FINAL REPORT

POOL DISCHARGE SPECIAL STUDY (PHASE I)

WATER QUALITY EVALUATION REPORT

Prepared for
Contra Costa Clean Water Program
255 Glacier Drive
Martinez, CA 94553-4897

July 14, 2000

URS

500 12th Street, Suite 200
Oakland, CA 94607-4014
51981129NA.00

TABLE OF CONTENTS

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

TABLE OF CONTENTS

PURPOSE AND OBJECTIVES

This report summarizes the Phase I results of a study performed by the Contra Costa Clean Water Program to support the practical resolution of where, and under what conditions swimming pool water can be discharged in Contra Costa County (the County), California. Swimming pool discharges in the County are considered a non-stormwater discharge, a class of discharges that is regulated under the Federal National Pollutant Discharge Elimination System (NPDES) Permitting Program. Dechlorinated swimming pool discharges are considered to be conditionally exempt. This means that they may be discharged to the stormwater drainage system, provided that the source of the discharge is identified and appropriate control measures to minimize the impacts of the discharge are identified and implemented by the County.

Due to the uncertain impact of pool discharges to receiving waters, stormwater regulators are concerned about allowing these discharges, or specifying the conditions or Best Management Practices (BMPs) that would make the discharges acceptable. An alternative discharge location for swimming pool discharges is the sanitary sewer system. However, local sanitary districts have concerns about accepting and regulating pool discharges because they also need to comply with their specific NPDES permit requirements.

The primary objectives of the Phase I study are the following:

1. Evaluate the conditions for which swimming pool water can be discharged to the storm drain and sanitary sewer in the County,
2. Identify whether there is a difference between private and public pool discharge water quality,
3. Identify constituents of concern for storm drain and sanitary sewer discharges, and
4. Develop a basis for implementing Phase II BMP development and public outreach.

The data collected for this study will also assist other stormwater programs within the Bay Area (specifically members of the Bay Area Stormwater Management Agencies Association) [BASMAA]) and elsewhere in addressing pool discharges.

A stakeholder advisory committee representing a broad range of interests from regulatory, academic and professional sectors was convened to help develop the study goals and approach, and provide a technical and practical review of the project submittals. The advisory group members and their affiliations include Mr. Dale Bowyer, Regional Water Quality Control Board - San Francisco Bay Region; Mr. Bart Brandenberg, Pollution Prevention Supervisor at Central Contra Costa Sanitary District; Mr. Marc Hannigan, Earl Adams Tile and Plaster; Professor Jim Hunt, Department of Civil and Environmental Engineering, University of California, Berkeley; Mr. Paul Palubicki, Paul's Pool Service, Mr. Mike Rugg, California Department of Fish and Game, Central Coast Region; Leo Sarmiento, Regional Water Quality Control Board - Central Valley Region; and Mr. Mori Struve, City of El Cerrito.

STUDY DESIGN

Eleven private and seven public pool discharges in Contra Costa County were sampled between September, 1999 and October, 1999. Pool drainage water was sampled for private pools. The types of discharges sampled from public pools that were sampled included diatomaceous earth and sand filter backwash (which were the majority of samples collected) diatomaceous earth filter rinse water, a continuous bleed discharge, and pool drainage water. Field observations were made at each site, including volume of water discharged, flow rate, time since last water quality maintenance performed (if possible), the presence of algae or debris in the pool, clarity of discharge, filter type (for public pools), type of discharge (for public pools), the reason for discharging the pool (for private pools), frequency of the discharge (i.e., last time pool was discharged), discharge location (storm drain, sanitary sewer, or other) and dechlorination procedures (for private pools and one public pool). Private pools were dechlorinated by the dischargers (two pool plastering companies) before discharge samples were collected in order to comply with NPDES Permit requirements.

The analytical suite for the pool discharge sampling is summarized in Table ES-1. The analyses were performed in the field at each sampling site, and at the Central Contra Costa Sanitary District analytical laboratory in Martinez, California. In addition, 48-hour acute toxicity tests were performed using undiluted private pool samples to evaluate the effect of the discharges on young (5-20 days old) Fathead minnows. Field screening was performed to eliminate those samples with parameters detected at levels known to cause toxicity to fish using the following criteria:

- If total residual chlorine is above 0.2 mg/L (ppm)
- If pH is less than 6.5 or more than 8.8
- If conductivity is above 6,000 microsiemens
- If total ammonia is above 5 mg/L (PPM)

RESULTS OF FIELD SAMPLING AND OBSERVATIONS

The major findings of the field observations and analytical data are the following:

- Of the 18 pools sampled, 14 pools were discharged to the sanitary sewer, 3 pools were discharged to the storm drain and/or vegetated areas, and one pool was discharged to an unidentifiable sump. Pools were discharged to the storm water drainage system or vegetated areas if a sanitary sewer connection was not available, or the flow needed to be rerouted due to sanitary sewer system overflow.
- Private pool dechlorination practices varied among pools and often were not fully effective. Of the nine pools that were dechlorinated, four pools had detectable amounts of chlorine when they were discharged.
- Seven of the eleven private pools did not pass the screening criteria of toxicity tests, due to chlorine concentrations or pH values that were above the screening criteria. The four samples that passed the screening criteria and were evaluated for toxicity to Fathead minnows had 100% survival.
- Constituents with the lowest number of detected values for both pool categories included total and dissolved silver, and ammonia as nitrogen. Also, turbidity was detected infrequently and residual free and total chlorine were detected about 50% of the time in private pool discharges.

- Public pools tended to have higher concentrations of total suspended solids (TSS), biochemical oxygen demand (BOD), chlorine, turbidity and conductivity than private pools. TSS concentrations were higher for public pools because most samples were backwash samples as opposed to pool drainage samples, and chlorine concentrations were higher because public pool discharges were not dechlorinated.
- Public pool samples containing diatomaceous earth had concentrations of TSS, total copper and chemical oxygen demand (COD) that were significantly higher than other public pools as well as private pools. Therefore, these sample results were excluded from statistical analyses used to evaluate constituents of concern, as discussed in the following section.

PROBLEM EVALUATION

In order to identify constituents of concern, the study results were compared to various receiving water objectives and local sanitary district influent acceptance criteria. In addition, to evaluate the future behavior of pool discharge samples in the County, a statistical assessment was performed that compared the 99% prediction limit calculated for each constituent to its respective criteria. A 99% prediction limit indicates that for many future sampling events (for a representative pool population), the given sample concentration will not exceed the prediction limit 95% of the time. Also, one or more future discharge samples will exceed the prediction limit 5% of the time.

Constituents that were identified as constituents of concern based on the problem evaluation methods include pH, total dissolved solids (TDS)/conductivity, and total and dissolved copper. Copper is most problematic for discharges to the storm drain, and conductivity/TDS and pH are problematic for discharges to the storm drain and sanitary sewer. TSS and copper, when associated with diatomaceous earth (copper associated with sand filters is also of concern to a lesser degree) are problematic for sanitary sewer discharges.

Chlorine has been identified as a constituent of concern for discharges to the storm drain because a moderate percentage of pools that were dechlorinated had detectable levels of chlorine when they were discharged, which is in violation of the County NPDES permits. This implies that because dechlorination practices used by pool professionals were not always effective, there are likely similar problems associated with pools that are dechlorinated and discharged by private residents.

Also of concern for sanitary sewer discharges are discharge flow rates, the high frequency of illicit discharges, and discharge of materials that may require special provisions, such as separate containment of diatomaceous earth.

The Stakeholders meeting on March 23, 2000 further defined constituents of concern that should be the focus of the Phase II study. The Stakeholders concluded the following:

- Chlorine is the primary constituent of concern for discharges to the storm drain. NPDES permits require that swimming pool discharges be dechlorinated prior to discharge. The current study data indicate there may be relatively frequent Permit violations.
- TDS and TSS (when associated with diatomaceous earth and sand filters) are constituents of concern for discharge to the sanitary sewer system. Copper is also of concern for sanitary sewer discharge based on current and future sanitary waste discharge requirements.

CONCLUSIONS AND RECOMENDATIONS

Based on the results of the Phase I report, and the Stakeholder meetings, URS will develop the Phase II of the Pool Discharge Special Study for the constituents of concern. The purpose of the Phase II is to recommend permitting procedures, certification requirements, and monitoring requirements that would be implemented cooperatively by the Clean Water Program and the Central Contra Costa Sanitation District to meet the sanitary discharge limits and/or receiving water quality criteria. This program is referred herein as the "Joint BMP Program". As part of the Phase II scope, URS will develop an outline of an outreach and training plan to support the Joint BMP Program.

DRAFT Pool Discharge Special Study
Water Quality Evaluation Report

Section 1 Introduction

This report summarizes the results of a water quality study performed to support the practical resolution of where, and under what conditions swimming pool water can be discharged in Contra Costa County (the County), California. Swimming pool discharges in the County are considered a non-stormwater discharge, a class of discharges that is regulated under the Federal National Pollutant Discharge Elimination System (NPDES) Permitting Program. Under the two Contra Costa Clean Water Program (Program) NPDES permits, dechlorinated swimming pool discharges are considered to be conditionally exempt. This means that they may be discharged to the stormwater drainage system, provided that the source of the discharge is identified and appropriate control measures to minimize the impacts of the discharge are identified by the County. However, due to the uncertain impact of pool discharges to receiving waters via the stormwater drainage system, stormwater regulators are concerned about allowing these discharges, or specifying the conditions or Best Management Practices (BMPs) that would make the discharges acceptable. The sanitary sewer system is an alternative discharge location for swimming pool discharges. However, local sanitation districts also have concerns about accepting and regulating these discharges.

The Program is comprised of twenty municipalities in Contra Costa County and is responsible for implementing its joint municipal NPDES permits (Permits) issued by the San Francisco Bay and Central Valley Regional Water Quality Control Boards (RWQCBs). One Permit requirement is to conduct special studies that evaluate the impact of non-stormwater discharges on the municipal stormwater drainage system. This particular study has been conducted to address the above issues related to swimming pool discharges.

This study consists of two phases. The purpose of Phase I is to identify whether swimming pool discharges to the storm drain and/or sanitary sewer are problematic. The purpose of Phase II is to develop, test and recommend methods to be used to address problematic discharges. Phase II tasks will be implemented based on the Phase I results, and may include developing guidance for testing BMPs; recommending appropriate BMPs; and developing an outreach plan to educate homeowners and pool professionals about requirements for draining and backwashing pools, and obtaining necessary permits. The data collected for this study will also assist other stormwater programs within the Bay Area (specifically members of the Bay Area Stormwater Management Agencies Association) [BASMAA]) and elsewhere in addressing pool discharges.

Before beginning the swimming pool water quality evaluation, a workplan was developed in which much of the background information that is the basis of this study, in addition to the study design, was summarized (Workplan) (URSGWC, 1999). Some information from the workplan, such as stormwater program policies regarding pool discharges and various information obtained from surveys has been included in this report as appendices, or is briefly reiterated in various sections of the report.

1.1 Stakeholder Advisory Process

The goal of the Pool Discharge Water Quality Evaluation is not to merely satisfy the requirements of the Permits. It is also to evaluate the real environmental issues associated with swimming pool discharges, and the most cost-effective way to address these issues. To achieve this goal, the Program convened a Stakeholder Advisory Group (Stakeholders) to provide input into the development of the study goals and approach, and provide a technical and practical review of the project submittals. The Stakeholders represent a broad range of interests from regulatory, academic and professional sectors. The advisory group members and their affiliations include Mr. Bart Brandenberg, Pollution Prevention Supervisor at Central Contra Costa Sanitary District; Mr. Marc Hannigan, Earl Adams Tile and Plaster; Professor Jim Hunt, Department of Civil and Environmental Engineering, University of California, Berkeley; Mr. Paul Palubicki, Paul's Pool Service, Mr. Mike Rugg, California Department of Fish and Game, Central Coast Region; and Mr. Mori Struve, City of El Cerrito.

1.2 Study Objectives

The following are the major objectives of the Phase I study:

1. Evaluate the conditions for which swimming pool water can be discharged to the storm drain and sanitary sewer in Contra Costa County,
2. Identify whether there is a difference between private and public pool discharge water quality,
3. Identify constituents of concern for storm drain and sanitary sewer discharges, and
4. Develop a basis for implementing Phase II BMP development and public outreach.

1.3 Report Organization

The organization for the remainder of this report is as follows. Section 2 summarizes the study design, including the types of discharges sampled, the analytical suite, and the types of field observations performed. Section 3 summaries the study analytical results and field observations, and compares the results obtained to a previous swimming pool water quality study. Section 4 discusses the quality assurance/quality control procedures for the study, and provides a data quality and data usability assessment. Section 5 presents the problem evaluation methodology and results. Section 6 presents to conclusions and recommendations for this study. References are provided in Section 7.

Section 2 Study Design

This section summarizes the types of swimming pool discharges sampled and field observations made, and the analytical suite for the study. The study design was based on the protocol documented in the Workplan, although some minor modifications were made.

2.1 Spa Sampling

Spa discharges were considered for the study, but were excluded after evaluation by the stakeholders because the volume of spa water is small compared to pools and it appears that private spas are more frequently discharged to vegetated areas, rather than directly to the storm drain or the sanitary sewer. Therefore, the impact to wither the storm drain or sanitary sewer is minimal.

2.2 Private Pool Sampling

Private pool sampling was coordinated with two pool plastering companies. The locations where samples were collected and field observations were made are shown on Figure 2-1. The pools that were sampled were drained for cleaning, replastering, and/or retiling. Prior to draining, the private pools were dechlorinated by the plasterers following their standard procedures. The dechlorination was performed to comply with Permit requirements for swimming pool discharges. For consistency, dechlorination was performed for both storm drain and sanitary sewer discharges, although this is not a requirement for discharges to the sanitary sewer. With one exception, the dischargers waited at least fifteen minutes after dechlorinating before the pool was discharged. A submersible pump was placed in the pool to discharge the water and water quality samples were collected from the end of the discharge hose as the pool was being drained. Typically, the samples were collected at he beginning of the discharge process (after the hose was purged). The discharge hose was purged with pool water for at least three minutes before water quality samples were collected.

2.3 Public Pool Sampling

Public pool sampling was coordinated either directly with facility personnel, or with a public pool service contractor. The locations where samples were collected and field observations were made are shown on Figure 2-1. Cities, the County, private community complexes, or private organizations operated the public pools that were sampled. The majority of public pool samples were backwash from sand or diatomaceous earth filters. This was because backwash water is the most regular type of public pool discharge. Raw pool water drainage, as opposed to backwashing water, was sampled from two pools. The backwash discharge was not dechlorinated for the study, because this is not the typical practice for public pools. Water from the one public pool that was discharged for structural maintenance was dechlorinated before draining.

Due to the high flow rate of backwashing procedures, backwash samples were generally collected in one-gallon, plastic containers, and then transferred into sample bottles for analysis. The backwash samples were collected either from the direct discharge stream, or from filter pits where the water was collected before it was discharged to the sanitary sewer system. Whenever possible, time-weighted composite samples were collected to obtain representative samples. This was because the backwash quality is dirtiest at the start of the procedure, and becomes cleaner as the process continues.

2.4 Field Observations

Field observations were performed to document information such as the volume of water discharged, flow rate, time since last water quality maintenance performed (if possible), the presence of algae or debris in pool, clarity of discharge, filter type (for public pools), type of discharge (for public pools), the reason for discharging the pool (for private pools), frequency of the discharge (i.e., last time pool was discharged), discharge location (storm drain, sanitary sewer, or other) and dechlorination procedures (for private pools and one public pool).

The flow rate of the discharge is important particularly for discharges to the sanitary sewer system, due to potential overflows and backups. The discharge flow rate was calculated by measuring the time required to fill a five-gallon bucket. In some cases, public pool discharge flow rates were recorded by an automated system at the facility.

2.5 Analytical Suite

Water quality analyses were performed in the field and at the Central Contra Costa Sanitary District (CCCSD) analytical laboratory in Martinez, California. Standard Method or United States Environmental Protection Agency (USEPA) analytical methods were used for laboratory analyses, and Lamotte test kits were used for the field analyses. The analytical methods are summarized in Table 2-1. The analytical suite was developed based on private pool owner and professional pool company chemical usage surveys (which are summarized in the Workplan), and the various surface water quality and local sanitary district criteria summarized in Section 5.

A 48-hour static acute toxicity test was performed by Aqua Science, in Davis, California, following a modified USEPA protocol to evaluate the effect of pool discharges on young (5-20 days old) Fathead minnows. The tests were performed on undiluted pool discharge samples. Field screening was performed to eliminate those samples with parameters detected at levels known to cause toxicity to fish. The following values were used as screening criteria:

- If total residual chlorine is above 0.2 mg/L (ppm)
- If pH is less than 6.5 or more than 8.8
- If conductivity is above 6,000 microsiemens
- If total ammonia is above 5 mg/L (ppm)

Samples designated for laboratory analyses were placed in coolers with blue ice, and maintained at 4°C ± 2°C. Samples were transported to CCCSD following standard chain-of-custody procedures.

Section 3 Study Results

This section summarizes the field observations performed at each pool site and the results of the water quality sampling. The current study data are also compared to the results of a previous pool water quality study.

