



**REPORT ON DEMONSTRATION STUDY
CONDUCTED AT
THE BAYONET GOLF COURSE
IN SEASIDE, CALIFORNIA
TO DETERMINE THE COMPATIBILITY
OF RECYCLED WATER
FOR GOLF COURSE IRRIGATION**

April 2006

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EXECUTIVE SUMMARY

Introduction

In cooperation with the Marina Coast Water District, MRWPCA is planning an urban reuse project that would include serving as many as five golf courses. Golf courses will be the largest water users, and will likely have the most stringent water quality requirements of all the urban users.

Some recycled water projects have encountered water quality problems with their golf course customers, and have needed to make additional capital investments to improve their water quality, or have found it necessary to make operational changes to address these problems. Dealing with these problems has increased the cost of the recycled water beyond what the users had been led to expect.

In order to determine how well recycled water will work on the golf courses within the proposed urban reuse service area, a three-year demonstration project was performed. The project was completed in the fall of 2005.

How the Demonstration Project was Performed

During the demonstration project, recycled water from MRWPCA's water recycling plant, the Salinas Valley Reclamation Plant (SVRP), was used to irrigate one green and its adjacent turf area, and a nearby area landscaped with shrubs and flowers, at the Bayonet and Blackhorse golf course located on the Monterey Peninsula on the central coast of California. The rest of the golf course was watered with well water, thereby allowing a direct side-by-side comparison to be made of turf and soil responses to the two types of water. One of the well water irrigated greens was used as the control green, against which to compare turf responses with the demonstration green.

The required volumes of recycled water from the SVRP were delivered by a tanker truck to a temporary storage tank and booster pump located at the golf course.

In order to use recycled water for the demonstration project, it was necessary to obtain the approval of several regulatory agencies. These agencies were the State Department of Health Services, the Monterey County Health Department, and the State Regional Water Quality Control Board.

Responsibilities for operations and maintenance activities during the demonstration project were divided up between MRWPCA and the golf course staff. MRWPCA's principal roles were to supply the recycled water to meet the golf course's irrigation demands and to perform all of the sampling and testing for the project. The golf course's principal roles were to perform irrigation

and turf management at the demonstration sites and to provide information and records to MRWPCA that were helpful in accomplishing the objectives of the project.

During the demonstration project the recycled water and the golf course's well water were tested for a variety of parameters by MRWPCA's laboratory. Soil samples were collected and analyzed by a private soils laboratory. MRWPCA personnel used a field measuring device to make multiple conductivity and soil moisture measurements on each green. Irrigation uniformity testing, which is a measurement of how uniformly the sprinkler systems apply water to the greens, was performed by a private irrigation consulting firm.

Discussion of Results

During each winter natural leaching from rainfall, along with the normal winter time reduction in fertilizer application, dramatically reduced the soil salinity of both the demonstration green and the control green. Soil salinity increased as each year's irrigation season progressed.

In Year 1, which had a summer with an above-average number of days of foggy, cool weather, and therefore lower than normal irrigation demands, no significant turf management problems developed.

In Year 2, which had a summer with an above-average number of sunny days, higher than average temperatures, and higher than normal irrigation demands, turf distress developed toward the end of the summer. A well water flushing period was conducted to remove the salt buildup in the soil.

In Year 3, which had a normal summer in terms of sunny days, average temperatures, and normal irrigation demands, flushing was conducted on a regular basis. However, in Year 3 flushing was performed using recycled water, not well water. The flushing program proved successful, and turf quality and appearance remained satisfactory throughout the irrigation season, using exclusively recycled water for both irrigation and flushing.

In the landscaped area no soil conductivity measurements were made, but the response of the various types of plantings was observed. Many of the plants were quite healthy, while others showed symptoms of distress. It was not possible to determine whether the signs of distress were related to the recycled water.

Turf Management Considerations When Using Recycled Water

There are a number of turf management issues which designers and operators of recycled water irrigation projects serving golf courses, and golf course superintendents, will need to take into account in order to be successful when using recycled water. These are: water quality, total salinity, soil salinity, sodium permeability, chloride and sodium toxicity, and nutrients. These multiple factors can all affect the successful use of recycled water for golf course irrigation, and therefore increase the management complexity of using recycled water rather than potable or

fresh water for irrigation.

Conclusions

Through proper management, both turfgrass and landscaping can generally be made to perform well using recycled water for irrigation. For the demonstration golf course it was found that flushing using recycled water, not potable water, was successful in preventing turf damage caused by salinity buildup in the soil.

The design of an urban reuse project to serve golf courses should include adequate recycled water hydraulic capacity to meet flushing requirements, in order for the project to be successful and to avoid the additional cost of having to provide a potable water supply to serve as the source of water for flushing.

Because of the additional complexities of turf management when irrigating with recycled water, it would be desirable to have a turf agronomist participate as a member of the design team for the recycled water project, and to be available to assist golf course superintendents when the project starts up and for a period thereafter. This will help ensure the success of the project, and the acceptance by the golf course industry of using recycled water for irrigation.

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April 2006

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INTRODUCTION

The Monterey Regional Water Pollution Control Agency (MRWPCA) was formed in 1971 to provide regional wastewater collection, treatment, and disposal for 250,000 residents and businesses in northern Monterey County, California.

MRWPCA operates and maintains a wastewater system comprised of pump stations, force-main and gravity interceptors, a modern secondary level wastewater treatment plant, and a water recycling plant. Recycled water is used for agricultural irrigation, and secondary effluent is discharged through an ocean outfall. Current average flows are approximately 21 million gallons per day (mgd).

Across the nation and around the world, recycled water projects are being developed to serve a variety of urban uses. Many of these projects include golf courses, which are often the largest water users, and which often have the most stringent water quality requirements of all the urban users. In cooperation with the Marina Coast Water District, MRWPCA is planning an urban reuse project that would include serving as many as five golf courses.

The green and tee areas of golf courses have turf that is highly stressed, because it is mowed very short and experiences intense foot traffic. Consequently, golf courses often have the most stringent water quality requirements of all the urban users. Some recycled water projects have encountered water quality problems with their golf course customers, and have needed to make additional capital investments to improve their water quality, or have found it necessary to make operational changes to address these problems. A high level of total dissolved solids (TDS) in the recycled water is the most common of these problems. Dealing with these problems has increased the cost of the recycled water beyond what the users had been led to expect. As the

golf course industry has become aware of these problems, operators of golf courses have become more wary of accepting recycled water.

In order to determine how well recycled water will work on the golf courses within MRWPCA's proposed urban reuse service area, a three-year demonstration project was performed. The project was completed in the fall of 2005.

The goals of this demonstration project were to:

- Determine the suitability of recycled water for irrigation of these courses
- Identify any water quality problems or operational issues that will need to be addressed in the design and operation of the full scale urban reuse project, and/or by the golf course superintendents
- Give local golf course operators the chance to see first-hand how recycled water performs on one of their courses
- Build acceptance of using recycled water for golf course irrigation
- Help facilitate implementation of the urban reuse project

This report includes an overview of turf management issues to be considered when using recycled water on golf courses, and describes an approach that can be used to predict the need for periodic flushing of golf course turf to reduce soil salinity. Identifying and addressing this potential problem during the design of an urban reuse project will be critical to the success of the project.

HOW THE DEMONSTRATION PROJECT WAS PERFORMED

Description of Facilities

During the demonstration project, recycled water from MRWPCA's water recycling plant, the Salinas Valley Reclamation Plant (SVRP), was used to irrigate one green and its adjacent turf area, and a nearby area landscaped with shrubs and flowers, at a golf course on the Monterey Peninsula, located on the central coast of California. These demonstration sites are shown in Figures 1 through 4. The rest of the golf course was watered with well water, which was the normal water supply. This allowed a direct side-by-side comparison to be made of turf and soil responses to the two types of water. During Years 1 and 2 the demonstration areas were irrigated at the same rates as the other areas of the golf course. During Year 3 the irrigation program for the demonstration green was modified to assess the effectiveness of leaching.

The required volumes of recycled water from the SVRP were delivered by a 4,000 gallon tanker truck to a 10,000 gallon temporary storage tank and booster pump located at the golf course. A local construction contractor was hired to do the water hauling. These facilities are shown in Figure 5. Programmable irrigation controllers, typical of those used on many golf courses, controlled the irrigation cycles. The individual sprinkler heads each had their own valves, which only opened when sufficient pressure existed in the water supply piping to meet the sprinkler's operational pressure range. This meant that the booster pump had to continuously maintain adequate system pressure. A small hydropneumatic tank, visible at the right in Figure 5, was

Figure 1 Demonstration Green



Figure 2 Landscaped Area



Figure 3 Turf Area Adjacent to Demonstration Green



Figure 4 Close-up of Landscaped Area



Figure 5 Storage Tank and Pumping Facilities



provided to avoid frequent pump cycling in order to maintain this pressure. The booster pump was connected to the existing sets of sprinklers that watered the green, turf, and landscaped areas, after those sprinklers had first been disconnected from the well water system.

The tanker truck was equipped with its own pump, and discharged its load of recycled water into the storage tank through a quick-connect fitting on the fill pipe. To provide a back-up water supply in the event the storage tank ran low, a separate fill pipe connected to the well water system was provided. This is visible in Figure 5 as the white plastic pipe that can discharge through an air-gap into the top of the storage tank. This air gap prevented any cross-connection between the recycled water system and the well water system.

The costs to conduct the demonstration project are summarized in Table 1.

Permits and Approvals to Conduct the Demonstration Project

In order to be able to use recycled water on the golf course for the demonstration project, it was necessary to consult with several regulatory agencies. A description of the proposed project was

Table 1 – Demonstration Project Costs	
ONE-TIME SETUP COSTS	
ITEM	APPROXIMATE COST
PURCHASE MATERIALS AND EQUIPMENT	
10,000 gallon steel storage tank, including shipping and taxes	\$4,400
Piping, electrical, and booster pump materials and supplies	\$5,000
Fabricate recycled water signs (made by a sign shop)	\$300
TOTAL MATERIALS AND EQUIPMENT COSTS=\$9,700	
STAFF LABOR COSTS	
Project design and coordination	\$3,000
Obtain permits and approvals	\$1,300
Train golf course personnel in use of recycled water	\$500
Labor to install storage tank, piping, booster pump, and associated electrical work	\$3,600
TOTAL STAFF LABOR COSTS=\$8,400	
TOTAL ONE-TIME SETUP COSTS=\$18,100	
ANNUAL O&M COSTS	
Fill storage tank (7 months at an average of 1.5 - 4,000 gallon loads per week @ \$140/load)	\$5,900
Water & soil testing (combined in-house and outside lab tests)	\$1,000
TOTAL ANNUAL O&M COSTS=\$6,900 (approximately \$1,000/month)	

provided to each of these agencies, and their approval to conduct the project was requested. The issues of concern to each agency, and how their concerns were addressed, are described below.

California State Department of Health Services (DHS) – In California this is the State agency that develops and administers recycled water regulations, which are found in Title 22 of the California Code of Regulations. DHS wanted assurances that the recycled water facilities would be constructed and would be used in a manner consistent with Title 22 requirements, including in particular that there would be physical separation between the recycled water piping system and the golf course’s well water supply system, and that there would be signage informing persons at the storage tank and at each of the reuse sites that recycled water was being used. Physical separation of the systems was achieved by cutting and capping the well water supply lines to the sprinklers at the demonstration irrigation sites, and then pressurizing the well water system to confirm that no water was discharged from the sprinklers at either of these sites. DHS’s other issues of concern were addressed to their satisfaction as described below under Monterey County Department of Health.

Monterey County Department of Health, Division of Environmental Health – In California each County has its own Health Department which establishes and enforces County health

regulations, and in some instances also performs inspections for other agencies that have their own health regulations. For this project the County Health requirements were:

- Providing them with construction details including existing piping, proposed new piping, and color and pipe specifications for the recycled water piping. This was easily accomplished using piping plans available from the golf course, sketches showing the intended layout of the new piping, and catalog cut sheets from manufacturers of purple-colored PVC pipe intended for use with recycled water distribution systems.
- Providing them an operations plan which included limiting the times of irrigation to only when the facility (the golf course) was closed to the public, and signage locations and verbiage. For this project the operations plan was based on a set of requirements that had been applied by the California Regional Water Quality Control Board (RWQCB) to several other nearby golf courses that were using recycled water. Those requirements included restricting irrigation with recycled water to times and manners that would prevent or minimize public contact, and to allow irrigated areas maximum opportunity to dry before allowing public use. In addition drinking fountains were protected from direct or windblown spray of recycled water. Latitude was allowed for the verbiage on the informational signs, so long as the message that recycled water was being used for irrigation was clearly conveyed. The precise language that was chosen for the signs at the storage tank was “Recycled water is stored in this tank. It is not suitable for potable water purposes. Do not use for drinking or washing.” For the informational signs at the irrigation sites the language read “To evaluate its use as a future water conservation measure, recycled water is being used to irrigate this area.”
- Coordinating with their staff for final piping trench inspections prior to backfill. In order to minimize disruption to golfers, the golf course maintenance crews installed the recycled water piping and made the modifications to the well water system in the early evening and in the very early morning, when no players were on the course. County Health was given advance notice of the dates and times the work was going to be performed, so they could be present to inspect the work in progress.

California Regional Water Quality Control Board (RWQCB) – In California the State’s water quality regulations are administered and enforced by nine RWQCB’s, each covering a specific geographic area. Consultation with the Central Coastal RWQCB, which had jurisdiction in the project area, led to their approval to proceed with the project, as long as the concerns and requirements raised by DHS and County Health were addressed.

In addition to satisfying these regulatory agency requirements, a Memorandum of Understanding was executed between MRWPCA and the golf course Manager to formalize the terms and conditions for the performance of the demonstration project. A copy of this Memorandum of Understanding is contained in [Appendix D](#).

Operational Responsibilities

Once the facilities to conduct the demonstration project were installed and the system was ready to start up, a series of meetings with MRWPCA staff and the golf course staff was held. The purpose of these meetings was to identify all operations and maintenance activities which could be expected to occur during the demonstration project, and to assign responsibilities to the

appropriate parties. As a result of these meetings, the following lists of responsibilities were developed.

MRWPCA Responsibilities:

1. Whenever the Golf Course called for a water delivery, immediately contact the water hauling contractor to set up the delivery. When the delivery date and time were known, the Golf Course was contacted to let them know when the water would be delivered.
2. For the initial water deliveries, MRWPCA staff accompanied the tanker truck to the storage tank site to supervise the filling of the tank. Once everything was going smoothly and no problems were occurring during deliveries, accompanying the tanker truck was discontinued.
3. Recycled water samples from the storage tank were collected on a regular basis, and analytical data from these samples was compiled in an Excel spreadsheet. The spreadsheet was accessible to all MRWPCA staff working on the project via MRWPCA's local area network.
4. Each recycled water delivery was logged, noting the date, time, and volume of each delivery. For each delivery the tanker truck was inspected prior to being filled at the SVRP to ensure that it was completely empty of any prior water it had held. In some instances the tank truck was rinsed with potable or recycled water before filling it, to remove any sediment or foreign water.
5. Initially it was planned to regularly read and log the water meter at the storage tank to track the delivery of recycled water to the project. However, this was discontinued after a short period when it was found that the logging of deliveries at the SVRP provided sufficient data for this purpose.
6. Soil samples were analyzed, and in situ soil conductivity measurements were made, on both the demonstration green (the 13th green) and on a nearby green (the 14th green) that was being irrigated with well water. The 14th green served as the control green.

Golf Course Responsibilities:

1. Irrigation of the demonstration green and landscaped area was performed in accordance with the following requirements:
 - Irrigation with recycled water was done at a time and in a manner to prevent or minimize public contact with recycled water, and to allow irrigated areas maximum opportunity to dry before use.
 - Drinking fountains were protected from direct or windblown spray of recycled water.
 - Recycled water was not used for irrigation during periods of rainfall.
2. MRWPCA was contacted whenever the storage tank level had dropped to 70% full, so MRWPCA could schedule a water delivery.
3. If the Golf Course Superintendent determined that turf distress potentially related to the use of recycled water was occurring, he could conduct a flushing cycle. If any well water was put into the storage tank for a flush or any other reason, he immediately notified MRWPCA when he initiated the well water flush and also the time the use of well water ended. This provided information about flushing volumes and frequencies.

4. Fertilization of both of the irrigation sites was logged, including the date and time of fertilization, what fertilizer was being used, and the application rate. [Note: This information turned out not to be particularly important for the demonstration project.]
5. Other turf management work that was done at either irrigation site, such as top dressing, aerification, application of any herbicides or fungicides, etc., was also logged. This information was available if needed to help explain any anomalies in the analytical results.
6. Soil samples were periodically taken from the demonstration green and the control green and provided to MRWPCA to send to the soils lab for analysis.

Sampling and Analysis

During the demonstration project the following types of samples and analyses were performed:

Water – The recycled water was tested for a variety of parameters on a regular basis, normally once per month during the irrigation periods. The golf course well water supply had been sampled by the golf course superintendent on a sporadic basis prior to the demonstration project, typically only once every few years, so little background data was available. In Year 3 of the demonstration project the well water was also sampled and tested on a monthly basis to provide corresponding data for the recycled water tests. This data is presented in Figures 6 through 12.

Soil – Soil samples were collected on the 13th and 14th greens and analyzed by a soils laboratory. The samples were taken using a small diameter soil coring tool, commonly used for this purpose on many golf courses. Samples were taken at numerous locations on each green and then composited before sending them to the laboratory. The results therefore represent average soil conditions across each of the greens. This data is presented in Figures 13 and 14.

In Year 3 an additional soil test was performed to characterize the soils of the 13th and 14th greens. These test results are contained in Appendix C.

In Situ Conductivity and Moisture – A field measuring device was used to make multiple conductivity and soil moisture measurements along two transects on each green. The transects were perpendicular to each other, running along the two major axes of the greens as shown in Figures 15 and 16. Measurements were taken at 5 foot intervals along these transects using a Dynamax WET Sensor, pictured in Figure 17. The WET Sensor measures water content, electrical conductivity, and temperature in the soil. The measurements are made by pushing the Sensor probe approximately two inches into the soil. The Sensor reads out digitally approximately two seconds after the probe is inserted into the soil, and the data is stored for later downloading into a computer for analysis and plotting. The WET Sensor is easy to use, and the manual that came with the unit provided all of the necessary instructions and other information. A summary of the results of these in situ conductivity measurements is shown in Figure 18. The detailed plots for each transect are contained in Appendix A. These include the soil moisture measurements that were taken in conjunction with the conductivity measurements.

