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MEMORANDUM

TO: **Kirby Biggs (OSRTI) and Daewon Rojas-Mickelson (Region 9)**

FROM: **Mindy Vanderford**

RE: **Long-Term Monitoring Optimization Review**
Intel Magnetics/Micro-Storage Corporation Site, Santa Clara, CA

cc: **Jody Edwards/Carolyn Pitera (Tetra Tech)**

INTRODUCTION

This memorandum summarizes the results of a long term monitoring (LTM) optimization review for the Intel Magnetics and Micro-Storage Corporation (IM/MSC) site, located in Santa Clara, California. The review focused on the conceptual site model (CSM) and opportunities for optimizing the site's LTM program, including strategic recommendations for future LTM efforts. The review was performed by GSI Environmental Inc. (GSI) under subcontract to Tetra Tech, under EPA contract EP-W-07-078, Work Assignment 2-58.

The U.S. Environmental Protection Agency supports the use of a suite of practical methods to maximize resource efficiency and enhance technical decision making during environmental cleanup projects. The process, known as optimization, is defined by EPA as:

> *"Efforts at any phase of the removal or remedial response to identify and implement specific actions that improve the effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation which may facilitate progress towards site completion. To identify these opportunities, regions may use a systematic site review by a team of independent technical experts, apply techniques or principles from Green Remediation or Triad, or apply other approaches to identify opportunities for greater efficiency and effectiveness."*[1]

Optimization reviews during Long-Term Response Action (LTRA) and Operation and Maintenance (O&M) are conducted after remedy selection and implementation, when site managers are assessing remedy performance and planning long-term strategies for attaining site goals.

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[1] EPA. 2012. Memorandum: Transmittal of the National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion. From: James. E. Woolford, Director Office of Superfund Remediation and Technology Innovation. To: Superfund National Policy Managers (Regions 1 – 10). Office of Solid Waste and Emergency Response (OSWER) 9200.3-75. September 28.

SITE AND REVIEW SUMMARY

The former IM/MSC facilities are located in a light-industrial park in Santa Clara, CA in the area known as the South Bay Sites (SBS) (EPA 1993). The SBS industrial area has been the location of multiple silicon chip, electronics and computer component manufacturing operations since the late 1970s. Several individual sites within the larger SBS have been placed on the National Priorities List (NPL). Many of these sites have undergone extensive remediation and are near achieving cleanup goals. Current SBS management challenges include designing efficient monitoring programs that provide support for determinations of protectiveness, progress toward remedial goals and, ultimately, closure for multiple sites.

In order to move toward a strategy for long-term site management leading to closure, IM/MSC site data were reviewed with the goal of identifying future data collection needs to demonstrate attainment of cleanup goals. As part of this effort, general site factors that may be critical to a determination of attainment of cleanup goals have been identified and are discussed below.

The IM/MSC CSM, as currently conceived, was compared to site data to determine if any data gaps or inconsistencies exist as related to: 1) site hydrogeology; 2) source area contribution and potential mass flux downgradient; 3) constituents of concern (COC) and attenuation mechanisms and 4) remedial history. Site data from monitoring reports were evaluated statistically and qualitatively to support a recommendation for optimized long-term O&M of the site. Several statistical and heuristic tools in the Monitoring and Remediation Optimization System software (MAROS) (AFCEC 2012) (Note: Air Force Civil Engineer Center [AFCEC] was formerly known as the Air Force Center for Engineering and the Environment [AFCEE]) were used to evaluate site data and support recommendations for future site management. Technical details and references for the data evaluation methods used in this report are presented in Appendix A and in the MAROS User Guide and Technical Manual (www.gsi-net.com/en/software/free-software/maros-30.html). Statistical results, trends and data sufficiency assessments relevant to the IM/MSC site are presented below. Conclusions include recommendations for future site characterization, spatial and temporal groundwater monitoring and data analysis.

Site documents and reports used as data sources for the analysis are listed under References, with additional technical references listed in Appendix A. The site Remedial Investigation (RI) Report was not available at the time of the review. A summary of site monitoring data (Lowney 2006) was provided by the EPA remedial project manager (RPM). Additional data were received from EPA Region 9 via personal communication with the RPMs.

CONCEPTUAL SITE MODEL

Intel Magnetics (IM) occupied property in the SBS from 1978 to 1987, operating a magnetic bubble production facility. Combined historic site activities at IM/MSC have resulted in shallow groundwater contamination. COCs include Freon 113 and chlorinated volatile organic compound (VOC) solvents. The property has been converted to office space and no solvent-requiring activities currently take place on site.

The IM facility had an underground solvent tank and an in-ground acid neutralization system. The underground storage tank (UST) was installed at the IM site in 1978 and was used to store waste solvents (near well IM-1 on Figure 1). The California Regional Water Quality Control Board (RWQCB) initiated UST leak detection requirements in 1982 that identified groundwater contamination in the vicinity of the IM UST. At the time of discovery of contamination on the IM site, the adjacent property to the south (upgradient) was occupied by International Diagnostic Technology (IDT) (1979-1984). IDT reported using small quantities of hazardous materials as part of testing and developing medical devices.

The Micro-Storage Corporation (MSC) leased the adjacent property after IDT, conducting research on computer disk drives at the site from January 1985 to December 1986. MSC used Freon 113 and other solvents to clean electronic components, storing chemicals and chemical waste in an outdoor enclosure. Elevated concentrations of Freon 113 were detected in groundwater samples collected from monitoring wells located upgradient of IM in 1986, indicating the presence of a dissolved phase plume emanating from area of the former MSC chemical storage shed.

The IM/MSC combined site encompasses approximately 3 acres and is located in a paved industrial area with limited landscaping around the edges. Site storm drains discharge to Calabazas Creek and, ultimately, to San Francisco Bay. The Applied Materials NPL site and a Hewlett-Packard site are located to the northeast of the IM/MSC across the Central Expressway, and are fairly well characterized, based on a previous optimization review of Applied Materials (GSI 2011). Limited environmental characterization data are available from upgradient properties to the south and west such as the Metropolitan Corporate Center (MCC). The Record of Decision (ROD) for IM/MSC (EPA 1991) indicated that there was a chlorinated solvent groundwater plume on the MCC property, but the source of contamination was not known.

IM/MSC remedial activities included removal of the UST along with 35 cubic yards of soil at the IM site in 1985. A groundwater extraction and treatment system (GETS) was installed near the former IM tank and began operation in 1986 to treat and control the spread of the plume. A GETS was later installed on the MSC site. The IM site was placed on the NPL in 1986, with the MSC site added in 1988. MSC was dissolved as a corporation in August 1988, and was, therefore, not included as a potentially responsible party (PRP).

The ROD for the IM/MSC site was published in 1991 and included the existing GETS as the primary remedy to both reduce contaminant mass and to control the spread of affected groundwater (EPA 1991). A public health assessment published in 1992 found that the site posed a low threat to public health based on both concentration of contaminants and potentially complete exposure pathways (CDHS 1992). The GETS was discontinued by 1996 due to poor recovery of dissolved COCs. Site documents indicate there is some concern about how the GETS may have affected other local surrounding groundwater plumes.

Five-Year Reviews for the site were completed in 1996, 2002, 2007 and 2012. Groundwater sampling was reduced to a semi-annual frequency supporting a monitored natural attenuation remedy (MNA) in 1996, after termination of the active remedy. The change in remedy was approved by the RWQCB, but no formal EPA document such as a ROD amendment or an Explanation of Significant Differences (ESD) was found in a literature search.

Site groundwater monitoring continued through 2006 creating a roughly 10-year dataset since termination of the active remedy. No groundwater sampling was conducted from 2006 through 2011, as the PRP for the site ceased communication with regulatory entities. One sampling event was conducted by Region 9 EPA in February 2012. Some institutional controls (IC) have been executed to restrict access to affected media, although it is unclear if these restrictions extend to the IM site. Concentrations of COCs have decreased over time, and appear to have stabilized at very low levels over much of the site. However, well MW-1, located upgradient of the source, showed concentrations above cleanup goals and upgradient well MW-6 showed some increasing concentration trends through 2006 indicating the potential migration of an off-site plume onto the MSC property.

HYDROGEOLOGY

The IM/MSC site is located in an area known as South San Francisco Bay (South Bay) in the Santa Clara Valley Groundwater Basin. The basin occupies the southern end of the structural trough filled by San Francisco Bay (RWQCB 2003). The SBS is located in a relatively flat portion of the Santa Clara Valley structural depression and is underlain by heterogeneous marine and alluvial sediments with groundwater flow largely northward toward San Francisco Bay. The stratigraphy is characterized by alternating coarse and fine deposits reflecting alluvial depositions from the mountains interbedded with fine-grained marine deposits as the level of the Bay fluctuated. Subsurface hydrogeology has been investigated extensively at the SBS due to multiple solvent plumes in the area.

Shallow groundwater at IM/MSC (30 – 40 feet [ft] below ground surface [bgs]) is classified as a potential drinking water source. However, most area municipal supply wells are screened much deeper (>200 ft bgs) in a lower, confined groundwater zone separated from the upper zones by a regional aquitard (EPA 2007). Because the shallow groundwater is classified as a potential drinking water supply, federal and state Maximum Contaminant Levels [MCLs] apply as cleanup standards.

The shallow subsurface below IM/MSC is divided into two water bearing zones. The *A-zone* aquifer extends from approximately 10 to 20 ft bgs, and the *B-zone* aquifer is present from approximately 30 to 40 ft bgs. The two zones are separated by an aquitard ranging from 2 to 10 ft in thickness. Across the SBS, the depths to the A and B zones and the continuity of the aquitard separating the units varies. At IM/MSC, contaminants are present in the A-zone, while the B-zone appears unaffected. The A-zone consists of a mixture of low and higher permeability clays, silts and sands. Neither cross-sections nor soil boring logs were available for the IM/MSC site. However, a cross-section of the adjacent Applied Materials site indicates alternating lenses of low, moderate and high permeability sediments. Subsurface heterogeneity may be responsible for the distribution of contaminants at the site, and the variability in contaminant concentration observed between adjacent sampling locations. As described below, contaminant concentration variability may also be a function of multiple potential sources.

Groundwater in the A zone flows from the MSC site across the IM site to the northeast. Historically, the groundwater flow direction in the shallow zone may have changed several times in response to GETS operation. B-zone groundwater is believed to flow northeast as well, but groundwater elevation data from 2006 (Lowney 2006) indicate groundwater flow to the southwest.

SOURCES

The CSM was evaluated to identify and assess the strength of the sources at the site. The strength of the sources refers to the magnitude of mass discharging to the dissolved phase, and is a good predictor of future plume behavior. A source that is still exporting mass indicates that the dissolved plume may expand in size downgradient, or remain stable, depending on the strength of the attenuation mechanisms. By contrast, demonstrating that a source area is depleted or exporting very little mass supports the conclusion that a plume is or will be attenuating. Additionally, the location and geometry of the source areas are strong determinants of how contamination will migrate.

Two primary and distinct sources of contamination have been identified for the IM/MSC site: the IM facility waste-solvent UST and the chemical storage area at MSC. Due to the density of electronics testing and manufacturing in the area of the site and poor records of chemical disposal, contributions from other site sources may have occurred. Also, groundwater pump and treat remedies in the area may have affected gradients, influencing plume behavior and morphology.

IM operated a 500 gallon single wall steel UST for waste solvents and a 1000-gallon, in-ground, cement-lined acid neutralization system from 1978 to 1985. The UST reportedly held a mixture of water and isopropanol with small volumes of Freon, n-butyl acetate and Hunt Developer (mixtures of constituents in photographic developer can include alkali compounds such as sodium hydroxide, organic acids including catechol, p-amino phenol and other compounds). The acid-neutralization system collected hydrochloric, hydrofluoric and other acids for treatment prior to discharge to the sanitary sewer. Groundwater testing in 1982 revealed 1,1,1-trichloroethane (1,1,1-TCA), Freon 113 and trichloroethene (TCE) in shallow A-zone groundwater near the IM UST. Wells screened in the B-zone were largely free of contaminants and have remained so in B-zone wells across the site.

No detailed information is available on IDT site activities. MSC stored chemicals and chemical wastes in 55-gallon drums in an outside area west of the building. Chemicals used in the MSC degreaser were transported in 55 gallon drums into the facility building; waste chemicals were returned to drums and stored in the exterior enclosure (CDHS 1992). No discrete source of contamination was found at MSC and extensive soil gas samples yielded ambiguous results (EPA 1991). MSC was added to the IM NPL site in 1986 based on groundwater sampling analytical results. The original RI report indicated a contaminant plume approximately 1,200 ft in length and 500 ft in width at the combined site (CDHS 1992). A map of the site reproduced from the 2006 monitoring report (Lowney 2006) showing property boundaries and monitoring locations is provided as Figure 1.

A third, off-site, potential source area has been proposed originating from the adjacent property (MCC), located to the southwest of IM/MSC. A specific source (for example, UST, or dry well) has not been identified on the adjacent properties and no Freon 113 has been detected in groundwater samples collect from the upgradient monitoring wells. Migration of the plume from IM/MSC upgradient to the west/southwest potentially could have been caused by changes in groundwater gradient from pumping on adjacent properties. However, data confirming the presence of historic pumping wells or an additional upgradient source are not available. Extensive characterization of adjacent properties has not been conducted to date. High concentrations detected in groundwater samples collected at monitoring well MMW-7, located on the western property boundary of MSC, could not be confirmed during the 2012 sampling event.

The potential comingling of an off-site source plume with contaminants originating from MSC and IM sources was identified in the 1991 ROD (EPA 1991). Every Five-Year Review performed since the ROD (RWQCB 1996; RWQCB 2002; EPA 2007) has recommended further characterization of the potential off-site source, but based on the documents reviewed for this optimization effort, no characterization or monitoring has occurred upgradient of MW-1. The adjacent property has monitoring wells MMW-6, MMW-7 and MMW-9 included as part of the IM/MSC monitoring network (indicated in Figure 1), but the off-site area upgradient (west and southwest) of these wells has not been characterized . Only wells MW-7 and MW-8 are still in the monitoring program. Monitoring wells in the current program are listed in Table 1.

Due to the comingling of plumes, the original chemical composition and the mass contributions from the IM tank, MSC storage area and, possibly, IDT and MCC activities cannot be determined. The distribution of contamination across the site is heterogeneous, creating uncertainty about the presumption of two distinct sources limited to IM and MSC. Although the subsurface is heterogeneous, the variation in concentration between well locations indicates that contamination may have originated in multiple locations. Site GETS operated historically may also have influenced contaminant migration in indeterminate ways. Uncertainty about the locations and release dates of primary sources in the vicinity of the IM/MSC site introduces some uncertainty about the long-term persistence of the dissolved phase plume.

CONTAMINANTS OF CONCERN

The primary COCs historically detected in site groundwater include Freon 13 and 113, 1,1,1-TCA, PCE, TCE and their degradation products. Preliminary Remediation Goals (PRGs or cleanup goals) that are presumed to be Remedial Action Objectives (RAOs) for concentrations in groundwater are listed in the table below. Based on a review of the most recent site data (EPA Region 9 data transfer, 2012), TCE is the primary COC exceeding cleanup goals on site both in terms of prevalence (number of well locations above the PRG) and toxicity (plume-wide exceedance of PRG). TCE degradation products *cis*-1,2-dichoroethene (*cis*-1,2-DCE) and trans 1,2-dichloroethene (*trans*-1,2-DCE) were monitored as total 1,2-dichloroethenes (1,2-DCE) until 2012. The 2012 data include results for *cis*-1,2-DCE. The cleanup goal for *cis*-1,2-DCE (6 micrograms per liter [µg/L]) was not exceeded during the 2012 sampling event. The 1,1,1-TCA degradation product 1,1-dichloroethene (1,1-DCE) exceeded the cleanup criterion at one well location (MW-6).

Concentrations of other COCs had decreased to levels below PRGs over most of the site by 2006. Many other VOCs have been detected in groundwater at lower concentrations including dichloromethane (DCM or methylene chloride), ethylbenzene, difluoromethane, toluene, and chloroform. Low concentrations of methyl tertiary butyl ether (MTBE) were detected in upgradient monitoring wells in 2006. PRGs for site COCs are listed below, based on values published in the ROD (EPA 1991). Maximum and recent concentrations of TCE, total 1,2-DCE and 1,1-DCE are shown in Table 2.

The ROD identified cleanup goals for 1,1-DCE as the California and federal drinking water standards at the time. Drinking water standards for 1,1,1-TCA have not changed, but toxicity evaluations of degradation products 1,1-dichloroethane (1,1-DCA) and 1,1-DCE have changed in the intervening years. The current EPA MCL for 1,1-DCE is 7 µg/L. In 2002, the consensus toxicity factors for 1,1-DCE changed (EPA 2002) and the Region 9 PRG was increased to 340 µg/L. However, the EPA MCL for 1,1-DCE was not changed, so the likelihood of renegotiating cleanup goals for this compound are uncertain. 1,1-DCA has never had a federal MCL. The Region 9 PRG for 1,1-DCA was reduced from 810 µg/L prior to 2004 to 2.4 µg/L in 2009. It is unclear how changes in toxicity evaluations for IM/MSC site COCs may affect future cleanup goals for these compounds.