3.1 Field Observations

Eleven private and seven public pools were sampled. For private pools, three were sampled in Walnut Creek, two in Moraga, and one each in Alamo, Concord, Oakley, Lafayette, Blackhawk and Danville. For public pools, two were sampled in Antioch, and one each in El Cerrito, Richmond, Concord, San Ramon and Walnut Creek. Field observations are summarized in Table 3-1 for private pools and Table 3-2 for public pools.

Of the eleven private pools sampled, seven were discharged to the sanitary sewer system, one was discharged directly into the storm drain, two were discharged to vegetated areas and one was discharged to a sump with an unknown ultimate discharge location. The discharge flow rate ranged from 15 gpm to 30 gpm. Three of the pools had not been discharged in at least 20 years; two pools has not been discharged in at least nine years; one pool was discharged 2 years ago; and the amount of time that passed since the last discharge was unknown for four pools (either because the owner was not present or was uncertain).

Many private pools contained leaves or other floating debris, sediment on the pool bottom, and/or algae on the pool walls. There were no chemicals added to seven pools for at least one week prior to discharge. The water quality maintenance performed for one pool is unknown. The other pools has chemicals added more closely to the time of discharge. Typical chemical additives include chlorine, acid and algaecides.

Nine private pools were dechlorinated using sodium thiosulfate (including Thio-trine), however, the amount of chemicals added, the mixing procedures and the amount of time elapsed before discharging varied among the pools. One pool was not dechlorinated because residual chlorine was not expected to present based on the last water quality maintenance performed. The dechlorination of one pool was uncertain because the pool plasters were not present when the pool discharge was sampled.

All of the public pools were discharged to the sanitary sewer. Typically filter backwash does not appear to be discharged to the storm drain, however, one municipal pool facility sampled for this study did discharge backwash water from three pools to the storm drain (although these pools were not sampled). Two of the public pool discharges were raw pool water. One pool was drained for structural maintenance and one was a continuous bleed performed to control total dissolved solids (TDS) levels. For the backwash samples, two filters were diatomaceous earth and the remainder were sand filters. Discharge flow rates for backwashing ranged from 80 gpm to 900 gpm. Backwashing lasted for 3 to 30 minutes. Some pools were backwashed as often as once per week, while the frequency for other pools was seasonal. All of the public pools were regularly treated with chemicals, which primarily included chlorine, acid, and alkalinity adjustments.

Photographs of some pool sampling locations are included in Appendix A.

3.2 Analytical Results

The analytical data are summarized in Table 3-3. Replicate analyses performed using field kits are averaged, while field duplicates collected for laboratory analysis are listed separately. Basic summary statistics (mean, standard deviation, coefficient of variation (expressed as percent), minimum and maximum) and the number of detects are presented by category in Table 3-4, Table 3-5 and Table 3-6. The two public pool samples with diatomaceous earth (PUB-03, PUB-05) were excluded from the data set, as they are considered outliers because the nature of these samples is very different from the rest of the data. Specifically TSS, total copper (which is associated with TSS) and COD concentrations are extremely high in the diatomaceous earth samples compared to the rest of the data set.

Constituents with the lowest number of detected values for both pool categories included total and dissolved silver, and ammonia as nitrogen. Also, turbidity and residual free and total chlorine were detected infrequently in private pool discharges.

Public pools tended to have higher concentrations of TSS, BOD, chlorine, turbidity and conductivity than private pools. TSS concentrations were higher for public pools because most samples were backwash samples as opposed to pool drainage samples, and chlorine concentrations were obviously higher because public pool discharges were not dechlorinated.

TDS/Conductivity ratios in the pool samples ranged from 0.27-1.2. Typical TDS/Conductivity ratios for fresh and salt water range from 0.55 to 0.75. TDS are defined as the total mass of ions in water plus silica. Conductivity is defined as the sum of cations in water, expressed in equivalent weight. Several TDS/Conductivity ratios exceed the typical range. This was likely due to presence of high concentrations of divalent cations, such as calcium and magnesium, which could be the result of chemicals additions for hardness and alkalinity adjustment.

Toxicity Tests

Only the private pools were screened for toxicity testing, because the public pools were not expected to pass because with one exception, they were not dechlorinated. The samples that passed and did not pass the screening criteria are as follows:

Private Pools That Did Not Pass Screening Criteria	**Private Pools That Passed Screening Criteria**
01	02
05	03
06	04
07	11
08	
09	
10	

The pools that did not pass the screening criteria failed either because the total residual chlorine concentration (4 samples) or pH (3 samples) was above its criterion. The samples that passed the screening criteria were sent to Aqua Science for toxicity testing. There was 100% survival for all undiluted samples after 48 hours. Toxicity data are included in Appendix B.

Comparison of Analytical Results to a Previous Pool Study

In 1998, CCCSD performed a study to better understand the potential impacts that draining private swimming pools may have on the environment and community, and to aid in the development of BMPs for swimming pool discharges (Laponis, 1998). A total of thirteen samples were collected, and analyzed for copper, hardness, free chlorine, and pH. The pools were not dechlorinated prior to discharging and sampling. Most pools were discharged to the stormwater drainage system.

A comparison of the CCCSD study to the current study data is presented below. Comparing the results of the CCCSD study to the current private pool data, total copper concentrations are comparable; hardness is marginally higher in the CCCSD study; and pH is higher and has a broader range for the current study data.

	CCCSD Study	**Current Data Private Pools**
No. of Data Points	13	11
Total Copper (ppb)		
Mean	69.1	71.1
Min	3.3	9.6
Max	310	243

Hardness (ppm)		
Mean	335	277
Min	55	90
Max	690	592
pH		
Mean	7	8.2
Min	7	7.2
Max	7	9.5

Note:

(1) Data set excludes backwash samples with diatomaceous earth

Section 4 Quality Assurance/Quality Control (QA/QC) Report

Both field and laboratory QA/QC procedures were implemented to obtain data that were of high quality and usable for making the decisions necessary for this study. A summary the QA/QC activities that were performed and the parameters that were reviewed for the field, analytical and toxicity analyses is provided below.

4.1 Field Personnel Training

Before beginning the field work for this study, field personnel were trained in a four-hour training session. The objectives of the training were to review the study objectives, learn how to use the field kits (using real pool and spa samples), collect samples, make field observations, complete chain-of-custody forms and implement proper QA/QC procedures during sampling and field analyses. The training class also included how to evaluate whether the field measurements obtained were reasonable, and how to implement corrective actions to check suspect results.

4.2 Field QA/QC

Field QA/QC was implemented while collecting samples for laboratory analysis, and when performing field analyses with test kits. When using test kits, equipment was dedicated to each type of field kit to minimize cross-contamination. Equipment used with the test kits was also decontaminated with distilled water before use. Blank samples consisting of distilled water were analyzed with each batch of free chlorine, total chlorine and total ammonia-nitrogen analyses. In addition, replicate analyses were performed for at least two parameters for every sample.

4.3 QA/QC Procedures for Laboratory Analytical Data

This section summarizes the parameters that were reviewed as part of the QA/QC evaluation process for the laboratory analytical data.

Method Holding Times

The analytical methods used for this project have prescribed holding times. The method holding time is defined as the maximum amount of time after collection that a sample may be held prior to extraction and/or analysis. Sample integrity becomes questionable for samples extracted and/or analyzed outside of the prescribed holding times due to degradation and/or volatilization of the sample. The analytical results of such samples extracted and/or analyzed outside the prescribed method holding time are suspect. The QA/QC review identifies results with exceeded method holding times.

Blanks

Blank samples analyzed for this study included method blanks and bottle blanks. Method blanks are prepared in the laboratory using deionized, distilled (Reagent Grade Type II) water. Method blanks are prepared and/or analyzed following the same procedures as an environmental sample. Analysis of the method blank indicates potential sources of contamination from laboratory procedures (e.g. contaminated reagents, improperly cleaned laboratory equipment). The QA/QC review identifies method blanks with detections of target analytes, and evaluates the effect of the detections on the sample results.

Bottle blanks were prepared and analyzed by the laboratory due to the low detection limits required for metals analyses. The laboratory acid-cleaned the sample bottles and checked five percent of the acid-cleaned sample bottles for contamination by filling the cleaned bottle with clean reagent water acidified to pH less than 2, and letting the bottle sit for two weeks. After two weeks, the water was analyzed by the laboratory for copper and silver to evaluate whether the bottle or cleaning procedures were a potential source of sample contamination. The QA/QC review identifies bottle blanks with detections of metals and evaluates the effect of the detections on the sample results.

Matrix Spikes and Laboratory Control Samples

Matrix spikes (MS), matrix spike duplicates (MSD) and laboratory control samples (LCS) are performed by the laboratory to evaluate the accuracy and precision of the sample extraction and analysis procedures, and also to evaluate potential matrix interference Matrix interference refers to the effect of the sample matrix on the analysis, which may partially or completely mask the response of the analytical instrumentation to the target analyte(s). Matrix interference may have a varying impact on the accuracy and precision of the extraction and/or analysis procedures, and may bias the sample results high or low.

The MS is prepared by adding known quantities of target compounds to a sample. The sample is then extracted and/or analyzed as a typical environmental sample, and the results are reported as percent recovery. The spike percent recovery is defined as:

$$\text{Recovery (\%)} = \frac{\text{spike analysis result - original sample concentration}}{\text{concentration of spike addition}} \text{x100\%}$$

MS recoveries are reviewed for compliance with laboratory-established control limits to evaluate the accuracy of the extraction and/or analysis procedures.

LCSs are prepared exactly like MSs, except a clean control matrix is used (Reagent Grade Type II water). LCSs are used to evaluate laboratory accuracy, independent of matrix effects.

The QA/QC review identifies spike recoveries outside laboratory control limits and evaluates the effect of these recoveries on the sample results. A LCS was performed for copper, silver, and TSS (using a standard prepared with diatomaceous earth). MS/MSDs were performed on project samples for copper, silver, and COD.

St*andard Reference Materials and Other Standards*

Standard reference materials (SRMs) are pre-spiked samples prepared by certified external sources for laboratory performance evaluations. SRMs used for this study included Environmental Resource Associates (traceable to National Institute of Standards and Technology SRMs) materials for TDS, alkalinity and hardness.

Hach standards were used for BOD and COD.

SRMs and other standards are used to evaluate analytical accuracy by the same methods used for MS/MSDs. The QA/QC review identifies SRM and other standard recoveries outside laboratory control limits and evaluates the effect of these recoveries on the sample results.

Laboratory Duplicate Analyses

The laboratory performs duplicate analyses to evaluate the precision of the analytical procedures. Duplicate analyses performed for this study included MSD and laboratory duplicates. In addition, field duplicates were collected with fictitious sample identifications to evaluate sample homogeneity, as well as sampling and analytical precision. The duplicate pairs collected were:

- PUB-05/PUB-11
- PUB-07/PUB-12
- PRIV-01/PRIV/22
- PRIV-10/PRV-23
- PRIV-11/PRIV/24

Precision is evaluated for laboratory spike analyses by calculating a relative percent difference (RPD) as follows:

$$\text{RPD (\%)} = \frac{|\text{Original Spike Recovery Conc} - \text{Duplicate Spike Recovery Conc}|}{\frac{1}{2}(\text{Original Spike Recovery Conc} + \text{Duplicate Spike Recovery Conc})} \text{ x } 100\%$$

The RPDs are compared to a control limit of 25% to evaluate analytical precision.

Precision is evaluated for laboratory duplicate and blind field duplicate analyses by calculating a relative percent difference (RPD) as follows:

$$\text{RPD (\%)} = \frac{|\text{Original Result} - \text{Duplicate Reuslt}|}{\frac{1}{2}(\text{Original Result} + \text{Duplicate Result})} \text{ x } 100\%$$

The RPDs are compared to a control limit of 25% to evaluate field and analytical precision.

This QA/QC review identifies RPDs outside laboratory control limits and evaluates the effect of these differences on the sample results.

Initial Calibrations

The initial calibration demonstrates that the instrument is capable of producing acceptable quantitative data at the beginning of the analytical run. A series of calibration standards are run, and a correlation coefficient of > 0.995 is required to ensure linearity over the calibrated range. Initial calibrations were run each day that metals analyses were performed. The QA/QC identifies correlation coefficients outside the control limits and evaluates the effects of the low correlation coefficients on the analytical data.

Summary of Qualifiers and Qualified Results

The analytical data were reviewed and qualified following USEPA (USEPA, 1994). The qualifiers assigned to results during the QA/QC process are defined below.

UJ The analyte was not detected above the sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

Analytical results that were qualified are summarized in Table 4-1. Samples were qualified as estimated because of field duplicate analyses, and matrix spike recoveries that were outside the QA/QC evaluation criteria. In addition, samples were qualified as estimated due to detections that were above the method detection limit, but below the lowest concentration calibration standard. Samples qualified as estimated were assigned "J" or

"UJ" qualifiers. Based on the parameters that were evaluated, the QA/QC review found the analytical data to be of acceptable quality, with no limitations for making decisions. This includes results qualified as estimated.

4.4 Toxicity Data

The parameters reviewed to evaluate the quality of the toxicity data are summarized below. Toxicity data and laboratory QA/QC are included in Appendix B.

Sample Holding Time: The test date was checked to verify that the test was performed within the appropriate holding time.

Water Chemistry Parameters: Water chemistry parameters (temperature, pH, alkalinity, conductivity, dissolved oxygen, residual chlorine, and total ammonia) were monitored before and after exposure of test organisms daily to ensure that the organisms were exposed to environmental conditions which will not cause a "toxic effect" by themselves. The QA/QC review evaluated whether the values fell within the ranges known as "safe" for the organisms.

Reference Toxicant Tests: A reference toxicant test were conducted for each batch of test organisms that was purchased by the laboratory from a supplier and was used for the toxicity tests. Organisms were exposed to multiple concentrations (0, 2.5, 5, 10, 15, 20 g/L) of a known toxic standard (sodium chloride), and the results compared to database information to see if the batch of test species responded normally (i.e., with resulting end point (e.g. 48h LC_{50}) within the laboratory control chart limit). There are no clear specifications of the test design and conditions, but they should follow an approved protocol.

Control Survival: Moderately hard bottled spring water was used as the control medium for the bioassay (or other water that represents a suitable environment for the organism). The QA/QC review evaluated the percent survival in the control samples, using the criterion of 80%.

The QA/QC review found that the toxicity tests met all QA/QC requirements of the test protocol.

Section 5 Problem Evaluation

5.1 Water Quality Criteria

In order to identify constituents of concern, the analytical results obtained in this study were compared to various receiving water objectives and local sanitary district influent acceptance limits. These criteria are summarized below.

5.1.1 Receiving Water Objectives

Depending on the discharge location in the County, the water quality criteria are mandated by the San Francisco Bay RWQCB Basin Plan (SF), or the Central Valley RWQCB Basin Plan (CV) (California Regional Water Quality Control Board, 1995 (SF);

1998 (CV)). Following is a summary of the criteria used to evaluate the pool discharge results.

1. **Dissolved Oxygen**- *(SF)* for non-tidal waters, minimum dissolved oxygen for water designated as cold water and warm water habitats are 7.0 mg/L (or approximately parts per million [ppm]), and 5.0 mg/L (ppm), respectively. *(CV)* 7.0 mg/L (ppm) for Delta waters west of the Antioch Bridge; 5.0 mg/L (ppm) in all other Delta waters.

2. **pH**- the pH shall not be depressed below 6.5 nor raised above 8.5. *(SF)* Controllable water quality factors shall not cause changes greater than 0.5 units in normal ambient pH levels. *(CV)* Changes in normal ambient pH levels shall not exceed 0.5 in fresh waters with designated cold or warm beneficial uses.

3. **Salinity/Total Dissolved Solids/Electrical Conductivity**- *(SF)* Controllable water quality factors shall not increase the total dissolved solids or salinity of waters of the state so as to adversely affect beneficial uses, particularly fish migration and estuarine habitat. *(CV)* San Joaquin River at Antioch Water Works Intake 1.5-1.8 mmhos in dry years, 1.5-3.7 in critically dry years (range is due to different criteria for different flow volumes).

4A. **Sediment**- *(SF, CV)* The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses. *(SF)* Controllable water quality factors shall not cause a detrimental increase in the concentrations of toxic pollutants in sediments or aquatic life.

4B. **Settleable Material**- *(SF, CV)* Waters shall not contain substances in concentrations that result in the deposition of material that cause nuisance or adversely affect beneficial uses.

4C. **Suspended Material**- *(SF, CV)* Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

4D. **Turbidity**- *(SF, CV)* Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. *(SF)* Increase from normal background light penetration or turbidity relatable to waste discharge shall not be greater than 10 percent in areas where the natural turbidity is greater than 50 nephelometric turbidity units (NTU). *(CV)* Except for periods of storm runoff, the turbidity of Delta waters shall not exceed 50 NTU in the Central Delta and 150 NTU in other Delta waters.

4E. **Suspended Solids**- Because the water quality criteria for solids in the Basin Plans are only semi-quantitative, and depend on background levels in surface waters, National Ambient Water Quality Criteria will also be used because these criteria provide numerical objectives. These criteria were published by USEPA under the Clean Water Act to protect human health and welfare, and freshwater and marine aquatic life from pollutants in surface waters. The "Blue Book" provides advisory suspended solids limits for maintenance of freshwater fisheries (USEPA Water Quality Criteria, 1972). The advisory limits are as follows:

- there is no evidence that concentrations of suspended solids less than 25 mg/L (ppm) have any harmful effects on fisheries;
- it should usually be possible to maintain good or moderate fisheries in waters that normally contain 25-80 mg/L (ppm) suspended solids; other factors being equal, however, the yield of fish from such waters might be somewhat lower than from those in the preceding category;
- waters normally containing 80-400 mg/L (ppm) suspended solids are unlikely to support good freshwater fisheries, although fisheries may sometimes be found at the lower concentrations within this range;
- only poor fisheries are likely to be found in waters that normally contain more than 400 mg/L (ppm) suspended solids.