The WET Sensor used in the demonstration project was checked against two laboratory conductivity meters, using two stock solutions with different known conductivities. Although there was some variability in the measurements obtained with the WET Sensor, its readings were

Figure 6
Recycled Water Quality Data
Year 1 (2003)

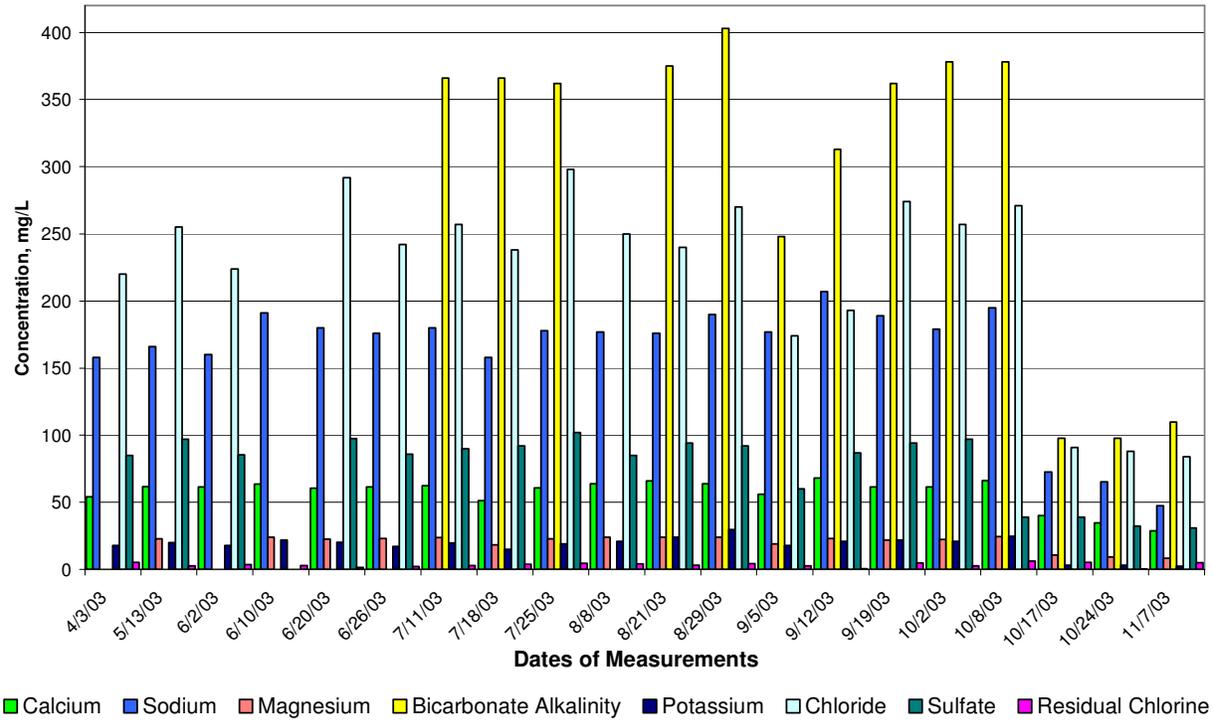


Figure 7
Recycled Water Quality Data
Year 2 (2004)

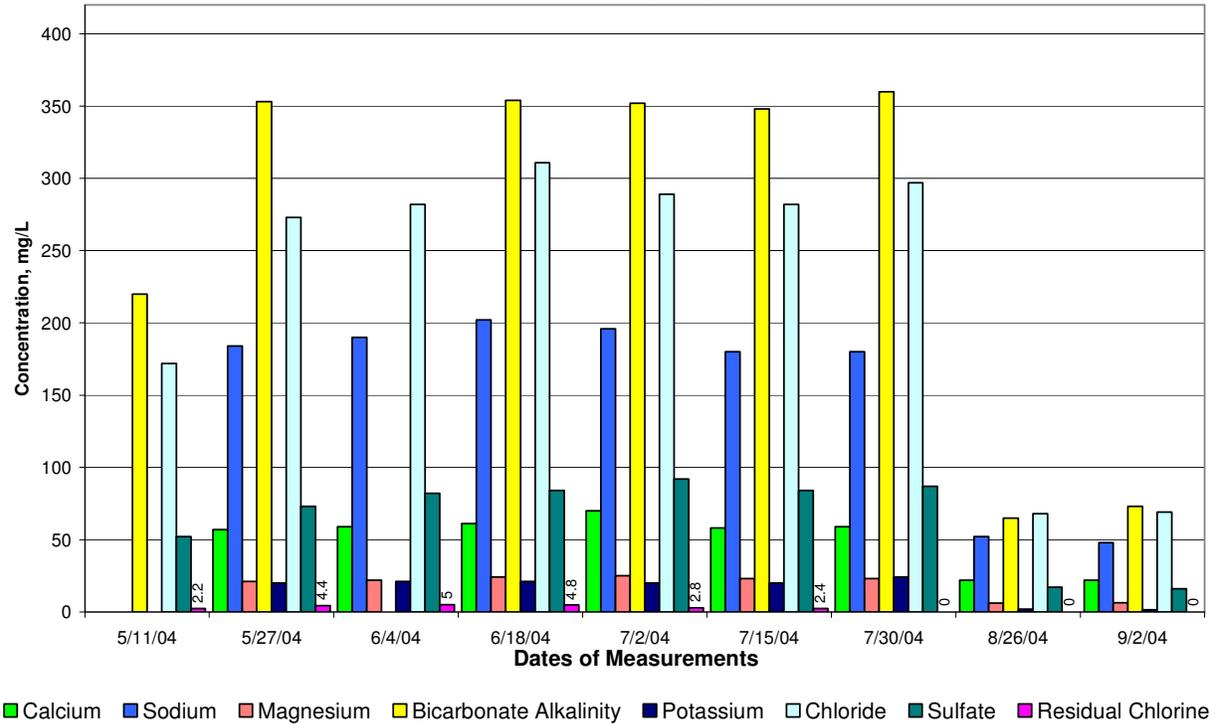


Figure 8
Recycled Water Quality Data
Year 3 (2005)

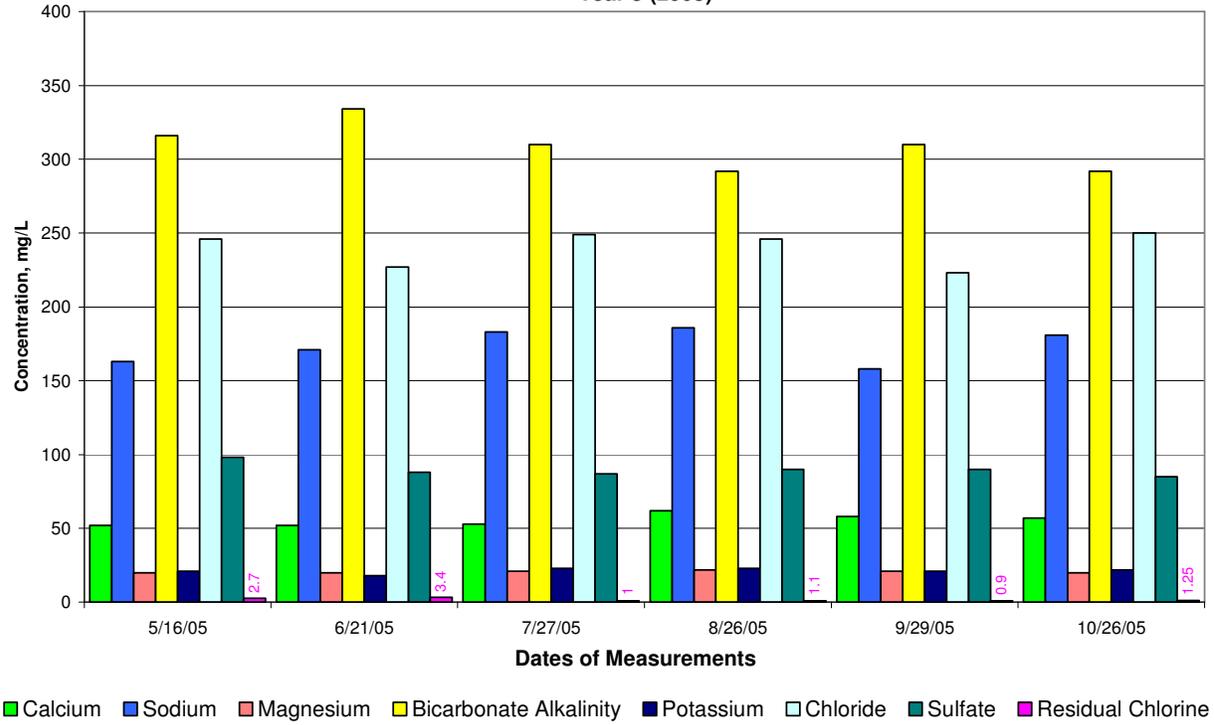


Figure 9
Recycled Water Conductivity and SAR Data
Year 1 (2003)

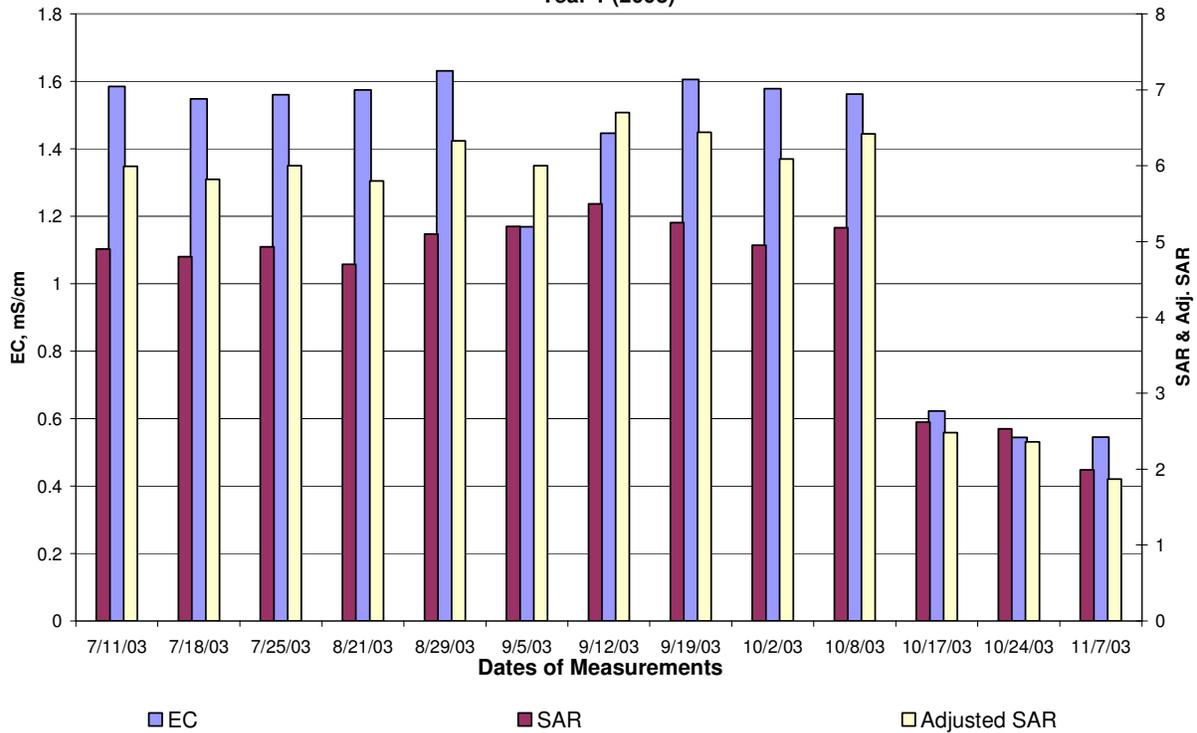


Figure 10
Recycled Water Conductivity and SAR Data
Year 2 (2004)

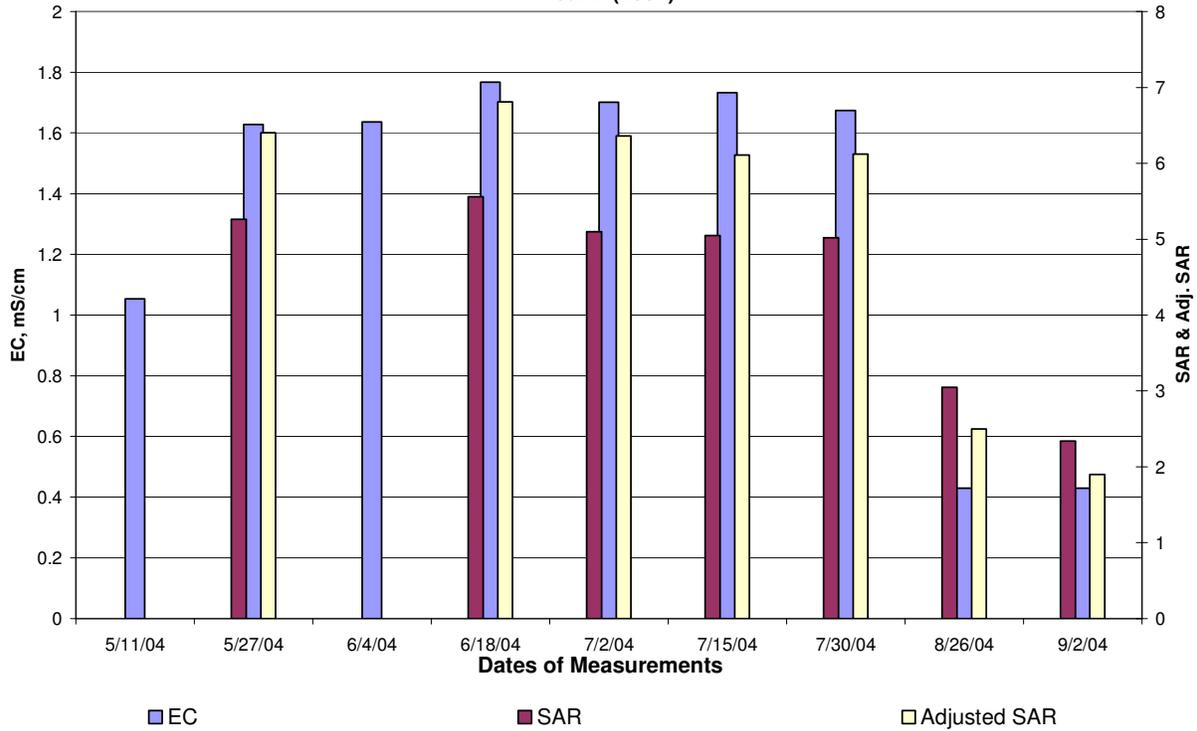


Figure 11
Recycled Water Conductivity and SAR Data
Year 3 (2005)