Preliminary Remediation Goals for IM/MSC Site Contaminants

Constituent Name	Standard	Basis for Standard
PCE	5 µg/L	EPA MCL
TCE	5 µg/L	EPA MCL
1,1,1-TCA	200 µg/L	California MCL
1,1-DCA	5 µg/L	California MCL
1,1-DCE	4 µg/L	Site-specific standard based on cumulative risk
cis-1,2- DCE	6 µg/L	California MCL
trans-1,2- DCE	10 µg/L	California MCL
Freon 113	1,200 µg/L	California MCL
DCM	40 µg/L	California MCL
Toluene	100 µg/L	California MCL
1,1,2-TCA	32 µg/L	California MCL
Chloroform	100 µg/L	California MCL

Concentrations of Freon 113 dropped rapidly between initial listing of the site and 1996. Concentrations identified in 2006 were all below cleanup goals. Based on its concentration and distribution, TCE is most likely a primary component of solvents used in the area, rather than a degradation product of PCE. Concentrations of PCE have always been low relative to TCE across the IM/MSC site. As of the 2012 sampling event, analytical results for samples from eight of 14 wells across the site exceeded the PRG for TCE. Wells with the highest TCE concentrations include IM-10, MW-1 and IM-11. The highest TCE concentration for Well MMW-7 was detected during the 2006 sampling event; however, the well was not sampled in 2012. Recent concentrations for site COCs relative to cleanup goals are shown on Table 2.

Both *cis*1,2-DCE and *trans* 1,2-DCE are anaerobic biodegradation products of TCE. Analytical results for four of the 15 wells sampled in 2006 exceeded the cleanup standard for total 1,2-DCE with none exceeding for *cis*1,2-DCE in 2012. Several locations in the network show non-detect (ND) results or values below the 6 µg/L CA MCL cleanup standard for *cis*-1,2- DCE. Stable concentration trends for 1,2-DCE indicate on-going biodegradation processes on site (statistical trends for COCs are shown in Table 3). No data on vinyl chloride (VC) concentrations were available. For the most recent sample event, only data for COCs exceeding cleanup goals were transmitted. The absence of VC at concentrations above cleanup goals may indicate either a degradation stall at *cis*-1,2- DCE stage or rapid degradation of VC after it is formed from parent compounds.

1,1,1-TCA as a parent compound is unique in that both biodegradation and abiotic chemical degradation pathways determine its fate in groundwater. Anaerobic microbial degradation of 1,1,1-TCA generates 1,1-DCA (cleanup goal = 5 µg/L) while spontaneous abiotic degradation produces 1,1-DCE (cleanup goal = 4 µg/L) and acetic acid (no drinking water standard). The presence of 1,1-DCA is an indication of a history of active anaerobic degradation processes. The abiotic decomposition process is not influenced by geochemical conditions such as the presence or absence of oxygen (Vogel and McCarty 1987; Haag and Mill 1988; Jeffers, Ward et al. 1989); therefore, spontaneous abiotic degradation occurs in both aerobic and anaerobic environments at the same rate, with the proportion of 1,1-DCE acting as a rough indicator of time since release of the parent compound.

No sampling and analytical data were found for 1,4-dioxane, a solvent stabilizer often used in commercial preparations of 1,1,1-TCA and TCE (Mohr 2001). 1,4-Dioxane can be very persistent in the subsurface and has a fairly low drinking water standard of approximately 3 µg/L. It is unclear if the lack of data for 1,4-dioxane is a result of ND results or absence of the constituent from the laboratory analysis program.

Only one well location, MW-6, had groundwater contamination which exceeded the PRG for 1,1-DCE at 7.7µg/L in 2012. Samples from well MW-6 had a concentration of 38.7 µg/L 1,1-DCA in August 2006 down to 16.3 in 2012. Both values exceed the 4 and 5 µg/L cleanup standards, respectively. Concentrations indicate proximity to a source of 1,1,1-TCA being degraded in an anaerobic environment. Upgradient well MW-1 does not show the pattern of 1,1,1-TCA degradation products. Well MW-4, between MW-6 and IM-11 does not show elevated levels of 1,1,-DCE or 1,1-DCA. These data indicate that there may be multiple primary sources or uncharacterized hydrogeologic heterogeneity.

In order to visualize the relative contributions of the anaerobic and spontaneous degradation pathways to 1,1,1-TCA degradation, Figure 2, a trilateral diagram, was constructed using site analytical data (Appendix C provides an explanation of how to read the diagram). The diagram compares the molar ratios of 1,1,1-TCA and its daughter products at various locations and times. The characteristic pattern produced in a trilateral diagram can indicate how the parent compound (1,1,1-TCA) is being converted by either the abiotic reaction (1,1-DCE) or the reductive dechlorination reaction (1,1-DCA) and can indicate hydraulic connection of locations with similar contaminant and daughter product ratios. Based on the ratios of constituents in different locations in the plume, the plot can indicate if groundwater in different areas is impacted by preferential flow paths or different attenuation mechanisms.

Trilateral diagrams are constructed by calculating the percent (%) molar concentration of each constituent in the groundwater sample relative to the total molar concentration of the three compounds together. The relative % molar concentrations are plotted on trilateral diagram, indicating the relative contribution of each constituent to the whole. Samples with relatively more 1,1,1-TCA are plotted near the top of the triangle, whereas samples where abiotic degradation processes dominate (generating 1,1-DCE) are plotted to the lower right. Locations where biodegradation is active (generating 1,1-DCA) plot to the lower left. The trilateral diagram does not indicate the total concentration of a contaminant at the site (i.e., wells with low and high concentrations are plotted the same way), but rather indicates the ratio of each contaminant in the mixture.

Figure 2 indicates representative compound ratios for IM/MSC wells over time. Representative data from 1989 to 2012 are shown for wells MW-6 (located upgradient of MSC), IM2 (located between MSC and IM) and IM-11 (located near the MSC treatment zone). Data from these wells were chosen because all of the wells have had detections of all three compounds. Sample analytical results from 1989 are dominated by 1,1,1-TCA and 1,1-DCE with lower concentrations of the anaerobic degradation product. The presence of higher proportions of 1,1-DCE in 1989 data indicates the 1,1,1-TCA had been released some time prior to this period as, new releases of 1,1,1-TCA typically show very low percentages of the degradation products.

Data from wells IM-2 and IM-11 show increasing proportions of 1,1-DCE over time, with only 1,1-DCE remaining in 2012, indicating the dominance of the abiotic degradation pathway. Data from well MW-6 shows approximately the same proportions of compounds in 1989 indicating that sources and time of release of contaminants at locations near IM-2, IM-11 and MW-6 may be fairly similar. As opposed to wells IM-2 and IM-11, data for well MW-6 show a dominance of 1,1-DCA over time. These data indicate that 1,1,1-TCA is being biodegraded anaerobically in the area of well MW-6. The different ratio and pattern of 1,1,1-TCA degradation products at wells MW-6 and IM-2 and IM-11 may indicate different environmental conditions (for example, oxidizing or reducing conditions) or transport mechanisms between wells MW-6, IM-11 and IM-2.

REMEDIES

The IM UST and 35 cubic yards of soil were excavated and removed in 1985, and a GETS was installed in the area. Soil testing beneath the UST indicated PCE and 1,1,1-TCA contamination; however, no leaks were detected in the UST and chemical records do not indicate the storage of large quantities of chlorinated solvents at this facility. The source of contamination at IM was determined to be overflow of the UST into the unlined gravel bed underlying the UST (EPA 1991).

In 1991, groundwater extraction and treatment began at the MSC site, pumping from three extraction wells. Extraction was discontinued in 1996. Current concentrations in the MSC source area exceed site cleanup goals for TCE but show a Probably Decreasing trend (MW-4) (see Trend Analysis). No 1,1-DCE is detected in the MSC source zone (MW-4) and concentrations of 1,2-DCEs were below the detection limit during the 2012 sampling event. The current site remedy is presumed to be monitored natural attenuation.

RESULTS OF STATISTICAL AND QUALITATIVE EVALUATION

Groundwater data collected between 2001 and 2012 were evaluated statistically and qualitatively to support recommendations for LTM at the IM/MSC site. Statistical and decision logic tools in the MAROS software are explained in Appendix A. Table 1 lists the monitoring wells used in the analysis and information about their locations and function in the monitoring program. Maximum and recent COC concentrations as well as detection frequencies for TCE, 1,1-DCE and total 1,2-DCE are shown in Table 2. Concentrations trends for site COCs are shown on Table 3 (see Appendix B for graphed data). Table 3 also lists the results of the 'attainment' evaluation for each well and the recommended sampling frequency. The attainment evaluation indicates which wells had groundwater concentrations reliably below federal and state MCLs for each COC.

TREND ANALYSIS

Concentration trend data can be used to support site management decisions by demonstrating that contaminant concentrations have Stable, Increasing, Decreasing or No Trends after active remediation efforts are completed. The EPA 1992 statistical guidance (EPA 1992) recommends collecting samples after the termination of active remediation to demonstrate that transient remediation-related effects have equilibrated. The IM/MSC data set contains routine samples from 1996 to 2006 and one sampling event in 2012. The dataset for the IM/MCS site summarized in Tables 1 and 2 was sufficient to develop conclusions about the progress of the site since termination of the active remedy. IM/MSC groundwater data from 2001 to 2012 were input into a database and used to evaluate trends using the MAROS 3.0 software (AFCEC 2012). The roughly 10-year time frame was considered representative of site conditions during the post-active remediation time frame.

Mann-Kendall Analysis Decision Matrix (Aziz, et. al. 2004)

Mann-Kendall Statistic	Confidence in the Trend	Concentration Trend
$S > 0$	> 95%	Increasing (I)
$S > 0$	90 - 95%	Probably Increasing (PI)
$S > 0$	< 90%	No Trend (NT)
$S \leq 0$	< 90% and COV ≥ 1	No Trend (NT)
$S \leq 0$	< 90% and COV < 1	Stable (S)
$S < 0$	90 - 95%	Probably Decreasing (PD)
$S < 0$	> 95%	Decreasing (D)
$S = 0$	0	Non-detect (ND)

Note: COV = Coefficient of Variation (Standard deviation/mean).

Non-parametric Mann-Kendall (MK) (Mann 1945) concentration trends were evaluated for all wells for TCE, total 1,2-DCE and 1,1-DCE between 2001 and 2006 and, after wells were sampled in 2012, for data between 2001 and 2012. TCE, 1,2-DCE and 1.1-DCE represent contaminants present in the highest concentrations with the lowest cleanup standards and are the most persistent in the subsurface. The MK trend method is appropriate for the dataset as it is not sensitive to the time between sample events and does not require an assumption of a normal distribution of the data to determine a trend (see Appendix A for a description of the MK method). The value ranges for statistical parameters used in the MK method and the resulting trend determinations are shown in the table above.

Concentration trend results for the IM/MSC site are variable, with most trends Stable to Decreasing, across the site. Wells IM-10, IM-11, MW-1, MW-4, and MW-6, with the highest concentrations of TCE on site, show Decreasing or Probably Decreasing concentration trends for TCE. Decreasing TCE concentrations for wells MW-1 and MW-6 may indicate that upgradient concentrations are decreasing, reducing the need for upgradient, off-site characterization. Increasing trends for 1,1-DCE at MW-6 may indicate that 1,1,1-TCA is still degrading and mobilizing from a source. Well MW-1, located upgradient of MW-6, showed a Decreasing trend for 1,1-DCE with concentrations below the PRG, while well MW-6 showed an increasing trend for 1,1-DCE. This result highlights some of the uncertainty in the hydrogeology and source zones at the site.

The Probably Increasing trend for TCE at well IM-2 through 2006 changed to ‘No Trend’ after concentrations were found to have leveled off during the 2012 sampling event. The Increasing TCE trend at well MW-8 is notable in that concentrations in groundwater collected from the well increased from ND for TCE in 2005 to detected concentrations in February 2006; TCE was detected in 2012 but concentrations are still below cleanup goals. Plume migration may be occurring near well MW-8, but concentrations are very low. Groundwater concentrations at well IM-1 near the former IM UST slightly exceed cleanup goals for TCE, based on the most recent sampling results. Concentration trends at well IM-1 are Stable for TCE and 1,1-DCE and show intermittent detections for total 1,2-DCE, with most recent results below cleanup goals. Wells IM-E1 and IM-E3 show largely Stable to No Trends for TCE. The remainder of wells show no detections or No Trend results for TCE. Variations of measured concentrations over time may result from diffusion into and back diffusion from the matrix of fine-grained zones.

The MAROS software was used to estimate total dissolved contaminant mass in the plume 2001 to 2012 (see Moment Analysis in Appendix A). Estimates of total dissolved mass within the well network indicate a Stable trend for total TCE concentrations, and No Trend for both 1,1-DCE and total 1,2-DCE. Center of mass estimates also showed Stable to No Trend results indicating the plume is fairly stable (based on the current monitoring network).

An evaluation of trends for specific well groups within the plume was performed for the source area wells, tail or downgradient wells, the MSC area and the IM area. For TCE, source area wells (IM-1, IM-11, IM-E1, MW-4 and MW-6) have a generally Stable trend and account for 14% of the total mass in the plume. Tail wells show No Trend and monitor roughly 86% of the mass in the plume. A plume where the majority of mass is located outside of the source is most likely not exporting significantly more mass and the plume is unlikely to expand downgradient, supporting a conclusion of plume stability.

Stable plumes with low source strength and limited potential for exposure of receptors to contaminants have been termed ‘low-threat’ plumes. The distribution of mass within the IM/MSC plume is consistent with a ‘low-threat’ designation, as described in the San Francisco Bay

RWQCB Assessment Tool for Closure of Low-Threat Chlorinated Solvent Sites (RWQCB 2009) and AFCEE *Low-Threat Site Closure* guidance (Farhat, Newell et al. 2012).

The majority of TCE mass (66%) is in the MSC area (wells MW-1, MW-6, MW-4 and IM-11) and shows a Stable trend. Less than 4 percent of the TCE mass is in the IM area (wells IM-1, IM-E1 and IM-E3) and concentrations show No Trend.

As a means to help prioritize wells for monitoring plan modification, the MAROS 3.0 software has a tool that estimates the percentage of mass and physical area that each well monitors. Well monitoring areas are estimated using a Voronoi spatial geometry method and mass is estimated based on the concentration at each well and the aquifer volume calculated from the Voronoi area, porosity and plume thickness (see Appendix A). The results for TCE are shown in Appendix B (MAROS Percent of Mass by Well). For the IM/MSC plume, well MMW-7 monitors the highest historic mass and largest area due to its position on the edge of the network and the relatively high concentrations. Well IM-11 also monitors an area with fairly high concentrations in an area with sparse monitoring locations to the west.

DELINEATION

A key component of the CSM is defining the vertical and horizontal extent of affected media. As discussed above, the vertical extent of affected groundwater has been delineated in B-zone wells IM-4, MW-5 and IM-6B. These B-zone wells have had ND results since initial site characterization, indicating that contamination is confined to the A-zone.

The downgradient extent of groundwater impacted by sources on IM/MSC is largely delineated below PRGs based on analytical results. The 2006 and 2012 sample results indicate that concentrations in downgradient well IM-E3 are below screening levels for all COCs. Detections of TCE are intermittent at this location and below the PRG. Downgradient well IM-7 has shown ND results with two exceptions that may be sampling artifacts. Analytical results for the September 2002 sampling event show detections for TCE and total-1,2-DCE at IM-7 that were not seen previously nor replicated in subsequent sampling events. Concentrations in wells AMW-12 and AMW-11 were below cleanup standards when they were sampled in 2001.

A primary uncertainty for the IM/MSC site is that the upgradient portion of the plume is not well delineated. Well MW-1 shows detections of TCE and 1,2-DCE above MCLs in an area that is believed to be upgradient from the source. However, recent data trends for TCE at this location are Decreasing. Detections at MW-1 may have resulted from shifting groundwater gradients or a possible off-site source. Documents produced since the 1991 ROD have concluded that an upgradient, off-site plume source has not been identified and the extent of the IM/MSC plume has not been characterized to the southwest. Concentrations of COCs upgradient of MW-1, therefore, are a source of uncertainty for long-term management of the site.

There is some uncertainty in the lateral, cross-gradient delineation of the plume. Well IM-10, a boundary well located east of the MSC plume centerline had high concentrations of TCE on the most recent sampling event (84 µg/L), but shows an overall decreasing concentration trend. No wells are located east-southeast of IM-10. Well AMW-12 is located downgradient from IM-10 and had ND results for all COCs when it was sampled in 2001. The extent of groundwater above PRGs east and north of IM-10 is currently unknown.

