Naval Information Warfare Center PACIFIC

TECHNICAL REPORT 3186
September 2019

Windmill Canyon Septic Leachate Assessment

Final Report 2.0

Project Number M3300015POFE174

Lewis Hsu
Kara C. Sorensen

Approved for public release.

NIWC Pacific
San Diego, CA 92152-5001

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ADMINISTRATIVE INFORMATION

The work described in this report was performed by the Energy and Environmental Sustainability branch (71760) and the Environmental Sciences branch (71750) of the Basic and Applied Research Division (717), Naval Information Warfare Center Pacific (NIWC Pacific), San Diego, CA. The Marine Corp Base Camp Pendleton, Environmental Security division provided funding for this Basic Applied Research project.

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We would like to thank Joel Guerra, Ernie Arias, and Ken Richter for field support, also Kyle Cook for his help in researching historic documents for this report.

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EXECUTIVE SUMMARY

An evaluation of the septic systems at the MCMGC in Windmill Canyon was performed as an extension to on-going water resource assessment of Windmill Canyon. The goal of this study was to better characterize and understand the overall condition of four active septic systems currently in operation at the golf course as well as collect additional field data so as to develop a conceptual model of any potential septic leach field contribution to the overall Windmill Canyon water budget model.

During Fall 2017, an evaluation of the current status of the septic systems at the MCMGC in Windmill Canyon was performed. These include systems providing service at Tee 6, Tee 17, the Maintenance Shed, and the Main Clubhouse. Planning and construction drawings were not readily available for all of the current in-use systems, so utility locating service was contracted to assess system conditions and locations using ground penetrating radar and down-hole camera equipment.

All of the systems were evaluated over two separate days. No major issues were detected at the Main Clubhouse and Tee 6 septic systems. The Maintenance Shed system was unable to be fully assessed due to vertical and horizontal turns preventing the passage of the camera equipment for access to the leach field. The system at Tee 17 showed an offset break in piping from the main septic system to the leach field that may have resulted from settling of either the main septic tank or drain line after initial construction.

Piezometers were successfully installed in the area of the Main Clubhouse septic system. Water quality measurements of groundwater indicated that no elevated nutrient or salt concentrations were seen compared with other groundwater samples in the area. Groundwater levels that were estimated in this area during piezometer sampling indicate that the water table may be around 12 feet below ground surface. Estimation of the leach field line depth was approximately 5–6 feet from ground penetrating radar analysis, which is consistent with normal septic field design. Current septic system codes in the County of San Diego require a 5 foot minimum standoff distance from the highest anticipated water table height. During wet weather events, increased irrigation, or high usage (i.e. large golf tournaments) the water table may be elevated enough to violate the standoff distance requirement and pose a potential risk of water table contamination. This potential risk may warrant future monitoring of this particular septic system and local water table.

Modeling equations and parameters for nitrogen and hydraulic flow were considered and presented here for future implementation. Estimation of wastewater design flows were performed and compared to leach field capacities. While the Main Clubhouse leach field has the capacity to handle all of the predicted design flow, it was unclear how much flow the smaller satellite septic systems would be expected to handle. Additional work to provide better estimates for wastewater flow at each system would be required for accurate model incorporation.

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CONTENTS

EXECUTIVE SUMMARY ..... **v**
1. INTRODUCTION **1**
2. STUDY SITE DESCRIPTION **3**
3. METHODS AND SOURCE DATA COLLECTED **9**
3.1 HISTORICAL INFORMATION / RESOURCES USED 9
3.1.1 Water Sample Collection 9
3.1.2 Sample Processing and Analysis 9
3.1.3 Processing methods used: 10
3.1.4 Analysis QA/QC 10
3.2 GROUND PENETRATING RADAR AND CABLE MOUNTED CAMERA 11
3.3 PIEZOMETER INSTALLATION/GROUND WATER ASSESSMENT 13
3.4 SURVEY TO ASSESS CONDITION OF FOUR ACTIVE SYSTEMS 14
4. RESULTS **15**
4.1 SEPTIC SYSTEM EVALUATION RESULTS 16
4.1.1 Tee 6 16
4.1.2 Maintenance Shed 19
4.1.3 Main Clubhouse 21
4.1.4 Tee 17 24
4.2 PIEZOMETER PLACEMENT AND SAMPLING RESULTS 27
4.2.1 Water quality and Water table results 37
5. PRELIMINARY MODEL CONSIDERATIONS **39**
5.1 HYDRAULIC COMPONENTS 40
5.2 INFILTRATION (SEPTIC FIELD) 40
5.2.1 Percolation Rate 41
5.3 CHEMICAL SPECIES MODEL COMPONENTS 46
6. CONCLUSIONS **49**
6.1 SUMMARY OF FOLLOWING EFFORT RECOMMENDATIONS 51
REFERENCES **53**

APPENDICES

A: GROUND PENETRATING RADAR TECHNICIAN REPORTS **A-1**
B: ANALYTICAL TEST REPORTS **B-1**
C: DRAWINGS PROVIDED BY MCBCP FACILITIES AND OTHER HISTORIC SYSTEM INFORMATION **C-1**
D: PIEZOMETER INSTALLATION PLAND.1 OVERVIEW ESTIMATED DEPTH AND LOCATION **D-1**
E: DATA USED FOR MODEL DEVELOPMENT AND ANALYSIS **E-1**

Figures

1. Location of four septic systems associated with Marine Corps Memorial Golf Course (MCMGC). 1
2. Marine Corps Base Camp Pendleton (grey shaded area) Windmill Canyon Project Area (black box) San Luis Rey tributaries, rivers (blue lines), and groundwater hydrology area (light blue). 4
3. Main Watersheds within Marine Corps Base Camp Pendleton (MCBCP) and San Luis Rey Watershed (brown shaded area) 5
4. Marine Corps Base Camp Pendleton **(**gray-shaded area**)** Windmill Canyon project area (blue box) & Elevation Model for Windmill Canyon. The shaded relief map includes draped aerial image showing the elevation model for Windmill Canyon. The golf course is visible in the middle of the image in the lower part of the canyon (Sorensen et al., 2017) 5
5. San Luis Rey Coastal Sub-basin, Main Tributaries and River. San Luis Rey River (SLRR-thick dark blue line). Section of Pilgrim Creek intersecting with windmill creek and SLRR (orange line). Windmill lake (dry) and Whalen lake (light blue dots in green circle). 6
6. Tee Six Leach Field located on north end of golf course. Restroom facilities (A). South end leach field looking toward restrooms (B). 7
7. Maintenance Shed Leach Field. Unearthed septic tank location (A). Potential leach field area (B and C). 7
8. Main Club House (MCH) Leach Field. Septic tanks (A). Old septic tanks, concrete basin (B). Views of leach field (C and D). 8
9. Tee 17 Leach Field. Septic tanks (A). Looking up toward restroom and septic tank (B). View from tee 17, looking toward restroom (C). Looking toward tee 17 from septic tanks (D). 8

10. Ground Penetrating Radar Approach. Schematic of GPR methodology (A). Example of GPR readout. Blue circles represent utility or water pipes (B). 12
11. Pipe Line Inspection Using Cable Mounted Camera. Picture of cable mounted camera moving through main pipe (A). Example of image inside of pipe using cable mounted camera (B)..... 13
12. Installation of Drive Point Piezometer at Tee 6 using a manual slide hammer. (A) shows a shielded drive point piezometer. Piezometer inserted into ground and pulled out of shield (B), along with two extension pipes, and with PTFE sample tubing running through sample tube barb. Typical sample collection using peristaltic pump (B, and C). 14
13. Conducting GPR Survey of Tee 6 Septic System (B, and D), 6 September 2016. Marked field lines post GPR survey (A and C). 17
14. Conducting Inspection of Septic Lines Using Camera Mounted Cable, 6 September 2016 18
15. Tee 6 septic location. Shaded region indicates location of leach field. 18
16. Septic Line Survey, Maintenance Shed Leach Field, 28 September 2016. Maintenance shed, blue arrows point to location of septic tanks (C). Orange circle and lines indicate location of septic tank and main drainage line which was located using cable mounted camera (E). 20
17. Maintenance Shed Septic System Location..... 21
18. GPR survey main club house leach field, 28 September 2016. Blue arrow shows marked leach lines (A). 22
19. Septic Line Inspection, Main Club House, 28 September 2016.Inspection of old tanks (A and B).Orange arrow in picture (C) points toward old septic tanks/concrete basin, whereas blue arrows point toward newer, operational septic tanks that drain into leach field. Orange circles show both location and picture of ground level access port (B and D).Green arrow (C) points to second, east bound line (point 7, Table 6). 23
20. Location of Main Clubhouse septic system. Shaded area indicates location of leach field. 24
21. Location of septic system at Tee 17. Shaded area indicates leach field location. 25

22. GPR and Cable Mounted Survey of Tee 17, 6 September 2016. Blue circle and arrow box (A) shows location of septic tanks as well as broken pipe. Green arrow shows direction main line, whereas orange arrows indicate direction of leach lines (B). 26
23. Shielded piezometer for groundwater assessments in soils. 27
24. Tee 6 Initial attempt to Install Piezometers, 25 January 2017. 28
25. Tee 6 Piezometer (Pz1 and Pz2) Installation Locations. See Table 8 for GPS coordinates 29
26. Interpolation of Water Table from Existing Water Level Data 30
27. Relative Locations of water level loggers and septic fields to be assessed with Piezometers 31
28. Main Club House (MCH) Piezometer install location. Pz4 – Piezometer 4; Pz5 – Piezometer 5; Blue start indicates location of active septic tanks; Orange star indicates location of old septic tanks. Refer to Table 8 for GPS coordinates. 32
29. Installation of Pz3 and Pz4 at Main Club House, January 2017. Picture A and B show installation of piezometer (Pz) 4 whereas picture C, including blue circle and arrow show installation and location of Pz3. 33
30. Silty water collected from south Piezometer (Pz4) at Main Clubhouse, May 2017. 34
31. In field sampling from installed Pz3,May 2017 35
32. Pz4 and Pz5 Installation at MCH, March 2017. Picture A and B shows initial testing of Pz5.Picture Pz4 shows driving down of additional extension at this location. 36
33. Hydraulic Components for a Septic Area. 39
34. Measured level during flood events in 2017 to estimate percolation rates at the Stormwater Recharge Pond (SWRP), located at north end of golf course. 42
35. Installation of Percolation Sensor at SWRP. Location of install and appearance (1 and 2). Sensor and perforated PVC pipe (3) which was inserted into ground ~ 3 feet. See Sorensen et al., for full methods description. 43
36. SWRP, north end of golf course Post Storm Event; 20 January 2017. East and west end of pond shown in 1 and 2. 44

37. Flooding on golf course during Storm Event (January 2017). Top two pictures show flowing around Tee 6, flowing directly past the leach field. Bottom picture of center of golf course in between Maintenance Shed system and Tee 6 System. Pictures were taken and provided by MCMGC Staff. 45
38. Results showing nitrogen species removal with distance from leach lines. 47

Tables

1. Main watersheds and percentage of acreage present on MCBCP. 4
2. List of water quality parameters and methods used for analytical analysis. 10
3 Septic system condition summary. 15
4 Tee 6 Septic System GPS Data. 16
5 GPS Data for the Maintenance Shed Septic System[a] 19
6 Main Clubhouse Septic System GPS Coordinates [a] 22
7 GPS Data for the Tee 17 Septic System[a] 25
8 Summary of Piezometer Install, Including Final Depth and Condition 28
9 Estimation of Septic Field Water Tables 29
10. In-Field Water Quality Measurements for MCHa Location 37
11. Analytical Chemistry Results for Samples Collected from Main Clubhouse Septic System* 37
12. Estimated Wastewater Design Flows Based on Patron Counts* 41
13 Estimates of Leach Field Area and Capacities* 42
14. Percolation Rates Estimated from Recharge Pond North of Golf Course 42
15. Follow up Recommendations, Including Level of Importance. 51

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1. INTRODUCTION

This report summarizes work conducted by the Environmental Sciences Branch of the Space and Naval Warfare Systems Center Pacific (SSC Pacific) for Marine Corps Base Camp Pendleton (MCBCP), Environmental Security (ES) in evaluating the four active septic systems (septic tanks and corresponding leach fields) located within Windmill Canyon (see Figure 1) Marine Corps Memorial Golf Course (MCMGC). The overall purpose of this work is covered in four main objectives: (1) to identify information and data gaps relative to the four active septic systems, (2) evaluate the overall function of the four septic systems, (3) conduct field work to assess water quality at specific leach fields for use in a computational model, and (4) assess contribution of the septic system leachate fields on the overall water quality (total nutrient load) and water capacity (water budget) within Windmill Canyon. Efforts to meet all four objectives included consultation with ES staff and MCMGC golf course superintendent, compilation of data regarding type of wastewater systems used, estimation of size of leach fields, location, volume, and overall description of potential discharge.

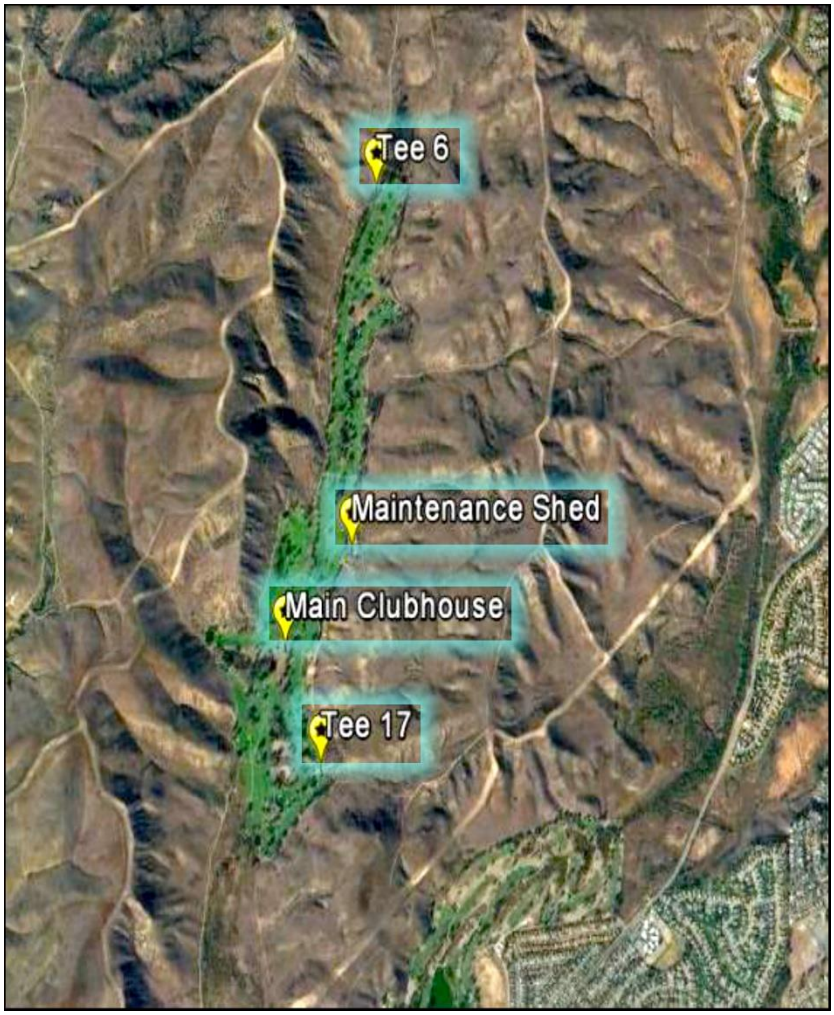

Figure 1. Location of four septic systems associated with Marine Corps Memorial Golf Course (MCMGC).

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2. STUDY SITE DESCRIPTION

MCBCP is located 38 miles north of the City of San Diego and 80 miles south of the City of Los Angeles, occupying approximately 200 square miles in northern San Diego County (Figure 2). The Base is composed of several watersheds including; San Mateo, San Onofre, Coastal Drainage, Las Flores, Aliso, Santa Margarita, and San Luis Rey (Figure 3). A summary of the main watersheds and approximate amount of land present on the base is provided in Figure 3 and Table 1. While the most notable is the Santa Margarita River (SMR) watershed, which includes the majority of water, wastewater, and water recycling activities and issues at the Base, the focus area in question for this study is located on the southeastern boundary of the Base, adjacent to the city of Oceanside (Figure 2) and situated within the San Luis Rey Watershed (SLRW, Figure 3 & 4). The SLRW in total is about 560 square miles (358,400 acres) of which, only about 2% (14 square miles or 9,100 acres) is located within base boundaries. This is in stark contrast to the other 6 watersheds or drainage areas which divide up the base (INRMP, 2012). Like the other main drainage systems and watersheds, SLRW consists of a complex network of tributaries. The main line, the San Luis Rey River (SLRR) intersects with Pilgrim Creek (one of four primary tributaries which runs to the east of windmill canyon) near Whalen Lake and drains the southern portion of the Base into the ocean (Figure 5). A smaller, secondary tributary, connecting to Pilgrim creek, Windmill Canyon Creek, runs down windmill canyon and into windmill lake (PBS&J, 2003).

The Base is situated on approximately 125,000 acres of land acquired in 1942 by the Department of the Navy at the beginning of World War II. It was then developed as a combat training facility for the Marine Corps and in 1946 became the west coast training center for the Marine Corps. Although the initial development of the Base was during the 1940s, construction of new facilities and the upgrading of old facilities has continued throughout its 69-year history.

The MCMGC was established in 1948 and services on average about 41,000 patrons (golf patrons) per year. The golf course itself is situated within Windmill Canyon and is 0.4 km^2 or consists of about 4% of total area within the canyon. The general topography of Windmill Canyon is characterized by a watershed of about 9.45 km^2 formed by relatively steep ridges to the east and west. Based on work completed under a prior study (Sorensen et al., 2017; Figure 4) overall topography of the canyon consists of a primary drainage system running for about 8.4 km down the canyon floor, and is fed by a complex network of tributaries with lengths up to about 2 km. The slope within the canyon floor is relatively shallow compared to the ridges, and maximum slopes within the watershed are generally in the range of 30–35 degrees.

Table 1. Main watersheds and percentage of acreage present on MCBCP.

Watershed Drainage Areas	Approximate Acreage (square mile) on Base	Approximate Total Acreage of Watershed	Percent of Watershed on Base
Aliso	11,400 (17.8)	11,400	100
Coastal Drainage	9,800 (15.3)	9,800	100
Las Flores	16,900 (26.4)	16,900	100
San Luis Rey (SLR)	9,100 (14)	357,120	2
Windmill Canyon	[b]2,336 (3.65)	---	26% (SLR)
San Mateo	18,200 (28.4)	87,680	21
San Onofre	27,520 (43)	27,520	100
Santa Margarita	31,200 (48.8)	474,880	7

[A] This table was adapted from Table 3-1 in MCBCP, Integrated Natural Resource Management Plan [March 2012-update].

[B] Windmill Canyon is drainage system located within the San Luis Rey Watershed and is where study site is located. Information provided as reference to overall watershed area.

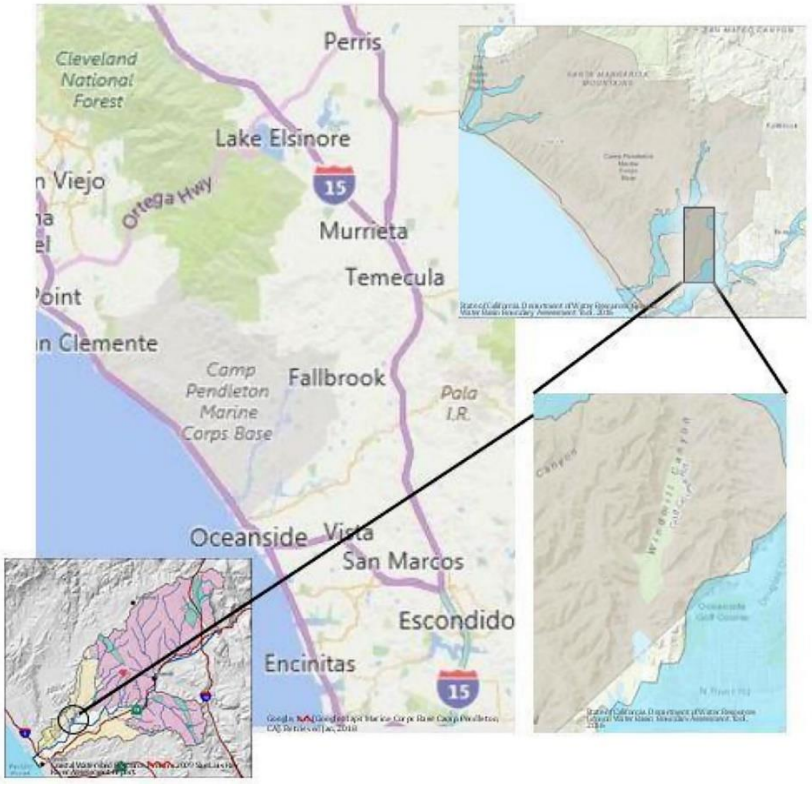

Figure 2. Marine Corps Base Camp Pendleton (grey shaded area) Windmill Canyon Project Area (black box) San Luis Rey tributaries, rivers (blue lines), and groundwater hydrology area (light blue).

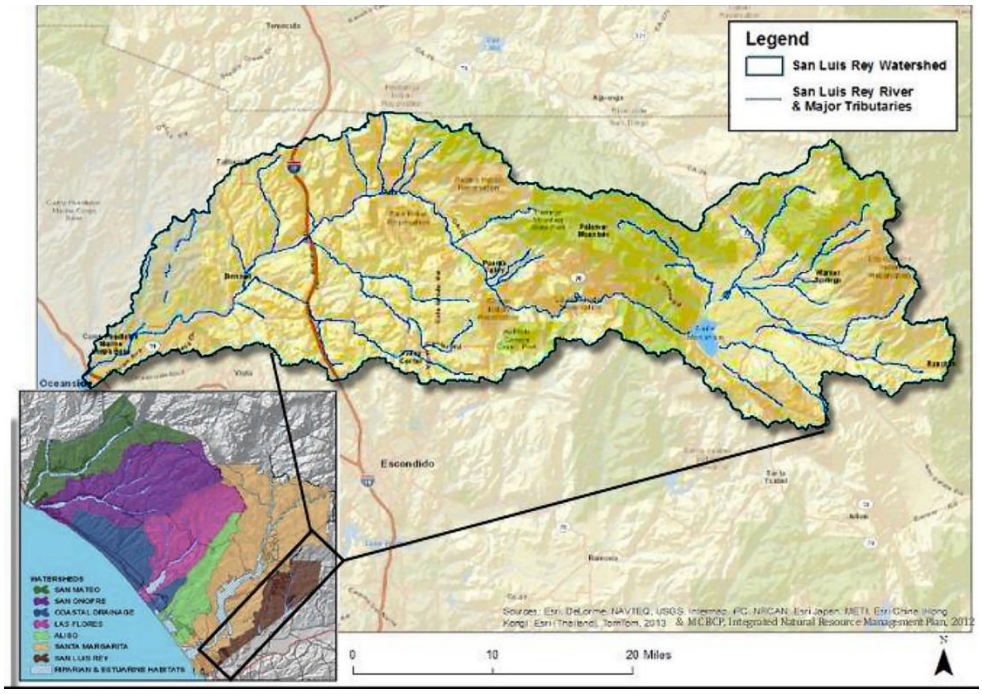

Figure 3. Main Watersheds within Marine Corps Base Camp Pendleton (MCBCP) and San Luis Rey Watershed (brown shaded area).

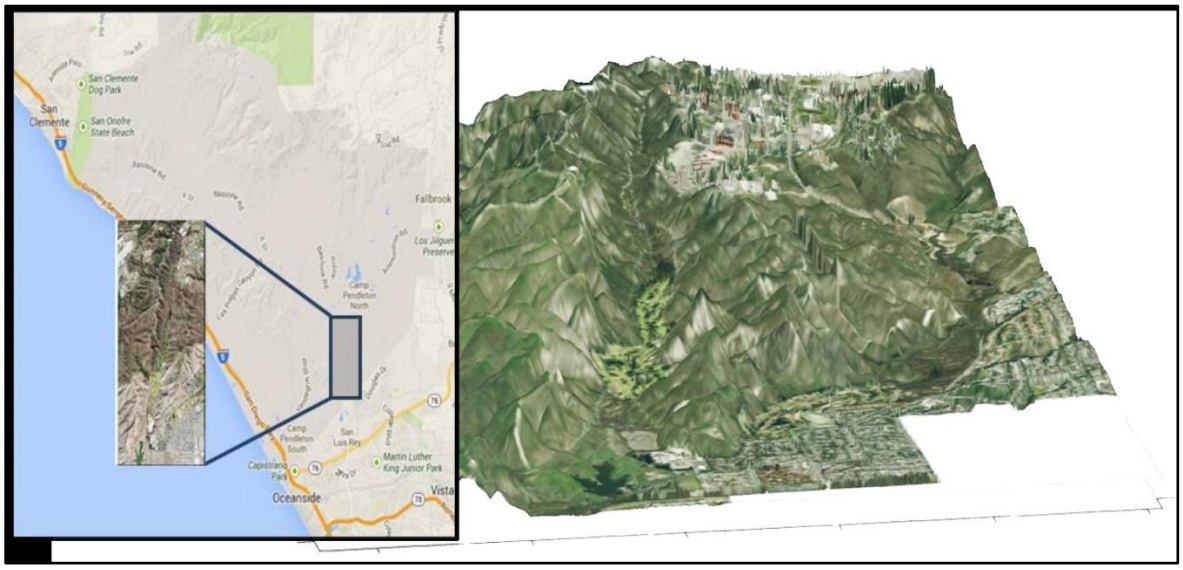

Figure 4. Marine Corps Base Camp Pendleton **(**gray-shaded area**)** Windmill Canyon project area (blue box) & Elevation Model for Windmill Canyon. The shaded relief map includes draped aerial image showing the elevation model for Windmill Canyon. The golf course is visible in the middle of the image in the lower part of the canyon (Sorensen et al., 2017).

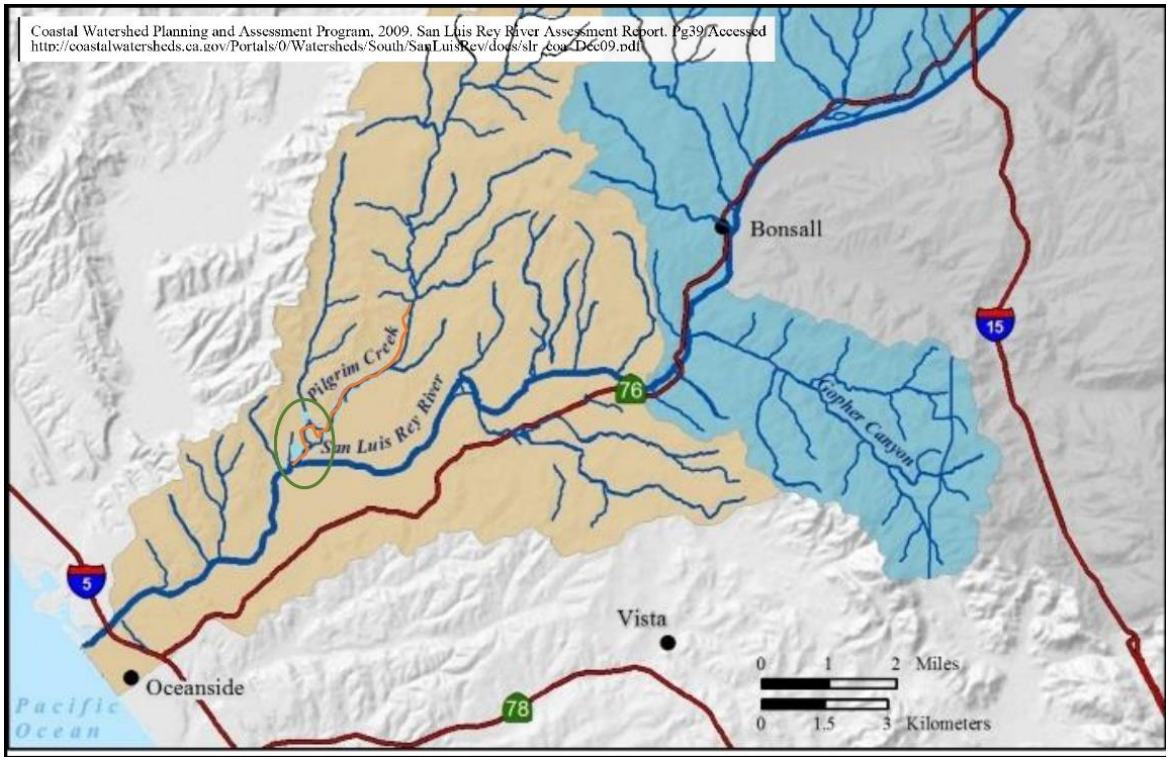

Figure 5. San Luis Rey Coastal Sub-basin, Main Tributaries and River. San Luis Rey River (SLRR-thick dark blue line). Section of Pilgrim Creek intersecting with windmill creek and SLRR (orange line). Windmill lake (dry) and Whalen lake (light blue dots in green circle).

Currently there are a total of four known active septic systems associated with the MCMGC (Figure 1). The first of the four systems is located at the north end of the golf course and is associated with Tee 6 (Figure 6).This is one of two systems that was thought to have had some upgrades to the septic tank infrastructure within the last 25 years. The second system is located adjacent to the maintenance shed on the east side of the golf course. This system has had some historic daylighting /flooding issues that led to uncovering of the septic tank to allow for routine pumping (Figure 7).The third system is located in the center of the golf course and is by far the largest known system on the golf course as it services the main club house and adjacent buildings, restaurant, and bathrooms (Figure 8). The last of the four septic systems evaluated is located on a hill near Tee 17 on the Southwest end of the golf course. This system is believed to be the most recent installed, although exact date is unknown, and services the adjacent restroom facilities (Figure 9).

Figure 6. Tee Six Leach Field located on north end of golf course. Restroom facilities (A). South end leach field looking toward restrooms (B).

Figure 7. Maintenance Shed Leach Field. Unearthed septic tank location (A). Potential leach field area (B and C).