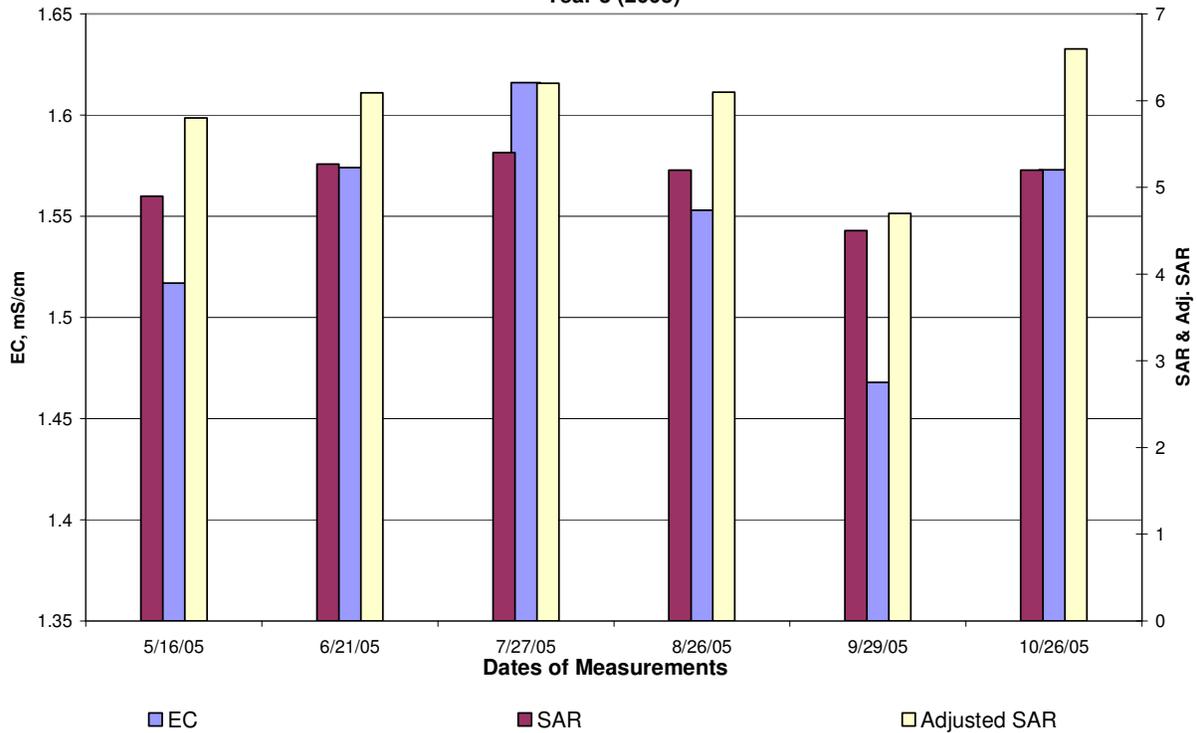


Figure 12
Well Water Quality Data

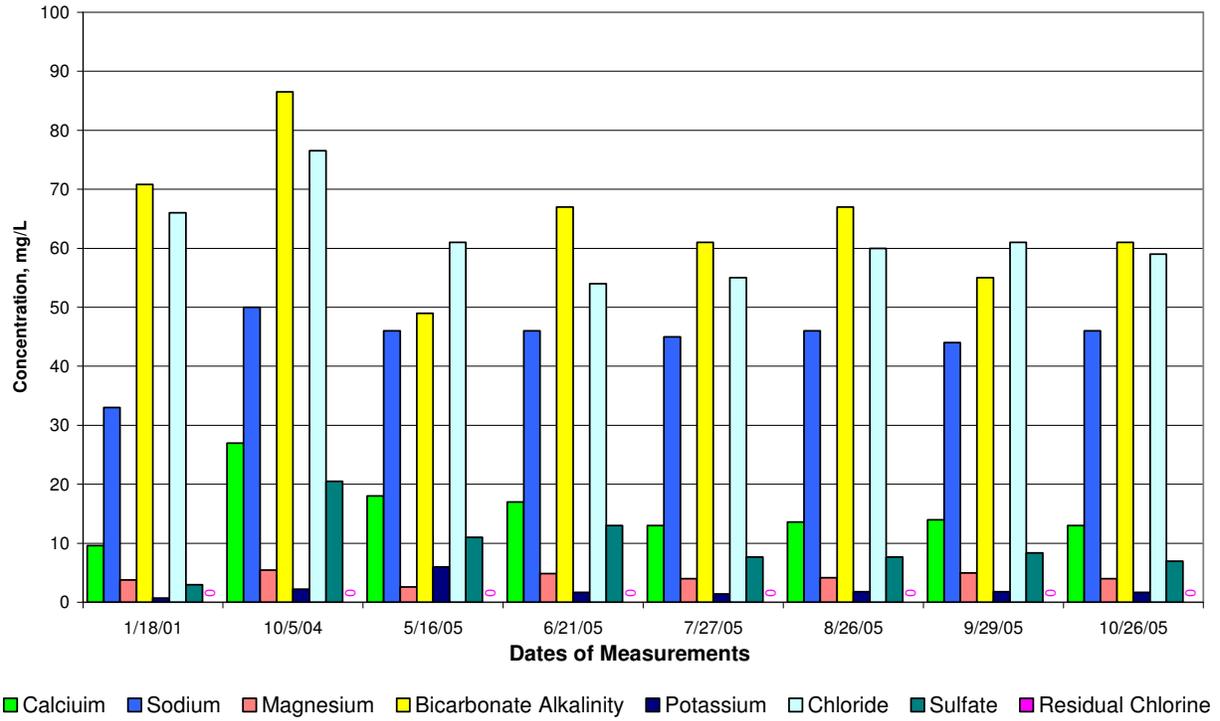


Figure 13
13th Green Soil Sampling Data

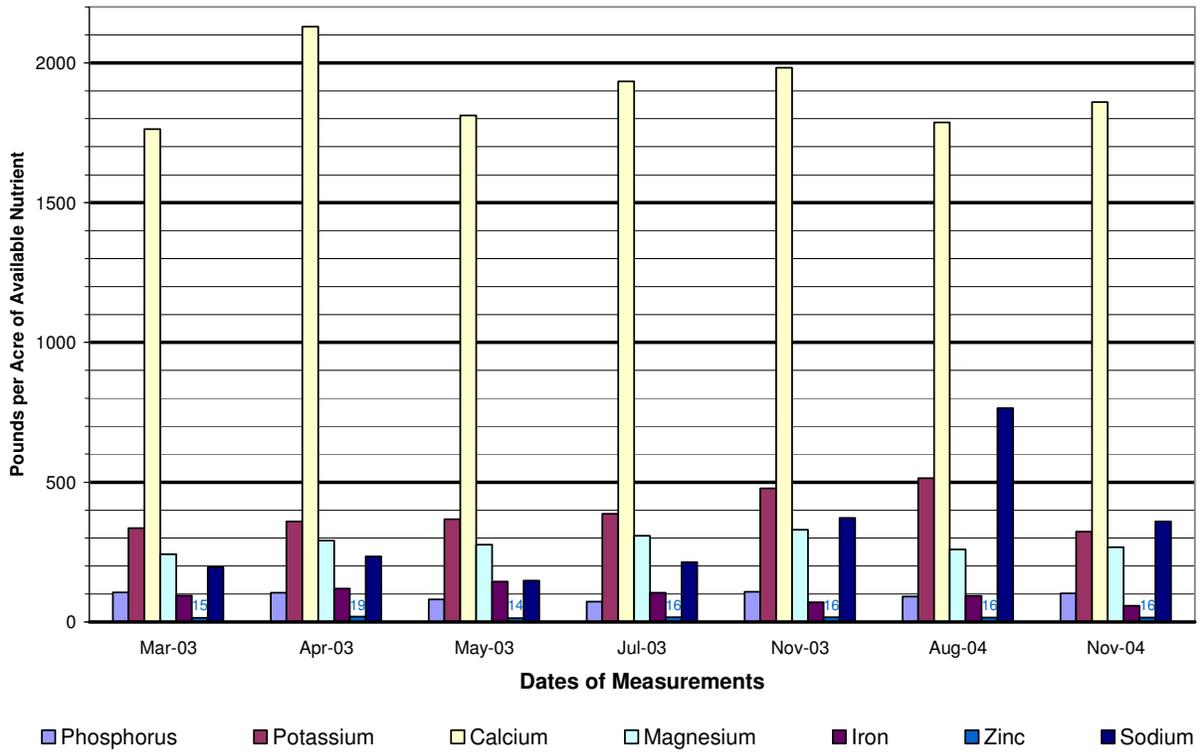


Figure 14
14th Green Soil Sampling Data

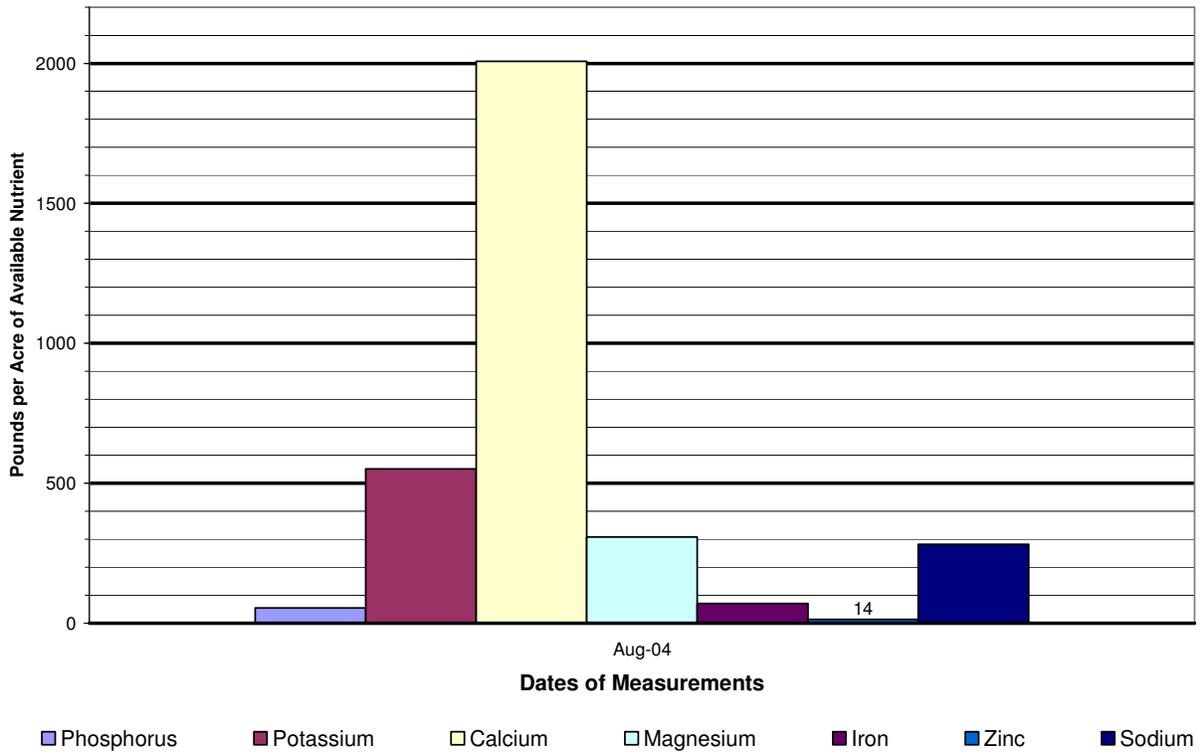


Figure 15 Demonstration Green (13th Green) Transects

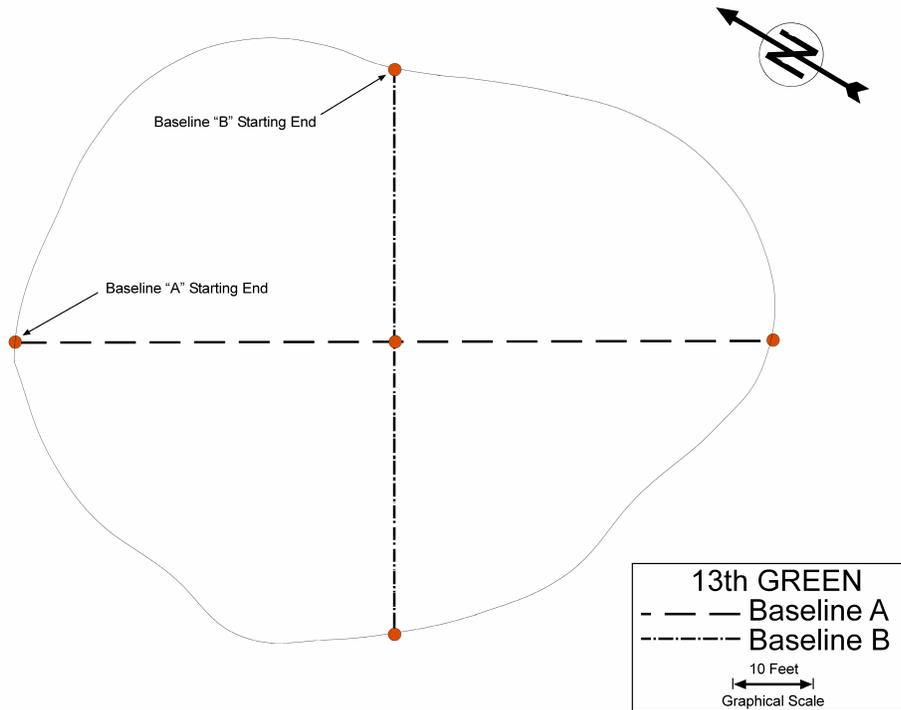


Figure 16 Control Green (14th Green) Transects

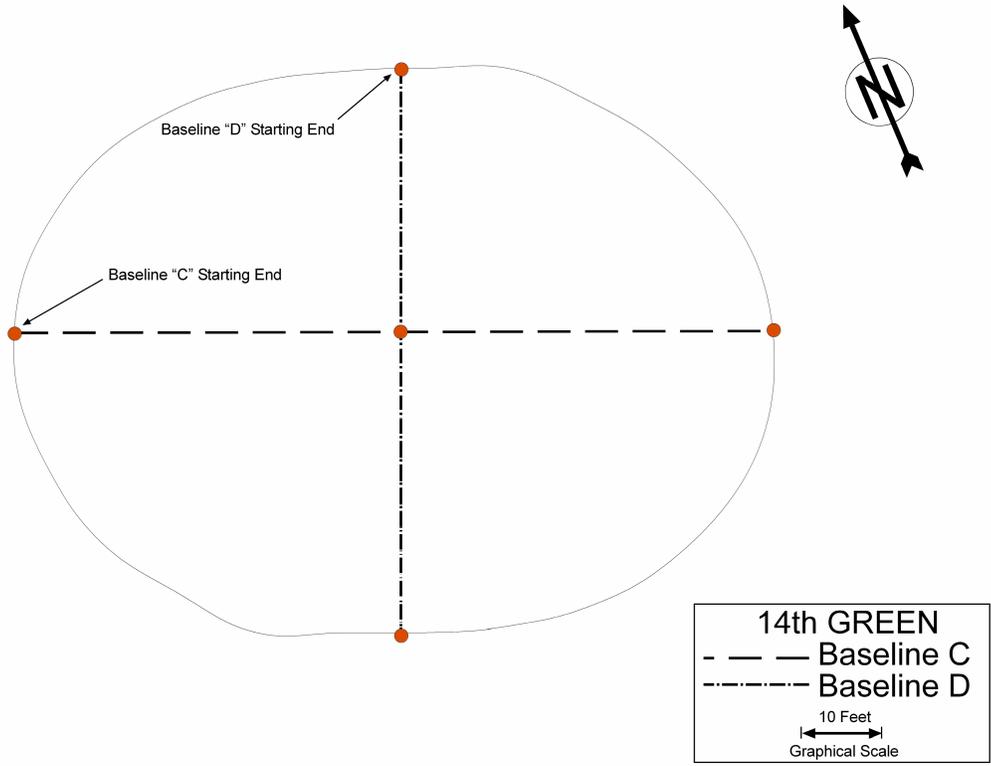


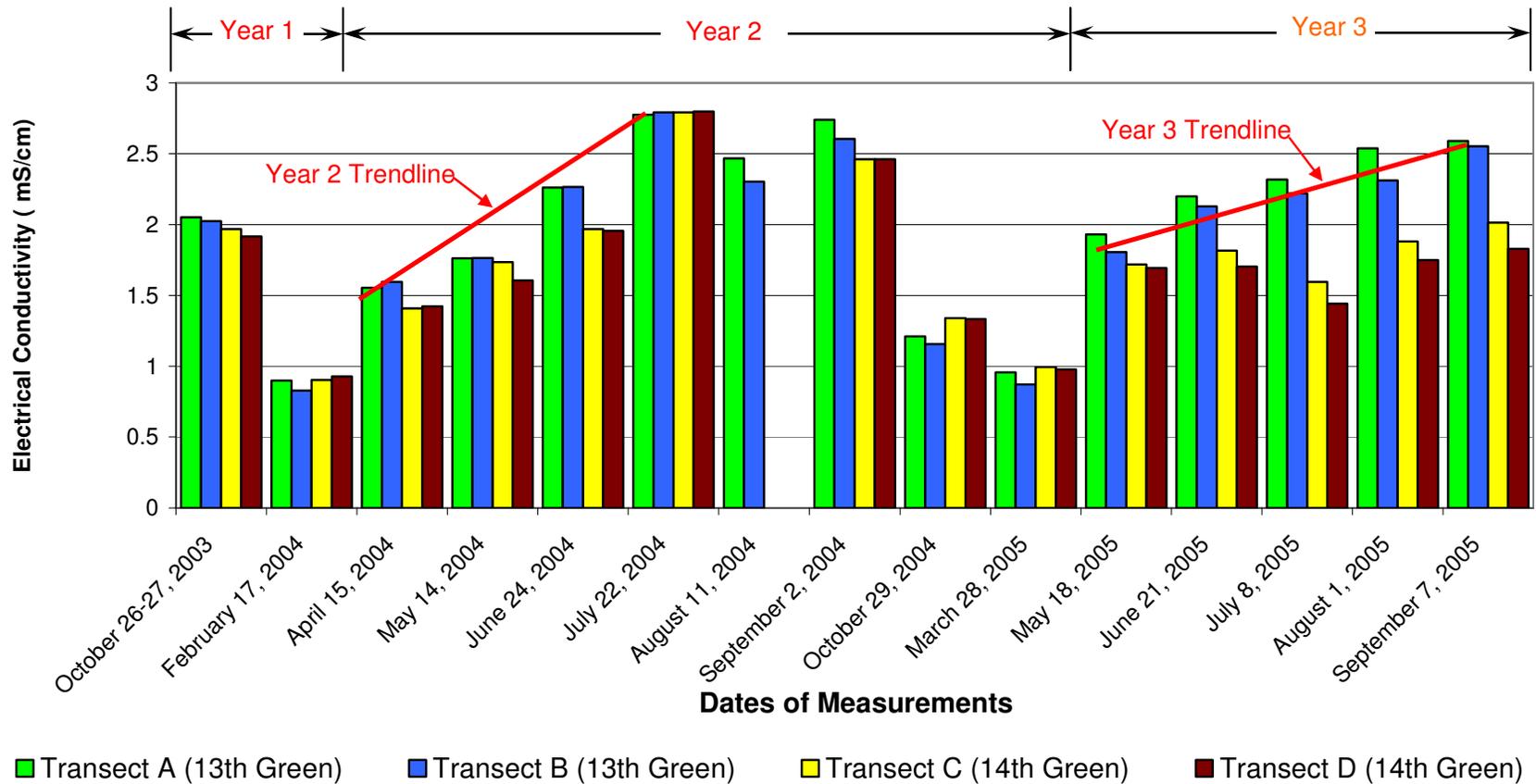
Figure 17 WET Sensor



Figure 18

Average Values of Electrical Conductivity Along Each Transect

Year 1: March 31 = First Recycled Water Delivery in 2003 September 22 = Last Recycled Water Delivery in 2003
Year 2: April 30 = First Recycled Water Delivery in 2004 October 15 = Last Recycled Water Delivery in 2004
Year 3: April 29 = First Recycled Water Delivery in 2005 September 22 = Last Recycled Water Delivery in 2005



consistently within 0.1 mS/cm of the laboratory meters. The WET Sensor was therefore considered to be quite acceptable for purposes of making turf conductivity measurements. The WET Sensor was purchased at a cost of approximately \$1,600. Information about the WET Sensor can be found on the Dynamax website at www.dynamax.com.

Irrigation Uniformity – Irrigation uniformity refers to how uniformly the sprinkler systems apply water to the greens. Non-uniform irrigation can result in ponding, turf disease, and other adverse impacts. Irrigation uniformity is determined by performing catch-can tests.

Calibrated containers, referred to as catch cans, are placed in a grid pattern over the green, and then the irrigation system is run for about 15 minutes. The volume of water captured in each container is measured, and a statistical analysis of the data is made to determine the distribution uniformity. If necessary, modifications to the sprinkler system can be made to bring the distribution uniformity into conformance with acceptable distribution uniformity ranges which have been established by the golf course industry.

Irrigation uniformity testing for the demonstration project was performed August 10, 2005. The testing was performed by Andy Slack, President of Spotwater Management, Inc. This firm provides independent irrigation design and consulting services throughout the United States, and is headquartered in San Jose, California. Mr. Slack is well qualified and licensed to perform this type of work, as noted in the descriptive information and irrigation uniformity testing results contained in Appendix B. The distribution uniformity was found to be 64% on the 13th green (the demonstration green) and 69 % on the 14th green (the control green). Mr. Slack noted that this range of distribution uniformity was "...not too bad considering the age of the piping system, and the inconsistent sprinkler spacing..." on these greens. He also noted that the operating pressures were lower on the 13th green (~60 psi) than the 14th green (~80 psi), which may explain the distribution uniformity results being a little lower on the 13th green. The pressure difference is due to the fact that a separate irrigation pumping and piping system was set up at the 13th green for the demonstration project, in order to keep the recycled water piping separate from the irrigation piping for the rest of the golf course.

Based on the irrigation uniformity testing, there does not appear to be a significant impact on the other test results, or the findings and conclusions of the study, due to differences in irrigation uniformity between the demonstration green and the control green.

Recycled Water Deliveries

MRWPCA began providing recycled water to the golf course on March 31, 2003, which was the start of Year 1 of the project. Regular recycled water deliveries were made throughout the 2003 irrigation season, with the last delivery in Year 1 being made on September 22, 2003. After that point the golf course superintendent determined that there was insufficient irrigation demand to continue delivering recycled water. After the storage tank was empty of recycled water, it was flushed out with well water and left ready to resume use in the spring of 2004. From the end of October 2003 until mid-April 2004, only minor infrequent irrigation of the greens was necessary, as there was sufficient precipitation and cool/cloudy weather to satisfy the turf's irrigation

requirements. In 2003 approximately 225,000 gallons (0.69 AF) of recycled water was delivered to the demonstration project.

In Year 2 the first recycled water delivery was made on April 30, 2004. Regular recycled water deliveries were made from that date until the end of July, 2004 at which time the superintendent determined that the grass on the demonstration green (the 13th green) was in distress. He felt this was probably caused by high salt levels, so he initiated a well water flushing cycle beginning on July 31. Irrigation using well water ended on September 7, at which time irrigation using recycled water was resumed. The last recycled water delivery in Year 2 was made on October 15, 2004. In 2004 approximately 224,000 gallons (0.69 AF) of recycled water was delivered to the demonstration project.

In Year 3 the first recycled water delivery was made on April 29, 2005. Regular recycled water deliveries were made throughout the 2005 irrigation season, with the last delivery in Year 3 being made on September 22, 2005. During Year 3 a concerted effort was made to closely monitor soil salinity levels and to conduct flushing cycles, using recycled water, whenever necessary. The objective of these flushing cycles was to prevent the occurrence of turf damage, which was experienced during Year 2. The flushing procedures and their effectiveness are described below. At the end of September the golf course superintendent determined that there was insufficient irrigation demand to continue delivering recycled water. In 2005 approximately 224,000 gallons (0.69 AF) of recycled water was delivered to the demonstration project.

The quantities of recycled water delivered to the golf course for Years 1, 2 and 3 of the demonstration project are shown in Figures 19 through 21.

DISCUSSION OF RESULTS

Soil Salinity

For this demonstration project soil conductivity was used as an indicator of soil salinity. The average soil conductivity values for all four of the transects are shown in bar chart format in Figure 18, which provides a side-by-side comparison of each of the transect average values. Figure 18 provides a useful indication of trends in salinity changes as the irrigation season progressed. It also shows the difference in salinity changes between the demonstration green and the control green. Figures 22 through 25 show the results of all of the soil conductivity measurements made along each of the four transects. Figures 22 through 25 indicate the variation in conductivity along the transects on each date that measurements were taken. The difference between the low and high conductivity values ranged from about 0.3 mS/cm to well over 1.2 mS/cm, over the range of measurements that were taken. This is important information for the golf course superintendent to know, as it is an indication of possible non-uniform irrigation, non-uniform fertilizer application, a non-uniform soil matrix, or some other turf management issue that may need attention to provide a healthy putting surface.

As Figure 18 indicates, during the winter of 2003-2004 which followed the Year 1 (2003) irrigation season, natural leaching from rainfall, along with the normal winter time reduction in

fertilizer application, dramatically reduced the soil salinity on both of the greens. The transects show increasing conductivity as the 2004 irrigation season progressed. During 2004 conductivity levels in the 14th green were lower than those in the 13th green up until the July 22, 2004 measurements were made, at which time they had become nearly identical. A fresh water flushing period was then conducted on the demonstration green, ending on September 2, 2004 when irrigation with recycled water was resumed. Figures 13 and 14 show that of the various constituents sampled in the soil on each of the two greens in August 2004, when the well water flushing period had only been going on for a few days, the constituent with the most significant difference was sodium. In that sampling event the sodium content in the demonstration green soil was approximately 2.7 times as high as it was in the control green soil. The significance of this is discussed below.

During the 2005 irrigation season, flushing was conducted on a regular basis. The first flushing cycle was conducted from June 22-June 24, 2005. The second flushing cycle was conducted from July 9-July 11, 2005. This second cycle was more intense, i.e. the duration of the heavy irrigation period was increased from 30 minutes to 45 minutes, resulting in approximately 3/8 inch of water being applied each night for two consecutive nights, for an overall flushing application of approximately 3/4 inch for the two nights. Flushing on two consecutive nights for 45 minutes was performed every three weeks in August and September, up until the end of the irrigation season on September 22, 2005. After that date only occasional hand watering of greens was performed, but no sprinkler irrigation was needed.

As described more fully under the section titled "Turf Management Considerations When Using Recycled Water" later in this report, the *Poa Annua* grass on the greens of the demonstration golf course is one of the most salt-sensitive types of turfgrass. It has a salinity tolerance level of approximately EC = 1.5 mS/cm. The initial strategy developed for the flushing program was to regularly measure the soil EC, and when the EC reached 1.5 to perform flushing at a duration and frequency that would keep the EC Below 1.5. However, it was found to be infeasible to keep the EC that low, because the EC of the recycled water itself was sometimes above that level. Therefore, the initial strategy was revised to perform flushing when the EC reached 2.0 to 2.5 mS/cm. The intent was to flush on two successive nights at 1 inch of applied water per night. However, it was subsequently found that the irrigation application rate was lower than anticipated, because of the lower water pressure in the recycled water piping system. The target of 1 inch per night was not achieved, and only 3/8 inch per night was actually applied. In spite of this, the flushing program proved successful, and turf quality and appearance remained satisfactory throughout the irrigation season, using exclusively recycled water for both irrigation and flushing.

The success of the flushing program is likely due in good part to the turf management measures taken by the golf course superintendent. These included applying additional calcium (Kelly's brand calcium, which is 10% calcium by weight) at a rate of 7 pounds per 1,000 square feet to replace the calcium that was leached by the flushing cycles. He also added a wetting agent ("Dispatch" brand) to the irrigation water, and increased the gypsum application rate, which he normally did anyway over the entire golf course to help balance the soil pH and to offset the sodium and other salts that are contained in fertilizers.

