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QUALITY ASSURANCE PROJECT PLAN GROUNDWATER MONITORING PROGRAM

Marathon Electric Manufacturing Company
Wausau, Wisconsin

PRINTED ON

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QUALITY ASSURANCE PROJECT PLAN GROUNDWATER MONITORING PROGRAM

Marathon Electric Manufacturing Company
Wausau, Wisconsin

AUGUST 1990
REF. NO. 2115 (9)

CONESTOGA-ROVERS & ASSOCIATES

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LIST OF ACRONYMS AND SHORT FORMS

CRA	-	Conestoga-Rovers & Associates
Marathon	-	Marathon Electric Manufacturing Company
GMP	-	Groundwater Monitoring Program
RAP	-	Remedial Action Plan
ROD	-	Record of Decision, Selected Interim Remedial Alternative
U.S. EPA	-	United States Environmental Protection Agency
WDNR	-	Wisconsin Department of Natural Resources
VOCs	-	Volatile Organic Compounds
BN/As	-	Base-Neutral/Acid Extractable Organic Compounds
Pest/PCBs	-	Pesticides/Polychlorinated Biphenyls
CN	-	Cyanide
GAC	-	Granular Activated Carbon
TCE	-	Trichloroethene
PCE	-	Tetrachloroethene
DCE	-	Dichloroethane
TCL	-	Target Compound List
TAL	-	Target Analyte List
Radian	-	Radian Corporation
QAPP	-	Quality Assurance Project Plan
RPD	-	Relative Percent Difference
SOP	-	Standard Operating Procedures
BFB	-	4-Bromofluorobenzene
QA/QC	-	Quality Assurance/Quality Control
NPL	-	National Priorities List
RI	-	Remedial Investigation
FS	-	Feasibility Study
PFS	-	Phased Feasibility Study
BMDL	-	Below Method Detection Limit
U.S. EPA-QA	-	U.S. EPA-Quality Assurance
U.S. EPA CRL	-	U.S. EPA Region V Central Regional Laboratory

LIST OF ACRONYMS AND SHORT FORMS

CDO	-	Central District Officer
DFTPP	-	Decafluorotriphenylphoshine
SPCC	-	System Performance Check Compounds
CCC	-	Calibration Check Compounds
ICAP	-	Inductively Coupled Argon Plasma
CLP	-	Contract Laboratory Program
SOW	-	Statement of Work
RAS	-	Routine Analytical Services

1.0 INTRODUCTION

In accordance with a Record of Decision - Selected Interim Remedial Alternative signed December 23, 1988, Marathon Electric Manufacturing Company (Marathon) is proceeding with an extraction well and associated treatment/discharge outlet installation. The purpose of the extraction well is to create a cone of depression capable of containing a contaminant plume source to prevent further migration toward City production wells.

The extraction well and associated treatment/discharge structures will be installed at the Marathon facility in Wausau, Wisconsin. The Site is located along the west side of the Wisconsin River within the City of Wausau. A regional and site location map are shown in Figures 1.1 and 1.2, respectively. The location of the extraction well and existing monitoring wells are shown on Figure 1.3.

A "Remedial Action Plan" (RAP) report, submitted under separate cover, has been prepared to summarize all activities associated with the design, installation/construction, operation/maintenance, scheduling, organization and reporting for the groundwater extraction, treatment and discharge system.

A "Groundwater Monitoring Program" (GPM) report, submitted under separate cover, has been prepared to address monitoring

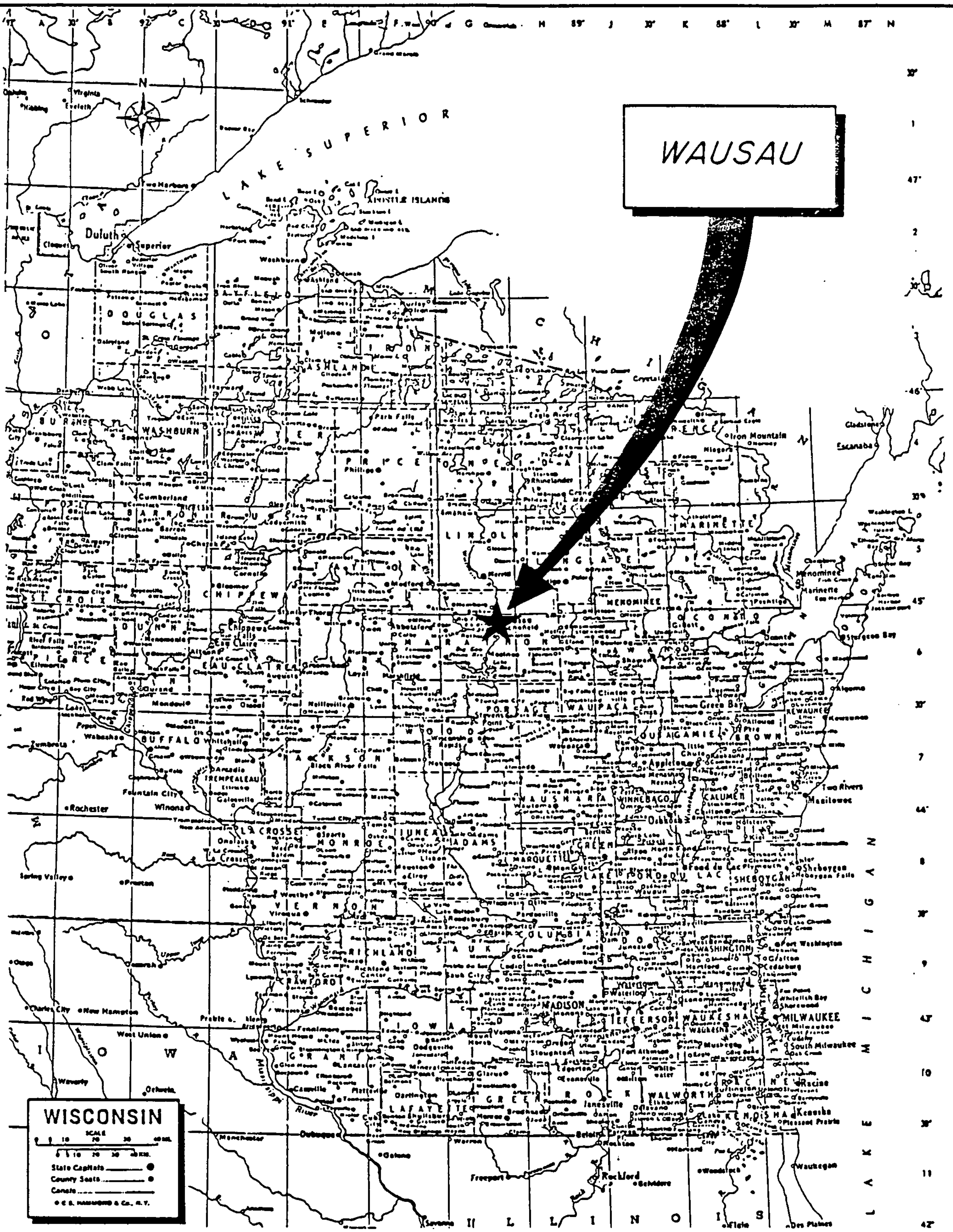

figure 1.1

REGIONAL LOCATION MAP

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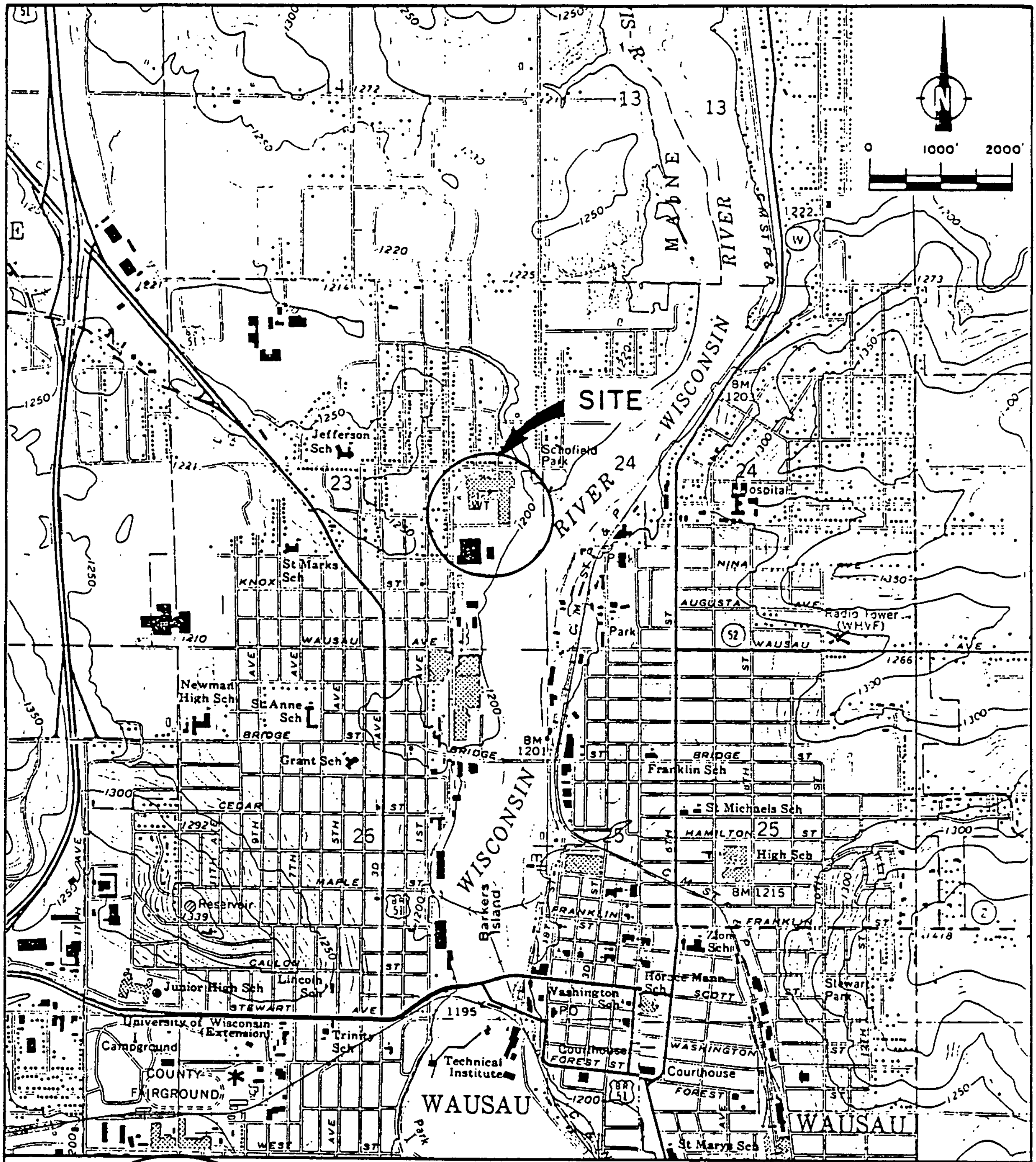


SOURCE: U.S.G.S. WAUSAU WEST QUADRANGLE MAP.

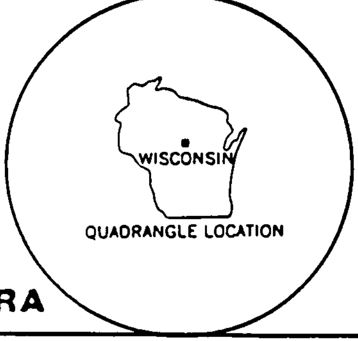


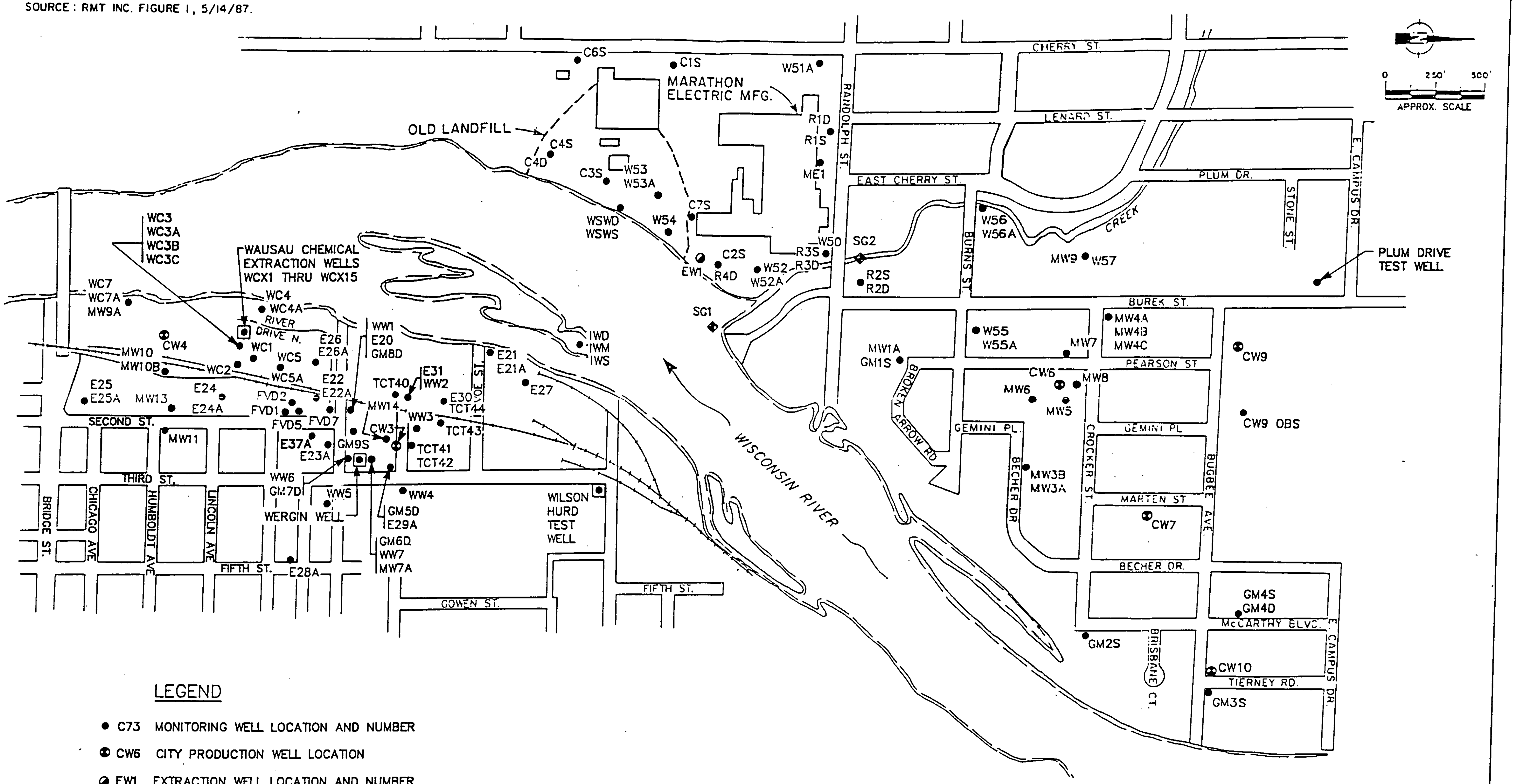
figure 1.2

SITE LOCATION

Marathon Electric Manufacturing Co.