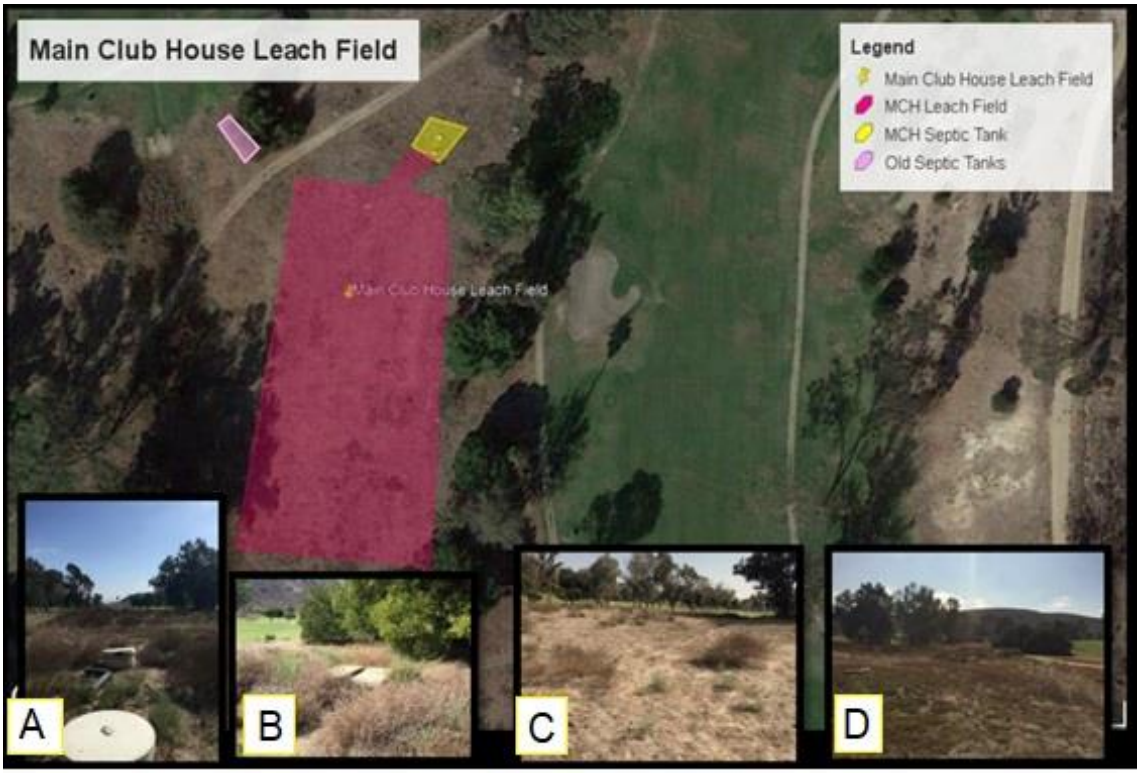

Figure 8. Main Club House (MCH) Leach Field. Septic tanks (A). Old septic tanks, concrete basin (B). Views of leach field (C and D).

Figure 9. Tee 17 Leach Field. Septic tanks (A). Looking up toward restroom and septic tank (B). View from tee 17, looking toward restroom (C). Looking toward tee 17 from septic tanks (D).

3. METHODS AND SOURCE DATA COLLECTED

This section describes the methods used for evaluating overall condition of the four active septic systems, including location and functionality as well as relative potential contributions to the overall water budget. Sections include historical information available and collected relative to infrastructure as well as system maintenance and usage; means of assessing location of and condition of each septic system; a description of primary model components; and data used in analysis.

3.1 HISTORICAL INFORMATION / RESOURCES USED

The following items were used to supply information regarding the history and current status of the septic infrastructure in Windmill Canyon. Copies of the below listed documents can be found in the appendix.

- Golf course tank diagram (PDF)- mainly only shows Tee 6 system
- Email communications from facilities regarding maintenance shed system
- Septic system pumping records
- Patron information /tee tickets info from MCMGC staff
- Septic Tank Memo

3.1.1 Water Sample Collection

Discrete water samples were attempted from both the piezometer installed at Tee 6 and the main club house in May 2017 (See Piezometer placement and sampling results section of report below). Samples were successfully collected from the piezometers located at the Main Clubhouse septic field and analyzed for a suite of nutrients including nitrogen, phosphorus, solids, and oxygen demand. For those sample sites where sufficient sample volume could not be collected (< 500 ml), a handheld water quality meter (Ultrameter II™ 6P, Myron L® Company, Carlsbad, CA) was used to analyze the samples in field. Water samples were collected using a field sampling pump (Masterflex® E/S™ Portable Water Sampler, Cole-Parmer, Vernon Hills, IL) and collected into small polyethylene bottles for nutrient analyses. All transfers were made after rinsing with sample water and while wearing nitrile gloves. The samples were kept in the dark on ice in coolers until submitted to the lab (EnviroMatrix Analytical, Inc., San Diego, CA) for processing and analysis. Sample submission was within 5 hours of initial collection.

3.1.2 Sample Processing and Analysis

Water samples were processed by scientific staff at Enviromatrix in accordance with standard methods for nutrient analysis. Methods used for analyzing samples are provided in Table 2. A brief summary of methods is provided below.

Table 2. List of water quality parameters and methods used for analytical analysis.

Analyte	Method
Chemical Oxygen Demand	EPA 410.4
Nitrate as N	Standard Methods 4500 NO3 E
Nitrite as N	Standard Methods 4500 NO2 B
Total Kjedahl Nitrogen	Standard Methods 4500 N C
Total Phosphorus	Standard Methods 4500 P B, and E
Total Dissolved Solids	Standard Methods 2540 C
Total Suspended Solids	Standard Methods 2540 D
Volatile Suspended Solids	Standard Methods 2540 E
Total Sulfide	Standard Methods 4500 S and D

3.1.3 Processing methods used:

Chemical oxygen demand (EPA 410.4): Samples are sealed in glass tubes with dichromate and heated to 150° C to digest oxidizable material. Resulting samples are then read by spectrophotometer to quantify amount of oxidation.

Nitrate (SM 4500 NO3 E) & Nitrite (SM 4500 NO2 B): Samples are processed by cadmium reduction for conversion to nitrite. Analysis of nitrite is then carried out through SM 4500 NO2 B where the sample is reacted with reagents to form a red color that is then read through spectrophotometer.

Total Kjedahl Nitrogen (SM 4500 N C): Samples are digested with persulfate at 121 °C which oxidizes all forms of nitrogen to nitrate. Analysis is then performed through SM 4500 NO3 E.

Total Phosphorus (SM 4500 B and E): Samples are digested with persulfate as in SM 4500 N C which converts all phosphorus to orthophosphate. Orthophosphate is then analyzed through reaction with sulfuric acid-antimony-molybdate solution, and subsequently with an ascorbic acid solution, yielding an intense blue color suitable for photometric measurement.

Total Dissolved Solids (SM 2540 C), Total Suspended Solids (SM 2540 D), & Volatile Suspended Solids (SM 2540 E): Samples are filtered with glass fiber filters for partitioning into suspended solids and dissolved solids. Suspended solids (captured on the filter) are dried at 105° C and weighed to determine mass. Filtrate containing dissolved solids is then dried and residue is weighed to determine mass. Volatile suspended solids are determined by heating the suspended solids filter to 550° C and weighing the remaining material. The lost material is considered volatile suspended solids.

3.1.4 Analysis QA/QC

Sample collection and processing procedures included using gloves, pre-cleaned bottles, sampling equipment, and pre-rinsing all materials with sample water prior to capture. Samples were stored in the dark on ice and processed in clean laboratory conditions within prescribed hold times to ensure consistency and less chance of contamination.

Quality assurance and quality control samples were processed along with field samples to ensure the performance of analytical tests. A blank and duplicate sample were included for all analytes tested. Laboratory control samples and matrix spikes were also included for nitrate, nitrite, total kjedhal nitrogen, phosphorus, sulfide, and chemical oxygen demand. Reference samples were included for analysis of dissolved and suspended solids.

3.2 GROUND PENETRATING RADAR AND CABLE MOUNTED CAMERA

Ground penetrating radar (GPR) was used in order to locate pipes not accessible through cabled camera system. GPR uses high frequency (range 10 MHz to 2.6 GHz) radar waves to permeate geophysical surfaces and detect subsurface objects. Figure 10 illustrates what a typical system looks like as well as provides a schematic of method and example of data read out. This system has a depth limitation of 6' below grade to detect subsurface objects. In addition, GPR detection capability is affected by many factors including; soil type, existing subsurface features, and soil moisture. A cable mounted camera system was used to visualize the condition and depth of the pipe where accessible. Figure 11 is a picture of system used by contractor as well as general method and typical image of cable inserted into pipeline. Access to pipe for inspection was limited to being able to force the cable around pipe bends and to prevent damage to existing systems. Ground penetrating radar and pipe condition evaluation was conducted by Cable, Pipe, and Leak Detection (El Cajon, CA). Survey reports are included in the appendix (Appendices A, page A2-A3). Irrigation in survey areas was halted for 1–2 days prior to evaluation to provide drier conditions that would provide a higher chance of success.

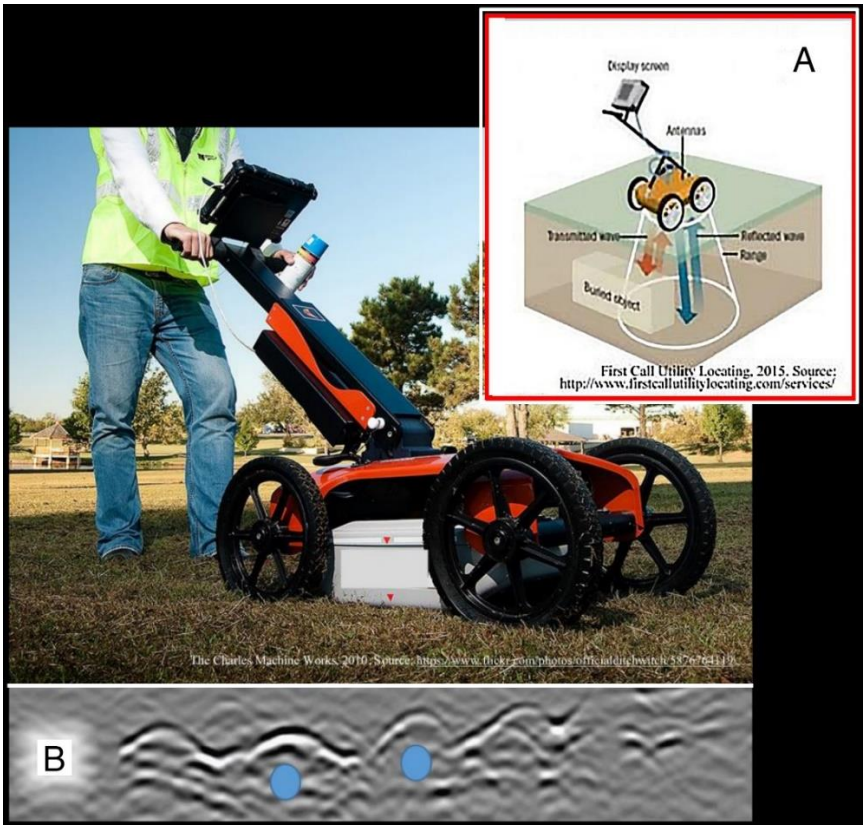

Figure 10. Ground Penetrating Radar Approach. Schematic of GPR methodology (A). Example of GPR readout. Blue circles represent utility or water pipes (B).

Figure 11. Pipe Line Inspection Using Cable Mounted Camera. Picture of cable mounted camera moving through main pipe (A). Example of image inside of pipe using cable mounted camera (B).

3.3 PIEZOMETER INSTALLATION/GROUND WATER ASSESSMENT

Piezometer installation was attempted in the effort to assess both groundwater level and collect potential samples in leach field areas. Drive-point piezometers (Model 615S, Solinst® Incorporated). Georgetown, Ontario, Canada were utilized in this effort to provide temporary sampling with low impact to ongoing golf course operations. These piezometers are rated as suitable for sampling to 20–25 feet below ground surface, but their use is highly dependent on soil conditions and ability to avoid refusal. Shielded piezometers were chosen to protect screens from soil clogging during installation (Figure 12, A).

The piezometers were installed using stainless steel threaded pipe and stainless steel couplers to minimize failure during installation. Installation was performed by using a manual slide hammer to drive the piezometers to the water table. Upon reaching the required depth, the piezometer and attached pipes were pulled from the surface until the sampling screens were exposed by at least 6 inches. Sample tubing was connected from the surface and collected through peristaltic pump (Figure 12, B and C).

Once installed, piezometers were allowed to stabilize for a minimum of 48 hours before water collection was attempted. If water was not observed, additional pipe sections were added if possible. If water was present, samples were collected for analysis (Figure 12 C).

Figure 12. Installation of Drive Point Piezometer at Tee 6 using a manual slide hammer. (A) shows a shielded drive point piezometer. Piezometer inserted into ground and pulled out of shield (B), along with two extension pipes, and with PTFE sample tubing running through sample tube barb. Typical sample collection using peristaltic pump (B, and C).

3.4 SURVEY TO ASSESS CONDITION OF FOUR ACTIVE SYSTEMS

As part of the initial study involving the septic systems at Windmill Canyon, a survey to assess the current conditions of the 4 active systems at the MCMGC was performed

Overall there was limited information available regarding exact date of installation for the four septic systems. Based on available blue prints provided by MCBC staff it is believed that Tee 6 system was upgraded within the last 25 years (Appendix C.4, Page C19) Tee 17 is believed to have been installed post Tee 12 system being decommissioned (sometime after 1985, MCBCP staff, September 2018, personal communications).Exact time frame of upgrades to the Main Clubhouse system is believed to have been within the last 20 years (MCMGC grounds keepers, August 2015, personal communications). While there has been some upgrades to at least two of the four systems there has been an increased number of daylighting incidents observed with at least three of the four systems (Maintenance Shed, Tee 6, Tee 17, MCMGC staff, August 2015, personal communications). These incidents resulted in MCBCP investing in a routine pumping of at least three of these locations on a bimonthly basis. Based on consultation with MCBCP staff and review of available infrastructure documentation for each of the 4 active septic systems (Appendix C.4, Page19-27) a significant data gap relative to system layout was identified. As a result, a field survey consisting of visual observations, ground penetrating radar, and internal piping examination using a camera mounted cable, was conducted to determine approximate layout and overall physical conditions for each of the four septic systems. General conditions for each for each system is discussed below and summarized in Table 3.

4. RESULTS

This section describes general findings relative to overall condition of the four active septic systems including location and functionality as well as relative potential contributions to the overall water budget. Sections include field surveys of each of the four septic systems as means of assessing location of and physical condition of each system; assessment of groundwater condition through installation of piezometers and chemical analysis; and results of model output relative to potential nutrient loading.

Table 3 Septic system condition summary.

Septic system	Usage	Condition	Observations/Comments
Tee 6	Moderate	Fair	Golf course operators and personnel have observed warfighter units utilizing this bathroom on occasion when training in the area. Daylighting reported at this system in relation to this. Utility lines appeared in good condition when examined by video camera. Ground penetrating radar indicates that a large tree may be growing in the middle of the leach field at this time.
Maintenance Shed	Low – Moderate	Poor / Unknown	Daylighting reported at this system. High number of vertical and horizontal turns in the utility lines prevented full assessment and location of the leach field. Field conditions were too wet for ground penetrating radar evaluation even after halting irrigation.
Main Clubhouse	High	Good	No problems reported with this system. Design of the septic tank prevented camera entry for visual evaluation of utility lines, but leach field lines located through ground penetrating radar.
Tee 17	Low – Moderate	Poor	Daylighting reported at this system Connection between septic tank and leach field observed to be broken during evaluation. Ground penetrating radar indicates leach field was built on steep slope with possible heavy vehicle traffic.

4.1 SEPTIC SYSTEM EVALUATION RESULTS

4.1.1 Tee 6

The septic system at Tee 6, located at the north end of the golf course, is shown at the location indicated below (Figure 15, Table 4). This system is the only system which had planning drawings (upgrade drawings to system, MCBCP staff, September 2018, personnel communications) available to compare to. First a GPR survey was conducted to locate leach field lines (Figure 13). Based on comparison to available drawings (Appendix C.4, page 15-20), we were able to confirm that the GPR survey successfully located the approximate position of the leach field (Figure 15). Once the GPR survey was completed, an inspection of septic lines was conducted using a camera mounted cable (Figure 14, Figure 11). The camera was used to determine approximate depth and the condition of the pipe from the septic tank to the first 90° bend (Figure 15 A). Depth at this point and of the rest of the system was approximately 5–6’ below grade.

The condition of this straight run of pipe was generally observed by the technician to be good. Pooling of water between the septic tank and the bend was observed indicating some settling of the pipe that may prevent complete drainage to the leach field. A large tree is located at Point 4 (Figure 15) that appears to be in the middle of the leach field area. While camera inspection was unable to evaluate the condition of the leach field piping, it is likely that root growth has infiltrated the system at this point and could lead to future system problems.

The design of the leach field from the planning drawing (Appendix C.4, page-19) indicated one continuous length of pipe in a serpentine orientation instead of the typical “finger” style leach field. While the general location of the leach field was verified, the design of the pipe layout for the leach field was not.

Table 4 Tee 6 Septic System GPS Data[a].

Location	Latitude	Longitude	Ground elevation (ft above MSL[a])	Description
1	33°16'55.09"N	117°19'34.81"W	188.75	Septic tank location
2	33°16'54.26"N	117°19'35.47"W	185.13	First 90° turn in pipe
3	33°16'54.24"N	117°19'35.32"W	178.23	Second 90° turn
4	33°16'54.46"N	117°19'35.09"W	201.56	Tree inside leach field
5	33°16'54.74"N	117°19'34.81"W	187.57	NW boundary of leach field
6	33°16'54.71"N	117°19'34.56"W	187.63	NE boundary of leach field

[a]Note: GPS coordinates and elevation data are approximate, [b] Mean Sea Level (MSL)

This table has a direct correlation “Location” to the numbers shown on Figure 15.

Figure 13. Conducting GPR Survey of Tee 6 Septic System (B, and D), 6 September 2016. Marked field lines post GPR survey (A and C).

Figure 14. Conducting Inspection of Septic Lines Using Camera Mounted Cable, 6 September 2016.

Figure 15. Tee 6 septic location. Shaded region indicates location of leach field.

4.1.2 Maintenance Shed

The maintenance shed septic system services the maintenance buildings located north of the main clubhouse (Figure 1). This system has had reported problems with effluent daylighting in the past, this resulted in the septic tanks being unearthed (Figure 16) and initiation of monthly pumping of tanks (MCMGC staff, August 2015, personal communications).Due to ground saturation issues and main line infrastructure, this location proved difficult to fully evaluate. There was some success in locating the main drainage line to the leach field, with the use of a camera mounted cable (Figure 16), however the technician encountered several 90 degree turns (vertical and horizontal) that made camera entry difficult. Depth of the pipes also increased beyond 5' by Point 4 (Figure 17, Table 5).

The leach field is believed to be located west of the maintenance buildings. While the contractor made two attempts (first on 6 September 2016, second on 28 September 2016) to locate the leach lines using the GPR, conditions prevented location determination due to soil water content and/or depth (ground penetrating radar only detects up to 6' in depth).It should be noted that the reason for the time lapse between the first and second survey was due to MCMGC staff minimizing irrigation for up to a week prior to conducting the second survey. However, the probable location of the leach field is within the normal irrigation area for the golf course which would seem to indicate that soil saturation is the prime inhibitor in the use of GPR in this area (Figure 16).

Overall, condition of the main line appeared to be in good condition. The elevation of the main tank does appear to be an issue however. The access ports for the tank are a couple feet below grade of the surrounding terrain which could become an issue during storm events (water infiltration) and general upkeep to prevent the system from becoming buried from erosion of surrounding terrain (Figure 16, E and F).

A change in pipe color was observed between points 4 and 5 (Figure 17, Table 5) suggesting the transition from the main line to the leach field. Roots were also observed in the pipes at this location. This will eventually lead to stoppage of the main line unless an access port is installed to facilitate clean out. Addition of the access port may also allow determination of the leach field with more accuracy.

Table 5 GPS Data for the Maintenance Shed Septic System.[a]

Location	Latitude	Longitude	Ground elevation (ft. above MSL[b])	Description
1	33°16'10.08"N	117°19'39.46"W	136.02	Septic tank location
2	33°16'10.16"N	117°19'39.45"W	140.48	90º turn,
3	33°16'10.25"N	117°19'39.71"W	138.13	90º turn,
4	33°16'10.32"N	117°19'39.73"W	138.77	Depth increase
5	33°16'10.37"N	117°19'40.04"W	136.75	Ice plant boundary
6	33°16'10.46"N	117°19'40.26"W	136.39	Extent of camera access

[a] Note GPS coordinates and elevation data are approximate
[b] Mean Sea Level (MSL)

Figure 16. Septic Line Survey, Maintenance Shed Leach Field, 28 September 2016. Maintenance shed, blue arrows point to location of septic tanks (C). Orange circle and lines indicate location of septic tank and main drainage line which was located using cable mounted camera (E).

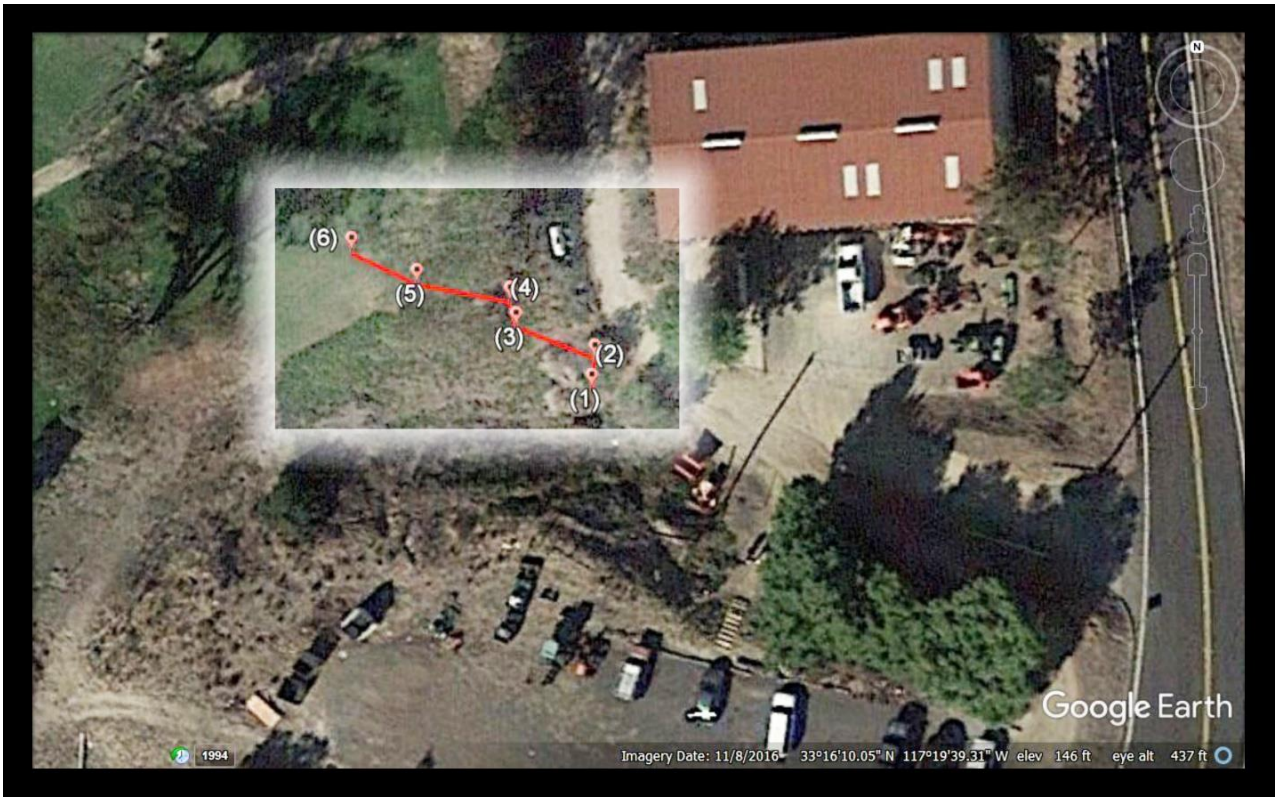

Figure 17. Maintenance Shed Septic System Location.

4.1.3 Main Clubhouse

The main clubhouse septic system services the facilities in the main clubhouse including changing rooms, showers, restrooms, bar, and café. The main septic tanks are located approximately 770' southwest of the main building (Figure 1). A separate concrete basin was located 140' west of the access ports from the main septic tank (Figure 8 (B), Figure 20 and Table 6, point 5). This separate basin was observed to have flowing water during the dry period of the year (September, 2016). Both this basin and the active septic system were evaluated using GPR and camera mounted cable.

Access to the main line of the active system (Figure 8 (A), Figure 20 and Table 6, point 1) with the camera was not possible due to the fact that the connection to the main line from the septic tank was made with an elbow pipe instead of a tee pipe. In order to access the main line from the tank this would require entry from the bottom of the tank, however the septic tanks are located below ground, making this option not possible without excavation (Figure 19). The location of the lines and leach field were determined using the GPR (Figure 18). Depth of the leach field was undeterminable from the radar data. A total of 4 parallel lines were located in the leach field that likely feed from the main line (Table 6). These lines extended for approximately 160' from the main line (Figure 20).

Two lines connecting to the concrete basin were located through camera inspection (Table 6, points 6 and 7). One line headed north to a ground level access port (Figure 19 (B and D), and Figure 20, point 6). Depth of this line was noted to be 4.5' below grade until the access port was reached. A second line headed east towards the existing septic system at the same depth. A camera was fed for

approximately 18’ down the length of this pipe (Figure 19 C). Continuous water flow was observed in this pipe. This does not appear to be originating from the active septic system. It is likely that this is either from applied irrigation or a broken irrigation line that is allowing water to infiltrate the pipe system.

Table 6 Main Clubhouse Septic System GPS Coordinates.[a]

Location	Latitude	Longitude	Ground elevation (ft above MSL[b])	Description
1	33°15'58.00"N	117°19'51.78"W	103.50	Septic tank location
2	33°15'58.20"N	117°19'52.55"W	103.56	NW leach field corner
3	33°15'56.60"N	117°19'53.27"W	99.62	SW leach field corner
4	33°15'56.44"N	117°19'52.68"W	--	SE leach field corner
5	33°15'58.14"N	117°19'53.41"W	94.60	Concrete basin
6	33°15'58.31"N	117°19'53.40"W	--	Access port at ground surface
7	33°15'58.04"N	117°19'53.06"W	101.96	Extent of camera access

[a] Note gps coordinates and elevation data are approximate
[b] Mean Sea Level (MSL)

Figure 18. GPR survey main club house leach field, 28 September 2016. Blue arrow shows marked leach lines (A).

Figure 19. Septic Line Inspection, Main Club House, 28 September 2016.Inspection of old tanks (A and B).Orange arrow in picture (C) points toward old septic tanks/concrete basin, whereas blue arrows point toward newer, operational septic tanks that drain into leach field. Orange circles show both location and picture of ground level access port (B and D).Green arrow (C) points to second, east bound line (point 7, Table 6).

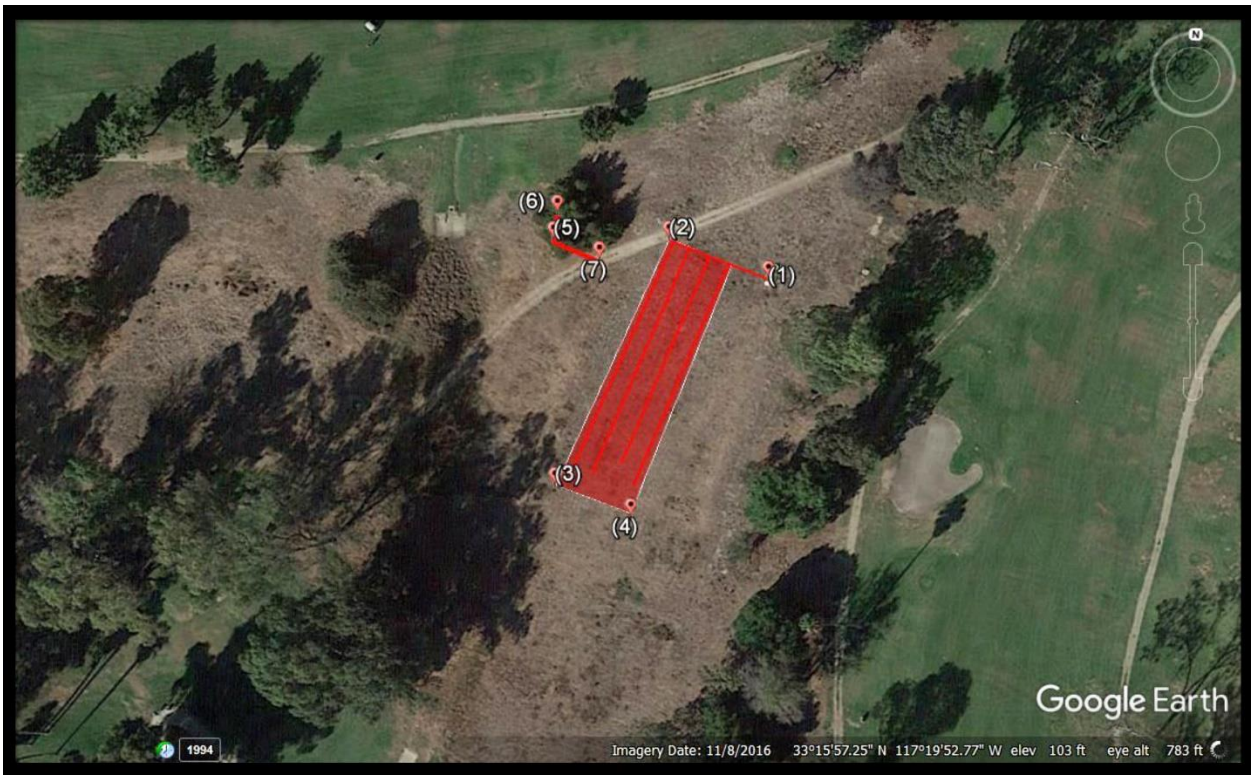

Figure 20. Location of Main Clubhouse septic system. Shaded area indicates location of leach field.

4.1.4 Tee 17

The tee 17 septic system services two restrooms approximately 2,030’ to the south of the main clubhouse (Figure 1). The septic system and leach field are located on a hill without groundcover (Figure 21 and Table 7). The area appears to be well traveled by vehicles (Figure 9). Daylighting of effluent was reported previously by maintenance personnel, but not observed during the teams evaluation.

