21, 2019

Via Hand Delivery

Daniel Orodenker, Executive Officer
Land Use Commission
State of Hawaii
State Office Tower
Leiopapa A Kamehameha Building
235 South Beretania Street, Suite 406
Honolulu, Hawaii 96813

SUBJECT: Twenty-First Annual Report for Land Use Commission Docket No. A97-721 (Makena Resort)

Dear Executive Officer Orodenker:

On behalf of the ATC Makena Entities (identified below), we hereby submit this Twenty-First Annual Report for Docket No. A97-721.

I. INTRODUCTION

On February 19, 1998, the Land Use Commission of the State of Hawaii (the "**Commission**") filed its *Findings of Fact, Conclusions of Law, and Decision and Order* (the "**1998 D&O**"), which reclassified 145.943 acres of land in Makena, Maui, Hawaii from the State Land Use Agricultural District into the State Land Use Urban District (hereinafter, the "**LUC Reclassified Property**").

The LUC Reclassified Property is currently owned by multiple owners. ATC Makena N Golf LLC, ATC Makena S Golf LLC, ATC Makena Land SF1 LLC, ATC Makena Land MF1 LLC, ATC Makena Land MF2 LLC, ATC Makena Land MF3 LLC, ATC Makena Land C1 LLC, ATC Makena Land U1 LLC, ATC Makena Land B1 LLC, ATC Makena Land MF4 LLC, ATC Makena Land SF2 LLC and ATC Makena Land AH1 LLC (collectively, "**ATC Entities**") acquired portions of the LUC Reclassified Property by two Commissioner's Deeds dated August

27, 2010. One deed was recorded in the Bureau of Conveyances of the State of Hawaii as Document No. 2010-125618 (applies to TMK No. (2) 2-1-005: 108). The other deed was recorded in the Bureau as Document No. 2010-125620 (applies to TMK No. (2) 2-1-008: 090). ATC Makena Hotel LLC, a Delaware limited liability company ("**ATC Hotel**", collectively with ATC Entities, "**ATC Makena Entities**"), acquired a portion of the Petition Area by Commissioner's Deed dated August 27, 2010 and recorded in the Bureau as Document No. 2010-125626 (applies to TMK Nos (2) 2-1-005: 086 (portion of which is within the Petition Area), and 125 (which is not within the Petition Area)). The remaining portion of the Petition Area is owned by H2R, LLC, a Hawaii limited liability company. Public records show that H2R, LLC acquired approximately 27.83 acres within the Petition Area by Warranty Deed recorded October 1, 2018. H2R, LLC is not affiliated with the ATC Makena Entities.

This Twenty-First Annual Report covers those portions of the LUC Reclassified Property that are owned by the ATC Makena Entities, identified by the following TMK Nos. (2) 2-1-005: 108 (por.), 2-1-008: 090 (por.), and 2-1-005: 086 (por.) (formerly TMK 2-1-007:004), and does not address any properties owned by others, including those owned by H2R, LLC, *e.g.*, the parcels currently identified by TMK No. 2-1-005:085.

On August 27, 2012, the Commission filed an Order Granting With Modification Movant's Motion for Sixth Amendment to the Findings of Fact, Conclusions of Law, and Decision and Order, Filed on February 19, 1998, and for Release of Certain Conditions (the "**2012 Amendment**"). Pursuant to the 2012 Amendment, the Commission released the ATC Makena Entities from Conditions 4, 15 and 21, and amended Conditions 12 and 22 (thereafter renumbered to 11 and 19). An Amended and Restated Declaration of Conditions was recorded on September 7, 2012, in the Bureau of Conveyances as Doc. A-46330782.

II. STATUS OF COMPLIANCE WITH LUC CONDITIONS

The following are the conditions set forth in the 1998 D&O, as amended by the 2012 Amendment, and a description of efforts that are being made to comply with each stated condition:

1. Petitioner shall provide affordable housing opportunities for low, low-moderate, and gap group income residents of the State of Hawai`i in accordance with applicable laws, rules, and regulations of the County of Maui. The location and distribution of the affordable housing or other provisions for affordable housing shall be under such terms as may be mutually agreeable between Petitioner and the County of Maui.

   Response: The ATC Makena Entities acknowledge that the Petitioner is subject to the provisions of said condition and will comply.

2. Petitioner shall coordinate with the County of Maui Board of Water Supply to incorporate the proposed project into the County Water Use and Development Plan for the area. Prior to the granting of the first discretionary permit for the single-family and multi-family residential development described in paragraph 20 of the Decision and Order or the hotel described in paragraph 21 of the Decision and Order and by or before one year from the issuance date of this Decision and Order, Petitioner shall furnish the Commission with a letter from the County of Maui Board of Water Supply confirming that (a) the potable water allocation that will be credited to Petitioner will be available to and sufficient for the proposed project as it is described in the Petition, (b) the availability of potable water will not be an obstacle or impediment to the development of the proposed project as described in the Petition and (c) the proposed project as it is described in the Petition has been incorporated into the County Water Use and Development Plan for the area and that this plan will prevent the continued overpumping of the sustainable yield of the Iao aquifer.

Response: As provided in Petitioner's Second Annual Report, this condition was complied with as set forth in a letter from David Craddick, Director of the Department of Water Supply, County of Maui, dated February 18, 1999.

Additional letters regarding compliance with this condition, dated October 1, 2003, from Petitioner to the Department of Water Supply, and the response from George Tengan, Director of Water Supply, dated October 7, 2003, were attached to the Sixth Annual Report.

The ATC Makena Entities understand that this condition has been satisfied.

3. Petitioner shall participate in the funding and construction of adequate water source, storage, and transmission facilities and improvements to accommodate the proposed project in accordance with the applicable laws, rules and regulations of the County of Maui, and consistent with the County of Maui water use and development plan.

Response: The ATC Makena Entities acknowledge this condition. Furthermore, the ATC Makena Entities understand that in 1976 the Petitioner participated in the Central Maui Source Development Joint Venture and also the Central Maui Transmission Joint Venture, which developed water sources in Waiehu, Maui and a transmission line from the newly developed water sources down to the Wailea and Makena regions. Further, in 1985, Makena Resort constructed a 1.5-million-gallon water storage tank at the Makena Resort.

4. Petitioner shall contribute to the development, funding, and/or construction of school facilities, on a pro rata basis for the residential developments in the proposed project, as determined by and to the satisfaction of the State Department of Education ("DOE"). Terms of the contribution shall be agreed upon by Petitioner and DOE prior to Petitioner acquiring county rezoning or prior to Petitioner applying for building permits if county zoning is not required.

   Response: ATC Makena Entities understand that this condition has been satisfied. Pursuant to an Educational Contribution Agreement for Makena Resort between Petitioner and the Department of Education dated August 17, 2000, the parties have agreed upon a cash contribution by Petitioner which shall represent a fair share payment for the development, funding and/or construction of school facilities by Petitioner.

5. Petitioner shall participate in the pro rata funding and construction of adequate civil defense measures as determined by the State of Hawai`i and County of Maui civil defense agencies.

   Response: This condition has been satisfied. Initially, at the request of the State Department of Defense ("DOD"), the ATC Makena Entities agreed to allow two (2) emergency siren sites to be developed on land owned by the ATC Makena Entities. One at the Makena Wastewater Treatment Plant, and one near Makena Big Beach (Oneloa) (sirens 157 and 158, respectively). As reported in the 15th Annual Report, the ATC Makena Entities executed Rights of Entry/License Agreements with the DOD in 2012. However, in December 2016, DOD informed the ATC Makena Entities that it had decided to forgo the location near Makena Big Beach (Oneloa), and instead would be installing the second siren at Makena State Park. However, DOD still intended to use the site near the Makena Wastewater Treatment Plant. In 2017, DOD completed installation of the siren at the Makena Wastewater Treatment Plant.

6. Should any human burials or any historic sites such as artifacts, charcoal deposits, stone platforms, pavings, or walls be found, Petitioner shall stop work in the immediate vicinity and contact SHPD. The significance of these finds shall then be determined and approved by SHPD, and an acceptable mitigation plan shall be approved by SHPD. SHPD must verify that the fieldwork portion of the mitigation plan has been successfully executed prior to work proceeding in the immediate vicinity of the find. Burials must be treated under specific provisions of Chapter 6E, Hawai`i Revised Statutes.

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

7. Petitioner shall follow the State DLNR recommendations for Petition Areas 1, 2 and 3, for archaeological data recovery and preservation. An archaeological data recovery plan (scope of work) must be approved by SHPD. That plan then must be successfully executed (to be verified in writing by the SHPD), prior to any grading, clearing, grubbing or other land alteration in these areas. In Petition Area 1, three significant historic sites (1969, 2563, 2569) are committed to preservation. A preservation plan must be approved by SHPD. This plan, or minimally its interim protection plan phase, must be successfully executed (to be verified in writing by the SHPD), prior to any grading, clearing, grubbing or other land alteration in these areas.

