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SAMPLING AND ANALYSIS PLAN
FOR VAPOR INTRUSION INVESTIGATION AT SITE 5, BUILDING 8, NAS CORPUS CHRISTI TX

10/1/2015

RESOLUTION CONSULTANTS

SAMPLING AND ANALYSIS PLAN

VAPOR INTRUSION INVESTIGATION
SITE 00005 — BUILDING 8
CORPUS CHRISTI ARMY DEPOT
NAVAL AIR STATION CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

Revision Number: 0

Prepared For:

Department of the Navy
Naval Facilities Engineering Command Southeast
Building 135 North, P.O. Box 30
Jacksonville, Florida 32212-0030

October 2015

SAP WORKSHEET #1: TITLE AND APPROVAL PAGE
(UFP-QAPP Manual Section 2.1)

SAMPLING AND ANALYSIS PLAN

VAPOR INTRUSION INVESTIGATION
SITE 00005 — BUILDING 8
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Prepared By:

Resolution Consultants
A Joint Venture of AECOM & EnSafe
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Norfolk, Virginia 23510

Contract Number: N62470-11-D-8013
CTO JM75

October 2015

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EXECUTIVE SUMMARY

Resolution Consultants has prepared this Uniform Federal Policy Sampling and Analysis Plan (UFP SAP) under Modification 1 of the Comprehensive Long-Term Environmental Action Navy Contract No. N62470-11-D-8013 Contract Task Order JM75 at Naval Air Station (NAS) Corpus Christi, Texas. This UFP SAP has been prepared for a Vapor Intrusion (VI) Investigation inside Building 8 consisting of sub-slab soil gas screening via high volume sampling techniques, sub-slab soil gas assessment, and an indoor air quality assessment associated with the potential sources of trichloroethene (TCE) and 10 other volatile organic compounds previously detected in groundwater at Building 8.

As a continuation of the ongoing and parallel Supplemental Groundwater Investigation (SGI), additional field investigations of the TCE groundwater plume associated with Site 00005 are being conducted under a companion UFP SAP for the SGI. The SGI investigation includes extent mapping of the Protective Concentration Level Exceedance (PCLE) zone via membrane interface probe sampling inside Building 8, as well as temporary and permanent groundwater monitoring well installation and sampling. This UFP SAP for the VI Investigation and the SGI UFP SAP will result in a combined report to be submitted as a Supplemental Affected Property Assessment Report (APAR) for Site 00005 — Building 8 at NAS Corpus Christi, Texas.

An APAR investigation conducted in 2001 identified the entire soil column beneath Building 8 as a soil PCLE zone. Due to the sensitive operations within Building 8, sampling through the floor of the building was not conducted. Contaminants of potential concern in soil included chlorinated solvents, fuels, and metals. No other soil PCLE zones were identified during the APAR.

One groundwater PCLE zone for TCE was identified north of Building 8. Shallow groundwater in the vicinity of the former Industrial Waste Pretreatment Plant (IWPP) on the eastern side of Building 8 exhibited elevated pH due to a release from an underground caustic line. Since the APAR, the caustic line has been removed from service and the Industrial Waste Pretreatment Plant has been shut down and relocated to Building 340 along with several of the industrial processes with industrial wastewater streams requiring pretreatment. The area of elevated pH in groundwater has remained the same since its discovery. At the time of the APAR, the TCE plume was not expanding.

The current and future land use for the Site 00005 — Building 8 area is identified as industrial; no changes to this classification are currently anticipated. The response action for Site 00005 — Building 8 soil included institutional controls, an engineered cap comprised of Building 8's concrete floor; the response action for groundwater was monitored natural attenuation (MNA).

During development of the response action, it was not possible to accurately predict the time frame for complete attenuation of contaminants of concern that may be present beneath Building 8 due to the unknowns remaining since the APAR investigations.

The Building 8 cap and institutional controls are to remain in place until the operations at Building 8 cease and additional investigation and response actions can be implemented. The shallow groundwater at Site 00005 — Building 8 meets Class 3 criteria and is presently not used for any purpose. The MNA process is to remain in effect until groundwater contaminants of concern and their daughter products are below the critical protective concentration levels. A 10-year implementation period was established for long-term monitoring of MNA and the TCE PCLE zone in groundwater. This implementation period ended in January 2014; however, available data indicate the TCE plume has not reduced in size or concentration.

Recent investigation data associated with the SGI include membrane interface probe profiling using a halogen specific detector and follow-up sampling that indicate the potential for elevated TCE concentrations in groundwater and soil gas to be present beneath Building 8. Confirmation groundwater sampling results from replacement monitoring well ES-GW-28R indicate a TCE concentration of 13,100 micrograms per Liter (µg/L). Additional results from two new wells, ES-GW-101 and ES-GW-107, indicate TCE concentrations ranging from 9,000 µg/L to 9,700 µg/L are within 25 feet of the Building 8 foundation.

This VI SAP outlines the organization, objectives, planned activities, and data review/reporting procedures associated with the VI Investigation at Building 8. Protocols for sample collection, handling, and storage, chain-of-custody, laboratory and field analyses, data validation, and reporting are also addressed herein. This SAP was generated for, and complies with, applicable United States Department of the Navy, United States Environmental Protection Agency (U.S. EPA) Region 6, and Texas Commission on Environmental Quality requirements, regulations, guidance, and technical standards, as appropriate. This includes the Department of Defense, Department of Energy, and U.S. EPA Interagency Data Quality Task Force environmental requirements regarding federal facilities, as specified in the Uniform Federal Policy Quality Assurance Project Plan guidance (U.S. EPA 2005) and the Navy's SAP guidance. Field activities conducted under this VI UFP SAP will be conducted in accordance with Resolution Consultants' Standard Operating Procedures and a Site-Specific Health and Safety Plan. The relationship between this VI UFP SAP and the SGI UFP SAP is further explained in Appendix C.

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List of Acronyms

AF	Attenuation factor
AI	Indoor air (NIRIS sample nomenclature)
$^{Air}RBEL_{Inh}$	Risk based exposure limit for inhalation of contaminants in air
ALS	ALS Environmental
APAR	Affected Property Assessment Report
bgs	Below ground surface
C	Cancer
CAS	Chemical Abstracts Service
CCAD	Corpus Christi Army Depot
CCV	Continuing calibration verification
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Contaminant of concern
Cox-Colvin	Cox-Colvin and Associates, Inc.
CSM	Conceptual site model
CTP	Communication test point
CVOC	Chlorinated volatile organic compound
DoD	Department of Defense
DoD ELAP	Department of Defense Environmental Laboratory Accreditation Program
DQO	Data quality objective
DVA	Data validation assistant
E/A&H	EnSafe/Allen & Hoshall
eQAPP	Electronic Quality Assurance Project Plan
FRC	Federal Records Center
FTL	Field team leader
GC/MS	Gas chromatograph/mass spectrometer
GSS	Sub-slab soil gas (NIRIS sample nomenclature)
HEPA	High-efficiency particulate air
Hg	Mercury
HSM	Health and safety manager
HVAC	Heating, ventilation, and air conditioning
HVS	High volume sampling
IA	Indoor air
ICAL	Initial calibration
ID	Identification
IDW	Investigation-derived waste
IWPP	Industrial waste pretreatment plant
KD Analytical	KD Analytical Consulting, Inc.

List of Acronyms (continued)

L	Liter
LCS	Laboratory control sample
LOD	Limit of detection
LOQ	Limit of quantification
µg/L	Micrograms per Liter
µg/m^3	Micrograms per cubic meter
MDL	Method detection limit
MIP	Membrane interface probe
mL	Milliliter
mL/min	Milliliters per minute
MNA	Monitored natural attenuation
MPC	Measurement performance criteria
NA	Not applicable/not analyzed
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NAVFAC SE	Naval Facilities Engineering Command Southeast
NC	Non-cancer
NELAP	National Environmental Laboratory Accreditation Program
NIRIS	Naval Installation Restoration Information Solution
OSHA	Occupational Safety and Health Administration
PCL	Protective concentration level
PCLE	Protective concentration level exceedance
PEL	Permissible exposure limit
piC/L	Picocuries per liter
PID	photoionization detector
PM	Project manager
POC	Point of contact
ppm	parts per million
ppbv	parts per billion by volume
PSQ	Principal Study Question
PVC	Polyvinyl chloride
PVOC	Petroleum volatile organic compound
QA	Quality assurance
QAO	Quality assurance officer
QC	Quality control
QSM	Quality systems manual

List of Acronyms (continued)

%R	Percent recovery
RAP	Remedial Action Plan
RBEL	Risk based exposure limit
RCRA	Resource Conservation and Recovery Act
RFI	Remedial
Rn	Radon
Rn-SOP	Radon standard operating procedure
RPD	Relative percent difference
RPM	Remedial project manager
RRT	Relative retention time
SAP	Sampling and analysis plan
SGI	Supplemental Groundwater Investigation
SOP	Standard operating procedure
SSO	Site safety officer
SWMU	Solid waste management unit
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
TOM	Task order manager
TRRP	Texas Risk Reduction Program
UFP	Uniform Federal Policy
UFP SAP	Uniform Federal Policy Sampling and Analysis Plan
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
USC	University of Southern California
U.S. EPA	United States Environmental Protection Agency
VI	Vapor intrusion
VISL	Vapor intrusion screening level
VOC	Volatile organic compounds

SAP WORKSHEET #2: SAMPLING AND ANALYSIS PLAN IDENTIFYING INFORMATION

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: Site 00005 — Building 8
Naval Air Station (NAS) Corpus Christi, Texas

Contractor Name: Resolution Consultants

Contract Number: Comprehensive Long-Term Environmental Action (CLEAN)

Contract Title: N62470-11-D-8013

Work Assignment No: JM75

1. This sampling and analysis plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (U.S. EPA 2005) and U.S. Environmental Protection Agency (U.S. EPA) *Guidance for Quality Assurance Project Plans, EPA QA/G-5* (U.S. EPA 2002).

2. Identify regulatory program: Resource Conservation and Recovery Act (RCRA) of 1976, and delegated authority under Section 3006. Texas Risk Reduction Program. Texas Hazardous Waste Program Permit Number HW-50038 and associated Groundwater Compliance Plan for Solid Waste Management Units (SWMUs) 244 to 247, 257 to 259, 264, 265, 274, 316 to 333 (also known as "Building 8").

3. This SAP is a project-specific SAP.

4. List organizational partners (stakeholders) and identify the connection with lead organization:

Organization Partners/Stakeholders	Connection
U.S. EPA Region 6	Lead Regulatory Oversight
Texas Commission on Environmental Quality	Lead Regulatory Oversight
Naval Facilities Engineering Command Southeast	Lead Agency
NAS Corpus Christi	Property Owner
Corpus Christi Army Depot	Property Tenant
The Management Edge	Tier I Team Partner
Resolution Consultants	Tier I Team Partner

5. Lead organization: Naval Facilities Engineering Command Southeast.

6. If any required SAP elements and required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below: Not Applicable, as there are no exclusions.

SAP WORKSHEET #3: DISTRIBUTION LIST

(UFP-QAPP Manual Section 2.3.1)

SAP Recipients	Title	Organization	Telephone Number	Email Address or Mailing Address
Karen Campbell	Navy Remedial Project Manager	Naval Facilities Engineering Command Southeast 135 Ajax Street North, PO Box 30 Jacksonville, Florida 32212-0030	904-542-6180 317-491-2929 (cell)	karen.j.campbell@navy.mil
Ross Ybarra	Lead Environmental Protection Specialist/Point of Contact	Naval Air Station Corpus Christi, Public Works Department 11001 D Street, Building 19 Corpus Christi, Texas 78419	361-961-2170 361-658-9572 (cell)	ross.ybarra@navy.mil
Gary Miller	Project Manager	U.S. Environmental Protection Agency Region 6, Multimedia Planning and Permitting Division (6PD-F) RCRA Federal Facilities Section 1445 Ross Avenue, Suite 1200 Dallas, Texas 75202	214-665-8306 817-896-3912 (cell)	miller.gary@epa.gov
Allan Posnick	Project Manager	Texas Commission on Environmental Quality PO Box 13087 Austin, Texas 78711	512-239-2332 512-739-0668 (cell)	allan.posnick@tceq.texas.gov
Claire Barnett	Task Order Manager	Resolution Consultants 5724 Summer Trees Drive Memphis, Tennessee 38134	901-937-4425 901-634-4554 (cell)	cbarnett@ensafe.com
Ben Elliott	Project Engineer/ Technical Lead	Resolution Consultants 10918 Whisper Valley San Antonio, Texas 78230	512-635-4229 (cell)	belliott@ensafe.com
Tina Cantwell	Project Chemist/Data Manager/ Quality Assurance Officer	Resolution Consultants 5724 Summer Trees Drive Memphis, Tennessee 38134	901-937-4315	tcantwell@ensafe.com
Leslie Baechler	Field Team Leader, Phase 4	Resolution Consultants 810 Belmont Avenue Collingswood, New Jersey 08108	856-240-1060 215-512-1060 (cell)	lbaechler@ensafe.com
Emily Brickman	Site Safety Officer	Resolution Consultants 4545 Fuller Drive, Suite 342 Irving, Texas 75038	972 865-4853 214-529-5600 (cell)	ebrickman@ensafe.com
Kate Aguilera	Laboratory Project Manager	ALS Environmental 2655 Park Center Drive, Suite A Simi Valley, California 93065	805-526-7161	Kate.Aguilera@alsglobal.com

SAP WORKSHEET #4: PROJECT PERSONNEL SIGN-OFF SHEET

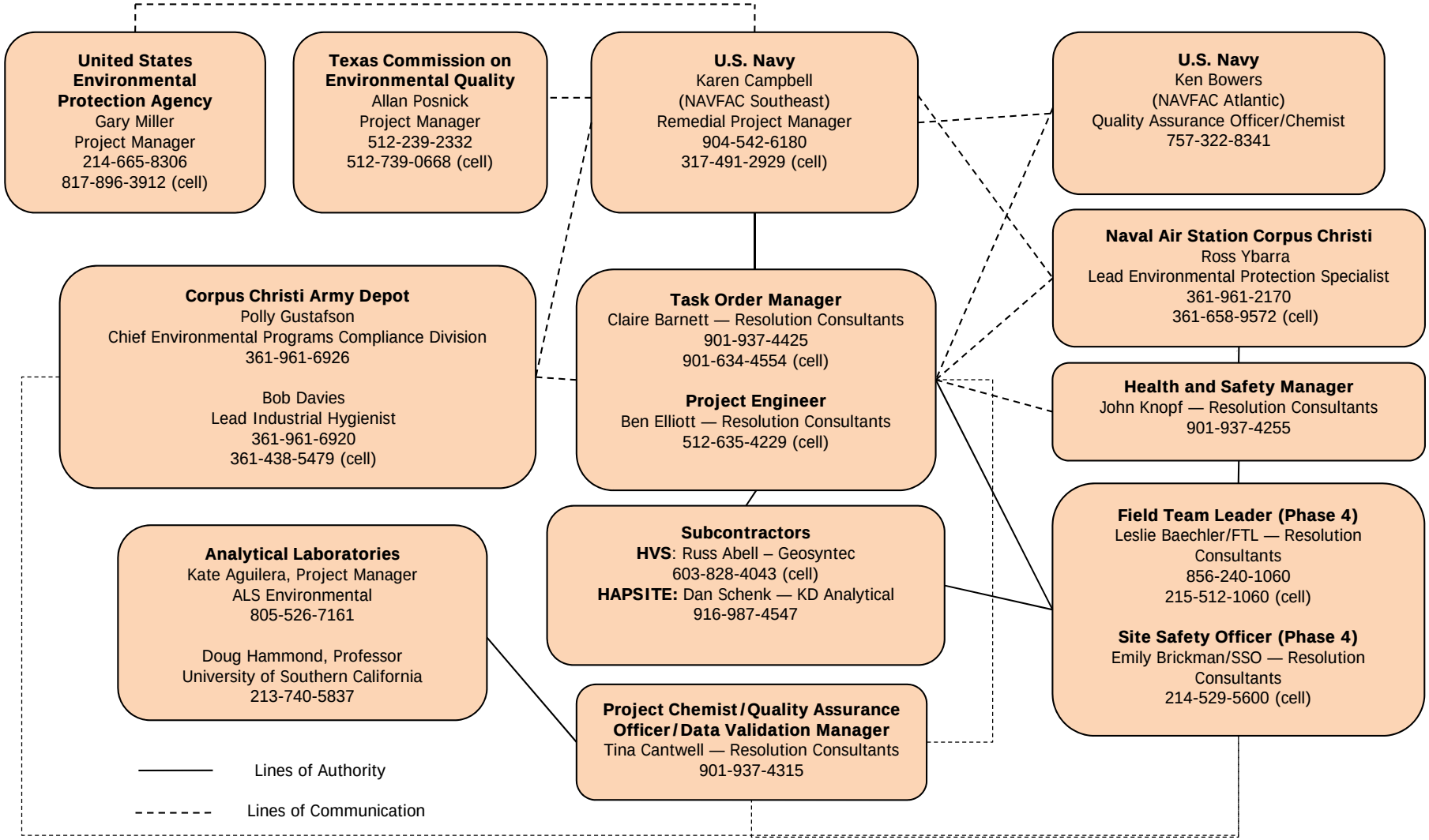
(UFP-QAPP Manual Section 2.3.2)

Certification that project personnel have read the text will be obtained by one of the following methods, as applicable:

Emails will be sent to Navy, Resolution Consultants, regulatory agencies, and subcontractor project personnel, who will be requested to verify by email that they have read the applicable SAP/sections and the date on which they were reviewed. Copies of the verification email will be included in the project files and identified in Worksheet #29. Copies of regulatory agency comments, if received, will be retained in the project files and will be listed in Worksheet #29 as project records.

SAP WORKSHEET #5: PROJECT ORGANIZATIONAL CHART

(UFP-QAPP Manual Section 2.4.1)



SAP WORKSHEET #6: COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)

The communication pathways for the SAP are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	Navy RPM TCEQ PM U.S. EPA PM	Karen Campbell Allan Posnick Gary Miller	904-542-6180 512-239-2332 214-665-8306	The Navy RPM informs the regulatory agencies of work progress on a periodic basis.
Field Progress Reports	Resolution Consultants FTL (Phase 4) Resolution Consultants TOM Resolution Consultants Project Engineer	Leslie Baechler Claire Barnett Ben Elliott	215-512-1060 901-937-4425 512-635-4229	The FTL will contact the TOM and/or Project Engineer on a daily basis via phone, and every 1 to2 days summarizing progress via email.
Gaining Site Access	Resolution Consultants FTL Resolution Consultants SSO NAS Corpus Christi POC CCAD POC	Leslie Baechler Emily Brickman Ross Ybarra Polly Gustafson Bob Davies	215-512-1060 214-529-5600 361-961-2170 361-961-6920 361-438-5479	The FTL/SSO will contact the NAS Corpus Christi POC and CCAD POC verbally or via email at least 3 days before commencement of field work to arrange for access to the site for all personnel.
SAP Changes prior to Field/Laboratory work	Resolution Consultants TOM Navy RPM TCEQ PM U.S. EPA PM	Claire Barnett Karen Campbell Allan Posnick Gary Miller	901-937-4425 904-542-6180 512-239-2332 214-665-8306	The FTL will verbally inform the TOM upon realizing a need for a SAP modification. The FTL or TOM will document the proposed changes via a SAP modification form within 5 days and send it to the project QAO/chemist. The project QAO/chemist will assess whether: (a) The modification has the potential to affect the project's ability to achieve DQOs, b) The modification requires a change in field or laboratory methods which may affect project schedule or cost, or c). The modification does not affect DQOs, schedule, or cost and is for documentation purposes only. SAP modifications potentially affecting DQOs will be submitted to the Navy RPM and Project Team for review and consideration and may require SAP amendments and approval. Modifications in laboratory/field methods, project schedule, or cost will be submitted to the Navy for review and consideration. Minor modifications not affecting DQOs, schedule, or cost will be documented in the project file. The Navy will notify U.S. EPA and TCEQ of any significant modifications. Any change of the approved SAP affecting the scope or implementation of the sampling program will be made only upon authorization of the Navy RPM and regulatory agencies.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Obtaining Utility Clearances for Intrusive Activities	Resolution Consultants Project Engineer Resolution Consultants SSO NAS Corpus Christi POC CCAD POC	Ben Elliott Emily Brickman Ross Ybarra Polly Gustafson Bob Davies	512-635-4229 214-529-5600 361-961-2170 361-961-6920 361-438-5479	The Project Engineer will coordinate verbally or via email with NAS Corpus Christi POC and CCAD POC at least 7 days in advance of the site access to initiate the utility clearance process for all intrusive sampling locations. The SSO will contact both the Texas 811 utility locator service and NAS Corpus Christi POC verbally or via email at least 3 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation.
Field Corrective Actions	Resolution Consultants FTL (Phase 4) Resolution Consultants SSO Resolution Consultants TOM Navy RPM	Leslie Baechler Emily Brickman Claire Barnett Karen Campbell	215-512-1060 214-529-5600 901-937-4425 904-542-6180	FTL/SSO informs TOM verbally within same day; TOM informs Navy RPM via email within 1 business day that corrective actions have been implemented. Corrective actions will be documented in weekly progress reports. Navy RPM will notify CCAD POC, TCEQ and U.S. EPA of any significant corrective actions taken.
Stop Work due to Safety Issues	Resolution Consultants TOM Resolution Consultants FTL (Phase 4) Resolution Consultants SSO Resolution Consultants HSM Navy RPM NAS Corpus Christi POC CCAD Lead Industrial Hygienist	Claire Barnett Leslie Baechler Emily Brickman John Knopf Karen Campbell Ross Ybarra Bob Davies	901-937-4425 215-512-1060 214-529-5600 901-937-4255 904-542-6180 361-961-2170 361-438-5479	Any field team member who observes an unsafe situation has the authority to stop work. If is the responsible party for a stop work command, the SSO will inform onsite personnel, TOM, HSM, subcontractor(s), the facility point of contact, and the identified Partnering Team members within 1 hour (verbally or by email). If a subcontractor is the responsible party, the subcontractor PM must verbally inform SSO within 15 minutes and the SSO will then follow the procedure listed above.
SAP Changes in the Field	Resolution Consultants FTL (Phase 4) Resolution Consultants SSO Resolution Consultants TOM Navy RPM TCEQ PM U.S. EPA PM	Leslie Baechler Emily Brickman Claire Barnett Karen Campbell Allan Posnick Gary Miller	215-512-1060 214-529-5600 901-937-4425 904-542-6180 512-239-2332 214-665-8306	The FTL will inform the TOM verbally within same day of the need for a SAP change in the field. The TOM will inform the Navy RPM by email within 24 hours; the TOM sends a concurrence letter to the Navy RPM, if warranted, within 7 calendar days and the RPM signs the letter within 5 business days of receipt. Scope change is to be implemented before work is executed. Document the change on the SAP modification form (within 2 business days) or SAP amendment (within timeframe agreed to by Project Team). The Navy will notify U.S. EPA and TCEQ of any significant SAP field changes within 5 business days. Any change of the approved SAP affecting the scope or implementation of the sampling program will be made only upon authorization of the Navy RPM and regulatory agencies.
Recommendations to stop work and initiate work upon corrective action	Resolution Consultants FTL (Phase 4) Resolution Consultants SSO Resolution Consultants TOM Navy RPM TCEQ PM U.S. EPA PM	Leslie Baechler Emily Brickman Claire Barnett Karen Campbell Allan Posnick Gary Miller	215-512-1060 214-529-5600 901-937-4425 904-542-6180 512-239-2332 214-665-8306	Responsible party verbally informs the TOM, FTL, and subcontractors within 1 hour of recommendation to stop work and within 24 hours of recommendation to restart work. Responsible party follows verbal notification with an email to the Project Team within 24 hours. Significant corrective actions will be communicated to the regulatory agencies.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Sample Receipt Variances	Laboratory PM Resolution Consultants TOM Resolution Consultants FTL	Kate Aguilera Claire Barnett Leslie Baechler	805-526-7161 901-937-4425 215-512-1060	The Laboratory PM will notify (verbally or via email) the FTL immediately upon receipt of any chain of custody/sample variances for clarification or direction from the FTL. The FTL will notify (verbally or via email) the TOM within 1 business day, if corrective action is required. The TOM will notify (verbally or via email) the Laboratory PM and the FTL within 1 business day of any required corrective action.
Analytical Data Quality Issues	Laboratory PM Resolution Consultants TOM Resolution Consultants Project Chemist Navy RPM	Kate Aguilera Claire Barnett Tina Cantwell Karen Campbell	805-526-7161 901-937-4425 901-397-4315 904-542-6180	The laboratory PM notifies (verbally or via email) the chemist within 1 business day of when an issue related to laboratory data is discovered. The project chemist notifies TOM within 1 business day. The project chemist notifies the TOM verbally or via email within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. TOM verbally advises the Navy RPM within 24 hours of notification from the project chemist. The Navy RPM takes corrective action that is appropriate for the identified deficiency. The Navy RPM, may at his discretion, contact the Navy QAO/Chemist for assistance in problem resolution. If there are significant data quality or non-useable data issues the Navy QAO/Chemist will be contacted to ensure the issues do not have the potential to impact other Navy projects.
Analytical Corrective Actions	Laboratory PM Resolution Consultants Project Chemist	Kate Aguilera Tina Cantwell	805-526-7161 901-397-4315	The laboratory shall notify the project chemist of any analytical data anomaly within 1 business day of discovery. After the laboratory receives guidance from the project chemist, the laboratory shall initiate any corrective action to prevent further anomalies.
Reporting Data Validation Issues/ Data Validation Corrective Actions	Resolution Consultants Project Chemist Resolution Consultants TOM	Tina Cantwell Claire Barnett	901-397-4315 901-937-4425	The project chemist or data validator, performing validation as specified in Worksheets #34, #35, and #36, will contact the laboratory as soon as possible if issues are found that require corrective action. If the project chemist/data validator identifies non-usable data that require corrective action, the TOM will coordinate with the project chemist to take corrective action appropriate for the identified deficiency to ensure the project objectives are met. Corrective action may include resampling and/or reanalyzing the affected samples, as determined by the TOM. All findings will be detailed in the data validation report.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Notification of Non-Usable Data	Laboratory PM Resolution Consultants TOM Resolution Consultants Chemist Navy RPM TCEQ PM U.S. EPA PM	Kate Aguilera Claire Barnett Tina Cantwell Karen Campbell Allan Posnick Gary Miller	805-526-7161 901-937-4425 901-397-4315 904-542-6180 512-239-2332 214-665-8306	If the laboratory determines that any data they have generated is non-usable, the Laboratory PM will notify (verbally or via email) the project chemist within 1 business day of when the issue is discovered. The project chemist will notify (verbally or via email) the TOM within 1 business day of the need for corrective action, if the non-usable data is a significant issue (i.e., critical sample data). Corrective action may include resampling and/or reanalyzing the affected samples. If the project chemist or data validator identifies non-usable data during the data validation process, the TOM will be notified verbally or via email within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has resulted in non-usable data. All findings will be detailed in the data validation report. The TOM will take corrective action appropriate for the identified deficiency to ensure the project objectives are met. The TOM will notify (verbally or via email) the Navy RPM of any problems with the laboratory or analysis that could significantly affect the usability of the data or project failures that impact the ability to complete the scope of work. The Navy RPM, may at his discretion, contact the Navy project chemist for assistance in problem resolution. Such notification will be made within 1 business day of when the issue is discovered. The Navy RPM will notify the TCEQ and U.S. EPA RPMs when any significant corrective action is taken.

Notes:

RPM = Remedial project manager
TOM = Task order manager
POC = Point of contact
HSM = Health and safety manager
TCEQ = Texas Commission on Environmental Quality
U.S. EPA = United States Environmental Protection Agency
CCAD = Corpus Christi Army Depot
FTL = Field team leader
NAS = Naval Air Station
SSO = Site safety officer
SAP = Sampling and Analysis Plan
PM = Project manager
QAO = Quality Assurance officer
DQO = Data quality objective

SAP WORKSHEET #7: PERSONNEL RESPONSIBILITIES TABLE

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Karen Campbell	Remedial Project Manager/ Manages project activities for the Navy	Naval Facilities Engineering Command Southeast	Primary Point of Contact for the Navy. Oversees project implementation, including scoping, data review, and evaluation, on behalf of the Navy.
Ross Ybarra	Activity Point of Contact/ Oversees onsite project activities	Naval Air Station Corpus Christi	Point of Contact for base-specific activity. Oversees onsite activities.
Gary Miller	Project Manager/ Regulatory Support	U.S. EPA Region 6	Functions as primary U.S. EPA interface. Participates in scoping and data review/evaluation, and provides review and approval of project deliverables.
Allan Posnick	Project Manager/ Regulatory Support	TCEQ	Functions as primary TCEQ interface. Participates in scoping and data review/evaluation, and provides review and approval of project deliverables.
Claire Barnett	Contractor Task Order Manager/ Manages project on a daily basis	Resolution Consultants	Primary point of contact for Resolution Consultants. Oversees project implementation, including financials, schedule, and technical aspects.
Ben Elliott	Contractor Project Engineer/ Manages project on a daily basis	Resolution Consultants	Secondary point of contact for Resolution Consultants. Assists in overseeing project implementation, including financials, schedule, and technical aspects.
Leslie Baechler	Field Team Leader Manages vapor intrusion field operations	Resolution Consultants	Supervises, coordinates, and performs vapor intrusion-related field activities.
Emily Brickman	Site Safety Officer/ Oversees site activities to ensure safety requirements are met	Resolution Consultants	Responsible for onsite project-specific health and safety training and monitoring site conditions.
Tina Cantwell	Project Chemist/Quality Assurance Officer/ Data Validation Manager/ Oversees quality and chemistry aspects of project	Resolution Consultants	As project chemist, prepares laboratory scopes of work, and coordinates laboratory related functions with laboratory. Performs or oversees data quality reviews and quality assurance of data validation deliverables. As QAO, ensures quality aspects of the project are implemented, documented, and maintained. As data validation manager, performs or oversees data validation and data input in both the project database and the Navy's Naval Installation Restoration Information Solution database.
John Knopf	Health and Safety Manager/ Oversees health and safety activities	Resolution Consultants	Oversees the Resolution Consultants Health and Safety Program.
Kate Aguilera	Laboratory Project Manager/ Analytical Subcontractor	ALS Environmental	Coordinates analyses with laboratory staff, ensures that scope of work is followed, provides quality review of data packages, and communicates with Resolution Consultants project staff.

Notes:

U.S. EPA = United States Environmental Protection Agency
TCEQ = Texas Commission on Environmental Quality
QAO = Quality Assurance officer

SAP WORKSHEET #8: SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

(UFP-QAPP Manual Section 2.4.4)

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations 1910.120(e). Additionally, the Site Safety Officer (SSO) will have the 30-hour OSHA Standards for Construction training.

SAP WORKSHEET #9: PROJECT SCOPING SESSION PARTICIPANTS SHEET

(UFP-QAPP Manual Section 2.5.1)

Project Name:	Vapor Intrusion Investigation	**Site Name:** Site 00005 — Building 8	
Projected Sampling Date(s):	Fall 2015	**Site Location:** NAS Corpus Christi, Texas	
Project Manager:	Claire Barnett/Ben Elliott — Project Engineer		
Date of Session:	27-28 May 2015 and follow up session held 29 July 2015 via teleconference		
Scoping Session Purpose:	Conceptual Site Model, Data Quality Objectives, and Sampling Design		

Name	Title/Role	Affiliation	Phone #	Email Address
Arne Olsen	Remedial Project Manager/ Tier 1 Representative	NAVFAC SE	904-542-6174	arne.olsen@navy.mil
Helen Lockard	Tier 2 Representative	NAVFAC SE	904-542-2464	helen.lockard@navy.mil
Bernice Perez-Snyder	NAS Corpus Christi Environmental Director	NAS Corpus Christi NAVFAC SE, Public Works Department	361-961-5353	bernice.perez-snyder@navy.mil
Ross Ybarra	Lead Environmental Protection Specialist/ Tier 1 Representative	NAS Corpus Christi NAVFAC SE, Public Works Department	361-658-2170	ross.ybarra@navy.mil
Allan Posnick	DSMOA Program Manager/ Tiers 1 & 2 Representative	TCEQ — Corrective Action — VCP Section	512-239-2332	allan.posnick@tceq.texas.gov
Richard Scharlach	Team 3 Supervisor	TCEQ — Corrective Action — VCP Section	512-239-1787	richard.scharlach@tceq.texas.gov
Danielle Lesikar	Technical Assistant	TCEQ — Corrective Action — VCP Section	512-239-2268	danielle.lesikar@tceq.texas.gov
Mike Aplin	Technical Support Team Leader	TCEQ — VI Workgroup Chair	512-239-1792	mike.aplin@tceq.texas.gov
Tara Hubner	Tier 1 Representative	U.S. EPA Region 6	214-665-7246	hubner.tara@epa.gov
Gary Miller	Tier 1 Representative	U.S. EPA Region 6	214-665-8306	miller.gary@epa.gov
Polly Gustafson	Chief Environmental Programs Compliance Division	Corpus Christi Army Depot	361-961-6926	polly.d.gustafson.civ@mail.mil
Bob Davies	Lead Industrial Hygienist	Corpus Christi Army Depot	361-961-6920	robert.c.davies8.civ@mail.mil
Claire Barnett	Task Order Manager	Resolution Consultants	901-937-4425	cbarnett@ensafe.com
Ben Elliott	Project Engineer	Resolution Consultants	512-635-4229	belliott@ensafe.com

Notes:

NAS = Naval Air Station
TCEQ = Texas Commission on Environmental Quality
VCP = Voluntary Cleanup Program
VI = Vapor Intrusion
NAVFAC SE = Naval Facilities Engineering Command Southeast
U.S. EPA = United States Environmental Protection Agency
DSMOA = Defense & State Memorandum of Agreement

Comments/Decisions:

The data quality objectives scoping session was held on 27-28 May 2015, at the NAS Corpus Christi partnering team meeting in Corpus Christi, Texas. At the data quality objectives scoping meeting, the project team reviewed and discussed the conceptual site model, project quality objectives/systematic planning process statements, and sampling design and rationale. A follow-up meeting was held via teleconference on 29 July 2015 to obtain further input and discussion from the Texas Commission on Environmental Quality (TCEQ) Vapor Intrusion (VI) Workgroup and U.S. EPA regarding target risk factors and hazard indices associated with the development of project action levels. Additionally, the rapid assessment screening approach (high volume sampling [HVS]) with respect to focusing the VI study site selection relative to sub-slab soil gas characterization and potential sources of VI was discussed. The TCEQ and U.S. EPA concurred with the expressed goals of the study: to evaluate potential risks associated with chlorinated volatile organic compounds (CVOC) VI to indoor air receptors using multiple lines of evidence (e.g., concurrent sub-slab soil gas, indoor, and outdoor air TO-15 results; radon data; pressure differential data; previously collected shallow groundwater data; building characteristics; HVS and membrane interface probe (MIP) investigation results; HAPSITE (portable gas chromatograph mass/spectrometer [GC/MS]) indoor air survey data; and chemical use history) at Site 00005 — Building 8.