CRA

SOURCE : RMT INC. FIGURE 1, 5/14/87.



LEGEND

- ● C73 MONITORING WELL LOCATION AND NUMBER
- ⊗ CW6 CITY PRODUCTION WELL LOCATION
- ◐ EW1 EXTRACTION WELL LOCATION AND NUMBER
- ◈ SG1 STAFF GAGE LOCATION AND NUMBER
- ⊡ INDUSTRIAL WELL LOCATION

figure 1.3

EXTRACTION WELL AND MONITORING WELL LOCATIONS

Marathon Electric Manufacturing Co.

CRA

2115-27/02/89-9-D-0

requirements necessary to assess the operation of and impacts from the groundwater extraction, treatment and discharge system.

This Quality Assurance Project Plan (QAPP) has been prepared for the GMP activities.

1.1 STATEMENT OF PURPOSE

The objectives of the GMP are as follows:

- To monitor the effectiveness of the extraction system in reducing VOC groundwater contamination;
- To monitor the effectiveness of the extraction system in creating hydraulic conditions (cone of depression) to control a west side plume contaminant source from further migrating to City production wells; and
- To monitor treated groundwater prior to surface water discharge.

In order to provide representative data to satisfy the above objectives, the GMP, submitted under separate cover, presents monitoring requirements including networks, parameters, frequencies and protocols to be adhered to. The QAPP, presented herein, presents field and laboratory Quality Assurance/Quality Control (QA/QC) protocols to be adhered to.

2.0 PROJECT DESCRIPTION

2.1 CITY OF WAUSAU WELL FIELD

The City of Wausau is located along the Wisconsin River in Marathon County, Wisconsin. The Wausau Groundwater Contamination Site encompasses an area in the northern section of the city which includes the City Well Field and six of its production wells (see Figure 1.3).

The City of Wausau provides drinking water for approximately 33,000 people. The City presently operates seven groundwater production wells, six of which are located on the north side of the City. The seventh well, Production Well CW8 (CW8), is located adjacent to the Wausau Municipal Airport, on the south side of the City. The water from CW8 has a high concentration of iron and is used only during peak demand periods. Production Wells CW6, CW7, CW9 and CW10 are located west of the Wisconsin River and are collectively referred to as the West Well Field. The West Well Field (Figure 1.2) is located in a predominantly residential area, although a few industrial facilities are located in this area. Production wells CW3 and CW4 are located on the east side of the Wisconsin River and are referred to as the East Well Field. Well CW4 is used only during peak demand periods. The East Well Field is located in a predominantly industrial section of the City.

The seven production wells are screened in an aquifer of glacial outwash and alluvial sand and gravel deposits which underlie and are adjacent to the Wisconsin River. This unconfined aquifer supplies nearly all potable, irrigation, and industrial water to residents and industries located in Wausau and the surrounding areas. Within the study area the alluvial aquifer ranges from 0 to 160 feet thick, and has an irregular base and lateral boundaries.

2.2 HISTORICAL WELL FIELD CONTAMINATION

The City of Wausau discovered in early 1982 that its production wells CW3, CW4, and CW6 were contaminated by volatile organic compounds (VOCs), predominantly with the volatile halogenated hydrocarbons (VHHs) tetrachloroethene (PCE), trichloroethene (TCE) and dichloroethene (DCE). Trichloroethene (TCE) is the predominant volatile organic compound detected at CW6, although below method detection limit (BMDL) concentrations for tetrachloroethene (PCE) and 1,2-Dichloroethene (DCE) have also been previously reported (Weston, 1984). Since the contamination was first detected in early 1982, TCE concentrations from CW6 have ranged from 70 micrograms per liter (µg/*l*) to 260 µg/*l*. Sampling conducted in March 1988 indicated TCE concentrations of approximately 160 µg/*l*. Sample results from the East Well Field (CW3 and CW4) have indicated PCE, TCE, and DCE impact at both wells. CW4 has generally indicated steadily decreasing concentrations of the three constituents since

February 1984. CW3 has indicated decreasing PCE and DCE concentration since the VOCs were discovered in early 1982. However, TCE concentrations at CW3 have remained relatively constant at concentrations ranging between 80 μg/*l* and 210 μg/*l*.

To reduce VHH concentrations, the City originally instituted a program where uncontaminated water from CW9 and CW7 was blended with water from CW3, CW4, and CW6 to dilute the VHH concentrations.

In 1983, the United States Environmental Protection Agency (U.S. EPA) awarded the City of Wausau a federal grant to help fund the design and installation of a packed tower air stripper in order to provide sufficient water of acceptable quality to City residents. As an interim measure in June 1984, the U.S. EPA installed a granular activated carbon (GAC) treatment system on CW6. Air stripping towers were installed in the Summer and Fall of 1984 at the City water treatment plant to treat water from CW3 and CW4. A federal grant helped fund one air stripper and the City of Wausau paid for the other air stripper. Subsequently, the GAC system was removed from service in October 1984. In December 1985 the Wausau Groundwater Contamination Site was added to the National Priorities List (NPL) for remedial activities under Superfund.

The City blends water treated for VHH removal with water from uncontaminated supply sources (CW7, CW9 and CW10) to reduce

VHH concentrations in the water supply distribution system. In July 1988, an additional crossing was completed, which enabled the City to pipe contaminated water from CW6 to the treatment plant.

Data indicate that prior to treatment (pre-July 1984), the water supply consistently contained trichloroethene (TCE) with concentrations ranging from detectable levels to 80 µg/L. Lower levels of tetrachloroethene (PCE) and 1,2-dichloroethene (DCE) were identified shortly after discovery of the contamination, probably before blending had reduced the levels of VHHs. Following installation of the treatment systems, the water supply distribution system has had relatively low levels of VHHs (generally below detection limits <1.0 µg/L). These levels are dependent on continued effective operation of the packed column air stripper treatment system, the influent VHH concentrations for each well, and continued use of the three clean wells (CW7, CW9 and CW10).

2.3 PREVIOUS STUDIES

Previous investigations have identified several potential point sources of VOC contamination in the vicinity of City production wells. Table 2.1 lists the previous studies conducted.

TABLE 2.1

HISTORIC REPORTS ON WAUSAU, WISCONSIN WATER SUPPLY SITE

1. Hydrogeological Investigation of Volatile Organic Contamination In Wausau, Wisconsin Municipal Wells, (for U.S.EPA), Roy F. Weston, Inc., September 1985.

2. Subsurface Exploration and Testing Program to Evaluate Ground Water Quality at the Wausau Chemical Facilities in Wausau, Wisconsin, (for Wausau Chemical Company), STS Consultants, Ltd., July 1984.

3. Investigation of An Abandoned City of Wausau Landfill, (for WDNR), CH_2M Hill, February 1986.

4. Existing Conditions Report and Exploration Program, Wausau East Municipal Well Field, Wausau, Wisconsin, (for WDNR), Twin City Testing Corporation, August 1986.

5. Groundwater Investigation, (for City of Wausau), Beecher Hoppe Engineers, Inc., 1983.

6. VOC Groundwater Investigation At The Former Wausau Energy Facility In Wausau, Wisconsin, (for Wausau Energy Corporation), Foth & Van Dyke and Associates, Inc., December 1986.

7. Hydrogeological Investigation of the Alluvial Aquifer Beneath City Well 6, Wausau, Wisconsin, (for City of Wausau and Marathon Electric), RMT, Inc. and Geraghty & Miller, Inc., July 1987.

2.4 WELL FIELD CURRENT STATUS

2.4.1 Current Status

A RI/FS was conducted for U.S. EPA by its contractor, Warzyn Engineering, Inc. The RI entailed two phases of field sampling events. Phase I of the RI field work was conducted from August 1987 through January 1988, results of which are summarized in an April 1988 technical memorandum. Phase II of the RI field work was conducted from June to September 1988. Results of this phase of work are included in the RI report for the site dated July, 1989. A draft final FS, dated August 1989, which addresses remediation of the entire site has been released for public review and comment.

The Wausau Water Supply Site consists of the City of Wausau well fields located each and west of the Wisconsin River (see Section 2.1). In July 1988, the City placed CW6, located in the west well field, back in service, which changed local hydrologic and hydrogeologic conditions. Due to the changing conditions, USEPA identified the need to begin a remedial response on the west side of the river. Therefore, a Phased Feasibility Study (PFS) was prepared for the west side plume portion of the Wausau Water Supply Site. The PFS was completed in September 1988.

2.4.2 West Side Plume

A contaminant plume, composed mainly of TCE, exists in the West Well Field and is being drawn toward CW6 due to pumpage. The apparent source area is located to the south in an area of an old City landfill located on Marathon property.

Until recently, CW6, which the City pumped directly into Bos Creek as waste, served as a blocking well to the rest of the West Well Field. The discharge of CW6 to Bos Creek resulted in a groundwater mound between the source area and CW6. The influence of the groundwater mound may not have fully penetrated the glacial outwash aquifer, but RI data suggest that the mound served effectively to divide the West Well Field contaminant plume into northern and southern portions. However, in summer 1988 the City of Wausau placed CW6 back in service after completion of a transport pipe to carry contaminated water to the air stripper. Because of this, the pumping rate of CW6 has increased substantially, and the untreated discharge to Bos Creek has been discontinued. These two factors tend to increase the rate of migration from the source area toward CW6. Water from CW6 is treated for VOC removal using the existing air strippers at the water utility (see Section 2.2). However, if no further action is taken, CW6 will continue to serve as an interceptor well, providing the sole protection for the remaining wells in the West Well Field.

The scope of the PFS was limited to the contaminant plume impacting the West Well Field and CW6. Ultimately, the solution to protecting the West Well Field involved additional controls to prevent contaminants from migrating to the north from the source area. Due to the apparently slowed contaminant migration to the north caused by discharge of CW6 to Bos Creek, additional protection of the West Well Field was determined possible by preventing or limiting the extent of future contaminant movement to the north. Implementation of plume migration controls would effectively limit the time during which CW6 draws in contaminants.

The EPA's PFS evaluated alternatives to address plume migration control in the West Well Field of the site. The selected interim remedial alternative to address the West Well Field plume is recorded in the Record of Decision (ROD), dated December 1988.

The selected interim remedial remedy remains consistent with the final ROD for the entire Site and no mid-course corrections are necessary.

2.5 WELL FIELD CHARACTERISTICS

2.5.1 Hydrogeology

The City production wells are located within glacial outwash and alluvial sediments underlying and adjacent to the Wisconsin River. The aquifer is located within a bedrock valley which is underlain and laterally bounded by relatively impermeable igneous bedrock. Groundwater flow within the unconfined glacial aquifer has been drastically changed by the installation of the production wells. Under non-pumping conditions, groundwater flows toward the Wisconsin River and its tributaries (Bos Creek). Groundwater naturally discharges at the surface water bodies. However, under pumpage conditions, groundwater flows toward the production wells. The natural groundwater flow directions are frequently reversed due to City well pumping which induces recharge of surface water into the aquifer. The cone of depression from the East Well Field appears to affect groundwater flow below and to the west of the Wisconsin River. Monitoring well nests located at Marathon indicate very slight downward gradients adjacent to the Wisconsin River. Below the Wisconsin river, the East Well Field production well pumpage has induced surface water recharge of the aquifer, causing flow downward through the river bed and toward CW3.

Aquifer hydraulic conductivity tests performed indicate hydraulic conductivity values ranging from 1.7×10^{-4} cm/sec to

8.1×10^{-2} cm/sec. The overall average hydraulic conductivity of the outwash aquifer is approximately 2.2×10^{-2} cm/sec, based on the hydraulic conductivity tests. Hydraulic conductivity values determined from pumping tests at CW6 indicate hydraulic conductivity values ranging between 2.8×1.0^{-1} cm/sec and 9.7×10^{-2} cm/sec.

2.5.2 West-Side Plume Chemical Characteristics

Groundwater quality sampling conducted during the RI indicated a vertical and lateral distribution of total chlorinated ethenes which suggested that a minimum of three sources are affecting the City well field.

West side monitoring wells appeared to delineate a deep (greater than 100-foot) north-south trending plume which affected CW6. This plume is predominantly composed of TCE, however, monitoring wells located within the southern portion of the plume also indicated relatively high (up to 890 µg/L) of 1,2-DCE concentrations. The maximum total chlorinated ethene concentrations were encountered within the plume approximately 500 feet south of CW6. Based on the vertical distribution of TCE throughout the aquifer in the vicinity of the former City landfill and the presence of TCE in the unsaturated zone in this area, a source appeared to be located in the area of an old City landfill located on Marathon property. The plume appeared to have migrated northward, under influence of the West Well Field, specifically, pumpage from CW6.

In general, ethene compounds (predominantly TCE and 1,2-DCE) have been found throughout the aquifer beneath the Marathon property/former City landfill. A maximum observed TCE concentration of approximately 5,000 µg/L was reported at the base of the aquifer during drilling of a monitoring well located on the Marathon property/former City landfill. Similar concentrations (>4,000 µg/L) have also been detected approximately 500 feet south of CW6 (approximately 1700 feet north of the Marathon property/former City landfill). Relatively elevated TCE concentrations of up to 1900 µg/L have also been detected in the shallow aquifer below and directly north of the Marathon property/former City landfill.

Several other VOCs have also been detected within the aquifer below the Marathon property/former City landfill. Carbon tetrachloride has been consistently detected at concentrations up to 108 µg/L. Chloroform has also consistently observed at concentrations up to approximately 50 µg/L. 1,1,1-TCA was detected at concentrations ranging up to 20 µg/L.