5. **Chlorine-** the Permits issued to the Program indicate that pool water needs to be dechlorinated prior to discharge to the storm water drainage system. The most stringent interpretation of this requirement would indicate a zero (nondetect) residual chlorine water quality objective.

6. **Copper and Silver-** The water quality objectives in the Basin Plans are to be compared to total metal concentrations. Two different exposure durations are included: acute objectives, based on a minimum 1-hour exposure duration; and chronic objectives, based on a minimum 4-day exposure duration. Pool and spa discharges are generally greater than one hour, but less than four days. Therefore, comparison with these two objectives brackets the actual exposure duration.

Water quality objectives are hardness dependent. Acute (AWQO) fresh water quality objectives for copper and silver, and the chronic (CWQO) fresh water quality objective for copper (there is no chronic objective for silver) are calculated using equations (1) and (2), respectively:

$$\mathrm{AWQO} = (\exp\{m_a[\ln(\mathrm{hardness})] + b_a\}) \tag{1}$$

$$\mathrm{CWQO} = (\exp\{m_c[\ln(\mathrm{hardness})] + b_c\}) \tag{2}$$

where:

m_a = 0.9422 for copper, 1.72 for silver;
m_c = 0.8545 for copper;
b_a = -1.700 for copper, -6.52 for silver;
b_c = -1.702 for copper;
hardness is expressed in mg/L (ppm).

Recently, recognizing that the dissolved metal fraction is a better representation of bioavailable metals concentrations, USEPA revised the above water quality standards under the Proposed California Toxics Rule (CTR) (40 CFR, Part 131, 1997). The CTR criteria are to be compared to dissolved metal concentrations. These criteria are also hardness dependent. To obtain dissolved metals fresh water criteria, Equations (1) and (2) are multiplied by acute and chronic conversion factors that express the relative distribution of total and dissolved metals fractions in the water column. The acute and chronic conversion factor for copper is 0.960, and the acute conversion factor for silver is 0.85

7. **Total and Un-Ionized Ammonia-** *(SF)* The discharge of wastes shall not cause receiving waters to contain concentrations of un-ionized ammonia as nitrogen in excess of 0.025 mg/L (ppm) (annual median). *(CV)* There are no criteria for total or un-ionized ammonia. (*USEPA*) Acute and chronic water quality goals for total and un-ionized ammonia have been developed for the protection of freshwater aquatic life (USEPA, 1986, 1998 (1)). The water quality objectives are temperature and pH dependent, and there are different standards depending on whether salmonids or other sensitive coldwater species are present.

In addition to the water quality criteria indicated above, the Fish and Game Code, which is enforced by the California Department of Fish and Game indicates that "it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of the state… any substance or material deleterious to fish, plant life, or bird life" (Fish and Game Code).

5.1.2 Local Sanitary Sewer Influent Criteria

County sanitary district personnel contacts, influent criteria and other provisions are summarized in Table 5-1. There are no specific acceptance criteria for pool discharges, therefore industrial or domestic limits were used where available.

Rodeo Sanitation District does not accept drainage from swimming pools or backwash. Dublin San Ramon Services District and Rodeo Sanitation District do not accept filter backwash.

5.2 Data Evaluation Methods and Results

This section summarizes the methodology used to compare the study data to the receiving water and sanitary district criteria.

5.2.1 Evaluation of Discrete Samples to Water Quality Criteria

Table 5-2 summarizes the total number of samples that exceeded the various water quality criteria. Samples were compared to all local sanitary district limits, regardless of the location of discharge. The sanitary district criteria used for comparison are the values included in Table 5-1. Receiving water quality objective criteria are summarized above in Section 5.1.1. The water quality objectives for metals, which are hardness-dependent, and therefore sample-specific, are provided in Table 5-3 for copper and Table 5-4 for silver**.**

Exceedances were evaluated by pool category (public, private) and as a combined data set (all pools). Whether the dechlorinated swimming pool discharges that are considered conditionally exempt in the County NPDES permits include filter backwash is uncertain, although the discharge of diatomaceous earth to the storm drain would certainly be prohibited due to its inherent toxicity to aquatic species. Diatomaceous earth is also a substance prohibited by the Fish and Game Code. Consequently, the backwash samples containing diatomaceous earth were excluded from the receiving water objective comparison. Backwash samples containing diatomaceous earth were included in the comparison to sanitary district criteria.

Parameters with more than fifty percent exceedances included:

- Total copper- both public and private pools exceeded receiving water criteria; samples containing diatomaceous earth exceeded sanitary district criteria,
- Dissolved copper- although there were receiving water objective exceedances for both categories, public pools were more problematic than private pools,
- TDS- both public and private pool exceeded sanitary district criteria, and
- Conductivity- both public and private pool exceeded receiving water criteria.

Constituents with at least one exceedance of a standard included:

- pH- public and private pools exceeded receiving water standard,
- TSS- public pools exceeded receiving water guidance (the “Blue Book” standard of 80 mg/L for maintenance of good to moderate fisheries was used), and pools with diatomaceous earth exceeded sanitary district criteria,
- Total chlorine- 36% of private pools and the one public pool that was dechlorinated had detectable levels of chlorine. Public pools that were not dechlorinated were not evaluated, and
- Total and unionized ammonia- Only one sample had detectable levels of ammonia-nitrogen. This sample exceeded all receiving water criteria (which are pH- and temperature-dependent).

Organic Carbon Availability

Biochemical oxygen demand (BOD) is defined as the amount of oxygen utilized when organic matter is degraded biologically under aerobic conditions. Chemical oxygen demand (COD) is defined as the total quantity of oxygen required for oxidation to carbon dioxide and water. COD measurements tend to be higher than BOD measurements because all organic matter is converted to carbon dioxide and water. The ratio of BOD to COD measures how much of the total organic matter is available for biological processes, such as consumption by bacteria. Such biological processes consume oxygen, reducing the amount of dissolved oxygen available to aquatic species. Therefore, BOD/COD ratios approaching 1 may, depending on the relative concentrations, cause deleterious effects to aquatic species.

BOD/COD ratios for the pool samples are provided in Table 5-5. The ratios were not calculated if both values were nondetect, or if BOD concentrations were greater than COD concentrations (for these cases, the values were close to the method detection limit, and were within acceptable limits of analytical error). Where BOD/COD ratios could be calculated, they ranged from 0.01 to 1. The one sample with the ratio of 1 had extremely low concentrations of BOD and COD (i.e., close to the detection limit). Therefore, the

BOD and COD concentrations in the pool samples are not expected to have deleterious effects on aquatic species.

5.2.2 Evaluation of Future Pool Discharges in the County Using Current Study Data

In order to support the practical resolution of where and under what conditions swimming pool water can be discharged in the County, the current study data were used to evaluate the water quality of future pool discharges in the County. The assessment was based on a statistical analysis estimate of prediction limits that can be compared to appropriate receiving water and/or local sanitary district criteria (California Code of Regulations, 1991; Gibbons, 1994; USEPA, 1989; ASTM, 1996). The prediction limit for a given constituent is the value such that no future sample results 9within the same population) will exceed that value. A 99% prediction limit was used to evaluate the behavior of future pools, so that the results could be expressed at a 95% confidence level. That is, a 99% prediction limit indicates for many future sampling events, the sample concentration will not exceed the prediction limit 95% of the time. Also, one or more samples from future sampling events will exceed the prediction limit 5% of the time.

In order to calculate the prediction limits, the first step was to perform a Student's t-Test to evaluate whether the two pool categories could be combined for a more robust data set. The next step was to evaluate the distribution of the data (i.e., normal, lognormal or nonparametric), because prediction limit calculations assume the data follow a normal or log-normal distribution. As with the summary statistics presented in Section 3, samples containing diatomaceous earth were excluded from the statistical analyses. The detailed statistical methodology used for the data pooling, distribution tests and prediction limits is provided in Appendix C.

Representativeness of the Data Sets

It is generally accepted for environmental data analysis, that seven to eight samples are considered to be the minimum number of samples required for a meaningful statistical analysis (hence the samples are representatives of the true population). For those constituents for which the two pool categories could be combined based on the Student's t-Test results, 16 samples were used for subsequent statistical analysis. For those parameters that could not be combined, private pools were considered to have a sufficient number of samples (11), however the number of public pools (5, excluding the diatomaceous earth samples) was considered to be marginally reliable (doubts about the samples being representative of the true population). Even where is was acceptable to combine the categories, it was still informative to evaluate the categories separately.

Results and Implications of Statistical Analysis

The prediction limit for each constituent is provided in Table 5-6 by pool category, and for the combined categories where appropriate. Table 5-6 also compares the prediction limit to the various water quality objectives. The prediction limits for copper are presented in Table 5-7. Because the copper water quality objectives are sample-specific, the prediction limits are as exceedance factors, which are the ratio of the copper concentration to the water quality objective.

A comparison of the prediction limit to water quality objectives was not performed for silver because of the large number of nondetects. The prediction limit for chlorine was not compared to the water quality objective. This is because the water quality objective for chlorine is nondetect, and the use of the detection limit for nondetects in the prediction limit calculation overestimates the number of exceedance that will occur.

Also, the prediction limit for total and unionized ammonia-nitrogen was not compared to USEPA water quality criteria because these criteria depend on sample pH and temperature. The Basin Plan standard for unionized ammonia as nitrogen was not used because the ammonia speciation also depends on pH and temperature. Therefore, the prediction limit for ammonia was compared to the sanitary district standard only.

Constituents with standards that exceeded the 99% prediction limit included dissolved oxygen, pH, TDS, conductivity, and total and dissolved copper. The prediction limit was relatively low compared to the receiving water standards for dissolved oxygen, particularly for public pools. In this case, the statistical assessment is believed to be limited by the small sample population. In addition, the data appear to follow a normal distribution, however, it is not likely that the dissolved oxygen concentration of any pool discharge will be less than 7.0 mg/L (ppm). This is because draining and backwashing pools are aerating processes by nature, and consequently, the dissolved oxygen concentration is likely be relatively high in all pools.

Based on the constituents that exceeded water quality objectives when compared to discrete samples collected for this study and the 99% prediction interval that evaluates the behavior of future samples, the constituents of concern for pool discharges are copper (total and dissolved) and TDS/conductivity. Copper is most problematic for storm drain discharges, while conductivity/TDS is of concern for both sanitary sewer and storm drain discharges.

pH is a constituent of concern for discharges to the storm drain and the sanitary sewer based on the prediction limit calculations. Moreover, the toxicity screening criteria indicate that the pH of three out of eleven swimming pool discharges was high enough to cause toxicity of fish.

Chlorine is a constituent of concern, because it was detected in four out of eleven samples at concentrations that could cause toxicity to fish. Also, chlorine warrants attention because dechlorination practices used by pool professionals for this study were not always effective in reducing levels to nondetect, as required by the Permits for discharge to the storm drain. If dechlorination is a problem with pool professionals, it is also likely that some pools discharged by private residents are not properly dechlorinated.

TSS is a problem for sanitary districts when associated with diatomaceous earth. The data from this study also indicate that copper is highly associated with diatomaceous earth, as is COD. It appears that sanitary districts do receive diatomaceous earth in filter backwash, even when it is required that it be captured separately (as is required by CCCSD).

For sanitary districts, the rate of discharge to the sanitary sewer system is also of concern. For pools discharged in this study, flow rates to the sanitary sewer ranged from 15 gpm to 30 gpm. In one case, the water overflowed when being discharged to the sanitary sewer, and the flow was therefore rerouted to a vegetated area. Flow rates during backwashing are significantly higher than drainage flow rates, but are of shorter duration. In addition, some sanitary districts require notification prior to discharge, or require that a discharge permit be obtained. This requirement does not appear to be enforced in practice.

5.3 Load Estimates for Constituents of Concern

Annual loads were estimated for copper and TDS to evaluate the magnitude of the contribution of swimming pool discharges to the storm drain and the sanitary sewer system. Data inputs and assumptions are summarized in Table 5-8. Data inputs were provided by swimming pool professionals, current study data, previous survey data included in the original Workplan and provided in Appendix D, and professional judgement.   In general, loads were calculated as follows:

$$\textit{Load (Pounds/Year)} =$$
$$\textit{Discharge Volume (gal) x Concentration (ppm or ppb) x Appropriate Conversion Factors}$$

Loads were calculated for private pool drainage, public pool drainage and public pool backwash. Loads from private pool backwash was assumed to be negligible because previous survey data indicated that most private pools are typically backwashed to vegetated areas.

Loads estimated for copper and TDS are presented in Table 5-9.   Overall, private pool discharges had the most significant impact on the stormwater drainage system. Relatively comparable amounts of copper are discharged to the storm drain and sanitary sewer from the various pool sources. Private pool drainage contributed the greatest amount of copper; loads to the storm drain and sanitary sewer are estimated at 17 pounds per year and 15 pounds per year, respectively. The copper contribution from public pool drainage and backwash is negligible.

TDS loads to the storm drain and sanitary sewer from private pools are 258,000 pounds per year and 229,000 pounds per year, respectively. TDS loads from public pool drainage to the storm drain and sanitary sewer are 414 pounds per year and 3,700 pounds per year, respectively. TDS loads to the storm drain and sanitary sewer from public pool backwashing are 5 pounds per year and 95 pounds per year, respectively.

The stormwater drainage system load contribution from swimming pools in Contra Costa County was compared to other point and nonpoint source loads for copper. The other sources were estimated discharges from Santa Clara County to the South San Francisco

Bay and were obtained from previous sources characterization studies (Woodward Clyde, 1997; URS Greiner Woodward Clyde and Tetra Tech, Inc., 1998). These sources include:

- discharges from publicly owned treatment works (POTWs),
- atmospheric deposition- industrial emissions, mobile (vehicles) sources and dust,
- bay sediments diffusion- diffusion from sediment porewater,
- brake pad wear,
- pesticide and fertilizer application,
- coolant leaks and illegal dumping,
- motor oil illegal dumping, and
- construction site erosion.

Compared to loads from other nonpoint sources, swimming pool have one of the smallest contributions of copper to receiving waters.

There are no load estimates available for other sources for TDS, therefore, the contribution of swimming pools could not be evaluated with respect to other sources.

Limitations of Approach

Data inputs that were not included in the estimates include discharge of some private pools due to overflow in the rainy season, and discharge from the estimated 1,250 salt pools in the County. These inputs were omitted because the information is highly uncertain, however, such omissions underestimate the copper and TDS loads.
Overall, the load estimates are considered to have medium uncertainty.

Section 6 Conclusions and Recommendations

This study was conducted to support the practical resolution of where, and under what conditions swimming pool water can be discharged in the County. Constituents of concern were identified by comparing study data to receiving water objectives and sanitary district acceptance criteria, and by also performing statistical analysis to evaluate the behavior of future discharges from the same population. Copper (total and dissolved), pH, conductivity and chlorine were identified as constituents of concern for discharges to the storm drain. Copper is present primarily in particulate form for pool backwash, and in dissolved form for pool drainage samples. However, both total and dissolved copper in both types of discharges exceeded receiving water quality objectives for the protection of aquatic life. What is interesting is that although copper and conductivity water quality objectives were exceeded, the four undiluted samples analyzed for Fathead minnow toxicity had 100% survival. The copper concentrations and conductivity (as well as other constituents) were considered representative of pool discharges. Parameters that appeared to be more problematic for toxicity were pH and chlorine, as many samples did not pass the screening criteria for these parameters.

TDS, pH, and TSS (when associated with diatomaceous earth are constituents of concern for discharge to the sanitary sewer system). Copper associated with both diatomaceous and sand (to a lesser degree) is also of concern for sanitary sewer discharge based on current and future sanitary waste discharge requirements. Also of potential concern are discharge flow rates, the high frequency of illicit discharges, and discharge of materials that may have special provisions, such as capture of diatomaceous earth.

6.1 Implications for Discharging Pool Water to the Storm Drain and Sanitary Sewer

Storm Drain

NPDES permits require that swimming pool discharges be dechlorinated prior to discharge. The current study data indicate there may be relatively frequent Permit violations. In addition, the concentration of TDS, pH and copper may require the implementation of appropriate control measures to minimize the impact of swimming pool discharges, especially in the dry weather season, when pools are most often drained.

Copper is likely the limiting constituent that will mandate whether discharge to the storm drain is possible. This is because the source of copper in swimming pools will determine if effective, practical BMPs can be developed. Potential sources of copper include copper-based algaecides, source water and corrosion from copper pipes. The study data could not relate those samples that exceeded water quality objectives for copper to the use of copper-based algaecides (which would be the source most amenable to the development of BMPs).