Action Items:

Resolution Consultants was tasked with completing the full SAP and submitting it to the project team for review and with completing the full Health and Safety Plan and providing it to the Navy and Corpus Christi Army Depot (CCAD) for their review.

Consensus Decisions:

The following hierarchy of sources developed for industrial scenario sub-slab soil gas and indoor air screening levels and associated notification requirements were discussed during the 29 July 2015 meeting:

- Target Indoor Air Concentrations for Commercial Properties (1E-05 and Hazard Index 1.0) from Office of Solid Waste and Emergency Response Vapor Intrusion Assessment Vapor Intrusion Screening Level Calculator Version 3.4, June 2015.

- U.S. EPA Regional Screening Levels, June 2015 (1E-05 and Hazard Index 1.0).

- TCEQ Texas Risk Reduction Program (TRRP) Tables, Table 10 Industrial risk based exposure limits (RBELs), Soil, ${}^{Air}RBEL_{Inh}$ (November 2014) for Industrial Air.

- Screening levels for sub-slab soil gas were developed using a standard attenuation factor of 0.03, as recommended in the Office of Solid Waste and Emergency *Response Final Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (June 2015).

- In addition to the screening levels for chronic exposure to volatile organic compounds (VOCs) listed in Worksheet #15, Resolution Consultants will compare trichloroethene (TCE) indoor air concentrations to an action level of 88 micrograms per cubic meter ($\mu g/m^3$), representing a hazard index of 10, as recommended in the Integrated Risk Information System (IRIS) guidelines. If TCE concentrations in indoor air exceed 88 $\mu g/m^3$, Resolution Consultants will immediately notify the Navy of site conditions and areas of concern. The Navy will contact the partnering team and CCAD to discuss results and any additional appropriate actions. Required response actions will be taken by CCAD and the Navy in accordance with their policies.

- In the event that indoor air samples (emergency samples or otherwise) exceed the Industrial RBELs, the affected workers must be notified within 60 days in accordance with requirements at 30 TAC §350.55(e) as explained in RG-366 TRRP 17 (TCEQ, March 2009).

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL

(UFP-QAPP Manual Section 2.5.2)

Recent groundwater investigation results indicate that contaminant concentrations within the Site 00005 — Building 8 TCE plume area could have the potential for indoor air quality impacts in Building 8. Therefore, an assessment of potential vapor intrusion of TCE into Building 8 from groundwater and vapor sources beneath the building is needed to evaluate current and future risk to site workers at this facility.

This worksheet presents a brief site description, history, and a conceptual site model (CSM) for Site 00005 — Building 8 at NAS Corpus Christi. The CSM was originally discussed in the following site documents:

- *Affected Property Assessment Report for Installation Restoration Sites 1, 3, 4, and Building 8* (EnSafe, August 2001)
- *Supplement to Affected Property Assessment Report Installation Restoration Sites 1, 3, 4, and Building 8* (EnSafe, March 2003)
- *Final Response Action Plan Sites 1, 3, and 4, and Building 8* (EnSafe, December 2003)
- Recent groundwater investigation findings, summarized during the 17 February 2015 and 27-28 May 2015 Partnering Team meetings (Resolution Consultants, February 2015 and May 2015).

The Affected Property Assessment Report (APAR), Supplemental APAR, and Response Action Plan (RAP) were prepared in accordance with the TRRP rules in Title 30 Texas Administrative Code Chapter 350. A new supplemental APAR will be prepared for Site 00005 — Building 8 and will incorporate the findings from the ongoing groundwater study, along with those from this VI study, into the updated site CSM.

10.1 Site Location, History, and Physical Features Site 00005 — Building 8

NAS Corpus Christi is in Nueces County, Texas, and lies approximately 140 miles southeast of San Antonio and approximately 25 miles south of the former Naval Station Ingleside, across Corpus Christi Bay (Figure 10-1). The installation encompasses 2,844 acres and lies within the corporate bounds of the City of Corpus Christi. NAS Corpus Christi is situated on the northern end of the Encinal Peninsula and is bounded on three sides by water: Oso Bay to the west, Corpus Christi Bay to the north, and Laguna Madre to the east. A barrier island (Mustang Island) lies east of Laguna Madre and separates Corpus Christi from the Gulf of Mexico. Residential neighborhoods and State Highway 358 bound the installation on the south.

Site 00005 — Building 8 comprises approximately 40 acres, bound by Ocean Drive on the north, 4th Street on the east, Avenue D on the south, and Crecy Street on the west. Building 8 occupies approximately 20 acres of the site and other associated buildings occupy approximately 5 additional acres (EnSafe, August 2001). Installation Restoration Program Site 00005 incorporates the 40 acres plus the extent of a groundwater zone defined during the 2001 APAR as exceeding protective levels for TCE. Figure 10-2 is a site map of the Site 00005 — Building 8 area and includes several features related to historical investigations, the current groundwater investigation, 29 SWMUs within the perimeter of the site, and multiple utilities located throughout the Building 8 complex.[1]

Site 00005 — Building 8
Site Size — 0+ acres

Uses —parts cleaning and degreasing, bulk fuel storage, painting, historical plating activities, former industrial wastewater pretreatment plant

Primary elements — 25 acres of buildings, 29 SWMUs. Building 8 slab is 20-acre engineered barrier to soil PCL exceedances, PCLE zone for TCE.

Plume data — assumed 2 acre plume with max TCE groundwater detections in lower sand at 29 feet (13,100 µg/L, 2015) and in upper sand at 11 feet (3,000 µg/L, 2009), compared to PCL of 500 µg/L. Plume based on limited data, source is not defined. Recent data indicate TCE above 9,000 µg/L at permanent wells within 25 feet of the Building 8 foundation.

Indoor Air — max TCE detection from 2003 indoor air study was 1.21 ppbv (6.5 µg /m^3) compared to 2015 RSL of 0.164 ppbv (0.88 µg/m^3) and an OSHA PEL of 100 ppm (537 mg/m^3) 8-hour time weighted average. Chlorinated solvents are no longer authorized for use at this facility, however TCE may still be prevalent in background sources.

Building 8 is leased by the CCAD, which serves under the United States Army Materiel Development and Readiness Command. CCAD's primary operations include performing depot-level maintenance of Army aircraft and aeronautical equipment, training military personnel in depot-level maintenance, and preparing aircraft for overseas shipment. Various industrial activities are conducted within the Building 8 complex, including parts cleaning and degreasing, bulk fuel storage, and painting (EnSafe, August 2001).

[1] Site 00005 has been historically identified as SWMU 5 in NIRIS and as a shorthand label for the Site 00005 records in the AR files. Site 00005 incorporates 29 SWMUs; none of these SWMUs are labeled as SWMU 0005.

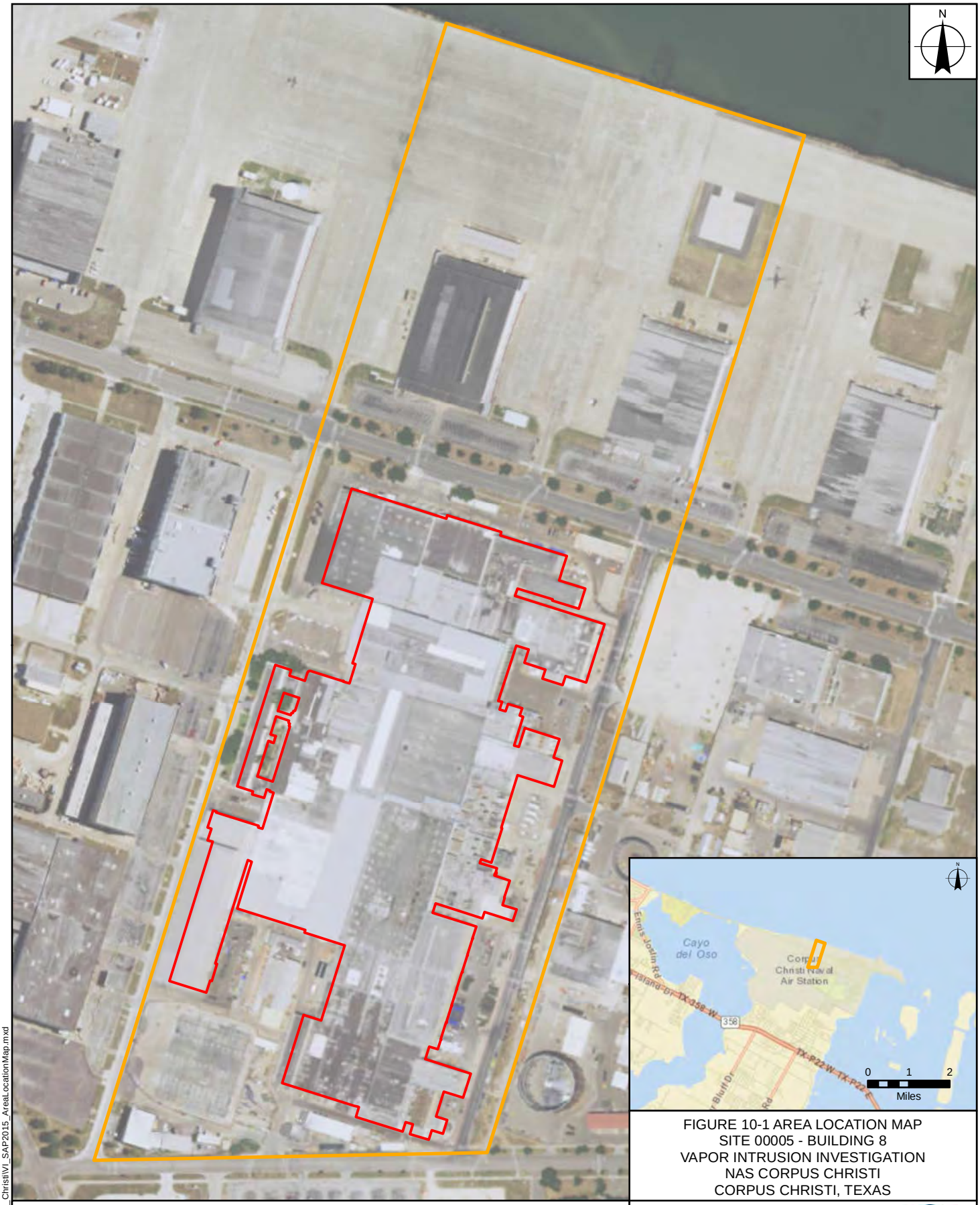


FIGURE 10-1 AREA LOCATION MAP
SITE 00005 - BUILDING 8
VAPOR INTRUSION INVESTIGATION
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

Building 8 Outline

Site Boundary

0 350 700 Feet

NAVFAC Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUESTED BY: B. Elliott	DATE: 10/14/2015
DRAWN BY: N. Rinehart	TASK ORDER: JM75

X:\Navy\NAS_Corpus_Christi\VI_SAP2015_AreaLocationMap.mxd

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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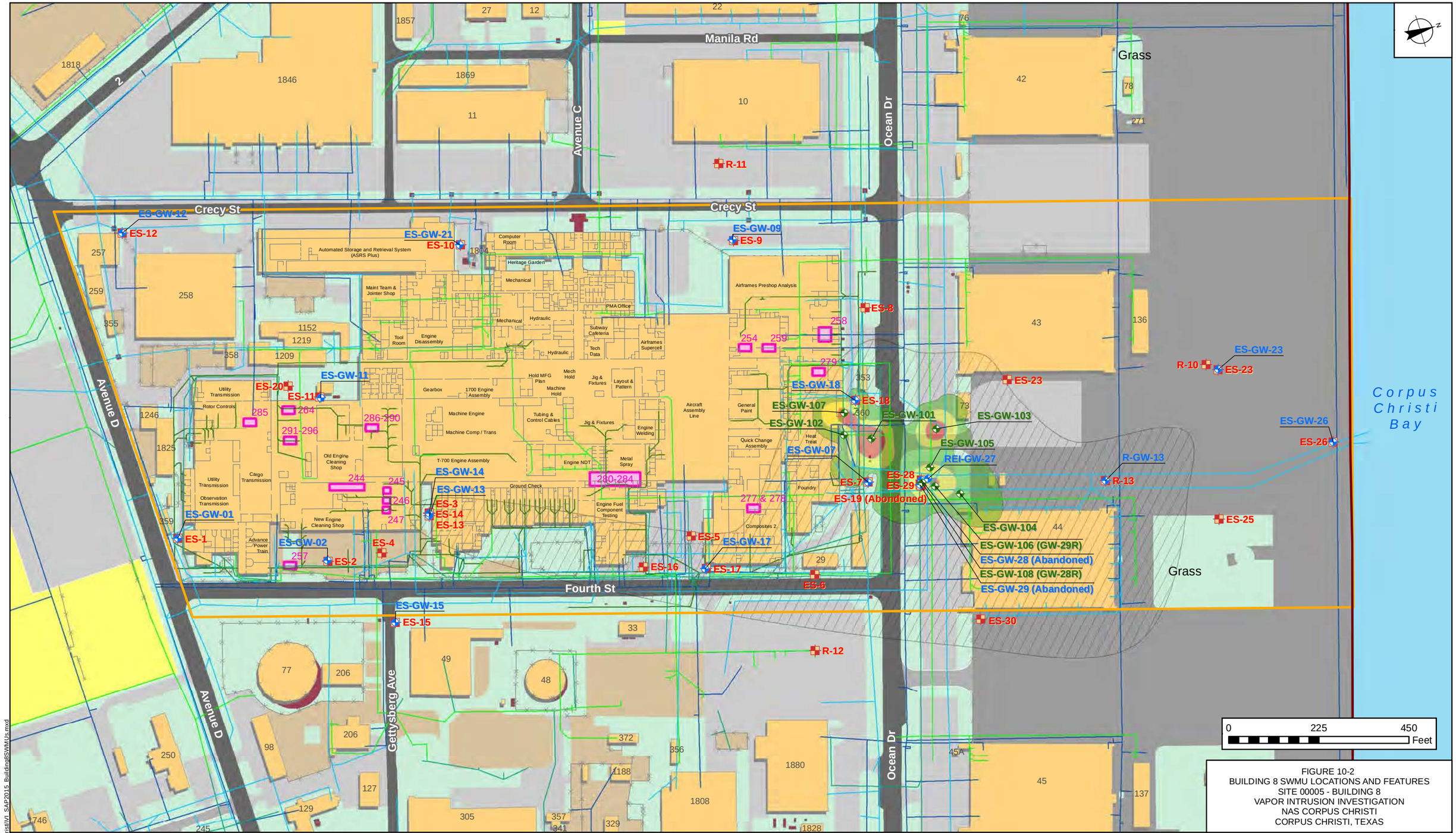


FIGURE 10-2
BUILDING 8 SWMU LOCATIONS AND FEATURES
SITE 00005 - BUILDING 8
VAPOR INTRUSION INVESTIGATION
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

Many of these industrial activities will be relocated to a new facility being constructed at a separate location that should be available for occupancy sometime in 2018. Portions of the building will be demolished after they are vacated. The Building 8 foundations will remain in place as part of the site remedy pending additional remedial investigation and subsequent actions, if needed (Resolution Consultants, May 2015).

10.2 Previous Investigations

Table 10-1 summarizes prior investigations at Site 00005 — Building 8.

Table 10-1
Summary of Prior Investigations

Date	Activity/Document	Description
1992	*Preliminary Assessment* (E/A&H, June 1992)	Collection and analysis of groundwater samples. Organic contaminants were detected in concentrations below the maximum contaminant levels, except for the area of the IWPP. Inorganic contaminants were detected in concentrations exceeding specific maximum contaminant levels in a slightly larger area, also centered around the IWPP. Additional assessment recommended.
1994	*Groundwater Assessment Report* (E/A&H, February 1994)	Installation of groundwater monitoring wells; no significant soil contamination was encountered. Groundwater contaminants, both organic and inorganic, were detected primarily in the vicinity of the IWPP. The report recommended an aquifer pumping test to characterize the hydrogeologic parameters of the site.
1996	*Aquifer Characterization Test Report* (E/A&H, February 1996)	Constant-rate pumping test was not completed due to excessive drawdown in the pumped wells. Slug testing determined the average transmissivity for the shallow aquifer was 0.0049 square feet per minute. Based on the pumping data, the maximum sustainable pumping rate for remediation was estimated to be less than 0.1 gallon per minute.
1999	*Technical Memorandum — Evaluation of Monitored Natural Attenuation, IR Sites 1, 3, 4, and Building 8* (EnSafe, November 1999)	VOC and geochemical analyses indicated natural attenuation was occurring in the Building 8 area as evidenced by the significant decrease in contaminant concentration between the 1997 and 1999 sampling events. The report concluded that monitored natural attenuation should be pursued as part of the remedy for Building 8.
2001	*Affected Property Assessment Report* (EnSafe, August 2001)	Additional assessment identified COCs in groundwater, but the sampled soil from the periphery of Building 8 was below the critical PCLs established for the site under TRRP. The soil beneath Building 8 was not sampled during the APAR investigation. A soil PCLE zone, consisting of the entire footprint of Building 8, was established for all soil COCs. Just north of Building 8, a TCE groundwater PCLE zone was established. Details on COCs defined during the APAR are described in Section 10.3.

Table 10-1
Summary of Prior Investigations

Date	Activity/Document	Description
2003	*Response Action Plan* (EnSafe, December 2003) and Supplemental *APAR* (EnSafe, March 2003)	Indoor air space sampling determined that vapor intrusion was not occurring because the primary groundwater contaminant (TCE) was not detected in the building above action levels (OSHA PELs); PELs were applicable because TCE was still being used throughout the building in process areas. According to base personnel, TCE is currently no longer in use at the site (Resolution Consultants, May 2015). Deep aquifer wells (R-10, R-11, R-12) were installed north, east, and west of Building 8, shallow aquifer replacement wells were installed, and shallow aquifer sentry wells (R-13 and ES-26) were established. Semiannual monitoring was initiated. The Building 8 RAP incorporated routine inspection and maintenance of the entire 20-acre Building 8 slab; the slab will be treated as an engineered barrier (cap) to the soil PCLE zone as defined by the footprint of building (EnSafe, December 2003). During the APAR and Supplemental APAR, a groundwater PCLE zone for TCE was identified under Ocean Drive just north of Building 8. In the 2003 RAP, Building 8 and the TCE PCLE zone were combined to define Site 00005 (Figure 10-2). The response action for the groundwater TCE PCLE zone was MNA (EnSafe, December 2003).
2002 through 2014	Long-Term Monitoring (various consultants)	Long-term monitoring results indicate stable to increasing TCE concentrations ranging from 3,200 µg/L to 7,900 µg/L based on samples collected from monitoring well ES-GW-28, which is screened between 23.5 and 28.5 feet bgs. From 2002 through 2014, groundwater sampling results from the 6.5- and 11.5-foot bgs zone of the same aquifer (monitoring well ES-GW-29) indicate TCE concentrations ranging from non-detect to 1,600 µg/L.
2014	MIP Profiling	MIP profiling using a halogen specific detector and follow-up sampling indicate the potential for elevated TCE concentrations in groundwater and soil gas to be present beneath Building 8. Confirmation groundwater sample results from ES-GW-28R indicate a TCE concentration of 13,100 µg/L. Additional results from two new wells ES-GW-101 and ES-GW-107 indicate TCE concentrations ranging from 9,000 µg/L to 9,700 µg/L are within 25 feet of the Building 8 foundation (Figure 10-3). These results will be formally presented in the pending Supplemental APAR report.

Notes:

E/A&H = EnSafe/Allen & Hoshall
IWPP = Industrial Waste Pretreatment Plant
VOC = Volatile organic compound
COCs = Contaminants of concern
PCL = Protective concentration levels
PCLE = Protective concentration level exclusion
TRRP = Texas Risk Reduction Program
APAR = Affected Property Assessment Report
TCE = Trichloroethene
OSHA = Occupational Safety and Health Act
PEL = Permissible Exposure Limit
RAP = Response Action Plan
MNA = Monitored natural attenuation
bgs = Below ground surface
µg/L = Micrograms per liter
MIP = Membrane interface probe

10.3 Potential or Known Contamination Site 00005 — Building 8

Prior investigations at the site identified TCE as the primary contaminant of concern (COC). Fourteen COCs were retained for soil during the 2001 APAR: cadmium, lead, benzo(a)pyrene, benzene, chlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, methylene chloride, 1,1,2,2-tetrachloroethane, tetrachloroethene (PCE), 1,1,2-trichloroethane, TCE, and vinyl chloride. Fourteen COCs were retained for groundwater during the 2001 APAR: cadmium, lead, benzene, chlorobenzene, 1,3-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, methylene chloride, 1,1,2,2-tetrachloroethane, PCE, 1,1,2-trichloroethane, TCE, and vinyl chloride. Protective concentration level exposure (PCLE) zones for soil and groundwater were established in the APAR and APAR Addendum, as described in Table 10-1. The current shallow aquifer monitoring well network indicates increasing concentrations for both primary constituents and degradation products at monitoring wells ES-28 and ES-29 (sites of historically high concentrations and point of compliance locations); however, the observation wells (R-13, ES-7, ES-26) do not indicate the plume is expanding. Deep aquifer wells (R-10, R-11, and R-12) indicate the deep aquifer has not been impacted by Site 00005 — Building 8 COCs.

10.4 Site Geology and Hydrogeology

The following summarizes regional lithology and local hydrogeology; additional information on local lithology may be obtained from boring logs and cross sections presented in the appendices to the APAR (EnSafe, August 2001), APAR Addendum (EnSafe, March 2003), RAP (EnSafe, December 2003), *Initial Assessment Study* (Harmon Engineering 1984), and in the CSM presented in Section 10.5.

The coastal plain of the Corpus Christi area is underlain by Pleistocene river, delta, and shoreline sediments deposited during the interglacial periods. NAS Corpus Christi is underlain by the Beaumont Formation, characterized by barrier islands and beach deposits composed of fine-grained sands. Numerous pimple mounds and poorly defined relict beach ridges characterize the land surface. Locally active sand dunes are present in undisturbed areas. The barrier island and beach deposits of the Beaumont Formation are typically less than 60 feet thick. Other stratigraphic units, in order of increasing age, include the Montgomery Formation, Lissie Formation, Willis Formation, and the Goliad Sand (Harmon Engineering 1984).

Three lithologic units of the Beaumont Formation have been encountered during drilling activities at Site 00005 — Building 8:

- The first unit (upper sand) is a very fine- to fine-grained silty sand. The unit's thickness ranges from 20.5 to 28.5 feet in the vicinity of Building 8. The upper unit contains a discontinuous clay layer at a depth of 10 to 15 feet below ground surface (bgs). In areas where wells are screened both above and below this clay, there is essentially no difference in the static water level elevation. (EnSafe, August 2001).

- The second unit is a clay layer that varies from 8 to 16.5 feet thick in the vicinity of Building 8. In general, the clay thins from west to east and from south to north. The clay's contact with the first unit is sharp, with only a 0.5 to 1 foot transition. The lower contact with the third unit is more problematic due to a thicker transition zone of 5 to 7 feet. For mapping purposes during the APAR, the lower boundary was picked at the first indication of sand or silt (EnSafe, August 2001).

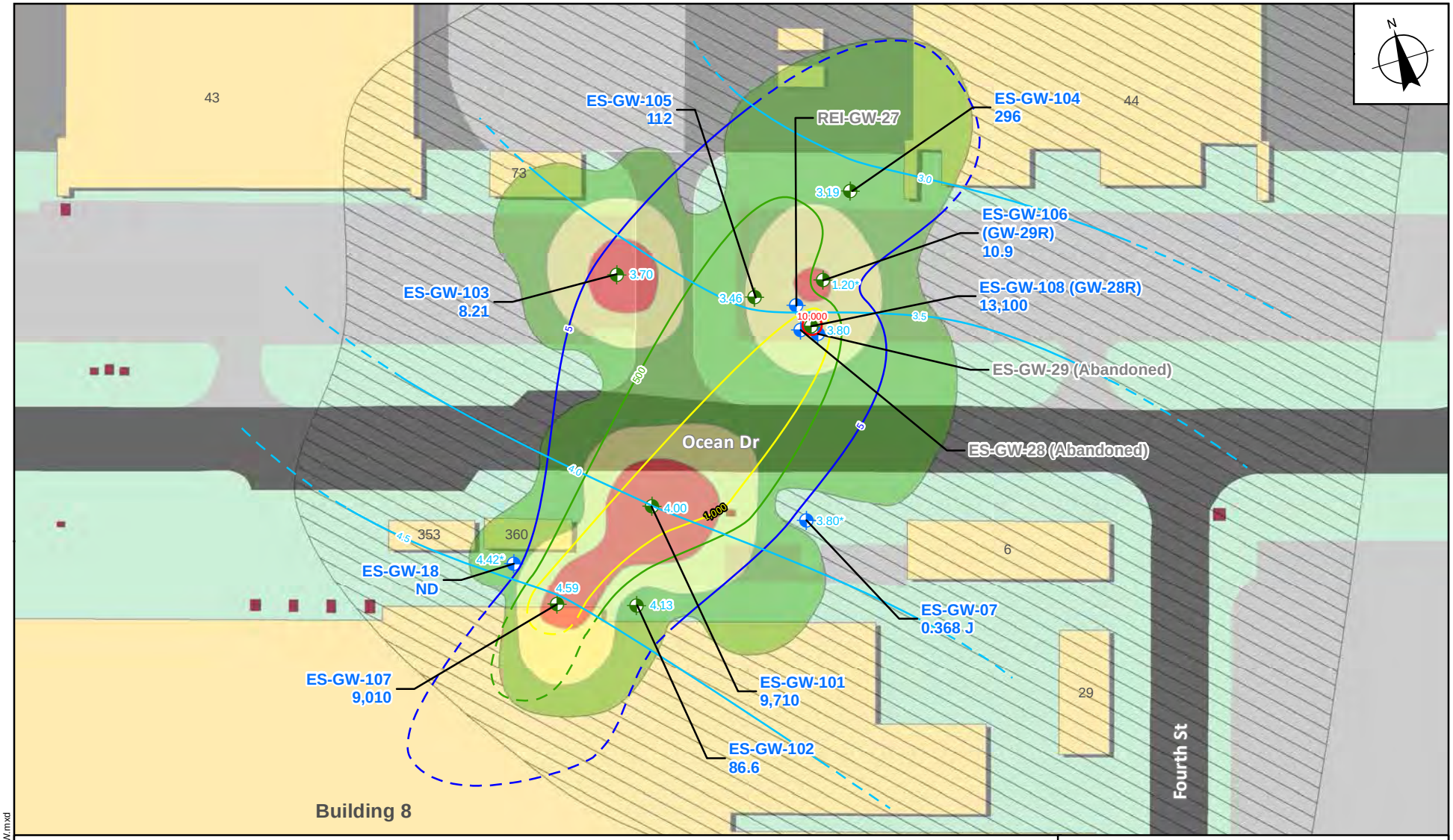
- The top of the third unit (lower sand) is 23 to 33.5 feet bgs. The lithology varies from fine-grained, silty clays of the transition zone to very fine- to fine-grained sands.

- A confining layer of varying thickness is below the third unit and the "deep aquifer" is below the confining layer at approximately 43 to 55 feet bgs.

The upper silty sand unit is typically saturated beginning at depths of 4 to 8 feet bgs. This water bearing unit is classified as a Class 3 groundwater resource (EnSafe, August 2001). Static water level elevations have been routinely contoured semi-annually for the shallow aquifer at Building 8 since 2002. The contours from February and March 2015 are presented in Figure 10-3 and show a continuation of the historical directional flow potential toward the northeast.

10.5 Conceptual Site Model — Site 00005 Building 8

Comprehensive site data were used to develop a data-driven lithological model in support of the Site 00005 — Building 8 CSM, shown on Figure 10-4.



Monitoring Wells - NIRIS

Phase 2 Wells (Feb. - Mar. 2015)

TCE Isocontours (Dashed Where Inferred)

- 5 µg/L - MCL
- 500 µg/L - PCL GW Class 3
- 1,000 µg/L
- 10,000 µg/L
- Potentiometric Surface Contour, Dashed Where Inferred (ft)

Building Footprint

Open Storage Area

Max XSD Values (1,000 x uV)

- <107k - Likely Below Detection
- <218k - Likely Below MSL (5 µg/L)
- <416k - Likely Below PCL (500 µg/L)
- >416k -Likely Exceeds PCL
- Open Areas
- Minor Structures, Paved

Paved Road

Airfield Pavement

Driveway

Paved Parking

Unpaved Parking

Water

Note:
- All units are in µg/L
- ND = Non Detect
- J = Estimated value
- * = Upper zone wells not included in elevation calculations

0 50 100 Feet

FIGURE 10-3
TRICHLOROETHENE IN GROUNDWATER
(FEBRUARY-MARCH 2015)
SITE 00005 - BUILDING 8
VAPOR INTRUSION INVESTIGATION
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 8/27/2015
DRAWN BY: N. RINEHART	TASK ORDER NUMBER: JM75

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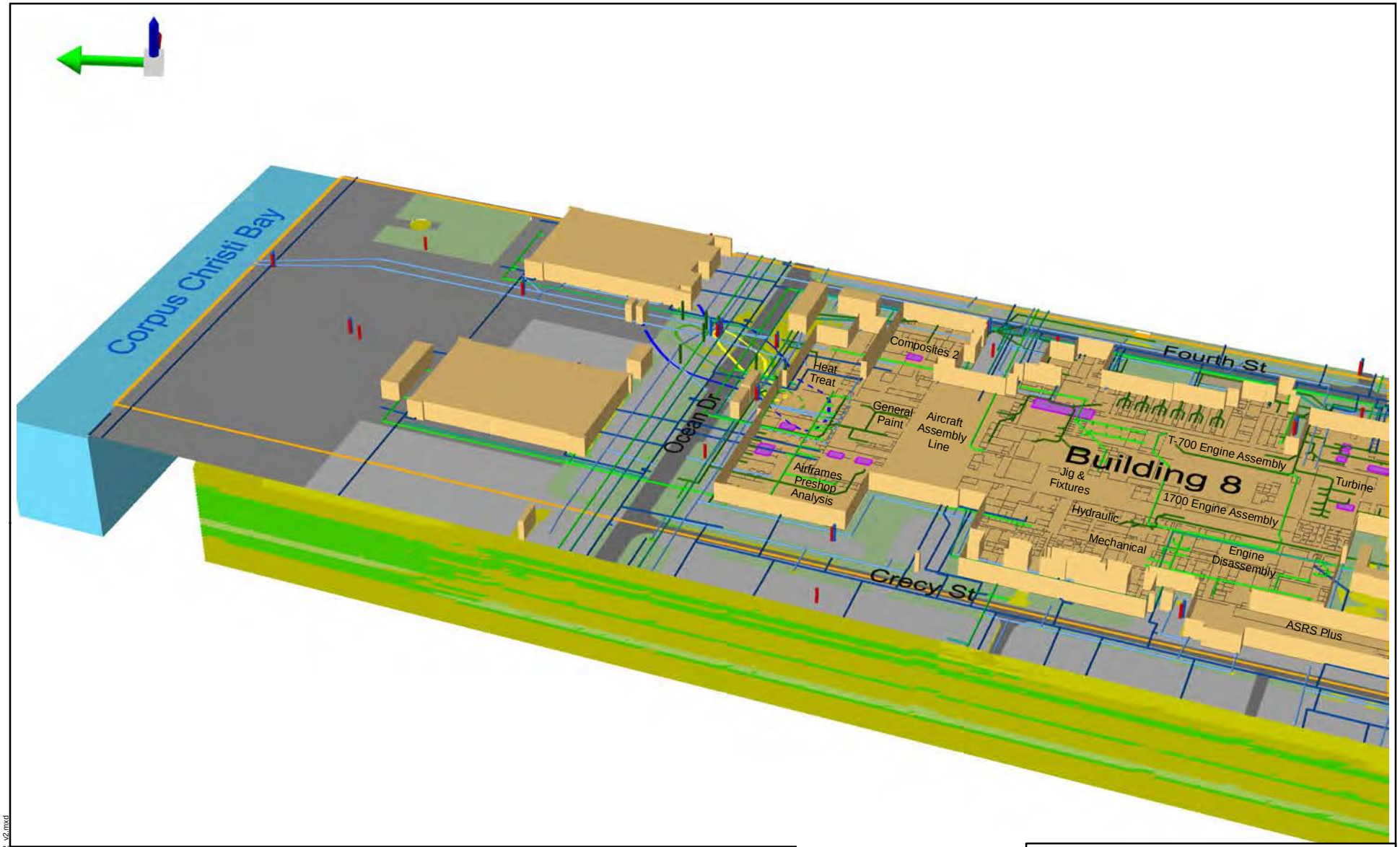

Legend

Lithology
- Clay
- Silty Sand
- Silt
- Plastic Clay
- Sand (Poorly Graded)
- Clayey Sand
- Water

- Phase 2 Wells (Feb. - Mar. 2015)
- Monitoring Wells - NIRIS
- Well Locations - NAVFAC GDB
- Approximate Storm Sewer Line - NAVFAC
- Approximate Water Line - NAVFAC
- Approximate Sanitary Sewer Line - Weston
- Approximate Sanitary Sewer Line - NAVFAC
- Approximate Industrial Sewer Line - Weston

TCE Isocontours: Feb. - Mar. 2015
(Dashed Where Inferred)
- 5 µg/L - MCL
- 500 µg/L - PCL GW Class 3
- 1,000 µg/L
- 10,000 µg/L
- SWMU Boundary
- Building Footprint

- Site Boundary
- Surface Water Flow Direction
- Groundwater Flow Direction
- Groundwater Level Anticipated

FIGURE 10-4
CONCEPTUAL SITE MODEL
SITE 00005 - BUILDING 8
VAPOR INTRUSION INVESTIGATION
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 8/27/2015
DRAWN BY: N. Rinehart	TASK ORDER NUMBER: JM75

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10.5.1 Nature and Extent — Data Gaps

The recently implemented MIP and groundwater sampling investigations within the TCE plume area north of Building 8 have identified data gaps in all media at Building 8, described as follows.