Complete Target Compound List (semivolatiles, pesticides, PCBs, metals and cyanides) analyses were performed on several of the Marathon property/former City landfill monitoring wells during the RI. No reportable levels of semivolatile compounds, pesticides, PCBs or cyanides were detected within the groundwater beneath the Site. State Preventative

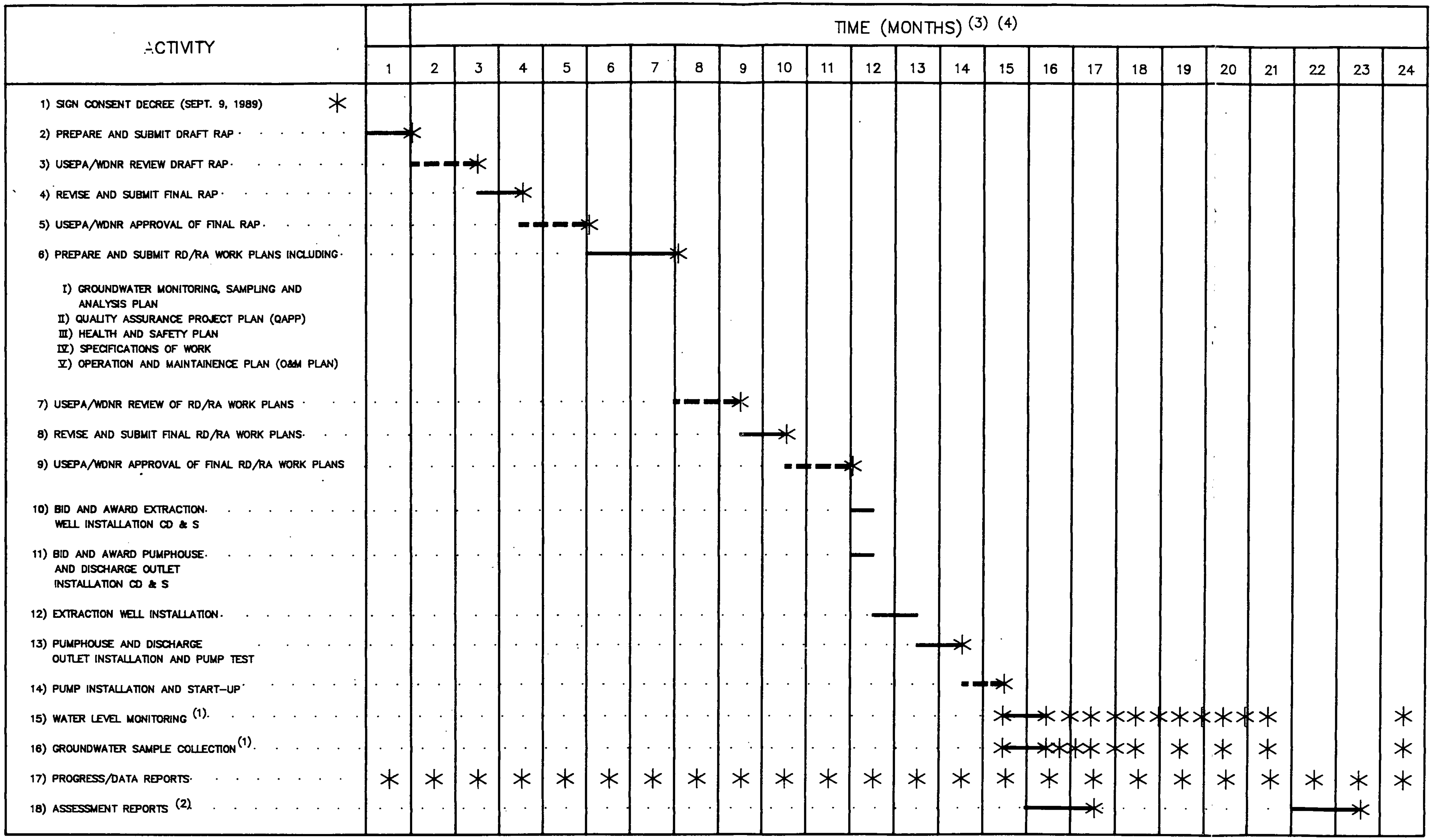
Action Limits (PALs) for dissolved iron (0.15 mg/L) and/or manganese (0.025 mg/L) were exceeded at six monitoring wells. However, groundwater within the aquifer possesses high concentrations of naturally occurring iron and manganese. Therefore, background dissolved iron and manganese levels frequently exceeded PALs. Total chromium was detected at concentrations ranging up to 0.594 mg/L. One on-Site monitoring well also indicated elevated dissolved metal concentrations for zinc (3.24 mg/L) and nickel (0.196 mg/L).

2.6 PROJECT SCOPE OF WORK

The scope of work to be completed under the RAP, including the GMP activities, includes; but is not limited to, the following:

1) Installation of a large diameter extraction well;
2) Extraction well pump test;
3) Construction of a groundwater extraction, treatment and discharge system;
4) groundwater level monitoring;
5) groundwater sample collection and analyses; and
6) associated monitoring data and assessment reports.

The scheduling of the RAP including the GMP activities, subsequent to all necessary approvals, is shown on Figure 2.1. Scheduling of



LEGEND

∗ EVENT/REPORT/ACTIVITY

── ACTIVITY DURATION

━ ━ ━ ACTIVITY OF UNDETERMINED DURATION

NOTES:
(1) ACTIVITIES OCCUR QUARTERLY FOLLOWING 6 MONTHS OF OPERATION
(2) ACTIVITY OCCURS ANNUALLY FOLLOWING 6 MONTHS OF OPERATION
(3) SCHEDULE SUBJECT TO REVISION DUE TO EXTREME ADVERSE WEATHER CONDITIONS
(4) SCHEDULE BASED ON TIMEFRAMES SPECIFIED IN CONSENT DECREE, ACTIVITIES MAY ACTUALLY BE COMPLETED PRIOR TO SCHEDULED DATE

figure 2.1

PROPOSED SCHEDULE

Marathon Electric Manufacturing Co.

CRA

2115-13/09/90-9-1 (S-04)

the activities are subject to revision due extreme adverse weather conditions or unavailability of a suitable contractor(s) upon approval of documents. Any revisions to the schedule will require approval by the U.S. EPA in consultation with WDNR prior to implementation. The Consent Order was signed on September 8, 1989.

All sample analyses will be completed within the specified holding times (see Table 5.1), calculated from the date of sample collection. Data reduction, validation, assessment and reporting will be performed in accordance with Section 9.0. The data packets (reports) supplied by Radian will be delivered to CRA within 35 days of the last day of sample collection for each individual sampling round (see Section 2.6.3). CRA will complete its validation and assessment within 21 days of receipt of each data packet. Monthly progress reports and GMP assessment reports will be prepared and submitted to the U.S. EPA and WDNR in accordance with the Remedial Action Plan.

Field activities specific to the GMP, which are subject to this QAPP, are discussed in detail in the following subsections.

Data quality objectives (DQO) have been established in accordance with the U.S. EPA guidance document entitled "Data Quality Objectives for the Remedial Response Activities", EPA/540/G-87/003, dated March 1987, to ensure that the database developed during the GPM meets the objectives and quality necessary for its intended use, namely, the assessment of the effectiveness of reducing VOC concentrations in the west side plume and satisfying discharge criteria. Level III DQO requirements will be met for all laboratory analyses. Level I DQO requirements will be met for all field measurements.

2.6.1 Groundwater Monitoring Program

The Groundwater Monitoring Program (GMP) has been designed, through discussions with the U.S. EPA and the WDNR, to gather data to be used in performing a complete assessment of the effectiveness of the groundwater extraction, treatment and discharge system on:

1) Creating cone of depression which controls the west side plume source;

2) Reducing VOC concentrations in the groundwater to attain specified cleanup standards; and

3) Satisfying Federal Clean Water Act Best Available Technology (BAT) requirements for surface water discharge.

Clean-up standards for the interim remedial action are based on WAC NR 140 Groundwater Quality Standards, Safe Drinking Water Act MCLs, Clean Water Act WQCs, and health based levels, as appropriate. The primary contaminant of concern is TCE. In addition, any contaminants specified in WAC NR 140 or in the Hazardous Substance List (HSL), which may be detected during the monitoring program, will at that time be considered to be additional contaminants of concern. In accordance with the Consent Decree, the extraction well system will be operated until:

1) the concentration of TCE is reduced to 1.8 ppb within the specified groundwater monitoring network (see Section 2.6.3).

2) the concentrations of additional contaminants of concern (as listed in WAC NR 140 or in the HSL) are reduced to the following levels:

    a. For additional contaminants which are specified by WAC NR 140, the levels specified for those additional contaminants by WAC NR 140: or

    b. For additional contaminants not specified by WAC NR 140, the levels required by the Safe Drinking Water Act MCLS; or

    c. For additional contaminants not specified by WAC NR 140 and not having a specified MCL;, the levels required by the applicable Clean Water Act WQC; or

    d. For additional contaminants not specified by WAC NR 140 and not having a specified MCL, and not having an applicable WQC level, health based levels set by U.S. EPA in consultation with the WDNR; and

3) a demonstration is made that the Water Quality Criteria (water discharge limits) have been complied with (for any discharge to the Wisconsin River); or until

4) the final remedy for the Facility directs otherwise.

An extraction well and observation monitoring program will be established and performed during and following start-up of the groundwater extraction, treatment and discharge system and will include:

1) Water level monitoring on thirty-four monitoring wells, the extraction well, Bos Creek and the Wisconsin River; and

2) Groundwater sample collection and chemical analysis from eleven monitoring wells, four production wells (3, 6, 7, 9), and the extraction well (influent/effluent).

2.6.2 Water Level Monitoring

2.6.2.1 Water Level Monitoring Network

A total of thirty-four (34) monitoring wells, Bos Creek, Wisconsin River and the extraction well (EW-1) are proposed to form the water level monitoring network. The water level monitoring network is summarized on Table 2.2. Figure 1.3, presented in Section 1.0 of this QAPP, locates all existing monitoring wells, the extraction well and staff gages in Bos Creek and the Wisconsin River.

The water level monitoring network will provide sufficient data to determine the extent of the cone of depression created by pumping of the extraction well.

2.6.2.2 Water Level Monitoring Frequency

Water levels will be measured in the well network, immediately prior to and subsequent to start-up of the extraction system, according to the schedule in Table 2.3.

During each water level monitoring event, water level measurements will be collected from the well network over a period of no longer than one working day.

TABLE 2.2

WATER LEVEL MONITORING NETWORK

MONITORING WELL NO.	*MONITORING WELL NO.*	*EXTRACTION WELL NO.*
C1S	W50	EW-1
C2S	W51A	
C3S	W52A	
C4S	W52	
C4D	W53A	
C6S	W53	
C7S	W54	*WISCONSIN RIVER*
	W55A	SG1
R1S	W55	
R1D		
R2S	IWD	
R2D	IWM	
R3S	IWS	
R3D		
R4D	WSWD	*BOS CREEK*
	WSWS	SG2
E21		
E21A		
E30	WC4	
	WC4A	
TCT44		

Note: Well locations and staff gage locations shown on Figure 1.3.

TABLE 2.3

SUMMARY OF WATER LEVEL MEASUREMENT FOR EACH MONITORING EVENT

	Frequency	
Time Period	*34 Monitoring Wells/ 2 Staff Gages*	*Extraction Well*
Prior to Startup	1 event	1 event
12 Hr. Subsequent to Startup	1 event	continuous
Week 1	2 events	daily
Month 1	twice/month	twice/week
Month 2 to 6	twice/month	twice/month
Month 6 onwards	quarterly*	quarterly*

*Dependent on whether a pattern is established in aquifer.

In addition to the above schedule, water levels will be measured prior to purging and sample collection.

The wells, IWD, IWM and IWS, located on the island, will be monitored according to the schedule summarized above, with the following exceptions. Wells IWD, IWM and IWS will not be sampled during the months of December, January and February. Wells IWD, IWM and IWS will not be sampled if they are inaccessible due to weather conditions. If these wells are inaccessible, the EPA project manager will be notified as soon as possible.

2.6.3 Groundwater Sampling

2.6.3.1 Groundwater Sampling Network

A total of eleven (11) monitoring wells, four (4) City production wells and the extraction well are proposed to form the groundwater sampling network. The groundwater sampling network is summarized on Table 2.4. Figure 1.3, presented in Section 1.0 of this QAPP, locates all existing monitoring wells and the extraction well.

The groundwater sampling network will provide sufficient data to assess the effectiveness of the extraction well system to

TABLE 2.4

GROUNDWATER SAMPLING NETWORK

MONITORING WELL NO.	*PRODUCTION WELL NO.*	*EXTRACTION WELL NO.*
C2S	CW3	EW1 (influent/effluent)
C4D	CW6	
R2D	CW7*	
R4D	CW9*	
W52		
W53A		
W53		
W54		
W55		
WSWD		
IWD		

Note:

* Sampled only during selected sampling events as specified in Section 2.6.2.

control the west side plume source and to monitor the reduction in VOC concentrations in the groundwater over time.

2.6.3.2 Groundwater Sampling Parameters

All groundwater samples collected will be measured in the field for pH, conductivity and temperature. All groundwater samples will be submitted to a laboratory for Target Compound List (TCL), Volatile Organic Compound (VOC) parameter analysis or for the full TCL organic and Target Analyte List (TAL) inorganic parameter analysis. Tables 2.5 through 2.8 summarize all parameters that will be analyzed.

2.6.3.3 Groundwater Sampling Frequency

Groundwater samples will be collected from the groundwater sampling network and analyzed for the VOC parameters listed on Table 2.5 according to the schedule on Table 2.9.

Well IWD, located on the island, will be sampled according to the schedule summarized above, with the following exceptions. Well IWD will not be sampled during the months of December, January or February, or if it is inaccessible due to weather conditions. If well IWD is inaccessible, the EPA project manager will be notified as soon as possible.

TABLE 2.5

PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET COMPOUND LIST (TCL) VOLATILE ORGANIC COMPOUNDS

Compound	*CAS Number*	*PQL* [1]*(µg/L)*	
Acetone	67-64-1	3.0	
Benzene	21-43-2	0.6	
Bromodichloromethane	75-27-4	0.7	
Bromoform	75-25-2	0.5	
Bromomethane	74-83-9	0.5	
2-Butanone	78-93-3	30[2]	
Carbon disulfide	75-15-0	0.5	
Carbon tetrachloride	56-23-5	0.6	
Chlorobenzene	108-90-7	0.7	
Chloroethane	75-00-3	1.0	
Chloroform	07-00-3	0.6	
Chloromethane	74-87-3	0.5	
Dibromochloromethane	124-48-1	0.7	
1,1-Dichloroethane	75-35-3	0.6	
1,2-Dichloroethane	107-06-2	0.6	(0.5)[3]
1,1-Dichloroethene	75-35-4	0.5	(0.24)
1,2-Dichloroethene (total)	540-59-0	0.5	
1,2-Dichloropropane	78-87-5	0.5	
cis-1,3-Dichloropropene	10061-01-5	0.8	
trans-1,3-Dichloropropene	10061-02-6	0.6	
Ethylbenzene	100-41-4	0.6	
2-Hexanone	591-78-6	1.2	
Methylene Chloride	75-09-2	0.5	
4-Methyl-2-pentanone	108-10-1	5.0	
Styrene	100-42-5	0.6	
1,1,2,2-Tetrachloroethane	29-34-5	0.5	

---

[1] Sample PQLs are highly matrix and instrument performance dependent. The PQLs listed herein are provided for guidance and may not always be acheivable. All PQLs are lower than existing Wisconsin Regulation NR-140 and Safe Drinking Water Act MCLs.

[2] Based on obtaining 1000 area counts on a 30 µg/L standard.

[3] PQLs listed in parentheses are lower than the CLP-RAS PQLs but are consistent with the Wisconsin Regulation NR-140. CLP-RAS PQLs are all lower than Safe Drinking Water Act MCLs.

TABLE 2.5

PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET COMPOUND LIST (TCL) VOLATILE ORGANIC COMPOUNDS

Compound	*CAS Number*	*PQL* [1]*(µg/L)*	
Tetrachloroethene	127-18-4	0.6	
Toluene	108-88-33	0.7	
1,1,1-Trichloroethane	71-55-6	0.6	
1,1,2-Trichloroethane	79-00-5	0.7	(0.6)[2]
Trichloroethene	79-01-6	0.5	
Vinyl acetate	108-05-4	1.0	
Vinyl chloride	75-01-4	0.5	(0.015)
Xylenes (total)	1330-20-7	0.5	

---

[1] Sample PQLs are highly matrix and instrument performance dependent. The PQLs listed herein are provided for guidance and may not always be acheivable.

