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HydroGeoLogic, Inc
Exceeding Expectations

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Kansas City Operations

October 13, 2010

Mr. Jim Seiler
AES Project Officer
U.S. Environmental Protection Agency, Region 7
901 North 5th Street
Kansas City, KS 66101

RE: Final Sampling and Analysis Plan and Site Management Plan for the Remedial Design, Garvey Elevator Site, OU1, Hastings, Nebraska.
U.S. EPA Region 7 AES Contract No. EP-S7-05-05; Task Order No. 0046
EPA Task Order Project Officer: Brian Zurbuchen, Ph.D.

Dear Mr. Seiler:

HydroGeoLogic, Inc. (HGL) is pleased to submit two hard copies of the Final Sampling and Analysis Plan (SAP) and Site Management Plan (SMP) for the Remedial Design, Garvey Elevator Site, OU1, Hastings, Nebraska. This document was prepared in accordance with Task Order 0046, our EPA-approved Task Order Proposal Revision 1 (July 7, 2010), and the EPA comments received on October 1, 2010. The SAP comprises the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) and includes the site Health and Safety Plan (HSP) as an appendix.

As requested by EPA, two additional hard copies of the final SAP and SMP will be sent to Laurie Brunner at the Nebraska Department of Environmental Quality. Should you have any questions or comments, please contact us at 913-317-8860.

Sincerely,

[redacted], P.G., CHMM
AES Program Manager

Enclosures

Hard copy does not match CD
CD contains the complete document
minus transmittal letter

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FINAL
SAMPLING AND ANALYSIS PLAN
REMEDIAL DESIGN
GARVEY ELEVATOR SITE
HASTINGS, NEBRASKA

Prepared for:

U.S. Environmental Protection Agency Region 7
901 North 5th Street
Kansas City, KS 66101

Architect and Engineering Services Contract EP-S7-05-05
Task Order: 0046

October 2010

HydroGeoLogic, Inc

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FINAL
SAMPLING AND ANALYSIS PLAN
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GARVEY ELEVATOR SITE
HASTINGS, NEBRASKA

Prepared for:

U.S. Environmental Protection Agency Region 7
901 North 5th Street
Kansas City, KS 66101

Prepared by:

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Overland Park, KS 66202

October 2010

SAMPLING AND ANALYSIS PLAN
REMEDIAL DESIGN
GARVEY ELEVATOR SITE
HASTINGS, NE
TASK ORDER 0046

PROJECT: Remedial Design
Garvey Elevator Site, Hastings, NE

TASK ORDER NUMBER: 0046

HYDROGEOLOGIC, INC.
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U.S. ENVIRONMENTAL PROTECTION AGENCY – REGION 7
TASK ORDER PROJECT OFFICER (TOPO): Brian Zurbuchen, Ph.D.

PREPARATION DATE: October 13, 2010
PLAN PREPARER: HGL
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DOCUMENT DISTRIBUTION LIST:

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LIST OF ACRONYMS AND ABBREVIATIONS

AES	Architect and Engineering Services
AGP	Ag Processing, Inc.
amsl	above mean sea level
AOC	Administrative Order on Consent
AST	above ground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
°C	degrees celsius
CS_2	carbon disulfide
CCl_4	carbon tetrachloride
CDM	CDM Federal Programs
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfm	cubic foot per minute
CFR	Code of Federal Regulations
COC	chain of custody
CSM	conceptual site model
DBA	Database Administrator
DHHS	Department of Health and Human Services
DM	Data Manager
DMP	Data Management Plan
DOT	Department of Transportation
DPT	direct-push technology
DQI	data quality indicators
DQO	data quality objective
EC	electroconductivity
EDB	ethylene dibromide
EDD	electronic data deliverable
EMSL	Environmental Monitoring Systems Laboratory
EPA/USEPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
ESA	environmental site assessment
ESRI	Environmental System Research Institute
°F	degrees Fahrenheit
FS	Feasibility Study

FFS	Focused Feasibility Study
FSP	Field Sampling Plan
ft	foot/feet
ft/day	feet per day
FTL	field team leader
GC/MS	gas chromatography/mass spectrometry
GET	groundwater extraction and treatment
GIS	Geographic Information System
gpd/ft	gallons per day per foot
gpm	gallons per minute
HGL	HydroGeoLogic, Inc.
HHRA	human health risk assessment
HICA	Hastings Institutional Control Area
hp	horsepower
HSP	Health and Safety Plan
IDW	investigation-derived waste
INW	Instrumentation Northwest, Inc.
LCS	laboratory control sample
MCL	maximum contaminant level
$\mu g/m^3$	micrograms per cubic meter
$\mu g/L$	micrograms per liter
mL	milliliter
mm	millimeter
MOA	memorandum of agreement
MQOs	measurement quality objectives
MS	matrix spike
MSD	matrix spike duplicate
MW	monitoring well
NAD	North American Datum
NAVD	North American Vertical Datum
NDEQ	Nebraska Department of Environmental Quality
NIST	National Institute of Standards and Technology
NPL	National Priorities List
NTU	nephelometric turbidity unit
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit

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PA/SI	Preliminary Assessment/Site Inspection
PID	photoionization detector
PLC	programmable logic controller
PPE	personal protective equipment
PRG	EPA Preliminary Remediation Goal
PRP	Potentially Responsible Party
psia	pounds per square inch absolute
PVC	polyvinyl chloride
QA	quality assurance
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QC	quality control
QMP	Quality Management Plan
RA	Removal Assessment
RAPMA	Remedial Action Program Monitoring Act
RD	Remedial Design Study
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
SAP	Sampling and Analysis Plan
SLERA	screening level ecological risk assessment
SM	Sample Manager
SOP	standard operating procedure
START	Superfund Technical Assessment and Response Team
SVE	soil vapor extraction
TCLP	toxicity characteristic leaching procedure
TOM	Task Order Manager
TOPO	Task Order Project Officer
USGS	United States Geological Survey
UTM	universal transverse mercator
VCP	Voluntary Cleanup Program
VFD	variable frequency drive
VOA	volatile organic analysis
VOC	volatile organic compound
WWTP	wastewater treatment plant

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FINAL
SAMPLING AND ANALYSIS PLAN
REMEDIAL DESIGN
GARVEY ELEVATOR SITE
HASTINGS, NEBRASKA

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) details the data collection activities to support the Remedial Design (RD) Study at the Garvey Elevator Site (site) located in Hastings, Nebraska (Figure 1.1). This SAP presents the site background, and discusses the objectives design, and procedures for pumping tests and well installations to be completed as part of the Operable Unit (OU) 1 studies. RD activities are being conducted by HydroGeoLogic, Inc. (HGL) under Region 7 U.S. Environmental Protection Agency (EPA) Architect and Engineering Services (AES) contract EP-S7-05-05, Task Order 0046. CDM Federal Programs (CDM) is a team subcontractor to HGL on the AES Contract and will support HGL on the Garvey Elevator project. The roles and responsibilities of HGL and CDM project staff are described in Section 6.1. The SAP is composed of two parts: Part 1 is the Field Sampling Plan (FSP); and Part 2 is the Quality Assurance Project Plan (QAPP). The site-specific Health and Safety Plan (HSP) is included as Appendix A. These planning documents provide specific details regarding the planned field activities, data quality objectives (DQOs) and data management procedures, and health and safety measures to be employed during field activities.

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) ID# for the site is NEN000704351. EPA has organized the site into two OUs. OU1 is designated as the area of soil and groundwater contamination that is generally within the boundaries of the former Garvey Elevators, Inc. facility property and commonly referred to as the source area. The RD study focuses solely on OU1. OU2 is the associated groundwater contaminant plume that extends east-southeast from OU1 approximately 4.5 miles, in the direction of groundwater flow.

1.1 OBJECTIVES

The project objectives are:

- Evaluate individually the performance of one shallow and one intermediate depth recovery well of the existing Groundwater Extraction and Treatment (GET) system to determine their sustainable pumping rate, specific capacity, and well efficiency.
- Estimate the transmissivity, hydraulic conductivity, and storage properties of the upper and medial zones of the Pleistocene aquifer in the vicinity of the tested recovery wells.
- Evaluate and characterize the hydraulic communication between the upper and intermediate zones of the Pleistocene aquifer beneath the site.

- Estimate the capture zone of the GET system during operation of all eight recovery wells in the system.
- Provide additional site-specific information to update the conceptual site model (CSM).

1.2 SCOPE OF WORK

The field measures detailed in this SAP have been designed to obtain the requisite data to satisfy the project objectives as listed in Section 1.1, and include the following primary activities:

- Install additional on-site monitoring wells to gather aquifer response data during groundwater extraction system and pumping tests.
- Conduct pumping tests on the full extraction system and individual recovery wells to select locations for additional recovery wells to be used during future remedial action.
- Collect and analyze geotechnical samples to supplement data from the aquifer pumping tests.

1.3 ORGANIZATION OF THE SAP

This SAP is composed of the FSP and QAPP. The following sections are included in this SAP:

Section 1 - Introduction
Section 2 - Site Background

Part 1: Field Sampling Plan
Section 3 - Sampling Program and Analytical Summary
Section 4 - Field Activity Methods and Procedures
Section 5 - Investigation-Derived Waste Management

Part 2: Quality Assurance Project Plan
Section 6 - Project Management
Section 7 - Measurement and Data Acquisition
Section 8 - Assessment and Oversight
Section 9 - Data Validation and Usability
Section 10 – Data Management

Section 11 – Schedule

Section 12 - References

Appendix A - Site Health and Safety Plan
Appendix B - EPA Estimated Drawdown Calculations
Appendix C - Standard Operating Procedures
Appendix D - Field Forms
Appendix E – Laboratory Quality Assurance Manual

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This SAP provides a brief description and history of the site, as detailed information regarding the operational history and past investigations are provided in other documents. The EPA-approved June 2009 Revised Final Work Plan for the Remedial Investigation/Feasibility Study at Garvey Elevator includes a detailed examination of the operational history, and known and potential source areas, and previous investigations (HGL, 2009a). The EPA-approved July 2009 Final Interim Data Summary for OU1 (on site) includes much of this same information focused on on-site areas and the existing source control measures (HGL, 2009b). The June 2010 Interim ROD provides a detailed regulatory history that includes both state-lead and federal-lead activities (USEPA, 2010b).

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FIGURE

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Filename: X:/EPA009/Garvey/Remedial_Design/Site_Loc_Map.mxd
Project: EP9033.01.46.11
Revised: 08/03/10 ST
Source: ESRI StreetMap USA
Nebraska DNR

HGL HydroGeoLogic, Inc

CDM

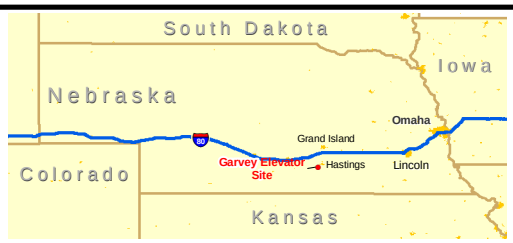

Figure 1.1
Site Location Map
Garvey Elevator Site
Hastings, NE

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2.0 SITE BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The 110-acre property formerly owned by Garvey is located in the NW l/4 of Section 23, T7N, Rl0W, approximately seven miles west of the Adams County/Clay County line in the southwest portion of the city of Hastings, Nebraska (Figure 1.1). The 110-acre property, consisting of an 88-acre parcel and a 22-acre parcel, is bounded on the north by U. S. Highway 6 and business and residential properties, on the east by the Burlington Northern and Santa Fe railroad track, on the west by Marion Road, and on the south by farmland (Figure 2.1). Garvey owned and operated a grain elevator facility on a 22-acre parcel along the eastern boundary of the property. Most of the remaining 88 acres are leased for crop production. The contamination associated with the site consists of soils and groundwater beneath the 22-acre parcel contaminated with volatile organic compounds (VOCs), and an associated groundwater contaminant plume approximately three miles long that extends from the property in an east-southeasterly direction.

2.2 SITE HISTORY

2.2.1 General Site History

The former Garvey property contains an active 8-million bushel capacity grain storage facility currently owned and operated by Ag Processing, Inc. (AGP). Garvey owned the grain storage facility from its construction in 1959 until 2005. Garvey operated the grain storage facility from 1959 until April 1, 1998, at which time a put through agreement with AGP became effective. In September 2005, Garvey, AGP, and EPA entered into an Agreement that allowed AGP to purchase the entire 110-acre property (USEPA, 2005b). The effective date of deed transfer to AGP was October 7, 2005. AGP currently owns and operates the grain elevator.

The property formerly owned by Garvey consisted of a total of 110 acres; but historically, only a 22-acre parcel was used for grain storage facility operations (Figure 2.1). The majority of the remaining 88 acres of property are used to cultivate crops. The grain storage facility at the Garvey terminal consists of a concrete elevator headhouse and silos, flat storage building, steel grain storage bins, and associated buildings (maintenance shop, office building, and chemical storage shed). The area surrounding the grain storage facility is rural with a sparse distribution of residential properties north, east and west of the site.

Garvey utilized a liquid mixture of carbon tetrachloride (CCl_4) and carbon disulfide (CS_2) as a grain fumigant from 1959 to 1985 (USEPA, 2003). This fumigant mixture is known as 80-20 fumigant. Some formulations of the 80-20 fumigant also may have contained a minor amount of ethylene dibromide (EDB), also known as 1,2-dibromoethane, CCl_4, CS_2, and EDB are Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances and are categorized as VOCs. In 1960, Garvey installed a 3,000-gallon, aboveground storage tank (AST) north of the silos to store the liquid fumigant (Figure 2.2).

The fumigant was transferred via piping from the AST to the silos' grain application gallery on top of the silos. The section of piping between the AST and the side of the silos was buried. The piping exited the subsurface at the side of the silos and extended up the north side of the silos to the application gallery (HGL, 2008a). In the mid-1970s, a release of CCl_4 at the ground surface was noted in the area where the trucks drove over the underground piping. The buried portion of this delivery pipe was excavated and found to be broken in two places: one near the AST, and one near the grain elevator (USEPA, 2010b). The piping was completely replaced at the time. Leaks and drips were reported to have occurred during the operation period of the AST and piping (HGL, 2008a). Staining in the area beneath the valve of the AST also was observed. Garvey ceased use of the liquid fumigant in 1985 and the AST and underground piping were removed in 1986 (USEPA, 2010b).

2.2.2 Regulatory History

In July 1994, Garvey notified the Nebraska Department of Environmental Quality (NDEQ) of a release of organic solvents and the presence of groundwater contamination at its grain storage facility (USEPA, 2010b). The discovery date of the CCl_4 release was June 16, 1994. The discovery occurred during a Phase I Environmental Site Assessment (ESA) when CCl_4 was detected in an on-site water supply well at 199 micrograms per liter (μg/L) (Terracon, 1994). The chronology of subsequent regulatory actions at the site is summarized below:

- In April 1995, Garvey Elevators, Inc. entered the NDEQ Remedial Action Program Monitoring Act (RAPMA) Voluntary Cleanup Program (VCP). While in the VCP, Garvey conducted further site characterization, installed the GET and soil vapor extraction (SVE) systems, and provided alternative drinking water sources to impacted residents.
- In 1997, the city of Hastings notified NDEQ that CCl_4 was detected in municipal well #13 located 1,500 feet northeast of the former Garvey property. The CCl_4 concentration detected in municipal well #13 was 5 μg/L, which is equivalent to the CCl_4 maximum contaminant level (MCL). In November 1997, the city of Hastings took municipal well #13 out of routine service placed the well on emergency use only status.
- In May 2002, Garvey Elevators refused to sign the NDEQ RAPMA Memorandum of Agreement (MOA). This agreement would have required cleanup of not only the source area, but also the groundwater contaminant plume extending eastward from the grain storage facility (USEPA, 2010b).
- In October 2002, NDEQ requested assistance from EPA in conducting a removal site evaluation to determine the extent of the groundwater contaminant plume. EPA recommended to NDEQ that they consider performing a Preliminary Assessment/Site Investigation (PA/SI) under their cooperative agreement with EPA (USEPA, 2010b). Subsequent to NDEQ's request for assistance from EPA, Garvey was no longer active in the VCP.
- In April 2003, NDEQ conducted a PA/SI of the Garvey Site to assess the threat to human health and the environment and identify the sources of groundwater contamination (TetraTech, 2003).
- On December 9, 2003, NDEQ requested further EPA assistance to provide alternative

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drinking water supplies to impacted residents, and to perform GET and SVE system evaluations and contaminated groundwater plume characterization (USEPA, 2010b).

- On September 14, 2005, the Garvey Elevator Site was placed on the National Priorities List (NPL).
- On September 28, 2005, Garvey Elevators, Inc., AGP, and EPA entered into an agreement to allow proceeds from the sale of the grain elevator to AGP to be used for investigation and site cleanup (USEPA, 2005b).
- On October 7, 2005, Garvey Elevators, Inc. signed an Administrative Order on Consent (AOC) with EPA to conduct removal assessments (RAs) and a remedial investigation/feasibility study (RI/FS) (USEPA, 2005a). In the AOC, Garvey agreed to conduct investigation and source area treatment activities at the Garvey Elevator Site. In a separate Agreement with AGP, Garvey Elevators, Inc. placed money into an escrow account to fund response actions at the site.
- On March 27, 2008, Garvey Elevators, Inc., filed Chapter 7 bankruptcy.
- In April 2008, EPA instructed Garvey Elevators, Inc. and its contractors to stop work at the site.
- In May 2008, EPA took over ongoing removal activities, including: providing alternative water supplies to impacted residents; and operation and maintenance (O&M) of the GET and SVE systems.
- In December 2008, EPA initiated a fund-lead RI/FS that includes a human health risk assessment (HHRA) and screening level ecological risk assessment (SLERA)
- In June 2010, EPA published an Interim ROD for Garvey Elevator Site OU1 that addressed soil and groundwater contamination on site. The selected interim remedy included continued operation, and possible expansion, of the existing GET system (USEPA, 2010b).

2.3 ENVIRONMENTAL SETTING

2.3.1 Land Use and Zoning

Surrounding land use is primarily agricultural with a mixture of urban and industrial use to the north and east. Land use along the Highway 6 corridor north of the site is primarily zoned commercial and industrial. Figure 2.3 shows the zoning designations of the site and surrounding properties. The nearest residential developments are approximately 1 mile to the northeast and east. However, isolated residences lie within 0.5 mile from the site. The zoning designations of the properties affected by groundwater contamination associated with the site include the following:

- A – Agricultural
- I-1 – Light Industrial
- I-2 – Heavy Industrial
- R-1 – Urban Single-family residential

Hastings is situated within the Little Blue Natural Resources District. Under the provisions of the Rules and Regulations for Enforcement of this district, the site is within a Wellhead Protection Area; therefore, wells that pump more than 50 gallons per minute (gpm) cannot be

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installed without first being permitted (Layne, 1997). EPA has provided alternate water supplies to all private well users, both business and residential, in the area that have been impacted by contaminants associated with the site.

2.3.2 Regional Climate

The City of Hastings is located in Adams County, Nebraska. Nebraska's climate is typical of the interior of large continents in the middle latitudes and large seasonal variations in both temperature and precipitation are common. The temperature and precipitation data that follows was drawn from *Comparative Climatic Data for the United States through 2007* (National Climatic Data Center, 2008). The U.S. Climate Normals Data report is a compilation of normals, means, and extremes for climatological elements for weather reporting stations throughout the United States. Climatological normals are defined in the report as "30-year average values that are updated decennially."

For the period from 1971 to 2000, the Hastings 4N, NE station experienced normal daily maximum temperatures ranging from 33.6 degrees Fahrenheit (°F) in January to 87.9 °F in July, and "normal daily minimum temperatures" ranging from 13.6 °F in January to 64.2 °F in July. The highest recorded temperature was 110 °F and the lowest was -23 °F. The mean number of days per year with temperatures at or below 32 °F was 143.2, and the mean number of days per year with temperatures at or above 90 °F was 41.6.

For the period from 1971 to 2000, the average monthly precipitation in inches ranged from 0.55 in January to 4.59 in May, with an annual average of 27.94 inches. The mean number of days per year with precipitation of 0.01 inches or more was 84.5, and snowfall averaged 26.5 inches per year.

2.3.3 Soils and Topography

The site is located within the Loess Plains subdivision of the High Plains section of the Great Plains physiographic province. The province covers approximately 450,000 square miles, extending from the foot of the Rocky Mountains to the Central Lowland physiographic province (approximately the Nebraska/Iowa border). The High Plains section consists of the remnants of a former fluviatile plain that composed of reworked stream deposits from the eastern slope of the Rocky Mountains. The original flat surface of the plain is preserved between existing streams. The Loess Plains subdivision of the High Plains section consists of fluviatile plain sediments that have been mantled with wind deposited silt and clay (loess). Loess deposits in central Nebraska north of the Platte River reach thicknesses of greater than 100 feet and form rolling plains that are deeply incised by streams. In south-central Nebraska where Adams County is located, the loess plains are nearly level and less deeply dissected (Leighty & Associates, Inc., 2001).

The topography of the site area where the elevator buildings are located is relatively flat (Figure 2.4). The topography slopes gradually away to the south and west from the area of the elevator buildings into agricultural fields. The field to the west of the buildings slopes in from

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the east and the west (Figure 2.4). The elevation at the site is about 1,930 feet above mean sea level (amsl) in the area of the elevator buildings. Immediately east of the site, the land surface slopes slightly to the east-southeast.

Surface soils in the vicinity of the site consist of Hastings and Holder silt loams (websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) (USDA, 2009). The Hastings silt loam makes up about 60 percent of the approximately 110-acre site. The soil consists of a very deep, well drained soil on uplands that formed in silty loess. The slope of the soil is from 0 to 1 percent. The Holder silt loam makes up approximately 40 percent of the site. Holder soils on slopes from 1 to 3 percent consist of a very deep, well drained soil on uplands that formed in loess. Holder soils on slopes from 3 to 7 percent consist of a very deep, well-drained, eroded soil on hillslopes that formed in loess.

2.3.4 Hydrology

The local drainage basin consists of gently rolling loess plains and small meandering streams that occupy wide shallow valleys. The nearest named perennial surface water feature to the site is Pawnee Creek, which is located about 0.5 miles south-southeast of the site (Figure 2.4).

There are no storm drains on the site; therefore, surface water drainage generally follows typography. Drainage is poor in the flat area north of the grain silos in the area of the maintenance, storage, and office buildings. Because this area is flat it is prone to ponding water. Drainage to the east is curtailed by the railroad tracks, which diverts surface waters on the very eastern portion of the site property between the rail spur and the railroad tracks northward toward Highway 6 (Figure 2.5). The area surrounding the flat storage grain building in the middle of the property drains surface water to the south-southwest from both the east and west. Runoff from this area enters a broad nondescript drainageway that discharges to Pawnee Creek approximately 4,600 feet from the south boundary of the site property. The west side of the immediate facility area drains into the cropland in the western portion of the site property, where runoff eventually is diverted south in a drainageway that bisects the crop field (Figure 2.5). A small pond lies at the end of this drainageway at the property boundary. It is not known if this pond is perennial.

Regionally, surface water flow is toward the south-southeast to the Little Blue River, which is about 8 miles south of the City of Hastings.

2.3.5 Geology

2.3.5.1 Regional Geology

Adams County lies adjacent to the north-south axis of the Salina Basin, which was formed by deformation of crystalline Precambrian rocks. The Salina Basin extends from central Nebraska into north-central Kansas, and the thickest sedimentary rock accumulations in Nebraska are found within the Salina Basin (Miller and Appel, 1997). The crystalline Precambrian rocks are overlain by the Upper Cretaceous-Age Niobrara Formation, which consists of yellow and light-

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to dark-gray marine chalky shale and chalk. The Niobrara surface in the area slopes to the southwest at an approximate gradient of 0.01 foot per foot. In the north-central portion of Adams County, the Niobrara Formation is overlain by the Upper Cretaceous-Age Pierre Shale, which can be described as a gray to black marine shale, and chalky shale. The uppermost portions are weathered and contain gray silty clay (Woodward Clyde, 1990). The Tertiary Ogallala Formation occurs only as buried knobs in the south and western portions of Adams County (Keech and Dreeszen, 1968).

The Adams County area is underlain by approximately 100 to 500 feet of unconsolidated Pleistocene age deposits lying unconformably on the Pierre Shale, or the Niobrara Formation where the Pierre Shale is absent. The unconsolidated deposits consist of the Peoria Loess, Loveland Loess, and other Pleistocene sand and gravel deposits. The Peoria and Loveland loess consist of silts and clayey silts that were deposited during the Wisconsin and Illinois glaciations, respectively. An interglacial soil named the Loveland Soil (known in Illinois as the Sangamon soil) separates the loess units (Condra et al., 1947). Pleistocene sands and gravels occur below the loess units and range in thickness from 130 to 200 feet. These are stream-deposited sands and gravels containing thick, regionally discontinuous layers of clay and silt. Gravel beds occur within this unit and can be as thick as 10 feet. The local groundwater table usually occurs within this unit.

2.3.5.2 Site-Specific Geology

The following description of the geology beneath the site is based on lithologic data from the monitoring wells completed on site and off site during earlier Garvey Elevator Site investigations; electroconductivity (EC) logs and lithologic logs collected from on-site and off-site borings during the 2009-2010 RI field effort; and from the Final Remedial Investigation Report for the W. Highway 6 & Highway 281 Site. The Highway 6 & Highway 281 Site is located approximately 0.5 northeast of the Garvey site (HGL, 2009d).

The geology underlying the site is summarized on Figure 2.5, which presents a generalized site-specific hydrostratigraphic column based on descriptions of the soil cores, drilling cuttings and EC logging. The thickness of the surficial silts and clays ranged from 33 feet to 82.75 feet. The average thickness of these sediments across the study area was 63.9 feet. The coloration observed in the surficial silts and clays was variable, ranging from black to various shades of brown and gray. Iron oxide staining was locally superimposed on the base soil color. Lenses/layers of fine sand or silty/clayey fine sand were observed within the surficial silts and clays. These sands were predominantly quartz, and poorly graded.

Underlying the surficial materials and extending to an approximate depth of 130 feet below ground surface (bgs) on site are numerous sand and gravel units that range from silty fine sands to poorly-graded sands to well-graded sands to silty gravels to well-graded gravels with sands. These sand and gravel deposits comprise the upper zone of the Pleistocene aquifer. The observed coloration of the sand and gravel layers was various shades of gray, yellow, brown, and olive brown. The sands were predominantly quartz, with subangular to rounded grains and varying percentages of multicolored feldspar and other dark mineral grains. The gravels were

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granitic in nature, and were predominantly fine gravels (less than 8 millimeters [mm]).

Underlying the upper zone of sands and gravels in the vicinity of Garvey Elevator is an upper fine-grained unit of variable composition and thickness. This unit consists of silt, clay, silty clay, clayey silt, clayey sand, and sandy clay, and the thickness ranges from 0.1 feet to 4 feet depending on location. Off site, thicknesses ranging from 0.45 feet to 7.3 feet were observed in EC borings. On site, the elevation of this upper fine-grained unit was around 1,800 feet amsl. This unit is recognized as the upper aquitard at the base of the upper zone of the Pleistocene aquifer (See Section 2.3.6.2 below). It was consistently observed on site in the EC borings completed during the RI, and the monitoring wells installed by HWS, and the multilevel wells installed in 2007. (ENSR/AECOM, 2007) (Figure 2.10)

Below the upper fine-grained unit from about 132 feet bgs are fine to coarse sands, silty sands, and sand-fine gravel mixtures (Figure 2.6). These sediments extend to approximately 150 feet bgs, where a lower fine-grained unit was observed. This lower fine-grained unit also has a variable composition and thickness that has been described as sandy clayey silt, clayey silt, silt and fine sand, and clayey sand with gravel. Unit thickness ranged from 0.7 feet to 2.5 feet. Accounting for topography, the elevation of the lower fine-grained unit on site varied from 1770 feet to 1780 feet amsl.

This lower fine-grained unit is recognized as the lower aquitard separating the medial and lower aquifers (See Section 2.3.6.2 below). Generally, it appears to be laterally continuous across the study area; however, it does not appear to extend northward. It was not observed in borings during the drilling and EC logging for the West Highway 6 & Highway 281 Site (HGL, 2009d).

Both the medial aquifer and the lower aquifer to the top of the Niobrara Formation at approximately 240 feet bgs, consist of alternating layers of poorly graded fine sand and well-graded fine to coarse sand with gravel. At selected locations, discontinuous lenses of well-graded gravel, silty sand, clayey sand, and clay were encountered.

Coloration of the fine sands was in various shades of gray and brown with occasional localized iron oxide staining. The fine sands were subangular to rounded, loose to moderately dense, and consisted primarily of quartz grains with varying percentages of feldspars and other dark minerals.

Coloration in the well graded sands was in various shades of gray, yellow, and brown with occasional localized iron oxide staining. The well graded sands were also subangular to rounded, loose, and consisted primarily of quartz with varying percentages of feldspars and other dark minerals. Gravel in the well-graded sands and gravel lenses ranged from <1 to 6 cm, was granitic in nature, with larger clasts flattened and elongated.

The unconsolidated materials are underlain by the Cretaceous age Niobrara Formation. The Niobrara generally consists of interbedded, soft, light grey calcareous shale and chalk. The

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Niobrara was encountered at depths of approximately 240 to 250 feet bgs at the site and consisted of a weathered yellow to pale red shale with calcium carbonate veins to a grayish brown clay.

2.3.6 Hydrogeology

2.3.6.1 Regional Hydrogeology

Hastings is located in the Little Blue River Natural Resource District (Steele and Wigley, 1992). Depth to groundwater in the Hastings area is typically about 100 feet bgs with localized zones of perched groundwater that can occur as shallow as 7 to 10 feet bgs (Layne, 1997). The regional groundwater flow generally follows the direction of the Little Blue River toward the east to southeast (NDEC, 1980).

The principal aquifer for Hastings is the Pleistocene aquifer. The aquifer is typically 100 to 150 feet thick in the Hastings area (NDEC, 1980). The Pleistocene aquifer is composed of unconsolidated sand and gravel that extends from about 100 feet bgs to the top of the Niobrara Formation which is about 233 feet bgs (HGL, 2009d).

Groundwater from the Pleistocene aquifer in the Hastings area is used for municipal, domestic, and agricultural use. Due to high use of the Pleistocene aquifer, the water table has dropped more than 20 feet between pre-1950s and 1992 (Steele and Wigley, 1992).

Transmissivity ranges from more than 200,000 gallons per day per foot (gpd/ft) in the central part of the county, to less than 50,000 gpd/ft in the northeastern corner and southernmost portions of the county (Keech and Dreeszen, 1968).

2.3.6.2 Site-Specific Hydrogeology

The Garvey Elevator site is situated southwest of the city of Hastings and lies approximately 1,500 feet outside the legal boundary of the Hastings Institutional Control Area (HICA) enacted on January 1, 2001, by the City of Hastings under Ordinance No. 3754 of the Hastings City Code. This ordinance is a component of the selected remedy for the Area-Wide OU19 of the Hastings Groundwater contamination site. Under the terms of the HICA, existing water wells that fell within the boundaries of the HICA, where groundwater contamination was known to exist, were allowed to remain in place, provided that reasonable safeguards were implemented to prevent human contact with contaminated groundwater. Agricultural irrigation wells and wells for noncontact business use are permissible under the ordinance as long as adequate safeguards are in place to prevent human consumption of water from these wells. No new domestic water wells are allowed to be installed within the HICA.

Groundwater typically occurs around 115 feet bgs at the site. Based on monitoring well boring logs from previous investigations, three aquifer zones exist at the site. These three aquifer zones are referred to as the upper, medial, and lower zones (Figure 2.6) (HWS, 1995). The general composition of these aquifers is discussed above in Section 2.3.5.2 above. The upper

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aquifer zone is unconfined and extends from about 115 feet bgs to 130 feet bgs. The upper fine-grained unit is a semi-confining layer (aquitard) that forms the base of the upper aquifer (Figure 2.6). Both the A and B Zones comprise the upper aquifer, as shown on the figure. The medial aquifer zone extends from the bottom of the upper aquitard to the top of the lower aquitard at approximately 150 feet bgs (Zone C). The lower aquifer zone is believed to be from approximately 152 feet bgs to 240 feet bgs (Zones D and E). The weathered shale of the Niobrara Formation forms the base of the Pleistocene aquifer.

Based on four pumping tests conducted in 1995 with various configurations, pumping rates, and durations, HWS concluded that the hydraulic conductivity in the upper aquifer was approximately 100 ft/day, and was approximately 270 ft/day in the medial and lower aquifers (HWS, 1995).

The general composition of the upper semi-confining unit, or aquitard, extending from approximately 130 feet to 132 feet bgs is discussed in Section 2.3.5.2 above. Generally, it is a mixture of silt and fine sand with some clay and occasional gravel. According to the boring logs for the recovery wells, the upper aquitard is present in the area of all eight GET system wells, and was generally described as clay. This fine-grained unit was also observed in the most of the on-site monitoring wells.

During the installation of the multilevel wells and a hydraulic testing well in 2007, particle size analysis was conducted on several samples collected from the upper aquitard in the MW-20, MW-30, and MW-33 boreholes (ENSR/AECOM, 2007). In these three wells, the upper aquitard was quantified as silt and fine to medium sand, to medium sand with some fine sand, to very fine sand and silt. Based on average values for these sediments, the expected hydraulic conductivity of the upper aquitard is expected to range from 0.028 ft/day to 28 ft/day (Fetter, 1988).

The composition of the lower semi-confining unit, or aquitard, is described in Section 2.3.5.2 above. Generally, it has been described as clayey sandy silt to clayey sand and gravel. This aquitard was observed in all three medial aquifer recovery well borings, and monitoring wells MW-3E, MW-5E, and MW-13E. Therefore, the lower aquitard appears to be present in the area of the recovery wells at the site.

During the installation of the multilevel wells and a hydraulic testing well in 2007, particle size analysis was conducted on several samples collected from the lower aquitard in the MW-20, MW-30, and MW-33 boreholes (ENSR/AECOM, 2007). In these three wells, the lower aquitard was quantified as hard clay, to silt and clay with fine sand, to fine to medium sand with some silt. Based on average values for these sediments, the expected hydraulic conductivity of the lower aquitard is expected to range from 2.8×10^{-5} ft/day to 28 ft/day (Fetter, 1988).

Given the varied composition and relatively thin nature of both aquitards, it is likely that they do not greatly inhibit downward migration of contaminants. The presence of carbon

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tetrachloride in historical groundwater samples collected from the medial and lower aquifer monitoring wells on site further support this conclusion.

However, it should be noted that during a pumping test conducted by HWS, the storage coefficient calculated for the lower aquifer was 0.0006, which is indicative of a confined aquifer. In this case, the pumped well was the former Garvey water supply well (pump set at 160 feet bgs), and drawdown was measured in MW-3D, which is screened from 171 feet 176 feet bgs. The lower aquitard was observed in MW-3E from 153 feet to 155 feet bgs, and logged as poorly graded sand with clay.

In general, the groundwater flow direction in June 2010 is to the east-southeast in all aquifer zones based on water levels in the sampled monitoring wells. Table 2.1 provides water level measurements for the June 2010. The water level measurements for June 2009 and August 2008 also are provided for comparison. Figures 2.7, 2.8, and 2.9 show the potentiometric surface for the upper, medial, and lower aquifers, respectively. The upper aquifer does appear to have a slightly more southwesterly trend in groundwater flow than is present in the medial and lower aquifers.

The June 2010 water levels indicate that a groundwater depression appears to be present in the immediate area of the GET system wells in the upper and medial aquifers (Figures 2.7 and 2.8). This shows that the GET system is exerting some hydraulic control of groundwater at the site. The water levels also indicate a groundwater depression centered around MW-20 D/E in the lower aquifer (Figure 2.9). However, the GET system is not likely to influence the lower aquifer to this degree because no recovery wells are installed in this aquifer zone. Also, nearby MW-13E and MW-30D/E do not show the same depressed water levels. It may be that the dedicated transducers at the D and E zone depths in this multilevel well have malfunctioned or were not calibrated correctly during installation. The data presented in Table 2.1 also shows the same anomalously lower water level elevations in June 2009; therefore, the problem is probably not a malfunctioning readout meter, or erroneously recorded data. It is possible that a nearby irrigation well (Walter-1 in Figure 2.9) may have impact on the water levels in the monitoring wells. The Walter-1 well is installed in the D and E zone depths. The Walter-1 well was not accessible to record water level measurements.

2.4 NATURE AND EXTENT OF CONTAMINATION

The following discussion of the nature and extent of contamination is limited to CCl_4. Chloroform, a degradation compound of CCl_4, is widely detected in conjunction with the parent compound throughout the groundwater in the study area. The July 2009 Final Interim Data Summary provides a detailed discussion of both primary contaminants (HGL, 2009b).

2.4.1 Unsaturated Zone

As discussed in the July 2009 Interim Data Summary, the only source area identified during previous investigations for the liquid fumigant contamination is the area beneath the location of the former fumigant AST and underground piping (HGL, 2009b). Preliminary assessment of

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the soil sample analytical data collected in 2009 during additional source investigations for the RI does not seem to indicate the presence of another source area. An RI report will be developed once all data have been evaluated, and a comprehensive report submitted under separate cover.

2.4.2 Saturated Zone

The distribution of CCl_4 beneath the site discussed below is based on the June 2010 sampling of the existing monitoring wells. A detailed examination of historical groundwater analytical data and contaminant distribution can be found in the July 2009 Final Interim Data Summary (HGL, 2009b).

In 1995, Garvey's contractor HWS installed a network of 36 monitoring wells in the upper, medial, and lower aquifer both on site and off site (HWS, 1995). Another Garvey contractor, ENSR, installed four multilevel monitoring wells to the east of the east property boundary along the railroad tracks in Spring 2007. HGL installed several monitoring wells off site in Spring 2010; three of which (MW-12D, MW-45C, MW-45D) are near enough to the site for inclusion in a discussion of contamination of OU1. Table 2.2 includes the construction information for monitoring wells installed in 1995, 2007, and 2010. Figure 2.10 illustrates locations of these on-site and near-site monitoring wells.

2.4.2.1 Horizontal Distribution

Figures 2.11, 2.12 and 2.13 illustrate the horizontal distribution of CCl_4 concentrations from June 2010 in the upper, medial, and lower aquifers, respectively. In the upper aquifer (A and B wells), the area of highest CCl_4 contamination (greater than 100 μg/L) is defined by MW-4B (1,300 μg/L) and MW-3B (190 μg/L) screened in the upper aquifer at the top of the upper aquitard. Based on the route of the fumigant transfer line and the location of the former line break, the high concentration area probably extends to the location of the former fumigant AST; however, no monitoring wells are situated in that area to evaluate groundwater contamination.

Based on the June 2010 monitoring data, CCl_4 concentrations exceeding the Region 9 EPA Preliminary Remediation Goal (PRG) of 5 μg/L extends cross gradient, relative to the former AST area, to the southeast (MW-5B; 27 μg/L) and northeast (MW-6A; 17 μg/L). However, the CCl_4 concentrations in MW-5B and MW-6A have dropped significantly between April 2009 and June 2010. In April 2009, the CCl_4 levels in MW-5B and MW-6A were 200 μg/L and 31 μg/L, respectively.

Also, the plume continues to nearly bifurcate close to MW-20A, where CCl_4 was not detected in June 2010 in the upper aquifer (Figure 2.11). This behavior also was observed in August 2008 and April 2009 and was discussed in detail in the July 2009 Final Interim Data Summary (HGL, 2009b).

In the medial aquifer (C-wells), the area of highest contamination in June 2010 is generally

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defined by MW-13C (170 µg/L) located near the properties eastern property boundary (Figure 2.12). This in an increase in CCl_4 concentration from the 44 µg/L observed in this well in April 2009. There are no other C-wells completed in the medial aquifer on site, although MW-30C is located about 100 feet southwest of MW-13C. The CCl_4 concentration in MW-30C was reported as nondetect in June 2010. MW-13C is screened at the top of the medial aquifer (133 feet to 135.5 feet bgs), while MW-30C is screened near at the bottom of the medial aquifer (152 feet to 162 feet bgs). It is apparent that the highest contamination in the medial aquifer is located directly below the aquitard separating the upper and medial aquifers.

The data as contoured on Figure 2.12 shows an apparent bifurcation of the plume in the medial aquifer. This interpretation is based primarily on two data points. First, CCl_4 concentrations in MW-17C declined from 130 J µg/L in April 2009 to 27 µg/L in June 2010 (Figure 2.12). Secondly, new monitoring well MW-45C, installed off site to the east about 2,600 feet and immediately north of what was previously thought to be the central axis of the plume, was nondetect for CCl_4 in June 2010.

It appears that generally steady operation of the GET system since EPA assumed control of the site in March 2008 has begun to show have a positive effect in decreasing contaminant concentrations in both the upper and medial aquifers downgradient of the site.

In the deep aquifer (D and E wells), the extent of CCl_4 contamination on site is defined by MW-6E completed at the base of the lower aquifer, where CCl_4 was detected for the first time in June 2010 at a concentration of 33 µg/L. However, no CCl_4 was detected in MW-6D in the upper portion of the lower aquifer. The anomalous detection CCl_4 in MW-6E is not fully understood. The analytical date will be fully evaluated for the RI report submitted under separate cover.

Off site, contamination in the lower aquifer is defined by monitoring wells MW-12D (2.1 µg/L) and MW-18D (3.7 µg/L) (Figure 2.13.). These wells are in line downgradient from both the northern and southern lobes of the bifurcated plumes observed in the upper and medial aquifers. MW-12D also is downgradient of the contamination observed in MW-6E. This is consistent with the some of the contaminant data discussed and displayed in cross section in Section 2.4.2.2.

2.4.2.2 Vertical Distribution

Figure 2.14 illustrates the vertical distribution of CCl_4 along cross section line A-A' (MW-31A/C to MW-19A/C) for the June 2010 data. This line of multilevel wells is located immediately off site along the eastern property boundary. At MW-30A/C/D/E, CCl_4 was detected in the A-zone (90 µg/L) only. In August 2008, CCl_4 was observed in all three aquifers at MW-30A/C/D/E. The June 2010 concentration in MW-30A was the highest detection of CCl_4 observed in the multilevel wells in this section line. MW-30A is approximately 450 feet directly downgradient to the southeast of the former fumigant AST.

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Based on the multilevel well data, CCl_4 is not present in the medial and lower aquifer wells along the A-A' cross section line. However, the presence of CCl_4 in MW-6E located approximately 300 feet north-northwest of MW-19A/C does not seem to support this conclusion (Figures 2.13 and 2.14). In addition, as discussed above in Section 2.4.2.1, the medial aquifer multilevel wells only represent water quality at the base of the medial aquifer. At the top of the medial aquifer (approximately 133 feet to 135 feet bgs), CCl_4 was detected at 170 μg/L in MW-13C located about 100 feet north-northwest of MW-30A/C/D/E.

Figure 2.14 also illustrates in cross section the bifurcation of the CCl_4 plume first discussed in Section 2.4.2.1. The plume appears to diverge in the area of MW-20A/C/D/E. The smaller northern lobe of the plume is monitored by MW-19A/C and MW-6A/D/E (Figures 2.11 and 2.12). The main portion of the plume is present south of MW-20A/C/D/E down to MW-31A/C on the southwest end of cross section line A-A'. This portion of the plume has consistently shown higher concentrations of CCl_4, as would be expected given that it is generally situated directly downgradient of the former fumigant AST.

Figure 2.15 illustrates that the June 2010 CCl_4 concentrations in groundwater generally parallel the groundwater flow direction from recovery well RW-5 near the former fumigant AST to downgradient off-site wells MW-18A/C/D (cross section line B-B'). As the figure illustrates, the CCl_4 plume is migrating vertically downward as it moves off site and downgradient.

As with the April 2009 data, the June 2010 results show that CCl_4 does not appear to be migrating vertically downward into the lower aquifer at the site (Figure 2.15). However, the August 2008 data set indicates that CCl_4 was in the lower aquifer on site (HGL, 2009b). It is likely that consistent operation of the GET system under EPA control has prevented, or largely inhibited, downward migration of CCl_4 to the lower aquifer.

2.5 EXISTING GET AND SVE SYSTEMS

SVE and GET systems were installed by the Potentially Responsible Party (PRP) at the site while it was under State oversight. These systems were installed in 1998, and began operation in 1999. The SVE system consists of 11 SVE wells and the GET system includes 8 recovery wells and 2 injection wells. Figure 2.16 illustrates the locations of the GET and SVE wells. Table 2.3 provides a summary of the existing SVE and GET systems wells. Since the bankruptcy of Garvey Elevators, Inc., EPA has been maintaining and operating the systems.

The sections below provide the layout and brief operational history of the SVE. The 2009 Interim Data Summary provides a detailed discussion of the SVE, including evaluations conducted by EPA and NDEQ (HGL, 2009b). The discussion of the GET system in section 2.5.2 is more exhaustive because the focus of the RD is OU1 groundwater remediation, and includes information from the Interim Data Summary, and the EPA-approved October 2009 Revised Final Focused Feasibility Study (HGL, 2009c).

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2.5.1 SVE System

Garvey Elevator installed an SVE system to treat on-site contaminated soils within the vadose zone at the site. The SVE system currently consists of eight functioning SVE extraction wells. SVE wells SVE-1 through SVE-8 are screened between from 20 feet to 50 feet bgs, and are considered the shallow wells. The three deep SVE wells are SVE-09, SVE-10, and SVE-11, and are screened from 60 feet to 110 feet bgs. For unknown reasons, SVE-02, SVE-05, and SVE-06 were not connected to the system (ENSR/AECOM, 2006). The system was constructed with a blower capacity of 200 cubic feet per minute (cfm) for the shallow wells, and a 600 cfm blower for the deep wells.

In general, the wells are installed around the area of the former 80-20 fumigant AST, and the area to the east toward the railroad tracks, and north of the elevator silos. SVE-07 is located nearest the location of the former fumigant AST. Three SVE wells (SVE-01, SVE-02, and SVE-09) are located north of the shop building north of the former fumigant AST location.

Initially, CCl_4 levels in the extracted soil vapor required treatment with a catalytic oxidation system before being discharged to the atmosphere. After four months of operation, the CCl_4 levels had dropped significantly and the catalytic oxidation unit was taken off-line because the contaminated vapors no longer required treatment before release. The piping from the SVE wells converges into the rear of the shop building where the oxidation unit and vent pipe are located. In September 2000, the system was reduced to just one well: SVE-7 (ENSR/AECOM, 2006). In March 2001, the system was shutdown because of the low concentrations being recovered (ENSR/AECOM, 2006). In May 2004, the system was restarted. Between 2004 and 2008, the system operated intermittently.

EPA restarted and has been conducting O&M of the SVE system since Garvey Elevators, Inc. filed for bankruptcy in March 2008. EPA restarted the SVE system during the RA (TetraTech, 2009a). The EPA Removal Section contractor collected samples from each SVE well at startup, 100 minutes of operation, and 1,000 minutes of operation. The combined system effluent concentration of CCl_4 at these sample times was 8,240 microgram per cubic meter ($\mu g/m^{3)}$; 16,900 $\mu g/m^3$; and 20,100 $\mu g/m^3$, respectively. The highest concentration observed in an individual well was 356,000 $\mu g/m^3$ in SVE-07 after 1,000 minutes (TetraTech, 2009). During the most recent sampling of the combined system effluent in June 2010, CCl_4 was detected at 790 $\mu g/m^3$ (USEPA, 2010c).

2.5.2 GET System

2.5.2.1 Treatment System Description

The GET system includes eight groundwater recovery wells (RW-1 through RW-8), influent particulate filters, a packed tower air stripper, effluent particulate filters and two injection wells (IW-1 and IW-2). Table 2.3 summarizes the construction details of the existing GET system recovery and injection wells.

Since this system came on-line in 1999, it was operational only sporadically until November 2008 due to various system malfunctions and mechanical problems. As of November 2008, the system was considered to be fully operational; however, well RW-5 was not operable due to a collapsed well screen.

Shown on Figure 2.16, the recovery wells are located in a rough north-south trending line downgradient to the east of areas of elevated groundwater contaminant concentrations, except for RW-5. RW-5 is located in proximity to the former location of the fumigant AST. Five of the recovery wells (RW-l, RW-2, RW-3, RW-4, and RW-5) are screened in the upper aquifer (A and B zones) between approximately 116 feet bgs to 130 feet bgs. Each of these shallow recovery wells has 10-foot screens (EMCON, 1998). The remaining three recovery wells (RW-6, RW-7, and RW-8) are completed in the medial aquifer (C zone) from approximately 135 feet bgs to 150 feet bgs. These deeper recovery wells have 15-foot screens. All eight wells have 0.040-inch slot, stainless steel screens (EMCON, 1998).

The GET system consists of the following major components:

- Grundfos® 460 volt, three-phase, submersible pumps
- Instrumentation Northwest, Inc. (INW) absolute pressure transmitters, model PS9000
- Signet 3-8510-XX paddlewheel flow sensors and Signet 85 12 flow rate transmitters
- Skid mounted Krystil Klear 4-bag 25 micron filter housings
- Carbonair® Model OS-500 packed tower air stripper
- Skid mounted Krystil Klear 4-bag 10 micron filter housings
- Myers Model M341A, 10 horsepower (hp), 3-phase, 230-460 volt horizontal end suction pump

The Grundfos® submersible pumps are installed in each recovery well. The five wells screened in the shallow unconfined aquifer have 5 hp pumps capable of pumping approximately 40 gpm at 245 feet of head. The medial wells have 10 hp pumps capable of pumping approximately 100 gpm at 260 feet of head. The submersible pumps are controlled by variable frequency drives (VFD). The VFD regulates the pumping rate of each well so that the desired groundwater elevation (set point) is obtained. The groundwater elevation in each well is monitored by a submersible pressure transmitter and a barometric pressure transmitter mounted on the outside of the treatment system control panel. Based on the current groundwater elevation and the set point, the programmable logic controller (PLC) instructs the VFD to increase or decrease the speed of the submersible pump motor.

Water levels in the recovery wells are monitored by INW absolute pressure transmitters, which have a 4 to 20 milliamp output. Transmitters in shallow wells have a range of 0 to 30 pounds per square inch absolute (psia) while transmitters in medial wells have a range of 0 to 50 psia. To compensate for fluctuating barometric pressure without the use of vented tubing and desiccant chambers, an INW barometric pressure transmitter is mounted on the outside of the groundwater treatment system control panel.

A Signet 3-8510-XX paddlewheel flow sensor and Signet 85 12 flow rate transmitter are

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installed in each of the well extraction lines. The individual well flow sensors are installed in Schedule 80 polyvinyl chloride (PVC) saddles provided by Signet and mounted using Signet 8010 integral mounting kits, which allow for reading water velocities from 1.0 to 20.0 feet per second. A k-factor programmed into the Signet 8512 transmitter automatically calculates and displays the flow rate in gpm based on the pipe diameter and water velocity. The transmitters internally totalize and record total flow. The units can either display the current flow rate or total flow. In addition, the flow rate from each meter is transmitted to the PLC, which allows for logging and remote monitoring via the HM1 communication software.

Groundwater from the individual recovery well lines is combined and piped to the treatment system building. Inside the building, the groundwater influent line is equipped with a sampling port. Particulates are removed from the influent water using two skid-mounted Krystil Klear 4-bag filter housings. These filter housings are designed to be operated normally in parallel, or individually during bag changes. Each 24-inch diameter carbon steel housing is a Model 2424 with a 6-inch threaded inlet and outlet, a pressure rating of 150 pounds per square inch, an ethylene propylene cover gasket, and an inside and outside 2-part epoxy coating. The basket is made of perforated stainless steel. The filter bags are No. 2 sized polyester felt with a 25-micron opening.

After passing through the influent filter, groundwater is treated with a 500 gpm capacity Carbonair® 60 Model OS-500 packed tower air stripper, and then passed through another set of bag filter housings. Effluent gas from the air stripper is discharged to the atmosphere with no secondary treatment. During the air stripping process, precipitation of certain solids may take place. The effluent filter housings will remove these solids and prevent their introduction into the injection wells. The filter bags currently being used for effluent are No. 2 sized polyester felt with a 10-micron opening.

Another paddlewheel flow sensor and transmitter is installed in-line with the groundwater discharge piping after the packed tower air stripper. This sensor is installed in a 6-inch diameter Schedule 80 PVC tapping saddle, which allows for reading total system flow rate. An effluent sampling port is also installed after the effluent bag filters.

Effluent treated groundwater is discharged back into the groundwater system through two injection wells (IW-1 and IW-2) (Figure 2.16). The injection wells are located west and upgradient of the contaminant source areas in the agricultural field on the western portion of the site property. The 10-inch diameter injection wells are screened in the lower aquifer (D and E zones) from 175 feet bgs to 230 feet bgs (ENSR/AECOM, 2006). IW-1 is equipped with INW 0 to 100 psia pressure transmitters. Groundwater is injected into IW-1. If the groundwater injection flow is greater than the capacity for IW-1, transmitters control the opening of another discharge valve to allow injected groundwater to be piped to both IW-1 and IW-2.

2.5.2.2 Treatment System Operation, Maintenance, and Effectiveness

In 2004, EPA conducted an evaluation of the remedial systems at the site (TetraTech, 2004).

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Regarding GET system performance, the system evaluation report noted the following:

- The GET system had generally operated sporadically between 1999 and 2004, with exception to 2003.
- At the time of a system evaluation site visit conducted by EPA contractor TetraTech in December 2003, the PRP contractor told TetraTech that some of the wells were not operating as a result of transducer malfunctions, and that the GET system had experienced significant downtime in 2003.
- Between January 1999 and September 2003, an estimated 2,260 pounds of CCl_4 had been removed, treated by the catalytic oxidation unit or discharged into the atmosphere. During this timeframe, approximately 1 billion gallons of groundwater had been pumped, treated, and re-injected.
- Contaminant removal had decreased considerably after the first five months of operation; and over the six months prior to completion of the system evaluation report, contaminant removal had decreased such that it appeared that the system influent was approaching asymptotic levels.

The system evaluation report conveyed the following conclusions and recommendations regarding groundwater on site and the GET system (TetraTech, 2004):

- CCl_4 concentrations decreased significantly in monitoring wells along the eastern (downgradient) boundary of the site.
- Although the GET system influent appeared to be reaching asymptotic levels, the report recommended continued operation of the system to help reduce off-site migration of on-site contaminated groundwater.
- The report recommended that monitoring wells MW-3A/B, MW-4A/B, and MW-5A/B be sampled more regularly because they have historically and consistently shown elevated levels of CCl_4.
- If CCl_4 levels remain high at the well clusters noted above, it was noted that further investigation and modification of the GET system may be warranted to address these areas.

The GET system had several mechanical problems before EPA took over the system in March 2008, and since that time. After EPA took over the system, the EPA Superfund Technical Assessment and Response Team (START) contractor walled off and insulated the portion of the Quonset hut containing the above-ground plumbing and packed tower air stripper, and the portion containing the electronic control systems. A climate control system was installed to prevent overheating and freezing of the electronic control systems. The walls and insulation alone were sufficient to prevent the above-ground plumbing and packed tower from freezing. Since taking over operation of the GET system, EPA has been taking corrective action on the following issues:

- The screen on RW-5 collapsed and this well had not been operating. Based on the site background documents, the screen collapsed sometime between the 2004 EPA Evaluation of Remedial System (TetraTech, 2004) and takeover of the site by EPA in March 2008. Corrective action for RW-5 is being conducted.

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- RW-1, RW-6, and RW-8 had electrical or transducer problems associated with the VFD that kept them from operating consistently. The EPA START contractor has replaced the VFDs for the pumps of these wells.
- At RW-4, the discharge pipe inside the well vault cracked during operation and flooded the vault. The pipe has been repaired.
- EPA discovered during the piping break at RW-4 that the system piping was not installed with check valves to prevent backflow. The EPA START contractor has recommended that check valves be installed.
- In April 2010, a new RW-5 was drilled and installed near adjacent to the existing defunct RW-5 recovery well.
- In May 2010, a new PLC was installed after the previous one malfunctioned due to moisture intrusion, and a replacement barometric pressure sensor was installed.

As of August 9, 2010, all recovery wells are operational, except RW-1. The problem with RW-1 appears to be the pump, but a full diagnosis has not been conducted. Also, electrical surges from lightning storms have caused the transducers in RW-2, RW-8, and IW-1 to malfunction.

Groundwater samples were collected from the recovery wells in August and October 2008 for the RA (TetraTech, 2009). Samples were collected from RW-2, RW-6, RW-7, and RW-8 in August 2008. Wells RW-1, RW-3, RW-4, and RW-5 were sampled in October 2008 after all but RW-5 had become operational. CCl_4 was detected in all eight wells at concentrations ranging from 9.4 μg/L to 439 μg/L. The highest concentration was observed in RW-3.

In April 2009, groundwater samples were collected from RW-2, RW-3, RW-7, and RW-8, and CCl_4 was detected at concentrations ranging from 53 μg/L to 120 μg/L (USEPA, 2009b). The highest concentration was observed in RW-2. Wells RW-1, RW-4, RW-5, and RW-6 were not sampled because they were not operational at the time of sampling.

In January 2010, groundwater samples were collected from RW-1, RW-2, RW-3, RW-4, RW-6, RW-7, and RW-8. CCl_4 was detected at concentrations ranging from 17 J μg/L to 82 J μg/L (USEPA, 2010a). The highest concentration was observed in RW-2. Well RW-5 was not sampled because it was not operational at the time of sampling.

Based on available monthly operational data for the period January 1999 through June 2009, the following GET system performance metrics were calculated. These values have a degree of uncertainty because the available data is incomplete (HGL, 2009c).

- Total volume of water treated – 1.24 billion gallons
- Maximum total system flow – 539 gpm (51 months recorded)
- Minimum total system flow – 120 gpm (51 months recorded)
- Average total system flow – 354 gpm (51 months recorded)
- Maximum influent concentration – 2,771 μg/L (74 samples collected)
- Minimum influent concentration – 14 μg/L (74 samples collected)

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- Average influent concentration – 230.9 μg/L (74 samples collected)

For the range of monthly data available, there are numerous months for which no total operational flow or influent contaminant concentration data exist. In most of these cases, the system was operational; however, no total system flow measurements were recorded and no samples were collected for that month. There are also several periods where the system was not operating and/or only some of the wells were functional. In general, the total system flow, not including periods when the system was off-line, was greater during the first few years of operation (average 439 gpm from 1999 through 2002) than during the last years of operation (average 264 gpm from 2004 through mid-2009). This trend corresponds with the fact that during the first few years of GET system operation, all eight recovery wells were reportedly functioning, and during the last five years some wells were not functioning due to mechanical problems or well screen failures.

2.5.2.3 Summary of Groundwater Modeling Results

A three dimensional finite difference groundwater flow model was developed by EPA using Visual MODFLOW to simulate the groundwater flow system at the site to provide a flow field for particle tracking simulations, to evaluate the capture zones of the current source area recovery wells, to assess whether the current monitoring well network is adequately characterizing the extent of groundwater contamination at the site, and to identify potential locations for additional monitoring wells. A summary of the groundwater modeling results is presented in this section, with a focus on the assessment of the capture zones of the current recovery wells. Additional information regarding the groundwater modeling setup and results can be found in the draft Garvey Ground Water Flow Model Report (USEPA, 2009a). It should be noted that EPA considered the model to be a low-fidelity groundwater flow model because it was only calibrated to unstressed aquifer conditions. EPA compiled the model prior to development of the Garvey Elevator site RI work plans.

The groundwater model was set up using input parameters from a number of sources, including site-specific data and RI data (such as hydraulic conductivity), from the West Highway 6 & Highway 281 Site, a Superfund groundwater contamination site located one-half mile northeast of the Garvey Site. The hydraulic conductivity values assigned to the aquifers and aquitards were as follows:

- Upper aquifer – 211.6 ft/day
- Medial and lower aquifer – 270 ft/day
- Upper and lower aquitard – 0.46 ft/day

Additionally, regional groundwater flow characteristics (gradient and direction) were compiled from the U.S. Geological Survey (USGS) hydrographic database, some hydrostratigraphic data was compiled from the University of Nebraska-Lincoln School of Natural Resources test-hole database. The groundwater flow directions modeled in cases 1, 2, and 3 were 7 degrees south of east; 21.4 degrees south of east; and 34.6 degrees south of east, respectively. Aquifer recharge data was compiled from the U.S. Army Corps of Engineers. Aquifer recharge was

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assigned a value of 0.016 ft/day in the model, which accounts for both irrigated grassland and non irrigated grassland at the site. Local groundwater flow characteristics were compiled from the water level measurements collected from site monitoring wells in August 2008. Since the GET system was not operational during the August 2008 sampling, the water level measurements are assumed to represent an uninfluenced baseline groundwater flow condition. Based on the range of local and regional data, three cases were developed for the model for different groundwater flow directions and gradients. Only Case 1 has been analyzed by EPA in the draft Garvey Ground Water Flow Model Report (USEPA, 2009a), so only this case is described further.

Modeling outputs consist of a series of graphs of particle flow tracking at different time events and for each aquifer zone. These output graphs are not shown in the FFS, but the modeling results for Case 1 generally indicate:

- In the upper and medial aquifers, particles escape capture by the existing recovery wells in two broad areas (refer to Figure 2.2): 1) along the southern third of the flat storage building; and 2) along the northern railroad tracks approximately between the edge of the concrete paved area (northeast of the office building) and the northern Garvey Elevator property boundary. One additional smaller area where particles escaped capture by the recovery wells in the upper aquifer lies between RW-1 and RW-2.
- The irrigation well located to the east of the headhouse and grain elevator exhibits a cycle of pull and release on particles, but its operation does not prevent particles not captured by the remediation well system from migrating downgradient.

EPA recommended additional aquifer response information should be collected under stressed conditions to better calibrate the model.

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TABLES

Table 2.1
On-site Groundwater Measurements
and Water Level Elevations
Garvey Elevator Site
Hastings, NE

Well ID	TOC Elevation* (ft amsl)	Depth to Water (ft btoc)			Water Level Elevation (ft amsl)		
		August-08	June-09	June-10	August-08	June-09	June-10
MW-1A	1927.081	112.58	111.63	111.73	1814.50	1815.45	1815.35
MW-2A	1930.219	116.64	115.09	115.21	1813.58	1815.13	1815.01
MW-3A	1934.269	121.45	121.26	121.14	1812.82	1813.01	1813.13
MW-3B	1932.754	120.4	119.19	119.69	1812.35	1813.56	1813.06
MW-3D	1933.37	121.22	119.28	119.53	1812.15	1814.09	1813.84
MW-3E	1932.254	120.12	118.19	118.44	1812.13	1814.06	1813.81
MW-4A	1931.601	118.24	118.86	118.21	1813.36	1812.74	1813.39
MW-4B	1931.375	118.05	118.66	118.31	1813.33	1812.72	1813.07
MW-5A	1930.259	117.22	117.14	116.87	1813.04	1813.12	1813.39
MW-5B	1931.722	118.38	118.27	117.97	1813.34	1813.45	1813.75
MW-5D	1931.873	119.93	117.9	118.16	1811.94	1813.97	1813.71
MW-6A	1931.993	118.82	117.72	117.80	1813.17	1814.27	1814.19
MW-6D	1931.141	119.61	117.69	117.92	1811.53	1813.45	1813.22
MW-6E	1932.131	120.56	118.64	118.85	1811.57	1813.49	1813.28
MW-7A	1923.22	110.13	107.75	108.11	1813.09	1815.47	1815.11
MW-7B	1923.838	110.72	108.41	108.78	1813.12	1815.43	1815.06
MW-8A	1943.221	127.05	125.55	125.82	1816.17	1817.67	1817.40
MW-9A	1928.031	112.34	111.16	111.43	1815.69	1816.87	1816.60
MW-10A	1923.479	109.7	108.83	108.71	1813.78	1814.65	1814.77
MW-10B	1923.353	111.08	109.75	109.68	1812.27	1813.60	1813.67
MW-11A	1911.838	NR	99.06	98.05	NR	1812.78	1813.79
MW-12A	1919.65	113.46	112.75	113.05	1806.19	1806.90	1806.60
MW-12C	1919.64	115.28	113.7	113.89	1804.36	1805.94	1805.75
MW-12D	1918.89	NR	NR	113.11	NR	NR	1805.78
MW-13C	1929.647	118.28	116.95	118.07	1811.37	1812.70	1811.58
MW-13E	1930.428	118.84	117	117.30	1811.59	1813.43	1813.13
MW-14A	1911.691	102.29	101.75	101.82	1809.40	1809.94	1809.87
MW-16A	1914.94	NR	NR	108.60	NR	NR	1806.34
MW-16C	1915.08	NR	NR	108.72	NR	NR	1806.36
MW-17A	1903.703	95.85	93.89	94.12	1807.85	1809.81	1809.58
MW-17C	1902.905	95.21	93.33	93.62	1807.70	1809.58	1809.29
MW-17D	1902.933	95.23	93.32	93.59	1807.70	1809.61	1809.34
MW-18A	1912.889	105.17	105.91	106.82	1807.72	1806.98	1806.07
MW-18C	1913.086	110.29	108.61	108.89	1802.80	1804.48	1804.20
MW-18D	1913.318	110.47	108.8	109.07	1802.85	1804.52	1804.25

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Table 2.1 (continued)
On-site Groundwater Measurements
and Water Level Elevations
Garvey Elevator Site
Hastings, NE

Well ID	TOC Elevation* (ft amsl)	Depth to Water (ft btoc)			Water Level Elevation (ft amsl)		
		August-08	June-09	June-10	August-08	June-09	June-10
MW-19A	1927.812	NR	114.07	114.03	NR	1813.75	1813.78
MW-19C		NR	115.20	115.20	NR	1812.61	1812.47
MW-20A	1927.97	NR	116.08	116.08	NR	1811.89	1811.38
MW-20C		117.45	115.89	115.89	1810.52	1812.08	1811.85
MW-20D		NR	116.21	116.21	NR	1811.76	1811.67
MW-20E		NR	116.82	116.82	NR	1811.15	1810.91
MW-30A	1929.032	NR	115.10	115.10	NR	1813.94	1814.01
MW-30C		117.30	115.38	115.38	1811.73	1813.65	1813.38
MW-30D		117.22	115.43	115.43	1811.81	1813.60	1813.32
MW-30E		118.14	116.44	116.44	1810.89	1812.59	1812.34
MW-31A	1930.08	119.46	116.78	116.78	1810.62	1813.31	1813.05
MW-31C		119.93	117.63	117.63	1810.15	1812.45	1812.37
MW-45C	1911.75	NR	NR	102.82	NR	NR	1808.93
MW-45D	1911.38	NR	NR	102.39	NR	NR	1808.99

* Ground surface elevations were used to calculate the groundwater elevation at the multilevel wells because the dedicated transducers provide depth of water above the sample port and the sample port depths were provided as feet below ground surface on the installation logs.
amsl above mean sea level
bgs below ground surface
btoc below top of casing
NR not recorded; for the irrigation wells, only the ground surface elevation could be measured
TOC top of casing

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Table 2.2
Existing On-Site Monitoring Well Construction
Garvey Elevator Site
Hastings, NE

Well ID[(1)]	Northing	Easting	TOC Elevation (ft amsl)	Ground Surface Elevation (ft amsl)	Stickup Height[(2)] (ft)	Total Depth[(3)] (ft btoc)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Top of Screen Elevation (ft amsl)	Bottom of Screen Elevation (ft amsl)	Sample Port Depth[(4)] (ft bgs)
MW-1A	270590.926	2080164.407	1927.081	1925.797	1.28	119.24	102	117	1823.797	1808.797	N/A
MW-2A	271240.41	2080539.87	1930.219	1927.33	2.89	121.17	103	118	1824.33	1809.33	N/A
MW-3A	270755.17	2080773.994	1934.269	1930.991	3.28	126.28	108	123	1822.991	1807.991	N/A
MW-3B	270761.378	2080778.055	1932.754	1931.072	1.68	135.33	130.6	133.5	1800.472	1797.572	N/A
MW-3D	270763.009	2080754.275	1933.37	1931.463	1.91	176.67	171	176	1760.463	1755.463	N/A
MW-3E	270744.057	2080767.604	1932.254	1930.989	1.26	244.99	233.4	238.4	1697.589	1692.589	N/A
MW-4A	270341.995	2080827.075	1931.601	1931.843	-0.24	122.25	108.5	123.5	1823.343	1808.343	N/A
MW-4B	270342.585	2080832.776	1931.375	1931.699	-0.32	131.43	127	132	1804.699	1799.699	N/A
MW-5A	269943.836	2080752.777	1930.259	1930.062	0.20	123.08	107.5	122.5	1822.562	1807.562	N/A
MW-5B	269947.071	2080745.584	1931.722	1930.118	1.60	133.59	129	132	1801.118	1798.118	N/A
MW-5D	269930.791	2080740.508	1931.873	1929.848	2.03	168.23	162	167	1767.848	1762.848	N/A
MW-6A	271237.345	2081216.968	1931.993	1929.48	2.51	125.09	107.5	122.5	1821.98	1806.98	N/A
MW-6D	271244.17	2081221.205	1931.141	1929.455	1.69	169.39	163.5	173.5	1765.955	1755.955	N/A
MW-6E	271244.606	2081208.806	1932.131	1929.645	2.49	229.57	225	235	1704.645	1694.645	N/A
MW-7A	269088.475	2079699.7	1923.22	1920.922	2.30	118.76	98	113	1822.922	1807.922	N/A
MW-7B	269088.781	2079692.537	1923.838	1920.887	2.95	142.64	130	135	1790.887	1785.887	N/A
MW-8A	271214.203	2079067.544	1943.221	1940.802	2.42	135.91	114.5	129.5	1826.302	1811.302	N/A
MW-9A	272193.736	2080628.145	1928.031	1925.397	2.63	120.82	101.3	116.3	1824.097	1809.097	N/A
MW-10A	272535.399	2081973.782	1923.479	1923.809	-0.33	118	101.8	116.8	1822.009	1807.009	N/A
MW-10B	272530.51	2081982.385	1923.353	1923.701	-0.35	124.97	120	125	1803.701	1798.701	N/A
MW-11A	271826.499	2083509.07	1911.838	1912.28	-0.44	107.28	91	106	1821.28	1806.28	N/A
MW-12A	270399.71	2085390.335	1919.65	1917.131	2.52	122.27	102.4	117.4	1814.73	1799.73	N/A
MW-12C	270400.369	2085379.468	1919.64	1916.677	2.96	168.02	150	160	1766.68	1756.68	N/A
MW-12C	270399.729	2085403.614	1918.89	1916.98	1.91	179.63	167	177	1749.98	1739.98	N/A
MW-13C	270368.902	2081015.694	1929.647	1928.742	0.90	138.93	133	135.5	1795.742	1793.242	N/A
MW-13E	270393.318	2081014.304	1930.428	1928.89	1.54	240.69	230.8	235.8	1698.09	1693.09	N/A
MW-14A	270968.774	2084137.323	1911.691	1909.556	2.13	111.57	91	106	1818.556	1803.556	N/A
MW-16A	267054.530	2084286.745	1914.94	1915.45	0.50	117	100	115	1815.45	1800.45	N/A
MW-16C	267048.593	2084285.984	1915.08	1915.47	0.39	155.5	140.2	150.2	1775.27	1765.27	N/A
MW-17A	268796.556	2082958.916	1903.703	1901.854	1.85	107.85	84.5	104.5	1817.354	1797.354	N/A
MW-17C	268795.876	2082969.298	1902.905	1901.674	1.23	142.54	130	140	1771.674	1761.674	N/A
MW-17D	268796.267	2082964.251	1902.933	1901.729	1.20	195.9	190	192.5	1711.729	1709.229	N/A
MW-18A	268693.818	2085938.384	1912.889	1910.637	2.25	113.45	97	112	1813.637	1798.637	N/A
MW-18C	268683.36	2085938.592	1913.086	1910.53	2.56	147.85	135	140	1775.53	1770.53	N/A
MW-18D	268704.658	2085938.735	1913.318	1910.605	2.71	200.82	188	193	1722.605	1717.605	N/A
Walter-1*	272985.052	2080619.317	NR	1929.148	NR	NR	107	124	1822.15	1805.15	1000
Walter-2*	268948.213	2079469.536	NR	1923.945	NR	NR	107	119	1816.95	1804.95	1000
Walter-3*	268893.975	2080785.037	NR	1933.216	NR	NR	103	127	1830.21	1806.16	1200

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Table 2.2 (continued)
Existing Monitoring Well Construction
Garvey Elevator Site
Hastings, NE

Well ID(1)	Northing	Easting	TOC Elevation (ft amsl)	Ground Surface Elevation (ft amsl)	Stickup Height(2) (ft)	Total Depth(3) (ft btoc)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Top of Screen Elevation (ft amsl)	Bottom of Screen Elevation (ft amsl)	Sample Port Depth(4) (ft bgs)
MW-19A	270955.133	2081332.85	1929.894	1927.812	2.082	162.5	127	132	1800.812	1795.812	130
MW-19C							152	162	1775.812	1765.812	157.5
MW-20A	270597.445	2081202.233	1929.929	1927.97	1.959	232.5	127	132	1800.97	1795.97	130
MW-20C							152	162	1775.97	1765.97	157.5
MW-20D							182	192	1745.97	1735.97	188
MW-20E							222	232	1705.97	1695.97	226.5
MW-30A	270271.723	2081095.43	1930.983	1929.032	1.951	232.5	127	132	1802.032	1797.032	130
MW-30C							152	162	1777.032	1767.032	157.5
MW-30D							182	192	1747.032	1737.032	188
MW-30E							222	232	1707.032	1697.032	226.5
MW-31A	269550.764	2080816.035	1932.347	1930.084	2.263	162.5	127	132	1803.084	1798.084	130
MW-31C							152	162	1778.084	1768.084	157.5
MW-33	271206.314	2079068.057	1942.172	1940.74	1.43	241.29	120	240	1820.74	1700.74	N/A
MW-45C	270056.013	2083476.694	1911.75	1909.82	1.93	149.3	137	147	1772.82	1762.82	N/A
HTW-40	271217.760	2079158.791	1941.64	1939.49	2.15	243.1	127	237	1812.49	1702.49	N/A
MW-45D	270046.773	2083475.763	1911.38	1909.46	1.92	171.4	159	169	1750.46	1740.46	N/A

Survey data and total depths for non-multilevel monitoring wells collected in June 2009, except MW-16A/C. MW-16A/C surveyed in June 2010.
Coordinates in feet Nebraska State Plane, NAD 1983; and elevations in feet NAVD 1988.
Note: MW-15A/C was abandoned. Records do not indicate a date.
(1) Walter-1, Walter-2, and Walter-3 are irrigation wells on property adjacent to the site property.
(2) Negative stickup heights indicates that the well is installed in a well vault flush to the ground surface.
(3) Total depths for traditional monitoring wells collected in June 2009. Total depths for multilevel wells MW-19A/C, MW-20A/C/D/E, MW-30A/C/D/E, and MW-31A/C are from PRP well construction logs.
(4) The 2-inch multilevel well system installed at MW-19A/C, MW-20A/C/D/E, MW-30A/C/D/E, and MW-31A/C have sample ports situated within the screened intervals of the outer 4-inch well.
***** Limited construction information is available from the Nebraska Department of Natural Resources Registered Well Database regarding construction of the Walter-1, Walter-2, and Walter-3 irrigation wells.
Additional information from the database was included in select columns in the above table as follows:
Top of Screen (ft bgs) column = Static Water Level (ft bgs)
Bottom of Screen (ft bgs) column = Pumping Water level (ft bgs)
Top of Screen (ft amsl) column = Static Water Level (ft msl)
Bottom of Screen (ft amsl) column = Pumping Water level (ft amsl)
Sample Port Depth (ft bgs) column = Pump capacity (gpm)

amsl above mean seal level
bgs below ground surface
ft feet
gpm gallons per minute
N/A not applicable
NAVD North American Vertical Datum
NAD North American Datum
NR not recorded
TOC top of casing

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Table 2.3
Existing SVE and GET System Well Construction Summary
Garvey Elevator Site
Hastings, NE

Current Well ID	Northing	Easting	Top of Casing Elevation (ft amsl)	Ground Surface Elevation (ft amsl)	Stickup Height (ft.)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)
RW-01	270924.258	2080881.294	1928.362	1931.602	-3.24	115	125
RW-02	270636.079	2080877.866	1926.417	1929.457	-3.04	116	126
RW-03	270327.507	2080992.501	1926.138	1929.138	-3	114	124
RW-04	270056.71	2080895.538	1926.101	1929.051	-2.95	116	126
RW-05	270441.785	2080592.154	1928.232	1931.432	-3.2	117	127
RW-06	270754.887	2081007.6	1931.616	1930.084	1.532	132	147
RW-07	270460.719	2080961.017	1927.385	1930.385	-3	135	150
RW-08	270193.287	2080946.173	1928.934	1931.844	-2.91	137	152
SVE-01	270553.785	2080615.882	1928.868	1931.708	-2.84	20	50
SVE-02	270490.398	2080714.177	1931.177	1931.347	-0.17	20	50
SVE-03	270484.194	2080525.078	1927.875	1930.725	-2.85	20	50
SVE-04	270453.965	2080616.161	1931.456	NA	NA	20	50
SVE-05	270417.31	2080729.751	1931.771	1932.111	-0.34	20	50
SVE-06	270380.987	2080804.755	1931.582	1931.702	-0.12	20	50
SVE-07	270412.172	2080564.029	1931.383	NA	NA	20	50
SVE-08	270382.286	2080648.617	1932.232	NA	NA	20	50
SVE-09	270617.947	2080719.086	1926.266	1929.496	-3.23	60	110
SVE-10	270411.814	2080657.696	1931.729	NA	NA	60	110
SVE-11	270373.081	2080850.415	1930.862	NA	NA	60	110
IW-1	270863.284	2080136.846	1921.184	1926.384	-5.2	175	230
IW-2	270331.729	2080129.836	1919.984	1925.274	-5.29	175	230

amsl = above mean seal level
bgs = below ground surface
ft = feet
NA = Not available
TOC = top of casing

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FIGURES

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.1
Current Site Map

Legend

- Railroad
- Garvey Property Boundary
- Buildings
- Concrete Paved Area
- Gravel Road

0 195 390 780
Feet

N

Filename: X:/EPA009/Garvey/GIS/MXDs
(2-01)SiteMap.mxd
Project: EP9033.01.12.05
Revised: 10/05/10 ST
Source: ENSR GDB 2008, DNR

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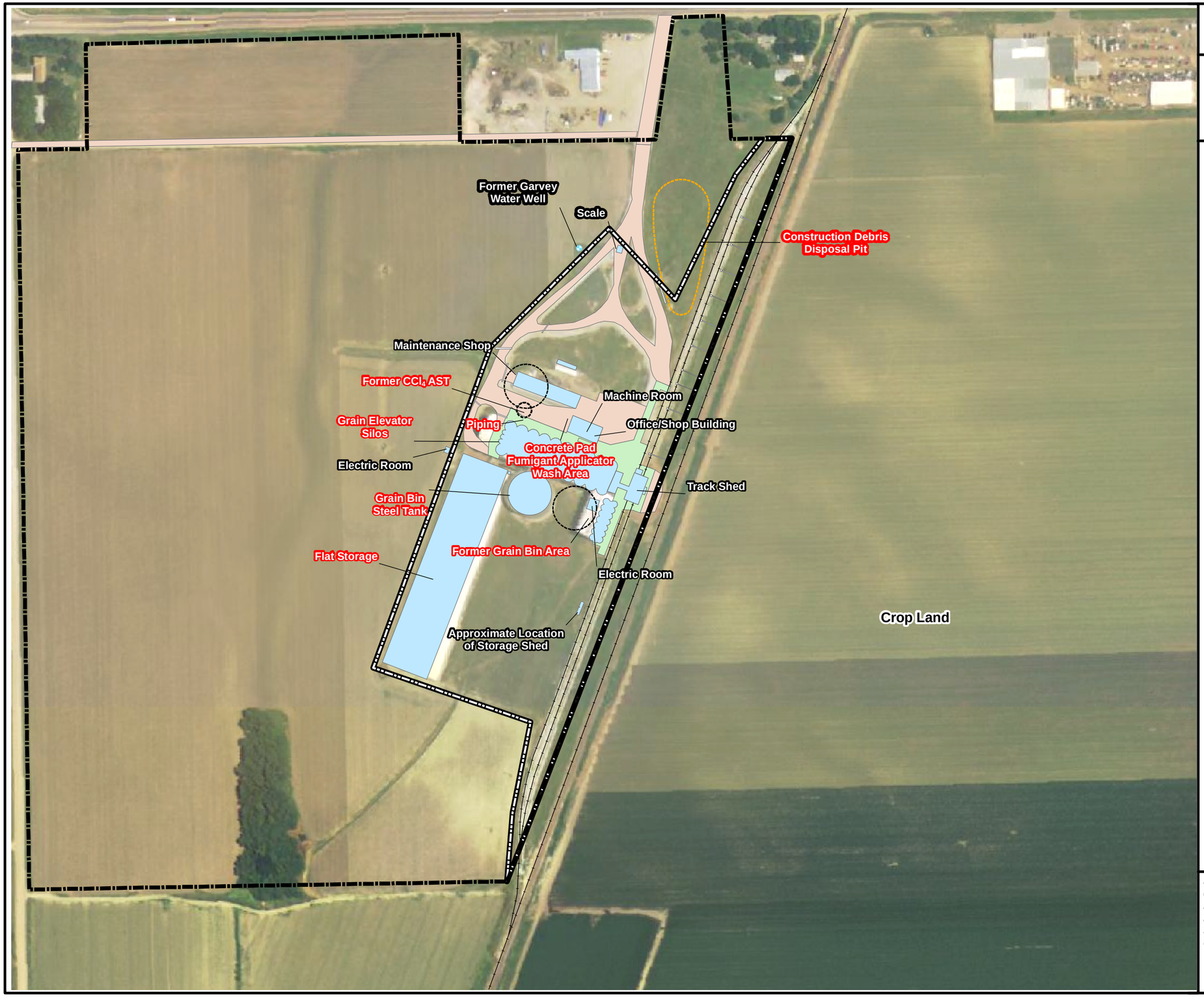

HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.2
Source Area Map

Legend

- Former Garvey Property Boundary
- Operable Unit 1
- Culverts
- Buildings
- Debris Pit
- Former Steel Grain Bin
- Concrete Paved Area
- Gravel Road
- Railroad
- Former Garvey Water Well

Potential Source Areas

CCl_4 AST = Carbon Tetrachloride Above Ground Storage Tank

N

0 150 300 600

Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/(2-02)SourceArea.mxd
Project: EP9033.01.12.05
Revised: 10/06/10 ST
Source: ENSR GDB 2008; DNR; Garvey, 2003

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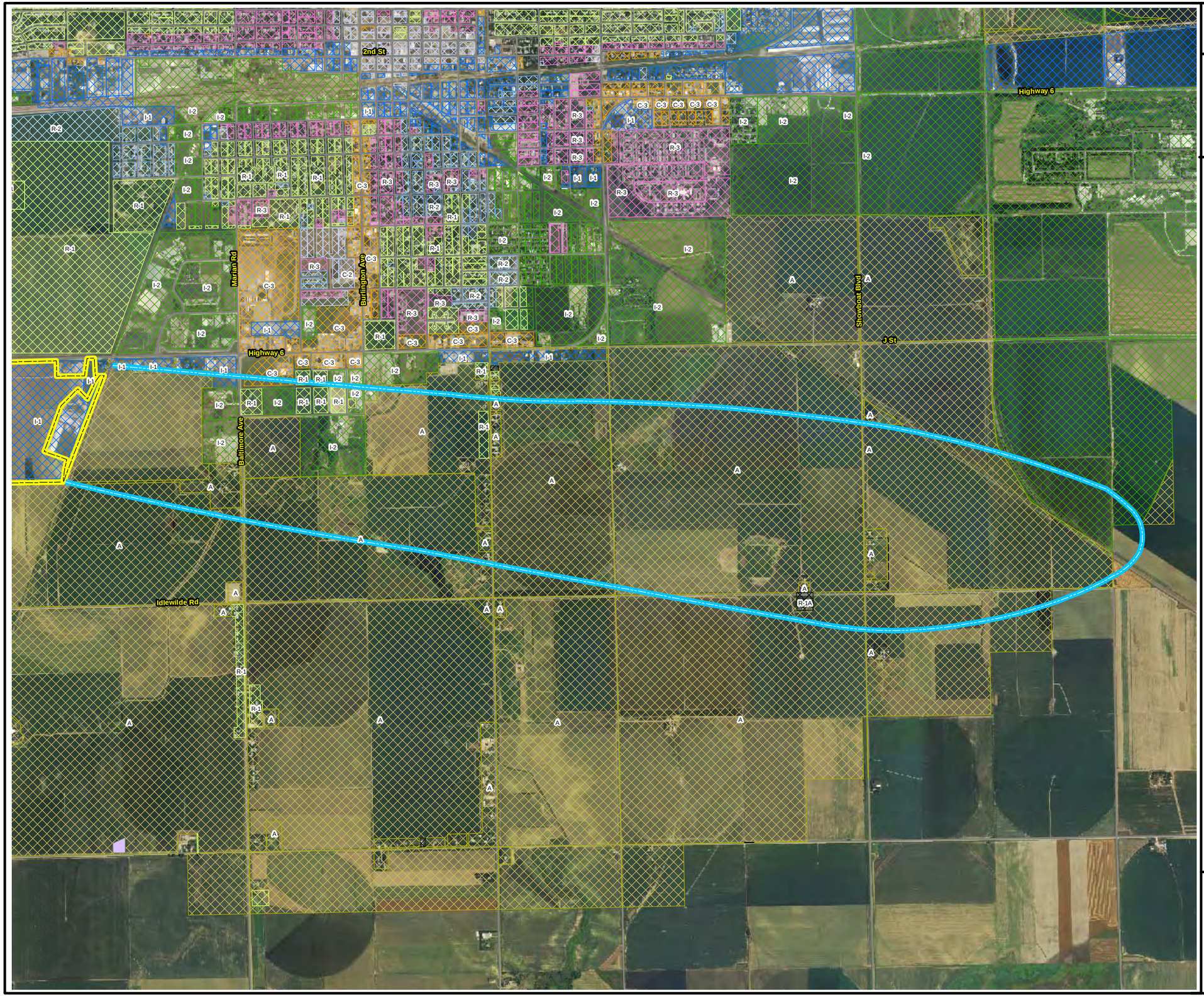

HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.3
Zoning Areas Affected by Groundwater Contamination

Legend

- Approximate Carbon Tetrachloride 5.5 µg/L Isoconcentration Line
- Site Boundary

Zones

- A - Agricultural District
- C-2 - Central Business District
- C-3 - Commercial District
- I-1 - Light Industrial District
- I-2 - Heavy Industrial District
- R-1 - Urban Single Family Residential District
- R-1A - Single Family Large Lot Residential
- R-1S - Single Family Suburban Acreage Residential
- R-2 - Two Family Residential District
- R-3 - Multiple Family Residential District

N

0 800 1,600 3,200 4,800
Feet

Filename: X:/EPA009/Garvey/GIS/MXDs
Hastings_Zoning_Affected.mxd
Project: EP9033.01.12.05
Revised: 08/10/10 ST
Source: NDEQ, 1996; Nebraska DNR
Hastings Utilities, 2005,

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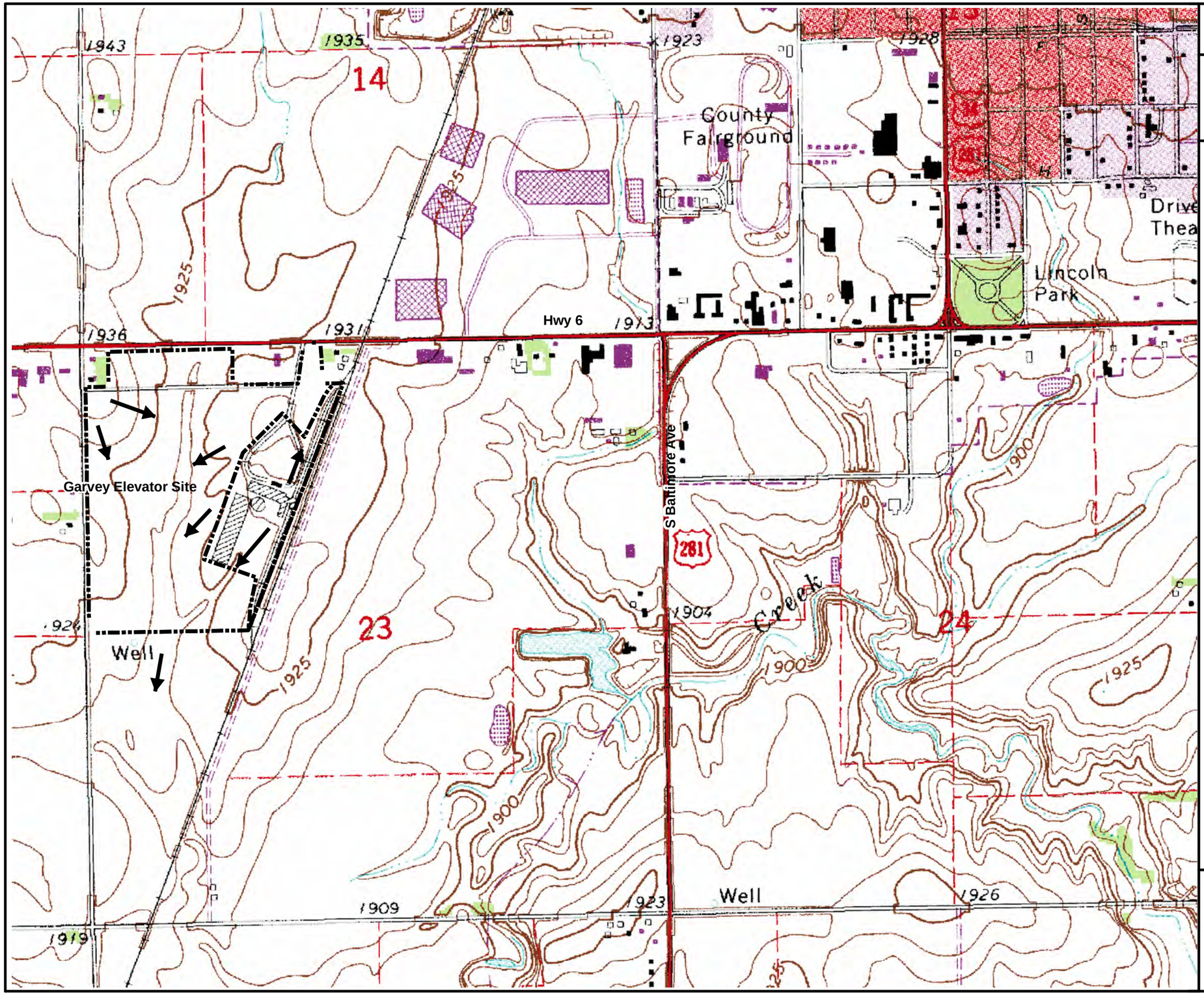

HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.4
Garvey Elevator Site
Topography/Hydrology

Legend

Site Boundary

Surface Water Flow

N

0 450 900 1,800
Feet

Filename: X:/EPA009/Garvey/Remedial_Design/Topography_Map.mxd
Project: EP9033.01.12.05
Revised: 08/03/10 ST
Source: USGS, 1983

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.5
On-Site Drainage

Legend

- Former Garvey Property Boundary
- Operable Unit 1
- Culverts
- Buildings
- Former Steel Grain Bin
- Concrete Paved Area
- Gravel Road
- Railroad
- Drainageways

0 150 300 600
Feet

N

Filename: X:/EPA009/Garvey/Remedial_Design/OnSite_Drainage.mxd
Project: EP9033.01.12.05
Revised: 10/12/10 ST
Source: ENSR GDB 2008, DNR

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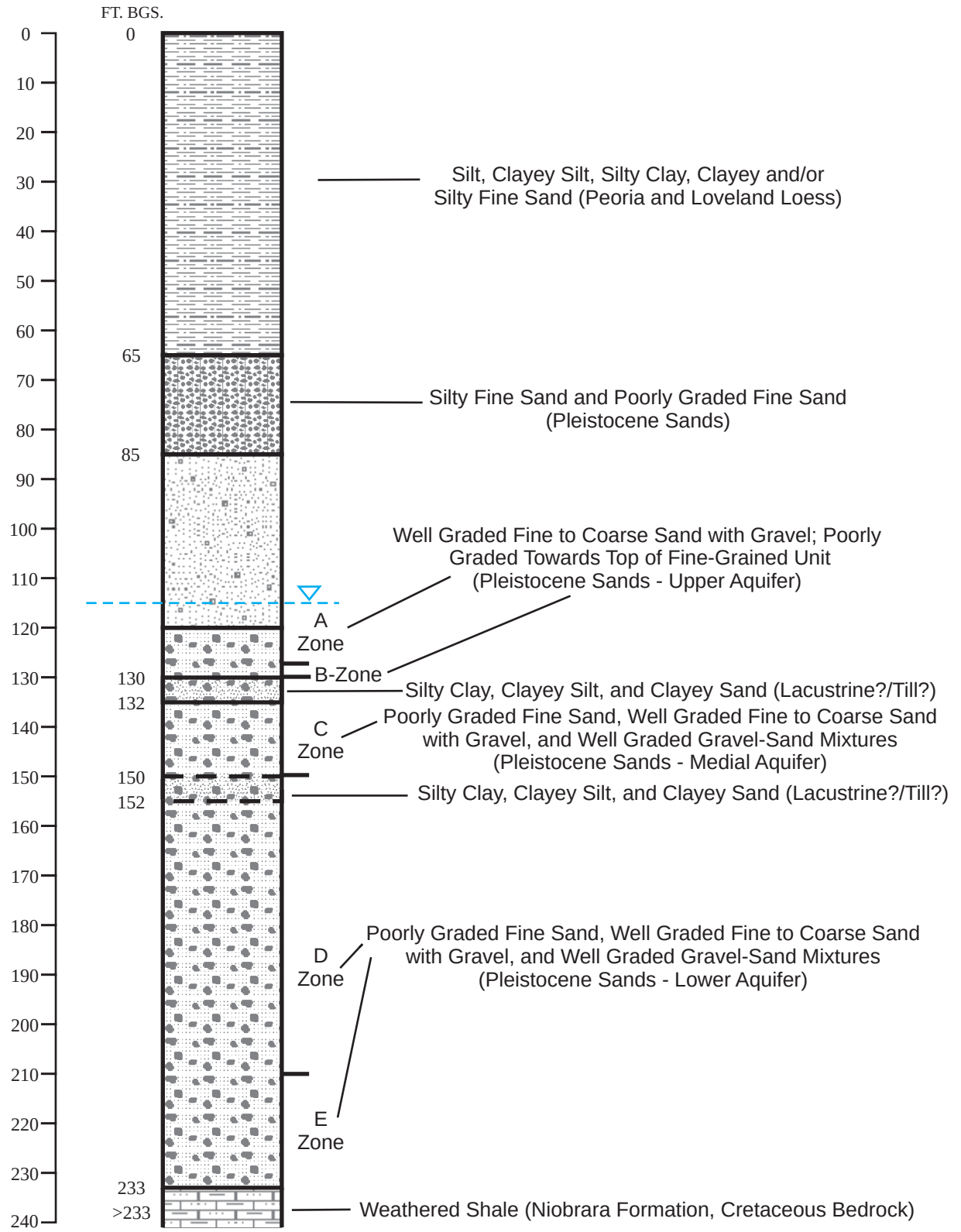

Filename: X:/EPA009/Garvey/Remedial_Design/General_Hydrostratigraphic_Column.cdr
Project: EP9033.01.46.11
Revised: 08/11/10 ST
Source: HWS, 1995; HGL, 2008; HGL 2009 -2010 RI Borings

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Note
A Zone: Water Table Zone, Upper Aquifer
B Zone: Uppermost Fine-Grained Unit/ Base of Upper Aquifer
C Zone: Medial Aquifer
D Zone: Upper Portion of the Lower Aquifer
E Zone: Lower Portion of the Lower Aquifer

Figure 2.6
Generalized Hydrostratigraphic Column

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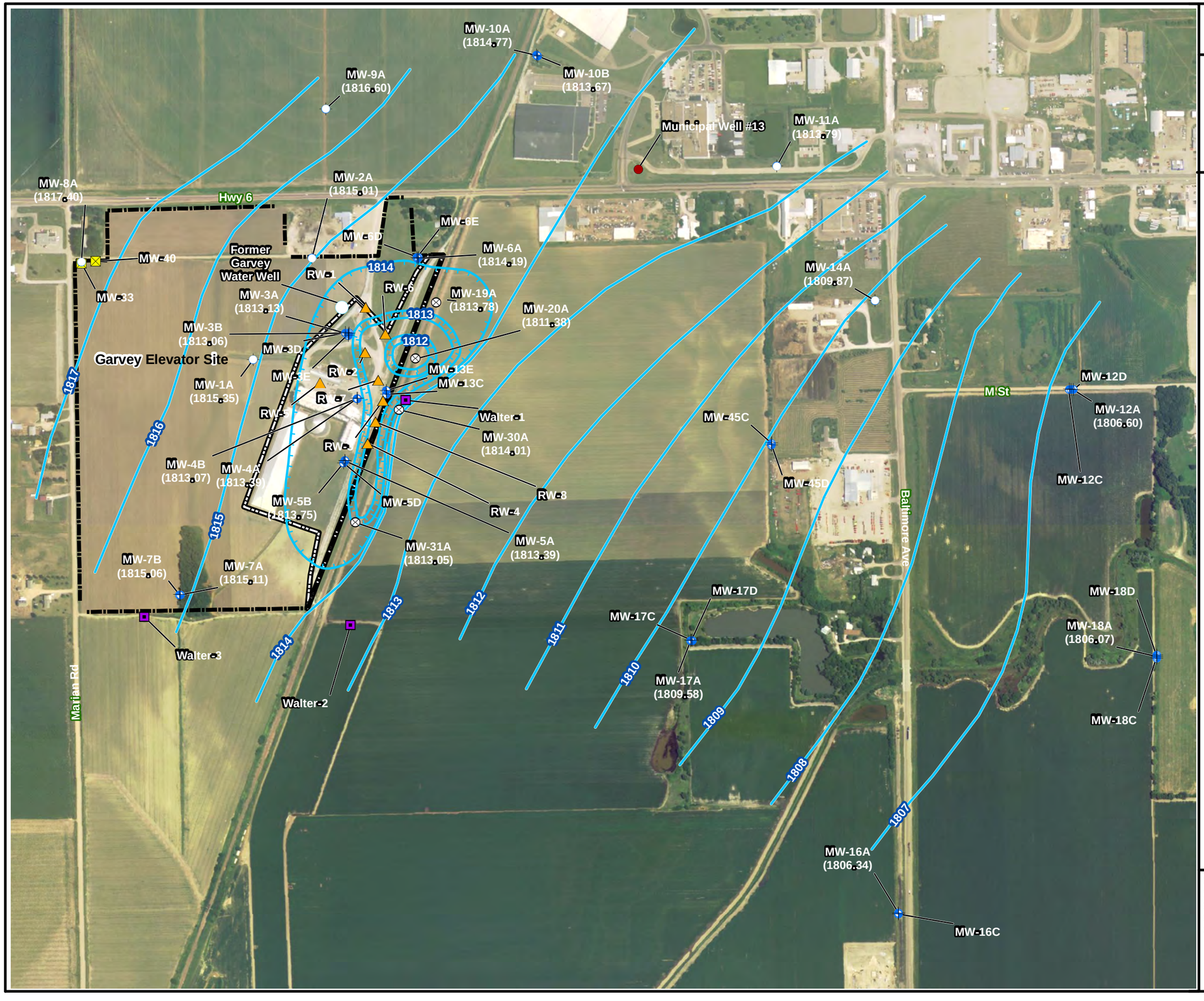

HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.7
June 2010 Groundwater Potentiometric Map for the Upper Aquifer

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Recovery Well
- Municipal Well
- Groundwater Contour (Feet Above Mean Sea Level)
- Former Garvey Property Boundary
- Operable Unit 1
- Former Garvey Water Well

N

0 630 1,260

Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/
(2-7)GW_Potentiometric_Map_UpperAquifer
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.8
June 2010 Groundwater Potentiometric Map for the Medial Aquifer

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Recovery Well
- Municipal Well
- Groundwater Contour (Feet Above Mean Sea Level)
- Former Garvey Property Boundary
- Operable Unit 1
- Former Garvey Water Well

N

0 630 1,260
Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/(2-8)GW_Potentiometric_Map_MedialAquifer
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.9
June 2010 Groundwater Potentiometric Map for the Lower Aquifer

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Recovery Well
- Municipal Well
- Groundwater Contour (Feet Above Mean Sea Level)
- Former Garvey Property Boundary
- Operable Unit 1
- Former Garvey Water Well

N

0 630 1,260
Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/
(2-8)GW_Potentiometric_Map_LowerAquifer
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.10
Existing On-Site Monitoring Wells

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Recovery Well
- Municipal Well
- Former Garvey Property Boundary
- Operable Unit 1
- Former Garvey Water Well

N

0 630 1,260

Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/
(2-10)Existing_OnSite_MonitoringWell_Locations
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.11
June 2010 Groundwater Data
Map for the Upper Aquifer

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Recovery Well
- Municipal Well
- Former Garvey Water Well
- Former Garvey Property Boundary
- Operable Unit 1
- 10 Carbon Tetrachloride Contour
- (9.8) Carbon Tetrachloride Concentration in µg/L
- (ND) Nondetect

N

0 630 1,260
Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/
(2-11)Historical_GW_DataMap_GW_Upper_Aquifer
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.12
June 2010 Groundwater
Data Map for the Medial Aquifer

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Recovery Well
- Municipal Well
- Former Garvey Property Boundary
- Operable Unit 1
- Former Garvey Water Well
- 10 — Carbon Tetrachloride Contour
- (9.8) Carbon Tetrachloride Concentration in µg/L
- (ND) Nondetect

N

0 630 1,260
Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/
(2-12)Historical_GW_DataMap_GW_Medial_Aquifer
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.13
June 2010 Groundwater
Data Map for the Lower Aquifer

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Recovery Well
- Municipal Well
- Former Garvey Property Boundary
- Operable Unit 1
- Former Garvey Water Well
- 5 Carbon Tetrachloride Contour
- (9.8) Carbon Tetrachloride Concentration in µg/L
- (ND) Nond etect

N

0 630 1,260
Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/
(2-13)GW_DataMap_Lower_Aquifer
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

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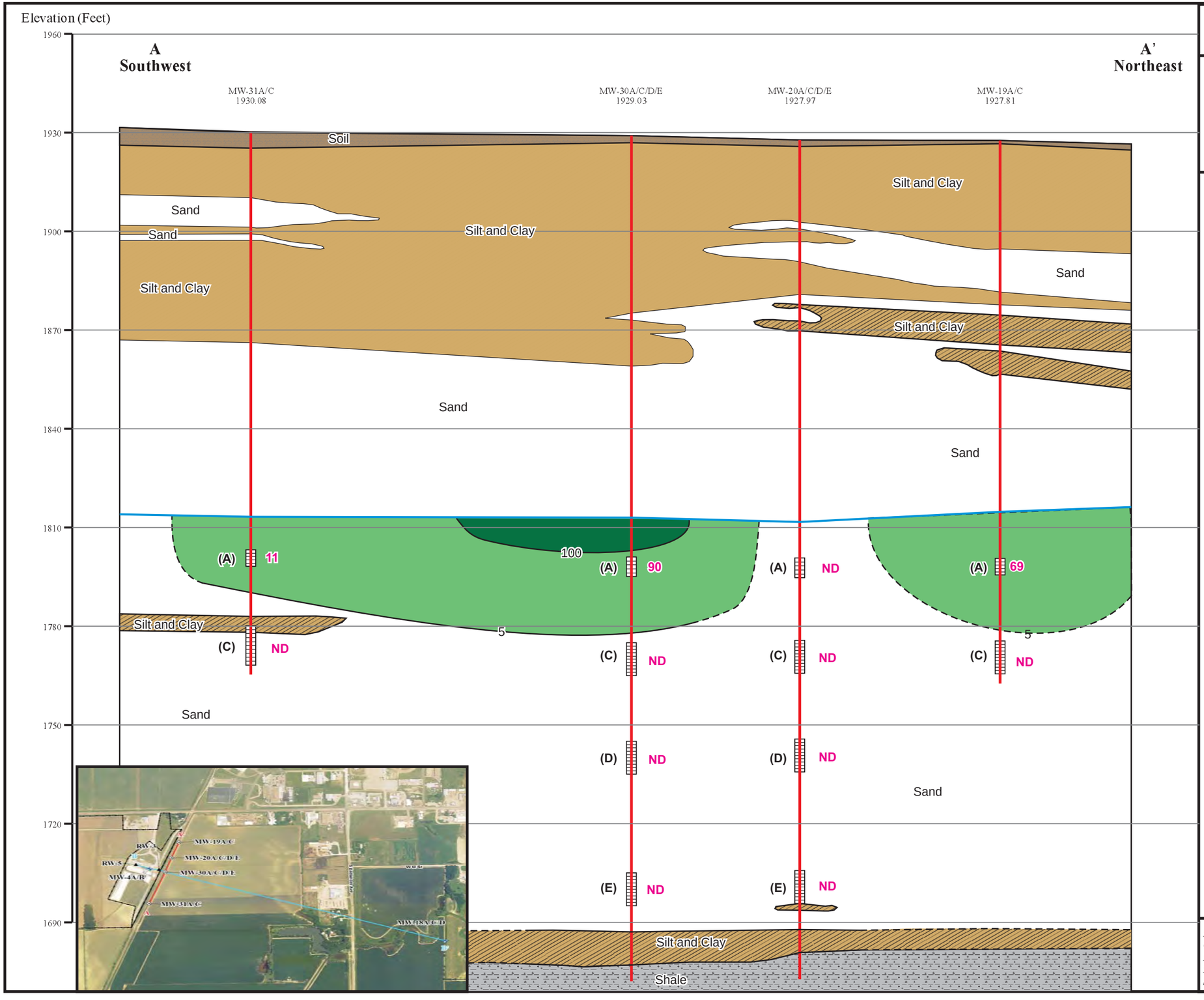

HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.14
Carbon Tetrachloride in Groundwater
Cross Section A-A'
June 2010

Legend

MW-31A/C — Monitoring Well

1866.7 — Ground Surface Elevation (MSL)

Monitoring Well

(A) — Screen (aquifer designation)

Carbon Tetrachloride Contour Intervals

5 µg/L
100 µg/L (Dashed where inferred)

Groundwater Table

120 J — Chloroform Concentration (in micrograms per liter)

ND — Nondetect

Aquifer Designations
A - Upper Aquifer, Water Table
B - Upper Aquifer, Top of Fine-Grained Unit
C - Medial Aquifer
D - Lower Aquifer, Upper Portion
E - Lower Aquifer, Lower Portion

Lithologies (dashed where inferred)

30
0
15
Vertical Scale in Feet

100 0 100 200
Horizontal Scale in Feet

Filename: X:/EPA009/Garvey/Remedial_Design/CarbonTet_2010_Cross_Section_A_A'.cdr
Project: EP9033.01.12.05
Revised: 08/13/10 ST
Source: HGL

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Elevation (Feet)

1960
1930
1900
1870
1840
1810
1780
1750
1720
1690

B
Northwest

B
Southeast

RW-5
1931.70

MW-4A
1931.84

MW-4B
1931.70

RW-3
1929.14

MW-30A/C/D/E
1929.03

MW-18A
1910.64

MW-18C
1910.60

MW-18D
1910.60

Silt and Clay

Silty Sand

Silt and Clay

Sand

Silt and Clay

Sand

Sand

Sand

Silt and Clay

Sand

Sand

12

NS

100

1,000

1300

NS

(A) 90

ND

11

(C) ND

5

Sand

(D) ND

3.7

Sand

(E) ND

Sand

Silt and Clay

Shale

HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.15
Carbon Tetrachloride in Groundwater
Cross Section B-B
June 2010

Legend

MW-4A — Monitoring Well

1931.70 — Ground Surface Elevation (MSL)

(A) — Monitoring Well Screen (aquifer designation)

Carbon Tetrachloride Contour Intervals

5 µg/L
100 µg/L
1,000 µg/L
(Dashed where inferred)

Groundwater Table

120 J — Carbon Tetrachloride Concentration (in micrograms per liter)

ND — Nondetect

NS — Not Sampled

J — Estimated Concentration

Section Break (Approximately 4,800 feet)

Aquifer Designations
A - Upper Aquifer, Water Table
B - Upper Aquifer, Top of Fine-Grained Unit
C - Medial Aquifer
D - Lower Aquifer, Upper Portion
E - Lower Aquifer, Lower Portion

Lithologies (dashed where inferred)

30
0
15
Vertical Scale in Feet

40 0 40 80
Horizontal Scale in Feet

Filename: X:/EPA009/Garvey/GIS/MXD/
CarbonTet_2010_Cross_Section_B_B'.cdr
Project: EP9033.01.46.11
Revised: 08/13/10 ST
Source: HGL

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 2.16
Existing GET and SVE Systems

Legend

- Former Garvey Property Boundary
- Operable Unit 1
- Packed Tower Stripper
- GET and SVE System Piping
- Recovery Wells
- Hydraulic Conductivity Well Installed by ENSR
- Multi level Well
- Injection Well
- Soil Vapor Extraction Well
- Monitoring Well
- Irrigation Well

N

0 190 380 760

Feet

Filename: X:/EPA009/Garvey/GIS/MXDs
(2-16)GET_SVE.mxd
Project: EP9033.01.27.01
Revised: 10/12/10 ST
Source: ENSR GDB 2008, DNR

United States Environmental Protection Agency

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PART 1: FIELD SAMPLING PLAN

3.0 SAMPLING PROGRAM AND ANALYTICAL SUMMARY

The RD investigation activities for this FSP are listed below and detailed in the following subsections:

- Install nested monitoring wells
- Collect geotechnical samples from monitoring well boreholes
- Conduct aquifer pumping tests (full GET system and select recovery wells)

These activities will be conducted to support remedial action in furtherance of the following objectives:

- Continued operation and maintenance of the existing GET system.
- Remedial design for expansion of the existing GET system, as necessary, to prevent or mitigate the migration of contaminated groundwater from OU 1.

Section 3.1 below provides a discussion of a preliminary evaluation of drawdown using existing site data hydrostratigraphic data and a range of conductivities based on previous hydrogeologic studies in the site area. Section 3.2 discusses the rationale for placement and construction of the proposed monitoring wells. Section 3.3 discusses the aquifer testing to be conducted using the new and select existing monitoring wells, and all or select recovery wells.

3.1 PRELIMINARY EVALUATION OF DRAWDOWN

It is necessary to install additional monitoring wells for the purpose of meeting the objectives discussed in Section 1.1 above with regard to evaluating GET system influence and aquifer characteristics. To determine the optimal locations for the additional monitoring wells (see Section 3.2), EPA provided HGL an evaluation of the radial drawdown distribution in the upper and medial aquifer for eight scenarios. Analytical solutions were employed to complete this evaluation. Appendix B presents the estimated drawdown calculations, assumptions, and a table of the estimated drawdowns.

3.1.1 Upper Aquifer Drawdown Estimates

For the upper aquifer, the Theis solution for drawdown in a confined aquifer was employed (Theis, 1935). Although the upper aquifer at the site is not confined, the Theis solution can be used to approximate drawdown in an unconfined aquifer because late-time drawdown data will follow the Theis type curves. For the estimation of drawdown in the upper aquifer on site; drawdown was estimated at time of t = 24 hours. Given the thickness of the upper aquifer (15 feet) and an estimated hydraulic conductivity of 70 feet per day (ft/day), theoretical type curves show that at 24 hours, drawdown values would be considered late-time data (Neuman, 1975).

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The shallow recovery well was assigned a pumping rate of 10 gpm; which is reasonable given the historical pumping rates for RW-2. (RW-2 is the shallow recovery well selected for the upper aquifer pumping test.) A full list of assumptions is provided in Appendix B.

As indicated on Table 1 in Appendix B, the assigned hydraulic conductivity value for the upper aquifer was either 70 ft/day or 130 ft/day in the various solution scenarios. These values bracket the hydraulic conductivity value of 100 ft/day estimated during the 1995 pumping tests conducted by HWS at the site (HWS, 1995).

Examination of Table 1 in Appendix B shows that expected drawdown in an upper aquifer monitoring well that fully penetrates the aquifer ranges from 0.7 feet at a radial distance of 10 feet from the pumping well to negligible 0.009 feet at a distance of 200 feet. To enable analysis for aquifer characteristics and capture zones using the drawdown data from a pumping test in the upper aquifer, EPA and HGL determined that monitoring wells should be installed at a radial distance of 20 feet or less from the pumping well. At a radial distance of 20 feet, the drawdown was 0.5 feet when the assigned aquifer hydraulic conductivity was 70 ft/day (Appendix B, Table 1). At a hydraulic conductivity of 130 ft/day, the expected drawdown at a distance of 20 feet was 0.32 feet.

3.1.2 Medial Aquifer Drawdown Estimates

For the medial aquifer, the USGS program WTAQ was employed to estimate drawdown values (Barlow and Moench, 1999). The drawdown again was computed at time = 24 hours, while the assigned pumping rate in the medial recovery well was 70 gpm, which is reasonable given the historical pumping rates for RW-7. (RW-7 is the shallow recovery well selected for the medial aquifer pumping test.) A full list of assumptions is provided in Appendix B.

It was necessary to estimate drawdown in a medial aquifer monitoring well to account for possible differing site conditions. Therefore, various solutions were compiled using WTAQ for the following scenarios:

- Medial aquifer hydraulic conductivity is 200 ft/day, the lower aquitard is present, aquifer thickness is 18 feet (medial aquifer thickness)
- Medial aquifer hydraulic conductivity is 340 ft/day, the lower aquitard is present, aquifer thickness is 18 feet
- Medial aquifer hydraulic conductivity is 200 ft/day, the lower aquitard is not present, aquifer thickness is 108 feet (combined medial and lower aquifer thickness)
- Medial aquifer hydraulic conductivity is 340 ft/day, the lower aquitard is not present, aquifer thickness is 108 feet

The assigned hydraulic conductivity values of 200 ft/day and 340 ft/day bracket the estimated hydraulic conductivity value of 270 ft/day estimated for the medial aquifer during the 1995 pumping tests conducted by HWS at the site (HWS, 1995).

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As shown on Table 1 in Appendix B, a medial aquifer monitoring well that is screened across the bottom 10 feet of the aquifer will have an estimated drawdown ranging from 3.35 feet at a radial distance of 10 feet to 0.2 feet at a distance of 200 feet from the pumping well. This range comprises all four site condition scenarios. To enable analysis for aquifer characteristics and capture zones using the drawdown data from a pumping test in the medial aquifer, EPA and HGL determined that monitoring wells should be installed at a radial distance between 50 feet and 100 feet from the pumping well. At 50 feet from the pumping well, maximum drawdown in a medial aquifer monitoring well was estimated to be 2.39 feet if the lower aquitard is present and the assigned hydraulic conductivity for the aquifer was 200 ft/day. The minimum estimated drawdown at this distance was 0.31 feet, when the lower aquitard was not present and the assigned hydraulic conductivity was 340 ft/day.

It should be noted that the drawdown estimates and underlying calculations discussed above are only for the purposes of informing the decision on placement of the proposed nested monitoring wells. The same solutions applied for making preliminary estimates of drawdown at various radial distances from pumping wells are not proposed for analysis of the drawdown data collected during the full GET system test and individual pumping tests conducted during the RD field investigation.

Appendix B also include preliminary evaluations of capture zones and stagnation zones for recovery wells in the upper and medial aquifer using existing data and certain assumptions. These calculations and assumptions will be revisited and refined using the data collected during the RD field investigation.

3.2 MONITORING WELL PLACEMENT AND CONSTRUCTION

The preliminary drawdown evaluation discussed above was used to determine the proposed placement of additional monitoring wells.

Monitoring wells will be installed at five locations and at three discrete depths on site to support the system performance monitoring and pumping tests and the objectives outlined in Section 1.1 of this SAP. The tentative monitoring well locations are shown on Figure 3.1.

3.2.1 Identification of Screen Intervals

Three wells will be nested, and isolated, in a single borehole at each of the five new monitoring well nest locations. The 15 wells will be installed using rotosonic drilling techniques. Well installation procedures and construction details are discussed in Section 4.4. Each groundwater monitoring well nest will consist of three 2-inch PVC monitoring wells and are tentatively planned to be installed to three discrete depths as follows:

- Base of upper aquifer (B-well) – 120 feet to 130 feet bgs, 10-foot screen
- Base of medial aquifer (C-well) – 140 feet to 150 feet bgs, 10-foot screen

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- Deep aquifer (D-well)– 160 feet to 170 feet bgs, 10-foot screen

The base of the upper aquifer (B-zone) was selected for monitoring because the 10-foot screens of the upper aquifer recovery wells are generally situated from the base of the aquifer upward (Table 2.3). In addition, historical analytical data show that contaminant concentrations are higher at the base of the upper aquifer than at the water table. The additional upper aquifer monitoring wells also will be sampled for chemical analysis to evaluate system effectiveness in subsequent field efforts at the site that are not included in this RD investigation. Furthermore, during the medial aquifer pumping test, the B-wells at each nested well location will be monitored to assess communication between the upper and medial aquifer.

The 15-foot screens of the medial aquifer recovery wells are generally situated at the base of the aquifer at approximately 150 feet bgs. The additional medial aquifer monitoring wells (C-wells) also will be screened at the base of the aquifer in accordance with the EPA guidance document *Suggested Operating Procedures for Aquifer Pumping Tests*, EPA/540/S-93/503, February 1993 (Appendix C). As indicated in this guidance, it is best practice to have observation wells screened in the same stratigraphic horizon as the pumping well. During the upper aquifer pumping test, the C-wells at each nested well location will be monitored to assess communication between the upper and medial aquifers.

The additional monitoring wells proposed for the lower aquifer (D-wells) will be screened in the upper portion of the lower aquifer. This depth is preferred to assess communication between the lower and medial aquifers during the pumping tests and full system test.

Both the C-well and D-well at each of the five well nests will be sampled for the same chemical analysis as the B-well. Analytical results will be used to assess the effectiveness the GET system in reducing groundwater contaminant concentrations on site. All of the monitoring wells will provide information to evaluate the full GET system influence and inform a long-term evaluation of capture zone, update the CSM, and assess hydraulic communication between the aquifers.

3.2.2 Identification of Monitoring Well Locations

The proposed rationale for placement of monitoring wells at each of the five locations is provided on Table 3.1. The general location and primary data use for each monitoring well nest is as follows:

MW-47: MW-47B/C/D will be installed approximately 55 feet northeast of RW-6. These monitoring wells will be used to estimate the GET system influence particularly the capture zone of RW-6, The modeling results discussed in Section 2.5.3.2 indicate that groundwater flowing through this area of the site is not captured by the GET system.

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MW-48: MW-48B/C/D will be installed approximately 20 feet southwest of RW-4. These monitoring wells will be used to estimate the GET system influence, particularly the capture zone of RW-4.

MW-49 MW-49A/C/D will be installed approximately 20 feet west-northwest of RW-2. These monitoring wells will used to monitor aquifer response during the pumping test proposed for RW-2 screened in the upper aquifer. These data will then be used to estimate characteristics of the pumping recovery well and aquifer properties.

MW-50: MW-50B/C/D will be installed approximately 65 feet west-northwest of RW-7. (The MW-50 location could not be moved closer to RW-7 because the elevator driveway lies immediately west of RW-7). These monitoring wells will be used to monitor aquifer response during the pumping test proposed for RW-7 screened in the medial aquifer. These data will then be used to estimate characteristics of the pumping recovery well and aquifer properties.

MW-51: MW-51B/C/D will be installed approximately 20 feet southwest of RW-3. These monitoring wells will be used to monitor aquifer response from pumping at nearby RW-3 (upper aquifer) and RW-8 (medial aquifer) during full operation monitoring. These data will be applied to the study of the GET system influence. This well nest is located directly downgradient from the highest concentration observed during the June 2010 groundwater sampling event (MW-4B; 1,300 μg/L)

3.2.3 Geotechnical Samples

Four geotechnical soil samples will be collected from select monitoring well boreholes during the drilling – one each from the upper aquifer, upper aquitard, medial aquifer, and lower aquitard. The well boreholes chosen for collection of geotechnical samples will be determined in the field based on the lithology observed in the continuous cores obtained during the drilling. These soil samples will be submitted to a subcontracted laboratory for geotechnical analysis including grain size distribution, moisture content, soil porosity calculations, permeability, maximum and minimum index density using a vibratory table, and bulk density. Geotechnical sample collection procedures are discussed in Section 4.5.1.

3.3 AQUIFER TESTING AND MONITORING

Aquifer pumping tests will be conducted on the full remediation system and individual recovery wells in the upper and medial aquifers. The proposed additional monitoring wells are situated for the pumping tests and full system test, and for long-term evaluation of the GET system through water level measurement and groundwater sampling for chemical analysis. The full system test will consist of all operable recovery wells pumping. Dedicated

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transducers for automated monitoring of groundwater levels will be installed in each of the 15 new monitoring wells. These transducers, and those in multilevel wells MW-19A/C, MW-20A/C/D/E, MW-30A/C/D/E, and MW-31A/C, will be fitted with communication instrumentation that will direct data to the GET system control panel for compilation. Additionally, other monitoring wells will be outfitted with rented transducers and dataloggers to monitor water levels during the pumping tests, as follows:

Additional Monitoring Wells for Observation			
Full System Test	RW-2 Constant-Rate Test	RW-7 Constant-Rate Test	RW-2 and RW-7 Pumping Tests Background Monitoring
MW-3A, -3B, -3D MW-4A, -4B MW-5A, -5B MW-13C, -13E, MW-6D, -6E	MW-3A MW-3B MW-3D	MW-13C MW-13E	MW-1A MW-6D MW-6E

The transducers will measure drawdown to the nearest 0.01 foot. The pumping tests field procedures are discussed in Section 4.6. In general, the requisite data will be recorded at a high frequency when pumping is either just started or just stopped. This early water level drawdown and recovery data is typically the most crucial portion of the data set for analysis.