- Elevated TCE has been identified close to the Building 8 foundation, but the source areas and nature and extent beneath Building 8 are not sufficiently defined for groundwater or soil gas to rule out the vapor intrusion pathway to indoor air receptors. This may be adversely affected by heterogeneities in site lithological structures relative to foundational structures and defects that may support preferential pathways to vapor intrusion.

- The TCE plume appears to extend to the south, beneath Building 8, but the extent of the plume is not known. It will be necessary to delineate the extent of the plume to gauge the potential for VI impacts within the building.

- Petroleum-related VOC (PVOC) plumes are also suspected beneath the building, potentially commingling with the CVOC plume.

- The impacts of site hydraulics on vapor intrusion are unknown. Site hydraulics may be affected by historical Building 8 SWMUs (including floor drains, process waste tunnels, and the former industrial sewer processing plant), the storm sewer, tidal influences, and both the sanitary and industrial sewer collection piping located throughout the building.

- The nature of the background indoor air sources have substantially changed since 2003 when the last indoor air study was performed. Some of the previously detected compounds in indoor air are no longer authorized for use in the Building 8 industrial process areas.

- The current conditions for indoor air quality are not well defined for TCE and the associated daughter products. Additionally, the actual chemicals used in Building 8 are not currently well defined. A full VI study, including the screening of indoor air sources, sub-surface vapor screening, indoor and background air quality sampling, and the development of site specific attenuation factors, is recommended.

Additional sampling, described in Worksheet#17, is required to delineate nature and extent and transport parameters for TCE in sub-slab soil gas with respect to vapor intrusion potential into indoor air. Portions of the Building 8 complex will be demolished after they are vacated

(scheduled for 2018). The Building 8 foundations will remain in place as part of the site remedy, pending additional remedial investigation and subsequent actions, if needed (Resolution Consultants, May 2015). For this reason, the current investigation will prioritize delineation of potential sources and extent of known groundwater impacts in the northern portion of the site and work southward until extent of TCE and its associated daughter products is well defined under Building 8 with respect to vapor intrusion potential.

10.5.2 Exposure Pathways — Site 00005 — Building 8

The following exposure pathways are considered complete or potentially complete at Site 00005 — Building 8:

- Ingestion of COCs in Class 3 groundwater: The shallow aquifer at Site 00005 — Building 8, which meets the criteria of Class 3 groundwater (EnSafe, August 2001), has been affected by COCs. Therefore, this pathway is considered to be complete at NAS Corpus Christi. Although, by definition, ingestion of Class 3 groundwater is not anticipated, there may be potential for incidental contact by construction workers, which could include ingestion.

- Inhalation of volatile emissions from COCs in groundwater bearing units and combined inhalation of volatile emissions and particulates from COCs in surface soil, dermal contact with COCs in surface soil, and ingestion of COCs in surface soil. The shallow aquifer at Site 00005 — Building 8 has been affected by COCs. The exterior pavements at Site 00005 — Building 8 are not designated as an engineering control (EnSafe, December 2003); therefore, this pathway is considered to be complete for outdoor air. The Building 8 foundations are designated as an engineering control in the RAP, as described in Table 10-1. However, the integrity of the foundation with respect to mitigation of potential impacts from vapor intrusion of COCs in groundwater is not well defined; therefore, this pathway is considered to be potentially complete for indoor air.

- Leaching of COCs in surface and subsurface soils to groundwater: The shallow aquifer at Site 00005 — Building 8 has been affected by COCs and the soils beneath Building 8 are designated as a PCLE zone. Groundwater at Site 00005 — Building 8 is influenced by stormwater runoff, potentially influenced by tidal fluctuations, and is in contact with potentially impacted surface and subsurface soils beneath Building 8; therefore, this pathway is considered to be complete.

- Inhalation of volatile emissions from COCs in subsurface soils: The soil beneath Building 8 is designated as a PCLE zone. The Building 8 foundations are designated as an engineering control in the RAP as described in Table 10-1. However, the integrity of the foundation with respect to mitigation of potential impacts from vapor intrusion of COCs in subsurface soils is not well defined; therefore, this pathway is considered to be potentially complete for volatile emissions in indoor air.

- Contact with surface water or sediment containing COCs originating from the source area: This pathway is considered to be potentially complete at Site 00005 — Building 8 because groundwater in the shallow aquifer contains COCs and has the potential to enter the storm sewer system, which discharges to Corpus Christi Bay approximately 1,000 feet north of the site.

10.5.3 Receptors and Future Land Use — Site 00005 Building 8

The most recent risk evaluation was performed as part of the 2001 APAR. Human receptors during that risk evaluation included personnel (CCAD or Navy) who may use the site, construction or maintenance workers, escorted visitors (e.g., contractors conducting environmental or ecological surveys), and trespassers (e.g., authorized personnel who may wander outside of designated areas). As documented in the APAR, the facility's land use is considered industrial and the shallow aquifer meets Class 3 criteria. Portions of the Building 8 complex will be demolished after they are vacated (scheduled for 2018). The Building 8 foundations will remain in place as part of the site remedy, pending additional remedial investigation and subsequent actions, if needed (Resolution Consultants, May 2015). Current land uses have not changed and are expected to remain unchanged in the future. The shallow aquifer currently meets Class 3 criteria and is not presently used for any purpose. Residential exposures were not evaluated due to the industrial land uses associated with Building 8.

Potential ecological receptors considered during the 2001 APAR risk evaluation included terrestrial plants and invertebrates, birds, and mammals. Ecological receptor exposures considered were direct contact with or ingestion of contaminated media, as well as the food chain (i.e., by ingesting plants and animals that have been impacted through uptake of soil contaminants). Site habitats were characterized using TCEQ's Tier 1 Ecological Exclusion Criteria Checklist to assess whether viable ecological receptors are present; Building 8 was not considered to be viable habitat. Additional risk assessment is not currently under consideration for this effort.

SAP WORKSHEET #11: DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

(UFP-QAPP Manual Section 2.6.1)

Field activities associated with this VI study include a two-staged approach to assess the risk associated with VI at Site 00005 — Building 8. This VI study is implemented as Phase 4 of the ongoing efforts to assess the current conditions and selected remedy for mitigating TCE contamination in groundwater (Phases 1 through 3), which are addressed in the SAP for the Supplemental Groundwater Investigation (SGI) (Resolution Consultants, August 2014) and subsequent modifications (Resolution Consultants, January & May 2015). This VI SAP covers the following field investigation elements.

- Rapid assessment techniques (HVS with HAPSITE followed by MIP in later phases) will be used to evaluate the spatial and vertical distribution of CVOCs in sub-slab soil gas at Site 00005 — Building 8. Real-time data from HVS and MIP investigations will be used to delineate CVOCs in the vadose zone beneath Building 8.

  - Onsite analysis using HAPSITE during the HVS investigation will be used to distinguish between CVOCs and petroleum-related sources using TCE as the indicator compound for CVOCs and benzene as the indicator compound for PVOCs.

  - A halogen specific detector (XSD) will be used during MIP investigation to distinguish between CVOCs and PVOCs.

  Based on the initial screening with HVS and follow up assessment with MIP, industrial process areas and other interior locations will be identified for VI assessment.

- Indoor air will be sampled for the 12 VOCs previously identified as site COCs and air quality will be assessed relative to VI sources, indoor air pollutant sources, background levels, and established site-specific risk-based screening levels and attenuation factors.[1] Collocated indoor air and sub-slab soil gas confirmation samples will be collected simultaneously with outdoor ambient air samples after the selected Building 8 focus areas are identified and further screened for indoor air pollution sources.

[1] The 12 VOCs identified as groundwater and soil COCs during the APAR include benzene, chlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, methylene chloride, 1,1,2,2-tetrachloroethane, tetrachloroethene, 1,1,2-trichloroethane, TCE, PCE, and vinyl chloride.

Results of the rapid assessment will feed into additional tasking for the VI effort and also in the ongoing groundwater investigation. If any indoor air TCE concentration exceeds the Industrial Urgent Response Action Level of 88 µg/m^3 (representing a hazard index of 10), as recommended in the IRIS guidelines, the Navy will be notified immediately so that the Navy may report to stakeholders in accordance with the Stakeholder Communication Plan.

11.1 Problem Statement

Recent groundwater investigation results indicate that contaminant concentrations within the Site 00005 — Building 8 TCE plume area could have the potential for indoor air quality impacts in Building 8. Therefore, an assessment for VI of TCE into Building 8 from potential groundwater and vapor sources beneath the building is required.

11.2 Goals of the Study

This VI study is a companion study to the ongoing groundwater investigation that is addressed by the SGI SAP (Resolution Consultants, August 2014, January & May 2015). The SGI SAP addresses Phases 1 through 3 of this effort; this VI SAP addresses Phase 4. Comprehensive goals for all fieldwork are defined in Appendix D; field decisions that inform other SGI and VI activities are noted in this appendix.

The goals of the Phase 4 activities are to:

- Phase 4a: Evaluate the spatial distribution of CVOCs in sub-slab soil gas in the vadose zone within the Site 00005 — Building 8 footprint to determine sub-slab soil gas and indoor air sampling locations for the VI study. These data will also be used to define MIP locations for the groundwater investigation (see the SGI SAP for details on the MIP investigation).

- Phase 4b: Evaluate the spatial and vertical distribution of CVOCs in groundwater beneath the Site 00005 — Building 8 foundation and define the structures within the soil that may affect contaminant transport using information obtained from Phase 4a. The investigation will begin at the northern end of Building 8 and extend to the south using a dynamic investigation approach to roughly delineate plume extents. Additional investigations will likely be required to refine the nature and extent of contamination. (Note Phase 4b groundwater assessment tasks are addressed under the SGI SAP and are only shown here for completeness. These tasks are not discussed in the VI SAP.)

- Phase 4c: Evaluate potential risks associated with CVOC VI to indoor air receptors using multiple lines of evidence at Site 00005 — Building 8. Notify the Navy immediately if TCE concentrations in indoor air exceed the action level defined for this field activity (see Section 11.3).

Multiple Lines of Evidence to be Considered in Phase 4c:
- Sub-slab soil gas, indoor, and outdoor air TO-15 results 12 VOCs
- Radon data
- Differential pressure differential data
- Historical shallow groundwater data
- Building characteristics
- HVS data
- MIP investigation results
- HAPSITE indoor air survey
- Chemical use history

Field activities will include:

- Assessment of building characteristics and conditions pertinent to VI (including, but not limited to, occupancy; floor type/condition; typical operation of the heating, ventilation, and air conditioning [HVAC] system; chemical products stored; and activities that may be sources of VOCs in indoor air) and supplemental indoor air source screening using the HAPSITE (portable GC/MS). These data will be used in a multiple-lines-of-evidence evaluation of Site 0005 — Building 8.

- An initial round of sub-slab screening samples collected using HVS techniques supported by HAPSITE for speciation of selected compounds (TCE and benzene) in sub-slab soil gas. Locations were selected based on prior analytical data (where available), former SWMU locations, known drains and sumps, etc. Locations will be field adjusted based on site conditions and real-time screening data. Additional data are provided in Worksheet #17.

- Follow-up sampling of 12 VOCs using concurrent indoor air (IA) and sub-slab (SS) samples, with collection of supplemental data (ambient air samples, radon samples, differential pressure data, etc.) that will also support the multiple-lines-of-evidence evaluation.

The assessments performed during Phase 4c of the Site 0005 — Building 8 investigations will be used to determine whether additional investigation is required, to establish a sound basis for remedial decision-making and optimization of the site remedy, and to support a request for formal modifications to the selected remedy for Site 00005 — Building 8 (if needed). This review and recommendation process is described as Study Phase 3 (SGI SAP [Resolution Consultants, August 2014, January and May 2015]) (see summary tables, Appendix D).

Principal study questions (PSQ), decision statements, and decision rules for the Site 0005 — Building 8 VI investigation are shown in Table 11-1.[2]

11.3 Inputs to Resolve the Problem

The inputs needed to resolve the project problem statement identified in Section 11.1 include the following measurements, observations, data, and project screening levels. Details of the sampling design are in Worksheet #17.

- Building Survey: Building surveys will be conducted to obtain building characteristics and conditions pertinent to VI including, but not limited to, occupancy, floor type/condition, typical operation of the HVAC system, chemical products stored, and activities that may be sources of VOCs in indoor air. This information will support the confirmation of potential areas of interest for VI assessment.

- HAPSITE Survey: The HAPSITE unit is a screening tool that will be used qualitatively to assess the presence/absence of the 12 VOCs, to evaluate potential background VOC sources in indoor air in Site 00005 — Building 8, as well as to identify potential locations where soil gas may be entering the building (cracks, expansion joints, sumps, etc.).[3] If elevated VOCs are identified while surveying, the HAPSITE will then be used in sample mode to obtain quantitative results sufficient to provide speciation for the 12 VOCs to determine which are present. More definitive assessment will occur when the indoor air samples are later collected for offsite laboratory analysis.

[2] PSQs for groundwater are presented in the SGI SAP for Phases 1 through 3 (Resolution Consultants, August 2014, January & May 2015). The PSQs are numbered sequentially from prior team questions given project phasing.
[3] The 12 VOCs identified as groundwater and soil COCs during the APAR include benzene, chlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, methylene chloride, 1,1,2,2-tetrachloroethane, tetrachloroethene, 1,1,2-trichloroethane, TCE, PCE, and vinyl chloride.

Table 11-1
VI Investigation PSQs, Decision Statements, and Decision Rules

Study Phase	PSQ ID	PSQ Short Name	PSQ Text	Decision Statement	Decision Rule Text	UFP-SAP
4a HVS	PSQ5	PSQ5: Spatial distribution of CVOCs in Sub-Slab Vapor	PSQ5: Have the spatial distributions of CVOCs in sub-slab soil gas beneath the Site 00005 - Building 8 foundation been adequately assessed during the HVS investigation such that quantitative sub-slab soil gas and indoor air sampling locations and MIP locations can be determined?	Assess the sub-slab soil gas screening data obtained by HVS techniques to determine appropriate sub-slab soil gas sampling, indoor air sampling, and MIP locations.	Decision Rule 5a: If CVOCs (as indicated by TCE) have been detected above field-established background levels and differentiated from PVOCs (as indicated by benzene) using screening instruments (PID, GEM 2000, and HAPSITE), then continue with the HVS investigation as outlined in Worksheet #17. However, if CVOCs are below screening levels at a selected HVS test location, then advancement of the next location will focus upon a new location or suspected contaminant direction until extent of potential sub-slab impacts have been determined in at least four cardinal directions.	VI
					Decision Rule 5b: If the HVS investigation findings are complete and sufficient, then determine the appropriate locations for MIP, indoor air, and sub-slab sampling. If findings indicate that the HVS investigation did not generate the information needed to complete the goal, then make alternate recommendations to the partnering team.	VI
4b Indoor MIP	PSQ1a	PSQ1a: Spatial & vertical distribution of CVOCs in groundwater	PSQ1a: Have the spatial and vertical distributions of CVOCs in groundwater been adequately defined during the MIP investigation such that the approximate boundaries of the TCE plume beneath the Building 8 foundation are sufficiently known to further assist in determining locations to sample sub-slab soil gas and indoor air?	Assess the presence/absence of CVOC in groundwater using MIP techniques to further assist in determining the appropriate sub-slab soil gas and indoor air sampling locations.	Decision Rule 1a: If CVOCs are above field-established background levels, then continue with MIP investigations as outlined in Worksheet #17. However, if CVOCs are below field-established background levels, then select a new transect direction or grid location and continue screening along a designated transect until all planned sample locations are evaluated along that transect, or until the CVOC plume has been mapped in at least the four cardinal directions.	SGI
	PSQ1b	PSQ1b: Potential CVOC source areas identified	PSQ1b: Did the MIP investigation identify potential source areas beneath the Building 8 foundation that may require additional study?		Decision Rule 1b: If the CVOC plume has been mapped to background levels in at least the four cardinal directions, then stop collecting MIP screening data for plume extent and continue with MIP investigations as outlined in Worksheet #17, but focusing on locations where hydrogeologic structures or potential CVOC sources could be better defined.	SGI
4b Indoor MIP	PSQ1c	PSQ1c: Data Sufficient to Make Decisions	PSQ1c: Does the investigation team have the information needed to provide input on the sub-slab soil gas and indoor air sampling locations?		Decision Rule 1c: If MIP findings are complete and sufficient, then determine the appropriate indoor air and sub-slab sampling locations. If findings indicate that the MIP investigation did not generate the information needed to complete the goal, then rely on the findings of the HVS investigation and the HAPSITE indoor air survey.	VI
4c Indoor Air	PSQ6	PSQ6: Building characteristics and chemical/process inventory identified	PSQ6: Do Site 00005 — Building 8 characteristics (construction, floor slab condition, HVAC system construction and operation, etc.) contribute to VI? Have chemical inventories and a breakdown of chemical processes been obtained and reviewed for possible CVOC sources?	Request a Hazardous Materials Inventory from CCAD prior to commencement of field activities. Conduct a building survey prior to or during the HAPSITE indoor air survey to document items housed in the areas of interest within Site 00005 - Building 8 that may contribute as an indoor background source of CVOCs (cleaning products, chemicals used/stored within the building for manufacturing, etc.). Other such items, including the types and typical operation of the HVAC systems, potential preferential pathways (piping and other conduits, etc.), and the condition of the slab, will also be assessed during the building survey.	Decision Rule 6: If access is not permitted in some areas of Site 00005 - Building 8, then a CCAD representative will be asked to perform the building survey using a form within the area.	VI
4c Indoor Air	PSQ7	PSQ7: Indoor air contaminant sources screened and identified by HAPSITE	PSQ7a: Do Site 00005 — Building 8 operation and maintenance activities result in potential background sources of CVOCs?	The HAPSITE will be used in both qualitative and quantitative modes to identify background sources (cleaning products, chemicals used within the building for manufacturing, etc.). The indoor air survey will also verify and locate potential CVOC-containing items listed on the requested Hazardous Material Inventory and identify those items that are not listed.	Decision Rule 7a: If the HAPSITE unit (while in quantitative mode) detects CVOC concentrations emitting from any items or processes, then appropriate communications will be made by the Navy to the site stakeholders. If the source of background CVOCs can be removed in advance of the IA sampling event, these actions will be completed no less than 48 hours prior to initiation of the IA sampling. All identified CVOC sources and the current conditions of those sources (i.e., addressed or not addressed) prior to the IA sampling will be logged in the field notebook.	VI
4c Indoor Air			PSQ7b: Are crack/joints/utilities inside Building 8 acting as conduits for VI?	The HAPSITE will be used in both qualitative and quantitative modes to identify vapor entry points for VI (cracks, joints, utilities, etc.).	Decision Rule 7b: If the HAPSITE unit (while in quantitative mode) detects CVOC concentrations emitting from cracks/crevices/joints/etc., then appropriate communications will be made by the Navy to the site stakeholders. If vapor entry points are identified that can be addressed (i.e., sealed) in advance of the IA sampling event, these actions will be completed no less than 48 hours prior to initiation of the IA samples. The Navy will coordinate with CCAD to complete building repairs that can be implemented within the timeframe of this investigation. All identified CVOC sources and the current conditions of those sources (i.e., addressed or not addressed) prior to the IA sampling will be logged in the field notebook.	VI

Table 11-1
VI Investigation PSQs, Decision Statements, and Decision Rules

Study Phase	PSQ ID	PSQ Short Name	PSQ Text	Decision Statement	Decision Rule Text	UFP-SAP
4cIndoor Air	PSQ8	PSQ8: Indoor air quality assessed relative to VI sources	PSQ8a: Are CVOCs present in sub-slab vapor beneath the Site 00005 — Building 8 foundation at concentrations that could result in indoor air concentrations above risk-based target levels?	Assess the collected sub-slab vapor concentration data and determine whether CVOCs in the subsurface (groundwater and/or soil) have volatilized and produced concentrations in the sub-slab vapor that could migrate into indoor air. After sub-slab soil gas samples are obtained, collect a subset of radon to evaluate attenuation across the slab. Use radon data with other contaminant ratios to develop a site-specific attenuation factor.	Decision Rule 8a1: If sub-slab soil gas CVOC concentrations are below risk-based target levels, then there is no significant risk of CVOC VI and no further investigation is warranted.	VI
					Decision Rule 8a2: If sub-slab soil gas CVOC concentrations exceed risk-based target levels but are not observed in corresponding indoor air samples, then there is potential to result in future exceedances of risk-based target levels in indoor air. A management plan will be recommended and discussed with the Partnering Team and CCAD.	VI
4c Indoor Air			PSQ8b: Are CVOCs present in indoor air in Site 00005 — Building 8 at concentrations above risk-based target levels?	Collect and assess indoor air concentration data to determine whether CVOCs in sub-slab soil gas have migrated into indoor air. After indoor air samples are obtained, collect a subset of radon samples to evaluate attenuation across the slab. Use radon data with other contaminant ratios to develop a site-specific attenuation factor.	Decision Rule 8b1: If indoor air CVOC concentrations exceed risk-based target levels but are not observed in corresponding sub-slab soil gas samples, then indoor air concentrations are not related to VI and are likely due to an indoor and/or outdoor air CVOC source. These exceedances of risk-based target levels that are not related to VI will be reported to the Partnering Team and CCAD.	VI
					Decision Rule 8b2: If indoor air CVOC concentrations exceed risk-based target levels and are also observed in corresponding sub-slab soil gas samples, then it is possible that the VI pathway is complete and/or significant. Assessing the multiple lines of evidence will determine whether indoor air exceedances are due to VI and/or indoor/outdoor background sources. If possible background sources have been ruled out and a VI pathway has been completed, then a human health risk assessment will be completed as part of the VI assessment report (Phase 3 — APAR Addendum Report).	VI
4c Indoor Air					Decision Rule 8b3: If TCE concentrations in indoor air exceed 88 µg/m^3, Resolution Consultants will immediately notify the Navy of site conditions and areas of concern. The Navy will contact the Partnering Team and CCAD to discuss results and any additional appropriate actions. Required response actions will be taken by CCAD and the Navy in accordance with their policies.	VI
4c Indoor Air			PSQ8c: Are CVOCs present in outdoor air at Site 00005 — Building 8 impacting indoor air concentrations?	Collect outdoor air samples concurrent with sub-slab soil gas and indoor air samples and assess ambient concentration data to determine whether CVOCs outside the building are impacting the concentrations within the building. Collect a subset of radon samples after outdoor air samples are collected as part of the attenuation factor study.	Decision Rule 8c: If outdoor air CVOC concentrations are above indoor air CVOC concentrations, then conclude that ambient conditions are influencing indoor air conditions.	VI
3 APAR Addendum	PSQ90	PSQ9: VI assessment	PSQ9: Are the data collected sufficient to evaluate whether the VI pathway is complete and significant enough to potentially pose a threat to indoor air receptors at Site 00005 - Building 8?	Evaluate potential risks associated with CVOC VI to indoor air receptors using multiple lines of evidence (e.g., concurrent sub-slab soil gas, indoor, and outdoor air results, radon data, differential pressure data, historical shallow groundwater data, building characteristics, HVS and MIP investigation results, HAPSITE indoor air survey, chemical use history, etc.) collected at Site 00005 — Building 8 and determine whether data gaps remain.	Decision Rule 9: If collected data are sufficient to evaluate whether the VI pathway is complete and/or significant, then proceed with the assessment report (Phase 3 — APAR Addendum Report). If data gaps remain, document limitations in the dataset and present to the team.	SGI

Notes:

VI	=	Vapor intrusion
UFP-SAP	=	Uniform Federal Policy-Sampling and Analysis Plan
PSQ	=	Principal study question
HVS	=	High volume sampling
CVOC	=	Chlorinated volatile organic compound
PVOC	=	Petroleum volatile organic compound
PID	=	Photoionization detector
MIP	=	Membrane interface robe
TCE	=	Trichloroethene
SGI	=	Supplemental groundwater investigation
HVAC	=	Heating, ventilation, and air conditioning
CCAD	=	Corpus Christi Army Depot
APAR	=	Affected Property Assessment Report
IA	=	Indoor Air

Shaded cells in the above table indicate places where activities/decisions the VI effort are overlapping with activities/decisions of the ongoing SGI effort.

- HVS Screening Data: HVS testing consists of extracting soil gas at a high flow rate over a short period of time, monitoring the extracted gas with handheld or portable instruments (e.g., photoionization detector [PID], landfill gas meter, and/or HAPSITE GC/MS) to assess vapor concentration trends as a function of volume purged. The HAPSITE unit will be used to differentiate between CVOC and PVOC sources using TCE as the indicator compound for CVOCs and benzene as the indicator compound for petroleum VOCs (PVOCs). It should be noted that the scope of the HVS investigation will be based on TCE delineation; benzene detections will only be recorded to note presence/absence of the petroleum plume. Benzene delineation will not be performed during this field event. The concentration trends and flow data from several HVS test cells and observation ports will be used to triangulate the approximate location of gas phase contamination sources and help establish the distribution of vapor concentrations for CVOCs.

- MIP data: MIP data will be used to determine VI investigation locations and will be considered in the multiple-lines-of-evidence approach. MIP field objectives and techniques are addressed in the SGI SAP.

- Indoor Air/Sub-Slab/Ambient Air Sampling Data: IA and SS samples will be collected concurrently from areas of interest in Building 8. IA/SS samples will be collected concurrently with ambient air samples during the VI sampling event. IA, SS, and ambient air samples will then be analyzed via TO-15 for 12 VOCs. Multiple-lines-of-evidence (radon, differential pressure data) will be collected concurrently with IA/SS samples.

- Sample Location Data: Sample location horizontal coordinates will be measured for use in mapping each location so that data can be analyzed and presented in a spatial context. Horizontal coordinates of each HVS, IA, SS, and ambient air sample will be determined by a combination of a professional surveyor-established indoor sampling grid, handheld Global Positioning System equipment where feasible, and measurements from established benchmark locations.

- Project Screening Levels: This VI study requires laboratory data be compared to screening values so that appropriate decisions can be made. Laboratory and HAPSITE quantitation limits must be low enough to measure VOC concentrations equal to or less than the applicable screening values. Sub-slab soil gas and indoor air screening levels for the industrial scenario were developed using the following hierarchy of sources:[1,2]

  — Target Indoor Air Concentrations for Commercial Properties (1E-05 and Hazard Index 1.0) from Office of Solid Waste and Emergency Response Vapor Intrusion Assessment Vapor Intrusion Screening Level Calculator Version 3.4, June 2015

  — U.S. EPA Regional Screening Levels, June 2015 (1E-05 and Hazard Index 1.0)

  — TCEQ TRRP Tables, Table 10 Industrial RBELs, Soil, $^{Air}RBEL_{Inh}$ (November 2014) for Industrial Air

  Screening levels for sub-slab soil gas were developed by Resolution Consultants using a standard attenuation factor of 0.03, as recommended in the Office of Solid Waste and Emergency Response *Final Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (June 2015). However, site-specific attenuation factors for VI will be established using a multiple-lines-of-evidence approach (contaminant ratios, radon data, etc.).

  In addition to the screening levels for chronic exposure to VOCs listed in Worksheet #15, Resolution Consultants will compare TCE indoor air concentrations to an action level of 88 µg/m^3, representing a hazard index of 10.0, as recommended in the IRIS guidelines.[3] If TCE concentrations in indoor air exceed 88 µg/m^3, Resolution Consultants will immediately notify the Navy of site conditions and areas of concern. The Navy will contact the Partnering Team and CCAD to discuss results and any additional appropriate actions. Required response actions will be taken by CCAD and the Navy in accordance with their policies.

[1] Note that the most current update for these references will be used in screening process.
[2] If both the Target Cancer Risk and the Hazard Index are listed for a particular analyte, the more conservative value was used.
[3] The U.S. EPA's June 2015 published screening value for TCE, based on a hazard index of 1.0, is 8.8 µg/m^3.

- Risk Assessments: Additional risk assessments beyond those reported in the 2001 APAR are not currently planned. Should additional risk evaluation be required as a result of this investigation, these risk assessments would be conducted under a separate task order in accordance with current U.S. EPA protocols and Navy guidance documents for human health risk assessments and ecological risk assessments (if performed).

11.4 Boundaries for the Study

The population of interest for the VI study includes the interior portions of Building 8 that might be impacted by VI from contaminated sub-slab soil gas or contaminated groundwater from beneath the building. The 10-acre horizontal study boundary for the VI study will encompass the Building 8 areas that have potentially been impacted by groundwater or sub-slab soil gas.

The anticipated duration for the VI investigation is 4 to 6 months. The sub-slab soil gas concentrations associated with the initial HVS screening effort are anticipated to be relatively unchanged (stable) over the short duration (less than 2 weeks) needed to conduct the environmental investigations for Phase 4a; therefore, no temporal constraints exist for the field mobilization of the HVS effort. However, temporal boundaries for indoor air and outdoor ambient air investigations (Phase 4c) are of concern as changes in building operational constraints relative to ambient temperature and pressure could have an impact on the sample composition due to potential for changes in the sources of flux into and out of the indoor air space. For this reason, the indoor air samples will be collected simultaneously with the sub-slab soil gas and outdoor ambient air samples over a single 24-hour period during Phase 4c. Seasonal variation is not anticipated to have a significant enough impact at NAS Corpus Christi, Texas to warrant two separate seasonal sampling events for completing the VI assessment; only one sampling event is planned for Phase 4c.

11.5 Performance Criteria

The objective of this section is to complete the following:

- Identify potential sources of study error (i.e., field error, analytical error)
- Establish and identify the methods used to reduce potential sources of error
- Determine how decision errors will be managed during the project

Sampling Strategy — The sampling design was developed to characterize the spatial distribution of CVOCs in sub-slab soil gas and to assess the potential risks associated with VI of CVOCs to indoor air receptors using multiple-lines-of-evidence (e.g., concurrent sub-slab soil gas, indoor, and ambient air TO-15 results; radon data; pressure differential data; previously collected shallow groundwater data; building characteristics; HVS and MIP investigation results; HAPSITE indoor air survey; chemical use history; etc.) at the site. Biased sampling approaches will be used to select HVS, MIP, and IA/SS sample locations to fill data gaps for decision making purposes. This sampling approach was determined to be the most appropriate due to the availability of previous sampling data at the site.

Sources of Error — Sources of error in the VI study may be divided into two main categories: sampling errors and measurement errors. A sampling error occurs when the sampling design, planning, and implementation do not provide for a representative range of heterogeneity or temporal variability at the site. A measurement error occurs due to performance variance from laboratory instrumentation, analytical methods, and operator error. The U.S. EPA identifies the combination of all these errors as a "total study error" (U.S. EPA 2006). One objective of the investigation is to reduce the total study error so that decision-makers can be confident that the data collected accurately represent the chemical characteristics of the site.

Managing Decision Error — The investigation will use decision-error minimization techniques in sampling design, sampling methodologies, and laboratory measurement of COCs. Possible decision errors will be minimized during the field investigation by using the following methods:

- Use standard field sampling methodologies (as discussed in Worksheets #18 and #21).

- Use applicable analytical methods and standard operating procedures (SOPs) for sample analysis by a competent analytical laboratory having Texas National Environmental Laboratory Accreditation Program (NELAP) accreditation, and be accredited through the Department of Defense (DoD) Environmental Laboratory Accreditation Program (DoD ELAP).

- Confirm analytical data to identify and control potential laboratory error and sampling error by using spikes, blanks, and replicated samples.

Decision errors associated with judgmental sampling are based on sample design and measurement errors. Assuming that the best possible professional judgment was used to develop the biased sampling plan (i.e., sampling locations positions), the most important decision errors will be associated with field and laboratory techniques involved in the collection and analysis of the data.

Sampling Methodologies and Procedures

Possible decision errors generated by sampling errors will be minimized during the field investigation by applying standardized field sampling methodologies (discussed in Worksheets #18, #20, #21, and #22). Sampling activities will be performed in accordance with the SOPs specified in this SAP.

Field Data Logs — All sample information will be transcribed into a field logbook and/or onto field data sheets.

Analytical Laboratory Sample Management — The sample matrix, number of samples, and number and type of laboratory quality assurance/quality control samples are summarized in Worksheets #18, #19, #20, and #30. Also, Worksheet #19 provides details on the analytical group, sample volumes, sample container specifications, preservation requirements, and maximum and holding times.

The laboratory will provide electronic data deliverable files, portable document format files of the data deliverables for all project data, and a hard copy of data deliverables for all results. Designated samples will be used to obtain necessary subsamples for laboratory quality control measurements (i.e., analytical sample duplicate and sample matrix spike/matrix spike duplicate). Tasks will be completed using the laboratory SOPs.

Resolution Consultants will provide data validation services and verify and evaluate the usability of the data as described in Worksheets #34 through #36.

Portable document format copies of all analytical data packages will be stored on CD-ROM, archived in the Naval Facilities Engineering Command (NAVFAC) Atlantic Administrative Record, and uploaded onto the Naval Installation Restoration Information Solution (NIRIS) database at the close of the project. All other data generated in the field and reports generated for the project will be stored as computer readable data files by Resolution Consultants.