The attempt to evaluate the system with the cable mounted camera showed a break in the joint connecting the main line to the septic tank. The camera was unable to proceed past this break to avoid further damage to the system (Figure 22 A). The remainder of the system was located through GPR (Figure 22 B).

Due to the fact that we were unable to pass the cable mounted camera past a couple feet from the septic tanks, we were unable to determine the condition of the rest of the system. However, the break between the main line and the septic tank would prevent effluent from currently travelling to the leach field. The location of the leach field is under an access road travelled by vehicles (Figure 9). Vehicular traffic in this area should be limited to prevent damage to the underground piping. The steep gradient of the leach field may also become an issue preventing even distribution of effluent across the entire area of the intended leach field.

Table 7 GPS Data for the Tee 17 Septic System.[a]

Location	Latitude	Longitude	Ground Elevation (ft above MSL[b])	Description
1	33°15'43.32"N	117°19'45.17"W	138.11	Septic tank location
2	33°15'43.09"N	117°19'45.53"W	134.25	SE leach field corner
3	33°15'43.25"N	117°19'45.75"W	133.65	NE leach field corner
4	33°15'43.36"N	117°19'45.58"W	133.54	NW leach field corner

[a] Note GPS coordinates and elevation data are approximate
[b] Mean Sea Level (MSL)

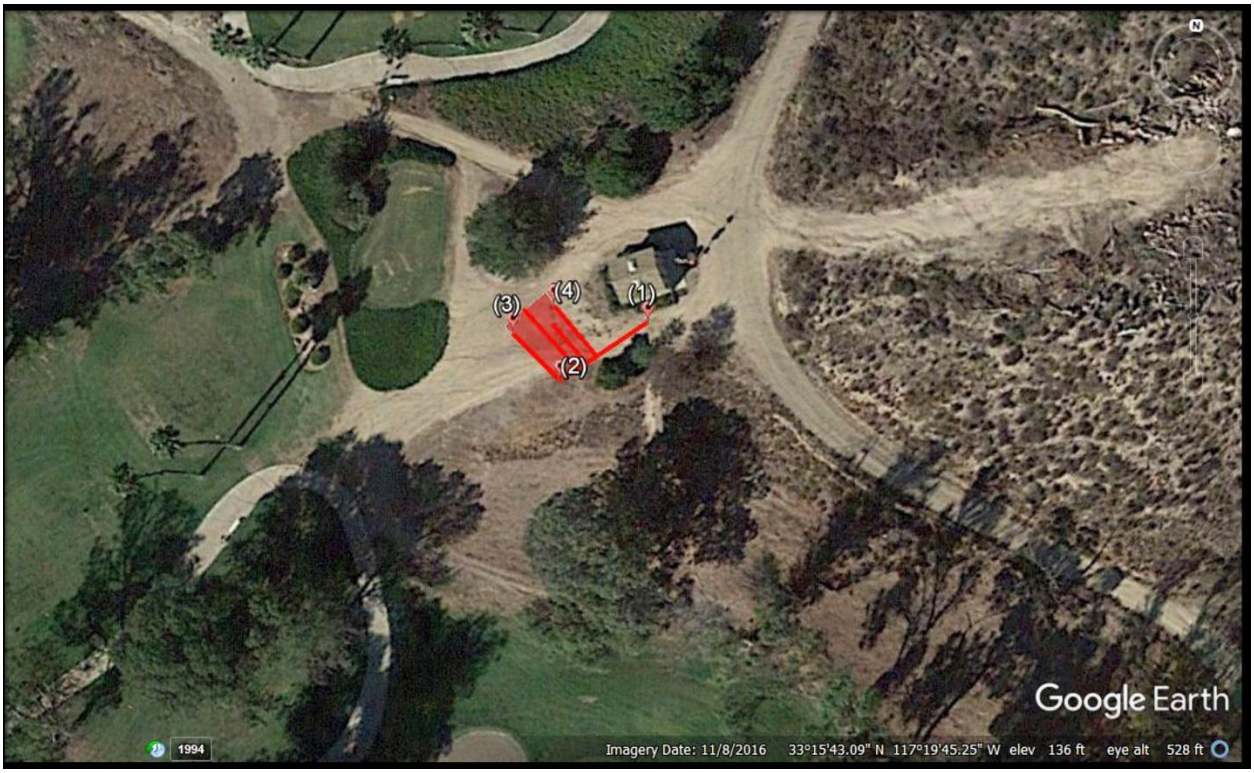

Figure 21. Location of septic system at Tee 17. The area shown in red indicates a leach field location.

Figure 22. GPR and Cable Mounted Survey of Tee 17, 6 September 2016. Blue circle and arrow box (A) shows location of septic tanks as well as broken pipe. Green arrow shows direction main line, whereas orange arrows indicate direction of leach lines (B).

4.2 PIEZOMETER PLACEMENT AND SAMPLING RESULTS

An assessment of the groundwater table beneath the septic fields at Tee 6 and the Main clubhouse was attempted using manual installation of shielded piezometers (Model 615S, Fondriest International®, Inc., Figure 23 and Figure 24). Semi-rigid ½" diameter tubing was attached to the internal barb of the piezometer and extended as necessary to reach the ground surface as the piezometer was installed through slide hammer (Figure 12 and Figure 24, pictures B and C). Five foot sections of ¾" stainless steel schedule 40 pipe was used to support the piezometer and tubing during installation. Connections between pipe sections were made with standard size stainless steel NPT pipe couplers. Upon reaching a certain depth, the pipe is pulled up to expose the screened area of the piezometer, allowing water to enter the internal sampling section. Long sections of clean ¼" O.D. polyethylene tubing was then fed through the ½" tubing to reach the bottom of the piezometer. The end of this ¼" tubing was attached to a peristaltic pump at the surface to facilitate sampling.

Piezometer installation depth was estimated from the length of ¼" tubing. Initial water table measurements were made by dusting the tubing with diatomaceous earth prior to insertion. A water table distance from the bottom of the piezometer was measured based on the water line observed on the tubing.

Figure 23. Shielded piezometer for groundwater assessments in soils.

Prior to installation, proposed locations were identified based on proximity to each leach field's location. Positions were identified and marked on location maps prior to field work and located using a handheld GPS at time of installation (Appendix DD1-D4). Actual latitude and longitude were recorded at time of installation. Initial installation was attempted at Tee 6 with a gas-powered post driver (Figure 24 A and A1). Installation through this method failed after 2–3 pipe extensions due to the stress on the pipe couplers. The remaining installations were all attempted with a manual 14 lb post driver (Figure 12) with mixed success. Progress and depth were limited by both the hardness of the ground and the strength of the pipe couplers. Figure 25 and Table 8 show the locations of the 2 piezometers installed at Tee 6 location.

Figure 24. Tee 6 Initial attempt to Install Piezometers, 25 January 2017.

So as to determine targeted depth of piezometer installation, location of water table at each septic system (Table 9) was estimated from water level data collected from the stormwater recharge pond (SWRP), located at the northern end of the golf course and a station near Windmill Lake (Figure 27). Data from both these location was summarized and verified in a prior water budget analysis study in Windmill Canyon (Sorensen et al., in draft). Water table along the length of the golf course was estimated with an exponential approximation between the known water table heights (Figure 26).

Table 8. Summary of Piezometer Install, Including Final Depth and Condition.

Piezometer	Location	Latitude (N[a])	Longitude (W[b])	Depth (ft[c])	Date of Install	Condition
1	Tee 6	33° 16' 54.552"	117° 19' 34.824"	6	25 Jan 2017	USLF[d], NF[e]
2	Tee 6	33° 16' 54.138"	117° 19' 35.1876"	13.5-14	15 Feb 2017	DSLF[f]. Initial water at 12 foot not a lotwhen checked on 2-15 (i.e. could have just been rain water) but no water presenton 3/21 corner
3	MCH[g]	33° 15' 58.176"	117° 19' 52.068"	20.2	25 Jan 2017	USLF[d]
4	MCH[g]	33° 15' 56.376"	117° 19' 53.004"	12.4	25 Jan 2017	DSLF[f]
5	MCH[g]	33° 15' 56.9052"	117° 19' 52.8276"	19.3	15 Feb 2017	DSLF[f], NWC[h]

[a] North; [b]West; [c]feet; [g]Main Club House; [d]Upstream of leach field; [e] Not functional; [f] Downstream of leach field; [h] North West Corner

Figure 25. Tee 6 Piezometer (Pz1 and Pz2) Installation Locations. See Table 8 for GPS coordinates.

Table 9 Estimation of Septic Field Water Tables.

Septic Field	Distance from SWRP[a] (ft)	Elevation (ft above MSL[b])	Water Table Height (ft above MSL[b])	Water Table Depth (ft bgs)
Tee 6	674	185.58	168.37	17.21
MF[c]	5142	136.39	92.48	43.91
MCH[d]	6560	102.24	76.47	25.78
Tee 17	7867	134.25	64.17	70.08

[a]Stormwater recharge pond (SWRP); [b] Mean sea level (MSL); [c] Maintenance facility (MF);[d] Main club house

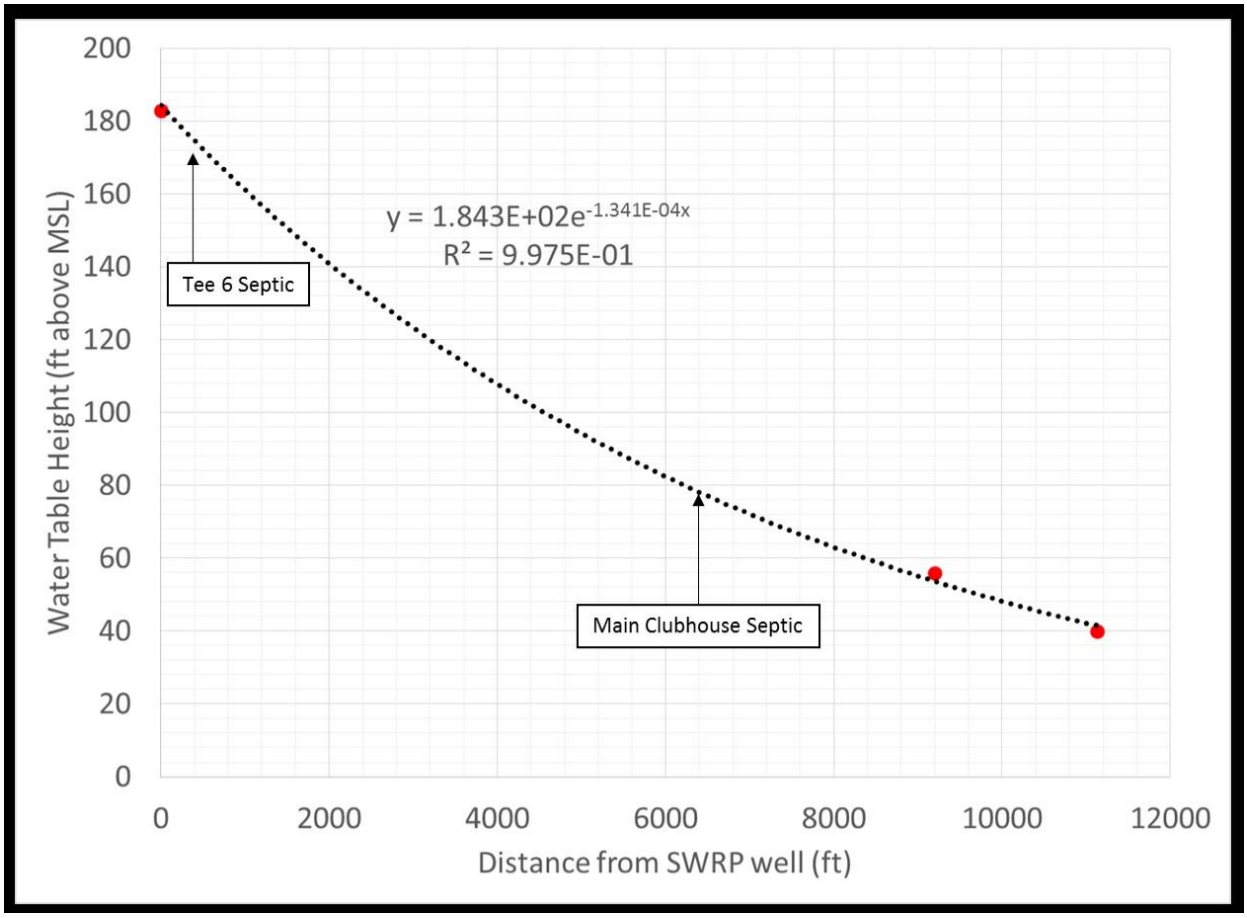

Figure 26. Interpolation of Water Table from Existing Water Level Data.

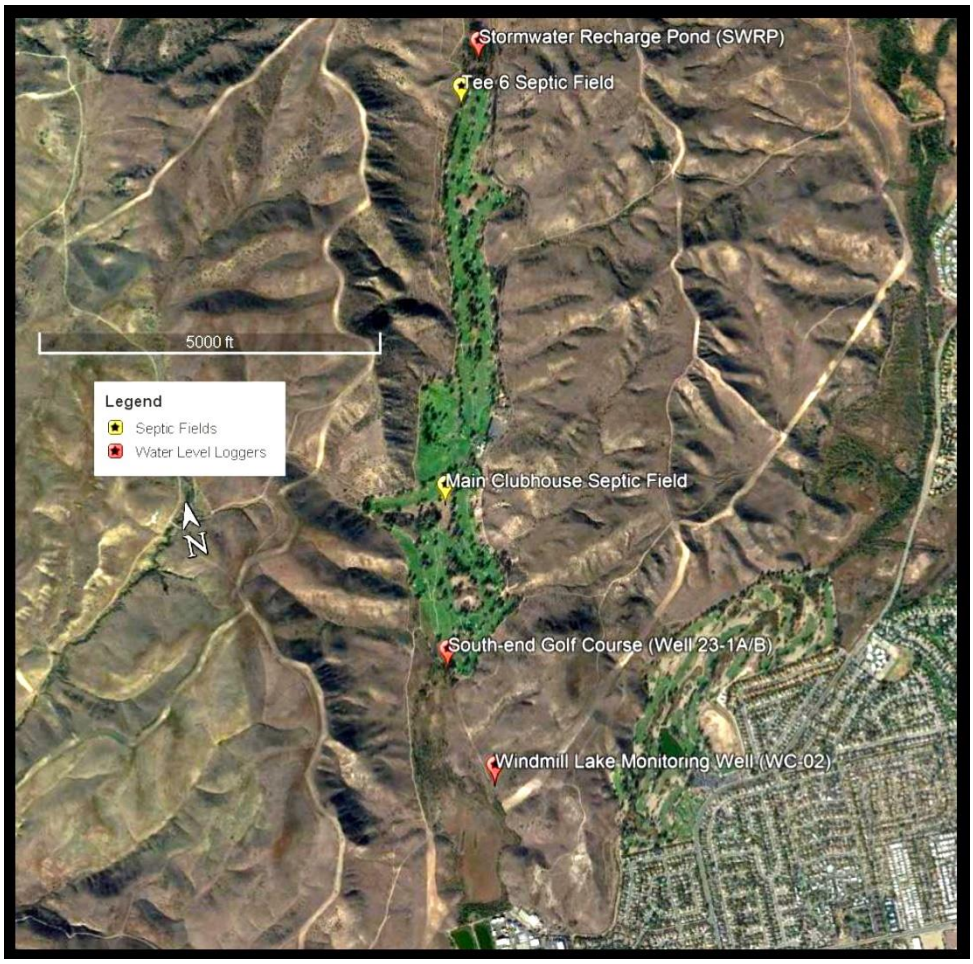

Figure 27. Relative Locations of water level loggers and septic fields to be assessed with Piezometers.

Piezometer locations at Tee 6 were directly upstream and downstream of the septic leach field identified in the ground penetrating radar survey (Figure 25). The ground here was considered hard packed at depth and was a limiting factor in the final depth in which the piezometers could be deployed. The piezometer on the north end of the leach field (closest to the restroom- Pz1) was only able to be driven to a depth of 6 feet before pipe couplers failed due to the stress from pounding (Figure 24, picture A, A1 and E). The piezometer south of the leach field (downstream based on hydraulic gradient- Pz2) was able to be installed to a final depth of 13.5–14 feet (Figure 25, Pz2). A small volume (<20 mls) of extremely turbid water was initially extracted from this location using the sample tube inserted into the piezometer and peristaltic pump. This site never seemed to recharge and no additional samples were able to be collected here. The locations' hard pack subsurface prevented further driving down of Pz2.

Three piezometers were installed at the main clubhouse septic leach field: one on the north side, one on the west side, and one on the south side (Figure 28, Table 8, piezometer 3–5). The north piezometer (Pz3) was intended to assess the water quality up-gradient of the septic field to assess water quality before potential influence of the septic system.

The west and south piezometers (Pz4 and Pz5) were intended to capture any impact of the septic field directly adjacent to the leach field. Installation notes are provided in Appendix D2, page D5-D9.

Figure 28. Main Club House (MCH) Piezometer install location. Pz4 – Piezometer 4; Pz5 – Piezometer 5; Blue start indicates location of active septic tanks; Orange star indicates location of old septic tanks. Refer to Table 8 for GPS coordinates.

The north piezometer (Pz3) was installed to a final depth of 20.2 feet below ground surface (bgs) (Figure 29 C) and is located above gradient of the leach field. The water table at this location was measured to be 17.9 feet bgs. This location successfully recharged after purging 250 ml. A water sample of 1.6 L collected from this location and was submitted for water chemistry analysis. Water quality measurements were also made using a handheld multiparameter meter (Ultrameter II 6P, Myron L Company, Carlsbad, Ca). Figure 31 shows an example of water sample collection from one of the Main Club house wells.

The west piezometer (Pz5) was installed to a depth of 19.3 feet bgs (Figure 32). The water table at this location was estimated to be 12.0 feet bgs. While this location did have water present during initial installation, subsequent recharge following purging was minimal. A total of 400 mLs water was purged from the well before attempting to take samples for water chemistry analysis. Unfortunately this piezometer was unable to produce water after an additional 100 mL was pumped. Recharge rate at this location was estimated to be between 10–50 mL/hour. A total of 30 mLs of therecharge water was collected and analyzed using a handheld meter. No additional water samples were collected and submitted to analytical lab for chemical analysis.

Figure 29. Installation of Pz3 and Pz4 at Main Club House, January 2017. Picture A and B show installation of piezometer (Pz) 4 whereas picture C, including blue circle and arrow show installation and location of Pz3.

Figure 30. Silty water collected from south Piezometer (Pz4) at Main Clubhouse, May 2017.

Figure 31. In field sampling from installed Pz3,May 2017.

Figure 32. Pz4 and Pz5 Installation at MCH, March 2017. Picture A and B shows initial testing of Pz5.Picture Pz4 shows driving down of additional extension at this location.

The south piezometer (Pz4) was installed to a depth of 12.4 feet bgs (Figure 29 and Figure 30). The ground hardness at this location was problematic and prevented installing the piezometer to a deeper depth without breaking the pipe couplers. The water table was measured to be approximately 12.1 feet bgs. A total volume of 30 mL was pumped from this location before the piezometer stopped

producing water. There was no recharge to the piezometer at this location after 1 hour. The volume of water collected was fairly silty (Figure 31) and was not considered for either analytic chemistry of in field water quality analysis. Field water sampling at Pz4 is shown in Figure 32.

4.2.1 Water quality and Water table results

Based on final installation depths for Pz 3–4 at the MCH system, and adjusting for the elevation of the ground surface, the water table heights appear to be 85.6 (Pz3), 87.6 (Pz5), and 87.5 (Pz4) feet above mean sea level respectively. As there is not much elevation change at this location , and all their measurements are fairly consistent between one another , adjusted water table heights appear to be fairly accurate. Water quality data (Table 10 and Table 11) for samples collected from the Main club house installed piezometers and septic tank were compared to assess if any insights could be gained relative to potential infiltration from this system into the ground water. Based on the condition of Tee 17 system, and the inability to locate the exact location of the leach field for the maintenance facility system, as well as the unsuccessful piezometer installation, and subsequent well water collection from Tee 6, this comparison could only be performed on the main club house system (See Table 3 for summary of system conditions as well as survey notes above).

Table 10. In-Field Water Quality Measurements for MCHa Location

Pzb Location	pH	Total Dissolved Solids (mg Na / L)	Conductivity (mS/cm)	Temperature (°C)	ORP (mV)
North (Pz3)	6.84	1,436	3.013	22.6	121
West (Pz5)	7.01	897.5	1.966	28.8	117
Septic Tank ww[c]	6.97	1,198	2.538	24	-210

[a] Main Club House; [b]Piezometer; [c]Wastewater

Table 11. Analytical Chemistry Results for Samples Collected from Main Clubhouse Septic System.*

Sample	COD (mg/L)	Nitrate (ppm)	Nitrite (ppm)	TKN (ppm)	TP (ppm)	TDS (mg/L)	TSS (mg/L)	VSS (mg/L)	TS (mg/L)
North (Pz3)	ND	5.06	ND	1.0	0.22	1780	ND	ND	ND
Septic Tank ww	899	ND	ND	183	8.36	1200	100	100	44.5
Potable Water	ND	0.18	ND	ND	0.14	819	ND	ND	ND

(*) Note there was not sufficient water sample from Pz5 location to be submitted for analytic chemistry; Acronyms used in table: Not detected (ND); Pz: Piezometer (Pz); waste water (ww); Chemical Oxygen Demand (COD); Total Kjeldahl Nitrogen (TKN); Total Phosphorus (TP); Total Dissolved Solids TDS); Total suspended Solids (TSS); Volatile Suspended Solids (VSS); Total Sulfide (TS).

The conductivity and total dissolved solids measurements at the piezometer wells indicate elevated levels similar to that of the septic water. However, the ORP readings indicate the groundwater is fairly aerobic and the high salt content is more likely a result of using reclaimed water and fertilizer on the golf course. The analytical lab results (Appendix B, page 2-10) appear to support this, showing signs of elevated inorganic salts in the north piezometer sample (Pz3) that serves as an indicator of groundwater quality before any influence of the septic system. The septic tank effluent

sample on the other hand is highly elevated in organic carbon, organic nitrogen, and solids typical of wastewater. The high organic carbon, nitrogen, and phosphorus for the septic effluent compared to the groundwater sample may serve as an indicator of septic contamination downstream if a more in depth assessment is desired in the future.

Future assessments of the aquifer below the leach field will most likely require additional piezometer or monitoring well installations. The depth to water table and hardness of the soils at the golf course may prevent efficient monitoring with drive-point piezometers at appropriate depths. If desired, additional piezometer installations should be performed with upgraded pipe extensions (Schedule 80) and use of a gas post driver if possible.

5. PRELIMINARY MODEL CONSIDERATIONS

A preliminary evaluation of the septic system for mathematical modeling was attempted for the main clubhouse septic system. Several mathematical models that incorporate hydraulic components and species tracking have been presented in literature (Collick et al., 2006, McCray et al., 2005). In a typical septic model, various components into the system are shown in the following figure (Figure 33).

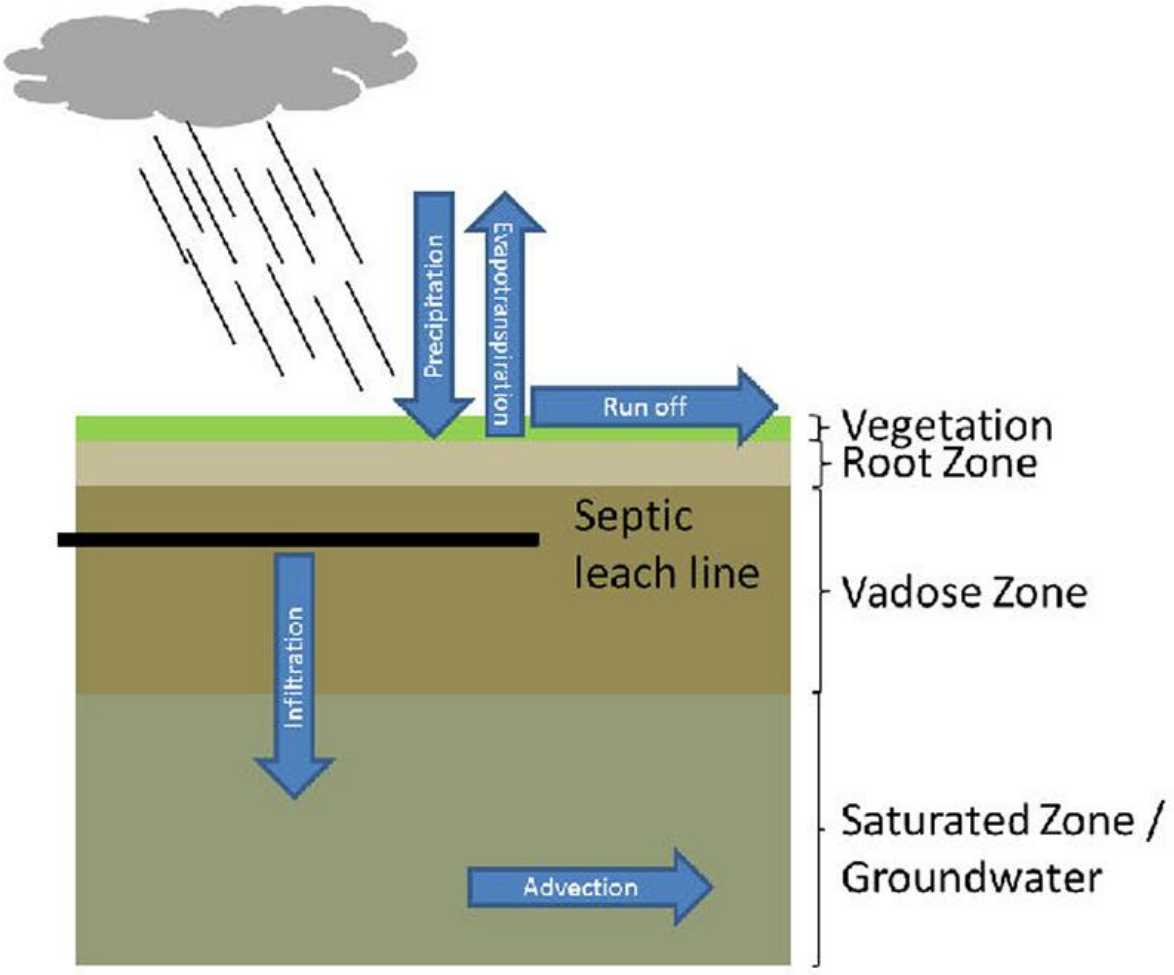

Figure 33. Hydraulic Components for a Septic Area.

5.1 HYDRAULIC COMPONENTS

A general water budget can be approximated by:

$$S = S_{t-\Delta t} + (P - E + I - Q)\Delta t (1)$$

where

S: Water in a given hydraulic unit
P: Rate of precipitation
E: Evapotranspiration rate
I: Infiltration rate from septic field
Q: Net rate of flow out of the leach field area (subsurface or runoff)
t: unit time

Defining the behavior of each of these components for modeling is fairly straightforward for several of these inputs. Existing water in the hydraulic unit is easily determined through soil moisture measurements in unsaturated zones and may be estimated by soil porosity for saturated conditions. Precipitation can be modeled using historical data and bounded by extreme events such as 10 or 100 year rainfalls (NOAA, 2011). Evapotranspiration can similarly be modeled using weather data and approximations through commercial software (Allen, Pereira, Raes, and Smith; 2006). Other model components are described in the following sections.

5.2 INFILTRATION (SEPTIC FIELD)

The amount of infiltration from the septic field could be estimated from the current pumping volume from the septic systems. Average values from bi-monthly septic system service invoicing approximate that the total generation is about 4200 gallons every two months (Appendix E, page E2-E5) or approximately 70 gallons/day. Overall this amount appears to be fairly low for a facility of this size and service volume. Alternatively, wastewater loading for a septic system can also be estimated based on design flows provided in literature. Guest and employee head counts were approximated based on unofficial tallies provided by the MCMGC staff (Appendix E, Page E5).Based on analysis of provided counts for both the golfers and restaurant patrons reveals what both a busy season (March – September) and slow season (October – February) for the golf course facilities looks like. Total calculated design flows for these two seasons are 1364 gallons/day and 993 gallons/day for the busy and slow season respectively (Table 12).

Table 12. Estimated Wastewater Design Flows Based on Patron Counts.*

Wastewater Source *(Category)*	Per Capita Design Flow (gallons / day)	Slow Season Daily Flow (gallons / day)	Busy Season Daily Flow (gallons / day)
Mulligan's *(Restaurant - Short order)*	6	426	522
Catering *(Restaurant – Conventional)*	9	117	207
Golf Round *(Visitor's Center)*	5	450	635
Employees *(Avg 20 / day)*	10	150	150
	Total	**993**	**1364**

*Per capita design flow adopted from Tables 3–4 and 3–6 of the USEPA Onsite Wastewater Treatment Systems Manual (USEPA, 2002)

The discrepancy between design flow and the flow derived from system service logs are fairly large, differing by orders of magnitude. It is not likely that the facilities only generates 70 gallons/day in wastewater, although wastewater flows may not be as high as predicted by head counts. Future studies should include a separation of potable water used for irrigation verses wastewater flows. Water meters at distribution points for irrigation and at point-of-use at the Main Clubhouse would be able to give data to support the fate of potable water consumed at the golf course.

5.2.1 Percolation Rate

The approximate area of each given leach field was estimated based on the ground penetrating radar survey results for each of the 4 different sites. Table 4–Table 7 provide measured GPS coordinates for each of 5 septic systems, while Figure 15, Figure 17, Figure 20 and Figure 21 show bounding parameters for each leach field based on survey results. Each leach field location was then entered into mapping software (Google Earth Pro 7.3, Google Inc., Mountain View, CA) and areas were estimated using a polygon tool to surround leach lines observed during ground penetrating radar detection (Table 13).

Table 13 Estimates of Leach Field Area and Capacities.*

Septic Field	Leach Field Area Estimate (m^2)	Estimated Flow Capacity (gallons / hr)
Tee 6	132	26.6–52.4
Main Clubhouse	850	171–337
Tee 17	41.2	8.29–16.4

* Note, area was not estimated for maintenance facility septic field as collection of GPR data at this location was not feasible due to high soil moisture content.