Figure 20
Quantities of Recycled Water Delivered to the Golf Course
in Year 2 (2004)

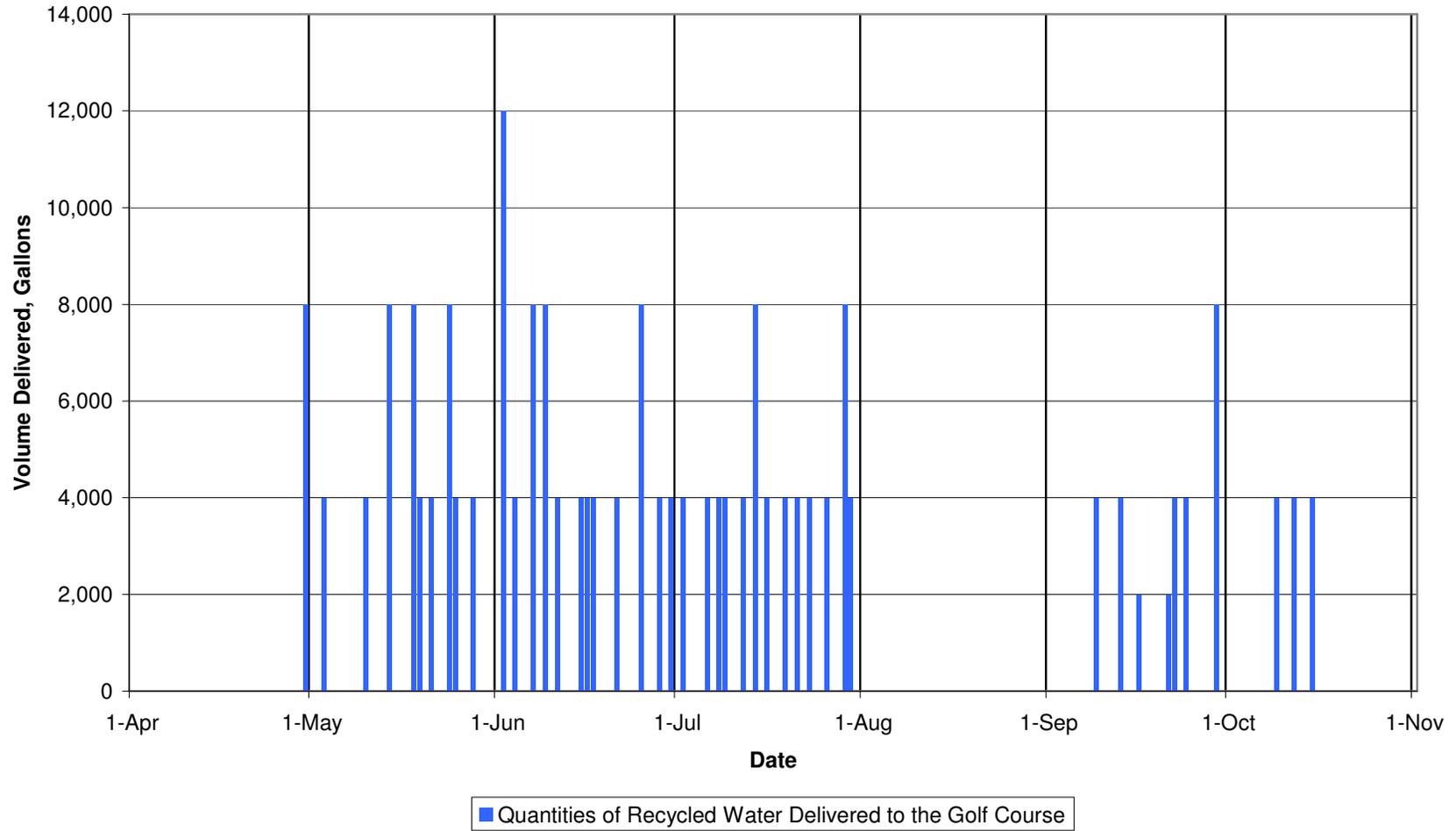


Figure 22
Values of Electrical Conductivity Along Transect A
Demonstration Green (13th Green)

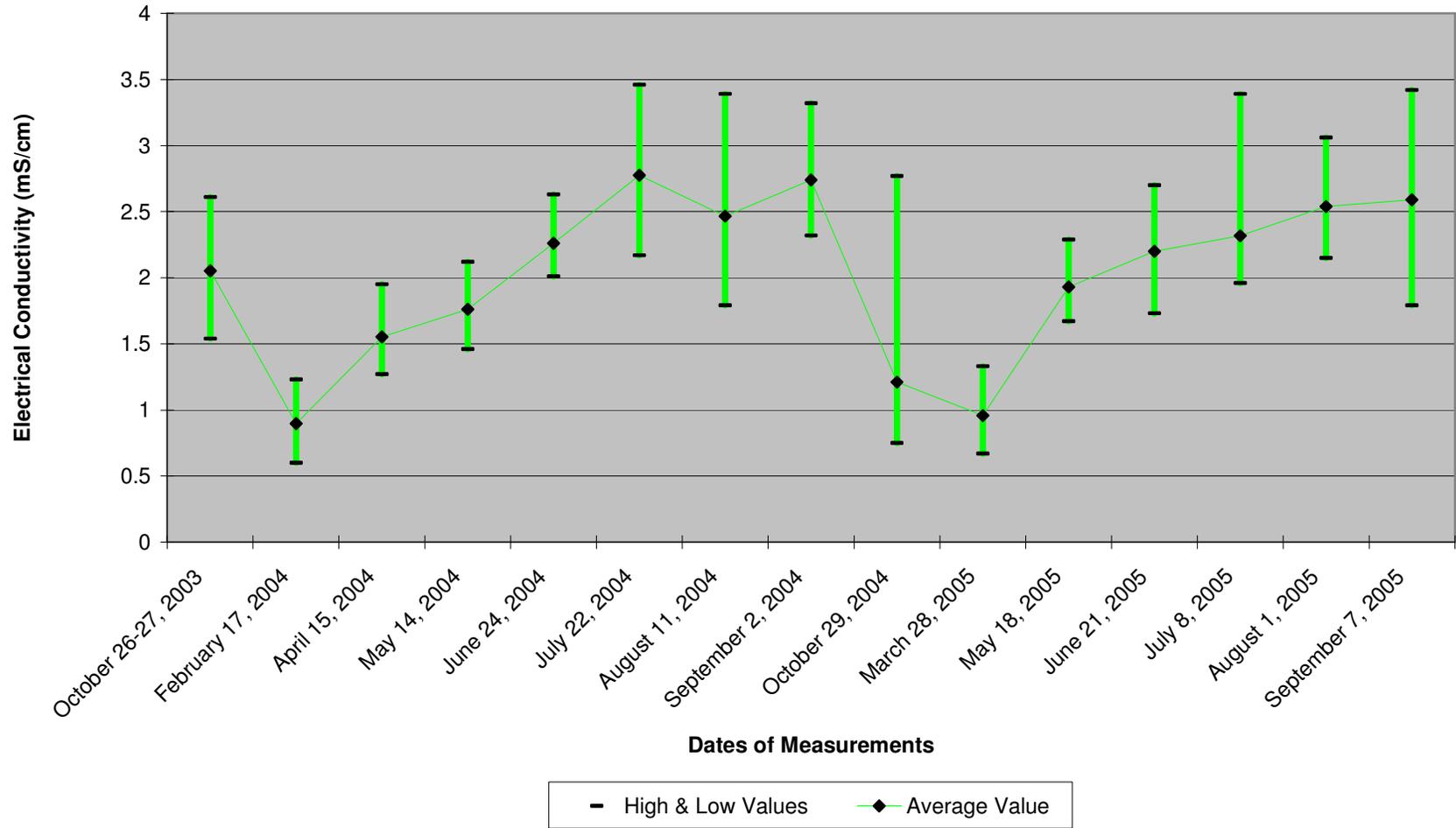


Figure 23
Values of Electrical Conductivity Along Transect B
Demonstration Green (13th Green)

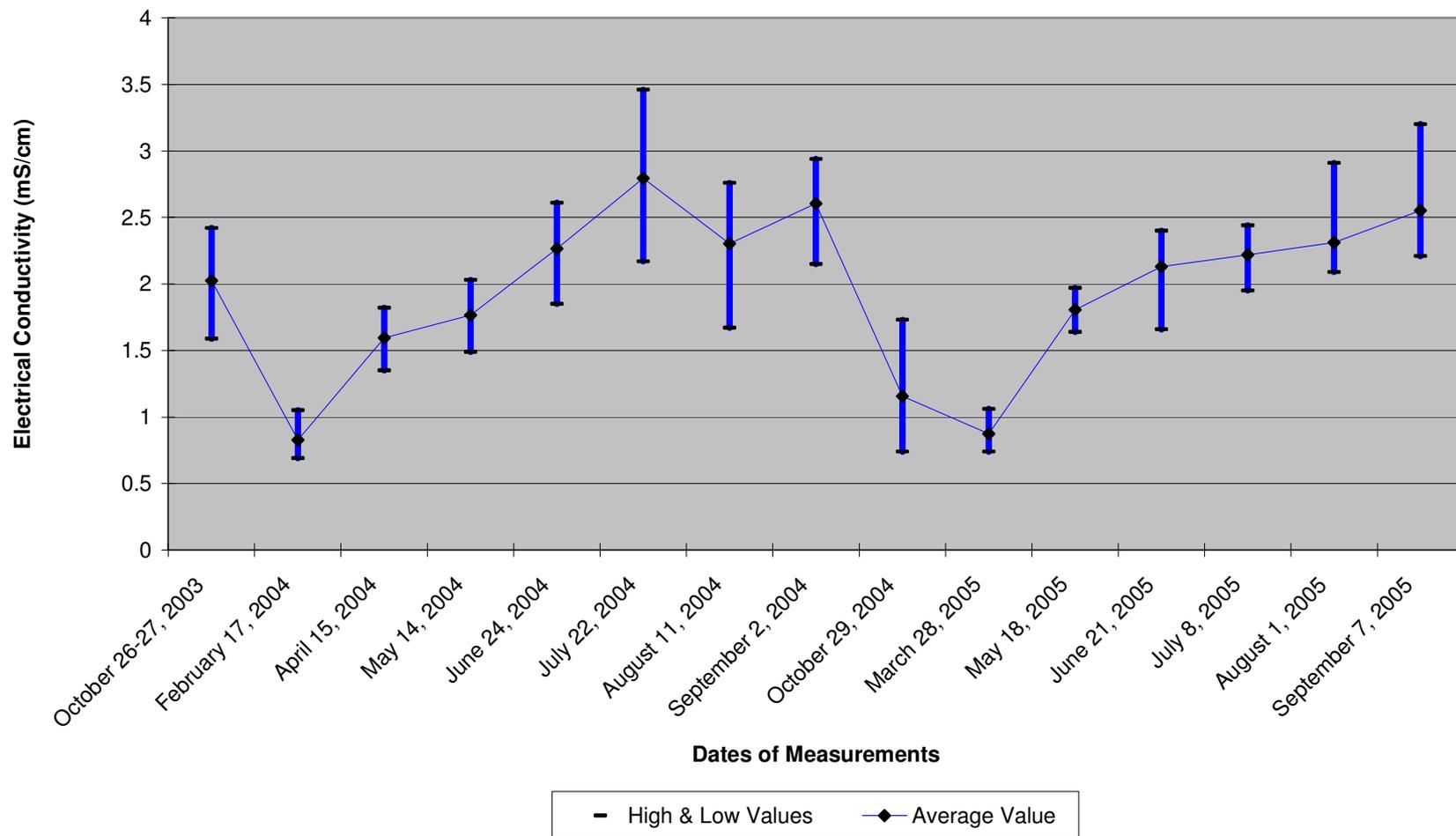


Figure 24
Values of Electrical Conductivity Along Transect C
Control Green (14th Green)

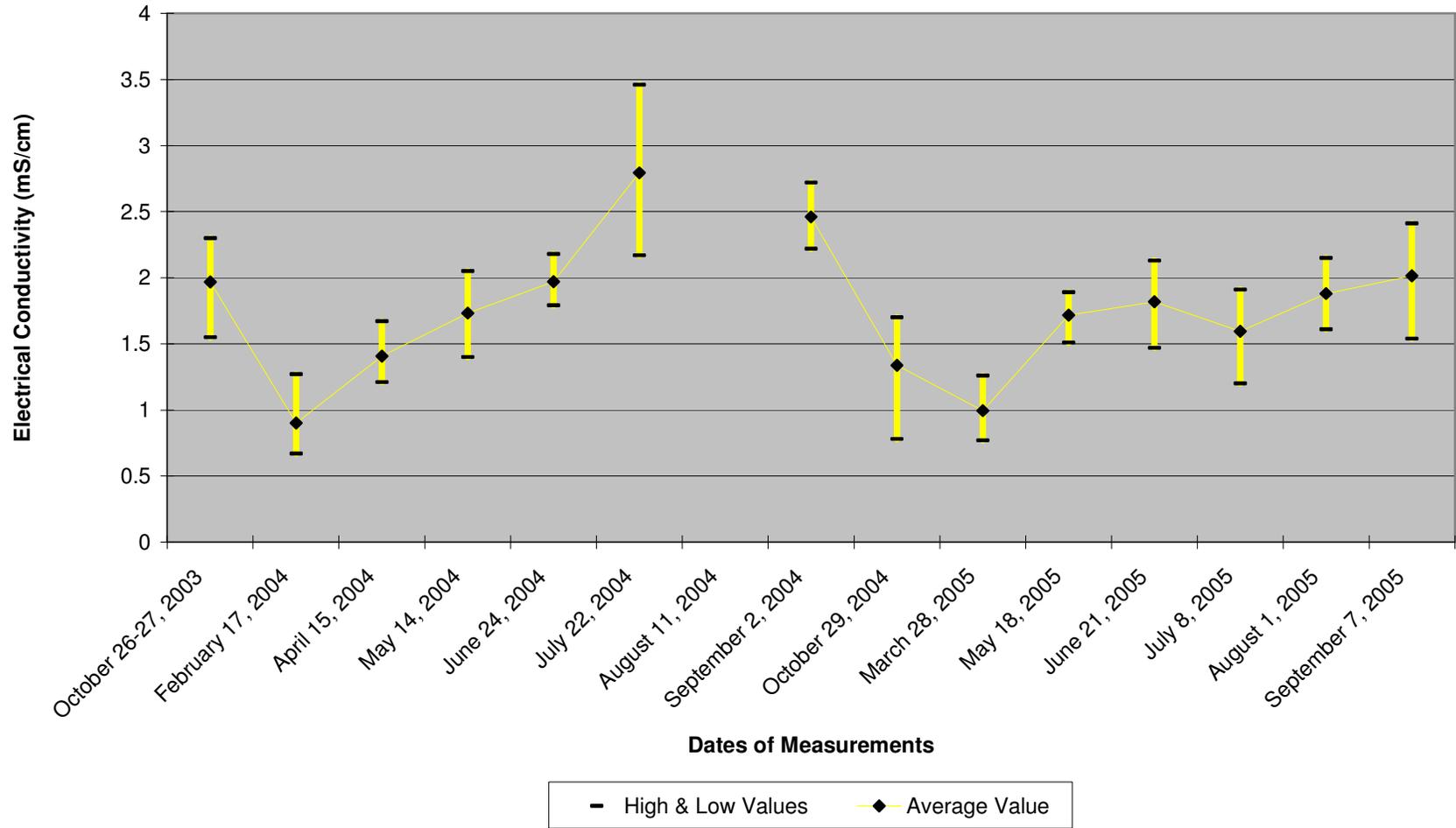
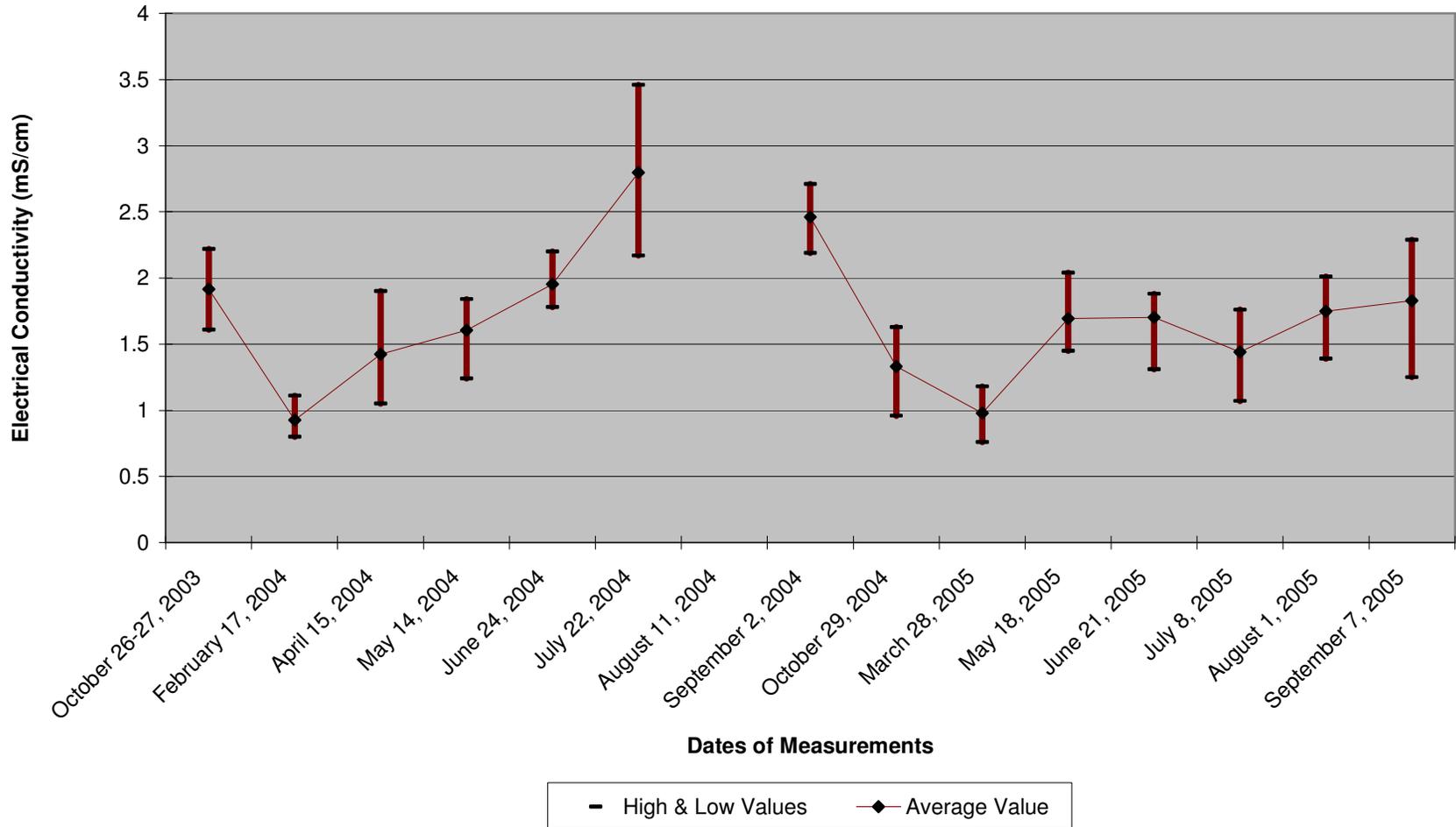


Figure 25
Values of Electrical Conductivity Along Transect D
Control Green (14th Green)



Based on the flushing experience of this one irrigation season, it may not be necessary to flush as much as originally anticipated.

Observations

Year 1 (2003) had a summer with an above-average number of days of foggy, cool weather. Consequently, irrigation demands were lower than normal. During Year 1 the golf course superintendent was pleased with the response of the turf to the recycled water. After the first few weeks of irrigating the demonstration green with recycled water, he commented that the demonstration green was growing faster, and was a deeper green in color, than the control green. Toward the end of the 2003 irrigation season he observed some light yellowing patches on the demonstration green, but not enough to cause him to discontinue use of the recycled water. He also noted some yellowing patches on other greens on the course which were not being irrigated with recycled water, and felt the yellow patches might be related to some form of mild turf disease not necessarily related to the recycled water.