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply prior to any grading, clearing, grubbing or other land alteration in these areas.

8. Petitioner shall implement efficient soil erosion and dust control measures during and after the development process to the satisfaction of the State Department of Health and County of Maui.

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply at the appropriate time prior to commencement of construction.

9. Petitioner shall initiate and fund a nearshore water quality monitoring program. The monitoring program shall be approved by the State Department of Health in consultation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Services, and the State Division of Aquatic Resources, DLNR. Petitioner shall coordinate this consultation process with the concurrence of the State Department of Health. Mitigation measures shall be implemented by Petitioner if the results of the monitoring program warrant them. Mitigation measures shall be approved by the State Department of Health in consultation with the above mentioned agencies.

Response: The ATC Makena Entities continue to implement and fund a nearshore water quality monitoring program. This program initially collected base line water samples and analyzed the same to determine turbidity, chemical compound contents and biota sampling. This monitoring program continues with at least semi-annual sampling at four separate nearshore sites.

The ATC Makena Entities are providing the two most recent marine water quality monitoring reports dated July 2018, and September 2018, along with copies of the transmittal to the State of Hawaii Department of Health dated December 17, 2018, as **Exhibits A** and **B** respectively.

The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

10. Petitioner shall submit a Traffic Impact Analysis Report (TIAR) for review and approval by the State Department of Transportation and the County of Maui.

Response: As set forth in the Second Annual Report, a TIAR was prepared and submitted for review by the State Department of Transportation (DOT) and the County of Maui as part of the change in zoning application. Following certain comments by DOT, revisions were made to the TIAR which DOT agreed with as set forth in a letter from Kazu Hayashida, Director of Transportation, dated May 2, 2000, a copy of which was attached to the Third Annual Report.

In addition, as set forth in prior Annual Reports, the Petitioner prepared and submitted a Makena Resort Master Traffic Study, dated June 6, 2003 (Revised September 14, 2003), which was submitted to the SDOT and County of Maui, and approved by the County on September 26, 2003. *See* Sixth Annual Report.

ATC Makena Entities understand that this condition has been satisfied.

11. Petitioner shall participate in the pro rata funding and construction of local and regional transportation improvements and programs including dedication of rights-of-way as determined by the State Department of Transportation ("DOT") and the County of Maui. Agreement between Petitioner and DOT as to the level of funding and participation shall be obtained within fourteen (14) years from June 1, 2000.

Response: The ATC Makena Entities acknowledge that they are subject to provisions of said condition and will comply.

This condition has been partially satisfied, and the ATC Makena Entities are in communication with DOT on their agreement to address the ATC Makena Entities' pro rata share of funding and participation toward transportation improvements.

Partial satisfaction of this condition was achieved through the "Agreement for Planning and Design of Piilani Highway Expansion" between Makena Resort

Corp. (the original Petitioner), and DOT in 2001. Under this Agreement, Petitioner agreed to fund the planning and design of the restriping and other improvements to Piilani Highway from Mokulele Highway to Kilohana Drive, to increase it from two lanes to four lanes. This work was completed.

Full satisfaction of this condition was initially planned to be accomplished as a joint effort between the ATC Makena Entities, Honua'ula Partners, LLC, A&B Wailea LLC, and Keaka LLC. These parties prepared a Final Environmental Assessment for the proposed widening, which was accepted by the DOT, and published by OEQC in May 2012. These same parties intended to enter into an "Inter-Developer Agreement" to address the actual construction of improvements. However, at that time, the multi-party approach seemed unworkable due to the landowners being at different stages of development. It is the understanding of the ATC Makena Entities that certain parties did or will be independently pursuing agreements with the DOT. Recently, however, there have been renewed discussions with certain of the parties regarding the multi-party approach to address the improvements sought by DOT. These discussions are underway.

12. Petitioner shall fund the design and construction of drainage improvements required as a result of the development of the Property to the satisfaction of the appropriate State of Hawai`i and County of Maui agencies.

Response: ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

As reported in the Fifth Annual Report, Petitioner prepared a Drainage Master Plan, which was submitted to the County Department of Public Works and Environmental Management and Planning Department on July 1, 2003, and approved by the County on August 20, 2003.

13. The Petition Areas will be developed in accordance with the Kihei-Makena Community Plan.

Response: The ATC Makena Entities acknowledge that development of the LUC Reclassified Property is to be in accordance with the Kihei-Makena Community Plan.

14. Petitioner shall fund, design and construct all necessary traffic improvements necessitated by development of the Petition Areas as required by the State Department of Transportation and the County of Maui Department of Public Works and Waste Management.

Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply. Traffic improvements required by DOT will be addressed pursuant to Condition 11.

15. Petitioner shall develop the Property in substantial compliance with the representations made to the Commission. Failure to so develop the Property may result in a reversion of the Property to its former classification, a change to a more appropriate classification, or other reasonable remedy as determined by the Commission.

    Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

16. Petitioner shall give notice to the Commission of any intent to sell, lease, assign, place in trust, or otherwise voluntarily alter the ownership interests in the Property, prior to development of the Property.

    Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply.

17. Petitioner shall timely provide without any prior notice, annual reports to the Commission, the Office of Planning, and the County of Maui Planning Department in connection with the status of the subject project and Petitioner's progress in complying with the conditions imposed herein. The annual report shall be submitted in a form prescribed by the Executive Officer of the Commission.

    Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition and will comply. The submittal of this Twenty-First Annual Report by the ATC Makena Entities is in compliance with this condition.

18. The commission may fully or partially release or amend the conditions provided herein as to all or any portion of the petition area upon timely motion and upon the provision of adequate assurance of satisfaction of these conditions by Petitioner.

    Response: The ATC Makena Entities acknowledge that they are subject to the provisions of said condition.

19. Petitioner shall record the conditions imposed herein by the Commission and every amendment thereto with the Bureau of Conveyances pursuant to Section 15-15-92, Hawai`i Administrative Rules.

Response: This condition has been satisfied and the ATC Makena Entities acknowledge that they are subject to the provisions of said condition in the event of any amendments.

The ATC Makena Entities recorded in said Bureau that certain Amended and Restated Declaration of Conditions Applicable To An Amendment to District Boundary From Agricultural to Urban on September 7, 2012, as Document Number A-46330782, a copy of which was included with the Fifteenth Annual Report.

If you have any questions or require any further information, please contact me or Mr. Ka'imi Judd at kjudd@makenagbc.com.

Sincerely,

Jennifer A. Lim

JAL/1jah
cc: State of Hawaii, Office of Planning
County of Maui, Department of Planning
Munekiyo & Hiraga, Inc.

Encls. **Exhibit A:** Marine Water Quality Monitoring Report dated July 2018, with transmittal to State of Hawaii Department of Health dated December 17, 2018.
Exhibit B: Marine Water Quality Monitoring Report dated September 2018, with transmittal to State of Hawaii Department of Health dated December 17, 2018.

EXHIBIT A.

Exhibit A

ATC MAKENAHOLDINGS, LLC
c/o Makena Golf & Beach
55 Merchant Street, Suite 1500
Honolulu, HI 96813

December 17, 2018

Mr. Myron Honda
State of Hawaii, Department of Health
Clean Water Branch
2827 Waimano Home Rd #225
Pearl City, HI 96782

Via PDF to Myron.Honda@doh.hawaii.gov Only unless hardcopy is requested.

Re: State Land Use District Boundary Amendment Docket A9-721 Condition No. 9, County of Maui Zoning Ordinance 3613 Condition No. 19, Marine Water Quality Monitoring.

Dear Mr. Honda,

ATC Makena Holdings, LLC, in compliance with the above referenced conditions, respectfully submits the enclosed Marine Water Quality Monitoring Reports prepared by AECOS Inc. dated July 2018 for tests performed in June 2018, and September 2018, for tests performed in early September 2018.

Should you have any questions, require a hardcopy, or require additional information please do not hesitate to contact me at (808) 640-6023, or by e-mail at kjudd@makenagbc.com.

Sincerely,

Makena Golf & Beach Club
For ATC Makena Holdings, LLC

Kammi Judd
Vice President of Development

Mākena Golf & Beach Club quarterly water quality sampling event

July 2018

September 14, 2018 | **_Final Report_** | _AECOS_ No. 1535

Allen Cattell, Ph.D.
AECOS, Inc.
45-939 Kamehameha Highway, Suite 104
Kāne'ohe, Hawai'i 96744
Phone: (808) 234-7770 Email: Cattell@aecos.com

Introduction

This report is the first quarterly report of the revised water quality monitoring program for Mākena Golf & Beach Club (MG&BC) as stipulated in Condition No. 10, Declaration of Conditions pertaining to the Amendment of the District Boundary, as required by the State Land Use Commission, dated April 17, 1998. County of Maui, Zoning Ordinance 3613, Condition 19 includes similar requirements. The primary goals of the monitoring program are: (1) assess the degree that fertilizers used on land to enhance golf course turf growth and resort landscaping, as well as other nutrient sources, leach to groundwater and subsequently discharge into the nearshore waters; (2) establish the delivery of these nutrients into the nearshore zone; and (3) determine if the subsequent water quality has any measurable impacts on biological community structure in the nearshore marine environment.