Sanitary Sewer

There are a large number of pools that are currently discharged to the sanitary sewer system. Depending on the source of copper in pool water, the number of pools that will be discharged to the sanitary sewer may increase. Consequently, it is likely that swimming pool discharges will need to be permitted (or in cases where there is already a permit requirement, the requirement will need to be enforced). Components of the permit might include:

- Establishing minimum operating standards to be conducted at the discharge source including location (prohibition on manhole discharges without site-specific authorization), flow restrictions, solids (e.g., filter media) removal,
- Periodic reporting of cleaning activities (e.g., location, volume discharged),
- Restricting the rate of discharge of pool water during significant rainfall events,
- Restricting the type and quantity of pools being discharged at one time, or within a specific area
- Sampling of discharge quality,
- Possible requirement of sewer charge (in addition to permit fee) based on the volume of pool water and its concentration, and
- Separate capture of sand and diatomaceous earth from backwashing and rinsing filters to reduce TSS and copper concentrations.

Due to new implementation of Federal water quality standards for deep water discharges from wastewater treatment plants, the water quality-based effluent limitations will no longer allow for the use of a dilution ratio (typically 10:1). Consequently treatment plant effluents will need to comply with the saltwater objectives in the Basin Plan. This policy change may be especially problematic for copper, because the effluents will have to meet a 4.9 ug/L (ppb) water quality objective. Therefore, sources of copper in the influents will likely require more stringent identification and regulation by sanitary districts in the future.

7.2 Recommendations for BMPs and BMP Options for Pools Discharged to the Storm Drain

Various clean water programs have developed BMPs for swimming pool discharges. These BMPs and general stormwater program policies regarding pool discharges are provided in Appendix E.

BMPs that have been developed by the stormwater programs to address pool-related discharges to the storm drain generally include:

1) Discharge to the sanitary sewer instead of to the storm drain,
2) Avoid the use of copper-based algaecides,
3) Manage pH and water hardness to minimize corrosion of copper pipes,
4) Allow residual chlorine concentration to dissipate prior to discharging, or add chemicals to dechlorinate,
5) Use pool and spa water for dust control and landscape irrigation, and
6) Rinse or backwash filters in areas where water can infiltrate into the ground or be discharged to the sanitary sewer.

BMPs 1, 2, and 6 are recommended by BASMAA.

These BMPs are affective for addressing most constituents of concern, but additional BMPs are warranted to address improper dechlorination procedures, and TDS and copper. As previously mentioned, whether BMPs can be developed for copper depends on the source of copper in swimming pool discharges.

Stormwater programs could work with pool professionals to develop pamphlets that describe procedures to be performed by residents periodically and before a pool is drained. Such procedures may include:

- ♦ Periodically discharging a portion of pool water to a vegetated area to reduce conductivity/TDS, and
- ♦ Not adding chlorine, or other chemicals for a least two weeks before the pool is drained.

In addition, before discharging, residual chlorine levels and pH should be measured, and pools should be dechlorinated and neutralized accordingly. Chlorine and pH should be remeasured and more dechlorination and neutralization chemicals added as necessary to reduce chlorine to nondetect and pH to within an acceptable range (6.5-8.5).

Further refinement of BMPs for swimming pool discharges will be the focus of Phase II.

Section 7 References

American Society for the Testing of Materials. 1996. Provisional Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs, PS 64-96.

California Code of Regulations. 1991. Water Quality Monitoring and Response Programs for Waste Management Units. Article 5, Title 23, pg. 100-104.8.

Federal Code of Regulations, Title 40, Part 131. 1997. USEPA Water Quality Standards; Establishment of Numeric Criteria for Toxic Pollutants for the State of California; Proposed Rule. August 5.

Fish and Game Code. Section 5650(a)(6).

Gibbons, R. D. 1994. *Statistical Methods for Groundwater Monitoring.* John Wiley & Sons, Inc., New York.

Laponis. A. 1998. *Draft* Analysis of Swimming Pool Discharge in Central Contra Costa County. Prepared by Central Contra Costa Sanitary District. January 15.

URS Greiner Woodward Clyde and Tetra Tech, Inc. 1998. *Draft* Task 2.1 Source Characterization Report Calculation of Total Maximum Daily Loads for Copper and Nickel in South San Francisco Bay. December.

URS Greiner Woodward Clyde. 1999. Final Workplan Pool Discharge Special Study Water Quality Evaluation Workplan. Prepared for Contra Costa Clean Water Program. August 19.

USEPA. 1972. Water Quality Criteria (“Blue Book”). A Report of the Committee on Water Quality Criteria. National Academy of Sciences, National Academy of Engineering. Washington, D.C.

USEPA. 1986. Quality Criteria for Water (“Gold Book”). May.

USEPA. 1989. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Interim Final Guidance. Office of Solid Waste.

USEPA. 1994. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

USEPA. 1998 (1). Update of Ambient Water Quality Criteria for Ammonia. August.

USEPA. 1998 (2). Guidance for Data Quality Assessment: Practical Methods for Data Analysis. USEPA QA/G-9.

Woodward Clyde. 1997. Metals Control Measures Plan (Volume I). Prepared for the Santa Clara Valley Runoff Pollution Prevention Program. February 12.

Appendix (Statistical Analyses)

Data Pooling

Because the number of samples in each pool category was relatively small, a statistical analysis was performed to evaluate if the two categories could be combined to enhance the data set. The Student's two-sample t-Test was performed on each constituent to test whether the sample means were statistically similar enough for the categories to be combined. Although the t-Test requires the assumptions that the sample means are normally distributed and the two populations have approximately equal variances, the test is also robust to violations of these assumptions (USEPA, 1998 (2)). If a constituent passed the test at a 5% significance level (i.e., p value > 0.05), the pool categories could be combined. The t-Test results are summarized in Table C-1. As with the summary statistics presented in Section 3, samples containing diatomaceous earth were excluded from the t-Test and subsequent statistical analyses.

<u>Test for Distribution Assumptions</u>

Normality tests were performed because tests used to evaluate concentrations of future pool discharges assume the data follow a normal or lognormal distribution. The Shapiro-Wilk Normality Test (Gibbons, 1994) was used to check whether the underlying distribution was normal or lognormal for each constituent. Normality tests were performed for the combined data set, where appropriate, and for the separate categories. If the data did not follow a normal distribution, the data were log-transformed and the test was performed to evaluate if the data followed a lognormal distribution. A 5% significance test was used for the tests. The results of the normality tests are provided in Table C-2.

Calculation of Prediction Limits/Intervals

Prediction limits and intervals were calculated to evaluate the behavior of future pool discharges in the County. The prediction limit is the statistical estimate used to represent a concentration limit for a given constituent such that none of the future sample results would exceed the limit (at a specific level of confidence) if they are from the same population as the sampled pools. This methodology is described in various references (California Code of Regulations, 1991; Gibbons, 1994; USEPA, 1989; ASTM, 1996).

For those constituents for which a normal distribution could be assumed (for raw or log-transformed data), the prediction limit was calculated as follows:

$$\text{Prediction Limit} \;=\; \bar{x} + t_{1-\alpha,n-1}\; s\; \sqrt{\frac{1}{1+n}} \qquad (1)$$

in which,

$\bar{x}$ = sample mean;

t = one-sided (1 - α) cummulative probability point of Student's t distribution with (n - 1) degrees of freedom;

s = sample standard deviation;

n = sample size; and

α = the false positive rate for an individual comparison (see discussion below).

For dissolved oxygen, a lower prediction limit was calculated, instead of an upper limit.

For constituents with standards designated by an upper and lower limit (such as pH and conductivity) the prediction interval was calculated as follows:

$$\text{Prediction Interval} \;=\; \bar{x} \pm t_{1-\alpha/2,n-1}\; s\; \sqrt{\frac{1}{1+n}} \qquad (2)$$

For data sets that were log-normally distributed, Equation (1) or (2) was applied to log-transformed data. The prediction limit calculated from Equation (1) or (2) was then transformed back to the arithmetic scale. For those data sets that were neither normally nor log-normally distributed, the prediction limit was calculated assuming a normal distribution, instead of a non-parametric distribution. A non-parametric method was not used for this assessment because as Gibbons (1994) indicates, the minimum number of sample values required for a reliable non-parametric test is often too large to be practical. Gibbons (1994) and ASTM (1996) suggest the alternative method of using the normal distribution for the original values under these circumstances.

The false positive rate, α, for each individual comparison for use in Equations (1) and (2) was calculated by first selecting an overall (all future independent comparisons) false positive rate, α*. In this case, α* was set at 5% (95% confidence level of no false). Then, using the Bonferroni method, the relationship between α and α* is as follows:

$$\alpha = \frac{\alpha^*}{k} \qquad (3)$$

in which k equals the number of individual comparisons to be made (number of constituents multiplied by the number of future samples). The theory of the Bonferroni method is that if k individual comparisons are to be tested, a desired overall false positive rate of at most α* can be guaranteed by testing each comparison at a level of α^*/k.

For this evaluation, a very conservative prediction limit was used so that the current study data could be extrapolated to almost all future pool discharges in the County, which will be a large number. Consequently, a sufficiently high (that is, the false negative error rate, β, was sufficiently low), α was set equal to the maximum of 0.01 (99% confidence level of no false positive), or the value obtained from Equation (3). This choice is consistent with the recommended USEPA (1989) protocol. The 99% prediction interval for each constituent indicates that for many future sampling events, the sample concentration will not exceed the prediction limit 95% of the time. Also, one of more samples from future sampling events will exceed the prediction limit 5% of the time.

TABLE 2-1
ANALYTICAL SUITE

Analyte	Method	Description	Holding Time	Detection Limit/ Resolution
Laboratory Methods				
Alkalinity as ($CaCO_3$)	SM 2320 B	Titrimetric	14 days	1.0 mg/L (ppm)
Total Hardness (as $CaCO_3$)	SM 2340 C	Titrimetric	6 months	3.3 mg/L (ppm)
Total and Dissolved Copper	EPA 7211	Inductively Coupled Plasma	6 months	1.3 ug/L (ppb)
Total and Dissolved Silver	EPA 7761	Inductively Coupled Plasma	6 months	0.1 ug/L (ppb)
Residual Chlorine	SM 4500 Cl	Colormetric	Same Day	0.1 mg/L (ppm)
Total Dissolved Solids	SM 2540 C	Gravimetric	7 days	10 mg/L (ppm)
Total Suspended Solids	SM 2540 D	Gravimetric	7 days	1.0 mg/L (ppm)
5-Day Biological Oxygen Demand	SM 5210 D	Colormetric	48 hours	1.0 mg/L (ppm)
Chemical Oxygen Demand	SM 5220	Titrimetric	28 days	2 mg/L (ppm)
48-Hour Static Acute Fathead minnow Bioassay	EPA-600/4-90-027 Modified		Same Day	
Field Kit/Instrumentation Methods				
Residual Free and Combined Chlorine	Lamotte Model No. SL-26, Code 3308	Colormetric N, N-Diethyl-1,4-phenylene-diamine (DPD) sulfate Method		0.2 mg/L (ppm)
Conductivity	Lamotte/Oakton- TDSTestr 20 with automated temperature compensation Model No. WD-35661-55	Electrode		0.01 mS
Temperature	Lamotte- Enviro-Safe Model 1066	Thermometer		0.5 °C
Turbidity	Lamotte Model TTM, Code 7519	Optical Comparison		5 JTU
pH	Lamotte/Oakton- pHTestr 2 with automated temperature compensation Model No 35624-20	Electrometric		0.1
Total Ammonia (measured as nitrogen)	Lamotte Code 3304	Colormetric Salicylate Method		0.05 mg/L (ppm)
Dissolved Oxygen	Lamotte Code 5860	Azide-Modified Winkler Titration		0.2 mg/L (ppm)

NOTES:

SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998.

EPA = USEPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, 3rd Edition, Update III, 1997.

TABLE 3-1
SUMMARY OF PRIVATE POOL FIELD OBSERVATIONS

Private Pool #	City	Pool Volume (gal)	Water Clarity	Last Water Quality Maintenance Performed	Reason for Discharging Pool	Discharge Location	Discharge Flow Rate (gal/min)	Discharge Frequency	Dechlorination Procedures
1	Moraga	11,000	Clear/ Leaves and suspended solids on surface	Did not add chlorine the week prior to discharge	Replastering	SS	19	1st time in 25 years	Added 10 oz sodium thiosulfate, ran water through filter for 20 minutes for mixing.
2	Walnut Creek	25,000	Clear/ some algae on pool walls	No water quality maintenance performed 2 weeks prior to discharge. Normal maintenance includes addition of chlorine and algaecide (occasionally)	Replastering	SS	15	1st time in 25 years	Added approximately 3 oz Thio-Trine. Checked residual chlorine concentrations before discharging.
3	Walnut Creek	30,000	Clear/ some floating debris and plaster from pool	Added chemicals 2 days prior to discharge: chlorine tablets, acid and caustic soda	Replastering	SS	30	Unknown	Added 3 oz Thio-Trine. Waited approximately 20 minutes before discharging.
4	Alamo	25,000	Clear/ Leaves/ yellow algae on pool walls	No chlorine added for five days before discharge. Normally add sodium hypochlorite, chlorine tablets, hydrochloric acid, and sodium bromide (algaecide).	Replace tile and replaster	SS	27	1st time in 9 years	Added 10 oz Thio-Trine. Waited 25 minutes before discharge. Tested free and total chlorine before discharging.
5	Walnut Creek	30,000	Clear/ floating leaves and other debris/ green algae on pool walls	No chemical additions for two weeks. Maintenance performed by contractor, so homeowner did not know what chemicals were added.	Replastering	SS	17	1st time in 22 years	Added 5 oz Thio-Trine. Discharged water immediately.
6	Concord	18,000 (approximate)	Clear/ dirt on pool bottom	Automated chlorine dispenser works daily	Replastering	SS	Not recorded	Unknown	Added 5 oz sodium thiosulfate. Waited 15 minutes before discharging.
7	Oakley	Not recorded	Clear/ water color is greenish-yellow	Unknown	Replastering	SS	20	Unknown	Unknown (sampled outsite property, after discharger was gone).
8	Moraga	25,000	Clear	Pools contractor instructed homeowner to not add chlorine 1-2 weeks before discharge.	Replace tiles and replaster	Vegetated area behind house (could not locate SS connection)	18	Discharged 2 years ago for acid washing	Added 10 oz Thio-Trine. Circulated water in pool with submersible pump for 20 minutes.
9	Danville	24,000 (approximate)	Clear/ Leaves and sediment on bottom	Last water quality maintenance performed 12 days before discharge. Maintenance performed by contractor, so homeowner did not know what chemicals were added.	Replastering	Sump on property- unknown discharge location	30	Unknown	Added Thio-Trine (amount unknown). Discharged water 3 minutes after dechlorination.
10	Lafayette	10,000	Some turbidity, algae and leaves	Added chlorine one month before discharge	Cleaning and replastering	SS- overflow resulting in remainder of water being discharged to vegetated area	Not recorded	Unknown- owner moved into home 3 months prior.	Not performed because chlorine was not expected to be present.
11	Blackhawk	Not recorded	Clear	Last contractor maintenance performed almost 6 months prior. Homeowner maintenance unknown	Replastering	SD	Not recorded	1st time in 10 years	Added Thio-Trine (volume unknown)

NOTE:

SS= Sanitary Sewer
SD = Storm Drain

TABLE 3-2
SUMMARY OF PUBLIC POOL FIELD OBSERVATIONS

Public Pool #	City	Volume (gallons)	Filter Type	Type of Discharge/Other Comment	Last Water Quality Maintenance Performed	Discharge Location	Discharge Flow Rate (gal/min)	Duration of Discharge (minutes)	Discharge Frequency
1	Antioch	148,565	Sand	Continuous bleed of pool water to maintain TDS levels	Chlorine and pH adjustments performed daily	SS	1	Continuous	Continuous
2	Antioch	5,240	Sand	Backwash	Chlorine and pH adjustments performed daily	SS	80	3	Once every 2 weeks for 3 months out of the year; once per month for the remainder of the year
3	El Cerrito	380,000	DE	Backwash. Discharges approx 10,000 gallons during backwashing	Chlorine and hydrochloric acid daily	SS	700	14 (calculated from total flow vol and rate)	Once per week
4	Richmond	4,200	Sand	Backwash. Discharges approx 1,000	Adds chlorine, sodium bicarbonate, hydrochloric acid, and "Pool Perfect" cleaning agent (enzyme) every other day.	SS	90-100	5-7	Once per week
5	Concord	1,000,000	DE	Diatomaceous earth filter rinse (not backwash). Discharges to sump along with filter backwash. A total of approximately 7,000 gallons is discharged.	Adds gaseous chlorine and soda ash as needed	SS		30	Every 3 weeks June-August, Every 2 months for remainder of the year
6	San Ramon	287,000	Sand	Backwash. Sump collects backwash from two filters. Conveyance to sanitary sewer drains from the top of the sump to allow solids to settle	Chlorine, carbon dioxide, calcium, bicarbonate	SS	300	3 minutes for each filter (2)	Every 3-4 days in summer, every couple of weeks in fall, once per month in the winter
7	Walnut Creek	140,000	DE	Pool drainage water. Discharged pool water to replaster pool and replace tiles. Pool water was dechlorinated prior to discharge.	Chlorine, acid	SS (toilet)	30	NA	NA