11.6 Sampling Design

Non-statistical methods, consisting of a biased sampling technique and step-outs based on historical sampling locations, building foundation and subsurface utility construction/engineering data, process information, and professional judgment, will be used as the primary basis for the sampling design. This approach was chosen to identify the extent of known site-specific COCs and to assess whether or not sufficient information is understood to evaluate potential risks associated with VI at Building 8. The sample design, rationale, and locations are presented in Worksheets #17 and #18. These worksheets identify where samples will be collected and the analyses to be conducted for each sample.

SAP WORKSHEET #12: FIELD QUALITY CONTROL SAMPLES

(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table — Field QC Samples				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators**	**Measurement Performance Criteria**
Field Duplicate	VOCs	One per 10 field samples per matrix	Precision	Values > 5X LOQ: RPD must be ≤30% Values ≤ 5X LOQ: absolute difference ≤ 2x the LOQ
Field Duplicate	Radon	One per 10 field samples per matrix	Precision	Values ≥ 4 piC/L: RPD must be ≤30% Values < 4 piC/L: RPD must be ≤50%

Notes:

QC = Quality Control
VOC = Volatile organic compound
LOQ = Limit of quantitation
RPD = Relative percent difference
piC/L = Picocuries per Liter

SAP WORKSHEET #13: SECONDARY DATA CRITERIA AND LIMITATIONS TABLE

(UFP-QAPP Manual Section 2.7)

Secondary Data Criteria and Limitations Table				
Secondary Data	**Data Source (originating organization, report title and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Historical Background Information, Conceptual Site Model, Conclusions and Recommendations, Analytical Data	*Final Response Action Plan Sites 1, 3, and 4 and Building 8. 2003.*	Originating Organization: EnSafe Inc. Data Types: Background information, conceptual site model, analytical data, findings and recommendations Data Collection Dates: 2001-2003	Background information, current conceptual site model, and findings and recommendations were used in planning the sampling effort. Analytical data will be considered during the Supplemental Groundwater Investigation to assess potential risk and remedial decisions.	None
Historical Background Information, Conceptual Site Model, Conclusions and Recommendations, Analytical Data	*Supplement to Affected Property Assessment Report Installation Restoration Sites 1, 3, and 4 and Building 8. 2003*	Originating Organization: EnSafe Inc. Data Types: Background information, conceptual site model, analytical data, findings and recommendations Data Collection Dates: 2001-2003	Background information, current conceptual site model, and findings and recommendations were used in planning the sampling effort. Analytical data will be considered during the Supplemental Groundwater Investigation to assess potential risk and remedial decisions.	None
Historical Background Information, Conceptual Site Model, Conclusions and Recommendations, Analytical Data	*Final Affected Property Assessment Report Installation Restoration Sites 1, 3, and 4 and Building 8. 2001.*	Originating Organization: EnSafe Inc. Data Types: Background information, conceptual site model, analytical data, findings and recommendations Data Collection Dates: 1998-2001	Background information, current conceptual site model, and findings and recommendations were used in planning the sampling effort. Analytical data will be considered during the Supplemental Groundwater Investigation to assess potential risk and remedial decisions.	None
Historical Background Information	*Draft-Final Follow-Up Facility Investigation Report, Building 8. 1998.*	Originating Organization: EnSafe Inc. Data Types: Background information Data Collection Dates: 1998	Background information was used in planning the sampling effort.	None
Historical Background Information	*Indoor Air Quality Screening Level Survey Building 8 NAS Corpus Christi TX, January 1, 2003*	Originating Organization: EnSafe Inc. Data Types: Background information Data Collection Dates: 2003	Background information was used in planning the sampling effort.	None
Historical Background Information	*Draft-Final Aquifer Characterization Report, Building 8. 1996.*	Originating Organization: EnSafe/Allen & Hoshall Data Types: Background information Data Collection Dates: 1996	Background information was used in planning the sampling effort.	None

Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
Historical Background Information	*Final Groundwater Assessment Report, February 1994.*	Originating Organization: EnSafe/Allen & Hoshall Data Types: Background information Data Collection Dates: 1993-1994	Background information was used in planning the sampling effort.	None
Historical Background Information	*Site Assessment Sampling and Analysis Report For Building 8, 1992.*	Originating Organization: EnSafe/Allen & Hoshall Data Types: Background information Data Collection Dates: 1992	Background information was used in planning the sampling effort.	None
Historical Background Information	*Preliminary Assessment Report, 1992.*	Originating Organization: EnSafe/Allen & Hoshall Data Types: Background information Data Collection Dates: 1992	Background information was used in planning the sampling effort.	None
Historical Background Information	*RFI Work Plan. September 1994.*	Originating Organization: Professional Service Industries Data Types: Background information Data Collection Dates: 1994	Background information was used in planning the sampling effort.	None
Analytical Data	*Annual Groundwater Sampling Report(s) for Installation Restoration Sites 1, 2, 4, and Building 8.*	Originating Organization: Terraine Environmental Consulting Data Types: Analytical data Data Collection Dates: 2003-2007	Analytical data will be considered during the Supplemental Groundwater Investigation to assess potential risk and remedial decisions.	None
Analytical Data	*Groundwater Sampling Report(s) Installation Restoration Sites 1 (SWMU 1 & 183), Site 3 (SWMU 2), Site 4 (SWMU 4), and Corpus Christi Army Depot — Building 8.*	Originating Organization: Dougherty Sprague Environmental, Inc. Data Types: Analytical data Data Collection Dates: 2008-2014	Analytical data will be considered during the Supplemental Groundwater Investigation to assess potential risk and remedial decisions.	None
Historical Background Information	*Work Plan: Industrial Wastewater Pretreatment Survey Flow Monitoring and Sampling Corpus Christi Army Depot, Texas. July 2008.*	Originating Organization: Weston Solutions, Inc. Data Types: Background information Data Collection Dates: 2008	Background information was used in planning the sampling effort.	None

Notes:

RFI = Resource Conservation and Recovery Act (RCRA) Facility Investigation
SWMU = Solid waste management unit

SAP WORKSHEET #14: SUMMARY OF PROJECT TASKS

(UFP-QAPP Manual Section 2.8.1)

The following project tasks are summarized below:

- Field Tasks
- Analytical Tasks
- Data Management and Review
- Technical Memorandum

Field Tasks

Mobilization/Demobilization — Mobilization includes the acquisition of personnel and vehicle base access badges; procurement of field equipment and supplies; a Site walkover; mobilization of field staff, equipment, and supplies to the Site; and Site set-up. The Navy Remedial Project Manager (RPM) and NAS Corpus Christi point of contact (POC) will be notified of Resolution Consultants' mobilizations a minimum of 3 days before the start of field activities. There will be four separate mobilizations of field work for this effort:

- Utility locate and clearance, HVS coring, HAPSITE survey, and HVS assessment
- Indoor/ambient air and sub-slab soil gas sampling
- MIP profiling part 1
- MIP profiling part 2

A field team orientation meeting will be conducted prior to starting each phase of the fieldwork to familiarize the team personnel with the Site-specific health and safety requirements, the objectives and scope of the field activities, and chain-of-command. This meeting, to be conducted by the Field Team Leader (FTL), will be attended by Resolution Consultants field staff and subcontractors. There are no specialized/non-routine project-specific training requirements or certifications needed by personnel to successfully complete the project or tasks. All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed the OSHA 40-hour Hazardous Waste Operations and Emergency Response course and 8-hour refresher, if applicable. Additional health and safety requirements are addressed in greater detail in the site-specific Health and Safety Plan.

Demobilization includes removing field equipment and supplies from the site, returning rented equipment, managing investigation-derived waste (IDW), performing general site cleanup, organizing and finalizing field paperwork, and entering field records/data into the database.

Utility Clearance — The Resolution Consultants FTL will coordinate verbally or via email with the NAS Corpus Christi POC and the NAS Corpus Christi Public Works Department at least 7 days in advance of the site access for each phase of field work to initiate the utility clearance process for all intrusive sampling locations in accordance with SOP-3-01 in Appendix A. The Resolution Consultants FTL will contact the Texas One Call system and will contact NAS Corpus Christi infrastructure personnel verbally or via email at least 3 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation. The Resolution Consultants FTL will document the utility clearance process and obtain all required approvals, as deemed necessary by the NAS Corpus Christi POC.

Utilities that are identified in the field, but not shown or incorrectly located on the work approval documentation, will be marked directly on the document and returned to the NAS Corpus Christi POC for inclusion in their records.

Additionally, a private utility locate contractor will be onsite to perform a more in-depth utility location survey at all locations where intrusive activity is proposed. The proposed HVS sample locations (extraction and communication test point locations) and sub-slab soil gas probe locations will be cleared to locate and differentiate between underground utilities, conduit, rebar, post-tension cables, wire mesh, and other non-conductive targets within or below the concrete slab that would jeopardize the health and safety of those performing the installation of the points. The private utility locate contractor will use ground penetrating radar, electronic utility-locating equipment, and other utility locator technologies as necessary.

HVS Assessment — The HVS assessment will be performed by Geosyntec under subcontract to Resolution Consultants. Twenty primary HVS sample points will be installed, purged, monitored, sampled, and abandoned within the Site 00005 — Building 8 footprint. Up to eight secondary HVS sample points may also be installed, purged, monitored, sampled, and abandoned based on the results gathered from the primary HVS sample points. Each HVS sample point will consist of a 2.5-inch extraction point, which will be advanced by a coring contractor, and up to four 5/8-inch communication test point (CTPs), which will be installed by Geosyntec personnel. Geosyntec will be using Vapor Pins, produced by Cox-Colvin and Associates, Inc. (Cox-Colvin), as the CTPs and will install them in accordance with Cox-Colvin's *SOP for Installation and Extraction of Vapor Pin*. HVS purging, monitoring, and abandonment will also be conducted by Geosyntec personnel in accordance with Geosyntec SOP#1 and Resolution Consultants SOP-3-17. SOPs are in Appendix A, and are summarized in Worksheet #21. The rationale and locations for the HVS testing points are described in Worksheet #17.

Each extraction point will be advanced by coring a 2.5-inch hole through the slab. Up to 1 cubic foot of fill material will also be removed from under the slab to create a small sump to enhance flow. A short length of 2-inch schedule 40 polyvinyl chloride (PVC) pipe will be set into the cored hole and sealed with quick setting anchor cement. An assembled apparatus consisting of an extraction fan (commonly a large wet/dry portable vacuum [e.g., Shop-Vac]), PVC piping, thermal anemometer, a sample port, a vacuum gauge, and a bleed valve will be installed. Once the cement surrounding the extraction point has set (a minimum of 20 minutes) the fan will be turned on. Extracted soil gas will be discharged to the nearest exterior opening using a 3 to 4-inch diameter hose. The hose will be a minimum of 200 feet long and the exit location will be cleared by CCAD Health & Safety prior to installation of each location.

After the fan is turned on, initial vacuum measurements will be recorded using the pressure gauge on the test apparatus. Air velocity will be recorded in the test apparatus using a thermal anemometer inserted through an orifice in the straight section of PVC pipe. If the extracted soil vapor flow rate is less than 5 cubic feet per minute, the dilution valve located before the fan may be opened to reduce the risk of overloading the fan.

As soon as practicable after the start of the test, a slipstream air sample will be collected from the sample port using a lung box and 3-Liter (L) Tedlar bag. Additional samples will be collected in a 1-L Tedlar bag every 3 to 5 minutes for the first 30 minutes of the test and every 10 to 15 minutes thereafter. The slipstream samples will be screened for total VOCs using a handheld 10.6 electron volt PID and for oxygen, carbon dioxide, and methane using a GEM 2000 landfill gas meter. The remaining purge gas from the initial 3-L Tedlar bag will be analyzed quantitatively for TCE and benzene using the HAPSITE, to distinguish between CVOC sources and PVOC sources. Sampling protocols are outlined in SOPs RC-VI-06 and RC-VI-07. The samples will be collected by the Resolution Consultant FTL and will be analyzed by a trained HAPSITE analyst from Resolution Consultants or KD Analytical Consulting, Inc. (KD Analytical) in accordance with KD Analytical SOP #1, in Appendix A. Additional samples may also be tested periodically using the HAPSITE to determine the speciation of the VOCs detected by the PID in the samples. Vacuum and flow velocity will be recorded at regular intervals throughout the test. Each test will run for 1 to 2 hours depending on observed extraction flow rates.

Up to four flush-mount CTPs will also be installed around the extraction point. The CTPs will be installed by drilling a shallow hole in the slab using a 1 ½-inch-diameter drill bit and then through the remainder of the slab with a rotary hammer drill using a 5/8-inch-diameter drill bit. The assembled Vapor Pin will be tapped into place with a dead blow hammer or rubber mallet and then

capped and covered for a flush mount finish when not in use. The CTPs will be located sequential distances from the extraction point (e.g., 3, 10, 15 feet) and/or placed in cardinal directions (radial distances) from the extraction point depending on field testing results and logistical constraints. Where HVS locations are near building footers, some CTPs will also be placed on the opposite side of building footers from the extraction points to assess the influence of test across these potential barriers to vapor migration. The CTPs may also be sampled using a lung box and screened using a PID, GEM 2000 landfill gas meter, and/or the HAPSITE.

Toward the end of the HVS testing at each extraction location, two sets of vacuum measurements (transient response data) will be collected from two of the CTPs using a digital micromanometer with data-logging capabilities. Each set of measurements will be a drawdown and recovery cycle resulting from turning the vacuum or fan on, off, on and off again for 1 minute each. The vacuum monitoring data will be used in Geosyntec's analytical model to assess the total area influenced by the HVS test at each location. If there is no clearly measurable vacuum, chemical smoke tubes may be used to assess whether there is downward flow into the CTP (which can occur at very modest vacuum levels, too low to easily measure with a manometer).

After completion of the testing, the HVS extraction points will be backfilled with sand to the bottom of the slab (as needed), then filled with fast-drying, expandable cement to create an air-tight tight seal in the floor. The CTPs will be securely covered and remain in place until the end of the vapor intrusion investigation when it is deemed they are no longer needed. Then the Vapor Pins will be removed by Resolution Consultants and the hole will be filled in as described above.

HAPSITE Survey — In addition to the qualitative and quantitative analysis as part of the HVS assessment (described above), the HAPSITE will be used concurrently to evaluate the target areas within Site 00005 — Building 8 for potential background VOC sources in indoor air, as well as to identify potential locations where soil gas may be entering the building (cracks, expansion joints, sumps, etc.). If elevated VOCs are identified, the HAPSITE will be used in sample mode to obtain quantitative results of target VOCs. An additional HASPITE survey will be performed concurrent with the subsequent indoor air sampling event.

Resolution Consultants will subcontract KD Analytical to perform the HAPSITE work, which will be conducted in accordance with Resolution Consultants SOP RC-VI-03 and KD Analytical SOP #1 in Appendix A and as summarized in Worksheet #21. Additional details of the HAPSITE sampling and analysis program are outlined in Worksheet #17.

MIP Sampling — Approximately 50 MIP points will be advanced at locations distributed throughout Building 8. The MIP investigation data may provide a secondary line of evidence in support of the VI investigation, but the primary role of the MIP investigation is in support of the SGI. Figure 17-2 illustrates initial MIP points, which will be modified in the field based on ongoing evaluation of HVS and MIP data and subsequent modifications to the dynamic CSM. The MIP methods and approach are discussed in detail in SGI SAP Worksheet #14 and the MIP vendor's SOP in the SGI SAP Appendix A (Resolution Consultants, August 2014, January & May 2015).

Building Surveys — The Resolution Consultants FTL will conduct building surveys at each of rooms/areas where VI sampling is conducted. Resolution Consultants will request that engineering drawings of each room/area be provided prior to each building survey. Building characteristics and conditions pertinent to VI will be documented in the field logbook. Such items include building use, history, occupancy, shift information, building dimensions, floor type/condition, and typical operation of the HVAC system. Chemical products stored and activities performed within the building that may be sources of VOCs in indoor air (i.e., bulk solvent containers, parts cleaning baths, solvents, cleaning products, etc.) will be documented and to the extent feasible, temporarily removed prior to indoor air sampling.

Coordination with the NAS Corpus Christi POC and CCAD POC will be performed prior to the building surveys to arrange for the appropriate work area manager and/or other POC to be present during the surveys. Building survey information will be obtained by visual inspection and from discussions with the POCs.

Indoor Air Sampling — Twenty indoor air samples will be collected from areas of interest within Site 00005 – Building 8. Indoor air samples will be collocated with sub-slab soil gas samples and will be collected concurrently with ambient air and sub-slab soil gas samples during the sampling event. Additional details of the sampling and analysis program are outlined in Worksheets #17 and #18. Sample collection and handling will be performed in accordance with Resolution Consultants SOP RC-VI-02, Resolution Consultants SOP-3-3A, and as summarized in Worksheet #21.

Indoor air samples will be collected over a 24-hour period in 6-Liter evacuated stainless-steel canisters (e.g., SUMMA canisters) equipped with flow controllers (approximate sampling flow rate of 3.75 milliliters per minute [mL/min]). Each canister and flow controller will be

individually-certified clean and documented by the laboratory prior to shipment. Each assembled canister is to be placed at the sampling location, turned on, and left undisturbed for a period of 24 hours. The canisters will be placed at roughly breathing zone height (approximately 3 to 5 feet above the floor), depending on the majority of area worker habits (sitting versus standing). A sign stating "Air Testing in Progress, Do Not Disturb" will be attached to each canister providing dates of the sampling period and contact information in case of questions or concerns. Sample canisters will be visually checked after approximately 20 hours to ensure that they were not disturbed or tampered with and that the canister pressure does not reach 0 inches of mercury (Hg).

Ambient Air Sampling — Ambient air samples will be collected to assess the potential for background VOCs from outdoor air to impact indoor air concentrations. Four ambient air samples will be collected from upwind (background) locations outside Site 00005 — Building 8. Ambient air samples will be collected concurrently with indoor air and sub-slab soil gas samples during the sampling event. Additional details of the sampling and analysis program are outlined in Worksheets #17 and #18. Sample collection and handling will be performed in accordance with Resolution Consultants SOP RC-VI-02, Resolution Consultants SOP-3-3A, and as summarized in Worksheet #21.

Ambient air samples will be collected in 6-Liter evacuated stainless-steel canisters equipped with flow controllers over a 24-hour period. Both the canisters and the flow controllers will be individually-certified cleaned by the laboratory. Each canister will be placed at breathing zone height (approximately 5 feet above the ground) at the sampling location and turned on. Canisters will be placed in a secure location and attached with a bike lock to an immovable structure (e.g., fence, pole, etc.). A sign stating "Air Testing in Progress, Do Not Disturb" will be attached to the canister providing dates of the sampling period and contact information in case of questions or concerns. In addition, base security and area POCs will be notified of the sampling. Sample canisters will be checked after approximately 20 hours to ensure that they have not been tampered with and canister pressure does not reach 0 inches of Hg.

Sub-slab Soil Gas Probe Installation, Sampling, and Abandonment — Twenty sub-slab soil gas samples will be collected from areas of interest within Site 00005 — Building 8. Sub-slab soil gas sample locations will be collocated with indoor air samples. Air-tight Vapor Pins will be used to collect the samples necessary to evaluate VOCs in sub-slab soil gas. The sub-slab soil gas sampling locations will be determined after the HVS assessment, HAPSITE survey

data collection efforts, and the building surveys are completed. The findings and proposed sampling locations will be presented to and discussed with the Navy. Proposed sampling locations will be finalized with concurrence of the CCAD area POCs.

If a proposed sample location coincides with a CTP location, the CTP will be used. Otherwise, a new sub-slab soil gas probe (i.e., Vapor Pin) will be installed by Resolution Consultants. After the 20 sub-slab soil gas sampling probes are installed, each one will be leak tested, purged, and sampled. After it has been determined that no future sub-slab soil gas sampling is needed, all Vapor Pins will be abandoned. Additional details of the sampling and analysis program are outlined in Worksheets #17 and #18.

Vapor Pin installation, leak testing, purging, screening, sampling, and abandonment will be performed in accordance with Cox Colvin SOPs for *Installation and Extraction of Vapor Pin* and *Leak Testing Vapor Pin Via Mechanical Means,* Resolution Consultants SOPs RC-VI-04, RC-VI-05, SOP-3-3A, SOP-3-20, and as summarized in Worksheet #21. Sampling data will be recorded in the field logbook and on the Resolution Consultants *Vapor Intrusion Sampling Form* (attached to SOP RC-VI-05).

The semi-permanent sub-slab soil gas probes (i.e., Vapor Pins) will be installed by drilling a shallow hole in the slab using a 1 ½-inch-diameter drill bit and then through the remainder of the slab with a rotary hammer drill using a 5/8-inch-diameter drill bit. If the slab is greater than 31 inches thick, a coring subcontractor will advance the hole through the rest of the slab. The sub-slab soil gas probes will consist of a new assembled Vapor Pin (a length of barbed stainless-steel, a silicone sleeve, and silicon cap) that will be sent directly from the manufacturer.

The silicone sleeve secures the probe in place with the slab. The opening of the Vapor Pin will be topped with a silicone cap to provide a complete seal between the subsurface and indoor environments. The probes will be securely covered with a secure stainless-steel flush mount cover during the periods when sampling is not occurring.

A water dam leak test will be performed on each installed Vapor Pin assembly prior to sampling to ensure that the silicone sleeve is secure and the seal is intact. If the leak test was performed more than 24 hours prior to purging/sampling, an additional leak test will performed during the purging process. Prior to sampling, each sub-slab soil gas probe will be purged using a sampling manifold (consisting of stainless-steel Swagelok gas-tight valves and fittings and new Teflon tubing) and a vacuum pump affixed with a flow meter. Approximately 2 liters of sub-slab soil gas will be

purged at a rate of 200 mL/min into a new Tedlar bag and screened with a PID for a preliminary measurement of VOC concentrations and a GEM 2000 landfill gas meter to measure biodegradation parameters (oxygen, carbon dioxide, and methane) underneath the slab. The purged soil gas will be screened outdoors to ensure that it is not exhausted into the indoor air where subsequent indoor air sampling will occur.

Sub-slab soil gas samples will then be collected in 6-liter evacuated stainless-steel canisters equipped with 24-hour flow controllers. Each canister and flow controller will be individually certified clean by the laboratory. The canisters will be visually checked after approximately 20 hours to ensure that they have not been tampered with and that the canister pressures do not reach 0 inches of Hg.

Once it has been determined that no further sub-slab soil gas sampling is needed in the future, all Vapor Pins will be removed and the holes will be abandoned as described in SOP RC-VI-04.

Radon Sampling — Radon will be analyzed and used as a tracer compound to calculate site-specific attenuation factors using sub-slab soil gas and collocated indoor air samples. Radon samples will be collected in Tedlar bags using lung box techniques using Resolution Consultants SOPs RC-VI-01 and RC-VI-06 in Appendix A, and summarized in Worksheet #21. Additional details of the sampling and analysis program are outlined in Worksheets #17 and #18.

Ancillary Data Collection Program — Ancillary data, in particular temperature, barometric pressure, and differential pressure, will be collected using a logging monitoring instrument, in up to four to-be-determined locations, throughout the duration of the 24-hour sampling. The monitoring instrument will be programmed to log data at 15-minute intervals. Upon completion of the sub-slab soil gas sampling, the data from the monitoring device will be downloaded onto a computer. This monitoring will be used as part of a multiple lines of evidence approach to evaluate VI potential. Pressure differential monitoring will be performed in accordance with Resolution Consultants SOP RC-VI-08 in Appendix A, and summarized in Worksheet #21.

Calibration and Data Recording — Field equipment calibration procedures are described in Worksheet #22. At a minimum, field equipment will be calibrated, if applicable, at the beginning and end of each day, unless stated otherwise by the equipment manufacturer. Documentation of the field equipment calibration will be recorded and maintained in project files.

Field Documentation Procedures — Field documentation will be performed during all field phases in accordance with SOP-3-02. Sample collection information will be recorded in bound field notebooks or specific field forms. Indoor and ambient air, sub-slab soil gas, and radon samples will labeled and chain-of-custody procedures are to be followed in accordance with SOP-3-3A (Appendix A). Indoor and ambient air, sub-slab soil gas, and radon samples will be packaged and shipped according to SOP-3-04A (Appendix A).

A summary of field activities will be properly recorded in indelible ink in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and stored in a secured area when not in use.

All entries will be written in indelible ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction; and the person making the correction will initial and date the change. Boring logs, sampling forms, and other field forms will also be used to document field activities.

Sample Location Measurement — After sample locations are identified and marked, the distance from each location to applicable reference points will be measured using a tape measure. All indoor sample locations will be measured relative to inside walls. All ambient air sample locations will be measured relative to the building corner(s). All sample locations and distances will be recorded in the field logbook.

Field Quality Control Tasks — Field quality control (QC) samples (i.e., field duplicates) for each matrix will be collected as part of each sample round. Sub-slab and indoor air field duplicates will be collected using a lab certified clean stainless-steel sampling tee. Worksheets #12 and #20 present the field QC sample summary.

Decontamination — Decontamination associated with MIP activities are explained in detail in the SGI SAP Worksheet #14 (Resolution Consultants, August 2014, January & May 2015).

Vapor Pins and associated sub-slab soil gas and radon sampling materials will be new and shipped directly from the manufacturer and/or supplier. Indoor air, ambient air, and sub-slab soil gas samples will be collected into dedicated evacuated stainless-steel sampling canisters, to be shipped directly to the analytical laboratory. The indoor and ambient air and sub-slab soil gas canisters and flow controllers will be individually certified clean prior to use.

Sub-slab soil gas sampling will use disposable tubing and Swagelok fittings dedicated to each sample location, which will eliminate the need for decontamination. Radon sampling will utilize disposable tubing. Vapor Pins will be left in place after the sampling event and securely covered until it has been determined that additional sampling is no longer necessary. After the data collected have been validated and determined usable from the second sampling event (if applicable), the Vapor Pins will be extracted, the holes sealed, and the ground surface restored to its original condition, to the extent feasibly possible.

Investigation-Derived Waste — IDW generated from MIP activities are explained in detail in the SGI SAP Worksheet #14 (Resolution Consultants, August 2014, January & May 2015).

Approximately 1 cubic foot of excess soil will be generated during installation of each HVS extraction point. The soil will be kept in covered 5-gallon buckets until HVS testing is complete. After testing is complete, the soil will be placed back into the extraction point hole and compacted using a tamping rod. The concrete will then be repaired by the HVS subcontractor or MIP drilling contractor (depending on whether the opening coincides with a planned MIP location) in accordance with SOP-3-17 (Section 7.7) using 5,000 psi strength concrete. Minimal solid IDW, in the form of concrete/asphalt dust, will be generated during Vapor Pin installation. The dust will be collected with a wet/dry vacuum equipped with a fine dust filter. The vacuum dust bag, personal protective equipment, discarded paper towels, used Tedlar bags, and sample tubing, will be bagged and properly discarded in an appropriate on-base solid waste dumpster.

Analytical Tasks

Analyses will be performed in accordance with the analytical methods identified in Worksheet #19, and where applicable, the laboratory will strive to meet the project quantitation limit goals specified in Worksheet #15. Laboratories will perform the chemical analyses following laboratory-specific SOPs identified in Worksheet #23. Applicable laboratory SOPs are in Appendix B.

The analytical laboratory for TO-15 analysis, ALS in Simi Valley, California, has current NELAP accreditation in Texas and through the DoD ELAP; certificates are in Appendix C. The ALS analytical data packages will contain summary forms, raw data, laboratory review checklists and exception reports and will comply with TCEQ's Regulatory Guidance for Review and Reporting of Chemical of Concern Concentration Data under TRRP (RG-366/TRRP-13 May 2010).

Radon analysis will be performed by the University of Southern California, Department of Earth Sciences of Los Angeles, California. Because radon data will be used as supporting information for the multiple lines of evidence evaluation of the VI pathway, the laboratory does not require accreditation.

The HAPSITE unit will be operated by KD Analytical, a specialized vendor with significant experience in similar studies at Department of Defense installations. Because this data will be used as a screening tool to identify COC presence/absence and potential step-out locations, the vendor does not require accreditation.

Data Management and Review

The principal data generated for this project will be from field data and laboratory analytical data. The field forms, chain of custody, air bills, and logbooks will be placed in the project files after the completion of the field program. The HVS contractor will be required to provide a final report summarizing the findings of the HVS study. The HAPSITE contractor will be required to provide a final report summarizing the results of the indoor air HAPSITE survey. The MIP vendor will be required to provide a final report summarizing CVOC and lithological findings. All reports submitted from contractors will be included with project documentation. The field logbooks for this project will be used only for this site, and will also be categorized and maintained in the project files after the completion of the field program. All project records will be maintained in a secure location.

Data Tracking — The Resolution Consultants Task Order Manager (TOM), or designee, is responsible for the overall tracking and control of data generated for the project. Data are tracked from generation to archiving in the project-specific files. The project chemist, or designee, is responsible for tracking the samples collected and shipped to the contracted laboratory. Upon receipt of the data packages from the analytical laboratory, the project chemist will oversee the data validation effort, which includes verifying that the data packages are complete and that results for all samples have been delivered by the analytical laboratory.

Resolution Consultants shall submit all Administrative Record Files, Site Files, and Post Decision Files in accordance with the specifications defined in the NAVFAC *Environmental Restoration Recordkeeping Manual* (NAVFAC 2009). Additionally, Resolution Consultants will update and manage the project related documents, data, and maps in NIRIS. Project related spatial data including maps, models, and associated collected or created data will also be uploaded into NIRIS. All documentation submittals for NIRIS will be coordinated with the Navy RPM.

Data Storage, Archiving, and Retrieval — After the data are validated, the data packages are entered into the Resolution Consultants file system and archived in secure files. The field records including field logbooks, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Resolution Consultants FTL to be entered into the file system before archiving in secure project files. Project files are audited for accuracy and completeness. Project files will be kept in a secured, limited access area. At the completion of the Navy contract, files will be shipped to the Federal Records Center for storage where the files will remain until 50 years after the last decision document for NAS Corpus Christi.

Data Security — Access to Resolution Consultants project files is restricted to designated personnel only. The Resolution Consultants data manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

Electronic Data — Laboratory data, provided in electronic format, will be verified for accuracy prior to use and during the data validation process. After data are validated, the electronic data results will be uploaded into the Resolution Consultants database for use in data evaluation and subsequent report preparation. The project database will be on a password protected secure network and access to changing data files will be restricted to qualified personnel. The Resolution Consultants TOM (or designee) is responsible for the overall tracking and control of data generated for the project. All final electronic data and administrative records will be compiled uploaded into NIRIS for final repository.

Data Review and Validation — After receipt of analytical laboratory results, Resolution Consultants will verify data completeness as specified in Worksheet #34. To ensure that the analytical results meet the project quality objectives, the laboratory data will undergo verification and validation as cited in Worksheets #34 through #36 and described as follows. The usability assessment processes are described in Worksheet #37.

Prior to data validation, electronic laboratory data will be verified for accuracy against the hardcopy laboratory report and the electronic quality assurance project plan (eQAPP) will be established using the project-specific criteria defined in Worksheets #12, #19, #24, and #28. The laboratory will be requested to resubmit electronic data found to be inaccurate.

During the data validation process, the Resolution Consultants Data Validation Assistant (DVA) tool will be used to review method accuracy and precision data from field and laboratory QC samples contained in the laboratory electronic data deliverable and qualify that data according to the project-specific eQAPP. The DVA tool uses the power of EarthSoft's EQuIS relational database to assemble a series of Excel worksheets into a DVA workbook for the validator that present:

- Data validation QC elements that need review, compared to control limits stored in the project-specific eQAPP.
- Associated sample results for duplicated samples and blanks.
- A place to make the necessary qualifications and result updates directly into an electronic format documentation of qualifications using coded reasons.
- A list of all samples affected by the qualification.

The hardcopy analytical data report will be manually reviewed for data not provided in the electronic data files (e.g., sample handling, tuning, and calibration). Hardcopy data will be assessed against the measurement performance criteria presented in this SAP and in the DoD Quality Systems Manual (DoD 2013); the results of these findings will be added to the Excel DVA workbook. The DVA workbook is used to update the project database with the validator's changes, eliminating the manual data entry process and allowing for 100 percent of data to be reviewed prior to uploading to the project database.

Technical Memorandum

Resolution Consultants will compile, review, and evaluate available data, and produce a Technical Memorandum to be submitted to TCEQ and U.S. EPA as an APAR Addendum within the TRRP regulatory framework. Technical Memorandum elements will include a summary of field efforts, deviations from the work planning documents (if any), data tables and figures, comprehensive discussion of the nature and extent of contamination, comprehensive discussion of the degradation environment in affected media, all other standard TRRP requirements for an APAR addendum, and conclude whether additional action(s) are warranted or if a no further action determination can be made.