The full remediation system test will evaluate the influence of the current groundwater extraction system on the groundwater flow regime at the site. Water levels in select wells will be monitored and logged over the duration of the following 12-day cycle of testing:

- Steady-state operation of the system (2 days)
- System shutdown and recovery (5 days)
- System startup and operation back to steady-state operation (5 days)

The pumping tests of individual recovery wells will consist of an 8-hour step-drawdown test and 24-hour constant-rate test performed on one recovery well from the shallow aquifer (RW-2) and one recovery well completed in the medial aquifer (RW-7) (Figure 3.1). The 8-hour step-drawdown tests will be performed first to determine the optimal pumping rate for the aquifer. Recovery time will be allowed before the constant-rate test is initiated. RW-2 (upper aquifer) and RW-7 (medial aquifer) were chosen as the pumping wells based on system performance data indicating these well can typically pump at a high rate. This will allow for more stress of the aquifer, and consequently greater drawdown in the monitoring wells nearby.

The constant-rate pumping test data will be used to estimate aquifer properties, including hydraulic conductivity and storativity, and may give some indication as to the radius of

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influence (ROI) of the pumping well at the chosen pumping rate. The optimum pumping rate that is determined during the step-drawdown tests will be used as the extraction rate during the constant-rate pumping tests. The aquifer properties and ROI information will subsequently be employed to determine optimal locations for additional recovery wells. Each constant-rate test will consist of recording water levels in selected wells during 24 hours of pumping at a constant flow rate in the recovery well. The water levels will then be monitored during the 24-hour recovery period after the pumping has been discontinued.

The pumping rate of the recovery wells used for both the full system test (all eight wells) and the individual pumping tests (RW-2 and RW-7) will be measured by existing flow meters installed within the GET system for each recovery well. For the full system test, the GET system will function automatically as programmed and the VFD of the individual recovery wells will control their pumping rates. During the step-drawdown tests and constant-rate tests, the pumping rates of the two recovery wells will be controlled manually, as discussed in Section 4.6, or programmed to pump at a certain rate. In either instance, the VFD will be overridden, and the pumping rates will be set at constant rates using the PLC.

Because of the approximately 2-week duration of the constant-rate and step-drawdown pumping tests at RW-2 and RW-7, water levels in select monitoring wells outside the influence of the GET system will be monitored. These wells, listed on the table above, also will be fitted with rental transducers for data acquisition. Water level data from these wells will be used during analysis of the pumping test data to account for fluctuations in water levels across the site area not related to the pumping tests.

An irrigation well (Walter-1) is situated immediately east of the east perimeter of the site property (Figure 3.1). The pumping rate of this well will be recorded during the various pumping tests at the site, if it is operational at the time of testing. These data will be used to identify any influence from the irrigation well on the pumping test data sets. The constant-rate pumping test data will be analyzed using the AQTESOLV 4.5™ software program to calculate the aquifer properties. Both drawdown (pumping) and recovery data will be evaluated.

3.4 FIELD INVESTIGATION REPORTING

The field investigation activities and the subsequent analysis and evaluation of the data will be presented in the Field Investigation Report. The report will compare and evaluate the field investigation data with the RI data to determine the aquifer characteristics, present an analytical model of the groundwater flow as an appendix (containment assessment technical memorandum), and evaluate the current remediation system performance at the site. The Field Investigation Report will provide a useful reference for the RD activities.

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TABLE

Table 3.1
Rationale for Monitoring Well Placement
Garvey Elevator Site
Hastings, NE

Well ID	1	2	3	4	5	6	7
MW-47B/C/D		X	X	X	X	X	X
MW-48B/C/D		X	X	X	X	X	X
MW-49B/C/D	X	X	X	X	X	X	X
MW-50B/C/D	X	X	X	X	X	X	X
MW-51B/C/D	X	X	X	X	X	X	X

Column Explanations

1 Determine select recovery well sustainable pumping rate, specific capacity, and well efficiency

2 Estimate transmissivity, hydraulic conductivity, and storage properties of aquifer

3 Evaluate hydraulic communication between the upper and medial aquifers

4 Estimate capture zone of groundwater extraction and treatment system

5 Provide information for updating the conceptual site model

6 Monitor influence of Walter-1 irrigation well on the capture zones of nearby recovery wells

7 Monitor water quality to evaluate capture of contaminated groundwater

Table Notes

-All wells will be used to collect water level data necessary to evaluate influence of GET system.

-Monitoring well location selections were limited by the building and road features at the site.

-Objectives 6 and 7 are not specific to this SAP, but will be likely objectives in a forthcoming Operation and Maintenance Work Plan.

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FIGURE

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HGL—Remedial Design,
Garvey Elevator Site—Hastings, NE

Figure 3.1
Proposed On-Site Monitoring Wells

Legend

- Hydraulic Conductivity Well
- Irrigation Well
- Monitoring Well
- Multilevel Well
- Proposed Nested Monitoring Well
- Recovery Well
- Former Garvey Property Boundary
- Operable Unit 1
- Former Garvey Water Well

N

0 400 800

Feet

Filename: X:/EPA009/Garvey/GIS/MXDs/
(3-1)Proposed_OnSite_MonitoringWells
Project: EP9033.01.46.11
Revised: 10/13/10 ST
Source: ENSR GDB 2008, DNR

United States Environmental Protection Agency

HGL HydroGeoLogic, Inc CDM

4.0 FIELD ACTIVITY METHODS AND PROCEDURES

This FSP has been developed to provide the rationale and procedures that will be used to conduct the RD field activities for the Garvey Elevator site. The following is a summary of field activities that will be performed by HGL personnel and/or subcontractors during RD field activities.

- Mobilize
- Locate and mark utility locations
- Purchase or procure equipment and supplies
- Install three nested monitoring wells in a single borehole at five locations
- Collect geotechnical soil samples from select monitoring well boreholes
- Conduct full GET system pumping test
- Conduct step-drawdown pumping tests at individual recovery wells
- Conduct constant-rate pumping tests at individual recovery wells
- Conduct photo documentation
- Conduct surveying
- Decontaminate equipment
- Manage investigation-derived waste (IDW)

The subsections in this section reference field forms and EPA Region 7 standard operating procedures (SOPs), where applicable. Referenced SOPs are included in Appendix C. Referenced field forms are included in Appendix D.

4.1 MOBILIZATION

HGL will identify and provide all necessary personnel, equipment, and materials for mobilization and demobilization to and from the site for the purpose of conducting the RD field activities. Equipment mobilization entails ordering required supplies and sample containers from EPA Region 7 Environmental Services Division and renting or purchasing any additional equipment or supplies needed. Mobilization activities will include the following:

- Setup temporary facilities (in AGP office building), and setup subcontractor staging area
- Obtain utility clearances for on-site work
- Setup decontamination pad, equipment storage area, and IDW storage area
- Conduct initial site safety meeting and field planning meeting with all field personnel including subcontractors

4.2 UTILITY LOCATES

HGL will contact the Nebraska utility location "One Call" service (DIGGERS HOTLINE 1-800-331-5666) to have all underground utilities clearly marked before the start of the drilling program. Boring locations will be adjusted in the field to avoid encountering underground utilities while drilling.

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4.3 EQUIPMENT, SUPPLIES, AND CONTAINERS

HGL has identified the equipment and supplies necessary to support the field activities. These items are summarized in Table 4.1.

A list of required containers and preservatives is included in Table 7.1 of the QAPP (Part 2 of this SAP).

4.4 WELL DRILLING, INSTALLATION, AND DEVELOPMENT

The well drilling, installation, development, and borehole abandonment procedures will comply with applicable regulations in Title 178 Nebraska Administrative Code Chapter 12 Water Well Construction, Pump Installation, and Water Decommissioning Standards.

4.4.1 Well Drilling and Installation Procedures

The monitoring wells will be drilled and installed using the rotosonic drilling technique. Rotosonic drilling combines rotational power, hydraulic down pressure, and mechanically generated oscillations to advance a dual line of drilling pipe. The two primary downhole components are the inner drill pipe which includes a core bit/core barrel sampler and the outer pipe. The override casing is used to prevent the collapse of the borehole. If sections of the subsurface do not require coring for logging purposes, the outer drilling pipe will be advanced without the core barrel, using water pressure and vibration to move the subsurface materials aside. During this RD well installation effort, lithologic sampling employing the core barrel will be conducted at three of the five proposed monitoring well cluster locations.

Rotosonic drilling is particularly advantageous when multiple wells are installed in a single borehole because the wells can be installed inside an override casing that maintains borehole stability. Because of the override casing, drilling fluid is not needed to maintain hydraulic pressure for borehole stability. The override casing is slowly withdrawn from the borehole as well installation proceeds from the deepest to the shallowest well, including the placement of alternating filter packs and bentonite seals in the annular space. Figure 4.1 provides a construction diagram illustrating how the wells and annular materials will be situated within a single borehole for the screen depths proposed in this RD field effort. Rotosonic drilling also is ideal for situations where aquifers need to be isolated during the drilling operation. If an aquitard is encountered, a larger override casing can be telescoped over the smaller initial override casing to seal the aquifer above the aquitard, which allows drilling to proceed with minimal interruption.

The specific well installation procedures are as follows:

1. An 8-inch override casing will be advanced to a depth of approximately 152 feet bgs. An approximately 6-inch override casing will be advanced to 170 feet bgs off-center inside the 8-inch borehole. Continuous coring will be conducted between approximately 100 feet to 170 feet bgs.

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2. A 2-inch schedule 80 PVC well casing and factory-slotted screen (0.010-inch slot) will be lowered into the override casing, and down to the bottom of the 6-inch borehole. The 10-foot screen will extend from 160 feet to 170 feet bgs in the upper portion of the lower aquifer (D-well). Blank casing will extend from 160 feet bgs to the ground surface.
3. As the 6-inch override casing is slowly retracted, filter sand (#16 to #30) will be placed in the annular space from 170 feet bgs to 157.5 feet bgs, followed by 5.5 feet of bentonite chips to 152 feet bgs, and 2 feet of filter sand on top of the bentonite up to 150 feet bgs. The bentonite chips are used to plug the annular space to isolate each of the screens in the borehole. Sand is overlain on the bentonite chips to prevent contact between the bentonite and the well screen for medial aquifer (C-well). The 6-inch casing will be completely removed from the borehole before continuing.
4. Next, the medial aquifer 2-inch schedule 80 PVC well casing and factory-slotted screen (0.010-inch slot) will be lowered into the 8-inch override casing. The 10-foot screen will extend from approximately 140 feet to 150 feet bgs. Blank casing will extend from 140 feet bgs to the ground surface.
5. As the override casing is again slowly retracted, filter sand (#16 to #30) will be placed in the annular space from 150 feet bgs to 137.5 feet bgs, followed by 7.5 feet of bentonite chips to 130 feet bgs, and 2 feet of filter sand on top of the bentonite up to 128 feet bgs.
6. The last 2-inch schedule 80 PVC well casing and factory-slotted screen (0.010-inch slot) will be lowered into the override casing. The 10-foot screen will extend from approximately 118 feet to 128 feet bgs in the upper aquifer. Blank casing will extend from 118 feet bgs to the ground surface.
7. As the override casing is again slowly retracted, filter sand (#16 to #30) will be placed in the annular space from 128 feet bgs to 115.5 feet bgs, followed by 5 feet of bentonite chips to 112.5 feet bgs.
8. High-solids bentonite grout will then be installed from the top of the bentonite seal at 112.5 feet to within 3 feet of the ground surface.

The monitoring wells will be completed with concrete from 3 feet bgs to ground surface. A protective above-grade or flush-mount well protector casing will be installed at each well. A 3-foot by 3-foot square concrete pad will be constructed to seal the well protector in place. The concrete pad will be coned downward around the well vault or stickup protector to at least 8 inches in thickness at the outside edge and constructed so that the surface slopes away from the outside of the cover to facilitate runoff away from the well. For above-grade well completions, four steel guard posts filled with concrete will be installed around the wells.

It should be noted that all depths are approximate. The actual screened depths, which dictate the placement of annular materials, will be based on the lithologic logging. The lithologic logging will indicate the depth to the base of the upper aquifer, depths to aquitards (if present), the depth to the medial aquifer, and the top of the lower aquifer.

A Declaratory Order has been requested from Nebraska Department of Health and Human Services (DHHS) for the described design on the basis that the design is substantially equivalent to construction requirements of Title 178, Chapter 12. Approval of the Declaratory Order by DHHS is forthcoming.

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4.4.2 Lithologic Logging

Drilling cores will be logged for lithology at monitoring well drilling locations. All pertinent borehole drilling information will be recorded on a drilling log (see Appendix D). Borings will be logged according to the general procedures described in CDM SOP 3.5 *Lithologic Logging* (March 2007), which is provided in Appendix C.

The borehole materials will be described using the Unified Soil Classification system (USCS) classification, and be noted for the following (at a minimum):

- Consistency of cohesive materials or apparent density of noncohesive materials;
- Moisture content assessment (e.g., moist, wet, saturated, etc.);
- Color;
- Other descriptive features (e.g., bedding characteristics, organic materials, etc.).

4.4.3 Well Development

The newly installed monitoring wells will be developed within 1 week after the wells has been constructed, but no sooner than 24 hours after grouting is complete, following the procedures in EPA SOP #2044, *Monitor Well Development* (Appendix C). The well will be developed by alternately surging and pumping the well over 5-foot intervals across the entire lengths of the various screens. Surging will be accomplished with a surge block attached to a ¾-inch PVC (or equivalent) pipe. Submersible pumps will be used to pump or purge the well.

Surging and purging will continue until all formation cuttings have been removed from the well, all water quality parameters have stabilized (as defined below) and three times the volume of water lost during drilling the formation adjacent to the screened zone of each well has been removed.

HGL's field geologist will collect periodic measurements of pH, specific conductance, temperature, and turbidity during development. Development will continue until all parameters (temperature, pH, and conductivity) have stabilized to less than 10 percent change for four consecutive readings and the water is clear and free of fines (turbidity <50 nephelometric turbidity units [NTUs]). Readings will be taken at least every 10 minutes during well development. Pumping and surging will not exceed 8 hours on a monitoring well. Details of the development procedure will be documented on a Well Development Log (Appendix D).

4.5 SAMPLE COLLECTION PROCEDURES

The subsections below outline the procedures to be employed during the collection of the various samples required for the RD investigation at Garvey Elevator site. Sampling methods will include geotechnical soil sampling and IDW sampling. In addition, decontamination and surveying methods to be utilized in the performance of this investigation are outlined below.

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4.5.1 Geotechnical Soil Sample Collection

Soil samples will be collected during drilling activities from four intervals in one or more of the monitoring well borings for geotechnical analysis. These disturbed soil samples will be collected from the rotosonic cores after examining them for logging purposes, and determining the sample interval. (Previous drilling operations in Hastings have shown Shelby tubes and split-spoon sampling to be ineffective.) The samples will be packaged in the clear plastic rotosonic core sleeve into which it was extruded from the core barrel.

The following lists the geotechnical parameters:

- Grain size distribution,
- Moisture content,
- Soil porosity calculations,
- Permeability,
- Bulk density.
- Maximum/minimum index density using a vibratory table

The samples will be transported to off-site geotechnical laboratories (Alpha-Omega Geotech, Inc. and Geotechnology, Inc.) for analysis. Table 7.1 lists the analytical requirements for the geotechnical samples.

4.5.2 IDW Sampling

IDW soil and water will be handled in accordance with Section 5.0. Soil sample collection will include grab samples sent to Test America, Inc. in University Park, Illinois for toxicity characteristic leaching procedure (TCLP) VOC analysis (72-hour turnaround). Two grab samples representative of the subsurface materials will be collected from the drill cuttings in each rolloff box and placed into a 4-ounce jar.

Non-hazardous soils will be sent to a municipal Subtitle D landfill for disposal. It is anticipated that soil IDW will be non-hazardous. IDW determined to be hazardous will be handled in accordance with Code of Federal Regulations (CFR) 40, Part 260.

VOC samples of IDW water will be analyzed as necessary to discharge this waste to the city of Hastings wastewater treatment plant (WWTP). Samples will be collected into 40-ml volatile organic analysis (VOA) vials from the poly tank(s) in which the IDW water is staged on site.

Section 7 discusses the sample collection requirements, sample handling and custody requirements, analytical method requirements for all samples collected during the field investigation. Table 7.2 lists the analytical requirements for the IDW samples.

4.6 PUMPING TEST PROCEDURES

Before any pumping test activities, water levels will be manually collected from all on-site monitoring wells. Manual water level measurement procedures are discussed in Section 4.6.4. Because the pumping wells will be recovery wells connected to the GET system, IDW water

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generated during the pumping tests will be captured in the extraction piping, treated, and discharged into the injection wells upgradient to the west of the elevator facilities.

The new monitoring wells will be installed with dedicated transducers that will communicate water level data directly to the GET system control panel where pumping rates and other data are compiled. The existing dedicated transducers in the multilevel wells (MW-19A/C, MW-20A/C/D/E, MW-30A/C/D/E, and MW-31A/C) will be retrofitted with datalogging and communication capabilities. These data also will be conveyed to the GET system control panel. In addition, a nearby irrigation well directly east of the site will be fitted with a flow meter and remote data transmission capabilities. The pumping rate for this irrigation well will be communicated to the GET system control panel for compilation.

4.6.1 Full GET System Test

To evaluate the influence of the GET system, water levels will be observed in the new and select existing monitoring wells. The select additional wells are enumerated in Section 3.2 above.

The procedures for setting up and conducting the full GET system testing is as follows:

- Initially, rented datalogging transducers will be programmed to begin collecting data at a predetermined time and measurement frequency. These rental transducers will be programmed exactly as the dedicated transducers linked to the GET system. Table 4.2 provides the measurement frequency and data collection needs for the full GET system pumping test. The rental transducers will then be deployed to the select existing monitoring wells. The transducers will be vented to accommodate for barometric fluctuations during the testing. Also, barometric pressure readings from a sensor at the GET system control panel will be recorded with the data from the dedicated transducers.
- The test setup for the dedicated transducers in the new monitoring wells and existing multilevel monitoring wells, and the recovery wells will be confirmed at the GET system control panel where they are programmed.
- The data collected from the transducers consists of elapsed time, and water levels. For the pumping recovery wells, collected data will include: elapsed time; water level; pumping rate for each recovery well; and influent flow rate (Table 4.2).
- The test will begin by starting the entire GET system (all recovery wells) and operating continuously for 48 hours, with measurements collected on an equal interval of 1,000 seconds. Throughout the test, regardless of the operation status of the GET system, the nearby irrigation well pumping rate will be recorded on 600-second equal intervals (Table 4.2)
- At the 48-hour mark, the system will automatically shut off. At this time, the measurement frequency shifts to logarithmic beginning with 10-second intervals for the first 10 minutes, with the time between measurements increasing for the duration of this second test period (Table 4.2).

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- After water levels have recovered from system pumping for 120 hours, the GET system will automatically turn on and begin pumping for the 120-hour duration of the final test period. The measurement frequency will reset to the beginning of the logarithmic cycle (10 seconds) and repeat (Table 4.2).
- At the end of the system test, the rented transducers/dataloggers will be retrieved from the select existing monitoring wells, and the data downloaded to a laptop computer, and a flash drive for backup. The data from the dedicated transducers and the GET system will compiled at the system panel computer and available for remote access, and will be downloaded immediately to a flash drive for backup.
- The rental transducers will be decontaminated in accordance with Section 4.7 below.

4.6.2 Step-Drawdown Tests

To determine the optimal pumping rate for the wells (RW-2 and RW-7) chosen for the constant-rate pumping tests, step-drawdown tests will be performed in accordance with EPA Region 7 SOP 2045 *Controlled Pumping Test*, and EPA Ground Water Issue: *Suggested Procedures for Aquifer Pumping Tests*, EPA/540/S-93/503, February 1993, which are included in Appendix C. The pumping well, select new and existing multilevel and traditional monitoring wells will be monitored throughout the tests. The select existing wells that will be utilized are enumerated in Section 3.2 above for the pumping tests at both recovery wells. Each recovery well will be tested individually.

The procedures for setting up and conducting the step-drawdown pumping tests at RW-2 and RW-7 are as follows:

- The test setup for the dedicated transducers in the new monitoring wells, existing multilevel monitoring wells, and the recovery well to be pumped, will be confirmed at the GET system control panel where they are programmed. Table 4.3 provides the measurement frequency and data collection needs for the step-drawdown pumping tests.
- The data collected from the transducers consists of elapsed time, and water levels. Data recorded for the pumping recovery well will include: elapsed time, water level; pumping rate; and influent flow rate (Table 4.3). Barometric pressure will be measure and recorded at the GET system control panel.
- No pumping will occur during the 120-hour first period. Data will be recorded on an equal interval of 10 minutes throughout the period to provide pre-test conditions.
- At the 120-hour mark, the first pumping period will be initiated at the selected recovery well. No other recovery wells will be pumped during this testing. The measurement frequency for data collection will be logarithmic and start at 1 second for the first 5 minutes, and decrease in frequency throughout the 1-hour period (Table 4.3).
- A low pumping rate will be used for the first period, with each successive pumping period having an approximately 5 to 10 percent higher pumping rate, based on the response in the pumping well. The VFD will be bypassed, and the pumping rates manually set to increase or decrease the pumping rate in the well for each step period.

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- Six 1-hour pumping periods are proposed for each of the two step-drawdown tests. Based on current system data for individual recovery well pumping rates, the range of pumping rates for RW-2 will likely be 5 to 30 gpm. For RW-7, the range of pumping rates will probably be 15 to 100 gpm.
- As with the full system test, if pumping from the irrigation well occurs, it will be recorded at the GET system control panel.
- At the beginning of each pumping period the logarithmic measurement frequency will reset to the beginning of the cycle (1 second).
- One or more pumping periods may be ended prematurely, if a chosen pumping rate is obviously causing an unsustainable amount of drawdown in the pumping recovery well. In this event, the pumping rate will either be decreased, or the test may be ended, based on how may test periods have been completed.
- The last monitoring period will be used to gather recovery data once the final pumping period is completed. These recovery data also will be collected on the same logarithmic scale as the data recorded during each pumping period.
- At the end of test, the rented transducers/dataloggers will be retrieved from the select existing monitoring wells, and the data downloaded to a laptop computer, and a flash drive for backup. The data from the dedicated transducers and the GET system will be compiled at a system panel computer and available for remote access, and will be downloaded immediately to a flash drive for backup.
- The data will be evaluated in the field to determine the optimal pumping rate for the constant-rate test.
- The rental transducers will be decontaminated in accordance with Section 4.7 below.
- Finally, setup will begin for the step-drawdown pumping test at the second recovery well.

4.6.3 Constant-Rate Tests

Using the optimal pumping rates determined for RW-2 and RW-7 from the step-drawdown pumping, constant-rate pumping tests will be conducted at each of these wells to determine aquifer properties. Testing will only begin after the pumping wells and associated monitor wells have fully recovered from the step-drawdown pumping. Each recovery well will be tested individually.

These tests will be performed in accordance with EPA Region 7 SOP 2045 *Controlled Pumping Test*, and EPA Ground Water Issue: *Suggested Procedures for Aquifer Pumping Tests*, EPA/540/S-93/503, February 1993, which are included in Appendix C. The pumping well, select new and existing multilevel and traditional monitoring wells will be monitored throughout the tests. The select existing wells that will be utilized are enumerated in Section 3.2 above for the pumping tests at both recovery wells.

Initial test setup, including the recorded measurements, is the same as for the step-drawdown tests. The differing procedures for conducting the constant-rate pumping tests at RW-2 and RW-7 are as follows:

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- The measurement parameters from both the pumped well and the monitoring wells will be collected on a logarithmic cycle that begins at 3 seconds (Table 4.4).
- The chosen recovery well will be pumped for 24 hours while measurements are recorded.
- The pumping rate data from a nearby irrigation well will be recorded to the GET system along with those data collected from the dedicated transducers throughout both the pumping and recovery periods of the constant-rate tests (Table 4.4).
- At the 24-hour mark, pumping of the recovery well will cease, and recovery data will be collected for 24 hours.
- At the start of the recovery period, the measurement frequency for data collection will reset to the beginning of the same logarithmic cycle employed for the pumping period (Table 4.4).
- At the end of test, the rented transducers/dataloggers will be retrieved from the select existing monitoring wells, and the data downloaded to a laptop computer, and a flash drive for backup. The data from the dedicated transducers and the GET system will compiled at system panel computer and available for remote access, and will be downloaded immediately to a flash drive for backup.
- The rental transducers will be decontaminated in accordance with Section 4.7 below.
- Finally, setup will be begin for the second constant-rate pumping test.

4.6.4 Background Water Level Monitoring

Water levels in monitoring wells MW-1A, MW-6D, and MW-6E will be recorded continuously throughout the duration of the constant-rate and step-drawdown pumping tests. These wells are outside the zone of influence of the GET system. This water level data will be used to assess trends and fluctuations in areawide water levels that may occur during the pumping tests.

The procedures for background groundwater level monitoring are as follows:

- Rented datalogging transducers will be programmed to begin collecting data at the start of the first individual pumping test and will be manually stopped at the end of the final individual pumping test. The measurement frequency will be linear at an interval of 15 minutes, which will provide 1,344 measurements over a 14-day span.
- The rental transducers will then be deployed to the select existing monitoring wells. The transducers will be vented to accommodate for barometric fluctuations during the testing.
- At the end of testing, the rented transducers/dataloggers will be retrieved from the select existing monitoring wells, and the data downloaded to a laptop computer and a flash drive for backup.

4.6.5 Manual Water Level Measurements

Groundwater level measurements will be collected manually from all existing monitoring wells

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before the testing begins using an electric water level indicator, except for the multi-level monitoring wells. The multi-level wells have dedicated transducers at each of the sampling ports in these four wells. A portable readout unit instrument will be used to gather water pressure data from the transducers for conversion to water levels.

Water level measurements will be taken in accordance with EPA Region 7 SOP 2043 *Manual Water Level Measurements* included in Appendix C. The location, date, time, and groundwater level will be recorded for all wells in the logbook. Before measurements are made, water levels in newly constructed monitoring wells will be allowed to stabilize for a minimum of 24 hours after well construction and development. In low yield situations, recovery of water levels to equilibrium may take longer. All measurements will be made to an accuracy of 0.01 feet. Water level measuring equipment will be decontaminated in accordance with Section 4.7. In general, measurements should proceed from the least to the most contaminated wells. Water level measurement events will be performed in as short a timeframe as possible to minimize variability due to ambient barometric variations.

4.7 EQUIPMENT DECONTAMINATION

4.7.1 Pump and Sampling Equipment Decontamination

Portable pumps used to sample existing monitoring wells, and other sample equipment that cannot be damaged by water, will be placed in a wash tub containing Alconox or low-sudsing non-phosphate detergent along with potable water. The interior of pumps will be flushed for at least 3 minutes; the exterior (and non-pump equipment) will be scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with tap water in a second wash tub followed by a deionized water rinse. The interior of pumps will be flushed with the rinse waters.

4.7.2 Drilling Equipment Decontamination

All downhole sampling equipment will require decontamination before use. Decontamination procedures to be followed are provided in EPA SOP 2006, *Sampling Equipment Decontamination* (Appendix C) and are discussed below.

A decontamination pad will be constructed at the equipment decontamination area north of the quonset hut to decontaminate the drill rig(s) and associated drilling equipment and materials. The pad will be lined with polyethylene sheeting and will have bermed sides and a bottom to contain washwater. The pad will also contain a sump to allow the water to pool so it can be pumped into a polyethylene storage tank.

All drill rods and the core barrel and other sampling equipment will be steam cleaned and devoid of any external oils or greases prior to use in each well. All contact equipment including pumps, hoses, and extension rods will be steam cleaned before each use. Decontamination water will be stored separately from purge water in a large capacity polyethylene storage tank at the equipment decontamination area.

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All reusable sampling equipment will be either steam cleaned (large equipment) or cleaned with phosphate-free detergent using the following decontamination procedures (smaller sampling equipment):

- Wash and scrub with phosphate-free detergent (Alconox®)
- Tap water rinse
- Air dry

4.8 SURVEYING

All survey work performed for this project will comply with State and Local regulations. A registered professional land surveyor licensed in the State of Nebraska will be subcontracted to determine by survey the elevations and/or horizontal locations of sample locations in support of this RD. Surveys will incorporate basic control for which closures are known, consisting of existing triangulation, traverse station monuments, markers, and benchmarks. These controls will be fully documented on the survey and in the field logbooks. All work will be conducted using equipment, personnel, and procedures that will insure compliance with the accuracy standards defined herein. The project requires that all sampling points as marked by the HGL Field Team Leader (FTL) be surveyed so that all horizontal data will be reported in Universal Transverse Mercator (UTM) North American Datum (NAD) 83, Zone 14 coordinates, and all vertical data will be referenced to North American Vertical Datum (NAVD) 88. Horizontal accuracy will be within ± 0.1 foot; vertical accuracy will be within ± 0.01 foot. Computations for all control stations and benchmarks will be furnished. The new dataset will be linked/verified with the existing survey data for consistency and to verify accuracy of the new survey data. All topographic and cultural features will be located in a manner to enable the calculation of coordinates of each feature shown on the site map.

The subcontracted surveyor will provide a hardcopy letter report and electronic deliverable to HGL containing all relevant survey information along with a legible copy of the field survey notes recorded. All documents submitted will bear the surveyor's seal, signature, and a certificate that all work was performed under the surveyor's supervision and that all information contained in the survey document is true and accurately represented.

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TABLES

Table 4.1
Field Equipment and Supplies
Garvey Elevator Site
Hastings, NE

Geotechnical and IDW Soil Sampling Supplies	
Chain-of-Custody forms	Sampling field forms
Sample Labels	Sample containers
Sample coolers	
Equipment	
Level Troll 700 (vented) w/rugged cable	Laptop computer
Photoionization detector	Water level indicator
Horiba U-52 Multi-parameter Water Quality Checker	
Health and Safety	
Hard hats	Safety glasses/high visibility vests
Nitrile gloves	First aid kits
Rubber gloves	Fire extinguishers
Eye wash station	Cotton glove liners
Rubber overboots or booties	Hearing protection
General Field Operations	
Logbooks	Indelible ink pens
Digital camera	Paper towels
Alconox®	Trash bags
Plastic squirt bottles	Clean water
Shovel	Lithologic logging forms
Plastic sheeting	5-gallon buckets for decontamination
Measuring tape	Utility knives
Munsell color chart	Work table
Brushes	Clear/duct tape

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Table 4.2
Full GET System Test Setup
Garvey Elevator - Hastings, NE

Well Category	Test Period	Period Type	Period Duration	Measurement Type	Measurement Frequency				Measurements Recorded				
					0-10 min	10- 100 min	100 - 1000 min	1000-10000 min	Elapsed Time (min)	Water level* (ft)	Pumping Rate** (gpm)	Influent (gpm)	Baro-metric Pressure
Recovery Wells	1	System Pumping	48 hr	equal interval	600 sec				Y	Y	Y	Y	Y
	2	System off	120 hr	logarithmic	10 sec	100 sec	1000 sec	10000 sec	Y	Y	N	N	Y
	3	System Pumping	120 hr	logarithmic	10 sec	100 sec	1000 sec	10000 sec	Y	Y	Y	Y	Y
Monitoring Wells	1	System Pumping	48 hr	equal interval	600 sec				Y	Y	NA	NA	NA
	2	System off	120 hr	logarithmic	10 sec	100 sec	1000 sec	10000 sec	Y	Y	NA	NA	NA
	3	System Pumping	120 hr	logarithmic	10 sec	100 sec	1000 sec	10000 sec	Y	Y	NA	NA	NA
Irrigation Well	1	System Pumping	48 hr	equal interval	600 sec				Y	NA	Y	NA	NA
	2	System off	120 hr	equal interval	600 sec				Y	NA	Y	NA	NA
	3	System Pumping	120 hr	equal interval	600 sec				Y	NA	Y	NA	NA

The measurement frequency restarts at the beginning of each period.
* Initial Water Level should be recorded at time = 0 of Test Period 1.
** Instantaneous Volumetric Flow Rate from each extraction well.
ft = feet
gpm = gallons per minute
hr = hour
min = minutes
NA = Not Applicable
sec = seconds

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Table 4.3
Step-Drawdown Pumping Test Setup
Garvey Elevator - Hastings, NE

Well Category	Test Period*	Period Type	Period Duration	Measurement Type	Measurement Frequency			Measurements Recorded			
					0-5 min	5-10 min	10 min-1hr	Elapsed Time (min)	Water level** (ft)	Pumping Rate*** (gpm)	Baro-metric Pressure
Recovery Wells	1	Pre-test	120 hr	equal interval	600 sec			Y	Y	N	Y
	2	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	Y	Y
	3	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	Y	Y
	4	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	Y	Y
	5	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	Y	Y
	6	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	Y	Y
	7	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	Y	Y
	8	Recovery	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	N	Y
Monitoring Wells	1	Pre-test	120 hr	equal interval	600 sec			Y	Y	NA	NA
	2	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	NA	NA
	3	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	NA	NA
	4	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	NA	NA
	5	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	NA	NA
	6	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	NA	NA
	7	Pumping	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	NA	NA
	8	Recovery	1 hr	logarithamic	1 sec	10 sec	100 sec	Y	Y	NA	NA
Irrigation Well	1	Pre-test	120 hr	equal interval	600 sec			Y	NA	Y	NA
	2	Pumping	1 hr	equal interval	600 sec			Y	NA	Y	NA
	3	Pumping	1 hr	equal interval	600 sec			Y	NA	Y	NA
	4	Pumping	1 hr	equal interval	600 sec			Y	NA	Y	NA
	5	Pumping	1 hr	equal interval	600 sec			Y	NA	Y	NA
	6	Pumping	1 hr	equal interval	600 sec			Y	NA	Y	NA
	7	Pumping	1 hr	equal interval	600 sec			Y	NA	Y	NA
	8	Recovery	1 hr	equal interval	600 sec			Y	NA	Y	NA

The measurement frequency restarts at the beginning of each period.
* The duration may be less than 1 hour if the pumping rate for a particular period leads to unsustainable drawdown.
** Initial Water Level should be recorded at time = 0 of Test Period 1.
*** Instantaneous Volumetric Flow Rate from each extraction well.
ft = feet
gpm = gallons per minute
hr = hour
min = minutes
NA = Not Applicable
sec = seconds

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Table 4.4
Constant-Rate Pumping Test Setup
Garvey Elevator - Hastings, NE

Well Category	Test Period	Period Type	Period Duration	Measurement Type	Measurement Frequency					Measurements Recorded			
					0-5 min	5- 15 min	15 min - 1 hr	1 - 5 hr	5 - 24 hr	Elapsed Time (min)	Water level* (ft)	Pumping Rate ** (gpm)	Baro-metric Pressure
Recovery Wells	1	Pumping	24 hr	logarithmic	1 sec	60 sec	300 sec	30 min	60 min	Y	Y	Y	Y
	2	Recovery	24 hr	logarithmic	1 sec	60 sec	300 sec	30 min	60 min	Y	Y	N	Y
Monitoring Wells	1	Pumping	24 hr	logarithmic	1 sec	60 sec	300 sec	30 min	60 min	Y	Y	NA	NA
	2	Recovery	24 hr	logarithmic	1 sec	60 sec	300 sec	30 min	60 min	Y	Y	NA	NA
Irrigation Well	1	Pumping	24 hr	equal interval	600 sec					Y	NA	Y	NA
	2	Recovery	24 hr	equal interval	600 sec					Y	NA	Y	NA

The measurement frequency restarts at the beginning of each period.
* Initial Water Level should be recorded at time = 0 of Test Period 1.
** Instantaneous Volumetric Flow Rate from each extraction well.
ft = feet
gpm = gallons per minute
hr = hour
min = minutes
NA = Not Applicable
sec = seconds

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FIGURES

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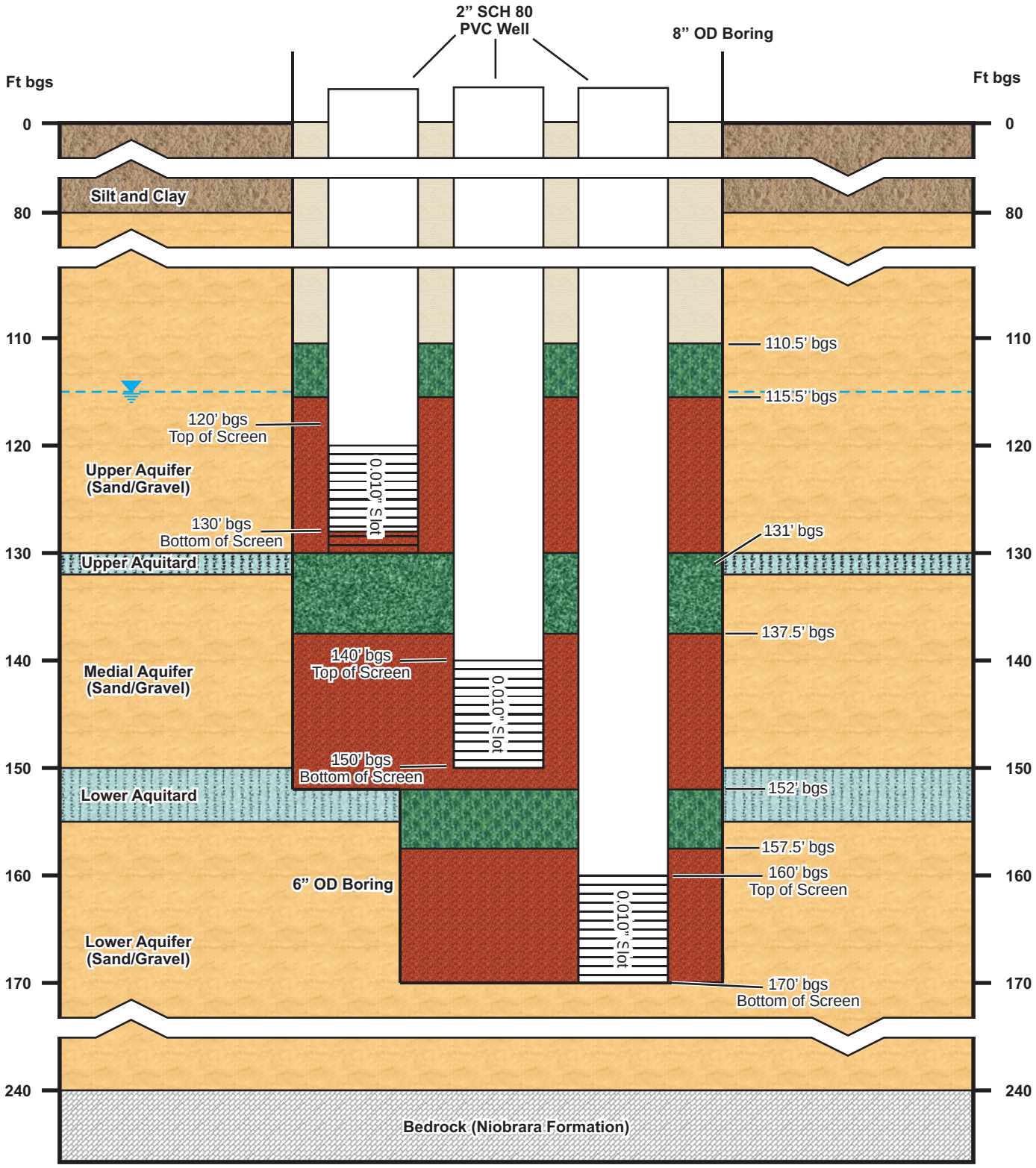

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(4-1)Proposed_Nested_Monitoring_Wells
Diagram.cdr
Revised: 10/12/10 ST
Source: HGL

HGL HydroGeoLogic, Inc

Legend

- Filter Pack (#16 / #30)
- Bentonite Chip Seal
- High Solids Bentonite Grout
- Section Break

10 0 5 Vertical Scale in Feet

Figure 4.1
Proposed Nested Monitoring Wells Construction Diagram

5.0 INVESTIGATION-DERIVED WASTE MANAGEMENT

All IDW will be properly containerized and stored on-site until its final disposition is determined. The IDW that will be generated during the RD field activities will consist of soil cuttings, drilling fluids, well development purge water, decontamination water, disposable personal protective equipment (PPE), and general municipal refuse. Used PPE and general refuse will be collected in garbage bags and disposed of as solid municipal waste. Contaminated or potentially contaminated IDW will be segregated from uncontaminated IDW.

Soil IDW will initially be containerized at the borehole in 55-gallon drums. The drums will be brought back to the staging area and emptied into 12-cubic yard rolloff boxes delivered to the site by a licensed, local, waste hauler. Based on previous analytical data from investigations at the site, no waste is anticipated to be hazardous. The soil IDW will be sampled at the rate of one sample per rolloff box, and analyzed for TCLP VOCs. After receipt of the analytical results for a particular rolloff box, approval for disposal will be requested of Hastings Adams County Landfill. After approval is granted, the accumulated cuttings in the rolloff box will be disposed of at the Hastings Adams County Landfill by the waste hauler. EPA had previously determined that wastes accumulated during CERCLA activities can be disposed in Phase IV of this landfill (USEPA, 2009c).

Liquid IDW will consist primarily of well development purge water and drilling fluids (water and drilling mud). These fluids will be containerized in poly tanks staged at the site. Periodically, the poly tanks will be emptied by a licensed waste hauler and the liquid IDW transported by to the city of Hastings wastewater treatment plant for disposal. Decontamination fluids will be pumped from the decontamination pad directly into the poly tanks for disposal.

IDW determined to be hazardous will be handled in accordance with Code of Federal Regulations (CFR) 40, Part 260.

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PART 2: QUALITY ASSURANCE PROJECT PLAN

The QAPP details the quality assurance/quality control (QA/QC) measures that will be employed for the Garvey Elevator Site to assure that data collected are of acceptable quality and sufficient quantity to support decision making.

6.0 PROJECT MANAGEMENT

This section discusses the project organization, overall project objectives, uses of the data and DQOs.

6.1 PROJECT ORGANIZATION

HGL will provide the necessary technical staff to supervise monitoring well installation, perform pumping test activities, and prepare reports for the project. HGL will procure subcontractors to provide drilling, geotechnical sample analysis, surveying, IDW laboratory services, and IDW disposal, as necessary.

Individual organizations and responsibilities specific to this investigation are discussed in this section.

6.1.1 Management Organization

For the Garvey Elevator Site, HGL is a contractor to EPA under the AES Region 7 contract. EPA management is described in Section 6.1.3. The HGL program manager is Mr. Bob Overfelt, and the Task Order Manager (TOM) for this project is Mr. Alan Rittgers. Mr. Jan Kool is the HGL QA manager. Mr. Doug Updike of CDM is the QA specialist who will oversee project activities assigned to CDM. Ms. Mary Knowles is the regional QC coordinator at HGL who will oversee day-to-day QA/QC activities for this project.

As the TOM, Mr. Rittgers is responsible for the overall management and coordination of the following activities:

- Coordinating the work of HGL technical and support staff and other team members
- Serving as the primary HGL point of contact and communicating directly with the EPA Region 7 Task Order Project Officer (TOPO) on project concerns, as needed
- Preparing monthly status reports
- Tracking work progress against planned budgets and schedules
- Supervising review and production of deliverables
- Coordinating with the laboratory regarding analytical services, data validation, and QA issues related to sample analysis
- Incorporating and informing EPA of changes in the SAP, the HSP, and/or other project documents
- Reviewing analytical results and deliverables from subcontractors
- Reviewing and approving subcontractor invoices

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- Notifying the HGL QA manager, QA specialist, or regional QC coordinator immediately of significant problems affecting the quality of data or the ability to meet project objectives
- Scheduling personnel and material resources
- Implementing field aspects of the investigation, including the SAP and other project documents
- Implementing the QC measures specified in the quality management plan (QMP) (HGL, 2005) for this contract, this QAPP, and other project documents
- Implementing corrective actions resulting from staff observations, QA/QC surveillance, and/or QA audits
- Providing oversight of data management.

The FTL, Mr. Jeff Gadt, will be responsible for the following:

- Organizing and conducting a field planning meeting
- Scheduling and conducting field work
- Leading a multidisciplinary field team to implement the RD SAP and HSP, as applicable to the investigation
- Gathering equipment and supplies and confirming required sample bottles and preservatives are on site, as needed
- Maintaining proper chain-of-custody forms and shipping samples to an off-site analytical laboratory (IDW samples and geotechnical soil samples)
- Ensuring that field activities are conducted in accordance with procedures detailed in the SAP, and that the quantity and location of all samples meet the requirements of these documents
- Identifying problems at the field team level, resolving difficulties in consultation with the QA staff, implementing and documenting corrective action procedures at the field team level, and providing communication between the field teams and HGL management.

The roles and responsibilities of other field team members will be to assist the FTL with sampling activities, sample handling, and overall documentation.

6.1.2 Quality Assurance Organization

The HGL QA manager, Mr. Jan Kool, implements the QA program. He is independent of the technical staff and reports directly to the President of HGL on QA matters. The QA manager has the authority to objectively review projects, identify problems, and use corporate resources, as necessary, to resolve any quality-related problems.

The regional QC coordinator for this project, Ms. Mary Knowles, reports to Mr. Kool on QA matters for this project. CDM QA specialist Mr. Doug Updike reports to Ms Knowles on QA matters for project tasks assigned to CDM. Under Mr. Kool's oversight, the regional QC coordinator is responsible for the following:

- Reviewing and approving all project-specific plans
- Directing the overall project QA program

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- Maintaining QA oversight of the project
- Reviewing QA sections in project reports, as applicable
- Reviewing QA/QC procedures applicable to this project
- Auditing selected activities of this project performed by HGL and subcontractors, as necessary
- Initiating, reviewing, and following up on response actions and corrective actions, as necessary
- Maintaining awareness of active tasks and their QA/QC needs
- Consulting with the HGL QA Manager, as needed, on appropriate QA/QC measures and corrective actions
- Conducting internal system audits to check on the use of appropriate QA/QC measures, if applicable
- Arranging performance audits of measurement activities, as necessary
- Providing written reports on QA/QC activity to the HGL QA Manager

6.1.3 EPA Management

The EPA Region 7 contract project officer, Mr. Jim Seiler, and contract officer, Mr. Anthony LaMaster, will be responsible for:

- Participating in task order proposal negotiations
- Tracking the task order budget
- Reviewing task order proposals
- Allocating and authorizing EPA funds to the task order
- Maintaining communication with the EPA TOPO and HGL contract personnel

The EPA Region 7 TOPO for this site, Mr. Brian Zurbuchen, Ph.D, is HGL's primary contact for coordinating work at the site. Mr. Zurbuchen will be responsible for:

- Reviewing all project deliverables prepared by HGL
- Maintaining communications with the HGL TOM regarding project status
- Maintaining communications with the EPA Headquarters Triad support group
- Reviewing monthly status reports
- Providing oversight of field efforts as desired
- Providing technical guidance to HGL
- Facilitating and maintaining communication with the stakeholders and others, where applicable
- Tracking work progress against planned budgets and schedules
- Scheduling EPA personnel and material resources, including the laboratory
- Providing oversight of EPA personnel responsible for project tasks
- Coordinating laboratory needs with EPA laboratory and HGL

The EPA regional QA manager, Ms. Diane Harris, is responsible for reviewing and approving the QAPP.

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6.1.4 NDEQ Management

The NDEQ Project Manager, Ms. Laurie Brunner, is the point of contact at NDEQ and is responsible for the following:

- Reviewing project deliverables prepared by HGL and providing comments to the EPA TOPO,
- Maintaining communications with the EPA TOPO regarding project status and funding requirements, and
- Providing oversight of field activities, as desired.

6.1.5 QAPP Organization

This QAPP is organized in accordance with EPA *Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Interim Final, March 2001 (USEPA, 2001). Section 6.0 presents project management and DQO information, Section 7.0 details measurement and data acquisition strategies, Section 8.0 details assessment and oversight aspects of the project, and Section 9.0 describes data validation and usability.

6.2 PROJECT DESCRIPTION

6.2.1 Project Background

Site background information for the Garvey Elevator Site was provided in Section 2. The objectives of this task order were discussed in Section 1.0. The purpose of this QAPP is to provide guidance to ensure that all environmentally related data collection procedures and measurements are scientifically sound and of known, acceptable, and documented quality conducted in accordance with the requirements of the project.

6.2.2 Project Scope and Objectives

The QAPP governs data collection activities that will be performed for this task order. These activities were described in detail in the FSP and generally include the following:

- Installing and developing monitoring wells,
- Collecting geotechnical soil samples,
- Conducting pumping tests, and
- Managing and disposing of IDW.

Geotechnical analysis of soil samples will be conducted by an off-site geotechnical laboratory. Analysis of IDW soil and water samples will be conducted by an off-site analytical laboratory providing a 72-hour turnaround time.

6.3 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT

6.3.1 End Uses of the Data

It is important for any project to identify how the data that are collected in the field will be used and what decisions will result. These end uses must be defined to ensure the appropriate

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type, amount, and quality of data is collected.

The data collected during the RD will be used to:

- Determine the physical characteristics of the upper and medial aquifers at the site.
- Determine the influence of the GET system at key locations on site.
- Update and refine the CSM to ensure site characterization is completed in sufficient detail for decision making.

The remainder of this section discusses the internal controls and review processes that will be employed to assure environmentally related measurements and data collected by HGL are of known quality and appropriate data can be generated to meet the end uses identified above.

6.3.2 Data Types

Quality of analytical data is defined as either "definitive data" or "screening data with definitive confirmation" in USEPA QA/G-4, Guidance on Systematic Planning Using the Data Quality Objectives Process, Publication No. EPA/240/B-06/001, February 2006 (EPA, 2006). Screening data provide analyte identification and quantification, although the quantification may be relatively imprecise and requires definitive-level confirmation. Definitive data are generated using rigorous analytical methods, such as approved EPA methods. Data are analyte-specific with verification of analyte identity and concentration. Methods produce tangible raw data in the form of paper printouts or computer-generated electronic files. Definitive data will be generated by the IDW sample analysis laboratory. No screening level data will be generated.

An additional data category of "other" is also defined in the guidance. This category is used to define data that do not fit exactly into either of the above two categories. Types of data collected for this task order that are included in the other category include: photoionization detector (PID) field screening measurements; water quality measurements taken with a field meter; water level measurements and flowmeter data from pumping tests; geotechnical; and surveying data. "Other" data are used to support the field investigation. These data will be used to guide field decisions, such as the optimal pumping rate for a constant-rate pumping test, but these data will not be directly used to characterize the nature and extent of site contaminants or to evaluate risk. The data types and DQO categories are listed in Table 6.1.

6.3.3 Data Quality Objectives

The DQO process is a series of planning steps based on the scientific methods that are designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended purpose. EPA has issued guidelines to help data users develop site-specific DQOs (EPA, 2006). The DQO process is intended to:

- Clarify the study objective
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions from which to collect the data
- Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the project objectives

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The goal of the DQO process is to help ensure that data of sufficient quality and quantity are obtained to support remedial decisions, reduce overall costs of data sampling and analysis activities, and accelerate project planning and implementation.

The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified. The DQO process consists of seven steps of which the output from each step influences the choices that will be made later in the process. These steps are:

Step 1: State the problem
Step 2: Identify the goals of the study
Step 3: Identify decision inputs
Step 4: Define the boundaries of the study
Step 5: Develop the analytical approach
Step 6: Specify performance or acceptance criteria
Step 7: Develop the plan for obtaining data

During the first six steps of the process, the planning team develops decision performance criteria (i.e., DQOs) that will be used to develop the data collection design. The final step of the process involves developing the data collection design based on the DQOs. A brief discussion of these steps and their application to this project are provided below.

Step 1: State the Problem

The purpose of this step is to describe the problem to be studied so that the focus of the study is unambiguous.

From 1959 to 2005 Garvey Elevators Inc. owned and operated a grain storage facility at the subject property where grain was stored in bins and transported by rail.

The VOC CCl_4 and its degradation product chloroform have been found in soils and groundwater beneath the facility. The groundwater plume extends approximately three miles downgradient of the facility and has impacted local drinking water wells.

SVE and GET systems were constructed and operated on the subject property by Garvey while participating in the NDEQ's VCP. Operation of the remedial systems and cleanup at the site has been turned over to EPA.

The GET system does not have sufficient hydraulic control of the aquifer to contain the groundwater contamination to the site property. Therefore, the contaminants continue to migrate in groundwater downgradient from the site.

Step 2: Identify the Goals of the Study

This step identifies what questions the investigation will attempt to resolve and what actions may result. The goals of the study are to answer the following principal investigation

questions:

- Are there areas where the influence of the GET system should be enhanced?
- What are the properties of the aquifer that effect ROI of recovery wells in the aquifers beneath the site?
- How many, if any, additional recovery wells are necessary to optimize the GET system?

Step 3: Identify Decision Inputs

The purpose of this step is to identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statements. Based on the investigation questions, the following information will need to be obtained during this investigation:

- Identify the hydrogeologic characteristics of the contaminated aquifers beneath the site.
- Identify the ROI of select recovery wells to assist in evaluating overall system performance.
- Identify areas not influenced by the GET system that would enhance system performance if the systems were expanded to capture the plume in these areas.

Step 4: Define the Boundaries of the Study

This step defines the temporal and spatial boundaries of the study.

The site is located in Hastings, Nebraska, at 2315 W. Highway 6. The RD study will be conducted on the site property, except for monitoring pumping rate of the irrigation well immediately east of the eastern property boundary downgradient of the source area. Nested monitoring wells will be installed at select locations on site. These wells and numerous existing wells will be monitored for water level fluctuations during a full GET system pumping test, a step-drawdown pumping test, and a constant-rate pumping test. The flow rate for all pumping wells will be measured and recorded.

The RD field activities are scheduled to occur between September and October 2010.

Step 5: Develop the Analytical Approach

The analytical approach consists of a series of if/then statements to determine what decisions will be made based on the principal investigation questions developed under Step 2, and the decision inputs identified in Step 3 of the DQO process. These decision statements are provided below:

The following decision statement applies to the analysis of the data from the full GET system pumping test:

- If the data (drawdown in response to system pumping) show that areas within the contaminated groundwater regime beneath the site that are deemed critical to optimizing the GET system are not being properly influenced by the remedial system, then installation of additional recovery wells may be required.

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The following decision statement applies to the analysis of the data from the constant-rate pumping test:

- If the data show that the aquifer characteristics are indicative of lower hydraulic conductivities and smaller ROIs, than potential additional recovery wells may be more numerous and spaced closer together.
- If the data show that the aquifer characteristics are indicative of higher hydraulic conductivities and larger ROIs, than potential additional recovery wells may be more less numerous and spaced farther apart.

Step 6: Specify Performance or Acceptance Criteria

The decision maker's tolerable limits on decision errors, which are used to establish performance goals for the data collection design, are specified in this step. Decision makers are interested in knowing the true value of constituent concentrations. Because analytical data can only estimate these values, decisions that are based on measurement data could be in error (decision error). There are two reasons why the decision maker may not know the true value of the constituent concentration, these are:

- Concentrations vary over time and space. Limited sampling may miss some features of this natural variation because it is usually impossible or impractical to measure every point of a population. Sampling design error occurs when the sampling design is unable to capture the complete extent of natural variability that exists in the true state of the environment.
- Analytical methods and instruments are never absolutely accurate; hence, a measurement can only estimate the true value of an environmental sample. Measurement error refers to a combination of random and systematic errors that inevitably arise during the various steps of the measurement process.

The combination of sampling design and measurement error is the total study error. Since it is impossible to completely eliminate total study error, basing decisions on sample concentrations may lead to a decision error. The probability of decision error is controlled by adopting a scientific approach in which the data are used to select between one condition (the null hypothesis) and another (the alternative hypothesis). The null hypothesis is presumed to be true in the absence of evidence to the contrary. For this project, the null hypothesis is that the GET system does not adequately influence the groundwater flow regime to prevent contaminated groundwater from migrating off site.

The alternative hypothesis is that the GET system does have adequate influence on the groundwater flow regime to control groundwater contaminate migration.

A false positive or "Type I" decision error refers to the type of error made when the null hypothesis is rejected when it is true, and a false negative or "Type II" decision error refers to the type of error made when the null hypothesis is accepted when it is false. For this project, a Type I decision error would result in deciding that the GET system influence was adequate to contain the groundwater contamination, when it was not adequate. A Type II decision error would result in deciding that the GET system does not adequately influence the groundwater

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flow regime to prevent contaminated groundwater from migrating off site, when it does control the groundwater contamination.

For this project, a Type II error is less acceptable than a Type I error because a Type II error could result in mistakenly not optimizing the GET system to fully capture the contaminated groundwater, whereas a Type I error could result in added recovery wells to the GET system that were not necessary. Neither type of decision error is desirable, but a Type II error is considered worse in that the contaminated groundwater would continue to migrate off site.

The sampling process design has been developed so that decision errors are minimized to the extent possible. That said, the only analytical samples scheduled for collection are IDW samples. HGL will not validate these data independent of the standard laboratory data validation that will accompany the data results. Therefore, measurement quality objectives (MQOs) are not applicable for this task order.

Step 7: Develop the Plan for Obtaining Data

Step 7 of the DQO process identifies the plan for generating the site data that are expected to satisfy the DQOs. The data collection plan (sampling program) is described in detail within Section 3.0 of the FSP.

6.3.4 Data Measurement Quality Objectives

Data quality indicators (DQIs) are quantitative and qualitative parameters that can help determine the acceptability of analytical data. The only analytical samples scheduled for collection are IDW samples. HGL will not validate these data independent of the standard laboratory data validation that will accompany the data results. Therefore, DQIs are not applicable for this task order.

6.3.5 Field Measurements

Field measurements will include real-time air monitoring equipment for health and safety, multi-parameter water quality meters, water level meters and datalogging transducers. All equipment will be rented from a reputable commercial equipment vendor. This equipment will be maintained and calibrated to ensure accurate readings are taken as discussed in Sections 7.6 and 7.7. All field measurements will be recorded in the applicable field logbook, or compiled in electronic data files.

6.4 SPECIAL TRAINING REQUIREMENTS

All HGL personnel and subcontractors working at the site will comply with the health and safety training requirements stated in 29 CFR 1910 and 1926. Personnel will additionally participate in an annual medical monitoring program as required by Occupational Health and Safety Administration (OSHA). Documentation of training and medical monitoring will be maintained in the field trailer for all personnel working on site. This documentation will additionally be requested for any visitors to the site including EPA and NDEQ personnel. If documentation is

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not provided or if training/medical monitoring is not current, visitors will be accompanied by a member of the HGL field team and will not be allowed in the exclusion zone.

Other health and safety requirements of the project including daily tailgate safety meetings and required PPE are specified in the HSP included as Appendix A.

In addition to health and safety training requirements, all field crew members will understand the proper operation of the field meters and all sampling procedures contained in this SAP.

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TABLE

Table 6.1
Data Types and DQO Categories
Garvey Elevator Site
Hastings, NE

Data Type	Purpose	DQO Category
Pumping Tests (water levels, elapsed time, pumping rates)	Aquifer flow characteristics and influence of GET system for design of the remedial alternative identified in the Interim ROD.	Other
Geotechnical data from monitoring well borings	Aquifer flow characteristics for design of the remedial alternative identified in the Interim ROD. Evaluate contaminant transport in groundwater	Other
Health and safety measurements using a PID	Ensure the health and safety of on-site personnel	Other
Surveying Measurements	Obtain horizontal and vertical location data to standardize measurements to mean sea level and accurately locate sample points and wells on GIS site maps	Other
IDW sampling data including TCLP VOCs	Obtain data to determine disposal requirements for IDW	Definitive

Notes:
DQO = data quality objective
GET = Groundwater Extraction and Treatment
IDW = investigation-derived waste
PID = photoionization detector
ROD = Record of Decision
TCLP = Toxicity Characteristic Leaching Procedure
VOC = volatile organic compound

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7.0 MEASUREMENT AND DATA ACQUISITION

7.1 SAMPLE PROCESS DESIGN

The sampling process presented in the FSP was designed to meet the DQOs previously discussed in Section 6. Information in this section provides details related to the sample collection to ensure the data are of known and acceptable quality.

7.2 SAMPLING METHOD REQUIREMENTS

Sampling methods include EPA, HGL, and CDM SOPs to ensure samples are collected in a standardized method to ensure they represent actual site conditions. The SOPs were previously discussed in Section 4 of the FSP. Information in this section discusses the sample container and collection requirements specific to each analytical laboratory where sample analysis will be performed.

7.2.1 Sampling Equipment and Preparation

Sampling equipment required for the field program (including environmental sampling, health and safety monitoring, equipment and personal decontamination, and general field operations) were listed in Table 4.1.

Field preparatory activities will include:

- Review of the FSP and QAPP and pertinent SOPs by all HGL field personnel
- Conducting a field planning meeting with HGL field personnel to discuss the content of the FSP, QAPP, and HSP and general logistics related to implementing the RD field program
- Procurement of field equipment and supplies.
- Mobilization of the rotosonic driller.

7.2.2 Sample Containers

All sample containers will be precleaned and traceable to the facility that performed the cleaning. Sampling containers will not be cleaned or rinsed in the field.

Table 7.1 provides the analytical methods, sample containers, preservation requirements, and holding times for the geotechnical analyses that will be conducted on soil by the off-site geotechnical laboratory.

7.2.3 Sample Collection for Offsite Geotechnical Laboratory Analysis

Soil samples will be collected for geotechnical analysis from the select monitoring well borings during well drilling. Geotechnical analysis will include grain size, moisture content, soil porosity, permeability and bulk density. Samples for permeability and bulk density analysis should be undisturbed samples collected in a drive tube, such as a Shelby tube. If soil is

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coarse grained, permeability samples may be submitted as 3 to 5 pounds of soil in Ziplock bags, rather than in a drive tube. However, previous attempts at Shelby tube and split-spoon sampling for both the Garvey site and the West Highway & Highway 281 site have not been successful. Therefore, the samples will be collected within the plastic liner into which the rotosonic soil cores are extruded during the coring operation. This sample containerization method was successfully employed during the rotosonic drilling for the West Highway & Highway 281 site. Additional detail on required sample containers is included in Table 7.1.

7.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Custody and documentation for field and laboratory work are described below, followed by a discussion of corrections to documentation.

7.3.1 Field Sample Custody and Documentation

The purpose and description of the sample label and the Chain of Custody (COC) record are discussed in the following sections. All identification and tracking procedures for samples will follow EPA Region 7 SOP 2420.5E *Identification, Documentation, and Tracking of Samples*, December 2003, provided in Appendix C.

7.3.2 Sample Labeling and Identification for non-EPA Samples

All pertinent sample information including: the site name, date and time the sample was collected, type of sample (e.g., soil), initials of person(s) collecting the sample, preservative used, and the analysis for which that sample is being submitted will be annotated on the sample label. The labels will be filled out with indelible ink, affixed to the appropriate sample containers and covered with clear cellophane tape.

Sample identifications for the geotechnical soil samples will consist of the monitoring well identification number (preceded by "MW-") for a particular location, followed by the depth interval in feet bgs from which the sample was collected. The following is an example: MW-50:140-142. This sample was collected from the MW-50 borehole at a depth of 140 feet to 142 feet bgs.

Sample identifications for the IDW soil samples will consist of the waste rolloff box number from which it was collected (for example, Rolloff #3). If it is necessary to collect IDW water samples, the samples will be identified "WW-date". The following is an example: WW-093010. This is the IDW water sample collected on September 30, 2010.

7.3.3 Chain of Custody Requirements

Chain of custody (COC) procedures will follow the requirements set forth in EPA Region 7 SOP 2420.4E, *Field Chain of Custody for Environmental Samples*, December 2003. The COC record is employed as physical evidence of sample custody and control. This record system provides the means to identify, track, and monitor each individual sample from the point of

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collection through final data reporting. An example COC record is included with the field forms in Appendix D.

The COC record is initiated with the acquisition of the samples and remains with the sample at all times. The COC includes the name of the field personnel assuming responsibility for the samples and documents transfer of sample custody. To simplify the COC record and eliminate sample custody questions, as few people as possible should handle the samples during the investigation.

A sample is considered to be under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession
- The sample is within the sampler's view after being in possession
- The sample was in the sampler's possession and then was locked up to prevent tampering
- The sample is in a designated secure area

A separate COC record will be completed for samples based on which laboratory will be conducting the analysis. Samples for geotechnical laboratory analysis will be recorded on a separate COC from IDW samples for analytical laboratory analysis.

In addition to the COC record, custody seals are used to maintain the custody of samples during shipment. Custody seals are adhesive seals placed on items (such as sample shipping containers) in such a manner that if the sealed item is opened, the seal would be broken. The COC seal provides evidence that no sample tampering occurred between shipment of the samples and receipt of the samples by the laboratory.

Records concerning the cleanliness of empty sample containers, container shipment from the laboratory to the site, and security of empty containers at the site also will be maintained in the project file.

A copy of the COC included in Appendix D will be completed by hand for each sample that will be submitted for geotechnical soil and IDW sample analysis. The COC will be completed by the field sampling team. The field sampler will sign off on the COC when the samples to Federal Express for shipment by noting "FedEx" and the FedEx air bill number on the COC form. The COC shall be shipped to the EPA laboratory with the samples, and a copy of the COC shall be maintained inside the field office.

7.3.4 Sample Packaging and Shipping

Samples will be packaged and shipped promptly after collection. When sent by common carrier, packaging, labeling, and shipping of hazardous materials are regulated by the U.S. Department of Transportation (DOT) under CFR 49, Part 172. Samples will be handled, packed, and shipped in accordance with CDM SOP 2-1, *Packaging and Shipping of Environmental Samples* (Appendix C), which includes applicable DOT requirements.
Key steps for packaging samples for shipment are outlined below.

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1. Wrap glass containers in bubble wrap to protect them during shipment. Enclose and seal labeled sample containers in appropriately sized plastic zip-top bags.
2. Place a large plastic garbage bag into a sturdy cooler in good repair. Pour 2 to 4 inches of Styrofoam peanuts or bubble wrap into the plastic bag. Place the sample containers in the bag with sufficient space to allow for the addition of more packing material and ice between the sample containers.
3. Place ice in large sealed, double-bagged zip-top plastic bags. Place the ice on top of and/or between the samples. Fill all remaining space between the sample containers with packing material. Enough bagged ice should be included to maintain the samples at 4 $^{\circ}$C until the cooler arrives at the laboratory. Seal the top of the garbage bag with fiber or duct tape.
4. Complete shipping/sample documentation including airbill shipment forms for each cooler. Seal COCs inside a waterproof plastic bag and tape the bag inside the shipping container lid. Include a return address for the cooler.
5. Close the shipping container, affix signed and dated custody seals, and seal the cooler with nylon fiber strapping tape.

All samples will be shipped by an overnight delivery service (i.e. Federal Express) to the designated laboratory. The IDW sample laboratory receives samples Monday through Saturday, so samples will be shipped Monday through Friday only. A copy of each air bill will be retained in the field office and the air bill number will be recorded in a site logbook so the cooler can be easily tracked if mishandled.

The geotechnical soil samples will be hand delivered to the laboratory.

7.3.5 Field Logbook(s) and Records

Field Logbooks

An important element of field documentation is the proper maintenance by field personnel of the site-specific field logbooks. Field logbook(s) will be maintained by the field team in accordance with HGL's SOP, *Field Activity Logbook Entries* (Appendix C). The logbook is an accounting of the accomplishment of scheduled activities, and will duly note problems or deviations from the governing plans and observations relating to the field program. Logbooks will be kept in the field team member's possession or in a secure place when not being used. The FTL will periodically check logbook entries to make sure the required information is present as specified in the SOP.

Field Forms

In addition to the field logbooks, field forms will be used to record sampling activities and measurements taken in the field. Field forms to be used during this project are included in Appendix D. Information included on the field sheets will not be repeated in the field logbook. Each completed field sheet will; however, be referenced in the field logbook, as appropriate. Field forms include the following:

- Soil boring log
- Well development log

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- Daily health and safety meeting record
- Equipment calibration records
- Field change request form
- Nonconformance report

At the conclusion of site activities or when the logbook is filled, the logbook will be incorporated into the project file as part of the document control procedure. Completed field sheets also will be maintained in the project file.

Photographs

Field activities and sampling points will be documented using a digital camera in accordance with CDM SOP 4-2, *Photographic Documentation of Field Activities* (Appendix C). For each photograph, the following items will be noted in a photographic record recorded the applicable field logbook:

- Date of photograph
- Time of photograph
- Signature of the photographer
- Identification of the site or sample by sample number
- General direction the photograph is oriented
- Sequential number of the photograph recorded on the disk

7.3.6 Drilling Documentation

All well boreholes will be logged for lithology in accordance with CDM SOP 3-5, *Lithologic Logging* (Appendix C) using the drilling log form included in Appendix D.

Construction details for each newly constructed monitoring well will be carefully recorded in the field logbook. Well construction diagrams will be prepared from this information for inclusion in the RD report.

7.3.7 Pumping Tests Documentation

Dedicated transducers communicating to the GET system control panel, and rented non-dedicated data logger transducers will be utilized to collect the water level data during the pumping test. The data will be managed electronically. Start and stop times, and the filenames for the various data files for each well will be recorded in the field logbook.

7.3.8 Laboratory Custody Procedures and Documentation

Laboratory custody procedures are provided in each laboratory's QA Manual. Upon receipt at the laboratory, each sample shipment will be inspected to assess the condition of the shipping cooler and the individual samples. This inspection will include measuring the temperature of the cooler (if cooling is required) to document that the temperature of the samples is within the acceptable criteria (4 ± 2 ° C) and verifying sample integrity. The pH of the samples will be measured, if preserved. The enclosed COC record(s) will be cross-referenced with all of the

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samples in the shipment. Laboratory personnel will then sign these COC records and copies provided to HGL will be placed in the project file. The sample custodian may continue the COC record process by assigning a unique laboratory number to each sample on receipt. This number, if assigned, will identify the sample through all further handling. It is the laboratory's responsibility to maintain internal logbooks and records throughout sample preparation, analysis, data reporting, and disposal.

7.3.9 Corrections to and Deviations from Documentation

The procedures for correcting erroneous field entries are described in HGL's SOP, *Field Activity Logbook Entries*, included in Appendix C. If required, a single strikeout initialed and dated is required to document changes. The correct information should be entered in proximity to the erroneous entry. The same procedure will be used on field logbooks, field sheets and COC records.

Any significant deviations from the guidance documents (FSP, QAPP, SOPs) will be recorded in the appropriate field logbook. A field change request form included in Appendix C will be completed prior to implementing the deviation. The field change request form will be signed by the FTL and project manager. Significant deviations will additionally require signature by the EPA TOPO before the deviation is implemented. Completed field change request forms will be included and discussed in the RD report.

7.4 ANALYTICAL METHODS REQUIREMENTS

7.4.1 Laboratory Quality Assurance Program

Samples collected during this project will be analyzed in accordance with standard EPA and/or nationally-accepted analytical procedures. The laboratory will adhere to all applicable QA/QC requirements stated in the applicable method and its laboratory QA Plan. Test America, Inc. in University Park, Illinois will perform the laboratory analysis of the IDW samples. The Quality Assurance Manual (QAM) for Test America is included in Appendix E. Alpha-Omega Geotech, Inc. and Geotechnology, Inc. will perform the geotechnical analysis. The QAMs for the geotechnical laboratories were not available for the work plan, but can be reviewed at the laboratory. The geotechnical laboratory QAM complies with the American Association of State Highway and Transportation Officials (AASHTO) R18 accreditation requirements.

7.4.2 Methods for Laboratory Analysis

Analytical methods that will be used by the off-site geotechnical laboratories (Alpha-Omega Geotech, Inc. and Geotechnology, Inc.) are specified in Table 7.1. The analytical methods used for the IDW laboratory analysis (Test America) are specified in Table 7.2.

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7.5 QUALITY CONTROL REQUIREMENTS

7.5.1 Field Quality Control Samples

Field quality control samples will not be collected in conjunction with the geotechnical or IDW samples.

7.5.2 Laboratory Quality Control Samples

Laboratory quality control samples are not applicable to the geotechnical soil sample analyses. Geotechnical laboratory quality control is maintained by adhering to the American Society for Testing and Materials (ASTM) methods specified in Table 7.1.

The IDW laboratory will adhere to all analytical and QC requirements specified in SW-846. The purpose of using standard EPA-approved procedures is to provide analytical data of known quality and consistency.

Laboratory QC samples will include continuing calibration checks, method blanks, laboratory control samples (LCS), laboratory duplicates, surrogate spikes, and matrix spikes (MS) are required by the analytical method. Laboratory QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination. Each type of laboratory QC sample will be analyzed at a rate of 5 percent (1 per every 20 samples), or one per batch, whichever is more frequent. Surrogates are spiked into every sample before analysis to gauge adequate recovery. Results of QC sample analysis will be provided with the analytical results within a 24-hour time period.

Calibration Check Samples. One of the working calibration standards (typically the mid-point standard) that is periodically used to check that the original calibration is still valid (e.g., continuing calibration standard).

Method Blanks. Method blanks contain all the reagents used in the preparation and analysis of samples and are processed through the entire analytical sequence to assess spurious contamination arising from reagents, glassware, or instrument carry-over introduced during the analysis.

Laboratory Duplicates. A duplicate aliquot taken from the same sample is carried through the entire preparative and analytical sequence. Duplicate samples will also be received from the field. The results of the laboratory and field duplicate samples are used to estimate the precision of the analytical procedures.

Spiked Samples. Known amounts of a particular constituent are added to high purity laboratory-grade water or solvent, or to a field sample. The percent recovery of the added amount is used to estimate the accuracy of the analytical procedure. If laboratory-grade water or solvent is spiked, the resulting sample may be called a LCS or blank spike. If a field sample is spiked, the resulting sample is a MS or surrogate spike.

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Laboratory Control Sample (LCS). This sample is usually prepared from EPA Environmental Monitoring Systems Laboratory (EMSL) concentrates or National Institute of Standards and Technology (NIST) standard reference materials. The LCSs are used to establish that an instrument or procedure is in control. An LCS is carried through the entire sample preparation and analysis procedure. These samples provide an indication of whether the laboratory processes are in control, in the absence of matrix effects.

Matrix Spike (MS). One field sample (submitted to the laboratory as a triple volume sample) is divided into three aliquots. One aliquot is analyzed as is (without spiking) and the remaining two aliquots are spiked and analyzed. The percent recovery of the known spikes provides information on the accuracy of the analysis, matrix interferences, and provides an indication of the suitability of the method for the matrix.

Matrix Spike Duplicate (MSD). When two aliquots are spiked, the analytical results provide information on analytical precision as well as accuracy and matrix interferences.

Surrogate Spikes. Samples requiring analysis by gas chromatography/mass spectrometry (GC/MS) are routinely spiked with a series of deuterated analogues of the compounds of interest. These compounds are used to assess the behavior of actual analytes in individual project samples during the entire preparation and analysis sequence. Surrogate spike recoveries are also used to assess accuracy of the analysis.

7.6 EQUIPMENT MAINTENANCE PROCEDURES

All equipment will be maintained in accordance with manufacturer's instructions. All rental equipment will be inspected upon receipt to ensure the item complies with its intended use and is functioning properly. Nonconforming items will be identified and segregated using documentation to prevent inadvertent use. Other items may be identified as nonconforming during routine observation, inspection, or testing. These items will be replaced, and the nonconforming item returned to the vendor.

7.7 INSTRUMENT CALIBRATION PROCEDURES AND FREQUENCY

7.7.1 Field Equipment

Equipment handling and calibration procedures will follow the manufacturer's instructions and CDM SOP 5-1, *Control of Measurement and Test Equipment* included in Appendix C. Except for rental datalogging transducers, field equipment used for measuring or monitoring will be calibrated daily and properly maintained to assure accuracy within specified limits. Daily calibration will be documented on the applicable Equipment Calibration Log Form included in Appendix D. The datalogging transducers will be factory-calibrated before the start of the field activities.

Field equipment will include the following:

- Multi-parameter water quality meters

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- Photoionization detectors
- datalogging transducers

7.7.2 Laboratory Equipment

Calibration of laboratory equipment will be based on written procedures approved by laboratory management and included in the laboratory's QA plan. Instruments and equipment will be initially calibrated and subsequently continuously calibrated at approved intervals, as specified by either the manufacturer or more frequent requirements (e.g., methodology requirements). Calibration standards used as reference standards will be traceable to EPA, ASTM, NIST , or another nationally recognized reference standard source.

Records of initial calibration, continuing calibration and verification, repair, and replacement will be maintained by the laboratory where the work is performed.

7.8 ACCEPTANCE REQUIREMENTS FOR SUPPLIES

Prior to acceptance, all supplies and consumables will be inspected to ensure that they are in satisfactory condition and free of defects. If defects are noted, the item will be replaced. HGL personnel will inspect all supplies and consumables provided by subcontractors.

7.9 NONDIRECT MEASUREMENT DATA ACQUISITION REQUIREMENTS

Nondirect measurement data include information from site reconnaissance, literature searches, and interviews. The acceptance criteria for such data include a peer review of this data documentation by someone other than the author. Any nondirect measurement data obtained from secondary sources such as literature searches or interviews will determine further action at the Garvey Elevator Site only to the extent that those data can be verified.

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TABLES

Table 7.1
Analytical Methods and Sample Preservation, Holding Time, and Container Requirements - Geotechnical Laboratory
Garvey Elevator Site
Hastings, NE

Analytical Parameter	Sample Matrix	Analytical Method	Sample Preservation	Holding Time	Containers
Soil					
Permeability	Soil	ASTM D 5084	None	NA	3-5 pounds of soil core (18-24 inches) in plastic sleeve tied at both ends
Bulk density	Soil	ASTM D 1895B	None	NA	
Grain size sieve and hydrometer test	Soil	ASTM D 422/ ASTM D 423	None	NA	
Moisture content	Soil	ASTM D 2216	None	NA	
Porosity	Soil	NA[1]	None	NA	NA[1]
Max/Min index density using vibratory table[2]	Soil	ASTM D4253/D4254	None	NA	5-gallon bucket

ASTM = American Society for Testing and Materials
NA = not applicable
mL = milliliter
oz = ounce
[1] - Porosity - calculated using results from moisture content, density, and specific gravity. No additional soil is needed.
[2] – Both wet uncompacted and wet compacted densities will be determined

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Table 7.2
Analytical Methods and Sample Preservation, Holding Time, and Container Requirements - IDW Laboratory
Garvey Elevator Site
Hastings, NE

Analytical Parameter	Sample Matrix	Analytical Method	Sample Preservation	Holding Time[1]	Containers
TCLP VOCs	Soil	EPA 1311 EPA 8260B	Cool to 4°C	14days/14 days	4-oz jar
VOCs	Water	EPA 8260B	HCl to pH <2; Cool to 4°C	14 days	40-mL glass vials with Teflon septa

°C = degrees Celsius
HCl = hydrochloric acid
mL = milliliter
oz = ounce
VOC = volatile organic compounds
[1] - Holding time is given as number of days prior to extraction / number of days prior to analysis. Dates are from day and time of sample collection.

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8.0 ASSESSMENT AND OVERSIGHT

8.1 ASSESSMENTS AND RESPONSE ACTIONS

Requirements for assessment and response actions detailed in the QMP (HGL, 2005) are summarized in this subsection. Assessments are project reviews that may include audits, surveillances, technical, management, or peer reviews. Assessments are conducted to access compliance with the requirements of the HGL Quality Program, project-specific planning documents such as this FSP and QAPP, or other client or regulatory requirements. The assessment may cover technical, safety, administrative, or regulatory subjects, as required.

Assessments may be independent or self-assessments of the internal quality systems, or may be technical reviews for the task to be evaluated. Audits, which are a type of assessment, shall be conducted by personnel who do not have responsibility for performing the activities being audited such that the auditor has the organizational freedom, authority, and capability to identify problems and perform effective assessments.

The QA Manager will schedule audits or other assessments as dictated by project activities. The QA auditor will be appropriately trained and deemed qualified by the QA manager to perform the audit.

The results of assessments shall be documented and reported to the QA Manager. Nonconforming conditions needing corrective action shall be identified and corrective actions performed promptly. Corrective actions implemented in the field shall be recorded in the applicable field logbook and verbally reported to the FTL. Corrective actions shall be evaluated to ensure adequate effectiveness and proper completion, documented, and reported to the QA Manager. The QA Manager will report deficiencies and corrective actions to the President, as appropriate.

One QA field audit has currently been planned for this project.

8.2 REPORTS TO MANAGEMENT

Reports will be generated for all QA audits that are conducted and provided to the QA Manager. Reports will include deficiencies that were noted during the audit and corrective actions that were planned or implemented.

The EPA TOPO will receive updates of field results during daily teleconferences and will be closely involved in the execution of project activities.

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9.0 DATA VALIDATION AND USABILITY

9.1 DATA VALIDATION

IDW sample data will not be validated by HGL. Data validation is not applicable to geotechnical sample data.

9.2 RECONCILIATION WITH USER REQUIREMENTS

9.2.1 DQO Reconciliation

After the data quality reviews and validation are complete, HGL will determine if and which data are usable for their intended purposes based on the DQOs that have been established for this project. Reconciliation with the DQOs and overall project objectives will be discussed in the RD report.

9.2.2 Data Reduction and Tabulation

Data reduction and tabulation will be performed using the various data that will be uploaded into the Environmental Quality Information System (EQuIS) database during the course of the RD field program as described in Section 10.2.

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10.0 DATA MANAGEMENT

10.1 INTRODUCTION

The sample collection activities to be conducted at this site will generate fixed laboratory data from the analysis of samples; survey data; field measurements; and other site-derived information. The resulting data will be entered into a single data management system for consistency in tracking samples; storing and retrieving data; evaluating analytical results; and generating data tables, figures, and reports. The Data Management Plan (DMP) presented in this section was prepared to assist in implementing a successful data management strategy. The DMP is augmented by the requirements and procedures for field sample collection detailed in the FSP, and the sampling and analytical methodologies detailed in the QAPP.

10.1.1 Objectives of Data Management Plan

Successful data management results from coordinating data collection, control, storage, access, reduction, evaluation and reporting. This DMP documents the methodology that will be employed during project execution to link the various data management tools, including software packages, to assure that the various data and information types to be collected are systematically collected and managed.
The specific objectives of this DMP are:

- Standardize and facilitate the collection, formatting, and transfer of project data into the data management system and components.
- Provide a structured data system that will support the end uses of the data, including planning, decision making and reporting. (Note: The end uses of the data are detailed in Section 6.3.1 of the QAPP.)
- Minimize the uncertainties associated with the data, data-derived products, and interpretation of results through defined QC measures and documented processes, assumptions and practices.
- Provide data that are adequately documented with descriptive information for technical defensibility and legal admissibility of the data.

10.1.2 Data Management Team Organization

A data management team has been established for the Garvey Elevator Site. The team will work together to properly execute the DMP and ensure that the project objectives and scope are realized. The team is composed of specialists in each related discipline and technical resource. The PM is an integral part of the data management team, and has overall responsibility for assuring the data are collected in accordance with the EPA-approved FSP and QAPP. The members of the data management team are as follows:

- Project Manager
- Data Manager (DM)
- FTL
- Project Geologist
- Project Chemist

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- Sample Manager (SM)
- Database Administrator (DBA)
- GIS Developer
- Modeler

The functional responsibilities of the data management team are described in Section 10.1.3. One person may perform multiple roles on a project depending on the level of data to be managed and analyzed.

10.1.3 Roles and Responsibilities of Data Management Team

The responsibilities of the members of the data management team are summarized below. Should the scope of the data require a division of labor, the TOM in consultation with the Data Manager will determine assignments as appropriate to assure the best work flow.

Team Member	Roles and Responsibilities
Task Order Manager	• Responsible for preparing the work plan, schedule and milestones. • Coordinates efforts with the EPA TOPO. • Determines the needs and objectives for tasks. • Assigns appropriate personnel to review data deliverables and complete the project. • Ultimately responsible for the completion of the project.
Data Manager (DM)	• Coordinates, documents and reports on all data management activities. • Acts as a liaison between the data users and the data holders, making certain that data are provided to those who need it in the appropriate format. • Loading Electronic Data Deliverables (EDDs) into EQuIS.
Field Team Leader (FTL)	• Responsible for the collection and documentation of all field generated data. • Reports collection efforts and information to the Sample Manager.
Project Geologist	• Provides field geological data to the DM as required to populate the geological fields within EQuIS database. • Prescribes the database input and output data formats as required to support the function of specialized geological software to create logs, borings, and other customized products.
Project Chemist	• Works with Subcontracts Manager to develop the scope of work for laboratory subcontracts. • Assists the SM in communicating with laboratories and data validators as needed. • Performs quality checks of the data deliverables. • Assists in the definition of regulatory criteria and threshold values, and maintains the regulatory criteria in the database. • Provides assistance to the PM and technical staff in interpreting analytical results.

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Team Member	Roles and Responsibilities
Sample Manager	• Responsible for tracking samples from collection through analysis to their inclusion in the project database. • Conducts QC checks between anticipated collection and actual collection; the accuracy of documentation; submission to and receipt from laboratories; and submission to the DBA.
Database Administrator (DBA)	• Has overall responsibility for the operation and maintenance of the project database. • Responsible for the implementation and evaluation of SOPs to ensure integrity of the database system.
GIS Developer	• Creates the Graphic Information System (GIS) project including geographical features and area characteristics. • Incorporates analytic data through query functionality.

10.1.4 Data Management Process

At the early planning stage of the Garvey Elevator project, the data sources, required tools, and end uses of the data were identified and were used to develop this site-specific DMP.

QC steps are implemented at each step of the data flow in which data undergoes a transformation. Transformations include conversion from hardcopy to electronic form, uploads to the database, output queries from the database, etc. After each process step, a 10 percent QC check is performed of the transformed data against the original data set to ensure that no data was corrupted or lost.

The DM is responsible for providing to the staff responsible for the analysis of the data both the data needed and a clear list of the output required. The DM is not, in most cases, involved in the creation of deliverables from analyzed data, but rather checks the completed deliverables against the scope and FSP to ensure that they are complete.

10.2 EQUIS DATABASE

The project data will be stored in an EQuIS database. EQuIS is a product of Earthsoft Inc. and is a broad data structure with a robust toolset and compatibility with multiple peripheral software packages. It is an industry standard both for contractors and regulators, and has a positive usage record, as well as the longevity and stability to support a project of this scope.

10.2.1 Pre-Processing Non-EDD Data

All data that will be non-EDD will be entered into an appropriate EDD in order to be loaded into the EQuIS database, rather than directly keyed into the database through the user interface. This is done so that the loading quality checks are uniformly applied, and to assure that all data pass through the same QC process. Data included in this step are sample collection information, geologic information, well construction specifications, and field parameters. All hand-entered data will receive a 100 percent QC check.

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10.2.2 Processing Electronic Data Deliverables

Each EDD will be loaded into the EQuIS database by the DBA using the data loading tool provided in the software. The loading process includes multiple quality checks on the data for format, compatibility, and referential integrity. Any data set that fails any of these quality checks will not be accepted into the database.

EDDs that are rejected will be returned to their originator along with the error log generated by the EQuIS system. Using the error log as a guide, the EDDs will be corrected and resubmitted until they pass the quality checks and are accepted into the database.

10.2.3 Post-Processing

Data will be exported to Environmental System Research Institute (ESRI) ArcGIS Geographic Information System (GIS) for data presentation in the RD report as discussed in Section 10.2.3 below.

10.2.4 Reporting

Database queries will be used to prepare analytical results tables for the Field Investigation Report and the RD reports after all data are entered and pass the quality checking process. Copies of the database will be provided as a deliverable to EPA with the interim data report, draft and final RD report.

10.3 GEOGRAPHIC INFORMATION SYSTEM (GIS)

ArcView GIS is a product of ESRI Corporation. It is a desktop version of GIS that can connect directly to the EQuIS database. ArcView displays information provided by the database in conjunction with spatial base-mapping. The power of the GIS lies in its ability to display a series of results in their natural arrangement and to allow the user to manipulate data based on proximity to various features – a function that cannot be accomplished in a database alone. The GIS will be developed to facilitate visualizing environmental data, mapping, generating figures for reports, and project tracking.

The following types of data will be included in the project GIS:

- Sampling locations
- Northing/easting coordinates
- Buildings, roads, site features and utilities
- Topography and land features

The base map data will be gathered from the existing GIS compiled and maintained by the city of Hastings and used in conjunction with layers from previous site-specific investigations, if available. The analytical data point layers will be created from temporary database queries during the sampling phase of the project.

The GIS Developer will be responsible for standardizing all the spatial data sources into the

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project coordinate system. The GIS Developer also will be responsible for maintaining the GIS including:

- Assigning colors, titles, symbols, fonts and sizes to each theme to ensure consistency of views and themes within the GIS.
- Organizing files stored within the GIS to ensure that they are located in the correct folders.

The GIS Developer will generate figures for reports as directed by the PM to meet data reporting needs.

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11.0 SCHEDULE

Upon approval of the RD SAP, the proposed project schedule for the RD will be implemented for the Garvey Elevator Site. The proposed schedule has been updated to reflect recent requirements for instrumentation design, specification, and fabrication. The project schedule is included as Figure 11.1.

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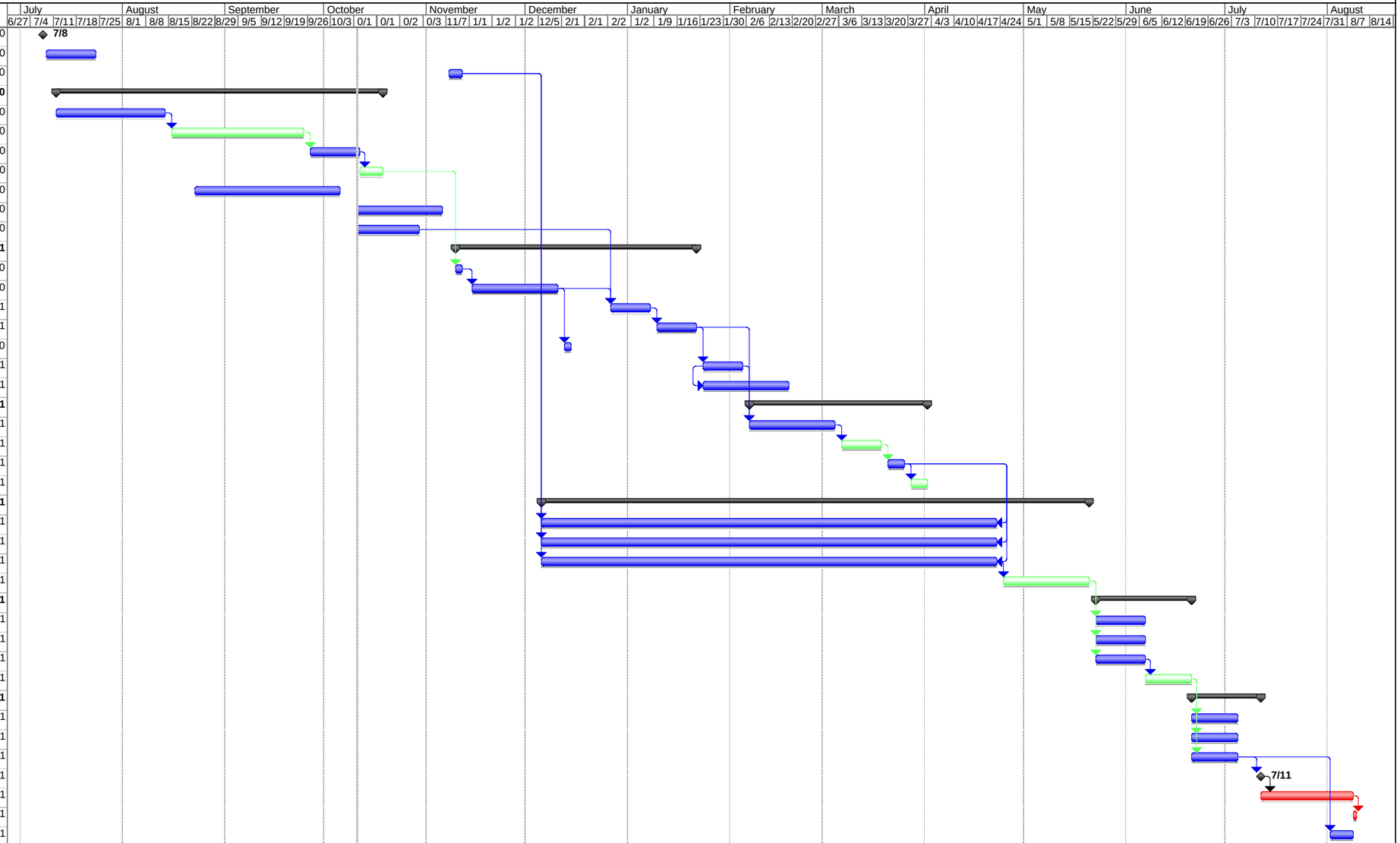
FIGURE

Figure 11.1
Project Schedule
Remedial Design
Garvey Elevator, Hastings, NE

ID	Task Name	Duration	Start	Finish
1	Task Order Award	0 days	Thu 7/8/10	Thu 7/8/10
2	Review Data	11 days	Fri 7/9/10	Fri 7/23/10
3	Site Visit	4 days	Mon 11/8/10	Thu 11/11/10
4	**Planning Documents**	**71 days**	**Mon 7/12/10**	**Mon 10/18/10**
5	Draft Documents	25 days	Mon 7/12/10	Fri 8/13/10
6	EPA Review	30 days	Mon 8/16/10	Fri 9/24/10
7	Final Documents	11 days	Mon 9/27/10	Mon 10/11/10
8	EPA Approval	5 days	Tue 10/12/10	Mon 10/18/10
9	Subcontracting	32 days	Mon 8/23/10	Tue 10/5/10
10	Field Preparation	20 days	Mon 10/11/10	Fri 11/5/10
11	Instrumentation/System Revision Specs	15 days	Mon 10/11/10	Fri 10/29/10
12	**Hydrogeological Assessment**	**53 days**	**Wed 11/10/10**	**Fri 1/21/11**
13	Mobilization/Demobilization	2 days	Wed 11/10/10	Thu 11/11/10
14	Well Installation & Development	20 days	Mon 11/15/10	Fri 12/10/10
15	Instrumentation Installation	10 days	Mon 12/27/10	Fri 1/7/11
16	Aquifer Testing & Monitoring	10 days	Mon 1/10/11	Fri 1/21/11
17	Waste Characterization & Disposal	2 days	Mon 12/13/10	Tue 12/14/10
18	Data Evaluation	10 days	Mon 1/24/11	Fri 2/4/11
19	Analytical Transport Model	20 days	Mon 1/24/11	Fri 2/18/11
20	**Field Investigation Report**	**40 days?**	**Mon 2/7/11**	**Fri 4/1/11**
21	Draft Report	20 days?	Mon 2/7/11	Fri 3/4/11
22	EPA Review	10 days?	Mon 3/7/11	Fri 3/18/11
23	Final Report	5 days?	Mon 3/21/11	Fri 3/25/11
24	EPA Approval	5 days?	Mon 3/28/11	Fri 4/1/11
25	**Preliminary Design**	**120 days**	**Mon 12/6/10**	**Fri 5/20/11**
26	Specifications	100 days	Mon 12/6/10	Fri 4/22/11
27	Drawings	100 days	Mon 12/6/10	Fri 4/22/11
28	Design Analysis Report	100 days	Mon 12/6/10	Fri 4/22/11
29	EPA Review	20 days	Mon 4/25/11	Fri 5/20/11
30	**Pre-Final Design**	**21 days**	**Mon 5/23/11**	**Mon 6/20/11**
31	Specifications	11 days	Mon 5/23/11	Mon 6/6/11
32	Drawings	11 days	Mon 5/23/11	Mon 6/6/11
33	Design Analysis Report	11 days	Mon 5/23/11	Mon 6/6/11
34	EPA Review	10 days	Tue 6/7/11	Mon 6/20/11
35	**Final Design**	**15 days**	**Tue 6/21/11**	**Mon 7/11/11**
36	Specifications	10 days	Tue 6/21/11	Mon 7/4/11
37	Drawings	10 days	Tue 6/21/11	Mon 7/4/11
38	Design Analysis Report	10 days	Tue 6/21/11	Mon 7/4/11
39	EPA Approval	0 days	Mon 7/11/11	Mon 7/11/11
40	Public Review	20 days	Tue 7/12/11	Mon 8/8/11
41	Public Meeting	1 day?	Tue 8/9/11	Tue 8/9/11
42	Task Order Closeout	5 days	Tue 8/2/11	Mon 8/8/11



Project: Garvey RD schedule ver1b
Date: Mon 10/11/10

Task — Progress — Summary — External Tasks — Deadline
Split — Milestone — Project Summary — External Milestone

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APPENDIX A
SITE-SPECIFIC HEALTH AND SAFETY PLAN

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Site Safety and Health Plan	Environmental Protection Agency --Region 7--	HydroGeoLogic, Inc.
		Project Name: Garvey Elevator RD—OU1 **Task Order No.: 0046**

Job Site Address:	**Task Order Manager:** Alan Rittgers
2315 West Highway 6, Hastings, Adams County, Nebraska	**WBS Work Area:** RI
Site Contact: NA	**EPA TOPO:** Brian Zurbuchen, TOPO
Telephone: NA	**Telephone:** 913-551-7101
	e-mail: **zurbuchen.brian@epamail.epa.gov**

☐ **Revision No. 0**

Objectives of Field Work: HGL has been tasked by EPA Region 7 to conduct a remedial design study at the Garvey Elevator OU1 Site in Hastings, Nebraska. This field effort will consist of: installation and development of 15 monitoring wells using rotosonic drilling, continuous logging and collection of geotechnical samples during drilling of the monitoring wells, installation of transducers and dataloggers in the new monitoring wells and select existing monitoring wells, and completion of pumping tests on the full extraction system and select individual wells.

Type: Check as many as applicable

☒ Active	☐ Landfill	☐ Unknown
☐ Inactive	☐ Uncontrolled	☐ Military
☐ Secure	☒ Industrial	☐ Enclosed space
☒ Unsecure	☐ Recovery	☐ Well Field
☐ Other **specify:**		

Description and Features: Summarize below. Include principal operations and unusual features (containers, buildings, dikes, power lines, hills, slopes, river).

The Garvey Elevator Site (site) is located in the NW1/4 of Section 23, T7N, R10W, approximately 7 miles west of the Adams County/Clay County line in the southwest portion of the City of Hastings, Nebraska. The site is bounded on the north by U.S. Highway 6/34, on the east by the Burlington Northern and Santa Fe (BNSF) railroad track, on the west by Marion Road, and on the south by farmland owned by the Walter Family Trust. The site is an area of soil and groundwater contamination that consists of the Garvey Elevator property at 2315 West Highway 6, Hastings, Nebraska (OU1), and the associated contaminated ground water plume that extends approximately three (3) miles east of the site (OU2).

The site is the location of an active 8-million bushel capacity grain storage facility which consists of a concrete elevator head house and elevator, a flat storage building, and steel bins. It was constructed in 1958 and originally owned and operated by Garvey Elevators, Inc., of Fort Worth, Texas. The facility is currently owned and operated by AGP Grain marketing, LLC.

The site is located within the Loess Plains, a portion of the Great Plains physiographic province. The topography of the area is relatively flat, with a slight slope to the east-southeast. The Platte River valley lies 15 miles north of the site and flows to the northeast, and the Little Blue River valley lies 10 miles to the south and flows toward the east.

Surface soils in the vicinity of the site consist of silt-loam. The elevation is approximately 1,930 feet above mean sea level (amsl). The Hastings area is underlain by approximately 200 to 240 feet of unconsolidated Pleistocene Age deposits lying unconformably on Upper Cretaceous Age Niobrara Formation, an argillaceous chalk and limestone formation containing interbedded layers of chalky shale. Groundwater is generally encountered at depths between 100 and 130 ft below the ground surface.

Surrounding land use is primarily agricultural with a mixture of urban and industrial use to the north and east. Land use along the Highway 6 corridor north of the site is primarily zoned commercial and industrial. The nearest residential developments are approximately 1 mile to the northeast and east. However, isolated residences lie within ½ or ¾ of a mile from the site.

Hastings is situated within the Little Blue Natural Resources District. Under the provisions of the Rules and Regulations for Enforcement of this district, the site is within a Wellhead Protection Area; therefore, no wells can be installed without first being permitted. Though there are expected to be some private wells in use within the affected area, businesses and residences having wells that are known to be contaminated have been placed on alternative water supplies.

Surrounding Population: ☒ Residential ☒ Industrial ☒ Rural ☐ Urban ☒ Other: Commercial

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Site History: Summarize below. In addition to history, include complaints from public, previous agency actions, known exposures or injuries, etc.

A fumigant, Liquid 80-20, which was composed of 80 percent carbon tetrachloride and 20 percent carbon disulfide, was applied to grain in all upright grain storage areas. In 1960, Garvey Elevator installed a 3,000-gallon aboveground storage tank that was used for storage of the liquid grain fumigant. The fumigant was transferred through a delivery pipe that connected the storage tank to piping mounted on the side of the elevator and then up the side of the elevator to the distribution gallery. A buried portion of this delivery pipe was found to be leaking and was replaced, sometime before 1986 when the tank was removed. The exact date of the repair and the amount of fumigant that leaked are unknown. The facility ceased use of the liquid fumigant in 1985.

Garvey Elevator was first identified as a source of carbon tetrachloride contamination in 1994 when an on-site water sample revealed the presence of carbon tetrachloride at 199 micrograms per liter (μg/L). During past investigations, 36 monitoring wells were installed to define the extent of groundwater contamination. Soil and soil vapor samples collected in 1994 documented the presence of extensive carbon tetrachloride contamination in on-site soils. Contamination in the soils extended from the ground surface to the water table at a depth of more than 100 feet bgs. It was estimated that 55 million cubic feet of contaminated soil existed at the site. These contaminated soils represented a continuing source of groundwater contamination as contaminants were dissolved with infiltrating precipitation. In 1996, the groundwater contaminant plume was estimated to be 6,500 feet long by 3,200 feet wide in the principal regional sand and gravel aquifer. The maximum carbon tetrachloride concentration in groundwater was observed in an on-site monitoring well at approximately 29,000 μg/L.

Garvey Elevator initiated remedial activities under the NDEQ's VCP, including installation of a soil vapor extraction (SVE) system to treat contaminated vapor in soils beneath the facility, and installation/operation of a groundwater extraction and treatment (GET) system to treat contaminated groundwater. The SVE began operation in January 1999. The GETS consisted of eight extraction wells and an air stripper to remove contaminants from extracted water. The treated groundwater is re-injected to the aquifer. Within the first approximately two years of operation, the combined SVE and GET system removed more than 10,000 pounds of carbon tetrachloride from the soil and groundwater. Garvey Elevator continues to operate the SVE and GET systems.

The first survey/sampling of residential and business wells was conducted by Garvey Elevator in late 1994. Of the 13 private wells sampled, 5 were found to be contaminated with carbon tetrachloride at levels above the EPA maximum contaminant level (MCL) of 5 μg/L. Subsequent sampling events also have identified additional impacted residential/business wells. According to NDEQ records, alternate water provisions of bottled water and/or carbon filtration systems were made available to impacted residents.

The NDEQ completed a Preliminary Assessment/Site Inspection (PA/SI) of the Site in April 2003. The PA/SI detected carbon tetrachloride in groundwater wells located more than 3 miles downgradient from the site. In May 2002, Garvey Elevators refused to sign the NDEQ Remedial Action Program Monitoring Act (RAPMA) Voluntary Cleanup Program (VCP) Memorandum of Agreement (MOA). Concerned about the ability of Garvey Elevator to address the on- and off-site contamination, NDEQ requested EPA assistance on December 9, 2003.

EPA entered into an Administrative Order on Consent (AOC) with the Potentially Responsible Party (PRP) Ag Processing, Inc. (AGP) on October 7, 2005. In the AOC, the PRP agreed to conduct investigation and source area treatment activities at the Garvey Elevator Site. In a separate Agreement AGP funded an escrow account to finance continued response actions at the site. The AOC and Agreement were issued pursuant to Sections 104, 106(a), 107, and 122 and to Section 102(h)(1) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (CERCLA).

Garvey filed Chapter 7 bankruptcy in March 2008. The EPA took over ongoing removal activities to address the immediate threats posed by contamination from the site. These removal efforts include providing alternate water to impacted private wells and operation and maintenance of the ground water extraction wells, packed tower air stripper, soil vapor extraction wells, soil vapor extraction blowers and catalytic oxidation unit.

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Waste Types: ☒ Liquid ☒ Solid ☐ Sludge ☐ Gas ☐ Unknown ☐ Other **Specify:**

Waste Characteristics: Check as many as applicable.

- ☐ Corrosive
- ☒ Toxic
- ☐ Inert Gas
- ☐ Other **Specify:**
- ☐ Flammable
- ☒ Volatile
- ☐ Unknown
- ☐ Radioactive*
- ☐ Reactive
- ☒ Carcinogenic

* Contact Regional HSO for further project planning

Work Zones: Describe the Exclusion, Contamination Reduction, and Support Zones in terms on-site personnel will recognize.

Exclusion, contamination reduction, and support zones will be independently established around each borehole or well using physical barriers to prevent access by unauthorized personnel. Unauthorized personnel will be removed a safe distance from work areas.

Hazards of Concern:

Indoors

- ☐ Exhaust
- ☐ Inorganic Chemicals
- ☐ Organic Chemicals
- ☐ Motorized Traffic
- ☐ Heavy Machinery
- ☐ Slips, Trips, and Falls
- ☐ Noise
- ☐ Explosive/Flammable
- ☐ Radiological
- ☐ Other Specify

Outdoors

- ☒ Noise
- ☐ Inorganic Chemicals
- ☒ Organic Chemicals
- ☒ Motorized Traffic
- ☒ Slips, Trips, and Falls
- ☒ Biological: stinging insects, venomous reptiles
- ☒ Cold Stress
- ☒ Heat Stress
- ☒ Heavy Machinery

Note here any incidents at this site that will affect any and all standard operating procedures:

Principle Disposal Methods and Practices for investigation derived waste. Summarize below:

Soil IDW will be containerized at the borehole in 55-gallon drums. The drums will be brought to the on-site staging area and emptied into 12-cubic yard rolloff boxes delivered to the site by a local, licensed waste hauler. The contents of each rolloff box will be sampled. After receipt of the analytical results for a particular rolloff box, approval for disposal will be requested of Hastings Adams County Landfill.

Liquid IDW will consist primarily of well development purge water and drilling fluids (water and drilling mud). Liquid IDW will be drummed at the wellhead then the drum contents transferred to poly tanks situated at the staging area. Periodically, the poly tanks will be emptied by a licensed waste hauler and the liquid IDW transported by to the city of Hastings wastewater treatment plant for disposal. Decontamination fluids will be pumped from the decontamination pad directly into the poly tanks for disposal.

All other IDW will be disposed in opaque heavy duty trash bags. Hastings municipal waste will remove these bags from the site on a weekly basis.

Project Specific Hazardous Material Summary: Check waste type and media in which the material is contained; estimate quantity if material exists in bulk quantities.

Chemicals Amounts/Units:	*Solids Amounts/Units:*	*Sludges Amounts/Units:*	*Solvents Amounts/Units:*	*Oils Amounts/Units:*	*Other Amounts/Units:*
☐ Acids	☐ Flyash	☐ Paint	☒ Halogenated (chloro, bromo)	☐ Oily Wastes	☐ Laboratory
☐ Pickling Liquors	☐ Asbestos	☐ Pigments	☒ Solvents	☐ Gasoline	☐ Pharmaceutical
☐ Caustics	☐ Milling/Mine Tailings	☐ Metal Sludges	☐ Hydrocarbons	☐ Diesel Oil	☐ Hospital
☐ Pesticides	☐ Ferrous Smelter	☐ POTW Sludge	☐ Alcohols	☐ Lubricants	☐ Radiological
☐ Dyes/Inks	☐ Non-ferrous Smelter	☐ Aluminum	☐ Ketones	☐ PCBs	☐ Municipal
☐ Cyanides	☐ Metals:	☐ Distillation Bottoms	☐ Esters	☐ Polycyclic Aromatics	☐ Construction
☐ Phenols	☐ Other	☐ Other	☐ Ethers	☐ Other	☐ Munitions
☐ Halogens	**Specify:**	**Specify:**	☐ Other	**Specify:**	☐ Other
☐ Dioxins			**Specify:** carbon tetrachloride, chloroform, carbon disulfide, trichloroethene		**Specify:**
☐ Other					
Specify:					

Overall Hazard Evaluation: ☐ High ☐ Medium ☒ Low ☐ Unknown (Where tasks have different hazards, evaluate each. Attach additional sheets if necessary.)

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Justification: Exposure routes are through ingestion and inhalation of VOC contaminated soil and water, dermal contact, and/or inhalation of particulates entrained in air. Toxicity of CCL is the same for exposure by either dermal or inhalation routes. Proper personal hygiene (i.e., laundering, showering, and washing hands) after field activities will minimize the potential for ingestion of contaminants.

Fire/Explosion Potential: ☐ High ☐ Medium ☒ Low ☐ Unknown

Background Review: ☒ Complete ☐ Incomplete Additional information to be collected in this and future investigations.

Known Contaminants	*Highest Observed Concentration (specify units and media)* [1]	*TLV ppm or mg/m³ (specify)*	*IDLH ppm or mg/m³ (specify)*	*STEL/ Ceiling Limit*	*Symptoms/Effects of Acute Exposure*	*Photo-ionization Potential*
Carbon Tetrachloride CAS: 56-23-5	1300 µg/L in groundwater 77 µg/kg in soil 3.7 µg/m³ in soil gas	5 ppm -Skin-	200 ppm (CA)	10 ppm -Skin-	Irritate eyes and skin; central nervous system depression; nausea, vomiting; liver, kidney damage; potential carcinogen	11.47 eV
Chloroform CAS: 67-66-3	18 µg/L in groundwater 18 µg/kg in soil 93.3 µg/m³ in soil gas	10 ppm	500 ppm	2 ppm	Irritates eyes and skin; dizziness, mental dullness, nausea, confusion; headache, weakness, exhaustion; anesthesia; enlarged liver; (potential occupational carcinogen)	11.42 eV
Carbon Disulfide CAS: 75-15-0	4.0 µg/L in groundwater Nondetect in soil 3.3 µg/m³ in soil gas	5,000 ppm	500 ppm	NE	Dizziness, headache, poor sleep, weakness, exhaustion, anxiety, anorexia, weight loss; psychosis; polyneuropathy; Parkinson-like syndrome; ocular changes; coronary heart disease; gastritis; kidney, liver injury; eye, skin burns; dermatitis; reproductive effects	10.08 eV
Trichloroethene (TCE) CAS: 79-01-6	7.3 µg/L in groundwater Nondetect in soil 39.9 µg/m³ in soil gas	50 ppm	1000 ppm (CA)	100 ppm	Irritate eyes and skin; vertigo, headache, fatigue, giddiness, tremors, nausea, potential carcinogen	9.45 eV

ACGIH = American Conference of Government Industrial Hygienists
CA = Human carcinogen
CAS = Chemical Abstract Service
IDLH = Immediately Dangerous to Life and Health (NIOSH standard enforced by law)
NE = Not established
NIOSH = National Institute for Occupational Safety and Health
OSHA = Occupational Safety and Health Administration
ppm = parts per million
STEL = Short Term Exposure Limit (15 minute TWA)
TLV = Threshold Limit Values (Recommended by ACGIH)
TWA = Time-Weighted Average (Average concentration for a normal 8-hour working day or 40-hour working week)
µg/kg = micrograms per kilogram
µg/L = micrograms per Liter
µg/m³ = micrograms per cubic meter

[1] As measured during the Remedial Investigation in 2009-2010 at which time 134 soil samples, 32 groundwater samples, and 10 soil gas samples were collected from the site.

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Activity Hazard Analysis – Complete Corresponding Detailed PPE Section for each task

Task Number/Activity Description/ Site Location	*Potential Hazards*	*Controls*	*Primary /Secondary PPE Level*	*Exposure Monitoring Required/ Frequency*
1. Monitoring well installation using rotosoinc drilling methods. Includes drilling, well installation, well development, and installation of transducers and dataloggers.	Traffic Machinery Chemical exposure Cold/Heat stress Noise Slips, trips and falls Heavy lifting Electrical/Fire Hazard	Wear high Visibility Vests Locate support equipment away from mechanical activities Wear appropriate PPE Schedule breaks according to weather, appropriate PPE Hearing Protection as required Employ good housekeeping practices, be alert Use proper lifting techniques, nothing over 50 lbs without assistance Conduct utility locate prior to intrusive activities	**Modified Level D/** Exit Area	PID, wellhead and breathing zone. Upgrade to Draeger Tubes as specified by action levels.
2. Borehole logging and geotechnical sample collection during drilling.	Traffic Machinery Chemical exposure Cold/Heat stress Noise Slips, trips and falls Heavy lifting	Wear high Visibility Vests Locate support equipment away from mechanical activities Wear appropriate PPE Schedule breaks according to weather, appropriate PPE Hearing Protection as required Employ good housekeeping practices, be alert Use proper lifting techniques, nothing over 50 lbs without assistance	**Modified Level D/** Exit Area	PID in breathing zone. Upgrade to Draeger Tubes as specified by action levels.
3. Installation and removal of temporary transducers and dataloggers at select existing monitoring wells.	Traffic Machinery Chemical exposure Cold/Heat stress Slips, trips and falls	Wear high Visibility Vests Locate support equipment away from mechanical activities Wear appropriate PPE Schedule breaks according to weather, appropriate PPE Employ good housekeeping practices, be alert	**Modified Level D/** Exit Area	PID, wellhead and breathing zone. Upgrade to Draeger Tubes as specified by action levels.
4. Pumping tests. All water levels will be measured remotely. No IDW water will be generated.	Traffic Machinery Cold/Heat stress Slips, trips and falls	Wear high Visibility Vests Locate support equipment away from mechanical activities Schedule breaks according to weather, appropriate PPE; wmploy good housekeeping practices, be alert	**Modified Level D**	None
5. Equipment decontamination. All reusable sampling and measuring equipment will be cleaned using a scrub with phosphate-free detergent, deionized water, and potable water. A power washer will be used to steam clean drilling equipment.	Traffic Chemical exposure Cold/Heat stress Slips, trips and falls Heavy lifting	Wear high Visibility Vests; wear appropriate PPE Schedule breaks according to weather, appropriate PPE; employ good housekeeping practices, be alert Use proper lifting techniques, nothing over 50 lbs without assistance	**Modified Level D**	None

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Activity Hazard Analysis – Complete Corresponding Detailed PPE Section for each task

Task Number/Activity Description/ Site Location	*Potential Hazards*	*Controls*	*Primary /Secondary PPE Level*	*Exposure Monitoring Required/ Frequency*
6. IDW - Handling of soil/water drums.	Traffic Machinery Chemical exposure Cold/Heat stress Slips, trips and falls Heavy lifting	Wear high Visibility Vests Locate support equipment away from mechanical activities Wear appropriate PPE Schedule breaks according to weather, appropriate PPE Employ good housekeeping practices, be alert Use proper lifting techniques, nothing over 50 lbs without assistance	**Modified Level D**	None
7. Surveying Oversight. Monitoring wells and sample locations will be surveyed for horizontal and vertical location.	Traffic Cold/Heat stress	Wear high Visibility Vests Schedule breaks according to weather, appropriate PPE	**Modified Level D**	None

PPE Levels = A, B, C, D – definitions of these levels available in Corporate H&S Manual.
Exposure Monitoring = PID, PDR (dust monitor), CGI, O2 meter, etc.

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Does the project require continuous air monitoring during the project?
☐ Yes ☒ No If Yes, Contact the Regional Health and Safety Coordinator for additional project safety planning.

Protective Equipment: Specify by task. Indicate type and/or material as necessary. Use copies of this sheet if needed.

Task Number: 1-7
PPE Level: D - Modified
☒ **Primary**
☐ **Contingency**

Respiratory: ☒ Not Needed
☐ SCBA, Airline
☐ APR Full face
☐ Cartridge
☐ Escape Mask
☐ Other

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit
☐ Splash Suit
☐ Apron
☒ Saranex Coverall: where potential splash exposure exists
☐ Cloth Coverall
☒ High Visibility Vests

Head & Eye: ☐ Not Needed
☒ Safety Glasses (as needed)
☐ Face Shield (optional, as needed)
☐ Goggles
☒ Hard Hat (as needed)
☒ Hearing Protection (as needed)
☐ Other

Gloves: ☐ Not Needed
☐ Undergloves
☒ Gloves; StanzSolve Nitrile, or Viton
☐ Overgloves

Boots: ☐ Not Needed
☒ Boots: Leather steel-toed safety boots
☐ Overboots
☐ Rubber

☒ Other – specify below:

Exit area and reevaluate personnel protection if unexpected conditions arise.

Task Number:
PPE Level:
☐ **Primary**
☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline
☐ APR Full face: MSA Advantage or 3M 6000
☐ Cartridge:
☐ Escape Mask
☐ Other

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit
☐ Splash Suit
☐ Apron
☐ Saranex Coverall
☐ Cloth Coverall
☐ High Visibility Vests
☐ Other

Head & Eye: ☐ Not Needed
☐ Safety Glasses (as needed)
☐ Face Shield (optional, as needed)
☐ Goggles
☐ Hard Hat (as needed)
☐ Hearing Protection (as needed)
☐ Other

Gloves: ☐ Not Needed
☐ Undergloves
☐ Gloves; StanzSolve Nitrile, or Viton
☐ Overgloves

Boots: ☐ Not Needed
☐ Boots: Leather steel-toed safety boots
☐ Overboots
☐ Rubber

☐ Other – specify below:

Note

Task Number:
PPE Level:
☐ **Primary**
☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline
☐ APR Full face
☐ Cartridge
☐ Escape Mask
☐ Other

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit
☐ Splash Suit
☐ Apron
☐ Saranex Coverall
☐ Cloth Coverall
☐ High Visibility Vests
☐ Other

Head & Eye: ☐ Not Needed
☐ Safety Glasses
☐ Face Shield
☐ Goggles
☐ Hard Hat
☐ Hearing Protection
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves
☐ Gloves
☐ Overgloves:

Boots: ☐ Not Needed
☐ Boots: Leather steel-toed safety boots
☐ Overboots
☐ Rubber

☐ Other – specify below:

☐ Other – specify below:

Task Number:
PPE Level:
☐ **Primary**
☐ **Contingency**

Respiratory: ☐ Not Needed
☐ SCBA, Airline
☐ APR Full face
☐ Cartridge: MSA GMC-H
☐ Escape Mask
☐ Other:

Prot. Clothing: ☐ Not Needed
☐ Encapsulated Suit
☐ Splash Suit
☐ Apron
☐ Saranex Coverall
☐ Cloth Coverall
☐ High Visibility Vest
☐ Other

Head & Eye: ☐ Not Needed
☐ Safety Glasses
☐ Face Shield
☐ Goggles
☐ Hard Hat
☐ Hearing Protection
☐ Other:

Gloves: ☐ Not Needed
☐ Undergloves
☐ Gloves
☐ Overgloves:

Boots: ☐ Not Needed
☐ Boots: Leather steel-toed safety boots
☐ Overboots
☐ Rubber

☐ Other – specify below:

☐ Other – specify below:

Personnel and Responsibilities ***(Include subcontractors)***

Name	Firm/Region	Medical Monitoring Clearance* (yes/no)	Responsibilities	On-site Involvement
Alan Rittgers	HGL/KC	Yes	TOM	
Jeff Gadt	HGL/KC	Yes	Field Team Leader/SSO	All Tasks
HGL Personnel	HGL	Yes	Field/sampling support	Field Support
CDM Personnel	CDM	Yes	Field/sampling support	Field Support
Well Drilling Subcontractor	TBD			Well Drilling
Surveying Subcontractor	TBD			Surveying

*Health clearance meets all the medical surveillance requirements of 29 CFR 1910.120. Medical surveillance certification for on-site personnel is presented in HGL Policy 3.1. Subcontractors are required to meet the medical requirements of 20 CFR 1910.120, if applicable

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Does the project have any permit required confined spaces that will need to be entered to accomplish the identified project tasks?
☐ Yes ☒ No If Yes, Attach the Permit Required Confined Space Entry Checklist (available via the Intranet) and contact the regional HSC for additional project safety planning.

Health and Safety Monitoring Equipment: Specify by task. Indicate type as necessary. Attach additional sheets as necessary.