To the west, wells MW-7 and MW-8 delineate contamination on the off-site property. Both wells MW-7 and MW-8 may be largely unaffected. Well MW-7 had only one detection of TCE and 1,2-DCE during the September 2002 sampling event discussed previously, with no detections prior to or since this time. The 2002 detections are statistical outliers by Dixon's Method and appear to be consistent with either sampling or laboratory artifacts. The Increasing TCE trend for well MW-8 is discussed above. Well MW-8 started exhibiting detections of TCE and 1,2-DCE below MCLs in 2005/2006, with concentrations remaining below cleanup goals in 2012. Well MMW-7 is located on the property boundary to the west of IM/MSC and south of MW-8. Well MMW-7 has had historic high concentrations of TCE, with a maximum concentration of 89.8 µg/L in 2006. MMW-7 is an inactive well and was not sampled during the 2012 event. So, the area between MW-7, MW8, MMW-7 and Well IM-3, 500 ft downgradient, has no monitoring locations. Delineation south of MW-7 and east and north of IM-11 is a source of uncertainty for evaluating the plume.

WELL SUFFICIENCY

A well sufficiency analysis was conducted for the IM/MSC monitoring network using the MAROS software. The well sufficiency analysis identifies uncertainty or discontinuities in concentrations across the plume. Areas with high concentration uncertainty may be candidates for new sampling locations. The area between MMW-7, MW-7 and MW-8 was identified as having higher concentration uncertainty and may benefit from additional sampling based on the Delaunay/Slope Factor analysis method (see Appendix A for description). Based on a calculation of relative concentration estimation error between well locations, the highest error is found at well IM-1, located down- and cross-gradient from MMW-7. This result indicates that an area of uncertainty still exists between MMW-7 and the downgradient portion of the plume. Figure 3 shows the relative position of each well in the network and the triangular areas between wells based on the Delaunay Triangulation spatial analysis in MAROS. The software calculates uncertainty between the wells in the triangle and ranks the uncertainty as Small (S), Medium (M), Large (L) or Extremely large (E). Locations with L or E values indicate new sampling locations may be required. Based on the results of the sufficiency analysis and a qualitative analysis of groundwater samples, groundwater monitoring in the area of MMW-7 should continue.

DATA SUFFICIENCY

Historic site data have been reviewed to identify sampling locations that have attained the cleanup goals. Determining when a groundwater location has statistically achieved a cleanup goal may depend on several metrics including quantity of data, variance in the dataset and detection limits as well as the qualitative confidence in the CSM.

One method of assessing when a dataset is reliably below a standard is a Sequential t-Test based on yearly concentration averages (Rogers 1992; EPA 1992). The test compares annual concentration averages at wells over a period of six or more years to a screening standard. The comparison is then subject to a conservative hypothesis test that is sensitive to the statistical power of the dataset. The MAROS software Data Sufficiency module uses this method to identify locations that have sufficient data to make a determination of statistical ‘attainment’ of the cleanup goal using the Sequential t-Test. Results of the test are presented in Table 3.

A-Zone wells IM-7, IM-E3, and MW-8 and B-Zone wells IM-4 and MW-5 have sufficient data between 2001 and 2012 to conclude that the three main COCs are statistically below the cleanup level at these locations. Wells IM-7, IM-E3 and MW-8 delineate the plume in the A-zone. Well MW-5 delineates the vertical extent of the plume in the B-zone area around MSC. TCE concentrations at MW-8 increased from ND to detected concentrations in 2006, but concentrations are still below MCLs in 2012. Well MW-7 had statistically-based outlier concentrations in 2002 and may be considered below MCLs for practical purposes. The majority of wells in the network monitor groundwater concentrations below the cleanup levels for 1,1-DCE and total 1,2-DCE. Based on data collected through 2012, the plume at IM/MSC has sufficient data to classify it as “low threat” (as defined by AFCEC and the San Francisco RWQCB (RWQCB 2009; Farhat, Newell et al. 2012), with most areas approaching cleanup goals for most COCs.

SAMPLING FREQUENCY

In order to recommend a data collection strategy for the IM/MSC site, data were evaluated using the sampling frequency module in the MAROS software. The module uses concentration trends and rates of change in a qualitative decision tree to recommend a sampling frequency. The results of the analysis indicate that the A-zone network should be monitored on a biennial (every 2 years) basis. Non-detect results in the B-zone resulted in a qualitative recommendation to sample wells once every 5 years (to support the Five-Year Review). Results are shown in Table 3 for TCE, the priority COC.

CONCLUSIONS

Remediation efforts at the IM/MSC site since 1985 have achieved groundwater concentrations fairly close to cleanup goals at most monitoring locations across the properties. Since the termination of active remediation in 1996, contaminant concentrations have decreased or remained stable in many areas of the plume. Statistical and qualitative evaluation of the plume indicates that it is generally stable.

The California Department of Health Services (CDHS) identified the IM/MSC site as a low-threat waste site as early as 1992. The site can still be considered ‘low-threat’ as it has low concentrations and largely exhausted sources; also, it lies in an industrial area with no complete exposure pathways. However, progress toward documenting conditions sufficient for site closure may be supported by closing some data gaps in the IM/MSC CSM. Notably, the extent of the plume is not well delineated in the upgradient and cross-gradient directions, and the primary sources of contamination do not seem to be well characterized. Cross-sections and boring logs were not available to evaluate the heterogeneity in the subsurface, which represents another source of uncertainty for long-term plume behavior.

The primary COC, TCE, is the only COC above the cleanup goal at multiple locations at the IM/MSC site at this time. As with other sites in the SBS, low-level concentrations of chlorinated compounds and their daughter products will most likely persist for many years. The presence of degradation byproducts of parent solvents indicates that biodegradation is on-going, but rates may be slow.

The following recommendations are based on the review of IM/MSC site data through 2012:

- Source identity and control are key elements of an evaluation of the future behavior of a groundwater plume. COC concentrations upgradient of well MW-1 are a source of uncertainty in long-term management of the site. However, because concentrations are relatively low, no potentially complete exposure pathways exist and source contaminants are highly degraded, the lack of source characterization does not constitute an imminent threat to protectiveness.

  Additional source characterization is recommended in areas around well MMW-7 and upgradient of well MW-1, if possible. Plume management decisions would benefit from delineation in the upgradient area and in some cross-gradient areas. The area east of well IM-10 should be sampled and additional sampling should occur in the area between wells MMW-7 and IM-3.

- Shallow hydrogeology at the SBS is highly heterogeneous. Long-term attenuation of site COCs may be influenced by the presence and distribution of preferential channels and low-permeability lenses that may act as long-term sources (due to matrix diffusion and back diffusion processes). The current distribution of COCs across the site may have been influenced by historic groundwater extraction, multiple source areas or subsurface heterogeneity.

  Historic data should be reviewed and cross-sections or 3-dimensional visualization and analysis should be performed to further refine the hydrogeologic CSM to explain and evaluate long-term distribution of COCs.

- Groundwater from all existing wells in the A-zone should be sampled biennially for the next 5 years to develop a sufficiently large dataset to attain statistical significance. B-zone wells appear unaffected, and may be sampled once before the next Five-Year Review to confirm this status. The 5-year sampling of the B-zone wells should be performed at the same time as one of the A-zone well sampling events to provide a fully synoptic sampling data set.

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Tables

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TABLE 1
MONITORING NETWORK INTEL MAGNETICS
2001 - 2012

Intel Magnetics, Santa Clara, California

WellName	Well Type	Groundwater Zone	Date Range for Analysis		Well Location/Monitoring Rationale	Status
			Minimum	Maximum		
IM-1	Monitoring	A	9/26/2001	2/1/2012	IM near source	Active
IM-10	Monitoring	A	9/26/2001	2/1/2012	downgradient of MSC	Active
IM-11	Monitoring	A	9/26/2001	2/1/2012	MSC near source/treatment area	Active
IM-2	Monitoring	A	9/26/2001	2/1/2012	Downgradient of MSC; upgradient of IM	Active
IM-7	Monitoring	A	9/26/2001	2/1/2012	Farthest downgradient	Active
IM-E1	Extraction	A	9/26/2001	2/1/2012	IM near source	Active
IM-E3	Monitoring	A	9/26/2001	2/1/2012	Near downgradient IM	Active
MMW-7	Monitoring	A	9/26/2001	8/14/2006	Cross-gradient, property boundary to west	Inactive
MW-1	Monitoring	A	3/21/2002	2/1/2012	Upgradient, on property boundary	Active
MW-4	Extraction	A	9/26/2001	2/1/2012	Near MSC source/treatment	Active
MW-6	Monitoring	A	9/26/2001	2/1/2012	Upgradient of MSC source/treatment area	Active
MW-7	Monitoring	A	9/26/2001	2/1/2012	Cross-gradient off-site west, delineation point	Active
MW-8	Monitoring	A	9/26/2001	2/1/2012	Cross-gradient off-site west, delineation point	Active
IM-4	Monitoring	B	9/26/2001	2/1/2012	IM near source B zone	Active
MW-5	Monitoring	B	9/26/2001	2/1/2012	near cross-gradient MSC	Active

Notes:
1. Data from Lowney, 2006 and EPA 2012.
2. 'Inactive' wells are those that have not been sampled since 2006 or wells where no data are available for 2012.

TABLE 2
SUMMARY RESULTS FOR IM/MSC
2001 - 2012

Intel Magnetics, Santa Clara, California

WellName	Number of Samples	Number of Detects	Percent Detection	Maximum Concentration [ug/L]	Maximum Above Cleanup Goal	Date of Maximum Concentration	Most Recent Concentration [ug/L]	Recent Concentration Above Cleanup Goal
Trichloroethene (TCE)								
IM-1	11	11	100	**12.0**	**Yes**	3/21/2002	**7.9**	**Yes**
IM-10	11	11	100	**130.0**	**Yes**	3/21/2002	**84.0**	**Yes**
IM-11	11	11	100	**110.0**	**Yes**	9/26/2001	**67.0**	**Yes**
IM-2	11	11	100	**19.8**	**Yes**	8/14/2006	**11.5**	**Yes**
IM-4	11	2	18	**15.0**	**Yes**	3/21/2002	ND	No
IM-7	10	1	10	1.4	No	7/24/2003	ND	No
IM-E1	11	11	100	**15.0**	**Yes**	1/28/2004	**8.2**	**Yes**
IM-E3	11	6	55	2.3	No	8/8/2005	ND	No
MMW-7	10	9	90	**89.8**	**Yes**	--	**89.8 (2006)**	**Yes**
MW-1	10	10	100	**390.0**	**Yes**	3/21/2002	**8.6**	**Yes**
MW-4	11	10	91	**17.0**	**Yes**	9/26/2001	**8.9**	**Yes**
MW-5	11	1	9	2.1	No	7/24/2003	ND*	No
MW-6	11	11	100	**120.0**	**Yes**	9/26/2001	**37.7**	**Yes**
MW-7	11	1	9	**72.0**	**Yes**	9/20/2002	ND	No
MW-8	11	3	27	3.0	No	8/14/2006	0.8	No
1,1-Dichloroethene								
IM-1	11	1	9	0.71	No	3/21/2002	ND	No
IM-10	11	11	100	1.63	No	8/14/2006	0.40	No
IM-11	11	11	100	2.14	No	8/14/2006	1.00	No
IM-2	11	11	100	2.50	No	9/20/2002	1.20	No
IM-4	11	0	0	0	No	--	ND	No
IM-7	10	1	10	0.31	No	8/8/2005	ND	No
IM-E1	11	3	27	0.68	No	2/24/2006	ND	No
IM-E3	11	1	9	0.22	No	9/26/2001	ND	No
MMW-7	10	0	0	0	No	--	ND	No
MW-1	10	5	50	0.81	No	3/21/2002	ND	No
MW-4	11	0	0	0	No	--	ND	No
MW-5	11	0	0	0	No	--	ND	No
MW-6	11	11	100	**15.40**	**Yes**	8/14/2006	**7.70**	**Yes**
MW-7	11	0	0	0	No	--	ND	No
MW-8	11	0	0	0	No	--	ND	No
Total 1,2-Dichloroethene [3]								
IM-1	11	5	45%	1.00	No	8/8/2005	0.20	No
IM-10	11	11	100%	**8.63**	**Yes**	8/14/2006	5.20	No
IM-11	11	11	100%	5.60	No	3/26/2003	2.70	No
IM-2	11	11	100%	2.12	No	8/14/2006	0.80	No
IM-4	11	0	0%	0	No	--	ND	No
IM-7	11	0	0%	0	No	--	ND	No
IM-E1	11	4	36%	1.40	No	2/24/2006	0.30	No
IM-E3	11	1	9%	0.58	No	7/26/2004	ND	No
MMW-7	10	9	90%	**20.10**	**Yes**	2/24/2006	**20.10**	**Yes**
MW-1	10	10	100%	**59.70**	**Yes**	9/20/2002	1.00	No
MW-4	11	3	27%	0.52	No	9/26/2001	ND	No
MW-5	11	0	0%	0	No	--	ND	No
MW-6	11	11	100%	**6.53**	**Yes**	9/26/2001	3.60	No
MW-7	11	1	9%	**12.10**	**Yes**	9/20/2002	ND*	No
MW-8	11	3	27%	3.34	No	8/14/2006	ND	No

Notes:

1. Data from Lowney, 2006 and EPA 2012.
2. Clean up goals TCE = 5 ppb, 1,1-DCE = 4 ppb, Total 1,2-DCE = 6 ppb (set to value for cis-1,2-DCE).
3. Analytical results for 2012 only include *cis*-1,2-Dichloroethene.
4. ND = Non-detect result; *ND = all values non-detect except for one outlier.

TABLE 3
TREND, ATTAINMENT AND SAMPLING FREQUENCY RESULTS
2001 - 2012

Intel Magnetics, Santa Clara, California

	Mann-Kendall Trends						Below Standard by Student's T-Test			Recommended Sampling Frequency TCE
WellName	**TCE**	**TCE 2012**	**1,1-DCE**	**1,1-DCE 2012**	**Total 1,2-DCE**	**Total 1,2-DCE 2012[6]**	**TCE**	**1,1-DCE**	**Total 1,2-DCE**	
IM-1	S	S	NT	S	PI	NT	NO	YES	YES	Biennial
IM-10	D	D	NT	S	S	PD	NO	YES	NO	Biennial
IM-11	D	PD	S	S	S	S	NO	YES	YES	Biennial
IM-2	PI	NT	S	S	NT	S	NO	YES	YES	Biennial
IM-4 (B-zone)	NT	NT	ND	ND	ND		**YES**	**YES**	**YES**	Every 5 years
IM-7	NT	S	NT	NT	ND	ND	**YES**	**YES**	**YES**	Biennial
IM-E1	S	NT	NT	NT	NT	NT	NO	YES	YES	Biennial
IM-E3	S	S	S	S	NT	NT	**YES**	**YES**	**YES**	Biennial
MMW-7	NT	--	ND	--	I	--	NO	YES	NO	Replace
MW-1	PD	D	D	D	PD	D	NO	YES	NO	Biennial
MW-4	PD	D	ND	ND	S	S	NO	YES	YES	Biennial
MW-5 (B-zone)	ND*	ND*	ND	ND	ND	ND	**YES**	**YES**	**YES**	Every 5 years
MW-6	D	D	I	I	D	D	NO	NO	YES	Biennial
MW-7	ND*	ND*	ND	ND	ND*	ND*	NO	YES	YES	Biennial
MW-8	PI	I	ND	ND	NT	NT	**YES**	**YES**	**YES**	Biennial

Notes:

1. Data from Lowney, 2006 and EPA 2012. Trend data were calcualted 2001- 2006 and 2001 - 2012 in column labeled 2012.
2. MK Trend Results: D = Decreasing, PD = Probably Decreasing, S = Stable
   PI = Probably Increasing, I = Increasing, NT = No Trend, ND = Non-Detect.
3. Attainment of cleanup standards by Sequential T-Test method from USEPA, 1992.
4. Recommended sampling frequency for TCE in wells from MAROS software. TCE results are most conservative.
5. *ND = all values non-detect except for one outlier.
6. Analytical results for 2012 only include cis-1,2-Dichloroethene.