Year 2 (2004) had a summer with an above-average number of sunny days and higher than average temperatures. Consequently, irrigation demands were higher than normal. As Figure 18 indicates, in Year 2 the salinity levels on the 13th green rose rapidly, and within a few months reached higher levels than were reached at the end of the Year 1 (2003) irrigation season. At the end of July 2004 the golf course superintendent determined that the demonstration green was in distress, and he initiated a well water flush to see if that would improve the turf's health and appearance. After a several-day flushing cycle, he resumed normal irrigation, but continued to use well water. As Figures 18, 22, and 23 indicate, flushing and the continued use of well water did lower the salinity on the demonstration green to the point where the turf recovered, and the golf course superintendent then resumed irrigation with recycled water. However, the salinity levels again rose to nearly their end-of-July levels by mid-September. An early winter brought rain in mid-October, and irrigation was discontinued at that time. The October 29, 2004 measurements showed significant reductions in soil salinity on both the demonstration and the control greens as a result of the rainfall.

Year 3 (2005) was a normal year in terms of sunny days and average temperatures, and irrigation demands were consequently normal. As described above, flushing with recycled water was performed during Year 3, starting in June and increasing in frequency as the summer progressed, up until the end of the irrigation season in late September. The flushing program proved successful in preventing turf distress due to salt buildup in the root zone.

In the landscaped area no soil conductivity measurements were made, but the response of the various types of plantings was observed. Many of the plants were quite healthy, while others showed symptoms of distress. However, many of the plantings were annuals, which often have blooming and die-back cycles, and it was not possible to determine whether the signs of distress were related to the recycled water. Selection of plants known to have higher salt tolerance will be a useful management tool for maintaining aesthetically pleasing landscaping around the golf course. Information on this is available in many gardening and landscaping books.

A separate nearby recycled water golf course irrigation project regularly performs potable water flushes, due to problems they have had with salinity and its impact on their greens. That project serves multiple golf courses, and has experimented with different flushing cycles. Its recycled water is delivered to a storage reservoir which serves all of the courses. The reservoir can also be filled with potable water from the domestic water supply system. At normal summer irrigation rates, when the recycled water plant is shut down it takes approximately one day for the recycled water that is stored in the reservoir to be depleted. Once that occurs the reservoir is filled with potable water. Each golf course then performs one nighttime flushing cycle. The courses coordinate their flushing cycles so as not to cause an over-demand which would exhaust the reservoir's storage capacity. For 2006 the project plans to perform a flushing cycle once per month starting in April and ending in November. The 2005-2006 rainfall period lasted later into the spring than normal. Consequently, the flushing cycles in 2006 will be started later than in years having a more normal rainfall pattern. Their planned 2006 flushing cycle will be as follows:

- Day 1 – Recycled water plant shuts down
- Day 2 – Stored recycled water is depleted
- Days 3 through 5 – Each course performs one potable water flush of its greens
- Day 6 – Recycled water plant starts back up

In the winter when irrigation demands are lower, it takes an additional day to deplete the stored recycled water. In October and November the recycled water plant is shut down for an additional day, and the golf courses don't start flushing until Day 4.

Each of the golf courses served by that project has only one irrigation-water distribution system. Therefore, the golf course superintendents have to set up their irrigation schedules for their greens and fairways, so that they are only irrigating their greens during the flushing cycle. Due to the possibility that the potable water supplier may change (increase) its rate structure for golf courses, the managers of this project are constantly evaluating their flushing procedures in an effort to minimize the amount of flushing water applied to the greens in order to reduce potable water usage.

TURF MANAGEMENT CONSIDERATIONS WHEN USING RECYCLED WATER

It was reported that in 2000 approximately 13% of the golf courses nationwide were using recycled water, with the percentage being 34% in the southwest (Huck et al., 2000). As a result of this widespread experience, more and more knowledge is being gained on turf management considerations when using recycled water. Turf management for golf courses using recycled water is a complex science, and a thorough discussion of this topic is beyond the scope of this paper. Some excellent and comprehensive articles on this subject can be found in the references (Huck et al., 2000, and Marcum, 2004). These references were drawn on extensively to prepare this section of this report.

This section briefly describes the major turf management issues which designers and operators of recycled water irrigation projects serving golf courses, and golf course superintendents, will need to take into account in order to be successful when using recycled water.

Water Quality

Water quality will vary from location to location, so it is important that laboratory testing be done in order to determine which quality constituents will have the greatest impact on the turf. Both water and soil testing should be performed prior to initiating irrigation with recycled water, and at regular intervals when it is being applied, in order to develop and maintain an effective turf management program.

Total Salinity

Normally the greatest potential hazard to the turf will come from salinity. Recycled water will typically contain higher levels of salt than other potable or non-potable water sources that golf courses are using. Salinity will normally be monitored through electrical conductivity measurements, as was done in this demonstration project. A general guide for evaluating the salinity hazard of the irrigation water supply is shown in Table 2 (Huck et al., 2000).

Table 2 – Salinity Hazard

Chemical Characteristics	Degree of Restriction on Use		
	None	Slight to Moderate	Severe
Electrical Conductivity of the Water (mS/cm)	< 0.7	0.7 – 3.0	> 3.0
TDS (mg/L)	< 450	450 – 2,000	> 2,000

Buildup of total soluble salts in the root zone (1) inhibits turfgrass water uptake resulting in moisture stress, and drought stress symptoms may appear even when the soil is moist; (2) causes turfgrass to lose color and fail to respond to nutrient applications (yellowing, browning, etc.); and (3) increases the potential for salt toxicity to root tissue. These effects are of special concern when using salt-sensitive grasses, trees, shrubs, and/or flowers. Creeping bentgrass/*Poa annua* mixture greens can become difficult to manage when water EC approaches 1.5 to 2.0 mS/cm, while bermudagrass greens can tolerate higher water EC levels in the range of 4 to 15 mS/cm. The actual point where turfgrass health declines is dependent on many factors including physical soil properties, surface drainage, and irrigation uniformity. Flushing with either recycled water or lower EC water is often used to combat these potential problems, as discussed below.

Sodium Permeability Hazard

On fine-textured soils sodium causes structural deterioration which reduces water infiltration/percolation/drainage. In sandy soils the particles are not themselves deteriorated by sodium, but high sodium levels in the irrigation water are likely to cause colloidal clay and organic matter to migrate downward to form a layer. Such a layer can result in lowered

permeability that can reduce the effectiveness of flushing as a means of mitigating the effects of salt buildup in the root zone.

The potential for sodium-induced permeability problems from irrigation water can be assessed by determining the sodium adsorption ratio (SAR) or the adjusted SAR of the water. Table 3 provides basic guidelines on these two parameters (Huck et al., 2000).

Table 3 – Sodium Permeability Hazard

Soil Type	Degree of Restriction on Use for Indicated Values of SAR or Adjusted SAR of the Irrigation Water		
	None	Slight to Moderate	Severe
2:1 Clay Type Soil	< 6	6 – 9	> 9
1:1 Clay Type Soil	< 16	16 – 24	> 24
Sand - water EC > 1.5 mS/cm	< 16	16 – 24	> 24
Sand - water EC < 1.5 mS/cm	< 6	6 – 9	> 9

Note: SAR is preferred for assessing sodium permeability hazard when HCO_3^{-1} is <120 mg/L and CO_3^{-2} is <15 mg/L. Above these levels adjusted SAR should be used.

Infiltration and permeability problems can develop if the SAR or adjusted SAR is high. Various approaches, such as the use of gypsum, acid, or other soil/water treatments, may be useful to help mitigate these problems.

Chloride and Sodium Toxicity

Excessive levels of chloride, sodium, and some other constituents can cause turfgrass root deterioration. Turfgrasses with low to moderate total salinity tolerance are often susceptible to this type of root damage, which results in roots that are less efficient in water and nutrient uptake.

If periodic flushing removes sodium from the root zone, the addition of a soluble form of calcium (not lime) into the root zone often helps to relieve the sodium toxicity problem.

Chloride reportedly does not cause direct turfgrass root tissue damage except at very high levels. However, chloride inhibits water and nutrient uptake. Turfgrass mowing generally limits grass blade injury from chloride by removal of the blade tips. Chlorine residual levels >1 mg/L reportedly can cause foliar damage.

Nutrients

A number of nutrients which may be present in recycled water, including nitrogen, potassium, phosphorous, calcium, magnesium, sulfur, iron, manganese, zinc, and boron, can have significant impacts on turfgrass. It is important to monitor and track seasonal variations in these constituents through regular soil and water analyses, so appropriate adjustments in fertilization programs can be made.

The quantity of nitrogen provided by recycled water will directly contribute to meeting the nutritional needs of turfgrass and other plants being irrigated with this water. This means that the fertilizing program needs to be adjusted to account for this, otherwise more nitrogen than desired may be added to the turfgrass. Certain types of grass deteriorate rapidly if they receive more nitrogen than they require. Providing too much nitrogen on greens can result in more growth than is desired, leading to slower putting speeds, increased mowing requirements, and a potential for thatch accumulation. Nitrogen also contributes to the growth of algae in ponds that may be used for storage of recycled water. Under certain weather conditions, golf course superintendents will often withhold applying fertilizer to control the growth rate of turfgrass on the greens. The amount of nitrogen contained in recycled water cannot normally be controlled, which means that the grass will continue to receive nitrogen and other nutrients in spite of the superintendent not applying fertilizer. He needs to be aware of this, and perhaps employ additional strategies to accomplish his growth control objectives under those conditions.

Phosphorous in recycled water is typically of less concern, because of the ability of turfgrass to tolerate reasonably high levels of phosphorous. However, phosphorous, like nitrogen, also contributes to the growth of algae in ponds that may be used for storage of recycled water.

Potassium in recycled water is generally considered beneficial. However, potassium will also be removed if flushing is employed, so this should be monitored to determine whether or not supplemental potassium needs to be applied to maintain the desired level in the root zone.

Recycled water calcium levels should be factored into the amount of supplemental calcium that the golf course superintendent applies. Too much calcium can contribute to soil clogging, if HCO_3^{-1} and CO_3^{-2} levels are high. On the other hand, high sodium levels can cause calcium to be replaced in the root tissues, leading to calcium deficiency. Regular analyses for calcium content in the water, soil, and tissue should be performed to determine whether or not to apply supplemental calcium.

Monitoring and Flushing

Monitoring of electrical conductivity to assess soil salinity is important in order to establish threshold levels to determine when flushing should be performed. This is the approach that was taken in the demonstration project. Once it has occurred, recovery from turf damage caused by salinity is difficult. Further, salt stressed turf is more susceptible to diseases. Therefore, it is preferable to perform flushing to leach salts from the root zone before damage occurs, rather than waiting until salt stress symptoms become visible.

Monitoring may consist of collecting samples and analyzing them in a laboratory, visual observations for salt stress symptoms, and in situ conductivity measurements. In situ conductivity measurements have the benefit of providing immediate information, but will not provide information on the various constituents that comprise the total salinity. As explained above, individual constituent information can be important in managing the fertilization program.

Good surface drainage is essential for proper flushing, as puddling can lead to algae growth which contributes to various turfgrass problems. Good infiltration/percolation rates are also necessary, so that sufficient quantities of flushing water can be put through the root zone to effectively dissolve and remove the accumulated salts. This can be enhanced through cultivation and aeration practices which are commonly employed on golf courses.

Flushing has been found to be most effective when it is performed over two or three successive evenings, with $\frac{3}{4}$ inch to 1 inch of water being applied each night (Huck et al., 2000). In some instances it may be desirable to use portable sprinklers, rather than the installed sprinklers, in order to apply the flushing water more uniformly and at the desired rate. In severe situations it may be necessary to install dual water supply systems for the greens and other sensitive areas, so that flushing with potable water can be performed. However, this can add considerably to the cost of a recycled water project. Therefore, it is desirable to determine whether or not flushing can be successfully performed using recycled water before designing the project. Making this determination was one of the main reasons for conducting the demonstration project.

Salinity tolerance levels for some commonly used golf course turfgrasses are shown in Table 4 (Huck et al., 2000). These can be used as starting points when establishing flushing thresholds on a golf course, with adjustments made based on testing and observations which indicate the effectiveness of the flushing cycles. Under good flushing conditions many grasses perform satisfactorily with recycled water containing salinity levels up to the salinity tolerance levels shown in Table 4, as long as leaching prevents the soil salinity from rising above these levels. It may be desirable to initiate a flushing cycle when the soil salinity level is still below the level shown in Table 4, until experience is gained with the effectiveness of the flushing process and the response of the turfgrass to leaching, in order to avoid salt-stress damage from occurring.

In Year 3 of the demonstration project flushing with recycled water was performed to evaluate the effectiveness of leaching in mitigating turf distress resulting from salinity buildup in the root zone. The flushing program is described in a preceding section of this report. Flushing with recycled water was found to be effective in preventing turf distress from salinity buildup. Therefore, it does not appear that it will be necessary to provide a separate potable water supply to this golf course in order to provide a source water for the flushing cycles. However, the recycled water supply system should be designed to deliver the additional volumes of recycled water that will be necessary to perform flushing. Flushing will need to be performed during non-golfing hours, and it may be necessary to flush multiple greens in a single night. For these reasons, the flushing requirements should be carefully considered in pipe and pump station sizing to ensure that a reliable and adequate flushing water supply can be provided during abnormally dry and sunny summers, when heavier irrigation will cause greater salt buildup than would occur in a normal irrigation season.

Table 4 – Salinity Tolerance of Turfgrasses

Salinity Tolerance	Electrical Conductivity in the Soil, (mS/cm)	Turfgrass
Very Sensitive	<1.5	Annual bluegrass*, Colonial bentgrass, Rough bluegrass, Centipedegrass
Moderately Sensitive	1.6 – 3.0	Kentucky bluegrass, most zoysia species
Moderately Tolerant	3.1 – 6.0	Creeping bentgrass, Fine-leaf fescues, Bahiagrass, Buffalograss, Blue grama, Annual ryegrass
Tolerant	6.1 – 10.0	Seaside bentgrass, common bermudagrass, Tall fescue, Zoysia matrella (some), Zoysia japonica (some), Perennial ryegrass, Kikuyu, Wheatgrasses
Very Tolerant	10.1 – 20.0	Hybrid bermudagrasses (some), St. Augustinegrass, Salt grass, Alkaligrass (some)
Superior Tolerance	>20.0	Seashore paspalum (some)

* *Poa annua*, a turfgrass found on many golf courses in California, is an annual bluegrass

Other Issues

Other issues not directly pertaining to recycled water quality, but which are also important in the design and operation of recycled water projects for golf course irrigation, include:

- Compliance with regulatory requirements
- Proper separation of potable and recycled water piping
- Training of golf course employees in the proper use of recycled water
- Site inspections to ensure recycled water is being properly used and applied
- Signage to inform the public that recycled water is being used

CONCLUSIONS

Through proper management, both turfgrass and landscaping can generally be made to perform well using recycled water for irrigation. The three-year demonstration project described in this report chronicled the impacts of irrigating with recycled water. During the first half of Year 1, the green irrigated with recycled water had a better, lush appearance than most of the other greens on the course. However, toward the end of the Year 1 irrigation season the demonstration green showed a somewhat higher susceptibility to some common turf diseases indigenous to the

area. These were treated with turf management products and procedures commonly used on golf courses. In Year 1 the golf course superintendent did not identify any other horticultural changes that had to be made in conjunction with using recycled water.

Between Years 1 and 2, winter rainfall flushed salts from the root zone, so that when Year 2 irrigation began, there was very little salt remaining in the root zone. However, as Year 2 progressed, the demonstration green showed signs of distress and had to be leached and irrigated with well water for a short period of time to reduce the soil salinity. After this flushing process was completed, irrigation with recycled water was resumed.

Data acquired from Years 1 and 2 of the demonstration project, along with data available from golf course industry sources, was used to develop guidelines for monitoring soil salinity in Year 3 in order to determine the need for flushing with either recycled water or fresh water to maintain turf quality. In Year 3 the effectiveness and required frequency of flushing cycles was evaluated. It was found that flushing using recycled water, not potable water, was successful in preventing turf damage from salinity buildup in the soil.

The design of an urban reuse project to serve golf courses should include adequate recycled water hydraulic capacity to meet flushing requirements, in order for the project to be successful and to avoid the additional cost of having to provide a potable water supply to serve as the source of water for flushing.

Because of the additional complexities of turf management when irrigating with recycled water, it would be desirable to have a turf agronomist participate as a member of the design team for the recycled water project, and to be available to assist golf course superintendents when the project starts up and for a period thereafter. This will help ensure the success of the project, and the acceptance by the golf course industry of using recycled water for irrigation.

ACKNOWLEDGEMENTS

The Agency expresses its appreciation to the City of Seaside, which owns the Bayonet and Black Horse Golf Courses, and BSL, which operated these golf courses for the City of Seaside when the demonstration project was performed, for allowing this project to be conducted and for participating in and supporting the project.

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- Marcum, Kenneth B. (2004) Use of Saline and Non-potable Water in the Turfgrass Industry: Constraints and Developments, Presented at the 4th International Crop Science Congress (*accessible at www.cropscience.org.au/icsc2004*).

APPENDIX A

Individual Transect Conductivity and Moisture Content Measurements for the 13th and 14th Greens

Figure A-1
13th Green Transect "A"
Electrical Conductivity
End of 2003 Irrigation Season and All of 2004 Irrigation Season