[2] PQLs listed in parentheses are lower than the CLP-RAS PQLs but are consistent with the Wisconsin Regulation NR-140. CLP-RAS PQLs are all lower than Safe Drinking Water Act MCLs.

TABLE 2.6

PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET COMPOUND LIST (TCL) BASE-NEUTRAL-ACID EXTRACTABLE ORGANIC COMPOUNDS (BN/As)

Semivolatiles	*CAS Numbers*	*PQL* [1] *(μg/L)*
Phenol	108-95-2	10
Bis (2-Chloroethyl)ether	111-44-4	10
2-Chlorophenol	95-57-8	10
1,3-Dichlorobenzene	541-73-1	10
1,4-Dichlorobenzene	106-46-7	10
Benzyl Acohol	100-51-6	10
1,2-Dichlorobenzene	95-50-1	10
2-Methylphenol	95-48-7	10
Bis (2-Chloroisopropyl)ether	108-60-1	10
4-Methylphenol	106-44-5	10
N-Nitroso-di-*n*-dipropylamine	621-64-7	10
Hexachloroethane	67-72-1	10
Nitrobenzene	98-95-3	10
Isophorone	78-59-1	10
2-Nitrophenol	88-75-5	10
2,4-Dimethylphenol	105-67-9	10
Benzoic acid	65-85-0	50
Bis (2-chloroethoxy)methane	111-91-1	10
2,4-Dichlorophenol	120-83-2	10
1,2,4-Trichlorobenzene	120-82-1	10
Naphthalene	91-20-3	10
4-Chloroaniline	106-47-8	10
Hexachlorobutadiene	87-68-3	10

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[1] Sample PQLs are highly matrix and instrument performance dependent. The PQLs listed herein are provided for guidance and may not always be acheivable. All PQLs are lower than existing Wisconsin Regulation NR-140 and Safe Drinking Water Act MCLs.

TABLE 2.6

PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET COMPOUND LIST (TCL) BASE-NEUTRAL-ACID EXTRACTABLE ORGANIC COMPOUNDS (BN/As)

Semivolatiles	*CAS Numbers*	*PQL* [1] *(µg/L)*
4-Chloro-3-methylphenol (*para*-chloro-*meta*-cresol)	59-50-7	10
2-Methylnaphthalene	91-57-6	10
Hexachlorocyclopentadiene	77-47-4	10
2,4,6-Trichlorophenol	88-06-2	10
2,4,5-Trichlorophenol	95-95-4	50
2-Chloronaphthalene	91-58-7	10
2-Nitroaniline	88-74-4	50
Dimethylphthalate	131-11-3	10
Acenaphthylene	208-96-8	10
2,6-Dinitrotoluene	606-20-2	10
3-Nitroaniline	99-09-2	50
Acenaphthene	83-32-9	10
2,4-Dinitrophenol	51-28-5	50
4-Nitrophenol	100-02-7	50
Dibenzofuran	132-64-9	10
2,4-Dinitrotoluene	121-14-2	10
Diethylphthalate	84-66-2	10
4-Chlorophenyl-phenyl Ether	7005-72-3	10
Fluorene	86-73-7	10
4-Nitroaniline	100-01-6	50
4,6-Dinitro-2-methylphenol	534-52-1	50
N-Nitrosodiphenylamine	86-30-6	10
4-Bromophenyl-phenyl Ether	101-55-3	10
Hexachlorobenzene	118-74-1	10
Pentachlorophenol	87-86-5	50
Phenanthrene	85-01-8	10
Anthracene	120-12-7	10

---

[1] Sample PQLs are highly matrix and instrument performance dependent. The PQLs listed herein are provided for guidance and may not always be acheivable. All PQLs are lower than existing Wisconsin Regulation NR-140 and Safe Drinking Water Act MCLs.

TABLE 2.6

PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET COMPOUND LIST (TCL) BASE-NEUTRAL-ACID EXTRACTABLE ORGANIC COMPOUNDS (BN/As)

Semivolatiles	*CAS Numbers*	*PQL* [1]*(μg/L)*
Di-*n*-butylphthalate	84-74-2	10
Fluoranthene	206-44-0	10
Pyrene	129-00-0	10
Butylbenzylphthalate	85-68-7	10
3,3'-Dichlorobenzidine	91-94-1	20
Benzo(a)anthracene	56-55-3	10
Chrysene	218-01-9	10
Bis (2-ethylhexyl) phthalate	117-81-7	10
Di-*n*-octylphthalate	117-84-0	10
Benzo(b)fluoranthene	205-99-2	10
Benzo(k)fluoranthene	207-08-9	10
Benzo(a)pyrene	50-32-8	10
Indeno(1,2,3-cd)pyrene	193-39-5	10
Dibenz(a,h)anthracene	53-70-3	10
Benzo(g,h,i)perylene	191-24-2	10

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[1] Sample PQLs are highly matrix and instrument performance dependent. The PQLs listed herein are provided for guidance and may not always be acheivable. All PQLs are lower than existing Wisconsin Regulation NR-140 and Safe Drinking Water Act MCLs.

TABLE 2.7

PRACTICAL QUANITATION LIMITS (PQLs) FOR TARGET COMPOUND LIST (TCL) PESTICIDES AND POLYCHLORINATED BIPHENYLS (PEST/PCBs)

Pesticides/PCBs	*CAS Number*	*PQLs* [1] *(μg/L)*
alpha-BHC	319-84-6	0.05
beta-BHC	319-85-7	0.05
delta-BHC	319-86-8	0.05
gamma-BHC (Lindane)	58-89-9	0.05
Heptachlor	76-44-8	0.05
Aldrin	309-00-2	0.05
Heptachlor expoxide	1024-57-3	0.05
Endosulfan I	959-98-8	0.05
Dieldrin	60-57-1	0.10
4,4'-DDE	72-55-9	0.10
Endrin	72-20-8	0.10
Endosulfan II	33213-65-9	0.10
4,4'-DDD	72-54-8	0.10
Endosulfan sulfate	1031-07-8	0.10
4,4'-DDT	50-29-3	0.10
Methoxychlor	72-43-5	0.5
Endrin ketone	53494-70-5	0.10
alpha-Chlordane	5103-71-9	0.5
gamma-Chlordane	5103-74-2	0.5
Toxaphene	8001-35-2	1.0
Aroclor - 1016	12674-11-2	0.5
Aroclor - 1221	11104-28-2	0.5
Aroclor - 1232	11141-16-5	0.5
Aroclor - 1242	53469-21-9	0.5
Aroclor - 1248	12672-29-6	0.5
Aroclor - 1254	11097-69-1	1.0
Aroclor - 1260	11096-82-5	1.0

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[1] Sample PQLs are highly matrix and instrument performance dependent. The PQLs listed herein are provided for guidance and may not always be acheivable. All PQLs are lower than existing Wisconsin Regulation NR-140 and Safe Drinking Water Act MCLs.

TABLE 2.8

PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTE LIST (TAL) PARAMETERS

Analyte	*PQLs [1] (µg/L)*
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	5
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

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[1] Sample PQLs are highly matrix and instrument performance dependent. The PQLs listed herein are provided for guidance and may not always be acheivable. All PQLs are lower than existing Wisconsin Regulation NR-140 and Safe Drinking Water Act MCLs.

TABLE 2.9

SUMMARY OF GROUNDWATER SAMPLING FOR EACH MONITORING EVENT

	Frequency		
Time Period	*Monitoring Wells*	*Production Wells*	*Extraction Well (influent/effluent)*
Immediately Prior to Start-Up	1 event	1 event	1 event
Month 1	once/week	twice/month*	twice/week
Month 2	once/month	once/month*	once/week
Month 3	once/month	once/month	twice/month
Month 4 and 5	once/month	once/month*	once/month
Month 6 onward	quarterly	quarterly	quarterly**

* only production wells 3 and 6 for these sampling events

** dependent on whether a pattern is established with contaminant levels in aquifer

In addition to analyzing samples for TCL VOCs, six groundwater samples (influent/effluent extraction well samples and four monitoring well samples whose locations will be specified by the EPA) will be collected during a sampling event in the first month of operation and analyzed for the full TCL and TAL parameters. These data will be presented in an assessment report prepared after the first month of operation. Subsequent to review of the data, it will be determined, in conjunction with the U.S. EPA and the WDNR, whether a second round of groundwater samples is required to be collected from the six locations for full or partial TCL/TAL analyses. The six sample locations will be sampled annually, thereafter, and analyzed for the full or partial TCL/TAL parameters, as determined necessary in conjunction with the U.S. EPA and WDNR.

The production wells and the extraction well (influent) will be sampled at their respective well heads. A treated groundwater (effluent) sample will also be collected from the rip rap discharge structure, immediately prior to the point where treated groundwater enters the Wisconsin River.

Table 2.10 summarizes the groundwater sample collection activities for each sampling event. Table 4.1 (Section 4.0) summarizes field quality control samples for each sampling event.

TABLE 2.10

SUMMARY OF GROUNDWATER SAMPLING AND ANALYSIS PROGRAM FOR EACH MONITORING EVENT

				QA SAMPLES				
Sampling Round	*Field Parameter*[1]	*Laboratory Parameter*	*Investigative Parameter*[2]	*Rinsate Blanks*	*Field Duplicates*	*Voc Trip Blanks*[3]	*MS/MSD*[4]	*Total Per Round*[5]
TCL/TAL	pH specific conductivity temperature static water level[6]	VOC by Appendix A	14	2	2	1	1	20
		BN/A by CLP-RAS	6	1	1	--	1	9
		PCB and Pesticides by CLP-RAS	6	1	1	--	1	9
		Metals by CLP-RAS						
		Cyanide by CLP-RAS	6	1	1	--	1	9
VOC only	pH specific conductivity temperature static water level[6]	VOC by Appendix A	14	2	2	1	1	20

---

[1] Standard operating procedures for pH, specific conductivity and temperature are found in Appendix B.

[2] See Section 2.6.3 for complete description of groundwater sampling network, parameters and frequency.

[3] One trip blank is required for each cooler containing VOC sample vials.

[4] Three times the normal sample volume is required for VOC MS/MSD samples, and twice the normal sample volume for the remaining parameter.

[5] The total number of samples for each sampling event of the GmP is tentative.

[6] See Section 2.6.2 Table 2.2 and Table 2.3 for complete water level monitoring metwork and frequency, respectively. Water level measurements summarized above are in addition to those discussed in Section 2.6.2.

After one month of operation, an assessment report will be prepared which will include an evaluation of the water level and sampling well networks, parameters and frequencies and will recommend revisions, for review/approval with U.S. EPA and WDNR, if necessary. A similar assessment report will follow after six months of operation.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Conestoga-Rovers & Associates Limited (CRA), will oversee all phases of the Groundwater Monitoring Program (GMP). CRA will perform or supervise all field activities. In addition, CRA will also assess the effectiveness of the groundwater extraction, treatment and discharge system to meet project objectives. All reports based on GMP activities will be produced by CRA.

The Radian Corporation-Sacramento (Radian), as analytical subcontractor to Marathon, will perform all chemical analyses of samples collected for the GMP. Radian's Standard Operating Procedures are provided in Appendix A.

All firms will provide project management as appropriate to their responsibilities. CRA will provide administrative oversight and QA/QC for all deliverable. All final project deliverable will be issued by CRA.

Figure 3.1 presents the key staff organization for the project. A summary of each of the key persons responsibilities is presented below:

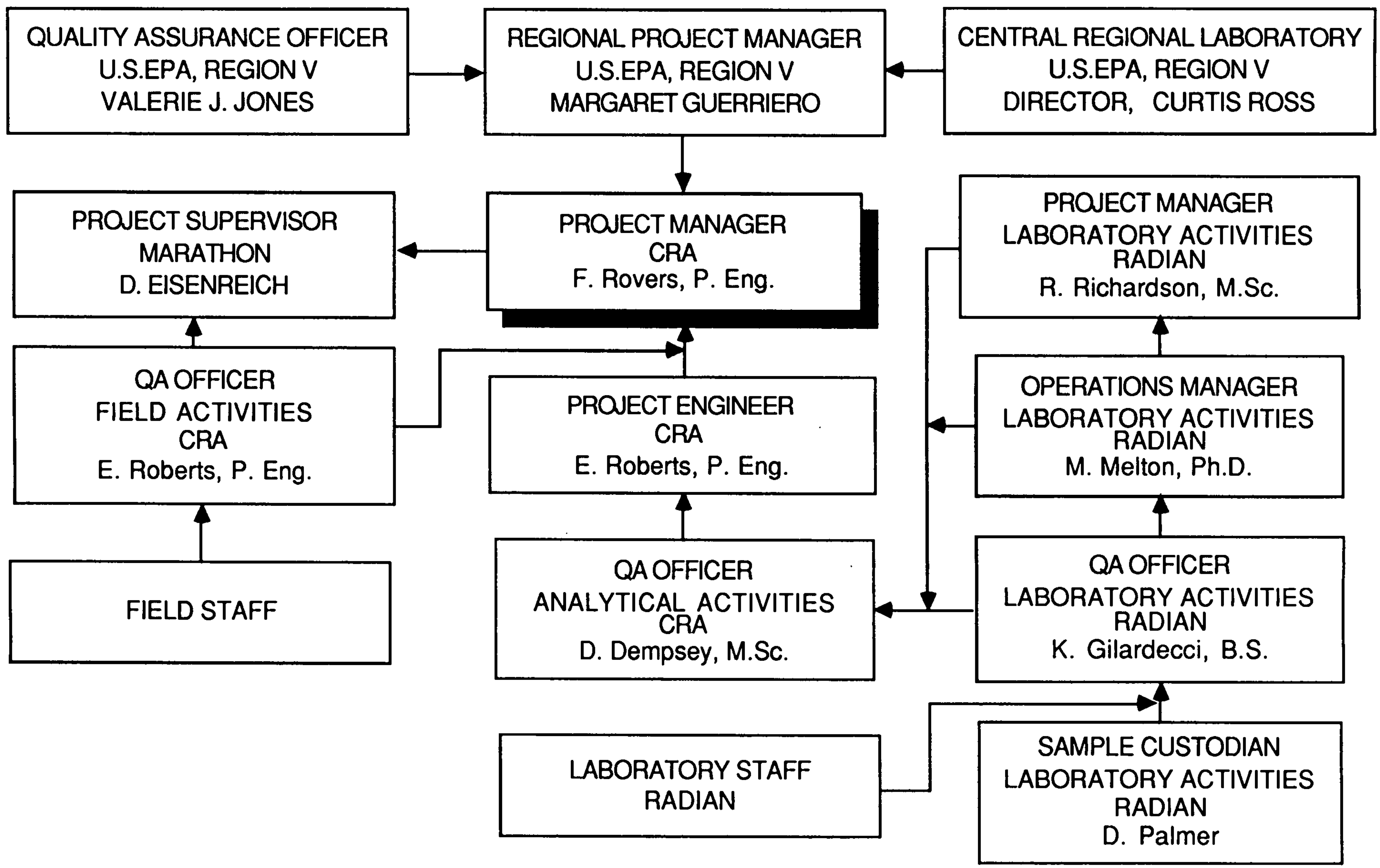

figure 3.1
STAFF ORGANIZATION
Marathon Electric Manufactoring Company

Dave Eisenreich - Project Supervisor, Marathon

- general overview of the project to ensure that the Marathon's objectives are met
- participation in key negotiations with the U.S. EPA
- managerial guidance to CRA's Corporate Project Manager

Frank Rovers - Project Manager and Principal Engineer, CRA

- provides overall project management
- ensures all resources of CRA are available on an as-required basis
- participation in technical negotiations with the U.S. EPA and attendance at project meetings on an as-required basis
- managerial and technical guidance to CRA staff
- preparation and review of assessment and monitoring reports
- approval of the QAPP

Dave Dempsey - Quality Assurance Officer - Analytical Activities, CRA

- overview of laboratory activities
- decide laboratory data corrective action
- analytical data assessment
- responsible for project internal performance and system audits
- approval of the QAPP

Ed Roberts - Quality Assurance Officer - Field Activities, CRA

- management of field activities and field QA/QC
- data assessment

- preparation and review of assessment and monitoring reports
- technical representation of field activities
- preparation of SOPs for field activities
- evidence file custodian

Rob Richardson - Project Manager (Radian - Austin)

- ensures all resources of the laboratory are available on an as-required basis
- overview final analytical report
- oversees all laboratories' activities
- approval of the QAPP

Marilyn Melton- Operations Manager (Radian - Sacramento)

- coordinate laboratory analyses
- supervise in-house chain-of-custody
- schedule sample analyses
- oversee data review
- oversee preparation of analytical reports
- approve final analytical reports prior to submission to CRA

Karen Gilarducci - Quality Assurance Officer (Radian - Sacramento)

- overview laboratory quality assurance
- overview QA/QC documentation
- conduct detailed data review
- decide laboratory corrective actions, if required
- technical representation of laboratory QA procedures

6) Percent Recovery

Percent recovery of spikes will be used to establish analytical accuracy and will be evaluated as follows:

$$\text{Matrix Spike Recovery} = \left(\frac{A-B}{C}\right) \times 100$$

where:

A = the analyte concentration determined experimentally from the spiked sample;

B = the background level determined by a separate analysis of the unspiked sample; and

C = the amount of the spike added.