Figures

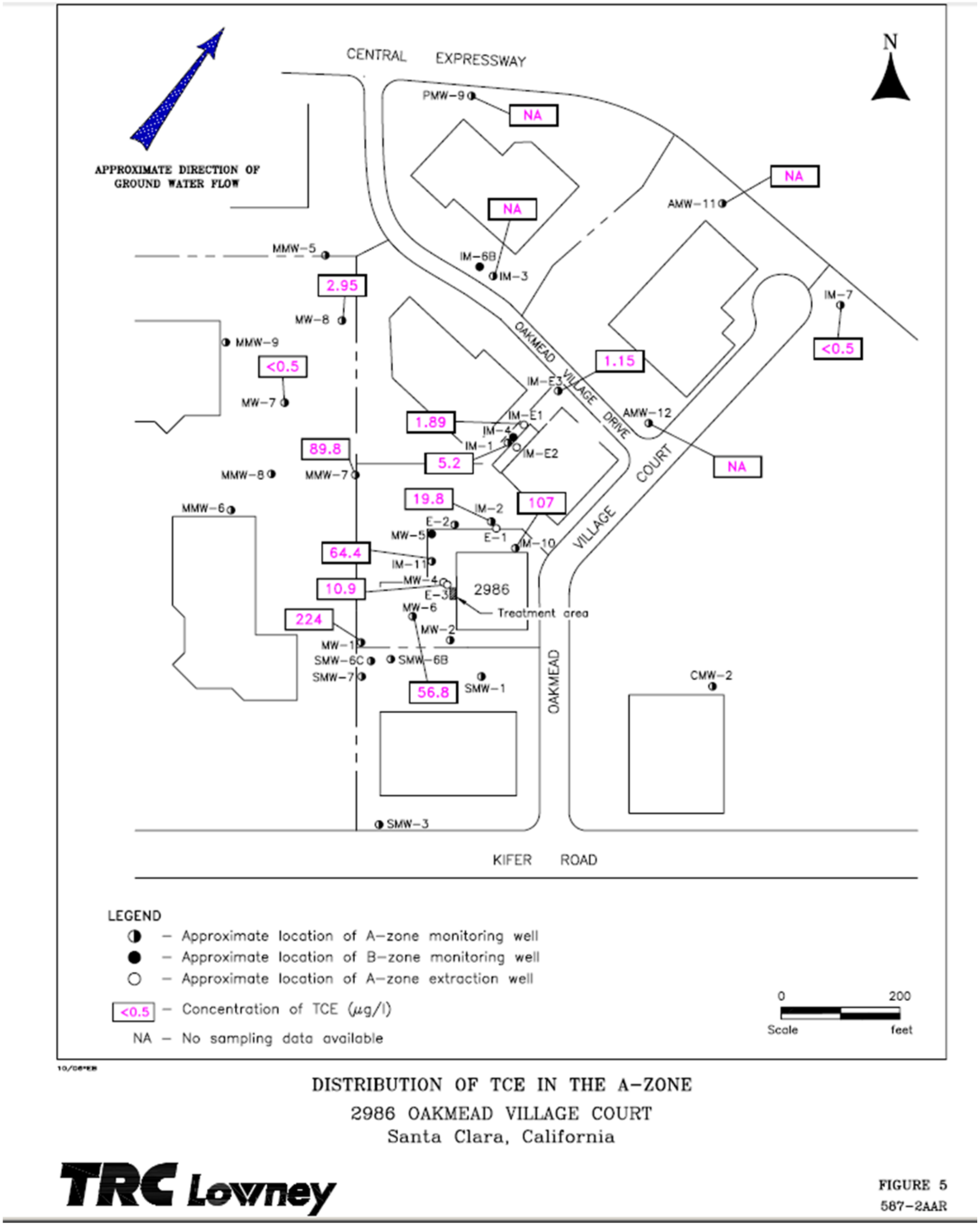
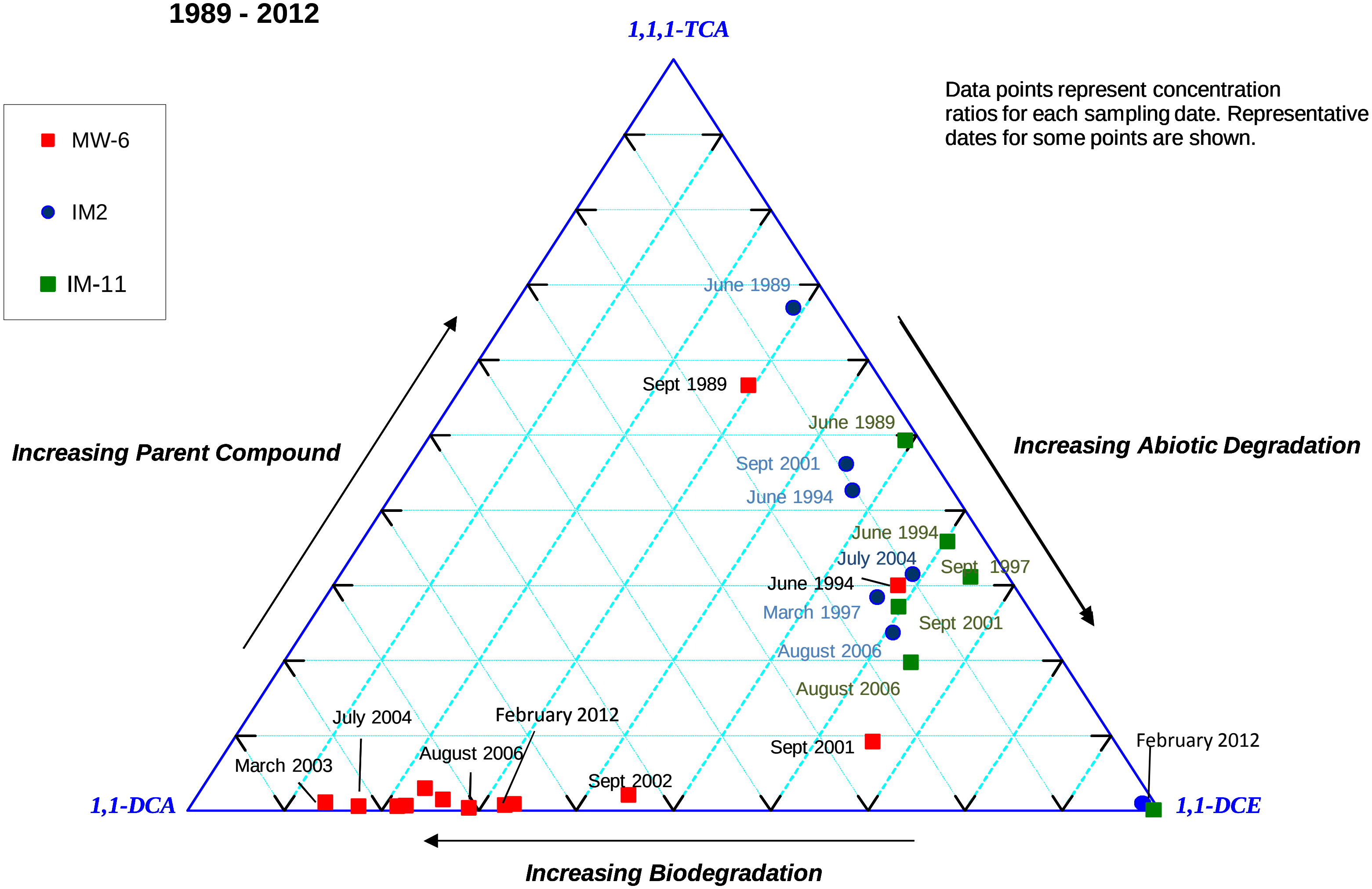


Figure 1: Site map reproduced from TRC Lowney (2006). Second Semi-Annual 2006 Ground Water Monitoring Report. San Jose, CA, Prepared for Kim Camp III c/o Kimball Small Properties.

05-, February 2013

Figure 2. IM/MSC COC Ratios

1989 - 2012



Data points represent concentration ratios for each sampling date. Representative dates for some points are shown.

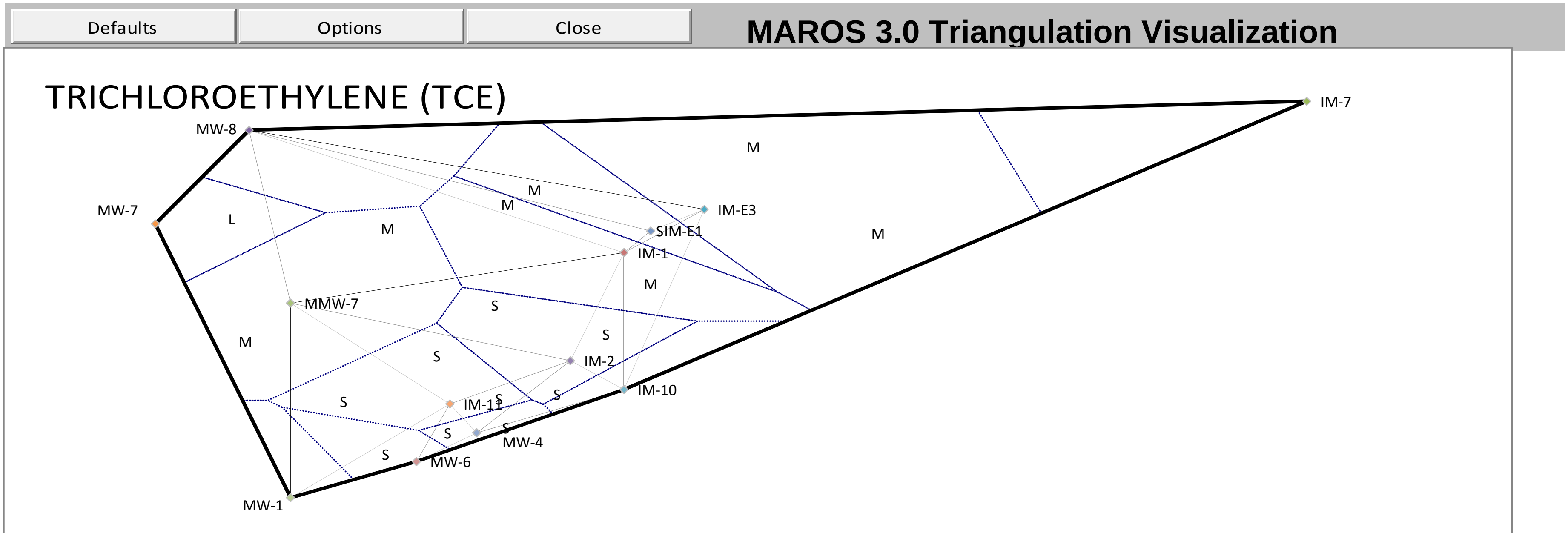


Figure 3: Spatial Analysis of IM/MSC Plume. Areas between wells are evaluated for uncertainty by Slope Factor method. L = Large, M = Medium, S = Small . Voronoi areas around wells are shown in blue.

Appendix A

APPENDIX A
MONITORING AND REMEDIATION OPTIMIZATION SYSTEM (MAROS) METHODOLOGY

Cited References

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MAROS METHODOLOGY

MAROS is a collection of tools in one software package that is used in an explanatory, non-linear but linked fashion to review and increase the efficiency of groundwater monitoring networks. The tool includes models, statistics, heuristic rules, and empirical relationships to assist the User in optimizing a groundwater monitoring network system. Results generated from the software tool can be used to develop lines of evidence, which, in combination with expert opinion, can be used to inform management decisions for optimal operation of remedies and safe and economical long-term monitoring of groundwater plumes. For a detailed description of the structure of the software and further utilities, refer to the MAROS Manual (http://www.gsi-net.com/software/free-software/maros-30.html#Downloads)

1.0 MAROS Conceptual Model

In MAROS, three levels of analysis are used for optimizing long-term monitoring plans: 1) a statistical evaluation of individual well concentration data with interpretive trend analysis, 2) a plume-level analysis including estimates of total dissolved mass, and distribution of mass and 3) a more detailed statistical monitoring optimization based to identify spatial and temporal well redundancy as well as estimations of well sufficiency (see Figures 1 for MAROS flow diagram).

The tools in MAROS are designed to assess the general monitoring system condition by considering individual well concentration trends, overall plume stability, hydrogeologic factors (e.g., seepage velocity, and current plume length), and the location of potential receptors (e.g., property boundaries or drinking water wells). The method relies on mass distribution and temporal trend analysis to assess plume stability, which is then used to determine the general monitoring approach.

Monitoring data interpretation in MAROS is based on historical analytical data from a consistent set of wells over a series of sampling events. Input data include the sampling location, location coordinates, date of samples, constituents sampled, results, detection limits and data flags. Statistical validity of the analyses requires constraints on the minimum data input of at least six wells (ASTM 1998) in which COCs have been detected. Individual sampling locations need to include data from at least four recent sampling events. Additional information needed for the MAROS analysis includes site-specific parameters such as seepage velocity and current plume length and width. Information on the location of potential receptors relative to the source and tail regions of the plume is entered at this point.

In MAROS, the User is required to identify monitoring locations as either Source wells or Tail wells. Source zone monitoring locations include wells in areas with non-aqueous phase liquids (NAPLs), contaminated vadose zone soils, and areas where aqueous-phase releases have been introduced into ground water. The source zone generally contains locations with historical high ground water concentrations of the chemicals of concern (COCs). The tail zone is considered to be the area downgradient of the contaminant source zone. Although this classification is a simplification of the plume conceptual model, this broadness makes the user aware on an individual well basis that the statistical results can have a different interpretation depending on the well location in and around the plume.

MAROS includes a short module that provides recommendations on prioritizing COCs based on toxicity, prevalence, and mobility of the compound. The toxicity ranking is determined by calculating a representative concentration for each COC for the entire plume. The representative concentration is then compared to the screening level or Preliminary Remediation Goal (PRG) (User supplied) for each compound by dividing the representative concentration by the PRG. The COCs are ranked by the percent exceedance of the plume-wide representative concentration of the PRG. COC prevalence is determined by calculating a representative concentration for each well location and comparing the value with the PRG. The number of wells with concentrations exceeding the PRG is calculated for each COC. The COCs with the most wells in the network exceeding the goal are ranked highest. COCs detected in the plume over PRGs are ranked for mobility based on Kd (sorption partition coefficient). COCs with the highest toxicity, prevalence and mobility are identified. The MAROS COC assessment provides the relative ranking of each COC, but the user must choose which COCs are included in the analysis.

MAROS allows Users to specify the period of interest in which data will be consolidated (i.e., monthly, bi-monthly, quarterly, semi-annual, yearly, or a biennial basis). In computing the representative value when consolidating, one of four statistics can be used: median, geometric mean, mean, and maximum. Non-detects can be transformed to one half the reporting or method detection limit (DL), the DL, or a fraction of the DL. Trace level results can be represented by their actual values, one half of the DL, the DL, or a fraction of their actual values. Duplicates are reduced in MAROS by one of three ways: assigning the average, maximum, or first value. The reduced data for each COC and each well can be viewed as a time series in a graphical form on a linear or semi-log plot generated by the software.

2.0 Individual Well Statistics

2.1 Summary Statistics

The Individual Well Analysis module is designed to provide the User with a number of metrics to assess contamination and remedy performance at each monitoring location. The statistical tools are designed to help assess both the completeness of the conceptual site model (CSM) and the importance of each well in characterizing the plume. The statistical methods and procedures outlined below were developed to assess appropriate response measures for affected groundwater plumes based on scientifically sound quantitative analyses of current and historical site groundwater conditions.

The first step in the review of a groundwater monitoring network is a review of the number of samples and detection rate for various priority constituents of concern (COC). MAROS calculates the detection frequency, date of maximum concentration and if the maximum concentration is above the cleanup goal. After the initial data summary, MAROS calculates summary statistics (mean, median, standard deviation, etc.) using the Kaplan-Meier method (Helsel 2005; USEPA 2009) to evaluate datasets including those with high levels of non-detect values (>30%). Further statistical evaluations include identifying outliers by Dixon's method and an estimated data distribution by the Shapiro-Wilk method. Details of the methods encoded in MAROS are described in the MAROS User Guide and USEPA *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance* (USEPA 2009).

The Summary Statistics module provides information on where, how often and at what magnitude COCs are detected in the plume. Data points outside expected values are identified by Dixon's method, alerting the User to possible artifacts or anomalies in the dataset. MAROS does not remove these data points from the dataset, but allows the User to interpret the dataset in the context of site conditions. Determination of the distribution of each dataset provides guidance on choosing other statistical methods to evaluate the data. For example, trends for normally distributed data can be estimated using Linear Regression rather than the non-parametric Mann-Kendall method.

2.2 Trends by Mann-Kendall Analysis

The Mann-Kendall test is a non-parametric statistical procedure that is well suited for analyzing trends in data over time (Gilbert 1987) (Mann 1945). The Mann-Kendall test can be viewed as a non-parametric test for zero slope of the first-order regression of time-ordered concentration data versus time. One advantage of the Mann-Kendall test is that it does not require assumptions as to the statistical distribution of the data (e.g. normal, lognormal, etc.) and can be used with data sets which include irregular sampling intervals and missing data. The Mann-Kendall test is designed for analyzing a single groundwater constituent, multiple constituents are analyzed separately. Details of the Mann-Kendall test as coded in the MAROS software are provided in the User Guide.