Instrument	*Task*	*Action Guidelines*		*Comments (Include schedules of use)*
Combustible Gas Indicator LEL/O_2 Meter		0-10% LEL **>10% LEL** 21.0% 02 <21.0% 02 **<19.5% 02**	No explosion hazard **Explosion hazard; interrupt task/evacuate** Oxygen normal Oxygen deficient; notify SHSC **Interrupt task/evacuate**	☒ Not Needed
Multi-gas Meter (CO_2/CO) Type _____		**Specify: Monitor CO levels**	If CO >25 ppm and/or CO_2 >5,000 ppm stop work and re-evaluate the ventilation design.	☒ Not Needed
Photoionization Detector Type: 11.7 eV	1 - 3	**Specify: Monitor VOC levels**	**If > 2 ppm is detected in the breathing zone and sustained for 15 minutes, pull Draeger Tubes (or equivalent) for CCl_4.** **Detectable Odor: If odor of any kind is detected, cease work and move to fresh air.**	☐ Not Needed **NOTE: CCL_4 has an odor threshold of about 50 ppm.**
Drager Tubes - 81 03 501 or 81 01 021 (or equivalent) for CCl_4. **Tubes must be sensitive enough to test for CCl_4 at < 2 ppm.**	1 - 3	**Specify: Monitor CCl_4 levels**	If tubes test positive for CCL_4 > 2 ppm, stop work and exit area. Contact CHSD.	☐ Not Needed
Sound level Meter Type _____		**Specify:**		☒ Not Needed
Respirable Dust Monitor (Digital) Type _____ Type _____		**Specify:**		☒ Not Needed Dusty conditions are not expected.
Other **Specify: Visible or nuisance dust and/or unusual vapors (odors)**	all	**Specify: If team notices unusual odors, heavy dust, or irritation of the eyes or throat, they will exit area and re-evaluate personnel protection.**		
Other **Specify:**		**Specify:**		☒ Not Needed

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Decontamination Procedures

Personalized Decontamination	*Sampling Equipment Decontamination*	*Heavy Equipment Decontamination*
Wash well before hand-to-mouth contact is made. A shower will be taken as soon as possible after leaving the field. Workers will remove protective clothing in this order: Wet or dry decontamination procedures will be selected per project. **Dry Decon Procedure** Place all disposable PPE in a garbage bag as removed in the following order: (1) Brush off work boots, remove disposable over boots, or booties (2) remove gloves (3) remove safety glasses (4) remove Tyvek or cloth coverall, if used (5) remove respirator, if used (6) remove inner gloves (7) wash hands/face before eating/drinking **Wet Decon Procedure** ☐ **Not Needed** (1) wash overboots in soapy water and rinse (2) remove overboots or booties (3) remove gloves (4) remove safety glasses (5) remove Tyvek or cloth coverall, if used (6) remove respirator, if used (7) remove inner gloves (8) wash hands/face before eating/drinking	All sampling equipment will be thoroughly decontaminated as follows: (1) wash and scrub with low phosphate detergent (2) potable tap water rinse 1 (3) potable tap water rinse 2 (4) thoroughly rinse with deionized water, if specified by the Work Plan (5) thoroughly rinse with solvent, if specified by the Work Plan (6) air dry (7) wrap in aluminum foil for transport , if specified by the Work Plan ☐ Not Needed	See HGL HSP Policy 6.6 for pressure washing protocols. All heavy equipment and tool parts that contact subsurface soil are constructed of heavy gauge steel and have no natural or synthetic components that could absorb and retain most soil-borne organic contaminants. Prior to removal from the work site, potential contaminated soil/groundwater will be scraped or brushed from the exterior surfaces. The drill rig, augers and any other large equipment in the exclusion zone will be taken to a decon pad and steam cleaned. Rain suits to protect from water spray and runoff will be used if necessary ☐ Not Needed
Containment and Disposal Method All disposable PPE will be double-bagged prior to disposal. Decon water to be contained on site for bulk disposal. ☐ Not Needed	*Containment and Disposal Method* Decon water to be contained on site for bulk disposal. ☐ Not Needed	*Containment and Disposal Method* All disposable PPE will be double-bagged before disposal. Decon water to be contained on site for bulk disposal. ☐ Not Needed

Hazardous Materials Inventory (MSDSs for Investigation-Associated Substances will be kept in a HAZCOM Notebook in the field office.)

Spill Response: The following materials will be kept on site for spill response (check all appropriate materials)

☒ Absorbent Pads ☐ Granular absorbent material(non flammable) ☒ Polyethylene Sheeting ☒ Waste Container ☐ Shovels or assorted hand tools

If a hazardous waste spill or material release to the air, soil, or water at the site is observed, the EPA site representative and the local Fire Department will be immediately notified. An assessment will be made of the magnitude and potential impact of the release. If it is safe to do so, site personnel will attempt to locate the source of the release, prevent further release, and contain the spilled and/or affected materials.

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Emergency Contacts	
Facility Management	1-402-462-2189
Dig/Utility Clearance	1-800-331-5666
Additional Utilities	
Health Department	
Sheriff's Department	1-402-461-7181
Fire Department	911
Police Department	911
Highway Patrol/State Police	1-402-370-3456
Highway Patrol/State Police	1-402-370-3456
Poison Control Center	1-800-525-5042
State Spill Line	1-402-471-2186

Emergency Contacts	*Name*	*Phone*
Task Order Manager	Alan Rittgers	913-317-8860
Site Safety Officer	Jeff Gadt	913-317-8860 W 816-589-4036 Cell
EPA TOPO	Brian Zurbuchen	1-913-551-710
HGL Regional HSC	Phyllis Chase	913-317-8860 W 913-980-1863 Cell
HGL Corporate Health and Safety Director	Mark A. McGowan, CSP, CIH	703-736-4561 W 703-888-6441 Cell
CDM RHSC	Doug Updike	816-444-8270 W 913-481-8506 Cell
CDM Corporate HSO	Shawn Oliveira, CSP, CIH	406-293-8595 W 406-293-1547 Cell
Occupational Physician	Washington Occupational Health Associates	1-800-777-WOHA
Occupational Physician	Washington Occupational Health Associates	1-800-777-WOHA
HGL Emergency Number	**1-800 341-3647**	

Contingency Plans **Summarize below:**

Evacuate site if any unexpected hazardous conditions are encountered. If staff observes hazards for which they have not been prepared, they will withdraw from the area and call HGL CHSD Mark McGowan or their regional health and safety coordinator.

The SSO will be notified immediately in the event of an emergency. The SSO will immediately evaluate the incident and, if necessary, notify the appropriate emergency support services and the client.

The weather will be monitored routinely. The SSO will decide what operations, if any, are safe to perform based on existing and anticipated conditions. In the case that immediate shelter is required all personnel will go to the field office (or other available shelter when working off site) and wait until hazardous conditions pass. If lightning is seen or thunder heard, the "30-30 Rule" shall be used.

Medical Emergency

Hospital Name: Mary Lanning Memorial Hospital	
Hospital Address: 715 N. Saint Joseph Avenue	1-402-463-4521
Name of Contact at Hospital: NA	
Name of 24-Hour Ambulance:	911

Health and Safety Plan Approvals

Prepared by: Phyllis Chase	Date: 8/2/10
HGL SSHO Signature: Jeff Gadt	Date:
HGL CHSC Signature:	Date:

Route to Hospital (See Figure 2)

Follow the attached map (Page 12) to the hospital. Become familiar with location of hospital prior to any site activities.

1. Head east on US 6/US 34 (0.8 mile)
2. Turn left (north) and stay on US 34 N / US 281 E / S. Burlington Ave (1.5 mile)
3. Turn right (east) onto W 6th St. (0.3 mile)
4. Turn left (north) onto N Saint Joseph Ave. ending at 715 N. St. Joseph Ave.

Site: Garvey Elevator, OU1 Site, Hastings, Nebraska

Distance to Hospital: 2.6 miles

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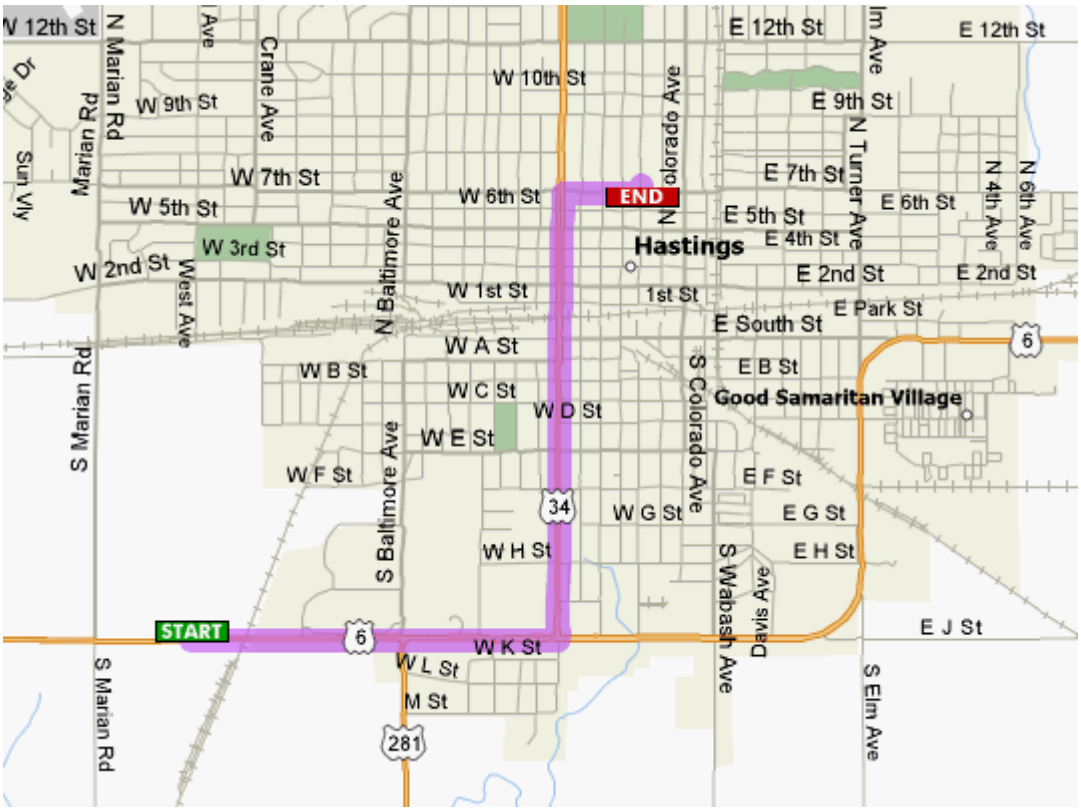

Route to Hospital (See Figure)

1. Head east on US 6/US 34 (0.8 mile)
2. Turn left (north) and stay on US 34 N / US 281 E / S. Burlington Ave (1.5 mile)
3. Turn right (east) onto W 6th St. (0.3 mile)
4. Turn left (north) onto N Saint Joseph Ave. ending at 715 N. St. Joseph Ave.

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The following personnel have read and fully understand the contents of this Health and Safety Plan and further agree to all requirements contained herein.

Site: Garvey Elevator, OU1 Site, Hastings, Nebraska | **Project No.: EPA009-046**

Name and Responsibility	Affiliation	Date	Signature

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APPENDIX B
EPA ESTIMATED DRAWDOWN CALCULATIONS

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Appendix D: EPA Estimated Drawdown Calculations

Estimate Drawdowns

Assumptions for drawdown estimates in the upper aquifer

Aquifer is confined. This assumption

Upper aquifer thickness b_{upper} = 15 ft.

Pumping well is fully penetrating.

Observation well is fully penetrating.

Pumping rate Q = 10 gpm for shallow well RW-2.

Drawdown at t = 24 hours.

Drawdown predicted according to Theis (1935).

Transmissivity (T) ranges from 1050 ft^2/day to 1950 ft^2/day (T = Kb)

Assumptions for drawdown estimates in intermediate aquifer

medial aquifer thickness b_{medial} = 18 ft.

Lower aquifer thickness b_{lower} = 90 ft.

Pumping well RW-7 screened over the lower 10 ft of medial aquifer. No well bore skin is present.

Observation well in the medial zone is screened over the lower 10 ft of medial aquifer.

Pumping rate Q = 70 gpm for medial well RW-7

Drawdown at t = 24 hours.

Drawdown predicted using WTAQ (Barlow and Moench, 1999)

For scenarios when the lower fine-grained unit is present it is assumed to be an aquaclude.

Transmissivity ranges from 3,600 ft^2/day to 6,120 ft^2/day in the medial aquifer when lower fine-grained unit is present. (T=Kb)

Transmissivity ranges from 21,600 ft^2/day to 36,700 ft^2/day in the medial/deep aquifer when lower fine-grained unit is not present. (T=Kb)

TABLE 1: Drawdown in Monitoring Well Positioned at Radial Distance (r) from the Pumping Well

Scenario	Upper Aquifer Hydraulic Conductivity (K)	Medial Aquifer Hydraulic Conductivity (K)	Lower Fine-grained Unit Present?	Lower Aquifer	Radial Distance to Monitoring Well (ft)													
					r = 10		r = 20		r = 30		r = 50		r = 100		150		200	
					A-zone	C-zone	A-zone	C-zone	A-zone	C-zone	A-zone	C-zone	A-zone	C-zone	A-zone	C-zone	A-zone	C-zone
1	70	200	Yes	200	0.7	3.35	0.5	2.94	0.38	2.7	0.24	2.39	0.09	1.98	0.03	1.73	0.009	1.57
2	70	200	No	200	0.7	0.99	0.5	0.72	0.38	0.61	0.24	0.49	0.09	0.39	0.03	0.34	0.009	0.32
3	70	340	Yes	340	0.7	2.06	0.5	1.82	0.38	1.68	0.24	1.5	0.09	1.25	0.03	1.16	0.009	1.015
4	70	340	No	340	0.7	0.6	0.5	0.44	0.38	0.37	0.24	0.31	0.09	0.24	0.03	0.22	0.009	0.2
5	130	200	Yes	200	0.42	3.35	0.32	2.94	0.25	2.7	0.17	2.39	0.08	1.98		1.73		1.57
6	130	200	No	200	0.42	0.99	0.32	0.72	0.25	0.61	0.17	0.49	0.08	0.39		0.34		0.32
7	130	340	Yes	340	0.42	2.06	0.32	1.82	0.25	1.68	0.17	1.5	0.08	1.25		1.16		1.015
8	130	340	No	340	0.42	0.6	0.32	0.44	0.25	0.37	0.17	0.31	0.08	0.24		0.22		0.2

Cells are highlighted in cases where estimated drawdown is at least 0.2 ft.

Rough Evaluation of Capture Zones

Calculation of optimal spacing between wells (upper aquifer) according to Javandel and Tsang (1986).

Assume a four well network. The optimal spacing x = 1.2*Q/(Pi*b*U), where U is the Darcy velocity for regional flow, B is the aquifer thickness, and Q is the single well pumping rate.

Aquifer thickness is assumed to be 15 ft. h1 = 14.58

Hydraulic gradient is approximately dh/dl = 0.002 145.155 h2 = 14.68

K in the upper aquifer is expected to range between 70 and 130 ft/day.

Therefore, U = K*dh/dl, ranges from 0.14 to .26 ft/day

For Q = 10 gpm * (0.1337 ft3/gal) * (1440 min/day) = 1925 ft3/day

Thus, 188 ft < x < 350 ft.

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Calculation of optimal spacing between wells (intermediate aquifer) assuming intermediate fine-grained unit is present.

For a three well network the optimal spacing x = 1.26*Q/(Pi*b*U), where U is the Darcy velocity for regional flow, B is the aquifer thickness, and Q is the single well pumping rate.

Aquifer thickness is assumed to be 18 ft.

Hydraulic gradient is approximately dh/dl = 0.002

K in the intermediate aquifer is expected to range between 200 and 340 ft/day.

Therefore, U = K*dh/dl, ranges from 0.4 to .68 ft/day

For Q = 70 gpm * (0.1337 ft3/gal) * (1440 min/day) = 13,477 ft3/day

Thus, 449 ft < x < 762 ft.

Calculation of optimal spacing between wells (intermediate aquifer) assuming intermediate fine-grained unit is absent.

Partial penetration of extraction wells is neglected.

For a three well network the optimal spacing x = 1.26*Q/(Pi*b*U), where U is the Darcy velocity for regional flow, B is the aquifer thickness, and Q is the single well pumping rate.

Aquifer thickness is assumed to be 108 ft.

Hydraulic gradient is approximately dh/dl = 0.002

K in the intermediate aquifer is expected to range between 200 and 340 ft/day.

Therefore, U = K*dh/dl, ranges from 0.4 to .68 ft/day

For Q = 70 gpm * (0.1337 ft3/gal) * (1440 min/day) = 13,477 ft3/day

Thus, 74 ft < x < 125 ft. 125.121 73.60058

Downgradient distance to stagnation zone (upper aquifer - for a single pumping well)

h = Q/(2*pi*K*B*dh/dl)

79 ft < h < 146 ft

Downgradient distance to stagnation zone (intermediate aquifer, assuming presence of intermediate fine-grained unit - for a single pumping well)

h = Q/(2*pi*K*B*dh/dl)

175 ft < h < 298 ft

Downgradient distance to stagnation zone (intermediate aquifer, assuming absence of intermediate fine-grained unit - for a single pumping well. Partial penetration of pumping well is neglected)

h = Q/(2*pi*K*B*dh/dl)

29 ft < h < 50 ft

Can Q be maintained over 24 hr duratio of test.

Drawdown at t = 24 can be estimated using Cooper-Jacob equation for drawdown in a fully screened well in a confined aquifer.

Drawdown is underestimated because well losses were not included.

s = ((2.3*Q)/(4*pi*T)*log((2.25*T*t)/(r^2*S)

Q = 10 gpm = 1925 ft3/day

T ranges from 70*15 = 1050 ft2/day to 1950 ft 2/day

r = 0.25 ft

S = 0.0002

t = 1 day

Then, 2.8 ft > s > 1.5 ft

Conclude that there is sufficient head available for pumping at Q = 10 gpm.

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APPENDIX C

STANDARD OPERATING PROCEDURES

1. EPA SOP 2044, *Monitor Well Development*
2. CDM SOP 4-2 *Photographic Documentation of Field Activities*
3. EPA SOP 2006, *Sampling Equipment Decontamination*
4. EPA Region 7 SOP 2420.5E *Identification, Documentation, and Tracking of Samples*
5. EPA Region 7 SOP 2420.4E, *Field Chain of Custody for Environmental Samples*
6. CDM SOP 2-1, *Packaging and Shipping of Environmental Samples*
7. HGL SOP *Field Activity Logbook Entries*
8. CDM SOP 3-5, *Lithologic Logging*
9. CDM SOP 5-1, *Control of Measurement and Test Equipment*
10. EPA SOP 2043, *Manual Water Level Measurements*
11. EPA SOP 2045, *Controlled Pumping Test*
12. EPA Suggested SOP, *Aquifer Pumping Tests*

U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

MONITOR WELL DEVELOPMENT

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1.0 SCOPE AND APPLICATION*

2.0 METHOD SUMMARY*

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

4.0 INTERFERENCES AND POTENTIAL PROBLEMS*

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- 7.1 Preparation
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8.0 CALCULATIONS*

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13.0 APPENDICES*

*These sections affected by Revision 0.1.

SUPERCEDES: SOP #2044; Revision 0.0; 2/18/00; U.S. EPA Contract 68-C99-223.

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1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide an overview of monitor well development practices. The purpose of monitor well development is to ensure removal of fine grained sediments (fines) from the vicinity of the well screen. This allows the water to flow freely from the formation into the well, and also reduces the turbidity of the water during sampling. The most common well development methods are: surging, jetting, overpumping, and bailing.

Surging involves raising and lowering a surge block or surge plunger inside the well. The resulting surging motion forces water into the formation and loosens sediment, pulled from the formation into the well. Occasionally, sediments must be removed from the well with a sand bailer to prevent sand locking of the surge block. This method may cause the sand pack around the screen to be displaced to a degree that damages its value as a filtering medium. Channels or voids may form near the screen if the filter pack sloughs away during surging (Keel and Boating, 1987).

Surging with compressed air is done by injecting a sudden charge of compressed air into the well with an air line so that water is forced through the well screen. The air is then turned off so that the water column falls back into the well and the process is repeated. Periodically, the air line is pulled up into a pipe string (educator) and water is pumped from the well using air as the lifting medium (air-lift pumping). The process is repeated until the well is sediment free. Method variations include leaving the air line in the pipe string at all times or using the well casing as the educator pipe.

Jetting involves lowering a small diameter pipe into the well and injecting a high velocity horizontal stream of water or air through the pipe into the screen openings. This method is especially effective at breaking down filter cakes developed during mud rotary drilling. Simultaneous air-lift pumping is usually used to remove fines.

Overpumping involves pumping at a rate rapid enough to draw the water level in the well as low as possible, and then allowing the well to recharge to the original level. This process is repeated until sediment-free water is produced.

Bailing includes the use of a simple manually operated check-valve bailer to remove water from the well. The bailing method, like other methods, should be repeated until sediment free water is produced. Bailing may be the method of choice in a shallow well or well that recharges slowly.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with a final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection

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Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

After installation, development of a well should occur as soon as it is practical. It should not occur any sooner than 48 hours after grouting is completed, especially if a vigorous well development method (i.e. surging) is being used. If a less vigorous method (i.e bailing) is used, it may be initiated shortly after installation. The method used for development should not interfere with the setting of the well seal.

Several activities must take place prior to well development. First, open the monitor well, take initial measurements (i.e., head space air monitoring readings, water level, total depth of the well) and record results in the site logbook. Develop the well by the appropriate method to accommodate site conditions and project objectives. Continue until the development water is clear and free of sediments, or until parameters such as pH, temperature, and specific conductivity stabilize. Containerize all purge water from wells with known or suspected contamination. Record final measurements in the site logbook. Decontaminate equipment as appropriate prior to use in the next well.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The following problems may be associated with well development:

1. Overpumping is not as vigorous as surging and jetting, and is probably the most desirable method for monitor well development. The possibility of disturbing the filter pack is greatest with surging and jetting well development methods.

2. The introduction of external water or air by jetting may alter the hydro chemistry of the aquifer.

3. Surging with air may produce “air locking” in some formations, preventing water from flowing into the well.

4. The use of surge blocks in formations containing clay may cause plugging of the screen.

5. Small (2-inch nominal diameter) submersible pumps that will fit in 2-inch diameter well casing are especially susceptible to clogging if used in well development applications.

6. Chemicals/reagents used during the decontamination of drilling equipment may complicate well development.

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5.0 EQUIPMENT/APPARATUS

The type of equipment used for well development is dependent on the diameter of the well and the development method. For example, the diameter of most submersible pumps is too large to fit into a two-inch inner diameter (I.D.) well, and other development methods should be used. Obtaining the highest possible yield is not usually an objective in developing monitor wells and vigorous development is not always necessary. Many monitor wells are constructed in fine-grained formations that would not normally be considered aquifers. Specifications for the drilling contract should include the necessary well development equipment (air compressors, pumps, air lines, surge blocks, generators).

6.0 REAGENTS

The use of chemicals in developing wells that will be used to monitor groundwater quality should be avoided if possible; however, polyphosphates (a dispersing agent), acids, or disinfectants are often used in general well development. Polyphosphates should not be used in thinly bedded sequences of sands and clays. The use of decontamination solutions may also be necessary. If decontamination of equipment is required at a well, refer to Environmental Response Team/Response Engineering and Analytical Contract (ERT/REAC) SOP #2006, *Sampling Equipment Decontamination* and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Coordinate site access and obtain keys to well locks.

2. Obtain information on each well to be developed (i.e., drilling method, well diameter, well depth, screened interval, anticipated contaminants).

3. Obtain a water level meter, a depth sounder, air monitoring instruments, materials for decontamination, and water quality instrumentation capable of measuring, at a minimum, pH, specific conductivity, temperature, and turbidity. Dissolved oxygen (DO) and salinity are also useful parameters.

4. Assemble containers for temporary storage of water produced during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field. The use of truck-mounted or roll-off tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e., activated carbon) may be used to decontaminate the purge water.

7.2 Operation

Development should be performed as soon as it is practical after the well is installed, but no sooner than 48 hours after well completion.

1. Assemble necessary equipment on a plastic sheet surrounding the well.

2. Record pertinent information in the site or personal logbook (personnel, time, location ID, etc.).

3. Open monitor well, take air monitor reading at the top of casing and in the breathing zone as appropriate.

4. Measure depth to water and the total depth of the monitor well. Calculate the water column volume of the well (Equation 1, Section 8.0).

5. Begin development and measure the initial pH, temperature, turbidity, and specific conductivity of the water and record in the site logbook. Note the initial color, clarity, and odor of the water.

6. Continue to develop the well and periodically measure the water quality parameters indicated in step 5 (above). Depending on project objectives and available time, development should proceed until these water quality parameters stabilize, or until the water has a turbidity of less than 50 nephelometric turbidity units (NTUs).

7. All water produced by development of contaminated or suspected contaminated wells must be containerized or treated. Each container must be clearly labeled with the location ID, date collected, and sampling contractor. Determination of the appropriate disposal method will be based on the analytical results from each well.

8. No water shall be added to the well to assist development without prior approval by the appropriate U.S. EPA ERT Work Assignment Manager (WAM) and/or appropriate state personnel. In some cases , small amounts of potable water may be added to help develop a poor yielding well. It is essential that at least five times the amount of water injected must be recovered from the well in order to assure that all injected water is removed from the formation.

9. Note the final water quality parameters in the site or personal logbook along with the following data:

   - Well designation (location ID)
   - Date(s) of well installation
   - Date(s) and time of well development

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- Static water level before and after development
- Quantity of water removed, and initial and completion time
- Type and capacity of pump or bailer used
- Description of well development techniques

7.3 Post-Operation

1. Decontaminate all equipment;

2. Secure holding tanks or containers of development water;

3. Review analytical results and determine the appropriate water disposal method. Actual disposal of the purge water is generally carried out by the On-Scene Coordinator (OSC).

8.0 CALCULATIONS

To calculate the volume of water in the well, the following equation is used:

Well Volume (V) = Br^2 h (cf) [Equation 1]

where:

B	=	pi (3.14)
r	=	radius of monitoring well in feet (ft)
h	=	height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf	=	conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3. [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2-, 3-, 4-, or 6-inches. A number of standard conversion factors can be used to simplify the above equation using the diameter of the monitor well. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:
where:

V (gal/ft) = Br^2 (cf) [Equation 2]

B	=	pi
r	=	radius of monitoring well (feet)
cf	=	conversion factor (7.48 gal/ft^3)

For example, a two inch diameter well, the volume per linear foot can be calculated as follows:

$$V\ (gal/ft) = Br^2\ (cf) \quad \text{[Equation 2]}$$
$$= 3.14\ (1/12\ ft)^2\ 7.48\ gal/ft^3$$
$$= 0.1631\ gal/ft$$

NOTE: The diameter must be converted to the radius in feet as follows:

$$\frac{\text{Well Diameter (inches)}}{12} \times 0.5 = \text{Well Radius (feet)} \quad \text{[Equation 3]}$$

The volume in gallons/feet for the common size monitor wells are as follows:

Well diameter (inches)	2	3	4	6
Volume (gal/ft)	0.1631	0.3670	0.6524	1.4680

If you utilize the volumes for the common size wells above, Equation 1 is modified as follows: where:

$$\text{Well volume} = (h)(f) \quad \text{[Equation 4]}$$

h = height of water column (feet)
f = the volume in gal/ft calculated from Equation 2

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance activities, which apply to the implementation of these procedures. However, the following general quality assurance/quality control (QA/QC) procedures apply:

1. All data must be documented in site and/or personal logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

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When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health (OSHA), and corporate health and safety practices.

12.0 REFERENCES

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Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 1: Conceptualizations".*Groundwater*, 25(3):300-313.

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13.0 APPENDICES

This section is not applicable to this SOP.

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Photographic Documentation of Field Activities

Prepared: David O. Johnson
Technical Review: Jo Nell Mullins
QA Review: Laura Splichal
Approved: _____ Signature/Date
Issued: _____ Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include still and digital photography and videotape recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This document shall provide guidelines designed for use by a professional or amateur photographer. This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

2.0 Background

2.1 Definitions

Photographer – A photographer is the camera operator (professional or amateur) of still photography, including digital photography, or videotape recording whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Identifier Component – Identifier components are visual components used within a photograph such as visual slates, reference markers, and pointers.

Standard Reference Marker – A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Slates – Slates are blank white index cards or paper used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black, indelible marking pens.

Arrows and Pointers – Arrows and pointers are markers/pointers used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds – Contrasting backgrounds are backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Data Recording Camera Back – A data recording camera back is a camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film.

2.2 Discussion

Photographs and videotape recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible

lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the "visual media" that, for the purpose of this document, shall encompass still photographs, digital photographs, and videotape recordings (or video footage). The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

2.3 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

3.0 Responsibilities

Field Team Leader (FTL) – The FTL is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer – The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP.

4.0 Required Equipment

The following is a general list of equipment that may be used:

- 35mm camera or disposable single use camera (35mm or panoramic use)
- Digital camera
- Extra batteries for 35mm camera
- Video camera
- Logbook
- Indelible black or blue ink pen
- Standard reference markers
- Slates
- Arrows or pointers
- Contrasting backgrounds
- Medium speed, or multi purpose fine-grain, color, 35 mm negative film or slide film (project dependent)
- Data recording camera back (if available)
- Storage medium for digital camera

5.0 Procedures

5.1 Documentation

A commercially available, bound logbook will be used to log and document photographic activities. Review the CDM Federal SOP 4-1, Field Logbook Content and Control and prepare all supplies needed for logbook entries.

Note: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log and documentation section.

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5.1.1 Field - Health and Safety Considerations

There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Federal Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation prior to commencing field activities. The site health and safety plan must be read prior to entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., traffic, low overhead hazard, edge of excavation).

5.2 Operation

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from close-up to wide-angle. Many shots will be repetitive in nature or format especially close-up site feature photographs. Consideration should therefore be given to designing a system or technique that will provide a reliable repetition of performance.
- All still film photographs should be made using a medium speed, or multi purpose fine-grain, color negative film in the 35 mm format unless otherwise directed by the FTL.
- It is suggested that Kodak brand "Ektapress Gold Deluxe" film or equivalent be used as the standard film for the still photography requirements of the field activities. This film is stable at room temperature after exposure and will better survive the time lag between exposure and processing. It is suggested that film speed ASA 100 should be used for outdoor photographs in bright sunlight, ASA 200 film should be used in cloudy conditions, and ASA 400 film should be used indoors or for very low-light outdoor photographs.
- No preference of videotape brand or digital storage medium is specified and is left to the discretion of the photographer.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. If the ambient lighting conditions are inadequate, the photographer should be prepared to augment the light (perhaps with reflectors or electronic flash) to maintain the desired visual effect.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

5.2.2 General Guidelines for Still Photography

Slate Information

When directed by the FTL, each new roll of film or digital storage medium shall contain on the first usable frame (for film) a slate with consecutively assigned control numbers (a consecutive, unique number that is assigned by the photographer as in sample numbers).

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Caption Information
All still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. The caption should contain the following information (digital photographs should have a caption added after the photographs are downloaded):

- Film roll control number (if required) and photograph sequence number
- Date and time
- Description of activity/item shown (e.g., name of facility/site, specific project name, project no.)
- Direction (if applicable)
- Photographer

When directed by the FTL, a standard reference marker should be used in all documentary visual media. While the standard reference marker will be predominantly used in close-up feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day.

Close-Up and Feature Photography
When directed by the FTL, close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size and contain a slate marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. When directed by the FTL, include a standard reference color strip (color chart such as Munsell Soil Color Chart or that available from Eastman Kodak Co.) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aid to the viewer for formal lithologic observations and interpretations.

Site Photography
Site photography, in general, will consist predominantly of medium and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the film/tape control number shall be entered in the photographic logbook along with the frame number and all other information pertinent to the scene.

Panoramic
In situations where a wide-angle lens does not provide sufficient subject detail, a single-use disposable panoramic camera is recommended. If this type of camera is not available, a panoramic series of two or three photos would be appropriate. Panoramas can provide greater detail while covering a wide subject, such as an overall shot of a site.

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To shoot a panoramic series using a standard 35 mm or digital camera, the following procedure is recommended.

- Use a stable surface or tripod to support the camera
- Allow a 20 to 30 percent overlap while maintaining a uniform horizon
- Complete two to three photos per series

5.2.3 General Photographic Documentation Using Video Cameras

As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or "show" videotape recording. The following guidelines are set for documentary videotape recordings only and should be implemented at the discretion of the FTL.

Documentary videotape recordings of field activities may include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

It is recommended that a standard reference marker and caption/slate be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original videotape recordings will not be edited. This will maintain the integrity of the information contained on the videotape. If editing is desired, a working copy of the original videotape recording can be made.

A label should be placed on the videotape with the appropriate identifying information (i.e., project name, project number, date, location, etc.).

5.2.4 Photographic Documentation

Photographic activities must be documented in a photographic logbook or in a section of the field logbook. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in CDM Federal SOP 4-1, the following information should be maintained in the appropriate logbook:

- Photographer name.
- If required, an entry shall be made for each new roll/tape control number assigned.
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used).
- Date and time (military time).
- Location.
- A description of the activity/item photographed.

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- If needed, a description of the general setup, including approximate distance between the camera and the subject, may be recorded in the logbook.
- Record as much other information as possible to assist in the identification of the photographic document.

5.3 Post Operation

All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer shall also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape to the project management representative.

5.3.1 Documentation

At the end of each day's photographic session, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in CDM Federal SOP 4-1.

5.3.2 Archive Procedures

1. Photographs and the associated set of uncut negatives, digital media, and original unedited documentary videotape recordings will be submitted to the project files and handled according to contract records requirements. The FTL will ensure their proper distribution.

2. Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines for the field amateur or professional photographer to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The FTL is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the FTL.

Note: Some sites do not permit photographic documentation. Check with the site contact for any restrictions.

7.0 References

U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3*, February 2001, Appendix F.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Athens, Georgia, November 2001.

U.S. Environmental Protection Agency, National Enforcement Investigations Center, *Multi-Media Investigation Manual*, EPA-330/9-89-003-R, Revised March 1992, p. 85.

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U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

SAMPLING EQUIPMENT DECONTAMINATION

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SUPERCEDES: SOP #2006; Revision 3.0; 1/23/92; U.S. EPA Contract 68-03-3482.

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1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse

5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. For the soil and water matrices, these are discussed in ERT/REAC SOP #2003, Sample Storage, Preservation and Handling. For air and waste samples, sample preservation, containers, handling, and storage are discussed in the specific SOPs for the technique selected.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).
- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.
- If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.
- Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and

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supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

Non-phosphate detergent
Selected solvents (acetone, hexane, nitric acid, etc.)
Tap water
Distilled or deionized water

5.2 Decontamination Tools/Supplies

Long and short handled brushes
Bottle brushes
Drop cloth/plastic sheeting
Paper towels
Plastic or galvanized tubs or buckets
Pressurized sprayers (H_2O)
Solvent sprayers
Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

Trash bags
Trash containers
55-gallon drums
Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes:

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- 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- Acetone (pesticide grade)(1)
- Hexane (pesticide grade)(1)
- Methanol(1)

(1) - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations.
- Decontamination equipment needed.
- Appropriate decontamination methods.
- Methods for disposal of contaminated clothing, equipment, and solutions.
- Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

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Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

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Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor

depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1 Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2 Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3 Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.

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Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station . Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4 Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5 Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6 Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7 Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8 Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

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Station 9 Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10 Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1 Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2 Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3 Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4 Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5 Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

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Station 6 Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7 Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8 Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9 Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field. Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives. For further information, refer to ERT/REAC SOP #2005, Quality Control Samples.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

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Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

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APPENDIX A
Table
SOP #2006
August, 1994

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TABLE 1
Soluble Contaminants and Recommended Solvent Rinse

SOLVENT[1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent[2]	Hexane	PCBs

[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

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APPENDIX B
Figures
SOP #2006
August, 1994

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FIGURE 1. Contamination Reduction Zone Layout

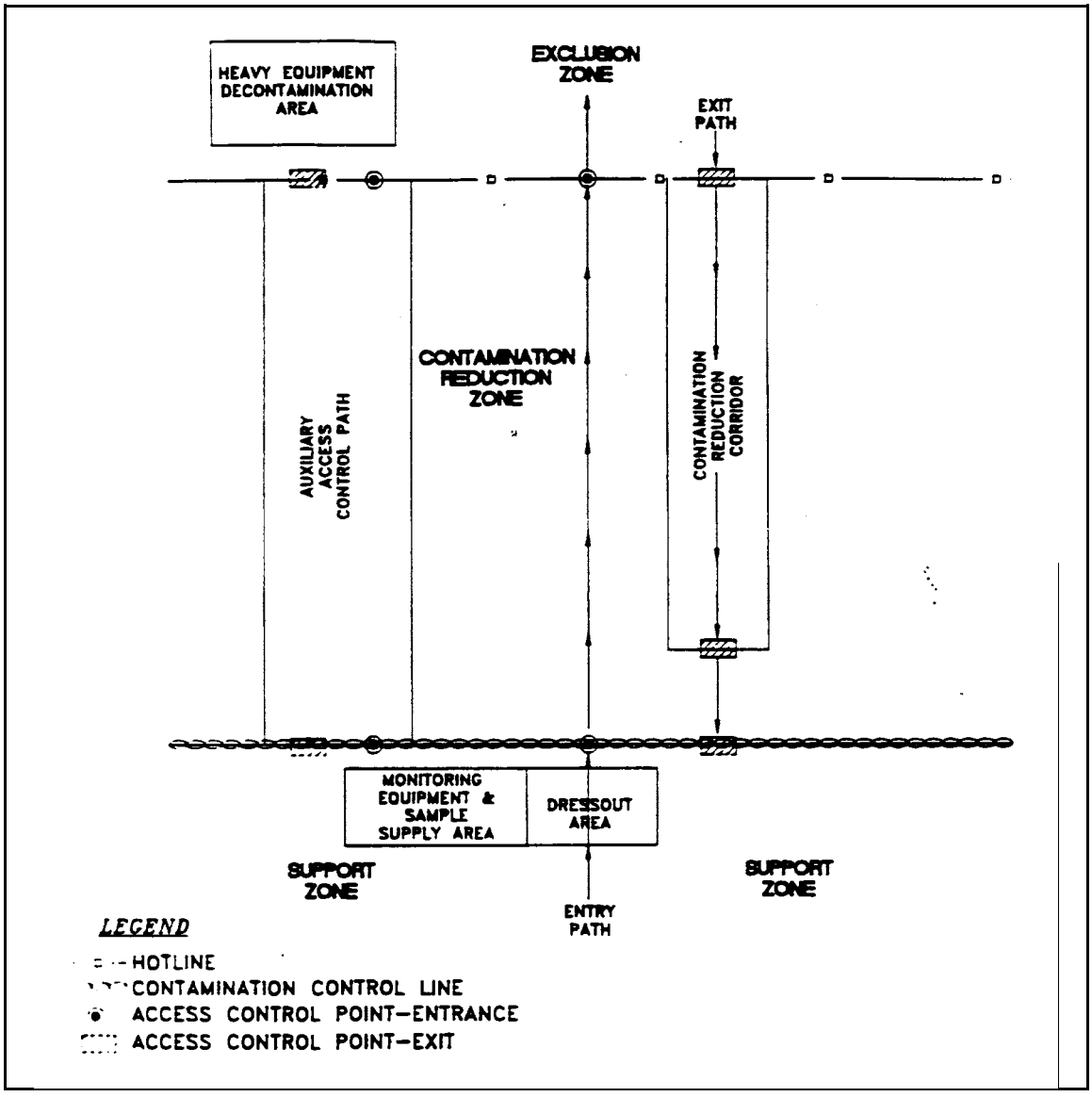

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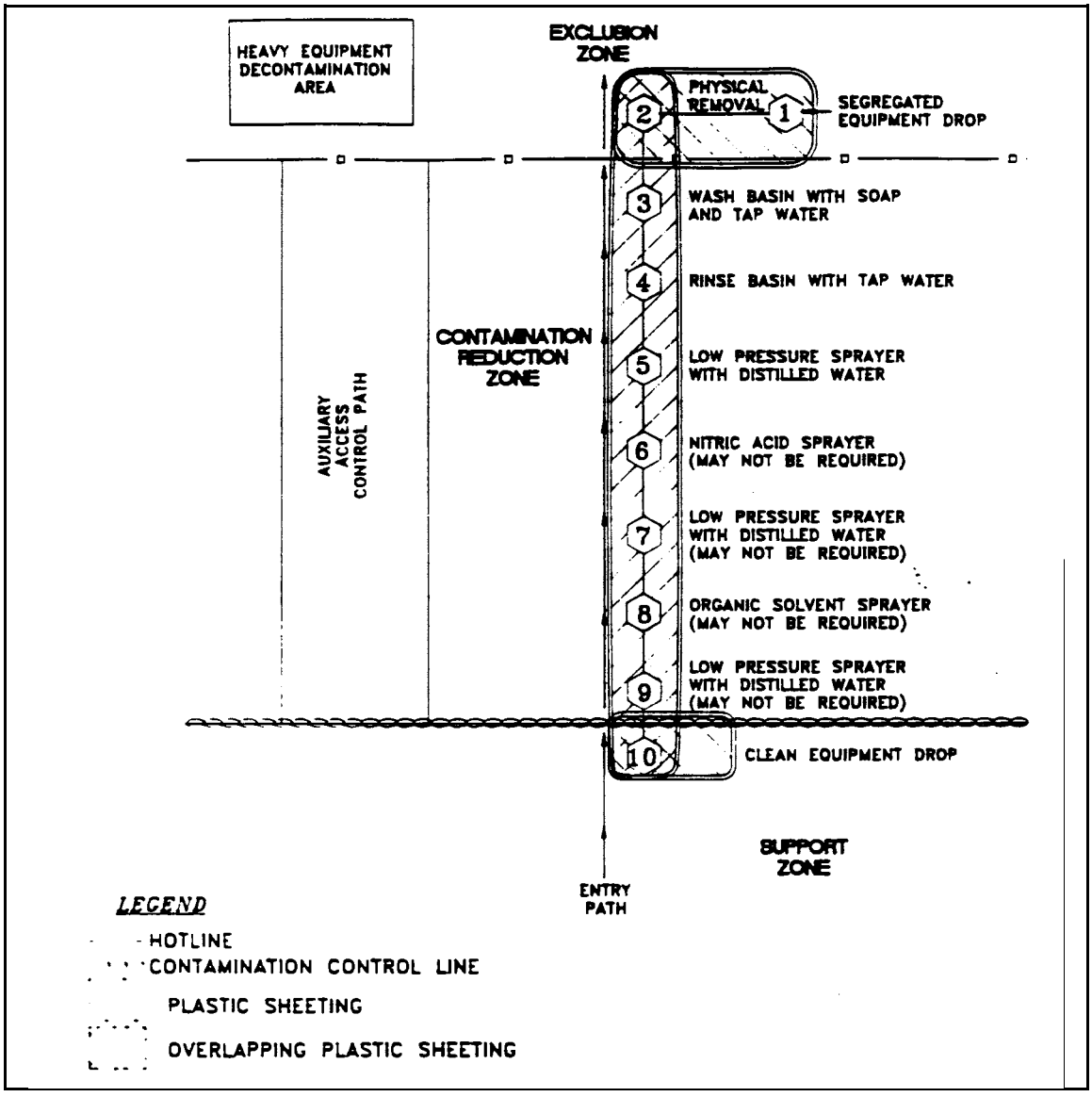
FIGURE 2. Decontamination Layout



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STANDARD OPERATING PROCEDURE

No. 2420.5E

IDENTIFICATION, DOCUMENTATION, AND TRACKING OF SAMPLES

August 28, 2007

by

Harry Kimball
ENSV/RLAB/ANOP

APPROVED:

Nicole Robles — Peer Reviewer — 9/7/07 — Date

J. Brus — Laboratory Manager — 9/10/07 — Date

Diane Harris — Independent QA Reviewer — 09/12/2007 — Date

dw 9/11

Recertified:

Reviewer	jnf				
Date	9/24/2008				

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A. PURPOSE AND APPLICABILITY

The purpose of this standard operating procedure (SOP) is to establish uniform procedures for assigning sample numbers, labeling sample containers, documenting the sample collection process, and for tracking samples.

The collection of samples is an essential step in the process for obtaining information on a variety of environmentally-related conditions and situations. Because the analytical results of samples are used extensively to support regulatory decisions, statutory actions, environmental and health assessments, and litigation proceedings, a critical component of the sample collection process is the proper identification, documentation, and tracking of each sample collected.

The procedures outlined herein are applicable to all samples received by the Region 7 Laboratory (RLAB) for analysis (either in-house analysis or out-source contract lab analysis) and to laboratory-generated quality control (QC) samples. The Regional Sample Control Coordinator (RSCC), or their designated backup, shall ensure, at the time of sample receipt, that samples received by RLAB conform to the identification and documentation requirements of this SOP. This SOP should be provided to all individuals (EPA, state, and tribal staff, plus their contractors) collecting samples for delivery to RLAB to facilitate compliance with these procedures.

B. SUMMARY OF PROCEDURE

1. Sample tracking is accomplished by using the Region 7 Laboratory Information Management System (LIMS). The LIMS is used to identify and track the status of all samples analyzed by the EPA Region 7 Laboratory and its contractors. The current LIMS is a product called R7LIMS. R7LIMS and any future LIMS products will follow the sample identification scheme defined in this SOP. Additionally, the LIMS can generate field sheets and tags (sample labels) to facilitate identification and documentation of field collected samples (see SOP 2420.13, "RLAB Procedures for Preparation of Field Sheets and Tags"). The physical location of samples is tracked by chain-of-custody procedures.

2. The identification and documentation of each sample is required in order to provide tangible evidence that shows the data resulting from sample analysis is linked directly to the sample collected. The basic mechanism used to establish this critical link between samples collected and analytical data is the assignment of a unique sample identifier to each sample collected, with supporting written information to document the sampling process. In addition to providing the means for establishing the relationship between samples and analytical results, the assignment of unique sample identifiers provides a means for tracking samples

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through the analytical data generation process.

3. Sample identification is achieved by labeling each field collected sample with a unique sample identifier. Samples contained in multiple sample containers will bear the same unique sample identifier on each container, plus, each container will be uniquely identified (usually by analysis). Quality control is an integral part of the process of obtaining reliable information about environmental samples; therefore, field and laboratory quality control samples will be uniquely identified in an appropriate and consistent manner.

4. Sample documentation is accomplished by recording the appropriate information about the sample on a field sheet which bears the sample's unique sample identifier. If samples are delivered to RLAB with sample identifiers that are not consistent with the unique sample identifiers described in this SOP, the RSCC (or designated backup) will assign the requisite unique sample identifiers and record the original sample identifier, if any, in the LIMS "External Sample Number" field. Laboratory QC samples are documented on the sample prep and/or analysis log.

5. Because the identification and documentation of samples establishes the foundation for substantiating reported analytical data, it is important that the individuals who collect and/or generate samples follow the procedures contained in this SOP. The procedures contained in SOP No. 2420.4, "Field Chain-of-Custody for Environmental Samples," should be used in conjunction with this SOP to provide complete field sample documentation.

C. DEFINITIONS

The following definitions of commonly-used terms relating to types of samples and sampled matrices are provided for clarification in the sample identification process:

1. Sample. The word 'sample' is an often overworked term. It can refer to a sample collected in the field, a portion of a field sample that has been spiked with additional analytes (matrix spike sample), or a sample generated entirely within the laboratory, such as a method blank. The term 'sample' most often refers to a Field Sample that is of one matrix collected from a specific point (or area if spatially composited) at a specific time (or period of time if temporally composited). A sample may be divided into several different containers, each for a different type of analysis and possibly requiring different methods of preservation (see SOP 2420.6, "Sample Container Selection, Preservation and Holding Times"). It is common for all of these containers to be collectively referred to as being a (one) sample and for all of them to bear the same unique

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sample identifier.

2. Field Sample. A representative portion of an environmental matrix (e.g. air, soil, water, etc.) collected from a specific location at a specific time to obtain information regarding environmental conditions and/or effects, process operations and material contents. Field Samples are actual portions of a matrix collected to determine its physical, chemical, or biological constituents and are distinguished from samples used for quality control (QC) purposes. Although QC samples collected in the field are in a sense field samples, the term Field Sample is used to denote a non-QC sample and is sometimes referred to as a "real" or "regular" Field Sample. Field Samples include those collected to evaluate background conditions and are categorized as grab, composite or continuous samples.

   a. Grab Sample. A discrete portion of a matrix collected at a specific location at one instance in time (this period of time is typically defined as not exceeding 15 minutes to allow adequate time for sample collection under most field situations). This type of sample is representative of the environmental condition at the time of collection. This type of sample is commonly used for in-situ determinations and for obtaining information on constituents that require special handling or may be lost if sampled in another manner.

   b. Composite Sample. A portion of a matrix consisting of a mixture of two or more discrete portions (grab samples) collected from a specific location over a period of time or from a specific area (multiple locations) at one time or over a period of time. This type of sample is a representative average of the environmental condition for a definable area and/or period of time. This type of sample is commonly used for assessing environmental conditions.

   c. Continuous Sample. As the name implies, it is a representative portion of a matrix collected in an uninterrupted manner for a period of time. This type of sample is normally associated with in-situ determinations and is, therefore, not usually collected for submittal to a laboratory for analysis. Continuous samples are most commonly used for collecting data of air and water media; e.g., flow, pH, temperature, etc.

3. Split Sample. As the name implies, it is a sample that is separated or split from the total amount of material sampled and sent to a different laboratory for analysis. Soil matrix samples are homogenized then split to ensure uniformity. The Split samples are used to independently verify laboratory analysis.

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4. Extract. An extract is the result of the extraction process. The sample extract is labeled by extraction personnel.

5. Digestate. A digestate is the result of the digestion process. The sample digestate is labeled by digestion personnel.

6. Quality Control Sample. Prepared in the laboratory, in the field, or combination thereof, a QC sample is incorporated into sample collection and/or analysis activities as a means of evaluating the quality of analytical results obtained from Field Samples. This type of sample may be a field-collected sample (e.g., duplicate sample) or a laboratory-generated sample, depending on its intended purpose, to evaluate and/or substantiate analytical results. Additional information on the use of QC samples for calculating data quality may be found in SOP No. 2410.15, "Estimating and Documenting Data Quality." The following types of QC samples are commonly encountered in sampling events and should be sufficient to categorize most QC samples:

   a. Duplicate Sample. It is recognized that there are several interpretations of this term. For the purpose of calculating data quality, there are essentially two types of duplicate samples: field and laboratory, as described below.

      (1) Field duplicate samples refer to two Field Samples collected simultaneously from the same location(s) under identical conditions. A duplicate grab sample consists of collecting two Field Samples at the same location and time. A duplicate composite sample consists of two Field Samples containing multiple grab samples each collected at the same location and time. If automatic samplers are used to collect composite samples, the collection of duplicate composite samples would require two automatic samplers to be collocated and set to collect the individual portions or aliquots at the same times. The dividing (also referred to as "splitting") of a single sample into two portions will be considered field duplicate samples in those situations where the preferred method of simultaneous collection cannot be met due to field conditions (e.g., the media being sampled is non-homogeneous like some soils, gravel, etc.).

      (2) Laboratory duplicate samples refer to equivalent aliquots taken from a single sample received by a laboratory for analysis as unique samples. The process of obtaining the duplicate aliquots should be preceded by ensuring the sample is well mixed.

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b. Blank Sample. A sample that is presumed to be free of contamination from constituents of concern and is designed to detect contamination due to the sampling and/or analysis process (collection, preservation, handling, sampling environment, extraction, analysis, etc.).

(1) Field Blank. Includes all blank samples which are prepared in or enter the field environment and include trip blanks, equipment blanks, bottle or container blanks, reagent or preservative blanks and tubing blanks. Ideally, a field blank for most analytical parameters should be exposed to the sampling, preservation and handling process used to collect the physical samples, but this may not always be possible (e.g., the field blanks for volatile organics are only transported unopened to and from the sampling environment). The type of field blank should be identified, as well as the group of Field Samples with which it is associated, in the appropriate sample documentation.

(a) Trip Blank. It is a sample that is presumed to be free of contamination from constituents of concern, and is carried into the field and returned while being exposed to the same field conditions which the sample containers experience during the sample shipping process.

(b) Tubing/Equipment Blank. It is a sample free from constituents of concern (normally deionized water that is distilled) and is pumped through or otherwise introduced into the sampling equipment. The process results in exposure of the sample to any constituents of concern which might be contained in or on the surfaces of the sampling equipment.

(c) Preservation Reagent Blank. It is a sample which is originally free from constituents of concern (normally distilled deionized water) and to which the preservative (acid or other chemical) is added in the same concentration and quantity as normally added to a sample. The purpose is to determine if any contaminants of concern exist in the preservative used.

(d) Container Blank. A sample originally free from constituents of concern (normally distilled deionized water) which is introduced into randomly chosen containers at the

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time of sampling. The purpose of this blank is to determine the existence of contaminants of concern in the sampling containers.

(2) Method Blank. A laboratory QC sample used to assess the level of contamination in the analytical system. A method blank is, typically, a portion of a clean matrix that is taken through the entire sample preparation and analysis process.

c. Laboratory QC Sample. A variety of QC samples are used by an analytical laboratory for internal QC purposes. For the purpose of sample identification, all such samples prepared by the laboratory for internal use are classified under this category. Commonly used laboratory QC samples include lab duplicate samples, method blanks, lab control samples, reporting limit check samples, and matrix spikes.

d. Performance Evaluation Sample. A sample that contains a known amount of a chemical constituent or parameter and is introduced for analysis to assess the accuracy of the analytical method. The actual content of the PE sample, either in regard to specific constituents and/or concentrations of constituents, is normally unknown to the receiving analytical laboratory.

e. Proficiency Testing Sample. Similar to a performance evaluation sample except that it is provided by a NELAC (National Environmental Laboratory Accreditation Conference) certified PT sample provider. Results of the analysis of these samples are used for NELAC accreditation purposes.

f. Some additional Field Samples may be thought of as QC samples due to the location or method of sample collection. These are labeled the same as, and analyzed the same as, other Field Samples.

(1) Rinsate Sample. This type of sample is used to evaluate the effectiveness of field decontamination procedures for sampling equipment. The sample is obtained by collecting the rinse water that is poured over the sampling equipment after decontamination has been completed (the water is normally distilled ionized water prepared in the laboratory and carried to the field).

(2) Background Sample. In some investigations, samples are collected to determine what is representative of the environment for constituents of concern. These samples, normally called

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background samples, are Field Samples which are collected off-site or upstream of an area that is affected by a contaminant of concern, but are not expected to contain any or significant amounts of the contaminant of concern.

7. Matrix. The matrix (also known as 'media') refers to the substance from which the sample was obtained and/or of which the sample consists. Since the sampled matrix has a direct bearing on how a sample is preserved and on the selection of the method to analyze the sample, the identification of the matrix is an important aspect of sample documentation.

a. RLAB Matrix. The RLAB matrix is the matrix name used by RLAB to identify the matrix of the sample. It is the matrix used in the LIMS and in the RLAB Methods.

(1) Air. All samples collected to evaluate or analyze the chemical and physical contents of the air, both indoor and outdoor. The resulting sample may be in different forms depending on the method of collection (e.g., Tenex tube, canister, PUF, etc.).

(2) Solid. All samples obtained of soils, sediments, sludge, dust, and any other solid material.

(3) Tissue. All samples obtained of living organisms; e.g., plants or vegetation, fish, animals, etc., either whole or portions thereof.

(4) Waste. All samples obtained of media that do not logically fit under one of the other specifically defined matrices or contain exceedingly high concentrations of analytes. (Previously referred to as "Hazardous/Other.") Examples of these type samples are wipe samples, drum samples, non-aqueous liquid samples, product or formulation samples and mixed media samples.

(5) Water. All samples obtained of aqueous liquid, e.g., wastewater, surface water, drinking water, groundwater, etc.

b. NELAC Matrix. NELAC has its own list of Quality System Matrices. These matrices are referenced in the RLAB Methods, but are not used in the LIMS or for sample definition/identification.

(1) Aqueous. Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes

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surface water, groundwater, effluents, and TCLP or other extracts.

(2) Drinking Water. Any aqueous sample that has been designated a potable or potential potable water source.

(3) Saline/Estuarine. Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

(4) Non-aqueous Liquid. Any organic liquid with <15% settleable solids.

(5) Biological Tissue. Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

(6) Solids. Includes soils, sediments, sludges and other matrices with >15% settleable solids.

(7) Chemical Waste. A product or by-product of an industrial process that results in a matrix not previously defined.

(8) Air and Emissions. Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device.

D. PERSONNEL QUALIFICATIONS

Personnel collecting and/or delivering samples to RLAB should have a basic knowledge and understanding of RLAB sample management procedures including chain-of-custody (SOP 2420.4, "Field Chain-of-Custody for Environmental Samples"). RLAB personnel receiving samples must be knowledgeable of the sample log-in process (SOP 2420.1, "Sample Receipt and Log-in"). Personnel defining samples in the LIMS must be familiar with using the LIMS (SOP 2410.20, "R7LIMS Functions and Security") and have an R7LIMS account.

E. SAMPLE IDENTIFICATION

1. Each sample is identified by a unique sample identifier which is assigned to it.

   a. This identifier is used to distinguish an individual sample from all other

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samples and is used on all documentation relating to collection, handling, analysis and reporting the analytical results of an individual sample.

b. Since a sample is normally analyzed for a number of different chemical constituents or parameters that require different sample containers and preservation techniques, the same unique sample identifier will be assigned to each portion of the original sample split among individual sample containers. For example, if a sample is split among three individual sample containers in order to properly preserve each portion for the specific parameter or group of parameters to be analyzed, each of the individual sample containers would be identified by the same unique sample identifier.

2. The unique sample identifier consists of three parts: the Analytical Services Request Number (ASR Number), Sample Number, and Quality Control Code (QC Code or QCC). These are frequently written together, separated by hyphens. The unique sample identifier is sometimes (confusingly) simply referred to as the sample number.

a. ASR Number - This is the number automatically assigned to an ASR at the time it is defined in the LIMS. Each ASR has its own unique number.

b. Sample Number - This number is assigned by the responsible Project Manager (or their designee) for each field sample collected for an ASR or by the analyst for each QC sample created for an ASR.

c. QC Code - This two or three character alpha code is used to identify the nature of the sample for QC purposes. Field personnel will normally only use the following codes to identify field collected samples:

__ = Field Sample (two underscore characters)
FD = Field Duplicate
FB = Field Blank
FS = Field Spike
FSD = Field Spike Duplicate

Laboratory personnel will use the following codes to identify laboratory QC samples:

MB = Method Blank
LD = Laboratory Duplicate
MS = Matrix Spike

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MSD = Matrix Spike Duplicate
LCS = Laboratory Control Sample
RLC = Reporting Limit Check sample
PE = Performance Evaluation sample
PT = NELAC Proficiency Testing sample

3. The following examples are provided to illustrate some unique sample identifiers:

26-1-__	-	Field Sample number 1 for ASR Number 26
26-1-FD	-	Field Duplicate of Field Sample above
26-2-FB	-	Field Blank submitted for same ASR Number
87-5-__	-	Field Sample number 5 for ASR Number 87
87-5-MS	-	Matrix spike of Field Sample above
87-900-LCS	-	Lab Control Sample number 900 for ASR Number 87

4. Some quality control samples have meaning only when referenced to another sample (i.e., QC Codes of FD, FS, FSD, LD, MS, MSD). To facilitate the identification of the referenced sample, the LIMS has two fields for use with these QC samples: Ref Sample Number and Ref QC Code. Rules for determining the Sample Number, Ref Sample Number, and Ref QC Code for these QC samples are given below.

   a. The QC sample and the referenced sample (the sample that the QC sample is a spike or duplicate of) must have the same ASR Number and Matrix.

   b. Field QC samples (FD, FS, FSD) will be assigned the same Sample Number as the original Field Sample (__) that they are a duplicate or spike of. The Ref Sample Number, and Ref QC Code are automatically assigned by the LIMS and can not be edited by the user.

   c. Lab QC samples (LD, MS, MSD) that are a duplicate or spike of a Field Sample or Proficiency Testing sample (__, PT) will be assigned the same Sample Number as the original Field Sample or Proficiency Testing sample that they are a duplicate or spike of. By default, the Ref Sample Number will be set to the Sample Number and the Ref QC Code will be set to "__" by the LIMS. If the sample being spiked or duplicated is a Proficiency Testing sample, a Ref QC Code of "PT" will need to be manually entered into the LIMS. Note that it is not appropriate for a Field Sample and a Proficiency Testing sample to have the same Sample Number.

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d. Lab QC samples (LD, MS, MSD) that are a duplicate or spike of any other field collected sample (QC Code of FB, FD, FS, FSD) must be assigned a different Sample Number than the original sample that they are a duplicate or spike of. The Ref Sample Number and Ref QC Code will need to be manually entered into the LIMS. Although not a requirement, it is suggested that a Sample Number in the "800" range be used for the lab QC sample.

e. MSD samples must have the same Sample Number, Ref Sample Number, and Ref QC Code as their associated MS sample. The MS sample must be defined in the LIMS before the MSD sample can be defined.

5. The following rules are provided for further clarification of the unique sample identifier assignment process:

a. Each sample collected of a specific media will have a unique sample identifier. For example, if two samples are collected at the same location and time, but are of two different media (e.g., air and solid, or water and tissue), the sample of each specific media will be considered a separate sample. Each sample will be assigned a separate sample number.

b. In-situ samples collected for instantaneous field determinations (e.g., pH, temperature, specific conductance, dissolved oxygen, residual chlorine) in connection with the collection of samples for submission to a laboratory for analysis will be identified by sample identification numbers. Results of field determinations are recorded on field sheets associated with the sample collected for laboratory analysis. The sample identification number of the sample used for the field determination will normally be the same as the sample identification number of the sample submitted for analysis.

c. Continuous samples do not require the assignment of sample identification numbers, but do require specific written documentation to record sampling locations, and times of sampling and readings. Since many continuous monitors provide strip charts and/or printouts of readings, this documentation should be kept to supplement other written documentation.

d. Even though samples for some analyses, such as those for volatile organics, are always collected in two or more containers, they are considered to be a single sample. Additionally, if multiple analyses are to be performed (such as metals, pesticides and VOAs), separate containers will be needed for each analysis. These containers are collectively

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considered to be one sample and will have the same unique sample identifier.

e. Sample extracts are labeled by the person performing the extraction of the sample. The sample extract container is labeled by hand-copying the sample label's information onto a smaller sample extract label. The sample extract label must identify the extraction solvent. Transcription errors are prevented by double checking the sample extract label prior to affixing the sample extract label to the sample extract container. The sample extract label is then affixed to the sample extract container.

f. Digestates are labeled by the person performing the digestion of the sample. The sample digestate container is labeled by hand-copying the sample label's information onto a blank label. The sample digestate label must identify the requested analysis. Transcription errors are prevented by double checking the sample digestate label prior to affixing the sample digestate label to the sample digestate container. The sample digestate label is then affixed to the sample digestate container.

g. As a general rule-of-thumb, Field Blanks that are associated with a group of samples will have their own Sample Number. Field Blanks that are associated with just one Field Sample (e.g., a separate Field Blank for each Field Sample) may have, but are not required to have, the same Sample Number as the Field Sample that it is associated with.

h. It is common practice for some laboratory QC samples (MB, LCS, RLC) to be assigned a Sample Number in the "900" range. This is not a requirement for these samples (any number may be used), however, it is a desirable practice as it helps avoid confusion by keeping these QC samples "numerically segregated" from Field Samples. Additionally, the practice of numbering water QC samples beginning with 900 and soil QC samples beginning with 950 can also help minimize sample number "collisions." For sampling events involving a large number of Field Samples, running into the 900 range, it may be desirable to number these QC samples in the 1500, 2000, or other appropriate range.

6. All samples submitted for analysis will have a sample label affixed to each sample container.

a. Sample labels currently in use are computer generated, therefore, minimal or no entries are required. Any entries made on the sample labels will be

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accomplished using indelible ink.

b. With the exception of volatile samples, samples packed inside a paint can for shipping and samples with extra volume for QC purposes, only one sample label is needed for each sample container. Since volatile, extra volume and over-packed samples consist of more than one container, multiple labels are required so that each container (including the outside container) can be labeled.

Note: Since some of the computer-generated sample labels (e.g. paper labels) are susceptible to deterioration from water, clear plastic tape should be placed over these sample labels if they will come into contact with water (including ice) during storage, transport and/or shipment. Some computer-generated sample labels (vinyl) are water resistant; these labels will not require tape protection.

c. Each sample container must be uniquely identified by the sample label. Where there is only one container for an analysis (such as Metals in Water by ICP), the container is uniquely identified by the unique sample identifier (ASR Number, Sample Number, and QC Code) and the analysis abbreviation (such as "Met W.3B"). Where there is more than one container for an analysis (such as VOCs in Water by GC/MS), the containers are uniquely identified by the unique sample identifier (ASR Number, Sample Number, and QC Code), the analysis abbreviation (such as "VOA W.1E"), and a sequential container number (1, 2, 3, etc.). "Specific" sample container labels generated by the laboratory's LIMS are uniquely identified as described above. When samples are received by the laboratory bearing LIMS "Generic" labels, labels generated by the sampler, or hand-made labels, the necessary additional information should be added to the label or a second label should be placed on the container to uniquely identify it. It is the responsibility of the laboratory person receiving the samples (RSCC or designated backup) to ensure that each container is uniquely identified.

F. SAMPLE DOCUMENTATION

1. A field sheet is used to document the field sample collection process and contains pertinent information relative to the sample collected. (Laboratory QC samples are documented on the sample prep and/or analysis log as described in SOP 2410.10, "Analytical Data Submission Package Contents and Review." This section deals primarily with field collected samples.)

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2. A field sheet will be completed for each sample collected and will be the official document that provides a permanent record of each sample collected. Since this document is the essential written component required to establish the relationship between the sample collected and the analytical results obtained, it will be controlled and will become a part of the official file on a sampling event.

3. Field sheets can be generated by the laboratory's LIMS, or alternate forms may be used. A field sheet should contain, at a minimum, the following information:

   a. Unique Sample Identifier - This may be recorded as three separate pieces of information (ASR Number, Sample Number and QC Code) or written as one entry (separated by hyphens).

   b. Matrix Sampled - The RLAB matrix as defined in section C.7.a.

   c. Project Information - This should include such things as the Project Manager, Project ID and description, city, state and other pertinent information.

   d. Location/Description - This short description should identify, to the satisfaction of the Project Manager, where the sample was collected. This is typically done by describing or naming the sample collection location.

   e. Sample Collection Date/Time - For time-composited samples, the start date and time and end date and time are required. For grab samples only the start date and time are needed. Times should be recorded in the 24-hour format.

   f. Analyses - An unambiguous list of the required laboratory analyses.

   g. Field Measurements - Recorded along with the measurement units.

   h. Comments - As appropriate.

   i. Sampler - The name of the person(s) collecting the sample.

4. The Project Manager is responsible for ensuring that all field sheets are properly and accurately completed, and are safeguarded until they are delivered to RLAB.

5. The original completed field sheets for each sampling activity will be delivered to RLAB along with the samples to be analyzed. They will be maintained in the RLAB analytical data file for the specific ASR.

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6. All entries on the field sheets will be legible and completed in indelible ink. Corrections to entries on field sheets should be accomplished by drawing a single line through the entry to be corrected, entering the correction above or adjacent to the lined-through entry and dating and initialing the correction.

7. In addition to the field sheet, another essential component of sample documentation is chain-of-custody. SOP 2420.4, "Field Chain-of-Custody for Environmental Samples," describes the procedures for chain-of-custody of field collected samples being delivered to RLAB. SOP 2420.2, "Storage and Security of Environmental Samples," describes chain-of-custody procedures for within-lab sample transfers of routine samples. For samples that are connected with a criminal investigation, SOP 2420.10, "RLAB Procedures for Custody and Tracking of Samples and Analytical Data Files to be used as Evidence in Criminal Investigations," describes chain-of-custody documentation procedures for within-lab sample transfers.

G. SAMPLE TRACKING

1. The LIMS database system is used for tracking the status of samples and sample analyses through the analytical process and for tracking and reporting the results of sample analysis. Numerous reports are available from the LIMS and provide a variety of information pertaining to the samples and sample analyses. SOP 2410.20, "R7LIMS Functions and Security" and the LIMS online help provide more information on this.

2. Information relating to the status of samples submitted for analysis and the status of sample analyses may be obtained by the Project Manager from the LIMS or the RLAB Data Coordinator.

3. It is recognized that changes frequently occur in the field which result in changes to planned sampling activities. Since the LIMS system is used for logging in samples upon receipt, tracking, and ultimately reporting the results, it is essential that Project Managers ensure the entries contained in LIMS for specific sampling activities are accurate and complete (especially any field data and measurements). Discrepancies relating to numbers and types of samples and parameters requested for analysis must be corrected at the time of sample receipt by RLAB in accordance with SOP 2420.1, "Sample Receipt and Log-in".

4. SOP 2420.2, "Storage and Security of Environmental Samples" describes, for routine samples, the procedures for tracking the location of samples and sample containers within the laboratory. For samples that are connected with a criminal

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investigation, SOP 2420.10, "RLAB Procedures for Custody and Tracking of Samples and Analytical Data Files to be used as Evidence in Criminal Investigations" describes the procedures used for tracking the location of samples and sample containers within the laboratory.

5. Unless otherwise requested, environmental samples will be properly disposed of in accordance with SOP 2420.9, "Sample Disposal," upon completion of the analysis and finalization of the analytical results.

H. QUALITY ASSURANCE AND QUALITY CONTROL

It is incumbent on all parties involved with sample collection, analysis, and management that these procedures be followed. Conformance with these procedures shall be evaluated during scheduled audits of RLAB operations as described in SOP 2430.5, "Quality Control Spot Checks of Regional Laboratory Data Packages," and SOP 2430.6, "Periodic Internal Program Review of the Region 7 Laboratory."

I. REFERENCES

1. Region 7 SOP 2410.10, Analytical Data Submission Package Contents and Review
2. Region 7 SOP 2410.15, Estimating and Documenting Data Quality
3. Region 7 SOP 2410.20, R7LIMS Functions and Security
4. Region 7 SOP 2420.1, Sample Receipt and Log-in
5. Region 7 SOP 2420.2, Storage and Security of Environmental Samples
6. Region 7 SOP 2420.4, Field Chain-of-Custody for Environmental Samples
7. Region 7 SOP 2420.6, Sample Container Selection, Preservation and Holding Times
8. Region 7 SOP 2420.9, Sample Disposal
9. Region 7 SOP 2420.10, RLAB Procedures for Custody and Tracking of Samples and Analytical Data Files to be used as Evidence in Criminal Investigations

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10. Region 7 SOP 2420.13, RLAB Procedures for Preparation of Field Sheets and Tags

11. Region 7 SOP 2430.5, Quality Control Spot Checks of Regional Laboratory Data Packages

12. Region 7 SOP 2430.6, Periodic Internal Program Review of the Region 7 Laboratory

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STANDARD OPERATING PROCEDURE

No. 2420.4E

FIELD CHAIN OF CUSTODY FOR ENVIRONMENTAL SAMPLES

January 26, 2010

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ENSV/CARB/ASRS

APPROVED:

Barry W. Evans — Peer Reviewer — 2/18/10 — Date

Laboratory Manager — 2/18/10 — Date

Diane Harris — Independent QA Reviewer — 02/18/2010 — Date

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Attachments

1. US EPA Official Sample Seal (EPA Form 7500-2);
Total number of pages: 1.

2. Chain of Custody Record (COC);
Total number of pages: 1.

3. Instructions for Completing a Chain of Custody Record (COC);
Total number of pages: 3.

* See Section G. Procedures for Records Management.

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A. PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish uniform policies and procedures for use by field personnel to maintain an accurate written record of environmental samples from the time of collection through their acceptance by a laboratory for analysis. The custody procedures utilized within the Science and Technology Center (STC) for receiving samples and maintaining custody through the analytical processes are not covered in this SOP. See SOP 2420.2, "Storage, Security, and Sample Sign-Out of Environmental Samples," for custody procedures utilized within the Environmental Services Division (ENSV).

B. APPLICABILITY

The policies and procedures outlined in this SOP are applicable to all US Environmental Protection Agency (EPA), ENSV personnel, state/local agencies, and/or EPA contractors who collect environmental field samples for analyses by the Chemical Analysis and Response Branch (CARB) or EPA contract laboratories.

C. SUMMARY OF PROCEDURES

As a requirement of any activity which may be used to support litigation proceedings, the validity of any data introduced into evidence must be clearly demonstrated. In the case of samples collected in support of an enforcement case, it must be clearly documented that the sample introduced into evidence is, in fact, the same sample collected and/or that the analytical data offered into evidence accurately represent the environmental conditions at the time of sample collection. It is imperative that there is adequate proof to demonstrate that transfer, storage or analysis, and that the analytical results were obtained from the same sample collected. Therefore, an accurate written record must be maintained to track the possession and handling Chain of Custody Record (COC) (see Attachment 2) of each sample from the moment of collection through analysis and its introduction into evidence.

By definition, a sample is in "custody" if:

1. It is in one's actual physical possession; or
2. It is in one's view, after being in one's physical possession; or
3. It is locked up so no one can tamper with it, after being in one's physical possession; or
4. It is placed in a designated secured area

D. DEFINITIONS/ACRONYMS

ANSETS	Analytical Services Tracking System
ASR	Analytical Services Request
CARB	Chemical Analysis and Response Branch
CLP	Contract Laboratory Program
COC	Chain of Custody Record
ENSV	Environmental Services Division
EPA	US Environmental Protection Agency
ESAT	Environmental Services Assistance Team
IOCS	Inorganic Chemistry Section
LIMS	Region 7 Laboratory Information Management System
ORCS	Organic Chemistry Section
PM	Project Manager
PO	Project Officer
QC	Quality Control
RASP	Region 7 Analytical Services Program
RSCC	Regional Sample Control Coordinator
Sample Tags	Sample container labels
SOP	Standard Operating Procedure
SRN	Sample Receipt Notice
STC	Science and Technology Center (also formerly known as RLAB)
UPS	United Parcel Service
VOA	Volatile Analysis

E. PERSONNEL QUALIFICATIONS

Personnel performing this task should have a basic knowledge of CARB sample and records management procedures.

F. RESPONSIBILTIES

1. Project Manager (PM)

   a. The PM or designee (i.e., field contractor) submits a completed Analytical Services Request (ASR) to CARB 30 days before initiation of the sampling activity.

   b. The PM or designee (i.e., field contractor) ships and/or delivers properly collected, preserved, labeled, and packaged samples to CARB.

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c. The PM or designee (i.e., field contractor) is responsible for the accuracy and completeness of all accompanying paperwork. If any changes are required as a result of the sampling (e.g., sample number changes, additional analyses, samples not collected, quality control (QC) code additions), the PM or designee (i.e., field contractor) must see that these corrections are made on all paperwork.

All changes made to the paperwork (COC, sample tags (sample container label), or field sheets) must also be made to the information contained in the Region 7 Laboratory Information Management System (LIMS) (a.k.a. R7LIMS). It is the responsibility of the PM or designee (i.e., field contractor) to supply correct information so that the Regional Sample Control Coordinator (RSCC) (or designated backup) can properly process the samples into the LIMS. Whenever possible, any changes are made prior to the delivery of the samples. If necessary, the RSCC (or designated backup) will assist the PM or designee (i.e., field contractor) when changes are noted prior to sample collection/delivery, concurrent with sample delivery or after.

d. The PM must be available to help resolve any problems with the samples or must designate someone to do this for them in their absence. This requires that when delivering samples, the PM or designee (i.e., field contractor) stays with the RSCC (or designated backup) to answer any questions. Samples must not be just dropped off (unless after normal business hours).

The PM or designee (i.e., field contractor) calls the RSCC (or designated backup) close to the anticipated delivery date and/or time that samples are sent by courier (i.e., Federal Express) to confirm that samples have arrived and to answer any questions the RSCC (or designated backup) may have.

2. RSCC

a. The RSCC (or designated backup) opens the ice chest (cooler) and utilizing the Infrared Digital Thermometer, checks the cooler temperature in three (3) different locations of the cooler (i.e., top, middle, and bottom of the cooler), records the temperature range (in degrees Celsius), and dates with initials in the last row of the “Receiving Laboratory Remarks/Other Information” column on the COC (see Attachment 2) (i.e., cooler temperature received between 2-4 degrees Celsius, NR 1/25/2010).

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b. The RSCC (or designated backup) verifies the presence of all samples, checks all documentation and signs the COC after all paperwork is complete and accurate.

c. The RSCC (or designated backup) works with the PM or designee (i.e., field contractor) to obtain correct information and puts the amended information into the LIMS.

d. The RSCC (or designated backup) notifies the PM or designee (i.e., field contractor) of problems which prevent acceptance of the samples by CARB. CARB maintains all samples received in a secure location including those pending reconciliation of problems.

e. The RSCC (or designated backup) logs samples into the LIMS, see SOP 2410.1, "STC Procedures for Sample Receipt and Log-In," and is responsible for the proper storage, tracking and/or distribution of the samples to the appropriate contract laboratories (this includes while the sample is in transit to the contract laboratory facility). The RSCC (or designated backup) prepares an electronic Sample Receipt Notice (SRN) message for each activity received by CARB and routes it to the Inorganic Chemistry Section (IOCS) and/or Organic Chemistry Section (ORCS) Managers (or designated backups), LIMS Administrator, RSCC (or designated backup), and to the Environmental Services Assistance Team (ESAT) personnel for Analytical Services Tracking System (ANSETS) tracking.

f. The RSCC (or designated backup) also electronically routes a SRN message to the appropriate CARB staff as appropriately designated on the SRN, such as, ESAT, the Contract Laboratory Program (CLP) Project Officer (PO), or the Region 7 Analytical Services Program (RASP) PO, and/or appropriate back-up personnel and specific EPA analysts.

G. **PROCEDURES**

1. In order to ensure adequate control and documentation of collected samples, the number of personnel handling the samples from the time of collection through delivery to CARB should be limited.

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2. The following actions must be accomplished in order to ensure that the relationship between the physical sample and the description of the sample is clearly, completely and accurately established, and that the custody of the sample is initiated from the time of actual sample collection.

   a. A unique number is assigned to each sample, see SOP 2420.5, "Identification, Documentation, and Tracking of Samples," in order to relate the descriptive information to a physical sample. If a sample consists of several containers for analysis of different parameters from the same physical sample, the same number is used for each portion of the original sample.

   b. A sample tag is securely attached to each container at the time of collection, for specific instructions for filling out the sample tag, see SOP 2420.5, "Identification, Documentation and Tracking of Samples."

   c. Custody of the sample is initiated at the time of collection by ensuring that the sample is in the sample collector's physical possession or view at all times, or is stored in a locked place where no one can tamper with it.

   The sample collector (or designated personnel) is responsible for the collected samples until they are delivered to the STC, properly transferred to the RSCC (or designated backup) or if after hours, are placed in the designated back dock refrigerator located in the northeast area of the STC.

3. Samples may be delivered to the STC by the sampler or EPA contractor via courier or commercial carrier.

   a. Sampler or EPA contractor-conveyed samples are those transported and delivered to the STC. The coolers may be sealed or unsealed, but the sampler or EPA contractor must ensure that they are secured in the transport vehicle when he/she is not physically with the vehicle.

   b. Samples may be delivered via courier (e.g., Greyhound). The cooler and sample containers must be transported with the lids secured. The transfer of possession of the samples must be recorded from the sampler or EPA contractor to the STC.

   c. Samples may be shipped via commercial carrier (e.g., Federal Express, Airborne, United Parcel Service (UPS)) from the field to the STC. The cooler and sample containers must be sealed at the time of shipment.

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4. Samples are considered to be sealed when they are packaged in such a manner that would prohibit tampering or readily reveal any tampering, if it occurred.

   a. A properly completed US EPA Official Sample Seal (custody seal) (EPA Form 7500-2) (see Attachment 1) may be used to secure the individual sample container, as appropriate to meet specific regulatory program requirements. These custody seals must be signed and dated by the sampler or EPA contractor when used to seal individual sample containers.

   b. The use of a custody seal must be used to secure the openings of boxes, plastic bags, ice chests or coolers containing samples. These custody seals must be signed and dated by the sampler or EPA contractor when used to seal the shipping containers.

5. The COC (see Attachment 2) is initiated at the time of sample collection and must accompany all samples. The COC is utilized to document the transfer of a sample from the sampler or EPA contractor through receipt by the RSCC (or designated backup).

   CARB instructions for the completion of the COC are outlined in Attachment 3.

   a. The transfer of possession of the samples would occur when the sampler or EPA contractor delivers the samples to the STC, gives them to the courier who will deliver the samples to the STC, or packs the samples in a sealed shipping container for shipment to the STC via commercial carrier.

   b. The original and yellow copy of the COC will accompany the samples to the STC. When the samples are conveyed by the sampler or EPA contractor, the COC may be hand carried. When the samples are delivered via courier or commercial carrier, the COC must be placed in a plastic document enclosure which is enclosed in the shipping container.

6. When samples are delivered the STC after duty hours, the samples and the COC will be placed in the refrigerator located on the back dock until acceptance by the RSCC (or designated backup) in accordance with the procedures outlined in SOP 2420.2, “Storage, Security and Sample Sign-Out of Environmental Samples.”

7. Once CARB has accepted the samples at the STC, the responsibility for custody of the samples transfers to the CARB personnel. Custody of the samples is maintained through analysis in accordance with the laboratory’s internal control procedures.

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8. The original of the completed COC is obtained by CARB at the STC for inclusion with the permanent site activity data files, and is included with the final data transmittal sent to the PM.

9. The yellow copy of the completed COC is returned to the PM for inclusion in their appropriate activity files after all samples, for a given activity, have been accepted.

10. The yellow copy of the completed COC can be given to the person relinquishing the samples.

11. The custody seals (see Attachment 1) associated with the specific samples or sample shipments are not retained.

H. QUALITY ASSURANCE/QUALITY CONTROL

A written tracking record (COC) is maintained from the time that the sample is collected to its transfer from the collection site to its laboratory destination. This record is used to demonstrate that sample possession has been secured and limited. Signed and dated custody seals (see Attachment 1) placed over the access points of the sample shipment demonstrate that the contents of the samples have not been tampered with or compromised.

I. REFERENCES

1. SOP 2420.1, “STC Procedures for Sample Receipt and Log-In”

2. SOP 2420.2, “Storage, Security and Sign-Out of Environmental Samples”

3. SOP 2420.5, “Identification, Documentation, and Tracking of Samples”

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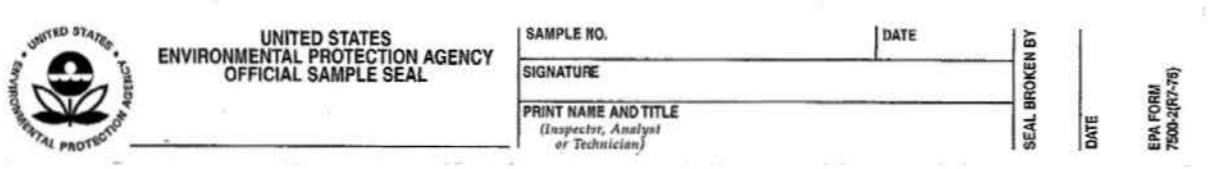
Attachment 1

US EPA Official Sample Seal



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Attachment 2

Chain of Custody Record

CHAIN OF CUSTODY RECORD
ENVIRONMENTAL PROTECTION AGENCY REGION VII

ACTIVITY LEADER(Print)	NAME OF SURVEY OR ACTIVITY	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET # of

CONTENTS OF SHIPMENT

SAMPLE NUMBER	TYPE OF CONTAINERS: CUBITAINER	BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
	NUMBERS OF CONTAINERS PER SAMPLE NUMBER										

DESCRIPTION OF SHIPMENT	MODE OF SHIPMENT
_____ PIECE(S) CONSISTING OF _____ BOX(ES)	_____ COMMERCIAL CARRIER: _____
_____ ICE CHEST(S); OTHER _____	_____ COURIER
	_____ SAMPLER CONVEYED (SHIPPING DOCUMENT NUMBER) _____

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			☐ SEALED ☐ UNSEALED	
RELINQUISHED BY	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			☐ SEALED ☐ UNSEALED	
RELINQUISHED BY	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			☐ SEALED ☐ UNSEALED	

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Instructions for Completing a Chain of Custody Record

(Note: Each numbered item explains what is to be entered into that particular block moving from left to right, top to bottom of the document.)

1. Activity Leader. Enter the first initial and last name of the EPA Project Manager.

2. Name of Survey or Activity. Enter the Project ID and/or Analytical Services Request (ASR) number (e.g., BMWSPS/4730) for which the samples were collected.

3. Date of Collection. Enter the day, month, and year the samples were collected.

4. Sheet. Enter 1 of 1 unless there are more than one total sheets describing the shipment. If multiple sheets, enter the consecutive number of each sheet of the total number of sheets (e.g., 1 of 3, 2 of 3, 3 of 3).

5. Contents of Shipment.

    a. Enter the specific sample numbers to include the ASR number, number of sample type of containers per sample number and sampled media in the appropriate column

        (1) The ASR number and the individual sample numbers composing the shipment are entered in the Sample Number column (e.g., 4730-1). If more than one sheet is required, continue on additional sheets. For shipments of a large group of samples, it would be more appropriate and efficient to complete a separate sheet for each shipping container.

        (2) The types of containers for each sample number are entered in the columns provided. The size should be entered above the container type, as appropriate. For Volatiles, the "VOA Set" refers to two = 40 ml vials contained in the cubitainer which are collected for volatile organics analyses. The container types are modified, as necessary or appropriate, to describe sample containers.

        (3) The sampled media for each sample number will be indicated by placing an "X" in the appropriate column. If the sample media is not listed, the actual media sampled should be entered in the "Other" column (e.g., wipe, sludge, air, biota, fish, etc.).

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b. The "Receiving Laboratory Remarks/Other Information" is to be used by the RSCC (or designated backup) to indicate any problems with the shipment or condition of the samples upon receipt; e.g., custody seal on sample container or shipping container broken, a sample container broken in transit, a sample lost due to leakage during shipment, etc. The temperature of the shipping coolers(s) are to be recorded in the lower area of this column. This column may also be used to record other sample numbers for cross-referencing purposes (e.g., external sample number).

c. After entering all of the above information, the total contents of the shipment should be indicated by marking out any remaining lines in this section. This can be accomplished either by drawing a line across the next line after the last entry and entering "Activity/ASR Not Complete" or "Activity/ASR Complete," or by drawing a line across the next blank line or diagonally across the remaining lines in the section and entering "Activity/ASR Not Complete" or "Activity/ASR Complete."

d. Description of Shipment. Enter the total number of pieces (e.g., samples or sample containers) packed in the total number of shipping containers (e.g., ice chests, boxes or other, which comprise the total shipment) (e.g., 12 pieces in 2 ice chests or 24 pieces in 2 boxes).

e. Mode of Shipment. Indicate the mode by which the samples are shipped to the STC by placing an "X" in the appropriate line preceding the specific mode in this block. If the shipment is via commercial carrier, the name of the carrier and the shipping document number (e.g., airbill) should be entered in the appropriate lines provided. This information may be entered by the sample shipper (sampler or individual to whom the sampler relinquished the samples), or the shipment receiver (lab sample custodian), as appropriate.

f. Personnel Custody Record. This portion of the form provides the record of changes of custody of the shipment (sample or group of samples) from the sample collector to the laboratory. To provide an adequate written record, all of the blocks should be completed as described below.

(1) The sample collector will sign the first "Relinquished By Sampler" block when the samples are presented to another individual or commercial carrier.

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(a) An “X” should be entered in the appropriate block to indicate whether the shipment is sealed or unsealed with a piece of completed custody seal tape, the date and time when the samples are relinquished should be entered in the appropriate blocks, and the reason for change of custody (e.g., transport to STC, receipt by STC, Analysis, etc.) should be entered in the appropriate block.

(b) If the sampler is presenting the samples to a commercial carrier for shipment, the name of the carrier should be entered in the next available “Received By” block. The signature of a representative of the carrier is not required.

(2) Each individual who received the shipment of samples will sign the next available “Received By” block and enter an “X” in the appropriate block to indicate whether the samples were received sealed or unsealed with a piece of completed custody seal tape. If the samples were shipped via commercial carrier, the individual receiving the samples (e.g., RSCC (or designated backup) at the STC) should enter the date and time the samples were received and the reason for change of custody (e.g., receipt by the STC) in the appropriate blocks.

(3) Each successive individual who relinquishes custody of the samples will sign the next available “Relinquished By Sampler” block, enter an “X” in the appropriate block to indicate whether the sample shipment is sealed or unsealed with a piece of completed custody seal tape, enter the date and time when custody is relinquished and enter the reason for change of custody in the appropriate blocks.

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Packaging and Shipping Environmental Samples

SOP 2-1
Revision: 3
Date: March 2007

Prepared: Krista Lippoldt

Technical Review: Chuck Myers

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VERIFY authenticity with ApproveIt

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Approved: *Signature/Date*

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt

Issued: *Signature/Date*

1.0 Objective

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples. Additionally, Sections 2.0 through 7.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and applies only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data loggers and self-contained breathing apparatus [SCBAs] or bulk chemicals that are regulated under the DOT, IATA, and ICAO.

1.1 Packaging and Shipping of All Samples

This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

Section 2.0 - Packaging and Shipping Samples Preserved with Methanol
Section 3.0 - Packaging and Shipping Samples Preserved with Sodium Hydroxide
Section 4.0 - Packaging and Shipping Samples Preserved with Hydrochloric Acid
Section 5.0 - Packaging and Shipping Samples Preserved with Nitric Acid
Section 6.0 - Packaging and Shipping Samples Preserved with Sulfuric Acid
Section 7.0 - Packaging and Shipping Limited-Quantity Radioactive Samples

1.2 Background

1.2.1 Definitions

Environmental Sample - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal - A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

Inside Container - The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

Outside Container - The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

Secondary Containment - The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

Excepted Quantity - Excepted quantities are limits to the mass or volume of a hazardous material in the inside and outside containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Limited Quantity - Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance Testing - Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper - A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*

1.2.3 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples shall be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

1.3 Required Equipment

- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

*Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.

2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. ***Note***: Trip blanks must be included in coolers containing VOA samples.

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5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally.

6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record. The chain-of-custody with the cooler shall reflect only those samples within the cooler.

7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) if the analytical method requires cooling. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.

8. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.

9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals shall be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

10. The shipping container lid must be marked **"THIS END UP"** and arrow labels that indicate the proper upward position of the container shall be affixed to the cooler. A label containing the name and address of the shipper (CDM) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

2.0 Packaging and Shipping Samples Preserved with Methanol

2.1 Containers

- The maximum volume of methanol in a sample container is limited to 30 ml.
- The sample container must not be full of methanol.

2.2 Responsibility

It is the responsibility of the qualified shipper to:

- Ensure that the samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

2.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packing may consist of glass or plastic jars
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

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2.4 Packaging Samples Preserved with Methanol

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Total volume of methanol per shipping container must not exceed 500 ml.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

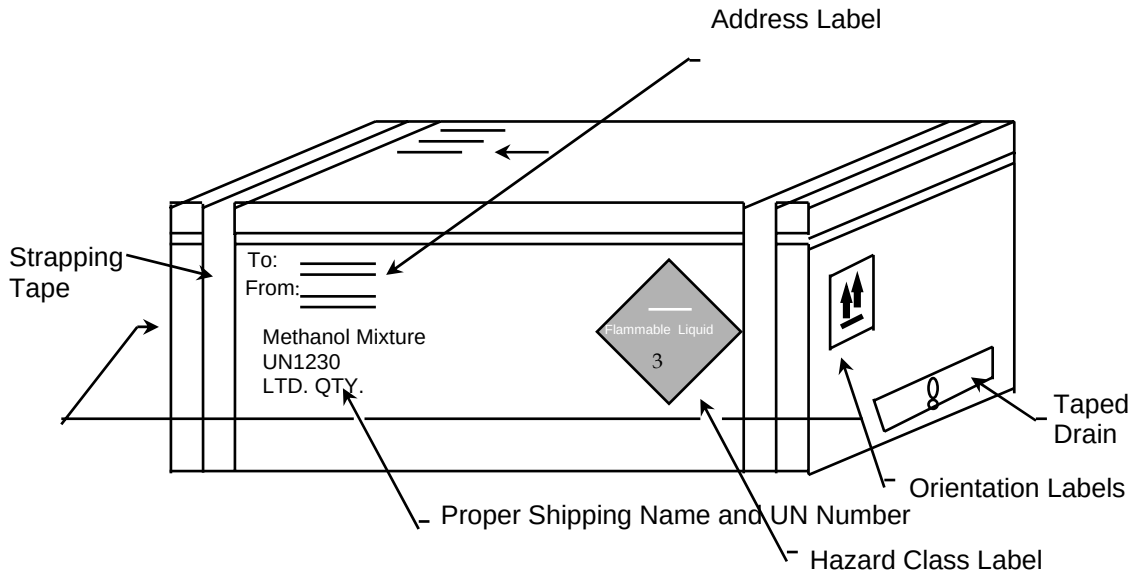
  Methanol Mixture
  UN1230
  LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: No marking or labeling can be obscured by strapping or duct tape.
Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

Figure 1
Example of Cooler Label/Marking Locations



3.0 Packaging and Shipping Samples Preserved with Sodium Hydroxide

3.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sodium Hydroxide Preservatives

Preservative		*Desired in Final Sample*		*Quantity of Preservative (ml) for Specified Container*				
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.2 Responsibility

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

3.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Inner packings may consist of glass or plastic jars no larger than 1 pint
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

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3.4 Packaging Samples Preserved with Sodium Hydroxide

Samples containing NaOH as a preservative that exceed the excepted concentration of 0.08 percent (2 ml of a 30 percent NaOH solution per liter) may be shipped as a limited quantity per packing instruction Y819 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- The total volume of sample in each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

  Sodium Hydroxide Solution
  UN1824
  LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.08 percent NaOH by weight may be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

4.0 Packaging and Shipping Samples Preserved with Hydrochloric Acid

4.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Hydrochloric Acid Preservatives

Preservative		*Desired in Final Sample*		*Quantity of Preservative (ml) for Specified Container*		
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**
HCl	2N	<1.96	0.04%	.2	.5	1

5 drops = 1 ml

4.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packing may consist of glass or plastic jars no larger than 1 pint.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

4.4 Packaging Samples Preserved with Hydrochloric Acid

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (No more than 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)

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- Total volume of sample inside each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

  Hydrochloric Acid Solution
  UN1789
  LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.04 percent HCl by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

5.0 Packaging and Shipping Samples Preserved with Nitric Acid

5.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Nitric Acid Preservatives

Preservative		*Desired in Final Sample*		*Quantity of Preservative (ml) for Specified Container*				
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
HNO_3	6N	<1.62	0.15%		2	4	5	8

5 drops = 1 mg/L

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5.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

5.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

5.4 Packaging Samples Preserved with Nitric Acid

Samples containing HNO_3 as a preservative that exceed the excepted concentration of 0.15 percent HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Nitric Acid Solution (with less than 20 percent)
UN2031
Ltd. Qty.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.15 percent HNO_3 by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

6.0 Packaging and Shipping Samples Preserved with Sulfuric Acid

6.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sulfuric Acid Preservatives

Preservative		*Desired in Final Sample*		*Quantity of Preservative (ml) for Specified Container*				
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
H_2SO_4	37N	<1.15	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

6.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

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- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

6.4 Packaging of Samples Preserved with Sulfuric Acid

Samples containing H_2SO_4 as a preservative that exceed the excepted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

  Sulfuric Acid Solution
  UN2796
  LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

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Note: Samples containing less than the exception concentration of 0.35 percent H_2SO_4 by weight will be shipped as nonregulated or nonhazardous in accordance with the procedure described in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

7.0 Packaging and Shipping Limited-Quantity Radioactive Samples

7.1 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

7.2 Description/Responsibilities

- The qualified shipper will determine that the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, *Limited Quantities of Radioactive Materials*.
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.
- If the shipment is from a DOE facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring before shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM will apply the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma). It shall be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked “Radioactive.”
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, **“This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910.”**

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Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

7.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Excepted quantities label
- Consignor/consignee labels

7.4 Packaging of Limited-Quantity Radioactive Samples

The following steps are to be followed when packaging limited-quantity sample shipments:

- The cooler is to be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- Place a label marked Radioactive on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: ***"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."***
- Note that both DOT and IATA apply different limits to the quantity in the inside packing and in the outside packing.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of the cooler labeling/marking is shown in Figure 2.

Note: No marking or labeling can be obscured by strapping or duct tape.

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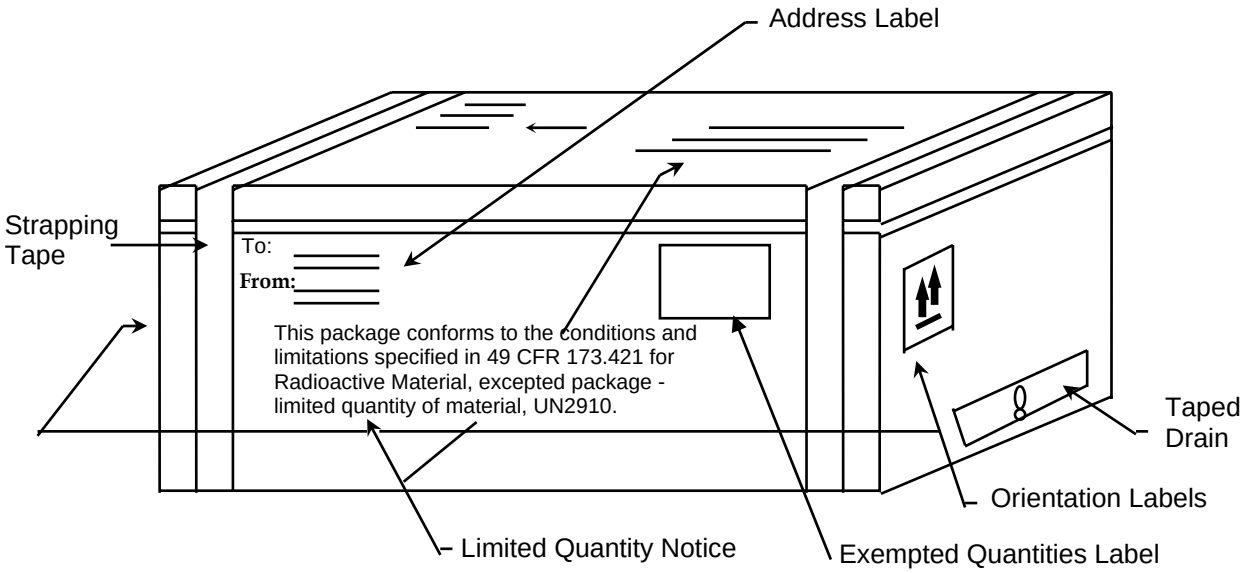
- Complete the Shipment Quality Assurance Checklist (Appendix B).

Note: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U.
Note: A declaration of dangerous goods is not required.

Figure 2
Radioactive Material – Limited-Quantity Cooler Marking Example



8.0 References

U. S. Environmental Protection Agency. Region IV. February 1991 or current. *Standard Operating Procedures and Quality Assurance Manual*.

_____. 1996 or current. *Sampler's Guide to the Contract Laboratory Program*, EPA/540/R-96/032.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous, Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Shippers General Requirements for Shipments and Packagings*, 49 CFR 173.

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Appendix A

Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity

Sample Packaging

Yes	No	N/A	
❑	❑	❑	The VOA vials are wrapped in bubble wrap and placed inside a zip-type bag.
❑	❑	❑	The VOA vials are placed into a polyethylene bottle, filled with vermiculite, and tightly sealed.
❑	❑	❑	The drain plug is taped inside and outside to ensure control of interior contents.
❑	❑	❑	The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C.
❑	❑	❑	The cooler weighs less than the 66-pound limit for limited-quantity shipment.
❑	❑	❑	The garbage bag has been sealed with tape (or tied) to prevent movement during shipment.
❑	❑	❑	The chain-of-custody has been secured to the interior of the cooler lid.
❑	❑	❑	The cooler lid and sides have been taped to ensure a seal.
❑	❑	❑	The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape.

Air Waybill Completion

Yes	No	N/A	
❑	❑	❑	Section 1 has the shipper's name, company, and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached.
❑	❑	❑	Section 2 has the recipient's name and company along with a telephone number where they can be reached.
❑	❑	❑	Section 3 has the **Bill Sender** box checked.
❑	❑	❑	Section 4 has the **Standard Overnight** box checked.
❑	❑	❑	Section 5 has the **Deliver Weekday** box checked.
❑	❑	❑	Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6?
❑	❑	❑	Under the **Transport Details** box, the **Cargo Aircraft Only** box is obliterated, leaving only the **Passenger and Cargo Aircraft** box.
❑	❑	❑	Under the **Shipment Type**, the **Radioactive** box is obliterated, leaving only the **Non-Radioactive** box.
❑	❑	❑	Under the **Nature and Quantity of Dangerous Goods** box, the **Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions, and Authorization** have been filled out for the type of chemical being sent.
❑	❑	❑	The **Name, Place and Date, Signature, and Emergency Telephone Number** appears at the bottom of the FedEx Airbill.
❑	❑	❑	The statement "In accordance with IATA/ICAO" appears in the **Additional Handling Information** box.
❑	❑	❑	The E**mergency Contact Information** at the bottom of the FedEx Airbill is truly someone who can respond any time of the day or night.

Proper Shipping Name	*Class or Division*	*UN or ID No.*	*Packing Group*	*Sub Risk*	*Quantity*	*Packing Instruction*	*Authorization*
Hydrochloric Acid Solution	8	UN1789	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Nitric Acid Solution (with less than 20%)	8	UN2031	II		1 plastic box × 0.5 L	Y807	Ltd. Qty.
Sodium Hydroxide Solution	8	UN1824	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Sulfuric Acid Solution	8	UN2796	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Methanol	3	UN1230	II		1 plastic box × 1 L	Y305	Ltd. Qty.

Sample Cooler Labeling

Yes	No	N/A	
❑	❑	❑	The proper shipping name, UN number, and Ltd. Qty. appears on the shipping container.
❑	❑	❑	The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape.
❑	❑	❑	The name and address of the shipper and receiver appear on the top and side of the shipping container.
❑	❑	❑	The air waybill is attached to the top of the shipping container.
❑	❑	❑	**Up Arrows** have been attached to opposite sides of the shipping container.
❑	❑	❑	Packaging tape does not obscure markings or labeling.

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Appendix B
Shipment Quality Assurance Checklist

Date: _____ Shipper: _____ Destination: _____

Item(s) Description: _____

Radionuclide(s): _____

Radiological Survey Results: surface _____mrem/hr 1 meter _____

Instrument Used: Mfgr: _____ Model: _____

S/N: _____ Cal Date: _____

Limited-Quantity or Instrument and Article

Yes	No		
___	___	1.	Strong tight package (package that will not leak material during conditions normally incidental to transportation).
___	___	2.	Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr.
___	___	3.	Removable surface contamination less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma).
___	___	4.	Outside inner package bears the marking "Radioactive."
___	___	5.	Package contains less than 15 grams of ^{235}U (check yes if ^{235}U not present).
___	___	6.	Notice enclosed in or on the package that includes the consignor or consignee and the statement, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**
___	___	7.	Activity less than that specified in 49 CFR 173.425. Permissible package limit: Package Quantity:
___	___	8.	On all air shipments, the statement **Radioactive Material, excepted package-limited quantity of material** shall be noted on the air waybill.

Qualified Shipper: _____ Signature: _____

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HGL HydroGeoLogic, Inc	**Standard Operating Procedure:** **Field Activity Logbook Entries**	
	Category: QA/QC	**Revised:** March 2006

1.0 INTRODUCTION

The Field Activity Logbook SOP establishes requirements for the entry of information into project logbooks, thereby assuring that HGL field activities are properly documented. This SOP describes logbook entry requirements for all manner of projects, but does not cover health and safety logbook requirements. This SOP specifies the type of information that must be recorded in field logbooks, and provides examples of improper and proper logbook entries. All field personnel are required to read and follow this SOP. It should be noted that some flexibility exists when implementing this SOP, as different types of projects mandate different data collection efforts. It is the responsibility of the HGL project manager and field team leaders to ensure that the proper information is collected in the field to fulfill the obligations of the project and contract. Logbooks are a critical component of the chain of evidence and are considered to be evidentiary documentation that is subject to subpoena.

Examples of logbook entries that are correct are included as Attachment 1.

2.0 PURPOSE

The purpose of this SOP is to establish the minimum content requirements of logbook entries for all field activities conducted by HGL. The SOP is intended to assure that the documentation for any HGL data collection field activity is correct, complete, and adequate for use in any potential legal proceeding. Field activities documentation can become evidence in civil and criminal law enforcement proceedings, in cost-recovery efforts, as well as in administrative hearings. The U.S. Environmental Protection Agency (USEPA) and the National Enforcement Investigation Center (NEIC) branch of the EPA have both prepared guidance documents outlining their documentation needs for legal proceedings. These guidelines stress the importance of thoroughly documenting all information obtained during the inspections, investigations, and evaluations for hazardous waste sites. Therefore, logbook entries must be detailed enough that will allow site work to be reconstructed at a later date. Project personnel must document where, when, how, and from whom any vital project information was obtained. This type of information is critical to establishing a proper basis for admissible evidence, and to maintain an accurate file record of project activities.

3.0 LOGBOOK PROCEDURES

Complete and accurate entries in field activity logbooks are important for two reasons: to maintain quality control and to support any legal proceedings associated with a given project.

Logbook Content

Quality Control for data collection on a project begins at the field level; it is critical that field personnel record all observations, activities, and decisions. It is particularly important to fully document any deviations for the project scope, work plans, sampling plans, site safety plans, and QA procedures, and changes in personnel and responsibilities, as well as the reasons for the deviations/changes. Any modifications requested by the client (or client representative) must be documented as it may affect the project costs. The HGL project manager must indicate to the field team what pertinent information must be collected during any field activity to meet the desired objectives of the data collection effort.

The importance of the field logbook in legal proceedings cannot be over-emphasized. They are links in the evidentiary process, and must be complete and accurate enough to permit the reconstruction of activities that took place during field events, sometimes years after the fact. Logbooks are also a device for identifying, locating, labeling, and tracking samples and their final disposition. Logbook entries also are essential for interpreting data. For example, if there was a heavy rain prior to surface water sample collection, this information would be vital for interpreting data later obtained for the analytical laboratory. Likewise storm events affect groundwater parameters often collected in the field. Data concerning site conditions should be recorded before the passage of time eliminates or alters site conditions. The accuracy, completeness, level of detail, and quality of the logbook is subject to scrutiny by internal HGL QC field audits, the client, the Potentially Responsible Party (PRP), legal counsel, and the courts.

Following is a summary of the types of information that should be included in the field logbook:

- Documentation of any photographs taken during the field event including a detailed description if what is shown in the photos.
- Summaries of any meetings/discussions held with the client, regulators or other oversight personnel on site during the field event.
- Documentation of any work stoppages and the reason work was suspended.
- Description of any other persons on site such as the PRP, media, or others.
- Documentation of all sampling and survey activities.

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General Guidelines for Logbook Entries

- A separate field activity logbook must be maintained for each project. Several logbooks may be created for a single field event, if more that one field team is deployed. If this is the case, the HGL project manager will designate the staff member who will record in the logbook (Section 5.0).

- All logbooks must be bound with stitching and contain consecutively numbered pages with the page numbers printed (not written) on each page.

- All field activities must be recorded in the field logbook, including names of those on site, time in/time, weather conditions, meetings, sampling, surveys, and instrument calibrations.

- All information entered into the field logbook must be **printed legibly** (no cursive writing) in waterproof ink, preferably black. Pencil may be used only if it is too cold or wet to write with ink. It should be specifically noted in the logbook why waterproof ink was not used.

- Do not skip lines when making logbook entries. If a line is skipped, cross thorough the line and initial it.

- Language used in the logbook should be objective, factual, and free of personal feelings or terminology that might later prove to be inappropriate.

- Contemporaneous entries are always best, because recollections fade over time. If the Project manager (or other field staff making logbook entries) is not able to record observations and activities real-time, they should be recorded as soon after as possible. The time that the logbook entry is made (if it differs from the time of the observation/activity itself) should be recorded.

- On the last page of the last logbook entry of the day, a line should be drawn through the remainder of the blank page and the last day's entry page should be initialed and dated at the bottom.

- The first entry of each successive day is made at the top of the next consecutively numbered page.

- Each page should be dated and all pages should have a time notation based on the 24-hour clock.

- At the completion of the field activity, the logbook becomes part of the permanent project file.

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Logbook Format

Each project manager is responsible for determining the information requirements of each field activity logbook. Such information will vary depending on the nature and scope of the project. The following example of a sample logbook format meets the minimum requirements for HGL project logbooks and can be adapted to meet site-specific requirements.

Title Page

- Site Name
- Location
- Job Number
- Start/Finish Date
- Book _____ of _____

First Page - Initial Entries

- Job Number
- Date
- Proposed work summary
- Team members and general duties
- Time on/time off site (24-hour clock)
- Other personnel on site (subcontractors, visitors, regulators, PRPs, media, etc.)
- On-site equipment (drill rigs, DPT rigs, excavation equipment, etc)

Successive Pages – Initial Entries

- Date
- Project Number
- Signature (bottom of page)
- Persons on site that day
- Weather conditions that day
- Planned activities for that day

General Documentation

- Levels of PPE (proposed, changes, reason for change, time of change)
- Specific activities undertaken (sampling, surveying, air monitoring, inventories, soil sampling, etc.)
- Persons contacted/interviewed and summary of discussions (site owners, adjacent property owners, etc.)
- Note changes in instruction or activities that occur on site.
- Note deviations for the Work Plan and why.
- Note start time and end time of any work stoppages and detail the reason (i.e. equipment problems, weather conditions, etc.)
- Note deviations from the Health and Safety Plan and why.
- Record equipment calibration information (model and serial number)

- Record any field measurements taken (pH, water level, specific conductance, etc.)

Sample Documentation

- Sample location
- Station number (well number, etc.)
- Sampler's Name
- Time of collection
- Designation of sample type as grab, composite, etc.
- Media
- Site sketch
- Field observations relative to sample integrity (e.g. heavy rain, odors, discoloration)
- Preliminary sample descriptions (e.g. clayey, very wet)
- Container type and preservative used
- Site monitoring instrument readings (OVA, YSI, PID/FID)
- Shipper and associated airbill number
- Laboratory
- Time coolers were relinquished to shipper

Photographic Documentation

The following information should be recorded in the field logbook to document photographs taken on site.

- Time, date, location, orientation, and weather conditions (if appropriate)
- Detailed description of the subject in the photograph and the reason for taking the photo
- Sequential number of photograph and film roll number.
- If taking photos with a digital camera, record the unique file identifier that appears in the frame.
- Camera type and serial number. Lens size and serial number (if appropriate).
- Name of photographer.

Signatures

Each page of the site logbook entries for a particular field activity must be initialed by the person recording the information. When two people make entries on the same page, they must initial their own entries. The individual making the last entry on the page must sign the bottom of the page. If logbook entries are made by someone other than the field team leader, the field team leader must review the logbook and sign and date the last page of each daily entry in the logbook. **If the last page of the logbook entries for the day is not full, draw a line through the remaining blank space and sign and date the bottom of the page.**

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4.0 DATA COLLECTION FORMS

If data collection forms are used to record specific information obtained during field activities, then the logbook must provide a record of what forms were used, and an inventory of the forms that includes applicable sample locations, and the name of the person completing the field form(s).

5.0 MULTIPLE FIELD ACTIVITIES

If several field activities are occurring concurrently and more that one field team is deployed, a separate field logbook will need to be maintained for each activity or team. Under these circumstances, a site summary logbook should be maintained in addition to each task/team logbook. The summary logbook should describe the ongoing operations and the general field activities (including personnel on site). The summary logbook should include an inventory of the separate activity/team logbooks and the field activity leaders.

6.0 CORRECTIONS

If corrections to a logbook are necessary, they must be made by drawing a single line through the entry in a manner that allows the original entry to still be read. **Do not ever erase or otherwise render the original entry illegible.** The correct entry should be made immediately after the corrected material. The correction must be initialed and dated. Some corrected entries will require a footnote explaining the reason for the correction.

Attachment 1: Acceptable Logbook Entry Examples
Attachment 2: Logbook Audit Checklist

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ATTACHMENT 1

Acceptable Logbook Entry Examples

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07/11/2005 10:33 FAX 402 502 2673 HGL INC → LENEXA 002

100 Location Omaha Lead Site Date 5/13/05
Project / Client USACE OMA009-002-04-01
Forecast, Possible rain, Temp~ 50s, Windy

0630 Arrive at laydown yard for H&S meeting
0700 Go back to H&S office
0745 Got gas
0815 Arrive at property 73
0840 Leave property 73. They are having to scrape a lot of mud off equipment due to rain from previous days.
0853 Arrive at property 99 (Team 4) Team 4 excavating B zones
0900 Leave property 99 for property 113. Took 2 photos @ prop. 99.
0910 Arrive at property 113. Matt calls to get excavation depths for properties 80, 61, & 77.
0930 Took photo of cracked sidewalk in 1st square of concrete to the right of the front steps. Observed Team 1 using entry/exit and decon station properly. Took 2 photos of operation and 1 of front terrace area.

WCE 5/13/05

Location Omaha Lead Site Date 5/13/05 101
Project / Client USACE OMA009-002-04-01

0952 Leave property 113 for HGL office
1000 Arrive @ HGL office to change camera batteries and pick up the cord for down-loading photos onto the computer.
1030 Leave HGL project office for property 73
1040 Arrive at property 73 Took several photographs of operations.
1100 Left property 73 for property 99. Neighbor @ houses down @ 413 Florence wanted the EPA number to call about having their yard tested. Stopped by their house - no body answered.
1135 Leave property 99 for HGL office
1150 Arrive at HGL office

WCE 5/13/05

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Location Omaha Lead Site Date 5/13/05

Project / Client USACE OMA 009-002-04-01

1210 Leave for lunch

1300 Arrive back at HGL office

1320 Leave HGL office for property 113

1340 Arrive at property 113. Team 1 excavating F-quads. Steve B. arrives on site.

1420 Leave property 113.

1430 Arrive at property 73. Take talking w/ property owners/tenants. Excavation of B-quads taking place. Gary (F.D.&A) arrives on site. Screening conducted includes the following:

Property 113

DZN (2" scrape)

1. 92 ± 36
2. 147 ± 41
3. 126 ± 62

Avg 121 ± 62 clear

F1 (2" scrape)

1. 43 ± 81
2. 17 ± 97
3. 80 ± 63

Avg 46 ± 97 clear

Location Omaha Lead Sit Date 5/13/05

Project / Client USACE OMA 009-002-04-01

DZE (6" scrape)

1. 201 ± 40
2. 188 ± 16
3. 164 ± 32

183 ± 40 clear

DZS (6")

1. 98 ± 37
2. 104 ± 46
3. 166 ± 77

122 ± 77 clear

Property 99

B2 (2" scrape)

1. 74 ± 60
2. 223 ± 49
3. 147 ± 36

148 ± 60 clear 126

B2 6"

1. 90 ± 74
2. 129 ± 90
3. 159 ± 83

Property 73

DZE (12-18")

1. 342 ± 21
2. 211 ± 67
3. 146 ± 90

→ Avg 233 ± 90 clear

Location Omaha Lead Site Date 5/13/05

Project / Client USACE OMA009-002-04-01

DZ 5 (12-18")

1. 436 ± 41
2. 316 ± 32
3. 271 ± 15

341 ± 41 clear

1506 Moved from prop 73 to prop. 99

1530 Left for HGL proj. office

1600 Left HGL proj. office for Lenexa, KS.

WCP 5/13/05

Location Omaha Lead Site Date 5/16/05

Project / Client USACE OMA009-002-04-01

Clear; Cool Temp 50-70°F; light wind

0630 Arrive @ HGL meeting. Discuss underground utilities

0645 Mobilized back to HGL project office. Picked up air monitors & work plans

0700 Mobilized to property 47 (Team 3). Tail gate work package. Downloaded data from Saturday Team 3 PDR # 146926x. Then calibrated the segue PDR and put out at the property. Downloaded data for Saturday operations - Team 4 (PDR# 101796) and team 1 (PDR# 162386)

0749 Mobilized from property 47 to property 31 (Team 4). Calibrated & zero PDR # 101796 & placed at property 31. Team 4 currently excavating E zones

0820 Mobilized from property 31

WCP 5/16/05

07/11/2005 10:35 FAX 402 502 2673 HGL INC → LENEXA 004

ATTACHMENT 2

Logbook Audit Checklist

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HydroGeoLogic, Inc	**Standard Operating Procedure:** **Logbook Field Audit Checklist**	
	Category: QA/QC	**Revised:** March 2006

Audit Date: _____ Reviewer: _____
Site Name and Location: _____
HGL Project Number: _____
Team Leader: _____

I. INITIAL INFORMATION				
	Yes	No	N/A	Comment
Job Number				
Project No.				
EPA ID				
Dates of work				
Book __ of __				
Proposed work summary				
Weather				
Team member				
Team member duties				
Others on site and affiliations				
On-site equipment				
II. HEALTH AND SAFETY				
Meeting Held				
SSHP referenced				
Attendance list				
PPE for each task				
Safety equipment/instrumentation				
Equipment/instrument ID numbers				
Calibration information				
Background reading				
On-site readings and locations				
III. FIELD DATA COLLECTION				
Types of equipment/instruments				
Serial # or ID #				
Calibration				
Background readings				
Field readings/measurements				
Location of readings				
Date and time of readings				
Field calculations				
Hazard characterization summary				

IV. DECONTAMINATION				
	Yes	No	N/A	Comment
Solutions used				
Procedures for personnel				
Procedures for equipment				
V. INVESTIGATION DERIVED WASTE				
Disposal method				
Hauler				
Final disposition				
Estimated quantity shipped off site				
Estimated quantity disposed on site				
Inventory of drummed wastes				
VI. PHOTO DOCUMENTATION				
Camera and serial #				
Lens and serial #				
Film type and roll #				
Sequence #				
Frame #				
Photographer				
Orientation				
Location/subject				
Date and time				
VII. SITE ACTIVITY				
Work Plan on site				
Stated Work Plan followed				
Deviations from Work Plan				
Reason for deviation				
Problems encountered and corrective action taken				
Interviews documented				
Site management practices				
Site maps/sketches				
Description of wastes				
Pathways/targets				
Reconnaissance observations				
Assumptions				
VIII. SAMPLE DOCUMENTATION				
Matrix				
Total # each matrix collected				
Analyses listed				
Sampling technique				
Field QC samples taken				
Sample IDs recorded				
Sample containers				
Preservative				
Field sheets referenced				
If field sheets are not referenced, the following information must be recorded in the logbook.				
Composite/grab				

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	Yes	No	N/A	Comment
Number of aliquots				
Physical description				
Dates/times collected				
Who collected samples				
Locations				
Depth				
Airbill # and Shipper				
Chain of custody # referenced				
Custody seal or tag				
Laboratory				
Splits documented				
Receipt obtained for coolers				
VIII. GENERAL				
Each signed/initialed				
Entries recorded by others initialed				
Daily entry signed by Team leader				
Blank pages/spaces voided				
Corrections made properly				
Corrections initialed and dated				
Late entries made properly				
24-hour clock notations				
Waterproof ink used				
New page for each day				
Other logbooks clearly referenced				
Other documents referenced				
Arrival/departure time recorded				
Log of off-site activity				
X. OVERALL EVALUATION OF FIELD ACTIVITY LOGBOOK				
Field activities can readily be reconstructed from this logbook(s) YES NO				
Comments/Discussion				

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Lithologic Logging

SOP 3-5
Revision: 7
Date: March 2007

Prepared: Del R. Baird

Technical Review: John Hofer

E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt

QA Review: Jo Nell Mullins

Approved:

Signature/Date

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt

Issued:

Signature/Date

1.0 Objective

This standard operating procedure (SOP) governs lithologic logging of core, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by CDM Federal Programs Corporation (CDM). The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used by all investigators in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

2.0 Background

2.1 Definitions

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the geologist in what to look for when following the sequences. Example lithologic logs are given in Attachment A.

Name of Sediment or Rock - In naming unconsolidated sediments, the logger shall use field equipment and reference charts to help identify the grain-size distribution and shall name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger shall examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

Texture - In examining unconsolidated sediments, the texture shall refer to the grain-size distribution, particle angularity, sorting, and packing. The logger shall provide estimates of the grain sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles shall be examined for angularity by comparing with Attachment B and the sorting shall be determined by percentage estimation. The logger shall note that the Unified Soil Classification System (USCS) uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliated structure (slaty, phyllitic, schistose, or gneissic) or nonfoliated structure (granular).

Color - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color shall be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names shall be listed, and an overall best color name shall be given.

Sedimentary Structures - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures, and the logger is referred to Compton's *Manual of Field Geology* (1962) book for more details. Among the more common structures are bedding, cross-bedding, laminations, and burrows. These structures shall only be included in the description if found in the samples.

Degree of Consolidation - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and shall

be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and shall be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials shall be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) shall be done and results recorded under the description. If the logger believes he/she can identify the cementing material, then it shall be included in the description.

Moisture Content - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and shall be described as dry, moist, wet (not flowing), or saturated (flowing water). Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks shall be noted.

Presence of Fractures, Cavities, and Secondary Mineralization - The rock that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they shall be noted and a description as to the density of fractures shall be given. Cavities or vugs may be present, and the density of voids, as well as size estimation, shall be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill shall be added.

Evidence of Contamination - The logger shall examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations shall be noted in the field book as shall any readings from the photoionization or flame ionization detector (PID/FID). PID/FID hits shall be recorded on the Lithologic Log Form also.

Description of Contacts - The logger shall note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts shall be noted as to whether they are erosional, gradational, or sharp, and the depth below the surface shall be noted.

Composition - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock shall be stated and an estimation of their percentage shall be noted. The classification charts listed in Attachments D and F provide a description of common compositions.

2.2 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist under a geologist's supervision, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks; grain-size percentage estimation; particle shape; grain-size charts; and lithologic symbols. To make lithologic descriptions produced by CDM staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

3.0 General Responsibilities

Geologist - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the field team leader (FTL).

Field Team Leader - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

***Note*:** Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

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4.0 Required Equipment

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log Form
- Clipboard
- Dilute (10 percent) HCl
- Plastic sheeting
- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts
- Engineers tape measure or folding stick

5.0 Procedures

5.1 Office

- Obtain field logbook and Lithologic Log Forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (i.e., hand lens, 10 percent HCl)
- Obtain CDM reference field charts
- Review field support documents (i.e., sampling plan, health and safety plan)
- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps

5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log Forms. Lithologic loggers will follow the general procedures for keeping a field logbook (SOP 4-1). When using a bound field logbook, record the same data required on the Lithologic Log Form. Data from the field logbook must be transcribed to the Lithologic Log Form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log Form, it shall be done within 1 day of the original data recording. All blanks in the Lithologic Log Form must be filled out. If an item is not applicable, an “NA” shall be entered. Note that the Lithologic Log may be modified based on the type of drilling (i.e., changing the blow count column to rock quality designation (RQD) for rock coring).

The Lithologic Log Form shall be filled out according to the following instructions:

The front page of the form contains general information:

- The project name, location, and description
- Borehole number
- Date that the drilling activity was started and completed
- Name of the person logging the well shall be recorded along with the total depth drilled
- Borehole diameter(s) and drilling methods shall be recorded
- Name and company of the driller and the type of drill rig and bits used

A map showing the drilling location may be attached.

The continuation page(s) shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and shall be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column shall contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes shall be recorded as to why the section was not recovered. The X shall be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a

solid horizontal line. Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits shall be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split-spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs shall ask the FTL whether it is required information. The description column is the most important part of the Lithologic Log Form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging shall determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger shall record the appropriate information into the logbook when there is a rig shutdown, rig problems, failures to recover cores, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This shall be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference.

General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions shall be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

Description detail will also be dependent on the drilling and sampling methods used. Descriptions of drill cuttings will generally be very basic verses detailed descriptions of soil split-spoon or rock core samples.