Background

Waters south from Nahuna Point, including Mākena Bay and Maluaka Bay (Figure 1) are designated as "Class A, open coastal waters" in State of Hawai'i, water quality standards (HDOH, 2014) and included on the HDOH 2016 list of impaired waters in Hawai'i prepared under Clean Water Act §303(d) for nitrate+nitrite, ammonium, total nitrogen, and turbidity (HDOH, 2017). These particular nearshore waters are listed as a "Category 3" water body—meaning that insufficient data and/or information exist to make use-support determinations—and as a "Category 5" water body—meaning that available data and/or information indicate that at least one designated use is not supported or is threatened, and a Total Maximum Daily Load (TMDL)[1] study is needed.

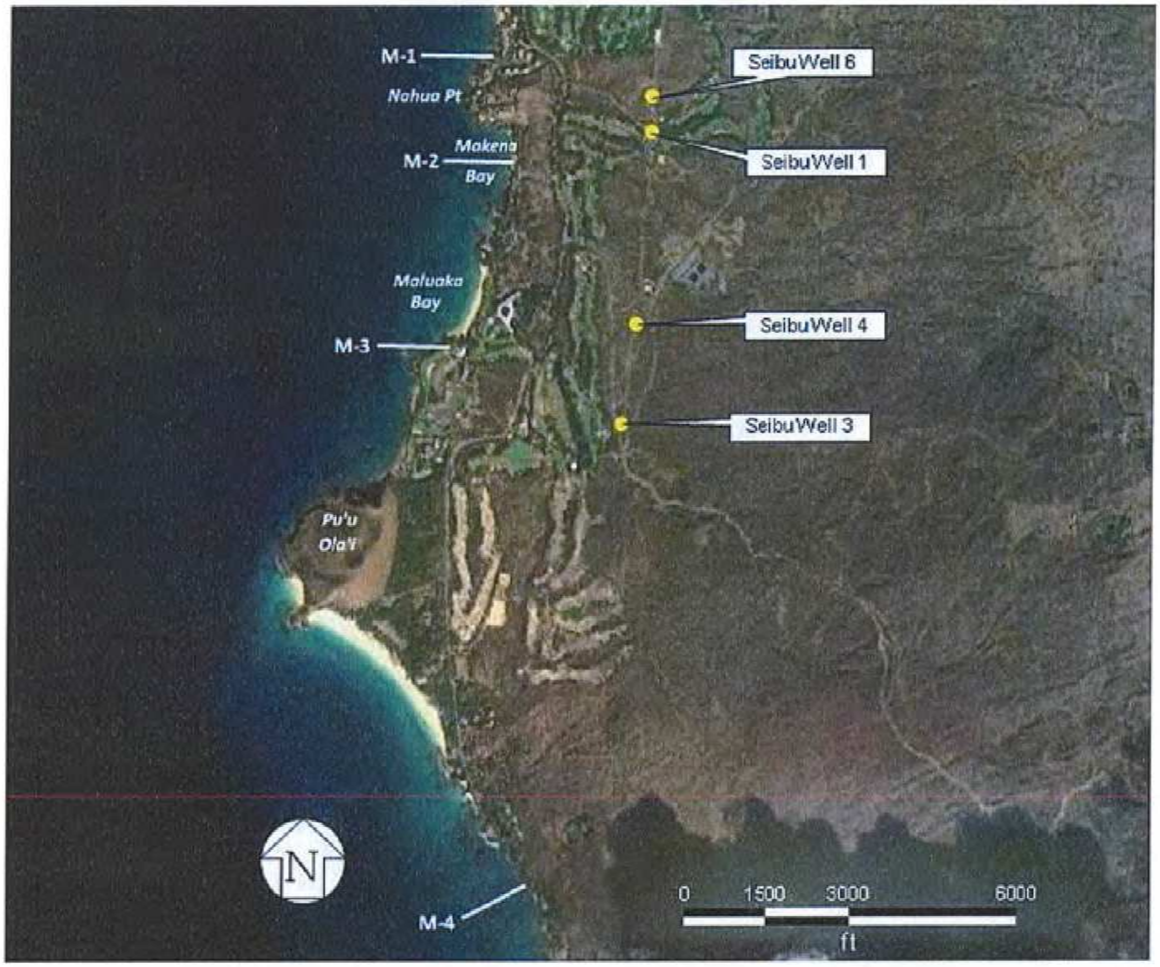

Figure 1. Location of quarterly water quality transects (M-1 through M-4) and irrigation wells.

Water quality parameters of particular interest for the purposes of our monitoring program are termed nutrients[2]. Nutrient enrichment of nearshore coastal waters from groundwater intrusion and storm water runoff can enhance

[1] TMDL studies are done to establish limits on discharges of substances causing impairments to water quality of aquatic environments.

[2] "Nutrients" are nitrogen and phosphorus chemical compounds that promote plant growth, including algal growth in the marine environment.

nuisance algae production (HDLNR, 2014) and have a deleterious impact on corals and other biological components in Hawai'i coastal waters (Laws et al., 2004; MRC, 2011; *AECOS*, 2016).

Methods

A previous monitoring program (1998 to 2017) included biannual surveys of water quality along four transects in the nearshore marine waters off MG&BC. A fifth transect, included as a control, was located south of the resort near the northern boundary of 'Ahihi-Kina'u Natural Area Reserve in an area with minimal interior land use. Our revised monitoring program, beginning with this report, includes quarterly sampling at a reduced number of transects (four instead of five) and a reduced number of stations on each transect (four instead of six). This new program puts more emphasis on monitoring MG&BC management practices that might influence coastal water quality and provides a better approach to detecting any developing trends in nearshore water quality by sampling more frequently. Water quality samples are collected only in surface waters; i.e., not at multiple depths, because groundwater intrusion into these nearshore marine waters tends to remain near the surface due to density differences between groundwater and ocean water. All water quality parameters monitored in the original program are monitored in the new program with the exception of silicates, a chemical not included in state water quality standards.

The first quarterly sampling event of the current monitoring effort took place on June 14, 2018. Water quality samples were collected along three of the original monitoring transects in nearshore waters adjacent to MG&BC: Transects M-1, M-2, and M-3 (was M-3A in the previous monitoring program), and at the control site, Transect M-4. Stations were sampled in the surface waters at 2 m 10 m, 50 m, and 100 m distances from the shore along each transect. Water quality samples were also collected at two irrigation wells: Seibu Well 1 and Seibu Well 6 (see Fig. 1).

Temperature, salinity, pH, and dissolved oxygen (DO) were measured *in situ*. Water samples were collected, chilled, and returned to the *AECOS* laboratory for additional analyses (*AECOS* Log No. 36269). The following parameters were measured from these samples: salinity, turbidity, ortho-phosphate, ammonium, nitrate+nitrite, total nitrogen (total N or TN), total phosphorus (total P or TP), and chlorophyll *a*. Table 1 lists the instruments and analytical methods used for these field and laboratory analyses.

Table 1. Analytical methods and instruments used for water quality analyses.

Analysis	Method	Reference	Instrument
Temperature	SM 2550B	SM (1998)	YSI Model 550 DO meter thermistor
Salinity	SM 120.1	SM (1998)	YSI 85 Meter
pH	SM 4500H+	SM (1998)	pH pHep HANNA meter
Dissolved Oxygen	SM 4500-O G	SM (1998)	YSI Model 550 DO meter
Turbidity	EPA 180.1, Rev. 2.0	USEPA (1993)	Hach 2100Q Turbidimeter
Ammonium	Kérouel and Aminot (1997)	USEPA (1993a))	Seal AA3 Autoanalyzer, colorimetric
Nitrate + Nitrite	Grasshoff	Grasshoff et al. (1999)	Seal AA3 Autoanalyzer, colorimetric
Total Nitrogen	Grasshoff 9.6.3	Grasshoff et al. (1999)	Seal AA3 Autoanalyzer, UV
Total Phosphorus	Grasshoff 9.1.5	Grasshoff et al. (1999)	Seal AA3 Autoanalyzer, UV
Chlorophyll α	SM10200H(M)	SM (1998)	Fluorometer

Results

Water quality data for 15 of the historical biannual surveys made between June 20, 2009 and December 2, 2017 are summarized in Table 2 and compared with the results of our June 14, 2018 sampling event. State of Hawai'i water quality standards for open coastal waters include two sets of criteria: so-called "wet" criteria for coastal waters receiving more than 3 million gallons of freshwater discharge per day per shoreline mile; and "dry" criteria for waters receiving less than 3 million gallons of freshwater water discharge per day per shoreline mile. Average annual rainfall in the Mākena area is less than 15 in. per year (Giambelluca et al. 2013), so results in Table 2 are appropriately compared with state "dry" criteria.