Additional risk assessments for human and ecological impacts at Site 00005 — Building 8 beyond those completed during the initial APAR from 2001 are not anticipated at this time. If, during data evaluation, additional information is required to complete the APAR addendum or to complete associated modifications to the RCRA Part B Permit Compliance Plan, Resolution Consultants will prepare recommendations for the Navy to fill data gaps as a modification to this SAP. Compliance Plan modifications addressing changes to the Site 00005 — Building 8 response action would be addressed as a separate task.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES

(UFP-QAPP Manual Section 2.8.1)

Matrix:	**Building Survey Indoor Air**							
Analytical Group:	**HAPSITE Building Survey Volatile Organic Compounds** [1]							
Analyte	**CAS No.**	**Project Action Level (µg/m³)**	**Cancer or Non-cancer**	**Project Action Level Source**	**Project Quantitation Limit Goal (µg/m³)**	**LOQ** [2] **(µg/m³)**	**LOD** [2] **(µg/m³)**	**MDL** [2] **(µg/m³)**
1,1,2,2-Tetrachloroethane	79-34-5	2.1	C	Indoor Air for Commercial Properties VISL[4]	0.7	0.5	0.5	—
1,1,2-Trichloroethane	79-00-5	0.88	NC	Indoor Air for Commercial Properties VISL[4]	0.29	0.5	0.5	—
1,1-Dichloroethene	75-35-4	880	NC	Indoor Air for Commercial Properties VISL[4]	293	0.5	0.5	—
1,2-Dichloroethane	107-06-2	4.7	C	Indoor Air for Commercial Properties VISL[4]	1.6	0.5	0.5	—
1,3-Dichlorobenzene	541-73-1	12	NC[3]	2014 TCEQ $^{Air}RBEL_{Inh}$	4.0	0.5	0.5	—
Benzene	71-43-2	16	C	Indoor Air for Commercial Properties VISL[4]	5.3	0.5	0.5	—
Chlorobenzene	108-90-7	220	NC	Indoor Air for Commercial Properties VISL[4]	73.3	0.5	0.5	—
cis-1,2-Dichloroethene	156-59-2	88	NC[3]	2014 TCEQ $^{Air}RBEL_{Inh}$	29	0.5	0.5	—
Methylene Chloride	75-09-2	2,600	NC	Indoor Air for Commercial Properties VISL[4]	867	0.5	0.5	—
Tetrachloroethene	127-18-4	180	NC	Indoor Air for Commercial Properties VISL[4]	60	0.5	0.5	—
Trichloroethene	79-01-6	8.8	NC	Indoor Air for Commercial Properties VISL[4]	2.9	0.5	0.5	—
Vinyl Chloride	75-01-4	28	C	Indoor Air for Commercial Properties VISL[4]	9.3	1.0	1.0	—

Notes:

[1] Volatile organic compound list is based on historical detections in groundwater. The HAPSITE unit is a screening tool and, if target compounds are identified above project action levels, data will be used to identify potential step-out locations.

[2] HAPSITE-specific LODs are instantaneous read limits that can be achieved when analyzing grab samples using the HAPSITE gas chromatograph/mass spectrometer as calibrated in the field. Actual detection limits will be dependent on the field calibration results (standard gas recoveries) and the atmospheric conditions within the areas assessed. HAPSITE specific MDLs not applicable.

[3] TCEQ TRRP Tables, Table 10 Industrial RBELs, Soil, $^{Air}RBE_{LInh}$ (November 2014). As discussed in TCEQ publication RG-366, TRRP-18 (TCEQ, October 2008), RBELs are based on a Target Cancer Risk of 1E-05 and a Hazard Index of 1.0.

[4] Target Indoor Air Concentrations for Commercial Properties (Target Cancer Risk 1E-05 and Hazard Index 1.0) from Office of Solid Waste and Emergency Response Vapor Intrusion Assessment Vapor Intrusion Screening Level Calculator Version 3.4, June 2015. If both the Target Cancer Risk and the Hazard Index are listed for a particular analyte, the more conservative value was used. The most current update will be used in screening process.

CAS	=	Chemical Abstracts Service
LOQ	=	Level of quantification
LOD	=	Limit of Detection
MDL	=	Method Detection Limit
$\mu g/m^3$	=	Microgram per cubic meter
$^{Air}RBEL_{Inh}$	=	Risk based exposure limit for inhalation of contaminants in air
TCEQ	=	Texas Commission on Environmental Quality
VISL	=	Vapor Intrusion Screening Level
TRRP	=	Texas Risk Reduction Program
C	=	Cancer
NC	=	Non-cancer
—	=	Not applicable

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES (continued)

Matrix:	**High Volume Sampling Sub-slab Soil Gas**							
Analytical Group:	**HAPSITE HVS Volatile Organic Compounds** [1]							
Analyte	**CAS No.**	**Project Action Level ($\mu g/m^3$)**	**Cancer or Non-cancer**	**Project Action Level Source**	**Project Quantitation Limit Goal ($\mu g/m^3$)**	**LOQ [2] ($\mu g/m^3$)**	**LOD [2] ($\mu g/m^3$)**	**MDL [2] ($\mu g/m^3$)**
Benzene	71-43-2	533	C	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	178	0.5	0.5	—
Trichloroethene	79-01-6	293	NC	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	98	0.5	0.5	—

Notes:

[1] Initial HVS slip stream samples will be analyzed for trichloroethene and benzene only using a field calibrated HAPSITE portable gas chromatograph/mass spectrometer. The HAPSITE unit is a screening tool and, if target compounds are identified above project action levels, data will be used to identify potential sampling step-out locations.

[2] HAPSITE-specific LODs are instantaneous read limits that can be achieved when analyzing grab samples using the HAPSITE gas chromatograph/mass spectrometer as calibrated in the field. Actual detection limits will be dependent on the field calibration results (standard gas recoveries), sample size, and vapor pressure of the Tedlar bags used to collect these samples. HAPSITE-specific MDLs are not applicable.

[3] Sub-slab soil gas project action levels were calculated by dividing either: the Target Indoor Air Concentrations for Commercial Properties (Target Cancer Risk 1E-05 and Hazard Index 1.0) from Office of Solid Waste and Emergency Response Vapor Intrusion Assessment Vapor Intrusion Screening Level Calculator Version 3.4, June 2015 or the TCEQ TRRP Tables, Table 10 Industrial RBELs, Soil, ${}^{Air}RBEL_{Inh}$ (November 2014) for Industrial Air by an attenuation factor of 0.03. If both the Target Cancer Risk and the Hazard Index are listed for a particular analyte, the more conservative value was used. The most current update of this guidance will be used in screening process.

CAS = Chemical Abstracts Service
LOQ = Level of quantification
LOD = Limit of Detection
MDL = Method Detection Limit
$\mu g/m^3$ = Microgram per cubic meter
HVS = High Volume Sampling
${}^{Air}RBEL_{Inh}$ = Risk based exposure limit for inhalation of contaminants in air
TCEQ = Texas Commission on Environmental Quality
VISL = Vapor Intrusion Screening Level
TRRP = Texas Risk Reduction Program
C = Cancer
NC = Non-cancer
— = Not applicable

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES (continued)

Matrix:	**Indoor Air**							
Analytical Group:	**U.S. EPA TO-15 Volatile Organic Compounds [1]**							
Analyte	**CAS No.**	**Project Action Level ($\mu g/m^3$)**	**Cancer or Non-cancer**	**Project Action Level Source**	**Project Quantitation Limit Goal ($\mu g/m^3$)**	**LOQ [2] ($\mu g/m^3$)**	**LOD [2] ($\mu g/m^3$)**	**MDL [2] ($\mu g/m^3$)**
1,1,2,2-Tetrachloroethane	79-34-5	2.1	C	Indoor Air for Commercial Properties VISL[4]	0.7	0.50	0.42	0.15
1,1,2-Trichloroethane	79-00-5	0.88	NC	Indoor Air for Commercial Properties VISL[4]	0.29	0.50	0.44	0.16
1,1-Dichloroethene	75-35-4	880	NC	Indoor Air for Commercial Properties VISL[4]	293	0.50	0.44	0.17
1,2-Dichloroethane	107-06-2	4.7	C	Indoor Air for Commercial Properties VISL[4]	1.6	0.50	0.43	0.16
1,3-Dichlorobenzene	541-73-1	12	NC[3]	2014 TCEQ $^{Air}RBEL_{Inh}$	4.0	0.50	0.46	0.15
Benzene	71-43-2	16	C	Indoor Air for Commercial Properties VISL[4]	5.3	0.50	0.45	0.16
Chlorobenzene	108-90-7	220	NC	Indoor Air for Commercial Properties VISL[4]	73.3	0.50	0.44	0.16
cis-1,2-Dichloroethene	156-59-2	88	NC[3]	2014 TCEQ $^{Air}RBEL_{Inh}$	29	0.50	0.44	0.16
Methylene Chloride	75-09-2	2,600	NC	Indoor Air for Commercial Properties VISL[4]	867	0.50	0.45	0.17
Tetrachloroethene	127-18-4	180	NC	Indoor Air for Commercial Properties VISL[4]	60	0.50	0.40	0.14
Trichloroethene	79-01-6	8.8	NC	Indoor Air for Commercial Properties VISL[4]	2.9	0.50	0.43	0.14
Vinyl Chloride	75-01-4	28	C	Indoor Air for Commercial Properties VISL[4]	9.3	0.50	0.40	0.17

Notes:

[1]Volatile organic compound list is based on historical detections in groundwater.

[2]Laboratory-specific MDLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. Actual detection limits will be dependent on the sample size and vapor pressure of SUMMA canisters.

[3]TCEQ TRRP Tables, Table 10 Industrial RBELs, Soil, $^{Air}RBE_{LInh}$ (November 2014). As discussed in TCEQ publication RG-366, TRRP-18 (TCEQ, October 2008), RBELs are based on a Target Cancer Risk of 1E-05 and a Hazard Index of 1.0.

[4]Target Indoor Air Concentrations for Commercial Properties (Target Cancer Risk 1E-05 and Hazard Index 1.0) from Office of Solid Waste and Emergency Response Vapor Intrusion Assessment Vapor Intrusion Screening Level Calculator Version 3.4, June 2015. If both the Target Cancer Risk and the Hazard Index are listed for a particular analyte, the more conservative value was used. The most current update will be used in screening process.

Undetected results will be reported down to the MDL in accordance with TCEQ's Review and Reporting of Chemical of Concern Concentration Data under TRRP (TCEQ, May 2010) and the LOQ (or sample quantitation limit, as it is defined in TRRP-13) will also be reported. The LOD is provided for completeness and to comply with the Department of Defense Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013.

CAS	=	Chemical Abstracts Service
LOQ	=	Level of quantification
LOD	=	Limit of Detection
MDL	=	Method Detection Limit
$\mu g/m^3$	=	Microgram per cubic meter
U.S. EPA	=	United States Environmental Protection Agency
$^{Air}RBEL_{Inh}$	=	Risk based exposure limit for inhalation of contaminants in air
TCEQ	=	Texas Commission on Environmental Quality
VISL	=	Vapor Intrusion Screening Level
TRRP	=	Texas Risk Reduction Program
C	=	Cancer
NC	=	Non-cancer

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES (continued)

Matrix:	**Sub-slab Soil Gas**							
Analytical Group:	**TO-15 Volatile Organic Compounds** [1]							
Analyte	**CAS No.**	**Project Action Level (µg/m³)**	**Cancer or Non-cancer**	**Project Action Level Source**	**Project Quantitation Limit Goal (µg/m³)**	**LOQ** [2] **(µg/m³)**	**LOD** [2] **(µg/m³)**	**MDL** [2] **(µg/m³)**
1,1,2,2-Tetrachloroethane	79-34-5	70	C	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	23	1.3	0.95	0.43
1,1,2-Trichloroethane	79-00-5	29	NC	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	9.8	1.3	1.0	0.38
1,1-Dichloroethene	75-35-4	29,333	NC	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	9,778	1.3	1.0	0.43
1,2-Dichloroethane	107-06-2	157	C	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	52	13	5.5	1.9
1,3-Dichlorobenzene	541-73-1	0.40	NC[4]	2014 TCEQ $^{Air}RBEL_{Inh}$ w/default attenuation factor of 0.03[3]	0.13	**1.3**	**1.1**	**0.43**
Benzene	71-43-2	533	C	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	178	1.3	1.1	0.50
Chlorobenzene	108-90-7	7,333	NC	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	2,444	1.3	1.1	0.38
cis-1,2-Dichloroethene	156-59-2	2.9	NC[4]	2014 TCEQ $^{Air}RBEL_{Inh}$ w/default attenuation factor of 0.03[3]	0.98	1.3	1.1	0.43
Methylene Chloride	75-09-2	86,667	NC	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	28,889	2.5	2.2	0.75
Tetrachloroethylene	127-18-4	6,000	NC	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	2,000	1.3	1.1	0.40
Trichloroethene	79-01-6	293	NC	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	98	1.3	1.1	0.35
Vinyl Chloride	75-01-4	933	C	Indoor Air for Commercial Properties VISL w/default attenuation factor of 0.03[3]	311	1.3	1.1	0.35

Notes:

[1] Volatile organic compound list is based on historical detections in groundwater.

[2] Laboratory-specific MDLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. Actual detection limits will be dependent on the sample size and vapor pressure of SUMMA canisters.

[3] Sub-slab soil gas project action levels were calculated by dividing either: the Target Indoor Air Concentrations for Commercial Properties (Target Cancer Risk 1E-05 and Hazard Index 1.0) from Office of Solid Waste and Emergency Response Vapor Intrusion Assessment Vapor Intrusion Screening Level Calculator Version 3.4, June 2015 or the TCEQ TRRP Tables, Table 10 Industrial RBELs, Soil, $^{Air}RBEL_{Inh}$ (November 2014) for Industrial Air by an attenuation factor of 0.03. If both the Target Cancer Risk and the Hazard Index are listed for a particular analyte, the more conservative value was used. Most current update of this guidance will be used in screening process.

[4] TCEQ TRRP Tables, Table 10 Industrial RBELs, Soil, $^{Air}RBE_{LInh}$ (November 2014). As discussed in TCEQ publication RG-366, TRRP-18 (TCEQ, October 2008), RBELs are based on a Target Cancer Risk of 1E-05 and a Hazard Index of 1.0.

Undetected results will be reported down to the MDL in accordance with TCEQ's *Review and Reporting of Chemical of Concern Concentration Data under* TRRP (TCEQ, May 2010) and the LOQ (or sample quantitation limit, as it is defined in TRRP-13) will also be reported. The LOD is provided for completeness and to comply with the Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.

CAS	=	Chemical Abstracts Service
LOQ	=	Level of quantification
LOD	=	Limit of Detection
MDL	=	Method Detection Limit
µg/m^3	=	Microgram per cubic meter
HVS	=	High Volume Sampling
U.S. EPA	=	United States Environmental Protection Agency
$^{Air}RBEL_{Inh}$	=	Risk based exposure limit for inhalation of contaminants in air
TCEQ	=	Texas Commission on Environmental Quality
VISL	=	Vapor Intrusion Screening Level
TRRP	=	Texas Risk Reduction Program
C	=	Cancer
NC	=	Non-cancer
Bold	=	Project action level is less than the LOQ and LOD but the MDL is sufficiently low to meet the intended data use

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES (continued)

Matrix:	**Sub-Slab Soil Gas and Indoor Air**						
Analytical Group:	**Radon by University of California Rn-SOP**						
Analyte	**CAS No.**	**Screening Level (piC/L)**	**Project Action Level Source**	**Project Quantitation Limit Goal (piC/L)**	**LOQ (piC/L)**	**LOD (piC/L)**	**MDL (piC/L)**
Radon	127-18-4	NA	None	NA	0.70	0.28	0.14

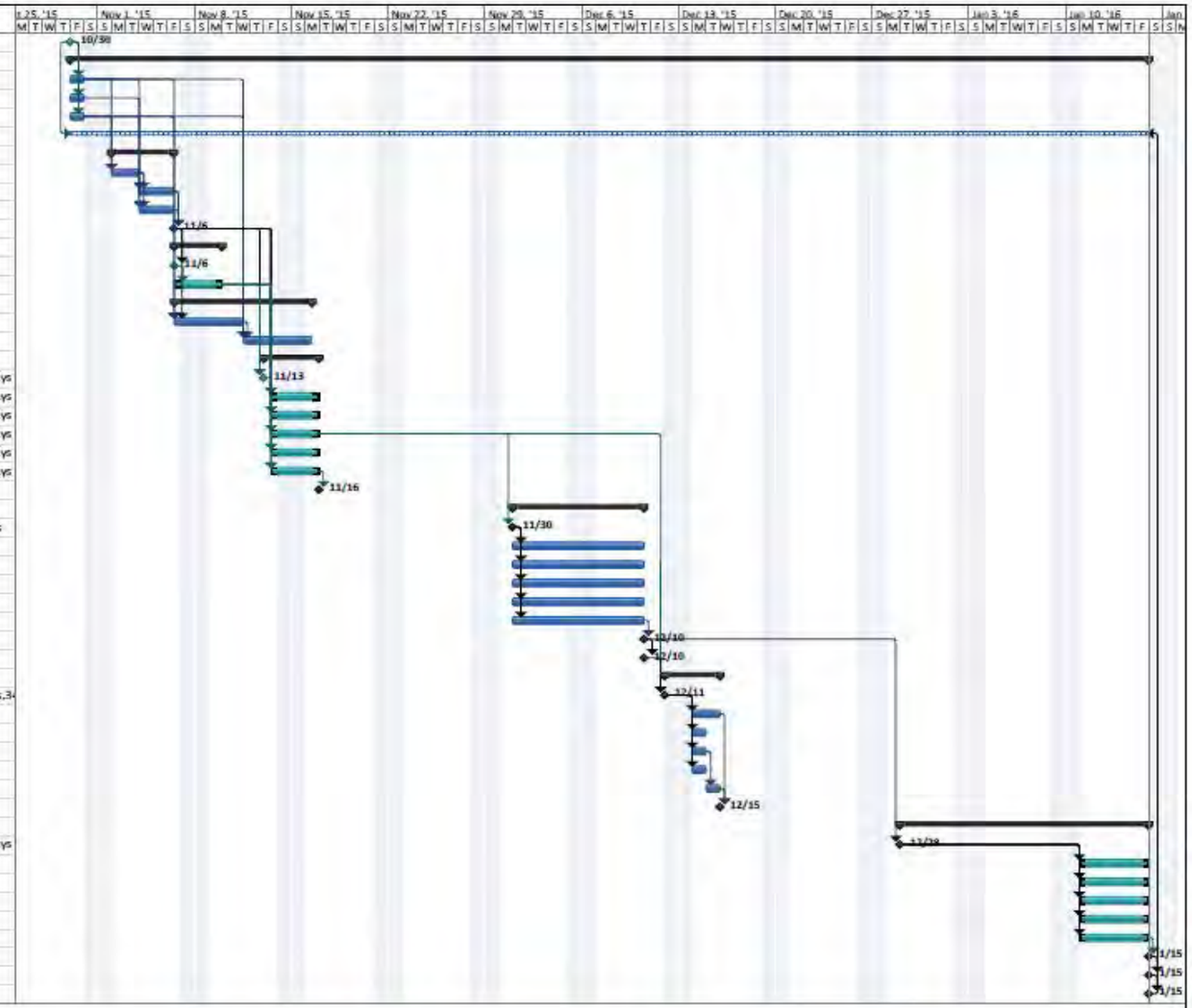
Notes:

Rn-SOP = Radon standard operating procedure
piC/L = Picocuries per Liter
NA = Not applicable
CAS = Chemical Abstracts Service
MDL = Method Detection Limit
LOQ = Level of quantification
LOD = Limit of Detection

SAP WORKSHEET #16: PROJECT SCHEDULE/TIMELINE TABLE

(UFP-QAPP Manual Section 2.8.2)

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Project Startup**	0 days	Fri 10/30/15	Fri 10/30/15	
2	**Coordination and Scheduling (1st Shift)**	**56 days**	**Fri 10/30/15**	**Fri 1/15/16**	
3	Establish CCAD Protocols for Site Access	1 day	Fri 10/30/15	Fri 10/30/15	1
4	Initiate CCAD and Navy Site Work Permits	1 day	Fri 10/30/15	Fri 10/30/15	1
5	Establish Site Access and Site Vacate Schedules	1 day	Fri 10/30/15	Fri 10/30/15	1
6	Stakeholder Communications	56 days	Fri 10/30/15	Fri 1/15/16	1SS,52FF
7	**Clearance Support (1st + 2nd Shifts)**	**4.5 days**	**Mon 11/2/15**	**Fri 11/6/15**	
8	Locations Marked	2 days	Mon 11/2/15	Tue 11/3/15	3,5
9	Complete Work Order for CCAD and Navy Clearance Support	2.5 days	Wed 11/4/15	Fri 11/6/15	4,8
10	Subcontractor GPR Clearance Support	2.5 days	Wed 11/4/15	Fri 11/6/15	3,8,5
11	Locations Cleared	0 days	Fri 11/6/15	Fri 11/6/15	9,10
12	**HVS Test Cell Coring Support (2nd Shift + Weekend)**	**1.5 days**	**Fri 11/6/15**	**Mon 11/9/15**	
13	Test Areas Vacated	0 days	Fri 11/6/15	Fri 11/6/15	11
14	Port Locations Cored	1.5 days	Fri 11/6/15	Mon 11/9/15	13
15	**Non-Invasive Inspections (1st Shift)**	**6 days**	**Fri 11/6/15**	**Mon 11/16/15**	
16	Visual Inspections	3 days	Fri 11/6/15	Wed 11/11/15	3,5,11
17	HAPSITE Screening	3 days	Wed 11/11/15	Mon 11/16/15	3,5,16
18	**HVS Test Cell Screening (2nd Shift + Weekend)**	**2 days**	**Fri 11/13/15**	**Mon 11/16/15**	
19	Test Areas Vacated	0 days	Fri 11/13/15	Fri 11/13/15	11,14FS+3 days
20	Sample and Observation Ports Installed	1.5 days	Fri 11/13/15	Mon 11/16/15	11,14FS+3 days
21	HVS Testing - Data Collection	1.5 days	Fri 11/13/15	Mon 11/16/15	11,14FS+3 days
22	HVS Test Data Analysis	1.5 days	Fri 11/13/15	Mon 11/16/15	11,14FS+3 days
23	HVS Ports Capped for Future Use	1.5 days	Fri 11/13/15	Mon 11/16/15	11,14FS+3 days
24	HVS Test Completion	1.5 days	Fri 11/13/15	Mon 11/16/15	11,14FS+3 days
25	Test Area Available for CCAD Occupation	0 days	Mon 11/16/15	Mon 11/16/15	24
26	**MIP Profiling - Phase 1 (2nd Shift)**	**7.5 days**	**Mon 11/30/15**	**Thu 12/10/15**	
27	Confirmation of Selected Locations	0 days	Mon 11/30/15	Mon 11/30/15	22FS+10 days
28	Test Area Vacated	1.5 wks	Tue 12/1/15	Thu 12/10/15	27
29	MIP Locations Cored	1.5 wks	Tue 12/1/15	Thu 12/10/15	27
30	MIP Locations Advanced - Data Collection	1.5 wks	Tue 12/1/15	Thu 12/10/15	27
31	MIP Data Analysis	1.5 wks	Tue 12/1/15	Thu 12/10/15	27
32	MIP Locations Filled - Concrete Repaired	1.5 wks	Tue 12/1/15	Thu 12/10/15	27
33	MIP Phase 1 Demob	0 wks	Thu 12/10/15	Thu 12/10/15	32
34	Test Area Available for CCAD Occupation	0 days	Thu 12/10/15	Thu 12/10/15	33
35	**Indoor Air Testing (24-hr)**	**2 days**	**Fri 12/11/15**	**Tue 12/15/15**	
36	Confirmation of Selected Locations	0 days	Fri 12/11/15	Fri 12/11/15	22FS+19 days,3
37	HAPSITE Screening	2 days	Mon 12/14/15	Tue 12/15/15	36
38	IA Test Kit Set Up - Data Collection	1 day	Mon 12/14/15	Mon 12/14/15	36
39	Sub-Slab Test Kit Set Up - Data Collection	1 day	Mon 12/14/15	Mon 12/14/15	36
40	Outdoor Air Test Kit Set Up - Data Collection	1 day	Mon 12/14/15	Mon 12/14/15	36
41	All Port Locations Filled - Concrete Repaired	1 day	Tue 12/15/15	Tue 12/15/15	39
42	Indoor Air Test Complete	0 days	Tue 12/15/15	Tue 12/15/15	41,37
43	**MIP Profiling - Phase 2 (2nd Shift)**	**14 days**	**Mon 12/28/15**	**Fri 1/15/16**	
44	Confirmation of Selected Locations	0 days	Mon 12/28/15	Mon 12/28/15	33FS+12.5 days
45	Test Area Vacated	5 days	Mon 1/11/16	Fri 1/15/16	44
46	MIP Locations Cored	5 days	Mon 1/11/16	Fri 1/15/16	44
47	MIP Locations Advanced - Data Collection	5 days	Mon 1/11/16	Fri 1/15/16	44
48	MIP Data Analysis	5 days	Mon 1/11/16	Fri 1/15/16	44
49	MIP Locations Filled - Concrete Repaired	5 days	Mon 1/11/16	Fri 1/15/16	44
50	MIP Phase 2 Demob	0 days	Fri 1/15/16	Fri 1/15/16	49
51	Test Area Available for CCAD Occupation	0 days	Fri 1/15/16	Fri 1/15/16	50
52	**End of Indoor Study**	0 days	Fri 1/15/16	Fri 1/15/16	51



Project: Building 8 VI Study Propo
Date: Mon 10/12/15

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress

Page 1

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE

(UFP-QAPP Manual Section 3.1.1)

17.1 Sampling Approach

This sampling approach has been designed to achieve the following objectives:

- Evaluate the spatial distribution of CVOCs in sub-slab soil gas in the vadose zone within the Site 00005 — Building 8 footprint.

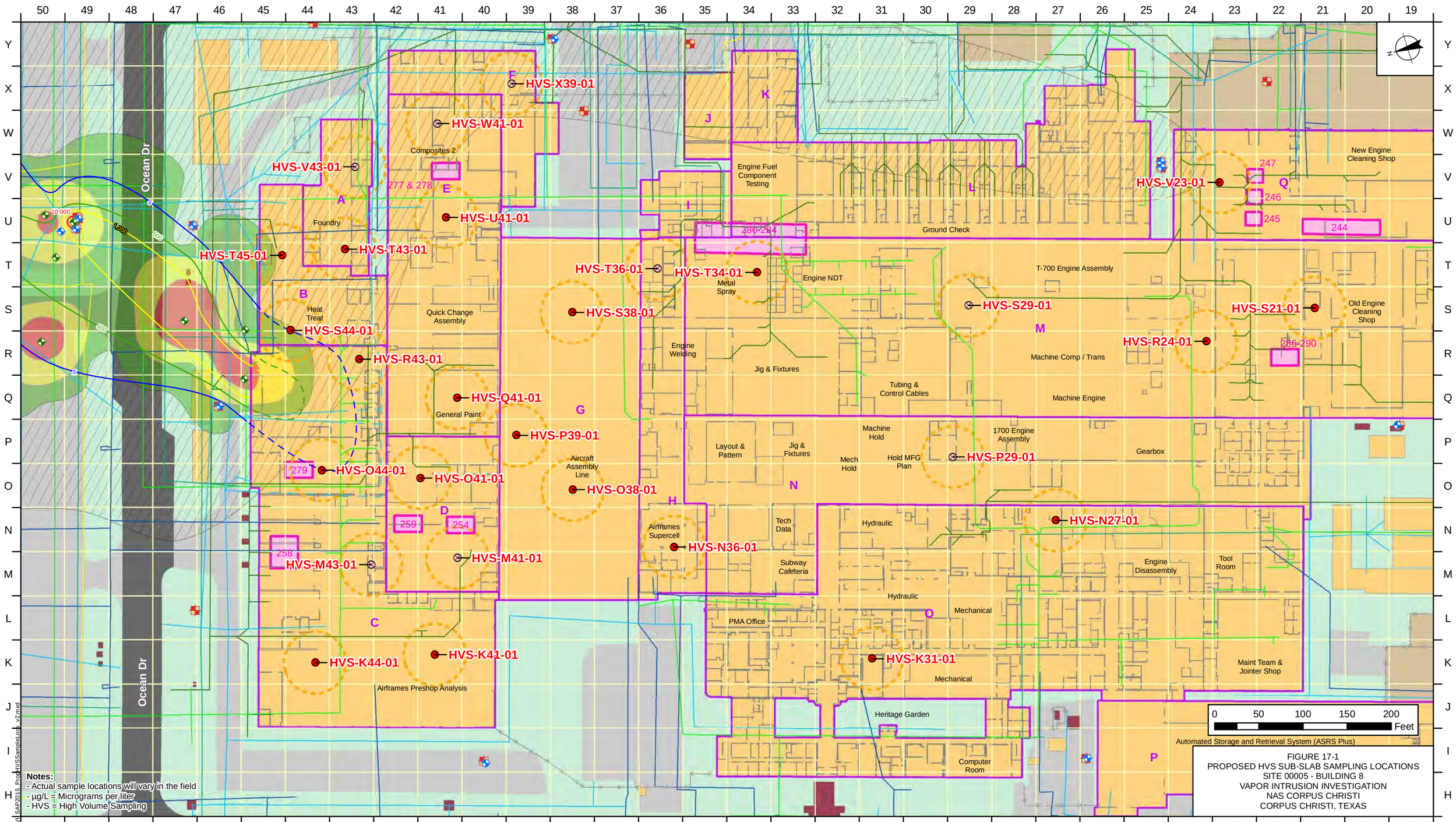
- Evaluate potential risks associated with CVOC vapor intrusion to indoor air receptors using multiple-lines-of-evidence (e.g., concurrent sub-slab soil gas, indoor, and ambient air TO-15 results, radon data, pressure differential data, previously collected shallow groundwater data, building characteristics, HVS and MIP investigation results, HAPSITE indoor air survey, chemical use history, etc.) at Site 00005 — Building 8.

The sampling strategy, as presented herein, was designed in general accordance with applicable U.S. EPA VI guidance and developed based on information on historical operations, the current CSM as presented in Worksheet #10, and results from previous environmental studies and investigations. Furthermore, the proposed strategy considers regulatory comments provided during scoping sessions, as summarized in Worksheet #9. Findings will provide information to support a decision concerning the need for future VI risk screening and/or management.

The subsequent sections describe proposed sampling locations that are shown on the following figures for Site 00005 — Building 8 and summarized in Worksheet #18 tables:

- Figure 17-1 Proposed HVS Assessment Locations
- Figure 17-2 Proposed MIP Locations
- Figure 17-3 Proposed Indoor Air and Sub-slab Soil Gas Sample Locations

Note that Figures 17-1 through 17-3 identify initial sampling locations; locations will be field adjusted based on site conditions and real-time screening data from HVS, HAPSITE, and MIP. The investigation will begin at the northern end of Building 8 and extend to the south using a dynamic investigation approach to roughly delineate soil gas source areas and groundwater plume extents. Additional investigations will likely be required to refine the nature and extent of contamination.