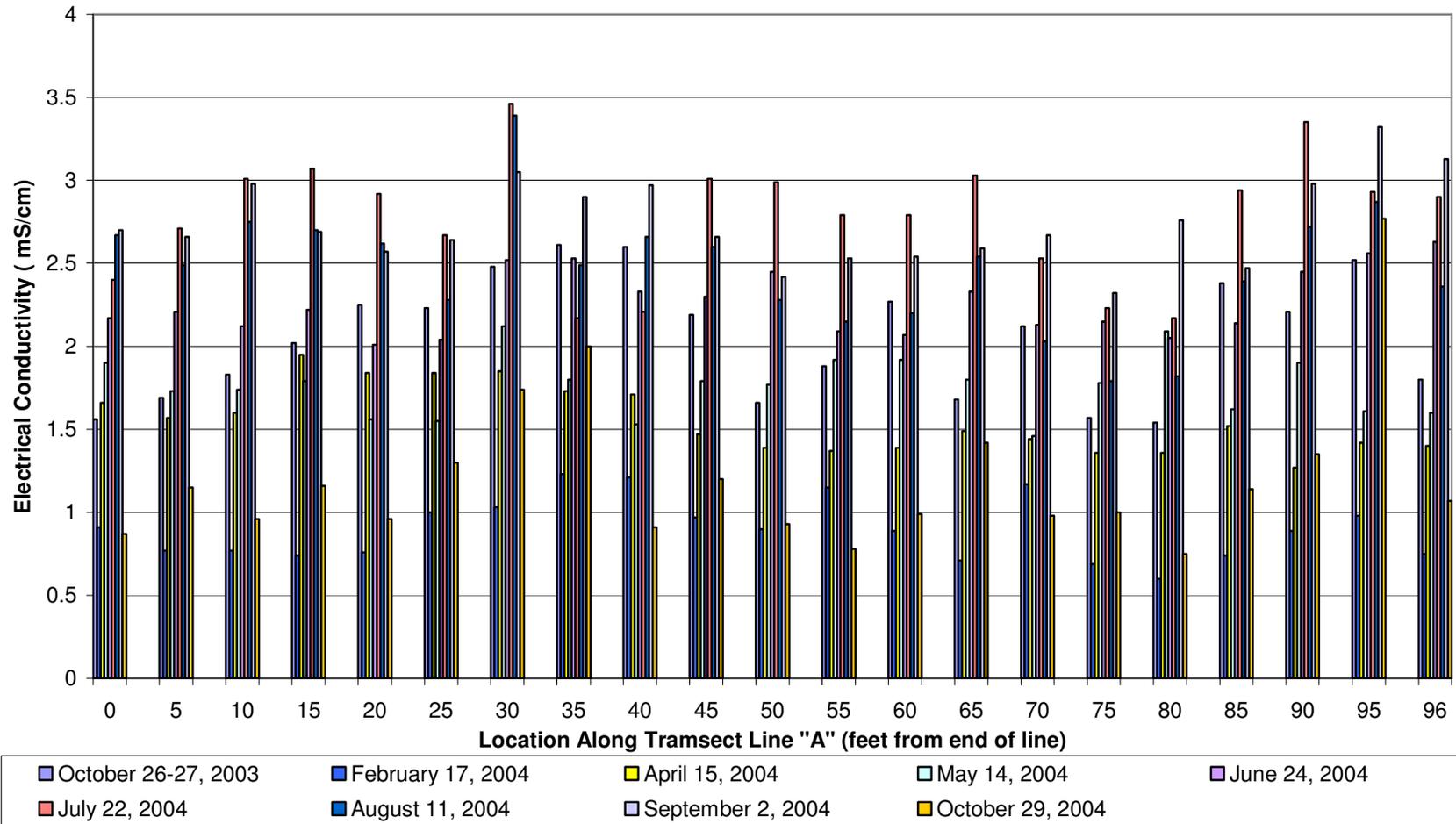


Figure A-2
13th Green Transect "A"
Electrical Conductivity
in 2005

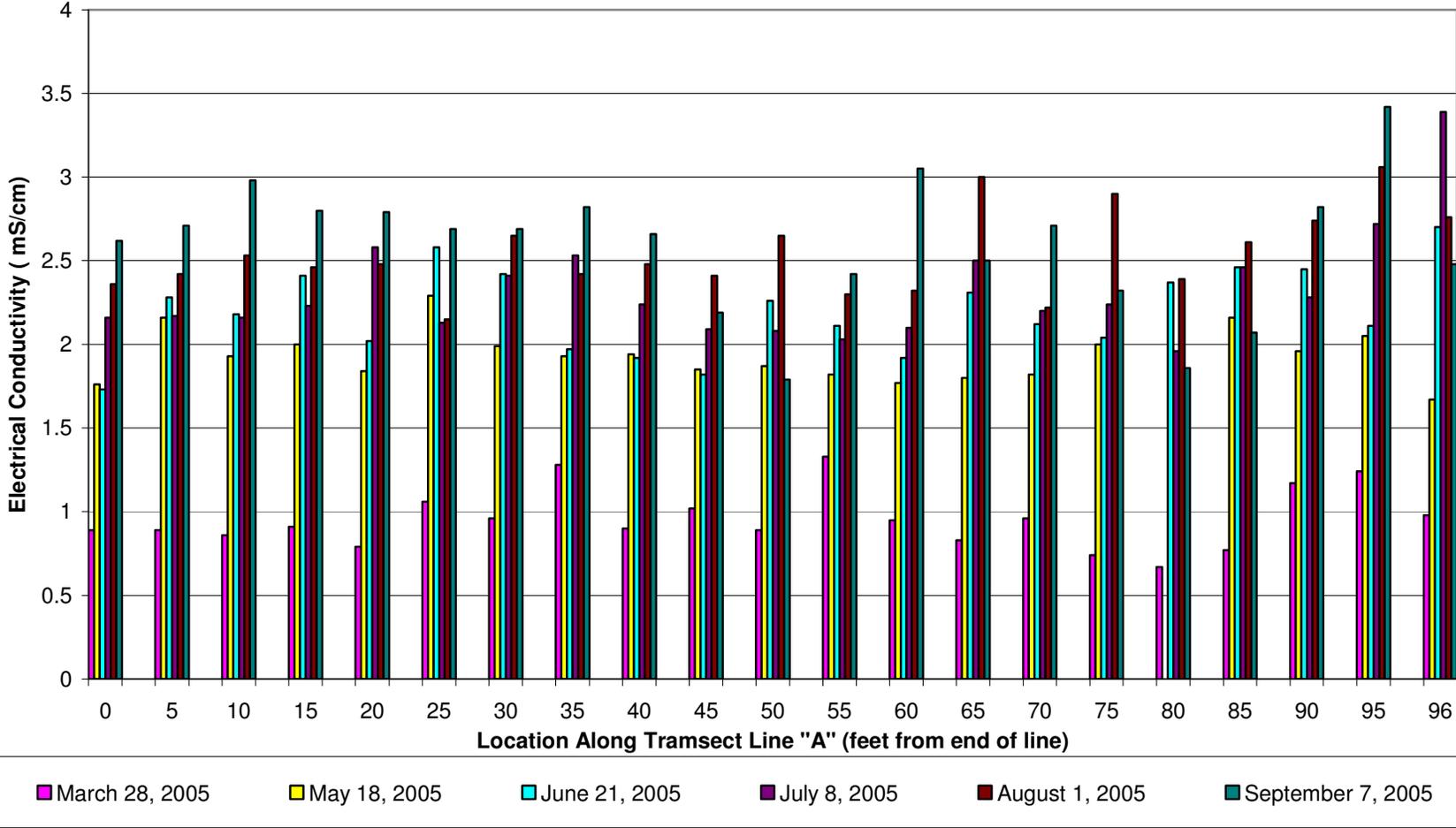


Figure A-3
13th Green Transect "B"
Electrical Conductivity
End of 2003 Irrigation Season and All of 2004 Irrigation Season

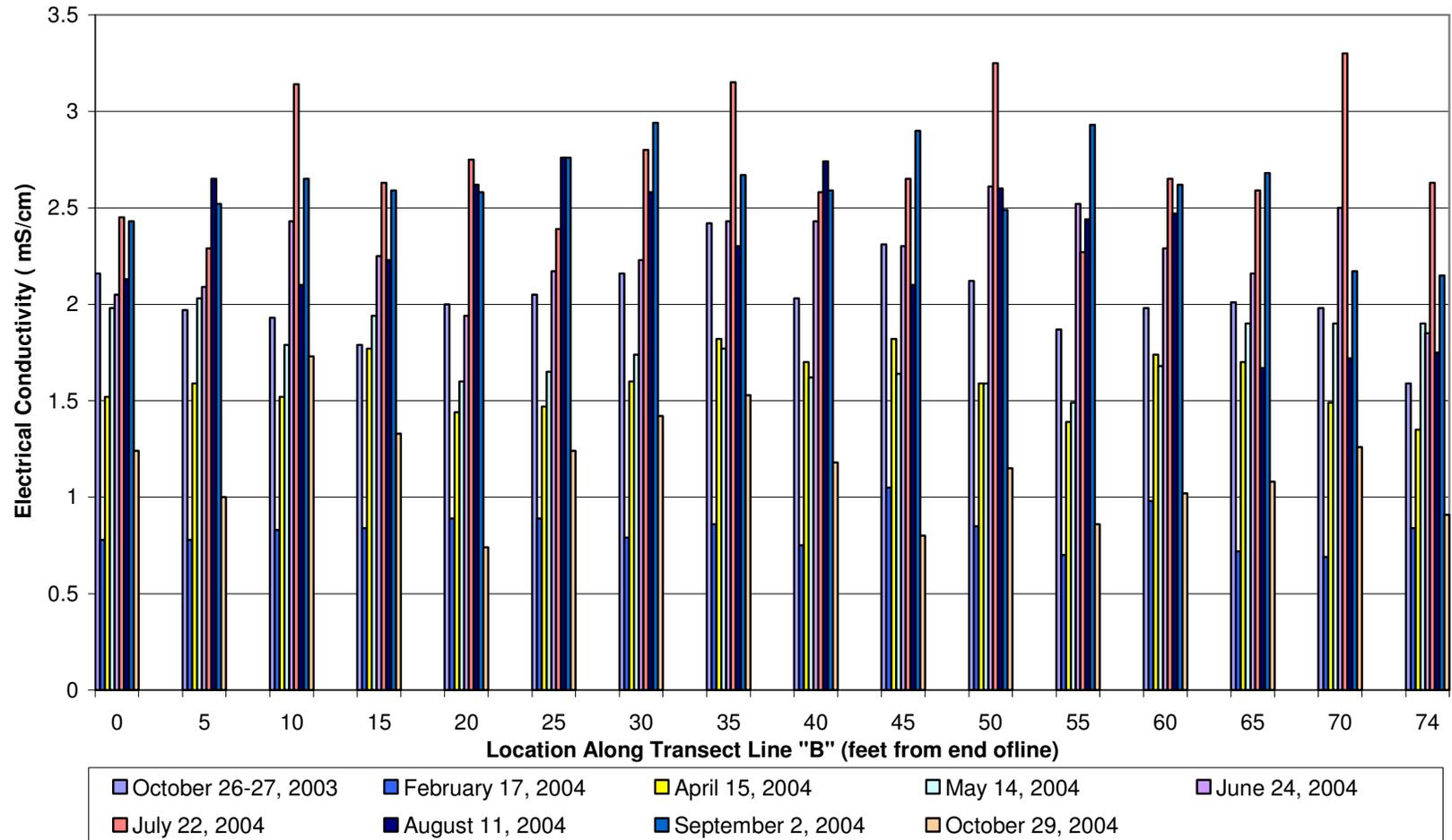


Figure A-4
13th Green Transect "B"
Electrical Conductivity
in 2005

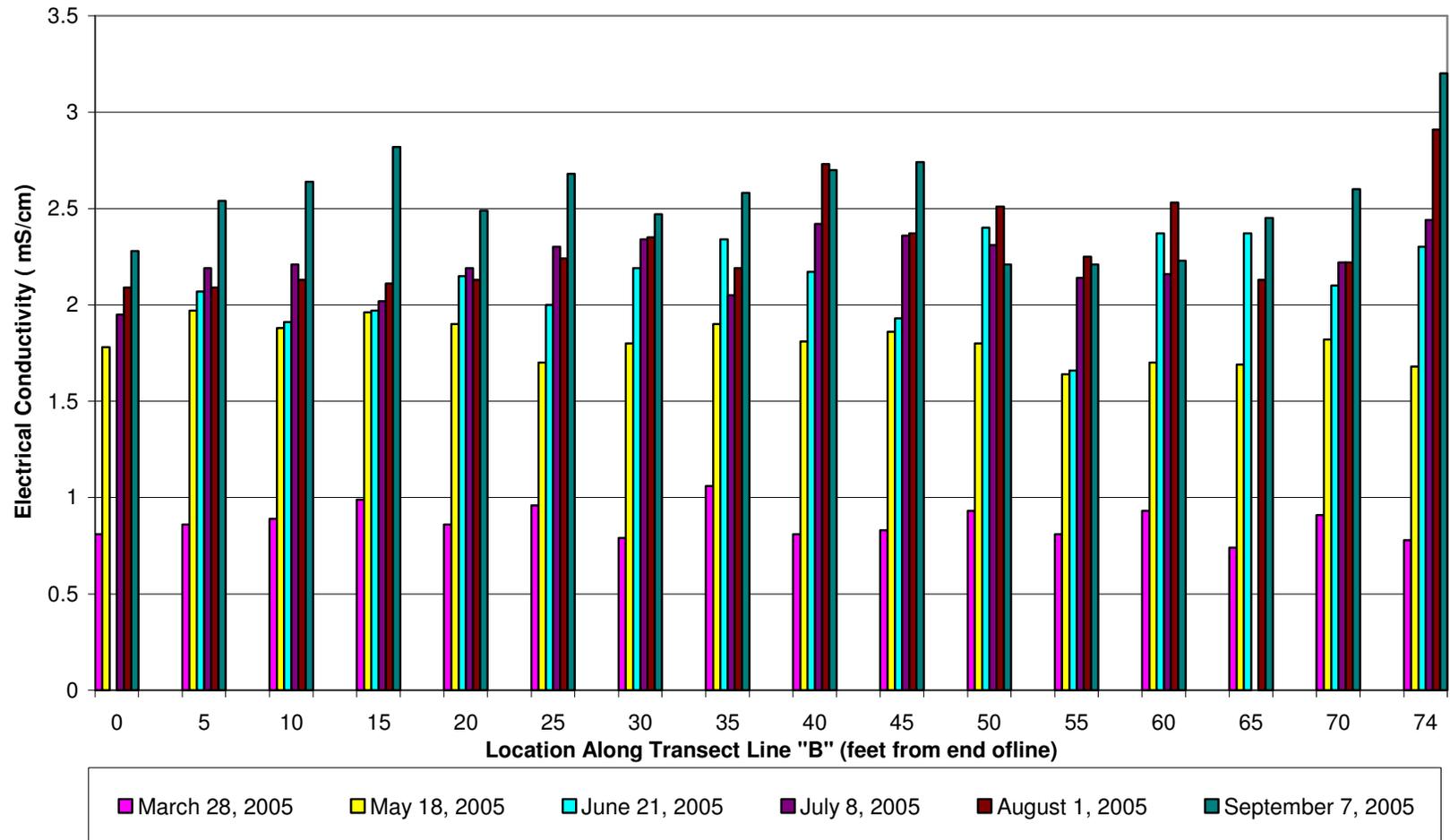


Figure A-5
14th Green Transect "C"
Electrical Conductivity
End of 2003 Irrigation Season and All of 2004 Irrigation Season

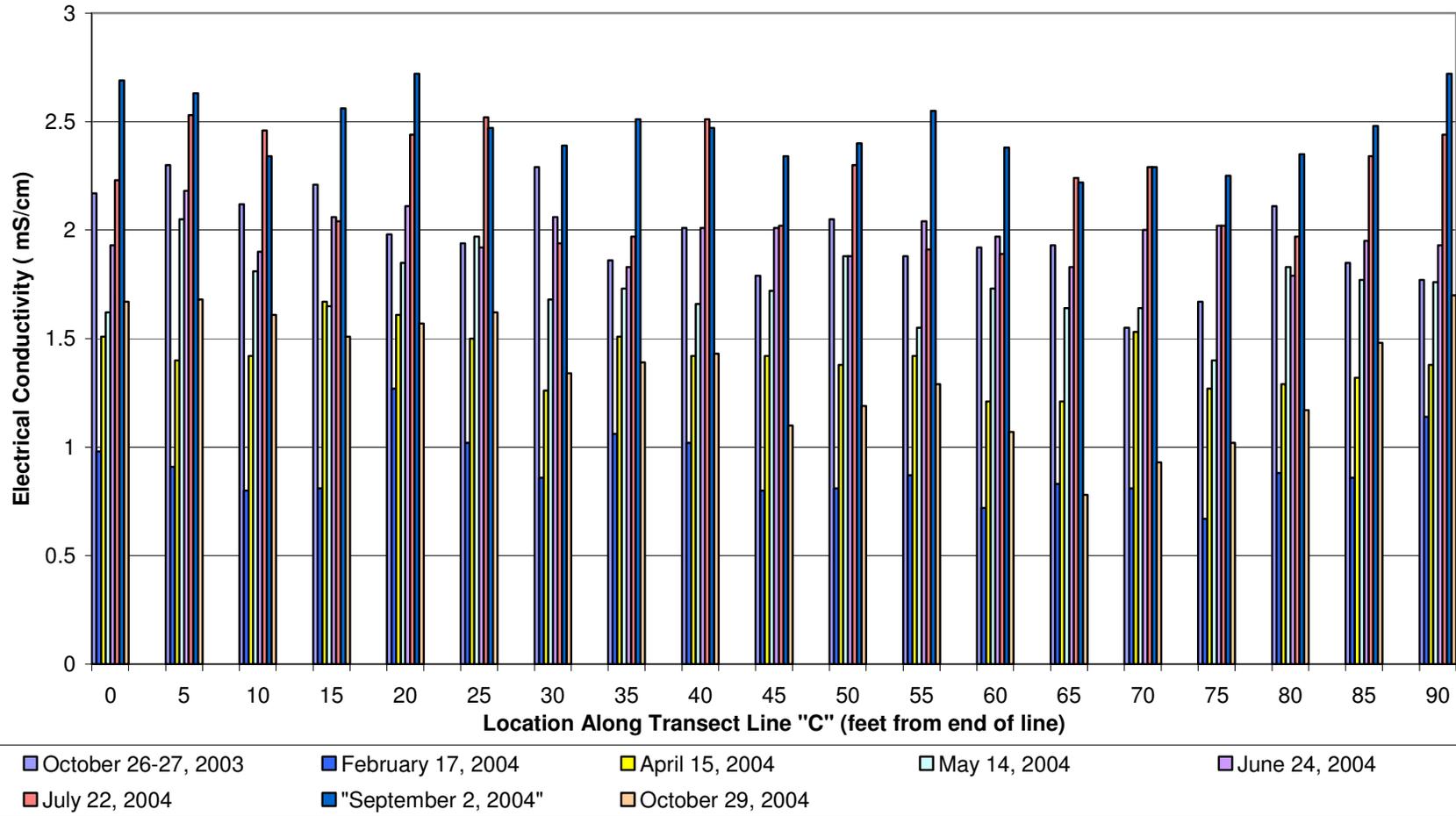


Figure A-6
 14th Green Transect "C"
 Electrical Conductivity
 in 2005

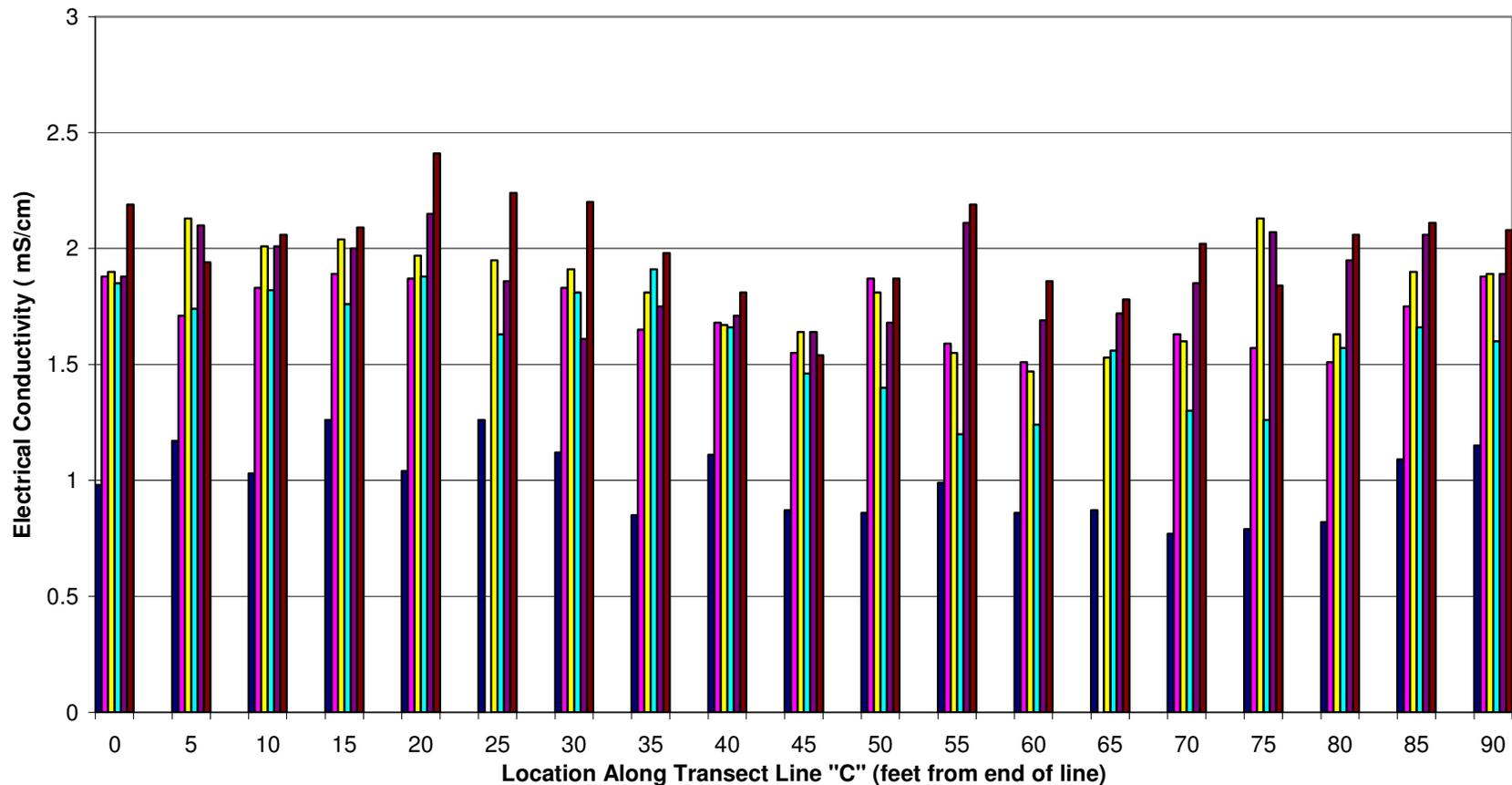
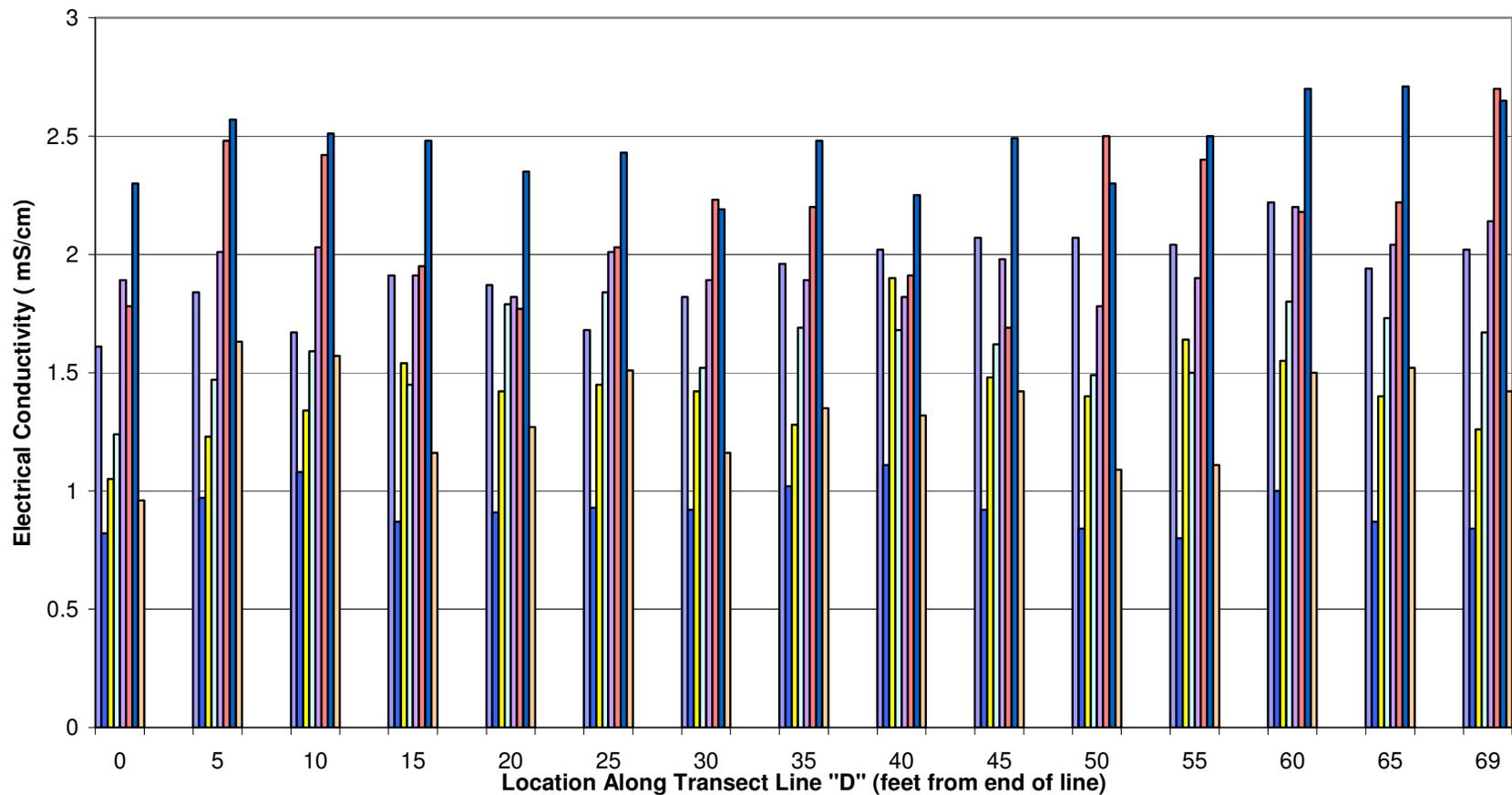