State criteria for temperature, salinity and pH are based on "deviations from ambient conditions"; i.e., pertain essentially to discharges that might cause deviations. Our sampling results are regarded as measurements of ambient conditions. Criteria for DO saturation are based upon not-to-exceed values. Criteria for turbidity, nutrients, and chlorophyll α are based on geometric means not to exceed specific criterion values. Since geometric means require a minimum of three separate sampling events per station, only the historic mean concentrations for these parameters can be compared with these geometric mean criteria.

Table 2. Nutrients: comparison of historic (2009 – 2017) water quality means (n = 15) and results of June 14, 2018 monitoring event.

Transect	DFS† (m)	PO_4 (µgP/L)		NO_3+NO_2 (µgN/L)		NH_4 (µgN/L)		TP (µgP/L)		TN (µgN/L)	
		mean‡	Jun-18	mean‡	Jun-18	mean‡	Jun-18	mean‡	Jun-18	mean‡	Jun-18
M-1	2	8.2	*2.0*	395	*43*	3.8	*13.0*	20	*<15*	606	*139*
	10	4.1	*2.0*	80	*30*	3.2	*24.0*	13	*<15*	217	*102*
	50	2.4	*2.0*	32	*29*	2.7	*15.0*	12	*<15*	142	*106*
	100	3.0	*2.0*	13	*20*	3.0	*13.0*	12	*<15*	117	*95*
M-2	2	6.3	*5.0*	73	*23*	3.4	*8.0*	16	*39*	183	*94*
	10	4.2	*4.0*	26	*41*	2.4	*8.0*	14	*17*	124	*114*
	50	3.5	*3.0*	20	*38*	2.6	*9.0*	13	*<15*	129	*95*
	100	3.4	*2.0*	6	*40*	2.1	*17.0*	12	*<15*	104	*103*
M-3	2	26.6	*20.0*	852	*174*	5.0	*24.0*	39	*32*	1147	*257*
	10	5.7	*13.0*	103	*141*	3.6	*28.0*	15	*<15*	252	*211*
	50	4.6	*11.0*	39	*111*	3.1	*33.0*	13	*<15*	165	*197*
	100	4.5	*41.0*	16	*59*	3.2	*44.0*	14	*45*	127	*174*
M-4	2	5.9	*7.0*	67	*23*	3.2	*14.0*	16	*32*	192	*107*
	10	3.7	*4.0*	13	*17*	3.7	*11.0*	13	*16*	113	*92*
	50	3.2	*3.0*	9	*12*	3.9	*9.0*	12	*<15*	112	*90*
	100	3.0	*4.0*	5	*12*	2.3	*12.0*	12	*<15*	99	*67*
Hawai'i Dry Criteria		ns		3.5		2.0		16		110	

† distance from shore ‡ geometric mean exceeds standard ns - no standard

The most notable aspects in Table 2 for the historic means are: (1) nitrogen components, especially nitrate+nitrite, ammonium, and total N, do not meet state criteria until well offshore along all transects; and (2) all phosphorus and nitrogen moieties decrease generally with distance from shore, ammonium

Table 3. Comparison of historic (2009 – 2017) mean water quality data (n = 15) and results of June 14, 2018 monitoring event (other physical and chemical parameters)

Transect	DFS† (m)	Salinity (ppt)		Temperature (°C)		pH		DO (% Sat.)		Turbidity (NTU)		Chl. α (µg/L)	
		mean	Jun-18	mean	Jun-18	mean	Jun-18	mean	Jun-18	mean‡	Jun-18	mean‡	Jun-18
M-1	2	28.40	34.05	25.9	27.5	8.13	8.16	105	108	0.37	1.94	0.60	0.59
	10	33.71	34.47	25.6	27.0	8.16	8.21	103	121	0.24	1.03	0.29	0.66
	50	34.53	34.50	25.7	26.9	8.15	8.17	103	115	0.19	0.57	0.24	0.31
	100	34.68	34.64	25.7	26.8	8.16	8.19	100	111	0.23	0.48	0.18	0.32
M-2	2	33.53	34.27	25.9	27.0	8.18	8.10	102	100	0.60	2.00	0.55	0.52
	10	34.40	34.08	25.7	26.9	8.15	8.14	100	100	0.30	0.84	0.27	0.24
	50	34.40	34.18	25.7	26.8	8.15	8.15	99	100	0.23	0.46	0.25	0.24
	100	34.70	34.12	25.7	26.6	8.16	8.16	100	99	0.16	0.32	0.20	0.23
M-3	2	25.92	33.51	25.3	26.2	7.97	8.06	103	112	0.29	0.29	0.43	0.57
	10	33.48	33.96	25.3	26.2	8.11	8.09	101	106	0.19	0.19	0.27	0.47
	50	34.30	34.19	25.7	26.2	8.13	8.11	101	104	0.17	0.17	0.22	0.39
	100	34.66	34.23	25.7	26.2	8.14	8.11	98	97	0.17	0.17	0.19	0.30
M-4	2	32.76	33.27	25.8	26.0	8.17	8.11	103	106	0.47	1.23	0.35	0.75
	10	34.47	33.43	25.6	26.0	8.13	8.15	100	105	0.20	1.26	0.25	0.76
	50	34.59	34.22	25.4	26.0	8.12	8.15	99	108	0.16	0.80	0.18	0.43
	100	34.70	34.62	25.5	26.0	8.13	8.12	97	98	0.13	0.58	0.16	0.38
Hawai'i Dry Criteria		+/- 10% ambient		+/- 1C° ambient		7.6–8.6		≥75%		≤0.20		≤0.15	

† distance from shore ‡ geometric mean exceeds standard

being an exception. Mean salinity values, on the other hand, increase progressively with distance from shore, indicating that nitrate+nitrite and ortho-phosphate concentrations are probably related to groundwater inputs.

Nitrogen compound concentrations do not meet the state geometric mean criterion until 100 m or more distant from the shore, even at Transect 4 (control transect located south of MG&BC). Total P, on the other hand, meets state geometric criterion at all locations, except just off the shoreline on

Transect 1 and 3A. State water quality standards have no criterion for ortho-phosphate (soluble fraction of Total P), but ortho-phosphate is included in this monitoring program because it is a measure of phosphorus available for algal growth (total P includes both available and unavailable phosphorus moieties).

Water quality data collected on June 14, 2018 were characterized by normal salinities and little change in salinity with distance from shore, indicating minimal groundwater input during this sampling event. As a result, nutrient concentrations close to shore were distinctly lower than long-term means and demonstrated little variation with distance from shore, except for nitrate+nitrite and TN[3] at Transect 1 and Transect 3A. Ammonium concentrations were notably elevated along all transects, compared with historic means, and demonstrated no trend with distance from shore, indicating little or no relation to groundwater inputs. Ammonium concentrations are likely related to processes ongoing in these nearshore waters, most probably intermediary biological excretion products.

State geometric mean for turbidity (see Table 3) is exceeded on all transects at least to a distance of 50 m from shore, except on Transect 3A (10 m). All other water quality parameters (temperature, salinity, DO, and pH) are consistently in line with state criteria values.

Exceedance of nutrient and turbidity criteria near shore in Hawaiian coastal waters is a common occurrence rather than an exception based on our experience. Nearshore nutrient enrichment in the Mākena area is due primarily to groundwater intrusion and runoff from major storm events. Turbidity is typically elevated by land runoff and stirring up of sediments due to wind and wave action in shallow water near shore. State water quality criteria do not account for these typical patterns in nearshore coastal waters, except off the Kona coast where special criteria have been developed to account for the considerable freshwater input there (HDOH, 2014). The majority of Hawaiian coastal waters, including Maui coastal waters, are subject to criteria that were developed nearly 40 years ago and in need of reevaluation.

[3] Total N includes both soluble nitrogen compounds like nitrate+nitrite and ammonium, as well as organic forms of nitrogen dissolved in the water or present as living or non-living particulates.