The Mann-Kendall (S) statistic is a preliminary estimate of the trend in the data: positive values indicate a possible increase in concentrations over time and negative values indicate a possible decrease. The strength of the trend is proportional to the magnitude of the Mann-Kendall statistic (i.e., a large value indicates a strong trend). The Mann-Kendall statistic (S) is defined as the sum of the number of positive differences minus the number of negative differences or :

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \operatorname{sgn}\left(x_j - x_k\right)$$

The confidence in the trend is determined by performing a hypothesis test to determine the probability of accepting the null hypothesis (no trend). The S statistic and the sample size, n, are found in a Kendall probability table such as the one reported in Hollander and Wolfe (1973). The Confidence in the Trend is found by subtracting the probability of no trend (ρ) from 1. For low values of ρ (<0.05), confidence in the trend is high (>90%) or ($\rho < 0.01$) very high (>95%).

The concentration trend is determined for each well and each COC based on results of the S statistic, the confidence in the trend, and the coefficient of variation (COV). The decision matrix for this evaluation is shown in Table 1. A Mann-Kendall statistic that is greater than 0 combined with a confidence of greater than 95% is categorized as an Increasing trend while a Mann-Kendall statistic of less than 0 with a confidence between 90% and 95% is defined as a probably Increasing trend, and so on.

Depending on statistical indicators, the concentration trend is classified into eight categories:

- Decreasing (D),
- Probably Decreasing (PD),
- Stable (S),
- No Trend (NT),
- Probably Increasing (PI)
- Increasing (I)
- Non-detect (ND)
- Insufficient Data (N/A).

Wells where the compound is not detected are labeled “ND” for the COC evaluated. Locations with insufficient data to evaluate a trend (i.e. less than 4 sample results) are indicated by “N/A”.

2.3 Data Sufficiency

The sufficiency of data, in the statistical context, refers to whether the observed data are adequate, both in quantity and in quality, for revealing changes in the variable of interest. The Data Sufficiency tool in MAROS is designed to provide statistical certainty that concentrations at individual wells are below the PRGs. The test represents a rigorous and conservative approach that is best used on plumes that are well characterized, stable and close to remedial goals.

For the first cleanup status evaluation, a modified sequential t-test for assessing attainment of cleanup standards based on the mean contaminant levels is performed (U.S. EPA 1992). The test procedures involve several steps comparing mean concentration in the well, variance in the data, and size of the dataset versus cleanup goals. The mathematics behind the sequential t-test are detailed in the MAROS User Guide and in the 1992 EPA guidance. Possible results of the sequential t-test include:

- *Not Attained* – the concentration at the sampling location is not near the cleanup goal;
- *Continue Sampling*—the concentration is approaching cleanup goals, but requires a larger sample size
- *Attained* – the dataset is sufficient to demonstrate that the concentration is below the cleanup goal.
- *Insufficient Data*

An optional power analysis on the cleanup status evaluation is also provided. This analysis uses the Student’s t-test on the mean to determine: 1) whether the mean concentration in a well is significantly below the cleanup goal; 2) the power associated with this test; and 3) the expected sample size in order to achieve the desired power. Because power analysis is difficult to perform for the sequential t-test but easy for the Student’s t-test, the optional power analysis is provided in MAROS as an alternative for assessing data sufficiency associated with the cleanup status evaluation. Results of the Student’s t-test indicate whether well concentrations are statistically above or below the PRG, the power of the test indicating a level of confidence in the t-test result and an estimate of the number of additional samples that may be required to that demonstrate concentrations are below the PRG.

MAROS identifies locations that have attained cleanup goals, but it is up to the User to determine how this information affects the overall monitoring strategy. Monitoring locations that have ‘attained’ cleanup goals can help demonstrate remedial performance or delineate the extent of contamination. Wells monitoring ‘clean’ areas can be removed from the network or can be sampled at reduced frequencies.

3.0 Plume-Level Analyses

Moving from concentration data at individual wells to evaluating concentrations on a plume-wide basis requires spatial interpolation of discreet data. In MAROS, a spatial area for each well is assigned based on the location of all wells in the network. The primary tool for spatial analysis is a mesh-creation method known as Delaunay Triangulation/Voronoi Diagram spatial geometry (George and Borouchaki 1998) Delaunay triangles and Voronoi diagrams have been widely used for centuries for solving spatial distribution problems (Okabe et al. 1992, Watson 1994). Figure 2 provides an illustration of how Delaunay Triangles and Voronoi Diagrams are constructed for a network of points in a plane. Details of spatial analysis methods used in MAROS can be found in the MAROS Technical Guide (AFCEE 2012).

Spatial analysis methods in MAROS are used to estimate total contaminant mass in the plume and distribution of mass as well as statistical uncertainty between monitoring locations.

3.1 Moment Analysis

The role of moment analysis in MAROS is to provide a relative estimate of plume stability and condition within the context of results from other MAROS modules. The Moment analysis algorithms in MAROS are simple approximations of complex calculations and are meant to estimate total mass, center of mass and spread of mass for groundwater plumes. A Mann-Kendall trend analysis is then performed for each metric, so the User has an estimation of how the plume is changing over time.

The analysis of moments can be summarized as:

The **zeroth moment** is an estimate of total mass in the plume calculated by interpolating concentration data from monitoring wells using the Delaunay Triangle spatial analysis. A Mann-Kendall Trend is then calculated on the total mass estimated for each sample event. The Zeroth Moment trend test allows the User to understand how the total plume mass has changed over time. Results for the trend include: Increasing, Probably Increasing, No Trend, Stable, Probably Decreasing, or Decreasing. Results for insufficient data (N/A) and non-detect (ND) are also displayed. Stable or Decreasing trends in total dissolved mass may indicate that the remedy is functioning well or the monitoring frequency may be reduced.

The **first moment** estimates the coordinates (Xc and Yc) of the center of mass in the plume, for each sample event and COC. The Mann-Kendall trend is estimated for the distance of the center of mass from the source over all the sample events. The changing center of mass locations indicate the movement of the center of mass – or the relative distribution of contaminant mass between up and downgradient areas over time. The trend provides a relative estimate of where the majority of the plume mass is located relative to the source. If the trend is Increasing, the center of mass is moving farther from the source indicating either a reduction in mass in the source or expansion of the plume downgradient. Spatial and temporal trends for the center of mass can indicate spreading or shrinking or variable mass movement based on seasonal variation in rainfall or other hydraulic considerations. No appreciable movement or a Stable trend in the center of mass would support a conclusion of plume stability.

The **second moment** indicates the spread of the contaminant plume about the center of mass in either the direction of groundwater flow (X) or orthogonal to groundwater flow (Y). The Second Moment is a relative measure of the amount of mass in the center of the plume versus the edges. The trend on the Second Moment indicates the change in mass in the center of the plume relative to mass on the edges. An Increasing trend in the Second Moment indicates relatively more mass is present on the edge of the plume over time. Users may see Increasing Second Moment trends when the center of the plume is becoming more dilute or when an extraction remedy in the center of the plume is removing mass effectively.

3.2 Percentage Mass by Well

The Percentage Mass by Well feature uses the results of the Voronoi Area calculation to estimate the percentage of total plume mass that each well in the network ‘monitors’. The purpose of this tool is to rank each well in the network in terms of how much contaminant mass is in its vicinity. The estimate of total plume mass using this tool is somewhat different from that performed in the Moment Analysis module, representing a rough calculation for the purpose of comparing relative magnitude of contaminants in different parts of the plume. Results of the Percentage Mass by Well tool can be used to identify wells that monitor the most or least mass in the plume. The User may use this information to identify wells that best indicate remedy performance or identify wells that should not be removed from the monitoring network. The User may compare results for different sampling events to monitor relative movement of mass in the plume over time.

Percentage Mass by Well is calculated for each sample event using the concentration at each monitoring location for the specific event multiplied by the volume of aquifer surrounding it. The Voronoi Diagram for each well identifies all points closer to one location than another. The ‘monitoring volume’ of the well is found by multiplying the Voronoi area for each well by the plume thickness and porosity. The volume is then multiplied by the COC concentration at the well. Total mass in the plume is estimated by summing the mass in all of the Voronoi areas for the sampling event. The fraction of total mass for each well is then calculated.

The results table indicates the Voronoi Area for each well, the mass calculated for the area around each well and the percentage of mass and percentage of total area for each well. In the MAROS report, a graph of the distribution of mass is shown.

3.3 Plume Stability Analysis

The purpose of the MAROS Analysis module is to estimate area-level trends and mass estimates for distinct areas within the plume. The default areas of consideration include the ‘Source’ area and ‘Tail’ wells as defined by the User under Site Details. The User can define two other custom groups of wells that may correspond to secondary source areas or specific remedy locations. In this way, several trends and mass estimates can be found for groups of wells representing areas of interest in the plume.

The purpose of finding area-level trends and mass percentages is to localize mass within the plume and design a sampling program to focus monitoring effort on high mass or rapidly changing areas or to reduce effort in areas with low mass and stable trends. For example, if the source area has a decreasing trend and a small percentage of the total mass in the plume, then reduced monitoring in the source is appropriate. A 'depleted' source indicates that there is little export of mass downgradient and effort may be reduced across the network.

For each well in the source, tail or custom groups, the Mann-Kendall trend is found (based on the data consolidation in the Moment Analysis module). Each trend result is weighted (e.g. Increasing =1, Probably Increasing =2, No Trend = 3, Probably Decreasing = 5, Decreasing =6, Non Detect = 7) and the weighted trends for all of the wells are averaged with the resulting number mapped to the corresponding trend.

For the estimate of total mass in each area, the average percentage of mass for each well for the period of interest is calculated from the Percentage Total Mass tool. The average percentage of mass for each well in the group is summed, resulting in an estimate of the percentage of the total mass represented by the group. The calculated values are shown in the table at the end of the tool.

4.0 Spatial Optimization Analysis

The MAROS Spatial Optimization modules provide a quantitative analysis for spatial and temporal optimization of the well network on a well-by-well basis.

Sampling Optimization in MAROS can be used to determine the minimal number of sampling locations and the lowest frequency of sampling that can still meet the requirements of sampling spatially and temporally for an existing monitoring program. It also provides an analysis of the sufficiency of wells in the monitoring program to manage concentration uncertainty between points.

Sampling optimization in MAROS consists of three parts:

- Well redundancy and sufficiency analysis using the Delaunay method
- Well sufficiency and redundancy using a Decision Logic method
- Sampling frequency determination for individual wells and plume-wide monitoring

The well redundancy analysis using the Delaunay method identifies and recommends elimination of redundant locations from the monitoring network. The well sufficiency analysis can determine the areas where new sampling locations might be needed. The sampling frequency method determines the optimal sampling frequency for a sampling location based on the direction, magnitude, and uncertainty in its concentration trend.

4.1 Well Redundancy and Sufficiency Analysis – Delaunay Method

The well redundancy analysis using the Delaunay method is designed to select the minimum number of sampling locations based on the spatial analysis of the relative importance of each sampling location in the monitoring network. The approach allows elimination of sampling locations that have little impact on the historical characterization of a contaminant plume.

The sampling location optimization process is performed in a stepwise fashion. A slope factor (SF) is calculated for each well location to indicate the significance of this well in the system. The SF is a measure of the concentration uncertainty between monitoring locations. If a well has a small SF (little significance to the network), the well may be a candidate for removal from the monitoring network. Step two involves evaluating the information loss of removing a well from the network. If one well has a small SF, it may or may not be eliminated depending on whether the information loss is significant. If the information loss is not significant, the well can be eliminated from the monitoring network and the process of optimization continues with fewer wells. However if the well information loss is significant then the optimization terminates. This sampling optimization process allows the user to assess “redundant” wells that will not incur significant information loss on a constituent-by-constituent basis for individual sampling events.

The well sufficiency analysis, using the Delaunay method, is designed to recommend new sampling locations in areas *within* the existing monitoring network where there is a high level of uncertainty in contaminant concentration. If the Delaunay/SF algorithm calculates a high level of uncertainty in predicting the constituent concentration for a particular area, a new sampling location is recommended. The Slope Factor (SF) values obtained from the redundancy evaluation described above are used to calculate the concentration estimation error for each triangle area formed in the Delaunay triangulation. The estimated SF value for each area is then classified into four levels: Small, Moderate, Large, or Extremely Large (S, M, L, E) because the larger the estimated SF value, the higher the estimation error at this area. Therefore, the triangular areas with the estimated SF value at the Extremely large or Large level can be candidate regions for new sampling locations.

The results from the Delaunay method and the method for determining new sampling locations are derived solely from the spatial configuration of the monitoring network and the spatial pattern of the contaminant plume. No parameters such as the hydrogeologic conditions are considered in the analysis. Therefore, professional judgment and regulatory considerations must be used to make final decisions.

4.2 Well Redundancy and Sufficiency -- Decision Logic Method

The Decision Logic Method of spatial analysis relies on four basic features of a well network: 1) spatial extent of the area around the well (Voronoi Area), 2) concentration at the well, 3) concentration uncertainty between sample locations, and 4) Mann-Kendall trend of concentration. MAROS employs two methods to evaluate uncertainty between sample locations: the SF from above and Relative Error (RE).

The Baseline Spatial Analysis screen ranks the wells by the various metrics for each COC, including the location in the hull or interior of the plume, Area of Influence (Voronoi

Area), Average Concentration, coefficient of variation (COV) of the SF and RE (variability in uncertainty) and RE. The wells are ranked by smallest to largest Voronoi Area (lowest = 1), Relative Error (by COC, lowest = 1) and average concentration (lowest and ND = 1). An overall rank is determined for each well/COC combination, and, in the next screen, an aggregate ranking for all COCs.

High ranking is given to large Voronoi Areas, high concentrations and high COV and RE. High numbers indicate important wells or wells that should not be removed from the network. The User is given the opportunity to save the Baseline comparison table for the particular network. At this point, the User can return to the Moment Analysis and choose a different set of wells – eliminating some if desired, and return to the Spatial Optimization to compare the Baseline table after changes to the network.

The Decision Logic module then provides the User with recommendations for additional well locations. The well network is separated into interior wells and hull (or boundary) wells, as the decision logic for adding wells in these areas is different. For hull wells, the software determines if the well is downgradient from the center (using the X, Y coordinates of the center of the network, source location and groundwater flow direction from Site Details), the detection frequency, COV for SF, overall rank and Mann-Kendall trend. The software recommends new wells outside the network for locations downgradient from the center, with detected concentrations and high COV and/or increasing trends. The User can confirm that the location is of concern by checking the box on the well's row.

4.3 Sampling Frequency

The Modified Cost Effective Sampling (CES) method optimizes sampling frequency for each sampling location based on the magnitude, direction, and uncertainty of its concentration trend derived from its recent and historical monitoring records. The Modified Cost Effective Sampling (MCES) estimates a conservative lowest-frequency sampling schedule for a given groundwater monitoring location that still provides needed information for regulatory and remedial decision-making. The MCES method was developed on the basis of the Cost Effective Sampling (CES) method developed by Ridley et al (1995). Details about the MCES method can be found in the MAROS User Guide.

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TABLE 1 MAROS MANN-KENDALL ANALYSIS DECISION MATRIX

Mann-Kendall Statistic	Confidence in Trend	Concentration Trend
$S > 0$	> 95%	Increasing (I)
$S > 0$	90 - 95%	Probably Increasing (PI)
$S > 0$	< 90%	No Trend (NT)
$S \leq 0$	< 90% and COV ≥ 1	No Trend (NT)
$S \leq 0$	< 90% and COV < 1	Stable (S)
$S < 0$	90 - 95%	Probably Decreasing (PD)
$S < 0$	95%	Decreasing (D)
$S = 0$		Non- Detect (ND)

Note: COV = Coefficient of Variation (Standard deviation/mean); N/A as a trend result indicates that there is insufficient data (< 4 sample events) to estimate a trend.