This SOP includes protocols for describing igneous, metamorphic, bedrock, sedimentary rocks, and unconsolidated materials. Common abbreviations used for lithologic logging purposes are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology and American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log Form or in the field logbook.
- The Munsell soil color chart may be used for descriptions of color.
- The *Dictionary of Geological Terms* (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions shall include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category shall be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All interpretive comments shall be segregated from lithologic descriptions by recording them in the remarks column.

Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation shall be described if observed. Exact measurement of apparent bed thicknesses shall be made when logging core and shall supplement terminology such as "thin" or "thick." Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible.

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In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the USCS or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they shall do so with permission from the FTL.

It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed; however, the abbreviation and its meaning shall be recorded on the lithologic log the first time it is used and shall be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

5.2.1 Protocols for Lithologic Description of Discrete Soil or Rock Cores

This section describes the protocols for completing a lithologic description based on discrete soil or rock core samples. The logger shall use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core, it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the "big" picture. For instance, in a 20-foot-thick zone, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 below ground surface (bgs) = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in "seeing" the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

Description of Unconsolidated Material

Unconsolidated material comprises a significant portion of the sections of interest at CDM sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and shall use the same description format. The scientist shall use the USCS classification if consistent with project objectives (Attachment K). More detailed soil descriptions shall only be made in addition to descriptions outlined below.

Descriptions of unconsolidated sediments shall follow the following sequence:

- Name of sediment (sand, silt, clay, etc.)
- Texture
- Composition of larger-grained sediments
- Color
- Structure
- Degree of consolidation and cementation
- Moisture content
- Evidence of bioturbation
- Description of contacts

In naming unconsolidated material (refer to Attachment I - Naming of Unconsolidated Materials), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written: _____(dominant grain) with _____(subordinate grain). For example, a sediment with 90 percent sand and 10 percent silt would be named a sand with silt. If a sediment contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt, and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt, and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage shall be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

Description of Bedrock Material

Descriptions of rock core can vary in detail depending on the experience of the geologist and the scope of the project. However, features that shall be noted while logging rock core include depth of major fractures, mineralization in fractures and cavities, degree of weathering, hardness, and RQD. The RQD is a ratio of the total length of intact rock 4 inches in length or longer to the length of the core run. The RQD provides a numeric indication of the degree of fracturing and weathering, and thereby, and indication of conductive zones and preferential contaminant migration pathways.

Description of Sedimentary Rocks
Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E - Classification of Sedimentary Rocks.

Descriptions for sedimentary rocks shall be given in the lithologic log in the following sequence:
- Name of rock
- Texture
- Color
- Bedding
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Bioturbation
- Description of contacts

Description of Igneous and Metamorphic Rocks
Igneous and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments D and F provide a classification system for these materials.

Igneous and metamorphic rock descriptions shall follow the general format:
- Name of rock
- Texture
- Color
- Degree of induration for volcaniclastics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization
- Foliation

5.2.2 Protocols for Lithologic Description from Drill Cuttings
The majority of boreholes drilled in bedrock are drilled without sampling or coring. This section describes the protocols that may be used for completing lithologic logs when discrete soil samples or rock cores are not collected. Lithologic logging of boreholes drilled without sampling generally requires a higher level of experience from the geologist as interpretations need to be made based on a number of factors that are usually not taken into account when logging from discrete samples. Certain details recorded on lithologic logs based on discrete sampling will not be seen (such as sedimentary structures) and therefore cannot be recorded from drill cuttings. Below are general guidelines that shall be used while filling out boring logs based on drill cuttings:

Auger Drilling
The following are general guidelines that can be used to describe cuttings from auger drilling:

- Collect cuttings for descriptions at least every 5 feet or if a change in the cuttings is noticed.
- Keep in mind travel time for cuttings to reach the surface when estimating the depth from which the cuttings originated.
- Pay attention to the reaction of the drill rig as different lithologies are encountered such as chattering versus smooth drilling, rapid easy auger advancement versus slow hard drilling, and auger refusal.
- Watch for the occurrence of water.

Bedrock Rotary Drilling (including air hammer, air rotary, and mud rotary)
The following are general guidelines that shall be used during rotary drilling:

- Use a strainer to collect cuttings at intervals of at least 10 feet or changes in lithology.
- Wash the cuttings in the strainer with potable water and examine for lithology.
- Note size of rock chips.
- Note changes in drill rig responses such as increasing or slowing drilling rate, sudden drop of the drill stem, increase in chatter and record in the remarks column of the lithologic log. These are usually good indicators of changes in lithology and/or fractures.
- If drilling with air, look for changes in color and reduction or disappearance of dust as an indicator of a lithology change and/or presence of water.
- If drilling with mud/fluid rotary, watch for gain or loss of water as an indicator of conductive zones.
- Record drilling rates as feet/minute, or as start and end times of each drill rod, in the remarks column of the boring log.

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6.0 Restrictions/Limitations

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 References

American Geological Society. 1989. *American Geological Society Data Sheets for Geology in the Field*, Laboratory, and Office, 3rd Ed.

Compton, R.R. 1962. *Manual of Field Geology*, John Wiley & Sons Inc., New York, New York.

Neuendorf, K.K.E, et. Al. 2005. *Glossary of Geology, Fifth Edition,* American Geological Institute.

Soil Test Inc. 1975. *Munsell Color Chart*. Evanston, Illinois.

U. S. Army Corp of Engineers. 1994. *Rock Foundations, EM 1110-1-2908,* Chapter 4. November 30.

_____. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites, EM 1110-1-4000,* Chapter 4. November 1.

U. S. Department of Agriculture Soil Conservation Service. 1972. *Soil Taxonomy*, U. S. Government Printing Office, Washington, D.C.

Woodward, L.A. 1988. *Laboratory Manual Physical Geology*, University of New Mexico Printing. Albuquerque, New Mexico.

8.0 Attachments

Note: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - CDM Federal Programs Corporation Lithologic Logs
Attachment B - Grain-Size Scale; Graph determining size of sedimentary particles, particle degree of roundness charts
Attachment C - Comparison Chart for Estimating Percentage Composition
Attachment D - Classification of Igneous Rocks
Attachment E - Classification of Sedimentary Rocks
Attachment F - Classification of Metamorphic Rocks
Attachment G - Lithologic Symbol Chart
Attachment H - Common Abbreviations for Lithologic Logging
Attachment I - Naming of Unconsolidated Materials
Attachment J - Sorting Chart
Attachment K - Example of Unified Soil Classification System (USCS)

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Attachment A

CDM Federal Programs Lithologic Logs

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Attachment B

Grain-Size Scale; Graph determining size of particles, particle degree of roundness charts

AGI DATA SHEET 29.1

Grain-size Scales

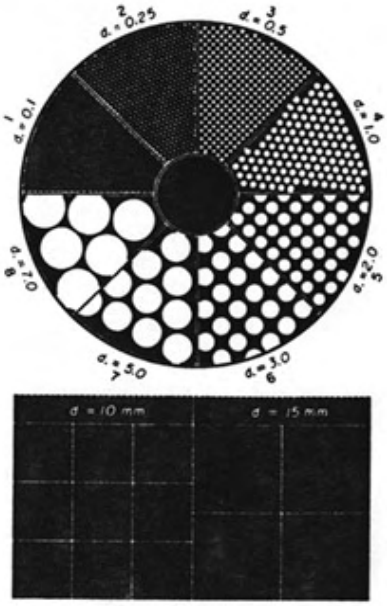
By Roy L. Ingram, University of North Caroline

GRAIN-SIZE SCALE USED BY AMERICAN GEOLOGISTS
Modified Wentworth Scale — after Lane, et al., 1947, Trans. American Geophysical Union, v. 28, p. 936-938

GRADE LIMITS phi	mm	mm	inches	U.S. Standard Sieve Series	GRADE NAME		
−12	4096		161.3		very large		
−11	2048		80.6		large		
−10	1024		40.3		medium	Boulders	
−9	512		20.2		small		
−8	256		10.1		large		
−7	128		5.0		small	Cobbles	GRAVEL
−6	64		2.52	63 mm	very coarse		
−5	32		1.26	31.5 mm	coarse		
−4	16		0.63	16 mm	medium	Pebbles	
−3	8		0.32	8 mm	fine		
−2	4		0.16	No. 5	very fine		
−1	2		0.08	No. 10	very coarse		
0	1		0.04	No. 18	coarse		
+1	1/2	0.500		No. 35	medium	Sand	SAND
+2	1/4	0.250		No. 60	fine		
+3	1/8	0.125		No. 120	very fine		
+4	1/16	0.062		No. 230	coarse		
+5	1/32	0.031			medium		
+6	1/64	0.016			fine	Silt	
+7	1/128	0.008			very fine		
+8	1/256	0.004			coarse		MUD
+9	1/512	0.002			medium		
+10	1/1024	0.001			fine	Clay size	
+11	1/2048	0.0005			very fine		
+12	1/4096	0.00025					

AGI DATA SHEET 28.2

LIGHT PARTICLES



References: (1) George V. Chilingar, 1956, Soviet classification of sedimentary particles and Vasil'evskiy graph: AAPG Bull., v. 40, no. 7, p. 1714. (2) M.S. Shvetsov, 1948, Petrography of sedimentary rocks, 2nd ed., 387 p. Gosgeoltizdat, Moscow-Leningrad

American Geological Institute, Data Sheets, Third Edition, 1989.

Compton, R.R., Manual of Field Geology, 1962.

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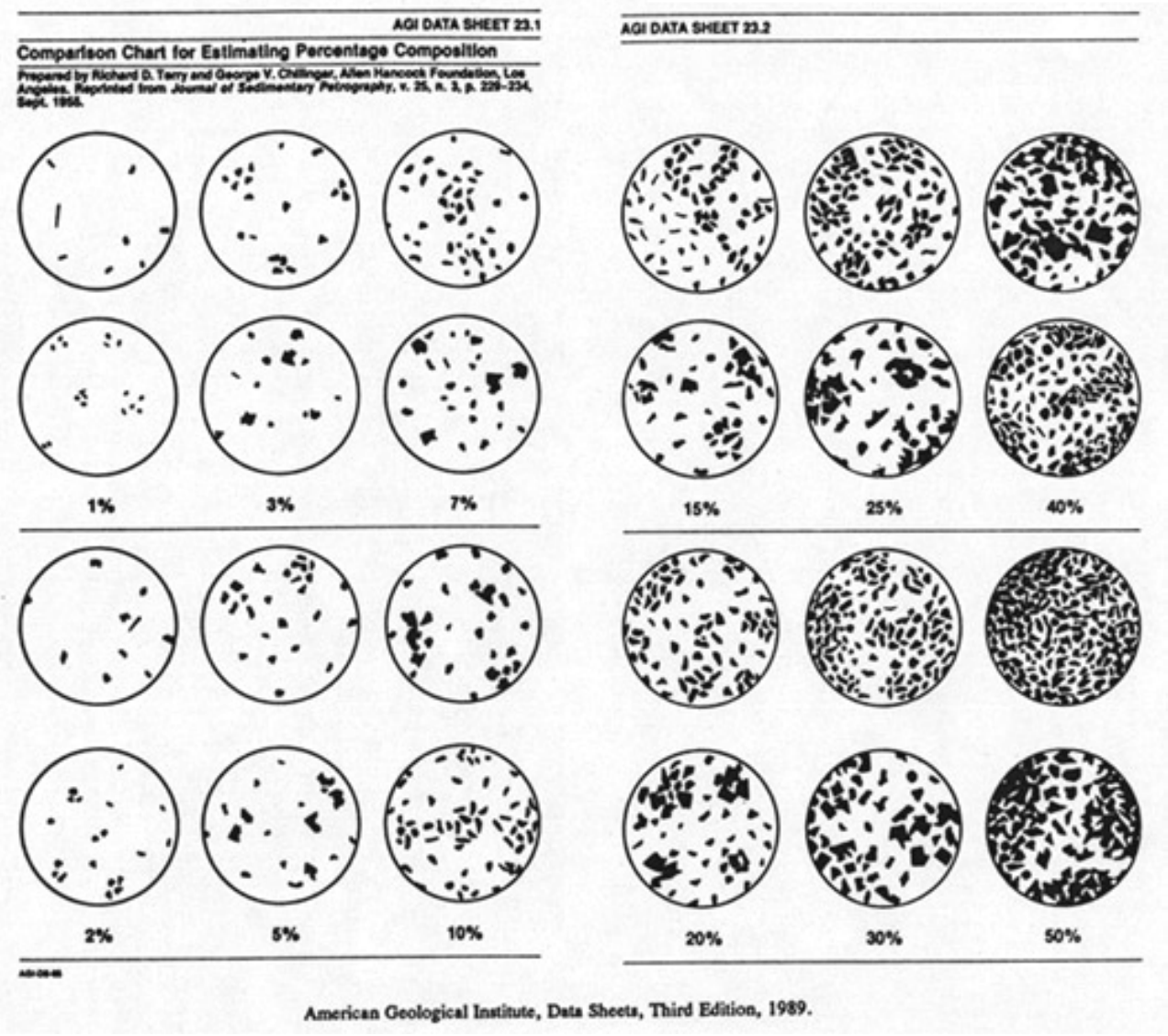
Attachment C

Comparison Chart for Estimating Percentage Composition



American Geological Institute, Data Sheets, Third Edition, 1989.

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Attachment D

Classification of Igneous Rocks

Classification of Igneous Rocks					
Mineral Composition					
		Quartz >10% Abundant feldspar Mafic minerals minor	Quartz <10% Abundant feldspar Mafic minerals moderate	Feldspar abundant Mafic Minerals 40-70%; Quartz minor or absent	Mafic minerals >70%
Color Index		Light Color	Intermediate color	Dark	Dark
Chemistry		SiO_2 70%	SiO_2 60%	SiO_2 50%	SiO_2 40%
	Phaneritic (visible with naked eye)	Granite (Gr)	Diorite (Dr)	Gabbro (Gb)	Peridotite (Pr) (mostly olivine)
TEXTURE	Aphanitic (microscopic)	Rhyolite (Ry) (quartz phenocrysts)	Andesite (An) (feldspar or mafic phenocrysts; no quartz)	Basalt (Ba)	Komatiite (Km) (very rare)
		Felsite (Fl) (no phenocrysts)			
	Glassy	Obsidian (ob) Pumice (Pu)		Rare	
	Glassy-Fragmental (Pyroclastic)	Tuff <4mm (Tf) Breccia >4mm (Br)		Rare	

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Attachment E

Classification of Sedimentary Rocks

Classification of Sedimentary Rocks				
Detrital	***Detrital Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Rudaceous (clast diameter > 2 mm)	Gravel	Rounded Clasts	Conglomerate (Cg)
			Angular Clasts	Breccia (Br)
	Arenaceous (clast diameter between 0.0625 mm [1/16 mm] and 2 mm)	Sand	Mineral composition and detrital matrix content varies. Additional detrital matrix qualifiers (arenite or wacke) and mineral composition qualifiers (quartz, arkose, feldspathic, etc.) may be necessary.	Sandstone (Sa)
	Argillaceous (clast diameter <0.0625 mm)	Mud	Non-fissile along bedding planes, silt predominant over clay	Siltstone (Sls)
			Non-fissile along bedding planes, clay predominant over silt	Claystone
			Non-fissile along bedding planes, silt and clay fraction approximately equal or unknown	Mudstone (Ms)
			Fissile along bedding planes	Shale (Shl)
Chemical	***Chemical Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Calcareous	Calcite (Calcium Carbonate)	Effervesces on contact with dilute HCl	Limestone (La)
		Dolomite (Calcium Magnesium Carbonate)	Pulverized sample effervesces on contact with dilute HCL	Dolomite (Dl), Dolostone
	Siliceous	Quartz (Silicon Dioxide)	Hard, dense, fractures conchoidally	Chert (Ch)
	Evaporites	Hydrated Calcium Sulfate	Earthy and crumbly	Gypsum (Gy)
		Calcium Sulfate	Usually exhibits indistinct stratification	Anhydrite
		Halite (Sodium Chloride)	Cubic cleavage	Rock Salt (Na)
Organic (Organogenetic or Biochemical)	***Chemical Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Calcareous	Fossil shells and fragments	Loosely cemented fragmental limestone	Coquina (Cq)
		Foraminiferal shells	Soft, micritic limestone	Chalk (Chk)
		Calcite or aragonite	Derived from evaporation of spring water	Travertine (Tvr)
	Siliceous	Diatom shells (saltwater or freshwater organisms)	Light-colored, soft, friable, and porous siliceous deposit	Diatomite (Dm)
	Carbonaceous	Plant Remains	Degree of lithification varies-additional qualifiers such as peat, lignite, bituminous and anthracite may be necessary.	Coal (Cl)

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Attachment F

Classification of Metamorphic Rocks

Classification of Metamorphic Rocks			
Structure	**Texture**	**Chief Minerals**	**Name**
Non foliate	granular; breaks across grains	quartz	Quartzite (Qzt)
	granular; grains clearly visible	calcite	Marble (Mbl)
	granular; grains altered and indistinct	plagioclase, chlorite, epidote hornblende	Greenstone (Grs)
	very fine-grained	indistinguishable; mostly submicroscopic micas and clays	Hornfels (Hnf)
Foliate	slaty	submicroscopic mica, quartz	Slate (Slt)
	phyllitic	microscopic mica, quartz	Phyllite (Pyl)
	schistose	microscopic mica, quartz, amphibole	Blueschist
		chlorite, mica plagioclase	chlorite schist (CL-Sch)
		muscovite, quartz	Muscovite (Ms) Schist (Sch)
		garnet, muscovite	Garnet (G) Muscovite (Ms) Schist (Sch)
		hornblende, plagioclase	Amphibolite (Amp)
		staurolite, garnet, muscovite	Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)
	gneissose	plagioclase, hornblende	Amphibolite (Amp) Gneiss (Gns)
		feldspar, quartz	Granitie (Gr) Gneiss (Gns)
		eye-shaped feldspar, mica	Augen (Au) Gneiss (Gns)

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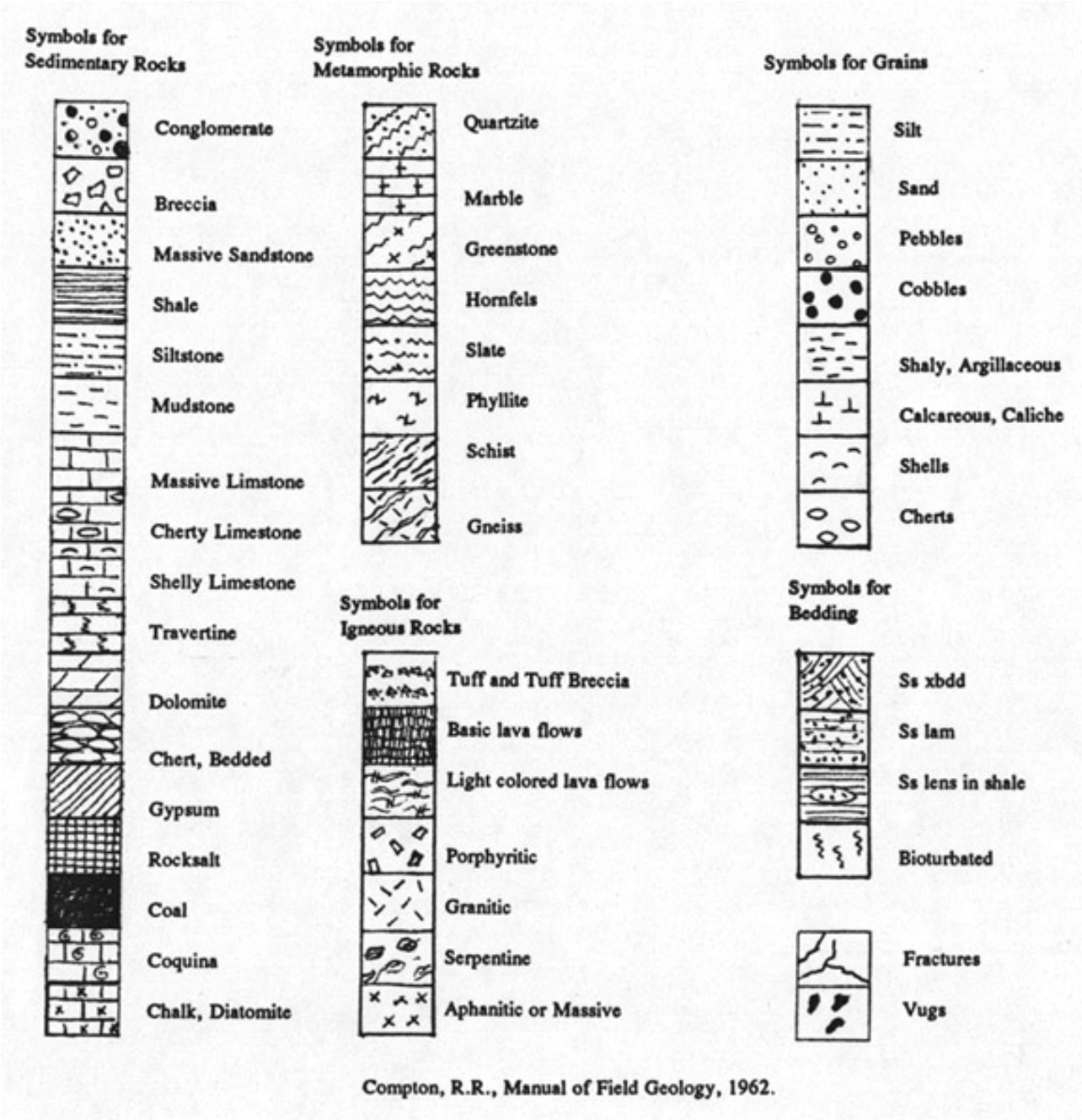
Attachment G

Lithologic Symbol Chart



Compton, R.R., Manual of Field Geology, 1962.

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Attachment H

Common Abbreviations for Lithologic Logging

Common Abbreviations		
Abundant – abnt	Diameter – dia	Laminated – lam
Amount – amt	Different – diff	Maximum – max
Approximate – approx	Disseminated – dissem	Pebble – pbl
Arenaceous – aren	Elevation – elev	Phenocryst – phen
Argillaceous – arg	Equivalent – equiv	Porphyritic – proph
Average – ave	foliated – fol	Probable – prob
Bedded – bdd	Formation frm	Quartz – qrz
Bedding – bdg	Fracture – frac	Regular – reg
Calcareous – calc	Fragmental – frag	Rocks – rx
Cemented – cmt	Granular – Gran	Rounded – rnd
Cobble – cbl	Gypsiferous – Gyp	Saturated – sat
Contact – ctc	Horizontal – hriz	Secondary – sec
Cross-bedded - xbdd	Igneous – ign	Siliceous – sil
Cross-bedding – xbdg	Inclusion – incl	Structure – struc
Cross-laminated – xlam	Interbedded – intbdd	Unconformity – uncnf
Crystal – xl	Irregular – ireg	Variegated – vrgt
Crystalline – xln	Joint – jnt	Vein – vn
Grain Size	**Contacts**	**Sorting**
grain – gn	gradational – grad	poor – pr
fine – f	erosional – er	moderate – mod
very fine – vf	abrupt – ab	well – well
medium – med		
coarse – crs	**Fabric**	
large – lg	grain supported – gs	
very large – vlg	matrix supported – ms	
small – sm	imbricate – im	

Adapted from, Compton, R.R., *Manual of Field Geology*, 1962.

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Attachment I

Naming of Unconsolidated Materials

Main Particle	Gravel	Sand	Silt	Clay
> 15 % gravel	Gravel	Gravelly Sand	Gravelly Silt	Gravelly Clay
> 15 % sand	Sandy Gravel	Sand	Sandy Silt	Sandy clay
> 15 % silt	Silty Gravel	Silty Sand	Silt	Silty Clay
> 15 % clay	Clayey Gravel	Clayey Sand	Clayey Silt	Clay
5-15 % gravel	Not Applicable	Sand with Gravel	Silt with Gravel	Clay with Gravel
5-15 % sand	Gravel with sand	Not applicable	Silt with Sand	Clay with sand
5-15 % silt	Gravel with silt	Sand with silt	Not applicable	Clay with silt
5-15 % clay	Gravel with clay	Sand with clay	Silt with clay	Not applicable
> 15% gravel plus 15% sand	Sandy Gravel	Gravelly Sand	Gravelly Sandy Silt	Gravelly Sandy Clay
> 15% gravel plus 15% silt	Silty Gravel	Gravelly Silty Sand	Gravelly Silt	Gravelly Silty Clay
> 15% gravel plus 15% clay	Clayey Gravel	Gravelly Clayey Sand	Gravelly Sandy Silt	Gravelly Clay
> 15% sand plus 15% silt	Silty Sand Gravel	Silty Sand	Sandy Silt	Sandy Silty Clay
> 15% sand plus 15% clay	Sandy Clayey Gravel	Clayey Sand	Sandy Clayey Silt	Sandy Clay
> 15% silt plus 15% clay	Silty Clayey Gravel	Silty Clayey Sand	Clayey Silt	Silty Clay
Note: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt.				

Compton, R.R., *Manual of Field Geology*, 1962.

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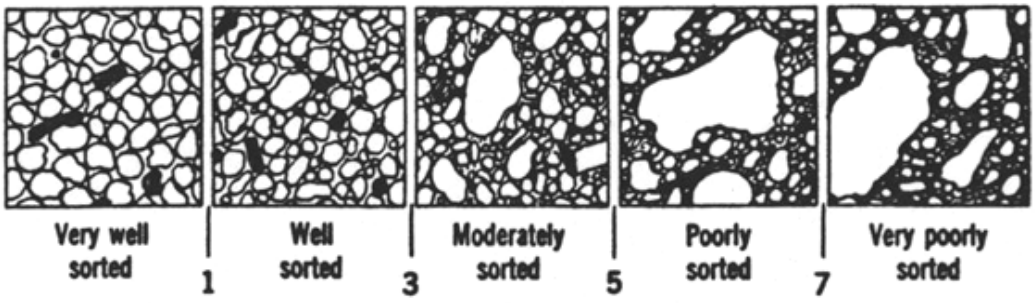
Attachment J

Sorting Chart



Compton, R.R., Manual of Field Geology, 1962.

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Attachment K

Example of Unified Soil Classification System (USCS)

Unified Soil Classification System (USCS)

	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL:			
COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND:			
COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40
FINE	.43 - .08	.02 - .003	No. 40 - No. 200
FINES:			
SILTS	< .08	< .003	< No. 200
CLAYS	< .08	< .003	< No. 200

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Attachment K

Example of Unified Soil Classification System (USCS) (Continued)

CLAY

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF) TORVANE	Unconfined Compressive Strength q_u Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4 " by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

SAND

SOILTYPE	SPT, N Blows/ft.	Relative Density,%	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

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Example of Unified Soil Classification System (USCS) (Continued)

Summary of USCS Field Identification Tests

Coarse-Grained Soils **More than half the material (by weight) is individual grains visible to the naked eye**	**Gravelly Soils** More than half of coarse fraction is larger than 4.75 mm		**Clean Gravels** Will not leave a stain on a wet palm	Substantial amounts of all grain particle sizes			GW
				Predominantly one size or range of sizes with some intermediate sizes missing			GP
			Dirty Gravels Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)			GM
				Plastic fines (to identify, see CL below)			GC
	Sandy Soils More than half of coarse fraction is smaller than 4.75 mm		**Clean Sands** Will not leave a stain on a wet palm	Wide range in grain size and substantial amounts of all grain particle sizes.			SW
				Predominantly one size or a range of sizes with some intermediate sizes missing			SP
			Dirty Sands Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)			SM
				Plastic fines (to identify, see CL below)			SC
Fine-Grained Soils **More than half the material (by weight) is individual grains not visible to the naked eye**	**Ribbon**	**Liquid Limit**	**Dry Crushing Strength**	**Dilatancy Reaction**	**Toughness**	**Stickiness**	
	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
(<0.074 mm)	Very Strong	>50	High to Very High	None	High	Very High	CH
Highly Organic Soils	Readily identified by color, odor, spongy feel, and frequently by fibrous texture						OL OH Pt

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Control of Measurement and Test Equipment

SOP 5-1
Revision: 7
Date: December 31, 2004

Prepared: Dave Johnson **Technical Review:** Mike Clark

QA Review: Doug Updike **Approved:** _____
Signature/Date

Issued: _____
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE). Contractual obligations may require more specific or stringent requirements that must also be implemented.

2.0 Background

2.1 Definitions

Traceability - The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of this equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures and in accordance with any other related project-specific requirements.

2.3 Associated Procedures

- CDM Federal (CDM) Technical SOP 4-1
- CDM Quality Procedures (QPs) 2.1 and 2.3
- Manufacturer's operating and maintenance and calibration procedures

3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE are responsible for being knowledgeable of and understanding and implementing the requirements contained herein as well as any other related project-specific requirements.

The project manager (PM) or designee (equipment coordinator, quality assurance coordinator, field team leader, etc.) is responsible for initiating and tracking the requirements contained herein.

4.0 Required Equipment

- Determine and implement M&TE related project-specific requirements
- The maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an Equipment Log or a Field Log as appropriate (Figure 1)
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

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5.0 Procedures

5.1 Determine if Other Related Project-Specific Requirements Apply

For All M&TE:
The PM or designee shall determine if M&TE related project-specific requirements apply. If M&TE related project-specific requirements apply, obtain a copy of them and review and implement as appropriate.

5.2 Obtain the Operating and Maintenance and Calibration Documents

For GF M&TE that is to be procured:
Requisitioner - Specify that the maintenance and calibration procedures be included.

For GF M&TE that is acquired as a result of a property transfer:
Receiver - Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, order the appropriate documentation from the manufacturer.

For M&TE that is to be rented or leased from an outside vendor:
Requisitioner - Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, ask Procurement to request it from the vendor.

5.3 Prepare and Record Maintenance and Calibration Records

For all M&TE:
PM or Designee - Record all maintenance and calibration events in a Field Log unless other project-specific requirements apply.

For GF M&TE only (does not apply to rented or leased M&TE):
If an Equipment Log is a project specific requirement, perform the following:

Receiver - Notify the PM or designee for the overall property control of the equipment of the receipt of an item of M&TE.

PM or Designee - Prepare a sequentially page numbered Equipment Log for the item using the maintenance and calibration form (or equivalent) from the CDM *Property Control Manual* (Figure 1).

PM or Designee and User - Record all maintenance and calibration events in an Equipment Log.

5.4 Label M&TE Requiring Calibration

For GF M&TE only (does not apply to rented or leased M&TE):
If calibration labeling is a project specific requirement, perform the following:

PM or Designee - Read the maintenance and calibration procedures to determine the frequency of calibration required.

PM or Designee - If an M&TE item requires calibration before use, affix a label to the item stating “Calibrate Before Use.”

PM or Designee - If an M&TE item requires calibration at other scheduled intervals, e.g., monthly, annually, etc., affix a label listing the date of the last calibration, the date the item is next due for a calibration, the initials of the person who performed the calibration, and a space for the initials of the person who will perform the next calibration.

5.5 Operating, Maintaining or Calibrating an M&TE Item

For all M&TE:
PM or Designee and User - Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the Equipment Log or Field Log.

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Figure 1

A subsidiary of Camp Dresser & McKee Inc.

Maintenance and Calibration

Date: Time: (AM/PM)

Employee Name: Equipment Description:

Contract/Project: Equipment ID No.:

Activity: Equipment Serial No.:

Maintenance

Maintenance Performed:

Comments:

Signature: Date:

Calibration/Field Check

Calibration Standard: Concentration of Standard:

Lot No. of Calibration Standard: Expiration Date of Calibration Standard:

Pre-Calibration Reading: Post-Calibration Reading:

Additional Readings: Additional Readings:

Additional Readings: Additional Readings:

Pre-Field Check Reading: Post-Field Check Reading:

Adjustment(s):

Calibration: □ Passed □ Failed

Comments:

Signature: Date:

5.6 Shipment

For GF M&TE:

Shipper - Inspect the item to ensure that the maintenance and calibration procedures are attached to the shipping case, or included, and that a copy of the most recent Equipment Log entry page (if required) is included with the shipment. If the maintenance and calibration procedures and/or the current Equipment Log page (if required) is missing or incomplete, do not ship the item. Immediately contact the PM or designee and request a replacement.

For M&TE that is rented or leased from an outside vendor:

Shipper - Inspect the item to ensure that the maintenance and calibration procedures and latest calibration and standards certification records are included prior to shipment. If any documentation is missing or incomplete, do not ship the item. Immediately contact Procurement and request that they obtain the documentation from the vendor.

5.7 Records Maintenance

For GF M&TE:

PM or Designee - Create a file upon the initial receipt of an item of M&TE or calibration standard. Organize the files by contract origin and by M&TE item and calibration standard. Store all files in a cabinet, file drawer, or other appropriate storage media at the pertinent warehouse or office location.

PM or Designee - Maintain all original documents in the equipment file except for the packing slip and Field Log.

Receiver - Forward the original packing slip to Procurement and a photocopy to the PM or designee.

PM or Designee - File the photocopy of the packing slip in the M&TE file.

PM or Designee and User - Record all maintenance and calibration in an Equipment Log or Field Log (as appropriate.) File the completed Equipment Logs in the M&TE records. Forward completed Field Logs to the PM for inclusion in the project files.

For M&TE rented or leased from an outside vendor:

Receiver - Forward the packing slip to Procurement.

User - Forward the completed Field Log to the PM for inclusion in the project files.

User - Retain the most current maintenance and calibration record and calibration standards certifications with the M&TE item and forward previous versions to the PM for inclusion in the project files.

5.8 Traceability of Calibration Standards

For all items of M&TE:

PM or Designee and User - When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.

PM or Designee and User - Require certifications for standards that clearly state the traceability.

PM or Designee and User - Note standards that are perishable and consume or dispose of them on or before the expiration date.

PM or Designee - Require Material Safety Data Sheet to be provided with standards.

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5.9 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:

PM or Designee - Immediately discontinue use and segregate the item from other equipment. Notify the appropriate PM and take appropriate action in accordance with the CDM QP 2.3 for nonconforming items.

PM or Designee - Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate PM(s) of the results of the review.

6.0 Restrictions/Limitations

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the HDQ health and safety manager and/or HDQ quality assurance director. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 References

CDM Federal Programs Corporation *Property Control Manual.* 2002. March.

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U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

MANUAL WATER LEVEL MEASUREMENTS

CONTENTS

1.0 SCOPE AND APPLICATION

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- 7.1 Preparation
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- A - Groundwater Level Data Form

SUPERCEDES: SOP #2043; Revision 0.0; 10/03/94; U.S. EPA Contract 68-C4-0022.

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MANUAL WATER LEVEL MEASUREMENTS

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1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to set guidelines for the determination of the depth to water and separate phase chemical product (i.e., gasoline, oil, PCE, TCE) in an open borehole, cased borehole, monitor well, or piezometer. These standard operating procedures may be varied or changed as required, dependent on site conditions , and equipment limitations. In all instances, the actual procedures employed will be documented and described in an appropriate site report. Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

Generally, water-level measurements taken in boreholes, piezometers, or monitor wells are used to construct water table or potentiometric surface maps and to determine flow direction as well as other aquifer characteristics. Therefore, all water level measurements at a given site should preferably be collected within a 24 hour period. However, certain situations may produce rapidly changing groundwater levels that necessitate taking measurements as close in time as possible. Large changes in water levels among wells may be indicative of such a condition . Rapid groundwater level changes may occur due to:

- Atmospheric pressure changes
- Tidal influences
- Changes in river stage, impoundments levels, or flow in unlined ditches
- Pumping of nearby wells
- Precipitation

2.0 METHOD SUMMARY

A survey mark should be placed on the top of the riser pipe or casing as a reference point for groundwater level measurements. If the lip of the riser pipe is not flat, the reference point may be located on the grout apron or the top of the outer protective casing (if present). The measurement reference point should be documented in the site logbook and on the groundwater level data form (Appendix A), if used. All field personnel must be made aware of the measurement reference point being used in order to ensure the collection of comparable data.

Before measurements are made, water levels in piezometers and monitor wells should be allowed to stabilize for a minimum of 24 hours after well construction and development. In low yield situations, recovery of water levels to equilibrium may take longer. All measurements should be made to an accuracy of 0.01 feet. Water level measuring equipment must be decontaminated and, in general, measurements should proceed from the least to the most contaminated wells.

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Open the well and monitor the headspace with the appropriate air monitoring instrument to determine the presence of volatile organic compounds. For electrical sounders lower the device into the well until the water surface is reached as indicated by a tone or meter deflection. Record the distance from the water surface to the reference point. Measurement with a chalked tape will necessitate lowering the tape below the water level and holding a convenient foot marker at the reference point. Record both the water level as indicated on the chalked tape section and the depth mark held at the reference point The depth to water is the difference between the two readings. Remove measuring device, replace riser pipe cap, and decontaminate equipment as necessary. Note that if a separate phase is present, an oil/water indicator probe is required for measurement of product thickness and water level.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This section is not applicable to this standard operating procedure (SOP).

4.0 POTENTIAL PROBLEMS

1. Cascading water, particularly in open-hole or rock wells, may interfere with the measurement.

2. Some older types of electric sounders are only marked at five-foot intervals. A surveyor's tape is necessary to extrapolate between the 5-foot marks.

3. Oil or other product floating on the water column can insulate the contacts of the probe on an electric sounder and give false readings. For accurate level measurements in wells containing floating product, a special oil/water level indicator is required.

4. Tapes (electrical or surveyor's) may have damaged or missing sections, or may be spliced inaccurately.

5. An airline may be the only available means to make measurements in sealed production wells but the method is generally accurate only to approximately 0.2 foot.

6. When using a steel tape, it is necessary to lower the tape below the water level in order to make a measurement. This assumes knowledge of the approximate groundwater level.

5.0 EQUIPMENT

The electric water level indicator and the chalked steel tape are the devices commonly used to measure water levels. Both have an accuracy of 0.01 feet. Other field equipment may include:

- Air monitoring instrumentation

- Well depth measurement device
- Chalk
- Ruler
- Site logbook
- Paper towels and trash bags
- Decontamination supplies as outlined in Section 7.2 or the current approved site specific work plan
- Groundwater level data forms

6.0 REAGENTS

No chemical reagents are used in this procedure; however, decontamination solutions may be necessary. If decontamination of equipment is required, refer to ERT/REAC SOP #2006 Rev 0.0 08/11/94, *Sampling Equipment Decontamination*, and the current approved site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the number of measurements needed, the methods to be employed, and the equipment and supplies needed.
2. Decontaminate or pre-clean equipment, and ensure that it is in working order.
3. Coordinate schedule with staff, clients, and regulatory agency, if appropriate.
4. If this is an initial visit, perform a general site survey prior to site entry in accordance with the current approved site specific Health and Safety Plan.
5. Identify sampling locations.

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7.2 Procedures

Procedures for determining water levels are as follows:

1. If possible, and when applicable, start at those wells that are least contaminated and proceed to those wells that are most contaminated.

2. Clean all the equipment entering the well(s) by the following decontamination procedure:

   - Triple rinse equipment with deionized water.
   - Wash equipment with an Alconox solution which is followed by a deionized water rinse.
   - Rinse with an approved solvent (e.g., methanol, isopropyl alcohol, acetone) as per the work plan, if organic contamination is suspected.
   - Place equipment on clean surface such as a teflon or polyethylene sheet to air dry.

3. Remove locking well cap, note well ID, time of day, and date in site logbook or an appropriate groundwater level data form.

4. Remove well cap.

5. If required by site-specific condition, monitor headspace of well with a photoionization detector (PID) or flame ionization detector (FID) to determine presence of volatile organic compounds, and record results in site logbook.

7. Lower water-level measuring device into the well. Electrical tapes are lowered to the water surface whereas chalked steel tapes are lowered generally a foot or more below the water surface. Steel tapes are generally chalked so that a 1-to 5-foot long section will fall below the expected water level.

8. For electrical tapes record the distance from the water surface, as determined by the audio signal or meter, to the reference measuring point and record in the site logbook. For chalked tapes, an even foot mark is held at the reference point, once the chalked section of the tape is below the water level. Both the water level on the tape and the foot mark held at the reference point is recorded. The depth to the water is then the difference between the two readings. In addition, note the reference point used (top of the outer casing, top of the riser pipe, ground surface, or some other reproducible position

on the well head). Repeat the measurement.

9. Remove all downhole equipment, replace well cap and locking steel caps.

10. Rinse all downhole equipment and store for transport to the next well. Decontaminate all equipment as outlined in Step 2 above.

11. Note any physical changes, such as erosion or cracks in protective concrete pad or variation in total depth of well, in field logbook or on groundwater level data form.

8.0 CALCULATIONS

To determine groundwater elevation above mean sea level, use the following equation:

$$E_W = E - D$$

where:

E_W	=	Elevation of water above mean sea level (feet) or local datum
E	=	Elevation above sea level or local datum at point of measurement (feet)
D	=	Depth to water (feet)

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance/quality control (QA/QC) procedures apply:

1. All data must be documented on field data sheets, groundwater level data forms, or within personal or site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.

3. Each well should be tested at least twice in order to compare results. If results do not agree to within 0.02 feet, a third measurement should be taken and the readings averaged. Consistent failure of consecutive readings to agree suggests that levels are changing because of one or more conditions as indicated in Section 1.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

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11.0 HEALTH AND SAFETY

The results of monitoring the well head and breathing zone with a FID or PID, as per section 7.2, may indicate the need to upgrade the personal protection level according to the current approved site Health and Safety Plan.

12.0 REFERENCES

Driscoll, F.G. 1986. Groundwater and Wells. Second Edition. Chapter 16. *Collection and Analysis of Pumping Test Data*. pp 534-579. Johnson Filtration Systems Inc. St. Paul, Minnesota.

U.S. Environmental Protection Agency, 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document, pp. 207.

U.S. Environmental Protection Agency, 1987, A Compendium of Superfund Field Operations Methods. EPA/540/p-87/001 Office of Emergency and Remedial Response Washington, D.C. 20460.

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APPENDIX A
Groundwater Level Data Form
SOP #2043
February 2000

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MANUAL WATER LEVEL MEASUREMENTS

FORM 1. Groundwater Level Data Form

PAGE __ OF __

SITE NAME:_____ LOGGER NAME: _____

LOG DATE: _____ WBS #: RIA _____

Well I.D.	Time	Elevation of well[1] (T.O.C.)	Depth to bottom of well (ft)	Depth to water (ft)	Depth to product (ft)	COMMENTS (pH, temperature, specific conductance)

TOC: top of casing (1) feet above mean sea level

MEASUREMENT REFERENCE POINT FROM __ GROUND SURFACE OR __ TOP OF CASING

Weather Conditions: Temperature(°C):_____ Rain: Heavy Medium Light (Circle one)

Other significant observations:

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CONTROLLED PUMPING TEST

1.0 SCOPE AND APPLICATION

The most reliable and commonly used method of determining aquifer characteristics is by controlled aquifer pumping tests. Groundwater flow varies in space and time and depends on the hydraulic properties of the rocks and the boundary conditions imposed on the groundwater system. Pumping tests provide results that are more representative of aquifer characteristics than those predicted by slug or bailer tests. Pumping tests require a greater degree of activity and expense, however, and are not always justified for all levels of investigation. As an example, slug tests may be acceptable at the reconnaissance level whereas pumping tests are usually performed as part of a feasibility study in support of designs for aquifer remediation.

Aquifer characteristics which may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (Sy) for unconfined aquifers, and storage coefficient (S) for confined aquifers. These parameters can be determined by graphical solutions and computerized programs. The purpose of this standard operating procedure (SOP) is to outline the protocol for conducting controlled pumping test.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

It is desirable to monitor pre-test water levels at the test site for about one week prior to performance of the pump test. This information allows for the determination of the barometric efficiency of the aquifer, as well as noting changes in head, due to recharging or pumping in the area adjacent to the well. Prior to initiating the long term pump test, a step test is conducted to estimate the greatest flow rate that may be sustained by the pump well.

After the pumping well has recovered from the step test, the long term pumping test begins. At the beginning of the test, the discharge rate is set as quickly and accurately as possible. The water levels in the pumping well and observation wells are recorded accordingly with a set schedule. Data is entered on the Pump/Recovery Test Data Sheet (Appendix A). The duration of the test is determinated by project needs and aquifer properties, but rarely goes beyond three days or until water levels become constant.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Interferences and potential problems include atmospheric conditions, impact of local potable wells, and compression of the aquifer due to trains, heavy traffic, etc.

5.0 EQUIPMENT/APPARATUS

The following equipment is required to perform a pump test:

- Tape measure (subdivided into tenths of feet)
- Submersible pump

- Water pressure transducer
- Electric water level indicator
- Weighted tapes
- Steel tape (subdivided into tenths of feet)
- Generator
- Electronic data-logger (if transducer method is used)
- Watch or stopwatch with second hand
- Semi-log graph paper (if required)
- Water proof ink pen and logbook
- Thermometer
- Appropriate references and calculator
- A barometer or recording barograph (for tests conducted in confined aquifers)
- Heat shrinks
- Electrical tape
- Flashlights and lanterns
- pH meter
- Conductivity meter
- Discharge pipe
- Flow meter

6.0 REAGENTS

No chemical reagents are used for this procedure; however, decontamination solutions may be necessary. If decontamination of equipment is required, refer to the SOP for Sampling Equipment Decontamination and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Identify and mark all sampling locations.

7.2 Field Preparation

1. Review the site work plan and become familiar with information on the wells to be tested.

2. Check and ensure the proper operation of all field equipment. Ensure that the electronic data-logger is fully charged, if appropriate. Test the electronic data-logger using a container of water. Always bring additional transducers in case of malfunctions.

3. Assemble a sufficient number of field data forms to complete the field assignment.

4. The pumping well should be properly developed prior to testing, following the guidelines outlined in the Well Development SOP.

5. An orifice, weir, flow meter, container or other type of water measuring device to accurately measure and monitor the discharge from the pumping well shall be provided.

6. Sufficient pipe to transport the discharge from the pumping well to an area beyond the expected cone of depression is needed. Conducting a pumping test in contaminated groundwater may require treatment, special handling, or a discharge permit before the water can be discharged.

7. The discharge pipe must have a gate valve to control the pumping rate.

8. Determine if there is an outlet near the well head for water quality determination and sampling.

7.3 Pre-Test Monitoring

It is desirable to monitor pretest water levels at the test site for about one week prior to performance of the test. This can be accomplished by using a continuous-recording device such as a Stevens Recorder. This information allows the determination of the barometric efficiency of the aquifer when

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barometric records are available. It also helps determine if the aquifer is experiencing an increase or decrease in head with time due to recharge or pumping in the nearby area, or diurnal effects of evapotranspiration. Changes in barometric pressure are recorded during the test (preferably with an on-site barograph) in order to correct water levels for any possible fluctuations which may occur due to changing atmospheric conditions. Pretest water level trends are projected for the duration of the test. These trends and/or barometric changes are used to "correct" water levels during the test so they are representative of the hydraulic response of the aquifer due to pumping of the test well.

7.4 Step Test

Prior to initiating a long term pumping test, a step test shall be conducted. The purpose of a step test is to estimate the greatest flow rate that may be sustained during a long term test. The test shall be performed by progressively increasing the flow rate on one hour intervals. The generated drawdown versus time data is plotted on semilogarithmic graph paper, and the discharge rate is determined from this graph.

7.5 Pump Test

7.5.1 Time Intervals

After the pumping well has fully recovered from the step test, the long term pumping test may start. At the beginning of the test, the discharge rate should be set as quickly and accurately as possible. The water levels in the pumping well and observation wells will be recorded according to the following schedule:

TABLE 1. Time Intervals for Measuring Drawdown in the Pumped Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-10	.5-1
10-15	1
15-60	5
60-300	30
300-1440	60
1440-termination	480

TABLE 2. Time Intervals for Measuring Drawdown in an Observation Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-60	2
60-120	5
120-240	10
240-360	30
360-1440	60
1440-termination	480

7.5.2 Water Level Measurements

Water levels will be measured as specified in the Well Level Measurement SOP. During the early part of the test, sufficient personnel should be available to have at least one person at each observation well and at the pumping well. After the first two hours, two people are usually sufficient to continue the test. It is not necessary that readings at the wells be taken simultaneously. It is very important that depth to water readings be measured accurately and readings recorded at the exact time measured. Alternately, individual pressure transducers and electronic data-loggers may be used to reduce the number of field personnel hours required to complete the pumping test. A typical aquifer pump test form is shown in Appendix A.

During a pumping test, the following data must be recorded accurately on the aquifer test data form.

1. Site ID - A number assigned to identify a specific site.

2. Location - The location of the well in which water level measurements are being taken.

3. Distance from Pumped Well - Distance the observation well is from the pumping well in feet.

4. Logger - The company conducting the pumping test.

5. Test Start Date - The date when the pumping test began.

6. Test Start Time - Start time, using a 24-hour clock.

7. Static Water Level (Test Start) - Depth to water, in feet and tenths of feet, in the observation well at the beginning of the pumping test.

8. Test End Date - The date when the pumping test was completed.

9. Test End Time - End time, using a 24-hour clock.

10. Static Water Level (Test End) - Depth to water, in feet and tenths of feet, in the observation well at the end of the pumping test.

11. Average Pumping Rate - Summation of all entries recorded in the Pumping Rate (gal/min) column divided by the total number of Pumping Rate (gal/min) readings.

12. Measurement Methods - Type of instrument used to measure depth-to-water (this may include steel tape, electric sounding probes, Stevens recorders, or pressure transducers).

13. Comments - Appropriate observations or information which has not been recorded elsewhere, including notes on sampling.

14. Elapsed Time (min) - Time of measurement record continuously from time 0.00 (start of test) recorded in minutes.

15. Depth to Water (ft) - Depth to water, in feet and tenths of feet, in the observation well at the time of the water level measurement.

16. Pumping Rate (gal/min) - Flow rate of pump measured from an orifice, weir, flow meter, container or other type of water measuring device.

7.5.3 Test Duration

The duration of the test is determined by the needs of the project and properties of the aquifer. One simple test for determining adequacy of data is when the log-time versus drawdown for the most distant observation well begins to plot as a straight line on the semi-log graph paper. There are several exceptions to this simple rule of thumb; therefore, it should be considered a minimum criteria. Different hydrogeologic conditions can produce straight line trends on log-time versus drawdown plots. In general, longer tests produce more definitive results. A duration of one to three days is desirable, followed by a similar period of monitoring the recovery of the water level. Unconfined aquifers and partially penetrating wells may have shorter test durations. Knowledge of the local hydrogeology, combined with a clear understanding of the overall project objectives is necessary in interpreting just how long the test should be conducted. There is no need to continue the test if the water level becomes constant with time. This normally indicates that a hydrogeologic source has been intercepted and that additional useful information will not be collected by continued pumping.

7.6 Post Operation

The following activities shall be performed after completion of water level recovery measurements.

1. Decontaminate and/or dispose of equipment as per the Sampling Equipment Decontamination SOP.

2. When using an electronic data-logger, use the following procedures.

   - Stop logging sequence.
   - Print data, or save memory and disconnect battery at the end of the day's activities.

3. Replace testing equipment in storage containers.

4. Check sampling equipment and supplies. Repair or replace all broken or damaged equipment.

5. Review field forms for completeness.

6. Interpret pumping/recovery test field results.

8.0 CALCULATIONS

There are several accepted methods for determining

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aquifer properties such as transmissivity, storativity, and conductivity. However, the method to use is dependent on the characteristics of the aquifer being tested (confined, unconfined, leaky confining layer etc.). When reviewing pump test data the following texts may be used to determine the method most appropriate to your case.

- Applied Hydrogeology (Fetter, 1980).
- Groundwater and Wells (Driscoll, 1986).
- Groundwater (Freeze & Cherry, 1979).

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

All gauges, transducers, flow meters, and other equipment used in conducting pumping tests shall be calibrated before use at the site. Copies of the documentation of instrumentation calibration should be obtained and filed with the test data records. The calibration records will consist of laboratory measurements and, if necessary, any on-site zero adjustment and/or calibration will be performed. Where possible, all flow and measurement meters will be checked on-site using a container of measured volume and stopwatch; the accuracy of the meters must be verified before testing proceeds.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, following U.S. EPA, OSHA, and corporate health and safety practices.

12.0 REFERENCES

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APPENDIX A

Pump/Recovery Test Data Sheet

PAGE __ OF __

PUMP/RECOVERY TEST DATA SHEET

SITE ID: DISTANCE FROM PUMPED WELL (FT):

LOCATION: LOGGER:

TEST START

DATE:

TIME:

STATIC WATER LEVEL (FT): __

TEST END

DATE:

TIME:

STATIC WATER LEVEL (FT): __

AVERAGE PUMPING RATE (GAL/MIN):

MEASUREMENT METHODS:

COMMENTS:

ELAPSED TIME (MIN)	PUMP TEST DEPTH TO WATER (FT)	PUMPING RATE (GAL/MIN)	RECOVERY TEST ELAPSED TIME (MIN)	DEPTH TO WATER (FT)
0.00			0.00	

APPENDIX A (Cont'd)

Pump/Recovery Test Data Sheet

PAGE __ OF __

PUMP/RECOVERY TEST DATA

SITE:

LOCATION ID: DATE:

ELAPSED TIME (MIN)	PUMP TEST DEPTH TO WATER (FT)	PUMPING RATE (GAL/MIN)	RECOVERY TEST ELAPSED TIME (MIN)	DEPTH TO WATER (FT)
0.00			0.00	

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United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-93/503 February 1993

Ground Water Issue

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Suggested Operating Procedures for Aquifer Pumping Tests

Paul S. Osborne*

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange up-to-date information related to ground water remediation at Superfund sites.

A very important aspect of ground water remediation is the capability to determine accurate estimates of aquifer hydraulic characteristics. This document was developed to provide an overview of all the elements of an aquifer test to assist RPMs and OSCs in the initial design of such tests or in the review of tests performed by other groups.

For further information, contact Jerry Thornhill, RSKERL-Ada, 405/436-8604 or Paul Osborne, EPA Region VIII, 303/293-1418.

INTRODUCTION

In recent years, there has been an increased interest in ground water resources throughout the United States. This interest has resulted from a combination of an increase in ground water development for public and domestic use; an increase in mining, agricultural, and industrial activities which might impact ground water quality; and an increase in studies of already contaminated aquifers. Decision-making agencies involved in these ground water activities require studies of the aquifers to develop reliable information on the hydrologic properties and behavior of aquifers and aquitards.

The most reliable type of aquifer test usually conducted is a pumping test. In addition, some site studies involve the use of short term slug tests to obtain estimates of hydraulic conductivity, usually for a specific zone or very limited portion of the aquifer. It should be emphasized that slug tests provide very limited information on the hydraulic properties of the aquifer and often produce estimates which are only accurate within an order of magnitude. Many experts believe that slug tests are much too heavily relied upon in site characterization and contamination studies. This group of professionals recommends use of slug testing during the initial site studies to assist in developing a site conceptual model and in pumping test design.

This document is intended as a primer, describing the process for the design and performance of an “aquifer test” (how to obtain reliable data from a pumping test) to obtain accurate estimates of aquifer parameters. It is intended for use by those professionals involved in characterizing sites which require corrective action as well as those which are proposed for ground water development, agricultural development, industrial development, or disposal activities. The goal of the document is to provide the reader with a complete picture of all of the elements of aquifer (pumping) test design and performance and an understanding of how those elements can affect the quality of the final data.

The determination of accurate estimates of aquifer hydraulic characteristics is dependent on the availability of reliable data from an aquifer test. This document outlines the planning, equipment, and test procedures for designing and conducting an accurate aquifer test. The design and operation of a slug test is not included in this document, although slug tests are often run prior to the design and implementation of an aquifer test. The slug test information can be very useful in developing the aquifer test design (see ASTM D-18

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Committee, D4050 and D4104). If an accurate conceptual model of the site is developed and the proper equipment, wells, and procedures are selected during the design phase, the resulting data should be reliable. The aquifer estimates obtained from analyzing the data will, of course, depend on the method of analysis.

This document is not intended to be an overview of aquifer test analysis. The analysis and evaluation of pumping test data is adequately covered by numerous texts on the subject (Dawson and Istok, 1991; Kruseman and de Ridder, 1991; Walton, 1962; and Ferris, Knowles, Brown, and Stallman, 1962). It should be emphasized, however, that information on the methods for analyzing test data should be reviewed in detail during the planning phase. This is especially important for determining the number, location, and construction details for all wells involved in the test.

A simple "pump" (specific capacity) test involves the pumping of a single well with no associated observation wells. The purpose of a pump test is to obtain information on well yield, observed drawdown, pump efficiency, and calculated specific capacity. The information is used mainly for developing the final design of the pump facility and water delivery system. The pump test usually has a duration of 2 to 12 hours with periodic water level and discharge measurements. The pump is generally allowed to run at maximum capacity with little or no attempt to maintain constant discharge. Discharge variations are often as high as 50 percent. Short-term pump tests with poor control of discharge are not suitable for estimating parameters needed for adequate aquifer characterization. If the pump test is, however, run in such a way that the discharge rate varies less than 5 percent and water levels are measured frequently, the test data can also be used to obtain some reliable estimates of aquifer performance. It should be emphasized that an estimate of aquifer transmissivity obtained in this manner will not be as accurate as that obtained using an aquifer test including observation wells.

By controlling the discharge variation and pumping for a sufficient duration, it is possible to obtain reliable estimates of transmissivity using water level data obtained during the pump test. However, this method does not provide information on boundaries, storativity, leaky aquifers, and other information needed to adequately characterize the hydrology of an aquifer. For the purpose of this document, an aquifer test is defined as a controlled field experiment using a discharging (control) well and at least one observation well.

The aquifer test is accomplished by applying a known stress to an aquifer of known or assumed dimensions and observing the water level response over time. Hydraulic characteristics which can be estimated, if the test is designed and implemented properly, include the coefficient of storage, specific yield, transmissivity, vertical and horizontal permeability, and confining layer leakage. Depending on the location of observation wells, it may be possible to determine the location of aquifer boundaries. If measurements are made on nearby springs, it may also be possible to determine the impact of pumping on surface-water features.

TEST DESIGN

Adequate attention to the planning and design phase of the aquifer pumping test will assure that the effort and expense of conducting a test will produce useful results. Individuals involved in designing an aquifer test should review the relevant ASTM Standards relating to: 1) appropriate field procedures for determining aquifer hydraulic properties (D4050 and D4106); 2) selection of aquifer test method (D4043); and 3) design and installation of ground water monitoring wells (D5092). The relevant portions of these standards should be incorporated into the design.

All available information regarding the aquifer and the site should be collected and reviewed at the commencement of the test design phase. This information will provide the basis for development of a conceptual model of the site and for selecting the final design. It is important that the geometry of the site, location and depth of observation wells and piezometers, and the pumping period agree with the mathematical model to be used in the analysis of the data. A test should be designed for the most important parameters to be determined, and other parameters may have to be de-emphasized.

Aquifer Data Needs

The initial element of the test design, formulating a conceptual model of the site, involves the collection and analysis of existing data regarding the aquifer and related geologic and hydrologic units. All available information on the aquifer itself, such as saturated thickness, locations of aquifer boundaries, locations of springs, information on all on-site and all nearby wells (construction, well logs, pumping schedules, etc.), estimates of regional transmissivities, and other pertinent data, should be collected. Detailed information relating to the geology and hydrology is needed to formulate the conceptual model and to determine which mathematical model should be utilized to estimate the most important parameters. It is also important to review various methods for the analyses and evaluation of pumping test data (Ferris, Knowles, Brown, and Stallman, 1962; Kruseman and De Ridder, 1991; and Walton, 1962 and 1970). Information relating to the various analytical methods and associated data needs will assist the hydrologist in reviewing the existing data, identifying gaps in information, and formulating a program for filling any gaps that exist.

The conceptual model of the site should be prepared after carrying out a detailed site visit and an evaluation of the assembled information. The review of available records should include files available from the U. S. Geological Survey, appropriate state agencies, and information from local drillers with experience in the area. Formulation of a conceptual model should include a brief analysis of how the local hydrology/geology fits into the regional hydrogeologic setting.

Aquifer Location

The depth to, thickness of, areal extent of, and lithology of the aquifer to be tested should be delineated, if possible.

Aquifer Boundaries

Nearby aquifer discontinuities caused by changes in lithology or by incised streams and lakes should be mapped. All known and suspected boundaries should be mapped such that

observation wells can be placed (chosen) where they will provide the best opportunity to measure the aquifer's response to the pumping and the boundary effects during the pumping test.

Hydraulic Properties

Estimates of all pertinent hydraulic properties of the aquifers and pertinent geologic units must be made by any means feasible. Estimates of transmissivity and the storage coefficient should be made, and if leaky confining beds are detected, leakage coefficients should be estimated. The estimation of transmissivity and the storage coefficient should be carried out by making a close examination of existing well logs and core data in the area or by gathering information from nearby aquifer tests, slug tests, or drill stem tests conducted on the aquifer(s) in question. It may also be feasible to run a slug test on the wells near the site to get preliminary values. (See ASTM Committee D-18 Standards D4044 and D4104). It should be noted that some investigators have found that slug tests often produce results which are as much as an order of magnitude low. Although some investigators have reported results which are two orders of magnitude high because the sand pack dominated the test. Such tests will, however, provide a starting point for the design. If no core analyses are available, the well log review should form a basis for utilizing an available table which correlates the type of aquifer material with the hydraulic conductivity. If detailed sample results from drill holes are available and they have grain size analyses, there are empirical formulas for estimation of transmissivity. Estimation of storage coefficient is more difficult, but can be based on the expected porosity of the material or the expected confinement of the aquifer. It is recommended that a range of values be chosen to provide a worst case and best case scenario (Freeze and Cherry, 1979). Trial calculations of well drawdown using these estimated values should be made to finalize the design, location, and operation of test and observation wells (Ferris and others, 1962; Campbell and Lehr, 1972; and Stallman, 1971).

If local perched aquifers are of a significant size and location to impact the pump test, this impact should be estimated if possible. The final test design should include adequate monitoring of any perched aquifers and leaky confining beds. This might involve the placing of piezometers into and/or above the leaky confining zone or into the perched aquifer.

Evaluation of Existing Well Information

Because the drilling of new production wells and observation wells expressly for an aquifer test can be expensive, it is advisable to use existing wells for conducting an aquifer test when possible. However, many existing wells are not suitable for aquifer testing. They may be unsuitably constructed (such as a well which is not completed in the same aquifer zone as the pumping well) or may be inappropriately located. It is also important to note that well logs and well completion data for existing facilities are not always reliable. Existing data should be verified whenever possible. The design of each well, whether existing or to be drilled, must be carefully considered to determine if it will meet the needs of the proposed test plan and analytical methods. Special attention must be paid to well location, the depth and interval of the well screen or perforation, and the present condition of existing perforations.

After the process of developing the site model and determining which analytical methods should be used, it is possible to move to the final design stage. The final stage of the design involves development of the key elements of the aquifer test: 1) number and location of observation wells; 2) design of observation wells; 3) approximate duration of the test; and 4) discharge rate.

Design of Pumping Facility

There are seven principal elements to be considered during the pumping facility design phase: 1) well construction; 2) the well development procedure; 3) well access for water level measurements; 4) a reliable power source; 5) the type of pump; 6) the discharge-control and measurement equipment; and 7) the method of water disposal. These elements are discussed in the following sections.

Well Construction

The diameter, depth and position of all intervals open to the aquifer in the pumping well should be known, as should total depth. The diameter must be large enough to accommodate a test pump and allow for water level measurements. All openings to the aquifer(s) must be known and only those openings located in the aquifer to be tested should be open to the well during the testing. If the pumping well has to be drilled, the type, size, and number of perforations should be established using data from existing well logs and from the information obtained during the drilling of the new well itself. The screen or perforated interval should be designed to have sufficient open area to minimize well losses caused by fluid entry into the well (Campbell and Lehr, 1972; and Driscoll, 1986).

A well into an unconsolidated aquifer should be completed with a filter pack in the annular space between the well screen and the aquifer material. To design an adequate filter pack, it is essential that the grain size makeup of the aquifer be defined. This is generally done by running a sieve analysis of the major lithologic units making up the aquifer. The sizing of the filter pack will depend on the grain size distribution of the aquifer material. The well screen size would be established by the sizing of the chosen filter pack (Driscoll,1986). The filter pack should extend at least one (1) foot above the top of the well screen. A seal of bentonite pellets should be placed on top of the filter pack. A minimum of three (3) feet of pellets should be used. An annulus seal of cement and/or bentonite grout should be placed on top of the bentonite pellets. The well casing should be protected at the surface with a concrete pad around the well to isolate the wellbore from surface runoff (ASTM Committee D-18, D5092; and Barcelona, Gibb, and Miller, 1983).

Well Development

Information on how the pumping well was constructed and developed should be collected during the review of existing site information. It may be necessary to interview the driller. If the well has not been adequately developed, the data collected from the well may not be representative of the aquifer. For instance, the efficiency of the well may be reduced, thereby causing increased drawdown in the pumping well. When a well is pumped, there are two components of

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drawdown: 1) the head losses in the aquifer; and 2) the head losses associated with entry into the well. A well which is poorly constructed or has a plugged well screen will have a high head loss associated with entry into the well. These losses will affect the accuracy of the estimates of aquifer hydraulic parameters made using data from that well. If the well is suspected to have been poorly developed, or nothing is known, it is advisable to run a step drawdown test on the well to determine the extent of the problem. The step drawdown test entails conducting three or more steps of increasing discharge, producing drawdown curves such as shown in Figure 1. The data provided by the step drawdown test (multiple discharge test) can be analyzed using various techniques (Rorabough, 1953; and Driscoll, 1986) to obtain an estimate of well entry losses. If a determination is made that plugging results in significant losses, the well should be redeveloped prior to the pumping test using a surge block and/ or a pump until the well discharge is clear: i. e. the development results in the well achieving acceptable turbidity unit limits (Driscoll, 1986). In many cases, running a step drawdown test to determine well efficiency after the well has been surged is needed to assess the results of the development process. The results of the post development test should be compared with the step-drawdown test run prior to development. This analysis will provide a means of verifying the success of the well development.

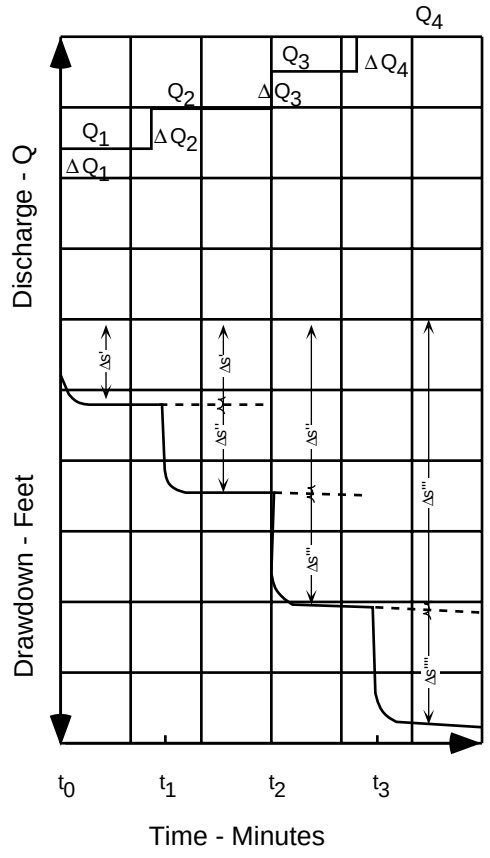

Figure 1. Variation of discharge and drawdown in multiple discharge tests (step drawdown tests).

Water Level Measurement Access

It must be possible to measure depth to the water level in the pumping well before, during, and after pumping. The quickest and generally the most accurate means of measuring the water levels in the pumped well during an aquifer test is to use an electric sounder or pressure transducer system. The transducer system may be expensive and may be difficult to install in an existing well. It may be possible to run a 1/4 inch copper line into the well as an air line. If the control well is newly constructed, the continuous copper line should be strapped to the pump column as it is being installed. If it is correctly installed, an air line can be used with somewhat less accuracy than an electric sounder or steel tape. An air line with a bubbler and either a transducer or precision pressure gage should be adequate for running an aquifer test.

With adequate temperature compensation, a surface mounted pressure transducer is as precise as one that is submerged. Steel tapes cannot always be used quickly enough in a pumping well, except in wells with a small depth to water (less than 100 feet) where the pump test crew has a fair amount of experience and the well is modified for access of the steel tape. Such modification often involves hanging a 3/4 inch pipe in the well as access for the steel tape. The pipe should be capped at the bottom with numerous 1/16 to 1/8 inch holes drilled in the pipe and cap (especially needed for wells subject to cascading water or surging). This will dampen water-level surging caused by the pump and will eliminate the problems caused by cascading water. In general, the use of a steel tape is usually confined to the later stages of the pump test where rapid changes in water levels are not occurring.

In cases where the pump is isolated by a packer to allow production from a particular zone, a transducer system should be used to monitor pumping hydraulic heads. It is important, however, to calibrate the transducers before and after the test. In addition, reference checks with an electric sounder or steel tape should be made before, during, and after the test. The ASTM Standard Test Method for determining subsurface liquid levels in a borehole or monitoring well (D4750) should be reviewed as part of the design process.

Reliable Power Source

Having power continuously available to the pump, for the duration of the test, is crucial to the success of the test. If power is interrupted during the test, it may be necessary to terminate the test and allow for sufficient recovery so that pre-pumping water-level trends can be extrapolated. At that point, a new test would be run. If, however, brief interruptions in power occur late in the test, the affect of the interruption can be eliminated by pumping at a calculated higher rate for some period so that the average rate remains unchanged. The increased rate must be calculated such that the final portion of the test compensates for the pumpage that would have occurred during the interruption of pumping.

Pump Selection

A reliable pump is a necessity during an aquifer test. The pump should be operated continuously during the test. Should a pump fail during the pumping period of the test, the time, effort, and expense of conducting the test could be

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wasted. Electrically powered pumps produce the most constant discharge and are often recommended for use during an aquifer test. However, in irrigation areas, line loads can fluctuate greatly, causing variations in the pumping rate of electric motors. Furthermore, electric motors are nearly constant-load devices, so that as the lift increases (water level declines), the pumping rate decreases. This is a particular problem for inefficient wells or low transmissivity aquifers.

The discharge of engine-powered (usually gasoline or diesel) pumps may vary greatly over a 24 hour period, requiring more frequent monitoring of the discharge rate during the test. For example, under extreme conditions a diesel-powered turbine pump may have more than a 10 percent change in discharge as a result of the daily variation in temperature. The change in air temperature affects the combustion ratio of the engine resulting in a variation in engine revolutions per minute (rpm). The greater the daily temperature range,the greater the range in engine rpm. Variations in barometric pressure may also affect the engine operation and resulting rpm. Running the engine at full throttle will reduce operational flexibility for adjusting engine rpm and the resulting discharge. In areas where outside temperatures are extreme, such as the desert or a very cold region, it may be advisable to undertake measures to prevent the engine from overheating or freezing.

In order to obtain good data during the period of recovery at the end of pumping, it is necessary to have a check valve installed at the base of the pump column pipe in the discharging well. This will prevent the back flow of water from the column pipe into the well when the pumping portion of the test is terminated and the recovery begins. Any back flow into the well will interfere with or totally mask the water level recovery of the aquifer and this would make any aquifer analysis based on recovery data useless or, at best, questionable (Schafer, 1978).

Discharge-Control and Measurement Equipment

The well bore and discharge lines should be accessible for installing discharge control and monitoring equipment. When considering an existing well for the test well to be pumped (control well), the well must either already be equipped with discharge measuring and regulating equipment, or the well must have been constructed such that the necessary equipment can be added.

Control of the pumping rate during the test requires an accurate means for measuring the discharge of the pump and a convenient means of adjusting the rate to keep it as nearly constant as possible. Common methods of measuring well discharge include the use of an orifice plate and manometer, an inline flow meter, an inline calibrated pitot tube, a calibrated weir or flume, or, for low discharge rates, observing the length of time taken for the discharging water to fill a container of known volume (e.g. 5 gallon bucket; 55 gallon drum).

In addition to the potentially large variation in discharge associated with the pump motor or engine, the discharge rate is also related to the drop in water level near the pumping well during the aquifer test. As the pumping lift increases, the rate of discharge at a given level of power (such as engine rpm) will decrease. The pump should not be operated at its maximum rate. As a general rule, the pumping unit, including the engine, should be designed so that the maximum pumping rate is at least 20 percent more than the estimated long term sustainable yield of the aquifer. The long term yield of the aquifer should be determined by collecting data on pumping rates in nearby wells. If possible, a short term test of one to two hours should be run when the pump is installed. This test data should be compared to the historic data as part of the estimation process.

The pumping rate can be controlled by placing valves on the discharge line and/or by placing controls on the pump power source. A valve installed in the discharge line to create back pressure provides effective control of the discharge rate while conducting an aquifer test, especially when using an electric-powered pump. A rheostatic control on the electric pump will also allow accurate control of the discharge rate. When an engine-powered pump is being utilized, installation of a micrometer throttle adjustment device to accurately control engine rpm is recommended in addition to a valve in the line.

Water Disposal

Discharging water immediately adjacent to the pumping well can cause problems with the aquifer test, especially in tests of permeable unconfined alluvial aquifers. The water becomes a source of recharge which will affect the results of the test. It is essential that the volumes of produced water, the storage needs, the disposal alternatives, and the treatment needs be assessed early in the planning process. The produced water from the test well must be transported away from the control well and observation wells so it cannot return to the aquifer during the test. This may necessitate the laying of a temporary pipeline (sprinkler irrigation line is often used) to convey the discharge water a sufficient distance from the test site. In some cases, it may be necessary to have on-site storage, such as steel storage tanks or lined ponds. This is especially critical when testing contaminated zones where water treatment capacity is not available. The test designer should carefully review applicable requirements of the RCRA hazardous waste program, the underground injection control program, and the surface water discharge program prior to making decisions about this phase of the design. It may be necessary to obtain permits for on-site storage and final disposal of the contaminated fluids. Final disposal could involve treatment and reinjection into the source aquifer or appropriate treatment and discharge.

Design of Observation Well(s)

Verification of well response

As part of the process of selecting the location of the observation wells needed for the chosen aquifer test design, existing wells should be tested for their suitability as observation wells. The existing information regarding well construction should be reviewed as a screening mechanism for identifying suitable candidates. The wells that are identified as potential observation wells should be field tested to verify that they are suitable for monitoring aquifer response. The perforations or well screens of abandoned wells tend to become restricted by the buildup of iron compounds, carbonate compounds, sulfate compounds or bacterial growth as a result of not pumping the well. Consequently, the response test is one of the most important pre-pumping examinations to be made if such wells are to be used for observation (Stallman, 1971; and Black and Kip, 1977). The

reaction of all wells to changing water levels should be tested by injecting or removing a known volume of water into each well and measuring the subsequent change of water level. Any wells which appear to have poor response should be either redeveloped, replaced, or dropped from consideration in favor of another available well selected.

Total Depth

In general, observation wells should penetrate the tested aquifer to the same stratigraphic horizon as the well screen or perforated interval of the pumping well. This will require close evaluation of logs to adjust for dipping formations. This assumes the observation well is to be used for monitoring response in the same aquifer from which the discharging well is pumping. Actual screen design will depend on aquifer geometry and site specific lithology. If the aquifer test is designed to detect hydraulic connection between aquifers, one observation well should be screened in the strata for which hydraulic inter-connection is suspected. Depending on how much information is needed, additional wells screened in other strata may be needed (Bredehoeft and others, 1983; Walton, 1970; Dawson and Istok, 1991; and Hamlin, 1983).

Well Diameter

In general, observation well casing should have a diameter just large enough to allow for accurate, rapid water level measurements. A two-inch well casing is usually adequate for use as an observation well in shallow aquifers which are less than 100 feet in depth. They are, however, often difficult to develop. A four- to six-inch diameter well will withstand a more vigorous development process, and should have better aquifer response when properly developed. Additionally, a four or six inch diameter well may be required if a water-depth recorder is planned, depending on the type of recording equipment to be used. The difficulties in drilling a straight hole usually dictate that a well over 200 feet deep be at least four inches in diameter.

Well Construction

Ideally, the observation well(s) should have five to twenty feet of perforated casing or well screen near the bottom of the well. The final well screened interval(s) will depend on the nature of geologic conditions at the site and the types of parameters to be estimated. Any openings which allow water to enter the well from aquifers which are not to be tested should be sealed or closed off for the duration of the test. Ideally, the annular space between the casing and the hole wall should be gravel packed adjacent to the perforated interval to be tested. The use of a filter pack in wells with more than one screened interval will, however, create a problem. There is no reliable method for sealing the annular space of any unwanted filter packed interval even though the screen can be isolated. The size of the filter material should be based on the grain size distribution of the zone to be screened (preferably based on a sieve analysis of the material). The screen size should be determined based on the filter pack design (Driscoll, 1986). The space above the gravel should be sealed with a sufficient amount of bentonite or other grout to isolate the gravel pack from vertical flow from above. If the bentonite does not extend to the surface, it will be necessary to put a cement seal on top of the bentonite prior to back filling the remaining annular space. A concrete pad should be placed around the well to prevent surface fluids from entering the annular material. After installation is finished, the observation well should be developed by surging with a block, and/or submersible pump (Campbell and Lehr, 1972; and Driscoll, 1986) for a sufficient period (usually several hours) to meet a pre-determined level of turbidity.

Radial Distance and Location Relative to the Pumped Well

If only one observation well is to be used, it is usually located 50 to 300 feet from the pumped well. However, each test situation should be evaluated individually, because certain hydraulic conditions may exist which warrant the use of a closer or more distant observation well. If the test design requires multiple observation wells, the wells are often placed in a straight line or along rays that are perpendicular from the pumping well. In the case of multiple boundaries or leaky aquifers, the observation wells need to be located in a manner which will identify the location and effect of the boundaries. If the location of the boundary is suspected before the test, it is desirable to locate most of the wells along a line parallel to the boundary and running through the pumping well, as shown in Figure 2. If aquifer anisotropy is expected, the observation wells should be located in a pattern based on the suspected or known anisotropic conditions at the site (Bentall and others, 1963; Ferris and others, 1962; Walton, 1962 and 1970; and Dawson and Istok, 1991). If the principal directions of anisotropy are known, drawdown data from two wells located on different rays from the pumping well will be sufficient. If the principal directions of anisotropy are not known, at least three wells on different rays are needed.

FIELD PROCEDURES

Well thought out field procedures and accurate monitoring equipment are the key to a successful aquifer test. The following three sections provide an overview of the methods and equipment for establishing a pre-test baseline condition and running the test itself.

Necessary Equipment for Data Collection

During an aquifer test, equipment is needed to measure/ record water levels, well discharges, and the time since the beginning of the test, and to record accumulated data. Appendix One contains a detailed description of the types of equipment commonly used during an aquifer test. Appendix Two is an example form for recording test data.

Establish Baseline Trend

Collecting data on pre-test water levels is essential if the analysis of the test data is to be completely successful. The baseline data provides a basis for correcting the test data to account for on-going regional water level changes. Although the wells on-site are the main target for baseline measurements, it is important to measure key wells adjacent to the site and to account for off-site pumping which may affect the test results.

Baseline water levels

Prior to beginning the test, it will be necessary to establish a

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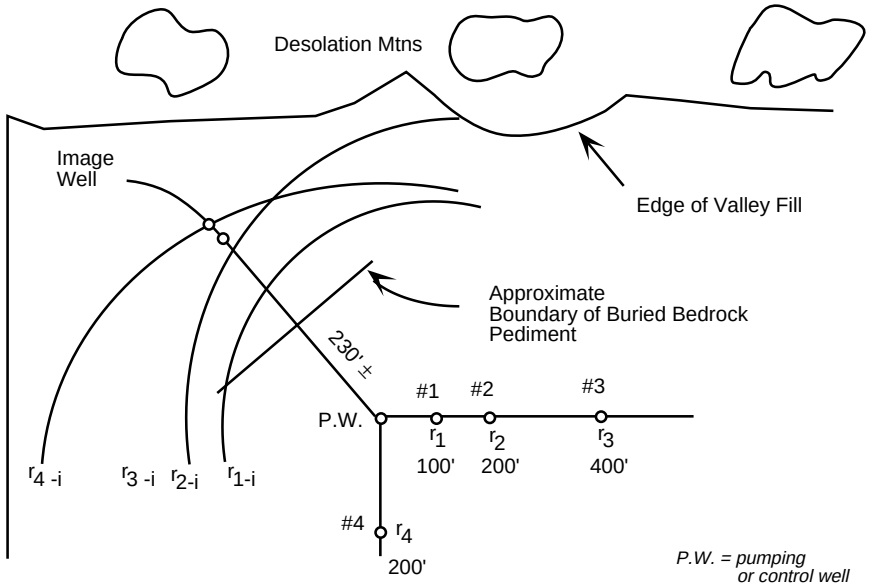

Figure 2. Observation well/pumping well location to determine buried impermeable boundary.

baseline trend in the water levels in the pumping and all observation wells. As a general rule, the period of observation before the start of the test (t_0), should be at least one week. Baseline measurements must be made for a period which is sufficient to establish the pre-pumping water level trends on site (see Figure 3). The baseline data must be sufficient to explain any differences between individual observation wells. As shown in Figure 3, the water levels in on-site wells were declining prior to the test. The drawdown during the test must be corrected to account for the pre-pumping trend.

Nearby pumping activities

During the baseline measurements, the on-off times should be recorded for any nearby wells in use. The well discharge rates should be noted as should any observed changes in the proposed on-site control well and observation wells. Baseline water level measurements should be made in all off-site wells within the anticipated area of influence. As shown in Figure 3, the baseline period should be sufficient to establish the pretest pumping trends and to explain any differences in trends between individual off-site wells.

Significant effects due to nearby pumping wells can often be removed from the test data if the on-off times of the wells are monitored before and during the test. Interference effects may not, however, always be observable. In any case, changes associated with nearby pumping wells will make analysis more difficult. If possible, the cooperation of nearby well owners should be obtained to either cease pumping prior to and during the test period or to control the discharge of these wells during the baseline and test period. The underlying principle is to minimize changes in regional effects during the baseline, test and recovery periods.

Barometric pressure changes

During the baseline trend observation period, it is desirable to monitor and record the barometric pressure to a sensitivity of plus or minus 0.01 inches of mercury. The monitoring should continue throughout the test and for at least one day to a week after the completion of the recovery measurement period. This data, when combined with the water level trends measured during the baseline period, can be used to correct for the effects of barometric changes that may occur during the test (Clark, 1967).

Local activities which may affect test

Changes in depth to water level, observed during the test, may be due to several variables such as recharge, barometric response, or “noise” resulting from operation of nearby wells, or loading of the aquifer by trains or other surface disturbances (King, 1982). It is important to identify all major activities (especially cyclic activities) which may impact the test data. Enough measurements have to be made to fully characterize the pre-pumping trends of these activities. This may necessitate the installation of recording equipment. A summary of this information should be noted in the comments section of the pumping test data forms.

Test Procedures

Initial water level measurements

Immediately before pumping is to begin, static water levels in all test wells should be recorded. Measurements of drawdown in the pumping well can be simplified by taping a calibrated steel tape to the electric sounder wire. The zero point of the tape may be taped at the point representing static water level. This will enable the drawdown to be measured directly rather than by depth to water.

Measuring water levels during test

If drawdown is expected in the observation well(s) soon after

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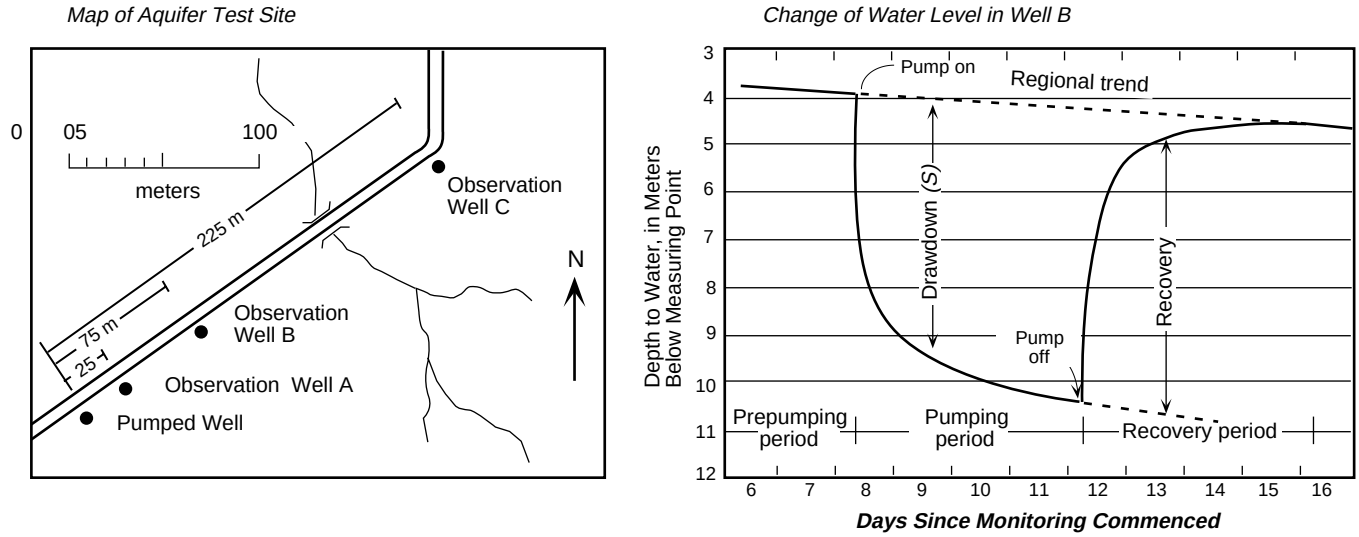

Figure 3. Example test site showing baseline, pumping test, and recovery water level measurements in one of the wells.

testing begins and continuous water level recorders are not installed, an observer should be stationed at each observation well to record water levels during the first two to three hours of testing. Subsequently, a single observer is usually able to record water levels in all wells because simultaneous measurements are unnecessary. If there are numerous observation wells, a pressure transducer/data-logging system should be considered to reduce manpower needs.

Time frame for measuring water levels

Table 1 shows the recommended maximum time intervals for recording water levels in the pumped well. NOTE: the times provided in Table 1 are only the maximum recommended time intervals--more frequent measurements may be taken if test conditions warrant. For instance, it is recommended that water level measurements be taken at least every 30 seconds for the first several minutes of the test (see ASTM Committee D-18, D 4050). Figure 4 is a hypothetical logarithmic plot of drawdown versus time for an observation well. This plot illustrates the need for the frequency of measurements given in Table 1. As shown on the plot, frequent measurements during early times are needed to define the drawdown curve. The data used in Figure 4 was collected with a downhole pressure transducer and electronic data recording equipment. Thus, water levels could be collected about every 6 seconds initially and less frequently as the test progresses. As time since pumping started increases, the logarithmic scale dictates that less frequent measurements are needed to adequately define the curve.

Measurements in the observation well(s) should occur often enough and soon enough after testing begins to avoid missing the initial drawdown values. Actual timing will depend on the aquifer and well conditions which vary from test area to test area. Estimates for timing should be made during the planning stages of aquifer testing using estimated aquifer parameters based on the conceptual model of the site.

Table 1. Maximum Recommended Time Intervals for Aquifer Test Water Level Measurements*

0 to 3 minutes	every 30 seconds
3 to 15 minutes	every minute
15 to 60 minutes	every 5 minutes
60 to 120 minutes	every 10 minutes
120 min. to 10 hours	every 30 minutes
10 hours to 48 hours	every 4 hours
48 hours to shut down	every 24 hours

** Dr. John Harshbarger, personal communication, 1968.*

Monitoring discharge rate

During the initial hour of the aquifer test, well discharge in the pumping well should be monitored and recorded as frequently as practical. Ideally, the pretest discharge will equal zero. If it does not, the discharge should be measured for the first time within a minute or two after the pump is started.

It is important when starting a test to bring the discharge up to the chosen rate as quickly as possible. How frequently the discharge needs to be measured and adjusted for a test depends on the pump, well, aquifer, and power characteristics. Output from electrically driven equipment requires less frequent adjustments than from all other pumping equipment. Engine-driven pumps generally require adjustments several times a day because of variation that occurs in the motor performance due to a number of factors, including air temperature effects. At a minimum, the discharge should be checked four times per day: 1) early

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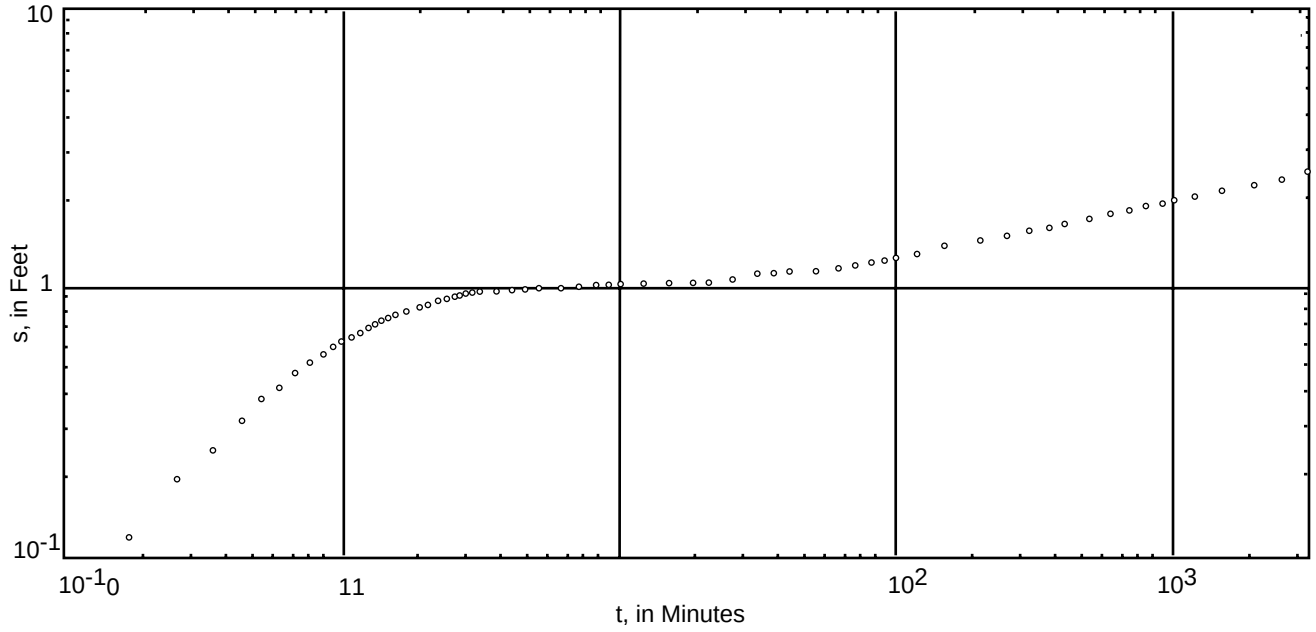

Figure 4. Logarithmic plot of s vs t for observation well.

morning (2 AM); 2) mid-morning (10 AM); 3) mid-afternoon (3 PM); and 4) early evening (8 PM). The discharge should never be allowed to vary more than plus or minus 5 percent (Ferris, J. G., personal communication, 1/19/68). The lower the discharge rate, the more important it is to hold the variation to less than 5 percent. The variation of discharge rate has a large effect on permeability estimates calculated using data collected during a test. The importance of controlling the discharge rate can be demonstrated using a sensitivity analysis of pumping test data. An analysis of this type indicates that a 10 percent variation in discharge can result in a 100 percent variation in the estimate of aquifer transmissivity. Thus, short-term pumping tests with poor control of discharge are not suitable for estimating parameters needed for adequate site characterization. If, however, the pumping test is run in such a way that the discharge rate varies less than 5 percent and water levels are measured frequently, the short-term pumping test data can be used to obtain some reliable estimates of aquifer performance.

It should be emphasized, however, that some random, short-term variations in discharge may be acceptable, if the average discharge does not vary by more than plus or minus 5 percent. A systematic or monotonic change in discharge (usually, a decrease in discharge with increasing time) is, however, unacceptable.

Water level recovery

Recovery measurements should be made in the same manner as the drawdown measurements. After pumping is terminated, recovery measurements should be taken at the same frequency as the drawdown measurements listed above in Table 1.

Length of test

The amount of time the aquifer should be pumped depends on the objectives of the test, the type of aquifer, location of suspected boundaries, the degree of accuracy needed to establish the storage coefficient and transmissivity, and the rate of pumping. The test should continue until the data are adequate to define the shape of the type curve sufficiently so that the parameters required are defined. This may require pumping for a significant period after the rate of water level change becomes small (so called water level “stabilization”). This is especially the case when the locations of boundaries or the effects of delayed drainage are of interest. Their influence may occur a few hours after pumping starts (see Figure 3), or it may be days or weeks. Some aquifer tests may never achieve equilibrium, or exhibit boundary effects.

Although it is not necessary for the pumping to continue until equilibrium is approached, it is recommended that pumping be continued for as long as possible and at least for 24 hours. Recovery measurements should be made for a similar period or until the projected pre-pumping water level trend has been attained. The costs of running the pump a few extra hours are low compared with the total costs of the test, and the improvement in additional information gained could be the difference between a conclusive and an inconclusive aquifer test.

Water disposal

As discussed previously, the water being pumped must be disposed of legally within applicable local, State, and Federal

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rules and regulations. This is especially true if the ground water is contaminated or is of poor quality compared to that at the point of disposal. During the pumping test, the individuals carrying out the test should carry out water quality monitoring as required by the test plan and any necessary disposal permits. This monitoring should include periodic checks to assure that the water disposal procedures are following the test design and are not recharging the aquifer in a manner that would adversely affect the test results. The field notes for the test should document when and how monitoring was performed.

Recordkeeping

All data should be recorded on the forms prepared prior to testing (See Appendix 2). An accurate recording of the time, water level, and discharge measurements and comments during the test will prove valuable and necessary during the data analyses stage following the test.

Plotting data

During the test, a plot of drawdown versus time on semi-log paper should always be prepared and updated as new data is collected for each observation well. A plot of the data prepared during the actual test is essential for monitoring the status and effectiveness of the test. The plot of drawdown versus time will reveal the effects of boundaries or other hydraulic features if they are encountered during the test, and will indicate when enough data for a solution have been recorded. A semi-log or log-log mass plot of water level data from all observation wells should be prepared as time allows. Such a plot can be used to show when aquifer conditions are beginning to affect individual wells. More importantly, it enables the observer to identify erroneous data. This is especially important if transducers are being used for data collection. The utilization of a portable PC with a graphics package is an option for use in carrying out additional field manipulation of the data. It should not, however, be a substitute for a manual plot of the data.

Precautions

(a) Care should be taken for all observers to use the same measuring point on the top of the well casing for each well. If it is necessary to change the measuring point during the test, the time at which the point was changed should be noted and the new measuring point described in detail including the elevation of the new point.

(b) Regardless of the prescribed time interval, the actual time of measurement should be recorded for all measurements. It is recognized that the measurements will not be taken at the exact time intervals suggested.

(c) If measurements in observation well(s) are taken by several individuals during the early stages of testing, care should be taken to synchronize stop watches to assure that the time since pumping started is standardized.

(d) It is important to remember to start all stop watches at the time pumping is started (or stopped if performing a recovery test).

(e) Comments can be valuable in analyzing the data. It is important to note any problems, or situations which may alter the test data or the accuracy with which the observer is working.

(f) If several sounders are to be used, they should be compared before the start of the test to assure that constant readings can be made. If the sounder in use is changed, the change should be noted and the new sounder identified in the notes.

PUMPING TEST DATA REDUCTION AND PRESENTATION

All forms required for recording the test data should be prepared prior to the start of the test and should be attached to a clip board for ease of use in the field. It is an option to have a portable PC located on-site with appropriate spreadsheets and graphics package to allow for easier manipulation of the data during the test. The hard copy of the forms should be maintained for the files.

Tabular Data

All raw data in tabular form should be submitted along with the analysis and computations. The data should clearly indicate the well location(s), and date of test and type of test. All data corrections, for pre-pumping trends, barometric pressure fluctuations and other corrections should be given individually and clearly labeled. All graphs used for corrections should be referenced on the specific table. These graphs should be attached to the data package.

Graphs

All graphs or plots should be drafted carefully so that the individual points which reflect the measured data can be retrieved. Semi-logarithmic and logarithmic data plots (see Figures 5 and 6) should be on paper scaled appropriately for the anticipated length of the test and the anticipated drawdown. All X-Y coordinates shall be carefully labeled on each plot. All plots must include the well location, date of test, and an explanation of any points plotted or symbols used.

ANALYSIS OF TEST RESULTS

Data analysis involves using the raw field data to calculate estimated values of hydraulic properties. If the design and field-observation phases of the aquifer test are conducted successfully, data analyses should be routine and successful. The method(s) of analysis utilized will depend, of course, on particular aquifer conditions in the area (known or assumed) and the parameters to be estimated.

Calculations

All calculations and data analyses must accompany the final report. All calculations should clearly show the data used for input, the equations used and the results achieved. Any assumptions made as part of the analysis should be noted in the calculation section. This is especially important if the data were corrected to account for barometric pressure changes, off-site pumping changes, or other activities which have affected the test. The calculations should reference the appropriate tables and graphs used for a particular calculation.

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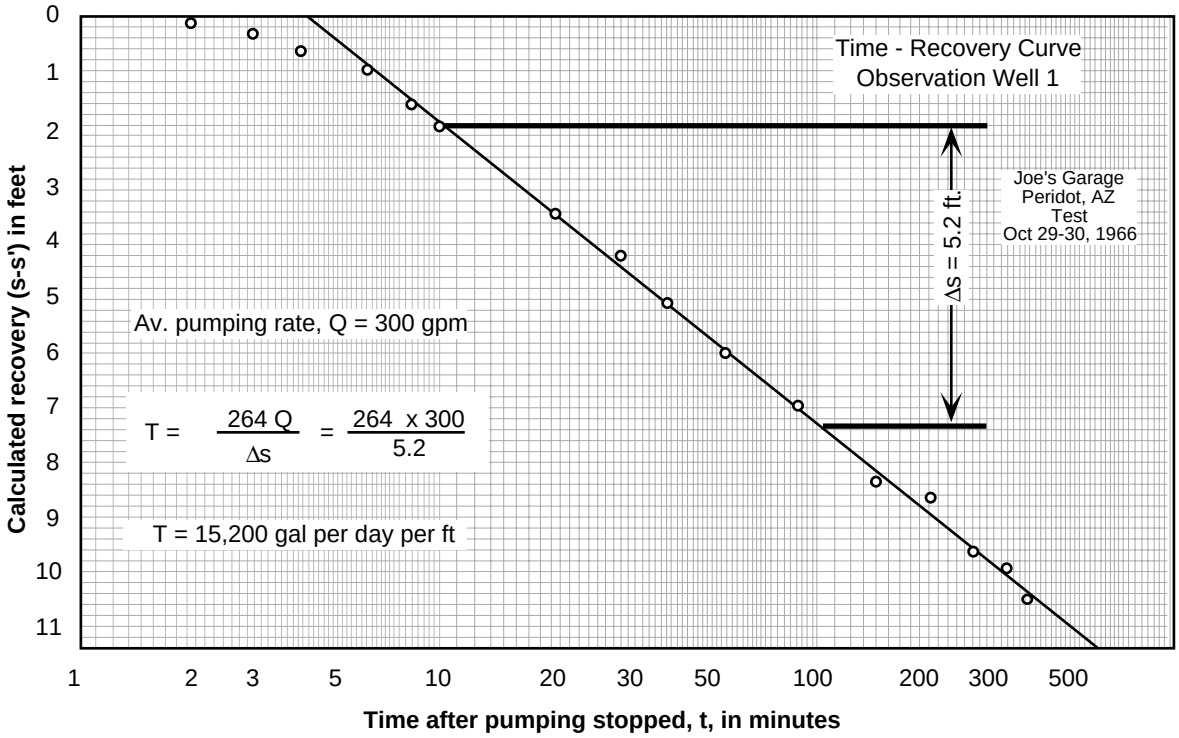

Figure 5. Time recovery curve for observation well - October 30, 1966.

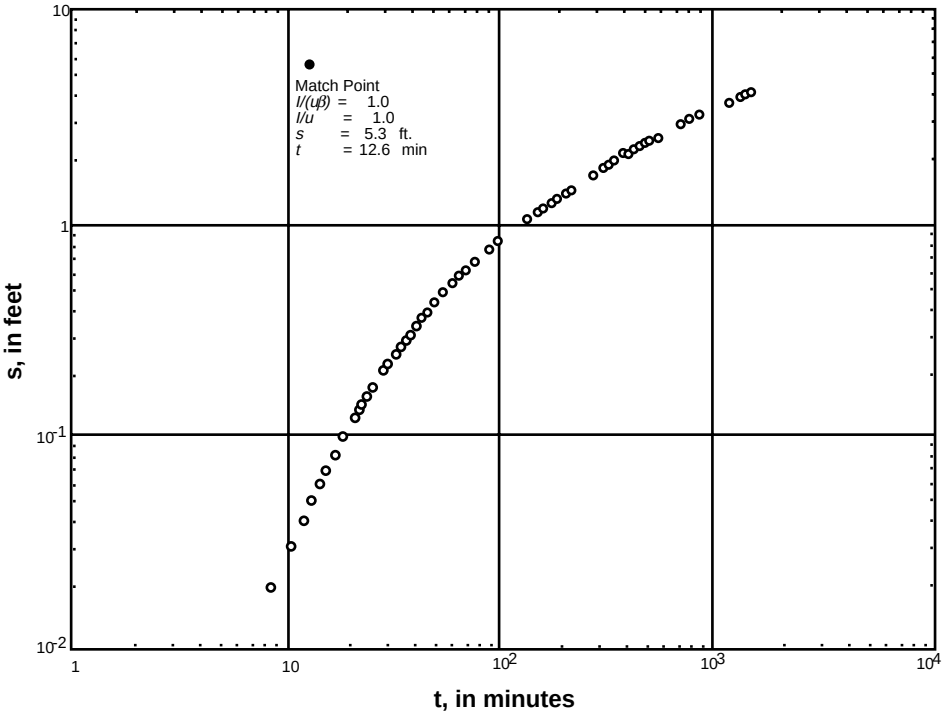

Figure 6. Logarithmic plot of s vs t for Observation Well 23S/25E-17Q_2 at Pixley, CA.

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Aquifer Test Results

The results of an aquifer pumping and recovery test should be submitted in narrative format. The narrative report should include the raw data in tabular form, the plots of the data, the complete calculations and a summary of the results of the test. The assumptions made in utilizing a particular method of analysis should also be included.

SUMMARY-EXAMPLE FACILITY DESIGN

As a means of focusing the discussions presented in the preceding sections, the following example of an aquifer pumping test is described. The facility layout is shown in Figure 7. The site is located near a normally dry river channel which is subject to flood flows. The site was constructed for the purpose of carrying out experiments relating to artificial recharge of a shallow alluvial aquifer. The proposed methods of recharge involved use of a pit and a well.

The aquifer at the site is comprised of unconsolidated basin fill material, mainly silty sand and gravel with some clay lenses. The depth to water is generally greater than 50 feet and the river is a source of recharge when it flows. There are extensive gravel lenses above the water table which outcrop at the base of the river channel. These lenses occur beneath the site.

Figure 7 shows the locations of the various monitoring wells relative to the recharge facilities and the river. The well locations were selected to facilitate both characterization of the site and subsequent evaluation of the various recharge tests. The recharge well (used as the pumping well during the site aquifer tests) and the eight inch observation wells were completed to a depth of 150 feet in the upper water bearing unit of a basin fill aquifer. The depth to water in the area was about 75 feet. The recharge and observation wells were screened from about 80 feet to 140 feet. The 1-3/4 inch access tubes were 80-100 feet deep with a five-foot well screen on the bottom of each tube.

The eight-inch observation wells were placed in a line parallel to the river to assess both the effect of flood flows on the aquifer and the hydraulic characteristics of the recharge site itself. The 1-3/4 inch access tubes were positioned for monitoring ground-water movement near the top of the water table in response to aquifer recharge and discharge (pumping) tests. The two inch piezometers at varying depths were constructed to evaluate shallow ground-water movement in response to recharge.

Figure 8 is a plan view of the recharge facility showing the pumping/recharge well and the water distribution system. The pumping well was equipped with a downhole turbine pump powered by a methane driven, 6-cylinder engine. As indicated

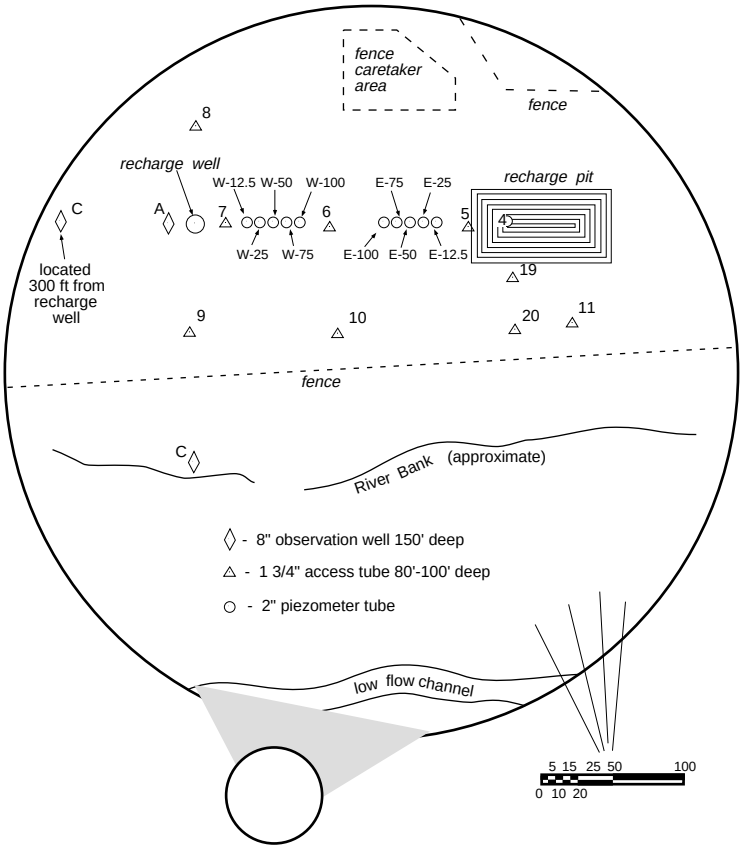

Figure 7. Recharge facility well layout.

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on Figure 8, the pump discharge was measured using a Parshall flume (see Figure 9). The water from pumping tests was discharged off-site via the concrete box and distribution line. To prevent interference with test results from nearby recharge of the pumping test water, a temporary pipeline was constructed from irrigation pipe. This temporary line ran from the end of the river drain line to a point 1200 feet down stream out of the estimated area of influence. The ground water was not contaminated. Thus, special water quality monitoring was not required.

The pumping tests for site characterization involved the following monitoring procedure:

1. The eight-inch observation well closest to the recharge well (Well A) was equipped with a Stevens water stage recorder with an electric clock geared for a 4-hour chart cycle;

2. The other two eight-inch observation wells (Wells B and C) were equipped with Stevens water stage recorders with an electric clock geared for a 12-hour chart cycle;

3. The pumping well was equipped with a stilling well composed of a 3/4-inch pipe strapped to the pump column. The stilling well was drilled with 1/4-inch holes through the length. The stilling well was used for assessing the well for water level measurements with a 150-foot steel tape. The steel tape was marked in 0.01 ft. increments for the first 100 feet and in 0.1 ft. increments for the remaining 50 feet;

4. The 1-3/4 inch access wells were monitored at least once a day with a neutron moisture logger to assess changes in saturation as the water level declined in response to the test. This information was used to verify the water level declines in the regular monitoring wells and to aid in assessing the delayed drainage effects which were to be estimated using the water level response data from the eight-inch observation wells;

5. A continuous recording barograph was located in a standard construction, USDA weather station shed located between access Wells 9 and 10; and

6. The pump engine was equipped with an rpm gage to monitor pump performance and a micrometer adjustment on the throttle.

A step drawdown test and several short-term pumping tests were run at the site prior to running the principal aquifer characterization test. The step drawdown test was used as a means of selecting the final pumping test design. The short term tests were used to obtain an initial picture of aquifer response.

The results of the step drawdown test run on the recharge well after development indicated that the well was suitable for use as a test well. The results of the step test were also used to estimate well efficiency at different rates. Table 2 gives the efficiencies for three (3) discharge rates. As indicated, the well efficiency was greater than 90% for a rate of about 200

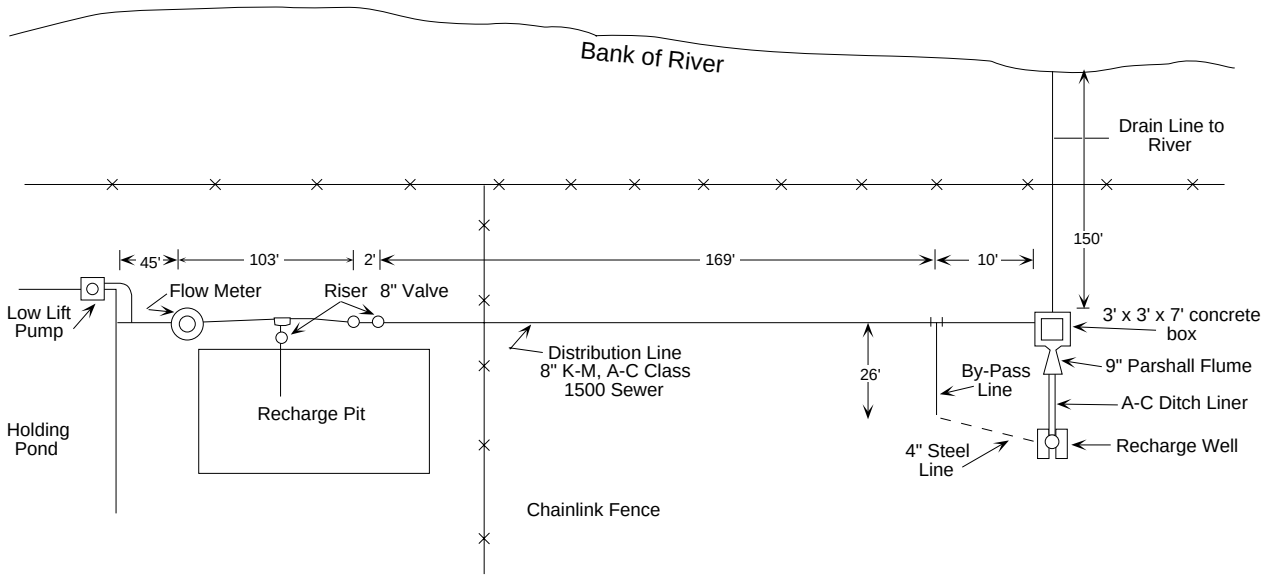

Figure 8. Water distribution and drainage facilities at the artificial recharge site.

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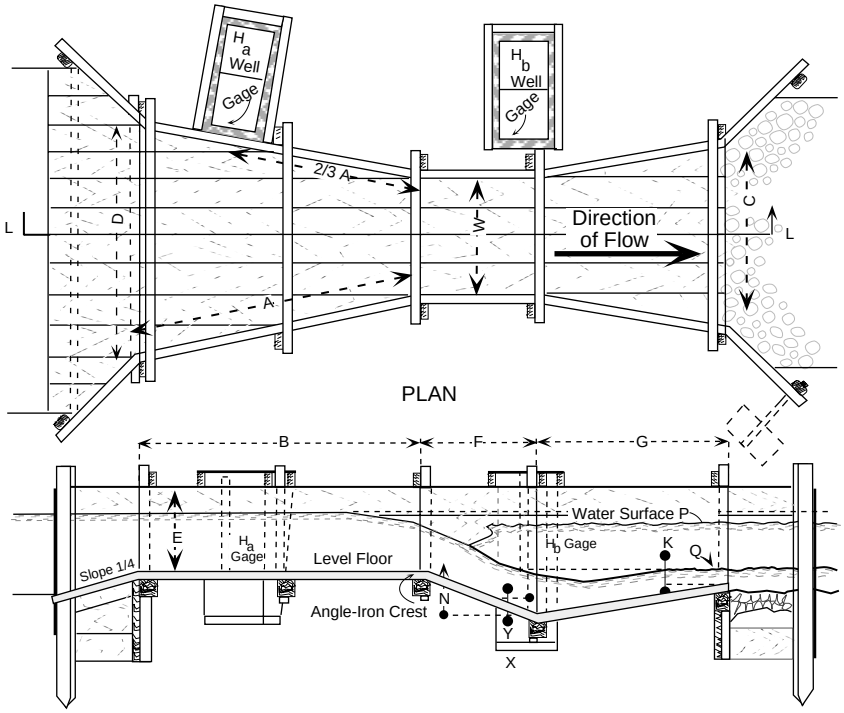

Figure 9. Parshall flume dimensions.

gpm. Based on this data, the design rate for the long-term test was set at about 200 gpm (actual average was 204 gpm).

Table 2. Well Efficiency of R#1 after 200 Minutes of Pumping

Discharge	Theoretical Drawdown	Actual Drawdown	Well Efficiency
gpm	*ft*	*ft*	*percent*
189	7.00	7.51	92
326	11.88	14.71	81
474	17.27	25.41	68

Because the initial short-term tests indicated that delayed drainage was an issue at the site, the main test was designed to run for a continuous period of at least 20 days. The actual scheduling of the test was established to try to avoid flow in the river as a result of a major precipitation event during the background, pumping, and recovery periods. The chosen test period was in the fall after the end of the irrigation season, which also minimized off-site pumping that might affect the results. It should be noted that two short-term tests were planned to follow the main pumping test during the winter rainy season when flow in the river was possible. This was done to allow the impacts of an uncontrolled recharge event on the system to be assessed. The main pumping test would provide a basis for comparison.

The discharging well was measured on a time schedule per the criteria in Table 1, except that measurements for the initial 10 minute period were taken every 30 seconds. The observation wells were observed manually on the same schedule for the initial 30 minute period and then the recorders were utilized. Discharge measurements were monitored at least every 5 minutes for the first 30 minutes and then were monitored with water levels for the first 12 hours. Discharge measurements were monitored at least four times daily until the end of the test. The access tubes were monitored twice daily to assess changes in saturation near the water table.

The results from the long term pumping test are shown on Figure 10 as a semi-log data mass plot (drawdown versus log time) of the data for the three (3) observation wells. The large initial water level decline for Observation Well A is due to its close proximity to the pumping well (15 feet). The rise in water level at the end of the test was caused by a slight decrease in discharge rate.

Values of T and S were obtained by the non-equilibrium method. The plots of drawdown as a function of log time did not give a good overlay on the non-equilibrium type curve for early times. For later times, it was possible to obtain a good match. The match points obtained for the three observation wells are listed in Table 3. The values of T and S are also shown in Table 3. As indicated, the estimates of T and S were in close agreement.

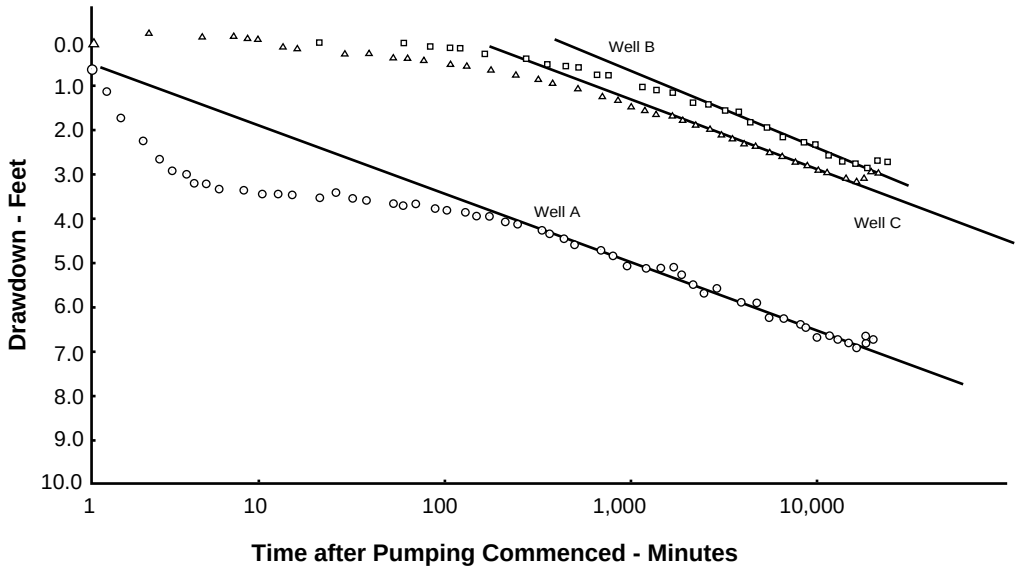

Figure 10. Drawdown versus log of time in observation wells A, B, and C during pumping of R#1.

Table 3. Values of T and S Obtained by Non-Equilibrium Equation for Discharge Conditions.

Location	w(u)	l/u	s	t	r	T	S
			ft	*min*	*ft*	*gpd/ft*	
Well A	110	10^5	0.62	14900	14.7	37,600	0.01
Well B	1	10	0.62	1780	280.0	37,600	0.03
Well C	1	10	0.58	530	175.4	40,200	0.03

The estimates for storativity were also in reasonable agreement. It is important to note that the test results showed delayed drainage to be a significant factor at this site. The initial estimates of storativity using data from the early part of the test were about 1×10^{-5} rather than 3×10^{-2} estimated after 20 days of pumping. This effect was expected because of the heterogeneous nature of the basin fill. As a means of comparison, water balance studies on a large well field located 15 miles away (completed in the same material) were reviewed. These studies provided an estimate of storage coefficient (based on 10 years of pumpage) of about 0.15. Thus, it was concluded that the aquifer at the site was under water table conditions, but significant delayed drainage effects were present.

The results of the pumping tests at the site were used to characterize the site and design several long-term recharge experiments. This included monitoring design for evaluation of the effect of river flows on the regional aquifer.

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Appendix One

Equipment for Data Collection

a. Water Levels

Water level measurements can be made with electric sounders, air line and pressure gages, calibrated steel tapes, or pressure transducers (Garber and Koopman, 1968; and Bentall and others, 1963).

(1) Electric Sounders

(a) An electric sounder is recommended for measuring water levels in the pumping well because it will allow for rapid, multiple water level readings, especially important during the early stages of aquifer pumping and recovery tests.

(b) A dedicated sounder should be assigned to each observation well throughout the duration of the test. This is particularly important in ground-water quality studies to prevent cross contamination.

(c) Each sounder should be calibrated prior to the commencement of testing to assure accurate readings during the test.

(2) Air Lines and Pressure Gages

(a) Air lines are only recommended when electric sounders or steel tapes cannot be used to obtain water level measurements. Their usefulness is limited by the accuracy of the gage used and by difficulties in eliminating leakage from the air line. A gage capable of being read to 0.01 psi will be needed to obtain the necessary level of accuracy for determining water level change. A continuous copper or plastic line of known length should be strapped to the column pipe when the pump is installed. This will minimize the potential for leaks.

(b) When air lines are used, the same precision pressure gage should be used on all wells.

(c) Each pressure gage should be calibrated immediately prior to and after the test to assure accurate readings.

(d) The air line and pressure gage assembly should also be calibrated prior to the test by obtaining static water level by another method, if possible.

(3) Calibrated Steel Tapes

(a) Steel tapes marked to .01 ft. are preferred unless rapid water level drawdown or buildup is anticipated. If rapid drawdown, cascading water, or high frequency oscillation are anticipated, electric sounders, float actuated recorders or pressure transducers are preferred.

(b) Steel tapes are not recommended for use in the pumping well because of fluctuating water levels caused by the pump action, possible cascading water and the necessity for obtaining rapid water level measurements during the early portions of the aquifer pumping and recovery tests. If tapes are used, and the water level fluctuates, the well must be equipped with a means of dampening fluctuating water levels. Additional manpower will be needed during the initial stages of the test.

(4) Pressure Transducers

Pressure transducers are often used in situations where access to the well is restricted, such as a well where packers are being used to isolate a certain zone. They may also be applicable in large-scale tests using a computerized data collection system. Such a system will significantly reduce the manpower needed during the initial stages of a multiple well test. The most common installation uses down hole transducers with recording of the results taking place on the surface.

(a) Transducers should be calibrated prior to installation, and should be capable of accurately detecting changes of less than .005 psi. Transducer systems which will accurately record water level changes of .001 feet are available. The resolution of transducers, however, depends on the full scale range. Where large drawdowns are expected, such resolution is not possible.

(b) After installation, the transducers and recording equipment should be calibrated by comparing pressure readings to actual water level measurements taken with a steel tape. Periodic measurements of the water level should be made during the test to verify that the transducers are functioning properly.

(c) The effect of barometric changes on the transducers should be determined prior to and during the test. This will require continuous monitoring of the barometric pressure at the site as well as periodic comparisons of water level and transducer readings (Clark, 1967).

b. Discharge Measurement

The equipment commonly used for measuring discharge in the pumping well includes orifice plates, in-line water meters, Parshall flumes and recorders, V-notch weirs, or, for low discharge rates, a container of known volume, and a stop watch (Driscoll, 1986). The choice of method will depend upon a combination of factors, including i) accuracy needed, ii) planned discharge rate, iii) facility layout, and iv) point of discharge. If, for instance, it is

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necessary to discharge the water a half mile from the pump, a flume or weir will probably not be used, because the distance between the point of discharge control and the point of discharge would make logistics too difficult. An in-line flow meter or a pitot tube would be the most likely calibrated devices (U.S. Bureau of Reclamation, 1981; King, 1982; U.S. EPA, 1982; and Leopold and Stevens, 1987).

(1) Orifice Plate

(a) Orifice plates with manometers (see Figure 11) are an inexpensive and accurate means of obtaining discharge measurements during testing. The thin plate orifice is the best choice for the typical pump test. An orifice plate has an opening smaller than that of the discharge pipe. A manometer is installed into and onto the end of the discharge pipe. The diameter of the plate opening must be small enough to ensure that the discharge pipe behind the plate is full at the chosen rate of discharge. The reading shown on the manometer represents the difference between the upstream and downstream heads.

(b) Assuming the devices are manufactured accurately and are installed correctly, an orifice plate will provide an accuracy of between two and five percent. The orifice tube must be horizontal and full at all times to achieve the design accuracy.