Discussion

Sources of Groundwater Nutrients in Mākena Coastal Waters

The historic distribution of soluble (available) nutrients (such as ortho-phosphate and nitrate+nitrite) along all transects demonstrates decreasing concentrations with distance from shore and is mirrored by increasing salinities over the same distance. This information indicates that groundwater seepage/intrusion is the primary source of nutrients in MG&BC nearshore waters. Possible sources of these groundwater nutrients are discussed below, together with statistical analyses and comparisons to estimate nutrient fractions/components entering nearshore waters

The nutrients in groundwater at MG&BC have two possible origins: (1) remote—present in groundwater that originates upslope of the resort and that can be measured in well water; and (2) local—seepage of MG&BC excess irrigation water into the groundwater. Brackish water pumped from 4 wells (Seibu wells 1, 3, 4 & 6) is used to irrigate MG&BC grounds and golf courses. North Golf Course, an 18-hole facility encompassing 91.8 acres of MG&BC property, is irrigated and fertilized on a regular basis by water from three wells: Seibu Well 3, Seibu Well 4, and Seibu Well 6 (Fig. 1). Groundwater is also pumped from Seibu Well 1 to irrigate vegetation along Mākena Alanui Road. Groundwater is pumped from Seibu Well 6 into No. 8 Lake and used to irrigate the northern nine holes of North Golf Course. Groundwater from Seibu Well 4 and Seibu Well 3 is pumped into No. 10 Lake and used to irrigate the southern nine holes of North Golf Course.

During normal MG&BC operations, R-1 effluent from Mākena Waste Water Reclamation Facility (WWRF) is also pumped into No. 10 Lake, where it mixes with well water, and is then used to irrigate the golf course, club house, and entry landscaping. At the present time, the WWRF is not operational as MG&BC is closed and in the process of redevelopment. Adding fertilizer to the golf course entails only the addition of a controlled release nitrogen fertilizer; no phosphorus-containing fertilizers are used. Average irrigation rates and fertilizer additions for March through May 2018 are shown in Table 4, together with well nitrate+nitrite and ortho-phosphate concentrations measured on June 14, 2018. Note: water quality, including nutrients, was only measured in Seibu wells 1 and 6 during this sampling event. Henceforth, these compounds will also be measured in Seibu wells 3 and 4.

Water and nutrients not directly assimilated by golf course turf and other vegetation during irrigation (or water lost to evapotranspiration), filter down through the soil and eventually reach groundwater. We can assume that excess irrigation water does not mix with water drawn from the wells for the following reasons: 1) irrigation is occurring mostly downslope of all wells; 2) well water is drawing from a depth of 200 ft or more below ground surface with excess irrigation water flowing downslope before reaching groundwater; and 3) the ratio of TN:TP in well water (21:1) is much less than TN:TP ratio for fertilizer (833:1).

Table 4. Average irrigation per day with mean nutrient content (based on Seibu wells 1 and 6 on June 14, 2018) and fertilizer additions per liter for March through May 2018.

2018	Irrigation (Liters/day)	NO_3+NO_2 (µgN/L)	PO_4 (µgP/L)
Wells	1,740,739	1,715	18
Fertilizer		13,275	0
Totals	1,740,739	14,990	18

Much of the ortho-phosphate in irrigation water leaching to groundwater will be adsorbed on subsurface soil particles (Busman et al., 2002; Laws et al., 2004) and effectively lost to the nutrient pool. Nitrogen on the other hand, may change form in subsurface soils and groundwater, but is typically present as nitrate+nitrite in MG&BC groundwater. Groundwater movement is towards the ocean shore, so eventually this water with its soluble nutrients enters nearshore waters, resulting in nutrient enrichment as evidenced by the data presented in Table 2.

That both nitrogen and phosphorus concentrations are highest near shore does not necessarily mean that fertilizer is the only cause of nutrient enrichment in these waters. Both phosphorus and particularly nitrogen compounds may be naturally elevated in groundwater relative to coastal marine waters as evidenced by nutrient concentrations for the wells shown in Table 4. No practical method exists for distinguishing between natural and fertilizer chemical components in a groundwater sample; however, an estimate can be made by comparing regression analyses in the nearshore waters at each transect with the range of nitrate+nitrite concentrations measured at various MG&BC well sites. Thus, regression equations of nitrate+nitrite as a function of salinity reciprocals[4] were calculated at the 2 m station of each transect using historic and current sampling results. The resulting equations were then solved for nitrate+nitrite concentration at a salinity of 1.767 PSU[5]—the average salinity for MG&BC wells.

The results of these analyses are shown in Figure 2. Groundwater nitrate+nitrite concentrations for MG&BC wells ranged from about 1500 to 2600 μgN/L. Nitrate+nitrite calculated concentrations for source water at a salinity 1.767 PSU (mean of all wells) for M-2 and M-4 fell within the range of actual measured well concentrations. Nitrate+nitrite concentrations for M-1 and M-3 exceeded well ranges by approximately 1500 to 2000 μgN/L and can be attributed to additions from fertilizer use on land.

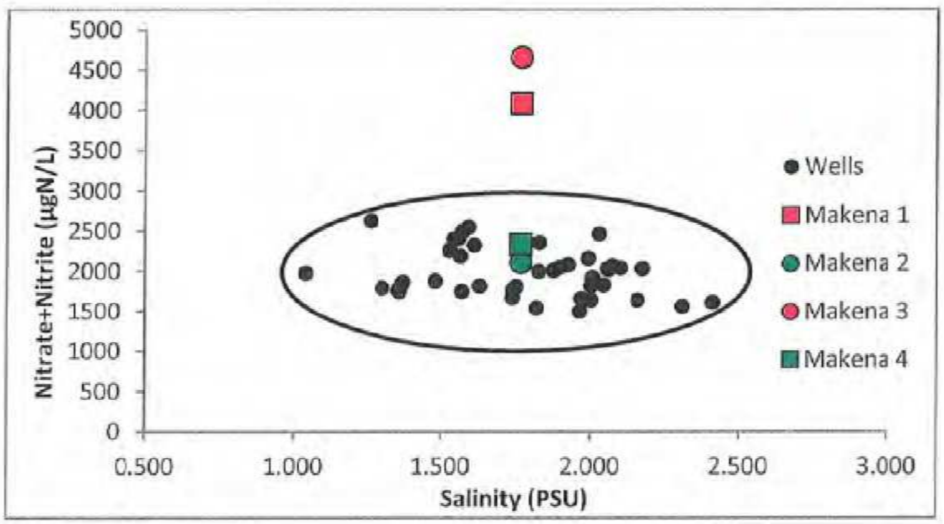

Figure 2. Estimates of groundwater source nitrate+nitrite concentrations for Transects 1 through 4 compared with actual groundwater concentrations.

Potential nitrate+nitrite surplus for the June 14, 2018 sampling event was estimated for each transect by calculating the change in salinity reciprocals between the mean salinity at Seibu Well 1 and Seibu Well 6 for that date and the 2 m (offshore) station of each transect and, using these results, to calculate the estimated dilution occurring between the wells and the nearest to shore (2 m) stations (Table 5):

[4] The reciprocal of salinity is used due to the inverse relationship between salinity and nutrients in groundwater.

[5] Practical Salinity Units (PSU) based on water conductivity measured against a seawater standard.

$$A = \frac{B \times C}{D}$$

Where:

A = Calculated nitrate+nitrite concentration at 2 m station;
B = Salinity reciprocal at 2 m station;
C = Nitrate+nitrite mean concentration for Seibu Well 1 & 6;
D = Mean salinity reciprocal for Seibu Well 1 & 6.

Estimated nitrate+nitrite surplus in nearshore coastal waters for June 14, 2018 sampling event were noted only at M-3. In these calculations, a negative result indicates no surplus.

Table 5. Calculated nitrate+nitrite surplus at 2 m station on each transect for June 14, 2018 sampling event.

Well Transect	Measured NO_3+NO_2	Salinity	Calculated NO3+NO2	Surplus NO3+NO2
	(µgN/L)	(PSU)	(µgN/L)	(µgN/L)
Seibu 1&6	1711	1.20	---	---
M-1	43	34.05	42	1
M-2	23	34.27	42	-19
M-3	174	33.51	43	131
M-4	23	33.27	43	-20

Fates of Groundwater Nutrients in Mākena Coastal Waters

Nutrients infiltrating to coastal waters has important implications regarding biological assemblages in these waters. For example, growth of marine benthic algae in Hawaiian coastal waters is typically regulated by nutrient supply, usually dissolved forms of inorganic nitrogen (nitrate, nitrite, and/or ammonium) or phosphorus (ortho-phosphate) and referred to as dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP). Typically in pristine coastal waters, either DIN or DIP is present in insufficient concentration to sustain runaway algal growth (Atkinson and Smith, 1983; Smith, 1984; Larned, 1998). Outbreaks of excessive amounts of algae off West Maui have been attributed to elevated concentrations of both DIN and DIP in sewage effluent injected into groundwater and migrating to nearshore waters (Laws et al., 2004; Dollar and Andrews, 2007; Dailer, 2010; MRC., 2011). No such outbreaks of algae have been recorded for nearshore waters off MG&BC

(MRC, 2006; *AECOS*, 2016). That excessive algal growth has not been seen in waters off Mākena may be due to several factors, including a limited supply of DIP or DIN in these coastal waters.