Table 14. Percolation Rates Estimated from Recharge Pond North of Golf Course.

Rain Event	Soil Percolation Rate (in/hr)
February 2017	0.0592
March 2017	0.0300

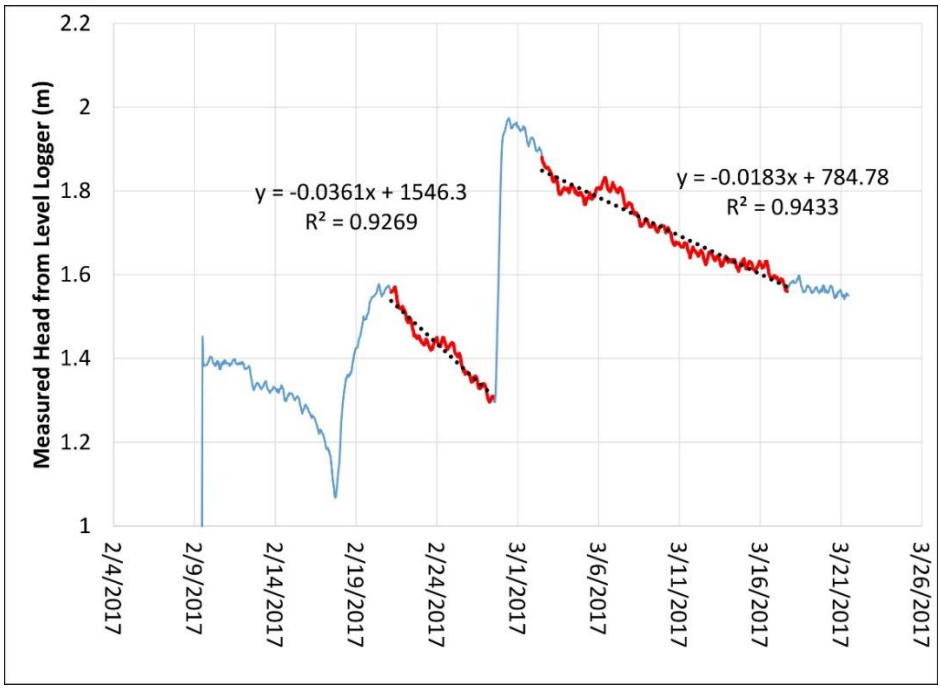

Figure 34. Measured level during flood events in 2017 to estimate percolation rates at the Stormwater Recharge Pond (SWRP), located at north end of golf course.

Percolation rates through the soil for this preliminary model were approximated using field data collected from level loggers installed at ground level within the SWRP (Figure 27). These areas were flooded during several rain events and data collected was then used to estimate percolation (Figure 34–Figure 36 and Table 14). Using these generated rates requires the assumption that the soil conditions in the area are similar both laterally and vertically within Windmill Canyon. In future studies, the actual infiltration rate dependence on depth at each septic site would need to be verified.

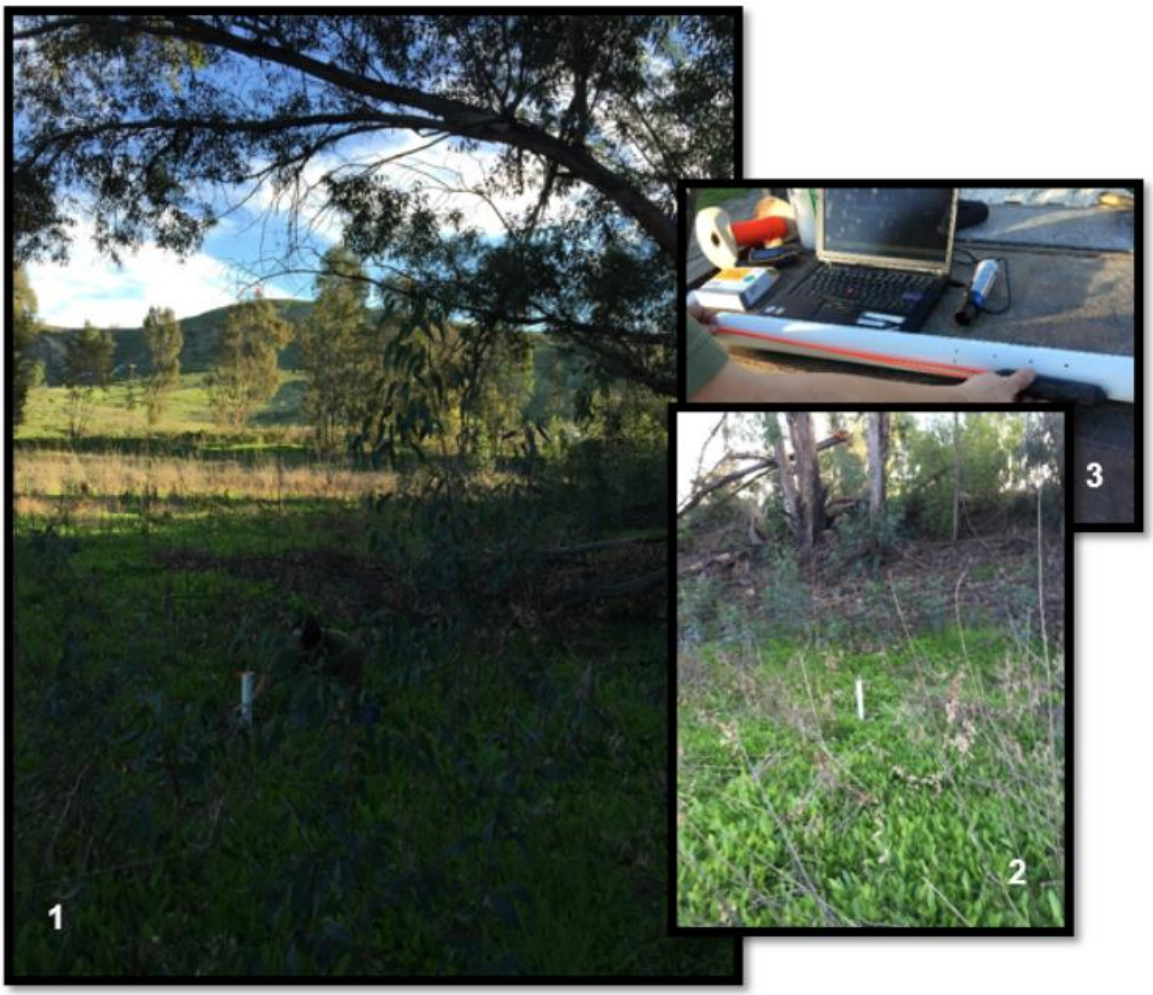

Figure 35. Installation of Percolation Sensor at SWRP. Location of install and appearance (1 and 2). Sensor and perforated PVC pipe (3) which was inserted into ground ~ 3 feet. See Sorensen et al., for full methods description.

Figure 36. SWRP, north end of golf course Post Storm Event; 20 January 2017. East and west end of pond shown in 1 and 2.

Figure 37. Flooding on golf course during Storm Event (January 2017). Top two pictures show flowing around Tee 6, flowing directly past the leach field. Bottom picture of center of golf course in between Maintenance Shed system and Tee 6 System. Pictures were taken and provided by MCMGC Staff.

Using the collected field data the capacity of the leach field was calculated based on estimated leach field area multiplied by the soil percolation rate (Table 13). For example, the main leach field would be expected to have a maximum capacity of 337 gallons per hour. The capacity of the main leach field is 5.9 times the design flow of the facility, so there would be no reason to expect failure

due to volumetric flow rates. On the other hand, the other septic fields are quite a bit smaller and have significantly less capacity than the main field. If the actual flows exceed the field capacity (due to special events, storm events, or other extreme circumstances), accumulation at the leach lines would be expected to occur. Figure 36 and 37 show examples of recent "extreme" circumstances. This would result in lateral spreading of the septic leachate that would extend the area of percolation and septic attenuation. At especially high flows, migration of the leachate towards the surface would be expected. Sustained high flow rates would be expected to result in system failure noted by daylighting leachate.

5.3 CHEMICAL SPECIES MODEL COMPONENTS

Specific species may also be tracked through a mass balance around the septic system area. As a preliminary modeling setup, we will assume dry weather and that the leach field is sufficiently below grade so that evapotranspiration will not be a factor. Furthermore, it has been shown that in septic systems vertical flux is generally much greater than lateral flux (Collick et al., 2006) so we will only consider the vertical direction. These simplifications reduce species reaction and transport to Equation 2 at steady state

$$0 = KAC|_{z-\Delta z} - KAC|_z + rA\Delta z \quad (2)$$

where

C: species concentration
A: cross-sectional flux area
z: vertical position
K: percolation rate
r: net species reaction rate

In developing a model for nitrate, the point of the leach field lines would be set to a boundary condition (z = 0). At this point, the nitrate flux would be a component of both the vertical percolation and input from the septic system. For septic systems, the vadose zone is where most of the wastewater nitrogen is assumed to be mineralized (transformed from ammonia to nitrite, nitrate, and finally to nitrogen gas) through nitrification and subsequent denitrification reactions (Holden and Fierer, 2005). A review of modeling papers suggests that both nitrification and denitrification could be modeled through first order chemical reactions (McCray et al., 2005). Nitrification rate constants were reported to range from 0.0768 to 211.2 (per day), while denitrification rate constants were reported to range from 0.004 to 2.27 (per day). While generally accepted that denitrification is orders of magnitude slower than nitrification, the large ranges of reported modeling constants indicate that the processed may not be well understood in the vadose zone and may be highly site specific.

Modeling results from a finite difference solution are shown in Figure 38. For this solution, we use the design loading of 337 gallons per hour. The initial values of nitrogen loading are taken from the sampling results of the septic effluent collected during this effort. Kinetic rate constants that were used were the lowest in the reported range (0.0768 and 0.004 for nitrification and denitrification, respectively) in order to show conservative results. The results show rapid ammonia removal followed by nitrate removal within 1.5 ft of the septic leach lines. During heavier usage periods, the depth required for nitrate removal would be expected to increase due to the increased rate of vertical movement through the soil.

Phosphorus reaction and transport can be modeled in a similar fashion. However, phosphorus is generally considered to be rapidly removed due to precipitation with soluble iron or aluminum and sorption to soil particles (Zaninia et al., 1998; McCray et al., 2005). These have also been modeled in literature with varying degrees of success.

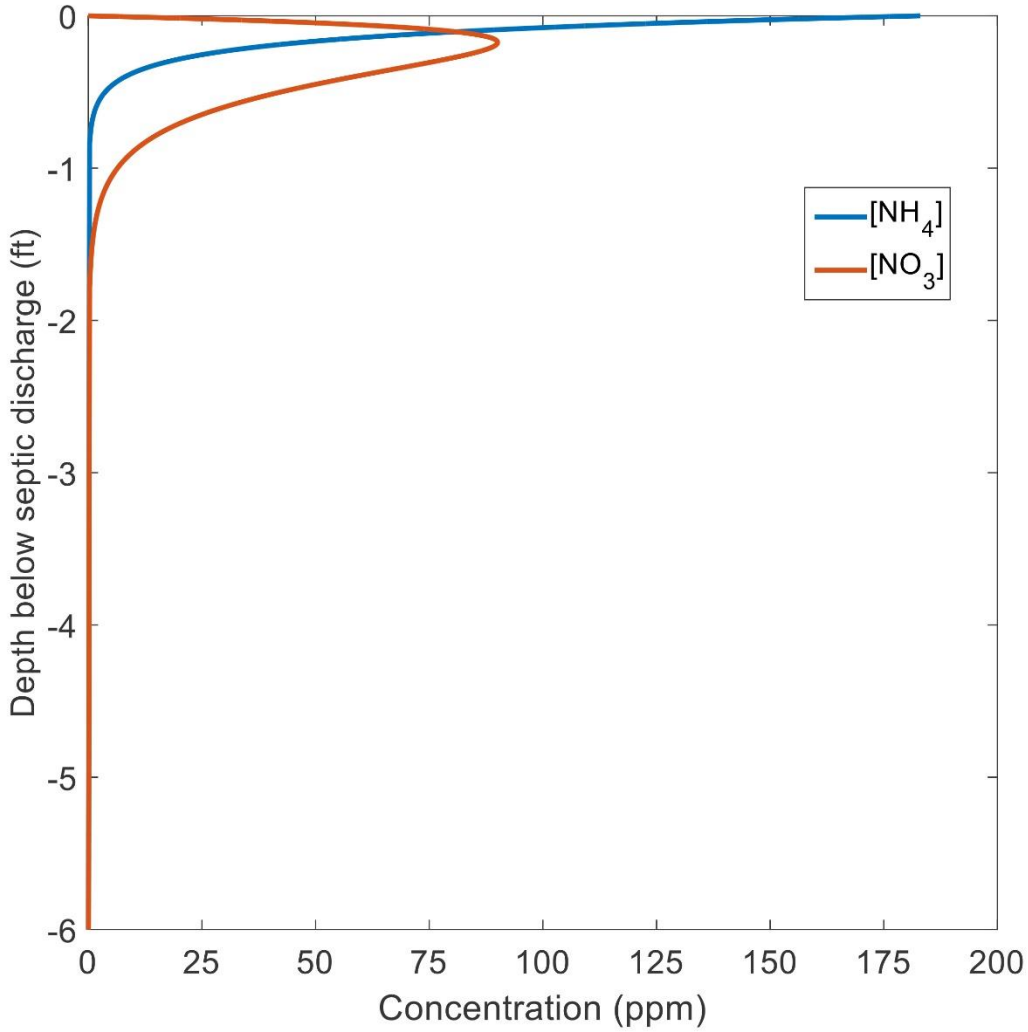

Figure 38. Results showing nitrogen species removal with distance from leach lines.

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6. CONCLUSIONS

This project was able to collect enough data to provide status and verify locations of most of the septic systems at Windmill Canyon. A total of four septic systems were identified as in-use and were identified by proximity to the following locations: Tee 6, Maintenance Shed, Main Clubhouse, and Tee 17. All systems were connected to active facilities and receiving wastewater as of this report. Note, while we were able to approximate general direction of flow from main line to leach field for the Maintenance Shed system, we were unable to identify the boundaries of the leach field. Again, this was due to the high soil moisture levels at this location. While the MCMGC staff did stop irrigation in this area as best they could, prior to the GPR survey, the potential to completely dry out this problematic based on proximity to the golf course greens. Review of current service contract reports (Appendix E, page E2-E5) and correspondence with MCBCP and MCMGC staff indicate that 3 of the 4 locations (e.g. Maintenance Shed, Main Clubhouse, and Tee 17) are currently being pumped on a bi-monthly basis. It was not clear if the Tee 6 system was also on a regular pump-out schedule. Except for during extreme conditions, as described above, based on this information alone, it is highly unlikely that any of the leachate from the 3 systems being pumped, is actually reaching their corresponding leach fields. In order to monitor the true effects of the septic system under normal operation and its potential risk to the water table, pumping would need to be temporarily stopped so that effluent could flow freely to the leach fields. This could help verify any anecdotal ponding or daylighting and give a more accurate assessment of effects on downstream groundwater quality.

During a utilities evaluation, the Tee 6 and Main Clubhouse systems were shown to have minimal to no issues with connection from the septic tank to the leach field. However, the Maintenance Shed tank connection to the septic field contained too many vertical and lateral bends to be able to completely evaluate this system. The lengths of pipe for this system which we were able to inspect with a cable mounted camera, appeared to be in good condition. The Tee 17 septic system, on the other hand, had the most serious issue; the pipe from the main septic tank appeared to have become dislodged and offset due to settling. This will prevent the septic system from draining properly to the installed leach field. There also appeared to be a lot of potential vehicular traffic that could occur on all components of the septic system at this location. This too would result in substantial failure issues for this system.

Ground penetrating radar was also able to identify the leach field line locations for all systems except the Maintenance Shed system. Depth of the fields was estimated for Tee 6 and the Main Clubhouse locations to be approximately 5–6 feet below ground surface. The septic field at the Maintenance Shed was not able to be evaluated due to depth and water content of the soil in the vicinity of the Maintenance Shed.

Water samples were successfully collected from the Main Clubhouse location. Indications of elevated nitrogen were seen in the samples taken upstream of the leach field, possibly due to fertilizer and the use of recycled water in this area. Downstream water quality measurements indicate the water table at the septic field periphery is largely unaffected by the septic field with dissolved solids, ORP, and pH levels that are typical of aerobic groundwater in the area.

Modeling equations and parameters are presented in this report to support implementation into future GIS model scenarios. Organic loading and phosphorous are considered to be quickly attenuated in the subsurface (USEPA, 2002; McCray et al., 2005). Similarly, suspended solids and coliform bacteria are typically not seen in areas more than 5 feet below from installed septic fields (Washington Department Of Health, 1990; USEPA, 2002). Thus, nitrogen contamination and hydraulic failure should be considered to be the primary concerns when evaluating the systems with

future models. Hydraulic loading and chemical species equations were presented here along with typical ranges for nitrogen processes typically used to track septic system contamination of water systems.

A few main concerns that may warrant further evaluation in future studies. Wastewater generation rates were estimated based on the septic service pump out volumes and head counts provided by MCMGC staff. The volumes suggested by the pump out service logs appear to be largely underestimated for a system servicing a facility with the attendance and size of the golf course. Design flows calculated from the head counts may be conservative for the area. A more directed effort to understand water usage at each of the field locations may be warranted if an accurate breakdown of flow at each location is desired. The main clubhouse field is well equipped to handle the current volume of customers and employees. On the other hand, estimates of the Tee 17 and Tee 6 capacities are quite low and may explain reports of daylighting by MCMGC staff. Without site specific water usage or head counts, it is not clear how often system failure would occur.

Current onsite septic tank regulations in San Diego County require a minimum distance between septic system components and potential water bodies that could lead to contamination. This setback is required to be a minimum of 5 feet at all times (including high water table heights due to wet weather). The criteria appears to be met for all the systems in Windmill Canyon, however the water table and leach field lines would likely be very close to that minimum distance. Further study is suggested in the future to monitor the water table at this site, especially if increased watering is implemented or water features installed in the area.

Future work to refine the model may be warranted since kinetic parameters and leach field rates were sourced from design calculations and published literature. Ideally, accurate metering of potable water use for each facility could give a more accurate measurement of wastewater loading at each facility. Other efforts should include additional studies to determine accurate, site-specific kinetic parameters for removal and percolation rate in addition to monitoring for model validation.

6.1 SUMMARY OF FOLLOWING EFFORT RECOMMENDATIONS

Based on the information discussed above a brief recap of recommendation and level of importance is provided in below.

Table 15. Follow up Recommendations, Including Level of Importance.

No.	Recommendation	Specific System/Overall Canyon	Level of Importance	Caveat/Comment
1	Repair Tee 17- connect tank to leach field, block vehicular traffic from crossing system boundaries	Tee 17	High	Currently system is not operational, there is no connection from tanks to leach field- and unclear condition of leach field lines
2	Halt bi–monthly pumping to validate no effect on downstream ground water	Overall Canyon	Medium	Piezometers are only at MCH system. Monitoring station as at other systems would be required and some locations extremely difficult for hand-installation of piezometers.
3	Reinstallation of piezometers Pz4 and Pz5 at MCH for possibility of better recharge for sampling	MCH	Medium - Low	
4	Installation of monitoring stations at Tee 6 and Tee 17	Tee 6 ; Tee 17	Medium	Ground hardness prevented successful installation of piezometers by hand. Recommend mechanical driving or installation if possible.
5	Installation of potable water metering at usage locations	Overall CYN	Medium - Low	This would give better granularity and awareness of water use at the site to inform conservation efforts and future modeling.

Table 15. Follow up Recommendations, Including Level of Importance. (Continued)

No.	Recommendation	Specific System/Overall Canyon	Level of Importance	Caveat/Comment
7	Additional modeling for septic flow and incorporation into larger hydraulic model	Overall Cyn	Medium	Integration of nutrient assimilation with 2D or 3D models could give potential plume areas and sizes.
8	Reassess maintenance leach field, possibly by mechanical excavation or addition of additional access point on the golf course	MF	Medium-High	Anecdotally, this was an area with ponding and daylighting issues. GPR technician was able to get close to the start of the leach field, but unable to proceed. Low cost start may be to put an access port on the edge of the play area so additional camera assessment could occur.
9	Investigate water flow in concrete basin near MCH during dry season	MCH	Low	Water flow was observed in piping and concrete basing near the leach field of the main clubhouse. Since piping was not connected to septic system, this steady water may indicate water leak in the irrigation system. Discovering the source or location of leak may be difficult to do since no above-ground evidence of leak or breakage was observed.

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APPENDIX A
GROUND PENETRATING RADAR TECHNICIAN REPORTS

OVERVIEW

Items included in this section are:

1. Contractor inspection reports A-2–A-3
2. Technology description brochures A-4–A-5
3.Hand written field notes, SSC PAC Staff A-6–A-11

CONTRACTOR INSPECTION REPORTS

EXAMPLES:

Cable Pipe & Leak Detection
UNDERGROUND DETECTION SERVICES

1483 N. Second, Suite 201
El Cajon, CA 92021
619-873-1530
http://www.cpldetection.com/

Invoice

September 28, 2016
Invoice #: 31413-973343
Tech: RM
Due Date: 10/20/2016
Job Date: 9/28/2016

Bill To:
SPAWAR SC PACIFIC CODE 71760
53560 HULL STREET
SAN DIEGO, CA 92152

Job Name:
CAMP PENDLETON GOLF COURSE
18415 MAINSIDE
CAMP PENDLETON, CA 92055

619-553-4934 619-553-4934 510-435-7345

Item Code	Description	Hrs/Qty	Price	Amount
	9/16/2016 FRI 9:54 AM> Melissa: RM WILL NEED LONGEST CAMERA WE HAVE 9/22/16 8AM COTW 510-435-7345 9/21/2016 WED 9:51 AM> Melissa: R/S FOR 9/28/16 MC TO SPEAK W/RM 9/27/2016 TUE 3:51 PM> donna: LEWIS CALLED TO CONFIRM 510-435-7345			
	Traced and marked sewer from septic tank in front of the maintenance building to approximately 60' to a section that was blocked with roots. Could not locate the leach field due to the depth and conductivity of the soil. Also marked the leach field from the club house septic tank. This field was located with GPR only because camera access was restricted. The old septic lines in this area were also located and it appears to have water leaking into the pipe, possibly from the irrigation system. Met Lewis on site ****8:00-12:30****			
9/28/2016	GPR	4.50	250.00	1125.00

Labor	Subtotal	Total
1125.00	1125.00	$1,125.00

Cable, Pipe & Leak Detection, Inc. agrees to perform the service indicated in a proper and professional manner, using equipment standard or this type of service, to the best of our ability. Customer understands that CPL makes no warranties and or guarantees expressed or implied and that no consequential damages will be recoverable by reason of the work performed hereunder. In the event we are locating underground utilities, customer fully acknowledges that some utilities are simply "UNTRACEABLE" and we shall not be liable for any losses or damages due to undetected utilities.

Cable, Pipe & Leak Detection does not do repairs. Manifolds/Water lines are estimates. Lines must be cut, capped and tested before any type of reroute is performed. Customer understands that line locating/leak detection is NOT an exact science, this includes all types of leak detection, water lines and utility lines. Return trips may be needed at the specified charges, per leak/trip.

In the event that mold is discovered, customer has been advised (A) of the presence of mold, and the need to address the problem; and or (B) that in the process of opening walls unforeseen mold may be exposed. Customer authorizes CPL to continue work and assumes all responsibility.

Customer agrees that they have read and fully understand the terms and conditions of this agreement, and that the customer has executed this agreement voluntarily. CPL must be notified immediately of any discrepancies with service performed.

Past due accounts will be charged 1 1/2% per month, annual percentage rate of 18% on the unpaid balances according to above stated terms.

Terms: Net 30 Signature _____ Date _____

THANK YOU FOR YOUR BUSINESS

Cable Pipe & Leak Detection
UNDERGROUND DETECTION SERVICES

1483 N. Second, Suite 201
El Cajon, CA 92021
619-873-1530
http://www.cpldetection.com/

Invoice

September 6, 2016
Summary: UTILITIES
Invoice #: 31413-972842
Tech: RM
Due Date: 10/7/2016
Job Date: 9/6/2016

Bill To:
SPAWAR SC PACIFIC CODE 71760
53560 HULL STREET
SAN DIEGO, CA 92152

Job Name:
CAMP PENDLETON GOLF COURSE
18415 MAINSIDE
CAMP PENDLETON, CA 92055

619-553-4934 619-553-4934 510-435-7345

Item Code	Description	Hrs/Qty	Price	Amount
	8/29/2016 MON 1:31 PM> Melissa: RM ONLY SPK W/CUSTOMER REGARDING LOCATING 9/6/16 8AM COTW 510-435-7345			
	Restroom 18411: scanned area and marked possible leach field with GPR. Also used camera to mark the main line from the septic tank to where it made a 90 degree turn to the field. The mark out matched the map provided by base facilities. Maintenance building 18412: attempted to locate leach field and main lines, but the GPR was ineffective possibly due to the area being scanned is watered daily because it is part of the golf course. An attempt was made to camera the main line, but it got stuck at approximately 20 feet out at a "t". Customer was advised that a larger camera may be used to locate more of the pipe on a later date. Restroom #2: Could only be scanned with radar because there was an offset joint right after the pipe exits the septic tank. Possible leach field was marked, but was unable to verify due to limitations with camera.			
9/6/2016	GPR	6.50	250.00	1625.00

Labor	Subtotal	Total
1625.00	1625.00	$1,625.00

Cable, Pipe & Leak Detection, Inc. agrees to perform the service indicated in a proper and professional manner, using equipment standard or this type of service, to the best of our ability. Customer understands that CPL makes no warranties and or guarantees expressed or implied and that no consequential damages will be recoverable by reason of the work performed hereunder. In the event we are locating underground utilities, customer fully acknowledges that some utilities are simply "UNTRACEABLE" and we shall not be liable for any losses or damages due to undetected utilities.

Cable, Pipe & Leak Detection does not do repairs. Manifolds/Water lines are estimates. Lines must be cut, capped and tested before any type of reroute is performed. Customer understands that line locating/leak detection is NOT an exact science, this includes all types of leak detection, water lines and utility lines. Return trips may be needed at the specified charges, per leak/trip.

In the event that mold is discovered, customer has been advised (A) of the presence of mold, and the need to address the problem; and or (B) that in the process of opening walls unforeseen mold may be exposed. Customer authorizes CPL to continue work and assumes all responsibility.

Customer agrees that they have read and fully understand the terms and conditions of this agreement, and that the customer has executed this agreement voluntarily. CPL must be notified immediately of any discrepancies with service performed.

Past due accounts will be charged 1 1/2% per month, annual percentage rate of 18% on the unpaid balances according to above stated terms.

TECHNOLOGY DESCRIPTION BROCHURES

EXAMPLE:

Locate Underground Utilities with Ground Penetrating Radar

UtilityScan® with SIR® 4000

www.geophysical.com

The ever-popular UtilityScan® system is now available with the newly designed SIR® 4000 control unit. UtilityScan is the industry standard ground penetrating radar solution for the designation of subsurface utilities.

With UtilityScan, users can quickly identify and mark the location and depth of service utilities – gas, communications, sewer lines – and other metallic and non-metallic targets including underground storage tanks and PVC pipes. It is also ideal for environmental assessment, shallow subsurface geophysics, archaeology and forensic applications.

4-wheel cart shown

1 SIR® 4000 control unit
2 Interior, capsule-protected GPR antenna
3 Survey wheel
4 Ergonomic handle with flexible mount
5 Rugged cart

Designate Targets

- Real-time data collection and processing
- Multiple techniques to calculate depth of targets

Flexible Design

- Easy to transport and deploy
- Several deployment options for in-field accessibility
- WiFi, USB or Ethernet file transfer

Integrated System

- Windows® 8 based user interface
- Ruggedized, high-resolution 10.4 inch LED display
- Plug-and-play GPS

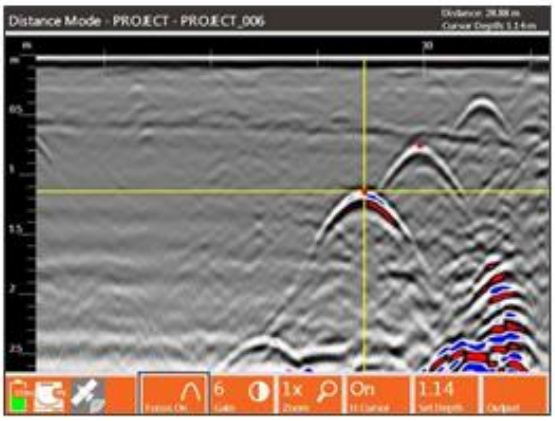
GSSI

"GSSI UtilityScan GPR is easy to use, lasts a long time and works well."

Patrick Moulin, GPRS Atlanta

Utility Locating Solutions

The SIR® 4000 comes with a new user interface offering a better user experience. The startup screen is very simple to navigate, users can launch application-specific modules, last used settings, start new projects or playback data from previous projects.



Designate the location of metallic and non-metallic pipes and other subsurface features in real time using the GSSI UtilityScan. The SIR 4000 offers users the ability to change display gain and filters in real-time while collecting data. Additionally, users can change the scale, add reference marks and personalize the color display for better data interpretation.