NOTES:
DE = Diatomaceous earth
SS = Sanitary sewer

TABLE 3-3
SUMMARY OF ANALYTICAL RESULTS

Sample I.D.	Discharge Type	City	Sample Date	Total Chlorine (ppm)	Free Chlorine (ppm)	pH	Total Ammonia as Nitrogen (ppm)	Total Copper (ug/L) (ppb)	Dissolved Copper (ug/L) (ppb)	Total Silver (ug/L) (ppb)	Dissolved Silver (ug/L) (ppb)
Public Pools											
PUB-01	Continuous bleed from pool	Antioch	09/14/99	**4.5**	**3.0**	**7.3**	< 0.05	**22.5**	**21.1**	**0.1 J**	**0.1**
PUB-02	Sand filter backwash	Antioch	09/14/99	**10**	**9**	**7.5**	< 0.05	**91.6**	**19.2**	< 0.1	< 0.1
PUB-03	DE filter backwash	El Cerrito	09/16/99	**4.5**	**3**	**7.7**	< 0.05	**7,850**	**106**	**0.4 J**	**0.1**
PUB-04	Sand filter backwash	Richmond	09/21/99	**5.9**	**4.1**	**8.6**	< 0.05	**670**	**23**	**0.2 J**	< 0.1
PUB-05	DE filter rinsewater	Concord	09/28/99	**0.8**	**0.7**	**7.9**	< 0.05	**3,990**	**44**	**3.5**	< 0.1
PUB-11 (DUP of PUB-05)	Same as PUB-05	Concord	09/28/99	NA	NA	NA	NA	**4,040**	**49**	**2.9**	< 0.1
PUB-06	Sand filter backwash	San Ramon	09/30/99	**3**	**2.5**	**7.8**	< 0.05	**120**	**27.4**	**0.2 J**	**0.2 J**
PUB-07	Pool drainage water	Walnut Creek	10/01/99	**1.85**	**1.8**	**7.6**	< 0.05	**16.0**	**15.1**	< 0.1	< 0.1
PUB-12 (DUP of PUB-07)	Same as PUB-07	Walnut Creek	10/01/99	NA	NA	NA	NA	NA	NA	NA	NA
Private Pools											
PRIV-01	Pool drainage water	Moraga	09/28/99	**4.3**	**2.9**	**7.6**	< 0.05	**18.7**	**17.5**	< 0.1	< 0.1
PRIV-22 (DUP of PRIV-01)	Same as PRIV-01	Moraga	09/28/99	NA	NA	NA	NA	**18.8**	**16.1**	< 0.1	< 0.1
PRIV-02	Pool drainage water	Walnut Creek	10/04/99	< 0.2	< 0.2	**8.5**	< 0.05	**18.0**	**12.8**	< 0.1	< 0.1
PRIV-03	Pool drainage water	Walnut Creek	10/04/99	< 0.2	< 0.2	**8.6**	< 0.05	**172 J**	**165 J**	< 0.1	< 0.1
PRIV-04	Pool drainage water	Alamo	10/06/99	< 0.2	< 0.2	**8.1**	< 0.05	**9.6**	**2.7 J**	< 0.1	< 0.1
PRIV-05	Pool drainage water	Walnut Creek	10/07/99	< 0.2	< 0.2	**8.9**	< 0.05	**35.9**	**22.1**	< 0.1	< 0.1
PRIV-06	Pool drainage water	Concord	10/12/99	**0.25**	**0.2**	**7.2**	< 0.05	**29.4**	**19.6**	0.1	< 0.1
PRIV-07	Pool drainage water	Oakley	10/13/99	< 0.2	< 0.2	**8.9**	**1**	**54.5**	**29.5**	< 0.1	< 0.1
PRIV-08	Pool drainage water	Moraga	10/15/99	**0.9**	**0.7**	**7.4**	< 0.05	**243**	**222**	< 0.1	< 0.1
PRIV-09	Pool drainage water	Danville	10/20/99	**0.7**	**0.5**	**8**	< 0.05	**133**	**92**	< 0.1	< 0.1
PRIV-10	Pool drainage water	Lafayette	10/21/99	< 0.2	< 0.2	**9.5**	< 0.05	**22**	**13**	< 0.1	< 0.1
PRIV-23 (DUP of PRIV-10)	Same as PRIV-10	Lafayette	10/21/99	NA	NA	NA	NA	**22**	**14**	< 0.1	< 0.1
PRIV-11	Pool drainage water	Blackhawk	10/25/99	< 0.2	< 0.2	**8.0**	< 0.05	**43.6**	**33.8**	< 0.1	< 0.1
PRIV-24 (DUP of PRIV-11)	Same as PRIV-11	Blackhawk	10/25/99	NA	NA	NA	NA	**49.3**	**36.1**	< 0.1	< 0.1

NOTES:
Detected values are in bold text
DE = Diatomaceous earth
NA = Not analyzed
J/UJ- See Table 4-1 for explanation
(1) The aliquot for alkalinity was filtered before analysis
(2) The analysis could not be performed due to the high concentration of DE

TABLE 3-3
SUMMARY OF ANALYTICAL RESULTS

Sample I.D.	TSS (mg/L) (ppm)	Turbidity (JTU)	TDS (mg/L) (ppm)	Conductivity (uS)	Alkalinity (mg/L) (ppm)	Hardness (mg/L) (ppm)	COD (mg/L) (ppm)	BOD (mg/L) (ppm)	DO (ppm) (ppm)	Temperature (^oC)	48-Hour Static Acute Fathead minnow Toxicity Test	Reason for Failing Field Toxicity Screening	Total Chlorine (CCCSD) (mg/L) (ppm)
Public Pools													
PUB-01	**8**	< 5	**1,980**	**3,570**	**150**	**108**	< 3	**4**	**11**	**26.5**	NA	NA	NA
PUB-02	**10**	**65**	**391**	**1,160**	**95**	**88**	< 3	**4**	**11.2**	**27.1**	NA	NA	NA
PUB-03	**430**	error in analysis	**1,471**	**1,520**	**59**[1]	**800**	**100**	**14**	**8.6**	**23**	NA	NA	NA
PUB-04	**86**	**53**	**491**	**961**	**100**	**91**	**5.9**	**7**	**9.3**	**23**	NA	NA	5.06
PUB-05	**28,990**	**> 200**	**1,370**	**5,100**	NA[2]	NA[2]	**228**	< 1 UJ	**6.1**	**22.5**	NA	NA	NA
PUB-11 (DUP of PUB-05)	**25,170**	NA	**1,350**	NA	NA[2]	NA[2]	**230**	**15**	NA	NA	NA	NA	NA
PUB-06	**37**	**40**	**2,872**	**4,620**	**138**	**312**	**6**	**5**	**7.6**	**26.5**	NA	NA	NA
PUB-07	< 1 UJ	< 5	**1,760**	**3,340**	**79**	**119**	**3 J**	**5**	**8.2**	**25**	NA	NA	NA
PUB-12 (DUP of PUB-07)	**3 J**	< 5	**1,340**	NA	**76**	**116**	NA	NA	NA	NA	NA	NA	NA
Private Pools													
PRIV-01	7	< 5	**1,020**	**869**	**76**	**340**	**230 J**	< 1	**8.5**	**24**	Failed Screening	Chlorine	3.22
PRIV-22 (DUP of PRIV-01)	**8**	< 5	**1,030**	NA	**80**	**348**	< 2 UJ	< 1	NA	NA			NA
PRIV-02	< 2	< 5	**820**	**971**	**97**	**282**	**3**	**3**	**8.2**	**21**	100% Survival		NA
PRIV-03	< 1	< 5	**670**	**1,060**	**237**	**106**	**5**	< 2	**8**	**21.5**	100% Survival		NA
PRIV-04	**2**	< 5	**1,026**	**1,481**	**76**	**236**	**3**	**2**	**7.6**	**22.5**	100% Survival		NA
PRIV-05	< 1	< 5	**394**	**602**	**99**	**94**	**7**	< 2	**9.6**	**18**	Failed Screening	pH	NA
PRIV-06	**4**	< 5	**2,303**	**3,040**	**41**	**592**	< 2	< 1	**8.4**	**20**	Failed Screening	Chlorine	NA
PRIV-07	**4**	**10**	**2,240**	**2,490**	**149**	**528**	**12**	< 1	**11.6**	**21.5**	Failed Screening	pH	NA
PRIV-08	< 2	< 5	**1,088**	**1,234**	**61**	**284**	**12**	**4**	**8.3**	**15**	Failed Screening	Chlorine	NA
PRIV-09	< 1	< 5	**1,062**	**1,590**	**178**	**188**	< 3	< 1	**9.0**	**17.25**	Failed Screening	Chlorine	0.45
PRIV-10	< 3	**7.5**	**232**	**378**	**52 J**	**92**	< 3	**2**	**11**	**25.5**	Failed Screening	pH	NA
PRIV-23 (DUP of PRIV-10)	< 3	< 5	**214**	NA	**121 J**	**88**	< 3	**2**	NA	NA			NA
PRIV-11	< 3	< 5	**908**	**1,237**	**71**	**304**	**11**	**2**	**9.2**	**18**	100% Survival		NA
PRIV-24 (DUP of PRIV-11)	< 3	< 5	**926**	NA	**64**	**300**	**8**	**1**	NA	NA			NA

TABLE 3-4
SUMMARY STATISTICS AND DETECTION RATES FOR ALL POOLS, EXCLUDING SAMPLES WITH DIATOMACEOUS EARTH
(PUB-03, PUB-05)

	Summary Statistics					*Detection*			
Parameter/Units	*Mean*	*Std Dev*	*CV(%)*	*Min*	*Max*	*Detection Limit*	*Total No. of Samples*	*No. of Detected*	*% Detected*
Total Chlorine (ppm)	2.1	2.8	138	0.2	10	0.2	16	9	56%
Free Chlorine (ppm)	1.6	2.4	144	0.2	9	0.2	16	9	56%
pH	8.1	0.7	8	7.2	9.45	0.1	16	NA	NA
Total Ammonia (ppm)	0.1	0.2	217	0.05	1	0.05	16	1	6%
Total Copper (ug/L) (ppb)	106.4	164.5	155	9.6	670	1.3	16	16	100%
Dissolved Copper (ug/L) (ppb)	46.0	61.6	134	2.7	222	1.3	16	16	100%
Total Silver (ug/L) (ppb)	0.1	0.0	30	0.1	0.2	0.1	16	4	25%
Dissolved Silver (ug/L) (ppb)	0.1	0.0	24	0.1	0.2	0.1	16	2	13%
TSS (mg/L) (ppm)	10.8	21.9	202	1	86	1	16	8.5	53%
Turbidity (JTU)	25.2	48.9	194	5	65	5	16	11.5	72%
TDS (mg/L) (ppm)	1190.8	782.4	66	223	2872	10	16	16	100%
Conductivity (uS)	1787.3	1235.8	69	378	4620	10	16	16	100%
Alkalinity (mg/L) (ppm)	108.2	50.3	47	41	237	1	16	16	100%
Hardness (mg/L) (ppm)	235.2	157.5	67	88	592	3.3	16	16	100%
COD (mg/L) (ppm)	12.3	27.9	227	2	116	2	16	10.5	66%
BOD (mg/L) (ppm)	2.8	1.8	63	1	7	1	16	10	63%
DO (ppm) (ppm)	9.2	1.3	15	7.6	11.55	0.2	16	16	100%
Temperature (^{o}C)	22.0	3.7	17	15	27.1	0.5	16	NA	NA

Notes:
The detection limit was used for non-detect results to calculate the statistics
Field duplicate samples were averaged to calculate the statistics
When the number of samples detected is not a whole number, for duplicate samples, one result was detected and the other result was non-detect.

TABLE 3-5
SUMMARY STATISTICS AND DETECTION RATES FOR PRIVATE POOLS

Parameter/Units	Summary Statistics					Detection			
	Mean	Std Dev	CV(%)	Min	Max	Detection Limit	Total No. of Samples	No. of Detected	% Detected
Total Chlorine (ppm)	0.7	1.2	178	0.2	4.3	0.2	11	4	36%
Free Chlorine (ppm)	0.5	0.8	156	0.2	2.9	0.2	11	4	36%
pH	8.2	0.7	9	7.2	9.45	0.1	11	11	100%
Total Ammonia (ppm)	0.1	0.3	210	0.05	1	0.05	11	1	9%
Total Copper (ug/L) (ppb)	71.1	76.9	108	9.6	243	1.3	11	11	100%
Dissolved Copper (ug/L) (ppb)	57.4	72.4	126	2.7	222	1.3	11	11	100%
Total Silver (ug/L) (ppb)	0.1	0.0	0	0.1	0.1	0.1	11	1	9%
Dissolved Silver (ug/L) (ppb)	0.1	0.0	0	0.1	0.1	0.1	11	0	0%
TSS (mg/L) (ppm)	2.8	1.9	69	1	7.5	1	11	4	36%
Turbidity (JTU)	5.6	1.5	27	7.5	10	5	11	1.5	14%
TDS (mg/L) (ppm)	1069.8	656.8	61	223	2303	10	11	11	100%
Conductivity (uS)	1359.2	788.6	58	378	3040	10	11	11	100%
Alkalinity (mg/L) (ppm)	106.4	58.4	55	41	237	1	11	11	100%
Hardness (mg/L) (ppm)	276.9	165.7	60	90	592	3.3	11	11	100%
COD (mg/L) (ppm)	16.0	33.4	209	2	116	2	11	7.5	68%
BOD (mg/L) (ppm)	1.9	1.0	51	1	4	1	11	5	45%
DO (ppm) (ppm)	9.0	1.2	14	7.6	11.55	0.2	11	11	100%
Temperature (^{o}C)	20.4	3.1	15	15	25.5	0.5	11	11	100%

Notes:

The detection limit was used for non-detect results to calculate the statistics
Field duplicate samples were averaged to calculate the statistics
When the number of samples detected is not a whole number, for duplicate samples, one result was detected and the other result was non-detect.

TABLE 3-6
SUMMARY STATISTICS AND DETECTION RATES FOR PUBLIC POOLS, EXCLUDING SAMPLES WITH DIATOMACEOUS EARTH (PUB-03, PUB-05)

	Summary Statistics					*Detection*			
Parameter/Units	***Mean***	***Std Dev***	***CV(%)***	***Min***	***Max***	***Detection Limit***	***Total No. of Samples***	***No. of Detected***	***% Detected***
Total Chlorine (ppm)	5.1	3.2	63	1.85	10	0.2	5	5	100%
Free Chlorine (ppm)	4.1	2.9	70	1.8	9	0.2	5	5	100%
pH	7.8	0.5	6	7.3	8.55	0.1	5	NA	NA
Total Ammonia (ppm)	0.1	0.0	0	0.05	0.05	0.05	5	0	0%
Total Copper (ug/L) (ppb)	184.0	275.3	150	16	670	1.3	5	5	100%
Dissolved Copper (ug/L) (ppb)	21.2	4.6	22	15.1	27.4	1.3	5	5	100%
Total Silver (ug/L) (ppb)	0.1	0.1	39	0.1	0.2	0.1	5	3	60%
Dissolved Silver (ug/L) (ppb)	0.1	0.0	37	0.1	0.2	0.1	5	2	40%
TSS (mg/L) (ppm)	28.6	34.8	122	2	86	1	5	4.5	90%
Turbidity (JTU)	33.5	27.5	82	40	65	5	5	3	60%
TDS (mg/L) (ppm)	1456.8	1043.3	72	391	2872	10	5	5	100%
Conductivity (uS)	2729.1	1599.8	59	960.5	4620	10	5	5	100%
Alkalinity (mg/L) (ppm)	112.1	30.6	27	77.5	150	1	5	5	100%
Hardness (mg/L) (ppm)	143.3	95.1	66	88	312	3.3	5	5	100%
COD (mg/L) (ppm)	4.2	1.6	39	3	6	2	5	3	60%
BOD (mg/L) (ppm)	5.0	1.2	24	4	7	1	5	5	100%
DO (ppm) (ppm)	9.5	1.6	17	7.6	11.2	0.2	5	5	100%
Temperature (^{o}C)	25.6	1.7	6	23	27.1	0.5	5	NA	NA

Notes:

The detection limit was used for non-detect results to calculate the statistics

Field duplicate samples were averaged to calculate the statistics

When the number of samples detected is not a whole number, for duplicate samples, one result was detected and the other result was non-detect.