Determination of which nutrient is present in a limiting concentration, and thus potentially regulating algal growth, can be calculated by comparing molar ratios of DIN to DIP concentrations. So-called "N:P ratios" measured in 20 Hawaiian algae species range from 15:1 to 44:1, with an average of about 29:1 (Atkinson and Smith, 1983). Thus, in Hawaiian nearshore waters, it is assumed that DIP is potentially limiting when environmental N:P exceeds 29:1 and DIN is potentially limiting when N:P ratio is less than 29:1. When a particular substance becomes limiting, any excess of other utilized substances remain unused in the environment (Liebig's Law of the Minimum). As an example, once all the available DIP is taken up by algae, uptake of nitrogen (up to that point being used for growth in an amount roughly equal to 29 times the phosphorus uptake) ceases and further algal growth is limited.

Geometric mean molar DIP and DIN concentrations and N:P ratios for all four transects are shown in Table 6. The data suggest DIP is potentially limiting to algae growth at Transects M-1 and M-3 during both historic and the current sampling events. The historic ratios at Transect s M-2 and M-4 are close to the tipping point between DIN and DIP limitation, while the current sampling results indicate DIN as the potentially limiting nutrient. It cannot be stated with certainty that either DIP or DIN concentrations are actually limiting algal growth (instead of some other factor), but the consistently low DIP concentrations along all transects (except nearshore at Transect M-3), and low DIN concentrations further offshore suggest that this is the case.

While a scarcity of benthic algae in coastal waters off MG&BC is likely due to low DIN or DIP concentrations, the general absence of silty sediments in nearshore waters may also have an influence. Sedimentation from terrestrial runoff can not only adversely affect coral assemblages, but also can provide a source of nutrients for growth of algae (Raffaelli et al., 1998; Laws et al., 2004; Fabricius, 2005). Based on benthic surveys in these waters (MRC, 2006; *AECOS*, 2016), there does not appear to be any significant accumulation of land-derived sediments that could serve as a nutrient source for enhancing algal productivity.

Table 6. DIP and DIN molar distributions and DIN:DIP ratios for historic and June 14, 2018 sampling events.

Transect	DFS† (m)	DIP (μM)		DIN (μM)		DIN:DIP ratio		N / P Limited potential	
		mean	Jun-18	mean	Jun-18	mean	Jun-18	mean	Jun-18
M-1	2	0.27	*0.06*	29.4	*27.1*	111	*420*	P	P
	10	0.13	*0.06*	6.2	*8.6*	47	*133*	P	P
	50	0.08	*0.06*	2.7	*1.8*	35	*27*	P	N
	100	0.10	*0.06*	1.4	*1.8*	14	*27*	N	N
M-2	2	0.20	*0.16*	5.6	*3.0*	28	*19*	N	N
	10	0.14	*0.13*	2.2	*2.0*	16	*16*	N	N
	50	0.11	*0.10*	1.8	*2.8*	16	*29*	N	N
	100	0.11	*0.06*	0.7	*2.8*	7	*44*	N	P
M-3	2	0.86	*0.65*	62.6	*121.7*	73	*189*	P	P
	10	0.18	*0.42*	8.0	*26.0*	43	*62*	P	P
	50	0.15	*0.35*	3.3	*15.3*	22	*43*	N	P
	100	0.14	*1.32*	1.5	*15.3*	10	*12*	N	N
M-4	2	0.19	*0.23*	5.6	*8.6*	29	*38*	N	P
	10	0.12	*0.13*	1.3	*1.1*	11	*9*	N	N
	50	0.10	*0.10*	1.0	*1.2*	10	*13*	N	N
	100	0.10	*0.13*	0.6	*1.2*	6	*10*	N	N

† distance from shore

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EXHIBIT B.

Exhibit A

ATC MAKENAHOLDINGS, LLC

c/o Makena Golf & Beach

55 Merchant Street, Suite 1500

Honolulu, HI 96813

December 17, 2018

Mr. Myron Honda
State of Hawaii, Department of Health
Clean Water Branch
2827 Waimano Home Rd #225
Pearl City, HI 96782

Via PDF to Myron.Honda@doh.hawaii.gov Only unless hardcopy is requested.

> Re: State Land Use District Boundary Amendment Docket A9-721 Condition No. 9, County of Maui Zoning Ordinance 3613 Condition No. 19, Marine Water Quality Monitoring.

Dear Mr. Honda,

ATC Makena Holdings, LLC, in compliance with the above referenced conditions, respectfully submits the enclosed Marine Water Quality Monitoring Reports prepared by AECOS Inc. dated July 2018 for tests performed in June 2018, and September 2018, for tests performed in early September 2018.

Should you have any questions, require a hardcopy, or require additional information please do not hesitate to contact me at (808) 640-6023, or by e-mail at kjudd@makenagbc.com.

Sincerely,

Makena Golf & Beach Club
For ATC Makena Holdings, LLC

Kaimi Judd
Vice President of Development

Mākena Golf & Beach Club
Quarterly water quality sampling event

September 2018

December 14, 2018 | ***Final Report*** | *AECOS* No. 1535B

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Introduction

This report is the second quarterly report of the revised water quality monitoring program for Mākena Golf & Beach Club (MG&BC); a program stipulated in Condition No. 10, Declaration of Conditions pertaining to the Amendment of the District Boundary dated April 17, 1998, as required by the State Land Use Commission. County of Maui, Zoning Ordinance 3613, Condition 19 includes a similar requirement. The primary goals of the monitoring program are: (1) assess degree that fertilizers, as well as other nutrient sources, used on land to enhance golf course turf growth and resort landscaping leach to groundwater and subsequently discharge into nearshore waters; (2) establish delivery of these nutrients into the nearshore zone; and (3) determine if subsequent water quality has any measurable impacts on biological community structure in the nearshore marine environment. Sampling locations are shown in Figure 1.

This second quarterly report is mostly an informal presentation of sampling event results with comparison to historic data, emphasizing information that may be of particular interest to MG&BC personnel. The next quarterly report will be a more formal document including all results and discussion of the past year (2018) sampling events.

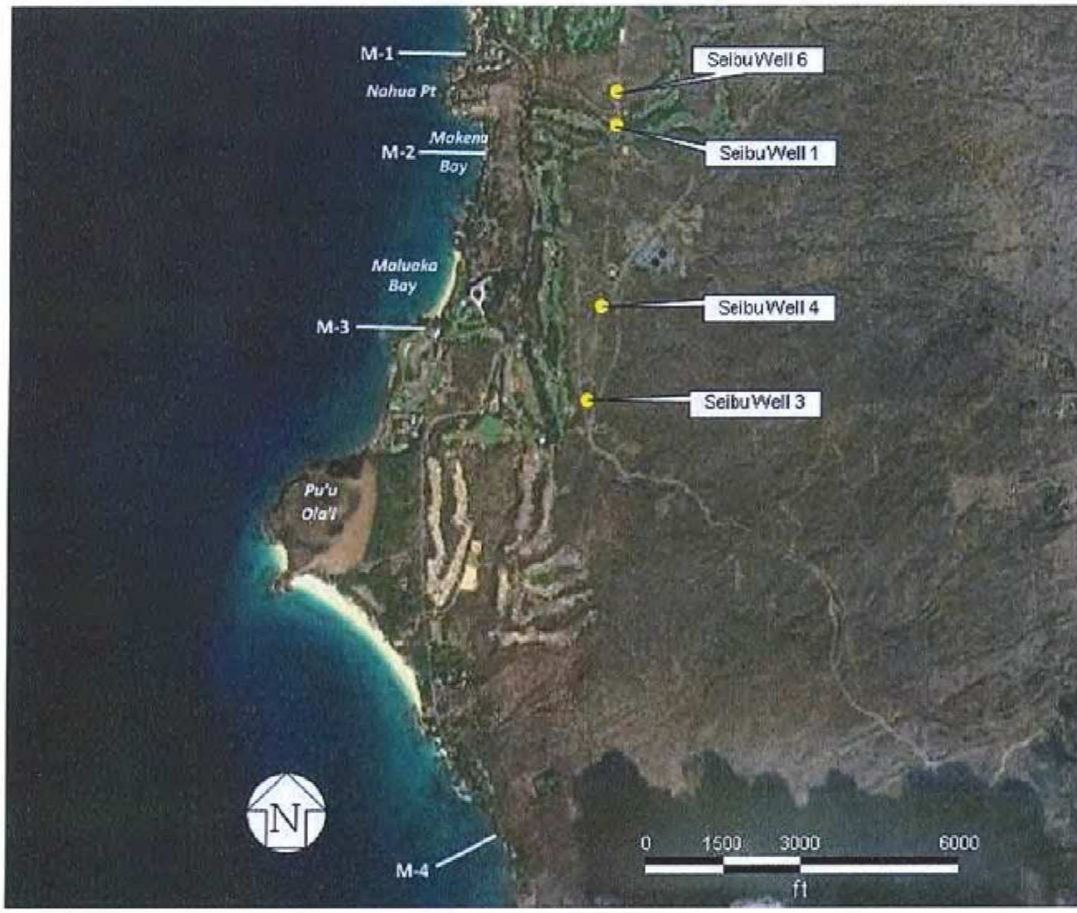

Figure 1.Location of quarterly water quality transects (M-1 through M-4) and irrigation wells.