TABLE 2 MAROS LINEAR REGRESSION ANALYSIS DECISION MATRIX

Confidence in Trend	Ln Slope	
	Positive	Negative
<90%	No Trend	*COV < 1* Stable *COV > 1* No Trend
90% – 95%	Probably Increasing	Probably Decreasing
> 95%	Increasing	Decreasing

COV = Coefficient of Variation

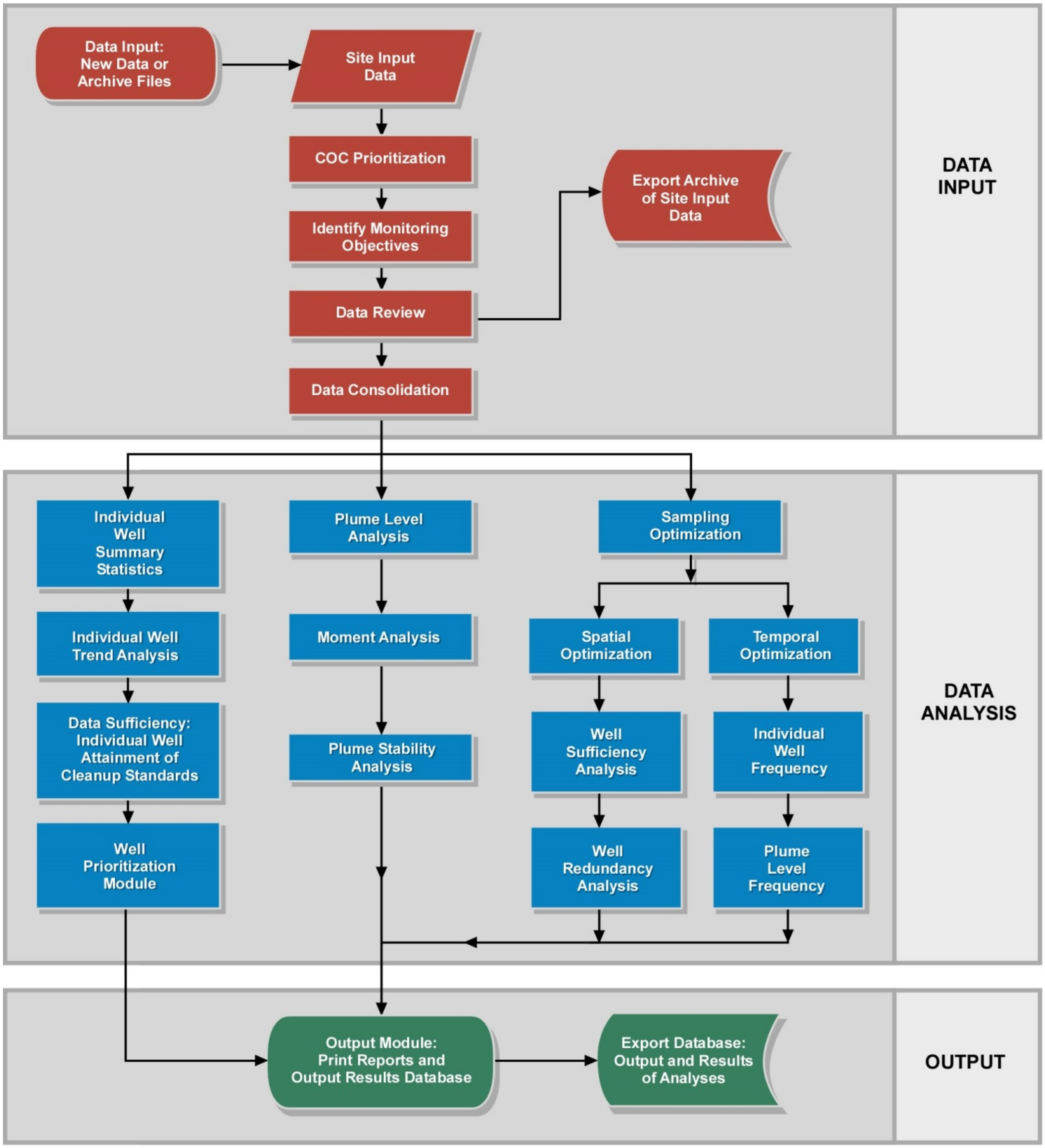


Figure 1: MAROS Decision Support Tool Flow Chart

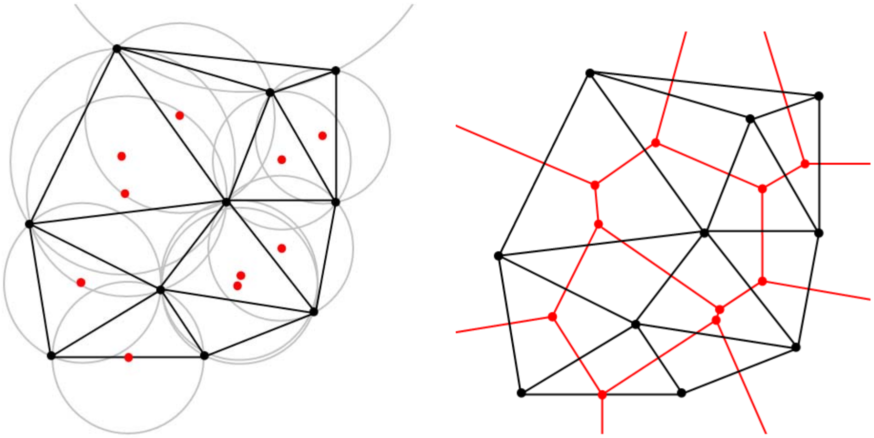


FIGURE 2: Illustration of Delaunay Triangulation (left, black lines) and Voronoi Diagrams (red lines) for a network of points.

Appendix B

MAROS COC Assessment

Project: Intel Magnetics **User Name:** MV

Location: Santa Clara **State:** California

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
TRICHLOROETHYLENE (TCE)	4.1E-02	5.0E-03	720.6%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage exceedance from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Exceedances	Percent Exceedances	Total detects
TRICHLOROETHYLENE (TCE)	ORG	15	10	66.7%	15

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total exceedances (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
TRICHLOROETHYLENE (TCE)	0.297

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

1,1-DICHLOROETHENE

TOTAL 1,2-DICHLOROETHENE

TRICHLOROETHYLENE (TCE)

MAROS Individual Well Summary Report

Project: Intel Magnetics **User Name:** MV

Location: Santa Clara **State:** California

COC	Priority COC for Well?	Detection Frequency	Recent Sample Above Goal?	MK Trend	COV	95% UCL	Outlier	Distribution Assumption	Attained Cleanup?	
									Normal	Lognormal
IM-1										
DCE11	NO	9 %	NO	S	0.00	0.0004	NO	No distribution	YES	YES
DCE12TOT	NO	45 %	NO	NT	0.77	0.0006	NO	No distribution	YES	NO
TCE	YES	100 %	YES	S	0.30	0.0108	NO	Normal	NO	NO
IM-10										
DCE11	NO	100 %	NO	S	0.45	0.0011	NO	Normal	YES	NO
DCE12TOT	NO	100 %	NO	PD	0.16	0.0075	NO	Normal	NO	NO
TCE	YES	100 %	YES	D	0.16	0.1169	NO	Normal	NO	NO
IM-11										
DCE11	NO	100 %	NO	S	0.33	0.0018	NO	Normal	YES	YES
DCE12TOT	NO	100 %	NO	S	0.32	0.0044	NO	Normal	YES	YES
TCE	YES	100 %	YES	PD	0.33	0.0885	NO	Normal	NO	NO
IM-2										
DCE11	NO	100 %	NO	S	0.38	0.0020	NO	Normal	YES	YES
DCE12TOT	NO	100 %	NO	S	0.24	0.0016	NO	Normal	YES	YES
TCE	YES	100 %	YES	NT	0.19	0.0163	NO	Normal	NO	NO
IM-7										
DCE11	NO	10 %	NO	NT	0.00	0.0003	YES	No distribution	YES	YES
DCE12TOT	NO	0 %	NO	ND	0.00	0.0003	NO	No distribution	YES	YES
TCE	YES	10 %	NO	S	0.00	0.0006	YES	No distribution	YES	NO
IM-E1										
DCE11	NO	27 %	NO	NT	2.01	0.0005	NO	No distribution	YES	YES
DCE12TOT	NO	36 %	NO	NT	1.83	0.0008	NO	No distribution	YES	NO
TCE	YES	100 %	YES	NT	0.63	0.0104	NO	Normal	NO	NO
IM-E3										
DCE11	NO	9 %	NO	S	0.00	0.0003	YES	No distribution	YES	YES
DCE12TOT	YES	9 %	NO	NT	0.00	0.0003	YES	No distribution	YES	YES
TCE	YES	55 %	NO	S	1.11	0.0017	NO	No distribution	YES	NO
MMW-7										

MAROS Individual Well Summary Report

Project: Intel Magnetics **User Name:** MV

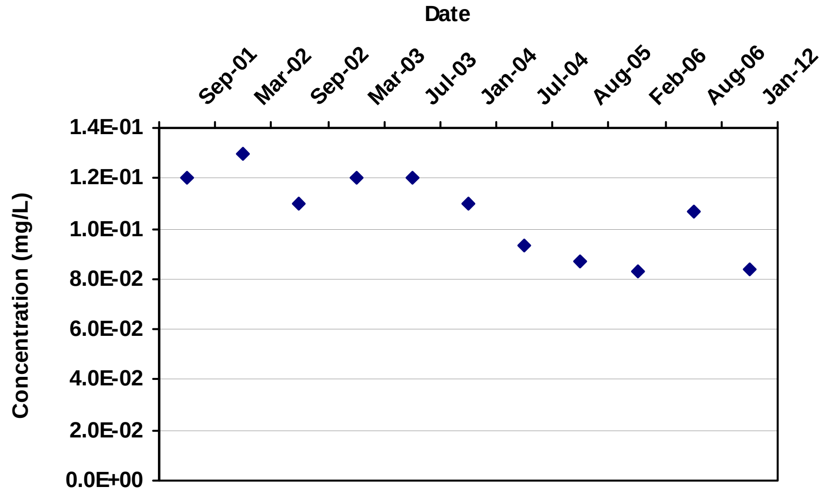
Location: Santa Clara **State:** California

COC	Priority COC for Well?	Detection Frequency	Recent Sample Above Goal?	MK Trend	COV	95% UCL	Outlier	Distribution Assumption	Attained Cleanup? Normal	Attained Cleanup? Lognormal
DCE11	NO	0 %	NO	ND	0.00	0.0003	YES	No distribution	YES	YES
DCE12TOT	NO	90 %	YES	I	0.52	0.0151	NO	Normal	NO	NO
TCE	YES	90 %	YES	NT	0.43	0.0722	YES	Normal	NO	NO
MW-1										
DCE11	NO	50 %	NO	D	1.14	0.0006	NO	No distribution	YES	NO
DCE12TOT	NO	100 %	NO	D	0.53	0.0464	NO	Normal	NO	NO
TCE	YES	100 %	YES	D	0.50	0.3059	NO	Normal	NO	NO
MW-4										
DCE11	NO	0 %	NO	ND	0.00	0.0003	YES	No distribution	YES	YES
DCE12TOT	NO	27 %	NO	S	1.96	0.0004	NO	No distribution	YES	YES
TCE	YES	91 %	YES	D	0.41	0.0137	NO	Normal	NO	NO
MW-6										
DCE11	NO	100 %	YES	I	0.73	0.0082	NO	Normal	NO	NO
DCE12TOT	NO	100 %	NO	D	0.20	0.0057	NO	Normal	NO	NO
TCE	YES	100 %	YES	D	0.34	0.0893	NO	Normal	NO	NO
MW-7										
DCE11	NO	0 %	NO	ND	0.00	0.0003	YES	No distribution	YES	YES
DCE12TOT	NO	9 %	NO	NT	0.00	0.0037	YES	No distribution	NO	NO
TCE	YES	9 %	NO	NT	0.00	0.0213	YES	No distribution	NO	NO
MW-8										
DCE11	NO	0 %	NO	ND	0.00	0.0003	YES	No distribution	YES	YES
DCE12TOT	YES	27 %	NO	NT	1.85	0.0016	NO	No distribution	YES	NO
TCE	YES	27 %	NO	I	2.43	0.0012	YES	No distribution	NO	NO

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics
User Name: MV
Location: Santa Clara
State: California

Well:	IM-10	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	T	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

-37

Confidence in Trend:

99.8%

Coefficient of Variation:

0.16

Mann Kendall Concentration Trend: (See Note)

D

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-10	T	9/26/2001	TRICHLOROETHYLEN	1.2E-01		1	1
IM-10	T	3/21/2002	TRICHLOROETHYLEN	1.3E-01		1	1
IM-10	T	9/20/2002	TRICHLOROETHYLEN	1.1E-01		1	1
IM-10	T	3/26/2003	TRICHLOROETHYLEN	1.2E-01		1	1
IM-10	T	7/24/2003	TRICHLOROETHYLEN	1.2E-01		1	1
IM-10	T	1/28/2004	TRICHLOROETHYLEN	1.1E-01		1	1
IM-10	T	7/26/2004	TRICHLOROETHYLEN	9.3E-02		1	1
IM-10	T	8/8/2005	TRICHLOROETHYLEN	8.7E-02		1	1
IM-10	T	2/24/2006	TRICHLOROETHYLEN	8.3E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics **User Name:** MV

Location: Santa Clara **State:** California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-10	T	8/14/2006	TRICHLOROETHYLEN	1.1E-01		1	1
IM-10	T	1/1/2012	TRICHLOROETHYLEN	8.4E-02		1	1

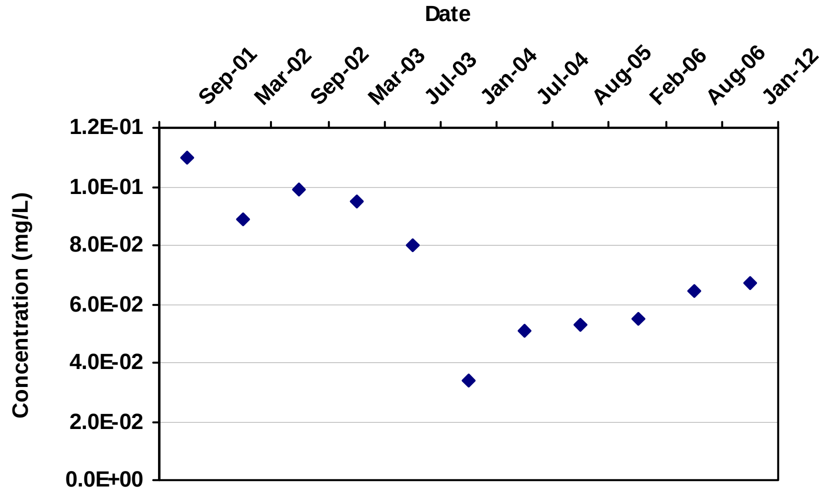
Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics | **User Name:** MV

Location: Santa Clara | **State:** California

Well:	IM-11	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	S	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

-21

Confidence in Trend:

94.0%

Coefficient of Variation:

0.33

Mann Kendall Concentration Trend: (See Note)

PD

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-11	S	9/26/2001	TRICHLOROETHYLEN	1.1E-01		1	1
IM-11	S	3/21/2002	TRICHLOROETHYLEN	8.9E-02		1	1
IM-11	S	9/20/2002	TRICHLOROETHYLEN	9.9E-02		1	1
IM-11	S	3/26/2003	TRICHLOROETHYLEN	9.5E-02		1	1
IM-11	S	7/24/2003	TRICHLOROETHYLEN	8.0E-02		1	1
IM-11	S	1/28/2004	TRICHLOROETHYLEN	3.4E-02		1	1
IM-11	S	7/26/2004	TRICHLOROETHYLEN	5.1E-02		1	1
IM-11	S	8/8/2005	TRICHLOROETHYLEN	5.3E-02		1	1
IM-11	S	2/24/2006	TRICHLOROETHYLEN	5.5E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics

User Name: MV

Location: Santa Clara

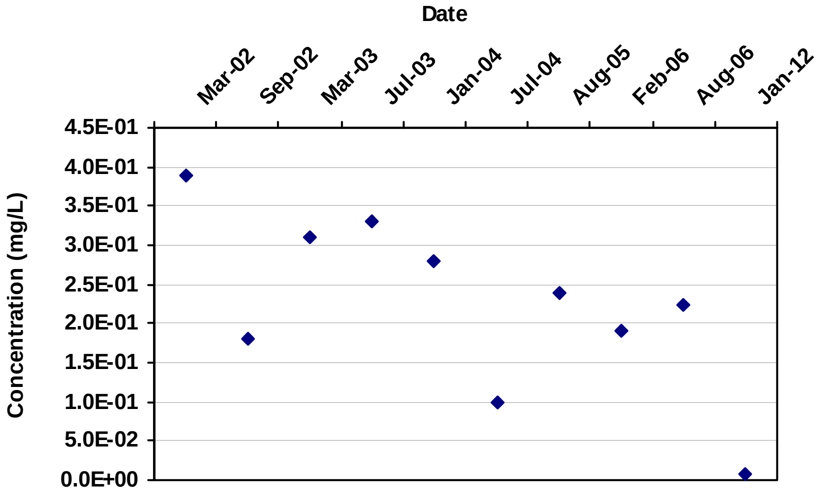
State: California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-11	S	8/14/2006	TRICHLOROETHYLEN	6.4E-02		1	1
IM-11	S	1/1/2012	TRICHLOROETHYLEN	6.7E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	MW-1	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	T	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

-23

Confidence in Trend:

97.7%

Coefficient of Variation:

0.50

Mann Kendall Concentration Trend: (See Note)

D

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-1	T	3/21/2002	TRICHLOROETHYLEN	3.9E-01		1	1
MW-1	T	9/20/2002	TRICHLOROETHYLEN	1.8E-01		1	1
MW-1	T	3/26/2003	TRICHLOROETHYLEN	3.1E-01		1	1
MW-1	T	7/24/2003	TRICHLOROETHYLEN	3.3E-01		1	1
MW-1	T	1/28/2004	TRICHLOROETHYLEN	2.8E-01		1	1
MW-1	T	7/26/2004	TRICHLOROETHYLEN	9.8E-02		1	1
MW-1	T	8/8/2005	TRICHLOROETHYLEN	2.4E-01		1	1
MW-1	T	2/24/2006	TRICHLOROETHYLEN	1.9E-01		1	1
MW-1	T	8/14/2006	TRICHLOROETHYLEN	2.2E-01		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics

User Name: MV

Location: Santa Clara

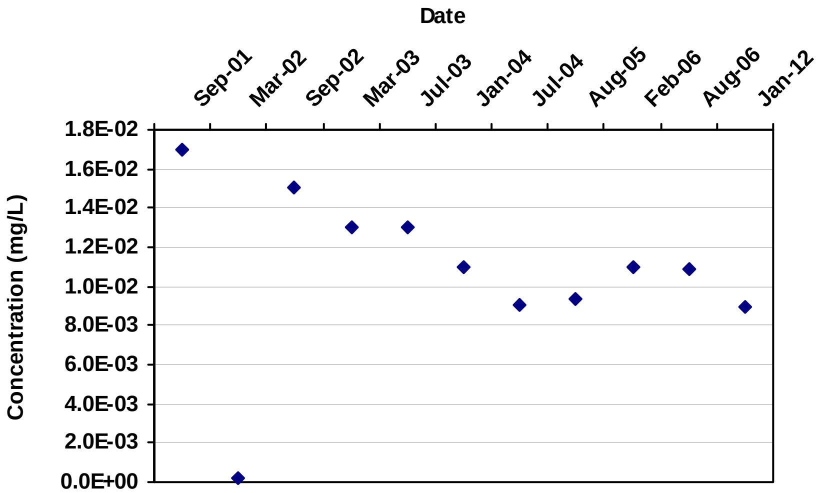
State: California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-1	T	1/1/2012	TRICHLOROETHYLEN	8.6E-03		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	MW-4	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	S	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

-25

Confidence in Trend:

97.0%

Coefficient of Variation:

0.40

Mann Kendall Concentration Trend: (See Note)

D

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-4	S	9/26/2001	TRICHLOROETHYLEN	1.7E-02		1	1
MW-4	S	3/21/2002	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-4	S	9/20/2002	TRICHLOROETHYLEN	1.5E-02		1	1
MW-4	S	3/26/2003	TRICHLOROETHYLEN	1.3E-02		1	1
MW-4	S	7/24/2003	TRICHLOROETHYLEN	1.3E-02		1	1
MW-4	S	1/28/2004	TRICHLOROETHYLEN	1.1E-02		1	1
MW-4	S	7/26/2004	TRICHLOROETHYLEN	9.1E-03		1	1
MW-4	S	8/8/2005	TRICHLOROETHYLEN	9.4E-03		1	1
MW-4	S	2/24/2006	TRICHLOROETHYLEN	1.1E-02		1	1

MAROS Mann-Kendall Statistics Summary

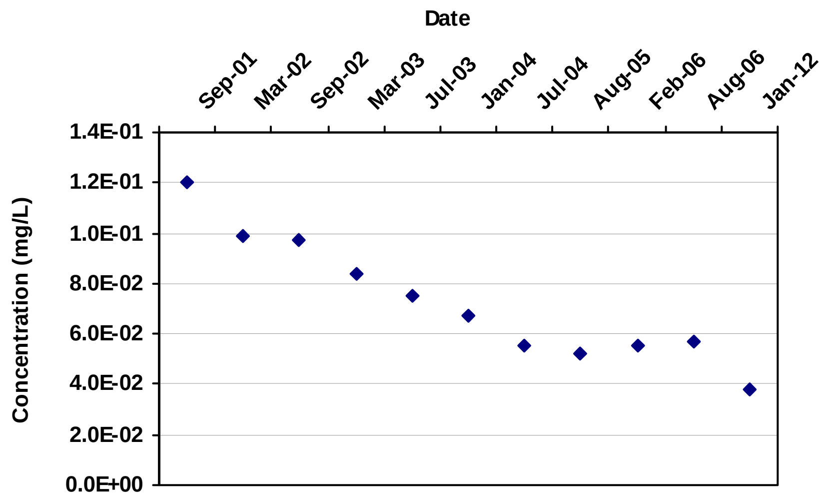
Project: Intel Magnetics
User Name: MV
Location: Santa Clara
State: California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-4	S	8/14/2006	TRICHLOROETHYLEN	1.1E-02		1	1
MW-4	S	1/1/2012	TRICHLOROETHYLEN	8.9E-03		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	MW-6	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	S	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

-46

Confidence in Trend:

100.0%

Coefficient of Variation:

0.34

Mann Kendall Concentration Trend: (See Note)

D

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-6	S	9/26/2001	TRICHLOROETHYLEN	1.2E-01		1	1
MW-6	S	3/21/2002	TRICHLOROETHYLEN	9.9E-02		1	1
MW-6	S	9/20/2002	TRICHLOROETHYLEN	9.7E-02		1	1
MW-6	S	3/26/2003	TRICHLOROETHYLEN	8.4E-02		1	1
MW-6	S	7/24/2003	TRICHLOROETHYLEN	7.5E-02		1	1
MW-6	S	1/28/2004	TRICHLOROETHYLEN	6.7E-02		1	1
MW-6	S	7/26/2004	TRICHLOROETHYLEN	5.5E-02		1	1
MW-6	S	8/8/2005	TRICHLOROETHYLEN	5.2E-02		1	1
MW-6	S	2/24/2006	TRICHLOROETHYLEN	5.5E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics

User Name: MV

Location: Santa Clara

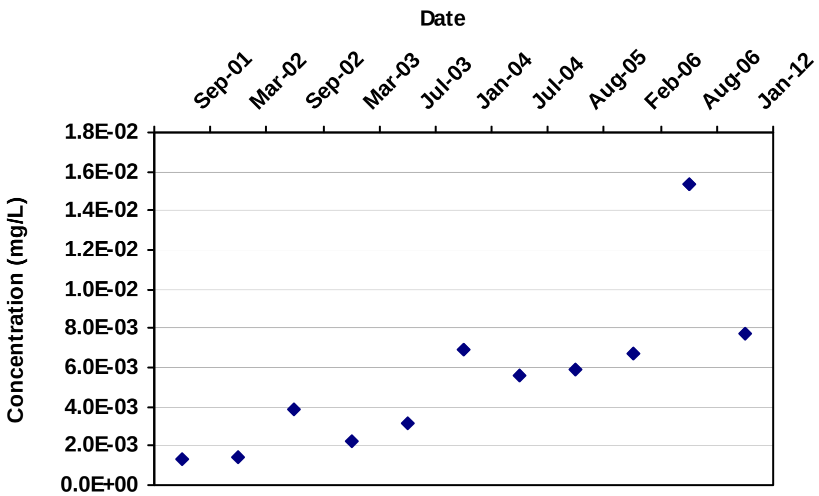
State: California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-6	S	8/14/2006	TRICHLOROETHYLEN	5.7E-02		1	1
MW-6	S	1/1/2012	TRICHLOROETHYLEN	3.8E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	MW-6	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	S	**Consolidation Period:**	No Time Consolidation
COC:	1,1-DICHLOROETHENE	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

43

Confidence in Trend:

100.0%

Coefficient of Variation:

0.73

Mann Kendall Concentration Trend: (See Note)

I

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-6	S	9/26/2001	1,1-DICHLOROETHE	1.3E-03		1	1
MW-6	S	3/21/2002	1,1-DICHLOROETHE	1.4E-03		1	1
MW-6	S	9/20/2002	1,1-DICHLOROETHE	3.9E-03		1	1
MW-6	S	3/26/2003	1,1-DICHLOROETHE	2.2E-03		1	1
MW-6	S	7/24/2003	1,1-DICHLOROETHE	3.2E-03		1	1
MW-6	S	1/28/2004	1,1-DICHLOROETHE	6.9E-03		1	1
MW-6	S	7/26/2004	1,1-DICHLOROETHE	5.6E-03		1	1
MW-6	S	8/8/2005	1,1-DICHLOROETHE	5.9E-03		1	1
MW-6	S	2/24/2006	1,1-DICHLOROETHE	6.7E-03		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics **User Name:** MV

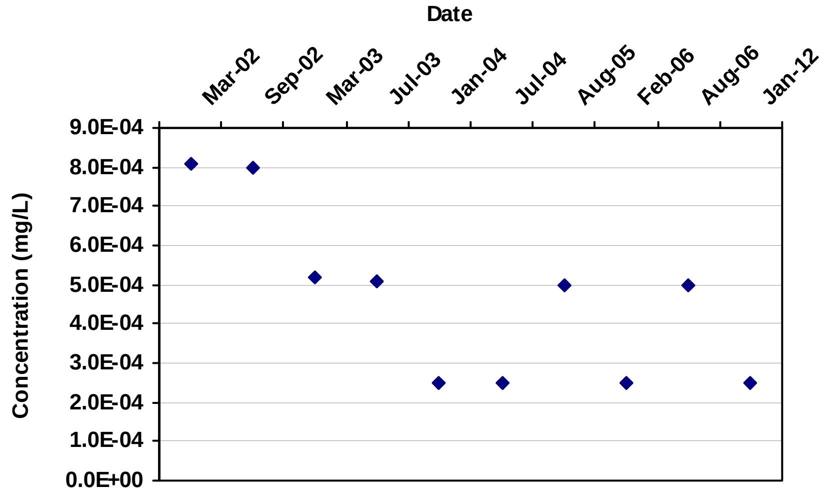
Location: Santa Clara **State:** California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-6	S	8/14/2006	1,1-DICHLOROETHE	1.5E-02		1	1
MW-6	S	1/1/2012	1,1-DICHLOROETHE	7.7E-03		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	MW-1	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	T	**Consolidation Period:**	No Time Consolidation
COC:	1,1-DICHLOROETHENE	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

-29

Confidence in Trend:

99.5%

Coefficient of Variation:

0.47

Mann Kendall Concentration Trend: (See Note)

D

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-1	T	3/21/2002	1,1-DICHLOROETHE	8.1E-04		1	1
MW-1	T	9/20/2002	1,1-DICHLOROETHE	8.0E-04		1	1
MW-1	T	3/26/2003	1,1-DICHLOROETHE	5.2E-04		1	1
MW-1	T	7/24/2003	1,1-DICHLOROETHE	5.1E-04		1	1
MW-1	T	1/28/2004	1,1-DICHLOROETHE	2.5E-04	ND	1	0
MW-1	T	7/26/2004	1,1-DICHLOROETHE	2.5E-04	ND	1	0
MW-1	T	8/8/2005	1,1-DICHLOROETHE	5.0E-04		1	1
MW-1	T	2/24/2006	1,1-DICHLOROETHE	2.5E-04	ND	1	0
MW-1	T	8/14/2006	1,1-DICHLOROETHE	5.0E-04	ND	1	0

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics **User Name:** MV

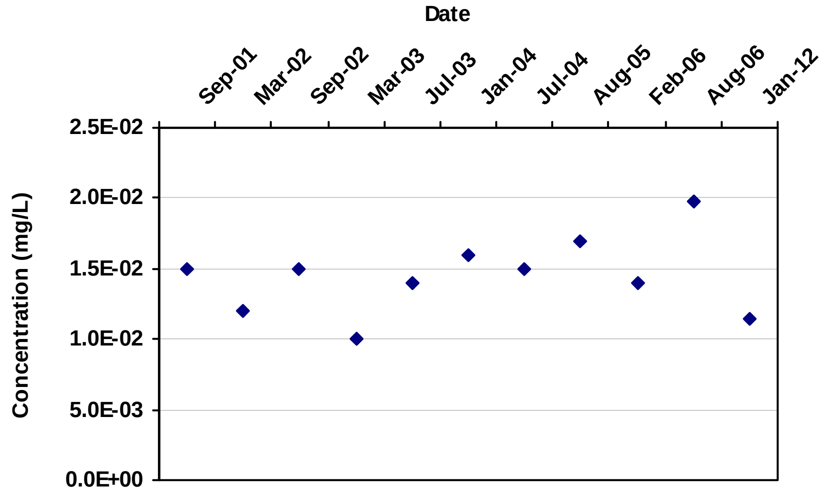
Location: Santa Clara **State:** California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-1	T	1/1/2012	1,1-DICHLOROETHE	2.5E-04	ND	1	0

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	IM-2	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	T	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

9

Confidence in Trend:

72.9%

Coefficient of Variation:

0.19

Mann Kendall Concentration Trend: (See Note)

NT

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-2	T	9/26/2001	TRICHLOROETHYLEN	1.5E-02		1	1
IM-2	T	3/21/2002	TRICHLOROETHYLEN	1.2E-02		1	1
IM-2	T	9/20/2002	TRICHLOROETHYLEN	1.5E-02		1	1
IM-2	T	3/26/2003	TRICHLOROETHYLEN	1.0E-02		1	1
IM-2	T	7/24/2003	TRICHLOROETHYLEN	1.4E-02		1	1
IM-2	T	1/28/2004	TRICHLOROETHYLEN	1.6E-02		1	1
IM-2	T	7/26/2004	TRICHLOROETHYLEN	1.5E-02		1	1
IM-2	T	8/8/2005	TRICHLOROETHYLEN	1.7E-02		1	1
IM-2	T	2/24/2006	TRICHLOROETHYLEN	1.4E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics **User Name:** MV

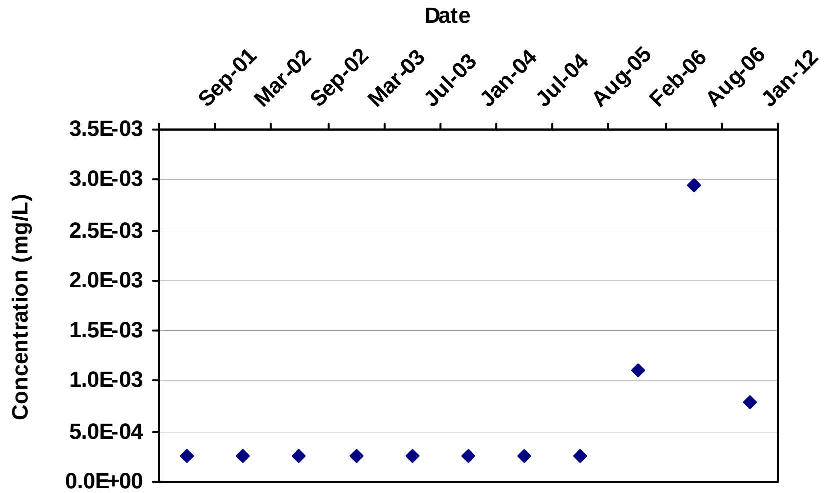
Location: Santa Clara **State:** California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-2	T	8/14/2006	TRICHLOROETHYLEN	2.0E-02		1	1
IM-2	T	1/1/2012	TRICHLOROETHYLEN	1.2E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	MW-8	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	T	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

23

Confidence in Trend:

95.7%

Coefficient of Variation:

1.32

Mann Kendall Concentration Trend: (See Note)

I

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-8	T	9/26/2001	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	3/21/2002	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	9/20/2002	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	3/26/2003	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	7/24/2003	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	1/28/2004	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	7/26/2004	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	8/8/2005	TRICHLOROETHYLEN	2.5E-04	ND	1	0
MW-8	T	2/24/2006	TRICHLOROETHYLEN	1.1E-03		1	1

MAROS Mann-Kendall Statistics Summary

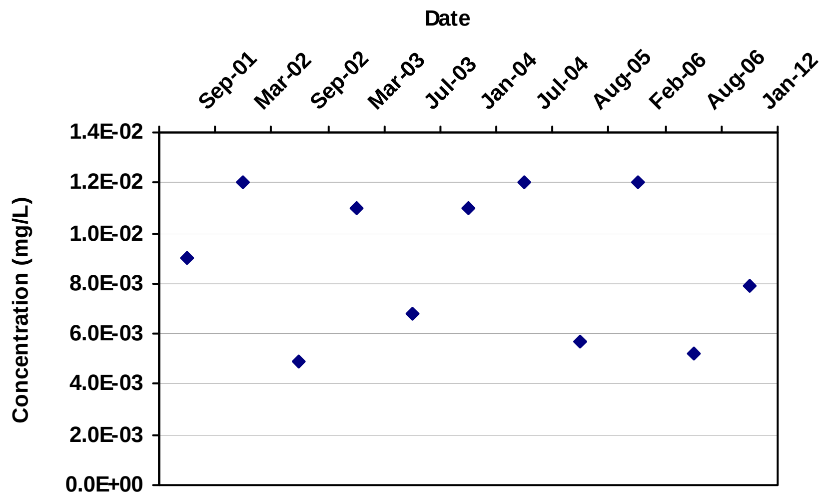
Project: Intel Magnetics
User Name: MV
Location: Santa Clara
State: California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
MW-8	T	8/14/2006	TRICHLOROETHYLEN	3.0E-03		1	1
MW-8	T	1/1/2012	TRICHLOROETHYLEN	8.0E-04		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	IM-1	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	S	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

-3

Confidence in Trend:

56.0%

Coefficient of Variation:

0.33

Mann Kendall Concentration Trend: (See Note)

S

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-1	S	9/26/2001	TRICHLOROETHYLEN	9.0E-03		1	1
IM-1	S	3/21/2002	TRICHLOROETHYLEN	1.2E-02		1	1
IM-1	S	9/20/2002	TRICHLOROETHYLEN	4.9E-03		1	1
IM-1	S	3/26/2003	TRICHLOROETHYLEN	1.1E-02		1	1
IM-1	S	7/24/2003	TRICHLOROETHYLEN	6.8E-03		1	1
IM-1	S	1/28/2004	TRICHLOROETHYLEN	1.1E-02		1	1
IM-1	S	7/26/2004	TRICHLOROETHYLEN	1.2E-02		1	1
IM-1	S	8/8/2005	TRICHLOROETHYLEN	5.7E-03		1	1
IM-1	S	2/24/2006	TRICHLOROETHYLEN	1.2E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics

User Name: MV

Location: Santa Clara

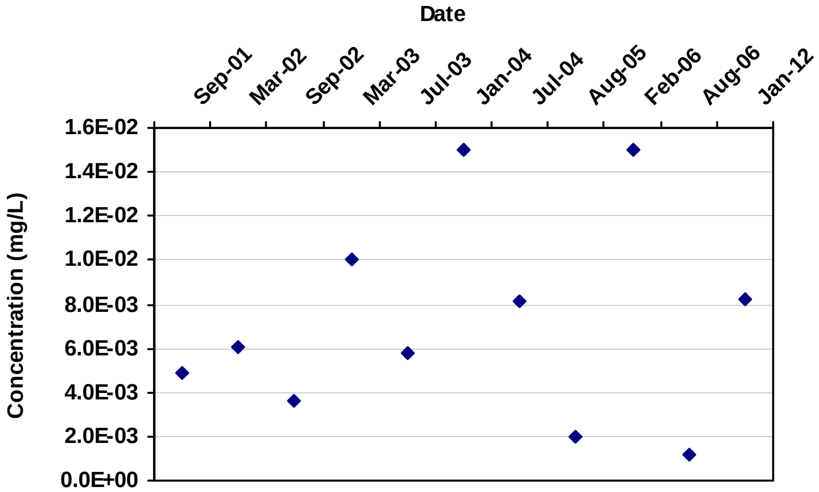
State: California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-1	S	8/14/2006	TRICHLOROETHYLEN	5.2E-03		1	1
IM-1	S	1/1/2012	TRICHLOROETHYLEN	7.9E-03		1	1

MAROS Mann-Kendall Statistics Summary

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Well:	IM-E1	**Time Period:**	9/26/2001 **to** 1/1/2012
Well Type:	S	**Consolidation Period:**	No Time Consolidation
COC:	TRICHLOROETHYLENE (TCE)	**Duplicate Consolidation:**	Median
		Consolidation Type:	Average
		ND Values:	1/2 Detection Limit
		J Flag Values :	Actual Value



Mann Kendall S Statistic:

4

Confidence in Trend:

59.0%

Coefficient of Variation:

0.64

Mann Kendall Concentration Trend: (See Note)

NT

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-E1	S	9/26/2001	TRICHLOROETHYLEN	4.9E-03		1	1
IM-E1	S	3/21/2002	TRICHLOROETHYLEN	6.1E-03		1	1
IM-E1	S	9/20/2002	TRICHLOROETHYLEN	3.6E-03		1	1
IM-E1	S	3/26/2003	TRICHLOROETHYLEN	1.0E-02		1	1
IM-E1	S	7/24/2003	TRICHLOROETHYLEN	5.8E-03		1	1
IM-E1	S	1/28/2004	TRICHLOROETHYLEN	1.5E-02		1	1
IM-E1	S	7/26/2004	TRICHLOROETHYLEN	8.1E-03		1	1
IM-E1	S	8/8/2005	TRICHLOROETHYLEN	2.0E-03		1	1
IM-E1	S	2/24/2006	TRICHLOROETHYLEN	1.5E-02		1	1

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics

User Name: MV

Location: Santa Clara

State: California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-E1	S	8/14/2006	TRICHLOROETHYLEN	1.2E-03		1	1
IM-E1	S	1/1/2012	TRICHLOROETHYLEN	8.2E-03		1	1

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics

Location: Santa Clara

User Name: MV

State: California

Well: IM-E3

Well Type: T

COC: TRICHLOROETHYLENE (TCE)

Time Period: 9/26/2001 **to** 1/1/2012

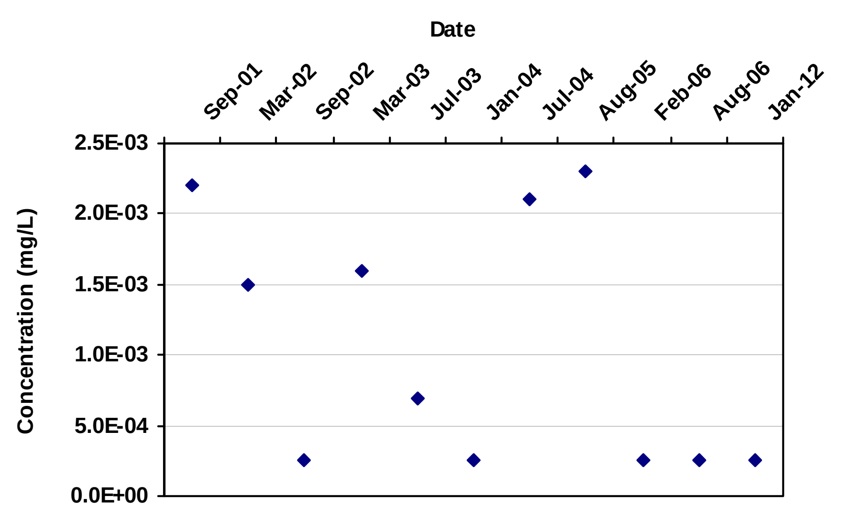
Consolidation Period: No Time Consolidation

Duplicate Consolidation: Median

Consolidation Type: Average

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value



Mann Kendall S Statistic:

-15

Confidence in Trend:

85.9%

Coefficient of Variation:

0.84

Mann Kendall Concentration Trend: (See Note)

S

Data Table:

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-E3	T	9/26/2001	TRICHLOROETHYLEN	2.2E-03		1	1
IM-E3	T	3/21/2002	TRICHLOROETHYLEN	1.5E-03		1	1
IM-E3	T	9/20/2002	TRICHLOROETHYLEN	2.5E-04	ND	1	0
IM-E3	T	3/26/2003	TRICHLOROETHYLEN	1.6E-03		1	1
IM-E3	T	7/24/2003	TRICHLOROETHYLEN	6.9E-04		1	1
IM-E3	T	1/28/2004	TRICHLOROETHYLEN	2.5E-04	ND	1	0
IM-E3	T	7/26/2004	TRICHLOROETHYLEN	2.1E-03		1	1
IM-E3	T	8/8/2005	TRICHLOROETHYLEN	2.3E-03		1	1
IM-E3	T	2/24/2006	TRICHLOROETHYLEN	2.5E-04	ND	1	0

MAROS Mann-Kendall Statistics Summary

Project: Intel Magnetics **User Name:** MV

Location: Santa Clara **State:** California

Well	Well Type	Effective Date	Constituent	Result (mg/L)	Flag	Number of Samples	Number of Detects
IM-E3	T	8/14/2006	TRICHLOROETHYLEN	2.5E-04	ND	1	0
IM-E3	T	1/1/2012	TRICHLOROETHYLEN	2.5E-04	ND	1	0

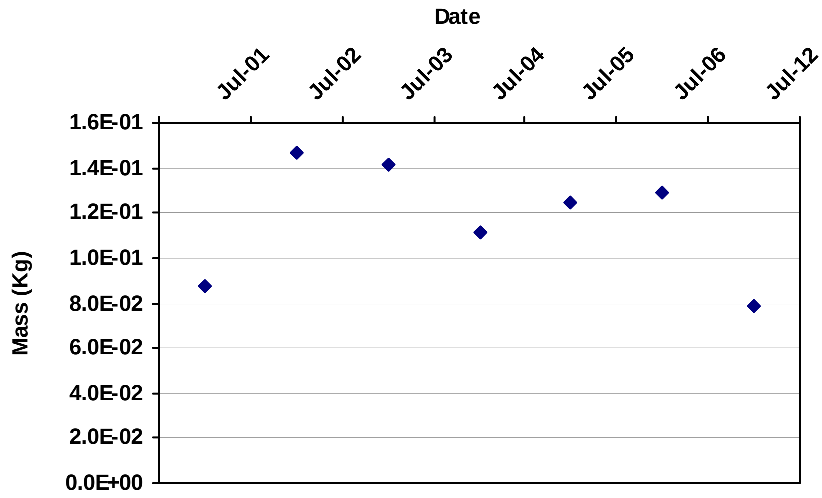
Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect

MAROS Zeroth Moment Analysis

Project:	Intel Magnetics	**User Name:**	MV
Location:	Santa Clara	**State:**	California

Change in Dissolved Mass Over Time

COC: TRICHLOROETHYLENE (TCE)



Porosity: 0.25

Saturated Thickness:

Uniform: 5 ft

Mann-Kendall S Statistic:

-5

Confidence in Trend:

71.9%

Coefficient of Variation:

0.22

Zeroth Moment Trend:

S

Data Table:

Effective Date	Constituent	Estimated Mass (Kg)	Number of Wells
7/1/2001	TRICHLOROETHYLENE (TCE)	8.8E-02	12
7/1/2002	TRICHLOROETHYLENE (TCE)	1.5E-01	13
7/1/2003	TRICHLOROETHYLENE (TCE)	1.4E-01	13
7/1/2004	TRICHLOROETHYLENE (TCE)	1.1E-01	13
7/1/2005	TRICHLOROETHYLENE (TCE)	1.2E-01	13
7/1/2006	TRICHLOROETHYLENE (TCE)	1.3E-01	13
7/1/2012	TRICHLOROETHYLENE (TCE)	7.9E-02	13

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); ND = Non-detect. Moments are not calculated for sample events with less than 6 wells.

MAROS First Moment Analysis

Project: Intel Magnetics

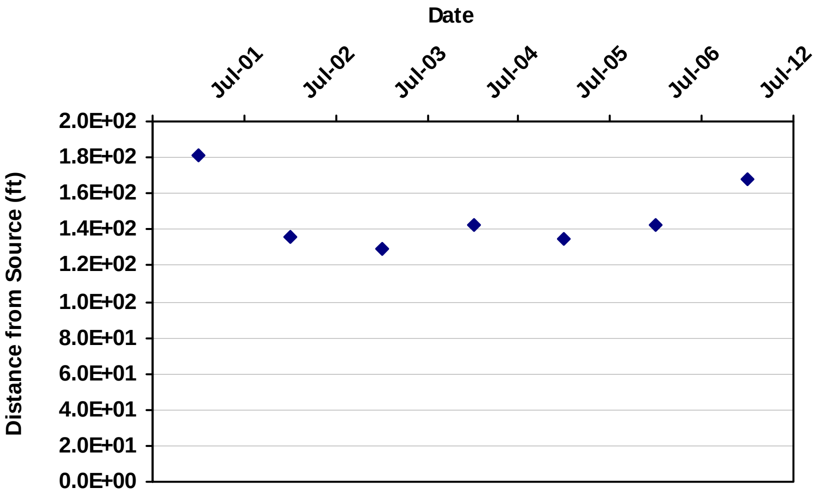
User Name: MV

Location: Santa Clara

State: California

COC: TRICHLOROETHYLENE (TCE)

Distance from Source to Center of Mass



Mann-Kendall S Statistic:

1

Confidence in Trend:

50.0%

Coefficient of Variation:

0.13

First Moment Trend:

NT

DATA TABLE

Effective Date	Constituent	Xc (ft)	Yc (ft)	Distance from Source	Number of Wells
7/1/2001	TRICHLOROETHYLENE (TCE)	147	524	181	12
7/1/2002	TRICHLOROETHYLENE (TCE)	71	484	136	13
7/1/2003	TRICHLOROETHYLENE (TCE)	100	480	130	13
7/1/2004	TRICHLOROETHYLENE (TCE)	104	492	142	13
7/1/2005	TRICHLOROETHYLENE (TCE)	98	485	135	13
7/1/2006	TRICHLOROETHYLENE (TCE)	89	492	142	13
7/1/2012	TRICHLOROETHYLENE (TCE)	113	517	168	13

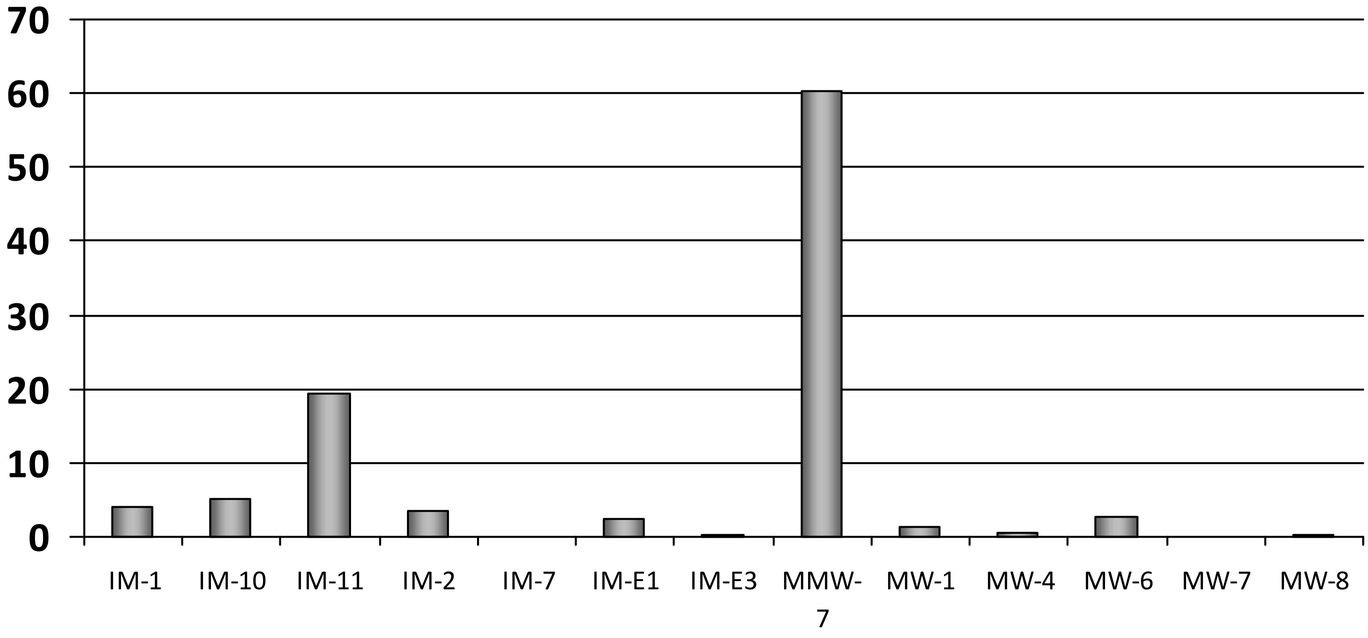
Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events). Moments are not calculated for sample events with less than 6 wells.

MAROS Percent of Mass by Well

Project: Intel Magnetics **User Name:** MV

Location: Santa Clara **State:** California

TRICHLOROETHYLENE (TCE) 7/1/2012



Well	Area (ft2)	Mass (mg)	Percent of Mass	Percent of Area
IM-1	26,956.83	9.32	4.09	11.72
IM-10	3,241.81	11.91	5.23	1.41
IM-11	15,002.63	43.98	19.31	6.52
IM-2	16,121.88	8.11	3.56	7.01
IM-7	17,874.04	0.20	0.09	7.77
IM-E1	15,384.65	5.52	2.42	6.69
IM-E3	60,485.59	0.66	0.29	26.31
MMW-7	34,926.60	137.22	60.26	15.19
MW-1	7,920.22	2.98	1.31	3.44
MW-4	2,823.42	1.10	0.48	1.23
MW-6	3,631.57	5.99	2.63	1.58
MW-7	7,476.69	0.08	0.04	3.25
MW-8	18,084.07	0.63	0.28	7.87
	229,930.0	227.7	100	100

Appendix C

How to Read a Trilateral Diagram

Ternary diagrams are designed to graphically represent proportions of three related components in a system.

Axes are scaled so they increase in a clockwise direction around the diagram. Points within the diagram represent the relative proportions of three classes and always sum to 1.

Data from well sampling in ug/L is converted to molar concentrations (moles/L).

Concentrations for each component are converted to fractions (%) of the total (i.e.[moles 1,1,1TCA]/[moles Total Chlorinated Solvent]) and plotted on the diagram.

For example, in the adjacent diagram, the fractions of 1,1,1-TCA, 1,1-DCA, and
1,1-DCE are illustrated for data from three different locations.