TABLE 4-1
SUMMARY OF QUALIFIED DATA

Pool I.D.	Analyte	QC Parameter	Recovery (%)	RPD(%) or Difference (mg/L)	QC Criteria	Qualifier	Comments
PRIV-10	Alkalinity	Field Duplicate	NA	80%	25%	J	
PRIV-23	Alkalinity	Field Duplicate	NA	80%	25%	J	
PUB-05	BOD	Field Duplicate	NA	175%	25%	UJ	
PUB-11	BOD	Field Duplicate	NA	175%	25%	J	
PRIV-01	COD	Field Duplicate	NA	197%	25%	J	
PRIV-22	COD	Field Duplicate	NA	197%	25%	UJ	
PUB-07	COD	Matrix Spike	48		69-129	J	Low bias
PRIV-03	Dissolved Copper	Matrix Spike	76.7		85-114	J	Low bias
PRIV-04	Dissolved Copper	Result below lowest calibration standard	NA	NA	NA	J	Lowest calibration standard is 5 ppb
PUB-06	Dissolved Silver	Result below lowest calibration standard	NA	NA	NA	J	Lowest calibration standard is 0.5 ppb
PRIV-03	Total Copper	Matrix Spike	76.7		85-114	J	Low bias
PUB-01	Total Silver	Result below lowest calibration standard	NA	NA	NA	J	Lowest calibration standard is 0.5 ppb
PUB-03	Total Silver	Result below lowest calibration standard	NA	NA	NA	J	Lowest calibration standard is 0.5 ppb
PUB-04	Total Silver	Result below lowest calibration standard	NA	NA	NA	J	Lowest calibration standard is 0.5 ppb
PUB-06	Total Silver	Result below lowest calibration standard	NA	NA	NA	J	Lowest calibration standard is 0.5 ppb
PUB-07	TSS	Field Duplicate	NA	2 mg/L	1 mg/L	UJ	The difference between the original and duplicate result should not exceed 1 mg/L (method detection limit)
PUB-12	TSS	Field Duplicate	NA	2 mg/L	1 mg/L	J	The difference between the original and duplicate result should not exceed 1 mg/L (method detection limit)

NOTES:
UJ = The analyte was not detected above the detection limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

TABLE 5-1
LOCAL SANITARY DISTRICT ACCEPTANCE CRITERIA

	Local Sanitary District and Service Area	Contact Person	Accept Discharge?	Influent Acceptance Criteria(1)	Accept Filter Backwash?	Comments
1	**Brentwood** Brentwood	Carl Gaston Wastewater Department 925-634-6941	See Comments	None	Yes	Only accepts pool discharge from one school and one hotel.
2	**Central CC Sanitary District** San Ramon to Martinez, Clayton to Orinda	Bart Bradenberg Pollution Prevention Supervisor 925-229-7361	Yes	Copper 5.0 mg/L Silver 1.0 mg/L pH 5.5-12.4 Discharge rate not to exceed capacity of sewer line	Yes	Requires a Special Discharge Permit. Concerned with discharge flow rate and possible overflows to the storm drain. Concerned about some metal concentrations and low pH. Copper does not appear to be a big problem. Diatomaceous earth need to be captured separately.
3	**City of Richmond** Southern Portion of Richmond	Lynne Scarpa Industrial Waste Inspector 510-412-2001	Yes	pH 6-10; TSS 300 mg/L; temperature < 40 degrees C; TDS 325 mg/L; Silver 1.0 mg/L; Copper 1.0 mg/L; BOD 350 mg/L	Yes	Reference: City Ordinance No. 30-88 A discharge permit is required. TSS limit applies for period of high stormwater flows. Ms. Scarpa indicated that discharges are not monitored, although limits have been established. Ordinance prohibits discharge of "solid or viscous substances which may cause obstruction to the flow in a sewer or other interference with the operation of the wastewater treatment facilities such as, ...sand.." Concerned with copper, chlorine and ammonia concentrations.
4	**Delta Diablo Sanitary District** Unincorporated areas of Bay Point, Antioch and Pittsburg.	Andrew Kobiashi Industrial Monitoring Dept 925-778-4040 x261	Yes	pH 6-10; Cu 0.5 mg/L; Ammonia as N 200 mg/L; Silver 0.2 mg/L	Yes	
5	**Discovery Bay Treatment** Discovery Bay	Randy Ricker Lead Operator #3 925-634-8818	See Comments	None	N/A	Plant is too small to monitor whether they are receiving pool discharges. Mr. Ricker believes most homeowners discharged pool & spa water in yard, if not connected to sanitary sewer.
6	**Dublin San Ramon Services District** Dublin and one third of San Ramon	Fernando Lomas Senior Industrial Waste Inspector 925-846-4565	Yes	Permit Fee pH 6.0-11.0; TDS 1,000 mg/L; Cu 10 mg/L; Silver 2.0 mg/L; BOD 400 mg/L	No	Considering developing criteria specifically for pool discharge in the near future.
7	**EBMUD** Portion of Richmond Annex and Stege Sanitary District	Stan Archacki Wastewater Control Representative, Source Control Division 510-287-1620	Yes	None	Yes	EBMUD does not monitor how often they receive pool discharges, and does not monitor for specific constituents. However, copper sources may become important in the near future because the RWQCB may reduce effluent copper limit.

TABLE 5-1
LOCAL SANITARY DISTRICT ACCEPTANCE CRITERIA

	Local Sanitary District and Service Area	Contact Person	Accept Discharge?	Influent Acceptance Criteria[(1)]	Accept Filter Backwash?	Comments
8	**Mountain View Sanitary District** Unincorporated areas of Martinez and SW Martinez. Portion of City of Martinez	Leslie Engler Pollution Prevention Coordinator 925-228-5635	Yes	Must be notified before discharge. (However, requirement is not enforced.)	Yes	There are no limiting concentrations for influent constituents. Most have pretreatment program requirements.
9	**Pinole Hercules Wastewater** Cities of Pinole and Hercules	Julian Misra, Plant Manager 510-724-8963	Yes	None	No	Pool & spa discharge drained into collection system and treated at plant.
10	**Rodeo Sanitation District** Rodeo	Ken Dennison, Operations Specialist, (NPDES permit) 510-799-2970	No	None	No	Only accept wastewater tied to laterals in sewer lines.
11	**Stege Sanitary District** El Cerrito, Kensington, Portion of Richmond Annex.	Larry Rugar District Manager/Engineer 510-524-4668	Yes	Wants to be notified when pools are drained. Industrial limit for metals.	Yes	Sends wastewater to EBMUD for treatment (see EBMUD). Stege directly treats filter backwash.
12	**West Contra Costa Sanitary District** San Pablo, El Sobrante, portions of North Richmond and Pinole	Gary Ng Support Services Supervisor 510-237-6603	Yes	Residual chlorine analysis prior to discharge. Copper 3.0 mg/L Silver 0.3 mg/L	Yes	Concerned with heavy metals, especially copper from algaecides.

(1) Acceptance criteria listed only for Pool Discharge Special Study target analytes.

TABLE 5-2
COMPARISON OF STUDY DATA TO RECEIVING WATER AND SANITARY DISTRICT CRITERIA

DO (mg/L) (ppm)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1)	No. of Samples Below Receiving Water Standard (1)	*% of Samples Below Receiving Water Standard (1)*	Receiving Water Standard (1)	No. of Samples Below Receiving Water Standard (1)	*% of Samples Below Receiving Water Standard (1)*
	Public	5		0	*0%*		0	*0%*
No Earth	Private	11	> 7	0	*0%*	> 5	0	*0%*
Filters	All	16		0	*0%*		0	*0%*

pH

Filter	Pool	Total No. of Samples	Receiving Water Standard (1)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	Public	5		1	*20%*
No Earth	Private	11	6.5 - 8.5	4	*36%*
Filters	All	16		5	*31%*

Filter	Pool	Total No. of Samples	Sanitary District Standard (2)	No. of Samples Exceeding Sanitary District Standard (2)	*% of Samples Exceeding Sanitary District Standard (2)*	Sanitary District Standard (3, 4)	No. of Samples Exceeding Sanitary District Standard (3, 4)	*% of Samples Exceeding Sanitary District Standard (3, 4)*	Sanitary District Standard (5)	No. of Samples Exceeding Sanitary District Standard (5)	*% of Samples Exceeding Sanitary District Standard (5)*
	Public	7		0	*0%*		0	*0%*		0	*0%*
All Filters	Private	11	5.5 - 12.4	0	*0%*	6 - 10	0	*0%*	6 - 11	0	*0%*
	All	18		0	*0%*		0	*0%*		0	*0%*

Temperature (^{o}C)

Filter	Pool	Total No. of Samples	Sanitary District Standard (3)	No. of Samples Exceeding Sanitary District Standard (3)	*% of Samples Exceeding Sanitary District Standard (3)*
	Public	7		0	*0%*
All Filters	Private	11	< 40	0	*0%*
	All	18		0	*0%*

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District
(6) West Contra Costa Sanitary District

TABLE 5-2
COMPARISON OF STUDY DATA TO RECEIVING WATER AND SANITARY DISTRICT CRITERIA

Total Copper (ug/L) (ppb)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1) (Acute WQO)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*	Receiving Water Standard (1) (Chronic WQO)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	Public	5		5	*100%*		4	*80%*
No Earth	Private	11	Hardness-Dependent	7	*64%*	Hardness-Dependent	6	*55%*
Filters	All	16		12	*75%*		10	*63%*

Filter	Pool	Total No. of Samples	Sanitary District Standard (4)	No. of Samples Exceeding Sanitary District Standard (4)	*% of Samples Exceeding Sanitary District Standard (4)*	Sanitary District Standard (6)	No. of Samples Exceeding Sanitary District Standard (6)	*% of Samples Exceeding Sanitary District Standard (6)*	Sanitary District Standard (2)	No. of Samples Exceeding Sanitary District Standard (2)	*% of Samples Exceeding Sanitary District Standard (2)*	Sanitary District Standard (5)	No. of Samples Exceeding Sanitary District Standard (5)	*% of Samples Exceeding Sanitary District Standard (5)*
	Public	6		2	*33%*		1	*17%*		1	*17%*		0	*0%*
All Filters	Private	11	< 500	0	*0%*	< 3,000	0	*0%*	< 5,000	0	*0%*	< 10,000	0	*0%*
	All	17		2	*12%*		1	*6%*		1	*6%*		0	*0%*

Dissolved Copper (ug/L) (ppb)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1) (Acute WQO)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*	Receiving Water Standard (1) (Chronic WQO)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	Public	5		5	*100%*		3	*60%*
No Earth	Private	11	Hardness-Dependent	6	*55%*	Hardness-Dependent	5	*45%*
Filters	All	16		11	*69%*		8	*50%*

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District
(6) West Contra Costa Sanitary District

TABLE 5-2
COMPARISON OF STUDY DATA TO RECEIVING WATER AND SANITARY DISTRICT CRITERIA

Total Silver (ug/L) (ppb)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1) (Acute WQO)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	Public	5		0	*0%*
No Earth	Private	11	Hardness-Dependent	0	*0%*
Filters	All	16		0	*0%*

Filter	Pool	Total No. of Samples	Sanitary District Standard (4)	No. of Samples Exceeding Sanitary District Standard (4)	*% of Samples Exceeding Sanitary District Standard (4)*	Sanitary District Standard (6)	No. of Samples Exceeding Sanitary District Standard (6)	*% of Samples Exceeding Sanitary District Standard (6)*	Sanitary District Standard (2, 3)	No. of Samples Exceeding Sanitary District Standard (2, 3)	*% of Samples Exceeding Sanitary District Standard (2, 3)*	Sanitary District Standard (5)
	Public	6		0	*0%*		0	*0%*		0	*0%*	
All Filters	Private	11	< 200	0	*0%*	< 300	0	*0%*	< 1,000	0	*0%*	< 2,000
	All	17		0	*0%*		0	*0%*		0	*0%*	

Dissolved Silver (ug/L) (ppb)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1) (Acute WQO)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	Public	5		0	*0%*
No Earth	Private	11	Hardness-Dependent	0	*0%*
Filters	All	16		0	*0%*

TDS (mg/L) (ppm)

Filter	Pool	Total No. of Samples	Sanitary District Standard (3)	No. of Samples Exceeding Sanitary District Standard (3)	*% of Samples Exceeding Sanitary District Standard (3)*	Sanitary District Standard (5)	No. of Samples Exceeding Sanitary District Standard (5)	*% of Samples Exceeding Sanitary District Standard (5)*
	Public	7		7	*100%*		5	*71%*
All Filters	Private	11	< 325	10	*91%*	< 1,000	6	*55%*
	All	18		17	*94%*		11	*61%*

Conductivity (uS)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*	Receiving Water Standard (1)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	Public	5		5	*100%*		3	*60%*
No Earth	Private	11	1500 - 1800	10	*91%*	1500 - 3700	8	*73%*
Filters	All	16		15	*94%*		11	*69%*

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District
(6) West Contra Costa Sanitary District

TABLE 5-2
COMPARISON OF STUDY DATA TO RECEIVING WATER AND SANITARY DISTRICT CRITERIA

TSS (mg/L) (ppm)

Filter	Pool	Total No. of Samples	Receiving Water Guideline (1)	No. of Samples Exceeding Receiving Water Guideline (1)	*% of Samples Exceeding Receiving Water Standard (1)*
No Earth Filters	Public	5	80 for maintenance of good to moderate fisheries	1	*20%*
	Private	11		0	*0%*
	All	16		1	*6%*

Filter	Pool	Total No. of Samples	Sanitary District Standard (3)	No. of Samples Exceeding Sanitary District Standard (3)	*% of Samples Exceeding Sanitary District Standard (3)*
All Filters	Public	7	300	2	*29%*
	Private	11		0	*0%*
	All	18		2	*11%*

Total Chlorine (mg/L) (ppm)

Filter	Pool	Total No. of Samples	Permit Dechlorination Requirement	No. of Samples Exceeding Permit Dechlorination Requirement	*% of Samples Exceeding Permit Dechlorination Requirement*
No Earth Filters	Public	1	0 residual (< 0.2)	1	*100%*
	Private	11		4	*36%*
	All	12		5	*42%*

Total Ammonia (mg/L) (ppm)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1) (Acute/Sensitive Cold Water Species Present)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Standard (1)*	Receiving Water Standard (1) (Acute/Sensitive Cold Water Species Absent)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*	Receiving Water Standard (1) (Chronic/Sensitive Cold Water Species Present)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*	Receiving Water Standard (1) (Chronic/Sensitive Cold Water Species Absent)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
No Earth Filters	Public	5	0.72	0	*0%*	1.01	0	*0%*	0.116	0	*0%*	0.163	0	*0%*
	Private	11		1	*9%*		1	*9%*		1	*9%*		1	*9%*
	All	16		1	*6%*		1	*6%*		1	*6%*		1	*6%*

Filter	Pool	Total No. of Samples	Sanitary District Standard (4)	No. of Samples Exceeding Sanitary District Standard (4)	*% of Samples Exceeding Sanitary District Standard (4)*
All Filters	Public	6	< 200 Ammonia as N	0	*0%*
	Private	11		0	*0%*
	All	17		0	*0%*

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District
(6) West Contra Costa Sanitary District

TABLE 5-2
COMPARISON OF STUDY DATA TO RECEIVING WATER AND SANITARY DISTRICT CRITERIA

Un-ionized Ammonia (mg/L) (ppm)

Filter	Pool	Total No. of Samples	Receiving Water Standard (1) (Acute/Sensitive Cold Water Species Present)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Standard (1)*	Receiving Water Standard (1) (Acute/Sensitive Cold Water Species Absent)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*	Receiving Water Standard (1) (Chronic/Sensitive Cold Water Species Present)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*	Receiving Water Standard (1) (Chronic/Sensitive Cold Water Species Absent)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	Public	5		0	*0%*		0	*0%*		0	*0%*		0	*0%*
No Earth	Private	11	0.26	1	*9%*	0.37	1	*9%*	0.042	1	*9%*	0.059	1	*9%*
Filters	All	16		1	*6%*		1	*6%*		1	*6%*		1	*6%*

Receiving Water Standard (1) (SF Bay Basin Plan)	No. of Samples Exceeding Receiving Water Standard (1)	*% of Samples Exceeding Receiving Water Standard (1)*
	0	*0%*
0.025 as Nitrogen	1	*9%*
	1	*6%*

BOD (mg/L) (ppm)

Filter	Pool	Total No. of Samples	Sanitary District Standard (3)	No. of Samples Exceeding Sanitary District Standard (3)	*% of Samples Exceeding Sanitary District Standard (3)*	Sanitary District Standard (5)	No. of Samples Exceeding Sanitary District Standard (5)	*% of Samples Exceeding Sanitary District Standard (5)*
	Public	7		0	*0%*		0	*0%*
All Filters	Private	11	< 350	0	*0%*	< 400	0	*0%*
	All	18		0	*0%*		0	*0%*

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District
(6) West Contra Costa Sanitary District

TABLE 5-4
WATER QUALITY OBJECTIVE EVALUATION FOR SILVER

	Results			Water Quality Objectives			
Pool I.D.	**Hardness (mg/L) (ppm)**	**Total Silver (ug/L) (ppb)**	**Dissolved Silver (ug/L) (ppb)**	**Total Silver Acute WQO**	**Exceeds WQO?**	**Dissolved Silver Acute WQO**	**Exceeds WQO?**
PUB-01	108	0.1	0.1	4.6	No	3.9	No
PUB-02	88	< 0.1	< 0.1	3.3	No	2.8	No
PUB-03	800	0.4	0.1	145.1	No	123.3	No
PUB-04	91	0.2	< 0.1	3.5	No	2.9	No
PUB-05/PUB-11	NA	3.2	< 0.1	NA	NA	NA	NA
PUB-06	312	0.2	0.2	28.7	No	24.4	No
PUB-07/PUB-11	117.5	< 0.1	< 0.1	5.4	No	4.6	No
PRIV-01/PRIV-22	344	< 0.1	< 0.1	34.0	No	28.9	No
PRIV-02	282	< 0.1	< 0.1	24.1	No	20.5	No
PRIV-03	106	< 0.1	< 0.1	4.5	No	3.8	No
PRIV-04	236	< 0.1	< 0.1	17.8	No	15.1	No
PRIV-05	94	< 0.1	< 0.1	3.6	No	3.1	No
PRIV-06	592	0.1	< 0.1	86.5	No	73.5	No
PRIV-07	528	< 0.1	< 0.1	71.0	No	60.4	No
PRIV-08	284	< 0.1	< 0.1	24.4	No	20.8	No
PRIV-09	188	< 0.1	< 0.1	12.0	No	10.2	No
PRIV-10/PRIV-23	90	< 0.1	< 0.1	3.4	No	2.9	No
PRIV-11/PRIV-24	302	< 0.1	< 0.1	27.2	No	23.1	No