N.B. - Accuracy will be assessed from spike percent recoveries and audit sample performance.

7) Relative Percent Difference (RPD)

$$RPD = \frac{X_1 - X_2}{[X_1 + X_2]/2} \times 100$$

where:

X_1 = first value, (i.e. MS value)

X_2 = second value, (i.e. MSD value)

8) Level of Completeness (LC)

$$LC = \frac{\text{Acceptable Samples}}{\text{Total Samples Expected Under Normal Conditions}} \times 100$$

where:

Acceptable Samples - number of samples satisfying QA/QC criteria;

Total Samples Expected Under Normal Conditions - total number of samples collected.

4.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analyses and reporting that will provide accurate data. Specific procedures to be used for sampling, chain-of-custody, calibration, laboratory analysis, reporting, quality control, audits, preventive maintenance and corrective actions are presented in other sections of this QAPP.

4.1 LEVEL OF QA EFFORT

To assess the quality of data resulting from the field sampling program, field duplicate samples, rinsate blank samples, trip blank samples, and matrix spike samples will be taken (where appropriate) and submitted to the analytical laboratory for each type of sample matrices.

For all field samples collected, field duplicate samples will be collected at a frequency of one per group of 10 investigative samples or once per sampling round (whichever is more frequent) per set of analytical parameters. Matrix spike/matrix spike duplicate (MS/MSD) samples will be analyzed at a frequency of one per group of 20 investigative samples. If a sampling round consists of less than 20 samples, a MS/MSD sample will still be collected. Three times the normal sample shall be collected for the

MS/MSD samples for VOC analyses, while twice the normal volume shall be collected for all other parameters.

Rinsate blank samples will be submitted at a frequency of one per group of 10 investigative samples or once per sampling round (whichever is more frequent) per set of analytical parameters. Rinsate blanks shall be collected by routing organic-free water through decontaminated sampling equipment for organic analyses; while de-ionized water shall be used for inorganic analyses.

One trip blank sample for VOC analyses (prepared by the laboratory and consisting of organic-free water poured into the sample vials and preserved with hydrochloric acid) will be shipped with each shipping cooler of VOC sample vials by the laboratory. The trip blank sample will be handled in a manner consistent with actual field sample handling and will be shipped back to the laboratory with each batch of water samples. The trip blank will provide a measure of potential cross contamination of samples during shipment and handling. It is noted, however, that the trip blank will not be opened in the field.

Table 4.1 summarizes the field quality control samples that will be collected.

TABLE 4.1

SUMMARY OF FIELD QUALITY CONTROL SAMPLES

Matrix	*Trip Blank*	*Rinstate Blank*	*Blind Duplicate*	*Matrix Spike/ Matrix Spike Duplicate*
Groundwater	one per shipping cooler of VOC samples	one per group of 10 or fewer investigative samples	one per group of 10 or fewer investigative samples	one per group of 20 or fewer investigative samples

Blank samples will be analyzed to check procedural contamination and/or ambient conditions at the Site that may cause sample contamination.

Upon examination of the results obtained by Radian, if any of the aforementioned blanks are found to contain any of the target parameters, the following procedure will be followed. First, determine if the contamination is real by examining the associated investigative samples and method blanks. If the contamination can be traced to an isolated source, e.g. a highly contaminated sample, the data are to remain unqualified. Otherwise, the data will be examined to determine the extent of contamination and all associated data will be qualified according to the data validation guidelines referenced by Section 9.0.

Field duplicate samples will be analyzed to check for combined sampling and analytical reproducibility. Field duplicate samples are to be used as a quantitative measure of precision throughout the sampling event. Comparison of field duplicate samples will be based upon the parameters, both non-detected and detected, and the relative percent differences (RPD) of each parameter's concentration. It will be required that RPD values for each parameter be less than twenty (20) to be used for quantitative assessment. Parameters with RPD values greater than 20 but less than 40, may be used for qualitative assessments.

4.2 SENSITIVITY, ACCURACY AND PRECISION OF ANALYSES

The fundamental QA objective with respect to the accuracy, precision, and sensitivity of analytical data is to achieve the QC acceptance criteria of each analytical protocol. The sensitivities required for these organic analyses will be at least the targeted detection limits listed on Table 2.5 through Table 2.8. These tables present targeted detection limits for all parameters. It should be noted that these limits are targeted detection limits. Lower method detection limits, if achieved by the laboratory, will be substituted for the targeted detection limits in the final report. In order to achieve low detection limits for several of the VOC parameters a 25 mL purge volume will be used (see Appendix A). Accuracy shall be determined by the surrogate and matrix spike recoveries, while the degree of precision shall be monitored via duplicate analyses. Table 10.1 presents the criteria to be met for laboratory accuracy and precision measurements.

4.3 COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

It is expected that all analyses conducted in accordance with CLP methods will provide data meeting QC acceptance criteria for 90 percent of all samples tested. Completeness shall be calculated by the equation listed in Section 13.0. Any reasons for variances will be documented. The corrective actions taken if the completeness goals are not met are described in Section 14.0 of this QAPP.

The sampling networks have been designed to provide data to enable an assessment of groundwater hydraulic and chemical conditions. During development of these networks, consideration was given to existing data from past studies completed for the Site and physical setting. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are documented in this QAPP. However, it may be necessary to verify similar documentation for previous analytical data to adequately establish comparability. Comparability of laboratory analyses will be ensured by the use of consistent units.

4.4 FIELD MEASUREMENTS

Measurement data will be generated in many field activities. These activities include, but are not limited to, the following:

i) Documenting time and weather conditions,
ii) Determining pH, specific conductivity, and temperature of water samples (see Appendix A for SOPs),
iii) Verifying pre-sampling purge volumes,
iv) Measuring groundwater elevations in wells, and

v) Documenting groundwater flow rate in extraction well system.

The general QA objective for such measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the use of standardized procedures.

5.0 SAMPLING PROCEDURES

The procedures and protocols for collecting samples and for performing all related field activities are described in detail in the GMP. Only groundwater samples, including a treated groundwater sample prior to discharge to surface water, will be collected.

Table 5.1 lists the sample containers and method of analyses that will be used for each sample.

TABLE 5.1

CONTAINER, PRESERVATION, SHIPPING AND PACKING REQUIREMENTS

Analysis	*Sample Containers*	*Preservation*	*Maximum Holding Time*[1]	*Volume of Sample*	*Shipping*[2]	*Normal Packaging*[3]
VOC	Three 40 ml volatile organic analysis (VOA) vials	HCl to pH<2 4°C	14 days	Fill completely no air bubbles	Transported daily by courier	Bubble Pack, Vermiculite or equivalent
BN/A	Two 1-l amber glass bottles	4°C	7 days until extraction, 40 days after extraction	Fill to neck of bottles	Transported daily by courier	Bubble Pack, Vermiculite or equivalent
PEST/PCB	Two 1-l amber glass bottles	4°C	7 days until extraction, 40 days after extraction	Fill to neck of bottles	Transported daily by courier	Bubble Pack, Vermiculite or equivalent
Metals	One 500 ml polyethylene	HNO_3 to pH<2 4°C	6 months (mercury 28 days)	Fill to neck of bottle	Transported daily by courier	Bubble Pack, Vermiculite or equivalent
Cyanide	One 1-l polyethylene or glass bottle	NaOH to pH>12 4°C	14 days	Fill to shoulder of bottle	Transported daily by courier	Bubble Pack Vermiculite or equivalent

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[1] The maximum sample holding time is calcuated from the date of sample collection.

[2] Samples shall be shipped via Federal Express Priority One.

[3] All samples shall be protected from light.

6.0 SAMPLE CUSTODY AND DOCUMENT CONTROL

6.1 CHAIN-OF-CUSTODY

A chain-of-custody will be maintained to document the transfer of sample containers. Each sample will be properly sealed. Sample container labels will include sample number, place of collection and date and time of collection. Samples shall be placed in the shipping cooler immediately after collection. Packing of the sample cooler will follow the procedure discussed in the Groundwater Monitoring Plan (GMP).

Each sample container being shipped to Radian will contain a chain-of-custody form. The chain-of-custody form consists of four copies which are distributed to the shipper, the receiving laboratory, the CRA laboratory, and the CRA office file. The shipper will maintain his copy while the other three copies are enclosed in a waterproof envelope within the cooler with the samples. Radian, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records. One copy will be returned to CRA upon receipt of the samples by the laboratory. One copy will be returned to CRA with the data deliverable package. Field custody procedures are further described in the GMP. Each sample number of each sample shipped will be recorded on the sheet. The container will then be sealed properly for shipment.

Upon receipt of the container at the laboratory, the container will be inspected by the designated sample custodian. The condition of the container will be noted on the chain-of-custody record sheet by the sample custodian. The sample custodian will document the date and time of receipt of the container, and sign the form.

If damage or discrepancies are noticed, it will be recorded in the remarks column of the record sheet, dated and signed. Any damage or discrepancies will be reported to the lab supervisor who will inform the lab manager and QA officer.

Chain-of-Custody procedures are further documented in Section 4.0 of the GMP and in Appendix B of this QAPP.

6.2 SAMPLE DOCUMENTATION IN THE LABORATORY

The sample custodian will assign a unique number to each incoming sample for use in the laboratory. The unique number and customer number will then be entered into the sample receiving log. The laboratory date of receipt will also be noted.

Radian will be responsible for maintaining analytical log books and laboratory data as well as a sample (on hand) inventory for submittal to CRA on an "as required" basis. Samples will be maintained by the laboratory for a period of 30 days following CRA's receipt of the respective sample data, under the conditions prescribed by the appropriate U.S. EPA methods, for additional analyses, if necessary. Raw laboratory data files will be inventoried and maintained by Radian for a period of five years at which time CRA will advise Radian regarding the need for additional storage.

Laboratory custody procedures are documented in detail in Appendix B.

6.3 STORAGE OF SAMPLES

After the sample custodian has prepared the log book, the chain-of-custody will be checked to ensure that all samples are stored in the appropriate locations. All samples will be stored within an access controlled location and will be maintained at 4°C until completion of all analytical work or as a minimum for 30 days.

6.4 SAMPLE DOCUMENTATION - CRA

Evidentiary files for the entire project will be inventoried and maintained by CRA and will consist of the following:

- Groundwater Monitoring Plan

- Project Logbooks
- Field Data Records
- Sample Identification Documents
- Chain-of-Custody Records
- Analytical Data Reports
- Correspondence
- Report Notes, Calculations, etc.
- References, Literature
- Miscellaneous - photos, maps, drawings, etc.
- Assessment and Monitoring Reports

The evidentiary file materials will be the responsibility of the evidentiary file custodian with respect to maintenance and document removal.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

The procedures indicated below will be performed for all samples delivered for analysis to the laboratory. Specific instructions relevant to a particular type of analysis are given in the pertinent analytical procedures for this project, and are referenced in Section 8.0.

The instruments will be calibrated on each day that analyses will be performed. The analyst will tune and calibrate the instrument and complete calibration records for the project file.

All quality control data and records produced from calibration and tuning will be retained by the laboratory and will be made available to CRA on an "as required" basis.

The following specific analytical quality control procedures are related to each analytical batch.

7.1 TUNING FOR TCL VOC AND BN/A ANALYSES

The tune of each GC/MS system used for the determination of VOC and BN/A will be checked with 4-bromofluorobenzene (BFB) and decafluorotriphenylphosphine (DFTPP). The ion abundance criteria required by the method will be met before determination of any analytes. Relative ion abundance criteria for BFB and DFTPP are given in Table 7.1. If the system does not meet the required specification of one or more of the specified ions, the instrument will be retuned and rechecked before preceding with sample analysis. The tune performance check criteria will be achieved on a daily basis.

7.2 CALIBRATION FOR TCL VOC ANALYSES

System performance is verified initially and after every 12 hours using a 10 μg/*l* standard containing all target analytes to ensure a minimum average response factor of 0.3 (0.10 for bromform due to poor purging efficiency) for the following system performance check compounds (SPCC):

- Chloromethane,
- 1,1-Dichloroethane,
- Bromoform,
- 1,1,2,2-Tetrachloroethane, and
- Chlorobenzene

Project Specific Compounds:

- Vinyl chloride,
- 1,2-Dichloroethane,

TABLE 7.1

BFB AND DFTPP KEY ION ABUNDANCE CRITERIA

Compound	*Mass*	*Ion Abudance Criteria*
BFB	50	15 to 40% of mass 95
	75	30 to 60% of mass 95
	95	base peak, 100% relative abundance
	96	5 to 9% of mass 95
	173	less than 2% of mass 174
	174	greater than 50% of mass 95
	175	5 to 9% of mass 174
	176	greater than 95% but less than 101% of mass 174
	177	5 to 9% of mass 176
DFTPP	51	30 to 60% of mass 198
	68	less than 2% of mass 69
	70	less than 2% of mass 69
	127	40 to 60% of mass 198
	197	less than 1% of mass 198
	198	base peak, 100% relative abundance
	199	5 to 9% of mass 198
	275	10 to 30% of mass 198
	365	greater than 1% of mass 198
	441	present, but less than mass of 443
	442	greater than 40% of mass 198
	443	17 to 23% of mass 442

- Trichloroethene, and
- Tetrachloroethene

shall be required to have response factors greater than 0.05.