Control Unit Specifications

Data Storage	32 GB
Display	Enhanced 10.4" LED display
GPS	Data logged internally
Data Format	RADAN™ (.dzt)
Operating Temperature	-20°C to 40°C external (-4°F to 104°F)
Battery	Inspired Energy Ni2040ED, 3 hour runtime*
Ports	Antenna inputs analog and digital (one at a time), DC power input, Serial RS232 (GPS port), Accessory connector, HDMI video output, Ethernet to PC, USB 2.0 port, mini USB
Environmental	IP-65

*battery life dependent on level of display brightness

System Includes

- SIR® 4000 control unit
- 400 MHz or 270 MHz antenna
- Choice of cart options
- 2 meter control cable
- 2 batteries
- Battery charger
- Sunshade
- SIR® 4000 transit case
- AC adapter
- UtilityScan Quick Start Guide
- 2-year warranty

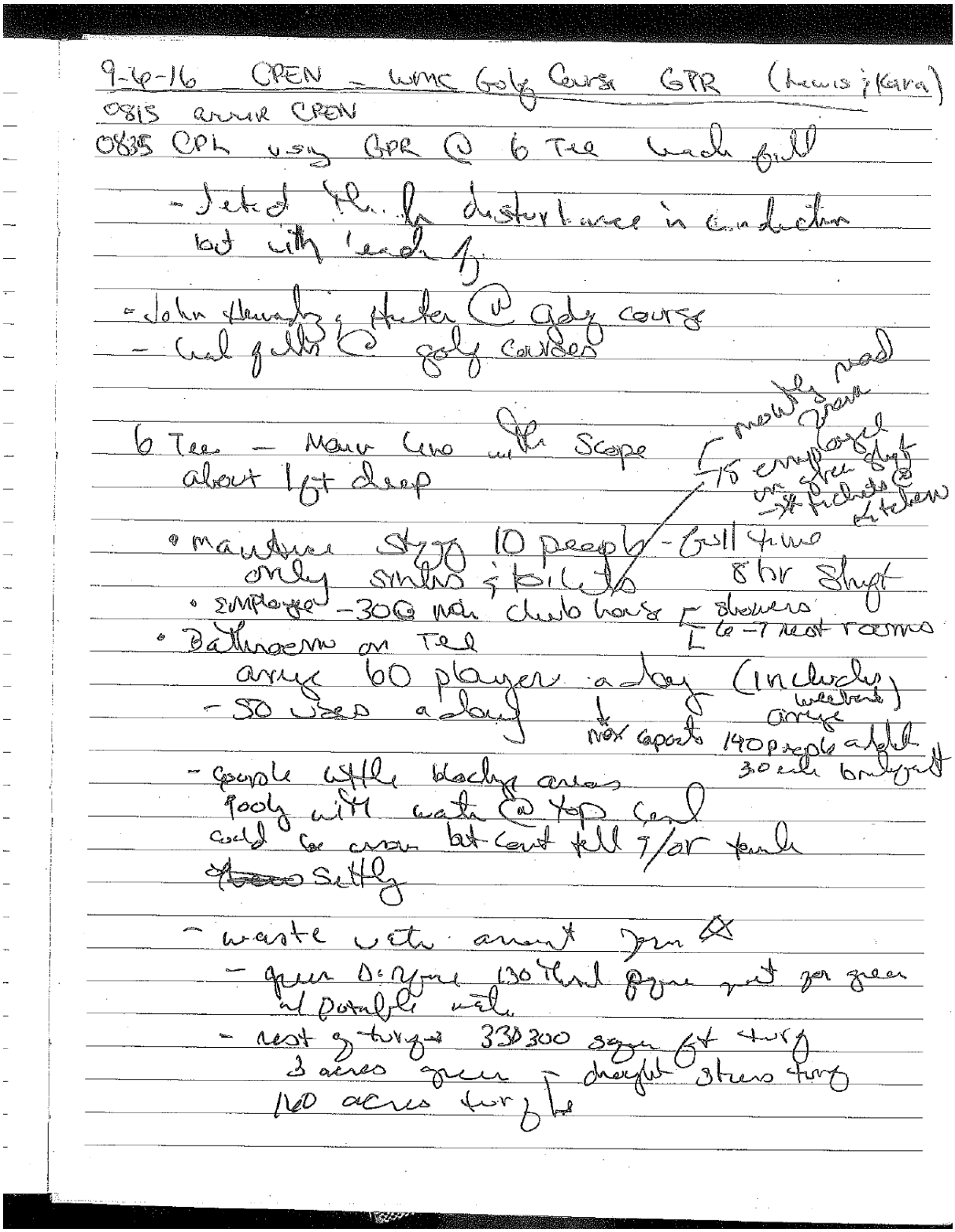
CE and FCC Compliant

sales@geophysical.com

12 Industrial Way • Salem, NH 03079-2837
Tel: 603.893.1109 • Toll Free: 800.524.3011 • Fax: 603.889.3984

HAND WRITTEN FIELD NOTES, SSC PAC STAFF

EXAMPLE:



9-6-16 CPEN - WMC Golf Course GPR (Lewis & Kara)
0815 arrive CPEN
0835 CPN using GPR @ 6 Tee back fill
- Noted high disturbance in conductivity but with 'weak' signal
- John Thomas & Hunter @ golf course
- Met Faith @ golf course

6 Tee - Mark Line with Scope
about 1ft deep

- maintenance staff 10 people - full time only summers part time
- employee - 300 min club house
- Bathrooms on Tee
- 75 employees mostly male
- 8 hr shift
- showers & 6-7 rest rooms
- area 60 players a day (including weekends)
- 50 used a day
- not capacity
- area 140 people a day with 30 with banquet
- people with blocky areas
pooly with water @ top end
could be areas but can't tell 1/or tank
~~Hard~~ Softly
- waste water amount from
- green D: from 130 Need from west for green
- Potable water
- rest of turf 33,300 sqft of turf
3 acres green - drought stress turf
160 acres turf

Started – main line ~ 100 ft gray with
water → I also grew feet
and as with all feet

Small bathroom – 17 ft
from here
looks like pipe separated – can't get
scope down. can only
get push down about 20 ft
– took few pictures on scope
camera screen

but not sure
tree or blockage

– was able to map out some lines
not 100% sure cuz can't get scope
down

- Richard will send us brief write up
of 3 holes we looked at

- need to reschedule for main line
& redo @ manhole shed
- as well as bring thumb out
with us as well to get altitude
- also need to call John & ask
him ~ well in advance to turn
off water @ manhole (lead
found

9-28-16 CPEN Lead Field - GPR DAY 2

Lewis, Kara

CPL contractor : Richard

Start time: 0810 @ Maintain step system
- using longer scope / lead line

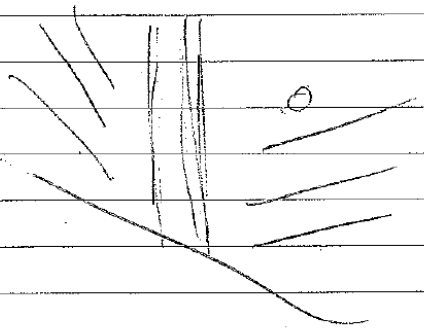
Spike to 60m - getting what data still on
Radar but get to get from on
Variation will ~~take~~ be back next
week -

@ First 90 start all soggy up
& put straight shot
- and/or install clean out

- Try foot pedal style first
90° so will ~~then~~

- Depth ~~about~~ immediately drops to 5ft
& below

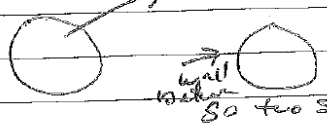
- can't see anything but looks like
Line Starts @ the plant



9-28-16

Part 2

Start @ Man Sykes about 9:40 AM



looks like line goes out w/ two purges
Can see into really well light
depth about 3ft
Look like set out from left
sperm down left

- Discussed w/ Kyle
bacteria amalgin in sham vials/
Mercury - discussed also
spray dad vials

Tech showed up Saw not
filled just a 2ft Core &
Clint's Metal plate

4 lines → good visibly
depth about 3ft
- get lat/lon, depth shot
- pictures

- 1220 complete

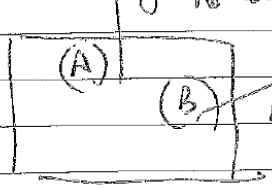
9-28-16

Page 3

(3) old tank - no longer connected but does leak (like they) irrigation leak potentially 45° into old system

33' 16.16gpm
11' 19.65gpm

small probably under tolerance



- so irrigation from (A) mixing w/ (B) tank in (B) now flow toward field ~33ft away
- doesn't look connected to backyard due to depth difference blocky @ last feather

(4) No much Hours the PIR → dry no visible under waves a Connect to the Lines are went out 5ft by Pully back

9-28-16 – GPR – Day 2 (Kara, Lewis)

(5) Note 17
collected trimble elevations & Lat/Lon readings
~1230pm + samples
- geotubes still in place

(6) Manhattan Blvd – finish
Trimble elevations/readings
finish 1300

(7) ~~Collect~~ 6th Ave
- collect elevations; Lat/Lon readings w/
trimble
Finish 1315pm

Depart OPEN

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APPENDIX B
ANALYTICAL TEST REPORTS

OVERVIEW

Items included in this section are:

1. Enviromatrix Nutrient Analysis Report B-1–B-10
2. Chain of custody …….. B-11

ENVIROMATRIX NUTRIENT ANALYSIS REPORT

EnviroMatrix Analytical, Inc.

09 June 2017

SPAWAR Systems Center Pacific
Attn: Lewis Hsu
53560 Hull Street
San Diego, CA 92152

EMA Log #: 17E0863

Project Name: Windmill Septic

Enclosed are the results of analyses for samples received by the laboratory on 05/25/17 08:03. Samples were analyzed pursuant to client request utilizing EPA or other ELAP approved methodologies. I certify that this data is in compliance both technically and for completeness.

Dan Verdon
Laboratory Director

CA ELAP Certification #: 2564

4340 Viewridge Avenue, Suite A - San Diego, California 92123 - (858) 560-7717 - Fax (858) 560-7763
Analytical Chemistry Laboratory

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Windmill Septic 1	17E0863-01	Grnd-Water	05/24/17 13:21	05/25/17 08:03
Septic	17E0863-02	Grnd-Water	05/24/17 15:30	05/25/17 08:03
FB	17E0863-03	Grnd-Water	05/24/17 16:30	05/25/17 08:03
Potable	17E0863-04	Grnd-Water	05/24/17 16:10	05/25/17 08:03

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

Conventional Chemistry Parameters by Standard/EPA Methods

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Windmill Septic 1 (17E0863-01) Grnd-Water Sampled: 05/24/17 13:21 Received: 05/25/17 08:03									
Chemical Oxygen Demand	ND	25	mg/l	1	7060222	06/02/17	06/02/17	EPA 410.4	
Nitrate as N	**5.06**	1.25	"	25	7060538	06/05/17	06/05/17	SM4500 NO3 E	W-02
Nitrite as N	ND	0.05	"	1	7052537	05/25/17	05/25/17	SM4500 NO2 B	
Total Kjeldahl Nitrogen	**1.0**	0.5	"	"	7060656	06/06/17	06/06/17	SM4500 N C	
Phosphorus, Total	**0.22**	0.05	"	"	7060210	06/02/17	06/02/17	SM4500 P B, E	
Total Dissolved Solids	**1780**	20.0	"	"	7052621	05/26/17	05/30/17	SM2540 C	
Total Suspended Solids	ND	20.0	"	"	7053088	05/30/17	05/31/17	SM2540 D	
Volatile Suspended Solids	ND	20	"	"	7053089	"	05/31/17	SM2540 E	
Total Sulfide	ND	0.05	"	"	7053129	05/29/17	05/29/17	SM4500 S D	
Septic (17E0863-02) Grnd-Water Sampled: 05/24/17 15:30 Received: 05/25/17 08:03									
Chemical Oxygen Demand	**899**	50	mg/l	2	7060222	06/02/17	06/02/17	EPA 410.4	
Nitrate as N	ND	0.05	"	1	7060538	06/05/17	06/05/17	SM4500 NO3 E	W-02
Nitrite as N	ND	0.05	"	"	7052537	05/25/17	05/25/17	SM4500 NO2 B	
Total Kjeldahl Nitrogen	**183**	12.5	"	25	7060656	06/06/17	06/06/17	SM4500 N C	
Phosphorus, Total	**8.36**	0.50	"	10	7060210	06/02/17	06/02/17	SM4500 P B, E	
Total Dissolved Solids	**1200**	20.0	"	1	7052621	05/26/17	05/30/17	SM2540 C	
Total Suspended Solids	**100**	20.0	"	"	7053088	05/30/17	05/31/17	SM2540 D	
Volatile Suspended Solids	**100**	20	"	"	7053089	"	05/31/17	SM2540 E	
Total Sulfide	**44.5**	5.00	"	100	7053129	05/29/17	05/29/17	SM4500 S D	
FB (17E0863-03) Grnd-Water Sampled: 05/24/17 16:30 Received: 05/25/17 08:03									
Chemical Oxygen Demand	ND	25	mg/l	1	7060222	06/02/17	06/02/17	EPA 410.4	
Nitrate as N	ND	0.05	"	"	7060538	06/05/17	06/05/17	SM4500 NO3 E	W-02
Nitrite as N	ND	0.05	"	"	7052537	05/25/17	05/25/17	SM4500 NO2 B	
Total Kjeldahl Nitrogen	ND	0.5	"	"	7060656	06/06/17	06/06/17	SM4500 N C	
Phosphorus, Total	ND	0.05	"	"	7060210	06/02/17	06/02/17	SM4500 P B, E	
Total Dissolved Solids	ND	20.0	"	"	7052621	05/26/17	05/30/17	SM2540 C	
Total Suspended Solids	ND	20.0	"	"	7053088	05/30/17	05/31/17	SM2540 D	
Volatile Suspended Solids	ND	20	"	"	7053089	"	05/31/17	SM2540 E	
Total Sulfide	ND	0.05	"	"	7053129	05/29/17	05/29/17	SM4500 S D	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

Conventional Chemistry Parameters by Standard/EPA Methods

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Potable (17E0863-04) Grnd-Water	**Sampled: 05/24/17 16:10**		**Received: 05/25/17 08:03**						
Chemical Oxygen Demand	ND	25	mg/l	1	7060222	06/02/17	06/02/17	EPA 410.4	
Nitrate as N	**0.18**	0.05	"	"	7060538	06/05/17	06/05/17	SM4500 NO3 E	W-02
Nitrite as N	ND	0.05	"	"	7052537	05/25/17	05/25/17	SM4500 NO2 B	
Total Kjeldahl Nitrogen	ND	0.5	"	"	7060656	06/06/17	06/06/17	SM4500 N C	
Phosphorus, Total	**0.14**	0.05	"	"	7060210	06/02/17	06/02/17	SM4500 P B, E	
Total Dissolved Solids	**819**	20.0	"	"	7052621	05/26/17	05/30/17	SM2540 C	
Total Suspended Solids	ND	20.0	"	"	7053088	05/30/17	05/31/17	SM2540 D	
Volatile Suspended Solids	ND	20	"	"	7053089	"	05/31/17	SM2540 E	
Total Sulfide	ND	0.05	"	"	7053129	05/29/17	05/29/17	SM4500 S D	

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EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

Conventional Chemistry Parameters by Standard/EPA Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 7052537										
Blank (7052537-BLK1)				Prepared & Analyzed: 05/25/17						
Nitrite as N	ND	0.05	mg/l							
LCS (7052537-BS1)				Prepared & Analyzed: 05/25/17						
Nitrite as N	0.10	0.05	mg/l	0.100		102	80-120			
LCS Dup (7052537-BSD1)				Prepared & Analyzed: 05/25/17						
Nitrite as N	0.10	0.05	mg/l	0.100		102	80-120	0	20	
Duplicate (7052537-DUP1)		**Source: 17E0827-03**		Prepared & Analyzed: 05/25/17						
Nitrite as N	ND	0.05	mg/l		ND				20	
Matrix Spike (7052537-MS1)		**Source: 17E0827-03**		Prepared & Analyzed: 05/25/17						
Nitrite as N	0.11	0.05	mg/l	0.100	ND	109	80-120			
Matrix Spike Dup (7052537-MSD1)		**Source: 17E0827-03**		Prepared & Analyzed: 05/25/17						
Nitrite as N	0.10	0.05	mg/l	0.100	ND	105	80-120	4	20	
Batch 7052621										
Blank (7052621-BLK1)				Prepared: 05/26/17 Analyzed: 05/30/17						
Total Dissolved Solids	ND	20.0	mg/l							
Duplicate (7052621-DUP1)		**Source: 17E0863-02**		Prepared: 05/26/17 Analyzed: 05/30/17						
Total Dissolved Solids	1220	20.0	mg/l		1200			2	20	
Reference (7052621-SRM1)				Prepared: 05/26/17 Analyzed: 05/30/17						
Total Dissolved Solids	280	20.0	mg/l	271		103	39-116.6			

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EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

Conventional Chemistry Parameters by Standard/EPA Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 7053088										
Blank (7053088-BLK1)				Prepared: 05/30/17 Analyzed: 05/31/17						
Total Suspended Solids	ND	20.0	mg/l							
Duplicate (7053088-DUP1)		**Source: 17E0863-02**		Prepared: 05/30/17 Analyzed: 05/31/17						
Total Suspended Solids	120	20.0	mg/l		100			18	20	
Reference (7053088-SRM1)				Prepared: 05/30/17 Analyzed: 05/31/17						
Total Suspended Solids	82.0	20.0	mg/l	100		82	77.1-110			
Batch 7053089										
Duplicate (7053089-DUP1)		**Source: 17E0863-02**		Prepared: 05/30/17 Analyzed: 05/31/17						
Volatile Suspended Solids	120	20	mg/l		100			18	20	
Batch 7053129										
Blank (7053129-BLK1)				Prepared & Analyzed: 05/29/17						
Total Sulfide	ND	0.05	mg/l							
LCS (7053129-BS1)				Prepared & Analyzed: 05/29/17						
Total Sulfide	0.20	0.05	mg/l	0.200		99	80-120			
LCS Dup (7053129-BSD1)				Prepared & Analyzed: 05/29/17						
Total Sulfide	0.20	0.05	mg/l	0.200		99	80-120	0	20	
Duplicate (7053129-DUP1)		**Source: 17E0863-04**		Prepared & Analyzed: 05/29/17						
Total Sulfide	ND	0.05	mg/l		ND				20	

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EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

Conventional Chemistry Parameters by Standard/EPA Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 7053129										
Matrix Spike (7053129-MS1)		**Source: 17E0863-04**		Prepared & Analyzed: 05/29/17						
Total Sulfide	0.23	0.05	mg/l	0.200	ND	115	80-120			
Matrix Spike Dup (7053129-MSD1)		**Source: 17E0863-04**		Prepared & Analyzed: 05/29/17						
Total Sulfide	0.23	0.05	mg/l	0.200	ND	116	80-120	0.4	20	
Batch 7060210										
Blank (7060210-BLK1)				Prepared & Analyzed: 06/02/17						
Phosphorus, Total	ND	0.05	mg/l							
LCS (7060210-BS1)				Prepared & Analyzed: 06/02/17						
Phosphorus, Total	0.51	0.05	mg/l	0.500		103	80-120			
LCS Dup (7060210-BSD1)				Prepared & Analyzed: 06/02/17						
Phosphorus, Total	0.50	0.05	mg/l	0.500		100	80-120	2	20	
Duplicate (7060210-DUP1)		**Source: 17E0803-01**		Prepared & Analyzed: 06/02/17						
Phosphorus, Total	0.10	0.05	mg/l		0.09			10	20	
Matrix Spike (7060210-MS1)		**Source: 17E0803-01**		Prepared & Analyzed: 06/02/17						
Phosphorus, Total	0.59	0.05	mg/l	0.500	0.09	100	80-120			
Matrix Spike Dup (7060210-MSD1)		**Source: 17E0803-01**		Prepared & Analyzed: 06/02/17						
Phosphorus, Total	0.59	0.05	mg/l	0.500	0.09	101	80-120	1	20	
Batch 7060222										
Blank (7060222-BLK1)				Prepared & Analyzed: 06/02/17						
Chemical Oxygen Demand	ND	25	mg/l							

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EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

Conventional Chemistry Parameters by Standard/EPA Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 7060222										
LCS (7060222-BS1)				Prepared & Analyzed: 06/02/17						
Chemical Oxygen Demand	207	25	mg/l	200		104	80-120			
LCS Dup (7060222-BSD1)				Prepared & Analyzed: 06/02/17						
Chemical Oxygen Demand	200	25	mg/l	200		100	80-120	4	20	
Duplicate (7060222-DUP1)		**Source: 17F0006-01**		Prepared & Analyzed: 06/02/17						
Chemical Oxygen Demand	ND	25	mg/l		ND				20	
Matrix Spike (7060222-MS1)		**Source: 17F0006-01**		Prepared & Analyzed: 06/02/17						
Chemical Oxygen Demand	188	25	mg/l	200	ND	94	80-120			
Matrix Spike Dup (7060222-MSD1)		**Source: 17F0006-01**		Prepared & Analyzed: 06/02/17						
Chemical Oxygen Demand	191	25	mg/l	200	ND	95	80-120	2	20	
Batch 7060538										
Blank (7060538-BLK1)				Prepared & Analyzed: 06/05/17						
Nitrate as N	ND	0.05	mg/l							
LCS (7060538-BS1)				Prepared & Analyzed: 06/05/17						
Nitrate as N	0.50	0.05	mg/l	0.500		99	80-120			
LCS Dup (7060538-BSD1)				Prepared & Analyzed: 06/05/17						
Nitrate as N	0.50	0.05	mg/l	0.500		99	80-120	0	20	
Duplicate (7060538-DUP1)		**Source: 17E0863-03**		Prepared & Analyzed: 06/05/17						
Nitrate as N	0.01	0.05	mg/l		0.02			40	20	QR-04

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EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific
Project Name: Windmill Septic

EMA Log #: 17E0863

Conventional Chemistry Parameters by Standard/EPA Methods - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 7060538										
Matrix Spike (7060538-MS1)		**Source: 17E0863-03**		Prepared & Analyzed: 06/05/17						
Nitrate as N	0.48	0.05	mg/l	0.500	0.02	93	80-120			
Matrix Spike Dup (7060538-MSD1)		**Source: 17E0863-03**		Prepared & Analyzed: 06/05/17						
Nitrate as N	0.48	0.05	mg/l	0.500	0.02	92	80-120	1	20	
Batch 7060656										
Blank (7060656-BLK1)				Prepared & Analyzed: 06/06/17						
Total Kjeldahl Nitrogen	ND	0.5	mg/l							
LCS (7060656-BS1)				Prepared & Analyzed: 06/06/17						
Total Kjeldahl Nitrogen	5.1	0.5	mg/l	5.00		101	80-120			
LCS Dup (7060656-BSD1)				Prepared & Analyzed: 06/06/17						
Total Kjeldahl Nitrogen	4.7	0.5	mg/l	5.00		94	80-120	8	20	
Duplicate (7060656-DUP1)		**Source: 17E0894-01**		Prepared & Analyzed: 06/06/17						
Total Kjeldahl Nitrogen	0.4	0.5	mg/l		0.4			11	20	
Matrix Spike (7060656-MS1)		**Source: 17E0894-01**		Prepared & Analyzed: 06/06/17						
Total Kjeldahl Nitrogen	5.0	0.5	mg/l	5.00	0.4	93	80-120			
Matrix Spike Dup (7060656-MSD1)		**Source: 17E0894-01**		Prepared & Analyzed: 06/06/17						
Total Kjeldahl Nitrogen	5.5	0.5	mg/l	5.00	0.4	102	80-120	9	20	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

EnviroMatrix Analytical, Inc.

Client Name: SPAWAR Systems Center Pacific **EMA Log #: 17E0863**
Project Name: Windmill Septic

Notes and Definitions

W-02	The sample for nitrate analysis was preserved with H2SO4 after the nitrite portion of the analysis was completed to extend the holding time for the sample. Nitrate results are corrected for the nitrite contribution per the method.
QR-04	The RPD between the sample and sample duplicate is not valid since both results are below the reporting limit for this analyte.
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

EnviroMatrix Analytical, Inc.

17E0963

CHAIN-OF-CUSTODY RECORD

– EnviroMatrix Analytical, Inc. —
4340 Viewridge Ave., Ste. A - San Diego, CA 92123 - Phone (858) 560-7717 - Fax (858) 560-7763

EMA LOG #:

Client: SPAWAR System Center Pacific
Attn: LEWIS HSU, KARA SORENSEN
Samplers(s): L. HSU ; J. GUERRERO
Address: 53560 HULL ST
SAN DIEGO CA 92126
Phone: 619-553-4934 Fax:
Email: LEWISHSU@SPAWAR.NAVY.MIL / KARA.SORENSEN1@NAVY.MIL
Billing Address:
Project ID: Windmill Septic
Project #: PO #:

Requested Analysis

ID #	Client Sample ID	Sample Date	Sample Time	Sample Matrix	Container # / Type	Oil & Grease □ 413.1 □ 413.2 □ 1664	8015 (TPH) □ Gas □ Diesel □ Ext	624/8260 (VOC) Full BTXE MTBE Oxy Nap	625 / 8270 (SVOC) □ PAH only	608 / 8081 (Organochlorine Pesticides)	608 / 8082 (Polychlorinated Biphenyls)	8141 (Organophosphorus Pesticides)	TBT (Organotin Compounds)	□ pH □ EC X TSS X TDS	X Nitrate X Nitrite X TKN □ NH3	CAC Title 22/CAM17 Metals □ TTLC □ STLC	TCLP (RCRA) □ Metals □ Organics	Cd Cr Cu Pb Ni Ag Zn □ Dissolved	Coliform, □ Total (MTF) □ Fecal (MTF)	Coilert, T+E.Coli □ P/A □ Enumeration	Enterococcus, □ MTF □ Enterolert	Heterotrophic Plate Count (HPC)	□ BOD X COD □ Cyanide	Total phosphate as P	Total Sulfide	Total Volatile Suspended Solids		
1	Windmill Septic 1	5/24	1321	GW	3									X	X								X	X	X	X		
2	Septic	5/24	1530	WW	3									X	X								X	X	X	X		
3	FB	5/24	1630	GW	3									X	X								X	X	X	X		
4	Potable	5/24	1610	DW	3									X	X								X	X	X	X		
5																												
6																												
7																												
8																												
9																												
10																												

Matrix Codes: A = Air, DW = Drinking Water, GW = Groundwater, SW = Storm Water
WW = Wastewater, S = Soil, SED = Sediment, SD = Solid, T = Tissue, O = Oil, L = Liquid
Shipped By: □ Courier □ UPS □ FedEx □ USPS X Client Drop Off □ Other
[1]Turn-Around-Time: □ Same Day □ 1 day □ 2 day □ 3 day □ 4 day □ 5 day X STD (7 day)
[1]Reporting Requirements: □ Fax X PDF X Excel □ Geotracker/EDF □ Hard Copy □ EDT
[1]Sample Disposal: X By Laboratory □ [2]Return to Client: P/U or Delivery □ Archive

Sample Integrity

Correct Containers: Yes No N/A
Containers Properly Preserved: Yes No N/A
Custody Seals Intact: Yes No N/A
Temp @ Receipt: 10°C on ice
COC/Labels Agree: Yes No N/A
Sampled By: Client EMA Autosampler

RELINQUISHED BY	DATE/TIME	RECEIVED BY
Signature: [signature]	5/25/17 9:03	Signature: [signature]
Print: Lewis Hsu		Print: mika mayer
Company: SPAWAR		Company: EMA
Signature:		Signature:
Print:		Print:
Company:		Company:
Signature:		Signature:
Print:		Print:
Company:		Company:

Project/Sample Comments:

[1]Additional costs may apply. Please note there is a $35 minimum charge for all clients.
[2]EMA reserves the right to return any samples that do not match our waste profile.
NOTE: By relinquishing samples to EMA, Inc., client agrees to pay for the services requested on this COC form and any additional analyses performed on this project. Payment for services is due within 30 days from date of invoice. Samples will be disposed of 7 days after report has been finalized unless otherwise noted. All work is subject to EMA's terms and conditions.

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APPENDIX C
DRAWINGS PROVIDED BY MCBCP FACILITIES AND OTHER HISTORIC SYSTEM INFORMATION

OVERVIEW

Items included in this section are:

1. CATEX (Categorical Exclusion) C-2–C-13
2. Golf Course Map.....C-14
3. Septic System Evaluation Memo C-15–C-18
4. Septic system infrastructure diagrams.....C-19–C-20
5. Irrigation diagrams.....C-21–C-23
6. Storm water conveyance diagrams.....C-24–C-27

CATEX (CATEGORICAL EXCLUSION)

UNITED STATES MARINE CORPS
MARINE CORPS INSTALLATIONS - MARINE CORPS BASE
PO BOX 555010
CAMP PENDLETON, CA 92055-0010

5090
ENVSEC
17 Sep 14

From: Commanding General
To: Assistant Chief of Staff G-F, Marine Corps Base, Camp Pendleton (Public Works Officer)

Subj: DECISION MEMORANDUM, CATEGORICAL EXCLUSION; WINDMILL CANYON TREATED WATER CAPACITY STUDY, Windmill Eval 14/15, (NEPA PE20140206)

Ref: (a) Environmental Security REIR of 8 Jul 14
(b) MCO P5090
(c) 32 CFR 775.6(f)

Encl: (1) REIR
(2) Site Maps
(3) Applicable Conditions

1. In response to reference (a), this document satisfies the National Environmental Policy Act (NEPA) review requirement under reference (b) and qualifies as a categorical exclusion in compliance with 32 CFR 775.6(f) (18), reference (c), which states:

(18) Studies, data, and information gathering that involve no permanent physical change to the environment (e.g., topographic surveys, wetlands mapping, surveys for evaluating environmental damage, and engineering efforts to support environmental analyses).

2. The project proposes the following scope as provided by the Action Sponsor:

A key component in evaluating the potential use of recycled wastewater in Windmill Canyon is obtaining a basic understanding of the characteristics and capacity of the subsurface aquifer in that region. Groundwater infiltration is a potential consequence of all of the conceptual water uses (e.g., golf course water feature, retention pond, Windmill Lake) and thus the rate of infiltration, the capacity of the underlying aquifer, and the potential down-gradient flows are all important considerations in the analysis of these strategies. Groundwater data at three sites are required to provide sufficient data to evaluate these potentials. A second key element in evaluating the potential water reuse in the retention pond area is to understand surface runoff potentials onto and off of the golf course area.

The contractor will install two temporary groundwater monitoring wells in the Windmill Canyon area (one groundwater monitoring well is currently in existence). The contractor in consultation with the ES staff will obtain all necessary permits and meet all base installation requirements prior to

proceeding with installation and for disposal of residuals during well development and decommissioning. The location of wells will be based on hydrologic considerations required to obtain flow and groundwater nutrient information. Wells will remain in place for a sufficient duration so as to obtain water table data in both a wet and dry season.

As part of potential options examined for recycled water, the contractor shall examine a stormwater runoff pond located on the east end of the golf course regarding hydraulic capacity, vegetation, soil, and ground water infiltration. This area is used to prevent flooding from stormwater, and also sediment deposit onto the golf course. The contractor will install automated samplers to evaluate flow-weighted composite stormwater samples above and below the golf course over three storm events, and will determine the stormwater characteristics through this region. The contractor will also examine normally dry Windmill Lake and its surrounding area, downstream from the golf course, for hydraulic capacity, vegetation, and soil characteristics. Field work will include wetlands determination, validating vegetation maps, and species list.