(c) The accuracy should be established prior to testing by pumping into a container of known volume over a given time. This should be repeated for several rates.

(2) In-line Flow Meter

(a) In-line flow meters can give accurate readings of the flow if they are installed and calibrated properly. The meter must be located sufficiently far from valves, bends in the pipe, couplings, etc., to minimize turbulence which will affect the accuracy of the meter. **The meter must be installed so that it is completely submerged during operation.**

(b) Use of a meter is an easy way to monitor the discharge rate by recording the volume of flow through the meter using a totalizer or other means at one minute intervals and subtracting the two readings. Some meters register instantaneous rate of flow and total flow volume.

(c) The meter should be calibrated after installation (prior to the test) to insure its accuracy.

(3) Flumes and Weirs

(a) There are numerous accurate flumes and weirs on the market. The choice depends mainly on the approximate discharge anticipated, the location of the discharge point and the nature of the facility. The cost of installation will preclude use at many non-permanent facilities.

(b) The weir (see Figure 12) or flume should be located close to the pump. There should be a permanent recorder on the device as well as means of making manual measurements (e.g., staff gage).

(c) The discharge canal should have a sufficient length of unobstructed upstream channel so as not to affect the accuracy of the chosen weir or flume.

(4) Pitot Tube

(a) The pitot tube is a velocity meter which is installed in the discharge pipe to establish the velocity profile in the pipe. Commercially available devices consist of a combined piezometer and a total head meter.

(b) The tube must be installed at a point such that the upstream section is free of valves, tees,

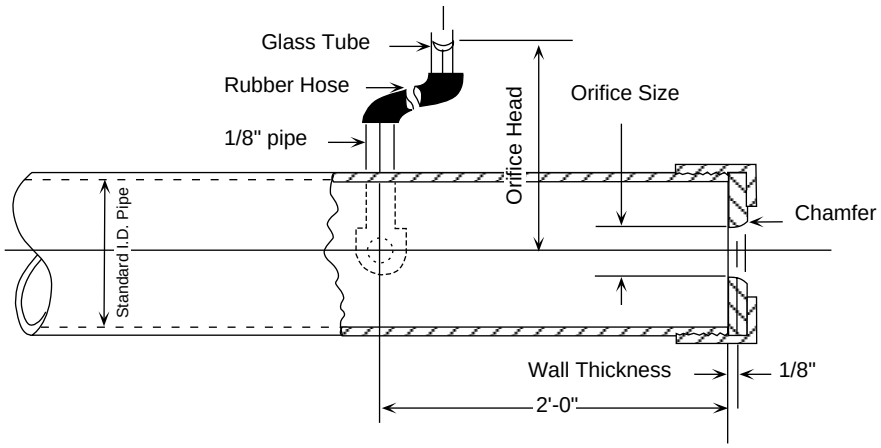

Figure 11. Diagram of orifice meter.

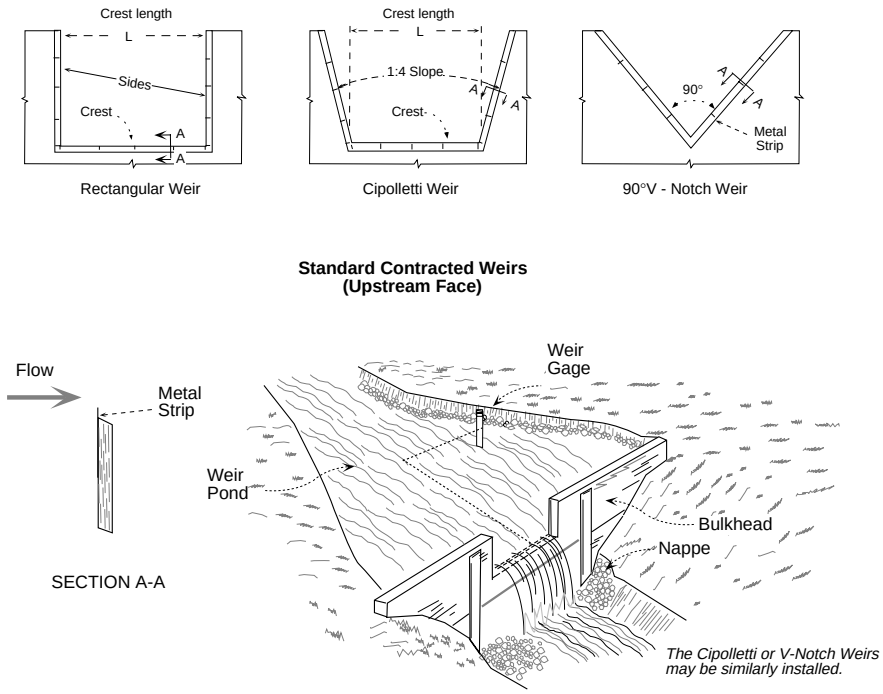

Figure 12. Standard contracted weirs, and temporary discharging at free flow.

elbows, etc., for a minimum distance equal to 15 to 20 times the pipe diameter to minimize turbulence at the location of the tube.

(c) Since the pitot tube becomes inaccurate at low velocities, the diameter of the pipe should be small enough to maintain reasonably high velocities.

(5) Container of Known Volume and Stop Watch

(a) The use of a container of known volume and a stop watch is a simple way to measure the discharge rate of a low volume discharging well.

(b) By recording the length of time taken for the discharging water to fill a container of known volume, the discharge rate can be calculated.

(c) This method can be used only where it is possible to precisely measure the time interval required for a known volume to be collected. If rates are sufficiently high so that water "sloshes" in the container, or they prohibit development of a relatively smooth surface on the water in the container, this method is likely to be inaccurate. Restricting use of this method to flows of less than 10 gpm is probably a conservative rule of thumb.

c. Discharge Regulation

(1) The size of the discharge line and the gate valve should be such that the valve will be from one-half to three-fourths open when pumping at the desired rate (during the initial phase of the test) with a full pipe.

(2) The valve should be placed a minimum of five (5) pipe diameters down-stream from an in-line flow meter, to ensure that the pipe is full and flow is not disturbed by excessive turbulence. In the case of some meters, such as a pitot tube, an in-line manometer, or an orifice plate, the valve would need to be upstream. (In this case the pipe downstream of the valve must be sized to be full at all times.)

d. Time

(1) A stop watch is recommended for use during an aquifer pumping and recovery test. Time should be recorded to the nearest second while drawdown is rapid, and to the nearest minute as the time period between measurements is increased beyond 15 minutes.

(2) If more than one stop watch is to be used during the testing, then all watches should be synchronized to assure that there is no error caused by the imprecise measurements of elapsed time.

(3) Accuracy of time is critical during the early stage of a pump or aquifer test and it is crucial to have all stop watches reflect the exact time. Later in the test the time recorded to the nearest minute becomes less critical.

(4) A master clock should be kept on site for tests longer than one day. This will provide a backup in case of

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stop watch problems.

Appendix Two

Recording Forms

It is very important that each well data form stand alone. The data forms must contain all information which may have a bearing on the analysis of the data. See the suggested format for pumping test data recording sheets located at the end of this appendix. The form should allow for the following data to be recorded on the data sheet for each well:

(a) date
(b) temperature
(c) discharge rate
(d) weather
(e) well location
(f) well number
(g) owner of the well
(h) type of test (drawdown or recovery)
(i) description of measuring point
(j) elevation of measuring point
(k) type of measuring equipment
(l) radial distance from center of pumped well to the center of the observation well
(m) static depth to water
(n) person recording the data
(o) page number of total pages

In addition to the above information to be recorded on each page, the forms should have columns for recording of the following data:

(a) the elapsed time since pumping started, shown as the value (t)
(b) the elapsed time since pumping stopped, shown as (t')
(c) the depth in feet to the water level
(d) drawdown or recovery of the water level in feet
(e) the time since pumping started divided by the time since pumping stopped, shown as (t/t')
(f) the discharge rate in gallons per minute
(g) a column for comments to note any problems encountered, weather changes (i.e. barometric changes, precipitation), natural disasters, or other pertinent data.

AQUIFER TEST FIELD DATA SHEET

Page___ of____

_____ Pumped Well No._____ Date _____
_____ Observation Well No._____ Weather _____
Owner _____ Location _____
Observers: _____

Measuring Point is _____ which is _____ feet above/below surface.
Static Water Level _____ feet below land surface.
Distance to pumped well _____ feet. Type of Test _____
Discharge rate of pumped well _____ gpm (gallons per minute).
Total number of observation wells _____ .
Water Measurement Technique _____ .
Recorded by _____ . Temperature during test _____ .

Clock Time	Elapsed Time Since Pump Started or Stopped (min)	Depth to Water Below Land (feet)	Drawdown or Recovery (feet)	Discharge or Recharge (GPM)	t/t'	Comments

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AQUIFER TEST FIELD DATA SHEET

Continuation Sheet

Distance to pumped well _____ Bearing _____ Page _____ of _____

_____ Pumped Well No._____ Date _____

_____ Observation Well No._____ Recorded by _____

Clock Time	Elapsed Time Since Pump Started or Stopped (min)	Depth to Water Below Land (feet)	Drawdown or Recovery (feet)	Discharge or Recharge (GPM)	t/t'	Comments

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Glossary

Aquifer: A unit of geologic material that contains sufficient saturated permeable material to conduct ground water and to yield economically significant quantities of ground water to wells and springs. The term was originally defined by Meinzer (1923, p. 30) as any water-bearing formation. Syn: water horizon; ground-water reservoir; nappe; aquafer.

Aquifer Test: A test involving the withdrawal of measured quantities of water from, or addition of water to, a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or addition.

Aquitard: A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer; a leaky confining bed. It does not readily yield water to wells or springs, but may serve as a confining bed storage unit for ground water. Cf: aquifuge; aquiclude.

Capillary Fringe: The lower subdivision of the zone of aeration, immediately above the water table in which the interstices contain water under pressure less than that of the atmosphere, being continuous with the water below the water table but held above it by surface tension. Its upper boundary with the intermediate belt is indistinct, but is sometimes defined arbitrarily as the level at which 50 percent of the interstices are filled with water. Syn: zone of capillarity; capillary-moisture zone.

Confined Aquifer: An aquifer bounded above and below by impermeable beds or beds of distinctly lower permeability than that of the aquifer itself; an aquifer containing confined ground water. Syn: artesian aquifer.

Confining Bed: A confining bed is a unit of distinctly less permeable geologic material stratigraphically adjacent to an aquifer. "Aquitard" is a commonly used synonym. Confining beds can have a wide range of hydraulic conductivities and a confining bed of one area may have a hydraulic conductivity greater than an aquifer of another area.

Drawdown: The vertical distance between the static water level and the surface of the cone of depression at a given location and point of time.

Effective Porosity: Effective porosity refers to the amount of interconnected pore space and fracture openings available for the transmission of fluids, expressed as the volume of interconnected pores and openings to the volume of rock.

Ground Water: Subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated.

Hydraulic Conductivity: Hydraulic conductivity, K, replaces the term "coefficient of permeability" and is a volume of water that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. Hydraulic conductivity is a function of the properties of the medium and the fluid viscosity and specific gravity; intrinsic permeability times specific gravity divided by viscosity. Dimensions are L/T with common units being centimeters per second or feet/day.

Hydraulic Gradient: Hydraulic gradient is the change in head per unit of distance in the direction of maximum rate of decrease in head.

Hydraulic Head: Hydraulic head is the sum of two components: the elevation of the point of measurement and the pressure head.

Intrinsic Permeability: Intrinsic permeability, k, is a property of the porous medium and has dimensions of L^2. It is a measure of the resistance to fluid flow through a given porous medium. It is, however, often used incorrectly to mean the same thing as hydraulic conductivity.

Porosity: Porosity of a rock or soil expresses its property of containing interstices or voids and is the ratio of the volume of interstices to the total volume, expressed as a decimal or percentage. Total porosity is comprised of primary and secondary openings. Primary porosity is controlled by shape, sorting and packing arrangements of grains and is independent of grain size. Secondary porosity is that void space created sometime after the initial formation of the porous medium due to secondary solution phenomena and fracture formation.

Potentiometric Surface: Potentiometric surface is an imaginary surface representing the static head of ground water and defined by the level to which water will rise in a well under static conditions. The water table is a particular potentiometric surface for an

unconfined aquifer representing zero atmospheric gage pressure.

Recharge Zone: A recharge zone is the area in which water is absorbed and added to the saturated soil or geologic formation, either directly into a formation, or indirectly by way of another formation.

Residual Drawdown: The difference between the original static water level and the depth to water at a given instant during the recovery period.

Saturated Zone: The saturated zone is that part of the water-bearing material in which all voids are filled with water. Fluid pressure is always greater than or equal to atmospheric, and the hydraulic conductivity does not vary with pressure head.

Specific Capacity: The rate of discharge of a water well per unit of drawdown, commonly expressed in gpm/ft. It varies with duration of discharge.

Specific Storage: Specific storage, S, is defined as the volume of water that a unit volume of aquifer releases from storage because of expansion of the water and compression of the matrix or medium under a unit decline in average hydraulic head within the unit volume. For an unconfined aquifer, for all practical purposes, it has the same value as specific yield. The dimensions are L^{1}. It is a property of both the medium and the fluid.

Specific Yield: Specific yield is the fraction of drainable water yielded by gravity drainage when the water table declines. It is the ratio of the volume of water yielded by gravity to the volume of rock. Specific yield is equal to total porosity minus specific retention. Dimensionless.

Storage Coefficient: The storage coefficient, S, or storativity, is defined as the volume of water an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in hydraulic head. It is dimensionless.

Transmissivity: Transmissivity, T, is defined as the rate of flow of water through a vertical strip of aquifer one unit wide extending the full saturated thickness of the aquifer under a unit hydraulic gradient. It is equal to hydraulic conductivity times aquifer saturated thickness. Dimensions are L^{2}/t.

Unconfined Ground Water: Unconfined ground water is water in an aquifer that has a water table. Also, it is aquifer water found at or near atmospheric pressure.

Unsaturated Zone: The unsaturated zone (also referred to as the vadose zone) is the soil or rock material between the land surface and water table. It includes the capillary fringe. Characteristically this zone contains liquid water under less than atmospheric pressure, with water vapor and other gases generally at atmospheric pressure.

Water Table: The water table is an imaginary surface in an unconfined water body at which the water pressure is atmospheric. It is essentially the top of the saturated zone.

Well Efficiency: The well efficiency is the theoretical drawdown divided by the measured drawdown. The theoretical drawdown is estimated by using pumping test data from several observation wells to construct a distance drawdown graph to estimate drawdown in the pumping well if there were no losses.

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APPENDIX D

FIELD FORMS

1. Daily Health and Safety Meeting Record
2. Equipment Maintenance and Calibration Record
3. HTRW Drilling Log
4. EPA Chain of Custody Record
5. Well Development Log
6. HGL/CDM Change Request Form
7. Nonconformance Report

HGL HydroGeoLogic, Inc. CDM

Training Conducted By: _____

Day:_____ **Date**:_____ **Time**:_____ **Duration**:_____

$ Field Health & Safety Meeting Record$

Site/Location: Garvey Elevator Site Hastings, Nebraska

Review:

: Health & Safety Plan : Buddy Teams : Hospital Route/Nearest Phone Location

: Weather Concerns : PPE □ Potential Problems:

: Action Levels: _____

□Other: _____

Protective Clothing/Equipment: _____

Special Equipment: Health and Safety; Equipment for particular sampling function

Chemical Hazards: Volatile organic compounds, metals, sample preservatives (HCl, etc)

Physical Hazards: Slips/trips/falls, traffic, inside hazards, outdoor hazards

Emergency Actions: Provide immediate emergency care, transport to hospital if possible without causing further harm to injured person (neck, back injury).

Other Issues: _____

Check:

: H&S Monitoring Equipment/Calibration : Fire Extinguisher

□ Communications/Radio Check : First Aid Kit/Eye Wash Station

: H&S Plan (each team) : Respiratory Protection/Cartridges

□ Other: _____ MSA GMC-H type: _____

	Please Print - Name/Firm/Office	*Signature*
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

Site Health and Safety Officer Signature: _____

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HGL HydroGeoLogic, Inc Exceeding Expectations

CDM

EQUIPMENT MAINTENANCE AND CALIBRATION RECORD

Contract/Project: Garvey Elevator Site

Activity: _____

Equipment Description: _____

Equipment ID: _____

Equipment Serial No.: _____

Calibration Date/Time	Parameter	Standard Used (Concentration)	Lot Control No./ Expiration Date	Post Calibration Reading	Comments Pass/Fail	Signature

Maintenance Performed: _____

HTRW DRILLING LOG

HOLE NO.

1. COMPANY NAME	2. DRILLING SUBCONTRACTOR
	SHEET OF SHEETS
3. PROJECT	4. LOCATION
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION
	9. SURFACE ELEVATION
	10. DATE STARTED / 11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREEING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE f	BLOW COUNTS g	REMARKS h

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HTRW DRILLING LOG

HOLE NO.

PROJECT

INSPECTOR

SHEET
OF SHEETS

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREEING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE f	BLOW COUNTS g	REMARKS h

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CHAIN OF CUSTODY RECORD
ENVIRONMENTAL PROTECTION AGENCY REGION VII

ACTIVITY LEADER(Print)	NAME OF SURVEY OR ACTIVITY	DATE OF COLLECTION DAY MONTH YEAR	SHEET of

CONTENTS OF SHIPMENT

SAMPLE NUMBER	TYPE OF CONTAINERS CUBITAINER	BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
	NUMBERS OF CONTAINERS PER SAMPLE NUMBER										

DESCRIPTION OF SHIPMENT	MODE OF SHIPMENT
_____ PIECE(S) CONSISTING OF _____ BOX(ES)	_____ COMMERCIAL CARRIER: _____
_____ ICE CHEST(S); OTHER _____	_____ COURIER
	_____ SAMPLER CONVEYED (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			☐ SEALED ☐ UNSEALED	
RELINQUISHED BY	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			☐ SEALED ☐ UNSEALED	
RELINQUISHED BY	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			☐ SEALED ☐ UNSEALED	

7-EPA-9262(Revised 5/85)

WELL DEVELOPMENT LOG	Well ID No.:	
Site: Garvey Elevator Site		Location: Hastings, Nebraska
Client: EPA	Contract/Delivery Order: EP-57-05-05	
A-E Contractor: HGL/CDM		Dev. Start (Date/Time):
Developed by:		Dev. End (Date/Time):
Casing Diameter:_____ (in)	Well Depth:_____ (ft)	Starting SWL:_____ (ft)
Water Column:_____ (ft)	Casing Volume:_____ (gal)	Total Volume to be Purged:_____ (gal)

Purge Volume Calculation:

Water Col. ____ ft (X) Csg. factor* ____ gal/ft (=) ____ gal/Csg. Vol. (X) ____ Csg. Vol to purge (=) ____

Total Volume To Be Purged (gal)

*Casing (Csg.) Factors: 2" Well Dia. = 0.16; 4" Well Dia. = 0.65; 6" Well Dia. = 1.47

Development Method: _____

Equipment: _____

Total quantity of water discharged:_____ (gal); Ending SWL:_____ (ft)**

Disposition of discharge water: _____

Time	Volume Removed (gal)	Water Level (ft)**	Turbidity (NTU)	Clarity/ Color	Temp (°C)	pH	Cond. (µmohs/cm) or (ms/cm)	Remarks (PID/FID Readings, etc.)

** Below top of casing (btoc)

US EPA ARCHIVE DOCUMENT

WELL DEVELOPMENT LOG	Well ID No.:
Site: Garvey Elevator Site	Site Location: Hastings, Nebraska

Time	Volume Water Removed	Water Level (ft)**	Turbidity (NTU)	Clarity/ Color	Temp (°C)	pH	Cond. (ms/cm)	Remarks (PID/FID Readings, etc.)

US EPA ARCHIVE DOCUMENT

HGL/CDM
CHANGE REQUEST FORM

Contract/Project: _____ Date: _____

Requested by: _____

Description of requested change: _____

_____

_____

_____

_____

Reason for change: _____

_____

_____

_____

_____

Expected results or impact: _____

_____

_____

_____

Submit this form to the project manager immediately.

Required before implementation of major changes:

Approved by: _____(Project Manager) Date: _____

Approved by: _____ (Title: _____) Date: _____

cc: QA Staff Member

12/2005

US EPA ARCHIVE DOCUMENT

NONCONFORMANCE REPORT	DATE OF NCR	NCR NUMBER
	LOCATION OF NONCONFORMANCE	PAGE ___ OF ___

INITIATOR (NAME/ORGANIZATION/PHONE)	FOUND BY	DATE FOUND
RESPONSIBLE ORGANIZATION/INDIVIDUAL		PROGRAM
		PROJECT

DESCRIPTION OF NONCONFORMANCE — CATEGORY: H&S Sampling/Analysis

[A] INITIATOR: DATE QA/QC OFFICER DATE CAR REQ'D YES NO

DISPOSITION:

PROBABLE CAUSE:

ACTIONS TAKEN TO PREVENT RECURRENCE:

[B] PROPOSED BY: NAME DATE

JUSTIFICATION FOR ACCEPTANCE

[C] INITIATOR: NAME DATE

VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL

REINSPECTION/RETEST REQUIRED YES NO IF YES;

DATE RESULT

[D] QUALITY ASSURANCE:

NAME DATE

US EPA ARCHIVE DOCUMENT

APPENDIX E
LABORATORY QUALITY ASSURANCE MANUAL
(MATERIAL PROVIDED IN ELECTRONIC COPY ONLY)

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Quality Assurance Manual

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Quality Assurance Manual Approval Signatures

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2-4-10 Customer Service Manager – Eric Lang Date	2-4-2010 EH&S Coordinator – John D. Nagel Date
Karen LeClair 2-4-10 Report Production Manager - Karen LeClair Date	2-4-10 Supervisor, Sample Receipt & Container Management Jeff James Date

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CA-L-P-001	Ethics Policy	5.2; 18.4; Appendix I
CA-L-P-002	Contract Compliance Policy	7.2
CA-L-S-001	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall	5.2; 12.2; 12.3; 13.5; Table 13.1; 16.4; 17.1; 17.3
CA-L-S-002	Subcontracting Procedures	8.1, 8.2; 26.5
CA-Q-M-002	Corporate Quality Management Plan	3.1
CA-Q-S-001	Solvent and Acid Lot Testing and Approval	9.3; 22.4
CA-Q-S-002	Acceptable Manual Integration Practices	20.14.2; 20.14.4; 20.14.5; Figure 16-2
CA-Q-S-003	Management of Change Procedure	14.2
CA-Q-S-004	Method Compliance & Data Authenticity Audits	16.1
CA-Q-S-005	Calibration Curves (General)	21.4.2.1; 21.4.2.3; 21.4.2.7
CA-Q-S-006	Detection Limits	20.7
CA-Q-S-008	Management Systems Review	17.2
CA-Q-WI-020	Management Review	17.2
CA-T-P-001	Qualified Products List	9.4
CW-E-M-001	Corporate Environmental Health & Safety Manual	9.3.4
CW-F-P-002	Authorization Matrix Policy	9.1
CW-F-P-004	Procurement & Contracts Polcy	9.1; 9.6
CW-F-S-007	Controlled Purchases Policy/Procedure	9.1
CW-F-S-018	Vendor Selection	9.6
CW-F-WI-007	J.D. Edwards Vendor Add Request Form	9.6.1
CW-F-WI-009	Vendor Performance Report	8.2.3; 9.6

SOP/Policy Reference	Title	Cited Section No(s)
CW-L-P-001	Record Retention	15.1; 15.5.6.3
CW-Q-S-001	Corporate Document Control and Archiving	6.1; 6.3
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)	6.3; 20.2

REFERENCED LABORATORY SOPs

SOP Reference	Title	Cited Section No(s)
UP-DM-002	Data Management: Record Retention & Purging	6.4; 15.0; 15.1; 15.1.3; 15.1.4
UP-FS-001	Field Services; Groundwater Sampling – Bailing Method	23.1
UP-IS-014	Proc/Processes Entry, Storage, Backup/Retrieval, Mgmt Bench Data	15.0; 15.1; 15.1.4; 20.14.1
UP-QA-003	Balance Calibration, Care and Use	21.3.1
UP-QA-006	Document Control	3.4.1; 6.1; 6.3; 20.2
UP-QA-014	Training Program: Mechanisms and Documentation Processes Defined by Operational Assessment	18.3
UP-QA-017	Method Detection Limits	20.7; 20.7.4; 20.7.6; 20.7.9; 20.9.1
UP-QA-022	Refrigerated Storage Monitoring Volatile Samples	24.4
UP-QA-032	SOP Change Protocol	3.4.1; 6.3; 20.2
UP-QA-034	Thermometer Calibrations	21.3.3
UP-QA-039	Sample Homogenization Sub Sampling Procedures	23.6
UP-QA-040	Quality Assurance – Measurement Uncertainty	20.12.4
UP-SR-001	Sample Receipt: Handling and Processing Procedures	24.2; 24.2.1.8; 24.2.2; Figure 24-5
UP-WM-001	Laboratory Waste Disposal Procedures	24.7

SECTION 3

INTRODUCTION *(NELAC 5.1 - 5.3)*

3.1 INTRODUCTION AND COMPLIANCE REFERENCES *(ISO17025 4.1.2; 4.2.4)*

TestAmerica Chicago's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with the 2003 National Environmental Laboratory Accreditation Conference (NELAC) standards and International ANS/ISO/IEC Standard 17025:2005. In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 5. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations. The relevant NELAC section is included in the heading of each QAM section.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- Statement of Work for Inorganics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th and 21st Edition.
- U.S. Department of Energy Order 414.1C, Quality Assurance, June 17, 2005.
- *U.S. Department of Energy*, *Quality Systems for Analytical Services*, Revision 2.4, October 28, 2008.
- U.S. Department of Defense, *Quality Systems Manual for Environmental Laboratories*, Final Version 4.1, April 2009.
- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP),* Version 4.0.02, May 2006.
- National Environmental Laboratory Accreditation Conference, Constitution, Bylaws, and Standards, EPA 600/R-04/003, US EPA Office of Research and Development, June 2003
- Toxic Substances Control Act (TSCA).

3.2 TERMS AND DEFINITIONS *(ISO17025 4.2.4)*

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 4 for the Glossary/Acronyms.

3.3 SCOPE / FIELDS OF TESTING *(ISO17025 4.1.2; 4.2.4)*

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among drinking water, surface water, groundwater, effluent water, leachates, wastewater, soil, sediment, sludge, ash, paint chips, filters, wipes, waste and tissue. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical process, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all requests to provide analyses are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in Appendix 7. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director, Project Manager and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 MANAGEMENT OF THE MANUAL

3.4.1 Review Process *(ISO17025 4.2.1; 4.2.7; 4.3.3.2; 4.3.3.3)*

This manual is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control & Updating procedures (refer to SOP No. UP-QA-006). Laboratory-specific QAM and SOP changes are approved and documented as detailed in the following SOP: *UP-QA-032*_SOP Change Protocol.

Figure 3-1.
Example - Policy/Procedure Memorandum *(ISO17025 4.3.3.2; 4.3.3.3)*

TestAmerica Chicago
STANDARD OPERATING PRACTICE (SOP) CHANGE FORM

Original SOP Number/Revision #: _____ Last Mod ID (circle): NA / ____
SOP Title:_____
Affected SOP Section Number(s):_____
Effective Date:_____

CONTROLLED DISTRIBUTION

COPY # :

ISSUED TO :

Full Signature Approvals Are Kept on File with TestAmerica Chicago Laboratories Standard Practice Records

Revision Number with Mod ID:

The following SOP change is in effect as of the stated date. This form will remain attached to the referenced SOP until such a time that the SOP is updated, approved, and redistributed, at which time it will become part of the historical SOP record. **Append this form to the front of the SOP copy.**

1. Reason for SOP Change:_____

_____

_____

_____

2. Summary of Procedure Change (circle to indicate if there are attachments to this form: No / Yes: # pages attached = ___)

_____

_____

_____

_____

_____

_____

_____

_____
Initiated/Reviewed By: Name/Date

_____
Approval Signature/Date: Section Manager

_____
Initiated/Reviewed By: Name/Date

_____
Approval Signature/Date: QA Manager or Designee

SECTION 4

ORGANIZATION AND MANAGEMENT *(NELAC 5.4.1)*

4.1 OVERVIEW *(ISO17025 4.1.1; 4.1.3; 4.1.5; 4.2.Z.2)*

TestAmerica Chicago is a local operating unit of TestAmerica Laboratories, Inc.. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Operating Officer, Corporate Quality Assurance, etc.) The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Chicago is presented in figure 4-1 and 4-2 respectively.

4.2 ROLES AND RESPONSIBILITIES *(ISO17025 4.1.3; 4.1.5; 4.2.Z.2; 5.2.4)*

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions define each role in its relationship to the Quality Assurance Program.

4.2.1 Quality Assurance Program

The responsibility for quality lies with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of the TestAmerica Chicago laboratory.

4.2.2 General Manager (GM)

Each GM reports directly to the COO. Each GM has full responsibility for the overall administrative and operational management of their respective laboratories. The GM's responsibilities include allocation of personnel and resources, long-term planning, setting goals, and achieving the financial, business, and quality objectives of TestAmerica. The GM ensures timely compliance with corporate management directives, policies, and management systems reviews. The GM is also responsible for restricting any laboratory from performing analyses that cannot be consistently and successfully performed to meet the standards set forth in this manual and in the Corporate Quality Management Plan.

4.2.3 Laboratory Director *(ISO17025 4.1.6; 4.2.6)*

TestAmerica Chicago's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective GM. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program.

The Laboratory Director, with the assistance of the Quality Assurance Manager, has the overall responsibility for establishing policies that ensure the quality of analytical services meet our client's expectations. These policies are defined in this QAM.

Specific responsibilities include, but are not limited to:

- Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Supports the Human Resources function to ensure that all policies and programs are applied consistently throughout the laboratory.
- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviews and approves Quality Assurance SOPs for the facility and ensures their implementation so that the facility is operated in a compliant manner which allows it to produce defensible data.
- Interfaces with Project Management and Customer Service to forecast receipts, provide quality analytical data to clients and meet on-time delivery dates.
- Communicates facility-specific goals and objectives to employees. Communicates and implements company initiatives designed to foster teamwork and communication.
- Ensures that the facility has appropriate Information Technology resources and that they are being used effectively to support operational requirements.
- Actively participates in the process of sharing and adopting best practices within TestAmerica. Provides technical assistance to other TestAmerica laboratories as needed to improve productivity and customer service.
- Prioritizes the activities of the operations groups to ensure key goals are achieved and customer service needs are addressed.
- Capital forecasting and instrument life cycle planning for second generation methods and instruments.

4.2.4 **Quality Assurance (QA) Manager** *(ISO17025 4.1.5; 4.1.Z.1; 4.1.6; 4.2.1; 4.2.6)*

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system based on ISO 17025.

The QA Manager reports directly to the Laboratory Director and has access to Corporate QA for advice and resources. This position is able to evaluate data objectively and perform assessments without outside (i.e., managerial) influence. Corporate QA may be used as a

resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

- Ensuring communication and monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training.
- Compliance with the ISO 17025 Standard.
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring laboratory certifications and scheduling of proficiency testing samples.
- Monitor and communicate regulatory changes that may affect the laboratory to the management staff.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Training documentation review and maintenance.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 13.
- Monitoring standards of performance to ensure that systems are in place to produce the level of quality control as defined in the QAM.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review and approval of IDL/MDL studies.
- Review and approval of Method Validation studies (IDOCs/CDOCs).
- Review and approve yearly statistical control limit evaluations.
- Review a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness

of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.

- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- QA Manager assists in the preparation, compilation, and submittal of quality assurance plans; reviews program plans for consistency with organizational and contractual requirements (advises appropriate personnel of deficiencies).
- TALs LIMs method development, validation, verification and maintenance LIMs method reference limits
- The QA Manager shall have the final authority to accept or reject data, and to stop work in progress in the event that procedures or practices compromise the validity and integrity of analytical data.
- The QA Manager is available to any employee at the facility to resolve data quality or ethical issues.
- The QA Manager must address any data integrity issue identified internally or externally, establish a corrective action plan and resolve the issue to the client's satisfaction. Issues that involve data recall must be discussed with the Corporate Quality Director Verl Preston.
- Asset Inventory Management

4.2.5 **Quality Assurance Specialist** *(ISO17025 4.1.5; 4.1.Z.1; 4.2.1)*

The QA Specialist is responsible for QA documentation and involvement in the following activities:

- Assist the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Facilitate external audits, coordinating with the QA Manager and Laboratory Staff to address any deficiencies noted at the time of the audit and subsequently presented in the final audit report.
- Assist the QA Manager in the preparation of new SOP's and in the maintenance of existing SOPs, coordinating annual reviews and updates.
- Manages the performance testing (PT) studies, coordinates follow up studies for failed analytes and works with QA Manager and Laboratory Staff to complete needed corrective action reports.
- Personnel training records review and maintenance.

- Document control maintenance.
- Assists the Quality Manager and Project Management Group in the review of program plans for consistency with organizational and contractual requirements. Summarize and convey to appropriate personnel anomalies or inconsistencies observed in the review process.
- Manages certifications and accreditations.
- Monitors for compliance the following QA Metrics: Temperature Monitoring of refrigeration units and incubators; thermometer calibrations; balance calibrations; eppendorf/pipette calibrations; and proper standard/reagent storage.
- Periodic checks on the proper use and review of instrument logs.
- Initiate the Mint-miner data file review process for organic instrumentation. Maintain tracking sheet of activity.
- Initiate the annual Instrument review.
- Assist in the technical review of data packages which require QA review.

4.2.6 Technical Director *(ISO17025 4.1.5; 4.1.Z.1; 4.2.1)*

At TestAmerica Chicago, the responsibilities of the Technical Director are divided among the supervisory, managerial, and QA staff. These individuals are responsible for compliance with the ISO 17025 Standard.

4.2.7 LIMS Administrator

The LIMS Administrator reports directly to the Regional IT Supervisor.

The overall role of the Information Technology (IT) Manager is to enhance laboratory productivity through improved information access, flow, and security. For information to be of greatest value, it must be readily accessible and reliable. It is the responsibility of the IT Manager to provide software tools that allow quick and user friendly access to that information, while at the same time controlling access to that information to those that have the need and proper authority.

Information flow can be enhanced through automation. Automation is the minimization of human intervention in a process. Reduction in human intervention can result in significant error reductions and time savings. The IT Manager assists the laboratory in automation by providing hardware and software solutions to help minimize human intervention in data collection, processing, and storage.

The IT Manager is responsible for providing data security by controlling access, as mentioned above, and for providing for disaster recovery. Data stored on the central Laboratory Information Management System (LIMS) is the direct responsibility of the IT Manager. No fewer than two copies of all data should exist at any time so that lost or destroyed data can always be retrieved from an alternate source. These copies may consist of data within the system and on magnetic tape in the case of live data, or two copies on magnetic tape for archived data. Data stored

electronically in other departments is the direct responsibility of those departments. However, the IT Manager is responsible for providing procedures and training to all laboratory operations, as appropriate, to assist in making backup copies of local data within the respective operating unit.

In the pursuit of his duties, he:

- Maintains the laboratory information system (LIMS) for tracking all samples in the laboratory.
- Maintains historical files of software, software operating procedures (manuals), software changes/modifications (Change Log) and software version numbers.
- Maintains log of repairs and service performed on LIMS hardware.
- Verifies security practices to assure the integrity of LIMS data. Identifies threats, potential threats, and future threats.
- Maintains awareness of any environmental conditions of the facility housing the LIMS that may compromise LIMS raw data and informs management.
- LIMS database back-up once daily.

4.2.8 **Department Manager (s)** *(ISO17025 4.1.5; 4.1.Z.1; 4.2.1)*

The Department Managers manage and direct the analytical production sections of the laboratory, and report directly to the Laboratory Director. More specifically, he/she:

- Is responsible for compliance with health, safety and quality assurance programs among the reporting laboratory groups.
- Continuously evaluates production capacity and improves capacity utilization.
- Continuously evaluates turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Develops and improves the training of all analysts in cooperation with the reporting Supervisors, QA department, and in compliance with regulatory requirements.
- Works with the reporting Supervisors to ensure that scheduled instrument maintenance is completed.
- Works with the Laboratory Director and reporting Supervisors to evaluate and maintain appropriate staffing levels within reporting sections.
- Is responsible for efficient utilization of supplies.
- Constantly monitors and modifies the processing of samples through the departments.
- Fully supports the quality system and, if called upon in the absence of the QA Manager, serves as his substitute in the interim.
- Assists with the review and development of standard operating procedures and offers recommendations as the need arises for new or revised analytical methods.
- Monitors the validity of the analyses performed and data generated in the laboratory, by analyzing the frequency and content of internal non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data

review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.

- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization.
- Captains department supervisors to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinates audit responses with reporting Supervisors and QA Manager.
- Participates in the selection, development of performance objectives and standards of performance, appraisal (measurement of objectives), counseling, discipline, and motivation of the reporting Supervisors and documents these activities in accordance with systems developed by the QA and Personnel Departments.
- Coordinating, writing, and reviewing preparation of all test methods, i. e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples. He/she insures that the SOPs are properly managed and adhered to at the bench.
- Ensure timely completion of all internal method audits and corrective actions.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance. Note: This responsibility is often shared with the Department Supervisors.

4.2.9 Data Management Supervisor

The Data Management Supervisor is responsible for coordinating receipt of all data from the various analytical groups within the laboratory, and ensuring that data are reported in a timely manner and in the proper format.

4.2.10 Hazardous Waste Coordinator

The Hazardous Waste Coordinator reports directly to the Laboratory Director. The duties consist of:

- Staying current with the hazardous waste regulations.
- Continuing training on hazardous waste issues.
- Reviewing and updating annually the Hazardous Waste Contingency Plan in the Environmental Health & Safety Manual.
- Auditing the staff with regard to compliance with the Hazardous Waste Contingency Plan.
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste.

4.2.11 Supervisors *(ISO17025 4.1.5; 4.1.Z.1; 4.2.1)*

Supervisors report to the Department Manager. Each one is responsible to:

- Ensure that analysts in their department adhere to applicable SOPs and the QA Manual. Perform frequent SOP and QA Manual review to determine if analysts are in compliance and if new, modified, and optimized measures are feasible and should be added to these documents.
- Participate in the selection, training (including familiarization with SOP, QC, safety, and computer systems), development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts. Ensure the documentation of these activities in accordance with systems developed by the QA and Personnel Departments.
- Work with the Department Manager and Laboratory Director to evaluate staffing sufficiency and overtime needs.
- Encourage the reporting analysts to become self-supervising and to function as a departmental team member by facilitating cross-training in various methods and/or the operation of multiple instruments efficiently.
- Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Department Manager, and/or QA Manager.
- Ensure the 200% review cycle is complete for all analysis, that non-conformance issues are completely documented and all corrective action taken in a timely manner and reported to the QA Manager, Department Manager, Project Manager and/or Laboratory Director, as appropriate. Be pro-active when possible.
- Ensure the on-time delivery of client sample results, as well as results for performance evaluation samples and IDLs/MDLs, and pro-actively report any late work to the Department Manager and/or Project Manager.
- Ensure all logbooks are completely and correctly maintained, current, and properly archived.
- Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual, the instrument operations manual, or the SOPs. Assist in the timely resolution of instrument problems by helping with non-scheduled instrument repairs and trouble-shooting when possible, and /or facilitating technical support from manufacturers.
- Coordinate the staff in order to achieve optimum turnaround time on analyses and compliance with holding times.
- Provide written responses to external and internal audit issues and performance evaluation sample issues, as requested by the Department Manager or QA department.

4.2.12 **Laboratory Analysts** *(ISO17025 4.1.5)*

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The responsibilities of the analysts are listed below:

- Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.

- Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on checklists, in lab data books and/or in the Non-Conformance Database by means of Non-Conformance Memos (NCMs).
- Pro-actively report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to the Supervisor, the Department Manager, Project Manager and/or the QA Manager or member of QA staff.
- Perform 100% review of the data generated and document the review in the raw data and on the review checklist prior to entering and submitting for secondary level review.
- Perform the analytical work critically, and suggest improvements to the Supervisor, the Department Manager, and the QA Manager. These improvements, if within the constraints of the reference material and approved, are encouraged and will be incorporated.
- Work cohesively as a team with others in the department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.
- Adhere to all safety protocols and attend safety meetings as required.
- Attend and participate in staff meetings.
- Maintain adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.
- Perform annual reviews of assigned SOPs to ensure that methods are followed and the SOP agrees with actual practices. SOPs must also be reviewed and revised any time a change has been made at the bench.
- Adhere to maintenance schedules outlined in instrument operations manuals and SOPs. Keep instruments and working areas clean with respect to both chemical contamination and clutter.
- Adhere to the ethics policies of TestAmerica Laboratories at all times and during all laboratory activities.
- Work to achieve optimal turn-around-times and adherence to all EPA-regulated holding times.

4.2.13 Safety Officer

The Safety Officer reports to the Laboratory Director and ensures that systems are maintained for the safe operation of the laboratory.

The Environmental Health and Safety Officer is responsible for the safety and well-being of all employees while at the laboratory. This includes, but is not limited to, administering the Corporate Safety Manual that complies with federal regulations, MSDS training and review, conducting laboratory safety orientation and tours for all new employees, providing instructions on safety equipment, cleaning up laboratory spills, and instructing personnel of laboratory procedures for emergency situations. The Health and Safety Coordinator is on-call 24-hours a day, 7-days a week for all laboratory situations.

The Environmental Health and Safety Officer responsibilities additionally include waste management of laboratory generated hazardous waste in accordance with appropriate regulations. This includes maintenance of required documentation, such as waste manifests, segregation of waste in accordance with requirements, and training of personnel in proper segregation of waste.

- Conduct ongoing, necessary safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Chemical Hygiene/Safety Manual.
- Administer dispersal of all Material Safety Data Sheet (MSDS) information.
- Perform regular chemical hygiene and housekeeping instruction.
- Give instruction on proper labeling and practice.
- Serve as chairman of the laboratory safety committee.
- Provide and train personnel on protective equipment.
- Oversee the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed.
- Supervise and schedule fire drills and emergency evacuation drills.
- Determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- When determined necessary, conduct exposure monitoring assessments.
- Determine when a complaint of possible over-exposure is “reasonable” and should be referred for medical consultation.
- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by TestAmerica’s medical consultants.

4.2.14 Log-in Manager

The Log-in Manager reports to the Director of Project Management. The responsibilities are outlined below:

- Direct the logging of incoming samples into the LIMS.
- Ensure the verification of data entry from login.
- Coordinating sample management from “cradle to grave,” insuring that no time is lost in locating samples.

4.2.15 Director of Project Management

The Director of Project Management reports to the Laboratory Director and serves as the interface between the laboratory’s technical departments and the laboratory’s clients. The staff consists of the Project Management team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

The laboratory recognizes the importance of efficient project management. The laboratory Project Managers (PM) are responsible for preparing quotes, preparing the Project Technical

Profile which summarizes QA/QC requirements for the project, maintaining the laboratory schedule, ensuring that technical requirements are understood by the laboratory, and advising the Laboratory, QA and Technical Managers of all variances. The laboratory Project Manager will provide technical guidance and the necessary laboratory-related information to the preparer of project-specific QAPPs and provide peer review of the final document to ensure accuracy of the laboratory information.

The Project Manager is designated as the Sample Management Coordinator for any work subcontracted under their management. The Project Manager verifies each subcontracting request to ensure that special client restrictions are not jeopardized (e.g., samples must be analyzed by the receiving affiliated or network laboratory and must maintain specific certification(s)). The Project Manager is also responsible for verifying the credentials; establishing the service agreement; ensuring data review; and invoicing of all laboratory subcontractors. The Project Manager discusses any deficiencies or anomalies with the subcontractor prior to reporting any data to the client.

- Responsible for providing quotes for new opportunities.
- Technical training and growth of the Project Management team.
- Technical liaison for the Project Management team.
- Human resource management of the Project Management team.
- Responsible to ensure that clients receive the proper sampling supplies.
- Accountable for response to client inquiries concerning sample status.
- Responsible for assistance to clients regarding the resolution of problems concerning COC.
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifying the supervisors of incoming projects and sample delivery schedules.
- Forecasting revenue and sample loading.
- Accountable to clients for communicating sample progress with agreed-upon due dates.
- Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff.
- Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness.
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports.
- Inform clients of data package-related problems and resolve service issues.
- Coordinate requests for sample containers and other services (data packages).

4.2.16 Shipping Manager/Sample Archiving

The Shipping/Sample Login Manager reports directly to the Laboratory Director. He is responsible for:

- Supervising the timely and correct shipment of sample containers, including proper preservatives and instructions, to clients.
- Maintaining accurate records of sample container shipments
- The organized storage and appropriate climate control of samples

4.2.17 Facilities Maintenance/Sample Disposal

The Facilities Maintenance Manager reports directly to the Laboratory Director. He is responsible for the following:

- Managing facility maintenance.
- Supervising the disposal of samples in accordance with the Waste Disposal SOP, the Hazardous Waste Contingency Plan in the Chemical Hygiene/Safety Manual, and the U. S. Department of Agriculture requirements.

4.3 DEPUTIES *(ISO17025 4.1.5; 4.2.Z.2)*

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy	Comment
Laboratory Director – Mike Healy	Eric Lang Karen LeClair John D. Nagel	Client / Quote Purchasing / CapEx. Facility
Customer Service Manager – Eric Lang	Dick Wright Bonnie Stadelmann Marilyn Krueding Donna Ingersoll Jim Knapp Cindy Pritchard	PM PM PM CSM – Decatur Service Center CSM – Chicago Service Center Proposal Coordinator
QA Manager – Terese Preston	Nadine Jernberg	QA Specialist
Organic Department Manager / Technical Director – Jodi Gromala	JoAnn Petruszak Kmetty Gary Rynkar Dan Knieriemen	Supervisor – GC VOA / MS VOA Supervisor – GC/ HPLC / GCMS SVOA Supervisor – Organic Extractions
Metals Department Manager / Technical Director - Diane Harper	Debbie Johnson	Supervisor – Metals
Wet Chemistry Technical Director – Diane Harper	Carla Bonner	Supervisor – Wet Chemistry
EH&S Coordinator – John D. Nagel	Jeff James	Supervisor – Sample Management
Data Management – Karen LeClair	Paula Buckley	Specialist – Data Management
Sample Management – Jeff James	Jeff Lunt Lisa Piunti	Login Bottle Prep

Figure 4-1.

Corporate Organization Chart *(ISO17025 4.1.3; 4.1.5; 4.2.Z.2)*

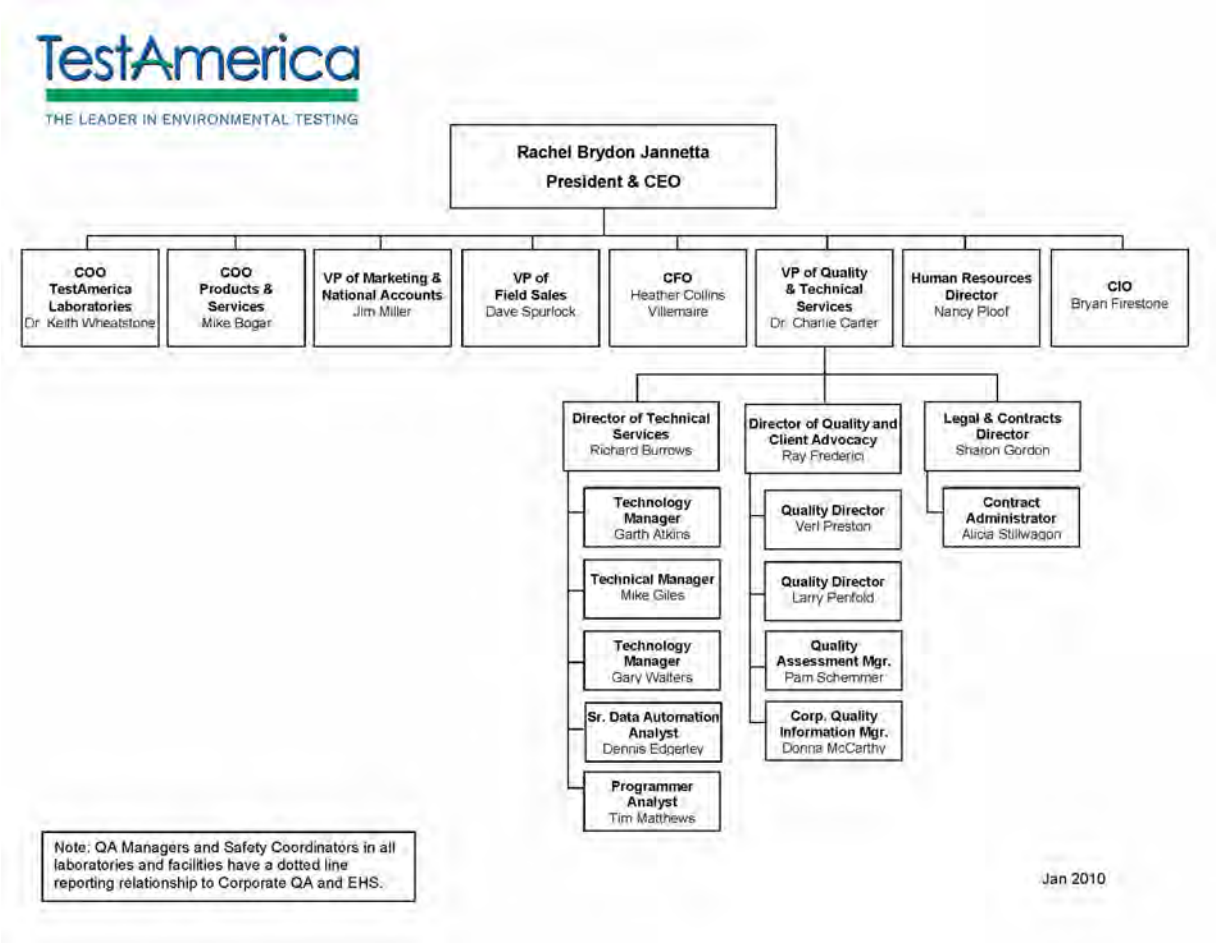
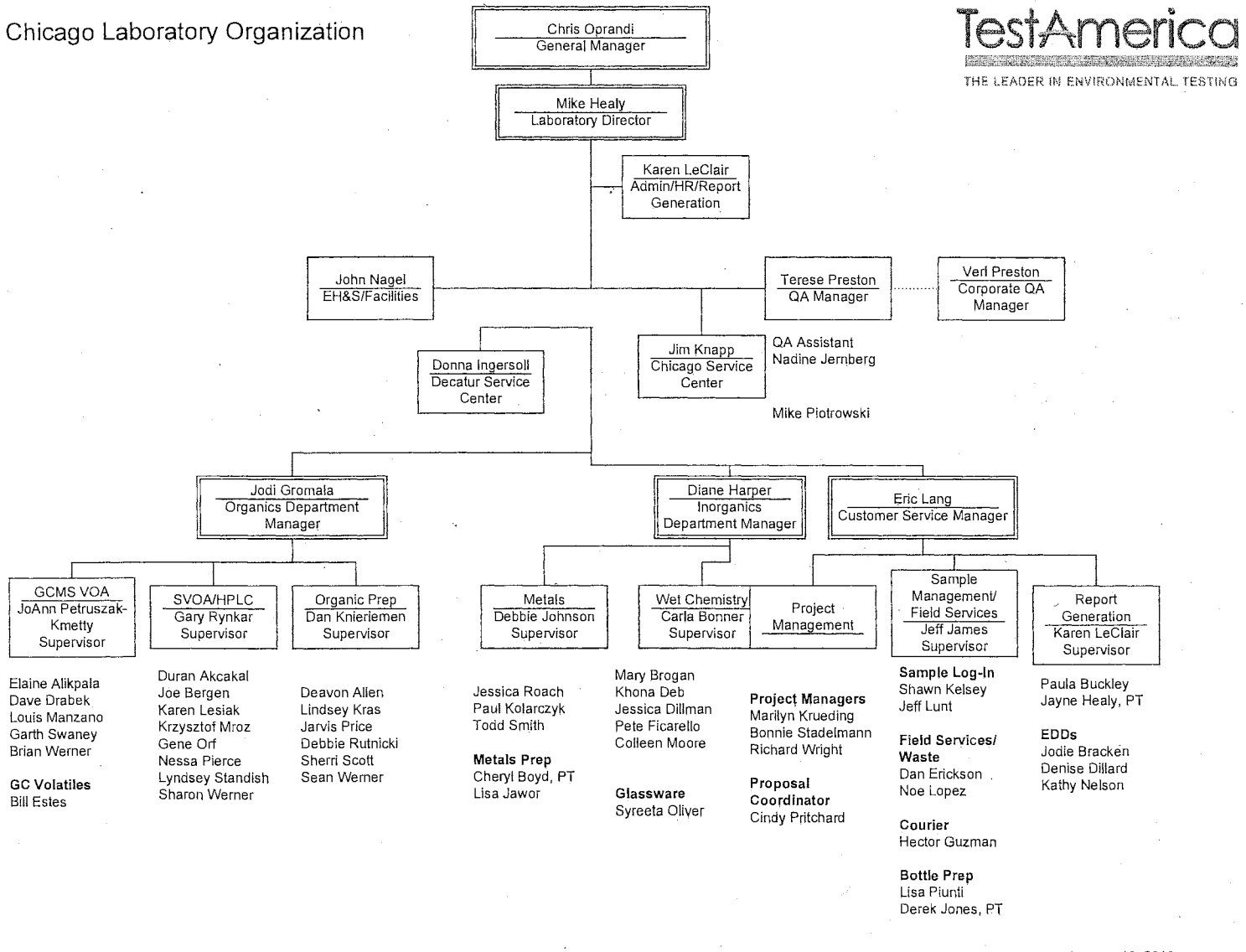


Figure 4-2.

TestAmerica Chicago Organization Chart *(ISO17025 4.1.3; 4.1.5; 4.2.Z.2)*



SECTION 5

QUALITY SYSTEM *(NELAC 5.4.2)*

5.1 QUALITY POLICY STATEMENT *(ISO17025 4.1.5; 4.2.2; 4.2.3)*

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- Provide clients with the highest level of professionalism and the best service practices in the industry.
- The laboratory management staff is committed to comply with International ANS/ISO/IEC Standard 17025:2005 and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 ETHICS AND DATA INTEGRITY *(ISO17025 4.1.5; 4.2.2)*

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CA-L-P-001) and Employee Ethics Statements (Appendix 1).
- Ethics and Compliance Officer (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CA-L-S-001)
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CA-L-S-001).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 16).

- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objective (DQO's).
- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 QUALITY SYSTEM SUPPORTING DOCUMENTATION *(ISO17025 4.2.2; 4.2.5)*

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab specific quality assurance manual.
- Corporate SOPs and Policies - Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions - A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Corporate Quality Policy Memorandums
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence *(ISO17025 4.2.5)*

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Policy Memorandum
- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC OBJECTIVES FOR THE MEASUREMENT OF DATA *(ISO17025 4.1.5; 4.2.2)*

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples. The calculation of precision is described in Section 25.5.3.2.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery. The calculation of accuracy is described in Section 25.4.1.7.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc..

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit or DL) or quantified (Reporting Limit or LOQ).

5.5 CRITERIA FOR QUALITY INDICATORS

The laboratory maintains a Quality Control Limit Summary that contains tables that summarize the precision and accuracy acceptability limits for performed analyses. This summary includes an effective date, is updated each time new limits are generated and is managed by the laboratory's QA department. The summary is located on the LAN in the U:/QC/LIMITS/STATS Directory. The excel spreadsheets enable a historical review of control limits that have been generated and applied to the methods. The current limits are updated in the TALs LIMs system for use in the evaluation of data in LIMs. This information is readily available to project managers at the quote, project and job level. Control limit summaries are available upon request. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for the development of control limits are contained in Section 25.6.

5.6 STATISTICAL QUALITY CONTROL

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as the Ohio Voluntary Action Plan (VAP)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Department Manager/Supervisor and QA Manager) and entered into the Laboratory Information Management System (LIMS). The Quality Assurance department maintains an archive of all limits used within the laboratory on the LAN in the U:/QC/LIMITS/STAT directory. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 25.6. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Surrogate recoveries are determined for a specific time period as defined above. The resulting ranges are entered in LIMS.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

Statistical control limits and control charts are used to establish method performance of a given analysis and to monitor trends of QC results graphically over time. Once a data base of the laboratory results for a method/matrix/QC analyte combination is established, the acceptability of a given analysis of that QC parameter (and of the analytical batch to which it belongs) can be evaluated in light of the laboratory's normal performance. This is intended to help identify problems before they might affect data. Often, patterns of response that are not at all evident in sets of numbers are very distinct when the same values are viewed as a chronological graph.

The charting program in the TALs LIMs system at TestAmerica Chicago automatically applies an outlier test to the queried data and identifies the data points that fail the test. The program also has 'Warning Triggers' for each of the chart types that are set as follows:
"Warn if number of consecutive points outside warning limit" (currently set at 3 points).
"Warn if number of consecutive points on either side of mean" (currently set at 5 points).

Establishment of Limits
The purpose of using statistical control limits is to define, for each analyte in a given method/matrix/QC type combination, a range of expected values. This range encompasses the random variation that occurs normally in the laboratory and allows one to evaluate control samples in that context, rather than according to an arbitrary or external set of values. Limits for accuracy and precision are defined below:

Accuracy
As recoveries of a QC analyte in a given matrix are tabulated over time, a mean value for recovery is established, as is the standard deviation (s) of those recoveries. If the analysis is in statistical control (e.g., if the set of QC recoveries over time show random variation about the mean) approximately 99.7% of all recoveries for that QC will fall within three standard deviations (3s) of the mean. Thus, assuming that the mean itself is an acceptable level of recovery, the values corresponding to 3s above and 3s below the mean are defined as the Control Limits. Any single recovery outside these values is assumed to have resulted from some circumstance other than normal variation and shall be investigated.

Roughly 95% of points should fall within 2s of the mean. The values +2s and -2s are the Warning Limits. Any normal result has approximately a 1/20 chance of being between 2s and 3s from the mean, so a result in this region doesn't necessarily warrant corrective action, but attention should be paid to such points.

Precision
Precision is used to indicate matrix variability so that appropriate decisions can be made by the client when repeated analyses vary significantly. The coefficient of variation, expressed as a percentage (e.g., the %RSD) for the data set used to calculate accuracy control limits defines the control limit for precision. Duplicate analyses of the QC samples, such as duplicates or MS/MSD, should have an RPD less than or equal to this established precision control limit to be considered free of matrix interferences.

The laboratory calculates statistical control limits on an annual basis or more frequently if instrument conditions or method procedure warrants the re-calculation of control limits. The QA Manager and Department Managers/Supervisors are responsible for the review and approval of the limits for use.

5.7 QUALITY SYSTEM METRICS

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 17). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6

DOCUMENT CONTROL *(NELAC 5.4.3)*

(ISO17025 4.2.7; 4.3.1; 4.3.2.2; 4.3.3.3; 4.3.3.4)

6.1 OVERVIEW

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual (QAM)
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

The Corporate Quality staff posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving and laboratory SOP *UP-QA-006*, Document Control.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports. Discussion on records control is described in Section 15.

6.2 DOCUMENT APPROVAL AND ISSUE *(ISO17025 4.3.2.1; 4.3.2.2; 4.3.2.3; 4.3.3.1)*

The pertinent elements of a document control system for each document include a unique document title and number, the number of pages of the item, the effective date, revision number and the laboratory's name. The Quality Assurance personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department. In order to develop a new document, a department manager or supervisor submits an electronic draft to the QA Department for suggestions and approval before use. Once approved, the document is issued a document control number and is added to the tracking spreadsheet located on the LAN at U:/QC/List/SOP List. Upon approval, QA personnel add the identifying version information to

the document and retain the official document on file. The official document is provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of yearly and revised as appropriate. Changes to documents occur when a procedural change warrants a revision of the document.

6.3 PROCEDURES FOR DOCUMENT CONTROL POLICY *(ISO17025 4.3.2.1; 4.3.2.2; 4.3.3.1)*

For changes to the QA Manual, refer to laboratory SOP *UP-QA-032*, SOP Change Protocol and the Corporate Document control SOP CW-Q-S-001. Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Hardcopies are filed within the QA department or in are archived in the secure data storage room and electronic copies are stored on the LAN in the U:/QC/SOP department directories for the applicable revision.

For changes to SOPs, refer to the SOP No. *CW-Q-S-002*, Writing a Standard Operating Procedure SOP and the laboratory SOP UP-QA-032. The SOPs identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions and information are organized by department in the QA office and tracked on the LAN in the U:/QC/List/SOP List excel spreadsheet. Electronic versions are kept on the LAN in the appropriate U:/QC directory; hard copies are kept in QA files. The procedure for the care of these documents is in the laboratory SOP *UP-QA-006*, Document Control.

6.4 OBSOLETE DOCUMENTS *(ISO17025 4.3.2.1; 4.3.2.2)*

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived as described in Section 15 and according to SOP UP-DM-002, Data Management: Record Retention & Purging.

SECTION 7

SERVICE TO THE CLIENT (NELAC 5.4.7)

(ISO17025 4.4.1; 4.4.2; 4.4.3; 4.4.4)

7.1 OVERVIEW *(ISO17025 4.4.5; 5.7.1)*

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these regulatory and client requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 REVIEW SEQUENCE AND KEY PERSONNEL *(ISO17025 4.4.5)*

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the National Account Director, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP No. CA-L-P-002**,** Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Legal & Contracts Director
- General Manager
- The Laboratory Project Management Director
- The Laboratory Operations Manager
- Laboratory and/or Corporate Technical Directors
- Laboratory and/or Corporate Information Technology Managers/Directors
- Regional and/or National Account representatives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The National Account Director, Legal Contracts Director, or local account representative then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Legal & Contracts Director maintains copies of all signed contracts**.** The laboratory's Proposal Coordinator, Cindy Pritchard also maintains a copy.

7.3 DOCUMENTATION

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Regional Account Manager. A copy of the contract and formal quote will be filed with the laboratory PM, Lab Director or local account representative/proposal coordinator.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client.

7.3.1 Project-Specific Quality Planning *(ISO17025 5.7.1)*

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. The PM is the first point of contact for the client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure that resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory during production meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Department Manager/Supervisor. After the modification is implemented into the laboratory process, documentation of the modification is retained as an attached document to the project or job in LIMs or as an NCM in the LIMs system which can then be added to the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 SPECIAL SERVICES *(ISO17025 4.7.1; 4.7.2)*

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 16.2.2 and 26.6)

Note: ISO 17025/NELAC 2003 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 26. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relavant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 CLIENT COMMUNICATION *(ISO17025 4.7.1; 4.7.2)*

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any con-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

Technical directors are available to discuss any technical questions or concerns that the client may have.

7.6 REPORTING *(ISO17025 4.7.1; 4.7.2)*

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 CLIENT SURVEYS *(ISO17025 4.7.1; 4.7.2)*

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client services.

TestAmerica's Client Advocacy team has developed a lab/client specific survey to assess client satisfaction. With each report emailed to a client, a link to a Report/Project Feedback Survey is attached with the invitation to the client to provide feedback regarding the service they have received. (Figure 7-1)

Figure 7-1

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Report/Project Feedback

Please let us know if we met your expectations by rating the service you received from TestAmerica on this project.

Which TestAmerica Laboratory location performed this work?
(Select One from the drop down box)

--Click Here--

If "other" was selected, please specify the location .

Please enter the TestAmerica report # .

How would you rate the overall performance of this laboratory location?

Provide a score ranging from 1 poor to 10 for excellent

Poor 1 2 3 4 5 6 7 8 9 10 Excellent

Are there any comments that you would like to share?

Please enter your company name .

Please enter your name: (optional) .

If you would like to be contacted to discuss and issue, please indicate your
(phone# or E-mail address .

If you need further assistance, please contact your TestAmerica Project Manager or our Director's of Client Advocacy (Tim O'Shields or Ray Frederici)

SECTION 8

SUBCONTRACTING OF TESTS *(NELAC 5.4.5)*
(ISO17025 4.4.3; 4.5.4)

8.1 OVERVIEW *(ISO17025 4.5.1; 4.5.2; 4.5.3; 5.3.1)*

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process SOP (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in NELAC/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-NELAC accredited work where required.

For DOD projects the subcontractor laboratories used must have an established and documented laboratory quality system that complies with DoD QSM requirements. If a lab meeting those criteria is not available, the client must pre-approve use of the subcontract laboratory. The subcontractor laboratories are evaluated following the procedures outlined below and as seen in Figure 8-1. The subcontractor laboratory must receive project-specific approval from the DoD client before any samples are analyzed.

The QSM has 5 specific requirements for subcontracting:

1. Subcontractor laboratories must have an established laboratory quality system that complies with the QSM.
2. Subcontractor laboratories must be approved by the specific DoD Component laboratory approval process.
3. Subcontractor laboratories must demonstrate the ability to generate acceptable results from the analysis of PT samples, subject to availability, using each applicable method, in the specified matrix, and provide appropriate documentation to the DoD client.
4. Subcontractor laboratories must receive project-specific approval from the DoD client before any samples are analyzed.
5. Subcontractor laboratories are subject to project-specific, on-site assessments by the DoD client or their designated representatives.

Project Managers (PMs) or Customer Service Managers (CSM), or Regional Account Executives (RAE) for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall be retained in the project folder.

Note: In addition to the client, some regulating agencies, such as the US Army Corps of Engineers and the USDA, require notification prior to placing such work**.**

8.2 QUALIFYING AND MONITORING SUBCONTRACTORS *(ISO17025 4.5.1; 4.5.2; 4.5.3)*

Whenever a PM, Customer Service Manager (CSM) or Regional Account Executives (RAE) becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories and supporting documentation is available on the TestAmerica intranet site. Verify necessary accreditation, where applicable, (e.g., on the subcontractors NELAC, A2LA accreditation or State Certification) for the requested tests prior to sending samples.
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- NELAC or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. Refer to Corporate SOP No. CA-C-S-001, Work Sharing Process.

When the potential sub-contract laboratory has not been previously approved, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP no. CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will add the lab to the approved list on the intranet site along with the associate documentation and notify the finance group for JD Edwards.

**USDA permit is required if soils less than three feet deep from New York, North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Texas, Oklahoma, New Mexico, Arizona, California, Hawaii, or outside the continental U. S. are to be analyzed. These samples require special shipping measures; check with the EHS Department. It may be necessary to heat-treat the samples before shipping if the subcontract laboratory does not have a USDA permit; however, some analytes/tests may be irrelevant after heat treatment.

8.2.2 The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints must be posted using the Vendor Performance Report (Form No. CW-F-WI-009)**.**
- Information must be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Lab Directors, QA Managers and Sales Personnel.

8.3 OVERSIGHT AND REPORTING

The PM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM or CSM responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented on a Subcontracted Sample Form (Workshare Agreement Figure 8-2) and the form is retained in the project folder. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a Chain of Custody (COC). A copy of the original COC sent by the client must be included with all samples subbed within TestAmerica.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilities successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-NELAC accredited work must be identified in the subcontractor's report as appropriate. If NELAC accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 CONTINGENCY PLANNING

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs. In the event this provision is utilized, the QA Manager will be required to verify certifications. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1.
Example - Subcontracting Laboratory Approval Form (Initial / Renewal)

SUBCONTRACTING LABORATORY APPROVAL

Reference: Section 8 – Quality Assurance Manual

Date: _____
Laboratory: _____
Address: _____
_____
Contact and e-mail address: _____
Phone: Direct _____ Fax _____

Requested Item[3]	Date Received	Reviewed/ Accepted	Date
1. QA Manual[3]			
2. Copy of State Certification[1]			
3. State Audit with Corrective Action Response (or NELAC or A2LA Audit)[3]			
4. Most Recent (and relevant) 2 Sets of WP/WS Reports with Corrective Action Response[1,3]			
5. SOQ or Summary list of Technical Staff and Qualifications [3]			
6. SOPs for Methods to Be Loadshifted[2,3]			
7. USDA Soil Permit			
8. Insurance Certificate			
9. Sample Report[3]			
10. For DoD Work: Statement that Lab quality system complies with QSM.			
11. For DoD Work: Approved by specific DoD Component laboratory approval process.			
11. Description of Ethics Program[3]			

1 - Required when emergency procedures are implemented.
2 - Some labs may not submit copies due to internal policies. In these cases, a copy of the first page and signature page of the SOP is acceptable. This requirement may also be fulfilled by supplying a table of SOPs with effective dates.
3 – If the laboratory has NELAC accreditation, Item #s 4 through 10 are not required.

On Site Audit Planned: YES NO If yes, Date Completed: _____ By Whom: _____

Comments:

Lab Acceptable for Subcontracting Work: YES NO Limitations: _____

QA Manager: _____ Date: _____
(Printed Name)

☐ Forwarded to Contract Coordinator, by: _____ Date: _____

Figure 8-2.
Example - Subcontracted Sample Form (Workshare Agreement)

TestAmerica	Work Sharing Agreement (Include with every sample shipment)		Exporting Lab	TAL xxxxxxxxxx
			Project Name	
Import Lab Information			**Export Lab Information**	
Lab Name	TAL Chicago		PM Contact Name	
PM Contact Name			Backup Contact Name	
Backup Contact Name			Agreement Date	
Pricing Information			**Project Information**	
QA/QC (i.e. MS/MSD) Billable?	No		Client Company Name	
Raw Data Surcharge		%	Date First Samples to Arrive	
EDD Surcharge		%	Est. Duration of Sampling Event	
TAT Surcharges		%		
Penalty Terms	None			
Other Charges Not in Unit Price? (i.e. canisters, Level IV/III , shipping, bottles)	None		Quote or Contract Reference ID	
Project Details				
Non-Standard Work Product	No			See Attached
Quality Assurance Plan	No			See Attached
List Certifications Required				See Attached
Analyte/Cmpd. List with RLs Attached	No			
Results Dry-Weight Corrected	No			
Special Method Holding Times	None			specify
Internal Chain of Custody Required	No			
Known Hazards/High Analyte Level	No			
Saturday/Special Delivery Options	None			
Special Instructions	None			
Reporting Limit Value Convention	Report to MDL with "J" Values up to RL		"Non-Detect" Presentation Convention	U

Deliverable Requirements		Transmittal medium	Format Column	Date Due to Export Lab
Preliminary Report:	No			
Final Report:	No			
EDD:	No		Type Format Name	
Total Access Reporting	No	NA	NA	
Custom Forms:	No	NA	Type Format Name	
"Other" Deliverable Definitions or Notes				

Import and Export Lab Agreement

Import lab must acknowledge receipt of Agreement and samples *via E-Mail*

Analysis	Method	Matrix	# of Samples	Import Lab's Unit Price	Unit Price w/Surcharges	Extended Price
					$ -	$ -
					$ -	$ -
					$ -	$ -
					Approximate Total Project Value	**$ -**

Work Instruction No. CA-WI-010/B-10/08

SECTION 9

PURCHASING SERVICES AND SUPPLIES *(NELAC 5.4.6)*
(ISO17025 4.6.1)

9.1 OVERVIEW *(ISO17025 4.6.2; 4.6.3; 4.6.4)*

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with the TestAmerica's Corporate Controlled Purchases Procedure, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts (Policy No. CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 GLASSWARE

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 REAGENTS, STANDARDS & SUPPLIES *(ISO17025 4.6.2; 4.6.3; 4.6.4)*

Purchasing guidelines for equipment and reagents must meet with the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP No. CA-Q-S-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst should completes the Material Request Sheet (Figure 9-1) when requesting reagents, standards, or supplies. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use.

The analyst must provide the item number, item description, package size, catalogue page number, and the quantity needed. If an item being ordered is not the exact item requested, approval must be obtained from the department manager or supervisor prior to placing the order. The laboratory's purchasing manager (Karen LeClair) enters the order into the JDE system. The order is approved by the LD and the Corporate Purchasing Department places the order with the vendor.

9.3.2 Receiving

It is the responsibility of the facility manager and sample login staff to receive the shipment and document date received. It is the responsibility of the analyst who ordered the materials to date the material when opened for use and inspect the item. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Material Safety Data Sheets (MSDSs) are available in the facility/safety manager's office on CD and online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

All methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, it may be assumed that it is not significant in that procedure and, therefore, any grade reagent may be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals unless noted otherwise by the manufacturer or by the reference source method. Chemicals should not be used past the manufacturer's or SOP expiration date unless 'verified' (refer to item 3 listed below).

- An expiration date can not be extended if the dry chemical is discolored or appears otherwise physically degraded. The dry chemical must then be discarded.
- Expiration dates can be extended if the dry chemical is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical is compared to an unexpired independent source in performing the method and the performance of the dry chemical is found to be satisfactory. The comparison must show that the dry chemical meets CCV limits. The comparison studies are maintained within the department where the study was performed, documented in the data book of the applicable method that was performed.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. The minimum total pressure must be 500 psig or the tank must be replaced. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- umho/cm (or specific resistivity of greater than 1.0 megaohm-cm) at 25^{o}C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is less than the specified limit, the Facility Manager and appropriate Department Managers/Supervisors must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased VOA vials must be certified clean and the certificates must be maintained. If uncertified VOA vials are purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in files or binders in each laboratory section. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technical Director or QA Manager.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001) and method SOPs or manufacturer instructions. Table 9-1 details specific storage instructions for reagents and chemicals. Section 22 discusses conditions for standard storage.

9.4 PURCHASE OF EQUIPMENT/INSTRUMENTS/SOFTWARE

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical Director and/or the Laboratory Director. If they agree with the request the procedures outlined in TestAmerica's Corporate Policy No. CA-T-P-001, Qualified Products List are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The

appropriate written requests are completed and purchasing places the order. The quote and justification are forwarded to the controller to start the capex process.

Upon receipt of a new or used piece of equipment, it is given an equipment tag number and is assigned a unique instrument ID such as ICPMS2 that will be used to identify the equipment in logbooks and in LIMs. The equipment list described in Section 21 that is maintained by the QA Department will be updated and IT will be notified so that can be set up in LIMs for data import (if applicable) and to synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 20). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department as specified in the laboratory's procedure for software verification. Software certificates supplied by the vendors are filed with the LIMS Administrator. The manufacturer's operation manual is retained at the bench with the instrument.

9.5 SERVICES

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 21. The need for service is determined by analysts and/or Department Managers. The service providers that perform the services are approved by the Department Managers/Lab Director.

9.6 SUPPLIERS

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Vendor Selection (SOP No. CW-F-S-018) and Procurement & Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report (CW-F-WI-009).

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form (CW-F-WI-007 – refer to Figure 9-2).

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department, Technical Director and/or the purchasing manager are consulted with vendor and product selection that have an impact on quality.

Figure 9-1.

Materials Request Sheet

PURCHASE REQUISITION

TestAmerica CHICAGO

Date of Order:
_____

SHIP TO:
TestAmerica Chicago
2417 Bond Street
University Park, IL 60484

Purchase Order #
_____

Purchase Req. #
_____

VENDOR: _____
_____
_____

Vendor Phone: _____
Contact: _____

QUANTITY	UOM	PART NUMBER	DESCRIPTION	UNIT PRICE	TOTAL	ACCOUNT #

SUBTOTAL: _____
TAX: _____
SHIP: _____
TOTAL: _____

DATE REQUIRED: _____
REQUISITIONED BY: _____
SUPERVISOR: _____

Table 9-1.

Storage of Reagents and Chemicals

Chemical	Storage Requirements
Concentrated Acids and Bases	Stored in the original containers at room temperature. All organic acids must be stored separately from inorganic acids. Acids should not be stored with bases.
Bulk Dry Chemicals	Stored in the original containers at room temperature. All organic acids must be stored separately from inorganic acids. Acids should not be stored with bases.
Working Solutions containing Organic Compounds	Stored as per method recommendation/ requirement. They are generally stored refrigerated at 4°C± 2°C (greater than freezing and < 6°C).
Working Solutions containing only Inorganics	Stored at room temperature; refrigeration is optional.
Flammable Solvents	Stored in solvent cabinets at room temperature.
Non-Flammable Solvents	Stored separately from the flammable solvents in cabinets at room temperature.

Note: Exceptions to the above detailed storage requirements may be made.

Figure 9-2
Example – JD Edwards Vendor Add Request Form

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JD Edwards Vendor Add Request Form

Vendor name:	Lab location and individual making request:
Vendor address (remit to):	Vendor phone:
Vendor address (remit to):	Vendor fax:
Contact name:	Product / service provided:

Reason for Vendor Addition: Check all reasons that apply

☐ Cost Reduction	Estimated Annual Savings $
☐ Replace Current Vendor	Reason?
	Vendor being Replaced?
☐ New Product / Service	Describe:
☐ ISO Approved (Required for Aerotech / P&K only)	

Small Business:

Does this vendor help us to meet our small business objectives: _____
If yes, which category: _____

Personal and Ethical Considerations:

Is there any personal conflict of interest with a TestAmerica employee and the vendor listed above? _____
_____
Have ethical considerations been taken into account in your evaluation of this vendor?_____
_____

Can this product be sourced from another TestAmerica facility?_____

Please complete form and email to NCPurchasing@testamericainc.com or fax to (330) 966-9275.

I approve the addition of this vendor:

_____ _____
Purchasing Manager - Patrick Eckman Corporate Controller - Leslie Bowers

Form No. CW-F-WI-007

SECTION 10

SERVICE TO THE CLIENT *(NELAC 5.4.7)*

10.1 OVERVIEW

Refer to Sections 7.4 through 7.7 for details regading client services.

SECTION 11

COMPLAINTS *(NELAC 5.4.8)*
(ISO17025 4.8)

11.1 OVERVIEW

The laboratory considers an effective client complaint handling process to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services, (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing with both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 13 (Corrective Actions) and is documented following the *TestAmerica Chicago – Complaint Handling Process* work instruction (CHI-22-23-002). It is the laboratory's goal to provide a satisfactory resolution to complaints in a timely and professional manner.

11.2 EXTERNAL COMPLAINTS

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to the *TestAmerica Chicago – Complaint Handling Process* work instruction (CHI-22-23-002).

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelyhood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

11.3 INTERNAL COMPLAINTS

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 13. In addition, Corporate Management, Sales and Marketing and Information Technology (IT) may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 13.

11.4 MANAGEMENT REVIEW

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 17)

SECTION 12

CONTROL OF NON-CONFORMING WORK *(NELAC 5.4.9)*
(ISO17025 4.9.1; 5.10.Z.10)

12.1 OVERVIEW *(ISO17025 4.9.1; 4.11.3; 4.11.5)*

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 13).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the supervisor for resolution. The supervisor may elect to discuss it with the Project Manager, QA Manager or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratories corrective action system described in Section 13. This information can then be supplied to the client in the case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 20. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Department Manager/Supervisor and QA Manager. Documentation detailing the method deviation must be included in the project folder. Deviations **must** also be noted on the final report with a statement that the compound is not reported in compliance with NELAC (or the analytical method) requirements and the reason. (The laboratory will use a Non-Conformance Memo (NCM) in LIMs which will be designated to print on the final report in the case narrative). Data being reported to a non-NELAC state would need to note the change made to how the method is normally run.

12.2 RESPONSIBILITIES AND AUTHORITIES *(ISO17025 4.9.1; 4.11.3; 4.11.5)*

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CA-L-S-001) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances the Laboratory Director, a Department Manager/Supervisor, or a member of the QA team may exceptionally authorize departures from documented procedures

or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures described in Section 13. This information may also need to be documented in logbooks and/or data review checklists and on a Non-Conformance Memo (NCM) in TALs LIMs as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, the Department Managers and Department Supervisors. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Director of Quality & Client Advocacy and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, the COO, General Managers and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

12.3 EVALUATION OF SIGNIFICANCE AND ACTIONS TAKEN *(ISO17025 4.9.1; 4.11.3; 4.11.5)*

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation and Recall Procedure (SOP No. CA-L-S-001) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECO's and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting (Section 13) in lieu of the data recall determination form contained in TestAmerica's Corporate SOP No. CA-L-S-001.

12.4 PREVENTION OF NONCONFORMING WORK *(ISO17025 4.9.2; 4.11.2)*

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system (Section 13). On a monthly basis, the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

12.5 METHOD SUSPENSION/RESTRICTION (STOP WORK PROCEDURES)

(ISO17025 4.9.1; 4.9.2; 4.11.5)

In some cases it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 12.2, Paragraph 5 above.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will also initiate a corrective action report as described in Section 13 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (i.e., Project Management, Log-in, etc…). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, QA Manager, Department Manager, Department Supervisor) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management and the Director of Client Services and Sales and Marketing **must** be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report as described in Section 13.

SECTION 13

CORRECTIVE ACTION *(NELAC 5.4.10)*

13.1 OVERVIEW *(ISO17025 4.9.2; 4.11.1; 4.11.2)*

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Non-Conformance Memos (NCMs) (refer to Figure 13-1).

13.2 GENERAL *(ISO17025 4.11.2; 4.11.3)*

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify Systematic Problems before they become serious.
- Identify and track Client complaints and provide resolution (see more on client complaints in Section 11).

13.2.1 Non-Conformance Memo (NCM) - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non matrix related)
- Missed sample Holding Times
- Isolated Reporting / Calculation Errors
- Client report based complaints and corrections.
- Discrepancies in materials / good received vs. manufacturer packing slips.

13.2.2 Corrective Action Report (CAR) – is used to document the following types of corrective actions:

- Questionable trends that are found in the monthly review of NCMs.
- Issues found while reviewing NCMs that warrant further investigation.
- Internal and external audit findings.
- Failed or unacceptable PT results.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic Reporting / Calculation Errors

13.3 CLOSED LOOP CORRECTIVE ACTION PROCESS *(ISO17025 4.11.2; 4.11.3; 4.12.2)*

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

13.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or corrective action report must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 13-1, Appendix 3 (Default) and Appendix 8 (DoD QSM 4.1) tables provide some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Supervisor, Lab Director, Project Manager or QA Manager (or QA designee) is consulted.

13.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM is used for this documentation.

13.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

13.3.4 Monitoring of the Corrective Actions *(ISO17025 4.11.4)*

- The Department Manager/Supervisor and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Department Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each NCM is entered into LIMs for tracking purposes and a monthly summary of all corrective actions is printed out for review to aid in ensuring that the corrective actions have taken effect.
- The QA Manager reviews monthly NCMs for trends. Highlights are included in the QA monthly report (refer to Section 17). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

13.3.5.1 Follow-up Audits *(ISO17025 4.11.4)*

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements. (Section 16 includes additional information regarding internal audit procedures.)
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 16.1.4, Special Audits.)

13.4 TECHNICAL CORRECTIVE ACTIONS

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method specific SOPs, Appendix 3 (Default), and in Appendix 8 (DoD QSM 4.1), the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 12 for information regarding the control of non-conforming work). The documentation of these procedures is through the use of an NCM.

Table 13-1 includes examples of general technical corrective actions. For specific criteria and corrective actions refer to the analytical methods or specific method SOPs. Appendix 4 of this QAM also summarizes QC requirements and corrective actions for the methods run in the lab.

Table 13-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method specific SOPs, Work Instructions, Appendix 3 (Default) and Appendix 8 (DoD QSM 4.1) of this QAM. QAM Sections 20 and 21, and SOP CA-L-S-001 (Internal Investigation of Potential Data Discrepancies and Determination for Data Recall). All corrective actions are reviewed at a minimum monthly by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by a written NCM and appropriate corrective action (e.g., reanalysis) is taken and documented**.**

13.5 BASIC CORRECTIONS *(ISO17025 4.11.1; 4.13.2.3)*

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original “uncorrected” file must be maintained intact and a second “corrected” file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 13-1.
Example – Non-conformance Memo *(ISO17025 4.11.2 ; 4.13.2.3)*

Non-Conformance Memo

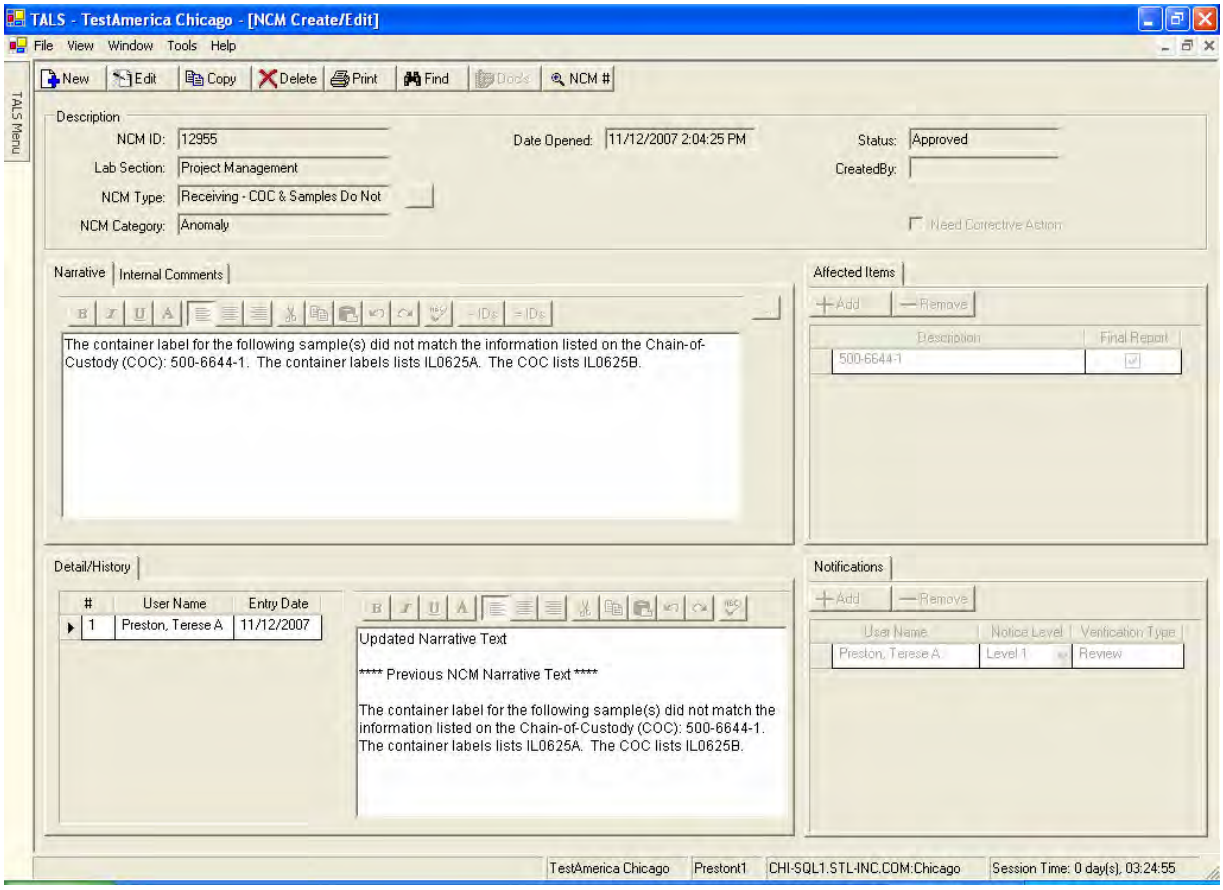


Table 13-1.

Example – General Corrective Action Procedures *(ISO17025 4.11.2)*

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Proficiency Testing (PT) Samples *(QA Manager, QA Specialist, Department Manager/Supervisor)*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits *(QA Manager, QA Specialist, Department Manager/Supervisor, Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc.	- Non-conformances must be investigated through CAR system and necessary corrections must be made.
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Department Manager/ Supervisor, QA Manager, Corporate QA, Corporate Management)	- SOP CA-L-S-001, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CA-L-S-001.
Client Complaints *(Project Managers, Lab Director, Sales and Marketing, QA Manager, Department Supervisor/ Manager)*	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 17 for an example) (QA Manager, Lab Director)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, NCMs for the month are reviewed and possible trends are investigated.
Health and Safety Violation (Safety Officer, Lab Director, Department Supervisor/Manager)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

SECTION 14.0

PREVENTIVE ACTION (NELAC 5.4.11)

(ISO17025 4.10; 4.12.1; 4.12.2)

14.1 OVERVIEW *(ISO17025 4.15.1; 4.15.2)*

The laboratory's preventive action programs improve, or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive continuous process improvement activity that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the QA Metrics Report, internal or external audits, proficiency testing performance, client complaints, staff observation, etc..

The monthly QA Metrics Report shows performance indicators in all areas of the quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. These metrics are used to help evaluate quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process (Section 13) is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

14.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action.
- Process for the preventive action.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action.
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process and management review.

Note: There may be varying levels of formality and documentation during the preventive action process due to the simplicity/complexity of the action taken.

14.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the Annual Management Review (Section 17). A highly detailed recap is not required; a simple recount of success and failure within the preventive action program will provide management a measure for evaluation.

14.2 MANAGEMENT OF CHANGE

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these various tracking indicators, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of indicators monitored under this collective system include:

- SOP Tracking
  - Current Revisions w/ Effective Dates
  - Required Annual Revisions w/ Due Date
- Proficiency Testing (PT) Sample Tracking
  - Pass / Fail – most current 2 out of 3 studies.
- Instrument / Equipment List
  - Current / Location
- Accreditations
  - New / Expiring
- Method Capabilities
  - Current Listing by program (e.g., Potable Water, Soils, etc.)
- Key Personnel
  - Technical Managers, Department Supervisors, etc..

These items are maintained on TestAmerica's Intranet (Proposal Library) or on our internal database (TotalAccess) which uploads to our company internet site.

This process is discussed in further detail in SOP CA-Q-S-003, Management of Change.

SECTION 15.0

CONTROL OF RECORDS (NELAC 5.4.12)

(ISO17025 4.2.7; 4.13.1.1)

The laboratory maintains a record system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued. Refer to *SOP UP-DM-002* Data Management: Record Retention & Purging and *SOP UP-IS-014* Proc/Processes Entry, Storage, Backup/Retrieval, Mgmt Bench Data for further details.

15.1 OVERVIEW *(ISO17025 4.13.1.1; 4.13.1.2; 4.13.2.2; 4.13.2.3)*

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 15-1. Quality records are maintained by the QA department on the local area network (LAN) in the U:/QC directory of data files which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained in accordance with the SOP UP-DM-002 *Data Management: Record Retention and Purging and* SOP UP-IS-014 *Proc/Processes Entry, Storage, Backup/Retrieval, Mgmt Bench Data.*

Table 15-1. Record Index[1] *(ISO17025 4.13.1.1)*

Record Type[1]		Retention Time:
Technical Records	- Raw Data - Logbooks - Standards - Certificates - Analytical Records - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*

	Record Type[1]	**Retention Time:**
QA Records	Internal & External Audits/Responses Certifications PTs Corrective/Preventive Actions/NCMs Management Reviews Review Checklists MDL/IDL/IDOC Studies Statistical Evaluations Laboratory Training Records Method & Software Validation / Verification Data Data Investigation	5 Years from archival* <u>Data Investigation:</u> 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	Sample Receipt & COC Documentation Contracts & Amendments Correspondence QAPP SAP Telephone Logs E-mail correspondence Lab Reports Electronic Data (EDD)	5 Years from analytical report issue*
Administrative Records	Finance & Accounting	10 Years
	EH&S Manual, Permits, Disposal Records	7 Years
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	7 Years (HR Personnel Files must be maintained Indefinitely)
	Administrative Policies Technical Training Records	7 Years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 15-2.

15.1.1 *(ISO17025 4.13.1.3)* All records are legible and stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or the offsite location that provides a suitable environment to prevent damage or deterioration and to prevent loss. Backup data tapes are stored at the File Center. Retention of records is maintained on-site at the laboratory for at least 1 year after their generation and moved offsite for the remainder of the required storage time. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Retention of records are maintained on-site at the laboratory for at least 1 year after their generation and moved off-site for the remainder of the required storage time. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 15-2 have lengthier retention requirements and are subject to the requirements in Section 15.1.2. Policy CW-L-P-001 (Record Retention) provides additional information on record retention requirements.

15.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 15-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 15-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	10 years (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio VAP	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

15.1.3 *(ISO17025 4.13.1.4)* The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 20.14 for more information. Refer to SOP *UP-DM-002 - Data Management: Record Retention and Purging* for the discussion on electronic archiving and the maintenance of electronic records.

15.1.4 *(ISO17025 4.13.2.1)* The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the invoice and the work order sheet generated by the LIMS within the TALs LIMs system and can be accessed via the Project Management Desktop. The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with this package. The original COC is filed separately by Job number in the report generation and data management department. A copy of the COC is included as part of every data report.
- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.
- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set refer to laboratory SOP UP-IS-014, *Proc/Processes Entry, Storage, Backup/Retrieval, Mgmt Bench Data* for further details. Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run log or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.
- Changes to hardcopy records shall follow the procedures outlined in Section 13 and 20. Changes to electronic records in LIMS or instrument data are recorded in audit trails.
- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "Analyzed by".
- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.
- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned. The procedure for this verification can be found in SOP *UP-DM-002 – Data Management: Record Retention and Purging.*
- Also refer to Section 20.14.1 'Computer and Electronic Data Related Requirements'**.**

15.2 TECHNICAL AND ANALYTICAL RECORDS *(ISO17025 4.13.2.2; 4.13.2.3)*

15.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement (refer to Section 15.1). The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the preparation, performance of each analysis and reviewing results.

15.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

15.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 13 and 20. Changes to electronic records in LIMS or instrument data are recorded in audit trails.
The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include (previous discussions relate where most of this information is maintained – specifics may be added below):

- laboratory sample ID code**;**
- Date of analysis and Time of Analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook and in the LIMs**.**
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type**;**
- all manual calculations and manual integrations**;**
- analyst's or operator's initials/signature**;**
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents**;**
- test results**;**
- standard and reagent origin, receipt, preparation, and use**;**
- calibration criteria, frequency and acceptance criteria**;**
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions**;**
- quality control protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats**.**

15.3 LABORATORY SUPPORT ACTIVITIES

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)**;**
- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value**;**
- copies of final reports**;**
- archived SOPs**;**
- correspondence relating to laboratory activities for a specific project**;**
- all corrective action reports, audits and audit responses**;**
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

15.3.1 Sample Handling Records

Sample handling and tracking is discussed in Section 24. Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

15.4 ADMINISTRATIVE RECORDS

The laboratory also maintains the administrative records in either electronic or hard copy form. See Table 15-1.

15.5 RECORDS MANAGEMENT, STORAGE AND DISPOSAL

15.5.1 All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available to the accrediting body upon request.

15.5.2 All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

15.5.3 Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access**.**

15.5.4 The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory bound notebooks are issued on a per analysis basis, and pages are numbered sequentially within a given logbook. All data are recorded sequentially within a series of sequential notebooks. Bench sheets, when used, are filed with any subsequent raw data by Department and sequentially by the TALs LIMs Batch number. Standards are maintained in the LIMS – logbooks are used in several departments in conjunction with the TALs LIMs record. Records are considered archived when noted as such in the records management system (a.k.a., document control).

15.5.5 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

15.5.6 Records Disposal

15.5.6.1 Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration (Refer to Tables 15-1 and 15-2).

15.5.6.2 Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

15.5.6.3 If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required. [Refer to Policy No. CW-L-P-001 (Records Retention).]

SECTION 16

AUDITS *(NELAC 5.4.13)*

16.1 INTERNAL AUDITS *(ISO17025 4.14.1; 4.14.2; 4.14.3; 5.9.1)*

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and when requested to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Audits, SOP No. CA-Q-S-004. The types and frequency of routine internal audits are shown in Table 16-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 16-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems	QA Department or Designee	All areas of the laboratory annually
QA Technical Audits - Evaluate raw data versus final reports - Analyst integrity - Data authenticity	QA Department or Designee	All methods within a 2-year period, with at least 15% of methods every quarter
SOP Method Compliance	Technical Director	- All SOPs within a 2-year period - All new analysts or new analyst/methods within 3 months of IDOC
Special	QA Department or Designee	Surveillance or spot checks performed as needed
Performance Testing	Analysts with QA oversight	Two successful per year for each NELAC field of testing or as dictated by regulatory requirements

16.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, the laboratory's Data Integrity and Ethics Policies, NELAC quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed. The audit is divided into modules for each operating or support area of the lab, and each module is comprehensive for a given area. The area audits may be done on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

16.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, MintMiner is used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

16.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical Director at least every two years. The work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

16.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

16.1.5 Performance Testing *(ISO17025 5.9.1; 5.9.A.15)*

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Drinking Water (WS), Nonpotable Water (WP), Soil (SW) and Sediment.

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

16.2 EXTERNAL AUDITS *(ISO17025 4.14.2; 4.14.3; 4.14.4)*

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. A copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

16.2.2 Confidential Business Information (CBI) Considerations

During on-site audits, on-site auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2003 NELAC standards.

16.3 AUDIT FINDINGS

Audit findings are documented using the corrective action process and database (refer to Section 13). The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Department Manager and Department Supervisor where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

Figure 16-1.

Example - Internal Audit Workbook *(ISO17025 4.14.1; 4.14.3)*

TestAmerica Chicago

Internal Audit Schedule 2009

Department Audited	Date Scheduled	Date Audited	# Findings	# Findings Open	Date Corrective Action Due	Date Audit Closed	Comments
Administrative:							
Container Management							
Sample Management							
Project Management							
Data Reporting & Archive							
Quality Assurance							
Sample Preparation:							
Metals Digestion / TCLP & SPLP							
Organic Extractions							
Inorganics :							
Metals Analysis							
Inorganic Chemistry							
Organics:							
GC/HPLC Extractables							
GC Volatiles							
GCMS Volatiles							
GCMS Semivolatiles							
Total	**0**	**0**	**0**	**0**		**0**	

Figure 16-2.

Example – Internal Audit System Checklist: Corrective Actions *(ISO17025 4.14.3)*

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

GC/MS VOLATILEs

Location: _____

Quality System Audit

March 2008

Revision 1

Audit Date:

Auditor:	**Personnel Interviewed:**

Methods Performed (List All): -

System Status:
0 = No system or system not defined
1 = Informal system or system being developed
2 = System initiated, documented, implemented; but failures or lapses occur
3 = System developed, documented, implemented and is functional
E = System in place, exceeds minimum expectations; evidence of continuous quality improvement (CQI)

'Follow Up' column indicates that:
a) the listed requirement needs to be audited in an alternate dept.; or
b) was / can be audited via the Internal Audit Workbook for Metrology Items (CA-Q-WI-011).

			System Status							
Item	**Requirement**	**Ref.**	**0**	**1**	**2**	**3**	**E**	**NA**	**Evidence/Comments**	**Follow Up**
1	***Procedure***									
2	Are controlled, current SOPs available in the department (electronic or hardcopy)?	5.5.4.1.1	**0**	**1**	**2**	**3**	**E**	**NA**	Auditor: Analyst or bench chemist should be able to readily locate. No uncontrolled copies of SOPs in use or in area.	
3	Do all posted Work Instructions or Flowcharts have a document control number?	5.4.3.1	**0**	**1**	**2**	**3**	**E**	**NA**		
4	How is work assigned/organized (i.e., each analyst backlog or dept. supervisor prepares daily assignments)?	Info.							Auditor: Aids in deciphering the labs processes.	
5	What are the general purge volumes (i.e., 5 or 25 mLs)? Are the 5035 weights measured to the 0.01g?	Methods	**0**	**1**	**2**	**3**	**E**	**NA**		

SECTION 17

MANAGEMENT REVIEWS *(NELAC 5.4.14)*

(ISO17025 4.1.6; 4.15.1; 4.15.2)

17.1 QUALITY ASSURANCE REPORT

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Customer Service Manager (CSM), Organics Manager, Inorganics Manager, their Quality Director as well as the General Manager. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, General Manager or Corporate QA may request that additional information be added to the report.

The TestAmerica QA Report template is comprised of a discussion of three key QA issues facing the laboratory and ten specific sections (Figure 17-1):

- **Metrics:** Describe actions or improvement activities underway to address any outlying quality metrics that have been reported in the monthly Quality System Metrics Table.
- **SOPs:** Report SOPs that have been finalized and report status of any outstanding SOP reviews.
- **Corrective Actions:** Describe highlights and the most frequent cause for report revisions and corrective/preventive action measures underway. Include a discussion of any recalls handled at the lab level as per Section 6.2.2 in the Investigation/Recall SOP (SOP: CA-L-S-001). Include a section for client feedback and complaints. Include both positive and negative feedback. Describe the most serious client complaints and resolutions in progress.
- **MDLs and Control Limits:** Report which MDLs/ MDL verifications are due. Report the same for Control Limits.
- **Audits:** Report Internal and External Audits that were conducted. Include all relevant information such as which methods, by whom, corrective actions needed by when and discuss unresolved audit findings.
- **Performance Testing (PT) Samples:** Report the PT tests that are currently being tested with their due dates, report recent PT results by study, acceptable, total reported and the month and year.
- **Certifications:** Report on any certification programs being worked on by due date, packages completed. Describe any issues, lapses, or potential revocations.
- **Regulatory Updates:** Include information on new state or federal regulations that may impact the laboratory. Report new methods that require new instrumentation, deletion of methods, changes in sampling requirements and frequencies etc…
- **Miscellaneous:** Include any issues that may impact quality within the laboratory. This section may also be used to communicate the status on any Management of Change Request Forms (CRFs) that have missed targeted due dates
- **Next Month:** Report on plans for the upcoming month.

- **Lab Director Comments Section:** This section gives the Laboratory Director the opportunity to comment on issues discussed in the report and to document plans to resolve these issues. Unresolved issues that reappear in subsequent monthly reports must be commented on by the Laboratory Director.
- **Quality System Metrics Table:** The report also includes statistical results that are used to assess the effectiveness of the quality system. Effective quality systems are the responsibility of the entire laboratory staff. Each laboratory provides their results in a template provided by Corporate QA (Figure 17-2).

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and General Managers.

17.2 ANNUAL MANAGEMENT REVIEW *(ISO17025 4.2.2)*

The senior lab management team (Laboratory Director, QA Manager, Department Managers and Customer Service Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining quality goals & objectives. Corporate Operations and Corporate QA personnel may be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory will summarize any critical findings that can not be solved by the lab and report them to Corporate IT.

This management systems review as outlined in the Corporate SOP CA-Q-S-008, *Management Systems Review,* references the Corporate Work Instruction No. CA-Q-WI-020. Part 1 of the Checklist uses information generated during the preceding year to assess the “big picture” by ensuring that routine quality actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review (refer to Section 17.1) should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management team meetings. Issues that may be raised from these meetings include:

  - Adequacy of staff, equipment and facility resources.
  - Adequacy of policies and procedures.
  - Future plans for resources and testing capability and capacity.
- The annual internal double blind PT program sample performance (if performed),
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and senior management staff in the form of the management systems review summary and an objectives and goals summary (Part 2 and Part 3 of CA-Q-WI-020). The report is distributed to the appropriate General Manager and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

17.3 POTENTIAL INTEGRITY RELATED MANAGERIAL REVIEWS

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/ Recall SOP shall be followed (SOP No. CA-L-S-001). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's COO, VP of Client & Technical Services, General Managers and Quality Directors receive a monthly report from the Director of Quality & Client Advocacy summarizing any current data integrity or data recall investigations. The General Manager's are also made aware of progress on these issues for their specific labs.

Figure 17-1.

Example - QA Monthly Report to Management *(ISO17025 4.15.1)*

TestAmerica Chicago *Name of preparer (QAM)* *Date report submitted to corporate* *GM, LD, additional staff as warranted*	**January 2010** **Prepared by:** **Report Date:** **Distributed To:**
THREE KEY ISSUES FOR MONTH: *Include a discussion of three key issues that were focused on this month.* **1** **2** **3**	-
METRICS CONCERNS *For any quality metrics that fall in 'red' or yellow', describe actions or improvement activities underway.* **Revised reports** **Data Recall** **Audits** **Performance Testing** **Corrective Action** **SOPs**	-
CORRECTIVE ACTIONS **Highlights:** *Provide discussion of any major investigations or closures.* **Revised Reports:** *Describe the most frequent cause for report revisions and corrective/preventive action measures underway.* **Data Investigations/Recalls:** *Provide a short summary or update of any events handled at the lab level as per Section 6.2.2 in the Investigation/Recall SOP. Include detailed explanation on the 'Data Recall' tab.* **Client Complaints:** *Describe the most serious client complaints and associated corrective actions in progress. Include client company names.* **Client Compliments:** *Descirbe any compliments received - include client company names.*	-
AUDITS **Internal Audits (QA Technical, Departmental Quality Systems and Lab Requested Investigations):** *Discuss any outstanding issues or concerns (may attach summary).* **External Audits:** *Discuss any outstanding issues or concerns (may attach summary). Include schedule for upcoming audits.*	-

PROFICIENCY TESTING STUDIES **PT Corrective Actions:** *Include discussion of any outstanding issues.*	-
SOPs **SOPs:** *Provide a discussion of any concerns. If SOPs are greater than 6 months overdue, provide a corrective action plan. Include an SOP Tracking Tab in your monthly report.* **SOPs have not been developed for the following methods or processes** (include list).	-
MDLs , TRAINING DOCUMENTATION AND CONTROL LIMITS **MDLs Due (or attach summary):** *Include discussion of any concerns* **Control Limits Due (or attach summary):** *Include discussion of any concerns* **Training Documentation:** *Describe any concerns or system failures*	-
HOLD TIME VIOLATIONS *Describe major HT violation events and associated corrective actions in progress.*	-
CERTIFICATIONS *Describe any issues, lapses or potential revocations:* **Certification Packages Being Worked On** (Include Due Date):	-
REGULATORY UPDATE *Include information on new state or federal regulations that may impact the laboratory – new methods that require new instrumentation, deletion of methods, changes in sampling requirements or frequencies, …*	-
MISCELLANEOUS *Include any issues that may impact quality within the laboratory.*	-
TRAINING or MEETINGS *Include information on participation in any industry or regulatory meetings or any training sessions being scheduled.*	-
NEXT MONTH (Items planned for next month)	-
LAB DIRECTOR COMMENTS AND PLANNED CORRECTIVE ACTIONS: Date: Comments: Signature (Name):	-

Figure 17-2. Example - Laboratory QS Metrics Categories *(ISO17025 4.15.1)*

Category	Objective	Period	Metrics
Revised Reports		This month	# Reports for month
		This month	# Reports revised due to lab error
	<3%	This month	**% Reports Revised due to lab error (1.0)**
	Indicator	This month	# Reports Reviewed by QA
Data Recall	<1	Jan-to-date	**# Data Recall Investigations Past Due (1.0)** (check data recall tab)
	Indicator	Jan09-date	Cumulative # Days Data Recalls Open
Client	>3	This month	**# Client Complaints (1.0)**
	>3	This month	# Client Compliments
QA Technical Data Audits		50% by end of Dec	# of Technical Method Data Audits Required for 2-year Review *(Total number of methods the lab performs)*
		Jan10 to Dec10	# of Technical Method Data Audits performed Jan10-Dec10
	4.167 per month	Jan10 to Dec10	**% of Technical Method Data Audits Performed (2.0)**
Audits		Cumulative per month	# of Planned Department Quality Systems Audits (cumulative)
		Jan-to-date	# of Planned Department Quality Systems Audits Complete
	activity per quarter	Jan-to-date	**% Annual Internal Systems Audit Complete (1.0)**
Corporate Internal Audits		Current	Date of Corporate Internal Audit *(enter NA if not Applicable - Use date of Debrief Meeting)*
		Current	% Audit Findings Closed (from Corporate)
	<6 months	Current	Date Audit Closed *(closure notification from Corp. QA)*
Audits - Corrective Actions		Jan-to-date	Total Number of Audit Findings (Int. & Ext.) (include summary tabs)
		Current	# Audit Findings Past Due (internal & external)
	Indicator	Opened in 2009	2009 Open Audit Findings
Proficiency Testing		Past 12 months	# of PT analytes participated and received scores (12 month total)
		Past 12 months	# of PT analytes not acceptable (12 month total)
	>97%	Past 12 months	**% PT Cumulative Score (2.0)** (rolling 12 month average)
	No more than 1 per 200 results	Jan-to-date	**# PT Repeat Analyte Failures Cumulative (1.0)** (analyte failed more than once in 4 consecutive studies by PT Type) (cumulative for 2010 - do not drop off when corrected)
Corrective Action		Jan-to-date	Total # Corrective Action Items (audits, PTs, lab invest)
		Current	# Corrective Action Items Past Due
	<15%	Current	**% Corrective Action Items Past Due (1.0)**
SOPs / Method Compliance		Current	# SOPs
		Current	# SOP with Procedure Compliance Review/Revision Past Due
		Current	# Methods or Administrative procedures without approved SOPs
	100%	Current	**% SOP Complete (1.0)**
Ethics Training		Current	Date of Last Comprehensive Ethics Training Session
	0	Current	**# Staff >90 Days from Hire Date AND have not received Comprehensive Ethics Training (1.0)**
Operations Method & Personnel	Good	Current	Total # MDLs/MDLVs Required
		Current	# MDLs/MDLVs Past Due
	100%	Current	**% MDLs/MDLVs Complete (1.0)**
	Good	Current	Training Documentation Records (Good>90%, Fair 70-90%, or Poor <70%)

Category	Objective	Period	Metrics
6	2009 Average	This month	Hold Time Violations due to Lab Error
Accreditation	Good	Current	Total Access Update Status (Good, Fair, Poor)
	Good	Current	Total Access Certification pdfs current (Good, Fair, Poor)
	<1	Jan-to-date	**Method certification Losses (performance or audit issues) (1.0)** (can be removed after certification is reinstated by agency)
Quality System Review		Current	Last NELAC Audit Date (Where applicable - informational)
		Current	QAM Effective Date
	<12 months	Current	**Last Management QS Review Date (1.0)**
			Good >90%, Needs Work between 80-90%, Poor <80%

SECTION 18

PERSONNEL *(NELAC 5.5.2)*
(ISO17025 5.2.1)

18.1 OVERVIEW *(SIO17025 5.2.2; 5.2.3; 5.2.5)*

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the laboratory's organization chart in Figure 4-2.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

18.2 EDUCATION AND EXPERIENCE REQUIREMENTS FOR TECHNICAL PERSONNEL *(ISO17025 5.2.1; 5.2.3; 5.2.4)*

The laboratory makes every effort to hire analytical staff that possesses a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. There are competent analysts and technicians in the industry who have not earned a college degree. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc. are also considered).

As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, Single component or short list Chromatography (e.g. BTEX-GC, IC)	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex GC Chromatography (e.g., Pesticides, PCB, Herbicides, Fuels, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience or 5 years of prior analytical experience
Technical Directors/ Department Managers/Supervisors	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Department Supervisor/Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

18.3 TRAINING *(ISO17025 5.2.5)*

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame*	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	Technical and PMs
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 20.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in their training file.
- Documentation of proficiency (refer to Section 20).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

For additional details on the laboratory's training program refer to the laboratory SOP *UP-QA-014*, Training Program: Mechanisms and Documentation Processes Defined by Operational Assessment.

18.4 DATA INTEGRITY AND ETHICS TRAINING PROGRAM

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica**.** It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy No. CA-L-P-001 and an Ethics Statement/Agreement (Appendix 1). All initial and annual training is documented by signature on the signed Ethics Policy and Code of Ethical Conduct demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy (Appendix 1)
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 19

ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS *(NELAC 5.5.3)*

19.1 OVERVIEW *(ISO17025 5.3.1; 5.3.3; 5.3.4; 5.3.5)*

TestAmerica Chicago is a 28,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc. OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample storage, sample disposal, organic glassware cleaning, inorganic glassware cleaning, organic sample preparation, metals sample preparation, GC and GC/MS Volatile sample analysis, GC Semivolatile & HPLC sample analysis, GC/MS Semivolatile sample analysis, General Chemistry sample analysis, Metals sample analysis, and administrative functions.

19.2 ENVIRONMENT *(ISO17025 5.3.1; 5.3.2; 5.3.3; 5.3.4; 5.3.5)*

Laboratory accommodation, test areas, energy sources, lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage and temperature in the laboratory

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels (refer to Section 12).

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

19.3 WORK AREAS *(ISO17025 5.3.3; 5.3.4; 5.3.5)*

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory.

Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

19.4 FLOOR PLAN

A laboratory floor plan can be found in Appendix 2.

19.5 BUILDING SECURITY *(ISO17025 5.3.4)*

Building keycards are issued to every employee, keys and alarm codes are distributed to several employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed.

Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

SECTION 20.0

TEST METHODS AND METHOD VALIDATION *(NELAC 5.5.4)*
(ISO17025 5.4.1)

20.1 OVERVIEW *(ISO17025 5.4.1; 5.4.5.1)*

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

20.2 STANDARD OPERATING PROCEDURES (SOPs) *(ISO17025 4.3.3.1; 5.4.2)*

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory (refer to Section 6 on Document Control):

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for preparation, review, revision and control are incorporated by reference to TestAmerica's Corporate SOP entitled 'Writing a Standard Operating Procedure', No. CW-Q-S-002 and the laboratory SOPs *UP-QA-032*, SOP Change Protocol and SOP *UP-QA-006*, Document Control.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water and DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

20.3 LABORATORY METHODS MANUAL

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

20.4 SELECTION OF METHODS *(ISO17025 5.4.1; 5.4.2; 5.4.4; 5.4.5.2; 5.4.5.3)*

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists, etc.), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

20.4.1 Sources of Methods *(ISO17025 5.4.2; 5.4.4; 5.4.5.1)*

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

20.4.1.1 The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM); Non-polar Material) by Extraction and Gravimetry, EPA-821-R-98-002, February 1999*
- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*

- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *NIOSH Manual of Analytical Methods, 4th ed., August 1994.*
- *Statement of Work for Inorganics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th edition/ on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996. Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

20.4.2 Demonstration of Capability *(ISO17025 5.4.3; 5.4.4)*

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

20.4.2.1 A demonstration of capability is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel.

20.4.2.2 The initial demonstration of capability must be thoroughly documented and approved by the Department Manager/Supervisor and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures (refer to Section 15, Control of Records).

20.4.2.3 The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct a method detection limit study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the Limit of Quantitation (LOQ), which must be at or above the lowest non-zero standard in the calibration curve and achieve an adequate level of precision and bias. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the LOQ must be qualified as estimated values. Also see Section 20.6.1.3, Relationship of Limit of Detection (LOD) to Limit of Quantitation (LOQ).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted and or narrated: *Reporting Limit (RL) or Limit of Quantitation (LOQ) is based on the low standard of the calibration curve.*

20.4.3 Initial Demonstration of Capability (IDOC) Procedures

20.4.3.1 The spiking standard used must be prepared independently from those used in instrument calibration.

20.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP. The laboratory will utilize the 'split and spike' procedure, i.e., a clean water or soil matrix shall be split into four portions first and then each portion is individually spiked.

20.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of several days).

20.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

20.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

20.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

20.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 20.4.3.3 above.
- Beginning with 20.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with 20.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (see Figure 20-1 as an example) shall be used to document the completion of each initial demonstration of capability. A copy of the certification statement is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits.

20.5 LABORATORY DEVELOPED METHODS AND NON-STANDARD METHODS *(ISO17025 5.4.2; 5.4.4; 5.4.5.2; 5.4.5.3; 5.4.Z.3)*

Any new method developed by the laboratory must be fully defined in an SOP/Methods Manual (Section 20.2) and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method. The information included in the checklist below (Figure 20-2) is needed before samples are accepted for analysis by a new method.

20.6 VALIDATION OF METHODS *(ISO17025 5.4.2; 5.4.4; 5.4.5.2; 5.4.5.3; 5.4.Z.3)*

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

20.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

20.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

20.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed. The laboratory determinations of MDLs/DLs are described in Section 20.7.

20.6.1.3 Relationship of Limit of Detection (LOD) to the Limit of Quantitation (LOQ)

An important characteristic of expression of sensitivity is the difference in the LOD and the LOQ. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The LOQ is the minimum concentration of analyte that can be quantitatively determined with adequate precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL/DL or LOD) and below the LOQ. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the LOQ, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

20.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

20.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by the highest acceptable calibration concentration. The lower limit of quantitation or LOQ cannot be lower than the lowest non-zero calibration level, and can also be constrained by required levels of bias and precision also see Section 20.4.2. The ICP and ICPMS instrumentation utilize a low range verification check standard at the beginning of each analytical run as specified per method or project specific criteria.

20.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

20.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

20.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

20.7 METHOD DETECTION LIMITS (MDL/DL)/ LIMITS OF DETECTION (LOD) *(ISO17025 5.4.Z.3)*

Method detection limits (MDL/DL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. The MDL/DL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The DL is further defined in the DoD QSM version 4.1 as representing a concentration that is 99% confident that it is distinquishable from a blank. The MDL/DL is determined for each analyte and associated surrogates initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements (refer to 20.7.10). The analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest (including the surrogates for DoD QSM compliance). Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL/DL. Refer to the laboratory SOP UP-QA-017, Method Detection Limits (MDL/DL) and the Corporate SOP No. CA-Q-S-006 for additional details and alternative approaches to the laboratory's MDL/DL process that may be used.

20.7.1 MDLs/DLs are initially performed for each individual instrument and non-microbiological method analysis. Unless there are requirements to the contrary, the laboratory will use the highest calculated MDL/DL for all instruments used for a given method as the MDL/DL for reporting purposes. This MDL/DL is not required for methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report values to the MDL/DL. Titration and gravimetric methods where there is no additional preparation involved, the MDL is based on the lowest discernable unit of measure that can be observed.

20.7.2 MDLs/DLs must be run against acceptable instrument QC, including ICV's and Tunes as per the requirement of the method that is being analyzed. This is to insure that the instrument is in proper working condition and falsely high or low MDLs/DLs are not calculated.

20.7.3 Use only clean matrix which is free of target analytes (e.g.: Laboratory reagent water, Ottawa Sand) unless a project specific MDL/DL is required in a field sample matrix.

20.7.4 The calculated MDL/DL can not be greater than the spike amount.

20.7.5 If the most recent calculated MDL/DL does not permit qualitative identification of the analyte then the laboratory may use technical judgment for establishing the MDL/DL (e.g., calculate what level would give a qualitative ID, compare with IDL (Section 20.8), spike at a level where qualitative ID is determined and assign that value as MDL/DL, minimum sensitivity requirements, Standard deviation of method blanks over time, etc.). These alternate verification procedures are documented in the laboratory SOP *UP-QA-017*, Method Detection Limits (MDLs/DLs).

20.7.6 Each of the 7 spikes must be qualitatively identifiable (e.g., appear in both columns for dual column methods, characteristic ions for GCMS mass spectra, etc). Manual integrations to force the baseline for detection are not allowed. The MDL/DL determination may be performed by the procedure in 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices (e.g., method blanks over time, single standard spikes that have been subjected to applicable sample prep processes, etc.). The procedures utilized are documented in the laboratory SOP UP-QA-017, Method Detection Limits (MDLs/DLs).

20.7.7 The initial MDL/DL is calculated as follows:

$$MDL/DL = t_{(n-1,\ 1-a\ =\ 0.99)} \times (\text{Standard Deviation of replicates})$$

where $t_{(n-1,\ 1-a\ =\ 0.99)} = 3.143$ for seven replicates.
where $t_{(n-1,\ 1-a\ =\ 0.99)} = 2.998$ for eight replicates.

20.7.8 In conjunction with the initial MDL/DL determination a MDL verification check standard (MDLV) is analyzed. The DoD QSM version 4.1 requires a quarterly verification (MDLV) on all instruments for each method represented on the DoD ELAP Scope of Accreditation. The concentration of the MDLV reflects the laboratory's Limit of Detection (LOD). DoD QSM defines the LOD as a standard that is detected at least 99% of the time at a concentration 2-3 times higher than the MDL/DL. If the MDLV is not detected, and there were no obvious instrument problems, the lab must elevate the LOD for that method/analyte.

20.7.9 Because of the inherent variability in results outside of the calibration range, TestAmerica does not recommend the reporting of results below the lowest calibration point in a curve; however, it is recognized that some projects and agencies require the reporting of results below the RL/LOQ. Any result that falls between the MDL/DL and the RL/LOQ, when reported, will be qualified as an estimated value. For DoD QSM compliance, non-detect values will be reported as less than the LOD. Positive results between the LOQ and the MDL/DL will be J-flagged as estimated.

20.7.10 Detections reported down to the MDL/DL must be qualitatively identified.

20.7.11 MDLs/DLs and RLs/LOQs are adjusted in LIMs based on moisture content and sample aliquot size.

20.8 INSTRUMENT DETECTION LIMITS (IDL)

20.8.1 The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

20.8.2 IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 x the absolute value of the standard deviation.

20.8.3 If IDL is > than the MDL, it may be used as the reported MDL.

20.9 VERIFICATION OF DETECTION AND REPORTING LIMITS

20.9.1 Once an MDL/DL is established, it must be verified, on each instrument on a quarterly basis per the requirements of the DoD QSM version 4.1, by analyzing a quality control sample (MDLV), prepared as a sample, at a concentration approximately ½ the RL/LOQ which is equivalent to the LOD. This verification (MDLV) does not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDL/DL does not verify, then the lab will not report to the MDL/DL, or redevelop their MDL or use the level where qualitative identification is established (See 20.7). MDLs/DLs must be verified at least annually. Quarterly verification is required for methods listed on the DoD ELAP Scope of Accreditation. This verification (MDLV) is extracted and analyzed along with the annual method detection limit study and thereafter on a quarterly basis with the LOQ verification for DoD QSM compliance. Refer to the laboratory SOP *UP-QA-017*, Method Detection Limits (MDLs/DLs) for further details.

20.9.2 Limit of Quantitation (LOQ) is the lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard. The laboratory's routine reporting limit is equal to the LOQ, unless project documents specifies a higher concentration to be used as the project-specific reporting limit.

When the lab establishes a Limit of Quantitation (LOQ), it must be initially verified by the analysis of a low level standard or QC sample at a concentration at or above the lowest calibration standard and quarterly thereafter for DoD QSM compliance. The acceptance criteria of $\pm$ 30% of the mean will be applied except for those poor performers that are identified in the specific methods and/or SOPs. The QC standard will be designated in LIMs as a Method Reporting Limit check standard (MRL). There are method, program or state requirements that specify the running and reporting of the method reporting limit check standard in sequence with the analytical runs associated with their samples. This special project requirement is communicated to the laboratory via project and Job login notes.