Results

The second quarterly report sampling event was undertaken on September 5, 2018. Weather in the morning (0900 hours) was mostly sunny (~5% cloud cover) with winds from the east at 10 mph and surf 1 to 3 ft. Sampling along the nearshore transects began close to noon. By 1430 hours (last transect sampling at M-1), conditions had changed to winds coming from the northwest at 15 to 20 mph and 2 to 4 ft waves. Tide was falling during most of the marine waters sampling from a high of +1.38 ft at 1300 hours towards a low of +0.07ft at 2030 hours (Mākena Station; NOAA, 2018).

Water quality data for 15 historical (previous) surveys made between June 20, 2009 and December 2, 2017 are summarized in Tables 1 and 2, and there

Table 1.Comparison of historic (2009 – 2017) water quality means ($n = 15$) and results of September 5, 2018 monitoring event for physical parameters and chlorophyll α.

Transect	DFS[†] (m)	Salinity (ppt)		Temperature (°C)		pH		DO (% Sat.)		Turbidity (NTU)		Chl. α (μg/L)	
		mean	Sep-18	mean	Sep-18	mean	Sep-18	mean	Sep-18	mean[‡]	Sep-18	mean[‡]	Sep-18
M-1	2	28.02	*35.38*	25.8	*28.4*	8.13	*8.07*	105	*102*	0.33	*3.21*	0.60	*0.50*
	10	33.66	*35.46*	25.5	*28.0*	8.16	*8.11*	102	*103*	0.21	*0.78*	0.28	*0.38*
	50	34.58	*35.47*	25.8	*27.9*	8.15	*8.10*	103	*100*	0.21	*2.26*	0.24	*0.25*
	100	34.69	*35.41*	25.7	*28.0*	8.15	*8.11*	100	*98*	0.22	*0.72*	0.17	*0.19*
M-2	2	33.48	*35.38*	25.8	*29.1*	8.18	*8.06*	102	*101*	0.55	*1.88*	0.56	*0.32*
	10	34.42	*35.26*	25.6	*28.8*	8.15	*8.09*	100	*102*	0.28	*2.85*	0.27	*0.25*
	50	34.41	*35.35*	25.6	*28.5*	8.15	*8.08*	99	*103*	0.22	*0.90*	0.25	*0.17*
	100	34.74	*35.32*	25.7	*28.5*	8.16	*8.06*	100	*102*	0.15	*0.72*	0.20	*0.20*
M-3	2	25.41	*35.44*	25.2	*28.1*	7.97	*8.09*	103	*116*	0.28	*1.06*	0.42	*0.23*
	10	33.45	*35.33*	25.2	*28.0*	8.12	*8.10*	101	*115*	0.18	*1.10*	0.26	*0.33*
	50	34.31	*35.44*	25.7	*27.8*	8.13	*8.10*	100	*107*	0.16	*0.94*	0.21	*0.11*
	100	34.69	*35.44*	25.7	*27.8*	8.14	*8.09*	98	*105*	0.16	*0.48*	0.18	*0.17*
M-4	2	32.73	*35.37*	25.8	*28.6*	8.17	*8.09*	103	*113*	0.44	*1.40*	0.33	*0.45*
	10	34.54	*35.33*	25.5	*28.5*	8.13	*8.17*	100	*115*	0.18	*0.88*	0.23	*0.10*
	50	34.62	*35.32*	25.4	*28.3*	8.11	*8.12*	98	*128*	0.15	*0.66*	0.17	*0.23*
	100	34.70	*35.34*	25.5	*28.3*	8.13	*8.12*	97	*120*	0.13	*0.75*	0.16	*0.18*
Hawai'i Dry Criteria		+/- 10% ambient		+/- 1C° ambient		7.6–8.6		≥75%		≤0.20		≤0.15	

[†] distance from shore [‡] geometric mean exceeds standard

compared with results of our September 5, 2018 sampling event. Water samples collected in September 2018 were characterized by elevated salinities close to shore compared with historic data. Also, little change in salinity with distance from shore was noted, probably due to strong winds in the afternoon causing considerable wind-mixing in these nearshore waters. As a result, groundwater inputs, as evidenced by slightly depressed salinity, were obscured on this sampling date.

Table 2. Nutrients: comparison of historic (2009 – 2017) water quality means ($n = 15$) and results of September 5, 2018 monitoring event.

Transect	DFS† (m)	PO_4 (µgP/L)		NO_3+NO_2 (µgN/L)		NH_4 (µgN/L)		TP (µgP/L)		TN (µgN/L)	
		mean‡	Sep-18	mean‡	Sep-18	mean‡	Sep-18	mean‡	Sep-18	mean‡	Sep-18
M-1	2	8.2	*<1*	395	*3*	3.8	*<5*	19	*11*	606	*97*
	10	4.1	*<1*	80	*2*	3.2	*<5*	13	*<3*	217	*80*
	50	2.2	*<1*	26	*1*	2.7	*<5*	10	*<3*	137	*76*
	100	2.7	*<1*	11	*1*	2.9	*<5*	11	*3*	114	*78*
M-2	2	6.3	*1.5*	73	*4*	3.4	*<5*	16	*11*	183	*82*
	10	4.2	*1.5*	26	*4*	2.4	*<5*	14	*4*	124	*106*
	50	3.5	*1.2*	20	*5*	2.6	*<5*	13	*6*	129	*75*
	100	3.4	*<1*	6	*8*	2.1	*<5*	12	*<3*	104	*87*
M-3	2	26.6	*<1*	852	*3*	5.0	*<5*	39	*<3*	1147	*92*
	10	5.7	*1.6*	103	*3*	3.6	*6.0*	14	*<3*	252	*77*
	50	4.6	*<1*	39	*4*	3.1	*<5*	13	*88*	165	*80*
	100	4.5	*<1*	16	*4*	3.2	*<5*	14	*<3*	127	*78*
M-4	2	5.9	*<1*	67	*3*	3.2	*<5*	16	*9*	192	*82*
	10	3.7	*3.8*	13	*4*	3.7	*12.0*	13	*<3*	113	*94*
	50	3.2	*<1*	9	*4*	3.9	*<5*	12	*30*	112	*78*
	100	3.0	*<1*	5	*4*	2.3	*<5*	12	*<3*	99	*88*
Hawai'i Dry Criteria		ns		**3.5**		**2.0**		**16**		**110**	

† distance from shore ‡ geometric mean exceeds standard ns - no standard

Turbidity values were notable elevated during the September sampling event, likely due to the wind effect along each transect stirring up bottom sediment. Nutrient concentrations close to shore were distinctly lower than long-term means, a factor related to the sea water salinities recorded (i.e., reflective of oceanic nutrient values). Nutrients and salinity demonstrated little variation with distance from shore.

Discussion

Nearshore Waters - A comparison of historic means and the first two latest quarterly sampling events suggests there may be differences between designs of the two sampling programs. Note in Table 3 and Figures 2 and 3 that both historic ortho-phosphate and nitrate+nitrite concentration means are much higher and more variable than those of the two recent *AECOS* sampling event means. Note also that historic mean salinities are somewhat lower and more varied than those of the *AECOS* means. These differences may be due to the fact that we are comparing 15 historic samples with only two recent samples. However, regressions of historic data at 2 m stations for both nutrients as a function of salinity (Fig. 2 and 3) indicate that much of the nutrient variation can be accounted for by salinity, especially for nitrate+nitrite ($R^2 > 94\%$). The coefficient of determination (R^2) is an estimate of the amount of nutrient that can be attributed to changes in salinity at each nearshore water quality station. *AECOS* results for the 2 m stations have been added to these figures in red to affect comparison between the two data sets.

Table 3. Comparison of historic for ortho-phosphate, nitrate+nitrite and salinity at 2 m (shore) sampling stations on each transect.