TABLE 5-5
BOD AND COD RESULTS

Pool I.D.	COD (mg/L) (ppm)	BOD (mg/L) (ppm)
PUB-01	< 3	4
PUB-02	< 3	4
PUB-03	100	14
PUB-04	5.9	7
PUB-05	229	8
PUB-06	6	5
PUB-07	3	5
PRIV-01	116	< 1
PRIV-02	3	< 1
PRIV-03	5	< 2
PRIV-04	3	2
PRIV-05	7	< 2
PRIV-06	< 2	< 1
PRIV-07	12	< 1
PRIV-08	12	4
PRIV-09	< 3	< 1
PRIV-10	< 3	2
PRIV-11	9.5	1.5

NOTES:
The detection limit was used for nondetect values, except in cases where BOD concentrations exceeded COD concentrations, or where both values were nondetect
Field duplicates were averaged

TABLE 5-6
COMPARISON OF PREDICTION LIMITS TO WATER QUALITY OBJECTIVES

DO (mg/L) (ppm)

Pool	99% Prediction Limit	Receiving Water Standard (1)	Prediction Limit Exceeds Standard?	Receiving Water Standard (1)	Prediction Limit Exceeds Standard?
Public	2.8		Yes		Yes
Private	5.4	> 7	Yes	> 5	Yes
All	6.5		Yes		Yes

pH

Pool	99% Prediction Limit	Receiving Water Standard (1)	Prediction Limit Exceeds Standard?
Public	5.3-10.2		Yes
Private	5.9-10.6	6.5 - 8.5	Yes
All	6.1-10.1		Yes

Pool	99% Prediction Limit	Sanitary District Standard (2)	Prediction Limit Exceeds Standard?	Sanitary District Standard (3, 4)	Prediction Limit Exceeds Standard?	Sanitary District Standard (5)	Prediction Limit Exceeds Standard?
Public	5.3-10.2		Yes		Yes		Yes
Private	5.9-10.6	5.5 - 12.4	No	6 - 10	Yes	6 - 11	Yes
All	6.1-10.1		No		Yes		No

Temperature (^oC)

Pool	99% Prediction Limit	Sanitary District Standard (3)	Prediction Limit Exceeds Standard?
Public	32.4		No
Private	29.4	< 40	No
All	NA		NA

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District
(6) West Contra Costa Sanitary District

TABLE 5-6
COMPARISON OF PREDICTION LIMITS TO WATER QUALITY OBJECTIVES

TDS (mg/L) (ppm)

Pool	99% Prediction Limit	Sanitary District Standard (3)	Prediction Limit Exceeds Standard?	Sanitary District Standard (5)	Prediction Limit Exceeds Standard?
Public	5,739		Yes		Yes
Private	6,218	< 325	Yes	< 1,000	Yes
All	3,290		Yes		Yes

Conductivity (uS)

Pool	99% Prediction Limit	Receiving Water Standard (1)	Prediction Limit Exceeds Standard?	Receiving Water Standard (1)	Prediction Limit Exceeds Standard?
Public	0-10,798		Yes		Yes
Private	0-3,970	1500 - 1800	Yes	1500 - 3700	Yes
All	NA		NA		NA

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District
(6) West Contra Costa Sanitary District

TABLE 5-6
COMPARISON OF PREDICTION LIMITS TO WATER QUALITY OBJECTIVES

TSS (mg/L) (ppm)

Pool	99% Prediction Limit	Receiving Water Guideline	Prediction Limit Exceeds Standard?
Public	171	80 for maintenance of good to moderate fisheries	Yes
Private	15.1		No
All	NA		NA

Pool	99% Prediction Limit	Sanitary District Standard (3)	Prediction Limit Exceeds Standard?
Public	171	300	No
Private	15.1		No
All	NA		NA

BOD (mg/L) (ppm)

Pool	99% Prediction Limit	Sanitary District Standard (3)	Prediction Limit Exceeds Standard?	Sanitary District Standard (5)	Prediction Limit Exceeds Standard?
Public	10	< 350	No	< 400	No
Private	6.7		No		No
All	NA		NA		NA

Total Ammonia-Nitrogen (mg/L) (ppm)

Pool	Total No. of Samples	Sanitary District Standard (4)	Prediction Limit Exceeds Standard?
Public	0.1	< 200 Ammonia as N	No
Private	1		No
All	0.7		No

(1) San Francisco Bay RWQCB Basin Plan; Central Valley RWQCB Basin Plan
(2) Central Contra Costa Sanitary District
(3) City of Richmond;
(4) Delta Diablo Sanitary District;
(5) Dublin San Ramon Services District

TABLE 5-6
COMPARISON OF PREDICTION LIMITS TO WATER QUALITY OBJECTIVES

(6) West Contra Costa Sanitary District

TABLE 5-7
PREDICTION LIMITS FOR COPPER

All Pools		Public Pools		Private Pools	
Parameter	**99% Prediction Limit (WQO Exceedance Factor)**	**Parameter**	**99% Prediction Limit (WQO Exceedance Factor)**	**Parameter**	**99% Prediction Limit (WQO Exceedance Factor)**
Total Copper Acute	48.3	Total Copper Acute	126	Total Copper Acute	15.7
Total Copper Chronic	32.1	Total Copper Chronic	84.4	Total Copper Chronic	9.9
Dissolved Copper Acute	14.5	Dissolved Copper Acute	3.8	Dissolved Copper Acute	18.6
Dissolved Copper Chronic	9.1	Dissolved Copper Chronic	2.3	Dissolved Copper Chronic	11.7

TABLE 5-8
INFORMATION USED TO ESTIMATE COPPER AND TDS LOADS

Private Pools

Input	Value	Data Source
Number of Pools in Contra Costa County	50,000	Paul Palubicki, Paul's Pool Service
Frequency of pool discharge	Once every 20 years	Paul Palubicki, Paul's Pool Service
Average pool volume (gal)	26,250 gal	Current study data and previous private resident surveys (Appendix D)
Average total copper concentration (ppb)	71.1	Current study data
Average TDS concentration (ppm)	1,070	Current study data
Percent of pools discharged to storm drain/ sanitary sewer/vegetated areas	39%/39%/22%	Current study data and previous private resident surveys (Appendix D)
Percent runoff from vegetated areas reaching storm drain	5%	Professional judgement

Public Pools (includes municipal, apartment complex, sports club and private clubs)

Input	Value	Data Source
Number of pools in Contra Costa County	12,000	Paul Palubicki, Paul's Pool Service
Frequency of pool discharge	Once every 20 years	Paul Palubicki, Paul's Pool Service
Average volume of backwash discharge per year (gal)	34,600	Current study data
Average volume of pool (gal)	280,715	Current study data
Average total copper concentration of backwash including DE filters (ppb)	2,549	Current study data
Average total copper concentration of backwash excluding DE filters (ppb)	294	Current study data
Average TDS concentration of backwash (ppm)	1,317	Current study data
Average total copper concentration of drained pools (ppb)	19.3	Current study data (concentration is average of discharged pool (#7) and continuous bleed (#1))
Average TDS concentration of drained pools (ppm)	1,765	current study data (concentration is average of discharged pool (#7) and continuous bleed (#1))
Percent of pools discharged to storm drain/ sanitary sewer during backwashing	5%/95%	Professional judgement
Percent of pools discharged to storm drain/ sanitary sewer when drained	10%/90%	Professional judgement

TABLE 5-9
LOAD ESTIMATES FOR COPPER AND TDS

	Loads from Contra Costa County					
	Private Pool Drainage (Pounds/Year)		**Public Pool Drainage (Pounds/Year)**		**Public Pool Backwash (Pounds/Year)**	
	Storm Drain	Sanitary Sewer	Storm Drain	Sanitary Sewer	Storm Drain	Sanitary Sewer
Copper	17	15	0.04	0.04	0.001	0.2
TDS	258,000	229,000	414	3,700	5	95

Comparison of Swimming Pool Loads to Storm Drain to Loads from Other Sources (for Copper)

Source	**Annual Load (Pounds)**	**Annual Load (Pounds/Acre)**
Swimming Pool Drainage and Backwash in Contra Costa County-Discharge to Storm Drain	17	0.00004
Loads to Lower San Francisco Bay from Santa Clara County		
South Bay POTW Discharges(1)	2,309	0.00950
Direct Atmospheric Deposition(1)	273	0.00113
Bay Sediments Diffusion(1)	494	0.00203
Brake Pads(2)	3,753	0.01544
Pesticide/Fertilizer Application(2)	36	0.00015
Coolant Leaks and Illegal Dumping(2)	112	0.00046
Motor Oil Illegal Dumping(2)	3	0.00001
Construction Erosion(2)	45	0.00019

References

(1) *Draft* Source Characterization Report. Calculation of Total Maximum Daily Loads for Copper and Nickel in South San Francisco Bay. URS Greiner Woodward Clyde, Tetra Tech, Inc. December, 1998.

(2) Metals Control Measures Plan (Volume I). Woodward Clyde. February, 1997. Prepared for the Santa Clara Valley Runoff Pollution Prevention Program.

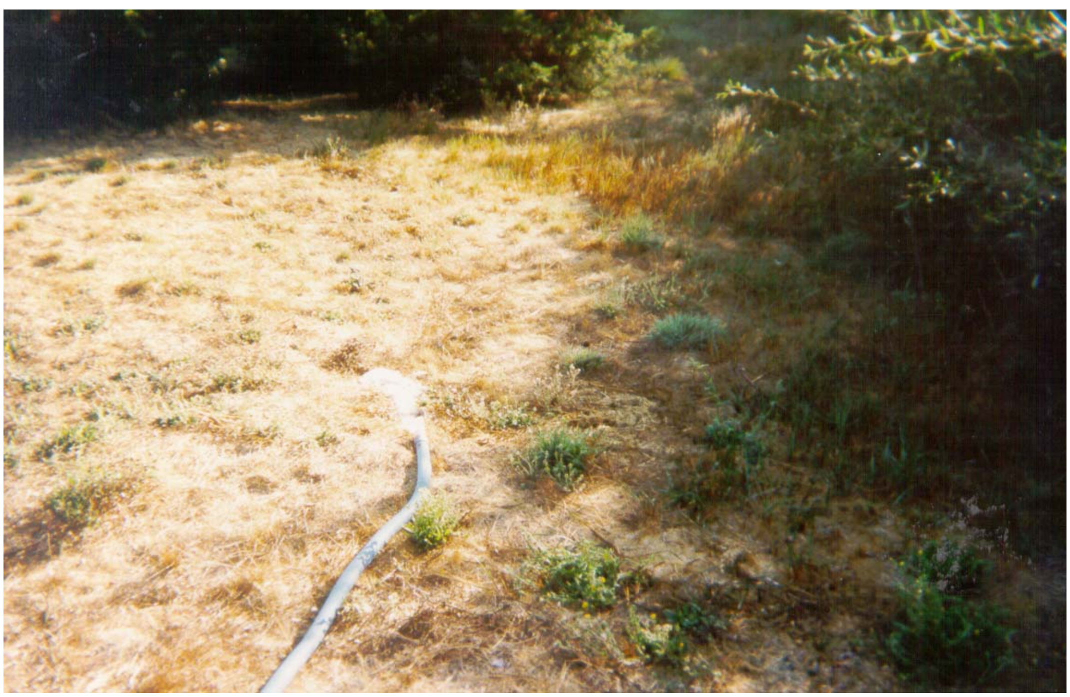
TABLE 5-3
WATER QUALITY OBJECTIVE EVALUATION FOR COPPER

	Results			Water Quality Objectives							
Pool I.D.	**Hardness (mg/L) (ppm)**	**Total Copper (ug/L) (ppb)**	**Dissolved Copper (ug/L) (ppb)**	**Total Copper Acute WQO**	**Exceeds WQO?**	**Total Copper Chronic WQO**	**Exceeds WQO?**	**Dissolved Copper Acute WQO**	**Exceeds WQO?**	**Dissolved Copper Chronic WQO**	**Exceeds WQO?**
PUB-01	108	22.5	21.1	10	Yes	15.1	Yes	9.6	Yes	14.4	Yes
PUB-02	88	91.6	19.2	8.4	Yes	12.4	Yes	8	Yes	11.9	Yes
PUB-03	800	7850	106	55.1	Yes	99.3	Yes	52.9	Yes	95.3	Yes
PUB-04	91	670	23	8.6	Yes	12.8	Yes	8.3	Yes	12.3	Yes
PUB-05/PUB-11	NA	3990	44	NA	NA	NA	NA	NA	NA	NA	NA
PUB-06	312	120	27.4	24.7	Yes	40.9	Yes	23.7	Yes	39.3	No
PUB-07/PUB-12	117.5	16.0	15.1	10.7	Yes	16.3	No	10.3	Yes	15.6	No
PRIV-01/PRIV-22	344	18.75	16.8	26.8	No	44.8	No	25.7	No	43	No
PRIV-02	282	18.0	12.8	22.6	No	37.2	No	21.7	No	35.7	No
PRIV-03	106	172	165	9.8	Yes	14.8	Yes	9.4	Yes	14.2	Yes
PRIV-04	236	9.6	2.7	19.4	No	31.4	No	18.7	No	30.2	No
PRIV-05	94	35.9	22.1	8.8	Yes	13.2	Yes	8.5	Yes	12.7	Yes
PRIV-06	592	29.4	19.6	42.6	No	74.8	No	40.9	No	71.8	No
PRIV-07	528	54.5	29.5	38.7	Yes	67.1	No	37.1	No	64.5	No
PRIV-08	284	243	222	22.8	Yes	37.4	Yes	21.9	Yes	35.9	Yes
PRIV-09	188	133	92	16	Yes	25.4	Yes	15.4	Yes	24.4	Yes
PRIV-10/PRIV23	90	22	13.5	8.5	Yes	12.7	Yes	8.2	Yes	12.2	Yes
PRIV-11/PRIV-24	302	46.5	35.0	24	Yes	39.7	Yes	23	Yes	38.1	No

Photograph of PRIV-10

Discharge to the Sanitary sewer at PRIV-07

Discharge to Sewer Cleanout Line at PRIV-02



Discharge to Vegetated Area at PRIV-08

Discharge to Vegetated Area at PRIV-10

Discharge into Storm Drain at PRIV-11

Field Personnel Collecting Samples at PRIV-09

Appendix C
Toxicity Data

Appendix D

Statistics Summary

DATA POOLING

Because the number of samples in each pool category was relatively small, a statistical analysis was performed to evaluate if the two categories could be combined to enhance the data set. The Student's two-sample t-Test was performed on each constituent to test whether the sample means were statistically similar enough for the categories to be combined. Although the t-Test requires the assumptions that the sample means are normally distributed and the two populations have approximately equal variances, the test is also robust to violations of these assumptions (USEPA, 1998 (2)). If a constituent passed the test at a 5% significance level (i.e., p value > 0.05), the pool categories could be combined. The t-Test results are summarized in Table C-1. As with the summary statistics presented in Section 3, samples containing diatomaceous earth were excluded from the t-Test and subsequent statistical analyses.

Normality tests were performed because tests used to evaluate concentrations of future pool discharges assume the data follow a normal or lognormal distribution. The Shapiro-Wilk Normality Test (Gibbons, 1994) was used to check whether the underlying distribution was normal or lognormal for each constituent. Normality tests were performed for the combined data set, where appropriate, and for the separate categories. If the data did not follow a normal distribution, the data were log-transformed and the test was performed to evaluate if the data followed a lognormal distribution. A 5% significance test was used for the tests. The results of the normality tests are provided in Table C-2.

CALCULATION OF PREDICTION LIMITS/INTERVALS

Prediction limits and intervals were calculated to evaluate the behavior of future pool discharges in the County. The prediction limit is the statistical estimate used to represent a concentration limit for a given constituent such that none of the future sample results would exceed the limit (at a specific level of confidence) if they are from the same population as the sampled pools. This methodology is described in various references (California Code of Regulations, 1991; Gibbons, 1994; USEPA, 1989; ASTM, 1996).

For those constituents for which a normal distribution could be assumed (for raw or log-transformed data), the prediction limit was calculated as follows:

$$\text{Prediction Limit} \;=\; \bar{x} \,+\, t_{1-\alpha,n-1} \;\; s \sqrt{\frac{1}{1\,+\,n}} \tag{1}$$

in which,

$\bar{x}$ = sample mean;

t = one-sided (1 - α) cummulative probability point of Student' s t distribution with (n - 1) degrees of freedom;

s = sample standard deviation;

n = sample size; and

α = the false positive rate for an individual comparison (see discussion below).

For dissolved oxygen, a lower prediction limit was calculated, instead of an upper limit.

For constituents with standards designated by an upper and lower limit (such as pH and conductivity) the prediction interval was calculated as follows:

$$\text{Prediction Interval} \;=\; \bar{x} \,\pm\, t_{1-\alpha/2,n-1} \;\; s \sqrt{\frac{1}{1\,+\,n}} \tag{2}$$

For data sets that were log-normally distributed, Equation (1) or (2) was applied to log-transformed data. The prediction limit calculated from Equation (1) or (2) was then transformed back to the arithmetic scale. For those data sets that were neither normally nor log-normally distributed, the prediction limit was calculated assuming a normal distribution, instead of a non-parametric distribution. A non-parametric method was not used for this assessment because as Gibbons (1994) indicates, the minimum number of sample values required for a reliable non-parametric test is often too large to be practical. Gibbons (1994) and ASTM (1996) suggest the alternative method of using the normal distribution for the original values under these circumstances.