The contractor will generate a GIS-enabled recycled water use "Option Library" that describes the data collected as part of the above efforts and can be expanded for evaluating other potential water uses in the area. The GIS library will be generated in accordance with ES GIS data deliverable requirements and provide ES Staff the ability to visualize various types of water use and water features when evaluating best uses of recycled water. A GIS data request has been submitted. Literature review will include information regarding plant populations, threatened and endangered species in the region, recycled water chemical analysis, storm water history, water table knowledge, and windmill lake water area and volume capacity. Vegetation maps, plant water uptake capacity, special status species considerations, wetlands classification, and biological surveys will be evaluated. Contractor staff will include a hydrologist and a plant ecologist.

3. The Action Proponent or their designated representative must notify the Environmental Security (ES) NEPA Section by phone (760) 725-9759, e-mail, or e-mail from the project page in the PAMS Web System, a minimum of two weeks prior to the start of actual ground-disturbing activities.

4. This categorical exclusion shall become void and further environmental review will be required to determine appropriate National Environmental Policy Act documentation if:

a. The subject action is not executed within one year of the date of this document (ground-breaking, demolition, other physical activity); or

b. The scope of the action changes from the description provided in the submittal; or

Subj: DECISION MEMORANDUM, CATEGORICAL EXCLUSION; WINDMILL CANYON TREATED WATER CAPACITY STUDY, Windmill Eval 14/15, (NEPA PE20140206)

c. All conditions of this document are not complied with.

Approved	/s/ D. F. LEVI By direction
Receipt Acknowledged	Kyle Cook 17 Sep 14

Request for Environmental Impact Review

Project Title: *Windmill Canyon Treated Water Capacity Study*

Short Plain English Description of Action: *Stormwater and groundwater monitoring and evaluation to determine the feasibility of increasing treated (recycled) wastewater useage and/or storage within the Windmill Canyon area of MCB Camp Pendleton.*

Project ID: *Windmill Eval 14/15*

Start By Date: *6-Mar-14*

End By Date: *28-Feb-16*

Duration (days): *24 months*

Activity Sponsor (Unit/Command): *Environmental Security*

Activity Sponsor POC: *Kyle Cook*

Phone/Fax: *760-763-7881/725-0207*

Base Location: *Golf Course*

WO Number: *M3300014POFE074*

Year Programmed: *2014*

Form 1391?: *No*

Funded?: *Yes*

Fund Source: *CMP 22*

Funds Expire On: *28-Feb-16*

Project Required To: *Conduct Non-Routine /Special Project*

Action Will Be Performed By: *Contract*

Project will result in permanent site improvement?: *No*

New or Modified Real Estate License Will Be Issued By Base?: *N/A*

Descriptive Information

Purpose and Need of Action: *Purpose is to determine the feasibility of increasing treated (recycled) wastewater useage and/or storage within the Windmill Canyon area of MCB Camp Pendleton. The Base generates a significant amount of recycled water at the Southern Regional Tertiary Treatment Plant that is discharged to the ocean at a cost per gallon. Utilizing recycled water in Windmill Canyon could reduce the discharge to ocean, represent a beneficial use, and reduce the need for potable water in this area.*

Scope of Preferred Alternative: *A key component in evaluating the potential use of recycled wastewater in Windmill Canyon is obtaining a basic understanding of the characteristics and capacity of the subsurface aquifer in that region. Groundwater infiltration is a potential consequence of all of the conceptual water uses (e.g., golf course water feature, retention pond, Windmill Lake) and thus the rate of infiltration, the capacity of the underlying aquifer, and the potential down-gradient flows are all important considerations in the analysis of these strategies. Groundwater data at three sites are required to provide sufficient data to evaluate these potentials. A second key element in evaluating the potential water reuse in the retention pond area is to understand surface runoff potentials onto and off of the golf course area. The contractor will install two temporary groundwater monitoring wells in the Windmill Canyon area (one groundwater monitoring well is currently in existence). The contractor in consultation with the ES staff will obtain all necessary permits and meet all base installation requirements prior to proceeding with installation and for disposal of residuals during well development and decommissioning. The location of wells will be based on hydrologic considerations required to obtain flow and groundwater nutrient information. Wells will remain in place for a sufficient duration so as to obtain water table data in both a wet and dry season. As part of potential options examined for recycled water, the contractor shall examine a stormwater runoff pond located on the east end of the golf course regarding hydraulic capacity, vegetation, soil, and ground water infiltration. This area is used to prevent flooding from stormwater, and also sediment deposit onto the golf course. The contractor will install automated samplers to evaluate flow-weighted composite stormwater samples above and below the golf course over three storm events, and will determine the stormwater characteristics through this region. The contractor will also examine normally dry Windmill Lake and its surrounding area, downstream from the golf course, for hydraulic capacity, vegetation, and soil characteristics. Field work will include wetlands determination, validating vegetation maps, and species list. The contractor will generate a GIS-enabled recycled water use "Option Library" that describes the data collected as part of the above efforts and can be expanded for evaluating other potential water uses in the area. The GIS library will be generated in accordance with ES GIS data deliverable requirements and provide ES Staff the ability to visualize various types of water use and water features when evaluating best uses of recycled water. A GIS data request has been submitted. Literature review will include information regarding plant populations, threatened and endangered species in the region, recycled water chemical analysis, storm water history, water table knowledge, and windmill lake water area and volume capacity. Vegetation maps, plant water uptake capacity, special status species considerations, wetlands*

classification, and biological surveys will be evaluated. contractor staff will include a hydrologist and a plant ecologist.

Identify Other Alternatives Considered: *Not applicable.*

Information concering avoidance, specific best management practices,or mitigation necessary to complete the project: *The contractor will generate a field sampling and analysis plan in consultation with the ES staff. All field sampling shall be coordinated with the MCB Camp Pendleton Natural Resources and Wildlife Management Branches to insure safe ingress and egress and to limit potential environmental damage to wildlife or plants. The sampling and analysis plan shall include proper personnel safety procedures for all field sampling activities. The sampling and analysis plan shall lay out the full scope for each of the other task elements.*

Preferred and Alternative Sites

Preferred Site Description: *Windmill Canyon from above the golf course to Windmill Lake downstream. See attached Project Area graphics.*

Installation Required Information

The project or action will:

a. potentially affect the human environment, involve unique or unknown risks, or be scientifically controversial?: *No*

b. set a precident, have significant future effects?: *No*

c. result in change to traffic flow patterns on- or off-base?: *No*

d. increase demand on local or state governments for support services?: *No*

e. cause an increase or decrease in the on- or off-site base population?: *No*

f. require construction of government facilities and/or private housing?: *No*

The project is within 500 feet of:

a. wetland area, water body or the 100-year floodplain?: *No*

b. threatened or endangered species?: *Unknown*

c. habitat of threatened or endangered species?: *Unknown*

d. an archeological site?: *Unknown*

e. culturally or historically significant sites/buildings?: *Unknown*

The project will:

a. introduce increased air emissions (e.g. new equipment or increase in operational hours)?: *No*

b. introduce new, relocated or increased hazardous material use or hazardous waste?: *No*

c. result in new or increased vehicle fueling or maintenance?: *No*

d. introduce new or increased aircraft flight operations?: *No*

e. occur within the 'coastal zone' (within one mile of the coast)?: *No*

f. involve groundwater dewatering operations?: *No*

g. result in increased vehicle traffic?: *No*

The project is within:

a. 1500 feet of an installation restoration (IR) site?: *Unknown*

b. 1500 feet of an underground storage tank (UST) site?: *Unknown*

d. 500 feet of a potable or non-potable well?: *Unknown*

d. 500 feet of a hazardous waste or material storage site?: *Unknown*

The project will require:

a. digging or grading?: *No*

b. clearing or grubbing of existing vegetation?: *No*

c. use of pesticides, herbacides, fungicides, rodenticide during/to maintain the installation?: *No*

d. new or enlarged firebreaks (mowed, disked, or graded)?: *No*

e. laydown area: *No*

The project will:

a. increase water demand?: *No*

b. introduce new or increased sewage or solid waste?: *No*

c. result in increased gas demand?: *No*

d. result in increased electrical demand?: *No*

Action Sponsor: *Environmental Security*

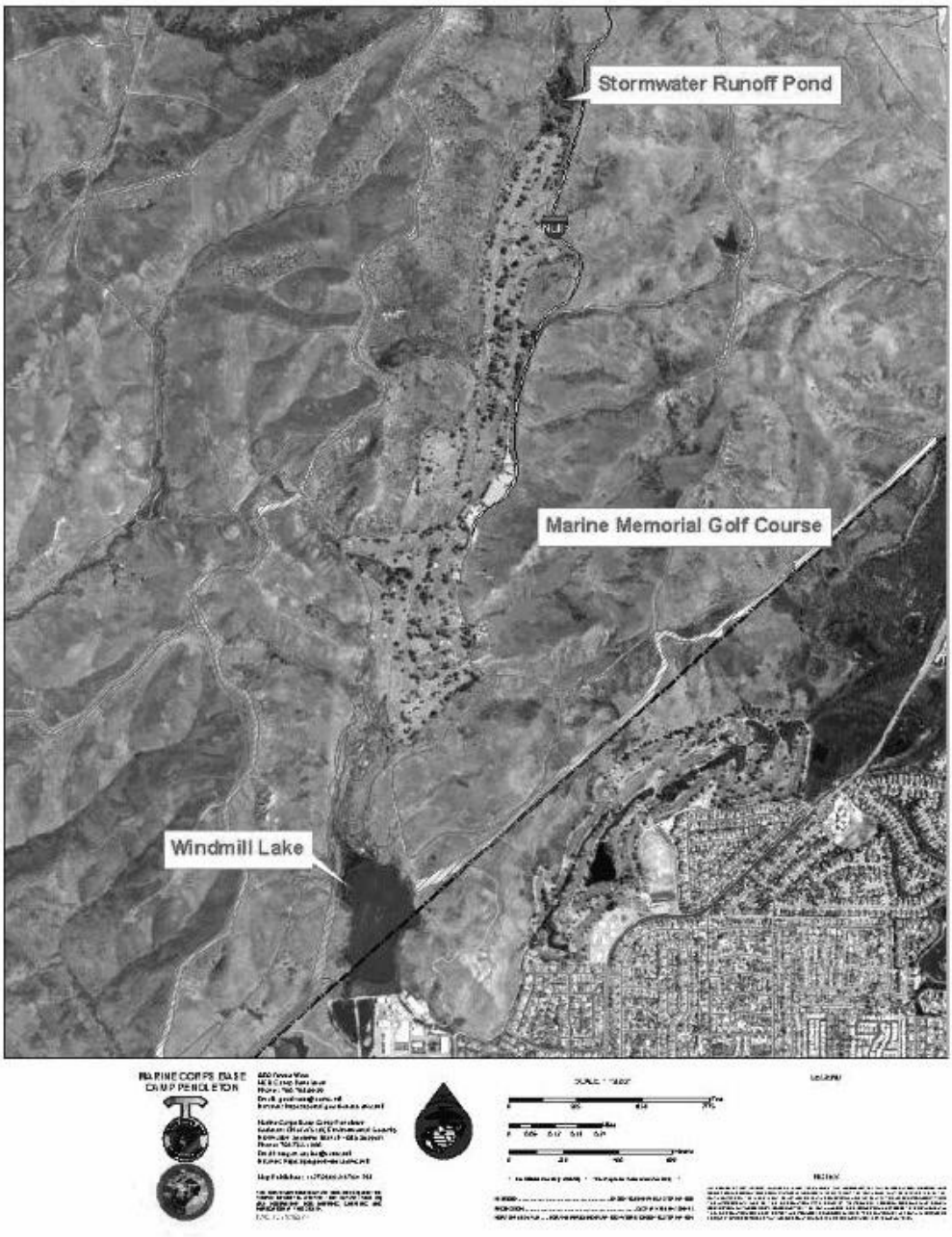
Rank: *Civilian GS-12*

Title: *Water Quality Section Head*

SITE MAPS

New File

WINDMILL CANYON PROJECT AREA



ENCLOSURE (2)

SITE ACCESS/RESTRICTIONS

a. The project work areas are limited to the sites specified in enclosure (1) and enclosure (2). Parking, driving, and project staging of equipment and vehicles (i.e., lay down) are limited to previously compacted and developed areas.

b. Access to the project site shall utilize existing Base roads.

c. All equipment and/or vehicles shall be power-washed before entering Camp Pendleton property and the project site. This is to control the spread of invasive (non-native) weeds. These measures are in support of Marine Corps Order P5090.2A, 11200.7, which requires installations to restrict the introduction of exotic species into natural ecosystems.

STORMWATER

a. Storm Water Best Management Practices shall be implemented where applicable to prevent sediment, oil and other pollutants from reaching storm drains and surface waters.

b. Low volume discharges to land must comply with San Diego Basin Plan Conditional Waiver No. 3, "Miscellaneous Low Threat Discharges to Land" found in San Diego Regional Water Quality Control Board (RWQCB) Resolution No. R9-2014-0041. Land applied water may not run off.

CULTURAL RESOURCES. In the event that archaeological materials (e.g., shell, wood, bone, or stone artifacts) are found or suspected during project operations or the project footprint is altered, work must be halted in the area of discovery and the ES Cultural Resources Management Section notified at (760) 725-9738, as soon as practicable, but no longer than 24 hours after the discovery. Project work at the discovery site shall not proceed until the Base Archaeologist has the opportunity to evaluate the find and gives permission to resume construction activities.

EXCESS MATERIAL DISPOSAL. All construction and demolition debris generated by the proposed action shall be appropriately identified, handled, and disposed of in accordance with federal, state, and local laws and regulations.

The waste generator shall not send unauthorized waste to the Base landfills as identified in Base Order 5000.2L, Chapter 10, and shall only send approved demolition waste as authorized by the Facilities Maintenance Officer (FMO).

At least 50% of the construction and demolition debris generated from the project shall be diverted from placement in a landfill through recycling, or reuse to comply with Executive Order (E.O.) 13514 and MCO P5090.2A, 17200.3.b (3).

Any dirt temporarily moved to install fencing should remain within the project boundary. Soil layers excavated from the site should be returned in the same order they were removed (i.e., the topsoil is to be returned to the topmost level).

TREATED WOOD MATERIALS

Any treated wood materials that are not proposed for recycling shall undergo the California Waste Extraction Test (WET); wastes that pass shall be designated as non-hazardous waste and appropriately identified, handled and disposed of in accordance with provisions outlined within CCR Title 14, Division 7, Chapter 3.

Wastes that fail shall be designated and disposed of as hazardous waste in accordance with CCR Title 8, Sections 66260.1 through 66279.91, and H&SC Section 25150.7 and 25143.1.5.

SPILL CONTROLS AND COUNTER MEASURES. The project must comply with the Base Spill Control and Countermeasures Plan, which is available by contacting the ES Spill Prevention and Planning Section at (760) 725-9743/9768. The action proponent will be responsible for their own hazardous material accidents in accordance with Base, local, state, and federal laws and regulations including clean up, and associated costs. All spills must be reported to the ES Spill Prevention and Planning Section immediately. This Section will make the appropriate regulatory reporting notifications for the spill.

WASTEWATER. The project proponent, construction oversight authority, or duly designated contractor shall ensure utility clearance is conducted for any digging, excavation, or other ground disturbance activity, prior to initiation of construction.

a. The project proponent, construction oversight authority, or duly designated contractor shall report any release of sewage resulting from the project's ground disturbing activity, regardless of volume to FMD Unity at (760) 725-4348/4324 for remedial assessment.

b. The project proponent, construction oversight authority, or duly designated contractor shall exercise caution to avoid damaging existing wastewater infrastructure. Any costs associated with repairing damage to the existing sanitary sewer infrastructure and all remedial efforts resulting from discharged sewage will be the sole responsibility of the project proponent, construction oversight authority, or duly designated contractor.

DRINKING WATER. This project is within 500 feet of a wetland area, river, or water body (Windmill Lake, Golf Course lake). Therefore, uncontained spills, dewatering wastewater, wash water, or erosion during construction activities could potentially discharge contaminated water to surface water via storm drains and natural drainages, violating the Water Quality Control Plan for the San Diego Region (Basin Plan – Regional Water Quality Control Board) water quality objectives and impacting beneficial uses and public safety. The project proponent shall employ proper procedures to minimize erosion, contain spills and prevent any discharges to surface water. Spill handling procedures

shall be outlined in the scope of work or in a Spill Control and Prevention Plan (SCPP). Any releases of contaminated liquids to surface water during construction activities shall be reported immediately to the ES Water Quality Section Head.

AIR QUALITY. The project proponent, construction oversight authority, or duly designated contractor shall provide power generation equipment (i.e., generators) for supplemental or back-up power requirements. Base-owned, permitted generators shall not be utilized to provide supplemental/back-up power for the proposed project.

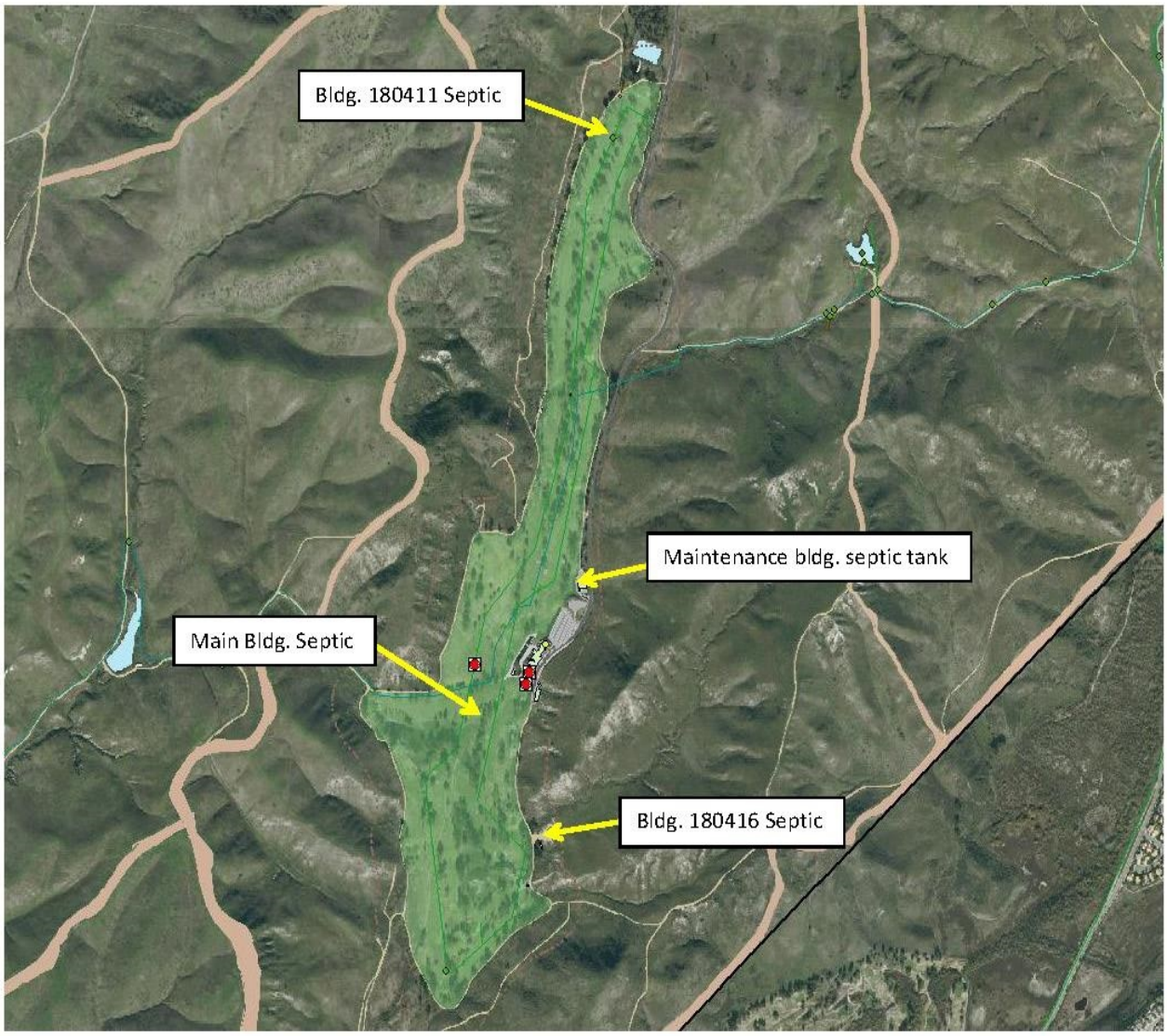
a. The project proponent, construction oversight authority, or duly designated contractor shall ensure that fugitive dust emissions do not extend beyond the property line for more than 3-minutes in any 60 minute period and shall mitigate fugitive dust to minimize track out/carry out emissions during demolition, construction, and transport in accordance with the San Diego Air Pollution Control District (SDAPCD) Rule 55.

b. Stockpiles shall be covered with tarps during proposed action to minimize fugitive dust emissions from crossing project site boundary and shall be removed upon completion.

c. The project proponent, construction oversight authority, or duly designated contractor shall not discharge into the atmosphere from any single source of emissions whatsoever any air contaminant for a period aggregating more than three minutes in any period of 60 consecutive minutes which is darker in shade than Number 1 on the Ringelmann Chart (i.e., dark smoke) and shall not discharge any quantity of air contaminant that may cause injury, detriment, or nuisance pursuant to the San Diego Air Pollution Control District (SDAPCD) Rules 50 and Rule 51.

d. All equipment use and activities proposed as part of this action shall comply with all federal, state, and local air quality regulations. This includes, but is not limited to: San Diego Air Pollution Control District (SDAPCD) permitting requirements; airborne toxic control measures (ATCM) requirements for fleet equipment; painting/coating, rock crushing/grinding, and paving/asphalt operation requirements; and anti-idling requirements for diesel vehicles.

GOLF COURSE MAP



SEPTIC SYSTEM EVALUATION MEMO

UNITED STATES MARINE CORPS
MARINE CORPS BASE
BOX 555010
CAMP PENDLETON, CALIFORNIA 92055-5010

ENV/WWS
September 9, 2013

Mark/Brian,

I have been in contact with Mr. Matthew Howard, P.E./Water Resource Control Engineer, State Water Resources Control Board Division of Water Quality, and he forwarded me the links to look at to research regulations and compliance for the State and County. He informed me that the information I needed was on the San Diego Department of Environmental Health's website.

According to the San Diego County Code of Regulatory Ordinance, Chapter 3, On-Site Wastewater Treatment Systems and Improper Disposal of Sewage; http://www.amlegal.com/nxt/gateway.dll?f=templates&fn=default.htm&vid=amlegal:sandiegoco_ca_mc, this is what I was able to find:

Section 68.321 - Application Procedures:
(a) A person applying for a permit to install a sewage holding tank shall complete an application form provided by the Director and submit with the application the tank specifications and a sketch showing the location and design features of the proposed installation.

Section 68.322. SEWAGE HOLDING TANK REQUIREMENTS:
(a) A sewage holding tank for which an applicant requests a permit shall be constructed of watertight concrete, have an alarm approved by the Director and have a capacity of at least 1500 gallons. The Director may require a tank to have a greater capacity than 1500 gallons depending on the projected use of the building for which the tank permit is requested.
(b) A person issued a sewage holding tank permit under this section shall empty the tank before it is filled to three quarters of its capacity or in compliance with a schedule prescribed by the Director.

Section 68.326. APPLICATION FOR INSTALLATION PERMIT:
(a) A person may apply for a permit to install an on-site wastewater treatment system by submitting an application for a permit on a form provided by the Director. A separate application and permit is required for each installation. The applicant shall submit with the application a diagram drawn to scale that shows the components of the system to be installed and their proposed location on the property. The applicant shall demonstrate that there is adequate area on the property to install the system and that there is adequate reserve area on the property that complies with the requirements of section.

Section 68.328. PERCOLATION TEST; PROFESSIONAL QUALIFICATIONS:
(a) Prior to issuance of an on-site wastewater treatment system permit, the Director may require the applicant to furnish a report of soil percolation tests performed on the site of the proposed on-site wastewater treatment system, including the results of the tests.
(b) Whenever the Director requires soil percolation testing the testing and the preparation of all plans or drawings required by this chapter shall be done by a: (1) California registered engineer, (2) California registered environmental health specialist or (3) California registered geologist. The Director may also require that these individuals demonstrate their knowledge of San Diego County ordinances and policies related to the design of on-site wastewater treatment systems.

During my site visit to the golf course on 4 September 2013, I was able to locate 3 of the 4 septic tanks, I was not able to visually see the 4th one, but know of the location of where it is supposed to be.

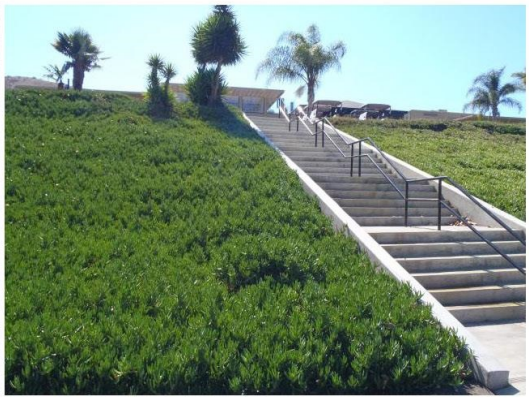
Here is a quick brief of what was found per location -

1. **The golf course maintenance facility** (only one not visible from the surface) -
   - There is 1 septic tank located in the ice plants directly adjacent to the bldg. The man-hole or access point is not visible. According to the grounds supervisor, the only thing that has changed in that system is that a portable bldg.(Maintenace Supervisor bldg..) was attached to the side of the maintenance warehouse and the bldg. was connected to the septic tank system.
   - **Recommended items** - ice plant needs to be removed from around cover of septic tank and kept clear.

2. **Bldg. 18411 (Tee off Hole #6) -**
   - This facility is has had an issue in the past (per Mr. Mike Grimaud, FMD Wastewater Supervisor and Mr. Fielder Grounds Supervisor). FMD went out and pumped the septic tank when there was an overflow and cleared and raised the manholes for easy access. This facility is in high use because there is a field path that the Marines use on their marches and walk past there and utilize that restroom. So at any given time, you could have over 200 occupants using that restroom in a day. Ever since FMD pumped the tank and raised the manholes, there has been no issues.
   - **Recommended items -** Keep the manhole areas clear of debris and bushes.

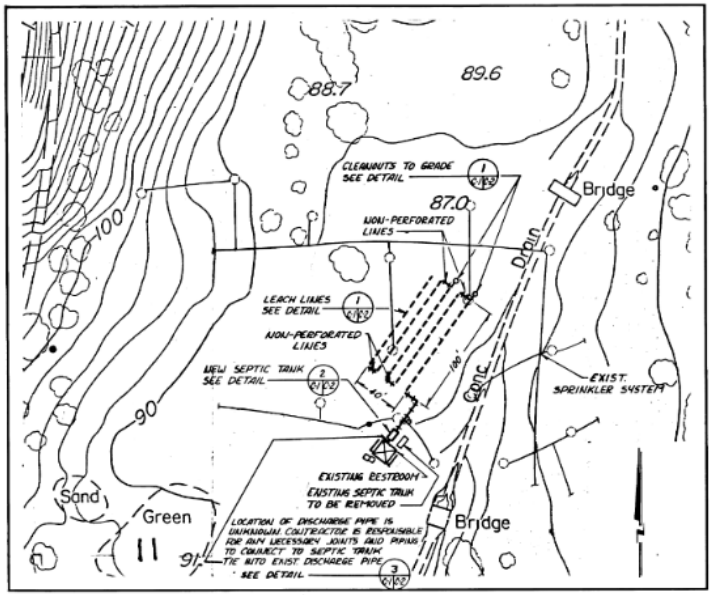
3. **Bldg. 180416 (Tee off Hole #17) -**
   - This facility is currently having issues with the leach field. The road to the restrooms goes right over the main line coming out of the restroom and to the leach field. It has in the past had issues with water (at the time), pooling up around the area and not until recently did the discover it was not water but sewage, due to the smell. Mr. Fielder has advised me that they monitor it closely now and have called FMD out if they feel the tank is getting too high to prevent overflows. There is a work order in to repair the leach field and piping system.
   - **Recommended items -** because the facility has the potential to leach sewage onto the ground where golfers could end up walking by, through or near, the restroom might want to be closed or upgraded to an emergency to prevent that.

4. The main golf course bldg. and snack bar -
   - The sewer line was recently upgraded and new lines and manholes were put in. According to Mr. Fielder, golf course maintenance supervisor, there is a manhole close to the #1 tee off spot that has a pipe in it that seem to be the cause of multiple blockages in the main and has informed the facility manager about it. He informed me that when the line gets plugged, it causes the restrooms in the facility to have sewer gas odors, so far no one has done anything about it. The manholes that lead to the septic tank for the facility are completely engulfed with ice plant, so much, as to you cannot see them, all you can see are bulges under the ice plant. The septic tank is located in the field across from the snack bar bathrooms. It is in a grassy area that is all brown except where a few green spots have grown. There is a water line in the area so, no telling if the green bushes growing there are from a leak in the water line or seepage from the septic system. The area is riddled with ground squirrels who have dug up all around the main lids to the septic tank and all around the leach field area.
   - **Recommended items -** Ice plants need to be removed from around all manhole covers for access. The manhole that is identified as a problem needs to be addressed by whoever is responsible for maintenance of the golf course. The area around the septic tank needs to be inspected to see if ground squirrels have caused any damage or infiltration.