Notes:
- Actual sample locations will vary in the field
- µg/L = Micrograms per liter
- HVS = High Volume Sampling

FIGURE 17-1
PROPOSED HVS SUB-SLAB SAMPLING LOCATIONS
SITE 00005 - BUILDING 8
VAPOR INTRUSION INVESTIGATION
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

- Primary HVS Sample Point
- Secondary HVS Sample Point
- Phase 2 Wells (Feb. - Mar. 2015)
- Well Locations - NIRIS
- Well Locations - NAVFAC GDB
- Natural Gas Line - NAVFAC
- Approximate Water Line - NAVFAC
- Approximate Storm Sewer Line - NAVFAC
- Approximate Sanitary Sewer Line - Weston
- Approximate Sanitary Sewer Line - NAVFAC
- Approximate Industrial Sewer Line - Weston
- Fence Line
- Proposed Sub-Slab Sampling Cell
- Installation Boundary
- Site Boundary
- SWMU Boundary
- Building Footprint
- Paved Parking
- Unpaved Parking
- Building 8 Grids

Max XSD Values (1,000 x uV)
- <107k - Likely Below Detection
- <218k - Likely Below MSL (5 µg/L)
- <416k - Likely Below PCL (500 µg/L)
- >416k -Likely Exceeds PCL

TCE Isocontours (Dashed Where Inferred)
- 5 µg/L - MCL
- 500 µg/L - PCL GW Class 3
- 1,000 µg/L
- 10,000 µg/L

- Paved Road
- Airfield Pavement
- Water
- Building Foundation Zone

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 10/14/2015
DRAWN BY: N. RINEHART	TASK ORDER NUMBER: JM75

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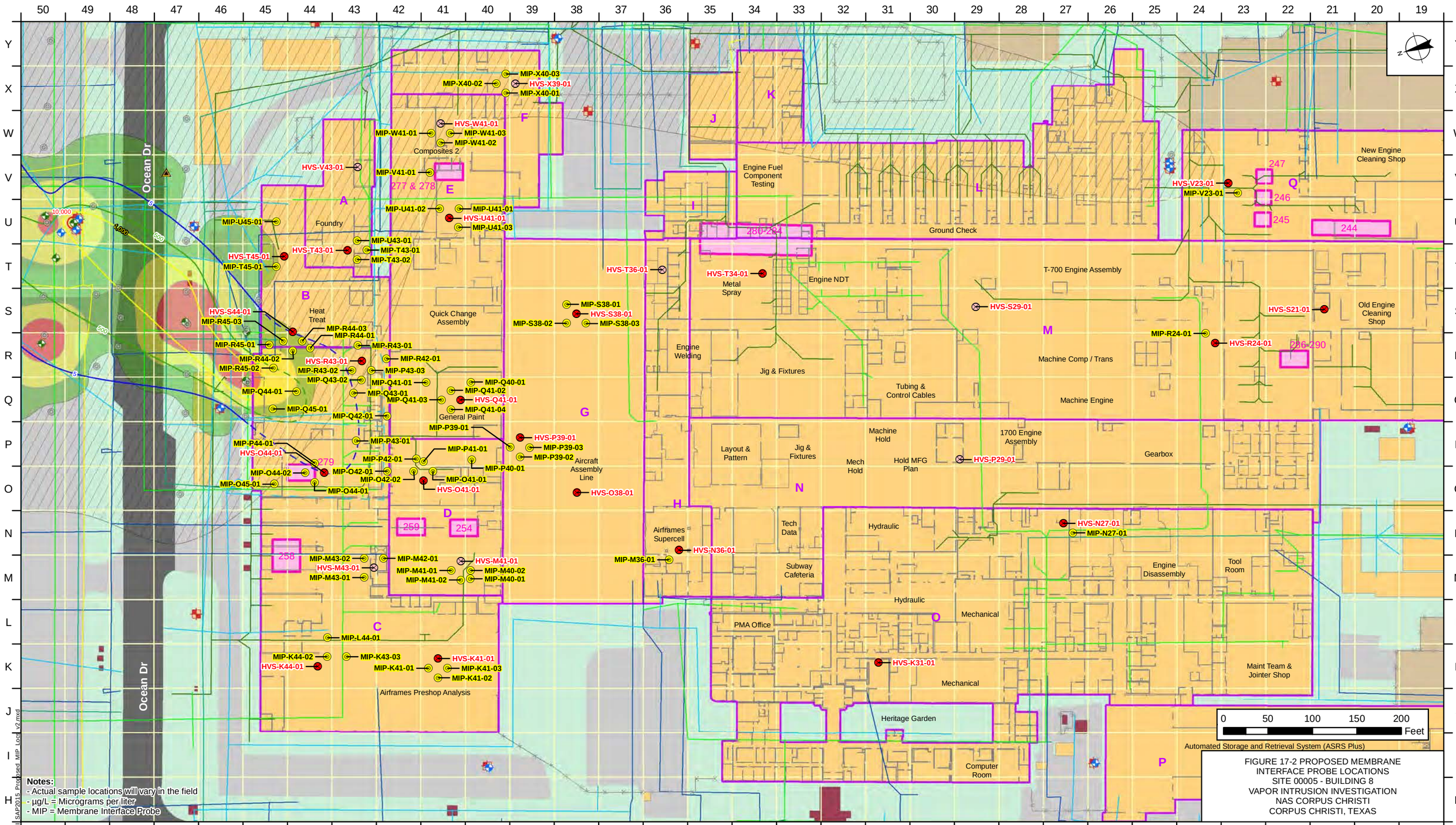

FIGURE 17-2 PROPOSED MEMBRANE INTERFACE PROBE LOCATIONS
SITE 00005 - BUILDING 8
VAPOR INTRUSION INVESTIGATION
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

Notes:
- Actual sample locations will vary in the field
- µg/L = Micrograms per liter
- MIP = Membrane Interface Probe

- Primary HVS Sample Point
- Secondary HVS Sample Point
- Proposed Indoor MIP (50)
- MIP Locations (Nov 2014)
- Wastewater Pump Location
- Phase 2 Wells (Feb. - Mar. 2015)
- Well Locations - NIRIS
- Well Locations - NAVFAC GDB
- Natural Gas Line - NAVFAC
- Approximate Water Line - NAVFAC
- Approximate Storm Sewer Line - NAVFAC
- Approximate Sanitary Sewer Line - Weston
- Approximate Sanitary Sewer Line - NAVFAC
- Approximate Industrial Sewer Line - Weston
- Fence Line
- Site Boundary
- SWMU Boundary
- Building Footprint
- Building 8 Grids

Max XSD Values (1,000 x uV)
- <107k - Likely Below Detection
- <218k - Likely Below MSL (5 µg/L)
- <416k - Likely Below PCL (500 µg/L)
- >416k -Likely Exceeds PCL

TCE Isocontours (Dashed Where Inferred)
- 5 µg/L - MCL
- 500 µg/L - PCL GW Class 3
- 1,000 µg/L
- 10,000 µg/L

- Paved Road
- Airfield Pavement
- Water
- Building Foundation Zone
- Paved Parking
- Unpaved Parking

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: B. ELLIOTT	DATE: 10/14/2015
DRAWN BY: N. RINEHART	TASK ORDER NUMBER: JM75

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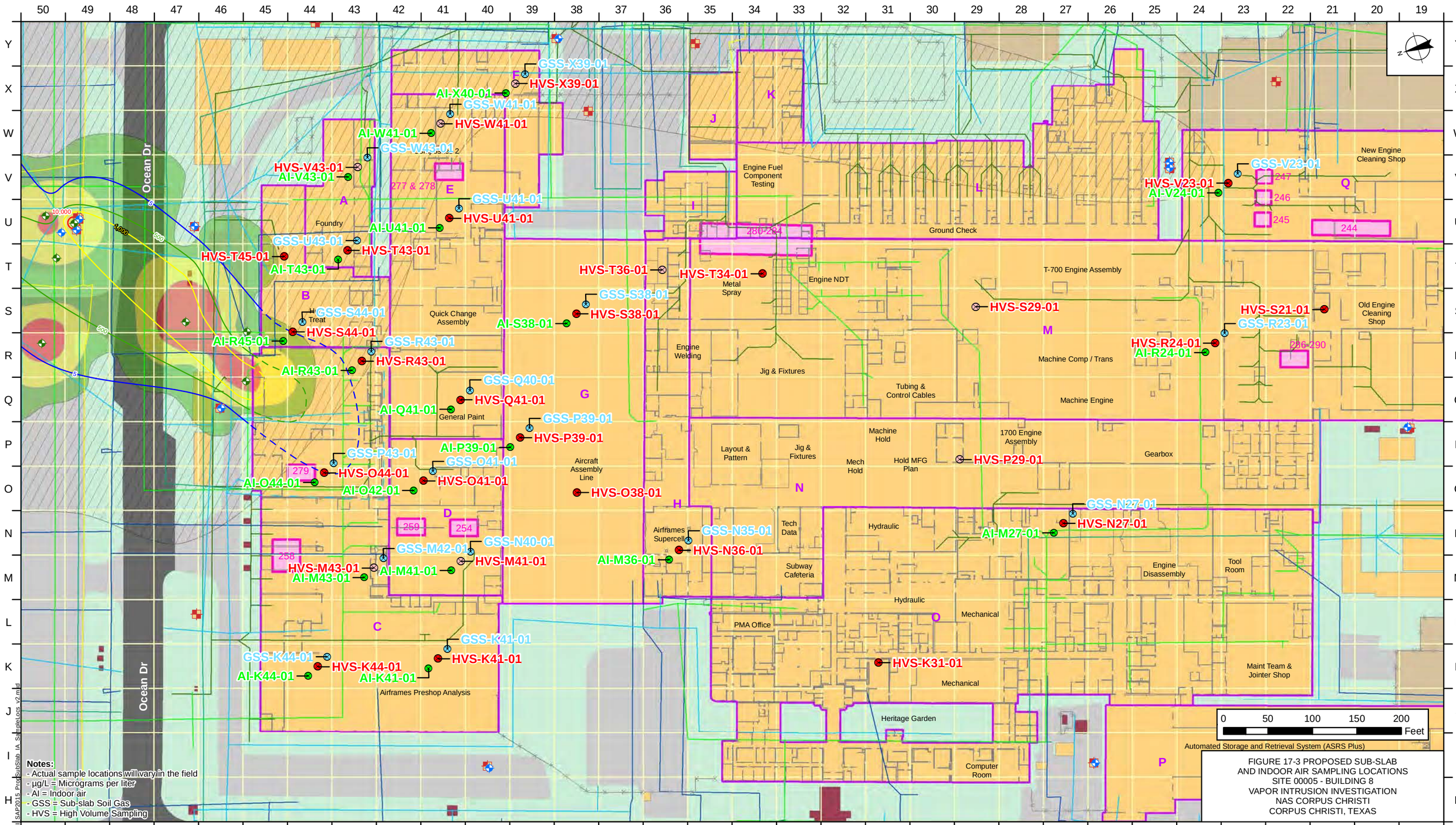

FIGURE 17-3 PROPOSED SUB-SLAB AND INDOOR AIR SAMPLING LOCATIONS
SITE 00005 - BUILDING 8
VAPOR INTRUSION INVESTIGATION
NAS CORPUS CHRISTI
CORPUS CHRISTI, TEXAS

Worksheet #18 is a summary table that includes sample identification numbers, relevant SOPs, and applicable laboratory and field analyses. Worksheet #14 identifies the field tasks required during this field event and SOPs relevant to each task. SOPs for field activities are summarized in Worksheet #21 and included in Appendix A. Observations made during the building survey, results of the HVS assessment and HAPSITE screening, communication with onsite staff, and professional judgment may be used to adjust sampling locations in the field.

Analytical requirements for this field event vary by task, summarized as follows:

- VOC samples will be submitted to ALS Environmental of Simi Valley, California, for analysis
  - Screening samples collected during the HAPSITE survey will be analyzed for a select VOC analyte list. This list is based upon the parameters previously detected in groundwater collected at the site.
  - Sub-slab soil gas grab samples collected during the HVS assessment will be analyzed using the HAPSITE for TCE and benzene only. Results will be used to distinguish between any potential CVOC plume (as indicated by TCE) and PVOC plume (as indicated by benzene). The scope of the HVS investigation will be based on TCE delineation; benzene detections will only be recorded to note presence/absence of the petroleum plume.
  - Indoor air, ambient air, and sub-slab soil gas samples will be analyzed for a site specific list of 12 VOCs, as approved by the partnering team.[8]
- Radon samples will be analyzed by University of Southern California, Earth Sciences Laboratory.

Worksheet #23 identifies the analytical methods. Laboratory SOPs are listed in Worksheet #23 and provided in Appendix B. The number of samples to be analyzed for each parameter are identified in Worksheets #18 and #20. Worksheets #19 and #30 present a summary of the sample analyses, container types and volumes, preservation requirements, and holding times.

[8] The 12 VOCs identified as groundwater and soil COCs during the APAR include benzene, chlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, methylene chloride, 1,1,2,2-tetrachloroethane, tetrachloroethene, 1,1,2-trichloroethane, TCE, PCE, and vinyl chloride.

Worksheet #12 presents the field QC sample summary. Horizontal coordinates of each sample location will be obtained and recorded in a project logbook using a global positioning system device (where satellite signals are accessible) or a boundary survey tied to known monuments with theodolite and relative electronic distance measuring (or standard surveyor's tape measure) between points in accordance with Resolution Consultants SOP-3-07 and SOP-3-02 to allow for future reacquisition.

17.2 HVS Assessment

This section provides the procedures that will be used to implement HVS at the Site 00005 — Building 8 target areas. The objectives of the HVS sampling effort are to:

- Assess the northern portion of the building for potential sources of target CVOCs in vadose soil and/or groundwater.
- Provide preliminary data to evaluate the potential for migration of target CVOCs in the subsurface to indoor air in the northern portion of the building.

The HVS assessment will be performed by Geosyntec, a specialized contractor with significant experience in similar studies at Department of Defense installations. Results will be analyzed in the field to be incorporated into real-time decision-making, and a report will be provided by Geosyntec.

HVS will consist of purging sub-slab soil gas from each extraction point over a period of time (typically between 30 and 120 minutes) and periodically monitoring the extracted soil gas using portable instruments to evaluate CVOC concentration trends as a function of volume purged. The HVS test method typically removes a sufficient volume to withdraw soil gas from beneath the slab to a radial distance of approximately 25 to 35 feet (assuming a typical sub-slab fill consisting of a 6-inch gravel layer with 30% porosity).

Approximately 20 primary HVS sample points are proposed at locations distributed throughout the Site 00005 — Building 8 investigation target areas. These primary locations are focused toward the northernmost portion of the building because available site groundwater data indicate that potential impacts to soil gas are more likely in this area. Locations were selected to assess potential soil gas impacts related to contaminated groundwater, potential soil gas impacts related to a discrete vadose zone source, and/or to evaluate the influence of likely sub-slab footers to vapor migration beneath the slab. Up to eight secondary HVS sample points will also be marked and cleared to

allow for dynamic changes to the sampling locations during the field effort. As primary samples are collected and screening data are analyzed in the field, changes to sample locations may occur to better focus the 20 sample points. Figure 17-1 presents the proposed primary and secondary HVS assessment sample locations.

17.3 HAPSITE Survey

A field survey will be conducted using a portable GC/MS HAPSITE unit. The screening will be conducted concurrently with the HVS assessment and will also be conducted during the indoor air sampling event. The HAPSITE survey will serve three purposes.

1) Distinguish between CVOC sources and PVOC sources as determined by the HAPSITE in the effluent of the HVS purge. Two indicator compounds will be used to distinguish between CVOC and PVOC compounds: TCE and benzene. The HVS delineation effort will be based on the extent of TCE; benzene presence/absence will be recorded for future assessment purposes. Benzene delineation will not be performed during this field event.

2) Identify processes and/or other background sources of VOCs being investigated.

3) Identify possible vapor intrusion entry points (cracks, joints, sumps, etc.) that could be a source of VOCs identified in indoor air.

The HAPSITE unit will be operated by KD Analytical, a specialized vendor with significant experience in similar studies at Department of Defense installations, and Resolution Consultants technical field staff. Results will be downloaded and reviewed by an appropriately trained HAPSITE analyst. The unit will initially be used to qualitatively identify VOC sources in indoor air, or associated with floor joints, cracks, or utility penetrations. Once possible sources are identified, the unit will be used for quantitative measurement of VOC concentrations.

Potential indoor air sources and vapor intrusion entry points (cracks, joints, sumps, etc.) (tasks 2 and 3, above) will be qualitatively identified and then quantitatively assessed to gauge VOC concentrations using the following select VOC analyte list:

- Benzene
- Chlorobenzene
- 1,3-Dichlorobenzene
- 1,2-Dichloroethane

- 1,1-Dichloroethene
- cis-1,2-Dichloroethene
- Methylene chloride
- 1,1,2,2-Tetrachloroethane
- 1,1,2-Trichloroethane
- Tetrachloroethene
- Trichloroethene
- Vinyl Chloride

17.4 Indoor Air Sampling Program

As detailed in Worksheet #18, indoor air samples will be collected from 20 locations in Site 00005 — Building 8 after the conclusion of the first phase of MIP testing. Indoor air samples and sub-slab soil gas sample locations are collocated; Figure 17-3 shows the proposed locations. These locations will be field adjusted based on site conditions and real-time screening data from HVS, HAPSITE, and MIP. The determination that 20 indoor air samples are sufficient to meet the goals and objectives of the VI investigation is based on the square footage of the investigative area; absence of sensitive populations; building construction; present usage and accessibility of the investigative area; and the relatively small portion of the investigative area overlying the groundwater contaminant plume. However, final determination of the indoor air sampling locations, to be agreed upon by the Navy, will be based on the following factors:

- Pre-screening results (HVS Assessment and HAPSITE survey)
- Building construction, slab condition, and utility conduits
- Areas frequented by receptors
- Concurrence with CCAD area points of contact

Indoor air samples will be collected concurrently with ambient air and sub-slab soil gas samples. Indoor air samples will be collected over a 24-hour period in 6-liter evacuated stainless-steel canisters equipped with flow controllers (approximate sampling flow rate of 3.75 mL/min). Each canister and flow controller will be individually-certified clean and documented by the laboratory prior to shipment.

17.5 Ambient Air Sampling Program

Approximately four ambient (outdoor) air samples will be collected around the Site 00005 — Building 8 perimeter. The ambient air samples will be collected from the upwind side of the building to assess the potential for background outdoor VOCs to impact indoor air concentrations. Locations will be determined in the field based on the prevailing winds of the sample start date. Ambient air samples will be collected concurrently with indoor air and sub-slab soil gas samples.

Ambient air samples will be collected in 6-liter evacuated stainless-steel canisters equipped with flow controllers over a 24-hour period. Both the canisters and the flow controllers will be individually-certified clean and documented by the laboratory prior to shipment.

17.6 Sub-slab Soil Gas Sampling Program

Twenty sub-slab soil gas samples will be collected from areas of interest within Site 00005 — Building 8. Sub-slab soil gas sample locations are collocated with indoor air samples and proposed locations are presented on Figure 17-3. As detailed in Worksheet #18, sub-slab soil gas samples will be collected from 20 locations beneath the floor slab of Site 00005 — Building 8. The determination that 20 sub-slab gas samples are sufficient to meet the goals and objectives of the VI Investigation is based on the square footage of the investigative area; absence of sensitive populations; building construction; present usage and accessibility of the investigative area; and the relatively small portion of the investigative area overlying the groundwater contaminant plume. However, final determination of the sub-slab soil gas sampling locations, to be agreed upon by the Navy, will be based on the following factors:

- Pre-screening results (HVS Assessment and HAPSITE survey)
- MIP results
- Building construction, slab condition, and utility conduits
- Areas frequented by receptors
- Sub-slab conditions (e.g., homogeneity and composition of sub-slab material, shallow water table, etc.)
- Concurrence with CCAD area points of contact

Vapor Pins, produced by Cox-Colvin and Associates, Inc., will be used to collect sub-slab soil gas at Site 00005 — Building 8.

Sub-slab soil gas samples will then be collected in 6-liter evacuated stainless-steel canisters equipped with flow controllers. Each canister and flow controller will be individually-certified clean and documented by the laboratory prior to shipment.

Once it has been determined that no further sub-slab soil gas sampling is needed in the future, all Vapor Pins will be removed and the holes will be abandoned by filling with fast-drying, expandable cement to create an air-tight seal in the floor.

17.7 Radon Sampling Program

In conjunction with indoor air, sub-slab soil gas, and ambient air sampling, radon will be evaluated through the collection of one radon sample per indoor air and sub-slab soil gas sample. Radon samples will be collected from the same locations as the indoor air and sub-slab soil gas samples, immediately after sample completion.

17.8 Ancillary Data Collection Program

Ancillary data, in particular temperature, barometric pressure, and differential pressure, will be collected using a logging monitoring instrument, in up to four to-be-determined locations, throughout the duration of the 24-hour sampling. The monitoring instrument will be programmed to log data at 15-minute intervals. Upon completion of the sub-slab soil gas sampling, the data from the monitoring device will be downloaded onto a computer. This monitoring will be used as part of a multiple-lines-of-evidence approach to evaluate VI potential.

SAP WORKSHEET #18: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

Sample matrix: Sub-Slab Soil Gas Screening Vapor from High Volume Sample

Location: Site 00005 — Building 8

Foundation Zone	CCAD Shop Designation	Nearby SWMUs	Investigation Grid Cells	Proposed Sample ID	Media	SOP Reference	TCE	Benzene
A	Foundry	None	T43-W43, T44-W44	HVS-T43-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
A	Foundry	None	T43-W43, T44-W44	HVS-V43-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
B	Heat Treat	None	R45-V45, R44-V44, R43-T43	HVS-S44-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
B	Heat Treat	None	R45-V45, R44-V44, R43-T43	HVS-T45-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
C	Airframes Preshop Analysis	None	J40-J42, K40-K42, L40-L42	HVS-K41-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
C	Airframes Preshop Analysis	None	K44, J44	HVS-K44-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
C	Airframes Preshop Analysis	None	M43, N43	HVS-M43-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
C	Cowling and Faring Area	279	O45-R45, O44-R44, O43-R43	HVS-O44-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
C	Cowling and Faring Area	279	O45-R45, O44-R44, O43-R43	HVS-R43-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
D	Airframes Cleaning	259 and 254	N42, N41	HVS-M41-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
D	Small Parts and Tanks, between Airframes Cleaning and General Paint shops	259 & 254	O40, O41, O42, P40, P41, P42	HVS-O41-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
E	Composites 1	277 & 278	U40, U41, V40, V41	HVS-U41-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
E	Composites 2	277 & 278	W40, W41	HVS-W41-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
E	General Paint	None	Q40, Q41, Q42, R40, R41, R42	HVS-Q41-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
F	Composites Expansion	None	V39, W39, X39, Y39, X40-X42, Y40-Y42	HVS-X39-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
G	Aircraft Assembly Line	None	M37- T37, M38-T38, M39-T39	HVS-O38-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
G	Aircraft Assembly Line	None	M37- T37, M38-T38, M39-T39	HVS-P39-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
G	Aircraft Assembly Line	None	M37- T37, M38-T38, M39-T39	HVS-S38-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
H	Airframes Supercell	None	M35-M36, N35-N36	HVS-N36-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
H	Metal Spray, Engine Welding, and	280-284	T36, T37	HVS-T36-01	Sub-Slab Soil Gas	See Worksheet #21	X	X

Sample matrix: Sub-Slab Soil Gas Screening Vapor from High Volume Sample

Location: Site 00005 — Building 8

Foundation Zone	CCAD Shop Designation	Nearby SWMUs	Investigation Grid Cells	Proposed Sample ID	Media	SOP Reference	TCE	Benzene
	Engine NDT							
M	Machine Comp/Trans	286-290	R24, S24, R23, S23	HVS-R24-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
M	Metal Spray, Engine Welding, and Engine NDT	280-284	QRST 33-35	HVS-T34-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
M	Storage area at location of Old Engine Cleaning Shop	286-290	S21, S22, R21, R22	HVS-S21-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
M	T-700 Engine Assembly	None	S29, S28	HVS-S29-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
O	Looking at industrial line in this area.	None	N27, N28, O27, O28	HVS-N27-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
O	Looking at industrial line in this area.	None	P28, P29 O28, O29	HVS-P29-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
O	Not a shop. These are offices.	None	L31, K31	HVS-K31-01	Sub-Slab Soil Gas	See Worksheet #21	X	X
Q	Former IWPP facility, north of New Engine Cleaning Shop	244, 245, 246, 247	V23, V24	HVS-V23-01	Sub-Slab Soil Gas	See Worksheet #21	X	X

Notes:

HVS = High volume sample
CCAD = Corpus Christi Army Depot
SWMU = Solid waste management unit
SOP = Standard Operating Procedure
TCE = Trichloroethene
ID = Identification
NDT = Non-destructive testing
IWPP = Industrial Waste Pretreatment Plant

Foundation Zones are designated on Figure 17-1 and represent Building 8 areas where the sub-slab soil gas zones are potentially isolated by subsurface features.
Investigation grid cells (50x50 feet in area) are established at the Building 8 site based on prior investigation approach and used to assist in sample location.
Example sample identification for HVS samples: HVS-Q41-01 = high volume sub-surface soil gas screening sample, grid Q41, location 1.

SAP WORKSHEET #18: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE (continued)

Sample Matrix: Indoor Air (AI) and Sub-Slab Soil Gas (GSS)

Location: Site 00005 — Building 8

Foundation Zone	CCAD Shop Designation	Nearby SWMUs	HAPSITE Area Sample ID	IA Sample ID	GSS Sample ID	Media	SOP Reference	CVOCs	PVOCs	Radon
A	Foundry	None	HAS-T43-01	AI-T43-01	GSS-U43-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
A	Foundry	None	HAS-V43-01	AI-V43-01	GSS-W43-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
B	Heat Treat	None	HAS-S44-01	AI-R45-01	GSS-S44-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
B	Heat Treat	None	HAS-T45-01			Sub-Slab Soil Gas	See Worksheet #21			
C	Airframes Preshop Analysis	None	HAS-K41-01	AI-K41-01	GSS-K41-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
C	Airframes Preshop Analysis	None	HAS-K44-01	AI-K44-01	GSS-K44-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
C	Airframes Preshop Analysis	None	HAS-M43-01	AI-M43-01	GSS-M42-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
C	Cowling and Faring Area	279	HAS-O44-01	AI-O44-01	GSS-P43-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
C	Cowling and Faring Area	279	HAS-R43-01	AI-R43-01	GSS-R43-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
D	Airframes Cleaning	259 and 254	HAS-M41-01	AI-M41-01	GSS-N40-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
D	Small Parts and Tanks, between Airframes Cleaning and General Paint shops	259 & 254	HAS-O41-01	AI-O42-01	GSS-O41-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
E	Composites 1	277 & 278	HAS-U41-01	AI-U41-01	GSS-U41-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
E	Composites 2	277 & 278	HAS-W41-01	AI-W41-01	GSS-W41-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
E	General Paint	None	HAS-Q41-01	AI-Q41-01	GSS-Q40-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
F	Composites Expansion	None	HAS-X39-01	AI-X40-01	GSS-X39-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
G	Aircraft Assembly Line	None	HAS-O38-01			Sub-Slab Soil Gas	See Worksheet #21			
G	Aircraft Assembly Line	None	HAS-P39-01	AI-P39-01	GSS-P39-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
G	Aircraft Assembly Line	None	HAS-S38-01	AI-S38-01	GSS-S38-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X

Sample Matrix: Indoor Air (AI) and Sub-Slab Soil Gas (GSS)

Location: Site 00005 — Building 8

Foundation Zone	CCAD Shop Designation	Nearby SWMUs	HAPSITE Area Sample ID	IA Sample ID	GSS Sample ID	Media	SOP Reference	CVOCs	PVOCs	Radon
H	Airframes Supercell	None	HAS-N36-01	AI-M36-01	GSS-N35-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
H	Metal Spray, Engine Welding, and Engine NDT	280-284	HAS-T36-01			Sub-Slab Soil Gas	See Worksheet #21			
M	Machine Comp/Trans	286-290	HAS-R24-01	AI-R24-01	GSS-R23-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
M	Metal Spray, Engine Welding, and Engine NDT	280-284	HAS-T34-01			Sub-Slab Soil Gas	See Worksheet #21			
M	Storage area at location of Old Engine Cleaning Shop	286-290	HAS-S21-01			Sub-Slab Soil Gas	See Worksheet #21			
M	T-700 Engine Assembly	None	HAS-S29-01			Sub-Slab Soil Gas	See Worksheet #21			
O	Looking at industrial line in this area.	None	HAS-N27-01	AI-M27-01	GSS-N27-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
O	Looking at industrial line in this area.	None	HAS-P29-01			Sub-Slab Soil Gas	See Worksheet #21			
O	Not a shop. These are offices.	None	HAS-K31-01			Sub-Slab Soil Gas	See Worksheet #21			
Q	former IWPP facility, north of New Engine Cleaning Shop	244, 245, 246, 247	HAS-V23-01	AI-V24-01	GSS-V23-01	Sub-Slab Soil Gas/Indoor Air	See Worksheet #21	X	X	X
Not Applicable	Northeast of Foundry	None	Not Applicable	AA-V44-01	Not Applicable	Ambient Air	See Worksheet #21	X	X	
Not Applicable	Northwest of Airframes Preshop Analysis	None	Not Applicable	AA-H44-01	Not Applicable	Ambient Air	See Worksheet #21	X	X	
Not Applicable	Southwest of Hangar 8	None	Not Applicable	AA-L37-01	Not Applicable	Ambient Air	See Worksheet #21	X	X	
Not Applicable	Southeast of Hangar 8	None	Not Applicable	AA-U37-01	Not Applicable	Ambient Air	See Worksheet #21	X	X	

Notes:

HAS	=	HAPSITE Area Samples collected as part of the Building Survey, assessing qualitative data for CVOC and PVOC sources in each shop area.
IA = AI	=	Indoor Air (note the NIRIS valid value for indoor air sample type is AI)
GSS	=	Sub-slab Soil gas Sample (note NIRIS valid value for sub-slab soil gas sample type is GSS)
CCAD	=	Corpus Christi Army Depot
IWPP	=	Industrial Waste Pretreatment Plant
SWMU	=	solid waste management unit
SOP	=	Standard Operating Procedure
NIRIS	=	Naval Installation Restoration Information Solution
CVOCs	=	chlorinated volatile organic compounds, for AI/GSS/HAS samples list includes the following: chlorobenzene; 1,3-dichlorobenzene; 1,2-dichloroethane; 1,1-dichloroethene; cis-1,2-dichloroethene; methylene chloride; 1,1,2,2-tetrachloroethane; 1,1,2-trichloroethane; tetrachloroethene; trichloroethene; vinyl chloride
PVOCs	=	petroleum volatile organic compounds, for AI/GSS/HAS samples list includes benzene only.

Foundation Zones are designated on Figure 17-1 and represent Building 8 areas where the sub-slab soil gas zones are potentially isolated by subsurface features.
Investigation grid cells (50x50 feet in area) are established at the Building 8 site based on prior investigation approach and used to assist in sample location.
Example sample identification for HAPSITE Area samples: HAS-Q41-01 = high volume sub-surface soil gas screening sample, grid Q41, location 1.
Example sample identification for IA samples: AI-Q41-01 = indoor air sample, grid Q41, location 1.
Example sample identification for SSS samples: GSS-Q40-01 = sub-surface soil gas sample, grid Q40, location 1.
Example sample identification for duplicate IA samples: AI-Q41D-01 = indoor air sample, grid Q41, location 1, field duplicate.
Example sample identification for duplicate SSS samples: GSS-Q40D-01 = sub-surface soil gas sample, grid Q40, location 1, field duplicate.

SAP WORKSHEET #19: FIELD SAMPLING REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Preparation and Analytical Method/ ***SOP Reference***	Containers (number, size, and type)	Sample Volume	Preservation Requirements	Maximum Holding Time[1]
HAPSITE Sub-slab Soil Gas Screening	VOCs	KD Analytical, Inc. HAPSITE SOP *Vapor Intrusion Analysis by Field-Portable GC/MS Standard Operating Procedures*	(1) Tedlar Bag, 1 or 3 Liter	Variable	None	4 hours
Sub-slab Soil Gas	VOCs	U.S. EPA Method TO-15/ALS SOP VOA-TO15	(1) SUMMA Canister, 6 Liter	6 Liter	None	30 days
Sub-slab Soil Gas	Radon	University of Southern California Rn-SOP/*Protocol and Procedures Used by D. Hammond for Analysis of Rn in Indoor Air and Soil Vapor*	(1) Tedlar Bag, 0.5 Liter	300 mL	None	10 days
Indoor/ Ambient Air	VOCs	U.S. EPA Method TO-15/ALS SOP VOA-TO15	(1) SUMMA Canister, 6 Liter	6 Liter	None	30 days
Indoor/ Ambient Air	Radon	University of Southern California Rn-SOP/*Protocol and Procedures Used by D. Hammond for Analysis of Rn in Indoor Air and Soil Vapor*	(1) Tedlar Bag, 0.5 Liter	300 mL	None	10 days

Notes:
[1] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted
VOCs = Volatile organic compounds
SOP = Standard operating procedure
U.S. EPA = United States Environmental Protection Agency
ALS = ALS Environmental (laboratory)
Rn = Radon
mL = Milliliter

SAP WORKSHEET #20: FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Total Number of Samples to Lab
Sub-Slab Soil Gas Screening Vapor from High Volume Sample (HVS)	HAPSITE Benzene/TCE	20	0	0
Ambient Air Screening (HAS)	HAPSITE CVOCs/PVOCs	28	0	0
Sub-Slab Soil Gas (GSS)	VOCs	20	2	22
Sub-Slab Soil Gas (GSS)	Radon	20	2	22
Indoor Air (AI)	VOCs	20	2	22
Indoor Air (AI)	Radon	20	2	22
Ambient Air (AA)	VOCs	4	0	4
Ambient Air (AA)	Radon	2	0	2

Notes:

VOCs = Volatile Organic Compounds
CVOCs = Chlorinated volatile organic compounds, for AI/GSS/HAS samples list includes the following: chlorobenzene; 1,3-dichlorobenzene; 1,2-dichloroethane; 1,1-dichloroethene; cis-1,2-dichloroethene; methylene chloride; 1,1,2,2-tetrachloroethane; 1,1,2-trichloroethane; tetrachloroethene; trichloroethene; vinyl chloride
PVOCs = Petroleum volatile organic compounds, for AI/GSS/HAS samples list includes benzene only.
AI = Indoor Air (note the NIRIS valid value for indoor air sample type is AI)
GSS = Sub-slab Soil gas Sample (note NIRIS valid value for sub-slab soil gas sample type is GSS)
TCE = Trichloroethene
NIRIS = Naval Installation Restoration Information Solution

SAP WORKSHEET #21: PROJECT SAMPLING SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.1.2)

The field standard operating procedures presented below are in Appendix A.