A 5-point calibration, used for generating response factors, will be performed initially using 4, 10, 20, 30, and 40 µg/*l* standards. The percent relative standard deviation (% RSD) must be less than 30 percent for the five response factors calculated for each of the following calibration check compounds (CCC):

- 1,1-Dichloroethene,
- Chloroform
- 1,2-Dichloropropane,
- Toluene,
- Ethylbenzene, and
- Vinyl chloride

Project Specific Compounds:

- Vinyl chloride,
- 1,2-Dichloroethane,
- Trichloroethene, and
- Tetrachloroethene

A continuing (every 12 hours) calibration check with a 10 μg/*l* standard will be performed, following the system performance check, for all analytes. A single concentration of each analyte will be analyzed and a response factor calculated. The single-point RF for each SPCC shall be greater than 0.3 (0.100 for bronoform). Also, the single-point RF for each CCC must be within 25 percent of the average five-point RF; otherwise, a new five-point calibration must be generated.

7.3 CALIBRATION FOR BN/A AND PEST/PCB ANALYSES

Prior to analysis, instruments will be calibrated using procedures from the CLP-SOW referenced in Section 8.1. For BN/A analyses, a five-point calibration curve will be established. Each SPCC will be required to have a RF greater than 0.05, while % RSD for each CCC shall be less than thirty (30).

Calibration checks for BNA analyses shall consist of a standard being analyzed prior to the batch analyses every 12 hours. The single-point RF for each SPCC shall be greater than 0.05, and the percent difference between each CCC RF shall within 25 of the average five-point RF. Failure to meet these criteria shall result in generation of a new five-point calibration.

Calibration of the gas chromatograph for PEST/PCB analysis consist of a three-point curve. Analytes aldrin, endrin, 4,4'-DDT and dibutylchlorendate are required to have %RSD less than ten (10). After every five (5) analysis a standard shall be analyzed. Calibration factors for each analyte must be within fifteen (15) percent of the initial calibration factors for the quantitative column. Percent difference values for the qualitative column were required to be less than twenty (20) for each analyte calibration factor.

7.4 STANDARD CURVES FOR INORGANIC ANALYSIS

Standard curves used in the determination of inorganic analytes will be prepared as follows:

Standard curves derived from data consisting of one reagent blank and a minimum of three concentrations will be prepared for each inorganic analyte analyzed by atomic adsorption methods. Standard curves for Inductively Coupled Argon Plasma (ICAP) will consist of one method blank and one mid-ranged standard. The standard curve for mercury will be derived from data consisting of one reagent blank and minimum of four concentrations. The standard curve will be used with each subsequent analysis, provided the standard curve is verified by using at least one reagent blank and one standard at a level normally encountered or expected in such samples. If the results of the verification are not within +/-10% of the original curve, a new standard will be prepared and analyzed. If the results of the second verification are not within +/-10% of the original standard curve, a reference standard will be used to determine if the discrepancy is with the standard or with the instrument. New standards will also be prepared on a quarterly basis at a minimum. All data used in drawing or describing the curve will be so indicated on the curve or its description. A record will be made of the verification.

7.5 FIELD INSTRUMENT CALIBRATION

Calibration of the field instruments will be done prior to the collection of each water sample if well purging data indicate a change (>±10 percent) in pH and conductivity from the last location sampled. Calibration of field instruments will, however, be conducted at least daily during groundwater sampling. The field equipment will be maintained, calibrated and operated in a manner consistent with the manufacturer's guidelines and USEPA standard methods. However, since the majority of field measurements will be limited to pH, conductivity, temperature and depth (water level) the following procedures will be conducted, at a minimum:

1) pH

- calibrate daily against two buffer solutions with a pH of 7 and pH of 4.

A) Calibration of pH Meter

The pH meter will be calibrated with commercially obtained pH 7 and 4 buffer solutions. The pH calibration will be temperature compensated, and will be performed immediately before initiating a sampling event. Calibration checks will be performed with every sample collected. In the event that the result fails to be within 0.1 pH units, the meter must be recalibrated and all samples after the last calibration must be re-measured.

Calibration will be performed in accordance with the following procedure:

1) Rinse the probe in deionized water;
2) Insert probe in a fresh pH 7 buffer solution;
3) Slide battery compartment cover back to the first stop exposing the adjustment potentiometers;
4) Adjust the "CAL" potentiometer such that the display reads 7.00;
5) Remove the probe; rinse in deionized water;
6) Insert probe in a fresh pH 4 buffer solution;
7) Adjust the slope potentiometer until the correct pH is displayed; and
8) Remove probe; rinse in deionized water.

Additional manufacturer SOPs are included in Appendix B of this QAPP.

2) Conductivity

- calibrate daily against a standard solution of potassium chloride and deionized water.

B) Calibration of the Specific Conductivity Meter

The specific conductivity meter is factory calibrated, but the calibration should be checked, at minimum, daily and the probe thoroughly rinsed between samples. Calibration of the specific conductivity meter will be performed as follows:

1) Rinse probe in deionized water;
2) Wipe probe and allow to dry;
3) The conductivity displayed should be zero in air;
4) Adjust the zero potentiometer if necessary;
5) Immerse the probe in a solution of known conductivity;
6) Adjust the "SPAN" potentiometer such that the correct conductivity is displayed; and
7) Rinse probes thoroughly with deionized water and allow to dry.

Additional manufacturer SOPs are included as Appendix B of this QAPP.

8.0 ANALYTICAL PROCEDURES

8.1 OVERVIEW

All groundwater samples collected for VOC analyses will be analyzed using a modified version of the Contract Laboratory Program - Routine Analytical Service (CLP-RAS) method. Appendix A presents Radian's SOP for this low level volatiles analysis. Remaining analyses of semivolatiles, pesticides/PCB's and metals shall be conducted using the CLP-SOW for Organics Analysis from February 1988, including revisions from September 1988 and March 1989, and the CLP-SOW for Inorganic Analysis from July 1988, including revisions from February 1989 and June 1989.

8.2 IDENTIFICATION

Identification of all target TCL analytes will be accomplished with an authentic standard of the analyte. When authentic standards are not available (i.e., for non-TCL compounds) identification will be considered tentative.

For gas chromatographic determinations of specific analytes, the relative retention time of the unknown will be compared with that of an authentic standard. Since a true identification by GC is not possible, an analytical run for compound confirmation will be followed according to the specifications in the methods. Peaks must elute within daily retention-time windows established for each indicator parameter to be declared a tentative or confirmed identification. Retention-time windows are determined via a standard 72-hour study defined in each method. Results of the study are to be filed in the laboratory and available for inspection during a QC audit.

For gas chromatographic/mass spectrometric determinations of specific analytes, the spectrum of the analyte will conform to a literature representation of the spectrum or to a spectrum of the authentic standard obtained after satisfactory tuning of the mass spectrometer. The appropriate analytical methods will be consulted for specific criteria for matching the mass spectra, relative response factors, and relative retention times to those of authentic standards.

9.0 DATA REDUCTION, VALIDATION, ASSESSMENT, AND REPORTING

Radian will perform analytical data reduction and validation in-house under the direction of the laboratory QA officer. The laboratory QA officer will be responsible for assessing data quality and advising of any data which were rated "preliminary" or "unacceptable" or other qualifications based on the QC criteria outlined in the CLP-SOW. Figure 9.1 illustrates analytical data flow through the laboratory. Data reduction, validation, and reporting by the laboratory will be conducted as detailed in the following. It should be noted, however, that "sign-off" will be required following completion of each step.

- Raw data produced and checked by the responsible analyst is turned over for independent review by another analyst.

- The area supervisor reviews the data for attainment of quality control criteria presented in the referenced analytical methods.

- Upon completion of all reviews and acceptance of the raw data by the laboratory operations manager, a report will be generated and sent to the laboratory quality assurance officer.

- The laboratory quality assurance officer will complete a thorough inspection of all reports.

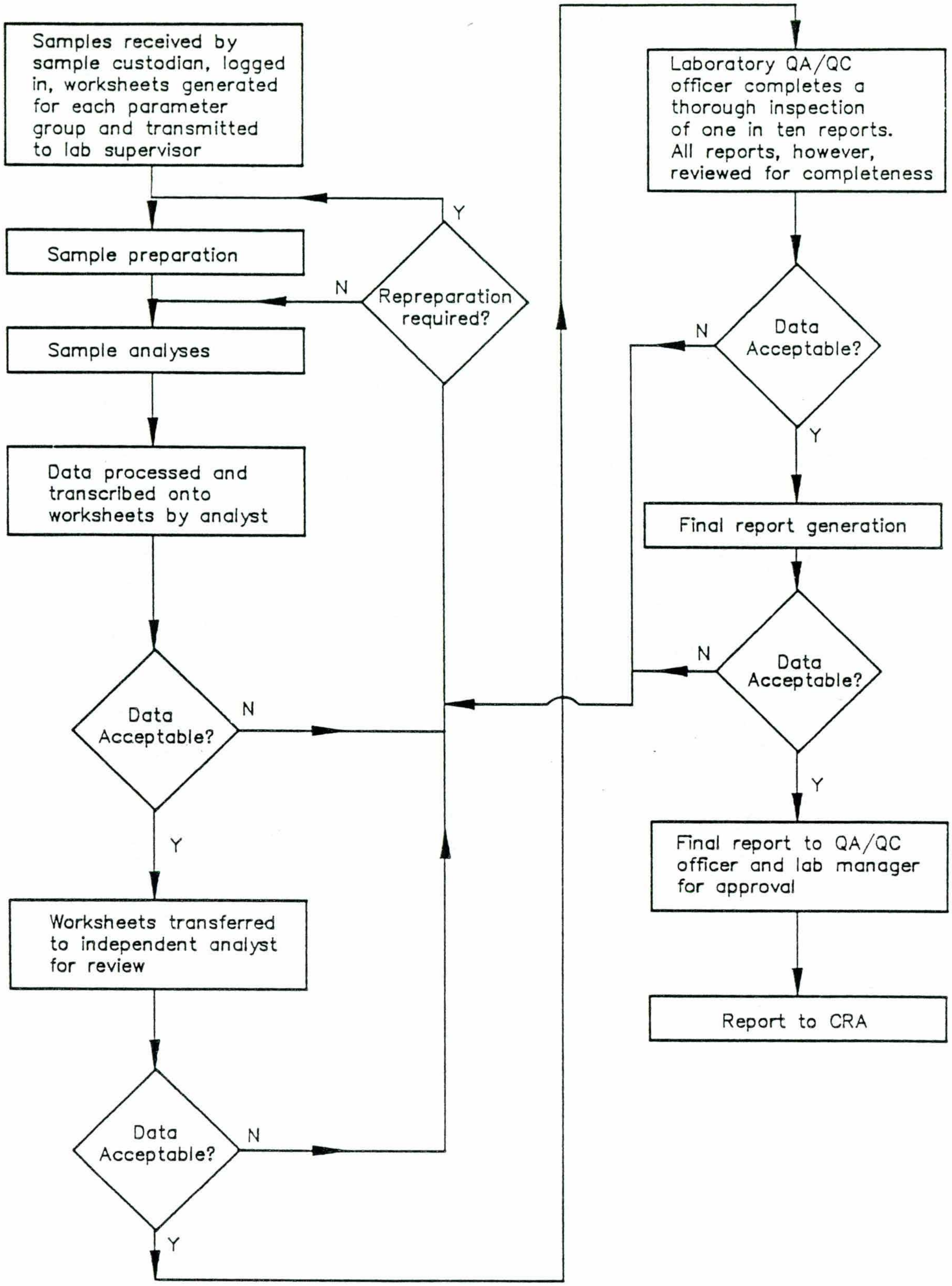

figure 9.1
ANALYTICAL DATA FLOW
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CRA

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- The QA officer and area supervisor will decide whether any sample re-analysis is required.

- Upon acceptance of the preliminary reports by the QA officer, final reports will be generated and signed by the laboratory manager.

The CRA QA Officer-Analytical Activities will conduct an evaluation of data reduction and reporting by the laboratory. These evaluations will consider the finished data sheets, compliance with holding time criterion, rinsate blank data, trip blank data, field duplicate data, and recovery data for surrogate and matrix spikes/matrix spike duplicates. The material will be checked for legibility, completeness, correctness, and the presence of requisite dates, initials, and signatures. The results of these checks will be assessed and reported to the project manager noting any discrepancies and their effect upon the acceptability of the data. All information garnered from QA/QC checks will be discussed in the assessment and monitoring reports

Validation of the analytical data will be performed by the CRA QA officer-analytical activities. The data validation shall be consistent with "Functional Guidelines for Evaluating Organics Analyses" (February 1988) and "Functional Guidelines for Evaluating Inorganics Analyses" (July 1988). Assessment of analytical and field data will include checks for data consistency by looking for comparability of duplicate analyses, potential sample contamination as indicated by results of blank sample analyses, laboratory QA procedures, adherence to accuracy and precision criteria, transmittal errors, and anomalously high or low parameter values. The results of these data validations will be reported to the project managers, noting any discrepancies and their effect upon acceptability of the data.

Raw data from field measurements and sample collection activities that are used in project reports will be appropriately identified and appended to the report. Where data have been reduced or summarized, the method of reduction will be documented in the report. In addition, field data will be audited for anomalously high or low values that may appear to be inconsistent with other data.

The data packets supplied by Radian to CRA will be consistent with deliverables specified by the CLP-SOWs. CLP-RAS form one will be modified to reflect the low level detection limits for volatiles as listed in Table 2.5.

10.0 INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

10.1 FIELD QUALITY CONTROL

Quality control procedures for field measurements will be limited to checking the reproducibility of the measurement in the field by obtaining multiple readings and by calibrating the instruments (where appropriate).

Quality control of field sampling will involve collecting field duplicates and rinsate blanks in accordance with the applicable procedures described in the GMP.

10.2 LABORATORY QUALITY CONTROL

Specific procedures related to internal laboratory QC samples (namely, matrix spikes, surrogate spikes, blanks, QC check samples and matrix spike duplicates) are detailed in the following subsections.

10.2.1 Blanks

A VOC reagent blank will be analyzed by Radian every 12 hours of instrument time. Reagent blanks for BN/A and Pest/PCB analyses will be analyzed at a frequency of one blank per twenty analyses or, in the event that an analytical round consists of less than twenty samples, one reagent blank will be analyzed. A reagent blank will be prepared for each batch of samples prepared for metals and cyanide analyses. Highly contaminated samples shall be followed by the reagent blank until a negative result is obtained. The reagent blank, an aliquot of analyte-free water or solvent, will be carried through the entire analytical procedure.

10.2.2 Matrix Spikes/Matrix Spike Duplicates (MS/MSD)

A MS/MSD sample will be analyzed at a minimum frequency of 1 in 20 for each. Table 10.1 presents a summary of the compounds and acceptable criteria for MS/MSD analyses for organic parameters. Percent spike recoveries will be used to evaluate analytical accuracy, while relative percent difference between the matrix spike and matrix spike duplicate analyses will be used to assess analytical precision.

Inorganic matrix spike analyses are required to fall within 25 percent of the spike added. Frequency of analysis shall be one in 10. Replicate analyses will be analyzed a minimum of one in 10.