The laboratory's nominal Reporting Limit (RL) or Limit of Quantitation (LOQ) should as general rule be between 3 and 5 times the MDL/DL. To be usable for a DoD project, the laboratory must be able to achieve specific precision and bias objectives at the LOQ. State or program specific MDL/DL criteria may be required, refer to the laboratory SOP *UP-QA-017*, Method Detection Limits (MDLs/DLs) for further details. For DoD QSM version 4.1 compliance, the Limit of Quantitation (LOQ) standard, must be analyzed and verified on a quarterly basis. The laboratory will analyze it in conjunction with the Limit of Detection (LOD) verification standard (MDLV) defined in section 20.7.8.

20.10 RETENTION TIME WINDOWS

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method as specified in the reference method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

For GC, HPLC and IC methods, there must be sufficient separation between analyte peaks so as to not misidentify analytes. In the mid-level standard, the distance between the valley and peak height cannot be any less than 25% of the sum of the peak heights of the analytes. This also applies to GCMS in the case where the two compounds share the same quantitation ion.

Note: Some analytes do not separate sufficiently to be able to identify or quantitate them as separate analytes (e.g. m-xylene and p-xylene) and are quantitated and reported as a single analyte (e.g. m,p-xylenes).

Once the analyst has determined that the instrument is in optimum working condition through calibration and calibration verification procedures, he or she uses a mid-range calibration or calibration verification standard to establish the retention times for each of the individual analytes in a method. The analyst makes three injections of the same standard over a 72-hour (24 hr period for 300.0) period, tabulating the retention times for each analyte for each of the three injections. The width of retention time window is normally the average absolute retention time ± 3 Standard Deviations. A peak outside the retention time window will not be identified by the computer as a positive match of the analyte of interest.

It is possible for the statistically calculated RT window to be too tight and need to be adjusted based on analyst experience. In these instances method default retention time windows may be used (e.g., for 8000 series methods a default of 0.03 minutes may be used, and EPA CLP 0.05 minutes is used). The same concept is applied when any peak outside of that window will not be identified by the computer as a positive match.

The calibration verification standard at the beginning of a run may be used to adjust the RT for an analyte. This is essentially re-centering the window but the size of the window remains the same. The RTs are verified when all analytes are within their RT windows and are properly identified.

20.11 EVALUATION OF SELECTIVITY

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

20.12 ESTIMATION OF UNCERTAINTY OF MEASUREMENT *(ISO17025 5.1.1; 5.1.2; 5.4.6.1; 5.4.6.2; 5.4.6.3; 5.4.Z.4)*

20.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

20.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

20.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the subsampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

20.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent a 99%-certain range for the reported result. As an example, suppose that the result reported is 1.0 mg/l, and the LCS percent recovery range is 50 to 150%. The uncertainty range would be 0.5 to 1.5 mg/l, which could also be written as 1.0 +/- 0.5 mg/l. Refer to the laboratory SOP *UP-QA-040*, Quality Assurance – Measurement Uncertainty for additional details.

20.12.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g. 524.2, 525, etc) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

20.13 SAMPLE REANALYSIS GUIDELINES *(ISO17025 5.9.1)*

Because there is a certain level of uncertainty with any analytical measurement, a sample reanalysis may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. **Client specific**

Contractual Terms & Conditions for reanalysis protocols may supercede the following items.

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within ± 1 reporting limit for samples ≤ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.
- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy. Reanalysis of the sample a third time for confirmation if sufficient sample is available may be required. An NCM will be written to document the anomalies and any actions taken.
- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.
- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Area Supervisor/Manager or Laboratory Director if unsure.

20.14 CONTROL OF DATA *(ISO17025 5.4.7.1)*

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

20.14.1 Computer and Electronic Data Related Requirements *(ISO17025 5.4.7.2)*

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in laboratory SOP *UP-IS-014*, TestAmerica Chicago IT Procedures and Processes. The laboratory is currently running the TALs LIMS which is a custom in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Microsoft SQL Server which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

20.14.1.1 Maintain the Database Integrity: Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use.

20.14.1.2 Ensure Information Availability: Protection against loss of information or service through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

20.14.1.3 Maintain Confidentiality: Ensure data confidentiality through physical access controls when electronically transmitting data.

20.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager, Supervisor or alternate analyst prior to updating the data in LIMS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP CA-Q-S-002, *Acceptable Manual Integration Practices*.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

20.14.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. All criteria pertinent to the method must be recorded. Raw data must include all pertinent information needed to reconstruct the final result from the bench notes or instrument file reported value, and accurately reflect the method used, instrument ID, analyst, and time of preparation and analysis. It may include annotated instrument hard-copies, bench notes, completed bound data book pages, or pages printed directly from the TALs LIMS system. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

20.14.2.2 In general, concentration results are reported in milligrams per liter (mg/l) or micrograms per liter (µg/l) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1**%.** Default reporting units are defined in each lab SOP and in the analytical method setup in LIMs. The reporting unit can also be designated at the project/job/method level in LIMs.

20.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

20.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. In all

cases, rounding should be limited to the final result as generated by TALs according to the method set-up.

20.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after the initial data review has been preformed by the analyst according to review procedures identified in the individual laboratory SOPs. (For example, included in the organics data review is the evaluation of the target system's quantitation report/spectra for each sample and analyte, actions such as removing unrequested or poor spectrally-matched compounds may be necessary prior to data import into TALs). Depending on the data to be reviewed, the analyst either prints a copy or views the data on screen to check for errors in accordance with the laboratory's analytical SOPs and data review checklists. Secondary review of the data is done and recorded on the same checklist by a peer reviewer or supervisor. The raw data, including the checklist, instrument print-outs, and manual entries, and electronic files are retained for easy retrieval in accordance with the laboratory's record and retention policy outlined in Seciton 15.5.

20.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 13.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.
- Worksheets are created with the approval of the Department Manager, Department Supervisor and QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

20.14.4 Review / Verification Procedures

Review procedures are out lined in several SOPs [e.g. Sample Control, Project Management, QA and Method Specific SOPs] to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The laboratory also follows the corporate SOP on Manual Integrations to ensure the authenticity of the data [SOP No. CA-Q-S-002, Acceptable Manual Integration Practices]. The general review concepts are discussed below, more specific information can be found in the laboratory SOPs.

20.14.4.1 The data review process at TestAmerica Chicago starts at Sample Log-In, where personnel review chain-of-custody forms and input the sample information and required analyses into the TALs LIMs system. The Project Managers perform the final review of the chain-of-custody forms, the analyses logged into TALs and all other inputted information.

20.14.4.2 The next level of data review occurs with the analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant EPA methodologies. The analysts transfer the data into the TALs LIMS in the Analyst Desktop module. Where non-compliance is observed, the analyst creates Non-Conformance Memos (NCMs) in TALs. Flags and data qualifiers can be method, project, program or QAPP specific (see Appendix 6 for list of default data qualifiers). The project manager selects a formatter in TALs that will be assigned to the project and any login associated with the project. The flags and qualifiers are then automatically applied to the data when calculated and is reviewed by the analyst as part of the data review process. The analyst documents the initial review on a data review checklist and sets the batch status in LIMs to 1st level review. The second level or peer review of the data is conducted by another individual who has been trained on the review process. This secondary review is documented on the same checklist, making any necessary corrections to the data or additions to the NCMs as necessary. The batch is then set to 2nd level review. All GC/MS Spectra and all manual integrations are reviewed. Manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to the ethics and manual integration policies.

Examples of items included in the above reviews are as follows:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

20.14.4.3 *(ISO17025 5.9.1)* When all the individual tests for a department are at 2nd level review for a job, the Supervisor or the Supervisor's designee reviews the entire job, comparing chemical relationships, reviewing for completeness and the presence of appropriate NCMs, and doing an overall evaluation of the results summary.

Examples of chemical relationships evaluated by the supervisor prior to setting data to 'Lab Complete' status include the following:

- Total Results are $\geq$ Dissolved results (e.g. metals)
- Total Solids (TS) $\geq$ TDS or TSS
- TKN $\geq$ Ammonia
- Total Phosphorus $\geq$ Orthophosphate
- COD $\geq$ BOD
- Total Cyanide $\geq$ Amenable Cyanide
- TDS $\geq$ individual anions

If the job has a deliverable designation of Level 3 or Level 4 a data package is prepared prior to setting the job to a 'Lab Complete' status.

Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Project Manager, Department Manager/Supervisor and Quality Assurance Manager for further investigation. Corrective action is initiated whenever necessary.

20.14.4.4 Any project that requires a data package is subject to a tertiary data review for transcription errors, acceptable quality control requirements, correct application of client specific criteria and overall completeness. The report generation staff assembles the preliminary report and the Project Manager or their designee will review the results for appropriateness and completeness, approve and sign the final report. The PM will update the Final Review task and Invoice Review Task to complete. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The accounting personnel will check for invoicing errors prior to its approval. When complete, the report is sent out to the client either in a hardcopy, emailed (.pdf) or facsimile format, depending on the deliverable instructions in the login. (Refer to Section 26 on Reporting Results for additional details).

20.14.4.5 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 20-3.

20.14.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline**.**

20.14.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

20.14.5.2 Analysts shall not increase or decrease peak areas to for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

20.14.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

20.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also

required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 20-1.
Example - Demonstration of Capability Documentation

TestAmerica Chicago

Initial Demonstration of Method Capability
Certification Statement

TestAmerica Chicago
2417 Bond Street
University Park, IL 60466

Analyst Name:_____
SOP No.:_____
Method No.:_____
Description:_____
Matrix:_____
Effective Date:_____

We the undersigned certify that:

- 1. The analyst identified above, using the cited test method(s), which is in use at this laboratory for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.
- 2. The test method(s) was performed by the analyst identified on this certification.
- 3. A copy of the reference method and laboratory-specific SOP(s) are available for all personnel on-site.
- 4. The data associated with the demonstration capability are true, accurate, complete and self-explanatory.
- 5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the laboratory, and that the associated information is well organized and available for review by authorized assessors.

_____ _____
Supervisor/Manager Signature Date

_____ _____
QAM Signature Date

Figure 20-2.

Example - New Instrument / Method / Additional Analyte Checklist

TESTAMERICA CHICAGO
INSTRUMENT VALIDATON CHECKLIST

Instrument Type: _____
Model#:_____
Serial #:_____
Lab Equip Code: _____ LIMS Equip Code: _____

Installation Date: _____
Installed By: _____

Instrument installed per specifications. Operational and functional per install guidelines.
Signature/Date of installer: _____

Outstanding items yet to be completed (If applicable):_____
_____
_____
_____

Completion Date: _____
Signature/Date Lab Representative: _____

Instrument passes all initial required lab checks and calibrations as appropriate for method of analysis: _____

Appropriate MDL's as applicable per method complete: _____
*MDL's must be forwarded to the QA Dept. for Validation to be considered complete.

Methods to be analyzed (may change over time): _____
_____

In-Service Date: _____

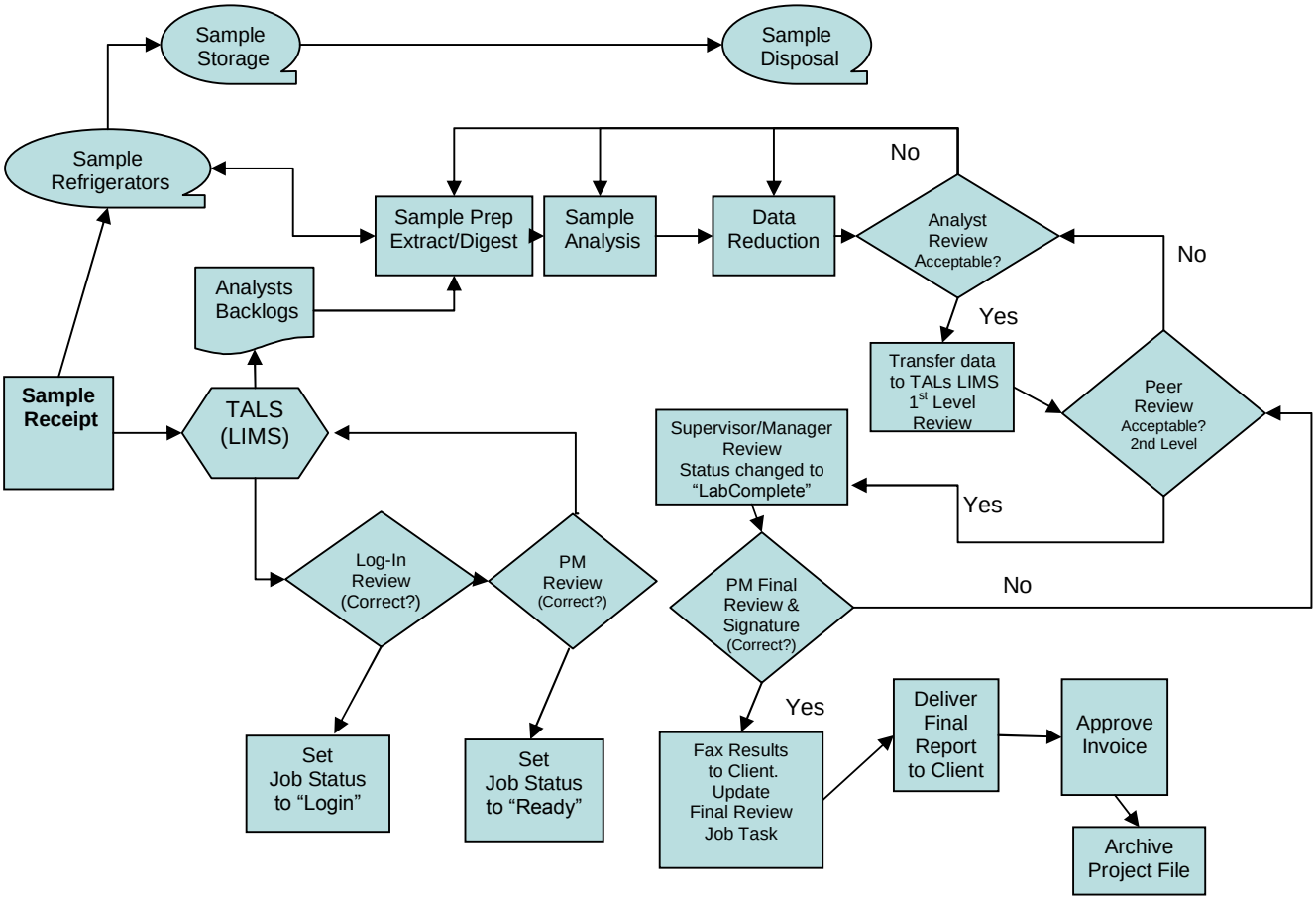
Signature/Date of Lab Representative: _____
Signature/Date of QA Representative: _____

****

QA Only
Software Verification Required (Y/N)
Verification Completed as Described: _____
_____
_____
_____
Software Verification Documentation Location:_____
Signature/Date of QA Representative: _____

Figure 20-3.

TestAmerica Chicago Work Flow



SECTION 21

EQUIPMENT (AND CALIBRATIONS) *(NELAC 5.5.5)*

(ISO17025 5.5.4; 5.5.5; 5.5.Z.5; 5.5.6; 5.5.Z.6)

21.1 OVERVIEW *(ISO17025 5.5.1; 5.5.2; 5.5.3; 5.5.5; 5.5.10; 5.6.1; 5.6.Z.8)*

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs, the laboratory default criteria are summarized in Appendix 3 of the QAM and the DoD QSM Version 4.1 criteria are summarized in Appendix 8 of the QAM. A list of laboratory equipment and instrumentation is presented in Table 21-1**.**

Equipment is only operated by authorized and trained personnel. Manufacturer's instructions for equipment use are readily accessible to all appropriate laboratory personnel.

21.2 PREVENTIVE MAINTENANCE *(ISO17025 5.5.1; 5.5.3; 5.5.7; 5.5.9; 5.6.1; 5.6.Z.8)*

21.2.1 The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

21.2.2 Routine preventive maintenance procedures and frequency, such as lubrication, cleaning, and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

21.2.3 Table 21-2 lists examples of scheduled routine maintenance. It is the responsibility of each Department Managers and Supervisors to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be / are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

21.2.4 Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

21.2.4.1 Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.

21.2.4.2 Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

21.2.4.3 When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

21.2.5 If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out of service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses (refer to Sections 12 and 13).

21.2.6 In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted using the procedures outlined in Section 8.

21.2.7 If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study and MDL Verification) prior to return to lab operations.

21.3 SUPPORT EQUIPMENT (ISO17025 5.5.10; 5.5.11; 5.6.2.1.2; 5.6.2.2.1; 5.6.2.2.2)

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

21.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains "calibration only" ASTM type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Refer to laboratory SOP UP-QA-003, *Balance Calibration Care and Use* for additional details.

21.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use, the ATC probes are verified annually.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm, the ATC probes are verified annually.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

21.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes and thermocouples are calibrated quarterly.

The NIST thermometer is recalibrated every five years (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 0.2 ºC, and has a range applicable to all method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logbooks. More information on this subject can be found in the laboratory SOP UP-QA-034, *Thermometer Calibration* and the method-specific SOPs.

21.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored continuously via an electronic monitoring system.

Ovens, water baths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0 ^{o}C and $\leq$ 6 ^{o}C. The electronic monitoring system applies the limits of 4 $\pm$ 2^{o}C to comply with those projects that require the tighter monitoring window.

Specific temperature settings/ranges for other refrigerators, ovens, water baths, and incubators can be found in method specific SOPs.

The temperatures that are continuously monitored are stored electronically on the Local Area Network (LAN) and the method specific temperature documentation of ovens water baths and incubators are maintained within the individual method logbooks or LIMs batch records.

21.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis. Glass micro-syringes are considered the same as Class A glassware.

For those dispensers that are not used for analytical measurements, a label is / can be applied to the device stating that it is not calibrated. Any device not regularly verified can not be used for any quantitative measurements.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an “Accuracy and Precision Statement of Conformance” from Hamilton attesting established accuracy.

21.4 INSTRUMENT CALIBRATIONS *(ISO17025 5.5.8; 5.5.Z.6; 5.5.10; 5.6.1; 5.6.Z.8)*

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 13).

Note: Instruments are calibrated initially and as needed after that and at least annually.

21.4.1 CALIBRATION STANDARDS *(ISO17025 5.6.3.1)*

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. However, the general procedures are described below.

21.4.1.1 For each analyte and surrogate (if applicable) of interest, prepare calibration standards at the minimum number of concentrations as stated in the analytical methods. If a reference or mandated method does not specify the number of calibration standards, the minimum number is three, not including blanks or a zero standard. All of the standard solutions are prepared using Class A volumetric glassware, calibrated pipettes, and/or microsyringes and appropriate laboratory quality solvents and stock standards.

21.4.1.2 Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement or to national or international standard reference materials wherever possible. Dilution standards are prepared from stock standards purchased from commercial suppliers. The standards are entered into the reagent module of the TALs LIMs system and are maintained for each department, containing concentration, date of receipt, date of standard preparation, any dilutions made, lot number, supplier, type of solvent and a unique code number to identify the standard.

21.4.1.3 The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample). The exception to these rules is ICP and ICP/MS methods or other methods where the referenced method does not specify two or more standards.

21.4.1.4 The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to 3 significant figures) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The lowest calibration standard must be at or below the reporting limit. The exception to these rules is ICP and ICPMS methods or other methods where the referenced method does not specify two or more standards.

21.4.1.5 All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations where no other source or lot is available, a standard made by a different analyst would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

21.4.2 CALIBRATION FOR ORGANIC METHODS (GC, HPLC, GC/MS)

21.4.2.1 Many of the organic analytical methods utilize an internal standard calibration (GCMS and some GC). Because of the complex nature of the multipeak chromatograms produced by the method, some instruments necessitate the use of external standard calibration (most GC and HPLC). Surrogate compounds are included in the calibration processes for all appropriate organic analyses. For more details on the calibration types listed below, refer to SOP No. CA-Q-S-005, Calibration Curves.

21.4.2.2 Once the operating parameters have been established according to the method, each instrument is calibrated for the appropriate method. The analyst prepares five or more standard solutions at various concentrations containing all of the analytes of interest, internal standards, and surrogates that are appropriate for the method. Note: There are several EPA methods that have different requirements and are exceptions (e.g. EPA 547) where a minimum of 3 calibration standards are prepared and analyzed.

21.4.2.3 The standard solutions are introduced into the instrument in the same manner as samples are; whether it be by direct injection, by headspace analysis, or by purge and trap. The calibration factor (CF) for methods that use external standards, and the response factor (RF) for methods that use internal standards are calculated for the five standards.

- External standard calibration involves comparison of instrument responses from the sample to the responses from the target compounds in the calibration standards. Sample peak areas (or peak heights) are compared to peak areas (or heights) of the standards. The ratio of the response to the amount of analyte in the calibration standard is defined as the Calibration factor (CF).

- Internal standard calibration involves the comparison of instrument responses from the target compounds in the sample to the responses of specific standards added to the sample or sample extract prior to injection. The ratio of the peak area (or height) of the target compound in the sample or sample extract to the peak area (or height) of the internal standard in the sample or sample extract is compared to a similar ratio derived for each calibration standard. The ratio is termed the response factor (RF), and may also be known as a relative response factor in other methods.

In many cases, internal standards are recommended. These recommended internal standards are often brominated, fluorinated, or stable isotopically labeled analogs of specific target compounds, or are closely related compounds whose presence in environmental samples is highly unlikely. The use of specific internal standards is available in the method SOP.

Whichever internal standards are employed, the analyst needs to demonstrate that the measurement of the internal standard is not affected by method analytes and surrogates or by matrix interferences. In general, internal standard calibration is not as useful for GC and HPLC methods with non-MS detectors because of the inability to chromatographically resolve many internal standards from the target compounds. The use of MS detectors makes internal standard calibration practical because the masses of the internal standards can be resolved from those of the target compounds even when chromatographic resolution cannot be achieved.

When preparing calibration standards for use with internal standard calibration, add the same amount of the internal standard solution to each calibration standard, such that the concentration of each internal standard is constant across all of the calibration standards, whereas the

concentrations of the target analytes will vary. The internal standard solution will contain one or more internal standards and the concentration of the individual internal standards may differ within the spiking solution (e.g., not all internal standards need to be at the same concentration in this solution). The mass of each internal standard added to each sample extract immediately prior to injection into the instrument or to each sample prior to purging must be the same as the mass of the internal standard in each calibration standard. The volume of the solution spiked into sample extracts should be such that minimal dilution of the extract occurs (e.g., 10 uL of solution added to a 1 mL final extract results in only a negligible 1% change in the final extract volume which can be ignored in the calculations).

An ideal internal standard concentration would yield a response factor of 1 for each analyte. However, this is not practical when dealing with more than a few target analytes. Therefore, as a general rule, the amount of internal standard should produce an instrument response (e.g., area counts) that is no more than 100 times that produced by the lowest concentration of the least responsive target analyte associated with the internal standard. This should result in a minimum response factor of approximately 0.01 for the least responsive target compound. Refer to SOP No. CA-Q-S-005, Calibration Curves, for specific calculations.

21.4.2.4 Policies regarding the use of calibration standard results for creating the calibration curve are as follows:

- A low calibration standard may be excluded from the calibration if the signal-to-noise ratio or spectral criteria are not suitable. The reporting level must be elevated to be the lowest calibration standard used for calibration.
- The upper calibration standard may be excluded if it saturates the detector or is obviously becoming non-linear. Any sample exceeding the upper standard used in the calibration must be diluted and re-analyzed.
- Mid-calibration standards may not be excluded unless an obvious reason is found, i.e., cracked vial, incorrectly made, etc. The failed standard should be re-run immediately and inserted into the initial calibration. If not useful, recalibration is required.
-

21.4.2.5 Percent RSD Corrective Action

Given the potentially large numbers of analytes that may be analyzed in some methods, it is likely that some analytes may exceed the acceptance limit for the RSD for a given calibration. In those instances, the following steps are recommended, but not required.

21.4.2.5.1 The first step is generally to check the instrument operating conditions. This option will apply in those instances where a linear instrument response is expected. It may involve some trade-offs to optimize performance across all target analytes. For instance, changes to the operating conditions necessary to achieve linearity for problem compounds may cause the RSD for other compounds to increase, but as long as all analytes meet the RSD limits for linearity, the calibration is acceptable.

21.4.2.5.2 If the RSD for any analyte is greater than the applicable acceptance criteria in the applicable analytical method, analytical SOP or project specific QAPP, the analyst may wish to review the results (area counts, calibration or response factors, and RSD) for those analytes to ensure that the problem is not associated with just one of the initial calibration standards. If the problem appears to be associated with a single standard, that one standard may be reanalyzed and the RSD recalculated. Replacing the standard may be necessary in some cases.

21.4.2.5.3 A third alternative is to narrow the calibration range by replacing one or more of the calibration standards with standards that cover a narrower range. If linearity can be achieved using a narrower calibration range, document the calibration linearity, and proceed with analyses. The changes to the upper end of the calibration range will affect the need to dilute samples above the range, while changes to the lower end will affect the overall sensitivity of the method. Consider the regulatory limits or action levels associated with the target analytes when adjusting the lower end of the range.

Note: When the purpose of the analysis is to demonstrate compliance with a specific regulatory limit or action level, the laboratory must ensure that the method quantitation limit is at least as low as the regulatory limit or action level.

21.4.2.6 Alternatively, the least squares regression may be used to determine linearity for organic method calibrations. A five point line must result in a correlation coefficient (r) $\geq$ 0.995 or the coefficient of determination (r^2) must be $\geq$ 0.990 or better.

21.4.2.7 Instead of a linear curve model (either Average RF or least squares regression), a second order curve (Quadratic) may be used (and preferred) as long as it contains at least six data points. As a rule of thumb, if there is a consistent trend in RFs (or CFs) in the calibration curve, either up or down, then quadratic curve fit may be indicated as the preferred calibration routine for that analyte. The coefficient of determination (COD or r^2) for the quadratic curve must be at least 0.99 for it to be considered acceptable. For more details on the calculations see Calibration Curve SOP CA-Q-S-005. Some limitations on the use of Quadratic Curve fits:

21.4.2.7.1 Care MUST be exercised to assure that the results from this equation are real, positive, and fit the range of the initial calibration.

21.4.2.7.2 They **may not** be used to mask instrument problems that can be corrected by maintenance. (Not to be used where the analyte is normally found to be linear in a properly maintained instrument).

21.4.2.7.3 They **may not** be used to compensate for detector saturation. If it is suspected that the detector is being saturated at the high end of the curve, remove the higher concentration standards from the curve and try a 1^{st} order fit or average RF.

21.4.3 Calibration for Inorganic Analyses

EPA Method 7000 from EPA SW-846 is a general introduction to the quality control requirements for metals analysis. For inorganic methods, quality control measures set out in the individual methods and in the *Standard Methods for the Examination of Water and Wastewater* (20th Edition) may also be included. Standard Operating Procedures for the analysis and the quality control documentation measures are kept in the individual laboratory areas.

In general, inorganic instrumentation is calibrated with external standards. Some exceptions would be Inductively Coupled Plasma (ICP) and Inductively Coupled Plasma Mass Spec (ICPMS). These analyses may use an internal standard to compensate for viscosity or other matrix effects. While the calibration procedures are much the same for inorganics as they are for organics, CF's or RF's are not used. The calibration model in 21.4.2.6 is generally used for most methods, however in some instances the model from section 21.4.2.7 may be used. A correlation coefficient (r) of 0.995 or greater must be used to accept a calibration curve generated for an inorganic procedure. Correlation coefficients are determined by computer programs and

documented as part of the calibration raw data. Coefficients of calibration curves used for quantitation must be documented as part of the raw data. Curves are not allowed to be stored in calculator memories and must be written on the raw data for the purposes of data validation.

21.4.3.1 "Calibrations" for titrimetric analyses are performed by standardizing the titrants against a primary standard solution. See specific methods in *Standard Methods for the Examination of Water and Wastewater* (20th Edition) for more information.

21.4.3.2 Spreadsheets that are used for general chemistry calculations must have all cells containing calculations locked to prevent accidental changes to the calculations.

21.4.4 Calibration Verification

The calibration relationship established during the initial calibration must be verified at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and NELAC (2003) standard, Section 5.5.5.10. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per NELAC (2003) Standard, Section 5.5.5.10.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs or project specific QAPPs.

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

21.4.4.1 Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift.

21.4.4.2 A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs.

Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

21.4.4.3 The acceptance limits for calibration verifications can be found in each method SOP. As a rule of thumb: GCMS ± 20% (for CCC's), GC and HPLC ± 15%, Inorganics: ± 10 or 15%. Actual methods may have wider or tighter limits; see the method SOP for specifics, also refer to Appendix 4.

21.4.4.4 If the response (or calculated concentration) for an analyte is within the acceptance limits of the response obtained during the initial calibration, then the initial calibration is considered still valid, and the analyst may continue to use the CF, RF or % drift values from the initial calibration to quantitate sample results.

21.4.4.5 If calibration verification, ICV or CCV, acceptance criteria are not met, then the problem should be investigated and corrected prior to sample analysis. Corrective actions vary by instrument and method (as described in method SOPs), but typically include:

- Checking instrument settings and SOPs to ensure there is no operator error,
- Rerunning the calibration verification standard,
- Repreparing and reanalyzing the verification standard,
- Performing routine instrument maintenance*,
- If the CCV still fails, then the instrument should be recalibrated and associated samples reanalyzed.

*If routine maintenance such as injection port cleaning, contaminated column clipping, guard column replacement, etc. are needed to pass the CCV, the associated field samples shall be reanalyzed. The only corrective action for passing CCV without the need of reanalysis of previous samples is preparing and using fresh CCV standards.

Note: Some programs may allow reporting of samples with non-detect results when the calibration verification indicates high bias, but this should be confirmed with the client before reporting.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

21.4.4.6 Verification of Linear and Non-Linear Calibrations

Calibration verification for linear calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent

analysis of the verification standard. Use the equations below to calculate % Drift or % Difference, depending on the procedure specified in the method SOP. Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

The Percent Difference is calculated as follows:

$$\% \text{ Difference} = \frac{(CF(v) \text{ or } RF(v)) - (\text{Avg. CF or RF})}{(\text{Avg. CF or RF})} \times 100$$

Where: CF(v) or RF(v) = CF or RF from verification standard
Avg. CF or RF = Average CF or RF from Initial Calibration.

The Percent Drift is calculated as follows:

$$\% \text{ Drift} = \frac{\text{Result} - \text{True Value}}{\text{True Value}} \times 100$$

The Percent Recovery is calculated as follows:

$$\% \text{ Recovery} = \frac{\text{Result}}{\text{True Value}} \times 100$$

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

21.5 TENTATIVELY IDENTIFIED COMPOUNDS (TICS) – GC/MS ANALYSIS

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

21.5.1 Use the following guidelines for making tentative identifications

21.5.1.1 Major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.

21.5.1.2 The relative intensities of the major ions should agree within ± 20%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30 and 70%).

21.5.1.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

21.5.1.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

21.5.1.5 Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting peaks. Data system library reduction programs can sometimes create these discrepancies.

The concentration of any non-target analytes identified in the sample (see above) should be estimated. The same formula as calibrated analytes should be used with the following modifications: The areas A_x and A_{is} should be from the total ion chromatograms, and the RF for the compound should be assumed to be 1.

The resulting concentration should be reported indicating: (1) that the value is an estimate, and (2) which internal standard was used to determine concentration. Use the nearest internal standard free of interferences.

Note: The above guidelines above are from EPA SW846 III edition, method 8260B.
For general reporting if TICs are requested, the ten (10), largest non-target analyte peaks whose area count exceeds 10% of the nearest internal standard will be termed “Tentatively Identified Compounds” (TICs). More or fewer TICs may be identified based on client requirements.

21.5.2 TIC Reporting Limits

In general Reporting limits cannot be specified because of the unknown nature of the TIC. Any reporting limit that is assigned to the TIC can only be evaluated as an estimate as the quantitation is based on the assumption that the TIC responds exactly as the IS responds which is most likely not the case. The TALs LIMs data report does not report TICs with a referenced reporting limit.

TICs that meet the above identification criteria (Section 21.5.1) at 10% area of the IS: If a RL were to be assigned, it would be 10% of the concentration of the internal standard used for quantitation. (e.g. 2.5 ug/L for 8260B, 4.0 ug/L for 8270C). In general, if the 10% area criteria are not met, the TIC RLs should be set at a level approximately 5x the level of the poorest performer in the analysis.

21.6 GC/MS TUNING

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

21.6.1 The concentration of the BFB or DFTPP must be at or below the concentrations that are referenced in the analytical methods. Part of the purpose of the tune is to demonstrate sensitivity and analyzing solutions at higher concentrations does not support this purpose. Tune failures may be due to saturation and a lower BFB/DFTPP concentration may be warranted.

21.6.2 Tune evaluations usually utilize the "Autofind" function and are set up to look at the apex +/- 1 scan and average the three scans. Background correction is required prior to the start of the peak but no more than 20 scans before. Background correction cannot include any part of the target peak.

21.6.3 Other Options or if Auto Tune Fails:

21.6.3.1 Sometimes the instrument does not always correctly identify the apex on some peaks when the peak is not perfectly shaped. In this case, manually identify and average the apex peak +/- 1 scan and background correct as in 21.6.2 above. This is consistent with EPA 8260 and 8270.

21.6.3.2 Or the scan across the peak at one half peak height may be averaged and background corrected. This is consistent with Standard Methods 6200, EPA 624 and EPA 625.

21.6.3.3 Adjustments such as adjustments to the repeller and ion focus lenses, adjusting the EM Voltage, etc. may be made prior to tune verification as long as all of the subsequent injections in the 12 hour tune cycle are analyzed under the same MS tune settings and it is documented in the run sequence log and/or maintenance log that an adjustment was made. Excessive adjusting (more than 2 tries) without clear documentation is not allowed. Necessary maintenance is performed and documented in instrument log.

21.6.3.4 A single scan at the Apex (only) may also be used for the evaluation of the tune or as specified in the reference method. For SW 846 and EPA 600 series methods, background correction is still required.

21.6.3.5 Cleaning the source or other maintenance may be performed and then follow steps for tune evaluation above. Note: If significant maintenance was performed, see methods 8000B or 8000C then the instrument may require recalibration prior to proceeding.

21.6.4 Tune evaluation printouts must include the chromatogram and spectra as well as the Tune evaluation information. In addition, the verifications must be sent directly to the printer or pdf file (no screen prints for DFTPP or BFB tunes). This ability should be built into the instrument software.

21.6.5 All MS tune settings must remain constant between running the tune check and all other samples. It is recommended that a separate tune method not be used, however a separate method may be used as long as the MS conditions between the methods are the same as the sample analysis method and tracked so any changes that are made to the analysis method are also made to the tune method.

Table 21-1.

Example - Laboratory Equipment and Instrumentation *(ISO17025 5.5.4; 5.5.5)*

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
GC Extractable INST0304	Agilent 6890 GC Plus with dual FID	6890A (G1530A)	S/N US00001850	2007	NEW
GC Extractable INST09	HP 5890A GC with FID	5890A	S/N 2750A18141	1988	NEW
GC Extractable INST1516	Agilent 6890N GC System with dual ECD	G6890N (G1530N)	S/N CN10411048	2004	NEW
GC Extractable INST2324	Agilent 6890N GC System with Dual ECD	G6890N (G1530N)	S/N CN10421024	2004	NEW
GC Extractable INST2930	HP 5890A Series II GC with Dual ECD	5890A Series II	S/N 3310A48787	1993	NEW
GC Extractable INST3132	Agilent 6890N GC System with dual ECD	6890N (G1530N)	S/N CN10411047	2004	NEW
GC Extractable INST3738	HP 6890 Series GC with Dual ECD	6890 (G1530A)	S/N US00004455	1996	NEW
GC Extractable INST4142	HP 6890 Series GC System: G1530A with Dual ECD	6890 (G1530A)	S/N US00006539	1997	NEW
GC Extractable INST4748	Agilent 6890A Series GC Plus System: G1530A with Dual ECD	6890A (G1530A)	S/N US00037876	2007	NEW
GC Volatile INST1112	HP5890A GC with FID	5890A	S/N 2750A17322	1992	NEW
GC Volatile INST1314	HP 5890A GC with FID	5890A	S/N 2750A17321	1988	NEW
HPLC INST4546	Agilent 1100 HPLC - Detector: Fluorescence Agilent 1100 HPLC - Detector: UV Variable Wavelength	G1321A FLD G1314A VWD	S/N DE23905110 S/N JP24020956	2003	NEW
HPLC INST35	Agilent 1100 HPLC - Detector: Variable wavelength	G1314A VWD	S/N JP11614612	2001	NEW
HPLC INST40	Agilent 1100 HPLC - Detector: Variable wavelength	G1314A VWD	S/N JP11414170	2001	NEW
HPLC INST43	Agilent 1100 HPLC - Detector: Variable wavelength	G1314A VWD	S/N JP92112755	2001	NEW

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
HPLC INST44	Agilent 1100 HPLC - Detector: Variable wavelength	G1314A VWD	S/N JP92112931	2001	NEW
GPC GPC2	J2 Accuprep 170 GPC Controller/Autosampler D-Star Fixed WvL Det Solvent Pump/ UPS	J2M 170 DFW-20	S/N 4237A1292 S/N None	2002	NEW
GPC GPC3	J2 Accuprep MPS GPC Injector/Autosampler /Detector APC-UPC	J2M 3300 J2 330	S/N 05C-1143-4.0 S/N DS00005388	2005	NEW
GPC GPC6	J2 Accuprep MPS GPC Injector/Autosampler /Detector	P/N 54022	S/N PUM-S13H-000	2008	NEW
GC/MS Semivolatile MS01	Agilent 6890N GC System Agilent 5973 MS Detector	6890N (G1530N) G2578A	S/N US10250131 S/N US21854134	2004	NEW
GC/MS Semivolatile MS11	Agilent 6890N GC System Agilent 5973 MS Detector	6890N (G1530N) G2578A	S/N CN10308018 S/N US30955129	2003	NEW
GC/MS Semivolatile MS12	Agilent 6890N GC System Agilent 5973 MS Detector	6890N (G1530N) G2578A	S/N CN10308019 S/N US21854871	2003	NEW
GC/MS Semivolatile MS20	Agilent 6890N GC System Agilent 5975 MS Detector	6890N (G1530N) G3171A	S/N CN10615045 S/N US861622903	2006	NEW
GC/MS Semivolatile MS21	Agilent 6890A GC System Agilent 5973 MS Detector	6890N (G1530A) G2577A)	S/N US00035156 S/N US10442182	2008	USED
GC/MS Volatile MS02	Agilent 6890N GC System Agilent 5973 MS Detector	6890N (G1530N) G2579A	S/N CN10340024 S/N US33220076	2003	NEW
GC/MS Volatile MS03 (Screener)	HP 5890 Series II Plus GC HP 5972 Series MS Detector	5890 Series II 5972	S/N 3336A59422 S/N 3609A03585	1998	NEW
GC/MS Volatile MS06	Agilent 6890 Series GC Plus G1530A Agilent 5973 Network MS Detector G2579A	6890 (G1530A) 5973 (G2579A)	S/N US10250132 S/N US21854172	2003	NEW
GC/MS Volatile MS08 (Screener)	HP GC 5890 Series II HP 5972 MS Detector	5890 Series II 5972	S/N 3310A47330 S/N 3307A00193	1993	NEW
GC/MS Volatile MS09 (Screener)	HP Series 5890 Series II Plus GC HP 5972 Series MS Detector	5890 Series II 5972	S/N 3336A60300 S/N 3435A01881	1998	NEW

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
GC/MS Volatile MS16	Agilent 6890 Series GC Plus G1530A Agilent 5973 Network MS Detector G2579A	6890 (G1530A) 5973 (G2579A)	S/N US00041196 S/N US10360253	2001	NEW
GC/MS Volatile MS18	Agilent 6890N Series GC HP 5975 Series MS Detector	6890N Series (G1530N) 5975 (G3172A)	S/N CN10528010 S/N US51530111	2005	NEW
GC/MS Volatile MS19	Agilent 6890N Series GC HP 5975 Series MS Detector	6890N Series (G1530N) 5975 (G3172A)	S/N US52430414 S/N CN10527059	2005	NEW
GC/MS Volatile MS22	Agilent 6890N Series GC HP 5973 Series MS Detector	6890N Series (G1530N) 5973 (G2571A)	S/N US10202110 S/N US10442062	2008	USED
Autoanalyzer AQ2 SEAL	AQ2 Analyzer	AQ2	S/N 090321	2004	NEW
Autoanalyzer PC Titrate	Burivar - I/2 Buret Module	PC-1104-00	S/N MS-0E3-585	2004	NEW
Ion Chromatography IC-4	Dionex DX-120 Ion Chromatograph	DX-120	S/N 99070500	1999	NEW
TOC TOC3	Tekmar Dohrmann Phoenix 8000 TOC	8000	S/N 97231001	1997	NEW
TOC TOC4	Tekmar Dohrmann Phoenix 8000 TOC w/Boat	8000	S/N 98239017	1999	NEW
TOX TOX2	Thermo Electron	ECS1200	SN 2005.0179	2005	NEW
Dissolved Oxygen Meter HACH-DO1	Sension6 Dissolved Oxygen Meter	Sension6	S/N 990400000150	1999	NEW
Dissolved Oxygen Meter HACH-DO2	Sension6 Portable Dissolved Oxygen Meter	Sension6	S/N None	2002	NEW
Flashpoint Tester FP1	Flashpoint Tester - Cleveland Open Cup		S/N 10AY-2	1990	USED
Flashpoint Tester FP4	Flashpoint Tester – Herzog Pensky Marten – Closed Cup	HFP339	S/N 073390090	2007	NEW
pH Meter pH2	pH Meter: Thermo Orion	410	S/N 074127	2003	NEW
pH Meter pH3	pH Meter: Symphony	SB20	S/N 00002006	2002	NEW
Oil & Grease	Horizon Technology: Oil & Grease Machine – Extractor	SPE-3000XL Plus-SS	S/N 04-2008	2005	NEW
Oil & Grease	Horizon Technology: Oil & Grease Controller Speed Vap II – Evaporator	SPE-3000 SPEED-VAP 9000	S/N 04-1279 S/N 02-0389	2005 2002	NEW

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Condition When Received
Spectrophotometer SPEC3	Spectrophotometer: Genesys 10vis	10 vis	S/N 2D7D054001	2001	NEW
Spectrophotometer SPEC5	UV mini 1240V Shimadzu	1240V	S/N A10934634610	2009	NEW
Conductivity Meter	Specific Conductivity Meter: VWR EC Meter	1056	S/N 0104022	2001	NEW
Turbidimeter TURB1	HACH Turbidimeter	2100A	S/N 773A35	1996	NEW
GFAA AA9	Varian 240 GFAA Spectrophotometer	240	S/N AL04093640	2008	USED
Mercury CV Analyzer HG3	Leeman Labs PS200 Auto Mercury Analyzer	PS200	S/N 1027A	1991	NEW
Mercury CV Analyzer HG4	Leeman Labs PS200 Auto Mercury Analyzer	PS200	S/N 0441	1996	NEW
Mercury CV Analyzer HG5	Leeman Labs PS200 Auto Mercury Analyzer	HYDRA AA PS200	S/N 7014 112-00064-1	2008	USED
ICP ICP5	TJA ICAP 61E Trace	13559500	S/N 10792	2001	NEW
ICP ICP6	TJA ICAP 6500 DUO	65400 DUO	S/N 20083806	2008	NEW
ICP-MS ICPMS2	ThermoElectron Corp ICP-MS S-Series II ID100 Autodiluter CETAC Autosampler ASX-520	S-Series II ID100 ASX-520	S/N 01189C S/N 00293 S/N 120476A520	2007	NEW
TCLP-4 Extraction Apparatus	TCLP Millipore Rotary (4 place extractor)	115V	S/N 455R44033	1991	NEW
TCLP-48 Extraction Apparatus	TCLP Rotation System: Associated Designer & Manufacturer	3470-48BRE	S/N 1581	1993	NEW

Table 21-2.

Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
AA (Graphite Furnace)	Clean lens and furnace head Replace windows Clean filters Change graphite tube/platform Empty waste container Remove carbon tube and check wear Check sample introduction probe	Daily As required Weekly As required Daily Daily Daily
Leeman Mercury Analyzer	Check tubing for wear Fill rinse tank with 10% HCl Insert clean drying tube filled with Magnesium Perchlorate Fill reductant bottle with 10% Stannous Chloride	Daily Daily Daily Daily
ICP	Check pump tubing Check fluid level in waste container Check filters Clean or replace filters Check torch Check sample spray chamber for debris Check nebulizer Check entrance slit for debris Check/Refill recirculator	Daily Daily Weekly As required Daily Monthly Monthly Yearly by Service Rep. Monthly
ICP MS	Change pump tubing Check torch Check / clean nebulizer Clean cones Check air filters Check multiplier voltages & do cross calibration Check/Change vacuum pump oil Check chiller water level/Refill	Daily Weekly As required As required As required Weekly Monthly Monthly
UV-Vis Spectrophotometer	Clean ambient flow cell Precision check/alignment of flow cell Wavelength verification check	As required As required Annually
Auto Analyzers	Clean sampler Check all tubing Clean inside of colorimeter Clean pump well and pump rollers Clean wash fluid receptacle Oil rollers/chains/side rails Clean optics and cells	As required As required As required As required As required As required As required

Instrument	Procedure	Frequency
Hewlett Packard GC/MS	Ion gauge tube degassing Pump oil-level check Pump oil changing Analyzer bake-out Analyzer cleaning Resolution adjustment Change multiplier Change filaments COMPUTER SYSTEM AND PRINTER: Air filter cleaning Change data system air filter Printer head carriage lubrication Paper sprocket cleaning Drive belt lubrication	As required Monthly Annually As required As required As required As required As required As required As required As required As required As required
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Check system for gas leaks (with SNOOP-MS VOA) Check for loose/frayed wires and insulation Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Daily Daily via use of known compound retention Daily As required W/cylinder change as required Monthly As Required As Required As Required As Required As Required
Electron Capture Detector (ECD)	Detector wipe test (Ni-63) Detector cleaning	Semi-annually As required
Flame Ionization Detector (FID)	Detector cleaning	As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change frit Filter all samples Change autosampler rotor/stator	As required As required Semi-annually or as required As required As required Daily As required
Autosamplers (GC/MS Volatiles GC Volatiles)	Check lines Change filters Replace Needles Check Gaskets Re-calibrate Replace Sensors	As required As required As required As required As required As required
Autosamplers (GC/MS Semivolatiles)	Replace Syringe	As required
Concentrators (GC/MS Volatiles GC Volatiles)	Change Trap Replace Lines	As required As required

Instrument	Procedure	Frequency
Balances	Class “S” traceable weight check Clean pan and check if level Field service	Daily, when used Daily At least Annually
Conductivity Meter	KCl calibration Conductivity cell cleaning	Daily, applicable standards As required
Turbidimeter	Check light bulb	Daily, when used
Deionized/Distilled Water	Conductivity Point Sources Daily conductivity check Check deionizer light Monitor for VOA’s System cleaning Replace cartridge & large mixed bed resins	Water Quality SOP *UP-QA-035* Daily Daily As required As required As required
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/ Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Continuous As required As required
Vacuum Pumps/ Air Compressor	Lubricate	Semi-annually
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
BOD Incubator	Temperature monitoring Coil and incubator cleaning	Continuous As required
Centrifuge	None	Serviced as required
Water baths	Temperature monitoring Water replaced	Daily As needed

SECTION 22

MEASUREMENT TRACEABILITY *(NELAC 5.5.6)*

22.1 OVERVIEW *(ISO17025 5.6.2.1.2; 5.6.2.2.2; 5.6.3.1)*

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 21.3) With the exception of Class A Glassware (including glass microliter syringes that have a certificate of accuracy), quarterly accuracy checks are performed for all mechanical volumetric devices. Microsyringes are verified at least semi-annually or disposed of after 6 months of use. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware should be routinely inspected for chips, acid etching or deformity. If the Class A glassware is suspect, the accuracy of the glassware will be assessed prior to use. The following definitions are provided by the American Association for Laboratory Accreditation (A2LA):

"Traceability is the property of a measurement result whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons, each step in the chain having stated uncertainties." There are six essential elements:

- An unbroken chain of comparison
- A calculated measurement uncertainty for each step in the chain to allow for an overall uncertainty calculation
- Documentation of each step in each calibration report
- All steps in the chain are performed by individuals with evidence of technical competence and accredited by a recognized accreditation body
- Reference to International Standard (SI) units
- Recalibration at appropriate intervals to preserve traceability

Calibration is defined as "determining and documenting the deviation of the indication of a measuring instrument (or the stated value of a material measure) from the conventional 'true' value of the measurand."

Uncertainty is defined as "a parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measurand." Measurement of Uncertainty is discussed is Section 20.12 of this QA Manual.

Note: Total measurement error is a function of both precision and bias.

22.2 NIST-TRACEABLE WEIGHTS AND THERMOMETERS *(ISO17025 5.6.3.1; 5.6.3.2)*

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation). A certificate and scope of accreditation is kept on file at the laboratory. (Refer to Section 21.3 for calibration of weights and thermometers).

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All in-service thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use or continuously monitored.

22.3 REFERENCE STANDARDS / MATERIALS *(ISO17025 5.6.3.1; 5.6.3.2; 5.6.3.3; 5.6.3.4; 5.9.1)*

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA or NVLAP with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. (Refer to Section 9 for additional information on purchasing). The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Name in TALs LIMs and expiration date. All documentation received with the reference standard is retained as a QC record and references the LIMs assigned Standard Name.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to Table 9-1 in Section 9 for general storage requirements and Table 22-1 for additional storage information as well as the Corporate Environmental Health & Safety Manual or individual laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

22.4 DOCUMENTATION AND LABELING OF STANDARDS, REAGENTS, AND REFERENCE MATERIALS

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company wide purchase. (Refer to TestAmerica's Corporate SOP (CA-Q-S-001), Solvent and Acid Lot Testing and Approval.)

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in the various laboratory sections. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to the method specific SOPs.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc.., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material.

22.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system in the reagent module, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS and in some departments a Standards Log book is used in conjunction with the LIMs record.

- Standard Name
- Description of Standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Applicable methods
- Applicable QC types

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

22.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID – TALs LIMs Name
- Special Health/Safety warnings if applicable

22.4.3 In addition, the following information may be helpful:

- Date of receipt for commercially purchased items or date of preparation for laboratory prepared items
- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include a preparation date, expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods; as specified in the laboratory SOP and 3) according to Table 22-1.

Table 22-1.

Standard Sources and Preparation *(ISO17025 5.9.1)*

Instrument	Source	How Received	Stock Storage	Preparation	Intermediate & Working Standard Storage	Frequency
ICP	Environmental Express Inorganic Ventures	1000 ppm Solutions	Room Temperature (Standards with Ag protect from light)	Working standards from stock	Room Temperature	Daily
ICPMS	Environmental Express; Inorganic Ventures	1000 ppm Solutions	Room Temperature (Standards with Ag protect from light)	Working standards from stock	Room Temperature	Daily
GC	Ultra; Restek; Supelco; Cerilliant; Absolute	Solutions and Neat	Refrigerate	Working standards from stock	Refrigerate	Monthly
GC (Herbicide)	Chemserv	Neat	Room Temperature or Refrigerate	Working standards from stock	Refrigerate	As needed or every 6 months
HPLC	Ultra; Restek; Supelco; Cerilliant	Solutions and Neat	Room Temperature or Refrigerate	Working standards from stock	Refrigerate	As needed or every 6 months
TOX	VWR; Aldrich; Sigma	Solid	Desiccate	Working standards from stock	Refrigerate	Monthly
TOC	VWR	Solid	Refrigerate	Working standards from stock	Refrigerate	Daily
Volatile Organics	Accustandard; Absolute; Chemservice; Restek; Supelco; Ultra	Ampoule/ Solutions and Neat	Freezer (-10^{o}C)	Working standards from stock	Freezer	Bi-weekly; Gas, weekly
Semi-Volatile Organics (GC/MS)	Accustandard; Restek; Supleco; Cambridge Cerilliant	Ampoule/ Solutions and Neat	Freezer (-10^{o}C) or Room temp.	Working standards from stock	Freezer	As needed or every 6 months
Ion Chromatography	APG; RICCA	Solutions	Refrigerate	Working standards from stock	N/A	Daily
AQ2 Seal	APG RICCA VWR	Solutions, Salts	Refrigerate	Working standards from stock	Refrigerate	Daily
GFAA	Environmental Express; Inorganic Ventures	Mixed Solutions	Room Temperature	Working standards from stock	Room Temperature	Daily- Working Std; Monthly- Intermediate Std.

SECTION 23.0

SAMPLING *(NELAC 5.5.7)*

23.1 OVERVIEW *(ISO17025 5.7.1; 5.7.3)*

TestAmerica Chicago provides sampling services. Sampling procedures for the bulleted items below are described in the SOP: UP-FS-001, *Field Services: Groundwater Sampling-Bailing Method*.

- Groundwater Sampling
- Wastewater Sampling
- Potable Sampling
- Field Parameter Analysis
- Cleaning and Decontamination of Field Equipment

23.2 SAMPLING CONTAINERS

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory.

23.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. The containers are purchased pre-preserved from the container supplier where the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent
- Sodium Hydroxide/Zinc Acetate – Instra-Analyzed or equivalent

23.2.2 Preparing Container Orders

When new containers arrive at the laboratory, the date of receipt is recorded on the packing list received with them for retained documentation. Periodically, containers are evaluated for cleanliness based upon their intended parameter sample analysis. Upon request, the containers are then sent to clients for use in collecting samples. The shipping date, type and number of containers are maintained on file by the lab. Shipping personnel insure that container stock is rotated so that “first in” is “first out.” When a client requests containers, a client services representative creates a container request in LIMS; it is then stored permanently in LIMS with a unique container order

number. Copies of the container request are printed for the shipping department. One copy goes to the client with the containers; one copy is filed in the shipping department**.**

The laboratory also provides EnCore, TerraCore or other soil sampling devices when requested.

If containers are provided directly to the client from the manufacturer or from other sources, the laboratory will not be responsible for any of the above records.

23.3 FIELD QUALITY CONTROL (QC) *(ISO17025 5.7.1)*

Common field quality control samples are defined in the following paragraphs. The frequency of field quality control samples should be specified in the site specific Quality Assurance Project Plan (QAPP) or by the client. TestAmerica provides trip blanks for VOC analysis with the sample containers for all volatile organic analyses. Blanks generated in the field will be analyzed along with the field samples (exception soil samples where the blank is aqueous).

23.3.1 Equipment Blank / Rinsate Blank - The equipment blank, sometimes referred to as a rinsate blank, is a sample of the water used to decontaminate sampling equipment. The source water should be as free of target analytes as possible. An aliquot of this water is poured over or through the sample collection device after decontamination, collected in a sample container, preserved with appropriate reagents, and returned to the laboratory. This serves as a check on sampling device cleanliness, and will also be affected by the site and sample handling conditions evaluated by the other types of blanks. The sampling time for the equipment blank should begin when the equipment is rinsed and the water is collected.

23.3.2 Field Blank - The field blank is water that is as free of target analytes as possible and from the same source as the equipment blank. The water is poured into a sampling container at the sampling site, preserved with the appropriate reagents, and returned to the laboratory. This serves as a check on reagent and environmental contamination. The sampling time for the field blank should be when the blank is prepared in the field.

23.3.3 Trip Blank - The trip blank pertains to volatile analysis only. This serves as a check on sample contamination originating from sample transport, sample container contamination, shipping and storage, or from certain site conditions. Trip blanks are often referred to as travel blanks. They are prepared using pre-cleaned sample containers. They are filled with organic-free water (the source of the organic free water is the same source of water used to prepare volatile standards, method blanks, LCS and sample dilutions), sealed and taken into the field with the empty containers which will be used for sampling. The recommended frequency is one trip blank per cooler (in duplicate or triplicate), per volatiles method. Unless otherwise specified, the sampling time for the trip blank is the time of receipt at the laboratory (When the “Trip” ends).

23.3.4 Field Duplicates - Field duplicates are replicate samples collected from the same sampling point or location during a field collection event. This control sample is used to demonstrate the ability of both the sampling and analytical process to generate data of acceptable precision.

23.4 DEFINITION OF HOLDING TIME

The date and time of sampling documented on the chain-of-custody (COC) form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in “days” (e.g 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in “hours” (e.g. 6 hours, 24 hours, etc.) are measured from date and time zero. The first day of holding time ends twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. However there are some special programs and projects that require the holding time to be calculated based on the date and specific time of analysis compared to the time of sampling. This method of calculating holding time can be accommodated by the laboratory through the Project setup in the TALs LIMs system.

23.4.1 Semi-Volatile - Holding times for sample preparation for semi-volatile organics are measured from the sampling date (and time where applicable) until the day (and time where applicable) solvent contacts the sample. If a sample is to be extracted on the day of expiration, the actual time of extraction must be recorded on the sample preparation worksheet and in the LIMs preparation batch. Holding times for analysis are measured from the date (and time where applicable) of initiation of extraction to the time of injection into the gas chromatograph.

23.4.2 Volatiles - Holding times for volatile organics are measured from the date (and time where applicable) of sampling to the date and time of injection into the gas chromatograph. The time of initiation of purging is considered the injection time, but data systems record the start of the chromatographic run rather than the start of purging. Hence, if a sample is so near expiration that the start-of-purging time rather than the chromatographic run time is needed to document the integrity of the sample; the analyst must observe and record the start-of-purging time in the instrument log. Extractions, e.g. for high level soils, must be completed in time to allow for analysis to be initiated within the maximum allowable holding time.

23.4.3 Inorganics - For inorganic and metals analysis, the preparation/digestion/distillation and analytical procedure must be completed within the maximum holding time as measured from the sampling date (and time where applicable).

23.5 SAMPLING CONTAINERS, PRESERVATION REQUIREMENTS, HOLDING TIMES

The preservation and holding time criteria specified in the following tables are derived from the source documents for the methods. If method required holding times (this information is in the laboratory SOPs) or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or “ASAP” is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

23.6 SAMPLE ALIQUOTS / SUBSAMPLING *(ISO17025 5.7.1)*

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory’s responsibility to take a representative sub-sample or aliquot of the sample provided for analysis. In that regard the following guidelines apply to analysts:

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis. Refer to the laboratory SOP UP-QA-039, *Sample Homogenization and Subsampling Procedures* for further details.

23.6.1 For water samples, before taking each aliquot for analysis, invert the sample container end-over-end three times and immediately pour off the aliquot. Especially when suspended solids are present, adequate mixing of the sample is extremely important.

23.6.2 For solid samples, when volatile organics are not requested, if the solid can be mixed, stir before removing the aliquot. Mix more than is needed for the analysis to be performed (e.g. if 30 g are needed, mix 50-100 g, if 1 g is needed, mix 20 g, etc…).

- If the solid cannot be easily mixed: After thoroughly mixing the sample within the sample container or, for non-organic methods, the sample can be transferred to a wip bag (or other suitable plastic bag) for manual mixing, a sub-sample from various quadrants and depths of the sample are taken to acquire the required sample weight.
- For soil samples, avoid debris in the sub-sample aliquot as much as possible (e.g. gravel, sticks, roots and grass); note this information in the sample preparation record.
- If the solid is extremely heterogeneous, and the client has given no instructions, utilize the following technique: separate the like materials into groups on a clean surface and take portions of masses from each group, proportional to their contribution to the original sample, to make a composite. Record in detail exactly how the composite was created. For very unusual samples, consult with the Project Manager, QA department or Department Supervisor/Manager.

23.6.3 For solid samples, when volatile organics analysis is requested, the sample should be manipulated as little as possible. In most cases, the sample will arrive already preserved or in an EnCore™ sampler of the correct mass (requiring quick preservation of the entire amount). If the client requests volatiles on a solid sample which has been collected in a jar and is in a common container from which aliquots for other test methods must be taken, login should deliver the container to the volatiles department for preparing a proper aliquot prior to any other aliquots being taken out.

23.6.4 For multiphasic samples, the client should instruct the laboratory as to the intent of the testing and how to handle the sample. If the entire sample is to be accounted for, and the phases do not mix easily with inversion/stirring, such that a representative aliquot can be taken, the analyst should record the percent by volume of each phase. The analysis must be conducted on each phase separately; the final results are combined mathematically, weighting the individual phase results by volume. One exception to this procedure is the situation addressed in the TCLP and SPLP methods for wastes containing free liquids. However, if the leachate and final filtrate are not miscible, it is necessary to combine mathematically the concentrations of the two (or more) solutions by volume.

SECTION 24

HANDLING OF SAMPLES (NELAC 5.5.8)

(ISO17025 5.8.1)

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

24.1 CHAIN OF CUSTODY (COC) *(ISO17025 5.7.2; 5.9.1)*

The COC form is the written documented history of any sample and can be initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 24-1.

24.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 24-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

The samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician

relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. Samples are only considered to be received by lab when personnel at the laboratory have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The sample receipt log is stored in log-in and it maintains a list of all receipts by date.

24.1.2 Legal / Evidentiary Chain-of-Custody *(ISO17025 5.8.4)*

If samples are identified for legal/evidentiary purposes on the COC or prearranged between the client and the project manager, login will complete the custody seal (Figure 24-2), retain the shipping record with the COC, and initiate an internal COC (Figure 24-3) for laboratory use by analysts and a sample disposal record (Figure 24-4).

24.2 SAMPLE RECEIPT *(ISO17025 5.8.2)*

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

Refer to laboratory SOP *UP-SR-001*, Sample Receipt: Handling and Processing Procedures for complete details.

24.2.1 Laboratory Receipt *(ISO17025 5.8.3)*

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on a Non-Conformance Memo (NCM) in TALs LIMs and brought to the immediate attention of the project manager and the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

24.2.1.1 Inspection of samples include a check for:

- Complete documentation to include sample identification, location, date and time of collection, collector's name, preservation type, sample type and any additional comments concerning the samples.
- Complete sample labels to include unique identification in indelible ink.
- Use of appropriate sample containers (see Section 23)
- Adherence to holding times as specified in the test method and/or summarized in Section 23.
- Adequate sample volume for required analyses (see Section 23).
- Damage or signs of contamination to sample container. Volatile vials are also inspected for headspace.

Refer to Figure 24-5 (Sample Acceptance Policy) and Figure 24-6 (Login Sample Receipt Checklist) for additional details.

24.2.1.2 Check and record the temperature of the samples or temperature blanks within each cooler that require thermal preservation using the IR gun located in the sample Login department.

- Samples shall be deemed acceptable if arrival temperature is just above freezing and less than or equal to 6.0° C (routinely 4°C +/-2). Samples that are hand-delivered immediately after collection may not be at the required temperatures; however, if there is evidence that the chilling process has begun, such as the arrival on ice, the samples shall be considered acceptable. This will be documented on the COC (Figure 24-1) and on the sample receipt checklist (Figure 24-6) in TALs LIMs.

- If the samples were shipped in ice and solid ice is still present and in direct contact with samples, report the samples as "received on ice." Direct contact means samples must be surrounded by ice cubes or crushed ice. Ice present in a plastic bottle or other container does not constitute direct contact. Samples shipped with only “blue ice” will be reported as “received on blue ice”.

24.2.1.3 Verify sample preservation as specified in the test method. Check for correct pH as specified in the test method. The results are documented on the sample receipt checklist in TALs LIMs. In the case of volatiles it is recorded by the analyst after analysis on the sample tracking sheet. Certain analytes are negatively affected by the presence of residual chlorine. BOD/cBOD and TOX are checked for chlorine content at the time of analysis. Cyanide, ammonia, and phenolics should be treated immediately upon collection, which is accomplished by providing treatment ampules with the sample bottles for those samples that might be suspected of containing chlorine, such as wastewaters or drinking waters. The chlorine treatment should be confirmed at log-in.

24.2.1.4 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

24.2.1.5 If samples are received without a COC, TestAmerica will provide a generic COC form to be completed by the client when the samples are brought to the laboratory. The client is always provided with a copy of the completed COC form for their records.

24.2.1.6 If analyses with short holding times are requested, the dates and times are inspected to ensure that holding times have not already expired. The appropriate laboratory staff is notified when short hold analysis is required.

24.2.1.7 Samples received after normal working hours are left in their coolers and placed in a cold storage location typically Walk-In Cooler #8. The person receiving the samples must record the date and time received, the presence or absence of ice and custody seals, the temperature of samples, presence and type of packing material, and initials.

24.2.1.8 *(ISO17025 5.8.3)* Any deviations from these checks described in Section 24.2.1 that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria (Section 24.3) are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples The project manager may be able to make decisions on samples with prior knowledge from the client, but documentation of acceptable scenarios must be provided and acknowledge by the client, and records of these decisions must be documented, or

- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Note: North Carolina requires that they be notified when samples are processed that do not meet sample acceptance criteria.

Once Sample acceptance is verified, the samples are logged into the LIMs according to the laboratory SOP UP-SR-001, Sample Receipt: Handling and Processing Procedures.

24.2.2 **Sample Log-in** *(ISO17025 5.8.2)*

All samples that are received by the laboratory are logged into the LIMS to allow the laboratory to track and evaluate sample progress in accordance with the laboratory SOP *UP-SR-001*, Sample Receipt: Handling and Processing Procedures. Each group of samples that are logged in together (typically one project from a given client/sampling event) is assigned a unique job number. Within each job, each sampling point (or sample) receives a unique number. Sample numbers are generated sequentially over time, and are not re-assigned. A sample may be composed of more than one bottle since different preservatives may be required to perform all analyses requested. Even if multiple containers are received for a single sample, each container is uniquely identified with a container ID. The LIMS generates sample labels that are attached to each bottle for a given sample.

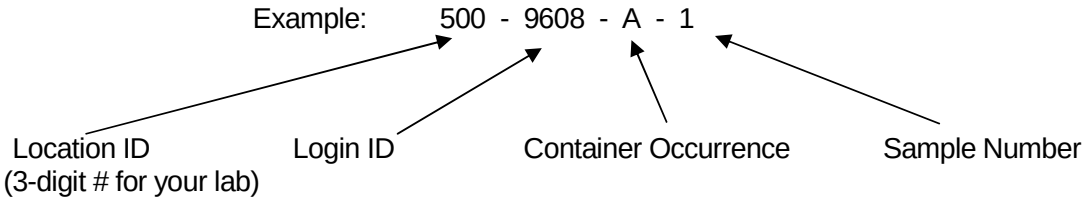
Each job/set of samples is logged into LIMS with a minimum of the following information:

- Client Name, Project Name, Address, Phone, Fax, Report to information, invoice to information (most of this information is “default information” that is stored in the LIMS).
- Date and time sampled;
- Date and time received;
- Job and/or project description, sample description;
- Sample matrix, special sample remarks;
- Reporting requirements (i.e., QC level, report format, invoicing format);
- Turn-around-time requirements;
- Parameters (methods and reporting limits or MDLs are default information for a given parameter)

24.2.2.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):



The above example states that TestAmerica Chicago Laboratory (Location 500). Login ID is 9608 (unique to a particular client/job occurrence). The container code indicates it is the first container ("A") of Sample #1.

If the primary container goes through a prep step that creates a "new" container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: 500 - 9608 - A - 1 - **A** ← **Secondary Container Occurrence**

Example: 500-9608-A-1-A, would indicate the PRIMARY container listed above that went through a step that created the 1st occurrence of a Secondary container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

24.3 SAMPLE ACCEPTANCE POLICY

The laboratory has a written sample acceptance policy (Figure 24-5) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC filled out completely;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- all samples submitted for water/solid Volatile Organic analyses must have a Trip Blank submitted at the same time;
- the project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined. A copy of the sample acceptance policy is provided to each client prior to shipment of samples.

24.4 SAMPLE STORAGE *(ISO17025 5.8.4)*

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators suitable for the sample matrix. Metals digestates are stored unrefrigerated in a sample storage closet in the metals instrument lab. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed at a minimum every two weeks. Refer to laboratory SOP *UP-QA-022, Refrigerated Storage Monitoring –Volatile Samples* for additional details.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. All samples are kept in the refrigerators for four to six weeks after analysis, which meets or exceeds most sample holding times. In general, samples that are not used for validation purposes are retained for 30 days and samples that are being used for validation purposes are retained for 60 days after the final report has been submitted to the client. This holding period allows samples to be checked if a discrepancy or question is raised by the client. Special arrangements may be made to store samples for longer periods of time.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

24.5 HAZARDOUS SAMPLES AND FOREIGN SOILS

To minimize exposure to personnel and to avoid potential accidents, known or found to be hazardous samples may be stored in an isolated area, in a fume hood or with secondary containment. The sample itself is clearly marked with a sample label reading “HAZARDOUS” or “FOREIGN SOIL”. The date, log number, lab sample number, and the result or brief description of the hazard are all written on the bottle. Analysts will notify a Sample Custodian or the Health and Safety Manager of any sample determined to be hazardous after completion of analysis. All hazardous samples are either returned to the client or disposed of appropriately in accordance with current regulations through a hazardous waste disposal firm that lab-packs all hazardous samples and removes them from the laboratory. Foreign soil samples are autoclaved by the laboratory or sent out for incineration by a USDA-approved waste disposal facility.

24.6 SAMPLE SHIPPING *(ISO17025 5.8.2)*

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank, that which was originally received with the samples, is enclosed for those samples requiring water/solid volatile organic analyses (see Note).. The chain-of-custody form is signed by the sample Login personnel and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

24.7 SAMPLE DISPOSAL

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP *UP—WM-001*, Laboratory Waste Disposal Procedure). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than three months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, or return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Waste Disposal Record (Figure 24-4) should be completed.

Figure 24-1.

Example: Chain of Custody (COC)

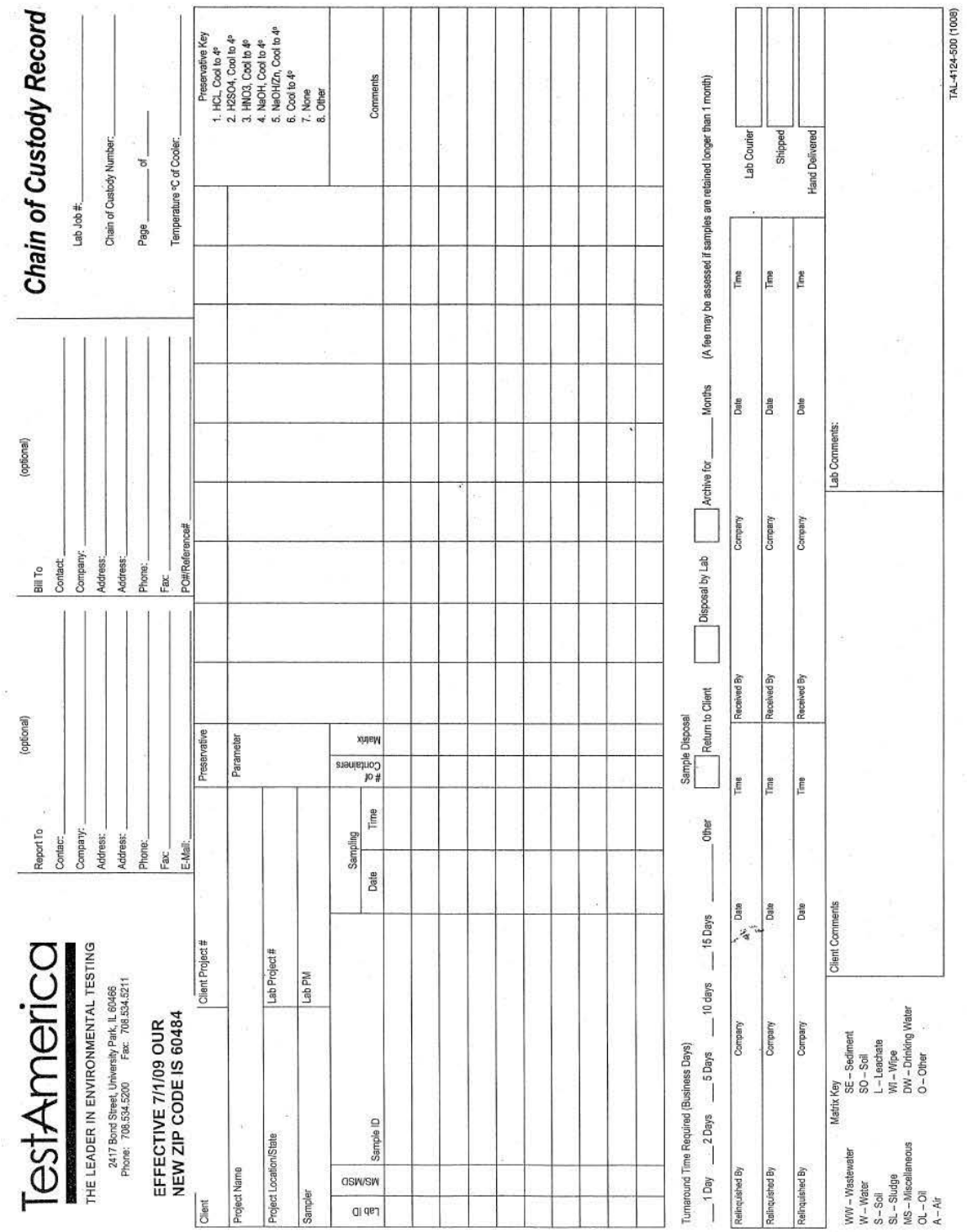


Figure 24-2.

Example: Custody Seal

Figure 24-3.

Example: Internal Chain of Custody (COC)

TestAmerica Chicago
Internal Sample Custody Transfer Record

Job#:_____ **Client:**_____

Sample No.	Analysis	Relinquished by:	Received by:	Date	Time	Comments

Figure 24-4.

Example: Sample Disposal Records

Sample Disposal via Aeration and/or Neutralization **Page No.:_____**

Drum No.	Aeration Start Date/Time	Aeration Stop Date/Time	Neutralized (pH)	Disposed By	Disposal Date
	/	/			
	/	/			

Figure 24-5.

Example: Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be documented on an NCM and on the laboratory report defining the nature and substance of the variation. In addition the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples. For further details, refer to the following TestAmerica Chicago SOP: *UP-SR-001- Sample Receipt: Handling and Processing Procedures*

TestAmerica Chicago Sample Acceptance Policy

The following describes TestAmerica Chicago's Sample Acceptance Policy. Upon receipt of samples at the facility, the laboratory will assess all samples based upon the following criteria. The purpose of such criteria is to maintain the integrity of the samples and ensure that proper sampling and preservation procedures have been followed. Samples found to be in 'non-compliance' with this policy will be formally addressed and conditions documented according to internal operating procedures. Subsequent analysis of such samples may or may not proceed and will be determined by discussion with the appropriate parties involved.

Samples are considered "compromised" if the following conditions are observed upon sample receipt:

- Cooler and/or samples are received outside of temperature specification.
- Samples are received broken or leaking.
- Samples are received beyond holding time.
- Samples are received without appropriate preservation.
- Samples are received in inappropriate containers.
- COC does not match samples received.
- COC is not properly completed or not received.
- Breakage of any Custody Seal.
- Apparent tampering with cooler and/or samples.
- Headspace in volatiles samples.
- Seepage of extraneous water or materials into samples.
- Inadequate sample volume.
- Illegible, impermanent, or non-unique sample labeling.

This policy will be made available to all TestAmerica Chicago clients where applicable.

Figure 24-6.

Example: Cooler Receipt Form *(ISO17025 5.8.3)*

LOGIN SAMPLE RECEIPT CHECK LIST

Client:_____**Job Number:**_____

Login Number:_____

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	True	
The Cooler's custody seal, if present, is intact	True	
The cooler or samples do not appear to have been compromised or tampered with	True	
Samples were received on ice.	True	3.3, 3.1, 2.7, 2.5
Cooler Temperature is acceptable	True	
Cooler Temperature is recorded	True	
COC is present	True	
COC is filled out in ink and legible	True	
COC is filled out with pertinent information	True	
There are no discrepancies between the sample IDs on the containers and the COC	True	
Samples are received within Holding Time	True	
Sample containers have legible labels	True	
Samples are not broken or leaking	True	
Sample collection dates/times are provided	True	
Appropriate sample containers are used	True	
Sample bottles are completely filled	True	
There is sufficient vol. for all requested analyses including any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is < 6mm (1/4") in diameter	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasis samples are not present	True	
Samples do not require splitting or compositing	True	

SECTION 25.0

ASSURING THE QUALITY OF TEST RESULTS
(NELAC 5.5.9)

25.1 OVERVIEW *(ISO17025 5.9.2)*

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 21, but also by routine process quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

25.2 CONTROLS *(ISO17025 5.9.2)*

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

25.3 NEGATIVE CONTROLS *(ISO17025 5.9.2)*

25.3.1 Method Blanks are used to assess preparation and analysis for possible contamination during the preparation and processing steps.

25.3.1.1 The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples.

25.3.1.2 The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).

25.3.1.3 The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.

25.3.1.4 Evaluation criteria and corrective action for method blanks is defined in the specific standard operating procedure for each analysis. Corrective action is taken if the concentration of a target analyte in the blank is greater than the reporting limit for the project being performed. Note that some programs have more stringent criteria (DoD requires method blanks to be < ½ the reporting limit.)

- The source of contamination is investigated
- Measures are taken to minimize or eliminate the source of the contamination
- Affected samples are reprocessed or the results are qualified on the final report.

25.3.2 **Calibration Blanks** are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.

25.3.3 **Instrument Blanks** are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.

25.3.4 **Trip Blanks** are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses. Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples. Trip Blanks are also sometimes referred to as Travel Blanks.

25.3.5 **Field Blanks** are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)

25.3.6 **Equipment Blanks** are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)

25.3.7 **Holding Blanks**, also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory (refer to section 24.4).

25.3.8 Field blanks, equipment blank and trip blanks, when received, are analyzed in the same manner as other field samples. When known, blanks should not be selected for matrix QC, as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB".

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

25.4 POSITIVE CONTROLS *(ISO17025 5.9.2)*

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision,

representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP also refer to Appendix 3 for a listing of the laboratory's default criteria and Appendix 8 for the DoD QSM Version 4.1 criteria that is followed.

25.4.1 Method Performance Control - Laboratory Control Sample (LCS)

25.4.1.1 The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

25.4.1.2 The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

25.4.1.3 Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

25.4.1.4 As stated in the opening of this section, the LCS goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).

25.4.1.5 The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis, it is also defined in Appendix 3 (Default criteria) and in Appendix 8 (DoD QSM Version 4.1 criteria). The frequency is generally 1 for each batch of samples; not to exceed 20 environmental samples.

25.4.1.6 If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

25.4.1.6.1 For methods that have 1-10 target analytes, spike all components.

25.4.1.6.2 For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.

25.4.1.6.3 For methods with more than 20 target analytes, spike at least 16 components.

25.4.1.6.4 Exception: Due to analyte incompatibility in pesticides, separate Toxaphene and Chlordane standards are only spiked at client request based on specific project needs. If required to meet project objectives, separate LCSs can be prepared and analyzed for Toxaphene, Chlordane, or an alternate Aroclor and project specified limits will be applied. The project / job notes in LIMs will be used to identify which projects require the additional LCS spikes.

25.4.1.6.5 Exception: Due to analyte incompatibility between the various PCB aroclors, aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

25.4.1.7 **Accuracy Calculation**: Percent Recovery (%R) Calculation (applies to LCS, CCV, Surrogates, and Matrix Spikes).

$$\%R = \frac{AV}{TV} \times 100$$

Where: AV = Analyzed Value
TV = True Value

25.5 SAMPLE MATRIX CONTROLS *(ISO17025 5.9.2)*

25.5.1 Matrix Spikes (MS)

25.5.1.1 The Matrix spike is used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used.

25.5.1.2 An MS is essentially a sample fortified with a known amount of the test analyte(s). At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects.

25.5.1.3 If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, a representative number of the listed components (see LCS analytes discussion in Section 25.4.1.6 above) may be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit-specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

25.5.1.4 The percent recovery calculation for matrix spikes is essentially the same as the calculation shown in 25.4.1.7 except that:

AV = Sp – Sa

Where: Sp = Spike result
Sa = Sample result

25.5.2 Surrogate Spikes

25.5.2.1 Surrogate Spikes are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples for organic analysis.

25.5.2.2 Surrogate compounds are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method (also refer to Section 25.5). Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.

25.5.3 Duplicates

25.5.3.1 For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure. Duplicate samples are usually analyzed with methods that do not require matrix spike analysis. LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

25.5.3.2 **Precision Calculation** (Relative Percent Difference - RPD)

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} \times 100$$

Where: S=Sample Concentration
D=Duplicate Concentration

25.5.4 Internal Standards

25.5.4.1 In most organic analyses, internal standards are spiked into all environmental and quality control samples (including the initial calibration standards). An internal standard is also used with some metals analyses (ICP and ICPMS). It is added to sample extracts after the extraction (post-prep). The acceptance criteria in most organic methods are 50% to 200% of the responses in the mid-point of the corresponding calibration curve. Consult the method-specific SOPs for details on the internal standard compounds, calculations and acceptance criteria.

25.5.4.2 When the internal standard recoveries fall outside these limits, if there are not obvious chromatographic interferences, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets internal standard recovery criteria, the second run is reported (or both are reported if requested by the client).

25.6 ACCEPTANCE CRITERIA (CONTROL LIMITS)

25.6.1 As mandated by the test method or regulation, each individual analyte in the LCS, MS, or Surrogate Spike are evaluated against the control limits as published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific or regulatory mandated control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Control charts are monitored to detect trends such as shifts in mean recovery, changes in standard deviation, and to assist in troubleshooting apparent trends. Control charts are also used as a visual aid to help ensure that an appropriate set of data is being selected when setting control limits. More rigorous statistical tests can also be used to determine if different portions of the selected data belong to the same population and may be pooled. For example, the t-test can be used to test means and the F-test can be used to test variances.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

25.6.2 Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating or significant changes to the method or preparation procedure warrant re-evaluation of the limits (e.g. EPA SW846 8000 series methods). Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized. Refer to Section 5.6.1 for additional details on control charts.

25.6.2.1 The lab should consider the effects of the spiking concentration on the control limits. The acceptance criteria for recovery and precision are often a function of the spike concentration used. Therefore, caution must be used when pooling data to generate control limits.

25.6.2.2 Not only should the results all be from a similar matrix, but the spiking levels should also be approximately the same (within a factor of 2). Similarly, the matrix spike and surrogate results should all be generated using the same set of extraction, cleanup and analysis techniques. For example, results from solid samples extracted by ultrasonic extraction are not mixed with those extracted by Soxhlet.

25.6.2.3 The laboratory should try and avoid discarding data that do not meet a preconceived notion of acceptable performance. This results in a censored data set, which, when used to develop acceptance criteria, will lead to unrealistically narrow criteria. For a 99% confidence interval, 1 out of every 100 observations likely will still fall outside the limits. For methods with long analyte lists this may mean occasional failures every batch or two. While professional

judgment is important in evaluating data to be used to develop acceptance criteria, specific results are not discarded simply because they do not meet one's expectations. However, data points shall be discarded if they were the result of human or mechanical error. Matrix spike results where the native analyte concentration is > 4 times the spike level are calculated and reported in the TestAmerica Chicago LIMs system with qualification. Further evaluation and narration of the MS/MSD results based on program specific criteria may be required.

25.6.3 Laboratory generated % Recovery acceptance (control) limits are generally established by taking $\pm$ 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

25.6.3.1 Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV), unless the analytical method specifies a tighter limit.

25.6.3.2 In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If the laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

25.6.3.3 The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

25.6.3.4 The maximum acceptable recovery limit will be 150%.

25.6.3.5 The maximum acceptable RPD limit will be 20% for waters and 30% for soils. The minimum RPD limit is 0%.

25.6.3.6 If the calculated control limit changes by $\leq$ 5% from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits. Additional statistical tests (e.g., t and F tests) may be applied to the mean and variance to determine if the new data belong to the same population and may be pooled to establish new control limits.

25.6.4 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits.

25.6.4.1 The QA department generates a Control Limit Summary table for each method and applicable matrix that contains the precision and accuracy acceptability limits for analyses performed at TestAmerica Chicago. This summary includes the date range from which the limits were generated and an approval date. The effective date for the control limits are governed by the date that the limits are entered into the LIMs system. The tables and LIMs are updated each time new limits are generated. The current summary tables and any historical limits are located in the U:/QC/LIMITS/STATS directory**.** Unless otherwise noted, limits within these tables are laboratory generated. The control limits that are entered into the Laboratory Information Management System (LIMS) are used by the methods in the evaluation of the data. Each applicable method and matrix is associated with a Method Limit Group in LIMs which houses all applicable limits used by the system in the evaluation of the data. The Quality Assurance department maintains an archive of all limits used within the laboratory.

25.6.5 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 13) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

25.6.5.1 The analyte results are below the reporting limit and the LCS is above the upper control limit.

25.6.5.2 If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

25.6.5.3 Or, for NELAC and Departement of Defense (DoD) work, there are an allowable number of Marginal Exceedances (ME):

- <11 analytes – 0 marginal exceedances are allowed.
- 11 – 30 Analytes – 1 marginal exceedance is allowed
- 31-50 Analytes – 2 marginal exceedances are allowed
- 51-70 Analytes – 3 marginal exceedances are allowed
- 71-90 Analytes – 4 marginal exceedances are allowed
- > 90 Analytes – 5 marginal exceedances are allowed

25.6.5.3.1 Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (NELAC).

25.6.5.3.2 Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

25.6.5.3.3 Though marginal excedences may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

25.6.5.3.4 The DoD QSM 4.1, Appendix G requires that the “when a laboratory’s in-house limits are outside the DoD control limits (upper and/or lower), they must report their in-house limits in the laboratory report even if the LCS associated with the batch fell within the DoD limits.” The laboratory will evaluate the DoD QSM 4.1 control limits against the laboratories internally derived statistical limits. Those internal limits that do not meet the DoD QSM 4.1 control limits will be used in the laboratory report. Those analytes which utilize the statistical limits as opposed to the DoD QSM 4.1 designated control limits will be clearly outlined in the case narrative of the report.

25.6.6 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in Appendix 3 (Default criteria), Appendix 8 (DoD QSM 4.1 criteria), within the method specific SOPs and in Section 13.

25.6.7 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis. A more detailed discussion of acceptance criteria and corrective action can be found in Appendix 3 (Default criteria), Appendix 8 (DoD QSM 4.1 criteria) and within the method specific SOPs.

25.7 METHOD DETECTION LIMITS (MDLs/DLs)

MDLs/DLs, calculated as described in Section 20.7, are updated annually, or as required by the method or program. Methods that reported for compliance with the DoD QSM version 4.1 are verified on a quarterly basis.

25.8 ADDITIONAL PROCEDURES TO ASSURE QUALITY CONTROL

25.8.1 The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 21), use of certified reference materials (see Section 22) and use of PT samples (see Section 16).

25.8.2 A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 20.

25.8.3 Use of formulae to reduce data is discussed in the method standard operating procedures and in Section 21.

25.8.4 Selection of appropriate reagents and standards is included in Section 9 and 22.

25.8.5 A discussion on selectivity of the test is included in Section 5.

25.8.6 Constant and consistent test conditions are discussed in Section 19.

25.8.7 The laboratories sample acceptance policy is included in Section 24.

25.8.8 A listing of the type of test result correlations that are looked at during report review (e.g. Total Chromium should be greater or equal to Hexavalent Chromium) is included in Section 20.14.4.3.

SECTION 26.0

REPORTING RESULTS *(NELAC 5.5.10)*

26.1 OVERVIEW *(ISO17025 5.10.1; 5.10.2; 5.10.8)*

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is a conflict between the client requests and laboratory ethics or regulatory requirements the laboratory's ethical and legal requirements are paramount, and an adequate solution will be devised working with the client at the time of project set up. (Refer to section 7 for additional details.)

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client.

Review of reported data is included in Section 20.

26.2 TEST REPORTS *(ISO17025 5.10.1; 5.10.2; 5.10.3.1; 5.10.3.2; 5.10.5; 5.10.6; 5.10.7; 5.10.8)*

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report cover page is printed with the corporate letterhead logo and the laboratory name. It is reviewed and signed by the appropriate project manager or designee. At a minimum, the standard laboratory report shall contain the following information:

26.2.1 The cover page of the report is printed with the company letterhead logo, which includes the laboratory name, address, telephone number, the Project Manager's name and email address.

26.2.2 A report title (e.g. Sample Results or Analytical Data) with a "Results" column header.

26.2.3 A unique identification of the report (e.g. Job Number: 500-6101-1) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as Page # of ##. Where the first number is the page number and the second is the total number of pages.

26.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.
- In all cases, the applicable COC is scanned and placed in the shipping and receiving documents folder of the data deliverable for its respective job number and is paginated as an integral part of the report.
- Any additional addenda to the report must be treated in a similar fashion so it is a recognizable part of the report and cannot accidentally get separated from the report (eg. Sampling information).

26.2.5 The name and address of client and a project name/number, if applicable.

26.2.6 Client project manager or other contact

26.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

26.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

26.2.9 Date reported or date of revision, if applicable.

26.2.10 Method of analysis including method code (EPA, Standard Methods, etc).

26.2.11 Reporting limit.

26.2.12 Method detection limits (if requested)

26.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

26.2.14 Sample results.

26.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

26.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 26.2.4 – Item 3 regarding additional addenda). A sample receipt checklist is completed by login personnel, temperatures are documented on the COC and on the checklist and are included as part of the data deliverable to the client.

26.2.17 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

26.2.18 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator.

26.2.19 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

26.2.20 When NELAC accreditation is required, the lab shall certify that the test results meet all requirements of NELAC or provide reasons and/or justification if they do not. The cover page of each report contains the following text: These test results meet all the requirements of NELAC for accredited parameters. The Lab Certification ID# is 100201. All questions regarding this test report should be directed to the TestAmerica Project Manager whose signature appears on this report. All pages of this report are integral parts of the analytical data. Therefore, this report should be reproduced only in its entirety.

26.2.21 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

26.2.22 When Soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.

26.2.23 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

26.2.24 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., *'Preliminary Report'* is printed across each page of the report), and that a complete report will follow once all of the work has been completed.

26.2.25 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor and may be appended to the TestAmerica Chicago report in its entirety for submission to the client. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

26.3 REPORTING LEVEL OR REPORT TYPE *(ISO17025 5.10.1; 5.10.7; 5.10.8)*

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 26.2 above with the exception that no QC results are reported.
- Level II is a Level I report plus batch QC summary information, including results for the method blank, percent recovery for laboratory control samples and matrix spike samples, the RPD values for all MSD, sample duplicate analyses and surrogate recoveries.
- Level III contains all the information supplied in Level II, supplemented with the presentation of data on CLP-like forms, including relevant tune (GC/MS), internal standard (GC/MS) and calibration information. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in CD deliverable form. Initial reports may be provided to clients by facsimile, as a .pdf file sent via email or CD, as a hardcopy report or by any combination of the three. Procedures used to ensure client confidentiality are outlined in Section 26.6.

26.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. TestAmerica Chicago offers a variety of EDD formats including Environmental Resources Program Information System (ERPIMS), Environmental Restoration Information System (ERIS), Automated Data Review (ADR), Staged Electronic Data Deliverable (SEDD), EQUIS [tm], GISKEY [tm] and other State deliverables besides general formats in Dbase [tm], Excel [tm] and text.

EDD specifications are submitted to an EDD Specialist by the PM or AE for review. The specification undergoes review for contract and LIMs compatibility. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated by the Corporate IT TALs LIMs staff. The validation of the code is retained by the Corporate IT staff coding the EDD. Changes to the format must be directed by the program or client and approved by the EDD Specialist and Corporate IT TALs LIMs staff.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review. If an EDD checker program is provided to the laboratory then the EDDs will be screened using this tool.

26.4 SUPPLEMENTAL INFORMATION FOR TEST *(ISO17025 5.10.1; 5.10.3.1; 5.10.5)*

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report. Refer to Appendix 6 for a list of the laboratory's standard footnotes and qualifiers.

26.4.1 Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

26.4.2 Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet NELAC sample acceptance requirements such as improper container, holding time, or temperature.

26.4.3 Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

26.4.4 Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the Department Manager/Supervisor, PM or QA Department depending on the type of non-conformance. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

26.5 ENVIRONMENTAL TESTING OBTAINED FROM SUBCONTRACTORS *(ISO17025 5.10.1; 5.10.6)*

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CA-L-S-002) also refer to in Section 8.

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of the TestAmerica network are reported to the client on the subcontract laboratory's original report stationary in its entirety.

26.6 CLIENT CONFIDENTIALITY *(ISO17025 4.1.5; 5.10.7)*

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

26.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

Confidentiality Notice: This e-mail communication, including any attachments, may contain privileged or confidential information for specific individuals and is protected by law. If you are not the intended recipient(s), you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited and you should delete this message and its attachments from your computer without retaining any copies. If you have received this communication in error, please reply to the sender immediately. We appreciate your cooperation.
Please consider the environment before printing this e-mail.

26.7 FORMAT OF REPORTS *(ISO17025 5.10.8)*

The formats of reports are designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

26.8 AMENDMENTS TO TEST REPORTS *(ISO17025 5.10.9; 5.10.Z.10)*

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 13).

The revised report is retained on the document server in the TALs LIMs system, as is the original report. The revised report can be accessed through PM Desktop under the Job Number in the Deliverable folder. The revised deliverable is identified as Rev(1) next to the report which has been revised.

When the report is re-issued, a notation of "Revision: 1" is printed on the cover page with the date of the submittal. The statement regarding the nature of the revision is placed at the top of the Job Narrative page with a brief explanation of reason for the re-issue. For example: The following report required a revision: 500-6101-1. Details are as follows: The client has added MTBE to the VOC compound list.

26.9 POLICIES ON CLIENT REQUESTS FOR AMENDMENTS *(ISO17025 5.10.Z.10)*

26.9.1 Policy on Data Omissions or Reporting Limit Increases *(ISO17025 5.9.1)*

Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

26.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same workorder where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. *(ISO17025 4.1.5)*

TESTAMERICA
ETHICS POLICY No. CA-L-P-001

Refer to CA-L-P-001 for complete policy.

TestAmerica
EMPLOYEE ETHICS STATEMENT

I understand that TestAmerica is committed to ensuring the highest standard of quality and integrity of the data and services provided to our clients. I have read the Ethics Policy of the Company.

- *With regard to the duties I perform and the data I report in connection with my employment at the Company, I agree that:*
- *I will not intentionally report data values that are inconsistent with the actual values observed or measured.*
- *I will not intentionally report the dates, times, sample or QC identifications, or method citations of data analyses that are not the actual dates, times, sample or QC identifications, or method citations.*
- *I will not intentionally misrepresent another individual's work as my own or represent my own work as someone else's.*
- *I will not intentionally misrepresent any data where data does not meet Method or QC requirements. If it is to be reported, I will report it with all appropriate notes and/or qualifiers; I shall not modify data (either sample or QC data) unless the modification can be technically justified through a measurable analytical process, such as one deemed acceptable to the laboratory's Standard Operating Procedures, Quality Assurance Manual or Technical Director. All such modifications must be clearly and thoroughly documented in the appropriate laboratory notebooks/worksheets and/or raw data and include my initials or signature and date.*
- *I shall not make false statements to, or seek to otherwise deceive, members of Management or their representatives, agents, or clients/customers. I will not, through acts of commission, omission, erasure, or destruction, improperly report measurement standards, quality control data, test results or conclusions.*
- *I shall not compare or disclose results for any Performance Testing (PT) sample, or other similar QA or QC requirements, with any employee of any other laboratory, including any other TestAmerica laboratory, prior to the required submission date of the results to the person, organization, or entity supplying the PT sample.*
- *I shall immediately inform my supervisor or other member of management regarding any intentional or unintentional reporting of my own inauthentic data. Such report shall be given both orally and in writing to the supervisor or other member of management contacted and to the local Quality Assurance Manager. The Quality Assurance Manager will initial and date the information and return a copy to me. I shall not condone any accidental or intentional reporting of inauthentic data by other employees and will immediately report its occurrence. If I have actual knowledge of such acts committed by any other employees, and I do not report such information to designated members of Management, it shall be considered as serious as if I personally committed the offense. Accordingly, in that event, I understand that I may be subject to immediate termination of employment.*

- *I understand that if any supervisor, manager, or representative of TestAmerica management instructs, requests, or directs me to perform any of the aforementioned improper laboratory practices, or if I am in doubt or uncertain as to whether or not such laboratory practices are proper, I will not comply. In fact, I must report such event to all appropriate members of Management including, but not limited to, the Lab Director, all supervisors and managers with direct line reporting relationship between me and the Lab Director, and the local Quality Assurance representative, excluding such individuals who participated in such perceived improper instruction, request, or directive. In addition, I may contact Corporate Quality Assurance / Ethics Compliance Officer(s) for assistance.*
- *I understand the critical importance of accurately reporting data, measurements, and results, whether initially requested by a client, or retained by TestAmerica and submitted to a client at a later date, or retained by TestAmerica for subsequent internal use;*
- *I will not share the pricing or cost data of Vendors or Suppliers with anyone outside of the TestAmerica family of companies.*
- *I shall not accept gifts of a value that would adversely influence judgment.*
- *I shall avoid conflicts of interest and report any potential conflicts to the management (e.g. employment or consulting with competitors, clients, or vendors).*
- *I shall not participate in unfair competition practices (e.g. slandering competitors, collusion with other labs to restrict others from bidding on projects).*
- *I shall not misrepresent certifications and status of certifications to clients or regulators.*
- *I shall not intentionally discharge wastes illegally down the drain or onto the ground.*
- *I understand that any attempt by management or an employee to circumvent these policies will be subject to disciplinary action.*

As a TestAmerica employee, I understand that I have the responsibility to conduct myself with integrity in accordance with the ethical standards described in the Ethics Policy. I will also report any information relating to possible kickbacks or violations of the Procurement Integrity Act, or other questionable conduct in the course of sales or purchasing activities. I will not knowingly participate in any such activity and will report any actual or suspected violation of this policy to management.

I understand that if my job includes supervisory responsibilities, I shall not instruct, request, or direct any subordinate to perform any laboratory practice which is unethical or improper. Also, I shall not discourage, intimidate, or inhibit an employee who may choose to appropriately appeal my supervisory instruction, request, or directive which the employee perceives to be improper, nor retaliate against those who do.

The Ethics Policy has been explained to me by my supervisor or at a training session, and I have had the opportunity to ask questions if I did not understand any part of it. I understand that any violation of this policy subjects me to disciplinary action, which can include termination of my employment. In addition, I understand that any violation of this policy which relates to work under a government contract or subcontract could also subject me to the potential for prosecution under federal law.

EMPLOYEE SIGNATURE _____ Date _____

Supervisor/Trainer: _____ Date _____

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TestAmerica

CONFIDENTIALITY AND PROPRIETARY INFORMATION AGREEMENT

TestAmerica and their predecessors, in their businesses, have developed and use commercially valuable technical and non-technical information and to guard the legitimate interests of TestAmerica and its clients, it is necessary to protect certain information as confidential and proprietary.

I, _____ , understand and acknowledge that during the term of my employment by TestAmerica, I will be privy to and entrusted with certain confidential information and trade secrets of TestAmerica and its clients.

Confidential information and trade secrets include, but are not limited to: customer and client lists; price lists; marketing and sales strategies and procedures; operational and equipment techniques; standard operating procedures; business plans and systems; quality control procedures and systems; special projects and technological research, including projects, research and reports for any government entity or client; client's plans and processes; client's manner of operation; the trade secrets of clients; client's data; vendor or supplier pricing; employee lists and personal information, and any other records, data, files, drawings, inventions, discoveries, applications, or processes which are not in the public domain.

I agree as follows:

1. I will not in any way, during the term of my employment, or at any time thereafter, except as authorized in writing by the Legal Department of TestAmerica or the client where client data is involved, disclose to others, use for my own benefit, remove from TestAmerica's premises (except to the extent off-site work is approved by my supervisor), copy or make notes of any confidential information and/or trade secrets of TestAmerica or its clients, excepting only that information which may be public knowledge. Technical and business information of any previous employer or other third party which I may disclose to TestAmerica shall be limited to that which was acquired legitimately and disclosed to me without restriction as to secrecy.

2. I agree that all inventions (whether or not patentable) conceived or made by me during the period of my employment by TestAmerica shall belong to TestAmerica, provided such inventions grow out of my work for TestAmerica and are related to the business of TestAmerica. I agree to disclose and assign such inventions to TestAmerica. In California, this provision shall not apply to any invention which qualifies fully under Section 2870 of the California Labor Code.

3. On termination of my employment from TestAmerica, I will deliver to TestAmerica all documents, records, notes, data, memoranda, files, manuals, equipment and things of any nature which relate in any way to confidential information and/or trade secrets of TestAmerica or its clients and which are in my possession or under my control.

4. I agree that during the period of my employment and for one (1) year from and after the termination (for any reason) of my employment with TestAmerica, I shall not directly or indirectly (without first obtaining the written permission of TestAmerica), recruit for employment, or induce to terminate his or her employment with TestAmerica, any person who is an active employee of TestAmerica on the last day of my employment with TestAmerica.

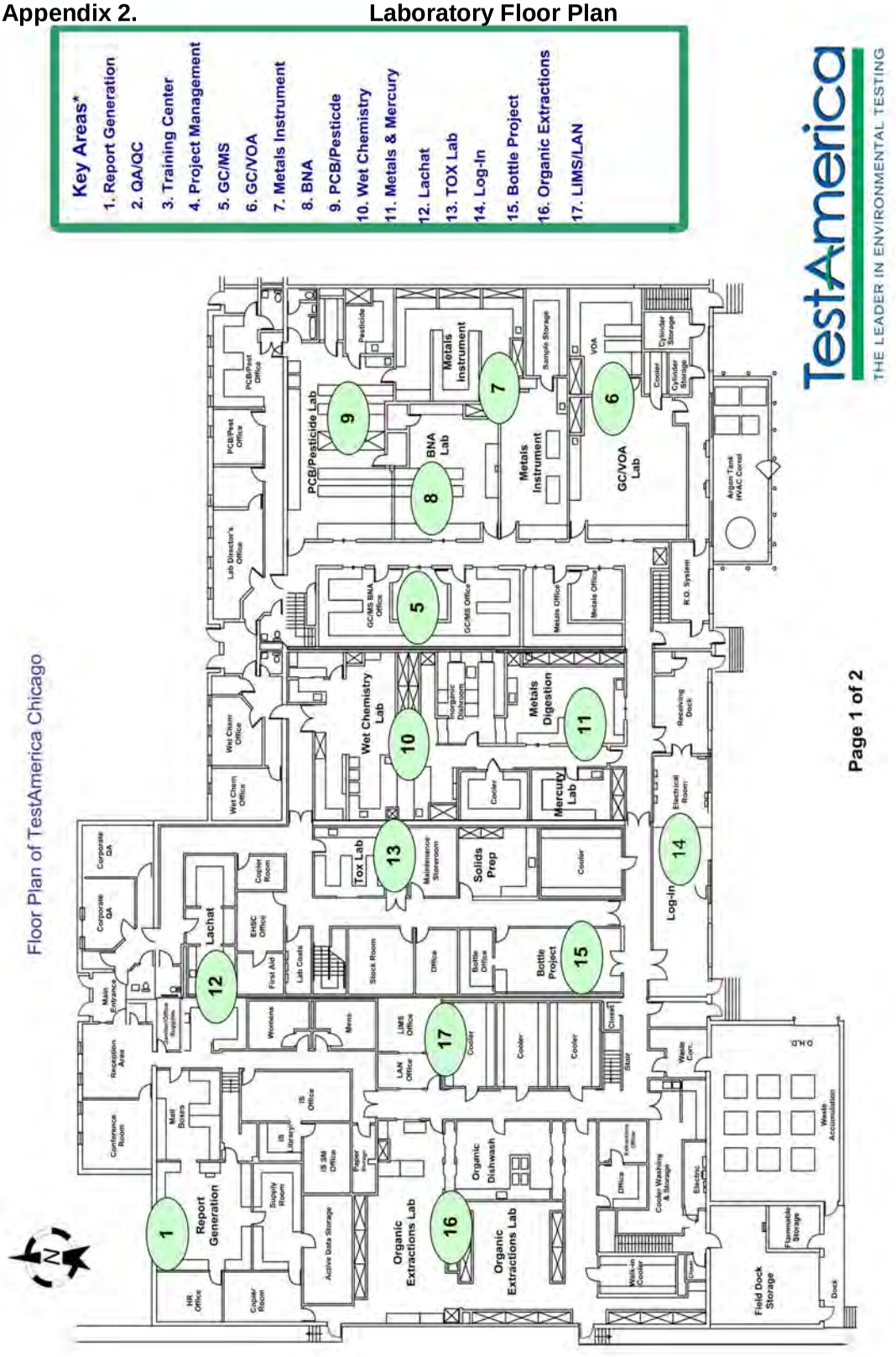
5. I acknowledge that if I were to breach any provision of this Confidentiality Agreement, money damages will be inadequate, and I hereby agree that TestAmerica shall be entitled, where appropriate, to specific performance and/or injunctive relief (i.e. to require me to comply with this Agreement). I further acknowledge that the willingness of TestAmerica to hire me or to continue my employment constitutes full and adequate consideration for the agreements, and obligations to which I have agreed as set forth in this document.

I have executed this Agreement, intending to be legally bound.

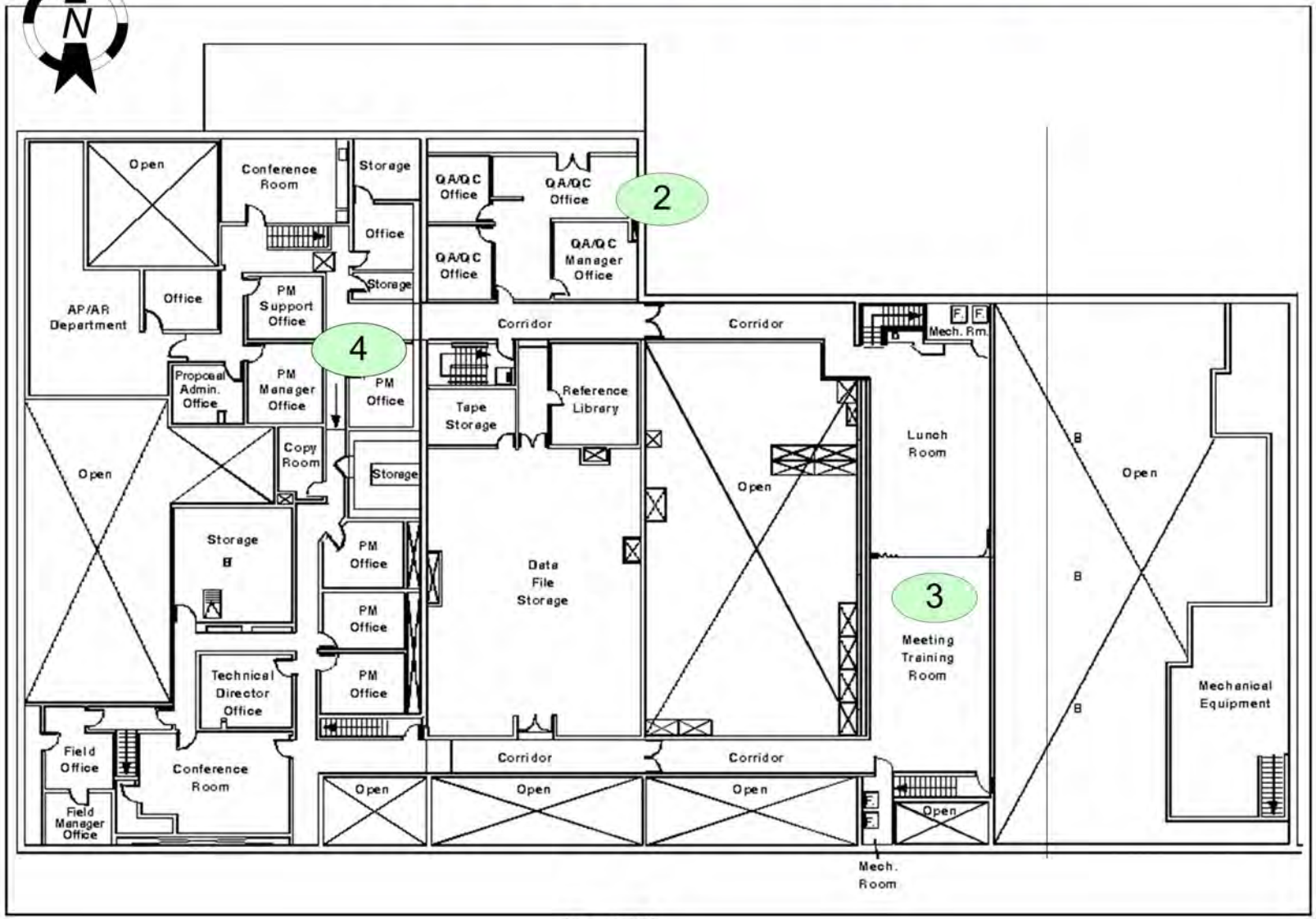
_____	_____	_____
Printed Name	*Signature*	*Date*

Company Confidential & Proprietary

Appendix 2. **Laboratory Floor Plan**



Upper Floor Plan of TestAmerica Chicago



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Appendix 3: Summary of Calibration and QC Procedures for GC Organics

Method	QC Check	Frequency	Acceptance Criteria[3]	Corrective Action[4]
SW8081A SW8081B SW8082 SW8082A SW8151A	Minimum five-point initial calibration for all target analytes[2]	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	Linear regression correlation coefficient $r^2 \geq 0.99$, $r \geq 0.995$. RSD of CF ≤ 20%	Correct problem then repeat initial calibration
	Initial calibration verification (ICV) must be from a 2nd source	Once immediately following initial calibration	All target analytes within 15% of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification (CCV)	Before sample analysis, every 12 hours, and at the end of the analysis sequence	All analytes within 15% of expected value and within the RT Window. Average of all analytes 15%.	Repeat CCV once, if it again fails criteria, identify and correct problem, repeat initial CCV (re-calibrate if necessary) and re-analyze all samples since last successful CCV.
	Breakdown check (Endrin and DDT)[1]	Before sample analysis	Degradation ≤15% for either Endrin or DDT.	Inlet/column maintenance; repeat breakdown check and re-analyze all samples since last successful breakdown check.
	Method blank	One per analytical prep batch, not to exceed 20 samples in a batch.	No analytes detected RL values between the RL and MDL will be evaluated and flagged with a 'J'	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One per prep batch, not to exceed 20 samples in a batch.	Statistical Control Limits	Re-prep and analyze the LCS and all samples in the affected analytical batch
	Surrogate(s)	Every sample, spike, standard, and method blank	Statistical Control Limits	Check system, re-inject, re-extract
	MS/MSD	One per batch per matrix, if insufficient sample for MS/MSD, then a LCS/LCSD will be analyzed.	Statistical Control Limits	None (LCS is used to determine if data is acceptable).
	Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis. If the relative % difference of results between the 2 columns is greater than 40%, a comment should be placed in LIMS.
	Retention time window calculated for each analyte (see section 9 for how to calculate RTWs).	System set-up, with each new column or major instrument maintenance. Update the mid-RTW at the start of the run or daily.	Each analyte of the LCS, MS/MSD and CCV must be within the calculated RTW.	Correct the problem and re-process or re-analyze samples. If questions, see the supervisor or technical director.
	MDL verification	Minimum - quarterly	Detectible	Re-evaluate MDL standard used and MDL

1 --8081A only
2 – Method 8082, a five-point calibration is only analyzed for Aroclors 1016 and 1260.
3 - This is a summary of the acceptance criteria, refer to the method SOP for specific or more information.
4 - All abnormalities must be noted on the data, the benchsheet and in LIMS.

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Appendix 3: Summary of Calibration and QC Procedures for GC Organics

Method	QC Check	Frequency	Acceptance Criteria[3]	Corrective Action[4]
EPA608	Minimum three-point (preferably five) initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	**RSD of CF ≤ 10%** Linear regression - correlation coefficient $r^2 > 0.990$, $r \geq 0.995$.	Correct problem then repeat initial calibration
	Initial calibration verification (ICV) must be from a 2nd source.	Immediately following initial calibration	All analytes within 15% of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification (CCV)	Before sample analysis, after every 10 samples, and at the end of the analysis sequence	All analytes within **15% of expected value** and within the RTW.	Repeat CCV once, if it again fails criteria, identify and correct problem, repeat initial CCV (re-calibrate if necessary) and re-analyze all samples since last successful CCV.
	Breakdown check (Endrin and DDT)[1]	Before sample analysis	Degradation ≤15% for either Endrin or DDT.	Inlet/column maintenance; repeat breakdown check and re-analyze all samples since last successful breakdown check.
	Method blank	One per analytical prep batch, **not to exceed 10 samples in a batch**.	No analytes detected ≥ RL values between the RL and MDL will be evaluated and flagged with a 'J'	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank
	LCS (QC check standard)	One per prep batch, **not to exceed 10 samples in a batch.**	Method Control Limits	Re-prep[7] and analyze the LCS and all samples in the affected analytical batch
	Surrogate(s)	Every sample, spiked sample, standard, and method blank	Method Control Limits	Check system, re-inject, re-extract
	MS	One per batch per matrix, 10%, if insufficient sample for MS, then an additional LCS will be analyzed.	Method Control Limits	All target compounds should be reported, and any compounds that are outside criteria must be within criteria in the LCS.
	Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis. If the relative % difference of results between the 2 columns is greater than 40%, a comment should be placed in LIMS.
	Retention time window calculated for each analyte (see section 9 for how to calculate RTWs).	System set-up, with each new column or major instrument maintenance. Update the mid-RTW at the start of the run or as needed.	Each analyte of the LCS, MS/MSD and CCV must be within the calculated RTW.	Correct the problem and re-process or re-analyze samples. If questions, see the supervisor or technical director.
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL; see Technical Director.

3 - This is a summary of the acceptance criteria, refer to the method SOP for specific or more information.
4 - All abnormalities must be noted on the data, the benchsheet and in LIMS.

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Appendix 3: Summary of Calibration and QC Procedures for GC/MS Organics

Method	QC Check	Frequency	Acceptance Criteria[2]	Corrective Action[3]
SW8260B SW8270C SW8270D	Check of mass spectral ion intensities[1], i.e., Tune	Prior to initial calibration or Continuing calibration verification, every 12 hours	Refer to criteria listed in the method SOP for Tune criteria, including DDT, Benzidine and Pentachlorophenol requirements for 8270.	Retune the instrument and verify (instrument maintenance may be needed).
SW8260B	Minimum five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration as necessary and after major instrument maintenance.	SPCCs average RF ≥ 0.30 or 0.1 depending on the compound and %RSD for RFs for CCCs ≤ 30% and all other target analytes %RSD grand mean <15%	Correct problem then repeat initial calibration
SW8270C			SPCCs average RF ≥ 0.050 and %RSD for RFs for CCCs ≤ 30% and all other target analytes grand mean <15%.	Correct problem then repeat initial calibration
			option (if %RSD is > 15%)–linear regression $r^2 \geq 0.990$, r ≥ 0.995.	Refer to individual SOP for corrective action procedure.
SW8270D			All analytes < 20% RSD, up to 10% of analytes can be > 20% RSD Most analytes must meet minimum RF's (see Table 4 in 8270D SOP)	Correct problem then repeat initial calibration
SW8260B SW8270C SW8270D	Initial calibration verification (ICV) must be from a 2nd source.	Immediately following five-point initial calibration and before samples are analyzed.	All analytes within 25% of expected value (8260B; 8270C) All analytes within 30% of expected value (8270D)	Correct problem then repeat ICV, if criteria fails it may be necessary to repeat initial calibration or report outlier with PM/QA approval and qualification (NCM required).
	Relative Retention time window	Each sample	Relative retention time (RRT) of the analyte within 0.06 RRT units of the RRT of the internal standard	Correct problem then reprocess or re-analyze all samples analyzed since the last retention time check
SW8260B	Continuing calibration verification (CCV)	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥ 0.30 or 0.1 depending on the compound; and	Correct problem then repeat CCV, if criteria is met, repeat associated samples. If criteria is not met, it may be necessary to repeat initial calibration and re-analyze all samples since last successful CCV.
SW8270C			SPCCs average RF ≥ 0.050; and	
SW8260B SW8270C			CCCs: ≤20% difference (when using RFs) or drift (when using least squares regression).	
SW8270D			All analytes < 20% RSD, up to 10% of analytes can be > 20% RSD Most analytes must meet minimum RF's (see Table 4 in 8270D SOP)	

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Method	QC Check	Frequency	Acceptance Criteria[2]	Corrective Action[3]
SW8260B SW8270C SW8270D	Method blank	One per analytical prep batch	No analytes detected ≥ RL values between the RL and MDL will be evaluated and flagged with a 'J'	Correct problem then re-prep[5] and analyze method blank and all samples processed with the contaminated blank
SW8260B SW8270C	Internal Standards	Every sample/standard and blank	Retention time ±30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). EICP area within -50% to +100% of ICAL mid-point std for the CCV and samples.	Refer to corrective action section of method SOP.
SW8270D			Retention time ±30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). EICP area within -50% to +100% of ICAL mid-point standard Area based on CCV	Refer to corrective action section of method SOP.
	LCS for all target analytes	Volatiles: one per tune per 12 hour sequence. Semivolatiles: One per prep batch, not to exceed the 20 samples in a batch.	Statistical Control Limits	Refer to corrective action section of method SOP.
	MS/MSD	One set per batch of 20 samples per matrix, if insufficient sample for MS/MSD, then a LCS/LCSD will be analyzed.	Statistical Control Limits	None (the LCS is used to evaluate and determine if the batch is acceptable).
	Surrogate(s)	Every sample, spike, standard, and blank	Statistical Control Limits	Refer to corrective action section of method SOP.
SW8260B	pH check	All 8260 water samples All low level 5035 soils are prepped in sodium sulfate (refer to the method SOP for exceptions).	pH ≤2.	If the pH is > 2, then comment the data, in the PIPE database, and LIMS.
SW8260B	Residual chlorine check (samples suspected of coming from a chlorinated waste stream)	Each sample.	Residual chlorine should be negative.	If the residual chlorine is positive, then comment the data, in the PIPE database, and LIMS.
	MDL verification	Minimum - quarterly	Detectible	Re-evaluate MDL standard used and MDL;

1 – SW8260B requires BFB; SW8270C and SW8270D requires DFTPP
2 - This is a summary of the acceptance criteria, refer to the method SOP for specific or more information.
3 - All abnormalities must be noted on the data, the bench sheet and in LIMS.

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Appendix 3: Summary of Calibration and QC Procedures for GC/MS Organics

Method	QC Check	Frequency	Acceptance Criteria[1]	Corrective Action[2]
EPA624 EPA625	Check of mass spectral ion intensities (i.e. Tune) 624-BFB; 625-DFTPP	Prior to initial calibration or Continuing calibration verification every 24 hours.	Refer to criteria listed in the method SOP for Tune requirements including DDT, Benzidine and Pentachlorophenol criteria for 625.	Retune instrument and verify instrument maintenance may be needed.
	625 Minimum of Three - point initial calibration for all target analytes. 624: Minimum of Four – point initial calibration for all target analytes.	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	%RSD < 35%	If the calibration is not considered linear by either %RSD or linear regression, then correct problem then repeat initial calibration
	Relative Retention time window	Each sample	Retention time (RT) of the analyte within 30 seconds of the RT (± 0.25 min. RTW is used) of the target.	Correct problem then reprocess or re-analyze all samples analyzed since the last retention time check
EPA624 EPA625	Continuing calibration verification (CCV)	Daily, before sample analysis	All calibration analytes within “Range of Q” of expected value. (Method Control Limits)	Correct problem then repeat initial calibration and re-analyze all samples since last successful CCV.
EPA624 EPA625	Method blank	624: One per tune 625:One per prep batch (not to exceed 20 samples per batch).	No analytes detected ≥ RL values between the RL and MDL will be evaluated & flagged with a ‘J’	Correct problem then re-prep[5] and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes in method specified spike list.	624: One per tune 625: One per prep batch (not to exceed 20 samples per batch)	Method Control Limits (Range of P)	Refer to the corrective action section of the Method SOP
	MS for all analytes in method specified spike list.	One per batch of 20 per matrix, if insufficient sample for MS, then a duplicate LCS will be analyzed.	Method Control Limits (Range of P)	None (the LCS is used to evaluate and determine if the batch is acceptable).
	Surrogate(s)	Every sample, spiked sample, standard, and method blank	Statistical Control Limits	Refer to the corrective action section of the Method SOP
EPA624 EPA625	Internal Standards	Every sample/standard	Retention time ±30 seconds from retention time of the mid-point std. in the CCV/ICAL (sample/standard). EICP area within -50% to +100% of ICAL mid-point std for the CCV and –50% to +100% of the prior CCV for the samples.	Refer to the corrective action section of the Method SOP
EPA624	pH check	All 624 samples	pH should be ≤ 2.	If the pH is > 2, then comment the data, in the PIPE database, and LIMS.
EPA624	Residual chlorine check (NC samples only)	All samples	Residual chlorine should be negative.	If the residual chlorine is positive, then comment the data, in the PIPE database, and LIMS.
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL

1 - This is summary of the acceptance criteria, refer to the method SOP for specific or more information.
2 - All abnormalities must be noted on the data, the benchsheet and in LIMS.

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Appendix 3: Summary of Calibration and QC Procedures for Method SW8310

Method	QC Check	Frequency	Acceptance Criteria[1]	Corrective Action[2]
SW8310 SW8310A (HPLC)	Minimum five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	CF RSD for each analyte ≤20% or mean RSD for all analytes ≤20% linear – $r^2 \geq 0.990$, $r \geq 0.995$.	Correct problem then repeat initial calibration
	Initial calibration verification (ICV) must be from a 2nd source.	Immediately following initial calibration	All analytes within 15% of expected value	Correct problem then repeat initial calibration
	Retention time verification	Update at start of run or daily	All standards within window	Correct problem then re-analyze all samples analyzed since the last retention time check
	Continuing calibration verification (CCV)	Before sample analysis, after every 10 samples, and at the end of the analysis sequence	All analytes within 15% of expected value	Repeat CCV, if criteria fails, correct problem then repeat initial CCV and re-analyze all samples since last successful CCV.
	Method blank	One per prep batch (not to exceed more than 20 samples per batch).	No analytes detected ≥ RL values between the RL and MDL will be evaluated and flagged with a 'J'	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One per prep batch (not to exceed more than 20 samples per batch).	Statistical Control Limits	Correct problem then re-prep and analyze the LCS and all samples in the affected analytical batch
	Surrogate	Every sample, spike, standard, and method blank	Statistical Control Limits	Check system, re-inject, re-extract
	MS/MSD	One per batch per matrix, if insufficient sample for MS/MSD, then a LCS/LCSD will be analyzed.	Statistical Control Limits	None (LCS is used to determine if the batch is acceptable).
	Confirmation	100% for all positive results (use response of both detectors)	Same as for initial or primary analysis. Comment LIMS if >40% difference in compound response between detectors.	Same as for initial or primary analysis.
	MDL verification	Minimum quarterly	Detectible	Re-evaluate MDL standard used and MDL

1 - This is a summary of the acceptance criteria, refer to the method SOP for specific information or more information.