SOP Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP-3-01	*Utility Clearance* Revision 0, June 2012	Resolution Consultants	None	No	None
SOP-3-02	*Field Log Books* Revision 0, May 2012	Resolution Consultants	None	No	None
SOP-3-03A	*Sample Labeling and Chain of Custody Procedures* Revision 0, August 2012	Resolution Consultants	None	No	None
SOP-3-04A	*Sample Handling, Storage, and Shipping of Low Level Samples*, Revision 0, May 2012	Resolution Consultants	None	No	None
SOP-3-05-TX	*Investigation-Derived Waste Management for Texas* Revision 0, May 2012	Resolution Consultants	None	No	None
SOP-3-07	*Land Surveying*, Revision 0, August 2012	Resolution Consultants	Global positioning system unit	No	None
SOP-3-17	*Direct Push Sampling Techniques* Revision 0, May 2012	Resolution Consultants	None	No	Only Section 7.7, Borehole Abandonment, will be followed.
SOP-3-20	*Operation and Calibration of a Photoionization Detector* Revision 0, May 2012	Resolution Consultants	PID, Isobutylene with cylinder regulator, and Tedlar bag	No	None
SOP RC-VI-01	*Indoor Air-Ambient Air Sample Collection With Tedlar Bags* (Revision 0, October 2015)	Resolution Consultants	Tedlar bags, Tygon tubing, lung box	Yes	A 3-liter lung box may be used.
SOP RC-VI-02	*Indoor Air-Ambient Air Sample Collection with Canisters* (Revision 1, October 2015)	Resolution Consultants	Sampling canister (SUMMA or equivalent) and sampling manifold, wrenches, bike lock	No	None
SOP RC-VI-03	*Screening Using the HAPSITE* (Revision 1, October 2015)	Resolution Consultants	HAPSITE		
SOP RC-VI-04	*Sub-slab Soil Gas Probe Installation and Leak Check* (Revision 0, October 2015)	Resolution Consultants	Hammer drill and drill bits, Shop-vac with HEPA filter, Vapor Pins and Vapor Pin tools, vacuum pump, tubing, water and bucket	No	None

SOP Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP RC-VI-05	*Sub-slab Soil Gas Sampling using Canisters* (Revision 0, October 2015)	Resolution Consultants	Swagelok nuts and ferrules, sampling manifold, sampling canister (SUMMA or equivalent)	No	Cox-Colvin Vapor Pins will be used as sub-slab probes. The manufacturer's SOPs for installation/extraction and leak testing will be used in conjunction with the Resolution Consultants SOP.
SOP RC-VI-06	*Sub-slab Soil Gas Sampling using Tedlar Bags* (Revision 0, October 2015)	Resolution Consultants	Tedlar bags, Tygon tubing, lung box	Yes	A 3-liter lung box may be used.
SOP RC-VI-07	*Tedlar Bag Screening Using Portable Screening Equipment* (Revision 0, October 2015)	Resolution Consultants	Tedlar bags, Tygon tubing, PID, landfill gas meter, HAPSITE, or similar	No	None
SOP RC-VI-08	*Differential Pressure Measurements for VI Investigations* (Revision 0, October 2015)	Resolution Consultants	Tygon tubing, air velocity meter, extension cord	No	None
Cox-Colvin & Associates, Inc. SOP	*Installation and Extraction of the Vapor Pin,* April 2015	Cox-Colvin & Associates, Inc.	Hammer drill, drill bits, Shop-Vac, extension cords, various tools	No	None
Cox-Colvin & Associates, Inc. SOP	*Leak Testing Vapor Pin Via Mechanical Means,* December 2013	Cox-Colvin & Associates, Inc.	Sampling train, extension cords, various tools	No	None
KD Analytical SOP #1	*Calibration & Operation Field-Portable GC/MS for Vapor Intrusion, ,* August 20, 2015	KD Analytical Consulting, Inc.	HAPSITE portable GC/MS	No	None
Geosyntec SOP #1	*High Volume Sub-slab Soil Gas Sampling, Revision August 2015*	Geosyntec Consultants, Inc.	Wet/dry Vacuum, Lung Box, various piping, valves, and gauges	No	None

Notes:

SOP = Standard operating procedure
GC/MS = Gas chromatograph/mass spectrometer
PID = Photoionization detector
HEPA = High-efficiency particulate air
VOC = Volatile organic compound

SAP WORKSHEET #22: FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
MiniRAE 3000 PID (or equivalent)	Visual Inspection Calibration/ Verification	Daily before use, at the end of the day, and when unstable readings occur.	Fresh air calibration reads 0.0 ppm ±3.0 ppm, span gas calibration (isobutylene) reads 100.0 ppm ±3.0 ppm	Replace filter, clean airway and check for obstructions. Use external filter if there is high humidity or if it is raining. Do not use instrument if not able to calibrate properly.	Resolution Consultants FTL or designee	SOP-3-20 and User's Manual	None
GEM 2000 Landfill Gas Meter (or equivalent)	Visual Inspection, Verification	Once upon receiving from vendor, then daily	Methane - ± 3% Carbon dioxide - ± 3% Oxygen- ± 1%	Operator correction or replacement	Resolution Consultants FTL or designee	User's Manual	None
Sample Canister (SUMMA or equivalent) Assembly (Canister, Flow Controller, Analog Vacuum Gauge)	Visual Inspection, Verification	Prior to sampling and after sampling	Prior to sampling: Canister vacuum to be -28 to -30 inches Hg After sampling: -10 to -2 inches Hg	If initial canister vacuum is < -28 inches Hg, use another canister, if possible; if not, call the Project Manager and Project Chemist for further guidance. If final canister vacuum is > -10 inches Hg or < -2 inches Hg, call the Project Manager and Project Chemist for further guidance.	Resolution Consultants FTL or designee	RC-VI-02, RC-VI-05	None
VelociCalc Multi-Function Ventilation Meter/Probe (or equivalent)	Visual Inspection, Verification	Once upon receiving from vendor	Differential Pressure <5%; Barometric Pressure < 5%; and Temperature <5%	Temperature <5%	Resolution Consultants FTL or designee	User's Manual	None

Notes:

FTL = Field team leader
Hg = Mercury
ppm = parts per million
PID = Photoionization detector
SOP = Standard operating procedure

SAP WORKSHEET #23: ANALYTICAL SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.2.1)

Laboratory Name and Address: ALS Environmental, 2655 Park Center Drive, Suite A, Simi Valley, CA 93065
Laboratory Project Manager: Kate Aguilera, kate.aguilera@alsglobal.com, 805-526-7161

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to Quality Systems Manual	Modified for Project Work? (Yes/No)
SMO-CAN_CERT	*Cleaning and Certification of SUMMA Canisters and Other Specially Prepared Canisters,* Revision 16.0, 30 April 2015	Definitive	Air Volatile Organic Compounds	GC/MS	No	No
VOA-TO15	*Determination of Volatile Organic Compounds in Air Samples Collected in Specially Prepared Canisters and Gas Collection Bags by Gas Chromatography/Mass Spectrometry (GC/MS)*, Revision 22, 21 March 2015	Definitive	Air Volatile Organic Compounds	GC/MS	No	No

Laboratory Name and Address: University of Southern California, Science Hall, Room 325B, Los Angeles, California 90089-0740
Laboratory Project Manager: Doug Hammond, 213-740-5837, dhammond@earth.usc.edu

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to Quality Systems Manual	Modified for Project Work? (Yes/No)
Rn-SOP	*Protocol and Procedures Used by D. Hammond for Analysis of Rn in Indoor Air and Soil Vapor*, 2 May 2013	Definitive	Air Radon	Scintillation Counter	No	No

Laboratory Name and Address: KD Analytical, 5045 College Oak Drive, Suite D, Sacramento, California 95841
Laboratory Project Manager: Dan Schenk, 916-897-4547, dan.schenk@kdanalytical.com

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to Quality Systems Manual	Modified for Project Work? (Yes/No)
KD Analytical SOP #1	*VOC Analysis by Field-Portable GC/MS* Revision 7, December 2014	Screening	Air Volatile Organic Compounds	Portable GC/MS	No	No

Notes:

SOP = Standard operating procedure
GC/MS = Gas chromatograph/mass spectrometer
Rn = Radon
VOC = Volatile organic compound

SAP WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/MS TO-15 VOCs	Tuning	Once every 24-hours or analytical batch	Ion abundance criteria as described in Table 3 of Method TO-15	Retune instrument and verify. Rerun affected samples. Flagging criteria are not appropriate.	Analyst, Supervisor	ALS VOA-TO15
GC/MS TO-15 VOCs	Initial Calibration — minimum of five levels	Initially or if continuing calibration no longer meets criteria	< 30% relative standard deviation with 2 exceptions up to 40%. Area response at each calibration level within 40% of internal standard mean area response over the ICAL range. Retention time for each internal standard within 20 seconds of the mean retention time over the ICAL range.	Repeat calibration if criterion is not met	Analyst, Supervisor	ALS VOA-TO15
GC/MS TO-15 VOCs	Initial Calibration Verification (Second source)	Following every ICAL	Within ± 30% of true value	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		
GC/MS TO-15 VOCs	Continuing Calibration Verification	Once every 24 hours, if an ICAL has not been performed (within the last 24 hours).	Within ± 30% of true value	Analyze two additional CCVs (within 1 hour). • If either of these two CCVs fail or if the laboratory cannot immediately analyze two CCVs, the associated samples cannot be reported and must be reanalyzed. • Corrective action(s) and recalibration must occur if the above scenario fails. All affected samples since the last acceptable CCV must be reanalyzed. • Flagging data for a failed CCV is only appropriate when the affected samples cannot be reanalyzed. The laboratory must notify the client prior to reporting data associated with a failed CCV.	Analyst, Supervisor	ALS VOA-TO15
GC/MS TO-15 VOCs	RRT Evaluation	Prior to sample analysis	RRT of each target analyte within ± 0.06 RRT units of the RRT standard.	Recalibrate, perform column maintenance, inspect pumps, and leak checks	Analyst, Supervisor	ALS VOA-TO15

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
Scintillation Counter	Up to 5 calibration standards	Annually	±5% uncertainty about the true value	Evaluate counting efficiency and cell backgrounds	Analyst	USC Rn-SOP
GC/MS HAPSITE VOCs	Tuning	Once every 12-hours or analytical batch	Ion abundance criteria as determined by the manufacturer	Adjust Tune Until Meets Criteria	Analyst	KD Analytical SOP#1
GC/MS HAPSITE VOCs	Initial Calibration — minimum of three levels	Prior to start of project or as required for acceptance criteria	Percent relative standard deviation ≤25%	Repeat calibration if criterion is not met	Analyst, Supervisor	KD Analytical SOP#1
GC/MS HAPSITE VOCs	Continuing Calibration Verification	Beginning of Each Day	Within ± 30% of true value	1) Repeat analysis 2) Prepare and run new standard 3) Recalibrate	Analyst, Supervisor	KD Analytical SOP#1

Notes:

SOP = Standard operating procedure
GC/MS = Gas chromatograph/mass spectrometer
VOCs = Volatile organic compounds
ICAL = Initial calibration
CCV = Continuing calibration verification
RRT = Relative retention time

SAP WORKSHEET #25: ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE

(UFP-QAPP Manual Section 3.2.3)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS TO-15	Check pressure and gas supply daily. Bake trap/column; manually tune if not in criteria. Perform the following as needed: change septa, cut/replace column, change pump oil, clean/change trap, clean source, clean injection port/liner.	VOCs	Inspect vacuum pressure, ion source, injector liner, column, column flow. Monitor instrument performance via calibrations and blanks.	Clean source and replace vacuum pump oil annually or as needed. Routine maintenance as necessary. Tune instrument after major maintenance. Inspect vacuum pressure daily.	Tune, calibration and QC criteria met	Repeat maintenance activity, correct problem, or remove from service.	Analyst, Department Manager	ALS VOA-TO15
Scintillation Counter	Photomultiplier Tube performance	Radon	Not applicable	Twice a year	±5% ^{241}Americum true value	Replace photomultiplier tube	Analyst	USC Rn-SOP
GC/MS HAPSITE	Clean air filters, replace ion source, as necessary, replace standard and carrier gas cylinders, as necessary, clean/decontaminate instrument as needed, replace batteries	VOCs	Inspect consumables and replace as necessary, monitor instrument performance via calibrations and blanks.	Routine consumable replacement and maintenance as necessary. Tune and calibrate instrument after major maintenance.	Tune must meet the criteria listed in the method and instrument manufacturer's instructions	Decontaminate instrument in accordance with operating manual	Analyst	KD Analytical SOP#1

Notes:
SOP = Standard operating procedure
GC/MS = Gas chromatograph/mass spectrometer
VOCs = Volatile organic compounds

SAP WORKSHEET #26: SAMPLE HANDLING SYSTEM

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT	
Sample Collection (Personnel/Organization):	FTL/Resolution Consultants
Sample Packaging (Personnel/Organization):	FTL/Resolution Consultants
Coordination of Shipment (Personnel/Organization):	FTL/Resolution Consultants
Type of Shipment/Carrier:	Overnight via FedEx
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Receiving Group/ALS Environmental and USC Department of Earth Sciences
Sample Custody and Storage (Personnel/Organization):	Sample Receiving Group/ALS Environmental and USC Department of Earth Sciences
Sample Preparation (Personnel/Organization):	Preparation Supervisor/ALS Environmental and USC Department of Earth Sciences
Sample Determinative Analysis (Personnel/Organization):	Laboratory Manager/ALS Environmental and USC Department of Earth Sciences
SAMPLE ARCHIVING	
Field Sample Storage (No. of days from sample collection):	180 Days from Receipt of Samples
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	180 Days from Receipt of Samples
SAMPLE DISPOSAL	
Personnel/Organization:	ALS Environmental and USC Department of Earth Sciences
No. of Days from Analysis:	180 Days from Receipt of Samples

Notes:

FTL = Field team leader
No. = Number
USC = University of Southern California

SAP WORKSHEET #27: SAMPLE CUSTODY REQUIREMENTS

(UFP-QAPP Manual Section 3.3.3)

The following sections outline the procedures that will be used to document project activities and sample collection, handling, tracking, and custody procedures during the investigation. All forms must be filled in as completely as possible.

Sample Nomenclature

Sample labeling will be conducted in general accordance with the procedures outlined in Resolution Consultants SOP-3-03A. Location nomenclature established for HVS, HAS, AI, GSS, and MIP locations during this field effort are based on a 50-foot interval site grid (Figures 17-1, 17-2, 17-3) to facilitate sample clearance, coring, reacquisition, relocation, and surveying. Each sample begins with a project specific sample "matrix" or type designation (e.g. HVS, HAS, AI, GSS, or MIP) and is followed by a dash with the alpha-numeric grid cell reference and a sample number (e.g., HVS-Q41-01).

Field duplicates will be labeled so they will be "blind" to the laboratory; they will use the same sample identification as the parent sample but the differentiator will be an added character ("D"), which will be affixed to the end of the grid cell reference. For example, a indoor air duplicate of AI-Q41-01 would be indicated using AI-Q41D-01. Worksheet #18 provides anticipated sample identifiers for this scope of work.

Sample Collection Documentation

Documentation of field observations will be recorded in a field logbook and/or field log sheets including the Vapor Intrusion Sampling Form and the Radon Sampling Form, found in Appendix A. Field logbooks used for this project will consist of a bound, water-resistant logbook. All pages of the logbook will be numbered sequentially and observations will be recorded with indelible ink, in accordance with SOP 3-02.

Field sample log sheets (Vapor Intrusion Sampling Form and the Radon Sampling Form, found in Appendix A) will be used to document sample collection details and other observations and activities will be recorded in the field logbook. Instrument calibration logs will be used to record the daily PID calibration. Calibration for the HAPSITE and instruments used during the HVS assessment will be documented by the respective subcontractor in accordance with their instrument specific SOPs.

For sampling and field activities, the following types of information will be recorded in the field logbook, as appropriate:

- Site name and location
- Date and time of logbook entries
- Personnel and their affiliations
- Weather conditions
- Activities involved with the sampling
- Subcontractor activity summary
- Site observations including site entry and exit times
- Site sketches made onsite
- Visitor names, affiliations, arrival and departure times
- Health and safety issues, including personal protective equipment

Sample Handling and Tracking System

Sample packages will be secured using strapping tape along with a signed custody seal. Samples will be shipped via priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical method. The laboratories will provide new or certified clean containers/canisters. Proper custody procedures will be followed throughout all phases of sample collection and handling.

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., FedEx). For all samples collected, chain-of-custody forms will document the date and time of sample collection, the sampler's name, and the names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the chain-of-custody form. Further details on chain-of-custody procedures are provided in SOP-3-03.

The following subsections outline the procedures that will be used by field and laboratory personnel to document project activities and sample-collection procedures. All forms must be filled in as completely as possible.

Resolution Consultants personnel will collect the samples. The samplers will take care not to contaminate samples through improper handling. Samples will be sealed in appropriate containers, packaged by Resolution Consultants personnel and placed into sealed packages under

chain-of-custody in accordance with the applicable SOP. Once received by the laboratory, receipt will be documented on the chain-of-custody form and the samples will be checked in. The samples will remain under chain-of-custody throughout the analysis period to ensure their integrity is preserved. Details are provided below.

Samples to be delivered to the laboratory(s) will be made by a public courier (i.e., FedEx). After samples have been collected, they will be sent to the laboratory(s) within 48 hours.

Field Sample Custody Procedures

Chain-of-custody protocols will be used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering. Samples for the laboratory will be packaged and shipped in accordance with Resolution Consultants SOP-3-04A.

A sample is under custody if:

- The sample is in the physical possession of an authorized person.
- The sample is in view of an authorized person after being in his/her possession.
- The sample is placed in a secure area by an authorized person after being in his/her possession.
- The sample is in a secure area, restricted to authorized personnel only.

Custody documentation is designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. A multi-part form is used with each page of the form signed and dated by the recipient of a sample or portion of sample. The person releasing the sample and the person receiving the sample each will retain a copy of the form each time a sample transfer occurs.

Integrity of the samples collected will be the responsibility of identified persons from the time the samples are collected until the samples, or their derived data, are incorporated into the final report.

The Resolution Consultants FTL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the chain-of-custody form. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier). Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the Laboratory SOPs.

Laboratory Chain of Custody

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used according to each laboratory's SOPs. A sample receipt form will be filled out to note conditions and any discrepancies. The chain-of-custody form will be checked against the sample tags/labels for accuracy. Samples will be logged into the laboratory information management system and given a unique log number which can be tracked through processing. The laboratory project manager will notify the Resolution Consultants FTL verbally or via email immediately if any problems are identified. Discrepancies and resolutions will be documented on the sample receiving checklist.

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE

(UFP-QAPP Manual Section 3.4)

Matrix:	Sub-slab Vapor, Soil Gas, and Ambient Air
Analytical Group:	Volatile Organic Compounds
Analytical Method:	U.S. EPA TO-15
SOP Reference:	ALS Environmental VOA-TO15

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per batch of 20 or fewer samples per matrix	No analytes detected >½ LOQ 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 laboratory contaminants, no analytes detected >LOQ.	Correct problem; reanalyze any sample associated with a blank that fails criteria.	Analyst, Supervisor, QA Manager	Bias, Contamination	See Method/SOP QC Acceptance Limit Column
Surrogates	All field and QC samples	**Surrogate** / **%Recovery** 1,2-Dichloroethane-d4: 70-130 4-Bromofluorobenzene: 70-130 Toluene-d8: 70-130	Reanalyze if sufficient sample is available. If reanalysis confirms failing recoveries, report and narrate.	Analyst, Supervisor, QA Manager	Accuracy, Bias	See Method/SOP QC Acceptance Limit Column
LCS	One per batch of 20 or fewer samples per matrix	**Analyte** / **%Recovery** Benzene: 69-119 Chlorobenzene: 70-119 1,3-Dichlorobenzene: 65-130 1,2-Dichloroethane: 65-128 1,1-Dichloroethene: 61-133 cis-1,2-Dichloroethene: 70-121 Methylene chloride: 62-115 1,1,2,2-Tetrachloroethane: 65-127 1,1,2-Trichloroethane: 73-119 Tetrachloroethene: 66-124 Trichloroethene: 71-123 Vinyl Chloride: 64-127	Correct problem. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise, re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Accuracy, Bias	QC acceptance criteria specified in DoD QSM Version 5.0 See Method/SOP QC Acceptance Limit Column

Matrix:	Sub-slab Vapor, Soil Gas, and Ambient Air
Analytical Group:	Volatile Organic Compounds
Analytical Method:	U.S. EPA TO-15
SOP Reference:	ALS Environmental VOA-TO15

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Internal Standards	In all field samples and standards	The area response for each internal standard in the blank must be within ±40% of the area response for each internal standard in the most recent valid calibration. (CCV or mid-point from the initial calibration, whichever is most current). The retention time for each internal standard must be within ±0.33 minutes of the retention time for each internal standard in the most recent valid calibration. (CCV or mid-point from the initial calibration, whichever is most current).	If the problem is with the instrument, perform maintenance. If the problem is with a sample, check for interferences. If the response is high, it is likely that interference is present. In this case, lower the sample volume or aliquot and re-analyze. If the problem persists, report the results with the best quality and qualify the results. If the problem is corrected with the lower volume analysis, report those results. If the retention time for any internal standard within the sample changes by more than 20 seconds from the latest daily calibration or initial calibration mid-point standard, the instrument must be inspected for malfunctions, and maintenance performed as required. Repeat sample analysis where required.	Analyst, Supervisor, QA Manager	Accuracy, Bias	See Method/SOP QC Acceptance Limit Column
Laboratory Duplicate	One per batch of 20 or fewer samples	Relative percent difference ≤25	Repeat analysis. If reanalysis is unacceptable, all sample results in associated batch must be flagged.	Analyst, Supervisor, QA Manager	Accuracy, Bias, precision	See Method/SOP QC Acceptance Limit Column

Notes:

U.S. EPA = United States Environmental Protection Agency
QC = Quality control
QA = Quality assurance
DoD QSM = Department of Defense Quality Systems Manual
SOP = Standard operating procedure
LOQ = Limit of quantitation
LCS = Laboratory control sample
CCV = Continuing calibration verification

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE (continued)

Matrix:	Sub-slab Vapor, Indoor Air, and Ambient Air
Analytical Group:	Radon
Analytical Method/SOP Reference:	University of Southern California Rn-SOP

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	Cell background is checked 2-3 times per year	120 cubic centimeter sample at 0.1 counts per minute counting background, 12 hour count with 3 days lapsed between collection and analysis is 0.14 pCi/L. (Based on 95% confidence level as recommended by U.S EPA 402-R-95-012, October 1997).	Correct problem; re-prepare and/or reanalyze any sample associated with a blank that fails criteria.	Analyst	Bias Contamination	See Method/SOP QC Acceptance Limit Column
Sample Duplicate	One per batch of 10 or fewer samples per matrix	±5%	Re-analyze samples not within precision limits.	Analyst	Precision	See Method/SOP QC Acceptance Limit Column

Notes:

SOP = Standard operating procedure
QC = Quality control
pCi/L = Picocuries per Liter
U.S. EPA = United States Environmental Protection Agency
Rn-SOP = Radon standard operating procedure

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE (continued)

Matrix:	Indoor Air, HVS Survey
Analytical Group:	Volatile Organic Compounds
Analytical Method:	HAPSITE KD Analytical SOP#1, Vapor Intrusion Analysis by Field-Portable GC/MS Standard Operating Procedure
SOP Reference:	KD Analytical SOP#1

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	Before Beginning of Day	Concentrations for All Calibrated Compounds <LOQ.	Correct problem; re-run blanks until criteria are met.	Analyst	Bias, Contamination	See Method/SOP QC Acceptance Limit Column
Internal Standards	In all field samples	-50% to 200% recovery from beginning of day	1) Re-run sample 2) Flag reported data	Analyst	Accuracy, Bias	See Method/SOP QC Acceptance Limit Column
Laboratory Duplicate	10% of the samples	Relative percent difference ≤30	Repeat analysis. If reanalysis is unacceptable, all sample results in associated batch must be flagged.	Analyst	Accuracy, Bias, precision	See Method/SOP QC Acceptance Limit Column

Notes:

HVS = High volume sample
SOP = Standard operating procedure
QC = Quality control
LOQ = Limit of quantitation

SAP WORKSHEET #29: PROJECT DOCUMENTS AND RECORDS TABLE

(*UFP-QAPP Manual Section 3.5.1*)

Document	Where Maintained
Sample Collection Documents and Records Project personnel sign-off record Field logbook (and sampling notes) Field sample forms (e.g., sample log sheets, drilling logs, etc.) Chain-of-custody records Sample shipment air bills Equipment calibration logs Photographs Sampling and Analysis Plans (SAP) including field sampling standard operating procedures (SOPs) Safe work permit forms	Sample collection documents and records (may include printed copy as well as electronic information) will be maintained at the Resolution Consultants office at 5724 Summer Trees Drive, Memphis, Tennessee 38134. These files will be retained for fifty (50) years after the last decision document is signed for NAS Corpus Christi.
Analytical Results Documents and Records Sample receipt/log-in forms Sample preparation logs Equipment calibration logs Sample analysis run logs Reported field sample results Reported results for standards, quality control checks Reported results for standards, quality control samples Data completeness checklists Data validation memoranda	Analytical results, documents and records will be provided by the laboratory in printed and electronic formats. Although available in the Administrative Record file, laboratory reports are typically filed at a separate location and are available upon request. Printed copies of laboratory data will be stored at a third-party secure professional document storage firm until transfer to the FRC. The records will be transferred to FRC 3 years after completion of a response action. These files will be retained for fifty (50) years after the last decision document is signed for NAS Corpus Christi. Electronic analytical results will also be verified, entered, and maintained in a database on a password protected Structured Query Language server. Data qualifiers will be added to the database during data validation. After validation, the validated data files will be transferred to the Navy's Naval Installation Restoration Information Solution (NIRIS) data management system.

Document	Where Maintained
Other Documents Personnel training records Health and Safety certifications Health and Safety Plan Field Sampling Audit Checklist Letter reports, technical memos, APAR Addendum for Site 00005 — Building 8, etc. Analytical Audit Checklist	Personnel training records and health and safety certificates will be stored in personnel records and electronically in the Resolution Consultants' training database in the project file at 5724 Summer Trees Drive, Memphis, Tennessee 38134. Plans and reports will be stored in printed version and electronically in the Administrative Record file. Printed copies will be stored at a third-party secure professional document storage firm until transfer to the FRC. The records will be transferred to FRC 3 years after completion of a response action. These files will be retained for fifty (50) years after the last decision document is signed for NAS Corpus Christi. Field Audit Checklists are not considered part of the Administrative Record file and will be stored in the Resolution Consultants project file at 5724 Summer Trees Drive, Memphis, Tennessee 38134, and electronically in the server library. Analytical Audit Checklists will be retained by the respective accreditation authorities.
Final Document/Records Repository Administrative Record files Site files Post decision files Analytical data Spatial data Maps	All final documents/Records repositories will be stored in accordance with in the NAVFAC Environmental Restoration Recordkeeping Manual. Printed copies will be stored at a third-party secure professional document storage firm until transfer to the FRC, and electronic copies will be maintained, verified, and stored on the Navy's NIRIS data management system. The records will be transferred to FRC 3 years after completion of a response action. These files will be retained for fifty (50) years after the last decision document is signed for NAS Corpus Christi.

Notes:

FRC	=	Federal records center
NAS	=	Naval Air Station
NIRIS	=	Naval Installation Restoration Information Solution
APAR	=	Affected Property Assessment Report

SAP WORKSHEET #30: ANALYTICAL SERVICES TABLE

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations / ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory / Organization
Sub-slab Soil Gas, Indoor Air, and Ambient Air	VOCs	See Worksheet #18	VOA-TO15 *Determination of Volatile Organic Compounds in Air Samples Collected in Specially Prepared Canisters and Gas Collection Bags by Gas Chromatography/ Mass Spectrometry (GC/MS)*, Revision 22, 21 March 2015	21 Days	ALS Environmental 2655 Park Center Drive, Suite A Simi Valley, CA 93065 Kate Aguilera, 805-526-7161	None
Sub-slab Soil Gas, Indoor Air, and Ambient Air	Radon	See Worksheet #18	Rn-SOP *Protocol and Procedures Used by D. Hammond for Analysis of Rn in Indoor Air and Soil Vapor*, May 2013	21 Days	USC Earth Sciences, ZHS 117 3651 Trousdale Pkwy Los Angeles, California 90089-0740 Doug Hammond, 213-740-5837	None
Indoor air, HVS survey	VOCs	See Worksheet #18	KD SOP#1 *VOC Analysis by Field-Portable GC/MS Standard Operating Procedures, Revision 7,* December 2014	21 Days	5045 College Oak Drive, Suite D Sacramento, California 95841 Dan Schenk, 916-897-4547	None

Notes:

VOCs = Volatile Organic Compounds
ID = Identification
SOP = Standard operating procedure
Rn = Radon
HVS = High volume sample

SAP WORKSHEET #31: PLANNED PROJECT ASSESSMENTS TABLE

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Onsite Laboratory Systems Audit	Every 18 months	External	DoD ELAP	DoD ELAP Auditor	QAO, ALS Environmental	QAO, ALS Environmental	QAO, ALS Environmental
Onsite Laboratory Systems Audit	Every 2 years	External	NELAP	NELAP Auditor	QAO, ALS Environmental	QAO, ALS Environmental	QAO, ALS Environmental
Onsite Field Sampling Systems Audit	Randomly selected program-wide[1]	Internal	Resolution Consultants	Tina Cantwell, QAO (or designee), Resolution Consultants	Claire Barnett, TOM Resolution Consultants	Tina Cantwell, QAO and Claire Barnett, TOM Resolution Consultants	Tina Cantwell, QAO and Claire Barnett, TOM Resolution Consultants
Work Product Peer Review	Draft, Draft Final and Final Documents	Internal	Resolution Consultants	Technical Experts and Technical Editors	Report Author	Claire Barnett, TOM Resolution Consultants	Claire Barnett, TOM Resolution Consultants

Notes:

[1] Field Audits are randomly selected at the Resolution Consultants program level and may or may not include this project.

DoD ELAP = Department of Defense Environmental Laboratory Accreditation Program
QAO = Quality assurance officer
NELAP = National Environmental Laboratory Accreditation Program
TOM = Task order manager

SAP WORKSHEET #32: ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES TABLE

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Laboratory Systems Audit	Verbal debriefing, Written audit report	QAO, ALS Environmental	Not specified by DoD ELAP or NELAP	Corrective action plan, Letter	DoD ELAP and NELAP Accrediting Bodies	Specified by DoD ELAP and NELAP Accrediting Bodies
Field Sampling Systems Audit	Audit checklist and written audit finding summary	Claire Barnett, TOM, Resolution Consultants; Leslie Baechler, FTL, Resolution Consultants	Dependent on findings; if major, a stop work may be issued immediately; however, if minor, within 1 week of audit	Written memo	Tina Cantwell, QAO, Resolution Consultants	Within 21 days of notification
Field Supervision	Site log book and sample collection logs	Claire Barnett, TOM, Resolution Consultants; Leslie Baechler, FTL, Resolution Consultants	Immediately, when discovered	Entry in site log book, potential retraining	Claire Barnett, TOM, Resolution Consultants; Leslie Baechler, FTL, Resolution Consultants	Within 24 hours

Notes:
Assessment findings will be communicated with appropriate staff during verbal audit debriefings and in the written audit report and will be documented on audit checklists, audit reports, and the APAR Addendum submitted to the regulatory agencies.

DoD ELAP = Department of Defense Environmental Laboratory Accreditation Program
QAO = Quality assurance officer
NELAP = National Environmental Laboratory Accreditation Program
TOM = Task order manager
FTL = Field team leader

SAP WORKSHEET #33: QUALITY ASSURANCE MANAGEMENT REPORTS TABLE

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data Validation	Report per data package	Within 4 weeks of receipt of laboratory data	Resolution Consultants project chemist or designee	TOM, project file, Resolution Consultants
Progress Report	Monthly for duration of the project	Monthly	TOM, Resolution Consultants	Navy RPM, program manager, project file, Resolution Consultants
Laboratory Quality Assurance Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem (within 1 day)	Laboratory quality assurance manager or project manager	TOM, project chemist, project file, Resolution Consultants

Notes:
TOM = Task order manager
RPM = Remedial project manager

SAP WORKSHEETS #34-36: DATA VERIFICATION AND VALIDATION (STEPS I AND IIA/IIB) PROCESS TABLE

(UFP-QAPP Manual Section 5.2.1), (UFP-QAPP Manual Section 5.2.2), (Figure 37 UFP-QAPP Manual), (Table 9 UFP-QAPP Manual)

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/ IIa/IIb [1]	Internal/ External
Verification Chain-of-custody forms Sample Login/Receipt	Review the sample shipment for completeness, integrity, and sign accepting the shipment. All sample labels will be checked against the chain-of-custody form, and any discrepancies will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms. Verification of sample login/receipt and chain-of-custody forms will be documented on the laboratory sample receipt form.	Laboratory sample custodians and analysts, ALS Environmental and University of Southern California Laboratories	I	Internal
Verification Chain-of-custody forms	Check that the chain-of-custody form was signed/dated by the sampler relinquishing the samples and by the laboratory sample custodian receiving the samples for analyses. Verification of chain-of-custody forms will be documented in the DVA workbook.	Project chemist or data validators, Resolution Consultants	I	External
Verification SAP sample tables	Verify that all proposed samples listed in the SAP tables have been collected. Sample completeness will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	FTL or designee, Resolution Consultants	I	External
Verification Sample log sheets and field notes	Verify that information recorded in the log sheets and field notes are accurate and complete. Sample log sheet verification will be documented by dated signature on the last page or page immediately following the review material.	FTL or designee, Resolution Consultants	I	External
Verification Field QC samples	Check that field QC samples, described in Worksheet #12 and listed in Worksheet #20, were collected as required. QC sample completeness will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	FTL or designee, Resolution Consultants	I	External
Verification Analytical data package	Verify all analytical data packages will be verified internally for completeness by the laboratory performing the work. The laboratory project manager (or designee) will sign the case narrative for each data package. All laboratory data package reviews will be documented on the laboratory review checklists and exception reports that accompany the data in accordance with TCEQ TRRP-13.	Laboratory project manager, ALS Environmental and University of Southern California Laboratories	I	Internal
Verification Analytical data package	Verify the data package for completeness. Missing information will be requested from the laboratory and validation (if performed) will be suspended until missing data are received. Data package completeness will be documented in the DVA workbook.	FTL, Project chemist or data validators, Resolution Consultants	I	External
Verification Electronic data deliverables	Verify the electronic data against the chain-of-custody and hard copy data package for accuracy and completeness. Electronic data deliverable verification will be documented in the DVA workbook.	Data manager and/or validator, Resolution Consultants	I	External
Validation Chain-of-custody	Examine the traceability of the data from time of sample collection until reporting of data. Ensure that the custody and integrity of the samples were maintained from collection to analysis and the custody records are complete and any deviations are recorded. Chain-of-custody verification will be documented in the DVA workbook.	Project chemist or data validators, Resolution Consultants	IIa	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb [1]	Internal / External
Validation Holding Times	Review that the samples were shipped and stored at the required temperature and sample pH for chemically-preserved samples meet the requirements listed in Worksheet #19. Ensure that the analyses were performed within the holding times. If holding times were not met, confirm that deviations were documented. Holding time examination will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa	External
Validation Sample results for representativeness	Check that the laboratory recorded the temperature at sample receipt and the pH of the chemically preserved samples to ensure sample integrity from sample collection to analysis. Sample receipt and preservation will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Laboratory data results for accuracy	Ensure that the laboratory QC samples were analyzed and that the measurement performance criteria, listed in Worksheet #28, were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed, as listed in Worksheet #12, and that the analytical QC criteria were met. Accuracy will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Field and laboratory duplicate analyses for precision	Check the field sampling precision by calculating the RPD for field duplicate samples. Check the laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses. Ensure compliance with the precision goals listed in Worksheet #12 and 28. Precision will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Project action limits	Assess and document the impact on matrix interferences or sample dilutions performed because of the high concentration of one or more contaminant, on the other target compounds reported as undetected. Project action limit achievement will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Data quality assessment report	Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all the data qualifications. Present tabular qualified data and data qualifier codes and summarize data qualification outliers. Determine if the data met the measurement performance criteria and determine the impact of any deviations on the technical usability of the data. Result qualification will be documented in the in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation SAP QC sample documentation	Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within acceptance limits. QC sample completeness and assessment will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Analytical data deviations	Determine the impact of any deviation from sampling or analytical methods and laboratory SOP requirements and matrix interferences effect on the analytical results. Data deviations will be documented in the DVA workbook and Data Usability Summary Report in accordance with TCEQ TRRP-13.	Project chemist or data validators, Resolution Consultants	IIb	External

<table>
<tr><th>Data Review Input</th><th>Description</th><th>Responsible for Verification (name, organization)</th><th>Step I / IIa / IIb [1]</th><th>Internal / External</th></tr>
<tr><td>Validation
Project quantitation limits for sensitivity</td><td>Ensure that the project detection limits were achieved. Project quantitation limit achievement will be documented in the DVA workbook and in the Data Usability Summary Report in accordance with TCEQ TRRP-13</td><td>Project chemist or data validators, Resolution Consultants</td><td>IIb</td><td>External</td></tr>
<tr><td>Validation
Indoor air, sub-slab air, and ambient air</td><td>Assess VOC data against MPC identified in Worksheets #12, 19, 24, and 28. U.S. EPA National Functional Guidelines for Superfund Organic Methods Data Review, (August 2014) will be used as a guidance on applying qualifiers when MPC identified in Worksheets #12, 19, 24, and 28 are not met, including identifying when samples will be qualified estimated or rejected and when individual or all samples in a batch will be qualified.