TABLE 10.1
MS/MSD PERCENT RECOVERY RANGES AND RPD FOR ORGANIC ANALYSES GROUNDWATER MONITORING PROGRAM - QAPP

Analysis	*Parameter*	*% Recovery*[1]
VOC	1,1-Dichloroethene	61-145 (14)
	Trichloroethene	71-120 (14)
	Chlorobenzene	75-130 (14)
	Toluene	76-125 (13)
	Benzene	76-127 (11)
BN	1,2,4-Trichlorobenzene	39-98 (28)
	Acenaphthene	46-118 (31)
	2,4-Dinitrotoluene	24-96 (38)
	Pyrene	26-127 (31)
	N-Nitroso-di-n-propylamine	41-116 (38)
	1,4-Dichlorobenzene	36-97 (28)
Acid	Pentachlorophenol	9-103 (50)
	Phenol	12-89 (42)
	2-Chlorophenol	27-123 (40)
	4-Chloro-3-methylphenol	23-97 (42)
	4-Nitrophenol	10-80 (50)
PEST/PCB	Lindane	56-123 (50)
	Heptachlor	40-131 (31)
	Aldrin	40-120 (43)
	Dieldrin	52-126 (38)
	Endrin	56-121 (45)
	4,4'-DDT	38-127 (50)

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[1] Values in parentheses indicate maximum acceptable relative percent difference (RPD) between duplicate analyses.

10.2.3 Surrogates

Surrogates are used in all organic analysis. Every blank, standard, and environmental sample including matrix spike/matrix duplicate samples will be spiked with surrogate compounds prior to purging volatiles.

Surrogates will be spiked into samples according to each analytical method. Surrogate spike recoveries will fall within the control limits set by procedures specified in the method for analytes falling within the quantification limits without dilution. Dilution of samples to bring the analyte concentration into the linear range of calibration may dilute the surrogates out of the quantification limit; assessment of analytical quality in these cases will be based on the quality control embodied in the matrix spike and matrix spike duplicate samples.

Table 10.2 presents a summary of the surrogate recovery control limits.

10.2.4 Continuing Calibration Check

A continuing calibration check shall be performed for every 12 hours of instrument time and shall be compared to the initial calibration curve.

TABLE 10.2
SURROGATE COMPOUNDS PERCENT RECOVERY LIMITS GROUNDWATER MONITORING PROGRAM - QAPP

Analysis	*Parameter*	*% Recovery*
VOC	d_8-Toluene	88-110
	4-Bromofluorobenzene	86-115
	d_4-1,2-Dichloroethane	76-114
BN	d_5-Nitrobenzene	35-114
	2-Fluorobiphenyl	43-116
	d_{14}-*p*-Terphenyl	33-141
Acid	d_6-Phenol	10-94
	2-Fluorophenol	21-100
	2,4,6-Tribromophenol	10-123
PEST/PCB	Dibutylchlorendate	24-154

11.0 PERFORMANCE AND SYSTEM AUDITS AND FREQUENCY

11.1 FIELD AUDITS

System audits of field protocols may be instigated by CRA's QA Officer Field Activities and/or the project manager. The audit shall include the following:

- check for proper decontamination of field equipment
- custody of samples maintained at all times
- proper sample handling procedures

Field audits will be conducted once in the first six months of operation and annually thereafter.

External field audits shall be carried out via the Regional V Central Regional Laboratory and/or the Central District Office.

11.2 LABORATORY AUDITS

For the purpose of external evaluation, performance evaluation check samples from the U.S. EPA and various State agencies are analyzed periodically by the laboratory.

Internally, the evaluation of data from these samples is done on a continuing basis over the duration of a given project.

The laboratory QA officer may carry out performance and/or systems audits to insure that data of known and defensible quality are consistently produced during a program.

Systems audits are qualitative evaluations of all laboratory quality control measurement systems. They determine if the measurement systems are being used appropriately. The audits may be carried out before all systems are operational, during the program, or after the completion of the program. Such audits typically involve a comparison of the activities given in the QA/QC plan described herein, with activities actually scheduled or performed. A special type of systems audit is the data management audit. This audit addresses only data collection and management activities.

The performance audit is a quantitative evaluation of the measurement systems used for a monitoring program. It requires testing the measurement systems with samples of known composition or behavior to evaluate precision and accuracy. A performance/system audit may be carried out by, or under the auspices of, the U.S. EPA Region V Central Regional Laboratory, without the knowledge of the analyst during each sampling event for this program. The scheduling of Performance Evaluation (PE) audits will be at the discretion of U.S. EPA.

In addition, one project internal QA audit may be conducted by CRA prior to the analyses of any investigatory samples. It should be noted, however, that any additional project internal QA audits will only be performed if deemed necessary by either Marathon's or CRA's project manager or QA officers. The project laboratory may also undergo PE audit(s) by the U.S. EPA, if so requested.

12.0 PREVENTIVE MAINTENANCE

All analytical instruments to be used in this project will be serviced by the laboratory personnel at regularly scheduled intervals in accordance with the manufacturers recommendations. A copy of the appropriate section of the contract laboratory's QAPP describes preventative maintenance procedures is included in Appendix C. Instruments may also be serviced at other times due to failure. Requisite servicing beyond the abilities of the laboratory personnel will be performed by the equipment manufacturer or their designated representative.

Daily checks of each instrument will be by the analyst who has been assigned responsibility for that instrument. This will include tuning GC/MS, checking operation of data systems, checking for leaks, etc. Manufacturer's recommended procedures will be followed in every case.

The pH meter will be calibrated in the field as described in Section 7.3. In addition, the following preventative maintenance measures will be taken in the field:

pH, Conductivity	- Keep probes clean and free of dirt by rinsing with deionized water. - Keep deionized water around probes to prevent dehydration.

Water Level Tape	-	Clean probe and lower 3 feet of tape with deionized water to prevent hard water and iron buildup.

13.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

13.1 QA MEASUREMENT QUALITY INDICATORS

13.1.1 Precision

Precision will be assessed by comparing the analytical results between matrix spike/matrix spike duplicates percent recoveries for organic samples and replicate analyses for inorganic samples.

13.1.2 Accuracy

Accuracy will be assessed by comparing a set of analytical results to the accepted or "true" values that would be expected. In general, surrogate recoveries, matrix spike/matrix spike duplicates analyses, and check sample recoveries will be used to assess accuracy.

13.1.3 Outliers

Procedures discussed previously and in Section 14.0 will be followed for documenting deviations. In the event a result deviates significantly from established control limits, this deviation will be noted and its effect on the quality of the remaining data assessed and documented.

13.2 STATISTICAL EVALUATIONS

In examination of data and determination of its precision and accuracy, standard statistical formulae will be used. Among these are the following:

1) Mean of Measurements Generated by Each Sample Parameter ($\bar{X}$)

$$\bar{X} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

where N = number of measurements
X_i = value of the measurement

2) Standard Deviation of a Series of Individual Determination(s)

$$s = \sqrt{\frac{\sum_{i=1}^{N} X_i^2 - \frac{\left(\sum_{i=1}^{N} X_i\right)^2}{N}}{N-1}}$$

where N = number of measurements
X_i = value of the measurement

3) Confidence Interval (CI)

$$CI = \overline{X} \pm \ t_q S_{\overline{x}}$$

Where t_q is taken from a table of Student's for the appropriate number of degrees of freedom

4) Standard Deviation from Duplicate Analyses

$$\text{Standard Deviation} = \sqrt{\frac{1}{2N} (\text{Sum of } d^2)}$$

N = degree of freedom
d = difference between duplicates

5) Percent Relative Standard Deviation (% RSD)

$$\%RSD = \frac{s}{\overline{x}} \quad X \quad 100$$

N.B. = RSD will be used to assess analytical precision
s = standard deviation for a series of individual measurements
$\overline{x}$ = mean of the measurements

significantly from established control limits, this deviation will be noted and its effect on the quality of the remaining data assessed and documented.

13.2 STATISTICAL EVALUATIONS

In examination of data and determination of its precision and accuracy, standard statistical formulae will be used. Among these are the following:

1) Mean of Measurements Generated by Each Sample Parameter ($\bar{X}$)

$$\overline{X} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

where N = number of measurements
X_i = value of the measurement

2) Standard Deviation of a Series of Individual Determination(s)

$$s = \sqrt{\frac{\sum_{i=1}^{N} X_i^2 - \frac{\left(\sum_{i=1}^{N} X_i\right)^2}{N}}{N-1}}$$

where N = number of measurements
X_i = value of the measurement

3) Confidence Interval (CI)

$$CI = \overline{X} \pm t_q S_{\overline{x}}$$

Where t_q is taken from a table of Student's for the appropriate number of degrees of freedom

4) Standard Deviation from Duplicate Analyses

$$\text{Standard Deviation} = \sqrt{\frac{1}{2N} (\text{Sum of } d^2)}$$

N = degree of freedom
d = difference between duplicates

5) Percent Relative Standard Deviation (% RSD)

$$\%RSD = \frac{s}{\overline{x}} \quad X \quad 100$$

N.B. = RSD will be used to assess analytical precision
s = standard deviation for a series of individual measurements
$\overline{x}$ = mean of the measurements

14.0 CORRECTIVE ACTION

The need for corrective action may be identified by system or performance audits or by standard QC procedures. The essential steps in the corrective action system will be:

- Checking the predetermined limits for data acceptability beyond which corrective action is required;
- Identifying and defining problems;
- Assigning responsibility for investigating the problem;
- Investigating and determining the cause of the problem;
- Determination of a corrective action to eliminate the problem (This may include reanalyses or resampling and analyses);
- Assigning and accepting responsibility for implementing the corrective action;
- Implementing the corrective action and evaluating the effectiveness;
- Verifying that the corrective action has eliminated the problem; and

- Documenting the corrective action taken.

For each measurement system, the QA officer-analytical activities will be responsible for initiating the corrective action and the laboratory supervisor will be responsible for implementing the corrective action. The corrective action taken will depend upon the QA/QC criteria that did not meet the necessary criteria, and may range from qualifying the data to resampling on the Site.

15.0 QUALITY ASSURANCE REPORT TO MANAGEMENT

Management will receive reports on the performance of the measurement system and the data quality following each sampling round.

Minimally, these reports will include:

- Assessment of measurement quality indicators, i.e., data accuracy, precision and completeness;
- Results of system audits; and
- QA problems and recommended solutions.

The project QA officers will be responsible within the organizational structure for preparing these periodic reports. The assessment report for the project will also include a separate QA section which will summarize data quality information contained in the periodic QA/QC reports to management, and details an overall data assessment and validation in accordance with the data quality objectives outlined in this QAPP.

APPENDIX A

STANDARD OPERATING PROCEDURES:
LABORATORY AND FIELD MEASUREMENTS

Group: GC/MS Procedure:

According to the CLP SOW, 2/88, the following modifications are:

1. 25ml purge volume is utilized for all standards, blanks and samples.

2. The initial calibration, containing all CLP TCL compounds, consists of five points at concentrations of 4, 10, 20, 30, and 40ug/L. Because of the poor purging efficiency of bromoform and 1,1,2,2-tetrachloroethane and the large purge volume, the SPCC RF criteria for these compounds is lowered to 0.10. All other SPCC and CCC criteria for the initial calibration are identical to the CLP SOW.

3. The calibration check standard, containing all CLP TCL compounds, is analyzed at 10ug/L. Because of the poor purging efficiency of bromoform and 1,1,2,2-tetrachloroethane and the large purge volume, the SPCC RF criteria for these compounds is lowered to 0.10. All other SPCC and CCC criteria for the continuing calibration are identical to the CLP SOW.

4. Internal standards and surrogates, identical to the CLP specified compounds, are spiked at a concentration of 10ug/L for all standards, blanks, and samples.

5. Matrix spike compounds are spiked at a concentration level of 10ug/L and consist of the identical compounds specified in the CLP SOW.

All other QC criteria as specified in the SOW, including tune criteria, blanks, internal standard and surrogate recoveries, etc., are identical to those specified in the SOW.

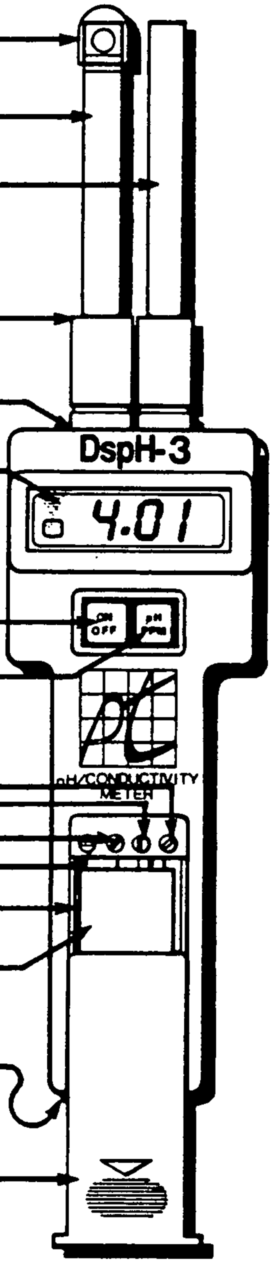
Detection limits have been experimentally determined to be a minimum of five times lower than the CLP reporting limits.

DspH - 3 pH/3 RGE CONDUCTIVITY METER

- pH
- CONDUCTIVITY

1of2

DspH-3 pH/3 RGE. CONDUCTIVITY METER



1. Vinyl storage cap
2. pH electrode
3. Conductivity electrode
4. *Do not immerse below electrode caps
5. Electrode pivot hinge
6. LCD display and enunciators:
   pH
   PPM (μS)
   X 10
   Lo Bat
7. On/Off switch
8. pH/PPM (μS) switch
9. Conductivity adjustment potentiometers: Zero
   Span
10. pH adjustment potentiometers: Cal
    Slope
11. Battery compartment
12. 9V transistor battery
13. Sliding electrode storage compartment (not shown)
14. Battery compartment door

PRESTO-TEK
CORPORATION

CRYSTAL VEND DIV. / INSTRUMENT DIV. / PUMP DIV.
4101 North Figueroa Street, Los Angeles, CA 90065
In California call: (213) 221-1178
Call Toll Free: 1 (800) 421-8660
EasyLink 62935437

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OPERATING INSTRUCTIONS

1. Slide back electrode compartment to release pH and conductivity electrodes.
2. Deploy electrodes in either the 90 or 180 degree measurement position.
3. Energize by depressing the On/Off switch once.
4. Immerse electrodes into solution to be measured. For proper operation, immerse electrodes ½ their length.
5. When energized, the LCD enunciator will indicate which parameter is being measured. E.G. pH, PPM (µS), or PPM (µS) X10. Only the 200K range utilizes the X10 enunciator. 20K and 2K are direct readings. Note selection sequence in #7. Overrange conductivity is indicated by a 1. Proceed to higher range for reading.
6. Agitate electrodes briefly and observe the reading.
7. For each range change desired, depress the pH/PPM (µS) switch once. This unit utilizes 3 ranges of conductivity. The range sequence is: pH-200K-20K-2K.
8. Rinse electrodes thoroughly and replace pH storage cap before returning to storage compartment.