2 - All abnormalities must be noted on the data, the benchsheet and in LIMS.

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Appendix 3: Summary of Calibration and QC Procedures for Method EPA610 (HPLC)

Method	QC Check	Frequency	Acceptance Criteria[1]	Corrective Action[2]
EPA610 (HPLC)	Minimum five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	RSD of CF of each analyte **<10%,** $r^2 \geq$ 0.990, r ≥ 0.995, or linear regression.	Correct problem then repeat initial calibration
	Initial calibration verification (ICV) must be from a 2nd source.	Immediately following initial calibration	All analytes within 15% of expected value	Correct problem then repeat initial calibration
	Retention time verification	Update at start of run or daily	All standards within window	Correct problem then reprocess or re-analyze all samples analyzed since the last retention time check
	Continuing calibration verification (CCV)	Before sample analysis and at the end of the analysis sequence	All analytes within 15% of expected value	Repeat CCV, if criteria fails, correct problem then repeat initial CCV and re-analyze all samples since last successful CCV.
	Method blank	One per prep batch **(not to exceed more than 10 samples per batch).**	No analytes detected ≥ RL values between the RL and MDL will be evaluated and flagged with a 'J'	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One per prep batch **(not to exceed more than 10 samples per batch).**	Statistical Control Limits	Correct problem then re-prep and analyze the LCS and all samples in the affected analytical batch
	Surrogate	Every sample, spiked sample, standard, and method blank	Statistical Control Limits	Check system, re-inject, re-extract
	MS	One per batch per matrix, if insufficient sample for MS, then an additional LCS will be analyzed.	Statistical Control Limits	All target compounds should be reported, and any compound that is outside criteria must be within criteria in the LCS.
	Confirmation	100% for all positive results (use response of both detectors)	Same as for initial or primary analysis. Comment LIMS if >40% difference in compound response between detectors.	Same as for initial or primary analysis
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL

1 - This is a summary of the acceptance criteria, refer to the method SOP for specific information or more information.
2 - All abnormalities must be noted on the data, the benchsheet and in LIMS.

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Appendix 3: Summary of Calibration and QC Procedures for Method SW8330

Method	QC Check	Frequency	Acceptance Criteria[1]	Corrective Action[2]
SW8330 SW8330A SW8332 (HPLC)	Five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	RSD of CF of each analyte ≤20% or mean RSD for all analytes ≤20% linear – $r^2 \geq 0.990$, $r \geq 0.995$	Correct problem then repeat initial calibration
	Initial calibration verification (ICV) must be from a 2nd source.	Immediately following initial calibration	All analytes within 15% of expected value	Correct problem then repeat initial calibration
	Retention time verification	Update at start of run or daily	All standards within RT window	Correct problem then reprocess or re-analyze all samples analyzed since the last retention time check
	Continuing calibration verification (CCV)	Before sample analysis, after every 10 samples, and at the end of the analysis sequence	All analytes within 15% of expected value	Repeat CCV, if criteria fails, correct problem then repeat initial CCV and re-analyze all samples since last successful CCV.
	Method blank	One per prep batch not to exceed more than 20 samples per batch.	No analytes detected ≥ RL values between the RL and MDL will be evaluated and flagged with a 'J'	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One per prep batch (not to exceed more than 20 samples per batch).	Statistical Control Limits	Correct problem then re-prep and analyze the LCS and all samples in the affected analytical batch
	Surrogate	Every sample, spike, standard, and blank	Statistical Control Limits	Check system, re-inject, re-extract
	MS/MSD	One per batch per matrix, if insufficient sample for MS/MSD, then a LCS/LCSD will be analyzed.	Statistical Control Limits	None (LCS is used to determine if the batch is acceptable).
	Confirmation	100% for all positive results; 2nd column (phenyl Hexyl column) confirmation	Same as for initial or primary analysis. Comment LIMS if >40% difference in compound response between detectors.	Same as for initial or primary analysis
	MDL verification	Minimum quarterly	Detectible	Re-evaluate MDL standard used and MDL

1 - This is a summary of the acceptance criteria, refer to the method SOP for specific or more information.
2 - All abnormalities must be noted on the data, the benchsheet and in LIMS.

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Appendix 3: Summary of Calibration and QC Procedures for GC Organics

Method	QC Check	Frequency	Acceptance Criteria[1]	Corrective Action[2]
SW8015B[3] SW8015C	Five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	RSD of CF ≤ 20% Linear – least squares regression $r^2 \geq 0.990$, $r \geq 0.995$	Correct problem then repeat initial calibration
	Initial calibration verification (ICV), must be from a 2nd source.	Immediately following five-point initial calibration	All analytes within 15% of expected value	Correct problem then repeat initial calibration
	LCS for all analytes	One per prep batch, not to exceed 20 samples in a batch.	Statistical Control Limits	Re-prep and analyze the LCS and all samples in the affected analytical batch
	Continuing calibration verification (CCV)	Before sample analysis, after every 10 samples, and at the end of the analysis sequence	All analytes within 15% of expected value and within the RTW.	Repeat CCV, if criteria fails, correct problem then repeat initial CCV (re-calibrate if necessary) and re-analyze all samples since last successful CCV.
	Method blank	One per analytical prep batch, not to exceed 20 samples in a batch.	No analytes detected ≥ RL values between the RL and MDL will be evaluated and flagged with a 'J'	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank
	Surrogate	Every sample, spiked sample, standard, and method blank	Statistical Control Limits	Check system, re-analyze, re-prep
	MS/MSD	One per batch per matrix, if insufficient sample for MS/MSD, then a LCS/LCSD will be analyzed.	Statistical Control Limits	None (LCS is used to determine if data is acceptable).
	GC/MS confirmation.	At the clients request or analyst judgment.		
	Retention time window calculated for each analyte (see section 9 for how to calculate RTWs).	System set-up, with each new column or major instrument maintenance. Update the mid-RTW as the start of the run or daily.	Each analyte of the LCS, MS/MSD and CCV must be within the calculated RTW.	Correct the problem and re-process or re-analyze samples. For questions, see the supervisor or technical director.
SW8015B SW8015C – GRO	pH Check	All water samples after analysis.	pH should be less than 2.	If pH is > 2, then place a comment on the benchsheet and in LIMS.
	MDL verification	Minimum quarterly	Detectible	Re-evaluate MDL standard used and MDL

1 - This is a summary of the acceptance criteria, refer to the method SOP for specific or more information.
2 - All abnormalities must be noted on the data, the benchsheet and in LIMS.
3 - For GRO and DRO, see state specific SOP/Method for acceptance criteria. If there is not a specific method for that state, then follow the acceptance criteria in this table.

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Appendix 3: Summary of Calibration and QC Procedures for Method SW6010B / SW6010C

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SW6010B SW6010C	Initial calibration (three standards for each element- and a blank)	Daily initial calibration prior to sample analysis.	>/= 0.995 (6010B) >/= 0.998 (6010C)	Re-calibrate
	Curve high-standards read-back	Daily after curve	+/- 5% of known concentration	Re-calibrate, re-run samples for affected elements
	Second-source calibration verification (ICV)	Daily after initial calibration	All analytes within 10% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Second-source calibration verification – Low Level (ICVL) 6010C only	Daily after mid-range ICV (Conc = RL Level)	All analytes within 30% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration blank (ICB)	After ICV	</= RL	Correct problem then re-analyze for affected elements; may report results >10X contamination level or non-detects if biased high
	CRI (2X RL)	At the beginning of an analytical run	50-150%	NA
	Interference check solution (ICSA)	At the beginning of an analytical run	+/- 20% of expected value of spiked elements. Non-spiked elements: < 2x RL (6010B); < RL (6010C)	Correct problem; re-analyze ICSA; re-analyze all affected samples; may report non-detects if biased high.
	Interference check solution (ICSB)	At the beginning of an analytical run	+/- 20% of expected value of spiked elements. Non-spiked elements: < 2x RL (6010B); < RL (6010C)	Correct problem; re-analyze ICSB; re-analyze all affected samples; may report non-detects if biased high.
	Method Blank	One per prep batch of </= 20 samples	+/- RL	Correct problem, re-prep and re-analyze the method blank and all samples for affected elements; may report results >10X contamination level or non-detects if biased high
	LCS	One per prep batch of </= 20 samples	+/- 20% of known concentration	Correct problem, then re-prep and analyze the LCS and all samples for affected elements; may report non-detects if biased high.
	Method duplicate	One per prep batch per matrix upon request	</= 20 RPD	Repeat
	MS/MSD	One per prep batch per matrix	+/- 25% of known concentration	None
	Dilution test	Each new sample matrix	1:5 dilution must agree within 10% of the original determination	Perform post digestion spike addition upon request
	Post digestion spike addition	When dilution test fails for some programs	Recovery within 25% of expected results	None
	Continuing Calibration Verification (CCV)	After every 10 readings and at the end of the analytical sequence	All analytes within 10% of expected value	Correct problem and re-analyze affected elements of bracketed samples; may report non-detects if biased high.

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Method 6010 cont.	QC Check	Frequency	Acceptance Criteria	Corrective Action
	Second-source calibration verification – Low Level (CCVL) 6010C only	After mid-range CCV (Conc = RL Level)	All analytes within 30% of expected value	Correct problem and re-analyze affected elements of bracketed samples; may report non-detects if biased high.
	Continuing Calibration blank (CCB)	After each CCV	+/- RL	Correct problem and re-analyze affected elements of bracketed samples; may report results >10X contamination level or non-detects if biased high
	MDL verification	Minimum – Quarterly	Detectible	Re-evaluate MDL standard used and MDL; see Technical Director.

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Appendix 3: Summary of Calibration and QC Procedures for Method SW6020 / SW6020A

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SW6020 SW6020A	Initial calibration (three standards for each element- and a blank)	Daily initial calibration prior to sample analysis.	>/= 0.995	Re-calibrate
	Curve high-standards read-back	Daily after curve	+/- 5% of known concentration	Re-calibrate, re-run samples for affected elements
	Second-source calibration verification (ICV)	Daily after initial calibration	All analytes within 10% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Second-source calibration verification – Low Level (ICVL) 6020A only	Daily after mid-range ICV (Conc = RL Level)	All analytes within 30% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration blank (ICB)	After ICV	</= RL	Correct problem then re-analyze for affected elements; may report results >10X contamination level or non-detects if biased high
	CRI (2X RL)	At the beginning of an analytical run and every 12 hours	50-150%	NA
	Interference check solution (ICSA)	At the beginning of an analytical run and every 12 hours	+/- 20% of expected value of spiked elements. Non-spiked elements: < 2X RL (6020); < RL (6020A)	Correct problem; re-analyze ICSA; re-analyze all affected samples; may report non-detects if biased high.
	Interference check solution (ICSB)	At the beginning of an analytical run and every 12 hours	+/- 20% of expected value of spiked elements. Non-spiked elements: < 2X RL (6020); < RL (6020A)	Correct problem; re-analyze ICSB; re-analyze all affected samples; may report non-detects if biased high.
	Method Blank	One per prep batch of </= 20 samples	+/- RL	Correct problem, re-prep and re-analyze the method blank and all samples for affected elements; may report results >10X contamination level or non-detects if biased high
	LCS	One per prep batch of </= 20 samples	+/- 20% of known concentration	Correct problem, then re-prep and analyze the LCS and all samples for affected elements; may report non-detects if biased high.
	Method duplicate	One per prep batch per matrix upon request	</= 20 RPD	Repeat
	MS/MSD	One per prep batch per matrix	+/- 25% of known concentration	None
	Dilution test	Each new sample matrix	1:5 dilution must agree within 10% of the original determination	Perform post digestion spike addition upon request
	Post digestion spike addition	When dilution test fails for some programs	Recovery within 25% of expected results	None
	Continuing Calibration Verification (CCV)	After every 10 readings and at the end of the analytical sequence	All analytes within 10% of expected value	Correct problem and re-analyze affected elements of bracketed samples; may report non-detects if biased high.

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	QC Check	Frequency	Acceptance Criteria	Corrective Action
Method 6020 cont.	Second-source calibration verification – Low Level (CCVL) 6020A only	After mid-range CCV (Conc = RL Level)	All analytes within 30% of expected value	Correct problem and re-analyze affected elements of bracketed samples; may report non-detects if biased high.
	Continuing Calibration blank (CCB)	After each CCV	+/- RL	Correct problem and re-analyze affected elements of bracketed samples; may report results >10X contamination level or non-detects if biased high
	MDL verification	Minimum quarterly	Detectible	Re-evaluate MDL standard used and MDL

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Appendix 3: Summary of Calibration and QC Procedures for GFAA Metals

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SW7000 series	Initial calibration (5 to 6 standards and a blank)	Daily initial calibration prior to sample analysis.	r ≥0.995	Correct problem then repeat initial calibration
	Second-source calibration verification (ICV)	Daily after initial calibration	All analytes within 10% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration blank (ICB)	After ICV	+/- RL	Correct problem then re-analyze for affected elements; may report results >10X contamination level or non-detects if biased high.
	CRA	At the beginning of an analytical run	NA	NA
	Method Blank	One per prep batch of </= 20 samples	+/- RL	Correct problem, re-prep and re-analyze the method blank and all samples for affected elements; may report results >10X contamination level or non-detects if biased high.
	LCS	One per prep batch of </= 20 samples	+/- 20% of known concentration	Correct problem, then re-prep and analyze the LCS and all samples for affected elements; may report non-detects if biased high.
	Method duplicate	One per prep batch per matrix upon request	</= 20 RPD	Repeat
	MS/MSD	One per prep batch per matrix	+/- 25% of known concentration	None
	Post Digestion Spike	Every sample, including MB and LCS	+/- 15% of known concentration	
	MSA	When applicable to low MS/MSD or PDS recovery	r >/= 0.995	Repeat once
	Continuing Calibration Verification standard (CCV)	After every 10 readings and at the end of the analytical sequence.	+/- 10% of known concentration	Correct problem and re-analyze affected elements of bracketed samples; may report non-detects if biased high.
	Continuing Calibration Blank (CCB)	After every CCV	+/- RL	Correct problem and re-analyze affected elements of bracketed samples; may report results >10X contamination level or non-detects if biased high.
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL; see Technical Director.

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Appendix 3: Summary of Calibration and QC Procedures for Method SW7196A

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SW7196A	Initial calibration (6 or 7 standards and a blank)	Initial calibration prior to sample analysis.	r ≥ 0.995	Correct problem then repeat initial calibration
	Second-source calibration verification (ICV)	Immediately following initial calibration	All analytes within 10% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration Blank (ICB)	After ICV	+/- RL	Correct problem then proceed; may report results >10X contamination level or non-detects if biased high
	Method blank	One per prep batch	No analytes detected ≥ ½ RL or MDL, whichever is greater[1]	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank. may report results >10X contamination level or non-detects if biased high
	LCS - soluble	One per batch	+/- 20% of known concentration	Re-prep, re-analyze all affected samples. ; may report non-detects if biased high.
	LCS – insoluble (soil sets only)	One per batch	+/- 20% of known concentration	Re-prep, re-analyze all affected samples. ; may report non-detects if biased high.
	Matrix duplicate	One per batch upon request	</= 20 RPD	Repeat once
	MS/MSD - soluble	One pair per batch	+/- 25% of known concentration	Persistent interference indicates the need to evaluate matrix further for reducing agents.
	MS/MSD – insoluble (soil sets only)	One pair per batch	+/- 25% of known concentration	Persistent interference indicates the need to evaluate matrix further for reducing agents.
	Post Digestion Spike (soil sets only)	One per batch	+/- 15% of known concentration	If check indicates interference, dilute and re-analyze sample. Persistent interference indicates the need to evaluate matrix further for reducing agents.
	Continuing calibration verification (CCV)	Beginning and after every 10 samples and at the end of the analysis sequence	All analytes within 10% of expected value	Correct problem and re-analyze all samples since last successful calibration; may report non-detects if biased high.
	Continuing Calibration Blank (CCB)	After every CCV	+/- RL	Correct problem and re-analyze all samples since last successful calibration. May report results >10X contamination level or non-detects if biased high

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Appendix 3: Summary of Calibration and QC Procedures for Method SW7470A/ SW7471A/ SW7471B

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SW7470A SW7471A SW7471B	Calibration curve – minimum 5 standards and blank	Quarterly, monthly, or daily – see individual SOP	r ≥ 0.995	Recalibrate
	Initial Calibration Verification – mid-level, second-source required (ICV)	Immediately following initial calibration and daily at the beginning of each analytical sequence.	±10% of known concentration	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration Blank (ICB)	After ICV	</= RL	Correct problem then proceed; may report results >10X contamination level or non-detects if biased high
	Method blank	One per batch of 20 or fewer samples	</= RL	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank. may report results >10X contamination level or non-detects if biased high
	CRA (at RL level)	One per batch of 20 or fewer samples	No established limits	None
	LCS	One per batch of 20 or fewer samples	+/- 20% of known concentration	Correct problem, re-prep and repeat LCS, MB and all samples in the batch; may report non-detects if the LCS is biased high.
	Matrix duplicate	One per matrix per batch of 20 or fewer samples as requested	</= 20 RPD	Repeat once
	MS/MSD	One pair per matrix per batch of 20 or fewer samples	+/- 25% of known concentration	None
	Continuing calibration verification (CCV)	Beginning, every 10 samples, and at end of sequence	±10% of known concentration	Correct problem then repeat CCV, CCB and all samples since last successful CCB; may report non-detects if biased high.
	Continuing Calibration Blank (CCB)	After every CCV	</= RL	Correct problem then repeat CCV,CCB and all samples since last successful CCB; may report results >10X contamination level or non-detects if biased high
	MDL verification	Minimum quarterly	Detectible	Re-evaluate MDL standard used and MDL; see Technical Director.

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Appendix 3: Summary of Calibration and QC Procedures for Cyanide

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SW9010B SW9010C SW9014 EPA 335.2 SM4500CNC	Initial calibration (six standards and a calibration blank)	Initial daily calibration prior to sample analysis.	r ≥ 0.995	Correct problem then repeat initial calibration
	Distilled standards (one high and one low)	Once per calibration	+/- 10% of known concentration (high) +/- 25% of known concentration (low)	Correct problem then repeat distilled standards and related samples
	Second-source calibration verification (ICV)	Immediately following initial daily calibration	+/- 10% of known concentration	Correct problem. Repeat, then repeat initial calibration if necessary
	Initial Calibration Blank (ICB)	Following ICV	</= RL	Correct problem. Repeat, then repeat initial calibration, ICV and ICB if necessary; may report non-detects if CCV is biased high
	Method blank	One per prep batch of 20 or fewer samples	</= RL	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank; may report non-detects and results >10X the contamination level.
	LCS	One per prep batch of 20 or fewer samples	+/- 20% of known concentration	Re-prep, re-analyze affected samples; may report non-detects if biased high
	Matrix duplicate	One per matrix per prep batch of 20 or fewer samples upon request	</= 20 RPD	None
	MS/MSD	One per matrix per prep batch	+/- 25% of known concentration	None unless both spike recoveries very low, then PDS
	Post Digestion Spike (PDS)	When both MS and MSD recoveries are very low	+/- 15% of known concentration	None
	Continuing calibration verification (CCV)	After every 10 readings and at the end of the analysis sequence	+/- 10% of known concentration	Correct problem then re-read the CCV, CCB and all samples since last successful CCV/CCB; may report non-detects if CCV is biased high
	Continuing Calibration Blank (CCB)	After every CCV	</= RL	Correct problem then re-read the CCV, CCB and all samples since last successful CCV/CCB; may report non-detects and results >10X the contamination level.

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Appendix 3: Summary of Calibration and QC Procedures for Mercury

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA245.1 EPA245.5	Calibration curve – minimum 5 standards and blank	Quarterly, monthly, or daily – see individual SOP	r ≥ 0.995	Recalibrate
	Initial Calibration Verification – mid-level, second-source required (ICV)	Immediately following initial calibration and daily at the beginning of each analytical sequence.	±5% of known concentration	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration Blank (ICB)	After ICV	</= RL	Correct problem then proceed; may report results >10X contamination level or non-detects if biased high
	CRA	One per calibration	No established limits	None
	Method blank	One per batch of 20 or fewer samples	</= RL	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank. may report results >10X contamination level or non-detects if biased high
	LCS	One per batch of 20 or fewer samples	+/- 15% of known concentration	Correct problem, re-prep and repeat LCS, MB and all samples in the batch; may report non-detects if the LCS is biased high.
	Matrix duplicate	One per matrix per batch of 20 or fewer samples as requested	</= 20 RPD	Repeat once
	MS/MSD	One pair per matrix per batch of 20 or fewer samples	+/- 30% of known concentration	None
	Continuing calibration verification (CCV)	Beginning, every 10 samples, and at end of sequence	±10% of known concentration	Correct problem then repeat CCV, CCB and all samples since last successful CCB; may report non-detects if biased high.
	Continuing Calibration Blank (CCB)	After every CCV	</= RL	Correct problem then repeat CCV,CCB and all samples since last successful CCB; may report results >10X contamination level or non-detects if biased high
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL

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Appendix 3: Summary of Calibration and QC Procedures for ICP Method 200.7

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA200.7	Initial calibration (three standards for each element- and a blank)	Daily initial calibration prior to sample analysis.	>/= 0.995	Re-calibrate
	Curve high-standards read-back	Daily after curve	+/- 5% of known concentration	Re-calibrate, re-run samples for affected elements
	Second-source calibration verification (ICV)	Daily after initial calibration	All analytes within 5% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration blank (ICB)	After ICV	</= RL	Correct problem then re-analyze for affected elements; may report results >10X contamination level or non-detects if biased high
	CRI (2X RL)	At the beginning of an analytical run	50-150%	NA
	Interference check solution (ICSA)	At the beginning of an analytical run	+/- 20% of expected value of spiked elements or < 2X RL	Correct problem; re-analyze ICSA; re-analyze all affected samples; may report non-detects if biased high.
	Interference check solution (ICSB)	At the beginning of an analytical run	+/- 20% of expected value of spiked elements or < 2X RL	Correct problem; re-analyze ICSB; re-analyze all affected samples; may report non-detects if biased high.
	Method Blank	One per prep batch of </= 20 samples	+/- RL	Correct problem, re-prep and re-analyze the method blank and all samples for affected elements; may report results >10X contamination level or non-detects if biased high
	LCS	One per prep batch of </= 20 samples	+/- 15% of known concentration	Correct problem, then re-prep and analyze the LCS and all samples for affected elements; may report non-detects if biased high.
	Method duplicate	One per 10 or fewer samples per matrix	</= 20 RPD	Repeat
	MS	One per10 or fewer samples per matrix	+/- 30% of known concentration	None
	Dilution test	Each new sample matrix	1:5 dilution must agree within 10% of the original determination	Perform post digestion spike addition
	Continuing Calibration Verification (CCV)	After every 10 readings and at the end of the analytical sequence	All analytes within 10% of expected value	Correct problem and re-analyze affected elements of bracketed samples; may report non-detects if biased high.
	Continuing Calibration blank (CCB)	After each CCV	+/- RL	Correct problem and re-analyze affected elements of bracketed samples; may report results >10X contamination level or non-detects if biased high
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL; see Technical Director.

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Appendix 3: Summary of Calibration and QC Procedures for ICP/MS Method 200.8

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA200.8	Initial calibration (three standards for each element- and a blank)	Daily initial calibration prior to sample analysis.	>/= 0.995	Re-calibrate
	Curve high-standards read-back	Daily after curve	+/- 5% of known concentration	Re-calibrate, re-run samples for affected elements
	Second-source calibration verification (ICV)	Daily after initial calibration	All analytes within 10% of expected value	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration blank (ICB)	After ICV	</= RL	Correct problem then re-analyze for affected elements; may report results >10X contamination level or non-detects if biased high
	CRI (2X RL)	At the beginning of an analytical run and every 12 hours	50-150%	NA
	Interference check solution (ICSA)	At the beginning of an analytical run and every 12 hours	+/- 20% of expected value of spiked elements or < 2X RL	Correct problem; re-analyze ICSA; re-analyze all affected samples; may report non-detects if biased high.
	Interference check solution (ICSB)	At the beginning of an analytical run and every 12 hours	+/- 20% of expected value of spiked elements or < 2X RL	Correct problem; re-analyze ICSB; re-analyze all affected samples; may report non-detects if biased high.
	Method Blank	One per prep batch of </= 20 samples	+/- RL	Correct problem, re-prep and re-analyze the method blank and all samples for affected elements; may report results >10X contamination level or non-detects if biased high
	LCS	One per prep batch of </= 20 samples	+/- 15% of known concentration	Correct problem, then re-prep and analyze the LCS and all samples for affected elements; may report non-detects if biased high.
	Method duplicate	One per 10 or fewer samples per matrix	</= 20 RPD	Repeat
	MS	One per10 or fewer samples per matrix	+/- 30% of known concentration	None
	Dilution test	Each new sample matrix	1:5 dilution must agree within 10% of the original determination	Perform post digestion spike addition
	Continuing Calibration Verification (CCV)	After every 10 readings and at the end of the analytical sequence	All analytes within 10% of expected value	Correct problem and re-analyze affected elements of bracketed samples; may report non-detects if biased high.
	Continuing Calibration blank (CCB)	After each CCV	+/- RL	Correct problem and re-analyze affected elements of bracketed samples; may report results >10X contamination level or non-detects if biased high
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL.

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Appendix 3: Summary of Calibration and QC Procedures for Gravimetric Analyses

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA160.1 SM2540 C (TDS) EPA160.2 SM2540D (TSS) EPA160.3 SM2540B (TS) EPA160.4 (TVS) ASTM D482-87 (Ash) ASTM D2974 (FOM) SM2540 G (Moisture) ASTM D5050 (Density)	LCS	Applicable to some gravimetric testing - one per batch of 20 or fewer samples	+/- 20% of known concentration	Repeat LCS, MB and all samples in batch; May report non-detects if LCS is biased high.
	Method blank	One per batch of 20 or fewer samples	</= RL	Repeat MB, LCS and all samples in batch; May report non-detects and samples > 10X the contamination level.
	Duplicate	10% of samples	</=20 RPD	None
	MS/MSD	Applicable to some gravimetric testing - one pair per set of 20 or fewer samples	+/- 25% of known concentration	None
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL.

Appendix 3: Summary of Calibration and QC Procedures for Titrimetric Analyses

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA310.1 SM2320B Alkalinity forms EPA376.1 SM4500 SF Sulfide Hach 8000 COD EPA330.4 SM4500ClF Cl_2 Res.	LCS	One per batch of 20 or fewer samples	± 20% of known concentration	Correct problem and repeat LCS, MB and all samples in the batch; May report non-detects if the LCS is biased high.
	Method blank	One per batch of 20 or fewer samples	No analyte detected > report limit	Correct problem and repeat MB, LCS and all samples in the batch; May report non-detects and samples >10X the contamination level
	Duplicate	One per batch of 20 or fewer samples	±20%	None
	MS/MSD	Available for some titrimetric tests at one pair per batch of 20 or fewer samples.	+/- 25% of known concentration	None
	Standardization	Per specific SOP	NA	NA

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Appendix 3: Summary of Calibration and QC Procedures for Spectrophotometric Analyses

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA350.2 SM4500NH3C: NH_3. EPA325.2 SM4500ClE: 9251: Cl^-. SM3500CrB Cr+6. EPA375.4: SW9038: SO_4^{-2}. EPA415.1 SM5310C 9060: TOC. EPA 354.1 $SM4500NO_2B$ Nitrite EPA 353.2 $SM4500NO_3F$ Nitrate 9066 EPA420.4 Phenols EPA365.2 SM4500P Phosphorus 353.2 $SM4500NH_3C$ TKN	Calibration curve – minimum 5 standards and blank	Quarterly, monthly, or daily – see individual SOP	r ≥ 0.995	Recalibrate
	Initial Calibration Verification – mid-level, second-source required (ICV)	Immediately following initial calibration and daily at the beginning of each analytical sequence.	±10% of known concentration	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration Blank (ICB)	After ICV	</= RL	Correct problem then proceed; may report results >10X contamination level or non-detects if biased high
	Method blank	One per batch of 20 or fewer samples	</= RL	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank. may report results >10X contamination level or non-detects if biased high
	LCS	One per batch of 20 or fewer samples	+/- 20% of known concentration	Correct problem, re-prep and repeat LCS, MB and all samples in the batch; may report non-detects if the LCS is biased high.
	Matrix duplicate	One per matrix per batch of 20 or fewer samples as requested	</= 20 RPD	Repeat once
	MS/MSD	One pair per matrix per batch of 20 or fewer samples	+/- 25% of known concentration	None
	Continuing calibration verification (CCV)	Beginning, every 10 samples, and at end of sequence	±10% of known concentration	Correct problem then repeat CCV, CCB and all samples since last successful CCB; may report non-detects if biased high.
	Continuing Calibration Blank (CCB)	After every CCV	</= RL	Correct problem then repeat CCV,CCB and all samples since last successful CCB; may report results >10X contamination level or non-detects if biased high
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL.

1 - Report all targets identified in the method blank above the MDL.

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Appendix 3: Summary of Calibration and QC Procedures for Electrometric Analyses

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA405.1: BOD[1], CBOD[1]. EPA120.1: SW9050: Cond.[1] EPA360.1: DO[1]. EPA340.2: F^-. SW9214: F^-. EPA150.1: SW9040, 9045:pH[1]. SM5320B: SW9020: TOX.	Calibration Curve – minimum of 5 standards and blank	Initial Calibration before each batch (where applicable)	r ≥ 0.995.	Recalibrate
	Initial Calibration Verification (second source) (ICV)	Immediately after initial calibration and daily at beginning of analytical sequence	±10% of known concentration	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration Blank	With ICV	</= RL	Correct problem then proceed; may report results >10X contamination level or non-detects if biased high
	Method blank	One per batch of 20 or fewer samples	</= RL	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank; may report results >10X contamination level or non-detects if biased high.
	LCS	One per batch of 20 or fewer samples	±20% of known concentration	Correct problem, re-prep and repeat LCS, MB and all samples in the batch; may report non-detects if the LCS is biased high.
	MS/MSD	Each batch	± 20%	None
	Duplicate	When spike not available	±20%	None
	Continuing Calibration verification (CCV)	Beginning, every 10 samples, and end of batch (every eight burns for TOX)	±10% of known concentration	Correct problem then repeat CCV, CCB and all samples since last successful CCB; may report non-detects if biased high.
	Continuing Calibration blank	With each CCV	</= RL (used to correct CCV and following samples in TOX analysis)	Correct problem then repeat CCV,CCB and all samples since last successful CCB; may report results >10X contamination level or non-detects if biased high
	Calibration checks	Alternate pH buffers every 10 readings. Read-back DO calibration bottle. Conductivity standards must bracket samples in each range.	pH buffers +/- 0.2 SU DO bottle +/- 0.5 mg/L Cond. stds. After samples, <10% drift	Re-calibrate and re-read samples since last in-control check.
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL

[1]Calibration curve and related QC items do not apply.

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Appendix 3: Summary of Calibration and QC Procedures for Ion Chromatographic Analyses

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
EPA300 & SW9056 SW9045A: Bromide Chloride Fluoride Nitrate Nitrite Sulfate.	Calibration Curves	Initial calibration. Perform instrument re-calibration once per month minimum.	R ≥ 0.995.	Recalibrate
	Initial Calibration verification (ICV), second source	Immediately following initial calibration and daily before the analytical sequence	±10% of known concentration	Correct problem then repeat initial calibration; may report non-detects if biased high.
	Initial Calibration Blank	After ICV	</= RL	Correct problem then proceed; may report results >10X contamination level or non-detects if biased high
	Method blank	One per batch of 20 or fewer samples	</= RL	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank; may report results >10X contamination level or non-detects if biased high.
	LCS	One per batch of 20 or fewer samples	±10% of known concentration for 300.0, 20% for 9056	Correct problem, re-prep and repeat LCS, MB and all samples in the batch; may report non-detects if the LCS is biased high.
	MS/MSD	One pair per batch of 20 or fewer samples	±25% of known concentration for 9056, 20% for 300.0	None, control batch on LCS
	Duplicate	One per batch of 20 or fewer samples upon request	</= 20 RPD	None
	Continuing calibration verification (CCV)	After every 10 readings and at the end of the analytical sequence	± 10% of known concentration	Correct problem then repeat CCV, CCB and all samples since last successful CCB; may report non-detects if biased high.
	Continuing Calibration blank (CCB)	After every CCV	</= RL	Correct problem then repeat CCV,CCB and all samples since last successful CCB; may report results >10X contamination level or non-detects if biased high
	Retention time window	Based on RTs of ICV anions	+/- 5% drift	Evaluate data
	MDL verification	Minimum yearly	Detectible	Re-evaluate MDL standard used and MDL.

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Appendix 3: Summary of Calibration and QC Procedures for Oil & Grease Analyses

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
9071B 1664A HEM SGT-HEM	Method blank	One per batch of 20 or fewer samples	</= RL	Correct problem then re-prep and analyze method blank and all samples processed with the contaminated blank; may report results >10X contamination level or non-detects if biased high.
	LCS	One per batch of 20 or fewer samples	78-114% for HEM, 64-132% for SGT-HEM	Correct problem, re-prep and repeat LCS, MB and all samples in the batch; may report non-detects if the LCS is biased high.
	MS/MSD	One pair per batch of 20 or fewer samples as available	78-114% for HEM, 64-132% for SGT-HEM	None, use LCS

Appendix 3: Summary of Calibration and QC Procedures for Physical Analyses

Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SW1010 / SW1010A D-93: Flash Point. SW9095A: Paint Filter. EPA160.5, SM 2540 F: Settleable Solids.				
	LCS	One per batch of 20 or fewer samples – applicable for flash point only	Statistical limits	Re-analyze
	Duplicate	One for each batch of 20 or fewer samples	Report results	None

Appendix 4. Glossary/Acronyms

Glossary:

Acceptance Criteria:
Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation:

The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accrediting Authority:
The Territorial, State, or Federal Agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation (NELAC) [1.5.2.3]

Accuracy:
The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst:
The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Batch:
Environmental samples which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) and /or those samples not requiring preparation, which are analyzed together as a group using the same calibration curve or factor. An analytical batch can include samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank:
A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Blind Sample:
A sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

Calibration:
To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Curve:
The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Method:
A defined technical procedure for performing a calibration. (NELAC)

Calibration Standard:
A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM):
A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30–2.2)

Chain of Custody:
An unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples. (NELAC) [5.12.4]

Clean Air Act:
The enabling legislation in 42 U>S>C> 7401 et seq., Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended, empowering EPA to promulgate air quality standards, monitor and enforce them. (NELAC)

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/SUPERFUND):
The enabling legislation in 42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601 et seq., to eliminate the health and environmental threats posed by hazardous waste sites. (NELAC)

Compromised Samples:
Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified. (NELAC)

Confidential Business Information (CBI):
Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. NELAC and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation:
Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

Second column confirmation
Alternate wavelength
Derivatization
Mass spectral interpretation
Alternative detectors or
Additional Cleanup procedures

(NELAC)

Conformance:
An affirmative indication or judgement that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction:
Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action:
The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit:
A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria). (NELAC)

Data Reduction:
The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency:
An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability (DOC):
Procedure to establish the ability to generate acceptable accuracy and precision.

Detection Limit Check Standard (DLCK):
A non-processed standard spiked at the method reporting limit or lowest calibration standard. Used in conjunction with the MRL Check standard in LCG analysis.

Detection Limit:
The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)

Document Control:
The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses:
The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Environmental Detection Limit (EDL):
The smallest level at which a radionuclide in an environmental medium can be unambiguously distinguished for a given confidence interval using a particular combination of sampling and measurement procedures, sample size, analytical detection limit, and processing procedure. The EDL shall be specified for the 0.95 or greater confidence interval. The EDL shall be established initially and verified annually for each test method and sample matrix. (NELAC Radioanalysis Subcommittee)

Equipment Blank:
Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)

External Standard Calibration:
Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Extraction Blank (LB, LB2, LB3):
A blank that has been taken through the extraction procedure such as TCLP/SPLP, 5035 AVS/SEM.

Federal Water Pollution Control Act (Clean Water Act, CWA):
The enabling legislation under 33 U.S.C. 1251 et seq., Public Law 92-50086 Stat 816, that empowers EPA to set discharge limitations, write discharge permits, monitor, and bring enforcement action for non-compliance. (NELAC)

Field Blank:
Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field Duplicate:
Duplicate field-collected sample.

Field of Testing:
NELAC's approach to accrediting laboratories by program, method and analyte. Laboratories requesting accreditation for a program-method-analyte combination or for an up-dated/improved method are required to submit to only that portion of the accreditation process not previously addressed (see NELAC, section 1.9ff). (NELAC)

Good Laboratory Practices (GLP):
Formal regulations for performing basic laboratory operations outlined in 40 CFR Part 160 and 40 CFR Part 729 and required for activities performed under FIFRA and TSCA.

Holding Times (Maximum Allowable Holding Times):
The maximum times that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Instrument Blank:
A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL):
The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is $\pm$ 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Internal Chain of Custody:
An unbroken trail of accountability that ensures the physical security of samples, data and records. Internal COC refers to additional documentation procedures implemented within the laboratory that includes special sample storage requirements, and documentation of all signatures and/or initials, dates, and times of personnel handling specific samples or sample aliquots.

Internal Standard:
A known amount of standard added to a test portion of a sample and carried through the entire measurement process as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (NELAC)

Internal Standard Calibration:
Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample):
A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), there is no LCS. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Note: NELAC standards allow a matrix spike to be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. (NELAC)

Laboratory Duplicate:
Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

Least Squares Regression (1st Order Curve):
The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit of Detection (LOD):
An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte- and matrix-specific and may be laboratory dependent. (Analytical Chemistry, 55, p.2217, December 1983, modified) See also Method Detection Limit.

Limit or Quantitation (LOQ):
Limit of Quantitation (LOQ) is the lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard. The laboratory's routine reporting limit is equal to the LOQ, unless project documents specifies a higher concentration to be used as the project-specific reporting limit.

Matrix:
The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-aqueous Liquid: any organic liquid with <15% settleable solids.

Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: includes soils, sediments, sludges, and other matrices with ≥15% settleable solids.

Chemical Waste: a product or by-product of an industrial process that results in a matrix not previously defined.

Air: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (NELAC)

Matrix Spike (spiked sample or fortified sample):

Prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix spikes shall be performed at a frequency of one in 20 samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as, total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the spike. (QAMS)

Matrix Spike Duplicate (spiked sample or fortified sample duplicate):
A second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Matrix spike duplicates or laboratory duplicates shall be analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or preparation method. The laboratory shall document their procedure to select the use of an appropriate type of duplicate. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in the duplicates may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the duplicate. (QAMS)

Method Blank:
A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. (NELAC)

Method Detection Limit:
The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B) The DoD QSM version 4.1 further defines the DL as representing a concentration that is 99% confident that it is distinguishable from a blank.

Method Detection Limit Check Standard (MDLCK):
A standard that is processed with the MDL Study that is spiked at ½ the spike level used for the MDL/DL study or ½ the method reporting limit or ½ the lowest calibration standard (RL/LOQ). This check standard is also required by the DOD QSM and is referred to as the MDLV which is to be analyzed on a quarterly basis for methods listed on the DoD ELAP Accreditation.

Method Reporting Limit Check Standard (MRL):
A standard that is not processed with the samples. It is analyzed in the analytical sequence at a spike concentration approximately 2x the low standard or reporting limit. This standard check is used in conjunction with the USACE LCG analysis and for DoD QSM sample analysis.

Negative Control:
Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)

Non-conformance:
An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Non-conformance Memo (NCM):
The term for the mechanism used in the TALs LIMs to document a non-conformance to a job, project, program or method analysis in the system.

Performance Audit:
The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Performance Based Measurement System (PBMS):
A set of processes wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

Positive Control:
Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Precision:
The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC)

Preservation:
Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample. (NELAC)

Proficiency Testing:
A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (NELAC) [2.1]

Proficiency Testing Program:
The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (NELAC)

Proficiency Test Sample (PT):
A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (QAMS)

Proprietary:
Belonging to a private person or company.

Quality Assurance:
An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)

Quality Assurance [Project] Plan (QAPP):
A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control:
The overall system of technical activities which purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS)

Quality Control Sample:
An uncontaminated sample matrix spiked with known amounts of analytes from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (EPA-QAD)

Quality Manual:
A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (NELAC)

Quality System:
A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC (ANSI/ASQC-E-41994)

Quantitation Limits:
The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with specified degree of confidence. (NELAC)

Range:
The difference between the minimum and the maximum of a set of values. (EPA-QAD)

Raw Data:
Any original information from a measurement activity or study recorded in laboratory notebooks, worksheets, records, memoranda, notes, or exact copies thereof and that are necessary for reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic/optical media, including dictated observations, and recorded data from automated instruments. Reports specifying inclusion of "raw data" do not need all of the above included, but sufficient information to re-create the reported data.

Reagent Blank (method reagent blank):
A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Record Retention:
The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material:
A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30-2.1)

Reference Standard:
A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.0-8)

Replicate Analyses:
The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Reporting Limit (RL):
The level to which data is reported for a specific test method and/or sample. The reporting limit is either the laboratory nominal Limit of Quantitation (LOQ) or the level of sensitivity required by the client based on a sensitivity requirement that meets project objectives. The reporting limit (RL) cannot be lower than the quantitation limit (QL).

Resource Conservation and Recovery Act (RCRA):
The enabling legislation under 42 USC 321 et seq. (1976), that gives EPA the authority to control hazardous waste from the "cradle-to-grave", including its generation, transportation, treatment, storage, and disposal. (NELAC)

Safe Drinking Water Act (SDWA):
The enabling legislation, 42 USC 300f et seq. (1974), (Public Law 93-523), that requires the EPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations. (NELAC)

Sample Duplicate:
Two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method including sampling and analysis. (EPA-QAD)

Sampling and Analysis Plan (SAP):
A formal document describing the detailed sampling and analysis procedures for a specific project.

Second Order Polynomial Curve (Quadratic):
The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity:
(Analytical chemistry) the capability of a test method or instrument to respond to a target substance of constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity:
The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Spike:
A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, a representative number (at a minimum 10%) of the listed components may be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.. (NELAC)

Standard:
The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies. (ASQC)

Standard Operating Procedures (SOPs):
A written document which details the method of an operation, analysis, or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (QAMS)

Standardized Reference Material (SRM):
A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD)

Storage Blank:
A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate:
A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit):
A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Toxic Substances Control Act (TSCA):
The enabling legislation in 15 USC 2601 et seq., (1976) that provides for testing, regulating, and screening all chemicals produced or imported into the United States for possible toxic effects prior to commercial manufacture. (NELAC)

Traceability:
The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)

Trip Blank:
A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty:
A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
CRS – Change Request Form
DL – Detection Limit
DLCK – Detection Limit Check Standard
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DU – Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LOD – Limit of Detection
LOQ – Limit of Quantitation
LIMS – Laboratory Information Management System
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NCM – Non-Conformance Memo
NELAC - National Environmental Laboratory Accreditation Conference
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Serial Dilution
SOP- Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 5.

Laboratory Certifications, Accreditations, Validations

TestAmerica Chicago maintains certifications, accreditations, certifications, and validations with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Organization	**Lab ID Number**
DoD-ELAP	ADE-1429
ISO/IEC 17025:2005	AT-1428
California	01132CA
Georgia	939
Hawaii	None
Illinois (NELAC)	100201
Indiana	C-IL-02
Iowa	82
Kansas	E-10161
Kentucky	90023 + UST 0066
Louisianna	02046
Massachusetts	M-IL035
Mississippi	None
North Carolina	291
Oklahoma	8908
South Carolina	77001
Texas	T104704252-09-TX
USDA	P330-09-00027
Wisconsin	999580010
Wyoming	IL01 (8TMS-Q)

The certificates and parameter lists (which may differ) for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, marketing, and project management.

Appendix 6. Example: Data Qualifiers

Flag	Flag Description
4	MS, MSD: The analyte present in the original sample is 4 times greater than the matrix spike concentration; therefore, control limits are not applicable.
*	ISTD response or retention time outside acceptable limits
*	LCS or LCSD exceeds the control limits
^	ICV,CCV,ICB,CCB, ISA, ISB, CRI, CRA or MRL standard: Instrument related QC exceeds the control limits.
^1	Analyte detected in calibration blank
^2	Calibration check high
^3	Calibration check low
+	MSA correlation coefficient is less than 0.995.
<	Not detected at or above the reporting limit
>	The analyte exceeded the indicated concentration
A	The tentatively identified compound is a suspected aldol-condensation product.
B	Compound was found in the blank and sample.
b	Result Detected in the USB
C	Pesticide identification was confirmed by GC/MS.
D	Surrogate or matrix spike recoveries were not obtained because the extract was diluted for analysis; also compounds analyzed at a dilution may be flagged with a D.
E	Result exceeded calibration range, secondary dilution required.
F	Duplicate RPD exceeds the control limit
F	MS or MSD exceeds the control limits
g	Result fails applicable drinking water standards
h	Alternate peak selection upon analytical review.
H	Sample was prepped or analyzed beyond the specified holding time
HF	Field parameter with a holding time of 15 minutes
I	Indicates the presence of an interference, recovery is not calculated.
J	Indicates an Estimated Value for TICs
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
L	A negative instrument reading lower than the absolute value of the reporting limit
N	MS, MSD spike recovery exceed upper or lower control limits
ND	Compound not detected.
P	The lower of the two values is reported when the % difference between the results of two GC columns is greater than 40%
p	The higher of the two values is reported when the % difference between the results of two GC columns is greater than 40%
Q	Result was qualitatively confirmed, but not quantitated.
R	The instrument was not calibrated for this compound. A non-detect indicates that the characteristic ions were not present and the compound was not qualitatively identified. No controls were present to determine either sample preparation efficiency or the instrument sensitivity for the compound. As a result, the limit of detection is not known and the reported concentrations are estimates.
S	Result was determined by the Method of Standard Additions
s	SCB Recovery High
s	SCB Recovery Low
T	Result is a tentatively identified compound (TIC) and an estimated value.
U	Indicates the analyte was analyzed for but not detected.
V	Serial Dilution exceeds the control limits
W	PS: Post-digestion spike was outside control limits
X	See case narrative notes for explanation of the 'X' flag
X	Surrogate exceeds the control limits
Y	The chromatographic response resembles a typical fuel pattern.
Z	The chromatographic response does not resemble a typical fuel pattern.

Appendix 7 Method Capability Listing *(ISO17025 4.2.5)*

Unit	Parameter	Method No.	NELAP	Matrix
GCE	Pesticides/PCBs	EPA 608	X	W
GCE	Organochlorine Pesticides	SW 8081A / 8081B	X	W/S
GCE	PCBs	SW 8082 / 8082A	X	W/S
GCE	Chlorinated Herbicides by GC	SW 8151A	X	W/S
GCV	Petroleum Hydrocarbons (DRO)	SW 8015B / 8015C	X	W/S
GCV	Petroleum Hydrocarbons (GRO)	SW 8015B / 8015C	X	W/S
HPLC	PAHs by HPLC	E 610	X	W
HPLC	PAHs by HPLC	SW 8310	X	W/S
HPLC	Explosives	SW 8330 / 8330A	X	W/S
M	GFAA Antimony	SW 7041	X	W
M	GFAA Thallium	SW 7841	X	W/S
M	Hardness (Ca, Mg)	E 200.7	X	W
M	Hardness (Ca, Mg)	SM 2340B	X	W
M	ICP Metals	E 200.7	X	W
M	ICP Metals- Soil Fractionation Analysis	M1213		S
M	ICP Metals- SEM Simultaneously Extracted Metals	SEM		S
M	ICP-MS Metals	E 200.8	X	W
M	CVAA Mercury	SW 7470A	X	W
M	CVAA Mercury	SW 7471A / 7471B	X	S
M	CVAA Mercury	E 245.1	X	W
M	ICP Metals	SW 6010B / 6010C	X	W/S
M	ICP-MS Metals	SW 6020/6020A	X	W/S
M	Metals-ICP	ILM04.0		W/S
M	Metals-Mercury	ILM04.0		W/S
MSB	GC/MS Semi-Volatiles	E 625	X	W
MSB	GC/MS Semi-Volatiles	SW 8270C / 8270D	X	W/S
MSB	GC/MS Semi-Volatiles	SW 8270C (SIM)		W
MSV	VOAs by GC/MS	E 624	X	W
MSV	GC/MS Volatiles	SW 8260B	X	W/S
P	GC/MS Soil VOAs in EnCore Samples	SW 5035 / 5035A		S
P	TCLP	SW 1311	X	S
P	SPLP	SW 1312	X	S
P	Extractable Organics; Accel. Liq.-Liq. Waters	SW 3520C (Limited Application)		W
P	Extractable Organics; Separatory Funnel	SW 3510C		W
P	Extractable Organics; Accel. Soxhlet	SW 3541A		S

Unit	Parameter	Method No.	NELAP	Matrix
P	Extractable Organics; Sonication	SW 3550B / 3550C		S
P	Acid Cleanup	SW 3665A		W/S
P	Alumina Cleanup	SW 3610B		W/S
P	Florisil Clean-up	SW 3620B		W/S
P	Gel Permeation Column Clean-up	SW 3640B		S
P	Sulfur Clean-up	SW 3660B		W/S
P	Waste Dilution	SW 3580A		S
P	Metals Digestions; Surface/Ground Water for ICP/ICPMS	SW 3005A		W
P	Metals Digestions; Waters/Extracts for ICP	SW 3010A		W
P	Metals Digestion; Waters/Extracts for GFAA	SW 3020A		W
P	Metals Digestions; Soils/Wastes for ICP/ICPMS	SW 3050B		S
W	Alkalinity	SM 2320B	X	W/S
W	Ammonia - Nessl.	SM 4500NH3B&C,18thEd	X	W/S
W	BOD - 5 Day	SM 5210B	X	W
W	Bromide, IC	EPA 300.0	X	W
W	Bromide, IC	SW-846 9056 /9056A	X	W/S
W	Carbonaceous BOD	SM 5210B	X	W
W	Chloride (AQ2 Seal)	SM 4500Cl E	X	W/S
W	Chloride (AQ2 Seal)	SW-846 9251	X	W/S
W	Chloride, IC	EPA 300.0	X	W
W	Chloride, IC	SW-846 9056 /9056A	X	W/S
W	Chlorine, Residual	SM 4500 Cl F	X	W
W	COD - High Level	SM 5220C	X	W/S
W	COD - Low Level	SM 5220C	X	W/S
W	Chromium, Hexavalent	SM 3500-CrB	X	W/S
W	Chromium, Hexavalent	SW-846 3060A/7196A	X	W/S
W	Cyanide, Amenable	SM 4500CN G & E	X	W/S
W	Cyanide	SW-846 9010B/9014	X	W/S
W	Cyanide	SM 4500CN C, E	X	W/S
W	Cyanide	ILM04.0		W/S
W	Ferrous Iron	SM 3500 Fe B		W/S
W	Flashpoint (Ignitability)	SW-846 1010 /1010A	X	W/S
W	Fluoride / Fluorine	SM 4500F C	X	W/S
W	Fluoride, IC	EPA 300.0	X	W
W	Fluoride, IC	SW-846 9056 /9056A	X	W/S
W	Langlier Index (Corrosivity)	SM 2330A+B	X	W/S

Unit	Parameter	Method No.	NELAP	Matrix
W	Nitrate-NO2 (AQ2 Seal)	EPA 353.2	X	W/S
W	Nitrate-NO2 (AQ2 Seal)	SM 4500NO3F	X	W/S
W	Nitrate, IC	EPA 300.0	X	W
W	Nitrate, IC	SW-846 9056 /9056A	X	W/S
W	Nitrite	SM 4500NO2B	X	W/S
W	Nitrite, IC	EPA 300.0	X	W
W	Nitrite, IC	SW-846 9056 /9056A	X	W/S
W	Oil & Grease	E 1664	X	W
W	Oil & Grease (Soil-Soxhlet)	SW-846 9071B	X	W/S
W	Oxygen, Dissolved	SM 4500 O G	X	W
W	pH - Low/High	SM 4500H+B	X	W
W	pH - Low/High	SW-846 9045C / 9045D SW-846 9040B /9040C	X	W/S
W	Paint Filter	SW-846 9095A / 9095B	X	W
W	Phenol (AQ2 Seal)	EPA 420.4	X	W/S
W	Phenol (AQ2 Seal)	SW-846 9066	X	W/S
W	Phosphate, Ortho	SM 4500 PE	X	W/S
W	Phosphate, Ortho , IC	EPA 300.0	X	W
W	Phosphate, Ortho , IC	SW-846 9056 /9056A	X	W/S
W	Phosphorus	SM 4500 P E	X	W/S
W	Specific Conductance	EPA 120.1	X	W
W	Specific Conductance	SM 2510B	X	W
W	Specific Conductance	SW-846 9050A	X	W/S
W	Specific Gravity	ASTM D2710F		W/S
W	Sulfate - Turbidimetric	SW-846 9038M SM4500SO4E	X	W/S
W	Sulfate, IC	EPA 300.0	X	W
W	Sulfate, IC	SW-846 9056 /9056A	X	W/S
W	Sulfide	SM 4500SF	X	W/S
W	Sulfide	SW-846 9030B/9034	X	W/S
W	AVS- Acid Volatile Sulfide	AVS		S
W	Solids, Settleable	SM2540F		W
W	Sulfide, Reactive	SW 7.3.4.2	X	W/S
W	TKN - Nesslerization	SM 4500NorgC, 18th Ed. (SM4500NH3C, 18th Ed.)	X	W/S
W	TOC (TIC/DIC) [Organic Carbon; Inorganic & Dissolved]	SM 5310C	X	W
W	TOC (TIC/DIC) [Organic Carbon; Inorganic & Dissolved]	SW-846 9060 /9060A	X	W
W	TOC (TIC/DIC) [Organic Carbon; Inorganic & Dissolved]	Lloyd Kahn		S
W	TOX (Total Organic Halogens)	SM 5320B		W

Unit	Parameter	Method No.	NELAP	Matrix
W	TOX (Total Organic Halogens)	SW-846 9020B	X	W
W	TS - Water (Total Solids-Residue)	SM 2540B	X	W
W	TSS (Total Suspended Solids)	SM 2540D	X	W
W	TDS (Total Dissolved Solids)	SM 2540C	X	W
W	TVS (Total Volatile Solids)	160.4 / SM2540E	X	W
W	TVDS (Total Volatile Dissolved Solids)	160.4 / SM2450E	X	W
W	TVSS (Total Volatile Suspended Solids)	160.4 / SM2540E	X	W

Matrix: W (Water) S (Soil/Solid) O (Other)
Note: NELAP accreditation may be matrix and program specific. Refer to TestAmerica Chicago's IL NELAP Accreditation Number: 100201

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-1 Summary of QC Check Definitions, Purpose, and Evaluation – Inorganics (Metals)

QC Check	Definition	Purpose	Evaluation
Calibration Blank	Reagent water containing no analytes of interest.	To determine the zero point of the calibration curve for all initial and continuing calibrations.	This is a required QC procedure. Continuing calibration blank responses above the LOD require corrective action
Continuing calibration verification (CCV)	This verification of the ICAL that is required during the course of analysis at periodic intervals. Continuing calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models	To verify that instrument response is reliable, and has not changed significantly from the current ICAL curve.	If the values for the analytes are outside the acceptance criteria, the ICAL may not be stable. Results associated with out-of-control CCV results require reanalysis or flagging
Demonstrate Acceptable Analytical Capability	QC samples are analyzed in series to verify ability to produce data of acceptable precision and bias.	To verify the ability to produce data of acceptable precision and bias for a specific instrument type, matrix, method, and analyst.	The average recovery of the spikes and standard deviation of the replicates must be within designated acceptance criteria. Analysis of field samples may not be conducted until this check is successful.
Dilution test (Metals only)	Analysis of a positive sample, which has been diluted to a concentration 1/5th of the original, to confirm that there is no interference in the original sample analysis. (Modified COE)	To assess matrix interference	Agreement within 10% between the concentration for the undiluted sample and 5x the concentration for the diluted sample indicates the absence of interferences, and such samples may be analyzed without using the MSA. Results outside acceptance limits indicate a possible matrix effect. For ICP a post-digestion spike must be run.
Duplicate Sample (replicate)	Two identical portions of material collected for chemical analysis, and identified by unique alphanumeric codes. The duplicate may be portioned from the same sample, or may be two identical samples taken from the same site. The two portions are prepared and analyzed identically. (modified QSM)	To provide information on the heterogeneity of the sample matrix or to determine the precision of the intralaboratory analytical process for a specific sample matrix	A duplicate sample will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the relative percent difference between the sample and the sample duplicate. If the sample matrix is homogeneous (such as with drinking water) and the relative percent difference is high, this could indicate a problem in the analytical system.
Initial calibration for all analytes (ICAL)	Analysis of analytical standards at different concentrations that are used to determine and calibrate the quantitation range of the response of the analytical detector or method	To establish a calibration curve for the quantification of the analytes of interest	Statistical procedures are used to determine the relationship between the signal response and the known concentration of analytes of interest. The ICAL must be successful before any samples or other QC check samples can be analyzed.
Instrument Detection Limit (IDL) Study (6010 and 6020 only)	The process to determine the minimum concentration of a substance (analyte) that an instrument can differentiate from noise. The procedure for calculating varies by method.	To provide evaluation of instrument sensitivity	IDLs must be established before samples can be analyzed.

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F-1 (cont.)			
QC Check	**Definition**	**Purpose**	**Evaluation**
Interference check solutions (ICP and ICP/MS only)	A pair of solutions containing interfering elements that are used to verify the correction factors of analytes of concern.	To verify the established correction factors by analyzing the interference check solution at the beginning of the analytical sequence	No samples can be run if this check does not pass acceptance criteria.
Internal Standards	A substance that is introduced in known amount into each calibration standard and field and QC sample of the analyte.	The ratio of the analyte signal to the internal standard signal is then used to determine the analyte concentration.	Any sample associated with out-of-control results must be reanalyzed.
Laboratory control sample (LCS) containing all analytes to be reported	A sample matrix, free from the analytes of interest, spiked with known amounts of analytes or a material containing known and verified amounts of analytes.	Used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Assesses the ability of the laboratory/analyst to successfully recover the target analytes from a control (clean) matrix. Control limits for LCS recovery, typically expressed as percent recovery, are used for the development of statistical control limits and serve as acceptance criteria for determining whether an analytical run is in control (batch acceptance).	This is a required QC Check. The inability to achieve acceptable recoveries in the LCS indicate problems with the precision and bias of the measurement system. Failure to achieve acceptable recoveries in a “clean” matrix is an indicator of possible problems achieving acceptable recoveries in field samples.
Linear dynamic range or high-level check standards (ICP and ICP.MS only)	High-level check standard periodically analyzed to verify the linearity of the calibration curve at the upper end.	To verify quantitative accuracy of data up to the high=level standard.	The QC check establishes the upper linear range of the calibration.
Low-Level calibration check standard (ICP only)	A reference standard that contains a quantity of analyte equal to or less than the reporting limit.	To confirm the accuracy of measurements at or near the RL.	This QC check must be within acceptance criteria before any samples are analyzed.
Matrix Spike (MS)	A sample prepared by adding a know mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.	To assess the performance of the method as applied to a particular matrix. Matrix spikes are used, for example, to determine the effect of the matrix on a method’s recovery efficiency. The recovery of target analytes from the matrix spike sample is used to determine the bias of the method in the specific sample matrix.	The lack of acceptable recoveries in the matrix spike often points to problems with the sample matrix. One test of this is a comparison to the LCS recoveries. If the corresponding LCS recoveries are within acceptable limits, a matrix effect is likely. The lab should not correct for recovery; only report the results of the analyses and the associated MS results and indicate that the results from these analyses have increased uncertainty
Matrix Spike Duplicate (MSD)	A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of recovery for each analyte	To assess the performance of the method as applied to a particular matrix and provide information on the homogeneity of the matrix. Also used to determine the precision of the intralaboratory analytical process for a specific sample matrix.	When compared to the MS, the MSD will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the RPD between the matrix spike and the matrix spike duplicate. If the sample matrix is homogeneous, such as with drinking water, and the RPD is high, this could indicate a problem in the analytical system.

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F-1 (cont.)			
QC Check	**Definition**	**Purpose**	**Evaluation**
MB	A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with an under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.	To assess background interferences or contamination in the analytical system that might lead to high bias or false positive data. Results of method blanks provide an estimate of the within-batch variability of the blank response and an indication of bias introduced by the preparation and analytical procedure.	This is one of the QC samples used to measure lab accuracy/bias. The sample could indicate whether contamination is occurring during sample prep and analysis. If analytes are detected > ½ RL, reanalyze or qualify (B-flag) all results for the specific analytes(s) in all samples in the associated prep batch as appropriate. For common lab contaminants, no analytes detected > RL. See Section D.1.1.1 and Box D-1
MSA (ICP only)	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration. (This process is also called spiking the sample.)	To compensate for a sample constituent that enhances or depresses the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences that cause a baseline shift.	This is the method used when matrix interferences are present and do not allow determination of accurate sample results
Post digestion spike addition (ICP and ICP/MS only)	An analyte spike added to a portion of prepared sample to verify absence or presence of matrix effects	To confirm the presence of a matrix interference. Assess matrix effects based on: 1. the occurrence of new and unusual matrices included within the batch, or 2. contingency analysis based on SD or MS failures	To verify the absence of an interference, the spike recovery must be between 75%-125% Results outside the acceptance limits require MSA for all samples within the batch
Second source calibration verification (ICV)	A standard obtained or prepared from a source independent of the source of standards for the ICAL. Its concentration should be at or near the middle of the calibration range. It is done after the ICAL.	To verify the accuracy of the ICAL.	The concentration of the 2nd source calibration verification, determined from the analysis, is compared with the known value of the standard to determine the accuracy of the ICAL. This independent verification of the ICAL must be acceptable before sample analysis can begin.

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-7: Inorganic Analysis by ICP and CVAA - Methods 6010 and 7000 Series

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise method- specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD Determination and verification (See Box D-13)					
LOQ Establishment and verification (See Box D-14)					
Instrument detection limit (IDL) study (ICP only)	At initial set-up and after significant change in instrument type, personnel, test method, or sample matrix.	IDLs shall be $\leq$ LOD	NA	NA	Samples may not be analyzed without a valid IDL
Linear dynamic range (LRS) or high-level check standard (ICP only)	Every 6 months	Within $\pm$ 10% of expected value	NA	NA	
Initial Calibration (ICAL) for all analytes ICP: min 1 high std and a Calib.Blank CVAA: min 5 stds and a Calib. Blank	Daily ICAL prior to sample analysis	If more than one calibration standard is used $r \geq 0.995$.	Correct problem then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
2nd Source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Value of 2nd source for all analyte(s) within $\pm$ 10% of true value.	Correct problem and verify 2nd source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.

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F-7 (cont.)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Continuing Calibration verification (CCV)	After every 10 field samples and at the end of analysis sequence.	ICP: within ± 10% of true value. CVAA: within ± 20% of true value.	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last successful CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level calibration check standard (ICP only)	Daily, after one-point ICAL.	Within ± 20% of true value	Correct problem, then reanalyze.	Flagging criteria are not appropriate.	No samples may be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the reporting limit.
Method Blank (MB)	One per prep batch	No analytes detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank results must not otherwise affect sample results. For common lab contaminants, no analytes detected >RL (see Box D-1)	Correct problem, then see criteria in box D-1; If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Calibration Blank (ICB / CCB)	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence	No analytes detected > LOD.	Correct problem. Reprep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Apply B-flag to all results for the specific analyte(s) in all samples associated with the blank.	
Interference check solutions (ICS) (ICP only)	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are verified trace impurity from one of the spiked analytes) ICS-AB: ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	

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F-7 (cont.)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
LCS containing all analytes to be reported	One per prep batch	QC acceptance criteria specified by DoD, if available; see Box D-3 and Appendix G.	Correct problem., then reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per prep batch per matrix (see Box D-7)	For matrix evaluation, use QC acceptance criteria specified by DoD for LCS	Examine the project-specific DQOs. If the matrix spike fails outside of DoD criteria, additional quality control tests are required to evaluate matrix effects.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Sample Duplicate	One per prep batch per matrix (see Box D-7)	MSD: For matrix evaluation use QC acceptance criteria specified by DoD for LCS. MSD or sample duplicate: RPD $\leq$ 20% (between MS and MSD or sample and sample duplicate)	Examine the project-specific DQOs. Contact client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Dilution Test (ICP only)	One per prep batch .	Five-fold dilution must agree within $\pm$ 10% of the original measurement.	ICP: Perform post-digestion spike (PDS) addition.	Flagging criteria are not appropriate.	Only applicable for samples with concentrations > 50x LOQ.
Post-digestion spike (PDS) addition (ICP only)	When dilution test fails or analyte concentration in all samples < 50 x LOD	Recovery within 75-125% (see Table B-1)	Run all associated samples in the prep batch by MSA or see flagging criteria.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Spike addition should produce a concentration of 10 – 100 x LOQ.
Method of Standard Addition (MSA)	When matrix interference is confirmed.	NA	NA	NA	Document use of MSA in the case narrative.
Results reported between DL and LOQ	NA	NA	NA	Apply J-flag to all results between LOD and LOQ	

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-1 Summary of QC Check Definitions, Purpose, and Evaluation – Inorganics (WC)

QC Check	Definition	Purpose	Evaluation
Calibration Blank	Reagent water containing no analytes of interest.	To determine the zero point of the calibration curve for all initial and continuing calibrations.	This is a required QC procedure. Continuing calibration blank responses above the LOD require corrective action
Continuing calibration verification (CCV)	This verification of the ICAL that is required during the course of analysis at periodic intervals. Continuing calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models	To verify that instrument response is reliable, and has not changed significantly from the current ICAL curve.	If the values for the analytes are outside the acceptance criteria, the ICAL may not be stable. Results associated with out-of-control CCV results require reanalysis or flagging
Demonstrate Acceptable Analytical Capability	QC samples are analyzed in series to verify ability to produce data of acceptable precision and bias.	To verify the ability to produce data of acceptable precision and bias for a specific instrument type, matrix, method, and analyst.	The average recovery of the spikes and standard deviation of the replicates must be within designated acceptance criteria. Analysis of field samples may not be conducted until this check is successful.
Duplicate Sample (replicate)	Two identical portions of material collected for chemical analysis, and identified by unique alphanumeric codes. The duplicate may be portioned from the same sample, or may be two identical samples taken from the same site. The two portions are prepared and analyzed identically. (modified QSM)	To provide information on the heterogeneity of the sample matrix or to determine the precision of the intralaboratory analytical process for a specific sample matrix	A duplicate sample will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the relative percent difference between the sample and the sample duplicate. If the sample matrix is homogeneous (such as with drinking water) and the relative pecent difference is high, this could indicate a problem in the analytical system.
Initial calibration for all analytes (ICAL)	Analysis of analytical standards at different concentrations that are used to determine and calibrate the quantitation range of the response of the analytical detector or method	To establish a calibration curve for the quantification of the analytes of interest	Statistical procedures are used to determine the relationship between the signal response and the known concentration of analytes of interest. The ICAL must be successful before any samples or other QC check samples can be analyzed.
Laboratory control sample (LCS) containing all analytes to be reported	A sample matrix, free from the analytes of interest, spiked with known amounts of analytes or a material containing known and verified amounts of analytes.	Used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Assesses the ability of the laboratory/analyst to successfully recover the target analytes from a control (clean) matrix. Control limits for LCS recovery, typically expressed as percent recovery, are used for the development of statistical control limits and serve as acceptance criteria for determining whether an analytical run is in control (batch acceptance).	This is a required QC Check. The inability to achieve acceptable recoveries in the LCS indicate problems with the precision and bias of the measurement system. Failure to achieve acceptable recoveries in a “clean” matrix is an indicator of possible problems achieving acceptable recoveries in field samples.

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F-1 (cont.)			
QC Check	**Definition**	**Purpose**	**Evaluation**
MS	A sample prepared by adding a know mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.	To assess the performance of the method as applied to a particular matrix. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. The recovery of target analytes from the matrix spike sample is used to determine the bias of the method in the specific sample matrix.	The lack of acceptable recoveries in the MS often points to problems with the sample matrix. One test of this is a comparison to the LCS recoveries. If the corresponding LCS recoveries are within acceptable limits, a matrix effect is likely. The lab should not correct for recovery; only report the results of the analyses and the associated MS results and indicate that the results from these analyses have increased uncertainty
MSD	A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of recovery for each analyte	To assess the performance of the method as applied to a particular matrix and provide information on the homogeneity of the matrix. Also used to determine the precision of the intralaboratory analytical process for a specific sample matrix.	When compared to the MS, the MSD will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the RPD between the matrix spike and the matrix spike duplicate. If the sample matrix is homogeneous, such as with drinking water, and the RPD is high, this could indicate a problem in the analytical system.
Matrix Verification sample (CR+6 only)	A pH-adjusted filtrate that has been spiked with CR+6 to ensure that the sample matrix does not have a reducing condition or other interferents that could affect color development. (Modified Method)	To ensure that the sample matrix does not have a reducing condition or other interferents that affect color development.	To verify the absence of an interference, the spike recovery must be between 85% and 115%. If the result of verification indicates a suppressive interference, the sample should be diluted and reanalyzed. If the interference persists after sample dilution, an alternative method (Method 7195, Coprecipitation, or Method 7197, Chelation/Extraction) should be used.
MB	A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with an under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.	To assess background interferences or contamination in the analytical system that might lead to high bias or false positive data. Results of method blanks provide an estimate of the within-batch variability of the blank response and an indication of bias introduced by the preparation and analytical procedure.	This is one of the QC samples used to measure lab accuracy/bias. The sample could indicate whether contamination is occurring during sample prep and analysis. If analytes are detected > ½ RL, reanalyze or qualify (B-flag) all results for the specific analytes(s) in all samples in the associated prep batch as appropriate. For common lab contaminants, no analytes detected > the RL. See Section D.1.1.1 and Box D-1
RT window position establishment for each analyte (and surrogate) (all chromatographic methods only)	Determination of the placement of the RT window (i.e. start/stop time) of each analyte or group of analytes as it elutes through the chromatographic column so that analyte identification can be made during sample analysis. This is done during the ICAL.	To idendify analytes of interest	Incorrect window position may result in false negatives, require additional manual integrations, or cause unnecessary reanalysis of samples when surrogates or spiked compounds are erroneously not identified.

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F-1 (cont.)			
QC Check	**Definition**	**Purpose**	**Evaluation**
RT window width calculated for each analyte (and surrogate) (non-MS chromatographic methods only)	Determination of the length of time between sample injection and the appearance of a peak at the detector. The total length of time (window) is established for each analyte or group of analytes and is set for complete elution of analyte peaks. It is based upon a series of analyses and statistical calculations that establish the measured band on the chromatogram that can be associated with a specific analyte or group of analytes.	To ensure that the chromatographic system is operating reliably and that the system conditions have been optimized for the target anaytes and surrogates in the standards and sample matrix to be analyzed. It is done to minimize the occurrence of both false positive and false negative results.	Used to evaluate continued system performance. Tight RT windows may result in false negatives or may cuase unnecessary reanalysis of samples when surrogates or spiked compounds are erroneously not identified. Overly wide RT windows may result in false positive results that cannot be confirmed upon further analysis.
Second source calibration verification (ICV)	A standard obtained or prepared from a source independent of the source of standards for the ICAL. Its concentration should be at or near the middle of the calibration range. It is done after the ICAL.	To verify the accuracy of the ICAL.	The concentration of the 2nd source calibration verification, determined from the analysis, is compared with the known value of the standard to determine the accuracy of the ICAL. This independent verification of the ICAL must be acceptable before sample analysis can begin.

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-9: Inorganic Analysis by Colorimetric Hexavalent Chromium: Method 7196

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published in method; otherwise QC acceptance criteria established in-house by laboratory.	Recalculate results; locate and fix problem, then rerun demonstration for the analyte that did not meet criteria (see Section C.1.f).	NA	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD Determination and verification (See Box D-13)					
LOQ Establishment and verification (See Box D-14)					
Reference Blank (reagent water)	Before beginning standards or sample analysis.	NA	NA	NA	Use for blank subtraction of standards, field and QC samples. For Turbid field samples, a turbidity blank must be used instead of the reference blank (using a sample aliquot prepped in accordance with method 7196A (Section 7.1)).
Initial Calibration (ICAL) (minimum 3 standards and a Calib. Blank)	Daily ICAL prior to sample analysis	$r \geq 0.995$.	Correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
2^{nd} Source calibration verification (ICV)	Before beginning a sample run.	Value of 2^{nd} source within $\pm$ 10% of true value.	Correct problem and verify 2^{nd} source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing Calibration verification (CCV)	After every 15 field samples and at the end of analysis sequence.	Value of CCV within $\pm$ 10% of true value.	Correct problem then repeat CCV and reanalyze all samples since the last successful CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. No samples may be run until calibration has been verified. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

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F-9 (cont.)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Method Blank (MB)	One per prep batch	No analytes detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank results must not otherwise affect sample results (see Box D-1).	Correct problem, then see criteria in box D-1; If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported	One per prep batch	QC acceptance criteria specified by DoD; see Box D-3 and Appendix G.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated batch for the failed analyte in all samples in the associated prep batch, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Sample matrix Verification (also known as Matrix Spike - MS)	One for every sample matrix analyzed	Spike recovery within 85 – 115%	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use MSA.	Flagging criteria are not appropriate.	Verification check ensures lack of reducing condition or interference from matrix. Additional corrective actions are identified in mtheo 7196A (Sections 7.4 and 7.5)
Matrix Spike Duplicate (MSD) or Sample Duplicate	Aqueous matrix: One per every 10 project samples per matrix. Solid matrix: One per prep batch per matrix.	Aqueous matrix: RPD ≤ 20% (between MS and MSD or sample and sample duplicate). Solid matrix: RPD ≤ 30%..	Examine the project-specific DQOs. Contact client as to additional measures to be taken.	Flagging criteria are not appropriate.	Refer to sample matrix verification sample for MS data evaluation.
Pre-digestion MS (Solid matrix samples only, Method 3060)	One soluble and insoluble pre-digestion MS analyzed per prep batch prior to analysis	MS recoveries within 75-125%	Correct problem and rehomogenize, redigest, and reanalyze samples. If that fails, evaluate against LCS results	If corrective action fails, apply J-flag to the analyte in all samples in the associated prep batch.	

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F-9 (cont.)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Post-digestion matrix spike (PDS)	One per prep batch	Recovery within 85-115%	Correct problem and rehomogenize, redigest, and reanalyze samples. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use MSA.	NA	
Results reported between DL and LOQ	NA	NA	NA	Apply J-flag to all results between DL and LOQ.	

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-10: Inorganic Analysis by Cyanide: Method 9010 and 9014

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise method- specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD Determination and verification (See Box D-13)					
LOQ Establishment and verification (See Box D-14)					
Initial Calibration (ICAL) 6 stds and a Calib. Blank	Daily ICAL prior to sample analysis	r $\geq$ 0.995.	Correct problem then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed. All calibration standards must be distilled if samples are expected to contain sulfides.
Distilled Standards (one high and one low)	Once per multipoint calibration	Within $\pm$ 15% of true value	Correct problem, then repeat distilled standards	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until distilled standards have passed.
2nd Source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Within $\pm$ 15% of true value.	Correct problem, then repeat distilled standards.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Method Blank (MB)	One per prep batch	No analytes detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank results must not otherwise affect sample results. For common lab contaminants, no analytes detected >RL (see Box D-1)	Correct problem, then see criteria in box D-1; If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

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F-10 (Cont.)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
LCS containing all analytes to be reported	One per prep batch	QC acceptance criteria specified by DoD, if available; see Box D-3 and Appendix G.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per prep batch per matrix (see Box D-7)	For matrix evaluation, use QC acceptance criteria specified by DoD for LCS	Examine the project-specific DQOs. If the matrix spike fails outside of DoD criteria, MSA shall be used for the analysis..	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Sample Duplicate	One per prep batch per matrix (see Box D-7)	MSD: For matrix evaluation use QC acceptance criteria specified by DoD for LCS. MSD or sample duplicate: RPD $\leq$ 20% (between MS and MSD or sample and sample duplicate)	Correct problem and reanalyze sample and duplicate.	Apply J-flag if sample cannot be rerun or reanalysis does not correct problem..	The data shall be evaluated to determine the source of difference.
Results reported between DL and LOQ	NA	NA	NA	Apply J-flag to all results between DL and LOQ.	

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1 Appendix F - Quality Control Requirements Summary
Table F-11: Inorganic Analysis by Common Anions: Method 9056

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise method- specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD Determination and verification (See Box D-13)					
LOQ Establishment and verification (See Box D-14)					
RT window width calculated for each analyte	After method set-up and after major maintenance (e.g., column change).	RT width $\pm$ 3 times standard deviation for each analyte RT over a 24-hour period.	NA	NA	
Initial Calibration (ICAL) for all analytes min 3 standards and one calibration blank	ICAL prior to sample analysis	$r \geq 0.995$.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
2nd Source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	All analytes within $\pm$ 10% of true value and RTs within appropriate windows.	Correct problem and verify 2nd source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
RT window position establishment for each analyte	Once per ICAL	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA	NA	
Midrange continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All project analytes within established RT windows. Within $\pm$ 10% of true value.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable CCV.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed. RT windows are updated per the method.

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F-11 (cont.)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Method Blank (MB)	One per prep batch	No analytes detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank results must not otherwise affect sample results (see Box D-1).	Correct problem, then see criteria in box D-1; If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported	One per prep batch	Laboratory in-house limits not to exceed ± 20%. Control limits may be not greater than ± 3 times the standard deviation of the mean LCS recovery. See Box D-3.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per prep batch per matrix (see Box D-7)	For matrix evaluation, use laboratory in-house LCS limits (not to exceed ± 20%).	Examine the project-specific DQOs. Contact client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix Spike Duplicate (MSD)	One per prep batch per matrix (see Box D-7)	For matrix evaluation use laboratory in-house LCS limits (not to exceed ± 20%). RPD ≤ 15% (between MS and MSD).	Examine the project-specific DQOs. Contact client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Sample duplicate (replicate)	One per every 10 samples.	% D ≤ 10% (between sample and sample duplicate).	Correct problem and reanalyze sample and duplicate.	Apply J-flag if sample cannot be rerun or reanalysis does not correct problem.	The data shall be evaluated to determine the source of difference.
Results reported between DL and LOQ	NA	NA	NA	Apply J-flag to all results between DL and LOQ	

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-1 Summary of QC Check Definitions, Purpose, and Evaluation – Organics (GC/HPLC)

QC Check	Definition	Purpose	Evaluation
Breakdown Check 8081: Endrin, DDT 8270: DDT	Analysis of s standard solution containing Endrin and DDT. Area counts of these compounds and their breakdown products are evaluated to assess instrument conditions.	To verify the inertness of the injection port because DDT and Endrin are easily degraded in the injection port.	If degredation of `either DDT or Endrin exceeds method–specified criteria, corrective action must be taken before proceeding with calibration
Confirmation of positive results (organics only)	Use of alternative analytical techniques (another method, dissimilar column, or different detector such as MS detector) to validate the presence of target analytes identified	To verify the identification of an analyte	All positive results must be confirmed.
Continuing calibration verification (CCV)	This verification of the ICAL that is required during the course of analysis at periodic intervals. Continuing calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models	To verify that instrument response is reliable, and has not changed significantly from the current ICAL curve.	If the values for the analytes are outside the acceptance criteria, the ICAL may not be stable. Results associated with out-of-control CCV results require reanalysis or flagging
Demonstrate Acceptable Analytical Capability	QC samples are analyzed in series to verify ability to produce data of acceptable precision and bias.	To verify the ability to produce data of acceptable precision and bias for a specific instrument type, matrix, method, and analyst.	The average recovery of the spikes and standard deviation of the replicates must be within designated acceptance criteria. Analysis of field samples may not be conducted until this check is successful.
Duplicate Sample (replicate)	Two identical portions of material collected for chemical analysis, and identified by unique alphanumeric codes. The duplicate may be portioned from the same sample, or may be two identical samples taken from the same site. The two portions are prepared and analyzed identically. (modified QSM)	To provide information on the heterogeneity of the sample matrix or to determine the precision of the intralaboratory analytical process for a specific sample matrix	A duplicate sample will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the relative percent difference between the sample and the sample duplicate. If the sample matrix is homogeneous (such as with drinking water) and the relative pecent difference is high, this could indicate a problem in the analytical system.
Initial calibration for all analytes (ICAL)	Analysis of analytical standards at different concentrations that are used to determine and calibrate the quantitation range of the response of the analytical detector or method	To establish a calibration curve for the quantification of the analytes of interest	Statistical procedures are used to determine the relationship between the signal response and the known concentration of analytes of interest. The ICAL must be successful before any samples or other QC check samples can be analyzed.
Internal Standards	A substance that is introduced in known amount into each calibration standard and field and QC sample of the analyte.	The ratio of the analyte signal to the internal standard signal is then used to determine the analyte concentration.	Any sample associated with out-of-control results must be reanalyzed.

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Table F-1 Cont.			
QC Check	**Definition**	**Purpose**	**Evaluation**
Laboratory control sample (LCS) containing all analytes to be reported	A sample matrix, free from the analytes of interest, spiked with known amounts of analytes or a material containing known and verified amounts of analytes.	Used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Assesses the ability of the laboratory/analyst to successfully recover the target analytes from a control (clean) matrix. Control limits for LCS recovery, typically expressed as percent recovery, are used for the development of statistical control limits and serve as acceptance criteria for determining whether an analytical run is in control (batch acceptance).	This is a required QC Check. The inability to achieve acceptable recoveries in the LCS indicate problems with the precision and bias of the measurement system. Failure to achieve acceptable recoveries in a “clean” matrix is an indicator of possible problems achieving acceptable recoveries in field samples.
MS	A sample prepared by adding a know mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.	To assess the performance of the method as applied to a particular matrix. Matrix spikes are used, for example, to determine the effect of the matrix on a method’s recovery efficiency. The recovery of target analytes from the matrix spike sample is used to determine the bias of the method in the specific sample matrix.	The lack of acceptable recoveries in the MS often points to problems with the sample matrix. One test of this is a comparison to the LCS recoveries. If the corresponding LCS recoveries are within acceptable limits, a matrix effect is likely. The lab should not correct for recovery; only report the results of the analyses and the associated MS results and indicate that the results from these analyses have increased uncertainty
MSD	A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of recovery for each analyte	To assess the performance of the method as applied to a particular matrix and provide information on the homogeneity of the matrix. Also used to determine the precision of the intralaboratory analytical process for a specific sample matrix.	When compared to the MS, the MSD will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the RPD between the matrix spike and the matrix spike duplicate. If the sample matrix is homogeneous, such as with drinking water, and the RPD is high, this could indicate a problem in the analytical system.
MB	A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with an under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.	To assess background interferences or contamination in the analytical system that might lead to high bias or false positive data. Results of method blanks provide an estimate of the within-batch variability of the blank response and an indication of bias introduced by the preparation and analytical procedure.	This is one of the QC samples used to measure lab accuracy/bias. The sample could indicate whether contamination is occurring during sample prep and analysis. If analytes are detected > ½ RL, reanalyze or qualify (B-flag) all results for the specified analytes(s) in all samples in the associated prep batch as appropriate. For common lab contaminants, no analytes detected > RL. See Section D.1.1.1 and Box D-1
RT window position establishment for each analyte (and surrogate) (all chromatographic methods only)	Determination of the placement of the RT window (i.e. start/stop time) of each analyte or group of analytes as it elutes through the chromatographic column so that analyte identification can be made during sample analysis. This is done during the ICAL.	To idendify analytes of interest	Incorrect window position may result in false negatives, require additional manual integrations, or cause unnecessary reanalysis of samples when surrogates or spiked compounds are erroneously not identified.

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Table F-1 Cont.			
QC Check	**Definition**	**Purpose**	**Evaluation**
RT window width calculated for each analyte (and surrogate) (non-MS chromatographic methods only)	Determination of the length of time between sample injection and the appearance of a peak at the detector. The total length of time (window) is established for each analyte or group of analytes and is set for complete elution of analyte peaks. It is based upon a series of analyses and statistical calculations that establish the measured band on the chromatogram that can be associated with a specific analyte or group of analytes.	To ensure that the chromatographic system is operating reliably and that the system conditions have been optimized for the target anaytes and surrogates in the standards and sample matrix to be analyzed. It is done to minimize the occurrence of both false positive and false negative results.	Used to evaluate continued system performance. Tight RT windows may result in false negatives or may cuase unnecessary reanalysis of samples when surrogates or spiked compounds are erroneously not identified. Overly wide RT windows may result in false positive results that cannot be confirmed upon further analysis.
Second source calibration verification (ICV)	A standard obtained or prepared from a source independent of the source of standards for the ICAL. Its concentration should be at or near the middle of the calibration range. It is done after the ICAL.	To verify the accuracy of the ICAL.	The concentration of the 2nd source calibration verification, determined from the analysis, is compared with the known value of the standard to determine the accuracy of the ICAL. This independent verification of the ICAL must be acceptable before sample analysis can begin.
Surrogate spike (organic analysis only)	A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.	To assess the ability of the method to successfully recover specific non-target analytes from an actual matrix. Because surrogates are generally added to each sample in a batch, they can be used to monitor recovery on a sample-specific, rather than batch-specific basis.	Whereas the MS is normally done on a batch-specific basis, the surrogate spike is done on a sample-specific basis. Taken with the information derived from other spikes (LCS; MS), the bias in the analytical system can be determined.

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-2: Organic Analysis by GC/HPLC - Methods 8015; 8081; 8082; 8151; 8310; 8330

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD Determination and verification (See Box D-13)					
LOQ Establishment and verification (See Box D-14)					
RT window width calculated for each analyte and surrogate	At method set-up and after major maintenance (e.g. column change).	RT width is $\pm$ 3 times standard deviation for each analyte RT from a 72-hour study.	NA	NA	
Breakdown check (Endrin/DDT Method 8081 only)	At the beginning of each 12-hour period, prior to analysis of samples	Degradation $\leq$ 15% for both DDT and Endrin	Correct problem then repeat breakdown check.	Flagging criteria are not appropriate.	No samples shall be run until degradation $\leq$ 15% .for both DDT and Endrin.
Minimum five-point initial calibration (ICAL) for all analytes	ICAL prior to sample analysis.	One of the options below. **Option 1:** RSD for each analyte $\leq$ 20% **Option 2:** linear least squares regression: r $\geq$ 0.995 **Option 3:** non-linear regression: coefficient of determination (COD) r^2 $\geq$ 0.99 (6 points shall be used for 2nd order, 7 points shall be used for 3rd order)	Correct problem then repeat initial calibration	NA	Problem must be corrected. No samples may be run until ICAL has passed. Caliration may not be forced through the origin. Quantitation for multicomponent analytes such as chlordane, toxaphene, and Aroclors must be performed using a 5-point calibration. Results may not be quantitated using a single point.
RT window position establishement for each analyte and surrogate	Once per ICAL and at the beginning of the analytical shift.	Position shall be set using midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA	NA	

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Table F-2 Cont.					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
2nd Source calibration verification (ICV)	Immediately following ICAL	All project analytes within established RT windows. GC Methods: All project analytes within ± 20% of expected value from the ICAL; HPLC Methods: All project analytes within ± 15% of expected value from the ICAL.	Correct problem, rerun, ICV. If that fails, repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Continuing calibration verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All project analytes within established RT windows. GC Methods: All project analytes within ± 20% of expected value from the ICAL; HPLC Methods: All project analytes within ± 15% of expected value from the ICAL.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed. RT windows are updated per the method.
Method Blank (MB)	One per prep batch	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see Box D-1).	Correct problem, then see criteria in box D-1; if required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported, including surrogates	One per prep batch	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery. See Box D-3 and Appendix G.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per prep batch per matrix (see Box D-7).	For matrix evaluation, use LCS acceptance criteria specified by DoD, if available. Otherwise, use in-house LCS control limits.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For specific analytes(s) in the parent sample, apply J-flag if acceptable criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.

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Table F-2 Cont.					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Matrix spike duplicate MSD or Sample Duplicate	One per prep batch per matrix (see Box D-7).	MSD: For matrix evaluation, use LCS acceptance criteria specified by DoD, if available. Otherwise, use in-house LCS control limits. MSD or sample duplicate: RPD $\leq$ 30% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Surrogate spike	All field and QC samples	QC acceptance criteria specified by DoD, if available. Otherwise use in-house control limits.	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated prep batch, if sufficient sample material is available. If obvious chromatographic interferences with surrogate is present, reanalysis may not be necessary.	Apply Q-flag to all associated analytes if acceptance criteria are not met.	Alternative surrogates are recommended when there is obvious chromatographic interferences.
Confirmation of positive results (second column or second detector)	All positive results must be confirmed (with the exception of Method 8015).	Calibration and QC criteria same as for initial or primary column analysis. Results between primary and second column RPD $\leq$ 40%.	NA	Apply J-flag if RPD > 40%. Discuss in the case narrative.	Using project-specific reporting requirements if available; otherwise, use method reporting requirements; otherwise, report the result from the primary column (see Box D-16).
Results reported between DL and LOQ	NA	NA	NA	Apply J-flag to all results between DL and LOQ.	

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-1 Summary of QC Check Definitions, Purpose, and Evaluation – Organics (GC/MS)

QC Check	Definition	Purpose	Evaluation
Breakdown Check 8081: Endrin, DDT 8270: DDT	Analysis of s standard solution containing Endrin and DDT. Area counts of these compounds and their breakdown products are evaluated to assess instrument conditions.	To verify the inertness of the injection port because DDT and Endrin are easily degraded in the injection port.	If degredation of `either DDT or Endrin exceeds method–specified criteria, corrective action must be taken before proceeding with calibration
Confirmation of positive results (organics only)	Use of alternative analytical techniques (another method, dissimilar column, or different detector such as MS detector) to validate the presence of target analytes identified	To verify the identification of an analyte	All positive results must be confirmed.
Continuing calibration verification (CCV)	This verification of the ICAL that is required during the course of analysis at periodic intervals. Continuing calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models	To verify that instrument response is reliable, and has not changed significantly from the current ICAL curve.	If the values for the analytes are outside the acceptance criteria, the ICAL may not be stable. Results associated with out-of-control CCV results require reanalysis or flagging
Demonstrate Acceptable Analytical Capability	QC samples are analyzed in series to verify ability to produce data of acceptable precision and bias.	To verify the ability to produce data of acceptable precision and bias for a specific instrument type, matrix, method, and analyst.	The average recovery of the spikes and standard deviation of the replicates must be within designated acceptance criteria. Analysis of field samples may not be conducted until this check is successful.
Duplicate Sample (replicate)	Two identical portions of material collected for chemical analysis, and identified by unique alphanumeric codes. The duplicate may be portioned from the same sample, or may be two identical samples taken from the same site. The two portions are prepared and analyzed identically. (modified QSM)	To provide information on the heterogeneity of the sample matrix or to determine the precision of the intralaboratory analytical process for a specific sample matrix	A duplicate sample will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the relative percent difference between the sample and the sample duplicate. If the sample matrix is homogeneous (such as with drinking water) and the relative percent difference is high, this could indicate a problem in the analytical system.
Initial calibration for all analytes (ICAL)	Analysis of analytical standards at different concentrations that are used to determine and calibrate the quantitation range of the response of the analytical detector or method	To establish a calibration curve for the quantification of the analytes of interest	Statistical procedures are used to determine the relationship between the signal response and the known concentration of analytes of interest. The ICAL must be successful before any samples or other QC check samples can be analyzed.
Internal Standards	A substance that is introduced in known amount into each calibration standard and field and QC sample of the analyte.	The ratio of the analyte signal to the internal standard signal is then used to determine the analyte concentration.	Any sample associated with out-of-control results must be reanalyzed.

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Table F-1 Cont.			
QC Check	**Definition**	**Purpose**	**Evaluation**
Laboratory control sample (LCS) containing all analytes to be reported	A sample matrix, free from the analytes of interest, spiked with known amounts of analytes or a material containing known and verified amounts of analytes.	Used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Assesses the ability of the laboratory/analyst to successfully recover the target analytes from a control (clean) matrix. Control limits for LCS recovery, typically expressed as percent recovery, are used for the development of statistical control limits and serve as acceptance criteria for determining whether an analytical run is in control (batch acceptance).	This is a required QC Check. The inability to achieve acceptable recoveries in the LCS indicate problems with the precision and bias of the measurement system. Failure to achieve acceptable recoveries in a "clean" matrix is an indicator of possible problems achieving acceptable recoveries in field samples.
MS	A sample prepared by adding a know mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.	To assess the performance of the method as applied to a particular matrix. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. The recovery of target analytes from the matrix spike sample is used to determine the bias of the method in the specific sample matrix.	The lack of acceptable recoveries in the matrix spike often points to problems with the sample matrix. One test of this is a comparison to the LCS recoveries. If the corresponding LCS recoveries are within acceptable limits, a matrix effect is likely. The lab should not correct for recovery; only report the results of the analyses and the associated MS results and indicate that the results from these analyses have increased uncertainty
MSD	A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of recovery for each analyte	To assess the performance of the method as applied to a particular matrix and provide information on the homogeneity of the matrix. Also used to determine the precision of the intralaboratory analytical process for a specific sample matrix.	When compared to the MS, the MSD will provide information on the heterogeneity of the sample matrix. The greater the heterogeneity of the matrix, the greater the RPD between the matrix spike and the matrix spike duplicate. If the sample matrix is homogeneous, such as with drinking water, and the RPD is high, this could indicate a problem in the analytical system.
MB	A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with an under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.	To assess background interferences or contamination in the analytical system that might lead to high bias or false positive data. Results of method blanks provide an estimate of the within-batch variability of the blank response and an indication of bias introduced by the preparation and analytical procedure.	This is one of the QC samples used to measure lab accuracy/bias. The sample could indicate whether contamination is occurring during sample prep and analysis. If analytes are detected > ½ RL, reanalyze or qualify (B-flag) all results for the specific analytes(s) in all samples in the associated prep batch as appropriate. For common lab contaminants, no analytes detected > RL. See Section D.1.1.1 and Box D-1
RT window position establishment for each analyte (and surrogate) (all chromatographic methods only)	Determination of the placement of the RT window (i.e. start/stop time) of each analyte or group of analytes as it elutes through the chromatographic column so that analyte identification can be made during sample analysis. This is done during the ICAL.	To idendify analytes of interest	Incorrect window position may result in false negatives, require additional manual integrations, or cause unnecessary reanalysis of samples when surrogates or spiked compounds are erroneously not identified.

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Table F-1 Cont.			
QC Check	**Definition**	**Purpose**	**Evaluation**
Second source calibration verification (ICV)	A standard obtained or prepared from a source independent of the source of standards for the ICAL. Its concentration should be at or near the middle of the calibration range. It is done after the ICAL.	To verify the accuracy of the ICAL.	The concentration of the 2nd source calibration verification, determined from the analysis, is compared with the known value of the standard to determine the accuracy of the ICAL. This independent verification of the ICAL must be acceptable before sample analysis can begin.
Surrogate spike (organic analysis only)	A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.	To assess the ability of the method to successfully recover specific non-target analytes from an actual matrix. Because surrogates are generally added to each sample in a batch, they can be used to monitor recovery on a sample-specific, rather than batch-specific basis.	Whereas the MS is normally done on a batch-specific basis, the surrogate spike is done on a sample-specific basis. Taken with the information derived from other spikes (LCS; MS), the bias in the analytical system can be determined.
Tuning (MS methods only)	The analysis of a standard compound to verify that the mass spectrometer meets standard mass spectra abundance criteria prior to sample analysis. (COE)	To verify the proper working of the mass spectrometer	Proper tuning of the mass spectrometer must be verified prior to sample analysis

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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DoD QSM Version 4.1: Appendix F - Quality Control Requirements Summary
Table F-4: Organic Analysis by GC/MS - Methods 8260 and 8270

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise method- specific criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD Determination and verification (See Box D-13)					
LOQ Establishment and verification (See Box D-14)					
Tuning	Prior to ICAL and at the beginning of each 12- hour period.	Refer to method specific ion criteria	Retune instrument and verify. Rerun affected samples	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be accepted without a valid tune.
Breakdown check DDT (8270 only)	At the beginning of each 12-hour period, prior to analysis of samples	Degradation $\leq$ 20% for DDT Benzidine & PCP should be present at their normal responses and should not exceed a tailing factor of 2.	Correct problem then repeat breakdown check.	Flagging criteria are not appropriate.	No samples shall be run until degradation $\leq$ 20%.
Minimum five-point initial calibration (ICAL) for all analytes	ICAL prior to sample analysis.	1. Average response factor (RF) for SPCCs: VOCs $\geq$ 0.30 for Chlorobenzene and 1,1,2,2-tetrachloroethane, $\geq$ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane SVOCs $\geq$ 0.050	Correct problem then repeat initial calibration	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed. Calibration may not be forced through the origin.

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Table F-4 Cont.					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Minimum five-point initial calibration (ICAL) Cont.		2. RSD for RFs for CCCs: VOCs and SVOCs ≤ 30% and one option below. **Option 1:** RSD for each analyte ≤ 15% **Option 2:** linear least squares regression: r ≥ 0.995 **Option 3:** non-linear regression-coefficient of determination (COD) r^2 ≥ 0.99 (6 points shall be used for 2nd order, 7 points shall be used for 3rd order)			
2nd Source calibration verification (ICV)	Once after each ICAL	All project analytes within ± 20% of true value	Correct problem and verify 2nd source standard. Rerun, 2nd source verification. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
RT window position establishement for each analyte and surrogate	Once per ICAL	Position shall be set using midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA	NA	
Evaluation of relative retention times (RRT)	With each sample	RRT of each target analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Flagging criteria are not appropriate.	Labs may update the RTs based on the CCV to account for minor performance fluctuations or after routine system maintenance (such as column clipping). With each sample, the RRT shall be compared with the most recently updated RRT. If the RRT has changed by more than ± 0.06 RRT units since the last update, this indicates a significant change in system performance and the lab must take appropriate corrective actions as required by the method and rerun the ICAL to reestablish the RTs.

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Table F-4 Cont.					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Continuing calibration verification (CCV)	Daily before sample analysis and every 12 hours of analysis time.	1. Average RF for SPCCs: VOCs ≥ 0.30 for Chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane SVOCs ≥ 0.050 2. %Difference/Drift for all target compounds and surrogates: VOCs and SVOCs ≤ 20% D (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that failes, then repeat ICAL. Reanalyze all samples since last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable CCV.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Internal Standards verification	Every field sample, standard, and QC sample.	RT ± 30 seconds from RT of the midpoint standard in the ICAL EICP area within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	If corrective action fails in field samples, apply Q-flag to analytes associated with the non-compliant IS. Flagging criteria are not appropriate for failed standards.	Sample results are not acceptable without a valid IS verification.
Method Blank (MB)	One per prep batch	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common lab contaminants, no analytes detected > RL (see Box D-1).	Correct problem, then see criteria in box D-1; if required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported, including surrogates	One per prep batch	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery. See Box D-3 and Appendix G.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated prep batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

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Table F-4 Cont.					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Matrix Spike (MS)	One per prep batch per matrix (see Box D-7).	For matrix evaluation, use LCS acceptance criteria specified by DoD, if available. Otherwise, use in-house LCS control limits.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For specific analytes(s) in the parent sample, apply J-flag if acceptable criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate MSD or Sample Duplicate	One per prep batch per matrix (see Box D-7).	MSD: For matrix evaluation, use LCS acceptance criteria specified by DoD, if available. Otherwise, use in-house LCS control limits. MSD or sample duplicate: RPD $\leq$ 30% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact client as to additional action measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Surrogate spike	All field and QC samples	QC acceptance criteria specified by DoD, if available. Otherwise use in-house control limits.	For QC and field samples, correct problem then reprep and reanalyze all failed samples for the failed surrogates in the associated prep batch, if sufficient sample material is available. If obvious chromatographic interferences with surrogate is present, reanalysis may not be necessary.	Apply Q-flag to all associated analytes if acceptance criteria are not met.	Alternative surrogates are recommended when there is obvious chromatographic interferences.
Results reported between DL and LOQ	NA	NA	NA	Apply J-flag to all results between DL and LOQ.	

Notes:
1. Project-specific requirements identified by the client supersede any requirements listed. The requirements are meant to be default, to be used when project-specific direction based on DQOs is not available.
2. If there is a contradiction between the method and the DoD tables, the requirements specified in the tables shall be followed.

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FINAL
SITE MANAGEMENT PLAN
GARVEY ELEVATOR SITE
REMEDIAL DESIGN, OPERABLE UNIT 1

HASTINGS, NEBRASKA

Prepared for:

U.S. Environmental Protection Agency Region 7
901 North 5th Street
Kansas City, KS 66101

EPA Contract No.: EP-S7-05-05
Task Order No.: 0046

October 2010

HydroGeoLogic, Inc
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LIST OF ACRONYMS AND ABBREVIATIONS

AES	Architect and Engineering Services
AGP	AGP Grain Marketing, LLC,
AHA	activity hazard analysis
AR	Administrative Record
AST	aboveground storage tank
bgs	below ground surface
CDM	CDM Federal Programs Corp.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
CIP	Community Involvement Plan
COC	contaminant of concern
CSP	Certified Safety Professional
DPT	direct-push technology
DQOs	data quality objectives
EC	electroconductivity
EDB	ethylene dibromide
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FAR	Federal Acquisition Regulations
FS	feasibility study
FSP	Field Sampling Plan
FTL	Field Team Leader
GET	groundwater extraction and treatment
HGL	HydroGeoLogic, Inc.
HSP	Health and Safety Plan
IDW	investigation-derived waste
NDEQ	Nebraska Department of Environmental Quality
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit

POC	point of contact
PPE	personal protective equipment
PRP	potentially responsible party
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	remedial action
RD	remedial design
RI	remedial investigation
ROD	Record of Decision
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
Site	Garvey Elevator Site
SMP	Site Management Plan
SSHO	Site Safety and Health Officer
SVE	soil vapor extraction
TO	task order
TOM	Task Order Manager
TOPO	Task Order Project Officer
VOC	volatile organic compound

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FINAL
SITE MANAGEMENT PLAN
GARVEY ELEVATOR SITE
REMEDIAL DESIGN, OPERABLE UNIT 1
HASTINGS, NEBRASKA

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Region 7 tasked HydroGeoLogic, Inc., (HGL) to conduct Remedial Design (RD) activities at the Garvey Elevator Site (Site) in Hastings, Nebraska. CDM Federal Programs Corporation (CDM) is HGL's teaming partner on the contract. This work is being executed under Architect and Engineering Services (AES) Contract EP-S7-05-05, Task Order (TO) 0046. The interim Record of Decision (ROD) signed on June 30, 2010, specified that Alternative 3, Continued Operation of the Groundwater Extraction and Treatment (GET) System and Soil Vapor Extraction (SVE) System, with Expansion of the GET system, is the selected interim remedy for Operable Unit (OU) 1 groundwater. The scope of this RD includes installing piezometers and conducting aquifer pumping tests at the Site to supplement existing data obtained during the Remedial Investigation (RI) and data from operation of the remediation system in place at the Site. Limited field sampling for geotechnical analyses and investigation-derived waste (IDW) characterization is planned. Data from the piezometer installations and pumping tests will be used to prepare the RD, which will provide details required to install and construct facilities necessary to expand the existing GET system and continue operation of the existing SVE system during the interim Remedial Action (RA) phase.

This Site Management Plan (SMP) provides the Site background, details the scope of HGL's role on the project, establishes the roles and responsibilities of involved parties, and discusses how Site activities will be managed and executed to assure that the objectives of this task order are achieved. Taking into consideration the size and complexity of the Site, and the need to implement early remedial actions at the source area, EPA divided the Site into two OUs. OU1 consists of the source area on the property and includes both groundwater and soil. OU2 consists of groundwater contamination outside of the property boundaries. The SMP addresses field activities to be conducted in association with the RD for OU1.

1.1 SITE LOCATION AND BACKGROUND

Garvey Elevator is located at 2315 W. Highway 6, immediately southwest of the City of Hastings, Nebraska (Figure 1.1). The Site is defined as the areal extent of contamination and all areas in very close proximity to the contamination necessary for implementation of the response action(s). Between 1959 and 1994, Garvey Elevators, Inc. (Garvey) owned and operated a grain storage facility on the Garvey Elevator property. The property encompasses 106 acres of land, 22 of which historically had been used for grain storage facility operations.

From 1959 to 1985, Garvey used a liquid fumigant for pest control called Liquid 80/20, which consisted of 80 percent carbon tetrachloride and 20 percent carbon disulfide. Some formulations of 80-20 fumigant used at the grain storage facility may have contained minor amounts of

ethylene dibromide (EDB), also known as 1,2-dibromoethane. In 1960, Garvey installed a 3,000-gallon aboveground storage tank (AST) that was used for storage of carbon tetrachloride. The storage tank had a delivery pipe that ran underground from the AST to the side of the elevator, and then up the side to the gallery of the elevator (Figure 1.2). Once in the gallery, it was routed to application piping that ran over the various bins in the gallery and applied the carbon tetrachloride to the surface of the grain. The portion of this delivery pipe that connected the AST to the base of the elevator was buried. During the time Garvey operated at the Site, carbon tetrachloride was released into the environment from a leak in the underground delivery pipe.

There is also evidence that Garvey applied the same carbon tetrachloride grain fumigant to outgoing rail cars loaded with grain. The carbon tetrachloride was applied at a rate of approximately one five-gallon bucket per rail car. Applications consisted of pouring the carbon tetrachloride on the top of the grain.

Garvey leased the property to AGP Grain Marketing, LLC, and AGP purchased the property in 2005. A detailed discussion of the Site background, regulatory history, and past investigations is provided in the RI/FS Work Plan submitted under separate cover.

1.2 SCOPE OF HGL'S ROLE ON THE PROJECT

Under this Task Order, HGL will conduct field investigation activities required to evaluate aquifer conditions as necessary to develop a design for expansion of the existing GET system, and develop the RD. Activities will include:

- Installing five well clusters (15 wells) for the purposes of conducting aquifer testing and measuring water levels during aquifer testing.
- Conducting aquifer testing to determine aquifer characteristics in the shallow and medial aquifers and to evaluate the effective capture zone of the current groundwater extraction system configuration in support of the RD.
- Preparing the RD (preliminary design, pre-final design and 100 percent design) that provides details required to install and construct facilities necessary to expand the existing GET system and continue operations of the existing SVE system during the interim RA.
- Evaluating design components and determining whether any components of the design should undergo a value engineering screening.

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FIGURES

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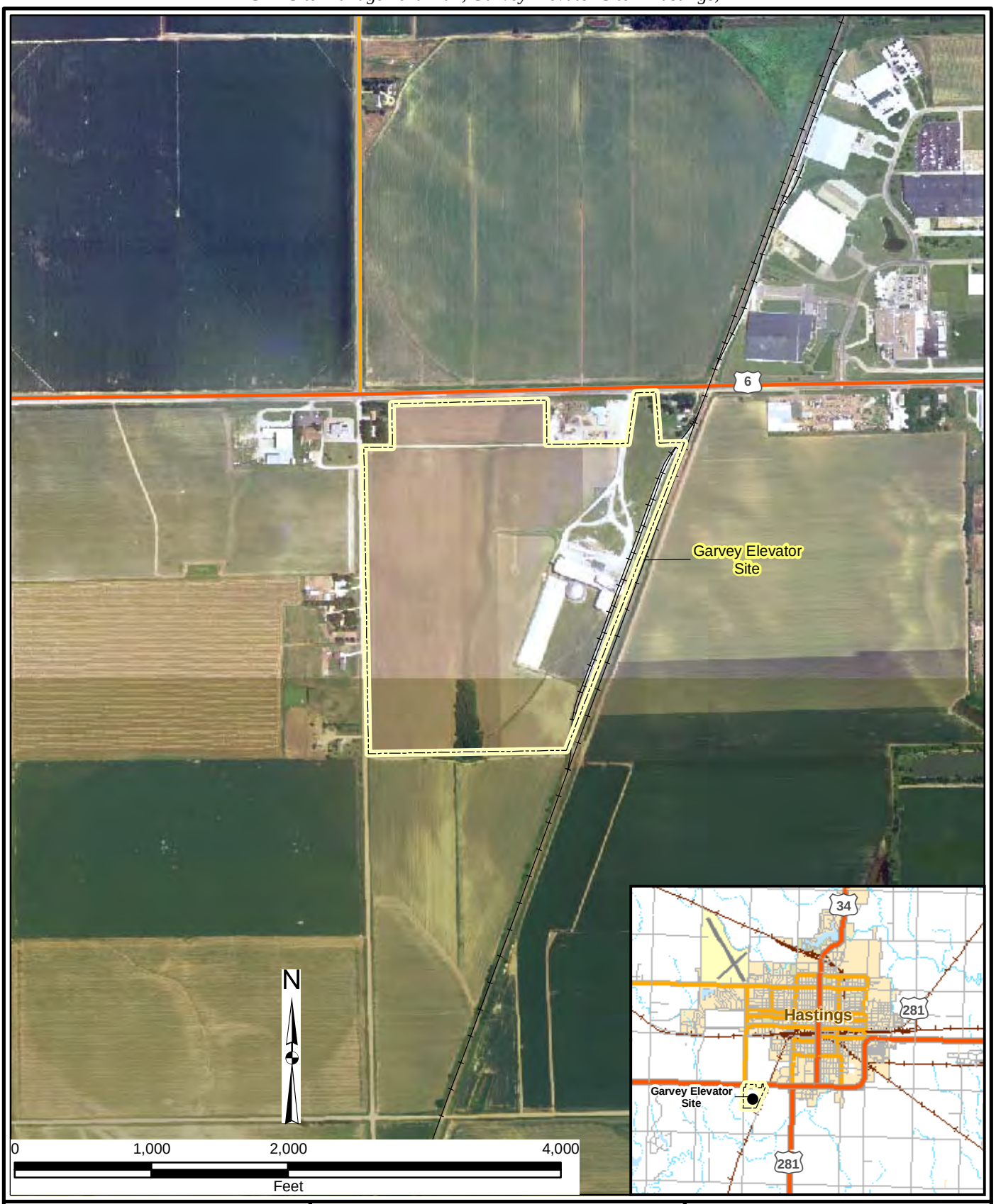

Filename: X:/EPA009/Garvey/SMP/Site_Loc_Map.mxd
Project: EP9033.01.46.11
Revised: 12/22/08 CV
Source: ESRI StreetMap USA
Nebraska DNR

HydroGeoLogic, Inc

CDM

Figure 1.1
Site Location Map
Garvey Elevator Site
Hastings, NE

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HGL—Site Management Plan,
Garvey Elevator Site—Hastings, NE

Figure 1.2
Current Site Map

Legend

- Former Garvery Elevator Inc., Property
- Concrete Paved Area
- Buildings
- Gravel Road
- Railroad
- OU1 Boundary

N

0 200 400 800

Feet

Filename: X:/EPA009/Garvey/RI_FS/SiteMap.mxd
Project: EP9046.02.46.07
Revised: 10/07/10 ST
Source: ENSR GDB 2008, DNR

United States Environmental Protection Agency

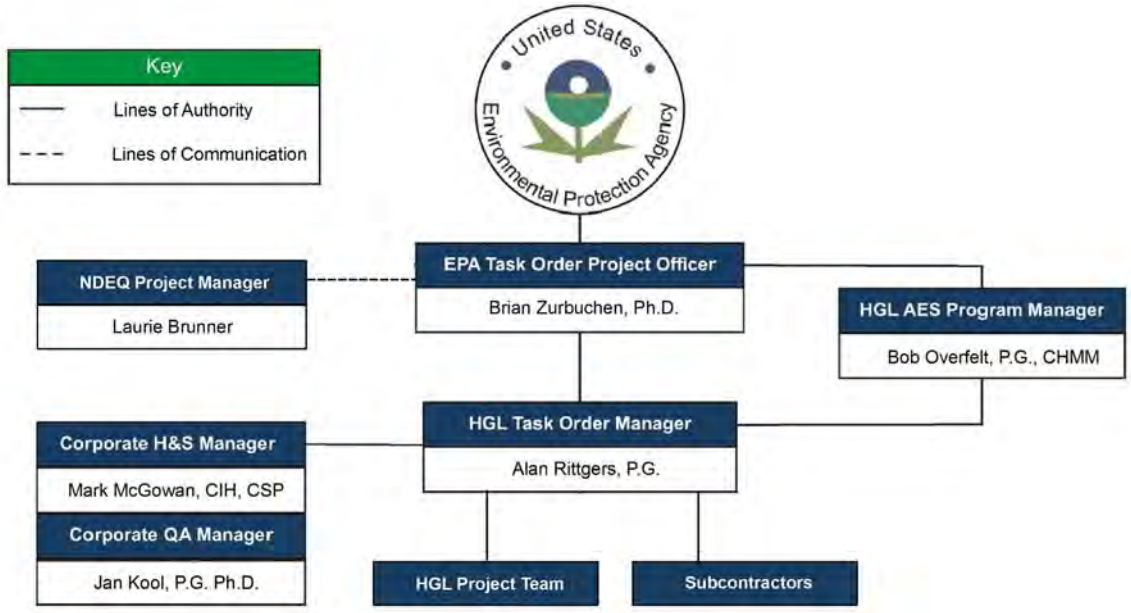
HGL HydroGeoLogic, Inc

CDM

2.0 PROJECT MANAGEMENT AND COMMUNICATION

This section describes the personnel, companies and agencies involved in the Garvey Elevator project and the roles, responsibilities, and authority of each. In addition to HGL/CDM and EPA, the Nebraska Department of Environmental Quality (NDEQ) will review project deliverables. The organizational chart provided as Figure 2.1 illustrates the lines of communication and authority for the agencies and firms involved in the project.

Figure 2.1



2.1 ROLES OF EACH AGENCY/FIRM OR STAKEHOLDER

The contact information for the primary and secondary points of contact (POCs) at each firm/agency as well as stakeholders is summarized in Table 2.1. This project is led by the EPA Region 7 Superfund Division in Kansas City, Kansas. The EPA task order project officer (TOPO) is Brian Zurbuchen, Ph.D. Dr. Zurbuchen is a Remedial Project Manager (RPM) in EPA's Superfund Branch. EPA has the ultimate decision making authority in all technical and administrative matters associated with this project.

HGL is a contractor to EPA under the Region 7 AES contract. CDM is a team subcontractor to HGL on the AES contract and will support HGL's efforts on this project. The EPA AES contract is managed by Region 7 Project Officer Mr. James Seiler and Contracting Officer Mr. Anthony LaMaster. These individuals communicate directly with HGL's AES program manager Bob Overfelt, P.G. CHMM, on matters regarding funding, budgets, schedules, and other administrative and technical functions. EPA Region 7 TOPO Brian Zurbuchen is HGL's primary contact for coordinating work at the Site. Dr. Zurbuchen will communicate directly with Alan Rittgers, P.G.,

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the HGL task order manager (TOM) for the Garvey Elevator Site project. As the TOM, Mr. Rittgers is responsible for the overall management and coordination of the Garvey Elevator Site project, and is the POC with EPA on technical and administrative matters. Mr. Rittgers will be supported by experienced field personnel and key project personnel. HGL is responsible for accomplishing the task elements necessary to achieve the project objectives as specified in the Task Order, including:

- Preparing planning documents.
- Coordinating (with EPA assistance) access for sampling activities with the Site tenant, the City of Hastings, and off-Site property owners as necessary.
- Conducting RD activities as summarized in Section 1.2.
- Maintaining Site control and managing health and safety during all field activities.
- Managing Site-derived data in EQuIS database and delivering data in electronic data deliverable (EDD) format to EPA.
- Preparing the Field Investigation Report summarizing significant findings of the field investigation activities to provide a useful reference to the design team.
- Preparing the RD (preliminary design, pre-final design and 100 percent design).

2.2 ROLES AND RESPONSIBILITIES OF KEY PERSONNEL

2.2.1 U.S. EPA Region 7

For the Garvey Elevator Site RD project, EPA AES contract Region 7 Project Officer Mr. James Seiler and Contracting Officer Mr. Anthony LaMaster are responsible for:

- Participating in task order proposal negotiations
- Tracking the task order budget
- Reviewing task order proposals
- Allocating and authorizing EPA funds to the task order
- Maintaining communication with the EPA TOPO and HGL contract personnel.

EPA Region 7 TOPO Dr. Brian Zurbuchen is responsible for:

- Reviewing all project deliverables prepared by HGL.
- Maintaining communications with the HGL TOM regarding project status and schedule.
- Keeping HGL apprised of the ongoing activities of the EPA Region 7 Removal Branch so that on-site activities can be scheduled accordingly.
- Reviewing monthly status reports.
- Providing oversight of field efforts.
- Providing technical direction to HGL.
- Facilitating and maintaining communication with the City of Hastings, and other stakeholders, as necessary.
- Tracking work progress against planned budgets and schedules.
- Scheduling EPA personnel and material resources.
- Providing oversight of EPA personnel responsible for project tasks.

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2.2.2 HydroGeoLogic, Inc.

2.2.2.1 Program Manager

The HGL EPA AES program manager is Mr. Bob Overfelt, P.G., Certified Hazardous Materials Manager (CHMM). As program manager, Mr. Overfelt is responsible for the overall management of the EPA AES contract and assuring that all appropriate personnel and administrative resources are allocated to meet project objectives.

2.2.2.2 Task Order Manager

As the TOM, Mr. Rittger's responsibilities include:

- Managing project activities on a day-to-day basis, ensuring appropriate project staffing, and managing subcontractors and vendors.
- Communicating as necessary with the EPA TOPO on technical and administrative matters that impact the project budget, schedule, or technical approach.
- Designating authority to other key personnel for specific tasks, and overseeing the conduct of their work.
- Performing periodic internal project status reviews with the AES program manager to ensure that the project is being managed efficiently and effectively.
- Monitoring costs and performance on the project. This involves reviewing the weekly labor charges, approving expenditures, and tracking the budget.
- Establishing and maintaining task order files. All correspondence and other documentation included in the files will be assigned a unique document control number under HGL's AES7 Document Control and Tracking System. Project files will be maintained at the HGL offices in Overland Park, Kansas. This system, administered by the HGL clerical staff, allows documents to be efficiently tracked and retrieved.
- Preparing monthly reports and invoices to be submitted to EPA summarizing project technical and financial status. The invoice will include charges incurred for labor and other direct expenses, such as travel, subcontractor costs, equipment rental, etc. Accounting personnel will verify that all travel expenses are within the Joint Travel Regulations and allowable per the Federal Acquisition Regulations (FAR). The monthly progress report will detail progress made during the month on the project, problems resolved, anticipated problem areas and recommended solutions, upcoming activities and events, key personnel changes, subcontracting, travel, schedule performance, and financial status information.

2.2.2.3 Field Team Leader

Field activities will be completed over a couple of months and multiple teams will be deployed to accomplish field activities in an efficient manner. Jeff Gadt, P.G. has been designated as the Field Team Leader (FTL) to lead the field activities and coordinate sampling teams. The FTL will be responsible for the following:

- Overseeing on-Site performance of field activities.
- Managing subcontractors on Site.

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- Obtaining sampling equipment, field supplies, personal protective equipment (PPE), and all other material necessary for executing field activities.
- Obtaining field monitoring devices and assuring that they are calibrated and in good working order.
- Ensuring that access has been obtained as necessary and that utility clearances are conducted.
- Communicating with the TOM as necessary regarding technical matters.
- Communicating with the Site Safety and Health Officer (SSHO) regarding health and safety matters.
- Participating in conference call(s) with the TOM and EPA as necessary to provide input regarding project issues.
- Identifying problems at the field level, implementing and documenting corrective actions taken at the field level, and providing communication between the field teams and HGL management.
- Communicating with the Regional QC Coordinator on matters of quality that may impact the project.

2.3 HEALTH AND SAFETY MANAGEMENT

HGL maintains a Corporate Health and Safety Program, outlined in the Corporate Safety and Health Manual, which is overseen by Mr. Mark McGowan. Mr. McGowan is a Certified Industrial Hygienist (CIH) and Certified Safety Professional (CSP) with over 20 years experience in the environmental industry managing corporate industrial hygiene, safety, medical monitoring and workers' compensation programs. HGL's Corporate Safety and Health Manual is compliant with Occupational Safety and Health Administration (OSHA) standards. HGL also has incorporated the U.S. Army Corps of Engineers EM-385-1-1 requirements into its safety and health procedures. The Corporate Health and Safety Manual is revised annually. Mr. McGowan reports directly to the president of the company on all safety and health matters. HGL provides extensive safety and health training to all its employees and the training program is in compliance with OSHA standards. As necessary, HGL personnel assigned to the Garvey Elevator Site RD project will be provided additional training in the hazards associated with Site-specific operations and chemical exposures. All HGL personnel have full authority to stop work when, in their judgment, an unsafe condition exists. As part of the Corporate Health and Safety Program, HGL maintains an extensive Safety and Health and Medical Monitoring Program to ensure the safety of its employees.

Mr. McGowan or his designeé will review the Site-specific Health and Safety Plan (HSP) prepared for this project. An SSHO will be assigned to manage day-to-day health and safety activities during field work. Phyllis Chase is the Regional Health and Safety Coordinator who will oversee the SSHO. As the Site Safety and Health Officer, Ms. Chase is responsible for:

- Assuring that the HSP is read and signed by all field personnel, including subcontractors.
- Contacting the HGL CIH if changes to an activity hazard analysis (AHA) are necessary, or if a new AHA is needed.
- Assuring that field activities are conducted in accordance with the HSP.
- Documenting health and safety matters in the field logbook.
- Communicating as necessary with the CIH regarding health and safety issues.