Transect	PO_4 (µg/L)		NO_3+NO_2 (µg/L)		Salinity (PSU)	
	Historic	*AECOS*	Historic	*AECOS*	Historic	*AECOS*
n =	*(15)*	*(2)*	*(15)*	*(2)*	*(15)*	*(2)*
M-1	9.0	1.0	458	11	28.02	34.72
M-2	6.4	2.7	79	10	33.48	34.83
M-3	27.1	3.2	947	22	25.41	34.48
M-4	5.8	1.9	87	8	33.73	34.32

A review of historic sampling methods indicates nutrient differences between the two data sets most likely result from differences in sampling strategies. The historic program routinely sampled (presumably by design) in the morning on falling to low tides when groundwater inputs to the nearshore waters would be most apparent. A refractometer was employed to locate the least saline water (indicating greatest groundwater input) in the vicinity of each transect

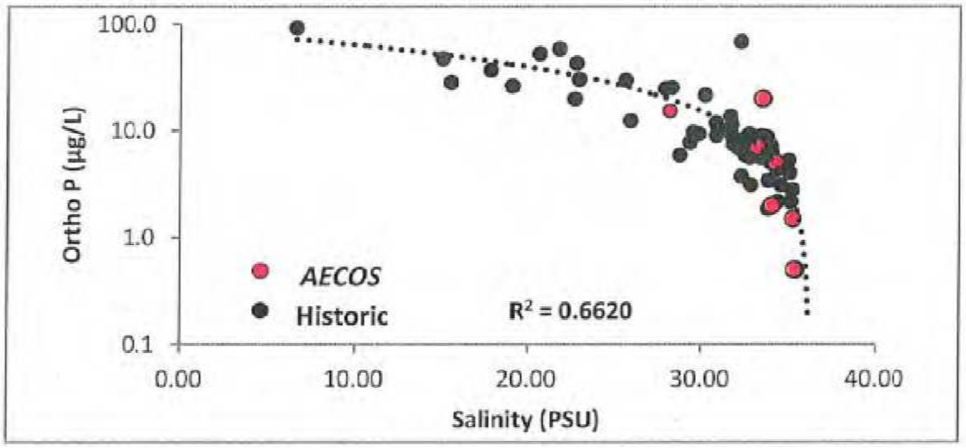

Figure 2. Regression of historic ortho-phosphate concentrations with salinities at 2 m stations. have been added in red.

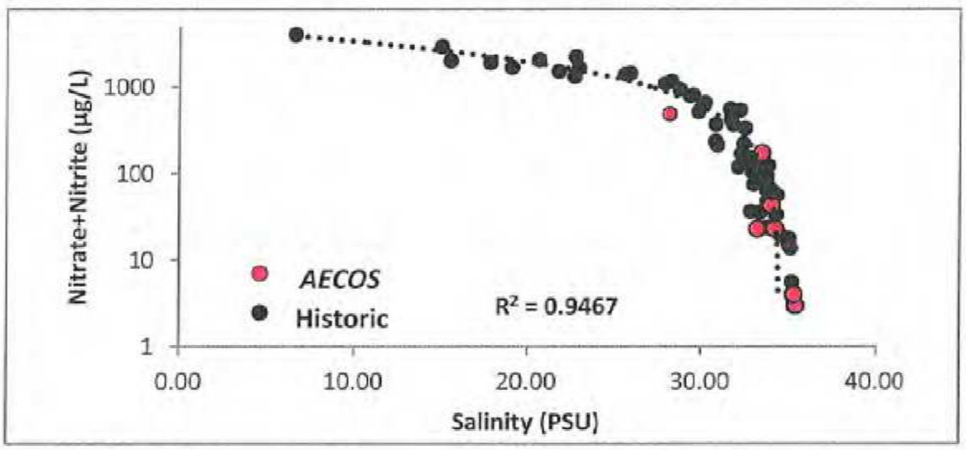

Figure 3. Regression of historic nitrate+nitrite concentrations with salinities at 2 m stations. *AECOS* results have been added in red.

and then samples were collected along a line extending offshore of that point. Our program samples along each predesignated transect location and is designed to include whatever nearshore conditions (high/low tide, wind/calm seas) occur on a preset event date. Thus, historic means identify larger differences in nutrients and salinity along each transect biased towards lower tides and lower salinities; our results identify prevailing conditions.

Regression analysis of all historic nitrate+nitrite and ortho-phosphate data (Figure 4) as a function of salinity demonstrate a common trend—groundwater is the primary source of the two moieties in these nearshore waters. Ammonium, on the other hand, demonstrates no significant relation to salinity and may well be unrelated to groundwater inputs.

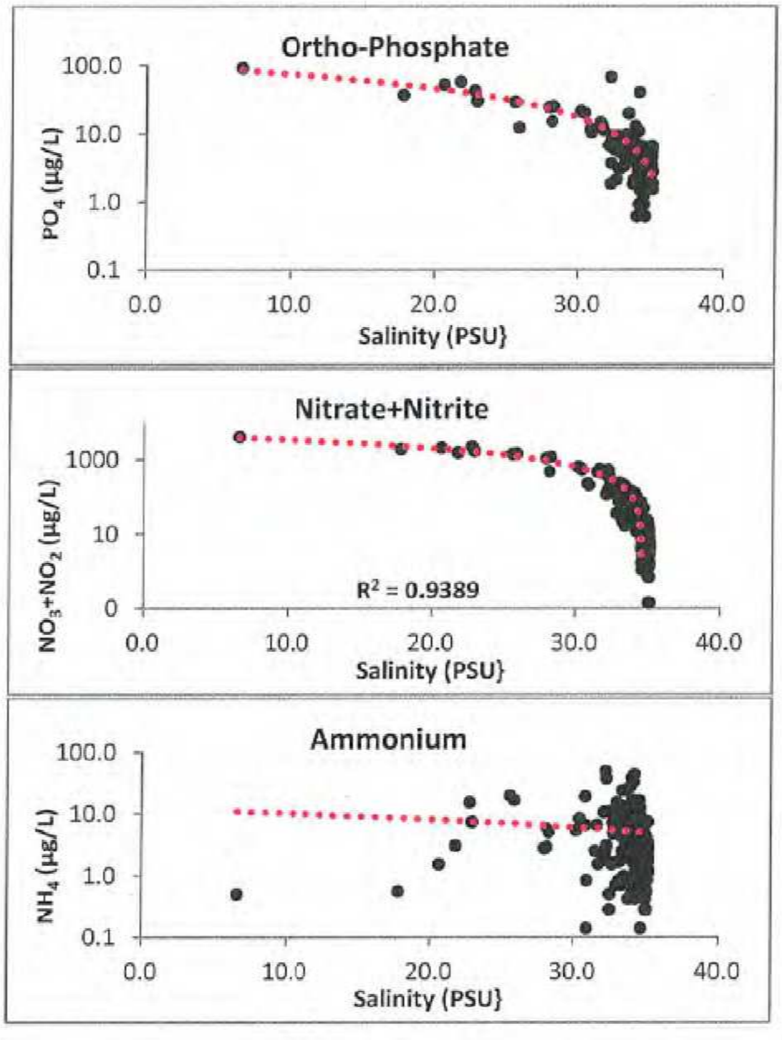

Figure 4. Relation between salinity and nutrients (R^2) for all historic samples between June 2009 and December 2017.

Water Supply Wells - Analysis of nitrate+nitrite dilutions between average well concentrations of this moiety to the shore station (2m off shore) at each transect during the September 2018 sampling event (Table 4; negative values indicate no subsidy) revealed no subsidies obvious on any transect. This result is expected considering that normal seawater salinities were present on this sampling date.

Table 4. Calculated nitrate+nitrite surplus at 2 m station on each transect for September 15, 2018 sampling event.

Well Transect	Measured NO_3+NO_2	Salinity	Calculated NO3+NO2	Surplus NO3+NO2
	(μgN/L)	(PSU)	(μgN/L)	(μgN/L)
Seibu 1,6,3,4	1980	1.33	---	---
M-1	3	35.38	40	-37
M-2	4	35.38	40	-36
M-3	3	35.44	40	-37
M-4	3	35.37	40	-37

We are tracking monthly turf fertilization and irrigation rates (data provided by Jonathan Galicinao, MG&BC) together with nutrient concentrations in the irrigation supply wells (Table 5) to explore long-term trends of groundwater effects on the Mākena nearshore waters.

Table 5. Average irrigation per day with mean nutrient content for Seibu wells and fertilizer additions for March through August, 2018.

		Fertilizer		Wells		Total
2018	**Irrigation**	**DIN**	**DIP**	**DIN**	**DIP**	**DIN**
	Liters/day	(μgN/L)	(μgP/L)	(μgN/L)	(μgP/L)	(μgN/L)
March	1,825,199	19,021	0	2015	58	21,037
April	2,056,822	9,540	0	1913	46	11,453
May	1,340,195	11,263	0	2023	59	13,286
June	1,626,646	18,559	0	1972	39	20,531
July	1,601,099	9,428	0	1969	39	11,397
August	2,248,571	5,370	0	1884	50	7,255
Mean	**1,783,089**	**12,197**	**0**	**1,963**	**49**	**14,160**

References

AECOS, Inc. 2018. Mākena Golf & Beach Club quarterly water quality sampling event. Prep. for Mākena Golf & Beach Club. *AECOS* Report. No. 1535A: 15 pp.

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