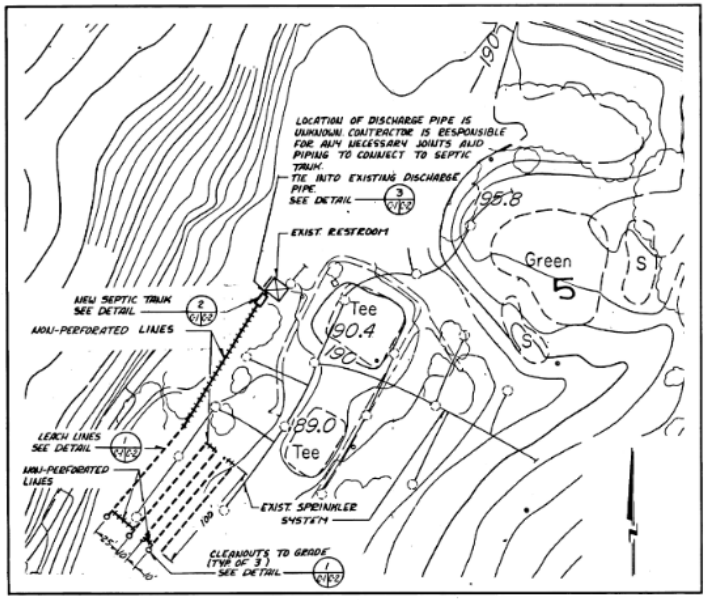


Since there is no documentation on when the septic systems were installed, diagrams or schematic of tank(s) or leach fields, maintenance records or inspection logs, we can only go by visual inspection of them. We know that at least one of the 4 (by hole #17) leach field and septic line has an issue, but besides that one, there is no complaint about the systems except they are old and covered with ice plants. The only way of knowing that they meet the requirements or are in compliance would be to do a complete study of each of the septic systems. Also, because there are no records of when they were installed, an upgrade to the systems may be needed because of changes to the facilities and usage of the course. The systems are scheduled to be added to a service contract per Mr. Jason Poe (FSC).

SEPTIC SYSTEM INFRASTRUCTURE DIAGRAMS



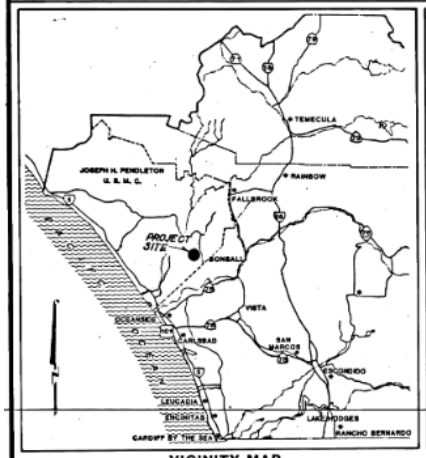
TWELFTH TEE AREA
SCALE 1"=50'



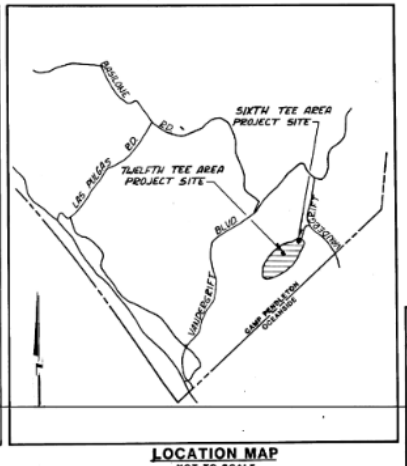
SIXTH TEE AREA
SCALE 1"=50'

NOTES TO CONTRACTOR

1. EXISTING SEPTIC TANKS ARE TO BE FIELD LOCATED AND REMOVED.
2. THE EXISTENCE AND LOCATION OF UTILITY STRUCTURES AND FACILITIES SHOWN ON THE CONSTRUCTION PLANS WERE OBTAINED BY A SEARCH OF THE AVAILABLE RECORDS. ATTENTION IS CALLED TO THE POSSIBLE EXISTENCE OF OTHER UTILITY FACILITIES OR STRUCTURES NOT KNOWN OR IN A LOCATION DIFFERENT FROM THAT SHOWN ON THE PLANS. THE CONTRACTOR IS REQUIRED TO TAKE DUE PRECAUTIONARY MEASURES TO PROTECT THE UTILITIES SHOWN ON THE PLANS AND ANY OTHER EXISTING FACILITIES OR STRUCTURES NOT SHOWN.
3. EXISTING SPRINKLER SYSTEM SHALL BE RESTORED TO ORIGINAL CONDITION PRIOR TO CONSTRUCTION OR AS SPECIFIED BY OFFICER IN CHARGE OF CONSTRUCTION.
4. LOCATION OF NEW SEPTIC TANKS MAY BE ADJUSTED IN FIELD TO ACCOMMODATE LOCATION OF DISCHARGE PIPES.
5. IN THE EVENT EXISTING LEACH LINES ARE ENCOUNTERED REMOVE EXISTING PIPE TO MINIMUM TRENCH WIDTH.



VICINITY MAP
NOT TO SCALE



LOCATION MAP
NOT TO SCALE

2 — DETAIL NUMBER
C-2 | C-4 — NUMBER OF SHEET WHICH DETAIL IS DRAWN / NUMBER OF SHEET WHICH DETAIL IS TAKEN

SHT. NO	NAVFAC DWG. NO.	TITLE
1	6233247	REHABILITATION OF GOLF COURSE PERCOLATION FIELDS
2	6233248	REHABILITATION OF GOLF COURSE PERCOLATION FIELDS

C-1

IF SHEET IS LESS THAN 24" X 36" IT IS A REDUCED PRINT - SCALE REDUCED ACCORDINGLY

0 50 100 150
SCALE: 1 IN. = 50 FT.

LUKE-DUDEK
Civil Engineers, Inc.
878 Second Street, Encinitas, CA 92024 (619) 942-8147

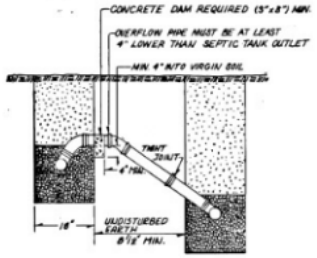
D. DAVIES — DATE
N. MCKINLEY — DATE 15MAR85
DATE 15MAR85
DATE 9 Apr 85

PUBLIC WORKS OFFICE
MARINE CORPS BASE CAMP PENDLETON, CALIF.

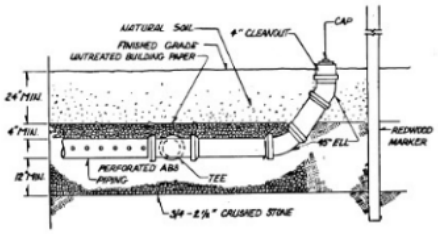
REHABILITATION OF GOLF COURSE PERCOLATION FIELDS
J. O. # 22-82-086

J. BOWMAN — DFMO
DRG. NO. 80091
DRG. NO. 6233247
CONT NO. 68C 9273
SCALE SHOWN
SPEC 12-85-9273
SHEET 1 OF 2

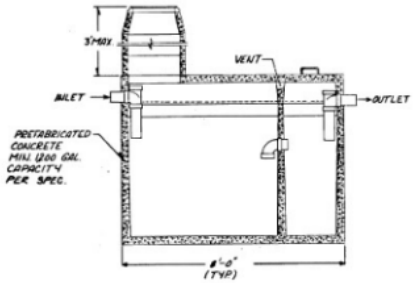
LD 84-05



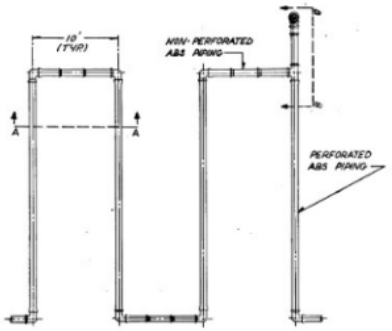
SECTION A-A



SECTION B-B

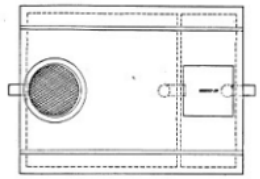


LONGITUDINAL SECTION



TYPICAL LEACH LINES

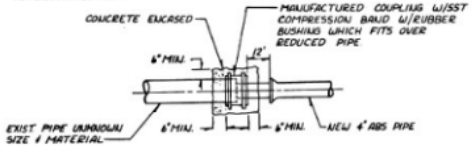
LEACH LINE DETAIL (1 C-1C2)
NOT TO SCALE



PLAN VIEW

SEPTIC TANK DETAIL (2 C-1C2)
NOT TO SCALE

NOTE:
CONTRACTOR MAY USE TRANSITION COUPLING MANUFACTURED SPECIFICALLY FOR PIPE SIZES & MATERIALS BEING INTERCONNECTED.



CONNECTION DETAIL (3 C-1C2)
NOT TO SCALE

IF SHEET IS LESS THAN 24" X 36" IT IS A REDUCED PRINT - SCALE REDUCED ACCORDINGLY

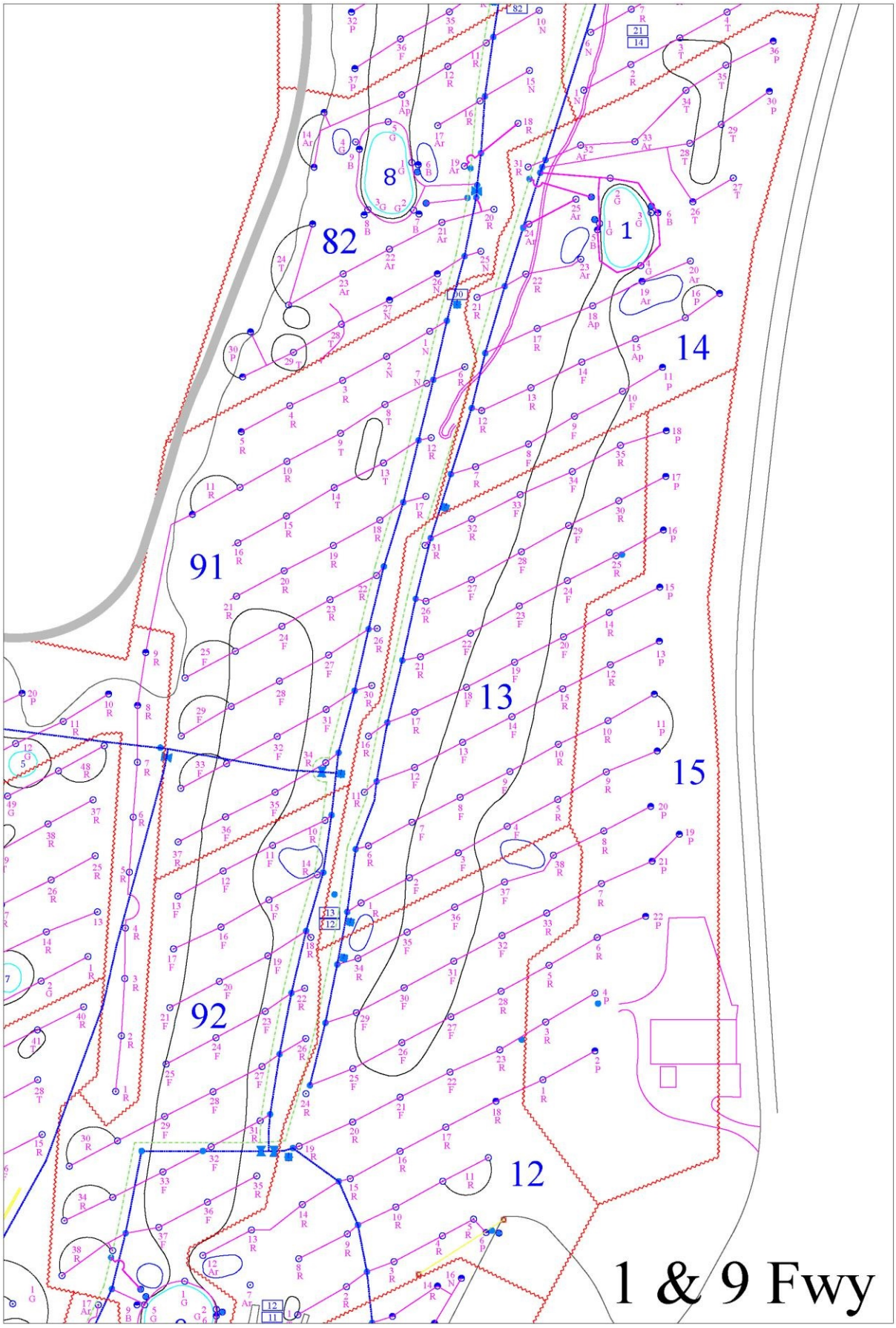
LUKE-DUDEK
Civil Engineers, Inc.
870 Second Street, Encinitas, CA 92024 (619) 942-5147

C-2

DESIGN G. DAVIES	PUBLIC WORKS OFFICE, MARINE CORPS BASE, CAMP PENDLETON, CALIF.
DRAWN N. MCKINLEY	REHABILITATION OF GOLF COURSE PERCOLATION FIELDS
TRACED NGUYEN/BOOGAY	J. O. # 22-82-085
CHIEF ENGR. KNEBS	
PLAN CHECK	
APPROVED PUBLIC WORKS OFFICER / DATE	CODE IDENT NO. 80091
DAT SPEC. CHIEF / TITLE	DWG. NO. 6233248
DATE	CONT. NAVFAC 85-9273
SCALE	DATE 12-85-9273 SHEET 2 OF 2

LD 69-05

IRRIGATION DIAGRAMS



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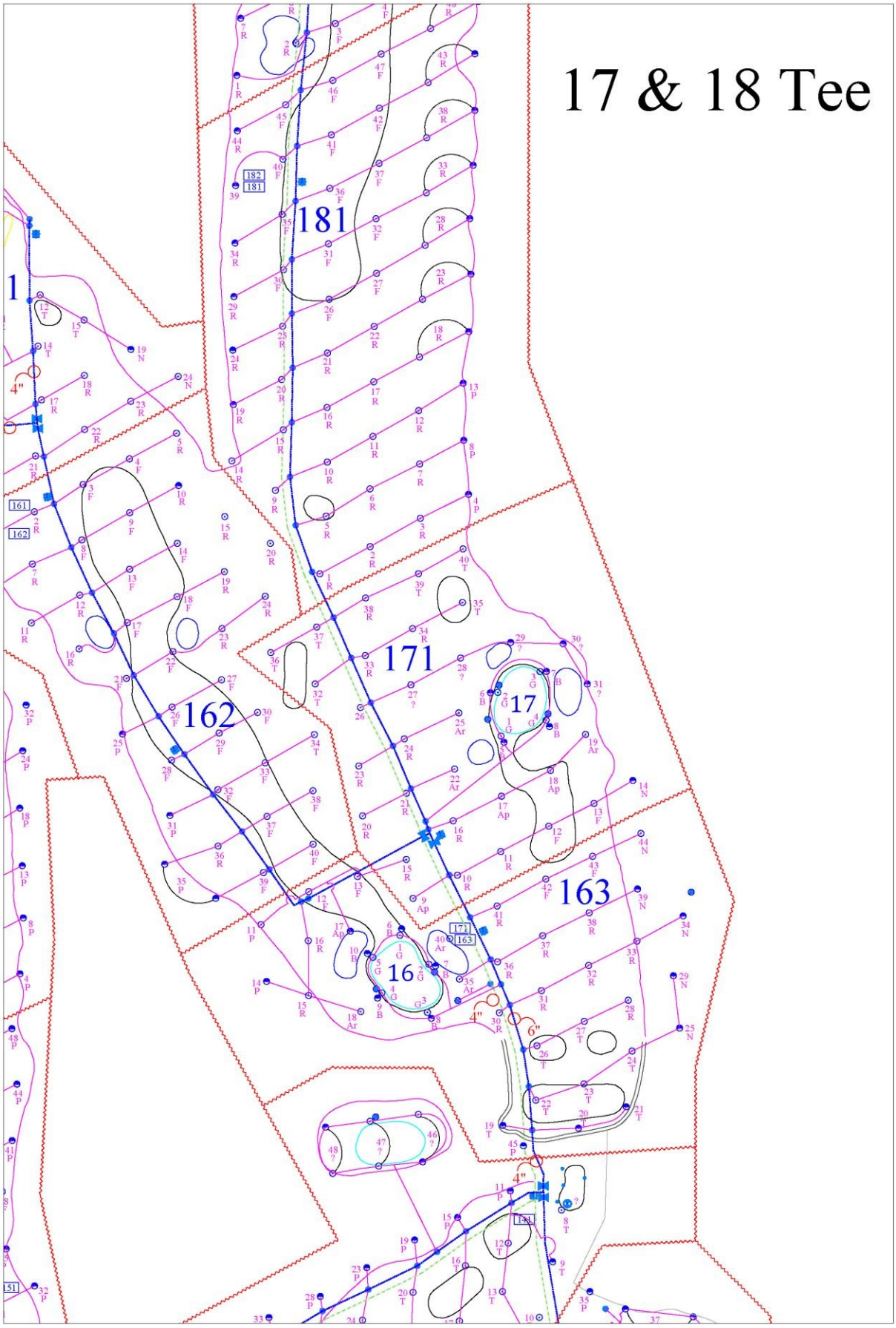
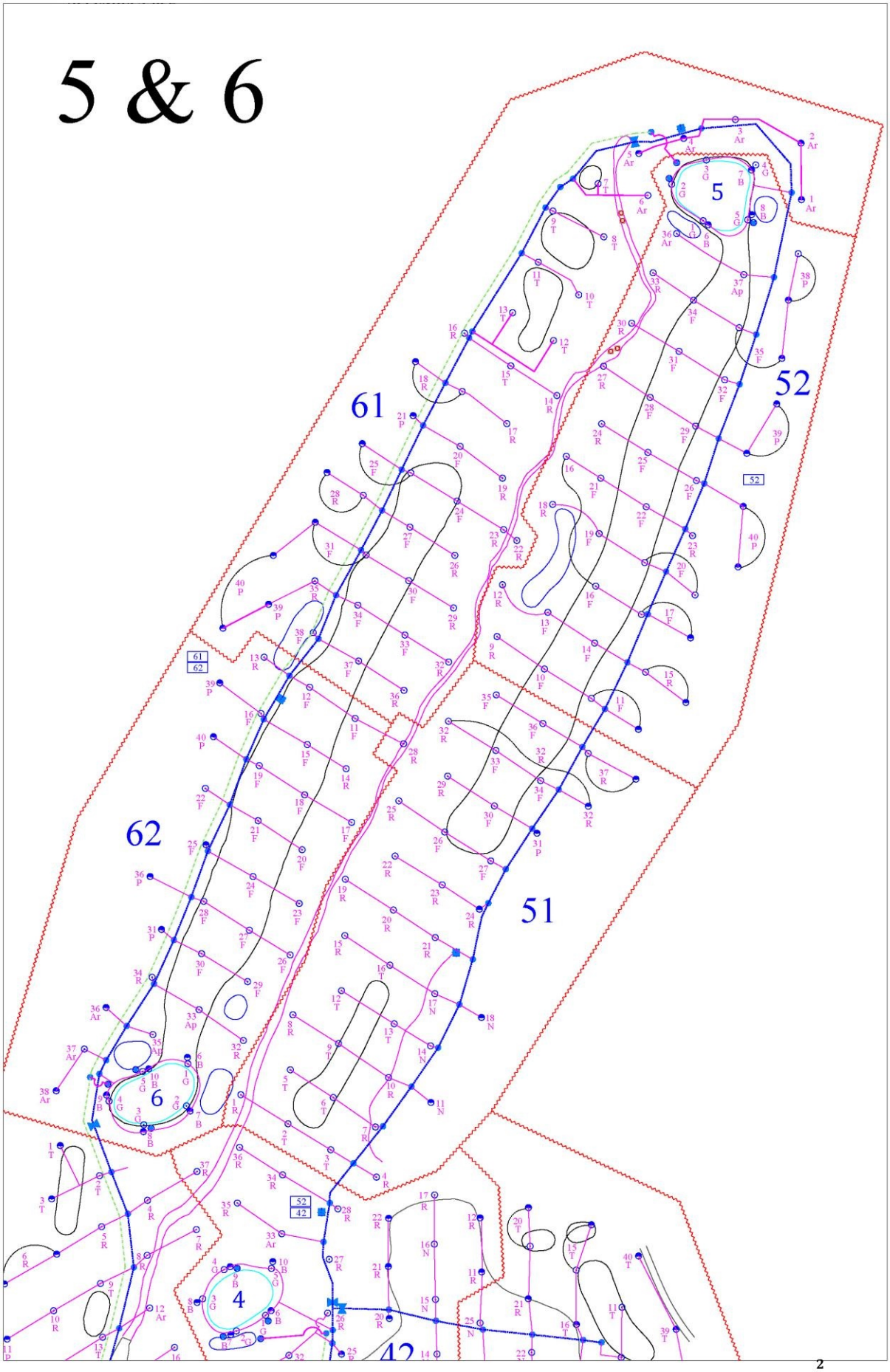
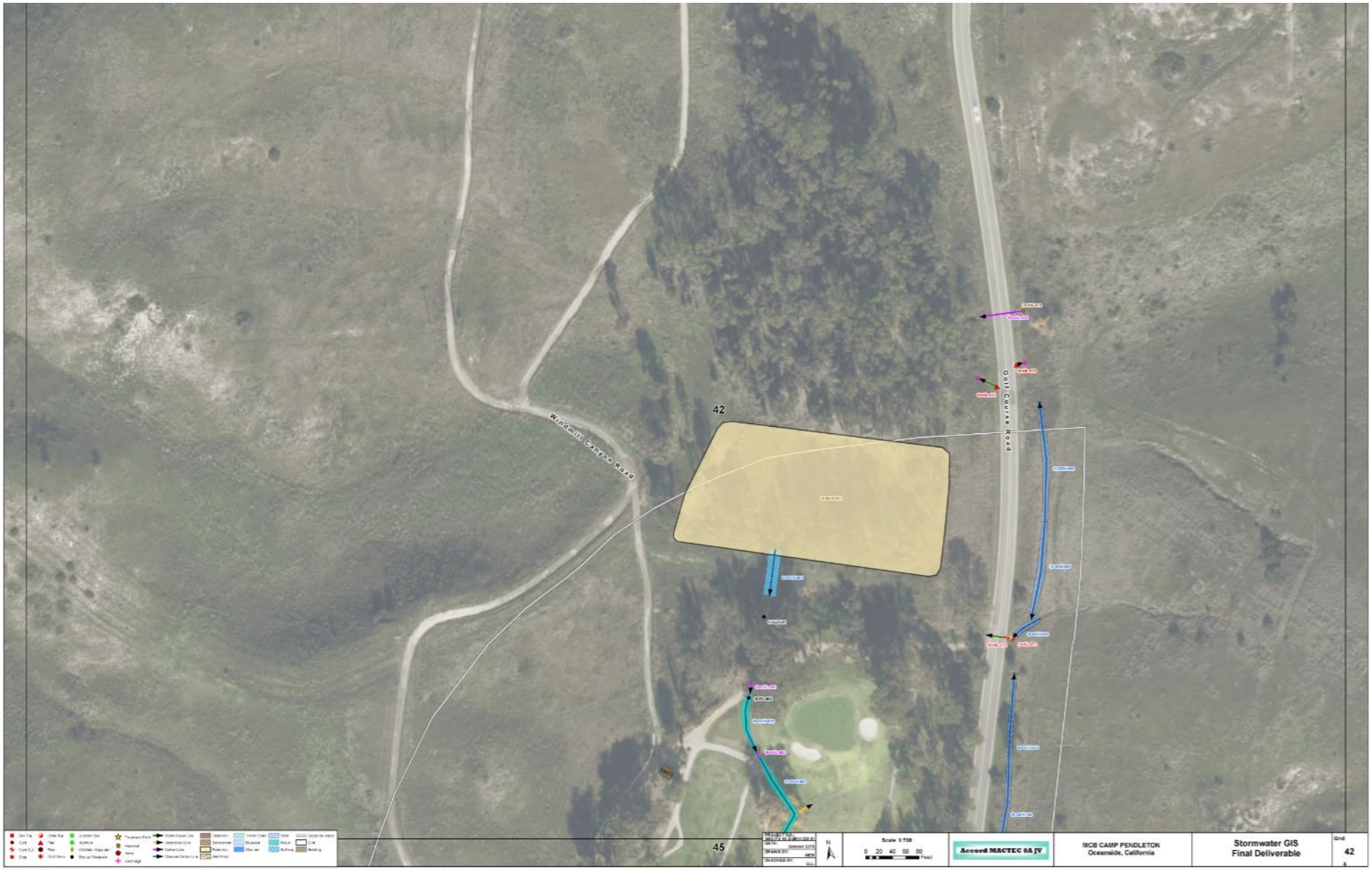

17 & 18 Tee
181
171
162
163
17
16
1

5 & 6

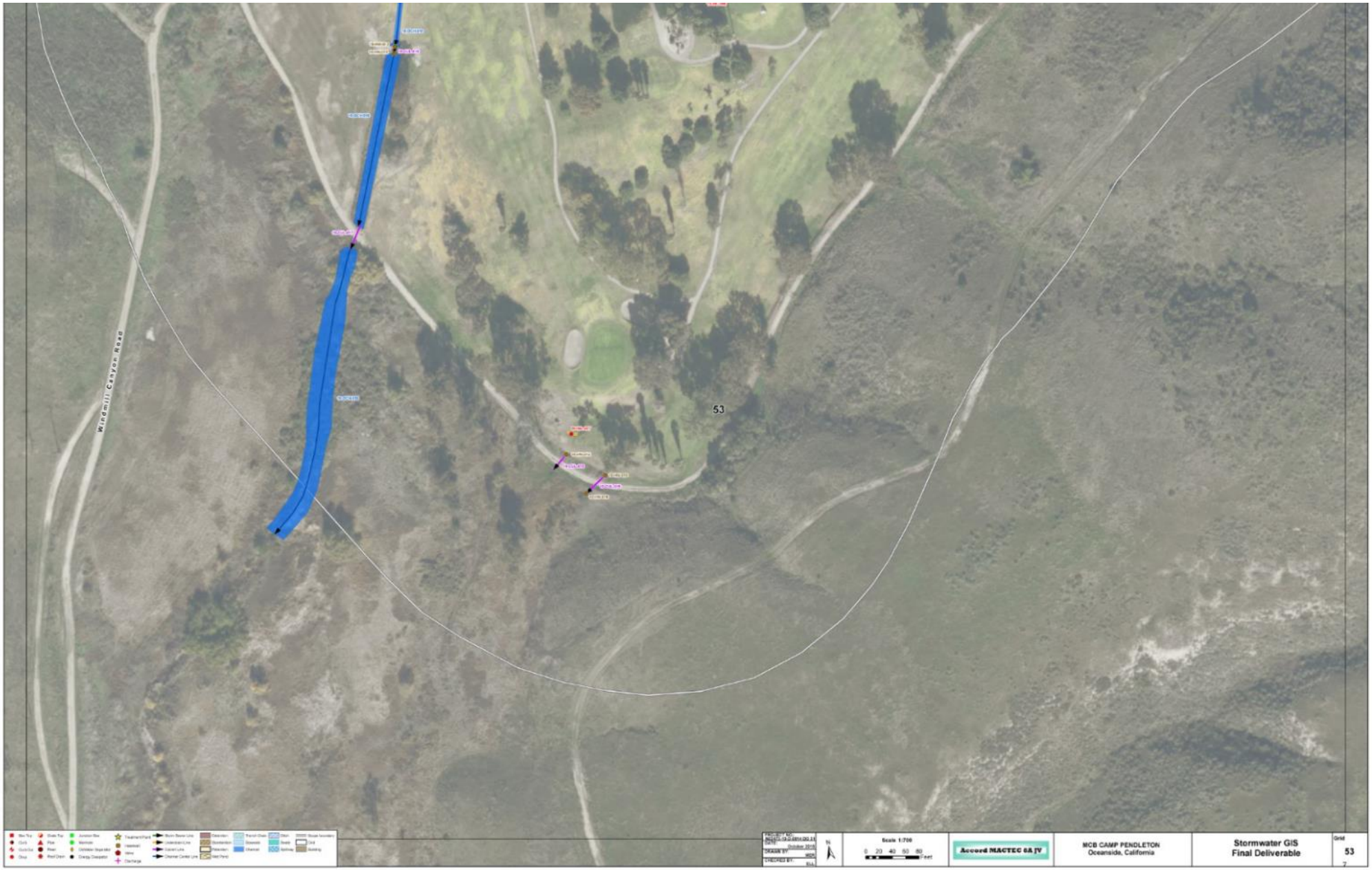


STORM WATER CONVEYANCE DIAGRAMS



Windmill Canyon Road
45
Golf Course Road
46
Scale 1:700
0 20 40 60 80
Feet
Accord MACTEC GA JV
MCB CAMP PENDLETON
Oceanside, California
Stormwater GIS
Final Deliverable
Grid
45

Windmill Canyon Road
Golf Course Road
48
49
Scale 1:700
0 20 40 60 80
Feet
Accord MACTEC GA JV
MCB CAMP PENDLETON
Oceanside, California
Stormwater GIS
Final Deliverable
Grid
48


Windmill Canyon Road
53
Scale 1:700
0 20 40 60 80 Feet
Accord MACTEC SA JV
MCB CAMP PENDLETON
Oceanside, California
Stormwater GIS
Final Deliverable
Grid
53

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APPENDIX D
PIEZOMETER INSTALLATION PLAND.1 OVERVIEW
ESTIMATED DEPTH AND LOCATION

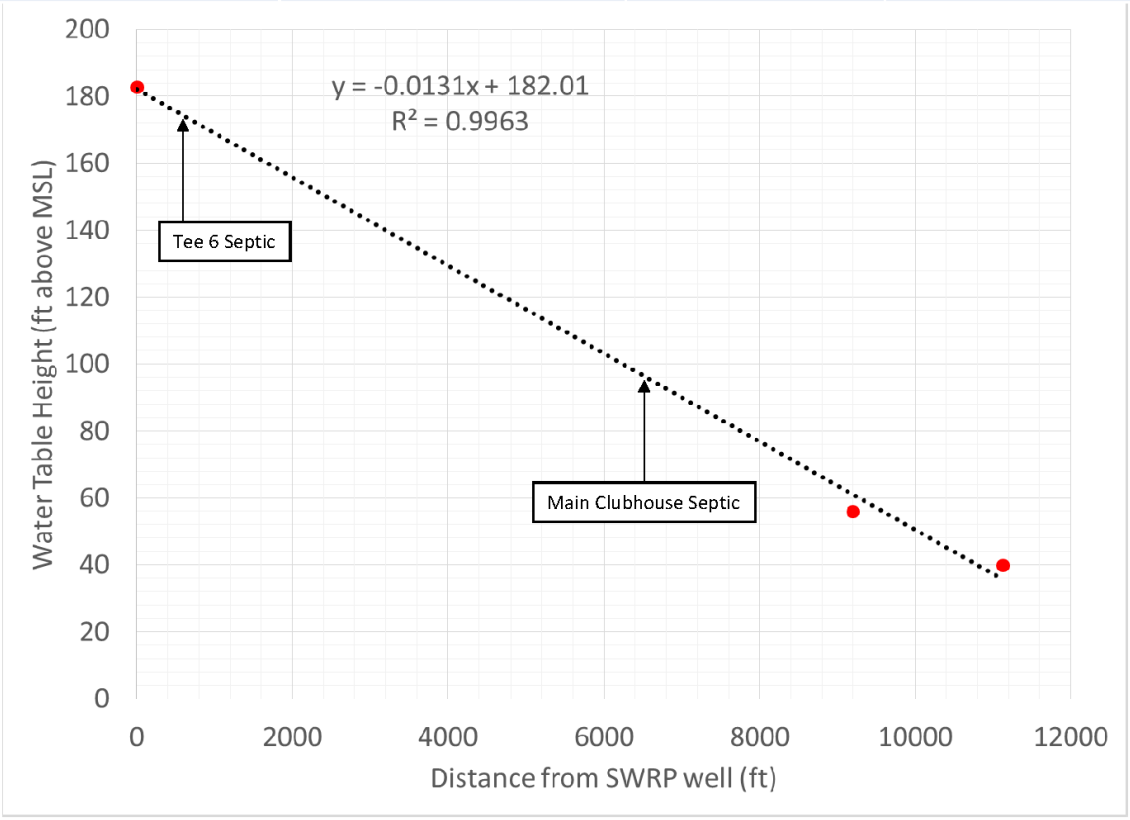
OVERVIEW

Items included in this section are:

1. Piezometer Installation Plan D-1–D-4
2. Installation Notes D-5–D-7
3. Update to Installation D-8–D-9

PIEZOMETER INSTALLATION PLAN

Distance from SWRP (ft)	Elevation (Max height above MSL)	Water Table Height (above MSL)	Water Table Depth (ft bgs)
674	185.58	173.18	12.40
6560	102.24	96.07	6.17



Piezometer	Long (approximate)	Lat (approximate)
1	117°19'34.69"W	33°16'54.77"N
2 (south of tree, pt 4)	117°19'34.98"W	33°16'54.29"N

Piezometer	Long (approximate)	Lat (approximate)
3	117°19'52.22"W	33°15'58.24"N
4	117°19'53.04"W	33°15'56.39"N

Third installation point added at MCH in March 2017

INSTALLATION NOTES

Piezometer Install 25Jan17 & 15Feb17
Field Notes

Team: Kara, Ernie, Joel, Joe
Arrive: CPEN 230
Plan: install piezometer @ 2 of 4 leach fields (Tee 6 and Main Club House) – target 2 at each field. See diagrams of estimated depth for each field.