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2.4 MANAGEMENT OF WORK PRODUCT QUALITY

Mr. Jan Kool, P.G., PhD, is HGL's Corporate Quality Assurance (QA)/Quality Control (QC) Officer and oversees quality control for HGL's Engineering and Construction Division. Mr. Kool has served as the Corporate QC officer on numerous EPA and USACE contracts and on contracts for other Department of Defense clients. Dr. Kool has designated authority for QC matters on the Garvey Elevator Site to Mary Knowles. Ms. Knowles will report directly to Dr. Kool on matters of QC. Quality control is independent of line management: Mary Knowles will review project planning documents and deliverables, audit project logbooks as necessary, communicate with the FTL to assure that Site work is conducted in accordance with approved planning documents, and report any QC discrepancies to the Corporate QA/QC Officer and ensure that appropriate corrective actions are taken.

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TABLES

Table 2.1
Garvey Elevator Site
Points of Contact

Name, Title	Organization	Contact Information
Brian Zurbuchen Remedial Project Manager and TOPO	EPA Region 7	IANE/SUPR U.S. EPA Region 7 901 N. 5th. Street Kansas City, KS 66101 913/551-7101 zurbuchen.brian@epamail.epa.gov
Randy Schademann EPA On-Scene Coordinator	EPA Region 7	U.S. EPA Region 7 901 N. 5th. Street Kansas City, KS 66101 913/551-7331 schademann.randy@epamail.gov
Greg McCabe Risk Assessor	EPA Region 7	U.S. EPA Region 7 901 N. 5th. Street Kansas City, KS 66101 913/551-7709 mccabe.gregory@epamail.epa.gov
Jan Lambert Public Affairs Specialist	EPA Region 7	U.S. EPA Region 7 Office of External Programs 901 North 5th Street Kansas City, KS 66101 913-551-7768 lambert.janette@epamail.epa.gov
Laurie Brunner Groundwater Geologist/Project Manager	NDEQ	1200 "N" Street, Suite 400 PO Box 98922 Lincoln, Nebraska 68509 402/471-2214 laurie.brunner@Nebraska.gov
Bob Overfelt AES Program Manager	HGL	HGL Kansas City Operations 6340 Glenwood; Suite 200 Overland Park, KS 66202 913/317-8860 boverfelt@hgl.com

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Table 2.1 (Continued)
Garvey Elevator Site
Points of Contact

Name, Title	Organization	Contact Information
Alan Rittgers Project Manager	HGL	HGL Kansas City Operations 6340 Glenwood; Suite 200 Overland Park, KS 66202 913/317-8860 arittgers@hgl.com
Jeff Gadt Field Team Leader	HGL	HGL Kansas City Operations 6340 Glenwood; Suite 200 Overland Park, KS 66202 913/317-8860 jgadt@hgl.com
David Wacker Director of Public Works/ City Engineer	City of Hastings	220 N. Hastings Avenue Hastings, NE 68901 402-461-2330 402-461-2323 FAX DWacker@cityofhastings.org
Marty Stange Director of Utilities	Hastings Utilities	Hastings Utilities 1228 N. Denver Avenue Hastings, NE 402/463-1371 MStange@hastingsutilities.org
Roger Rumsey Facility Manager	AGP	AGP, Grain Marketing, LLC 2315 W. Highway 6 Hastings, NE 68901 402/463-1420

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Table 2.2
Summary of Key Project Milestones
Garvey Elevator Site RD
Hastings, NE

Activity	Dates
Preparation of planning documents	Draft – 08/14/2010; Final – 10/12/2010
Mobilization	11/08/2010
RD field activities	11/15/2010 to 01/21/2011
Preparation of EQuIS database EDDs	01/24/2011 to 01/28/2011
Data analysis and interpretation	01/24/2011 to 02/18/2011
Preparation of Field Investigation Report	Draft – 03/04/2011; Final – 03/25/2011
Preliminary Design Analysis Report	04/22/2011
Pre-Final Design Analysis Report	06/06/2011
Final Design Analysis Report	07/05/2011

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3.0 COMMUNICATION WITH LOCAL COMMUNITY

3.1 COMMUNITY INVOLVEMENT

EPAprepared a Community Involvement Plan (CIP) for the Garvey Elevator Site in October 2006. The CIP outlines the steps that EPA will implement to ensure that the community is appropriately informed about the investigation and to detail steps for public participation in the remediation process of the Site. EPA has primary responsibility for implementing the planned community involvement activities at the Site. This effort is tasked under TOs 0033 and 0034 for the RI and Feasibility Study (FS) component of the Garvey project. Under the RD TO, HGL's role in the community involvement effort for the Garvey Elevator Site is limited to supporting EPA in its efforts to keep the community apprised of project issues. HGL will provide support to EPA through attendance at public meetings and/or open houses, and preparation of presentation materials for EPA's use during these meetings.

3.2 ADMINISTRATIVE RECORD

EPA established an information repository of Site-related documents at the Hastings Public Library at 517 W. 4th Street. EPA made the public aware of the establishment of the information repository through a fact sheet that was mailed November 21, 2005, and in a display advertisement in the Hastings *Tribune*. The repository contains documents such as fact sheets, technical summaries, Site reports (including the CIP), and information regarding proposed or planned remediation actions at the Site. Additionally, the information repository contains the Administrative Record (AR). As required by the Comprehensive Response, Compensation and Liability Act (CERCLA), the ARcontains information that forms the basis for the selection of a response action, including verified sampling data, quality control and quality assurance documentation, chain of custody forms, Site inspection and evaluation reports, and Agency for Toxic Substance and Disease Registry health assessments. It contains EPA's Proposed Plan for the Interim Action Remedy, the Interim ROD, and supporting information. The information contained in the repository will be updated by EPA as new information becomes available. The ARwas last updated by EPA in February 2010.

3.3 PROPERTY ACCESS

The grain elevator facility is currently owned and operated by AGP Grain Marketing, LLC and grain handling/storage operations are ongoing. Additionally the approximately 88 acres bounding the grain elevator facility on the east (Figure 1.2) formerly owned by Garvey Elevators Inc. is also owned by AGP Grain Marketing, LLC and is used for irrigated row crop production. It is anticipated that well clusters will be located on the Site property. However, one well cluster may need to be installed on private property in an adjacent farm field. The approach for obtaining Site access is detailed in the following subsections.

3.3.1 Tenant Agreements

The Agreement that EPA Region 7 has with AGP is provided in Appendix A. This Agreement includes provisions that allow EPA and its contractors access to the Site for the purpose of conducting any response activity related to the Site.

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3.3.2 Access to Off-Site Properties

It is anticipated that all piezometers and well clusters will be installed on the Site property, However, if any piezometers or well clusters need to be located on private properties to provide adequate placement to support the aquifer testing, EPA will be responsible for coordinating access agreements. HGL will assist in this effort as necessary. HGL will make every effort to ensure that activities conducted on private properties do not cause damage to landscaping or structures, and that activities are conducted in a manner that is not disruptive to the owner. After work is completed, the Site will be restored to its original condition to the extent practical.

3.4 SUPPORT FOR THE CLEANUP PLAN

HGL will support EPA in conducting a public meeting with interested parties to discuss the overall Site cleanup schedule and related activities. The purpose of the meeting is to inform the public about EPA's investigation and answer questions from citizens. EPA will schedule the meeting and make arrangements for the meeting place.

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4.0 FIELD INVESTIGATION/DATA ACQUISITION ACTIVITIES

4.1 PREPARATION OF PLANNING DOCUMENTS

HGL will prepare planning documents to outline and document how the RD TO will be executed, establish the health and safety protocols to be followed, and present the quality measures to be implemented to ensure that data quality objectives (DQOs) are met. The RD planning documents that will be prepared to support Site work will be submitted concurrently and structured as follows:

- Sampling and Analysis Plan (SAP)
  - Part 1: Field Sampling Plan (FSP)
  - Part 2: Quality Assurance Project Plan (QAPP)

A Site-specific HSP will be prepared and submitted as an appendix to the SAP. The SMP will be submitted concurrently as a separate document. The content of specific planning documents is discussed in detail below.

4.1.1 Field Sampling Plan

The FSP will describe the locations and construction particulars of the proposed piezometers and well clusters, potential geotechnical samples, aquifer testing procedures, and associated field measurement procedures. Procedures for conducting aquifer tests and recording associated field measurements will be detailed to ensure that data obtained meet the DQOs identified for the project. The FSP also will include the plan for managing IDW. The FSP will be prepared in draft and final versions.

4.1.2 Quality Assurance Project Plan

HGL will prepare a Site-specific QAPP that presents the QA and QC procedures that will be followed during the completion of RD activities. The QAPP will specifically address the QA/QC requirements to ensure that DQOs are achieved, and field QC procedures. The QAPP will be prepared in accordance with EPA QA/R-5 *EPA Requirements for Quality Assurance Project Plans*, Final, March 2001, and companion document EPA/G-5, EPA 600/R-98-018 *Guidance for Quality Assurance Project Plans*, dated February 1998. The QAPP will discuss the project objectives and organization, functional activities, and QA/QC protocols that will be used to achieve the desired DQOs. HGL will use *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G4, EPA/240/B-06/001 to define DQOs for data collection at the Site. The QAPP also will detail how field data and laboratory data (if obtained) will be managed to facilitate sample tracking and data reporting. As with the other planning documents, the QAPP will be prepared in draft and final versions.

4.1.3 Heath and Safety Plan

HGL will prepare a Site-specific HSP that defines and documents the health and safety procedures to be implemented for the project. This document will incorporate by reference the HGL corporate HSP (see Section 2.3), and will be inclusive of all activities to be conducted

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under this task order. The HSP will meet the requirements of 29 Code of Federal Regulations 1910 and 1926, National Institute of Occupational Safety and Health *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985), EPA Order 1440.1 - Respiratory Protection, and EPA Order 1440.3 - Health and Safety Requirements for Employees Engaged in Field Activities.

4.2 HYDROGEOLOGICAL ASSESSMENT

The primary chemicals of potential concern for the Site are likely the result of the practice of using carbon tetrachloride to fumigate grain at the Garvey Elevator Site. Releases occurred through leaks in piping, and possibly through direct spills to the ground surface as carbon tetrachloride was poured over grain in railcars at the rail siding on Site. The primary contaminants of concern (COCs) at the Site include carbon tetrachloride and its degradation product chloroform, as well as EDB, which may have been a component of some formulations of the 80-20 fumigant used at the grain storage facility. Under this RD TO, aquifer testing will be conducted to augment chemical and field data collected under the RI/FS TOs (0033 and 0034) and derive a design for remediating on-Site groundwater. RD field activities are summarized in the following subsections.

4.2.1 Well Installation and Development

Fifteen piezometers (wells) will be installed in 3-well clusters at five locations on Site. The function of the piezometers is to detect water level changes during the performance of the aquifer pumping tests on the existing groundwater extraction system. The five well clusters will each have three 2-inch diameter wells installed in a single borehole in the shallow (130 feet below ground surface [bgs]), medial (150 feet bgs), and deep (170 feet bgs) aquifers. In three of the on-Site borings, continuous cores will be collected to approximately 170 feet bgs for lithologic descriptions. Geotechnical samples (up to four samples) may be collected from selected intervals in two well boring locations to provide additional information on the subsurface soil properties. During the well installation activities, a QC audit will be conducted by a senior-level engineer/scientist to ensure that the procedures outlined in the SAP are being followed.

A Nebraska-licensed land surveyor will be subcontracted to provide survey data (location and elevation) for all sampling points and monitoring wells.

4.2.2 Aquifer Testing and Monitoring

Aquifer pumping tests will be conducted to determine aquifer characteristics in the shallow and medial aquifers and to evaluate the effective capture zone of the current groundwater extraction system configuration in support of the RD. Pumping tests of the full remediation system test are designed to evaluate the influence of the current groundwater extraction system on the groundwater flow regime at the Garvey Elevator OU1 Site. Water levels in select wells will be monitored and logged over the duration of the following 12-day cycle of testing:

- Steady-state operation of the system (2 days)
- System shutdown and recovery (5 days)
- System startup and operation back to steady-state operation (5 days)

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The pumping tests of individual extraction wells will consist of an 8-hour step-drawdown test and 24-hour constant-rate test performed on one extraction well from the shallow aquifer and one extraction well completed in the medial aquifer (two 8-hour step-drawdown tests and two 24-hour constant-rate tests.)

4.2.3 Data Evaluation and Modeling

The field effort will generate the following types of data:

- Piezometer well logs
- Field sampling data
- Aquifer testing data
- Analytical results
- Survey data
- IDW data

HGL will compare and evaluate the field investigation data with the RI data to determine the aquifer characteristics, develop an analytical model of the groundwater flow, and evaluate the current remediation system performance at the Site. The Aqtesolv software package will be used to compile and analyze the aquifer test data. The results of the aquifer tests will be incorporated into the analytical groundwater flow and transport model simulations and will be presented in a Field Investigation Report (see Section 5.1).

The primary objective of analytical modeling is to define the capture zone under the current pumping configuration and to select optimal locations for additional extraction wells, if necessary. Winflow and Wintran are complementary software packages that will be used for the analytical two-dimensional groundwater flow and contaminant transport model.

4.3 SITE CONTROL

AGP operates an active grain handling and storage business of the property. Operations are conducted in one shift that runs from 8:00 a.m. to 4:30 p.m., Monday through Friday.

The HGL field schedule will be executed in 10-day shifts, 10 hours per day, with 4 days off between work cycles. This schedule allows some sampling to be conducted over the weekend when no AGP workers will be present. When field activities will be conducted when AGP workers are on Site, HGL will make every effort to minimize disruptions to ongoing operations. The FTL will forecast sampling locations 3 days in advance, so that workers are aware of possible overlap in work areas and any locational issues can be resolved.

To install piezometers (wells), HGL's subcontractor will employ a rotosonic drill rig. During drilling activities, work zones will be established around the location using temporary pylons and construction tape. Access will be restricted to essential HGL and subcontractor personnel. Field personnel will be required to check in with the FTL on a daily basis during the field work. Any personnel within the work zone will be required to don safety glasses, a hard hat, and hearing protection. Workers will be required to wear high visibility vests at all times. The provisions for PPE will be detailed in the HSP. All personnel, including subcontractors, will be required to

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follow the PPE requirements of the HSP and the work practices detailed in this SMP and the SAP.

The work zone to be established around HGL field work locations will separate AGP employees from operating sampling equipment by a safe distance. However, HGL will require AGP employees near the work areas to don hearing protection and hardhats. The use of additional PPE will be coordinated with Mr. Roger Rumsey of AGP. Complete details of the health and safety procedures to be implemented during field activities are provided in the HSP provided as Appendix A of the SAP.

4.4 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

The IDW that will be generated during the RI field activities will consist of soil cuttings and well purge water generated during drilling, decontamination water, and general municipal refuse. Contaminated or potentially contaminated IDW will be segregated from uncontaminated IDW. Water and soil IDW will be containerized in closed-top 55-gallon drums and 20 cubic yard roll-off containers, respectively, while being held at a secure location on Site awaiting disposal.

Drummed IDW will be clearly labeled and secured while inside the building to avoid worker contact. The drums will remain on pallets and will be relocated by the subcontractor to a holding area near HGL's job trailer or other designated secure temporary staging area to await off-Site transport and disposal. (Note: HGL field operations will be set up in the existing on-Site job trailer that has been used by previous contractors.)

Samples will be collected for waste characterization to determine proper disposal methods. All IDW will be managed and disposed in accordance with all applicable local, State, and Federal regulations. IDW management and disposal requirements will be detailed in the FSP.

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5.0 REMEDIAL DESIGN ACTIVITIES

5.1 PRELIMINARY DESIGN

To aid in preparation of the preliminary design, a Field Investigation Report will be prepared to summarize field investigation findings and other pertinent information for use by EPA and the design team. HGL will evaluate and interpret the data collected from the RI and the RD field effort and prepare the preliminary design. The selected remedy, objectives, and performance criteria for the Site are specified in the Interim ROD issued on June 30, 2010. The ROD specified that Alternative 3, Continued Operation of the GET and SVE systems, with expansion of the GET system, is the selected interim remedy. The RD will provide details required to install and construct facilities necessary to expand the existing GET system and continue operations of the existing SVE system during the interim RA phase.

The preliminary design will consists of specifications, drawings, a design analysis, construction QA plan, and preliminary costs. Preliminary design drawings at approximately a 50% design level will be prepared using AutoCAD and will indicate the locations of proposed additional extraction wells and associated appurtenances. A preliminary construction schedule and cost estimate will be developed as part of the preliminary design package.

HGL and CDM will participate in two briefings at EPA's offices to discuss the design and resolve questions and comments.

5.2 PREFINAL/100% DESIGN

Once EPA comments to the preliminary design are received, the prefinal (90% design level) and final (100% design level) design packages will be prepared, with a brief review and comment period between the prefinal and final phase submittals. The pre-final and final design package be prepared will include design drawings, specifications, a technical memorandum summarizing general design scope and inputs, and cost estimates prepared using Excel spreadsheets to a +15% and -10% accuracy.

5.3 VALUE ENGINEERING SCREENING

HGL will evaluate design components and identify any areas to EPA that may require value engineering screening in accordance with EPA requirements. HGL will prepare a list of remedial components for discussion during a screening level evaluation, hold a meeting with senior engineering staff to discuss these components and possible alternative materials or construction means, and prepare a technical memorandum summarizing the discussions and identifying any areas for completing value engineering screening.

5.4 OPERATION AND MAINTENANCE PLAN

The existing GET and SVE systems at the Site are operated under an existing operation and maintenance (O&M) manual. After the RD has been completed, HGL will revise the existing GET and SVE system O&M manual. HGL will identify any new system O&M requirements resulting from the RA activities that will be implemented under the RD. This will include

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revising the roles and responsibilities for O&M activities, describing process and control systems, detailing system operating procedures, and presenting any new field documentation and reporting requirements.

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6.0 DATA MANAGEMENT

Data collected under this TO will be managed in accordance with the Data Management Plan included as part of the QAPP for the RI/FS. This DMP describes how the data collected in association with this project will be managed. Data will be incorporated into the existing database created for the Garvey Elevator Site under the RI/FS TO.

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Appendix A

AGP Access Agreement with Region 7 EPA

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
901 NORTH 5TH STREET
KANSAS CITY, KANSAS 66101

September 28, 2005

A722 7ES
Site: Carver Elevator
ID#: NEN000704351
Break: 10.1
Other:
9-28-05

Ms. Terry J. Satterlee
Lathrop & Gage, L.C.
2345 Grand Boulevard
Suite 2800
Kansas City, Missouri 64108-2684

David M. Traster, Esq.
Foulston & Siefkin L.L.P.
Commerce Bank Center
1551 North Waterfront Parkway
Suite 100
Wichita, Kansas 67206-4466

Re: CERCLA Docket No. 07-2005-0268

Dear Terry and David:

Pursuant to Paragraphs 49 and 50 of the above-referenced Agreement, and in accordance with Section 122(i)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), 42 U.S.C. § 9622(i)(1), and Section 7003(d) of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. § 9673(d), this letter serves as written notice that the public comment period has closed and EPA did not receive any comments regarding the Agreement. Thus, there were no additional facts disclosed or considerations presented during the comment period which would indicate that the Agreement is inappropriate, improper or inadequate. Therefore, the Effective Date of the Agreement is the date of this letter. We appreciate your assistance in finalizing this Agreement, and please do not hesitate to give me a call at (913) 551-7826 if you need additional information or have any questions or concerns.

Sincerely,

Alyse Stoy
Assistant Regional Counsel

cc: Mike Felix, NDEQ
Annette Kovar, NDEQ

40225892
SUPERFUND RECORDS

RECYCLE

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII

05 SEP 28 AM 9:43

ENVIRONMENTAL PROTECTION AGENCY-REGION VII REGIONAL HEARING CLERK

IN THE MATTER OF:	)	**AGREEMENT**
	)	
Garvey Elevator Site	)	**U.S. EPA Region VII**
Hastings, Nebraska	)	***CERCLA Docket No. 07-2005-0268***
	)	
AGP Grain Marketing, LLC	)	**PROCEEDING UNDER SECTION**
and Garvey Elevators, Inc.	)	**122(h)(1) OF CERCLA**
	)	**42 U.S.C. §9622(h)(1)**

I. JURISDICTION

1. This Agreement is entered into pursuant to the authority vested in the Administrator of the U.S. Environmental Protection Agency ("EPA") by Section 122(h)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. § 9622(h)(1), which authority has been delegated to the Regional Administrators of the EPA by EPA Delegation No. 14-14-D and redelegated to the Director, Superfund Division by EPA Regional Delegation No. R7-14-014-D. This Agreement is also entered into pursuant to the authority of the Attorney General of the United States to compromise and settle claims of the United States, which authority, in the circumstances of this settlement, has been delegated to Assistant Attorney General of the Environment and Natural Resources Division.

2. This Agreement is made and entered into by EPA and AGP Grain Marketing, LLC. ("Settling Party"), the party purchasing the Garvey Elevator Site ("Site"), and Garvey Elevators, Inc. ("Garvey"), the current owner/operator of the Site. Settling Party and Garvey consent to and will not contest the authority of the United States to enter into this Agreement or to implement or enforce its terms.

II. BACKGROUND

3. This Agreement concerns the Site which is located near Hastings, Nebraska. EPA alleges that the Site is a facility as defined by Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

4. The Site is an active grain elevator owned and operated by Garvey since 1959. Carbon tetrachloride was used by Garvey as a grain fumigant from 1959 to 1985. Carbon tetrachloride was released into the environment from a leak in an underground delivery pipe at the Site. Settling Party was not involved at the Site until 1993.

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5. Garvey has performed certain actions to investigate and address the contamination at the Site, including the installation of ground water recovery wells and soil vapor extraction wells to address the on-Site soil and groundwater contamination. In addition, Garvey has provided alternate sources of drinking water to nearby homes and businesses with private wells that have been impacted by contamination from the Site.

6. A Preliminary Assessment/Site Investigation was performed by the Nebraska Department of Environmental Quality ("NDEQ") at the Site in January 2003. NDEQ collected ground water samples, conducted a domestic well information and water treatment system survey, conducted a drinking water source/supply survey and a Global Positioning System survey. Information collected at and near the Site suggests that carbon tetrachloride from the Site has reached the aquifer and migrated to nearby drinking water wells.

7. In response to the release or threatened release of hazardous substances at or from the Site, EPA has determined that response actions are necessary at the Site pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604.

8. In performing and/or overseeing response actions at the Site, EPA has incurred response costs and will incur additional response costs in the future.

9. EPA, Settling Party and Garvey recognize that this Agreement has been negotiated in good faith and that this Agreement is entered into without the admission or adjudication of any issue of fact or law. The actions undertaken by Settling Party and Garvey in accordance with this Agreement do not constitute an admission of any liability by Settling Party or Garvey. Settling Party denies it has any liability for the Site. Settling Party and Garvey do not admit, and retain the right to controvert in any subsequent proceedings other than proceedings to implement or enforce this Agreement, the validity of the facts or allegations contained in this Section.

III. PARTIES BOUND

10. This Agreement shall be binding upon EPA and upon Settling Party, Garvey, and their successors and assigns. Any change in ownership or corporate or other legal status of Settling Party or Garvey, including but not limited to any transfer of assets or real or personal property, shall in no way alter Settling Party's or Garvey's rights and responsibilities under this Agreement. Notwithstanding any other provisions of this Agreement, all of the rights, benefits and obligations conferred upon Settling Party under this Agreement may be assigned or transferred to any person with the prior written consent of EPA. EPA shall conduct its review and approval or disapproval of any request for assignment or transfer within a reasonable timeframe, and any consent by EPA will not be unreasonably withheld. Each signatory to this Agreement certifies that he or she is authorized to enter into the terms and conditions of this Agreement and to bind legally the party represented by him or her.

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IV. STATEMENT OF PURPOSE

11. By entering into this Agreement, the mutual objectives of the Parties are to: (1) allow Settling Party to resolve any potential civil liability under Sections 106 and 107 of CERCLA, 42 U.S.C. §§ 9606 and 9607, with regard to the Site as provided in the Covenant Not to Sue by EPA in Section VIII, subject to the Reservations of Rights by EPA in Section IX; and (2) provide for funds paid by Settling Party in consideration for this Agreement to be used by Garvey solely for EPA-approved response actions at the Site in accordance with the Escrow Agreement.

12. Settling Party's responsibilities pursuant to this Agreement include: (i) payment of funds into an escrow account following closing of the purchase agreement to be used by Garvey to fund response actions at the Site; (ii) provide Garvey and EPA access to the Site to conduct response actions; (iii) refrain from any activity that would interfere with the response actions or exacerbate the existing contamination at the Site; and (iv) comply with certain Site use restrictions, described herein.

V. DEFINITIONS

13. Unless otherwise expressly provided herein, terms used in this Agreement that are defined in CERCLA or in regulations promulgated under CERCLA shall have the meanings assigned to them in CERCLA or in such regulations. Whenever terms listed below are used in this Agreement or in any appendix attached hereto, the following definitions shall apply:

a. "Agreement" shall mean this Agreement and any attached appendices. In the event of conflict between this Agreement and any appendix, the Agreement shall control.

b. "CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq*.

c. "Day" shall mean a calendar day. In computing any period of time under this Agreement, where the last day would fall on a Saturday, Sunday, or federal holiday, the period shall run until the close of business of the next working day.

d. "EPA" shall mean the United States Environmental Protection Agency and any successor departments, agencies, or instrumentalities of the United States.

e. "Escrow Agreement" shall mean the Escrow Agreement entered into between Garvey, AGP, EPA and the Escrow Agent, attached as Appendix A.

f. "Interest" shall mean interest at the rate specified for interest on investments of the Hazardous Substance Superfund established by 26 U.S.C. § 9507, compounded on October 1 of each year, in accordance with 42 U.S.C. § 9607(a). The applicable rate of interest shall be the

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rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year.

g. "Paragraph" shall mean a portion of this Agreement identified by an Arabic numeral or a lower case letter.

h. "Parties" shall mean EPA, Settling Party and Garvey.

i. "RCRA" shall mean the Solid Waste Disposal Act, as amended, 42 U.S.C. § 6901, *et seq.* (also known as the Resource Conservation and Recovery Act).

j. "Section" shall mean a portion of this Agreement identified by a Roman numeral.

k. "Settling Party" shall mean AGP Grain Marketing, LLC.

l. "Site" shall mean the Garvey Elevator Superfund Site, encompassing approximately 106 acres, located at 2315 W. Highway #6, Hastings, Adams County, Nebraska, and generally shown on the map included in Appendix B.

m. "United States" shall mean the United States of America, including its departments, agencies, and instrumentalities.

n. "Work" shall mean any and all activities performed by Garvey pursuant to the Administrative Order on Consent for Removal Action and Remedial Investigation/Feasibility Study (Docket No. CERCLA-07-2005-0215), and any response action required by EPA as set forth in any future Record of Decision, Action Memorandum, Administrative Order on Consent, Consent Decree, Unilateral Administrative Order and/or any other directive to be issued by EPA for the Site, as more particularly set forth in the Escrow Agreement.

VI. PAYMENT OF RESPONSE COSTS

14. Within 45 days after the Effective Date of this Agreement as defined in Section XXIII, and pursuant to the terms of the Escrow Agreement attached as Appendix A, and provided that those conditions that warrant Cancellation under Section XXIV have not occurred, Settling Party shall deposit with the Escrow Agent $2,050,000.00 to be placed into an interest bearing Escrow Fund. These funds paid by Settling Party in consideration for this Agreement shall be used by Garvey to perform Work at the Site as directed and approved by EPA in its sole discretion. Garvey further agrees to grant EPA a security interest in the Escrow Fund pursuant to the terms of the Escrow Agreement attached as Appendix A in order to secure Garvey's obligation to EPA pursuant to this Agreement.

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VII. INSTITUTIONAL CONTROLS

15. Commencing on the Effective Date, Settling Party shall refrain from using the Site, or such other property, in any manner that would unreasonably interfere with or adversely affect the implementation, integrity, or protectiveness of the response actions to be performed at or near the Site. Such restrictions include, but are not limited to, (1) the construction, installation, maintenance or use of any wells on the Site for the purpose of extracting water for human use or consumption; (2) disturbance of the subsurface of the Site; and (3) any type of residential development on the Site.

16. Settling Party shall execute and record in the Recorder's Office of Adams County, State of Nebraska, an easement, running with the land, that (i) grants a right of access for the purpose of conducting any activity related to response actions at or near the Site, and (ii) grants the right to enforce the land/water use restrictions listed in Paragraph 15 of this Agreement, or other restrictions that EPA determines are necessary to implement, ensure non-interference with, or ensure the protectiveness of the response actions to be performed at or near the Site. Settling Party shall grant the access rights and the rights to enforce the land/water use restrictions to (i) the United States, on behalf of EPA, and its representatives, (ii) the State and its representatives, (iii) Garvey, its contractors, subcontractors, and/or vendors, and/or (iv) other appropriate grantees. Settling Party shall, within 45 days of acquiring title to the Site, submit to EPA for review and approval with respect to such property:

a. A draft easement, in substantially the form attached hereto as Appendix C, that is enforceable under the laws of the State of Nebraska, and

b. a current title insurance commitment or some other evidence of title acceptable to EPA, which shows title to the land described in the easement to be free and clear of all prior liens and encumbrances, subject to easements, restrictions, reservations of record, liens or encumbrances that are approved by EPA or when, despite best efforts, Settling Party is unable to obtain release or subordination of such prior liens or encumbrances.

Within 15 days of EPA's approval and acceptance of the easement and the title evidence, Settling Party shall update the title search and, if it is determined that nothing has occurred since the effective date of the commitment to affect the title adversely, record the easement with the Recorder's Office of Adams County. Within 30 days of recording the easement, Settling Party shall provide EPA with a final title insurance policy, or other final evidence of title acceptable to EPA, and a copy of the original recorded easement showing the clerk's recording stamps. If the easement is to be conveyed to the United States, the easement and title evidence (including final title evidence) shall be prepared in accordance with the U.S. Department of Justice Title Standards 2001, and approval of the sufficiency of title must be obtained as required by 40 U.S.C. § 255.

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17. For purposes of Paragraph 16 of this Agreement, "best efforts" includes the payment of reasonable sums of money in consideration of an agreement to release or subordinate a prior lien or encumbrance. If Settling Party is unable to obtain an agreement pursuant to Paragraph 16 from the holder of a prior lien or encumbrance to release or subordinate such lien or encumbrance to the easement being created pursuant to this consent decree within 45 days after Settling Party acquires title to the Site, Settling Party shall promptly notify the United States in writing, and shall include in that notification a summary of the steps that Settling Party has taken to attempt to comply with Paragraph 16 of this Agreement. The United States may, as it deems appropriate, assist Settling Party in obtaining the release or subordination of a prior lien or encumbrance. Settling Party shall reimburse the United States for all costs incurred, direct or indirect, by the United States in obtaining such release/subordination of prior liens or encumbrances including, but not limited to, the reasonable cost of attorney time and the amount of monetary consideration paid or just compensation.

18. If EPA reasonably determines that land/water use restrictions in the form of state or local laws, regulations, ordinances or other governmental controls are needed to implement the remedy selected in the future by EPA for the Site, ensure the integrity and protectiveness thereof, or ensure non-interference therewith, Settling Party shall provide reasonable cooperation with EPA's efforts to secure such governmental controls.

19. Notwithstanding any provision of this Agreement, the United States retains all of its rights to require land/water use restrictions, including enforcement authorities related thereto, under CERCLA, RCRA and any other applicable statute or regulations.

VIII. DUE CARE/COOPERATION

20. Settling Party shall exercise due care at the Site with respect to the contamination and shall comply with all local, State, and federal laws and regulations. EPA and Garvey agree, consistent with their responsibilities under applicable law, to use reasonable efforts to minimize any interference with Settling Party's operations by their entry and response. EPA believes based on current information that response actions to address the contamination should not materially interfere with Settling Party's operations, and EPA agrees, consistent with the NCP, to make every effort to select future response actions that will not result in material interference with Setting Party's operations. In the event Settling Party becomes aware of any action or occurrence which causes or threatens a release of hazardous substances, pollutants or contaminants at or from the Site that constitutes an emergency situation or may present an immediate threat to public health or welfare or the environment, Settling Party shall immediately take all reasonable and appropriate action to prevent, abate, or minimize such release or threat of release, and shall, in addition to complying with any applicable notification requirements under Section 103 of CERCLA, 42 U.S.C. § 9603, or any other law, immediately notify EPA of such release or threatened release.

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IX. CERTIFICATION

21. By entering into this Agreement, Settling Party certifies that to the best of its knowledge and belief it has fully and accurately disclosed to EPA all information known to Settling Party and all information in the possession or control of its officers, directors, employees, contractors and agents which relates in any way to any hazardous substances, pollutants or contaminants present or existing on or under the Site as of the Effective Date of this Agreement, or any past or potential future release of hazardous substances, pollutants or contaminants at or from the Site. The Settling Party also certifies that to the best of its knowledge and belief it has not caused or contributed to a release or threat of release of hazardous substances or pollutants or contaminants at the Site. If the United States determines that information provided by Settling Party is not materially accurate and complete, the Agreement, within the sole discretion of the United States, shall be null and void and United States reserves all rights it may have.

X. FAILURE TO COMPLY WITH AGREEMENT

22. Interest on Late Payments. If Settling Party fails to make any payment required by Paragraph 14 by the required due date, Interest shall continue to accrue on the unpaid balance through the date of payment. Payment of Interest made under this Paragraph shall be in addition to such other remedies or sanctions available to the United States by virtue of Settling Party's failure to make timely payments pursuant to Section VI, including but not limited to, payment of stipulated penalties pursuant to Paragraph 23.

23. Stipulated Penalty.

a. If the amount due to EPA under Paragraph 14 is not paid by the required date, Settling Party shall be in violation of this Agreement and shall pay to EPA, as a stipulated penalty, in addition to the Interest required by Paragraph 22, $2,500.00 per violation per day that such payment is late.

b. If Garvey fails to fully comply with the terms of this Agreement and Escrow Agreement attached as Appendix A, as determined by EPA, Garvey shall be in violation of this Agreement and shall pay to EPA, as a stipulated penalty $2,500.00 per violation per day of such noncompliance.

c. Stipulated penalties are due and payable within 30 days of the date of demand for payment of the penalties by EPA. All payments to EPA under this Paragraph shall be identified as "stipulated penalties" and shall be made by certified or cashier's check made payable to "EPA Hazardous Substance Superfund." The check, or a letter accompanying the check, shall identify the name and address of the party making payment, the Site name, the EPA Region and Site/Spill ID # A72Z, and the EPA docket number for this action (CERCLA-07-2005-0268), and shall be sent to:

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Mellon Bank
EPA Superfund
P.O. Box 371099M
Pittsburgh, Pennsylvania 15251

d. At the time of each payment, Settling Party and/or Garvey shall also send notice that payment has been made to EPA in accordance with Section XIV (Notices and Submissions). Such notice shall identify the EPA Region and Site-Spill ID # A72Z and the EPA Docket Number for this action.

e. Penalties shall accrue as provided above regardless of whether EPA has notified Settling Party or Garvey of the violation or made a demand for payment, but need only be paid upon demand. All penalties shall begin to accrue on the day after payment or performance is due or the day a violation occurs, and shall continue to accrue through the date of payment or the final day of correction of the noncompliance or completion of the activity. Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Agreement.

24. In addition to the Interest and Stipulated Penalty payments required by this Section and any other remedies or sanctions available to the United States by virtue of Settling Party's or Garvey's failure to comply with the specified requirements of this Agreement, Settling Party and Garvey shall be subject to enforcement action pursuant to Section 122(h)(3) of CERCLA, 42 U.S.C. § 9622(h)(3) for failure or refusal to comply with any term or condition of this Agreement. If the United States brings an action to enforce this Agreement and is successful, Settling Party and Garvey shall reimburse the United States for all costs of such action, including but not limited to costs of attorney time. The rights and obligations of Garvey and Settling Party pursuant to this Agreement are severable and shall not be in any manner dependent upon each other.

25. Notwithstanding any other provision of this Section, EPA may, in its unreviewable discretion, waive payment of any portion of the stipulated penalties that have accrued pursuant to this Agreement. Settling Party's or Garvey's payment of stipulated penalties shall not excuse Settling Party or Garvey from payment as required by Section VI or from performance of any other requirements of this Agreement.

XI COVENANT NOT TO SUE BY EPA

26. Covenant Not to Sue by EPA. Except as specifically provided in Section XII (Reservations of Rights by EPA), EPA covenants not to sue or to take any other civil or administrative action against Settling Party, its successors and assigns pursuant to Sections 106 and 107(a) of CERCLA, 42 U.S.C. §§ 9606 and 9607(a), and Section 7003 of RCRA, 42 U.S.C. § 6973, with regard to the Site. This covenant shall take effect upon receipt by EPA of the amount required by Section VI (Payment of Response Costs). This covenant not to sue is conditioned upon the satisfactory performance by Settling Party of its obligations under this Agreement. This covenant not to sue extends only to Settling Party and does not extend to any

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other person. EPA, and the United States on behalf of EPA, expressly do not extend this covenant not to sue to Garvey or any of its predecessors, successors, assigns, parent corporation(s), subsidiary(s), officer(s), director(s), or employees.

XII. RESERVATIONS OF RIGHTS BY EPA

27. EPA reserves, and this Agreement is without prejudice to, all rights against Settling Party with respect to all matters not expressly included within the Covenant Not to Sue by EPA in Paragraph 28. Notwithstanding any other provision of this Agreement, EPA reserves all rights against Settling Party with respect to:

a. liability for failure of Settling Party to meet a requirement of this Agreement;

b. criminal liability;

c. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments;

d. liability resulting from exacerbation by Settling Party, its successors, assignees, lessees or sublessees, of contamination at the Site;

e. liability, based upon Settling Party's transportation, treatment, storage, or disposal, or the arrangement for the transportation, treatment, storage, or disposal, of a hazardous substance or a solid waste at or in connection with the Site, after signature of this Agreement by Settling Party;

f. liability arising from the past, present, or future disposal, release or threat of release of a hazardous substance, pollutant, or contaminant by Settling Party outside of the Site; and

g. liability under RCRA arising after the Effective Date of this Agreement on account of any actions by Settling Party, its successors, assignees, contractors, subcontractors, representatives, lessees or sublessees that require a RCRA permit in accordance with 42 U.S.C. § 6925 and 40 C.F.R. Parts 264 through 270.

28. Nothing in this Agreement is intended to be nor shall it be construed as a release, covenant not to sue, or compromise of any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or in equity, which EPA may have against any person, firm, corporation or other entity not a signatory to this Agreement. In addition, nothing in this Agreement is intended to be nor shall it be construed as a release, covenant not to sue, or compromise of any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or in equity, which EPA may have against Garvey or any of its predecessors, successors, assigns, parent corporation(s), subsidiary(s), officer(s), director(s), or employees.

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29. Nothing in this Agreement is intended to limit the right of EPA to undertake future response actions at the Site or to seek to compel parties other than Settling Party to perform or pay for response actions at the Site. Nothing in this Agreement shall in any way restrict or limit the nature or scope of response actions which may be taken or be required by EPA in exercising its authority under federal law. Settling Party acknowledges that it is purchasing property where response actions may be required.

XIII. COVENANT NOT TO SUE BY SETTLING PARTY

30. Settling Party covenants not to sue and agrees not to assert any claims or causes of action against the United States, or its contractors or employees, with respect to the Site or this Agreement, including but not limited to:

a. any direct or indirect claim for reimbursement from the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, based on Sections 106(b)(2), 107, 111, 112, or 113 of CERCLA, 42 U.S.C. §§ 9606(b)(2), 9607, 9611, 9612, or 9613, or any other provision of law;

b. any claims arising out of response actions at or in connection with the Site, including any claim under the United States Constitution, the Nebraska Constitution, the Tucker Act, 28 U.S.C. § 1491, the Equal Access to Justice Act, 28 U.S.C. § 2412, as amended, or at common law; and

c. any claim against the United States pursuant to Sections 107 and 113 of CERCLA, 42 U.S.C. §§ 9607 and 9613, relating to the Site.

Except as provided in Paragraph 34 (Waiver of Claim-Splitting Defenses), these covenants not to sue shall not apply in the event the United States brings a cause of action or issues an order pursuant to the reservations set forth in Paragraph 27(c), (e), or (f), but only to the extent that Settling Party's claims arise from the same response action or response costs that the United States is seeking pursuant to the applicable reservation.

31. Nothing in this Agreement shall be deemed to constitute approval or preauthorization of a claim within the meaning of Section 111 of CERCLA, 42 U.S.C. § 9611, or 40 C.F.R. 300.700(d).

XIV. EFFECT OF SETTLEMENT/CONTRIBUTION PROTECTION

32. Nothing in this Agreement shall be construed to create any rights in, or grant any cause of action to, any person not a Party to this Agreement. EPA reserves any and all rights (including, but not limited to, any right to contribution), defenses, claims, demands, and causes of action that it may have with respect to any matter, transaction, or occurrence relating in any way to the Site against any person not a Party hereto.

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33. The Parties agree that Settling Party is entitled, as of the effective date of this Agreement, to protection from contribution actions or claims as provided by Sections 113(f)(2) and 122(h)(4) of CERCLA, 42 U.S.C. §§ 9613(f)(2) and 9622(h)(4), for "matters addressed" in this Agreement. The "matters addressed" in this Agreement are all response actions taken or to be taken and all response costs incurred or to be incurred, at or in connection with the Site, by the United States or by any other person. The "matters addressed" in this Agreement do not include those response costs or response actions as to which EPA has reserved its rights under this Agreement (except for claims for failure to comply with this Agreement), in the event that EPA asserts rights against Settling Party coming within the scope of such reservations.

34. In any subsequent administrative or judicial proceeding initiated by EPA, or the United States on behalf of EPA, for injunctive relief, recovery of response costs, or other relief relating to the Site, Settling Party shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, *res judicata*, collateral estoppel, issue preclusion, claim-splitting, or other defenses based upon any contention that the claims raised by EPA, or the United States on behalf of EPA, in the subsequent proceeding were or should have been brought in the instant case; provided, however, that nothing in this Paragraph affects the enforceability of the Covenant Not to Sue by EPA set forth in Section XI.

XV. SITE ACCESS

35. Commencing upon the effective date of this Agreement, and to the extent Settling Party has legal authority to control access to the Site, Settling Party agrees to provide EPA, Garvey and their representatives and contractors access at all reasonable times to the Site for the purpose of conducting any response activity related to the Site, including but not limited to:

a. Monitoring, investigation, removal, remedial or other activities at the Site;

b. Verifying any data or information submitted to EPA;

c. Conducting investigations relating to contamination at or near the Site;

d. Obtaining samples;

e. Assessing the need for, planning, or implementing response actions at or near the Site; and

f. Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Settling Party or its agents, consistent with Section XVI (Access to Information).

36. Settling Party shall ensure that assignees, successors in interest, lessees, and sublessees of the Site property shall be subject to the same requirement to provide the same access and cooperation. Settling Party shall ensure that a copy of this Agreement is provided to any current

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lessee or sublessee on the Site property as of the effective date of this Agreement and shall ensure that any subsequent leases, subleases, assignments or transfers of the Site property or an interest in the Site property are consistent with this Agreement.

37. Notwithstanding any provision of this Agreement, EPA retains all of its access authorities and rights, including enforcement authorities related thereto, under CERCLA, RCRA, and any other applicable statutes or regulations.

XVI. ACCESS TO INFORMATION

38. Settling Party shall provide to EPA, upon request, copies of all records, reports, or information (hereinafter referred to as "records") within its possession or control or that of its contractors or agents relating to activities at the Site or to the implementation of this Agreement, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence, or other documents or information related to the Site.

39. Confidential Business Information and Privileged Documents.

a. Settling Party may assert business confidentiality claims covering part or all of the records submitted to EPA under this Agreement to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. § 9604(e)(7), and 40 C.F.R. 2.203(b). Records determined to be confidential by EPA will be accorded the protection specified in 40 C.F.R. Part 2, Subpart B. If no claim of confidentiality accompanies records when they are submitted to EPA, or if EPA has notified Settling Party that the records are not confidential under the standards of Section 104(e)(7) of CERCLA or 40 C.F.R. Part 2 Subpart B, the public may be given access to such documents or information without further notice to Settling Party.

b. Settling Party may assert that certain records are privileged under the attorney-client privilege or any other privilege recognized by federal law. If Settling Party asserts such a privilege in lieu of providing records, they shall provide EPA with the following: 1) the title of the record; 2) the date of the record; 3) the name, title, affiliation (*e.g.*, company or firm), and address of the author of the record; 4) the name and title of each addressee and recipient; 5) a description of the subject of the record; and 6) the privilege asserted. If a claim of privilege applies only to a portion of a record, the record shall be provided to EPA in redacted form to mask the privileged portion only. Settling Party shall retain all records that it claims to be privileged until EPA has had a reasonable opportunity to dispute the privilege claim and any such dispute has been resolved in the Settling Party's favor. However, no records created or generated pursuant to the requirements of this or any other settlement with the EPA pertaining to the Site shall be withheld on the grounds that they are privileged.

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40. No claim of confidentiality shall be made with respect to any data, including but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, or engineering data, or any other documents or information evidencing conditions at or around the Site.

XVII. RETENTION OF RECORDS

41. Until 15 years after the Effective Date of this Agreement, Settling Party shall preserve and retain all records now in its possession or control, or which come into its possession or control, that relate in any manner to response actions taken at the Site or to the liability of any person for response actions or response costs at or in connection with the Site, regardless of any corporate retention policy to the contrary.

42. After the conclusion of the document retention period in the preceding paragraph, Settling Party shall notify EPA at least 90 days prior to the destruction of any such record, and, upon request by EPA, Settling Party shall deliver such records to EPA. Settling Party may assert that certain records are privileged under the attorney-client privilege or any other privilege recognized by federal law. If Settling Party asserts such a privilege, it shall provide EPA with the following: 1) the title of the record; 2) the date of the record; 3) the name, title, affiliation (*e.g.*, company or firm), and address of the author of the record; 4) the name and title of each addressee and recipient; 5) a description of the subject of the record; and 6) the privilege asserted. If a claim of privilege applies only to a portion of a record, the record shall be provided to EPA in redacted form to mask the privileged portion only. Settling Party shall retain all records that it claims to be privileged until EPA has had a reasonable opportunity to dispute the privilege claim and any such dispute has been resolved in the Settling Party's favor. However, no records created or generated pursuant to the requirements of this or any other settlement with the EPA pertaining to the Site shall be withheld on the grounds that they are privileged.

XVIII. RECORDS CERTIFICATION

43. Settling Party hereby certifies that, to the best of its knowledge and belief, after thorough inquiry, it has not altered, mutilated, discarded, destroyed or otherwise disposed of any records, reports, or information relating to the Site or its involvement with the Site and that it has fully complied with any and all EPA requests for information regarding the Site pursuant to Sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e), and Section 3007 of RCRA, 42 U.S.C. § 6927.

XIX. DISPUTE RESOLUTION

44. Unless otherwise expressly provided for in this Agreement, the dispute resolution procedures of this Section shall be the exclusive mechanism for resolving disputes arising under this Agreement. The Parties shall attempt to resolve any disagreements concerning this Agreement expeditiously and informally.

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45. If Settling Party and/or Garvey objects to any EPA action taken pursuant to this Agreement it shall notify EPA in writing of its objection(s) within 10 days of such action, unless the objection(s) has/have been resolved informally. EPA and Settling Party and/or Garvey shall have 30 days from EPA's receipt of the written objection(s) to resolve the dispute through formal negotiations (the "Negotiation Period"). The Negotiation Period may be extended upon mutual agreement of the Parties to the dispute.

46. Any agreement reached by the Parties pursuant to this Section shall be in writing and shall, upon signature by the parties to the dispute, be incorporated into and become an enforceable part of this Agreement. If the Parties are unable to reach an agreement within the Negotiation Period, the EPA Region VII Regional Judicial Officer will issue a written decision on the dispute. The EPA's decision shall be incorporated into and become an enforceable part of this Agreement. Settling Party's and/or Garvey's obligations under this Agreement shall not be tolled by submission of any objection for dispute resolution under this Section, unless EPA otherwise agrees in writing. Following resolution of the dispute, as provided by this Section, Settling Party and/or Garvey shall fulfill the requirement that was the subject of the dispute in accordance with the agreement reached or with EPA's decision, whichever occurs.

XX. NOTICES AND SUBMISSIONS

47. Whenever, under the terms of this Agreement, notice is required to be given or a document is required to be sent by one Party to another, it shall be directed to the individuals at the addresses specified below, unless those individuals or their successors give notice of a change to the other Parties in writing. Written notice as specified herein shall constitute complete satisfaction of any written notice requirement of this Agreement with respect to EPA, Settling Party and Garvey.

As to EPA:

Alyse Stoy
Office of Regional Counsel
U.S. Environmental Protection Agency
901 N. 5th Street
Kansas City, Kansas 66101

Brian Mitchell, Environmental Engineer
Superfund Division
U.S. Environmental Protection Agency
901 North 5th Street
Kansas City, Kansas 66101

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As to Settling Party:

AGP Grain Marketing, LLC
Attn: Legal Department
12700 West Dodge Road
Omaha, Nebraska 68154

As to Garvey:

Garvey Elevators, Inc.
Attn: Richard Garvey, President
2918 Wingate Street
P.O. Box 9600
Fort Worth, Texas 76147

David M. Traster
Foulston Siefkin, LLP
1551 North Waterfront Parkway
Suite 100
Wichita, Kansas 67206-4466

XXI. INTEGRATION/APPENDICES

48. This Agreement and its appendices contains the entire understanding between the Parties with respect to the matters set forth herein. Provided, however, the parties have entered into other agreements including the Purchase Agreement between AGP and Garvey, an Administrative Order on Consent between EPA and Garvey (Docket No. CERCLA-07-2005-0215), an Escrow Agreement between EPA, Garvey, AGP, and JPMorgan Chase Bank, N.A., and a Security Agreement between EPA and Garvey. Further, this Agreement contemplates disbursements for Work to be set forth in any future Record of Decision, Action Memorandum, Consent Decree, Administrative Order on Consent, Unilateral Administrative Order, and/or other directive to be issued by EPA for the Site. Nothing in this Agreement shall be deemed to alter or amend such other agreements, and there shall be no merger of said agreements. Nevertheless, such agreements shall be construed in light of one another to accomplish the purposes of the parties as provided in all of such agreements. The following appendices are attached to and incorporated into this Agreement:

Appendix A is the Escrow Agreement;
Appendix B is the Site Map;
Appendix C is the Restrictive Covenant and Environmental Easement.

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XXII. PUBLIC COMMENT

49. This Agreement shall be subject to a public comment period of not less than 30 days pursuant to Section 122(i) of CERCLA, 42 U.S.C. § 9622(i). In accordance with Section 122(i)(3) of CERCLA, the United States may modify or withdraw its consent to this Agreement if comments received disclose facts or considerations which indicate that this Agreement is inappropriate, improper, or inadequate.

XXIII. EFFECTIVE DATE

50. The Effective Date of this Agreement shall be the date upon which EPA issues written notice that the public comment period pursuant to Paragraph 49 has closed and that comments received, if any, do not require modification of or withdrawal by the United States from this Agreement.

XXIV. CANCELLATION

51. This Agreement is subject to Cancellation by Settling Party within thirty (30) days of the Effective Date if for any reason Settling Party and Garvey have failed to close on the purchase agreement for the Site. This provision does not in any way affect Settling Party or Garvey's rights or obligations under the Purchase Agreement or alter or amend the terms thereof.

IT IS SO AGREED:

AGP Grain Marketing, LLC

By: J. Keith Spackler 6/30/05
Name: J. KEITH SPACKLER Date
MANAGER, SECRETARY & TREASURER

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Garvey Elevators, Inc.

By: Richard F. Garvey

Name RICHARD F. GARVEY

PRESIDENT

7-5-05

Date

U.S. Environmental Protection Agency

By: _____ July 6, 2005
Alyse Stoy Date
Assistant Regional Counsel
U.S. Environmental Protection Agency, Region VII

By: _____ 7/11/05
Cecilia Tapia, Director Date
Superfund Division
U.S. Environmental Protection Agency, Region VII

U.S. Department of Justice

By: Kelly A Johnson
Kelly A. Johnson
Acting Assistant Attorney General
Environment and Natural Resources Division
U.S. Department of Justice
Washington, D.C. 20530

8/8/05
Date

By: Katherine A. Loyd
Katherine A. Loyd
Trial Attorney
U.S. Department of Justice
Environmental Enforcement Section
Environment and Natural Resources Division
P.O. Box 7611
Washington, DC 20044-7611

08/10/05
Date

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Appendix A

Escrow Agreement

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ESCROW AGREEMENT

This Escrow Agreement (the "Escrow Agreement") is entered into to be effective as of September 28, 2005 by and between Garvey Elevators, Inc., a Kansas corporation ("Garvey"), AGP Grain Marketing, LLC, an Iowa limited liability company ("AGP"), the United States of America by and through the Environmental Protection Agency (the "EPA"), and JPMorgan Chase Bank, N.A., a national association ("Escrow Agent").

I. RECITALS

1.1 Whereas, Garvey, as Seller, and AGP, as Buyer, have entered into a certain Real Estate Purchase Agreement (the "Purchase Agreement") dated the sixth (6th) day of December, 2004, as amended, wherein Garvey has agreed to sell to AGP and AGP has agreed to purchase from Garvey certain real and personal property more particularly described in the Purchase Agreement. Escrow Agent is not a party to, has not received and will not be responsible for the Purchase Agreement.

1.2 Whereas, the real property described in the Purchase Agreement is known as the Garvey Elevator Superfund Site ("Site") and is a location where hazardous substances have been released.

1.3 Whereas, EPA alleges that Garvey is liable pursuant to the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as Amended, 42_U.S.C. § 9601 *et seq.* ("CERCLA") for all response actions to be performed at the Site and all response costs incurred and to be incurred by the United States in connection with the Site.

1.4 Whereas, Garvey and AGP have agreed to deposit a portion of the proceeds of the sale of the Site into an Escrow Fund to be held and disbursed by the Escrow Agent pursuant to an Agreement between EPA, AGP and Garvey (CERCLA-07-2005-0268)("Agreement") and the terms of this Escrow Agreement.

1.5 Whereas, Garvey asserts that it has limited funds and that the Escrow Fund is Garvey's only source of funds available to perform all response actions to be implemented at the Site and to pay for response costs incurred and to be incurred by EPA and NDEQ related to the Site.

1.6 Whereas, all disputes regarding the enforcement of this Escrow Agreement shall be resolved using the Dispute Resolution provision set forth in Section XIX of the Agreement. Escrow Agent will not be responsible for the Dispute Resolution provision set forth in Section XIX of the Agreement.

1.7 Whereas, the Escrow Agent is independent of the parties and has no prior relationship with Garvey or AGP.

1.8 Whereas, in consideration of the premises, the mutual covenants and agreements contained herein and other good and valuable consideration, the receipt and sufficiency of which are hereby mutually acknowledged and agreed, Garvey, EPA, AGP and the Escrow Agent agree to the matters set forth in this Escrow Agreement.

1.9 Garvey and AGP hereby appoint the Escrow Agent as their escrow agent for the purposes set forth herein, as approved by EPA, and the Escrow Agent hereby accepts such appointment under the terms and conditions set forth herein.

II. AGREEMENT

2.1 In conjunction with the closing of the sale under the Purchase Agreement, AGP shall transfer and deposit with the Escrow Agent Two Million Fifty Thousand Dollars ($2,050,000.00) of the Purchase Price as defined in the Purchase Agreement (the "Escrow Deposit"). The Escrow Agent shall hold the Escrow Deposit and, subject to the terms and conditions hereof, shall invest and reinvest the Escrow Deposit and the proceeds thereof (together, the "Escrow Fund") as directed in Section 2.2. The Escrow Fund shall be irrevocable. Further, this Escrow Agreement shall not be effective unless or until the closing occurs under the Purchase Agreement and this Escrow Fund is funded.

2.2 Upon receipt of the Escrow Fund, the Escrow Agent shall deliver to Garvey, the EPA and AGP an acknowledgment of receipt showing the amount of the Escrow Fund. The Escrow Fund shall be placed by the Escrow Agent in an interest bearing account ("JPMorgan MMA"), unless otherwise instructed in writing by Garvey and EPA. Such written instructions, if any, referred to in the foregoing sentence shall specify the type and identity of the investments to be purchased and/or sold and will be executed through JPMorgan Asset Management ("JPMAM"), in the investment management division of JPMorgan Chase. Subject to the principles of best execution, transactions are effected on behalf of the Escrow Fund through broker-dealers selected by JPMAM. A reasonable and customary agency fee will be assessed in connection with each transaction as set forth in Exhibit C (Fee Schedule). The Escrow Agent shall have the right to liquidate any investment held in order to provide funds necessary to make required payments under this Escrow Agreement. The Escrow Agent shall have no liability for any loss sustained as a result of any investment made pursuant to the terms of this Escrow Agreement or as a result of any liquidation of any investment prior to its maturity or for the failure of the parties to give the Escrow Agent instructions to invest or reinvest the Escrow Fund. The parties acknowledge that the Escrow Agent may receive reasonable and customary compensation with respect to any investment directed hereunder, however this compensation shall not in any way be paid from or deducted from the Escrow Fund. Receipt, investment and reinvestment of the Escrow Deposit shall be confirmed by Escrow Agent as soon as practicable by account statement, and any discrepancies in any such account statement shall be noted by the parties to the Escrow Agent within 30 calendar days after receipt thereof. All interest and other income earned on the Escrow Fund, less all applicable state and federal income taxes due on such income, shall be included in and become part of the Escrow Fund.

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2.3 Eligible Payments from Escrow Fund: The escrow created by this Escrow Agreement will provide funds necessary to implement response actions at the Site, pay for any and all past and future response costs that have been or may be incurred by the United States or the Nebraska Department of Environmental Quality ("NDEQ") at the Site pursuant to CERCLA, and to otherwise fund any and all past and future costs, including but not limited to oversight costs, natural resource damages and any obligation Garvey has or may have to EPA or NDEQ at the Site under the Administrative Order on Consent for Removal Action and Remedial Investigation/Feasibility Study (EPA Docket Number CERCLA-07-2005-0215) as well as any response action required by EPA as set forth in any future Record of Decision, Action Memorandum, Consent Decree, Administrative Order on Consent, Unilateral Administrative Order, and/or other directive to be issued by EPA for the Site (collectively the "Work"). EPA asserts that the Work is necessary for investigation and cleanup of the currently existing environmental contamination at the Site owned by Garvey and legally described on Exhibit "A" attached hereto. The Work also expressly includes EPA past response costs and shall also include EPA and NDEQ direct and indirect costs that Garvey has agreed to pay pursuant to an Administrative Order on Consent or Consent Decree, and incurred by EPA and/or NDEQ in reviewing or developing plans, reports and other items prepared by Garvey to implement the Work, verifying the Work, or otherwise implementing, overseeing, or enforcing the Work, including but not limited to, payroll costs, contractor costs, travel costs, laboratory costs, Agency for Toxic Substances and Disease Registry costs, costs paid to secure access, emergency response, and Work takeover. Eligible payments further include any taxes owed by Garvey to the appropriate taxing authority as set forth in Section 2.37. Garvey acknowledges and warrants to AGP and to the EPA that Garvey will use reasonable efforts to complete the Work in a timely and workmanlike manner and that the Escrow Fund will be used for only the purposes outlined in this Escrow Agreement. Garvey further warrants to AGP and the EPA that Garvey will begin the Work as soon as reasonably practical after the execution of this Escrow Agreement and the funding of the Escrow Fund.

2.4 EPA Approval of Disbursements: Except as otherwise provided in this Escrow Agreement, the Escrow Agent shall disburse Escrow Funds directly to Garvey's contractors, subcontractors and/or vendors as the charges become due after Garvey submits written disbursement requests for Work performed that have been approved in writing by EPA. Except as provided in Sections 2.5 and 2.7, prior to Garvey's submission of a disbursement request to the Escrow Agent, Garvey shall submit the request to the EPA for review and approval. The EPA shall have thirty (30) days, or shorter timeframe as agreed to by Garvey and EPA for any particular disbursement request, from the receipt of such request to review and approve or disapprove the request. After the request has been approved in writing by the EPA, Garvey shall submit the request to the Escrow Agent for payment and the Escrow Agent shall make disbursements of the Escrow Fund without any further instructions or documentation from Garvey or EPA. Any EPA disapproval of a disbursement request shall be subject to Garvey's right to invoke the Dispute Resolution provision set forth in Section XIX of the Agreement. There is a presumption that any disbursement request by Garvey to disburse funds necessary to

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implement response actions pursuant to an EPA-approved or NDEQ-approved work plan will be approvable by EPA.

The request shall state the payee(s), a description of the Work performed relating to the disbursement request, the amount of the requested disbursement to be paid directly to each contractor, subcontractor or vendor who has performed part of the Work and shall include copies of invoices for labor, materials and/or any other expenses applicable to that portion of the Work for which disbursement of the Escrow Fund is requested. The Escrow Agent shall not have any obligation to review any supporting invoices, and Escrow Agent shall not be liable for any action taken or omitted to be taken in reliance upon any written notice, request, waiver, consent, certificate, receipt, authorization, or other paper or document delivered to Escrow Agent by Garvey or EPA and believed by it to be genuine.

2.5 EPA Pre-Approval of Disbursements: Garvey may submit a request to the EPA for pre-approval of a disbursement request. The EPA shall have thirty (30) days, or shorter timeframe as agreed to by Garvey and EPA for any particular disbursement request, from the receipt of such pre-approval request to review and approve or disapprove the request. The request for pre-approval shall state the proposed payee(s), a description of the Work to be performed relating to the disbursement request, the amount of the requested disbursement to be paid directly to each contractor, subcontractor or vendor who will perform part of the Work and shall include an estimate prepared by the contractor, subcontractor or vendor for labor, materials and/or any other expenses applicable to that portion of the Work for which disbursement of the Escrow Fund is requested. If the request has been pre-approved in writing by the EPA, the Work actually performed was substantially the same as the Work described in the pre-approval request to EPA, and the actual cost of the Work performed by the contractor or subcontractor is 90% to 110% of the amount pre-approved by EPA, Garvey shall provide documentation to EPA identifying the payee(s), a description of the Work performed relating to the disbursement request, the amount of the requested disbursement to be paid directly to each contractor, subcontractor and/or vendor who has performed part of the Work and copies of invoices for labor, materials and/or any other expenses applicable to that portion of the Work for which disbursement of the Escrow Fund is requested. EPA then shall submit approval of such disbursement as provided in Paragraph 2.4. Upon EPA approval, Garvey may submit the request to the Escrow Agent for payment. If the actual cost of the Work performed by the contractor or subcontractor is less than 90% or more than 110% of the amount pre-approved by EPA, or if the Work performed is substantially changed from the Work described in the pre-approval request to EPA, then Garvey shall submit a new request for approval to EPA pursuant to Section 2.4. Mere variance between the original estimated cost and the actual cost consistent with the terms of this Paragraph shall not be a basis for disapproval of a payment request.

2.6 It is the intent of EPA and Garvey to work cooperatively throughout the implementation of the review and approval process of requests for disbursements from the Escrow Fund. The requirements of the review and approval process may be modified upon mutual agreement of the parties as set forth in Section 2.18.

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2.7 EPA Demands for Past Costs and EPA/NDEQ Bills for Costs: Any demand by EPA for reimbursement of past costs incurred in connection with the Site shall be paid from the Escrow Fund to the extent there are funds available to pay such demand. Garvey reserves its right to raise any defenses it may have to liability for payment of such past response costs.

Any EPA or NDEQ bill for direct and indirect costs (as further described in Section 2.3) issued by EPA or NDEQ to Garvey shall be paid from the Escrow Fund to the extent there are funds available to pay such bill. EPA and NDEQ shall send any bill for direct and indirect costs to Garvey and the Escrow Agent instructing Escrow Agent to pay such bill, and the Escrow Agent shall make disbursements of the Escrow Fund by the due date specified in the bill (which shall be at least 30 days after Garvey's receipt of the bill) without any further instructions, approval, signatures or documentation from Garvey, EPA or NDEQ, subject to any dispute resolution rights Garvey may have. If Garvey invokes its right to dispute resolution to resolve a dispute relating to a bill, the Escrow Agent shall make disbursements from the Escrow Fund for such costs in accordance with the agreement reached by the EPA and Garvey or any final decision issued by the Regional Judicial Officer.

Payments to EPA made pursuant to this Section shall be by a trust check made payable to "EPA Hazardous Substances Superfund" to be placed into the Garvey Elevator Site Special Account, referencing the name and address of the party making the payment and EPA Site/Spill ID number A72Z. The check shall be sent to: Mellon Bank, U.S. Environmental Protection Agency Region VII, P.O.Box 371099M, Pittsburgh, PA, 15251. At the time of payment, the Escrow Agent shall send notice that payment has been made to:

Linda Long
Regional Financial Management Officer
U.S. Environmental Protection Agency
901 N. 5th Street
Kansas City, Kansas 66101

Brian Mitchell, Environmental Engineer
Superfund Division
U.S. Environmental Protection Agency
901 North 5th Street
Kansas City, Kansas 66101

Garvey Elevators, Inc.
P.O. Box 9600
Fort Worth, Texas 76147
Attention: Richard Garvey, President

Payments to NDEQ made pursuant to this Section shall be by a trust check or checks made payable to "Department of Environmental Quality, State of Nebraska" referencing the name and

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address of the party making the payment and NDEQ number 36-345-4596. The check shall be sent to: Nebraska Department of Environmental Quality, Attn: Diane Hiller, Suite 400, The Atrium, 1200 N. Street, P.O. Box 98922, Lincoln, NE 68509-8922, with notice of such payment to EPA and Garvey.

2.8 Final Request: Upon final completion of the Work, Garvey shall deliver to the EPA, for review and approval, which approval or disapproval shall not be unreasonably withheld or delayed, a statement certifying that the Work has been fully completed (the "Final Request"). Garvey shall only be entitled to the remaining balance in the Escrow Fund if and upon the express condition that the EPA approves the Final Request in writing and certifies in writing to Garvey that the Work has been completed in full compliance with CERCLA and in satisfaction of Garvey's obligations under CERCLA to the EPA's satisfaction (the "Final Certification"). After the EPA has issued its Final Certification, Garvey shall submit the Final Request to the Escrow Agent for payment with a copy of the Final Certification. The Escrow Agent shall thereupon make the disbursement of the remaining balance of the Escrow Fund to Garvey.

2.9 Whenever under the terms hereof the time for performance of any provisions shall fall on a date which is not a regular Business Day of Escrow Agent, the performance thereof on the next succeeding regular Business Day of Escrow Agent shall be deemed to be in full compliance. Whenever time is referred to in this Escrow Agreement, it shall be the time recognized by Escrow Agent in the ordinary conduct of its normal business transactions. Escrow Agent shall be deemed to have properly delivered any item of property upon (i) placing the item in the United States mail in a suitable package or envelope with first class prepaid postage - affixed, addressed to the addressee at such addressee's address as set forth in this Escrow Agreement or such other address as any of the undersigned shall have furnished to Escrow Agent in writing; (ii) delivery in person at Escrow Agent's offices; or (iii) delivery in any other manner pursuant to written instructions of the party to whom such property is to be delivered.

2.10 All reasonable and customary escrow fees charged by the Escrow Agent (Exhibit "C", Fee Schedule) shall be paid from the Escrow Fund. In the event that there are inadequate funds in the Escrow Fund to pay moneys owing to Escrow Agent hereunder, AGP and Garvey jointly and severally agree to pay Escrow Agent such amount. Upon such payment, the Escrow Fund shall be closed and all obligations of the Parties pursuant to this Escrow Agreement shall terminate. In addition, AGP and Garvey hereby jointly and severally agree, to the extent funds are not available in the Escrow Fund, to pay to Escrow Agent all reasonable expenses, disbursements and advances incurred or made by the Escrow Agent in performance of its duties hereunder, including but not limited to, legal fees and expenses, in the event Escrow Agent deems it necessary to retain counsel. Such amounts shall be paid to Escrow Agent within 10 days following receipt by AGP or Garvey of a written statement setting forth such expenses.

2.11 During the term of this Escrow Agreement, the Escrow Agent at no additional charge shall provide AGP, Garvey, EPA and NDEQ each with quarterly statements containing the beginning balance in the Escrow Account as well as all transactions for the statement period.

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2.12 Escrow Agent is not responsible or liable in any manner whatsoever for the sufficiency, correctness, genuineness, or validity of any agreement or document out of which this Escrow Agreement may arise; nor is Escrow Agent liable in any manner for the identity or authority of any person executing this Escrow Agreement or any other document out of which this Escrow Agreement may arise. Escrow Agent shall not be responsible or liable for any loss, damage or liability occasioned by reason of Escrow Agent's duties or rights hereunder, save and except acts of fraud or negligence by Escrow Agent. Anything in this Escrow Agreement to the contrary notwithstanding, in no event shall the Escrow Agent be liable for special, indirect or consequential loss or damage of any kind whatsoever (including but not limited to lost profits) even if the Escrow Agent has been advised of the likelihood of such loss or damage.

2.13 In the event of any disagreement or the presentation of adverse or conflicting claims or demands or requests, Escrow Agent may, at its sole option, be entitled to refuse to comply with any such claims or demands or requests during the continuance of such disagreement or conflicting claims or requests, and, in making such refusal, may refrain from ordering any disbursements of the Escrow Fund or taking any other affirmative action hereunder. In such event, Escrow Agent may, at its sole option, interplead the Escrow Fund, or any portion thereof, into the Registry of a Court of competent jurisdiction. In so acting, Escrow Agent shall not become personally liable to any party hereto, or any other person or entity, for or because of its failure to comply with any request in connection with such disbursement or such adverse or conflicting claims or demands.

2.14 It is expressly agreed that the parties hereto may not assign, in whole or in part, or delegate any of their respective rights, titles, interests or duties hereunder without the written consent of all parties hereto. Provided, however, the parties understand and agree that many of the functions and obligations set out herein will actually be undertaken by Garvey's contractors, subcontractors, and/or vendors.

2.15 It is expressly agreed that this Escrow Agreement is for the sole benefit of the EPA and shall not be construed or deemed to be made for the benefit of any other party or third parties.

2.16 This Escrow Agreement and the obligations of the parties hereunder shall be interpreted, construed, and enforced in accordance with the laws of the State of Kansas.

2.17 If any provision of this Escrow Agreement or the application thereof to any entity, person or circumstance shall be invalid or unenforceable to any extent, the remainder of this Escrow Agreement and the application of such provisions to other entities, persons or circumstances shall not be affected thereby and shall be enforced to the greatest extent permitted by law.

2.18 This Escrow Agreement contains the entire understanding between the parties hereto with respect to the matters set forth herein. No variations, modifications or changes

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hereof shall be binding upon any party hereto unless set forth in a document duly executed by all parties hereto. Provided, however, EPA, AGP and Garvey have entered into other agreements including the Purchase Agreement between AGP and Garvey, an Administrative Order on Consent between EPA and Garvey (CERCLA-07-2005-0215), an Agreement between EPA, Garvey and AGP (CERCLA-07-2005-0268), and a Security Agreement between EPA and Garvey attached hereto as Exhibit B. Further, this Escrow Agreement contemplates disbursements for Work to be set forth in any future Record of Decision, Action Memorandum, Consent Decree, Administrative Order on Consent, Unilateral Administrative Order, and/or other directive to be issued by EPA for the Site. Nothing in this Escrow Agreement shall be deemed to alter or amend such other agreements, and there shall be no merger of said agreements. Nevertheless, such agreements shall be construed in light of one another to accomplish the purposes of the parties as provided in all of such agreements. Escrow Agent is only a party to this Escrow Agreement.

2.19 Whenever used herein, the singular number shall include the plural, and the use of any gender shall include all genders. This Escrow Agreement shall be binding upon and shall inure to the benefit of the parties hereto and their respective heirs, executors, administrators, legal representatives, successors, assigns, and trustees.

2.20 The Escrow Agent may resign for any reason, upon 30 days written notice to Garvey, AGP and the EPA as parties to this Escrow Agreement. Upon expiration of such 30 day notice period, the Escrow Agent may deliver all cash and other property in its possession, after the payment of all fees and expense of the Escrow Agent, under this Escrow Agreement to any successor escrow agent jointly appointed by Garvey, AGP, and the EPA, or if no successor escrow agent has been so appointed to any court of competent jurisdiction in the Federal Court registry. Upon either such delivery, the Escrow Agent shall be released from any and all liability under this Escrow Agreement. A termination under this paragraph shall in no way discharge clauses 2.10 and 2.39 affecting reimbursement of expenses, indemnity and fees. The Escrow Agent shall have the right to deduct from the property to be transferred to any successor agent any unpaid fees and expenses. In the event that Garvey, the EPA, and AGP are unable to mutually agree upon the successor escrow agent within the thirty (30) day notice period described above, the Escrow Agent shall designate the successor escrow agent by written notice to Garvey, AGP and the EPA.

2.21 All notices or other communications required or permitted to be given pursuant to this Escrow Agreement shall be in writing and shall be considered as properly given if mailed by certified mail, postage prepaid, with return receipt requested, upon confirmed transmittal if by facsimile, or by overnight delivery using a nationally recognized overnight delivery service or by delivering the same in person to the intended addressee as follows:

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Garvey:

Garvey Elevators, Inc.
P.O. Box 9600
Fort Worth, Texas 76147
Attention: Richard Garvey, President
Facsimile No.: (817) 335-1905

David M. Traster
Foulston Siefkin, LLP
1551 North Waterfront Parkway
Suite 100
Wichita, Kansas 67206-4466
Facsimile No.: (866) 347-3138

AGP:

AGP Grain Marketing, LLC
12700 West Dodge Road
Omaha, Nebraska 68154
Attention: Legal Department
Facsimile No.: (402) 431-5050

Escrow Agent:

JPMorgan Chase Bank, N.A.
600 Travis, 53rd Floor
Houston, Texas 77002
Attn: Luis Bustamante
Facsimile No.: (713) 216-6927
Telephone No.: (713) 216-5793

EPA:

Alyse Stoy
Assistant Regional Counsel
U.S. EPA Region VII
901 North 5th Street
Kansas City, Kansas 66101
Facsimile No.: (913) 551-7925

Brian Mitchell, Environmental Engineer
Superfund Division

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U.S. EPA Region VII
901 North 5th Street
Kansas City, Kansas 66101
Facsimile No.: (913) 551-7948

NDEQ:

Mike Felix
Section Supervisor
Remediation Section
Waste Management Division
Nebraska Department of Environmental Quality
Suite 400, The Atrium, 1200 N Street
P.O. Box 98922
Lincoln, NE 68509-8922
Facsimile No.: (402) 471-2909

Notice which is so mailed or placed with an overnight delivery service shall be effective upon its deposit in the United States Mail or with the overnight delivery service. Notice given in any other manner shall be effective upon its receipt by the addressee. It is agreed that any party shall have the right to change its address for notice hereunder by giving 30 days prior written notice of such change to the other parties to this Escrow Agreement in the manner set forth herein. "Business Day" shall mean any day other than a Saturday, Sunday or any other day on which the Escrow Agent located at the notice address set forth above is authorized or required by law or executive order to remain closed.

2.22 This Escrow Agreement may be executed in multiple original counterparts, all of which shall be deemed originals and with the same effect as if all parties hereto had signed the same document. All such counterparts shall be construed together and shall constitute one and the same instrument. All signatures of the parties to this Escrow Agreement may be transmitted by facsimile, and such facsimile will, for all purposes, be deemed to be the original signature of such party whose signature it reproduces, and will be binding upon such party.

2.23 Either Garvey, AGP or EPA may hereafter act through an agent or attorney-in-fact only if written evidence of authority in form and substance satisfactory to Escrow Agent is furnished to Escrow Agent and agreed to by Escrow Agent.

2.24 The death, disability, bankruptcy, insolvency, dissolution or reorganization of any of the undersigned shall not affect or prevent performance by Escrow Agent of its obligations or its right to rely upon instructions received hereunder.

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2.25 Escrow Agent shall have no discretionary powers, including no power to choose proper investments. Escrow Agent shall never be required to post a bond in connection with the providing of its services hereunder.

2.26 Escrow Agent may consult with and rely on the advice of legal counsel satisfactory to it at any time in respect to any question relating to its duties or responsibilities hereunder or otherwise in connection herewith, and shall not be liable for any action taken, suffered, or omitted by Escrow Agent in good faith upon the advice of such counsel, and shall be fully protected in doing so, and shall be fully compensated for all costs and expenses in doing so.

2.27 All parties acknowledge and agree that Escrow Agent is acting solely and exclusively as a depository hereunder. Escrow Agent is not a party to, and is not bound by or charged with notice or knowledge of, any agreement out of which this escrow may arise, or any agreement or undertaking which may be evidenced by or disclosed by the Escrow Fund, other than this Escrow Agreement, it being the intention of the parties hereto that Escrow Agent assent to and be obligated to give consideration only to the terms and provisions hereof.

2.28 Escrow Agent may enter into business dealings with any party to this Escrow Agreement, and such business dealings shall not constitute a conflict of interest with the responsibilities of Escrow Agent hereunder.

2.29 Escrow Agent shall have no duty to determine or inquire into the happening or occurrence of any event or contingency or the performance or failure of performance of any of the undersigned with respect to arrangements to contracts with each other or with others. Escrow Agent's sole duty hereunder being to hold the Escrow Fund and to dispose of and deliver the same in accordance with instructions given to it as provided in this Escrow Agreement. Escrow Agent shall be obligated to perform only such duties as are expressly set forth herein, and no implied covenants or obligations shall be inferred from this Agreement.

2.30 All interest or other income earned on funds in the Account, less applicable taxes, shall automatically be reinvested in the Escrow Fund.

2.31 The Escrow Fund is owned by Garvey, and this Escrow Agreement does not transfer ownership of said funds to the EPA, or to any other person or entity. Nevertheless, Garvey acknowledges and agrees that this Escrow Fund is subject to the security interest of EPA substantially in the form set forth in the attached security agreement which is Exhibit B ("EPA Security Agreement").

2.32 If any bankruptcy proceeding is filed with respect to Garvey during the term of this Escrow Agreement, whether voluntary or involuntary, this Escrow Agreement shall remain in effect according to the terms hereof and the Security Agreement attached as Exhibit B.

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2.33 Garvey represents and warrants that, as of the date of this Escrow Agreement, it has a good and valid ownership interest in the Escrow Fund, and that the Escrow Fund is not subject to any lien, pledge, charge, or security interest other than the security interest of EPA in the Escrow Fund, as set forth in the EPA Security Agreement attached as Exhibit B. For so long as this Escrow Agreement remains in effect, Garvey covenants and agrees that it shall not create or incur, or permit to be created or incurred, any lien, pledge, encumbrance, charge, or security interest upon the Escrow Fund other than the security interest of EPA in the Escrow Fund, as set forth in the EPA Security Agreement attached as Exhibit B.

2.34 Escrow Agent as Depository: Escrow Agent is not a party to and is not bound by or charged with notice of any agreement out of which this escrow may arise. Escrow Agent acts hereunder solely as a depository and is not responsible or liable in any manner whatsoever for the sufficiency, correctness, authenticity or validity of the subject matter of the Escrow, the form of execution thereof or for the identity or authority of any person executing this Escrow Agreement or depositing the subject matter of the Escrow. The responsibility of the Escrow Agent extends only to the duties affirmatively stated in this Escrow Agreement and to the exercise of ordinary diligence. Escrow Agent shall not be responsible for any act or omission except for actual fraud, dishonesty, negligence, or bad faith. No implied duties or obligations of Escrow Agent shall be read into this Escrow Agreement, and Escrow Agent shall not in any event be required to construe or determine the rights of any party under this Escrow Agreement.

2.35 Entitlement to Rely: Escrow Agent shall be protected in acting upon any written notice, request, waiver, consent, certificate, receipt authorization, power of attorney or other paper or document that Escrow Agent reasonably and in good faith believes to be genuine and what it purports to be, including but not limited to items directing investment or non-investment of funds, items requesting or authorizing release, disbursement or retention of the subject matter of the Escrow and items amending the terms of this Escrow Agreement. Escrow Agent may rely upon any such instructions and deliver the subject matter of the Escrow as directed without further investigation.

2.36 If any party to this Escrow Agreement is a legal entity other than a natural person, Escrow Agent may conclusively presume that the representative of such party has full power and authority to instruct Escrow Agent on behalf of such party unless written notice to the contrary is delivered to Escrow Agent.

2.37 Garvey represents that its correct Taxpayer Identification Number assigned by the Internal Revenue Service ("IRS") or any other taxing authority is set forth on the signature page hereof. In addition, all interest or other income earned under the Escrow Agreement shall be reported to the IRS or any other taxing authority. Escrow Agent shall withhold any taxes it deems appropriate and shall remit such taxes to the appropriate authorities. Any tax returns or reports required to be prepared and filed on behalf of or by the Escrow Fund will be prepared and filed by Garvey, and the Escrow Agent shall have no responsibility for the preparation and/or filing of any tax return with respect to any income earned by the Escrow Fund. In addition, any

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tax or other payments required to be made pursuant to such tax return or filing that has not already been remitted by Escrow Agent will be paid by Garvey and will be reimbursed from the Escrow Fund as provided in Paragraph 2.3. Escrow Agent shall have no responsibility for such payment unless directed to do so by the appropriate authorized party.

2.38 In the event that any escrow property shall be attached, garnished or levied upon by any court order, or the delivery thereof shall be stayed or enjoined by an order of a court, or any order, judgment or decree shall be made or entered by any court order affecting the property deposited under this Escrow Agreement, the Escrow Agent is hereby expressly authorized, in its sole discretion, to obey and comply with all writs, orders or decrees so entered and issued, which it is advised by legal counsel of its own choosing is binding upon it, and in the event that the Escrow Agent obeys or complies with any such order, writ, order or decree it shall not be liable to any of the parties hereto or to any other person, firm or corporation, by reason of such compliance with nothwithstanding such writ, order or decree be subsequently reversed, modified, annulled, set aside or vacated.

2.39 Garvey shall indemnify, defend and save harmless the Escrow Agent and its directors, officers, agents and employees (the "indemnitees") from and against any and all loss, liability or expense (including the fees and expenses of in house or outside counsel and experts and their staffs and all expense of document location, duplication and shipment) arising out of or in connection with (i) the Escrow Agent's execution and performance of this Escrow Agreement, except in the case of any indemnitee to the extent that such loss, liability or expense is finally adjudicated to have been primarily caused by the negligence or willful misconduct of such indemnitee, or (ii) its following any instructions or other directions from Garvey or EPA, except to the extent that its following any such instruction or direction is expressly forbidden by the terms hereof. Garvey acknowledges that the foregoing indemnities shall survive the resignation or removal of the Escrow Agent or the termination of this Escrow Agreement.

2.40 Account Opening Information/TINs

IMPORTANT INFORMATION ABOUT PROCEDURES FOR OPENING A NEW ACCOUNT:

For accounts opened in the US: To help the government fight the funding of terrorism and money laundering activities, Federal law requires all financial institutions to obtain, verify, and record information that identifies each person who opens an account. When an account is opened, the Escrow Agent will ask for information that will allow us to identify relevant parties. For non-US accounts: To help in the fight against the funding of terrorism and money laundering activities we are required along with financial institutions to obtain, verify and record information that identifies each person who opens an account. When you open an account, the Escrow Agent will ask for information that will allow us to identify you.

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2.41 In the event funds transfer instructions are given, whether in writing, by telecopier or otherwise, the Escrow Agent is authorized to seek confirmation of such instructions by telephone call-back to the person or persons designated in this Section, and the Escrow Agent may rely upon the confirmation of anyone purporting to be the person or persons so designated. The persons and telephone numbers for call-backs may be changed only in a writing actually received and acknowledged by the Escrow Agent.

For Garvey Elevators:	Richard Garvey (817) 335-5881 Reece Pettigrew (817) 335-5881
For EPA:	Brian Zurbuchen (913) 551-7101 Alyse Stoy (913) 551-7826
For NDEQ:	Mike Felix (402) 471-2938 Annette Kovar (402) 471-3194

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GARVEY ELEVATORS, INC.

Tax Certification: Taxpayer ID # [redacted]

Under the penalties of perjury, the undersigned certifies that:

- the entity is organized under the laws of the United States
- the number shown above is its correct Taxpayer Identification Number; and
- it is not subject to backup withholding because: (a) it is exempt from backup withholding or (b) it has not been notified by the Internal Revenue Service (IRS) that it is subject to backup withholding as a result of failure to report all interest or dividends, or (c) the IRS has notified it that it is no longer subject to backup withholding.

Investors who do not supply a tax identification number will be subject to backup withholding in accordance with IRS regulations.

By: Richard F Garvey

Name: RICHARD F. GARVEY

Title: PRESIDENT

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AGP GRAIN MARKETING, LLC

Tax Certification: Taxpayer ID #[redacted]

Under the penalties of perjury, the undersigned certifies that:

- the entity is organized under the laws of the United States
- the number shown above is its correct Taxpayer Identification Number; and
- it is not subject to backup withholding because: (a) it is exempt from backup withholding or (b) it has not been notified by the Internal Revenue Service (IRS) that it is subject to backup withholding as a result of failure to report all interest or dividends, or (c) the IRS has notified it that it is no longer subject to backup withholding.

Investors who do not supply a tax identification number will be subject to backup withholding in accordance with IRS regulations.

By: J. Keith Spackler

Name: J. KEITH SPACKLER

Title: MANAGER, SECRETARY & TREASURER

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JPMorgan Chase Bank, N.A.

By:_____

Name:_____

Title:_____

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U.S. ENVIRONMENTAL PROTECTION AGENCY

7/11/2005

CECILIA TAPIA
Director, Superfund Division
U.S. Environmental Protection
Agency, Region VII
901 North 5th Street
Kansas City, Kansas 66101

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Exhibit "A"
Garvey Elevator

A tract of land comprising a part of the Northwest Quarter (NW1/4) of Section 23, Township 7 North, Range 10 West of the 6th P.M. said tract being more particularly described as follows:

With reference to the Northeast corner of said NW 1/4; thence running S 89°49'03" W on the North line of said NW 1/4 for a distance of 436.32 feet; thence S 00°10'08" E for 60.00 feet to a point on the Southerly right-of-way line of U.S. Highway #6, said point also being the actual POINT OF BEGINNING; thence continuing S 00°10'08' E for 272.97 feet; thence N 89°49'17" E for 194.51 feet to a point on the Westerly right-of-way line of the Burlington Northern and Santa Fe Railway; thence S 21°11'46" W on said right-of-way for 2485.27 feet to a point on the South line of said NW 1/4; thence S 89°44'25" W on the South line of said NW 1/4 for a distance of 1462.52 feet to a point on the Easterly right-of-way line of Marion Avenue, said right-of-way line being 33.00 feet Easterly from the West line of said NW 1/4; thence on an assumed bearing of N 00°00'00" E on said right-of-way line, parallel with and 33.00 feet Easterly from the West line of said NW 1/4 for 2316.23 feet; thence N 89°49'15" E for 145.08 feet; thence N 00°01'46" E for 273.01 feet to a point on the Southerly right-of-way line of said Highway #6; thence N 89°49'03" E on said right-of-way line for 1185.61 feet; thence S 11°57'18" W for 297.73 feet; thence N 89°48'44" E for 598.68 feet; thence N 11°57'39" E for 297.68 feet to a point on the Southerly right-of-way line of said Highway #6; thence N 89°49'03" E on said right-of-way line for 236.25 feet to the POINT OF BEGINNING, said tract containing 110.269 acres more or less.

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Exhibit "B"

EPA SECURITY AGREEMENT

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SECURITY AGREEMENT

This SECURITY AGREEMENT (this "Security Agreement"), dated as of September 28, 2005, is made by Garvey Elevator, Inc., a Kansas corporation (the "Grantor"), in favor of the United States Environmental Protection Agency, an agency of the federal government of the United States of America ("EPA").

RECITALS

WHEREAS, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9607 et seq. ("CERCLA"), Grantor has entered into an Agreement with EPA and AGP Grain Marketing, LLC ("AGP")(Docket No. CERCLA-07-2005-0268)(the "Agreement"), and an Administrative Order on Consent ("AOC") for Removal Action and Remedial Investigation/Feasibility Study (Docket No. CERCLA-07-2005-0215) to, among other things, provide for Grantor's performance of removal actions and a remedial investigation/feasibility study at the Garvey Elevator Site ("Site") and provide for funds paid by AGP pursuant to the Agreement to be deposited into an Escrow Fund to be held by the Escrow Agent and will be used by Grantor for response actions related to the Site; and

WHEREAS, in order to implement the Agreement and AOC (i) an Escrow Fund has been established with JPMorgan Chase Bank, N.A. ("Bank"), Account No. [redacted] the "Escrow Fund"); (ii) Grantor has agreed that the Escrow Fund shall be disbursed pursuant to the terms of the Escrow Agreement pertaining to the Escrow Fund dated as of September 28 2005, between the Grantor, EPA, AGP and the Escrow Agent (the "Escrow Agreement"); and (iii) Grantor has agreed to grant EPA a security interest in the Escrow Fund in order to secure the Grantor's obligation required under the Agreement and AOC.

NOW, THEREFORE, in consideration of the mutual agreements contained herein and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties hereto hereby agree as follows:

1. Definitions. Unless otherwise defined herein, all capitalized terms used herein that are defined in the AOC, the Agreement or the Escrow Agreement shall have their respective meanings as therein defined. For purposes of this Security Agreement, all other undefined terms used herein, whether capitalized or not, but that are defined in Article 8 or Article 9 of the Uniform Commercial Code (as the same may be in effect from time to time in the State of Kansas or any other applicable jurisdiction, the "UCC"), shall have their respective meanings as therein defined, except for the capitalized term "Escrow Fund," which shall have the meaning set forth for such term in the above Recitals.

2. Grant of Security Interest.

(a) Collateral. As security for the prompt and complete performance when due of any and all of the Obligations (as defined below), the Grantor hereby collaterally assigns, conveys, pledges, hypothecates, and transfers to the EPA, and grants and creates a lien on and first priority security interest (the "Security Interest") in favor of the EPA in, all right, title, and interest of the Grantor in, to, and under the following, whether now existing or hereafter arising or acquired (the "Collateral"): the Escrow Fund, together with all funds, cash, monies, financial assets, investments, instruments, certificates of deposit, promissory notes, and any other property at any time on deposit therein or credited thereto, all rights to payment or withdrawal therefrom, and all income, profits, gains, and interest thereon; and all proceeds, products, substitutions, replacements, and accessions of and to the foregoing Collateral, or any rights arising out of the Collateral, and any and all other amounts paid or payable in connection with any of the Collateral;
provided, however, that any distributions, payments, or releases of Collateral (whether in the form of cash, instruments, or otherwise) properly made pursuant to the Escrow Agreement, Agreement, or AOC shall be released from the Security Interest granted hereunder and shall no longer be part of the Collateral upon the making of such distribution.

(b) Sufficiency of Collateral Description. It is the intention of the parties hereto that the description of the Collateral set forth in Section 2(a) be sufficient to enable the EPA, upon exercise of its remedies set forth in this Security Agreement, to take possession of, and foreclose upon, all of the right, title, and interest of the Grantor in and to the Collateral upon the occurrence and during the continuance of an Event of Default (as defined below) and subject to the limitations set forth in this Security Agreement; provided, however, that the Collateral is hereby assigned to the EPA solely as security, and the EPA shall have no duty, liability, or obligation whatsoever with respect to the Collateral, unless the EPA so elects in a writing delivered to the Grantor.

(c) Obligations. This Security Agreement secures, in accordance with the provisions hereof, the following obligations now existing or hereafter arising (collectively, the "Obligations"):

(i) payment and performance of each and every obligation, covenant, and agreement of the Grantor set forth in the Agreement;

(ii) payment and performance of each and every obligation, covenant, and agreement of the Grantor set forth in the AOC;

(iii) payment and performance of each and every obligation, covenant, and agreement of the Grantor as required by EPA and set forth in any future Record of Decision, Action Memorandum, Consent Decree, Administrative Order on

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Consent, Unilateral Administrative Order, and/or any other directive to be issued by EPA for the Site;

(iv) payment of all sums advanced in accordance herewith by or on behalf of EPA to protect, retake, or hold, or realize upon, the Collateral.

(d) Event of Default. EPA shall have the right, but not the obligation, to exercise any or all of its rights and remedies against the Collateral as set forth in this Security Agreement upon the occurrence and during the continuance of any of the following (each, an "Event of Default"): (i) the filing by the Grantor of a petition seeking to take advantage of any laws relating to bankruptcy, insolvency, reorganization, winding up or composition or adjustment of debts; (ii) Grantor's consent to (or failure to contest in a timely manner) any petition filed against it in an involuntary case under such bankruptcy or other laws; (iii) Grantor's application for (or consent to or failure to contest in a timely manner) the appointment of, or the taking of possession by, a receiver, custodian, trustee, liquidator, or the like of itself or of all or a substantial part of its assets; Grantor's making a general assignment for the benefit of creditors; or (iv) Grantor's taking any corporate action for the purpose of effecting any of the foregoing.

3. Perfection of Collateral.

(a) Financing Statement(s). The Grantor agrees to do such acts and things, including but not limited to, authorizing the filing of financing and continuation statements, as the EPA may from time to time reasonably request as are necessary or required by applicable law to enable EPA to create, preserve, perfect, or validate the Security Interest in the Collateral in favor of the EPA. Grantor agrees to pay all costs and fees connected with the filing of all financing, continuation, termination or similar statements reasonably filed by the EPA in connection with this Security Agreement. The EPA is hereby appointed as the Grantor's attorney-in-fact to file all financing or continuation statements and to do such other acts as the EPA may reasonably deem appropriate to perfect and continue perfected the Security Interest created by this Security Agreement or to protect the Collateral.

(b) Escrow Fund. The Grantor agrees to duly execute and deliver the Escrow Agreement to the EPA and cooperate with the EPA and the Bank in the establishment and maintenance of the Escrow Fund until the termination of the Escrow Agreement and the final disposition of the Escrow Fund in accordance with the terms of the Escrow Agreement. Funds deposited in the Escrow Fund shall be managed, administered and withdrawn from the Escrow Fund in accordance with the terms and provisions of the Escrow Agreement.

(c) Further Assurances. To the extent not included in the foregoing, the Grantor shall, from time to time at the Grantor's expense, promptly execute and deliver all further agreements, instruments, and documents, and take all further action, that may be necessary in order to create, perfect, or protect the Security Interest granted or purported to be granted hereby or to enable the EPA to exercise and enforce its rights and remedies hereunder with respect to the Collateral.

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4. Representations and Warranties. The Grantor hereby represents and warrants as of the date hereof as follows:

(a) Title; No Other Liens. The Grantor has full power and authority to grant the Security Interest in and to the Collateral hereunder. The Grantor is the legal and beneficial owner of the Collateral in existence on the date hereof free and clear of any and all liens, pledges, encumbrances, charges, or security interests other than a "Permitted Encumbrance." "Permitted Encumbrance" shall mean the Security Interest created by this Security Agreement. Except with respect to the Permitted Encumbrance, no security agreement, financing statement, or other public notice with respect to all or any part of the Collateral is on file or of record in any public office.

(b) Perfection Representations. The exact legal name of the Grantor is Garvey Elevator, Inc., the Grantor is a duly formed and validly existing corporation organized under the laws of the State of Kansas, and its certificate of incorporation is duly filed with the Secretary of State of the State of Kansas. The Grantor's chief executive office is located at 2918 Wingate Street, P.O. Box 9600, Fort Worth, Texas 76147. The Escrow Account is held, maintained, and administered by the Escrow Agent

(c) Other Perfection Matters. Subject to compliance with the perfection, other requirements of the UCC, and to the effects of bankruptcy, insolvency, reorganization, receivership, moratorium and other similar laws affecting the rights and remedies of creditors generally, this Security Agreement creates a valid, continuing, and perfected first-priority security interest in the Collateral in favor of the EPA, subject to no liens or security interests other than the Permitted Encumbrance, and is enforceable as against creditors of the Grantor.

5. Covenants and Agreements. The Grantor hereby covenants and agrees that the Grantor shall observe and fulfill, and shall cause to be observed and fulfilled, each and all of the following covenants until all Obligations have been indefeasibly paid and performed in full or this Security Agreement has terminated in accordance with its terms:

(a) Legal Status. The Grantor shall not change its name, place of business, chief executive office, or its mailing address, or change its type of organization or jurisdiction of organization, without notifying EPA in writing at least 60 days in advance of any such change.

(b) Prohibition Against Transfer of Collateral. The Grantor shall not dispose of any part of the Collateral, whether in one or a series of transactions, or otherwise undertake disposal of any of the Collateral, except as permitted pursuant to this Security Agreement and the Escrow Agreement.

(c) Filing Fees, Taxes, Etc. The Grantor shall pay all filing, registration, and recording fees or re-filing, re-registration, and re-recording fees, and all federal, state, county, and

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municipal stamp taxes and other similar taxes, duties, imposts, assessments, and charges arising out of or in connection with the execution and delivery of this Security Agreement.

(d) Maintenance of Collateral Records. The Grantor shall keep and maintain at all times and at its own cost and expense complete records of the Collateral. The Grantor shall furnish to the EPA such other information regarding the Collateral as the EPA may reasonably request, all in reasonable detail.

(e) Limitation on Liens on the Collateral. The Grantor shall not create, assume, incur, suffer to exist, or permit to be created, assumed, incurred, or suffered to exist, shall defend the Collateral against, and shall take such other action as is necessary to remove, any lien, pledge, charge, security interest, encumbrance, or claim on or to the Collateral, other than the Permitted Encumbrance, and shall defend the right, title, and interest of the EPA in and to any of the Collateral against the claims and demands of all persons whomsoever other than with respect to the Permitted Encumbrance.

(f) Location of Collateral. The Collateral, to the extent not delivered to the EPA in accordance with the terms of this Security Agreement or disposed of in accordance with the terms of the Escrow Agreement, will be kept at the Bank.

6. Remedies; Rights upon Event of Default. Upon the occurrence and during the continuance of an Event of Default, the EPA may do the following:

(a) Provide written notice to the Escrow Agent directing the Escrow Agent to deliver all or any part of the Collateral to the EPA at any place or places designated by the EPA, it being understood that such obligations are of the essence under this Security Agreement;

(b) Make such payments and do such acts as the EPA may deem necessary to protect, perfect, or continue the perfection of the Security Interest in the Collateral, including, without limitation, commencing, appearing, or otherwise participating in or controlling any action or proceeding purporting to affect the Security Interest in or ownership of the Collateral;

(c) In accordance with applicable laws, accept the Collateral in full or partial satisfaction of the Obligations; and

(d) Exercise in respect of the Collateral, in addition to other rights and remedies provided for herein or otherwise available to it, all the rights and remedies of a secured party after default under the UCC and any relevant laws in any jurisdiction.

7. EPA Appointed Attorney-in-Fact. Upon the occurrence and during the continuance of an Event of Default and in the EPA's discretion, the Grantor hereby irrevocably constitutes and appoints the EPA and any agent thereof, with full power of substitution, as its true and lawful attorney-in-fact (which appointment as attorney-in-fact shall be coupled with an interest), with full

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authority in the place and stead of the Grantor and in the name of the Grantor or otherwise, from time to time, to take any action and to execute any and all documents and instruments that the EPA may deem necessary or advisable to accomplish the purposes of this Security Agreement in a commercially reasonable manner to the extent required by the UCC.

8. No Duty on the EPA's Part; Limitation on the EPA's Obligations. The powers conferred on the EPA hereunder are solely to protect the interest in the Collateral and shall not impose any duty upon the EPA to exercise any such powers, including, without limitation, any calls, conversions, maturities, tenders, or other matters relating to the Collateral. The EPA shall be accountable only for amounts that it receives as a result of the exercise of such powers. Except as provided in the next sentence, anything herein to the contrary notwithstanding, the Grantor shall remain liable under the Escrow Agreement to the extent set forth therein to perform all of its duties and obligations thereunder to the same extent as if this Security Agreement had not been executed. The exercise by the EPA of any of the rights or remedies hereunder shall not release the Grantor from any of its duties or obligations under the Escrow Agreement unless expressly assumed by the EPA in writing. The Collateral is hereby assigned to the EPA solely as security, and the EPA shall have no duty, liability, or obligation whatsoever with respect to the Collateral, including, without limitation, the filing of any continuation statements, unless the EPA so elects in writing consistent with its rights under this Security Agreement.

9. Absence of Fiduciary Relation. The EPA in its capacity as beneficiary of the Security Interest is not a fiduciary of, or shall owe or be deemed to owe any fiduciary duty to, the Grantor or any other party.

10. Notices. All notices, demands, requests, and other communications required or permitted hereunder shall be in writing and shall be given in accordance with the Escrow Agreement.

11. No Waiver; Cumulative Remedies. By exercising or failing to exercise any of its rights, options, or elections hereunder (without also expressly waiving the same in writing), the EPA shall not be deemed to have waived any breach or default on the part of the Grantor or to have released the Grantor from any of its obligations secured hereby. No failure on the part of the EPA to exercise, and no delay in exercising (without also expressly waiving the same in writing) any right, power, or privilege hereunder shall operate as a waiver thereof, nor shall any single or partial exercise of any such right, power, or privilege preclude any other or further exercise thereof, or the exercise of any other right, power, or privilege. The remedies provided herein are cumulative and not exclusive of any remedies provided by law. The EPA shall have all of the rights and remedies granted under the Escrow Agreement and available at law or in equity and these same rights and remedies may be pursued separately, successively, or concurrently against the Grantor or the Collateral, at the discretion of the EPA. The application of the Collateral to satisfy the Obligations pursuant to the terms hereof shall not operate to release the Grantor from its Obligations until payment or performance in full of any deficiency has been made.

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12. Exculpatory Provisions. The EPA shall not be liable or responsible in any manner to any person for any recitals, statements, representations, or warranties made by the Grantor or any officer thereof contained in this Security Agreement or in any certificate, report, statement, or other document referred to or provided for in, or received by the EPA under or in connection with, this Security Agreement.

13. Severability. In the event any one or more of the provisions contained in this Security Agreement should be held invalid, illegal, or unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions contained herein shall not in any way be affected or impaired thereby.

14. Amendment. This Security Agreement may not be modified, amended or otherwise changed in any manner, except by written amendment executed by the Grantor, subject to prior written approval of the EPA of any such modification, amendment, or change.

15. Successors and Assigns. This Security Agreement shall be binding upon and inure to the benefit of the Grantor and its successors and assigns, as well as the EPA and any successor agency thereto.

16. Headings. Article and Section headings used herein are for convenience of reference only, are not part of this Security Agreement, and are not to affect the construction of, or to be taken into consideration in interpreting, this Security Agreement.

17. Governing Law. This Security Agreement shall be governed by, and construed in accordance with, the laws of the State of Nebraska.

18. Entire Agreement. The terms of this Security Agreement, the Agreement, the AOC and the Escrow Agreement are intended by the parties hereto as a final expression of their agreement with respect to the subject matter hereof, and may not be contradicted by evidence of any prior or contemporaneous agreement. The parties further intend that this Security Agreement constitutes the complete and exclusive statement of all related terms, and that no extrinsic evidence whatsoever may be introduced in any proceedings (whether judicial or otherwise) involving this Security Agreement, except for any future Record of Decision, Action Memorandum, Consent Decree, Administrative Order on Consent, Unilateral Administrative Order, and/or any other directive to be issued by EPA for the Site or any evidence of a subsequent written amendment to this Security Agreement.

19. Continuing Security Interest; Termination. This Security Agreement shall create a continuing Security Interest in the Collateral and shall remain in full force and effect for the benefit of the EPA until the date that the Escrow Agreement terminates in accordance with its terms. Upon the happening of such event, the Security Interest granted hereby shall terminate.

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IN WITNESS WHEREOF, the parties hereto have caused this Security Agreement to be duly executed as of the day and year first above written.

GARVEY ELEVATORS, INC., as Grantor

By: Richard F. Garvey

Name: RICHARD F. GARVEY

Title: PRESIDENT

STATE OF TEXAS,

COUNTY OF TARRANT.

BE IT REMEMBERED, that on this 5th day of July, 2005, before me, the undersigned, a Notary Public in and for the county and state aforesaid, came Richard F. Garvey, President of Garvey Elevators, Inc., who is personally known to me to be the same person who executed, as such officer, the within instrument of writing on behalf of said corporation, and such person duly acknowledged the execution of the same to be the act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my notarial seal on the day and year last above written.

(Seal)

Carol J Billings

Notary Public

My Appointment Expires: 8-1-08

CAROL J. BILLINGS
NOTARY PUBLIC
STATE OF TEXAS
MY COMMISSION EXPIRES 08-01-2008

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U.S. ENVIRONMENTAL PROTECTION AGENCY

CECILIA TAPIA
Director, Superfund Division
U.S. Environmental Protection
Agency, Region VII
901 North 5th Street
Kansas City, Kansas 66101

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FINANCING STATEMENT FILINGS

Debtor:	Garvey Elevator, Inc.
Secured Party:	United States Environmental Protection Agency, an agency of the federal government of the United States of America
Jurisdiction(s):	Secretary of State of the State of Kansas

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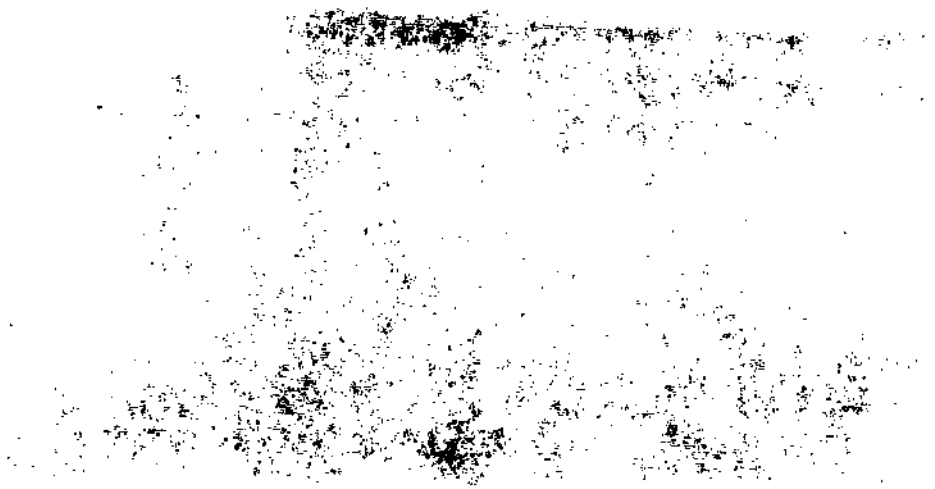
Exhibit "C"

Fee Schedule



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JPMorgan

Schedule of Fees for Escrow Agent Services

New Account Acceptance Fee . . . . . **$ 750 Waived**
Payable upon Account Opening

Minimum Administrative Fee **$2,000**
Payable Upon Account Opening and in Advance each year in which we act as Escrow Agent

ACTIVITY FEES:
Activity fees will not be assessed for any month in which fewer than 10 transactions occur.

Disbursements

Per Check		$ 35
Per Wire	U.S.	$ 35
	International	$ 100

Receipts

Per Deposit	$ 10

Investments

Per directed buy/sell	$ 75

The Investments fee will be waived if JPMorgan's Money Market Account sweep product offered by JPMorgan's Escrow Group is the selected investment.

A one (1) year Minimum Administrative Fee will be assessed for any account that is funded. The account will be invoiced in the month in which the account is opened and annually thereafter. Payment of the invoice is due 30 days following receipt.

Modification of Fees:

Circumstances may arise necessitating a change in the foregoing fee schedule. The Bank will attempt at all times, however, to maintain the fees at a level that is fair and reasonable in relation to the responsibilities assumed and the duties performed.

Additional Disclosures:

- The escrow deposit shall be continuously invested in a JPMorgan Money Market Account. The Minimum Administrative Fee would include a supplemental charge up to

25 basis points on the escrow deposit amount if another investment option were chosen.

- This proposal is subject to our review and acceptance of the documentation governing the transaction, transaction structure, final determination of our duties and responsibilities and satisfactory due diligence review of the parties to the agreement.

Compliance:

- To help the government fight the funding of terrorism and money laundering activities, Federal law requires all financial institutions to obtain, verify, and record information that identifies each person who opens an account. When an account is opened, we will ask for information that will allow us to identify relevant parties.

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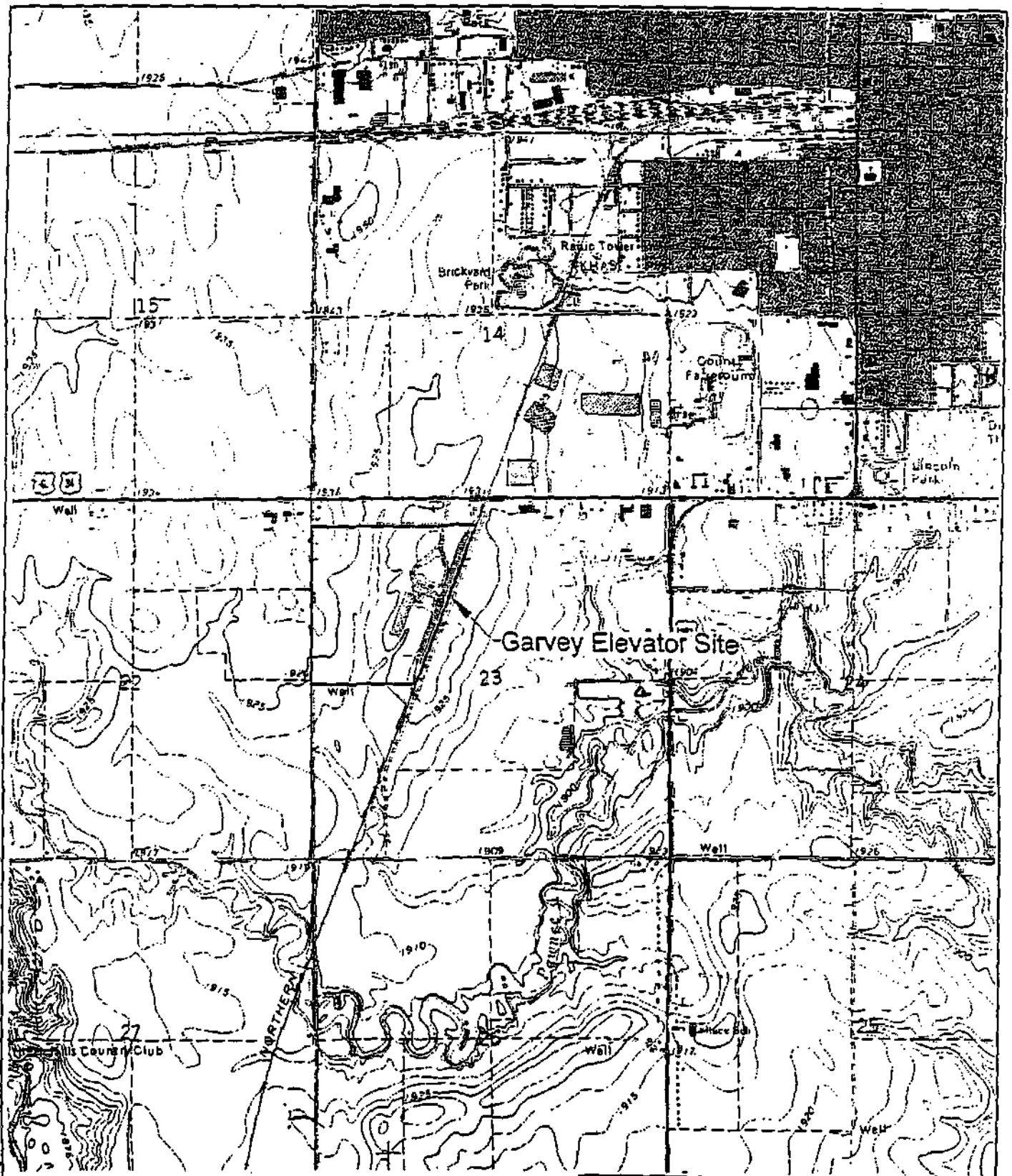
Appendix B

Site Map



Garvey Elevator
Hastings, Nebraska

Figure 1
Site Location Map

Tetra Tech EM Inc

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Appendix C

ENVIRONMENTAL PROTECTION EASEMENT
AND
DECLARATION OF RESTRICTIVE COVENANTS

1. This Environmental Protection Easement and Declaration of Restrictive Covenants is made this ____ day of _____, 2005, by and between AGP Grain Marketing, LLC. ("Grantor"), having an address of_____;
and_____("Grantee"), having an address of _____.

WITNESSETH:

2. WHEREAS, Grantor is the owner of a parcel of land located in the county of Adams, State of Nebraska, more particularly described on Exhibit A attached hereto and made a part hereof (the "Property"); and

3. WHEREAS, the Property is part of the Garvey Elevator Superfund Site ("Site"), with respect to which the U.S. Environmental Protection Agency ("EPA"), pursuant to 40 C.F.R. § 300.415 of the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), has initiated response actions; and

4. WHEREAS, in an Agreement between Grantor and the United States, Docket No. CERCLA-07-2005-0268 ("Agreement"), Grantor agreed to conduct certain actions that are generally described as follows:

Pay $2,050,000.00 into an Escrow Fund to be used for investigation and cleanup actions at the Site, and implement institutional controls to prevent exposure to contaminated soil and groundwater; and

5. WHEREAS, the parties hereto have agreed 1) to grant a permanent right of access over the Property to the Grantee for purposes of implementing, facilitating and monitoring the response actions to be performed at the Site; and 2) to impose on the Property use restrictions as covenants that will run with the land for the purpose of protecting human health and the environment; and

6. WHEREAS, Grantor wishes to cooperate fully with the Grantee in the implementation of all response actions at the Site;

NOW, THEREFORE:

7. Grant: Grantor, on behalf of itself and its successors and assigns, in consideration of the

terms of the Order, hereby covenants and declares that the Property shall be subject to the restrictions on use set forth below, and do give, grant and convey to the Grantee, and its assigns, with general warranties of title, subject to easements, reservations, restrictions of record, liens or encumbrances that are approved by EPA, 1) the perpetual right to enforce said use restrictions, and 2) an environmental protection easement of the nature and character, and for the purposes hereinafter set forth, with respect to the Property.

8. Purpose: It is the purpose of this instrument to convey to the Grantee real property rights, which will run with the land, to facilitate the cleanup of past environmental contamination and to protect human health and the environment by reducing the risk of exposure to contaminants.

9. Restrictions on use: The following covenants, conditions, and restrictions apply to the use of the Property, run with the land and are binding on the Grantor. Unless otherwise approved in writing by EPA, Grantor shall not:

a) Utilize the ground water underlying the Property for human use or consumption;

b) Cause or allow a disturbance of the subsurface of the Site; and

c) Use the Property for residential purposes.

10. Modification of restrictions: The above restrictions may be modified, or terminated in whole or in part, in writing, by the Grantee. If requested by the Grantor, such writing will be executed by the Grantee in recordable form.

11. Environmental Protection Easement: Grantor hereby grants to the Grantee an irrevocable, permanent and continuing right of access at all reasonable times to the Property for the purposes of:

a) Implementing any response actions at and near the Site;

b) Verifying any data or information submitted to EPA;

c) Verifying that no action is being taken on the Property in violation of the terms of this instrument or of any federal or state environmental laws or regulations;

d) Monitoring response actions on the Site and conducting investigations relating to contamination on or near the Site, including, without limitations, sampling of water and specifically, without limitation, obtaining split or duplicate samples;

12. Reserved rights of Grantor: Grantor hereby reserves unto itself, its successors, and assigns, all rights and privileges in and to the use of the Property which are not incompatible with the restrictions, rights and easements granted herein.

13. Nothing in this document shall limit or otherwise affect EPA's rights of entry and access

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or EPA's authority to take response actions under CERCLA, the NCP, or other federal law.

14. No Public Access and Use: No right of access or use by the general public to any portion of the Property is conveyed by this instrument.

15. Notice requirement: Grantor agrees to include in any instrument conveying any interest in any portion of the Property, including but not limited to deeds, leases and mortgages, a notice which is in substantially the following form:

NOTICE: THE INTEREST CONVEYED HEREBY IS SUBJECT TO AN ENVIRONMENTAL PROTECTION EASEMENT AND DECLARATION OF RESTRICTIVE COVENANTS, DATED _____, 200__, RECORDED IN THE PUBLIC LAND RECORDS ON _____, 200___, IN BOOK _____, PAGE _____, IN FAVOR OF, AND ENFORCEABLE BY, THE UNITED STATES OF AMERICA.

Within thirty (30) days of the date any such instrument of conveyance is executed, Grantor must provide Grantee with a true copy of said instrument and, if it has been recorded in the public land records, its recording reference.

16. Administrative jurisdiction: The federal agency having administrative jurisdiction over the interests acquired by the United States by this instrument is the EPA.

17. Enforcement: The Grantee shall be entitled to enforce the terms of this instrument by resort to specific performance or legal process. All remedies available hereunder shall be in addition to any and all other remedies at law or in equity, including CERCLA. Enforcement of the terms of this instrument shall be at the discretion of the Grantee, and any forbearance, delay or omission to exercise their rights under this instrument in the event of a breach of any term of this instrument shall not be deemed to be a waiver by the Grantee of such term or of any subsequent breach of the same or any other term, or of any of the rights of the Grantee under this instrument.

18. Damages: Grantee shall be entitled to recover damages for violations of the terms of this instrument, or for any injury to the removal action, to the public or to the environment protected by this instrument.

19. Waiver of certain defenses: Grantor hereby waives any defense of laches, estoppel, or prescription.

20. Covenants: Grantor hereby covenants to and with the United States and its assigns, that the Grantor is lawfully seized in fee simple of the Property, subject to easements, restrictions and reservations of record, liens or encumbrances that are approved by EPA, that the Grantor has good and lawful right and power to sell and convey it or any interest therein, that the Property is free and clear of encumbrances, except those noted on Exhibit B attached hereto, and that the Grantor will forever warrant and defend the title thereto and the quiet possession thereof.

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21. Notices: Any notice, demand, request, consent, approval, or communication that any party desires or is required to give shall be in writing and shall either be served personally or sent by first class mail, postage prepaid, addressed as follows:

Grantor:
AGP Grain Marketing, LLC
Attn: Legal Department
12700 West Dodge Road
Omaha, Nebraska 68154

Grantee: _____
Address

22. General provisions:

a) Controlling law: The interpretation and performance of this instrument shall be governed by the laws of the United States or, if there are no applicable federal laws, by the laws of the state of Nebraska.

b) Liberal construction: Any general rule of construction to the contrary notwithstanding, this instrument shall be liberally construed in favor of the grant to effect the purpose of this instrument and the policy and purpose of CERCLA, 42 U.S.C. § 9601 et seq. If any provision of this instrument is found to be ambiguous, an interpretation consistent with the purpose of this instrument that would render the provision valid shall be favored over any interpretation that would render it invalid.

c) Severability: If any provision of this instrument, or the application of it to any person or circumstance, is found to be invalid, the remainder of the provisions of this instrument, or the application of such provisions to persons or circumstances other than those to which it is found to be invalid, as the case may be, shall not be affected thereby.

d) Entire Agreement: This instrument sets forth the entire agreement of the parties with respect to rights and restrictions created hereby, and supersedes all prior discussions, negotiations, understandings, or agreements relating thereto, all of which are merged herein.

e) No Forfeiture: Nothing contained herein will result in a forfeiture or reversion of Grantor's title in any respect.

f) Successors: The covenants, terms, conditions, and restrictions of this instrument shall be binding upon, and inure to the benefit of, the parties hereto and their respective personal representatives, heirs, successors, and assigns and shall continue as a servitude running in perpetuity with the Property. The term "Grantor", wherever used herein, and any pronouns used in place thereof, shall include the persons and/or entities named at the beginning of this document, identified as "Grantor" and their personal representatives, heirs, successors, and assigns. The term "Grantee", wherever used herein, and any pronouns used in

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place thereof, shall include the persons and/or entities named at the beginning of this document, identified as "Grantee" and their personal representatives, heirs, successors, and assigns. The rights of the Grantee and Grantor under this instrument are freely assignable, subject to the notice provisions hereof.

g) Termination of Rights and Obligations: A party's rights and obligations under this instrument terminate upon transfer of the party's interest in the Property, except that liability for acts or omissions occurring prior to transfer shall survive transfer.

h) Captions: The captions in this instrument have been inserted solely for convenience of reference and are not a part of this instrument and shall have no effect upon construction or interpretation.

i) Counterparts: The parties may execute this instrument in two or more counterparts, which shall, in the aggregate, be signed by both parties; each counterpart shall be deemed an original instrument as against any party who has signed it. In the event of any disparity between the counterparts produced, the recorded counterpart shall be controlling.

TO HAVE AND TO HOLD unto the United States and its assigns forever.

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IN WITNESS WHEREOF, Grantor has caused this Agreement to be signed in its name.

Executed this _____ day of _____, 200__.

AGP Grain Marketing, LLC:

_____

By: _____

Its: _____

STATE OF NEBRASKA)
) ss
COUNTY OF _____)

On this __ day of _____, 200__, before me, the undersigned, a Notary Public in and for the State of Nebraska, duly commissioned and sworn, personally appeared _____, known to be the _____ of _____, the corporation that executed the foregoing instrument, and acknowledged the said instrument to be the free and voluntary act and deed of said corporation, for the uses and purposes therein mentioned, and on oath stated that they are authorized to execute said instrument.

Witness my hand and official seal hereto affixed the day and year written above.

_____
Notary Public in and for the
State of Nebraska

My Commission Expires: _____.

This declaration is accepted this ____ day of _____, 200__.

By: _____

_____

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This declaration is accepted this ____ day of _____ , 200__.

U.S. ENVIRONMENTAL PROTECTION AGENCY

By: _____

_____

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EXHIBIT A

LEGAL DESCRIPTION OF THE PROPERTY

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EXHIBIT B

LIST OF PERMITTED TITLE ENCUMBRANCES