The false positive rate, α, for each individual comparison for use in Equations (1) and (2) was calculated by first selecting an overall (all future independent comparisons) false positive rate, α*. In this case, α* was set at 5% (95% confidence level of no false). Then, using the Bonferroni method, the relationship between α and α* is as follows:

$$\alpha = \frac{\alpha\,*}{k} \tag{3}$$

in which k equals the number of individual comparisons to be made (number of constituents multiplied by the number of future samples). The theory of the Bonferroni method is that if k

individual comparisons are to be tested, a desired overall false positive rate of at most α^* can be guaranteed by testing each comparison at a level of α^*/k.

For this evaluation, a very conservative prediction limit was used so that the current study data could be extrapolated to almost all future pool discharges in the County, which will be a large number. Consequently, a sufficiently high (that is, the false negative error rate, β, was sufficiently low), α was set equal to the maximum of 0.01 (99% confidence level of no false positive), or the value obtained from Equation (3). This choice is consistent with the recommended USEPA (1989) protocol. The 99% prediction interval for each constituent indicates that for many future sampling events, the sample concentration will not exceed the prediction limit 95% of the time. Also, one of more samples from future sampling events will exceed the prediction limit 5% of the time.

Appendix E

Private Resident Surveys

Appendix E
Private Resident Surveys

Appendix F

Stormwater Program Policies for Pool Discharges

APPENDIX E
SUMMARY OF PRIVATE RESIDENT DISCHARGE PRACTICES

Location	Pool/Spa	Volume (gallons)	Discharge Frequency	Discharge Location
Alamo	Pool	25,000	2-4 times per month during filter backwash	sanitary
Alamo	Pool	30,000	never	N/A
Antioch	Pool	5,184	2 times per year due to overflow from rain	storm drain (dechlorinates prior to discharging)
Brentwood	Pool	10,000	never	N/A
Clayton	Pool	20,000	never	N/A
Clayton	Pool	35,000	once to do acid wash	lawn and street gutter
Concord	Pool	20,000	never	N/A
Danville	Pool	15,000	500 gallons every 2 weeks	street gutter
Danville	Pool	25,000	Never	N/A
Danville	Pool	60,000	never	N/A
El Cerrito	Pool	1,800	once (resident has only lived in present location for 1 year)	lawn
El Cerrito	Pool	3,000	never	N/A
El Cerrito	Pool	19,000	once time in 4 years (upon move-in)	storm drain
El Cerrito	Pool	20,000	as needed during winter due to overflow	storm drain
El Cerrito	Pool	25,000	never	N/A
El Cerrito	Pool	60,000	uses contractor. does not know frequency	unknown
El Cerrito	Pool	?	never	N/A
El Cerrito	Pool	large	every 3 years	vegetated area, but discharge flows to storm drain
El Sobrante	Pool	100,000	never	N/A
Hercules	Pool	40,000	never	N/A
Lafayette	Pool	16,000	never	N/A
Martinez	Pool	30,000	never	N/A
Moraga	Pool	?	as needed during the winter due to overflow	street gutter
Moraga	Pool	?	never	N/A
Oakley	Pool	35,000	never	N/A
Orinda	Pool	33,000	never	N/A
Pinole	Pool	35,000	2 times, once to reline pool	lawn
Pittsburg	Pool	15,000	never	N/A
Rodeo	Pool	15,000	never	N/A
Walnut Creek	Pool	3000	once, 3 years ago	street gutter
Walnut Creek	Pool	20,000	No discharge in eight years	N/A
Walnut Creek	Pool	30,000	one time	back yard
Alamo	Pool/Spa	50,000	drained once to do backwash	sanitary sewer

APPENDIX E
SUMMARY OF PRIVATE RESIDENT DISCHARGE PRACTICES

Location	Pool/Spa	Volume (gallons)	Discharge Frequency	Discharge Location
Discovery Bay	Pool/Spa	16,000	never	N/A
Richmond	Pool/Spa	40,000	once when pool was refurbished	unknown
Antioch	Spa	85	3 times per month	sub drain system
Antioch	Spa	?	3 times per year	storm drain (dechlorinates prior to discharging)
Danville	Spa	400	3 times per year	lawn
Danville	Spa	?	once every 3 months	yard
El Cerrito	Spa	?	unknown	into pool
El Sobrante	Spa	100,000	never	N/A
Hercules	Spa	800	never	N/A
Moraga	Spa	?	3-4 times per year	into pool
Oakley	Spa	475	every 6 months	yard
Orinda	Spa	500	3 times per year	shrubs
Pittsburg	Spa	?	one time	storm drain
Pleasant Hill	Spa	500	2-3 times per year	sanitary sewer
Walnut Creek	Spa	500	2 times per year	lawn
Average Pool Volume		27,483		
Average Spa Volume		12,908		

APPENDIX F
SUMMARY OF STORMWATER PROGRAM POOL AND SPA DISCHARGE POLICIES

Municipality	Type of Document	Document Reference	Policy Regarding Swimming Pool Water Discharges	Comments
CONTRA COSTA COUNTY City of Antioch, Contra Costa County, Contra Costa County Flood Control and Water Conservation District (Central Valley Region)	NPDES Waste Discharge Requirements	Order No. 94-001 NPDES No. CA0083313	Dechlorinated swimming pool discharges need not be prohibited provided the source is identified and appropriate control measures are developed under the [Stormwater Management] plan.	
Contra Costa County, Contra Costa County Flood Control District, 16 incorporated cities in Contra Costa County (San Francisco Bay Region)	NPDES Waste Discharge Requirements	Order No. 93-105 NPDES No. CA0029912	Dechlorinated swimming pool discharges need not be prohibited provided the source is identified and appropriate control measures to minimize the impacts of such sources, are developed under the [Stormwater Management] plan.	
Contra Costa County	Storm Water Management and Discharge Control Ordinance Code	Ordinance No. 96-21	Dechlorinated swimming pool discharges are exempt from prohibition, provided they are not a source of pollutants to the waters of the United States.	
Richmond	Ordinance	Ordinance No. 30-88 Adopted 11-93	Dechlorinated swimming pool discharges are not considered to be a source of pollutants to the city's stormwater system. Pool discharges are an acceptable non-stormwater discharge.	
OTHER BAY AREA MUNICIPALITIES Alameda Countywide Clean Water Program	NPDES Waste Discharge Requirements	Order No. 97-030 NPDES No. CAS0029831	Swimming pool discharges are not identified as conditionally exempt. They should consequently be considered prohibited.	Swimming pool discharges were conditionally exempt in original Permit (Order No. 91-146). The Program is currently petitioning the RWQCB to relist swimming pool discharges as conditionally exempt in the current permit. (Reference: L. Sanchez, EOA, Inc.)

APPENDIX F
SUMMARY OF STORMWATER PROGRAM POOL AND SPA DISCHARGE POLICIES

Municipality	Type of Document	Document Reference	Policy Regarding Swimming Pool Water Discharges	Comments
Alameda Countywide Clean Water Program	Model Storm Water Management and Discharge Ordinance	Prepared by Alan Waltner, Attorney at Law and EOA, Inc.	Dechlorinated swimming pool discharges are not considered a source of pollutants to waters of the United States when properly managed. Pool discharges are considered an acceptable non-stormwater discharge.	
Alameda Countywide Clean Water Program	Public Information Flyer	Pool, Spas and Fountains, April 1998	It is illegal to discharge filter rinsewater and backwash to creeks, gutters, or storm drains. The preferred method to discharge pool, spa, or fountain water is to the sanitary sewer, unless prohibited by local ordinances. Water may be discharged to the storm drain if all of the following conditions are met: the water has been dechlorinated; the water is within ambient temperature; and no copper-based algae control products have been added to the water.	Flyer also provides guidance for cleaning filters and properly disposing of the rinsewater and backwash.
Santa Clara Valley Urban Runoff Management Program	NPDES Waste Discharge Requirements	Order No. 95-180 NPDES No. CAS029718	Swimming pool discharges are not identified as conditionally exempt. They should consequently be considered prohibited.	

APPENDIX F
SUMMARY OF STORMWATER PROGRAM POOL AND SPA DISCHARGE POLICIES

Municipality	Type of Document	Document Reference	Policy Regarding Swimming Pool Water Discharges	Comments
Santa Clara Valley Urban Runoff Management Program	BMP Pamphlet	Home Maintenance Tips for a Cleaner Bay	Control algae by regulating chlorine levels and by using a pool cover to block sunlight. Do not use copper-based algaecides. Always discharge pool or spa water to a sanitary sewer line cleanout. Never discharge pool or spa water to a creek, street, or storm drain. Dispose of filter rinsewater and backwash into soil, not the gutter, creek, or storm drain. Make sure your pool service contractor is not using copper products in your pool, and not disposing of filter backwash where it can run off to a storm drain. Make sure acid-wash rinsewater is neutralized before it is pumped to the sewer line cleanout. Call your wastewater treatment plant for guidance.	
City of Palo Alto	Municipal Code	Revised Ordinance adopted 12/94. Section 16.09.	It shall be unlawful to discharge water from pools and spas to the storm drain system.	
BASMAA	BMP Pamphlet	Keep Your Pool, Spa, or Fountain Copper-Free	Control algae without copper algaecides. Don't drain your pool, spa, or fountain to a street, gutter, or storm drain, or where water might flow to a creek or seasonal stream. It is almost always possible to discharge to a sanitary sewer line cleanout. Manage pH and water hardness to minimize corrosion of copper pipes. Rinse cartridge filters onto a dirt area, and spade filter residue into soil. Backwash sand and diatomaceous earth filters onto dirt, or discharge to the sanitary sewer.	

APPENDIX F
SUMMARY OF STORMWATER PROGRAM POOL AND SPA DISCHARGE POLICIES

Municipality	Type of Document	Document Reference	Policy Regarding Swimming Pool Water Discharges	Comments
San Mateo Countywide Stormwater Pollution Prevention Program	NPDES Waste Discharge Requirements	Order No. 93-106 NPDES No. CA0029921	Dechlorinated swimming pool discharges need not be prohibited provided the source is identified and appropriate control measures to minimize the impacts of such sources, are developed under the [Stormwater Management] plan.	
San Mateo Countywide Stormwater Pollution Prevention Program	BMP Pamphlet	Draining Your Pool, Spa and Fountain. Water Disposal Guidelines	Contact your local stormwater program to inform them that you are discharging pool, spa or fountain. Determine where to discharge the water following local city ordinances. You must dechlorinate if you discharge to the street or storm drain. Avoid using copper algaecides (suggests use of heavy chlorination). Or contact your wastewater treatment plant and find out if there are any restrictions. Do not discharge filter rinsewater or backwash to the storm drain.	
Marin County Stormwater Pollution Prevention Program	Pamphlet	Landscaping, Gardening, and Pool Maintenance Best Management Practices for the Construction Industry	Do not discharge chlorinated pool or spa water to a street or storm drain. Let chlorine dissipate for 5 to 7 days. Recycle water by draining it gradually onto a landscaped area. Chlorinated water may be discharged to the sanitary sewer. Do not use copper-based algaecides.	Marin County does not have a NPDES Permit. However, they do have a baseline stormwater program and a Stormwater Management Ordinance.
Napa County	Personal Communication		Napa County does not have a NPDES Permit, however, it is developing a storm drain master plan, and is concerned with pool and spa discharges. Some residents pump discharge into street gutter with no pretreatment. Otherwise, discharge goes to Napa Sanitation District (source: Dennis Bowker, Napa County Resource Conservation District)	

APPENDIX F
SUMMARY OF STORMWATER PROGRAM POOL AND SPA DISCHARGE POLICIES

Municipality	Type of Document	Document Reference	Policy Regarding Swimming Pool Water Discharges	Comments
OTHER CALIFORNIA MUNICIPALITIES City of Monterey	Stormwater Ordinance	Chapter 31.5 of the City Code (Reference obtained via internet www.monterey.org)	Dechlorinated swimming pool discharges will not be considered a source of pollutants to the storm drain system and to waters of the U.S. when properly managed to ensure that no pollutants are present. Therefore, they shall not be considered an illegal discharge unless determined to cause a violation of the provisions of the Porter-Cologne Act, Clean Water Act, or this ordinance.	
City of Monterey, City of Santa Cruz	BMP Report Appendices	How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Developed by the City of Monterey, Santa Cruz, and Woodward-Clyde. 1998.	Test chlorine level and consider using water for irrigation in landscaped area or for dust suppression at a city construction site. Or discharge water to sanitary sewer if acceptable to the wastewater treatment plant in your community. Or allow active chlorine to dissipate, and test the water for residual chlorine before discharging to the storm drain. Also test for residual chlorine every half-hour during the discharge event. Or dechlorinate the water using chemicals before discharging to the storm drain. Test for residual chlorine prior to discharge, and monitor every half hour during discharge.	BMPs include the proper amounts of chemicals to add for various chlorine concentrations.
County of Sacramento, Cities of Sacramento, Folsom and Galt	NPDES Waste Discharge Requirements	Order No. 96-105 NPDES No. CA0082597	Dechlorinated swimming pool discharges are not prohibited unless determined to be sources of pollutants.	If determined to be a pollutant source, the discharge shall be addressed in accordance with the requirements established in Provision D.4.a of the Order.
City of Sacramento	Stormwater Management and Discharge Control Code (Ordinance)	Ordinance No. 98-007 Adopted February 3, 1998	Dechlorinated swimming pool discharges are exempt from the discharge prohibition.	Allowed if the discharge does not cause or contribute to the violation of any Plan Standard.

APPENDIX F
SUMMARY OF STORMWATER PROGRAM POOL AND SPA DISCHARGE POLICIES

Municipality	Type of Document	Document Reference	Policy Regarding Swimming Pool Water Discharges	Comments
Fairfield-Suisun Sewer District	Storm Water Discharge Ordinance	Ordinance No. 93-6 Adopted 11/22/93	Dechlorinated swimming pool discharges are considered "Unpolluted Water". Discharge to the storm drain is acceptable.	
Los Angeles County	NPDES Waste Discharge Requirements	Order No. 96-054 NPDES No. CAS614001	Dechlorinated swimming pool discharges are conditionally exempt. However, if they are identified as being significant sources of pollutants to receiving waters, then appropriate BMPs to minimize the adverse impacts shall be developed and implemented under the Stormwater Management Plan or the Watershed Management Area Plan.	
County of Los Angeles Department of Public Works	Statement to be Signed by Pool Owner Prior to Issuance of Swimming Pool Permit		Owner must obtain a Storm Drain Connection Permit. The water must be dechlorinated (acceptable method is to allow water to stand with no additional chlorine added for 5 days). No swimming pool filter backwash shall be discharged to the storm drain.	
County of Orange, Orange County Flood Control District and Incorporated Cities of Orange County	NPDES Waste Discharge Requirements	Order No. 96-03 NPDES No. CAS0108740	Dechlorinated swimming pool discharges need not be prohibited unless identified as a source of pollutants to the receiving waters.	
City of Cathedral City	Swimming Pool Drainage Permit	Permit issued in accordance with Section 14.24.060 of the City Ordinance Code.	Discharge to the storm water drainage system is permitted between 7:00 P.M. and 7:00 A.M., Monday through Thursday. Pool water must be allowed to stand for at least two days prior to drainage.	Permit fee is $2.50
Riverside County Flood Control and Water Conservation District, the County of Riverside and Incorporated Cities of Riverside County (Santa Ana Region)	NPDES Waste Discharge Requirements	Order No. 96-30 NPDES No. CAS618033	Swimming pool discharges need not be prohibited unless identified as sources of pollutants to the waters of the United States.	

APPENDIX F
SUMMARY OF STORMWATER PROGRAM POOL AND SPA DISCHARGE POLICIES

Municipality	Type of Document	Document Reference	Policy Regarding Swimming Pool Water Discharges	Comments
Riverside County Flood Control District	Personal Communication	Mark Willis	There is no consistent policy for addressing swimming pool discharges. One permittee is considering prohibiting the discharge even though the NPDES Permit allows the discharge of dechlorinated swimming pool water to the storm drain. Residents would be required to discharge to the sanitary sewer.	
County of San Diego, Incorporated Cities of San Diego and San Diego Unified Port District	NPDES Waste Discharge Requirements	Tentative Order No. 99-01 NPDES No. CA0108758 (to be adopted March 10, 1999)	Identified as a Higher Water Quality Threat Discharge. Dechlorinated swimming pool discharges need only be prohibited from entering an MS4 [Municipal Separate Storm Sewer System] if such discharges are identified as a significant source of pollutants to waters of the United States. If identified as a significant pollutant source, the copermittee shall: 1. Prohibit discharge from entering the MS4 2. Require BMP implementation to the MEP and report the discharge and BMPs to SDRWQCB	Previous permit states that Copermittees may, but not need prohibit dechlorinated swimming pool discharges. Discharge does not need to be prohibited provided it is identified to SDRWQCB and appropriate BMPs be implemented to prevent of reduce pollutant discharges.