Tee 6 Install:

Piezometer 1 Start install at 1120am

Lat 33.28182
Long 117.32634

Initially used hydraulic pounder
1st pipe – 49 inch
2nd pipe – 48 inch

Got down about 6 ft and then joints failed due to pressure of pounder. Believe ground to hard at this location. Marked off well and will come back later. Estimate water table about another 6 ft down.

Main Club House Install:

Piezometer 3 Start install at 1330

Lat 33.26616
Long -117.33113
Target : 8ft

Initially dug down about 3 ft first, moist soil, then used hand hammer
Estimate getting down about 7 ft with sheath exposed
Finish 1423

Piezometer 4 Start 1423

Lat 33.26566
Long -117.33139

Depth ~ 7.5 ft down in ground with sheath exposed
Completed 1520

Piezometer Install 25Jan17 & 15Feb17
Field Notes

WMC 15 Feb 17 **Team Kara, Joel, Ernie, Lewis**

Tee 6 Arrive 1025

Piezometer 1:
Lat: 33.281924
Long: -117.326334
Same hole which down about 6 ft , using manual driver second attempt but threds gone can't take down any farther.

Dig down about 2ft

Piezometer 2:

Lat: 33.281705
Long: -117.326441

Dug down about 2 ft, auger another 2-3 ft. ground softer in this location. Got down about 12 ft (3-4 pipes) completed at 1352.

Main Club House Arrive 1415

Piezometer 5:

Lat: 33.265807
Long: -117.331341

Dug down about 2-3ft, then auger another 4ft. 8.5 ft down at 250, capped off and will return.

Piezometer 4: @ 1456

Piezometer Install 25Jan17 & 15Feb17
Field Notes

Pushed down another 2 ft to about 8.5 ft as well

Piezometer 3: @ 1521

Measured depth. Believe about 7 ft, had pulled out sheath so decided not to push down any farther at this point.

Depart 15

UPDATE TO INSTALLATION

Tee 6: Piezometer install Status
22Mar17

- Estimated GW depth is 12.4 ft
- PZ 1: could only get to 6ft before joints failed- no water present when tested 2-15.
- PZ2: Got to total 13.5-14 ft. Initial water at 12ft not a lot when checked on 2-15 (i.e. could have just been rain water) but no water present on 3/21.
- For this location- ground is much harder/more clay.
- Conclusion: Can't push PZ down to grown water at this location without bringing in some more heavy duty equipment to drill down and then install.

Main Club House: Piezometer install
Status
22Mar17

Initial estimated GW depth was 6 ft but no really data (from well) in this location to confirm

- PZ 3: ~16ft now- No water as of 21Mar. In process of installing another 4ft extension (hammer broke on this one).
- PZ4: 8ft. Water from this one on 21Mar- seemed to recharge after 2 hours- but very very slow. Plan to add at least one more extension
- PZ5: ~20 FT- Water on 21Mar with good recharge within 1.5 hours.
- Conclusion: Ground is soft enough here that feel can get to ground water. Will add additional extensions once supplies arrive.

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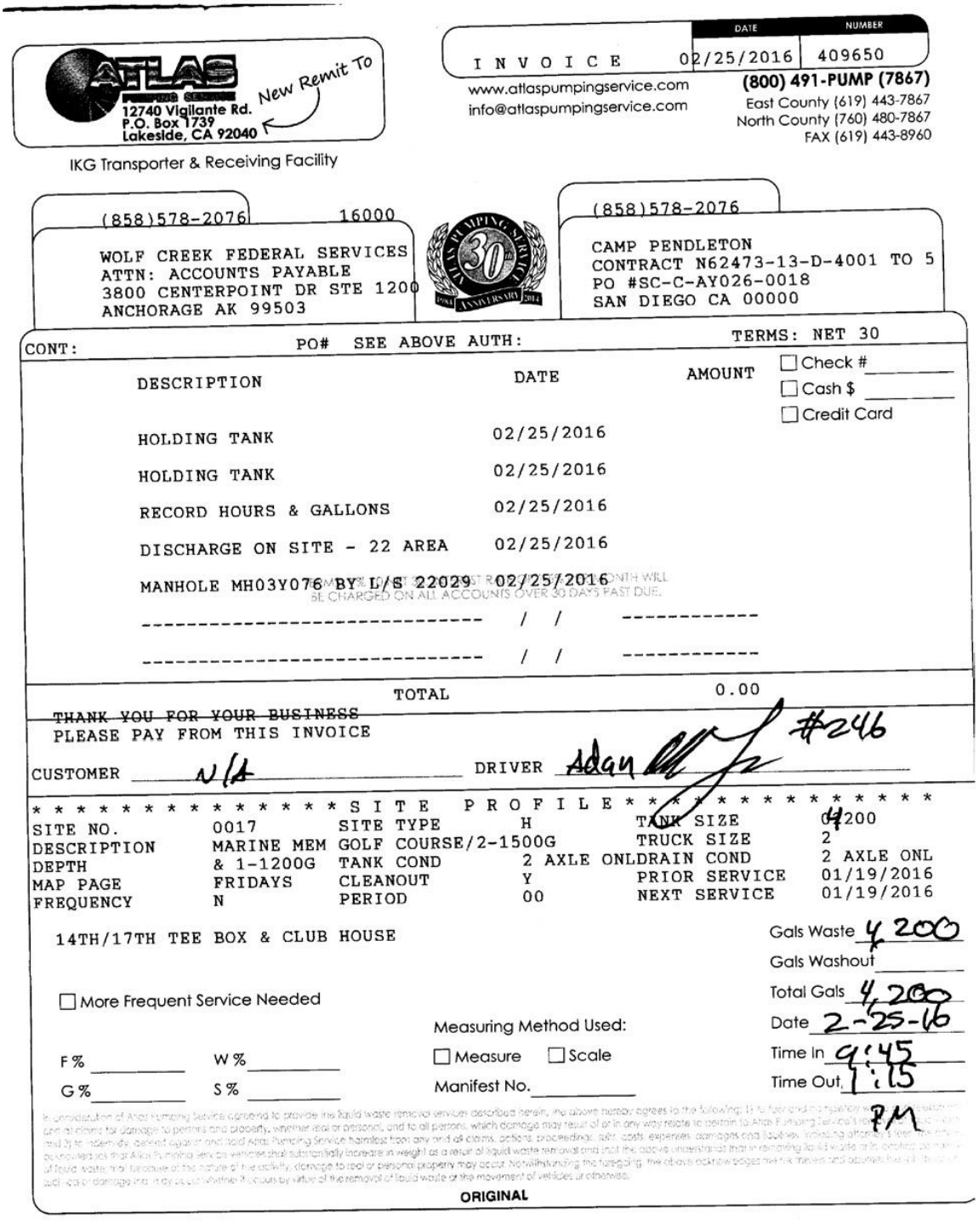
APPENDIX E
DATA USED FOR MODEL DEVELOPMENT AND ANALYSIS

OVERVIEW

Items included in this section are:

1. Septic System Pumping Records E-2–E-5
2. 2016 Metered potable water usage E-5
3. Recycled Water Nutrient Data 2014–2015:..... E-6–E-8

SEPTIC SYSTEM PUMPING RECORDS



ATLAS Pumping Service
12740 Vigilante Rd.
P.O. Box 1739
Lakeside, CA 92040
New Remit To

IKG Transporter & Receiving Facility

INVOICE | DATE 02/25/2016 | NUMBER 409650

www.atlaspumpingservice.com
info@atlaspumpingservice.com

(800) 491-PUMP (7867)
East County (619) 443-7867
North County (760) 480-7867
FAX (619) 443-8960

(858)578-2076 16000

WOLF CREEK FEDERAL SERVICES
ATTN: ACCOUNTS PAYABLE
3800 CENTERPOINT DR STE 1200
ANCHORAGE AK 99503

(858)578-2076

CAMP PENDLETON
CONTRACT N62473-13-D-4001 TO 5
PO #SC-C-AY026-0018
SAN DIEGO CA 00000

CONT: PO# SEE ABOVE AUTH: TERMS: NET 30

DESCRIPTION	DATE	AMOUNT
HOLDING TANK	02/25/2016	
HOLDING TANK	02/25/2016	
RECORD HOURS & GALLONS	02/25/2016	
DISCHARGE ON SITE - 22 AREA	02/25/2016	
MANHOLE MH03Y076 BY L/S 22029	02/25/2016	
---------- / /		----------
---------- / /		----------
TOTAL		0.00

☐ Check #
☐ Cash $
☐ Credit Card

~~THANK YOU FOR YOUR BUSINESS~~
PLEASE PAY FROM THIS INVOICE

CUSTOMER N/A DRIVER Adam #246

* * * * * * * * * * * * * SITE PROFILE * * * * * * * * * * * * *

SITE NO.	0017	SITE TYPE	H	TANK SIZE	4200
DESCRIPTION	MARINE MEM GOLF COURSE/2-1500G			TRUCK SIZE	2
DEPTH	& 1-1200G	TANK COND	2 AXLE ONL	DRAIN COND	2 AXLE ONL
MAP PAGE	FRIDAYS	CLEANOUT	Y	PRIOR SERVICE	01/19/2016
FREQUENCY	N	PERIOD	00	NEXT SERVICE	01/19/2016

14TH/17TH TEE BOX & CLUB HOUSE

Gals Waste 4,200
Gals Washout
Total Gals 4,200
Date 2-25-16
Time In 9:45
Time Out 1:15 PM

☐ More Frequent Service Needed

Measuring Method Used:
☐ Measure ☐ Scale
Manifest No.

F % W %
G % S %

In consideration of Atlas Pumping Service's agreement to provide the liquid waste removal services described herein, the above-named agrees to the following: (1) to defend, indemnify and hold harmless Atlas Pumping Service from any and all claims, actions, proceedings, suits, costs, expenses, damages and liabilities, including attorney's fees, arising out of or connected with damage to persons and property, whether real or personal, and to all parcels, which damage may result of or in any way relate to certain to Atlas Pumping Service's liquid waste removal services; and (2) to indemnify, defend against and hold Atlas Pumping Service harmless from any and all claims, actions, proceedings, suits, costs, expenses, damages and liabilities, including attorney's fees, arising out of or connected with damage to persons and property, whether real or personal, and to all parcels, which damage may result of or in any way relate to certain hazardous waste or its constituents contained in the liquid waste removed by Atlas Pumping Service. Customer acknowledges that Atlas Pumping Service cannot warrant that the weight of the liquid waste removed will not substantially increase in weight as a result of liquid waste removal and that the above-mentioned tank or receiving facility may not contain sufficient capacity for the liquid waste removed

ATLAS PUMPING SERVICE
12740 Vigilante Rd.
P.O. Box 1739
Lakeside, CA 92040
New Remit To

IKG Transporter & Receiving Facility

INVOICE

DATE	NUMBER
04/28/2016	414794

www.atlaspumpingservice.com
info@atlaspumpingservice.com

(800) 491-PUMP (7867)
East County (619) 443-7867
North County (760) 480-7867
FAX (619) 443-8960

(858)578-2076 16000

WOLF CREEK FEDERAL SERVICES
ATTN: ACCOUNTS PAYABLE
3800 CENTERPOINT DR STE 1200
ANCHORAGE AK 99503

(858)578-2076

CAMP PENDLETON
CONTRACT N62473-13-D-4001 TO 5
PO #SC-C-AY026-0018
SAN DIEGO CA 00000

CONT: PO# SEE ABOVE AUTH: TERMS: NET 30

DESCRIPTION	DATE	AMOUNT
HOLDING TANK	04/28/2016	
HOLDING TANK	04/28/2016	
RECORD HOURS & GALLONS	04/28/2016	
DISCHARGE ON SITE - 22 AREA	04/28/2016	
MANHOLE MH03Y076 BY L/S 22029	04/28/2016	
---------- / /		----------
---------- / /		----------

☐ Check #_____
☐ Cash $_____
☐ Credit Card

BE CHARGED ON ALL ACCOUNTS OVER 30 DAYS PAST DUE.

TOTAL 0.00

THANK YOU FOR YOUR BUSINESS
PLEASE PAY FROM THIS INVOICE

CUSTOMER N/A DRIVER Adan Lepe #246

* * * * * * * * * * * * * * * S I T E P R O F I L E * * * * * * * * * * * * * * *

SITE NO.	0017	SITE TYPE	H	TANK SIZE	04200
DESCRIPTION	MARINE MEM GOLF COURSE/2-1500G			TRUCK SIZE	2
DEPTH	& 1-1200G	TANK COND	2 AXLE ONL	DRAIN COND	2 AXLE ONL
MAP PAGE	FRIDAYS	CLEANOUT	Y	PRIOR SERVICE	02/25/2016
FREQUENCY	N	PERIOD	00	NEXT SERVICE	02/25/2016

14TH/17TH TEE BOX & CLUB HOUSE

Gals Waste 4200
Gals Washout 100
Total Gals 4,300
Date 4-27-16
Time In 7:00
Time Out 11:00 AM

☐ More Frequent Service Needed

Measuring Method Used:
☐ Measure ☐ Scale
Manifest No._____

F %_____ W %_____
G %_____ S %_____

In consideration of prices charged, customer agrees to provide the solid waste removal services described herein, the above named agrees to the following: To the full and complete extent permitted by law, customer agrees to defend, indemnify, and hold Atlas Pumping Service harmless from any and all claims, actions, proceedings, suits, costs, expenses, damages and liabilities, including attorney's fees, brought against Atlas Pumping Service by any person or entity, whether real or personal, and by all persons, which damage may result of or in any way relate to owner or Atlas Pumping Service's removal of the above described solid waste. Customer agrees that the above described solid waste removed by Atlas Pumping Service will not increase in weight as a result of liquid waste removal and that the above understates that in removing the above described solid waste, Atlas Pumping Service will not be responsible for any damage to real or personal property that may occur. Notwithstanding the foregoing, the above shall not relieve Atlas Pumping Service of liability for damages caused by its own willful misconduct or the negligence of its employees or agents. Customer agrees that any solid waste left after the removal of solid waste at the agreed upon time will be removed at customer's expense. If invoice is not paid within 30 days of the date of invoice, a finance charge of 1.5% per month will be charged on all accounts over 30 days past due.

ORIGINAL

ATLAS PUMPING SERVICE

12740 Vigilante Rd.
P.O. Box 1739
Lakeside, CA 92040

New Remit To

IKG Transporter & Receiving Facility

INVOICE

DATE	NUMBER
06/25/2015	394996

www.atlaspumpingservice.com
info@atlaspumpingservice.com

(800) 491-PUMP (7867)
East County (619) 443-7867
North County (760) 480-7867
FAX (619) 443-8960

(858)578-2076 16000

WOLF CREEK FEDERAL SERVICES
ATTN: ACCOUNTS PAYABLE
3800 CENTERPOINT DR STE 1200
ANCHORAGE AK 99503

(858)578-2076

CAMP PENDLETON
CONTRACT N62473-13-D-4001 TO 5
PO #SC-C-AY026-0018
SAN DIEGO CA 00000

CONT: PO# SEE ABOVE AUTH: TERMS: NET 30

DESCRIPTION	DATE	AMOUNT
HOLDING TANK	06/25/2015	
HOLDING TANK	06/25/2015	
RECORD HOURS & GALLONS	06/25/2015	
DISCHARGE ON SITE - 22 AREA	06/25/2015	
MANHOLE MH03Y076 BY L/S 22029	06/25/2015	
----------	/ /	----------
----------	/ /	----------

☐ Check #_____
☐ Cash $_____
☐ Credit Card

A MINIMUM $25 SERVICE CHARGE PER MONTH WILL BE CHARGED ON ALL ACCOUNTS OVER 30 DAYS PAST DUE.

TOTAL 0.00

THANK YOU FOR YOUR BUSINESS
PLEASE PAY FROM THIS INVOICE

CUSTOMER N/A DRIVER Adan Lepe #246

* * * * * * * * * * * * * * * * S I T E P R O F I L E * * * * * * * * * * * * * * * *

SITE NO.	0017	SITE TYPE	H	TANK SIZE	02200
DESCRIPTION	MARINE MEM GOLF COURSE/2-1500G			TRUCK SIZE	2
DEPTH	& 1-1200G	TANK COND	2 AXLE ONL	DRAIN COND	2 AXLE ONL
MAP PAGE	FRIDAYS	CLEANOUT	Y	PRIOR SERVICE	04/28/2015
FREQUENCY	N	PERIOD	00	NEXT SERVICE	04/28/2015

14TH/17TH TEE BOX & CLUB HOUSE

2@1500 — 3000GAL
1@1200 — 1200GAL
4200GAL

Gals Waste 4,200
Gals Washout _____
Total Gals 4,200
Date 6-25-15
Time In 10:00
Time Out 1:45

☐ More Frequent Service Needed

Measuring Method Used:
☐ Measure ☐ Scale

F % _____ W % _____
G % _____ S % _____

Manifest No. _____

PM

In consideration of Atlas Pumping Service agreeing to provide the liquid waste removal services described herein, the above hereby agrees to the following: 1) to fully and completely release, relieve and all claims for damage to persons and property, whether real or personal, and to all persons, which damage may result of or in any way relate to pertain to, Atlas Pumping Service's removal of liquid waste; and 2) to indemnify, defend against and hold Atlas Pumping Service harmless from any and all claims, actions, proceedings, suits, costs, expenses, damages and liabilities, including attorney's fees. The above acknowledges that Atlas Pumping Service vehicles shall substantially increase in weight as a result of liquid waste removal and that the above understands that in removing liquid waste or in locating customer's of liquid waste, that because of the nature of the activity, damage to real or personal property may occur. Notwithstanding the foregoing, the above acknowledges the risk thereof, and assumes the liability for any such loss or damage that may occur whether it occurs by virtue of the removal of liquid waste or the movement of vehicles or otherwise.

ORIGINAL

From: Cook, Kyle R UNK AC/S ENV
To: Hsu, Lewis CIV SPAWARSYSCEN-PACIFIC, 71760
Cc: Sorensen, Kara C CIV SPAWARSYSCEN-PACIFIC, 71750
Subject: Golf Course septic pumping
Date: Wednesday, November 9, 2016 5:23:22 PM

Lewis,

The Base maintenance contract shows only the Clubhouse septic tanks and the 14/17 tee restroom septic tank on a pumping schedule. However we know that the maintenance shop tank is also pumped. Recommend we confirm all of these with golf course personnel and also ask about the 6th tee restroom tank, unless you have already confirmed. I don't believe the 6th tee tank is pumped, but not absolutely sure.

Regards, Kyle

Kyle Cook, MSE
Water Quality Section Head/Engineering Branch
Environmental Security, Building 22165
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MCB Camp Pendleton, CA 92055
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Fax: (760) 725-0207
Email: kyle.r.cook@usmc.mil

2016 METERED POTABLE WATER USAGE

Monthly Facility Usage 2016 (Data provided by MCBP Marine Memorial Golf Course)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Golf Rounds	2696	2729	4333	3356	3490	4540	3680	3809	4338	2959	2787	2656
Mulligan's Patrons	2284	2496	2603	2670	2952	2719	2879	2557	2450	2221	1921	1966
Catering Patrons	721	587	873	425	811	853	833	713	456	403	199	50
Patron Total	5701	5812	7809	6451	7253	8112	7392	7079	7244	5583	4907	4672

RECYCLED WATER NUTRIENT DATA 2014–2015

Metered Water Levels 2014 & 2015

RE Golf Course Septic Systems and Monitoring questions trying to chase down drawings for golf course, buildings on golf course, plumbing drawings, surveys, etc...

Ok, let me know if I missed anything.

Kara

-----Original Message-----
From: Cook, Kyle R UNK AC/S ENV [mailto:kyle.r.cook@usmc.mil]
Sent: Wednesday, September 02, 2015 3:43 PM
To: Bartu, Daniel P CIV MARFORPAC, AC/S Facilities, OWR <daniel.bartu@usmc.mil>; Sorensen, Kara C CIV SPAWARSYSCEN-PACIFIC, 71750 <kara.sorensen1@navy.mil>
Cc: Hsu, Lewis CIV SPAWARSYSCEN-PACIFIC, 71760 <lewis.hsu1@navy.mil>
Subject: RE: Golf Course Septic Systems and Monitoring

Potable water is now used regularly on the greens.

Kyle Cook
Water Quality Section Head
Environmental Security
USMC Camp Pendleton, CA
(760) 763-7881

-----Original Message-----
From: Bartu CIV Daniel P
Sent: Wednesday, September 02, 2015 11:45 AM
To: Sorensen Kara C
Cc: Cook CIV Kyle R; Hsu Lewis
Subject: RE: Golf Course Septic Systems and Monitoring

I believe the main meter measures water use at all golf course buildings including maintenance facility. It may also measure potable water use on the greens. I don't know if it is used regularly on the greens or just occasionally to flush salts from the use of reclaim water.

-----Original Message-----
From: kara sorensen [mailto:kara.sorensen1@navy.mil]
Sent: Wednesday, September 02, 2015 11:17 AM
To: Bartu CIV Daniel P
Cc: Cook CIV Kyle R; Hsu Lewis
Subject: RE: Golf Course Septic Systems and Monitoring

Thanks Dan, this is great. Do you know approximately what area the main meter covers (i.e. beyond windmill canyon golf course area)?

-----Original Message-----
From: Bartu CIV Daniel P [mailto:daniel.bartu@usmc.mil]
Sent: Wednesday, September 02, 2015 10:05 AM
To: Sorensen Kara C <kara.sorensen1@navy.mil>
Cc: Cook CIV Kyle R <kyle.r.cook@usmc.mil>
Subject: RE: Golf Course Septic Systems and Monitoring

Kara,

I don't know most of your questions but compiled monthly metered water amounts at two separate meters. The one meter is at the golf course

RE Golf Course Septic Systems and Monitoring_questions trying to chase down club house and the other is the main meter measuring flow into the area. This main meter is describe as being on the 1st right onto a dirt road from the entrance to golf course in a vault. There is actually two meters for the main, a 2 inch and 8 inch line. However, the 8 inch high flow line readings haven't changed for all of 2014. This could mean that flows aren't high enough to register on the high flow meter or it's broken.

		Main Meter (kgal)	Club House (kgal)
2014	Jan	28.6	14.5
	Feb	56.4	19.5
	Mar	82.2	15.5
	Apr	73.6	
	May	111.8	26.99
	Jun	71.1	25.99
	Jul	203.9	27.19
	Aug	226.8	34.45
	Sep	144.1	32.61
	Oct	110.9	24.4
	Nov	469.2	25.3
	Dec	98.3	24.4
2015	Jan	66.3	12.4
	Feb	59.7	11.4
	Mar	119.7	25.4

Dan

-----Original Message-----
From: kara sorensen [mailto:kara.sorensen1@navy.mil]
Sent: Wednesday, September 02, 2015 8:47 AM
To: Bartu CIV Daniel P
Subject: RE: Golf Course Septic Systems and Monitoring

Hi Dan,

This is great, thank you. We took some readings on 23W-01A back in April when we did the initial ground water sampling. I'll send you those.

On a separate, but directly related to the original subject lin
e, note so we are finally kicking off the golf course septic leachate field evaluation study. Lewis, Kyle and I met last week to discuss. Back in August of last year you sent us the potable water use related to that. Can you send us an update on that? So from last conversations I think you mentioned the only metering is maybe at the club house and/or that most of the potable water you believe goes to the club house - that main septic field- is that correct? Do you have any information on the smaller septic tanks/leachate fields up near the maintenance shed or the bathrooms at the top of the golf course or the one down under the main building leachate field/septic system (i.e. the bathrooms on that hill) ? In particular, we are looking for any data on say estimated percentage of potable water might go to those from your total potable water going into that area, septic system size perspective, any historic design build plans on those systems, any metering or plans from metering in that area, survey drawings of area if any, plumbing information if any, any water quality data collected from systems, volume of water being pumped off of systems (Kyle mentioned they are all now being pumped regularly)...etc. I know Kyle (cc'd here) is trying to track some of this down for us but thought it wouldn't hurt to ask you if Kyle hasn't already. Kyle gave us some drawings for the system up by the bathrooms (top of golf course) but didn't have any for the rest.

Wastewater Systems Aboard MCBCP
Contract N62473-10-C-5011
P-1041 (SRTTP FY2012 OM)
OM Monthly Report

November, 2015

1. Safety:
No LTA's or reportable incidents for November

2. Midnight Flow Data:

PARAMETER	Min. Daily Q MGD	Max. Daily Q MGD	Avg. Daily Q MGD	Total Month Q MG
Influent Q	1.69	2.12	1.93	57.95
OOOPS Q	1.20	2.60	1.94	58.30
OFR Q	1.00	2.00	1.50	45.10
Reclaim Q	0.00	0.98	0.23	6.94

Note: OFR = Overflow Ring

3. Reclaim Water Quality Data:

LOCATION	Min. Daily Q MGD	Max. Daily Q MGD	Avg. Daily Q MGD	Total Month Q MG
RWPS #1	0.000	0.940	0.220	6.610
RWPS #2 (FG)	0.000	0.040	0.011	0.330
GNLPS #1	0.000	0.964	0.194	5.811
GNLPS #2	0.000	0.119	0.018	0.528
Horse Lake	0.000	0.964	0.194	5.811
Horse Pasture	0.000	0.000	0.000	0.000
Reservoir 16151	0.000	0.119	0.018	0.528
Front Gate	0.000	0.040	0.011	0.330

Note: FG = Front Gate

4. Influent/Effluent Water Quality Data:

PARAMETER	BOD mg/l	TSS mg/l	Total N mg/l	Total P mg/l	TDS mg/l	Manganese ug/L
Influent Min.	190.00	180.00	53.00	6.70	440.00	24.00
Influent Max.	230.00	350.00	72.00	8.80	650.00	27.00
Influent Avg.	212.86	242.86	62.00	7.87	542.86	24.75
OFR Flow Min.	1.00	2.50	1.70	4.00	490.00	N/A
OFR Flow Max.	8.00	4.00	2.40	4.80	590.00	N/A
OFR Flow Avg.	4.17	3.00	2.10	4.47	541.67	N/A
OOOPS Min.	1.00	2.50	1.60	3.40	1300.00	N/A
OOOPS Max.	5.00	4.00	2.30	4.10	1800.00	N/A
OOOPS Avg.	2.67	2.75	2.00	3.78	1633.33	N/A
Reclaim Min.	1.00	2.50	1.40	4.60	600.00	10.00
Reclaim Max.	4.00	2.50	1.70	5.10	630.00	19.00
Reclaim Avg.	2.60	2.50	1.56	4.82	622.00	15.40

Notes: Babcock Analytical results. "OFR" = Overflow Ring.

5. Total Process Performance:

Average VSR WAS -> DIG #1 %	Average VSR WAS -> DIG #2 %	Average VSR WAS -> DIG #3 %
42.20	30.54	

Note: % VS reduction based on primary digester thickened sludge.

Primary Digester Number	Secondary Digester Number
1	2

6. Sludge Processing:

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REPORT DOCUMENTATION PAGE

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September 2019	Final	

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Windmill Canyon Septic Leachate Assessment
Final Report 2.0
Project Number M3300015POFE174

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5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

Lewis Hsu
Kara C. Sorensen

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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13. SUPPLEMENTARY NOTES

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14. ABSTRACT

Marine Corp Base Pendleton is currently assessing potential uses for recycled water, including increased irrigation and water features for the on-base golf course at Windmill Canyon. In support of this effort, an assessment of the current state of the septic systems at the golf course was performed. During the course of this study, ground penetrating radar and visual assessments were made to determine the location and physical condition of the septic tanks and leach fields. Groundwater samples were taken in select locations to determine current water quality. Potential impacts of leachate on groundwater quality were estimated from 1-dimensional modeling. Results from these assessments were used to develop recommended actions to mitigate current problems and future directions.

15. SUBJECT TERMS

septic system; hydraulic modeling; groundwater; Windmill Canyon; Marine Corps Base Pendleton

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Kara C. Sorensen
U	U	U	U	142	19B. TELEPHONE NUMBER *(Include area code)* (619) 553-1340

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