CALIBRATION INSTRUCTIONS

Your instrument has been pre-calibrated prior to shipment. Calibration should be performed periodically with fresh pH buffers and known conductivity solutions.

pH MODE

1. Rinse the pH probe in distilled water.
2. Insert in a fresh #7 buffer solution.
3. Slide back the battery compartment cover to the first stop exposing the adjustment pots.
4. Adjust the CAL pot until the display reads 7.00.
5. Remove probes, rinse and insert in a #4 or 10 buffer solution.
6. Adjust the SLOPE pot until the display reads the correct value.

CONDUCTIVITY MODE

1. Rinse probes thoroughly by agitating in pure water.
2. Wipe off conductivity probe and allow to dry.
3. Once dry, conductivity should read 0 in air.
4. Adjust ZERO pot if reading is incorrect.
5. Immerse sensor in known conductivity solution. Adjust SPAN pot to desired conductivity value.
6. Only a single point calibration in the 2K range is required to standardize. However, if unit is to be used primarily in higher ranges, it is recommended that the single point calibration be performed near point of use for best resolution.
7. Rinse probes and return to storage compartment.

HELPFUL HINTS

1. Electrodes should be rinsed thoroughly after each test.
2. Be sure to replace the protective pH cap after each use.
3. Fill the cap with a small amount of pH 4 buffer or tap water.
4. If the conductivity probe does not zero, it may indicate dried solids on the sensor. Clean with a mild detergent solution.
5. For best results, calibrate pH with a buffer that is within 3 pH units of the test sample.
6. Choose a conductivity calibration solution that is near the samples to be measured.
7. Remove the battery when the instrument will be stored for a long period.

TEMPERATURE

Method 170.1 (Thermometric)

STORET NO. 00010

1. Scope and Application
   1.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.
2. Summary of Method
   2.1 Temperature measurements may be made with any good grade of mercury-filled or dial type centigrade thermometer, or a thermistor.
3. Comments
   3.1 Measurement device should be routinely checked against a precision thermometer certified by the National Bureau of Standards.
4. Precision and Accuracy
   4.1 Precision and accuracy for this method have not been determined.
5. Reference
   5.1 The procedure to be used for this determination is found in:
   Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 125, Method 212 (1975).

Approved for NPDES
Issued 1971

APPENDIX B

STANDARD OPERATING PROCEDURES: DOCUMENTATION/CHAIN OF CUSTODY

RADIAN
CORPORATION

Radian Analytical Services - Sacramento 322-SP-004 1 of 2

Monitoring Incoming Samples

1.0 PURPOSE

1.1 To ensure accurate information for incoming samples.

1.2 To provide data to assess instrument and personnel capacities.

1.3 To provide data for projecting laboratory capacity and revenues.

1.4 To provide data for directing marketing strategies.

2.0 MONITORING INCOMING SAMPLES

2.1 Sample monitoring is done by Client Support Coordinator, Operations Manager, Technical Director or Marketing Associate.

2.2 The Sample Control Center has established a mechanism by which sample monitoring is done both routinely and effectively. This mechanism is the Internal Client Contact (ICC) form shown in Figure 1.

2.2.1 The ICC allows collection of pertinent client information which is routed to Operations Manager and appropriate laboratory personnel.

2.2.2 This form allows the collection of client information:

a. Company contact
b. Company name
c. Name of individual preparing contact
d. Project
e. Location
f. Phone number

2.2.3 It allows the documentation of requested analytical services data:

a. Analytical methods requested
b. Number of sample submission
c. QC requirements
d. Frequency of QC
e. Price

2.2.4 It can also document:

a. Shipment supplies requirements
b. Reportable data vs non-reportable data
c. Other special request packages
d. Final report contact and address

2.3 This form offers a detailed description of incoming work as well as projection data for future work.

3.0 SAFETY

Normal laboratory and office safety practices will apply. See Radian Corporation Health and Safety Manual.

1.0 PURPOSE

1.1 To ensure chain-of-custody requirements are met upon sample receipt and inspection.

1.2 To enforce proper documentation and handling of sample receipt discrepancies.

1.3 To increase awareness of safety requirements in handling hazardous samples.

1.4 To specify differences in receipt of CLP vs commercial samples.

2.0 SAMPLE RECEIPT - Overview

2.1 Samples are received at the rear door of the Sacramento Analytical Services facility by the shipping clerk or designee who logs shipments in immediately.

2.2 Samples are then released to Sample Control Custodian for inspection in the Sample Control receipt area.

2.3 Before inspection begins routine safety requirements should be met (i.e. gloves, overcoat, safety glasses, closed-toe shoes, etc). Custodian should check chain-of-custody for notification of special handling instructions to see if samples are deemed hazardous vs non-hazardous.

2.4 The Custodian then completes the Sample Control inspection and documentation before transferring the documents to the Sample Control Supervisor.

2.5 Supervisor or designee then log-in samples on Analytical Services Sample and Analysis Management (SAM®) computer system.

2.6 Each sample container should arrive at Sacramento Analytical Services with a tag or sample label containing the sample number and sample description to identify the contents of the bottle. Additionally, the sample number shall be marked on the outside of any special packaging containers to facilitate identification. Typical sample tags or labels are shown in Figure 1.

2.7 Prior to shipment, each sample within a packing container is identified on a chain-of-custody record (Analytical Services), Figure 2 or on SMO Traffic Reports or EPA Chain-of-Custody, as shown in Figure 3. Each sample I.D. and the number of containers shipped are recorded on the sheets. Other information regarding the project such as, date of collection, shipper, method of shipment, analytical requirements, shipper signature and date are entered on the sheet. The original custody sheet is then placed inside the package protected from damage. The package must be sealed upon arrival.

2.8 Sample containers, shipped boxes, coolers or other packages may be sealed by using the seals shown in Figure 4. The seal should be placed so the containers could not be opened without breaking it.

3.0 SAMPLE INSPECTION - Procedure

3.1 Upon receipt of samples in custody, inspect the package and note any damage to the sealing tape or custody seals. Note on the custody record that the seals or locks were intact upon receipt and that no tampering or damage appears to have occurred.

3.2 The Sample Custodian will record the following information on the sample log-in form (Figure 5) for EPA samples or chain-of-custody form for commercial clients.

- a. Presence/absence of custody seal(s) on the shipping container(s).
- b. Condition of custody seal (i.e., intact, broken).

3.3 Move the shipping container to the designated inspection area. Open the package and verify that each item listed on the sheet is present and correctly identified. The Sample Custodian will record the following on the sample log-in form.

- a. Presence/absence of the chain-of-custody record(s).
- b. Presence/absence of SMO forms (Traffic Reports, Chronicles).
- c. Presence/absence of airbills and/or bills of lading documenting shipment of samples.

3.4 Remove sample containers and record on the sample log-in form:

- a. Condition of samples (intact, broken, leaking, etc.).
- b. Presence/absence of sample tags (EPA samples only).

<u>If Sample Tags are Present</u>:

- c. Record sample tag document control numbers.

d. Compare with chain-of-custody record(s) - if tag numbers are listed, do they match the sample tag numbers received?

e. Document whether these numbers agree. If there is a discrepancy between tag numbers received and those listed on the chain-of-custody record, document this and notify Sample Control Supervisor.

f. If sample tag numbers are not listed on the chain-of-custody record, record this fact.

3.5 Compare the following documents to verify agreement among the information contained on them:

a. Chain-of-custody records.
b. Sample tags.
c. Sample Management Office (SMO) forms.
d. Airbills or bills of lading.

3.6 Document any discrepancies found.

a. If discrepancies are found, notify Sample Control Supervisor who will contact SMO or commercial client for clarification. Supervisor will document resolution of discrepancies, person contacted, time and date of contact on chain-of-custody.

b. If all samples recorded on the chain-of-custody record were received in the lab and there were no problems observed with the sample shipment, the Custodian will sign the chain-of-custody record in the "received for laboratory by:" box on the document. Chain-of-Custody will be released to SCS for log-in.

4.0 SAFETY

4.1 When unpacking and inspecting samples, Sample Control personnel are required to wear safety glasses, gloves, lab overcoat, and closed toe shoes.

4.2 If there is a definite odor transmitting from samples a respiratory maybe necessary.

4.3 Sample containers should be appropriately cleaned before handling to prevent slippage and/or breakage.

5.0 QA

5.1 Each work order is closely checked by Sample control Supervisor or Client Support Coordinator by sample I.D.

5.2 If there is a discrepancy during log-in, correction will be made before sample analysis or clean-ups begin.

RADIAN
CORPORATION

Sample Control 000-00-00
Sample Check-out/Sample Storage 1 7/10/87
10/87

1.0 PURPOSE

1.1 To define procedures and specific documentation format for logging samples into and out of refrigerators and other storage locations.

1.2 To ensure that sample tracking from sample receipt to disposal is achievable.

2.0 SAMPLE STORAGE

2.1 Sample storage area is controlled by Sample Custodian.

2.2 After inspection and sample log-in has been accomplished, samples are stored in designated areas. Storage areas are determined as follows:

- GC VOA's are stored in GC VOA refrigerator
- GC/MS VOA's are stored in GC/MS VOA refrigerator
- GC extractables can be stored in walk-in 2 or Sample Control Deli Refrigerator
- GC/MS extractables can be stored in walk-in 2 or Sample Control Deli Refrigerator
- Inorganics are stored in Inorganics walk-in

2.3 Samples are logged into designated area by Sample Control Supervisor or designee.

2.4 The procedure for log-in of samples to a specific storage area requires the Sample Control personnel to log-in the following information to the appropriate refrigerator logbooks: (See Figure 1).

- date of storage
- SAM work order number
- initials of designee responsible for storage
- number of samples stored

2.5 Logbook is placed securely in holder located on refrigerator.

2.6 Refrigerator is locked to maintain security of sample as per chain-of-custody requirements.

2.7 Keys are returned to Sample Control in a secured area.

3.0 SAMPLE CHECK-OUT

3.1 Once a sample has been stored, access to the sample is only permitted through the sample check-out procedure. This procedure requires the analyst to log into the sample check-out log book the following information:

1. work order number
2. sample or split removed
3. date out
4. time
5. destination
6. initials
7. date returned

8. time
9. initials
10. comments

4.0 SAMPLE RETURN

4.1 After analyses have been performed, remaining samples are returned by analyst to original storage designation. He/She indicates when the return took place and who returned it.

4.2 If sample containers are empty analyst should indicate on logbook the status of the samples and transfer location for disposal.

4.3 Empty containers are normally transferred to walk-in 1 until disposal authorization has been obtained.

4.4 Samples are logged into walk-in 1 logbook as a transfer from original storage designation.

4.5 When disposal is necessary, each sample is then logged out indicating disposal, designee responsible for disposal, and date of disposal. (For further information, see Sample Disposal Notification).

APPENDIX C

CONTRACT LABORATORY: PREVENTATIVE MAINTENANCE PROCEDURES

SECTION 9

PREVENTATIVE MAINTENANCE

9.0 INTRODUCTION

The primary objective of a preventative maintenance program is to help ensure the timely and effective completion of a measurement effort. Radian's preventative maintenance program is designed to minimize the down time of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas:

- Establishment of maintenance responsibilities;
- Establishment of maintenance schedules for major and/or critical instrumentation and apparatus; and
- Establishment of an adequate inventory of critical spare parts and equipment.

9.1 Maintenance Responsibilities

Maintenance responsibilities for permanently assigned equipment are assigned to the respective laboratory supervisors. The laboratory supervisors then establish maintenance procedures and schedules for each major equipment item. Responsibilities for specific items may be delegated to laboratory personnel, although the laboratory supervisors retain responsibility for ensuring adherence to prescribed protocol.

9.2 Maintenance Schedules

The effectiveness of any maintenance program depends to a large extent on adherence to specific maintenance schedules for each major equipment item. A specific schedule is established for all routine maintenance activities. Other maintenance activities may also be identified as requiring attention on an as-needed basis. Manufacturers' recommendations provide the primary basis for the established maintenance schedules, and manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC instruments, atomic absorption spectrometers, analytical balances, etc.). All aspects of routine and nonroutine instrument maintenance are recorded in logbooks, and a logbook is dedicated to each instrument.

9.3 Spare Parts

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. This inventory should emphasize those parts (and supplies) which:

- are subject to frequent failure;
- have limited useful lifetimes; or
- cannot be obtained in a timely manner should failure occur.

Laboratory supervisors are responsible for maintaining an adequate inventory of necessary spare parts.

RADIAN
CORPORATION

STANDARD OPERATING PROCEDURE

MAINTENANCE OF GC/MS SEMIVOLATILE INSTRUMENT
FINNIGAN 4500 AND 4000

I. Maintenance Performed on a Routine Basis.

   A. Replace vacuum pump oil in mechanical pumps to be performed once each 6 months or sooner if vacuum performance degrades.

   B. Replace diffusion pump oil at a frequency of once each two years or less if vacuum performance degrades.

II. Maintenance Performed on An As Needed Basis.

   A. Clean ion source and ion volume (Model 4000) if tuning criterion of BFB cannot be met. Replace disposable ion source (Model 4500) if tuning cannot be met.

   B. Replace consumables (filaments and multipliers, ec.) on an as needed basis if SW8240 performance specifications cannot be met.

STANDARD OPERATING PROCEDURE

Maintenance of Varian 3700 (Pesticides/PCB)

I Maintenance Performed on a Routine Basis

A. Replace septum after every 100 injections

II Maintenance Performed on an as needed basis

A. Bake out column overnight or longer if necessary. Do Not exceed maximum temperature for column.

B. Clean or replace liner or column splitter if breakdown is a problem. Resilanize if necessary.

C. Break off front end of column (1-3 ft.) or solvent flush column.

D. Clean or replace electron capture detector if the response is erratic.

E. If retention times vary, check for leaks and check gas flow.

STANDARD OPERATING PROCEDURE

ICP Preventive Maintenance

I. Every 6 months, change the vacuum pump oil - or when the vacuum gauge reaches 10 millitorr.

II. Every 2 weeks (or after particularly nasty samples) clean the torch and mixing chamber. Align the torch vertically and horizontally after putting the torch back in. Profile manually on Cu.

III. About every 1-2 months clean the cooling air filters (as needed).

IV. Change pump tubing about every 2 weeks or as needed.

V. Periodically check fatigue lamp to make sure it's working.

VI. Periodic maintenance is provided by manufacturer according to terms of service agreement.

STANDARD OPERATING PROCEDURE

AA Preventive Maintenance

I. Contact cones are cleaned with methanol and Q-tips to remove soot each time a new tube is installed.

II. Contact cones are replaced if noticeable wear has occurred. Check each time a tube is replaced.

III. Quartz windows are inspected every 2 days and cleaned as needed.

IV. Disk drives are cleaned every month.

V. Water recirulator water level checked every month, air filter checked and cleaned as needed every three months.

VI. Periodic maintenance is provided by manufacturer according to terms of service agreement.

STANDARD OPERATING PROCEDURE

Technicon Autoanalyzer Preventive Maintenance

Prior to analysis:

Pump Brij solution through reagent lines before pumping reagents.
Pump deionized water through all lines that pass through auto distiller. Never pump Brij through auto distiller.
After 15 min. start pumping reagents and wait 30 min. to establish baseline.

After analysis:

Pump Brij through reagent lines for 15 min.
Pump deionized water through auto distiller.
After 10 minutes remove tubes and pump dry - once dry, turn off all power and release tension on reagent lines.
Replace tubes after 50-60 hours of use.