Figure A-7
14th Green Transect "D"
Electrical Conductivity
End of 2003 Irrigation Season and All of 2004 Irrigation Season



■ October 26-27, 2003
■ February 17, 2004
■ April 15, 2004
■ May 14, 2004
■ June 24, 2004
■ July 22, 2004
■ September 2, 2004
■ October 29, 2004

Figure A-8
 14th Green Transect "D"
 Electrical Conductivity
 in 2005

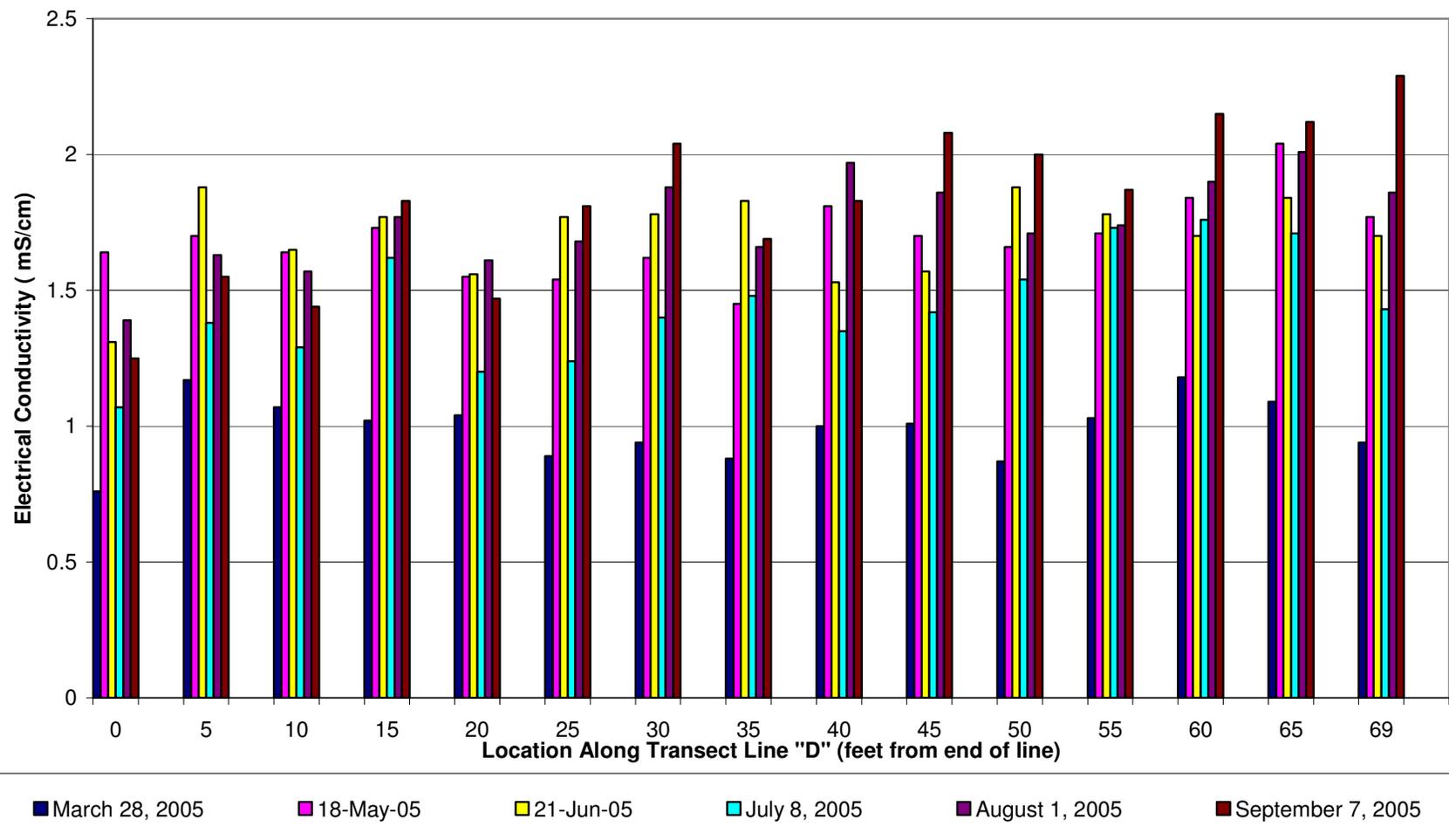
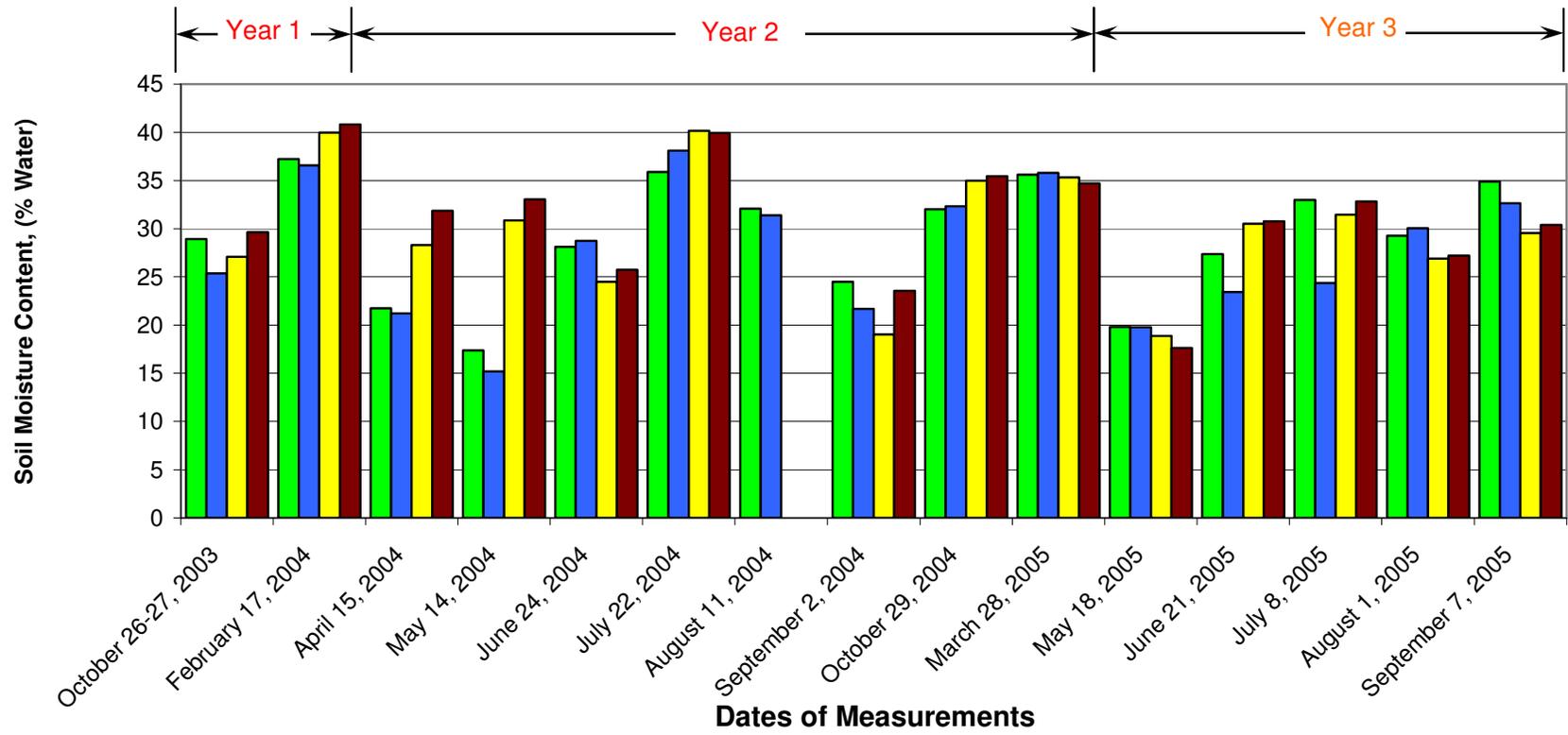


Figure A-9

Average Values of Soil Moisture Content Along Each Transect

Year 1: March 31 = First Recycled Water Delivery in 2003
 Year 2: April 30 = First Recycled Water Delivery in 2004
 Year 3: April 29 = First Recycled Water Delivery in 2005

September 22 = Last Recycled Water Delivery in 2003
 October 15 = Last Recycled Water Delivery in 2004
 September 22 = Last Recycled Water Delivery in 2005



■ Transect A (13th Green)
 ■ Transect B (13th Green)
 ■ Transect C (14th Green)
 ■ Transect D (14th Green)

APPENDIX B

Irrigation Uniformity Testing Results

August 31, 2005

Bob Jaques
MPWMD
#5 Harris Court, Bldg. D
Monterey, CA 93940

Dear Bob,

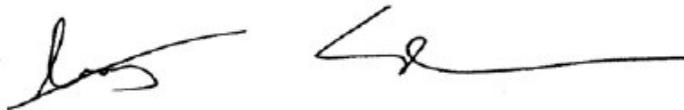
Enclosed with this letter is the data for the catch can tests at Fort Ord (Bayonet I believe).

The DU result (64 & 69 %) is not too bad considering the age of the piping system, and the inconsistent sprinkler spacing (approximately 69', but varies down to 65' and up to 75'). The operating pressures were lower on 13 green (~60 psi) than 14 green (~80 psi), which is fully expected based on the source of pressure for each green. This may explain the DU results being a bit lower on 13 green.

I will be emailing digital copies of the data in addition to the hard copies attached. The spreadsheet data w/ the graphs illustrates where and how much water was applied throughout the green based on the catch can data. Please disregard the '0s', as they are necessary to provide a graph of water application depth. The '0s' do not factor into the DU results.

Thank you for hiring us to do the catch can tests for you. If you have any questions, or would like to discuss the result further, please give me a call – 408.288.8153.

Sincerely,

A handwritten signature in black ink, appearing to read 'Andy Slack', followed by a horizontal line.

Andy Slack, CID, CGIA, CLIA, LI9371
President
aslack@spotwater.com - www.spotwater.com

Enclosure: catch can data results

Base Schedule Worksheet

Project Name: Fort Ord Date: 8/10/2005
 Project Location: 13G
 Controller No: On post Station No: 1-4 Ref. Period Month of: Aug.

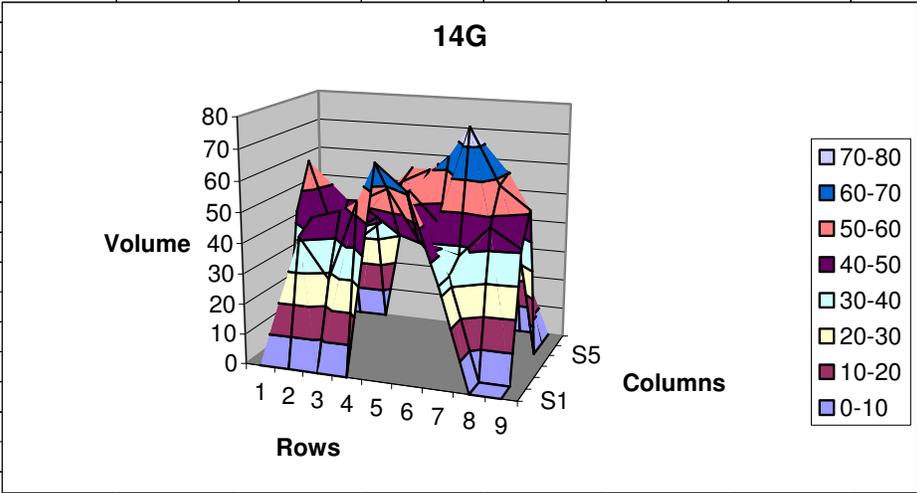
Item	Source		Value	Unit or Function
I. Plant Water Requirement				
A. Plant Material	Audit or Planting Plan		CST	classification
B. Reference Period	Judgement		7	days
C. Reference ET (ET _o)	Various sources		0.98	inches of water
K _s K _d K _{mc} (refer to sheet KL)	K _s	K _d	K _{mc}	
D. Landscape Coefficient (K _L)	0.70	1.00	1.00	0.70 plant specific multiplier
(Optional) Allowable Stress	K _{as}	0.60	D X K _{as}	0.42 site specific multiplier
E. Plant Water Requirement	ET _o X K _L	C X D	0.41	inches
II. Irrigation Water Requirement				
F. Precipitation Rate (PR)	Audit or Calculation		0.56	inches per hour
G. Distribution Uniformity (DU)	Audit or Estimate		0.64	efficiency adjustment
H. Irrigation Water Requirement	ET requirement	E/G	0.64	inches
I. Total Run Time per Period	Irrig. water requirement/PR	(H/F) X 60	69.01	minutes
III. Scheduling Requirements				
J. Root Zone Soil Type	Audit or Estimate	Sandy Loam		classification
K. Available Water (AW)	Table		0.12	inches per inch of soil
L. Active Root Zone Depth	Audit or Estimate		3.00	inches
M. Plant Available Water (PAW)	AW X active root zone	K X L	0.36	inches
N. Allowable Depletion	MAD:	0.50	MAD X M	0.18 budget multiplier
O. Irrigation Days Per Period	Plant ET/AD	E/N	2	days in a period
P. Total Run Time per Day	Total run-period/irrigation days per	I/O	35	minutes
Q. Run Time per Cycle	Audit or Calculation	P/R	35	minutes
R. Cycles per Day	Total run-day/run time-cycle	P/Q	1	cycles

Base Schedule Worksheet

Project Name: Fort Ord Date: 8/10/2005
 Project Location: 14G
 Controller No: 13G-bac Station No: 1-4 Ref. Period Month of: Aug.

Item	Source		Value	Unit or Function
I. Plant Water Requirement				
A. Plant Material	Audit or Planting Plan		CST	classification
B. Reference Period	Judgement		7	days
C. Reference ET (ET _o)	Various sources		0.98	inches of water
K _s K _d K _{mc} (refer to sheet KL)	K _s	K _d	K _{mc}	
D. Landscape Coefficient (K _L)	0.70	1.00	1.00	0.70 plant specific multiplier
(Optional) Allowable Stress	K _{as}	0.60	D X K _{as}	0.42 site specific multiplier
E. Plant Water Requirement	ET _o X K _L	C X D	0.41	inches
II. Irrigation Water Requirement				
F. Precipitation Rate (PR)	Audit or Calculation		0.71	inches per hour
G. Distribution Uniformity (DU)	Audit or Estimate		0.69	efficiency adjustment
H. Irrigation Water Requirement	ET requirement	E/G	0.59	inches
I. Total Run Time per Period	Irrig. water requirement/PR	(H/F) X 60	49.61	minutes
III. Scheduling Requirements				
J. Root Zone Soil Type	Audit or Estimate	Sandy Loam		classification
K. Available Water (AW)	Table		0.12	inches per inch of soil
L. Active Root Zone Depth	Audit or Estimate		3.00	inches
M. Plant Available Water (PAW)	AW X active root zone	K X L	0.36	inches
N. Allowable Depletion	MAD: 0.50	MAD X M	0.18	budget multiplier
O. Irrigation Days Per Period	Plant ET/AD	E/N	2	days in a period
P. Total Run Time per Day	Total run-period/irrigation days	I/O	25	minutes
Q. Run Time per Cycle	Audit or Calculation	P/R	25	minutes
R. Cycles per Day	Total run-day/run time-cycle	P/Q	1	cycles

<u>14 Green CC test data</u>								
					Baseline			
Left	0	0	0	44	59	0	0	Right
	0	41	45	29	32	44	0	
	0	28	48	39	35	44	0	
	0	54	49	45	43	52	55	
Baseline	69	59	42	54	53	57	21	Baseline
	61	44	39	44	64	54	35	
	33	33	37	76	66	41	0	
	0	0	47	58	60	34	0	
	0	0	41	51	0	0	0	
				14 Tee				



Spot Water Management, Inc. Company Background

Spot Water Management Inc. (SWM) is a professional services company providing independent irrigation design and consulting services through offices located in San Jose, California. SWM works with customers throughout the United States, including Hawaii. SWM was founded in 1994 by Andy Slack and was later incorporated in March of 2002. Over the years, SWM has experienced significant expansion throughout California, Arizona, and the West Coast.

Since our inception, SWM has been dedicated to the proper design of irrigation systems and related components, with water conservation and energy efficiency as focal points. We have earned a reputation among our clients and professional colleagues for excellence in design and attention to detail as well as for innovative solutions to complex problems. We have built strong long-term client relationships. Our business has grown primarily through repeat business and client referrals in both public and private golf sectors.

The goal of every design project is to design the best system possible within the scope of a designated budget. We also oversee the installation and ensure contractor quality, as well as provide state of the art, survey grade GPS record drawings for the project. We strive to protect our Clients and their investment.

At SWM we utilize tools such as computer hydraulic modeling for more cost effective, longer lasting systems. Our designers keep in touch with the industry through training, certifications, and trade events to maintain the knowledge that supports our work and protects our customers. Our staff wide industry associations include:

The Irrigation Association

Golf Course Superintendents Association of America

Mid-West Regional Turf Foundation

The Center for Irrigation Technology – CSU Fresno

APPENDIX C

Soil Testing Report

July 1, 2005

Mr. Robert S. Jaques
Director of Engineering Planning and Technology
Monterey Regional Water Pollution Control Agency
5 Harris Court, Bldg. D
Monterey, CA 93940

Dear Bob:

Enclosed are the soil analysis results for the samples from the greens at Bayonet Golf Course.

Key Findings Soil Test Results/Greens: G13, G14

SOIL pH:	Slightly Acidic to Neutral	6.8 – 7.0
Calculated CECs	Cation Exchange Capacities	8.73 - 9.1
Exchangeable Calcium, Ca	Adequate	G13, G14
Exchangeable Magnesium, Mg	Adequate	G13, G14
Exchangeable Potassium, K	High	G13, G14
Exchangeable Sodium, Na	Very High	G14
	High	G13
Phosphorus, P205	High	G13
	Slightly Low	G14
Sulfates, SO ₄	Slightly High	G13, G14
Total Soluble Salts (mmhos/cm)	Slightly High	G13, G14
Micronutrients: Boron, B	Adequate	G13, G14
Copper, Cu	Adequate	G13, G14
Zinc, Zn	Adequate	G13, G14
Manganese, Mn	Adequate	G14
	Low	G13
Iron, Fe	High	G13, G14

Key Findings Water Soluble Soil Nutrient Results/Green: G13, G14

Water Extract pH	Slightly Acidic	6.9
Calcium, Ca	Low	G13, G14
Magnesium, Mg	Low	G13, G14
Potassium, K	Slightly High	G13, G14
Sodium, Na	High	G13, G14
Ammonium-Nitrogen, NH ₄ -N	Adequate	G13, G14
Bicarbonates, HCO ₃	Acceptable	G13, G14
Sulfates, SO ₄	Adequate	G13, G14
Chlorides, Cl	High	G13
	Acceptable	G14
Nitrate-Nitrogen, NO ₃ -N	High	G13
	Slightly High	G14
Phosphate-Phosphorus, PO ₄ -P	Low	G13, G14

COMMENTS: The EC and SAR are slightly higher in green # 13. Sodium, chlorides, and nitrate-nitrogen are higher in # 13 green.

Fertility Inputs for Bayonet Golf Course greens

7/1/05

- Nitrogen:** Maintain the tissue nitrogen level in the 5.0% to 5.25% range for the summer season. When additional nitrogen is needed for maintenance, apply nitrogen at 1/10 pound per thousand sq. ft. Use ammonium sulfate (spring and fall) and calcium nitrate or potassium nitrate (summer) as the nitrogen sources.
- Calcium:** Apply 10 pounds of calcite calcium and 10 pounds of gypsum per thousand sq. ft. monthly to the greens to maintain the soil calcium level when the greens are under a routine flushing program. Calcite calcium could be incorporated into the top-dressing sand at 75 to 100 pounds per cubic yard of sand. The greens should be flushed on a weekly to every other week schedule to prevent sodium build-up.
- Magnesium:** Apply 2 fluid ounces of a 5% magnesium formulation per thousand sq. ft. per week.
- Potassium:** Apply 1/8 pound of potassium per thousand sq. ft. per week for maintenance.
- Phosphorus:** Apply 1/20 pound per thousand sq. ft. every other week to the greens. Mono-potassium phosphate (0-50-30) or foliar phosphite (such as 2-40-16) is suggested.
- Iron/Micronutrients:** A micronutrient formulation (less boron) should be applied to the greens every other week to provide the essential micronutrients to the turf. In addition, apply 2 fluid ounces of a 5% soluble manganese formulation per thousand sq. ft. every other week to the greens.
- Optional/Granular Humic acid:** Apply at label rates.
- Optional/Biostimulant:** Apply at label rates.

If you have any questions about these results, please feel free to call me at (724) 898-2329.

Sincerely,

David W. York, Ph.D.
Tournament Turf Laboratories, Inc.

cc: Mark Mahady

Tournament Turf Laboratories, Inc.
Water Soluble Soil Nutrient Analysis And Balance Report
TTL4

Account # 836
Bayonet Golf Course

Date: 06/24/05

Sample ID # 13 Green

pH = 6.9

Total soluble salts, mmhos/cm 0.32

WATER SOLUBLE CATIONS

**% OF TOTAL
SOLUBLE CATIONS**

Calcium, Ca	Value found (ppm) =	54	(meq/l) =	2.7	27.0%
Magnesium, Mg	Value found (ppm) =	15	(meq/l) =	1.2	11.9%
Potassium, K	Value found (ppm) =	66	(meq/l) =	1.7	16.8%
Sodium, Na	Value found (ppm) =	95	(meq/l) =	4.1	41.0%
Ammonium-Nitrogen, 4-N	Value found (ppm) =	4.6	(meq/l) =	0.3	3.3%

RATIOS: Ca:Na = 0.7 Ca:Mg = 2.3 Ca:K = 1.6 Mg:K = 0.7

WATER SOLUBLE ANIONS

**% OF TOTAL
SOLUBLE ANIONS**

Bicarbonate, HCO ₃	Value found (ppm) =	174	(meq/l) =	2.9	28.2%
Sulfate, SO ₄	Value found (ppm) =	41	(meq/l) =	2.6	25.4%
Chloride, Cl	Value found (ppm) =	112	(meq/l) =	3.2	31.2%
Nitrate-Nitrogen, NO ₃ -N	Value found (ppm) =	19.2	(meq/l) =	1.4	13.6%
Phosphate-Phosphorus, PO ₄ -P	Value found (ppm) =	1.1	(meq/l) =	0.1	1.1%
Boron, B	Value found (ppm) =	0.2	(meq/l) =	<0.1	0.6%

Sodium Adsorption Ration, SAR 2.9

Electrical Conductivity, ECe mmho/cm 0.9

Tournament Turf Laboratories, Inc.
Water Soluble Soil Nutrient Analysis And Balance Report
TTL4

Account # 836
 Bayonet Golf Course

Date: 06/24/05

Sample ID # 14 Green

pH = 6.9

Total soluble salts, mmhos/cm 0.30

WATER SOLUBLE CATIONS

**% OF TOTAL
SOLUBLE CATIONS**

Calcium, Ca	Value found (ppm) =	52	(meq/l) =	2.6	27.4%
Magnesium, Mg	Value found (ppm) =	12	(meq/l) =	1.0	10.4%
Potassium, K	Value found (ppm) =	80	(meq/l) =	2.0	21.8%
Sodium, Na	Value found (ppm) =	77	(meq/l) =	3.4	35.9%
Ammonium-Nitrogen, 4 -N	Value found (ppm) =	5.9	(meq/l) =	0.4	4.5%

RATIOS: Ca:Na = 0.8 Ca:Mg = 2.6 Ca:K = 1.3 Mg:K = 0.5

WATER SOLUBLE ANIONS

**% OF TOTAL
SOLUBLE ANIONS**

Bicarbonate, HCO ₃	Value found (ppm) =	211	(meq/l) =	3.5	36.1%
Sulfate, SO ₄	Value found (ppm) =	45	(meq/l) =	2.8	29.5%
Chloride, Cl	Value found (ppm) =	86	(meq/l) =	2.4	25.3%
Nitrate-Nitrogen, NO ₃ -N	Value found (ppm) =	10.2	(meq/l) =	0.7	7.6%
Phosphate-Phosphorus, PO ₄ -P	Value found (ppm) =	1.2	(meq/l) =	0.1	1.2%
Boron, B	Value found (ppm) =	0.1	(meq/l) =	<0.1	0.4%

Sodium Adsorption Ration, SAR 2.5
Electrical Conductivity, ECe mmho/cm 0.8

APPENDIX D

Agreement with Golf Course to Conduct Demonstration Project

MEMORANDUM OF UNDERSTANDING
for
Conducting a Demonstration Program
for
Use of Recycled Water for Irrigation of Seaside Golf Courses

THIS MEMORANDUM OF UNDERSTANDING (hereinafter "MOU") is made and entered into on 11/6 _____, 2002, by and between the MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY (the "Agency"), a Joint Powers Authority (JPA) organized under the laws of the State of California, and BSL ("BSL"), a corporation organized under the laws of the State of Texas, as follows:

Recitals

This MOU is entered into with reference to the following facts and circumstances:

- a) **The Parties.** The Agency is a public agency providing regional wastewater collection, treatment, disposal, and recycling services to much of northern Monterey County. BSL is the contract operator of the Bayonet and Black Horse Golf Courses, which are located in, and owned by, the city of Seaside, California.
- b) **Water Recycling.** The Agency owns and operates the Salinas Valley Reclamation Plant, which produces recycled water for irrigation of food crops grown in the Castroville area. The Agency is actively involved in efforts to expand the use of recycled water, and, in coordination with other agencies, is planning an urban recycling project. This project would provide recycled water for irrigation of golf courses and landscaped areas in and near the Monterey Peninsula.
- c) **Recycled Water Demonstration Program.** In order to verify the suitability of using recycled water for irrigation of golf courses, the Agency would like to conduct a demonstration program using recycled water to irrigate a small portion of the Bayonet golf course. The description, conduct, implementation, cost and other matters pertaining to the demonstration program are described in "Exhibit A", which is attached hereto and is incorporated herein by this reference. Rights, duties, and obligations set

out in Exhibit A are as applicable to the parties hereto as if set out at length in the body of this MOU.

- d) Purpose and Intent. The purpose and intent of this MOU, therefore, is to set forth in writing certain agreements between the parties relating to the recycled water demonstration program.

Terms and Conditions

In consideration of the mutual promises contained herein, the Agency and BSL hereby agree to the following terms and conditions:

1. Construction. BSL hereby authorizes the installation and construction of the facilities necessary to conduct the demonstration program, as described in Table 1 of "Exhibit A". The Agency will install and construct those facilities indicated in Table 1 as being furnished by the Agency, and BSL will install and construct those facilities indicated in Table 1 as being furnished by BSL. The Agency shall be solely responsible for obtaining all permits which may be required for the construction of these facilities, and for conducting the demonstration program. During construction the Agency shall address any issues or concerns raised by BSL.

2. Restoration of the Work Site and Repair of Affected Facilities. The Agency shall be responsible for the restoration of the work site where it has installed its portion of the facilities, following completion of the demonstration program. The Agency shall fully repair, restore or replace any of BSL's facilities or improvements which are altered, damaged or affected by the Agency or its contractors or subcontractors, unless BSL informs the Agency that such facilities or improvements need not be replaced, restored or repaired.

3. Coordination of Activities. The Parties agree to carry out the logistical activities indicated as being performed by each of them, as described in Table 2 of "Exhibit A." The Parties also agree to cooperate with each other to facilitate construction of the demonstration program facilities in accordance with the schedule shown in Table 3 of "Exhibit A." The Parties further agree to minimize disruptions to their respective operations and activities by coordinating the work with each of their schedules. In the event that either of the Parties must respond to an emergency, each party shall take immediate action to provide access for the other party's personnel and equipment to operate, repair or maintain its facilities.

4. Hold Harmless and Indemnity. The Agency shall defend, indemnify and hold harmless BSL from any and all damages, liabilities, losses and costs or expenses suffered or incurred by BSL, or claims or lawsuits against BSL, arising out of or

resulting from any damages caused by the Agency or its contractors or subcontractors or agents in the performance of any activities hereunder.

BSL shall defend, indemnify and hold harmless the Agency from any and all damages, liabilities, losses and costs or expenses suffered or incurred by the Agency, or claims or lawsuits against the Agency, arising out of or resulting from any damages caused by BSL or its contractors or subcontractors or agents in the performance of any activities hereunder.

5. Attorney's Fees. In any action or legal proceeding to enforce any part of this MOU, the prevailing party shall recover reasonable attorney fees and court costs.

6. Term of MOU. This MOU shall continue from its date of execution until the demonstration program is completed, or until such time as either party files with the other party a written notice requesting that the MOU be terminated, whichever comes first.

7. Non-Waiver of Rights. The parties each agree that no party hereto shall be considered or deemed to have waived, released or altered in any manner any and all rights which it would otherwise have pursuant to law with regard to any other matter dealt with or affected by this MOU.

8. Interpretation. It is agreed and understood by the parties hereto that this agreement has been arrived at through negotiations and that none of the parties is to be deemed the party which prepared this agreement within the meaning of Civil Code §1654. The provisions of this MOU shall be interpreted in a reasonable manner to effect the purpose of the parties and this MOU.

9. Amendment or Modification. This MOU may be amended, altered or modified only by a writing, specifying such amendment, alteration or modification, executed by authorized representatives of both of the parties hereto.

10. Relationship of the Parties. Nothing in this MOU shall create a joint venture, partnership or principal-agent relationship between the parties.

11. Counterparts. This MOU may be executed in two counterparts, each of which shall be deemed an original, but each of which shall be deemed to constitute one and the same instrument.

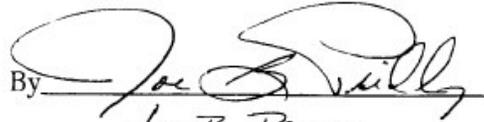
12. Entire Agreement. This MOU, consisting of four (4) pages and one (1) exhibit, constitutes the entire and complete agreement between the parties regarding the subject matter hereof, and supersedes all prior or contemporaneous negotiations, understandings or agreements of the parties, whether written or oral, with respect to

such subject matter.

MONTEREY REGIONAL WATER
POLLUTION CONTROL AGENCY

BSL

By 
Keith E. Israel
General Manager

By 
Joe B. Friddy
GENERAL MANAGER

”EXHIBIT A”

DEMONSTRATION PROGRAM **FOR USE OF** **RECYCLED WATER FOR IRRIGATION OF SEASIDE GOLF** **COURSES**

Purpose of Demonstration: The Agency’s Board of Directors set as one of its Strategic Goals to “Increase Public Acceptance of Recycled Water”. One Objective toward accomplishing this Goal is to conduct a recycled water demonstration project at the Seaside Golf Course.

Background: BSL’s Director of Golf Course Maintenance felt the best way to see how the most sensitive grass on the course would respond to irrigation with recycled water would be to conduct the demonstration project using a putting green. . If the grass on the green shows any distress from recycled water, then subsequent testing could be done on a tee, which is the next most sensitive grass on the course. In the Superintendent’s opinion, the fairway grass should be the least sensitive grass, and therefore would not need to be included in the demonstration project, if the response of the green and tee grass was satisfactory. In addition the Agency would like to demonstrate the use of recycled water on a landscaped area that would be typical of decorative landscaping used on golf courses.

Description of Demonstration Project: Over a period of approximately six months (May through October) recycled water from the Salinas Valley Reclamation Plant (SVRP) will be used to irrigate one putting green and a nearby area landscaped with shrubs and flowers. All other areas will be watered with well water, which is the present water supply for the golf course. This will allow a direct side-by-side comparison to be made of turf and soil response to the two types of water. If results of this six month test indicate that further testing is needed, the Agency and BSL will work together to develop a test plan to perform that work.

How the Project Will be Conducted: MRWPCA will produce the required volumes of recycled water from the SVRP to meet the irrigation demands of the areas to be irrigated, and will deliver the water to a storage tank that will be located at the Golf Course Maintenance Yard. Temporary piping will be installed from the storage tank to a small booster pump. The pump will deliver water through temporary underground piping to each of the irrigation sites.

The areas to be irrigated with recycled water are the 13th green and a nearby area landscaped with flowers and shrubs, both on the Bayonet Course.

For the green demonstration area BSL will install temporary underground PVC

pipng to connect the booster pump to the existing sets of sprinklers that water the green and the landscaped area. BSL will install a separate programmable timer to control the irrigation of these areas with recycled water, so they will be irrigated at the same rates as the other areas of the golf course.

Based on this approach, the average weekly volume of recycled water that will be required to irrigate the putting green during the summer irrigation months will be:

4 Sprinklers x 40 gpm x 15 minutes per irrigation x Every 4 days = 4,200 gallons/week.

The landscaped area is expected to require an additional 2,000 gallons/week.

During peak irrigation periods, the total irrigation volume may be as high as approximately 10,000 gallons per week for the green and landscaped area combined.

Implementation of the Project:

Hardware: A list of the major items needed, and the party to provide them, is shown in Table 1.

The storage tank has already been purchased and installed by the Agency.

Temporary piping shall be purple PVC of sufficient diameter to serve the peak instantaneous irrigation demand. A 2 or 3 inch diameter line from the booster pump to the green will be adequate.

The Agency will furnish and install the booster pump needed to deliver the recycled water. The pump will be mounted on a small concrete pad or some other temporary base. Electrical power is close by and available for the pump. Wiring and an on-off switch for the booster pump will be furnished and installed by the Agency. A programmable irrigation timer, furnished and installed by BSL, will be used to control the irrigation cycle. An adjustable time-delay switch may also need to be installed, so that the booster pump can pressurize the piping before the irrigation controller opens each sprinkler solenoid valve. If this switch is found to be necessary, it will be furnished and installed by BSL.

Logistics: Table 2 lists the major logistical tasks to be done, and the party to do them.

Design of the Project refers to defining the scope, purpose, and objectives of the Project and to getting all the hardware and logistical tasks taken care of. This will be a joint effort of the Agency and BSL, to ensure the expectations and needs of both parties are met.

Permits and/or approvals from regulatory agencies will be required to conduct the Project. The Agency will obtain these approvals. The permits/approvals expected to be required are those of the County Health Department and the Regional Water Quality Control Board (RWQCB). BSL will obtain whatever approvals are needed from its governing body to conduct the project.

Signs in the demonstration areas will be furnished and installed by the Agency saying "Recycled Water in Use." Other signs at the storage tank and the booster pump, if required, will also be furnished and installed by the Agency.

The Agency will provide BSL's irrigation personnel a short in-person training program on the safe and proper use of recycled water.

The Agency will fill the storage tank on a regular basis.

BSL will provide a list of the water quality parameters it would like to have tested to compare the recycled water to its well water. The Agency will have this testing performed and will provide this data to BSL. BSL will provide to the Agency data it has on water quality parameters from its wells.

Operating and maintaining the booster pump, and performing the irrigation itself, will be performed by BSL. BSL will keep records of the volumes of recycled water that are used, the irrigation schedule, and anything else that will help in comparing the irrigation practices on both the well water and recycled water irrigation areas.

Soil samples and soil-water extract samples will be taken and analyzed by the Agency monthly for several months before beginning irrigation with recycled water. The Agency will also take and analyze such samples at intervals throughout the demonstration project.

Schedule:

The schedule for the demonstration Project is shown in Table 3. Irrigation with recycled water will begin in May 2003 and continue through October 2003. Depending on the results of the testing and the response of the grass, irrigation may be continued into subsequent years.

TABLE 1-HARDWARE ITEMS		
ITEM	FURNISHED/INSTALLED BY	
	AGENCY	BSL
Storage Tank	X	
Temporary PVC Piping to Booster Pump	X	
Booster Pump and Time Delay Switch	X	
Programmable Controller and Wiring		X
PVC Irrigation Piping from Booster Pump to Demonstration Areas		X

TABLE 2-LOGISTICAL ITEMS		
TASK	TO BE PERFORMED BY	
	AGENCY	BSL
Design the Project (Joint Effort of MRWPCA and Golf Course)	X	X
Obtain County Health, RWQCB, and Any Other Required Permits or Approvals to Conduct the Demonstration Project	X	
Fabricate and Install Necessary Signage	X	
Train Irrigation Personnel in Safe/Proper Use of Recycled Water	X	
Keep Storage Tank Filled with Recycled Water	X	
Do Any Required or Desired Irrigation Water Quality Testing	X	
Operate and Maintain Booster Pump		X
Perform Irrigation, and Keep Irrigation and Fertilization Records		X
Take and Analyze Soil and/or Grass Samples	X	

TABLE 3-PROJECT SCHEDULE	
DATE	ACTIVITY
June 2002-October 2002	Prepare and execute agreement between the Agency and BSL to proceed with the Project
November-December 2002	Complete Obtaining Permits and Approvals
January-March 2003	Obtain and install hardware
April 2003	Begin irrigation with recycled water
October 2003	Conclude irrigation with recycled water
January 2004	Prepare first year report on the Project
March 2004	Prepare work plan for further testing, if needed

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