As described in Worksheet #14, checklists will not be used for validation because it will be performed using a combination of electronic automated data review and data package review. All findings will be documented on the DVA workbook and in the data validation report.

All data validation finding will be documented in a Data Usability Summary Report in accordance with TCEQ TRRP-13.

The end use of HAPSITE data is screening level; therefore, data will not be validated.</td><td>Project chemist or data validators, Resolution Consultants</td><td>IIa/IIb</td><td>External</td></tr>
<tr><td>Validation
Data qualifiers</td><td>Qualifiers that will be applied during the data validation process are summarized below and, as indicated, results will be considered usable for interpretation. Use of rejected data will be decided by the project team.
<table>
<tr><th>Data Qualifier</th><th>Qualifier Definition</th><th>Interpret Result As a Detection?</th><th>Result Usable?</th><th>Potential Result Bias</th></tr>
<tr><td>no qualifier</td><td>Acceptable</td><td>Yes</td><td>Yes</td><td>None expected</td></tr>
<tr><td>J</td><td>Estimated</td><td>Yes</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>JH</td><td>Estimated and Biased High</td><td>Yes</td><td>Yes</td><td>High</td></tr>
<tr><td>JL</td><td>Estimated and Biased Low</td><td>Yes</td><td>Yes</td><td>Low</td></tr>
<tr><td>U</td><td>Undetected</td><td>No</td><td>Yes</td><td>None expected</td></tr>
<tr><td>UJ</td><td>Undetected and Estimated</td><td>No</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>UJL</td><td>Undetected and Estimated Biased Low</td><td>No</td><td>Yes</td><td>Low</td></tr>
<tr><td>UR</td><td>Undetected and Rejected</td><td>No</td><td>No</td><td>Unspecified</td></tr>
<tr><td>R</td><td>Rejected</td><td>No</td><td>No</td><td>Unspecified</td></tr>
</table></td><td>Project chemist or data validators, Resolution Consultants</td><td>IIa/IIb</td><td>External</td></tr>
</table>

Notes:

[1] IIa Compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
[1] IIb Comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]
[2] Internal or external in relation to the data generator.

SAP	=	Sampling and analysis plan
FTL	=	Field team leader
QC	=	Quality control
RPD	=	Relative percent difference
SOP	=	Standard operating procedure
VOC	=	Volatile organic compounds
U.S. EPA	=	United States Environmental Protection Agency
MPC	=	Measurement performance criteria
DVA	=	Data Validation Assistant
TCEQ	=	Texas Commission on Environmental Quality
TRRP-13	=	Texas Risk Reduction Program *Review and Reporting of Chemical of Concern (COC) Concentration Data under TRRP*, RG-366/TRRP-13, Revised May 2010

SAP WORKSHEET #37: USABILITY ASSESSMENT

(UFP-QAPP Manual Section 5.2.3)

Data Review

The usability of the data directly affects whether project objectives can be achieved and the following characteristics will be evaluated at a minimum. The results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these data characteristics:

- Completeness — Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct normal conditions. It is expected that 100% of the planned sampling points will be collected. The completeness goal for field measurements will be greater than 90%. Laboratory analysis for this project will have a completeness goal greater than 95% to account for unanticipated results that may be rejected during data validation. Completeness can be calculated using the following equation.

$$\%\,Completeness = \frac{No.\ of\ Valid\ Tests}{Total\ Tests\ Taken} x100$$

  The FTL, acting on behalf of the Project Team, will determine whether deviations from the scheduled sample collection or analyses occurred. If they have occurred and the Resolution Consultants TOM determines that the deviations compromise the ability to meet project objectives they will consult with the Navy RPM and other project team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

- Precision — Precision measures the reproducibility of measurements and methods, and is defined for qualitative data as a group of values' variability compared with its average value. To assess the precision of the measurement systems used in this project, field duplicates will be obtained and analyzed with the samples collected. Precision of laboratory analysis will be assessed by comparing the relative percent difference (RPD) of analytical results between matrix spike and matrix spike duplicates (or sample duplicates) and the measurement quality objectives will be those cited in Worksheets #12 and #28. The RPD will be calculated for each pair of duplicate analysis using the following equation:

$$RPD = \frac{(S - D)}{(S + D) / 2} x\ 100$$

Where:

S = sample result
D = duplicate result

The project chemist, acting on behalf of the Project Team, will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in Worksheets #12 and #28. This will also include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met or data have been flagged as estimated (J qualifier) limitations on the use of the data will be described in the project report.

- Accuracy — Accuracy is the degree to which a given result agrees with the true value. The accuracy of an entire measurement system is an indication of any bias that exists. Spiked sample results provide information needed to assess the accuracy of analyses. Specifically, surrogate spik and laboratory control sample (LCS) percent recoveries (%Rs) are used to assess accuracy. Every organic sample is spiked with known quantities of non-target surrogate compounds. If the calculated %Rs for the known spike concentrations are within defined control limits set by each method, the reported sample concentrations are considered accurate. The accuracy measurement quality objectives will be those cited in Worksheets #12 and #28. Accuracy is calculated using the following equation:

$$\%R = \frac{(SSR - SR)}{SA} x100$$

Where:

SSR = spike sample recovery
SR = sample recovery
SA = concentration of spike added

The project chemist, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates and LCSs against the goals identified in worksheets #24 and #28. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will be described in the project report.

- Representativeness — A project scientist, identified by the Resolution Consultants TOM and acting on behalf of the Project Team, will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and analyzed in accordance with this SAP, by reviewing spatial and temporal data variations, and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the project scientist indicates that a quantitative analysis is required.

- Comparability — The project chemist, acting on behalf of the Project Team, will determine whether the data generated under this project are sufficiently comparable to historical property data generated by different methods and for samples collected using different procedures and under different property conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless the project chemist indicates that such quantitative analysis is required.

- Sensitivity — The project chemist, acting on behalf of the Project Team, will determine whether project sensitivity goals listed in Worksheet #15 are achieved. The overall sensitivity and quantitation limits from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

After completion of the data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and the proportion of samples with detected and non-detected results. The Project Team members, identified by the Resolution Consultants TOM, will assess whether the data collectively support the attainment of project objectives. They will consider whether any missing or rejected data have

compromised the ability to make decisions or to make the decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated by other data.

Identify the personnel responsible for performing the usability assessment:

The Resolution Consultants TOM, project chemist, and FTL will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the Project Team. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face to face meeting or a teleconference depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). The project report will identify and describe the data usability limitations and suggest re-sampling or other corrective actions, if necessary. Graphical presentations of the data such as concentration tag maps will be generated as part of the overall data evaluation process.

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Appendix A
Field Standard Operating Procedures

Utility Clearance

Procedure 3-01

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials.

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 The procedure applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities.

1.4 The primary purpose of the procedure is to minimize the potential for damage to underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

1.5 If there are procedures, whether it be from Resolution Consultants, state, and/or federal, that are not addressed in this SOP and are applicable to utility clearance, those procedures should be added as an appendix to the project specific SAP.

1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 Field and subcontractor personnel shall adhere to a site-specific health and safety plan (HASP).

3.0 Terms and Definitions

3.1 **Utility**

For the proposes of this SOP, a utility is defined as a manmade underground line or conduit, cable, pipe, vault or tank that is, or was, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewage, product transfer lines, or underground storage tanks).

3.2 **As-Built Plans**

As-built plans are plans or blueprints depicting the locations of structures and associated utilities on a property.

3.3 **One-Call**

The Utility Notification Center is the one-call agency for nationwide call before you dig. The Utility Notification Center is open 24 hours a day, and accepts calls from anyone planning to dig. The phone number 811 is the designated call before you dig phone number that directly connects you to your local one-call center. Additional information can be found at www.call811.com.

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Calling before you dig ensures that any publicly owned underground lines will be marked so that you can dig around them safely. Having the utility lines marked not only prevents accidental damage to the lines, but prevents property damage and personal injuries that could result in breaking a line.

The following information will need to be provided when a call is placed to One-Call:

- Your name, phone number, company name (if applicable), and mailing address.
- What type or work is being done.
- Who the work is being done for.
- The county and city the work is taking place in.
- The address or the street where the work is taking place.
- Marking instructions, (specific instructions as to where the work is taking place).

Under normal circumstances it takes between 2 to 5 days from the time you call (not counting weekends or holidays) to have the underground lines marked. Because these laws vary from state to state, exactly how long it will take depends on where your worksite is located. You will be given an exact start time and date when your locate request is completed, which will comply with the laws in your area.

In the event of an emergency (any situation causing damage to life or property, or a service outage), lines can be marked sooner than the original given time if requested.

3.4 **Toning**

Toning is the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Typically, toning is conducted after identifying the general location of utilities and carefully examining all available site utility plans. Each location is marked according to the type of utility being identified. In addition, areas cleared by toning are flagged or staked to indicate that all identified utilities in a given area have been toned.

4.0 Training and Qualifications

4.1 The **Contract Task Order (CTO) Manager** is responsible for verifying that these utility locating procedures are performed prior to the initiation of active subsurface exploration.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all utility locating activities are performed in accordance with this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Equipment and supplies necessary for locating subsurface utilities will be provided by the subcontractor; however, the project **Field Manager/Field Personnel** will provide any additional equipment and supplies as needed as well as maintain information regarding the utility clearance activities in the field logbook.

6.0 Procedure

Proceed wtih the following steps where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, always exercise caution while conducting subsurface exploratory work.

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6.1 Prepare Preliminary Site Plan

- Prepare a preliminary, scaled site plan depicting the proposed exploratory locations as part of the project specific Sampling and Analysis Plan (SAP) or Work Plan. Include as many of the cultural and natural features as practical in this plan.

6.2 Review Background Information

- Search existing plan files to review the as-built plans to identify the known location of utilities at the site. Plot the locations of utilities identified onto a preliminary, scaled site plan. Inform the CTO Manager if utilities lie within close proximity to a proposed exploration or excavation location. The CTO Manager will determine if it is necessary to relocate proposed sampling or excavation locations.
- Include the utility location information gathered during previous investigations (e.g., remedial investigation or remedial site evaluation) in the project design documents for removal or remedial actions. In this manner, information regarding utility locations collected during implementation of a CTO can be shared with the subcontractor during implementation of a particular task order. In many instances, this will help to reduce the amount of additional geophysical surveying work the subcontractor may have to perform.
- Conduct interviews with onsite and facility personnel familiar with the site to obtain additional information regarding the known and suspected locations of underground utilities. In addition, if appropriate, contact shall be made with local utility companies to request their help in locating underground lines. Pencil in the dimensions, orientation, and depth of utilities, other than those identified on the as-built plans, at their approximate locations on the preliminary plans. Enter the type of utility, the personnel who provided the information, and the date the information was provided into the field log.
- During the pre-field work interviewing process, the interviewer will determine which site personnel should be notified in the event of an incident involving damage to existing utilities. Record this information in the field logbook with the corresponding telephone numbers and addresses.

6.3 Site Visit/Locate Utilities/Toning

- Prior to the initiation of field activities, the Field Task Manager or similarly qualified field personnel shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression. Compare notes of the actual site configuration to the preliminary site plan. Note deviations in the field logbook and on the preliminary site plan. Accurately locate or survey and clearly mark with stakes, pins, flags, paint, or other suitable devices all areas where subsurface exploration is proposed. These areas shall correspond with the locations drawn on the preliminary site plan.
- Following the initial site visit by the Field Task Manager, a trained utility locating subcontractor will locate, identify, and tone all utilities depicted on the preliminary site plan. The Field Task Manager or similarly qualified field personnel shall visit the site and identify the areas of subsurface disturbance with white spray paint, chalk, white pin flags or some other easily identifiable marking. The utility locator should utilize appropriate sensing equipment to attempt to locate utilities that might not have appeared on the as-built plans. At a minimum, the utility subcontractor should utilize a metal detector and/or magnetometer; however, it is important to consider the possibility that non-metallic utilities or tanks might be present at the site. Use other appropriate surface geophysical methods such as Ground Penetrating Radar, Radiodetection, etc. as appropriate. Clear proposed exploration areas of all utilities in the immediate area where subsurface exploration is proposed. Clearly tone all anomalous areas. Clearly identify all toned areas on the preliminary site plan. All utilities near the area of subsurface disturbance should also be marked out by the utility subcontractor using the universal colors for subsurface utilities (i.e., red – electric; blue – water; green – sewer; yellow – gas; etc.). After toning the site and plotting all known or suspected buried utilities on the preliminary site plan, the utility locator shall provide the Field Task Manager with a copy of the completed preliminary

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site plan. Alternatively, the Field Task Manager or designee shall document the results of the survey on the preliminary site plan.

- Report to the Field Task Manager anomalous areas detected and toned that are in close proximity to the exploration or excavation areas. The Field Task Manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate the proposed exploration or excavation areas. If this is required, the Field Task Manager or designee shall relocate them and clearly mark them using the methods described above. Completely remove the markings at the prior location. Plot the new locations on the site plan and delete the prior locations from the plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to dig by hand or use techniques such as air knife to determine the location of the utilities.

6.4 **Prepare Site Plan**

- Prior to the initiation of field activities, draft a final site plan that indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Provide copies of this site plan to the Navy Technical Representative (NTR), the CTO Manager, and the subcontractor who is to conduct the subsurface exploration/excavation work. Review the site plan with the NTR to verify its accuracy prior to initiating subsurface sampling activities.

7.0 Quality Control and Assurance

7.1 Utility locating must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

8.1 A bound field logbook will be kept detailing all activities conducted during the utility locating procedure.

8.2 The logbook will describe any changes and modifications made to the original exploration plan. The trained utility locator shall prepare a report and keep it in the project file. Also, a copy of the final site plan will be kept in the project file.

9.0 Attachments or References

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Author	Reviewer	Revisions (Technical or Editorial)
Caryn DeJesus Senior Scientist	Bob Shoemaker Senior Scientist	Rev 0 – Initial Issue (June 2012)

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Logbooks

Procedure 3-02

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the activities and responsibilities pertaining to the identification, use, and control of logbooks and associated field data records.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 In order to keep the logbook clean, store it in a clean location and use it only when outer gloves used for PPE have been removed.

3.0 Terms and Definitions

3.1 **Logbook**

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 **Data Form**

A data form is a predetermined format utilized for recording field data that may become, by reference, a part of the logbook (e.g., soil boring logs, trenching logs, surface soil sampling logs, groundwater sample logs, and well construction logs are data forms).

4.0 Training and Qualifications

4.1 The **Contract Task Order (CTO) Manager** or **designee** is responsible for determining which team members shall record information in field logbooks and for obtaining and maintaining control of the required logbooks. The **CTO Manager** shall review the field logbook on at least a monthly basis. The **CTO Manager** or **designee** is responsible for reviewing logbook entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.

4.2 A knowledgeable individual such as the **Field Manager**, **CTO Manager**, or **Program Quality Manager** shall perform a technical review of each logbook at a frequency commensurate with the level of activity (weekly is suggested, or, at a minimum, monthly). Document these reviews by the dated signature of the reviewer on the last page or page immediately following the material reviewed.

4.3 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.4 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures and that the logbook is completed properly and daily. The **Field Manager** is also responsible for submitting copies to the **CTO Manager**, who is responsible for filing them and submitting a copy (if required by the CTO Statement of Work).

4.5 The **logbook user** is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The **logbook user** is also responsible for safeguarding the logbook while having custody of it.

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4.6 All **field personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Field logbooks shall be bound field notebooks with water-repellent pages.

5.2 Pens shall have indelible black ink.

6.0 Procedure

6.1 The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Store the logbook in a clean location and use it only when outer gloves used for personal protective equipment (PPE) have been removed.

6.2 Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, include names of all samples collected in the logbook even if they are recorded elsewhere.

6.3 Enter field descriptions and observations into the logbook, as described in Attachment 1, using indelible black ink.

6.4 Typical information to be entered includes the following:

- Dates (month/day/year) and times (military) of all on-site activities and entries made in logbooks/forms;
- Site name and description;
- Site location by longitude and latitude, if known;
- Weather conditions, including temperature and relative humidity;
- Fieldwork documentation, including site entry and exit times;
- Descriptions of, and rationale for, approved deviations from the work plan (WP) or field sampling plan;
- Field instrumentation readings;
- Names, job functions, and organizational affiliations of on-site personnel;
- Photograph references;
- Site sketches and diagrams made on site;
- Identification and description of sample morphology, collection locations, and sample numbers;
- Sample collection information, including dates (month/day/year) and times (military) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain-of-custody (COC) information such as sample identification numbers cross-referenced to COC sample numbers;
- Sample naming convention;
- Field quality control (QC) sample information;
- Site observations, field descriptions, equipment used, and field activities accomplished to reconstruct field operations;

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- Meeting information;
- Important times and dates of telephone conversations, correspondence, or deliverables;
- Field calculations;
- PPE level;
- Calibration records;
- Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number);
- Equipment decontamination procedures and effectiveness;
- Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested; and
- User signatures.

6.5 The logbook shall reference data maintained in other logs, forms, etc. Correct entry errors by drawing a single line through the incorrect entry, then initialing and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.

6.6 At least at the end of each day, the person making the entry shall sign or initial each entry or group of entries.

6.7 Enter logbook page numbers on each page to facilitate identification of photocopies.

6.8 If a person's initials are used for identification, or if uncommon acronyms are used, identify these on a page at the beginning of the logbook.

6.9 At least weekly and preferably daily, the **preparer** shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

7.0 Quality Control and Assurance

7.1 Review per Section 4.2 shall be recorded.

8.0 Records, Data Analysis, Calculations

8.1 Retain the field logbook as a permanent project record. If a particular CTO requires submittal of photocopies of logbooks, perform this as required.

8.2 Deviations from this procedure shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

9.0 Attachments or References

9.1 Attachment 1 – Description of Logbook Entries

9.2 Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

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Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

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Attachment 1
Description of Logbook Entries

Logbook entries shall be consistent with Section A.1.4 *Field Documentation SOPs* of the UFP-QAPP Manual (DoD 2005) and contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

Name of Activity	For example, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing.
Task Team Members and Equipment	Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information.
Activity Location	Indicate location of sampling area as indicated in the field sampling plan.
Weather	Indicate general weather and precipitation conditions.
Level of PPE	Record the level of PPE (e.g., Level D).
Methods	Indicate method or procedure number employed for the activity.
Sample Numbers	Indicate the unique numbers associated with the physical samples. Identify QC samples.
Sample Type and Volume	Indicate the medium, container type, preservative, and the volume for each sample.
Time and Date	Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year.
Analyses	Indicate the appropriate code for analyses to be performed on each sample, as specified in the WP.
Field Measurements	Indicate measurements and field instrument readings taken during the activity.
Chain of Custody and Distribution	Indicate chain-of-custody for each sample collected and indicate to whom the samples are transferred and the destination.
References	If appropriate, indicate references to other logs or forms, drawings, or photographs employed in the activity.
Narrative (including time and location)	Create a factual, chronological record of the team's activities throughout the day including the time and location of each activity. Include descriptions of general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact the work schedule, request information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself. It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate.
Recorded by	Include the signature of the individual responsible for the entries contained in the logbook and referenced forms.
Checked by	Include the signature of the individual who performs the review of the completed entries.

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Sample Labeling and Chain of Custody Procedures

Procedure 3-03A

1.0 Purpose and Scope

1.1 The purpose of this standard operating procedure is to establish standard protocols for all field personnel for use in maintaining field and sampling activity records, labeling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

Not applicable

3.0 Definitions

3.1 **Logbook**

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person responsible for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 **Chain-of-Custody**

Chain-of-custody (COC) is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

4.0 Training and Qualifications

4.1 The **CTO Manager**, or designee, is responsible for determining which team members shall record information in the field logbook and for checking sample logbooks and COC forms to ensure compliance with these procedures. The **CTO Manager**, or designee, shall review COC forms at the completion of each sampling event.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all field equipment is decontaminated according to this procedure.

4.4 The **Project Chemist**, or designee, is responsible for verifying that the COC/analytical request forms have been completed properly and match the sampling and analytical plan. The **Project Chemist**, or designee, is responsible for notifying the laboratory, data managers, and data validators in writing if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with the laboratory and must be made in accordance with a respective contract.

4.5 All **Field Personnel** are are responsible for recording pertinent data onto the COC forms to satisfy project requirements and for attesting to the accuracy of the entries by dated signature.

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5.0 Procedure

This procedure provides standards for labeling the samples, documenting sample custody, and completing COC/analytical request forms. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

5.1 Sample Labeling

Affix a waterproof sample label with adhesive backing to each individual sample container. Record the following information with a waterproof marker on each label:

- Project name or number (optional)
- COC sample number
- Date and time of collection
- Sampler's initials
- Matrix (optional)
- Sample preservatives (if applicable)
- Analysis to be performed on sample (This shall be identified by the method number or name identified in the subcontract with the laboratory)

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels.

5.2 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. A description of sample custody procedures is provided below.

Sample Collection Custody Procedures

According to the EPA guidelines, a sample is considered to be in custody if one of the following conditions is met:

- It is in one's actual physical possession or view
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal)
- It is retained in a secured area with restricted access
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal

Place custody seals on shipping coolers (and sample jars, if required) if the cooler/container is to be removed from the sampler's custody. Place a minimum of two custody seals in such a manner that they must be broken to open the containers or coolers. Label the custody seals with the following information:

- Sampler's name or initials
- Date and time that the sample/cooler was sealed

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment 1.

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Field personnel shall also log individual samples onto COC forms (carbon copy or computer generated) when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 0, indicating sample identification number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The samplers will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the sampler and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying carbon copy COC forms, and the individual relinquishing the samples shall retain a copy of each form. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the coolers. The laboratory shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. An example COC form is provided in Attachment 2.

5.3 Completing COC/Analytical Request Forms

COC form/analytical request form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment 2 is an example of a completed COC/analytical request form that may be used by field personnel, with box numbers identified and discussed in text below. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Each record on the form (Attachment 2) is identified with a bold number corresponding to the instructions given below.

1. Record the project name, site location.
2. Record the site location, including the state.
3. Record the Contract Task Order number
4. Record the Resolution Consultants Task Order Manager
5. Record the sampler/site phone or cell number (if applicable).
6. Record the laboratory name where the samples were sent.
7. Record the requested turnaround time, in days. If a specific turnaround time is required to meet project objectives, but was not indicated on the laboratory service request form submitted to the purchasing department, the sampler, project manager, or site manager should contact the purchasing department so the laboratory contract can be modified.
8. Record the COC number that is defined by the sampler and should be unique throughout the project's history. An example would be to use the sampler's initials followed by the data. If multiple custodies are generated on a given day, use a unique sequential identifier. Example: CRC040105A, CRC040105B
9. Record the purchase order number provided by the purchasing department.
10. Record the page and total number of COC forms used in a shipment.
11. Record the project, and phase applicable to the sampling task.
12. Record the two-character code corresponding to the *chemical* preservation type, which is found on the bottom of the COC form. If no chemical preservation was added to the sample, the field should be left blank. Temperature preservation need not be documented at this location, but will be indicated elsewhere on the COC form (see 33).

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13. List the requested analysis. Whenever possible, list the corresponding analytical method. (e.g., VOCs, 8260).

14. For Lab identification use only.

15. Record the full *unique* sample identification as detailed in the Site's Sampling and Analysis Plan.

16. Record the location identification, which is a shortened ID used for presentation and mapping, as detailed in the Site's Sampling and Analysis Plan.

17. Record the sample date using the format mm/dd/yy.

18. Record the sample time using the military format of hhmm.

19. Record the matrix code of the sample, which is located at the bottom of the COC form. The matrix code is a crucial element of the Navy's data management system. For simplicity, only typical matrix codes are listed on the bottom COC form, but below is a complete listing of all applicable Navy matrix codes:

Table 1
Navy Matrix Codes

Matrix Code	Matrix Code Description	Matrix Code	Matrix Code Description
AA	Ambient air	RK	Rock
AC	Composite air sample	SB	Bentonite
AD	Air - Drilling	SBS	Sub-surface soil (> 6")
AIN	Integrated air sample (under sample form of gas)	SC	Cement/Concrete
AQ	Air quality control matrix	SD	Drill cuttings — solid matrix
AQS	Aqueous	SE	Sediment
ASB	Asbestos	SEEP	SEEP
ASBF	Asbestos-Fibrous	SF	Filter sand pack
ASBNF	Asbestos-Non-Fibrous	SJ	Sand
AVE	Air-Vapor extraction, effluent	SK	Asphalt
AX	Air sample from unknown origin	SL	Sludge
BK	Brick	SM	Water filter (solid material used to filter water)
BS	Brackish sediment	SN	Miscellaneous solid/building materials
CA	Cinder ash	SO	Soil
CK	Caulk	SP	Casing (PVC, stainless steel, cast iron, iron pipe
CN	Container	SQ	Soil/Solid quality control matrix
CR	Carbon (usually for a remediation system)	SS	Scrapings
DF	Dust/Fallout	SSD	Subsurface sediment
DR	Debris/rubble	STKG	Stack gas
DS	Storm drain sediment	STPM	Stripper Tower Packing Media
DT	Trapped debris	SU	Surface soil (less than 6 inches)
EF	Emissions flux	SW	Swab or wipe
EW	Elutriate water	SZ	Wood
FB	Fibers	TA	Animal tissue
FL	Forest litter	TP	Plant tissue
GE	Soil gas effluent — stack gas (from system)	TQ	Tissue QC
GI	Soil gas influent (into system)	TX	Tissue
GL	Headspace of liquid sample	UNK	Unknown
GQ	Gaseous or Headspace QC	W	Water (not groundwater, unspecified)
GR	Gravel	WA	Drill cuttings - aqueous mix
GS	Soil gas	WB	Brackish Water

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Table 1
Navy Matrix Codes

Matrix Code	Matrix Code Description	Matrix Code	Matrix Code Description
GT	Grit	WC	Drilling water (used for well construction)
IC	IDW Concrete	WD	Well development water
IDD	IDW Solid	WF	Freshwater (not groundwater)
IDS	IDW soil	WG	Ground water
IDW	IDW Water	WH	Equipment wash water
IW	Interstitial water	WI	Ground water influent (into system)
LA	Aqueous phase of a multiphase liquid/soil	WL	Leachate
LF	Product (floating or free)	WM	Marine water
LQ	Organic liquid quality control matrix	WN	Pore water
MA	Mastic	WO	Ocean water
MO	Mortar	WP	Drinking water
MR	Marine sediment	WQ	Water for QC samples
MS	Metal shavings	WR	Ground water effluent (from system)
NS	Near-surface soil	WS	Surface water
PA	Paper	WT	Composite groundwater sample
PC	Paint Chips	WU	Storm water
PP	Precipitate	WW	Waste water
RE	Residue		

Field QC blanks will require matrix codes that identify the type of blank associated with parent sample. Aqueous field QC blanks are not automatically identified with a matrix code of "WQ," indicating a water quality control blank; they are only identified with a matrix code of "WQ" if the associated samples are also aqueous. Trip blanks, field blanks, and equipment rinsate blanks collected in association with ***soil*** samples will be identified with a matrix code of "SQ," even though the actual matrix is aqueous, because the blanks were collected to assess potential contamination imparted during decontamination activities or transport of ***soil*** samples.

20. Record the sample type code, which is located at the bottom of the COC form. The sample type is a crucial element of the EQuIS data management system. For simplicity, only typical sample type codes are listed on the bottom of the COC form, but below is a list of all applicable Navy field sample type codes:

Table 2
Navy Sample Type Codes

Sample Type Code	Sample Type Code Description
AB	Ambient condition blank
BIOCON	Bioassay control sample
BS	Blank spike
BSD	Blank spike duplicate
EB	Equipment blank
EBD	Equipment blank/rinsate duplicate
FB	Field blank
FD	Field duplicate
FS	Field spike
IDW	Purge and rinsate water
LB	Lab Blank

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Table 2
Navy Sample Type Codes

Sample Type Code	Sample Type Code Description
LR	Lab Replicate
MB	Material blank
MIS	Multi-Incremental Sample
MS	Matrix spike
N	Normal (Regular)
PE	Performance evaluation
PURGE	Purge water sample
RD	Regulatory duplicate
SB	Source blank
SBD	Source blank duplicate
SCREEN	Screening Sample
SD	Matrix spike duplicate
SPLIT	Sample split
SRM	Standard reference material
TB	Trip Blank
TBD	Trip blank duplicate
TBR	Trip blank replicate

Field duplicate samples — Field duplicates will be identified using the format detailed in the Site's Sampling and Analysis Plan. However, field duplicates will also be differentiated from the parent sample on the chain-of-custody form. The parent sample will have a sample type code of "N," for normal environmental sample; while its duplicate will have a sample type code of "FD."

21. Record whether the sample is field filtered with a "Y" or not field filtered with an "N." If a project requires collecting samples for both total and dissolved constituents, the same sample and location ID is used for both (see 15 and 16); however, the sampler will indicate whether the sample is field filtered at this location on the COC form. This field must always be filled out; even when soil samples are collected (where "N" appropriately applies, in most cases).

22. Record the total number of containers that are submitted for all of the tests. This must add up to the total number of containers listed for each individual test in 23.

23. Record the number of containers for each test. Do not use Xs, rather indicate the number of containers submitted for each test listed in 14. For example, Sample 010MW007002 requires analysis for VOCs (8260), and SVOCs (8270). Record 3 under the VOC analysis and 2 under the SVOC (assuming 3 containers were submitted for VOCs and 2 were submitted for SVOCs). The total number of containers in this example is 5, which should be the total number of containers listed in 22. Extra containers submitted for matrix spike/matrix spike duplicates (MS/MSDs) will be appropriately recorded.

24. Indicate if extra sample volume was included for MS/MSD analysis using an "X." Samples to be used for MS/MSDs will use the same sample ID and location ID (see 15 and 16), but will be collected in triplicate, particularly for liquid samples, to ensure the analytical laboratory receives sufficient volume for the analyses.

25. Indicate if the samples should be held by the laboratory for future testing using an "X."

26. Record any field comments.

27. Reserved for laboratory comments.

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28. Indicate the total number of coolers in each shipment. *Note*: When multiple coolers are submitted, each should contain a COC form.

29. Signature(s) of the person(s) relinquishing sample custody.

30. Signature(s) of the person(s) receiving sample custody.

31. Indicate whether the samples are iced, by checking the appropriate response.

32. Indicate the method of shipment (e.g., FedEx, hand-delivered, laboratory courier).

33. Record the airbill number when a commercial courier is used. This is particularly important when multiple coolers are sent in the same shipment or when the laboratory is sent the COC form in advance of receiving samples because it aids in tracking lost coolers.

34. Record the date the coolers were shipped.

COC forms tailored to each CTO can be drafted and printed onto multiple forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; turnaround time; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, place all volatile organic analyte vials into one cooler in order to reduce the number of trip blanks. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

6.0 Records

The COC/analytical request form shall be faxed or emailed approximately daily to the Project Chemist, or designee for verification of accuracy. Following the completion of sampling activities, the sample logbook and COC forms will be transmitted to the CTO Manager for storage in project files. The original COC/analytical request form shall be submitted by the laboratory along with the data delivered. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

7.0 References and Attachments

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf.

Attachment 1: Chain-of-Custody Seal

Attachment 2: Generic Chain-of-Custody/Analytical Request Form

Author	Reviewer	Revisions (Technical or Editorial)
Tina Cantwell QA Officer	Ben Brantley Project Manager	Rev 0 — Initial Issue

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Attachment 1
Chain-of-Custody Seal

EXAMPLE CHAIN-OF-CUSTODY SEAL

[LABORATORY]	SAMPLE NO.	DATE	SEAL BROKEN BY
	SIGNATURE		DATE
	PRINT NAME AND TITLE *(Inspector, Analyst or Technician*		

Attachment 2
Example Chain-of-Custody / Analytical Request Form

RESOLUTION CONSULTANTS

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD

COC No. 7 | Page of 9

Project Name: 1 | PO No. 8 | Project No. 10

Site Location: 2 | Lab Name 11

Contract Task Order No. 3

Sampler/Site Phone# 4

Send Results To: 5

Data Shipping Address: 6

Sample Analysis Requested (Enter number of containers for each test)

Lab ID	Sample ID (sys_samp_code)	Location ID (sys_loc_code)	Date (mm/dd/yy)	Time (Military) (hhmm)	Matrix Code (1)	Sample Type (2)	Field Filtered (Y/N)	Total No. of Containers	12										Extra Volumes for MS/MSD	HOLD
									13											
14	15	16	17	18	19	20	21	22	23										24	25

Turnaround Time(specify): 26 Final _____ days Email (if applicable) _____ days

Deliverable(check): 27 Level 2_____ Level 3_____ Full/Level 4_____ TX TRRP-13_____

Field Comments: 28

Lab Comments: 29

Sample Shipment and Delivery Details

Number of coolers in shipment: 30

Relinquished by (signature)	Date	Time	Received by (signature)	Date	Time
1 31			1 32		
2			2		
3			3		

Samples Iced?(check) 33 Yes___ No___

Method of Shipment: 34

Airbill No: 35

Date Shipped: 36

(1) **AA**=Ambient air, **AQ**=Air quality control, **ASB**=Asbestos, **CK**=Caulk, **DS**=Storm drain sediment, **GS**=Soil gas, **IC**=IDW Concrete, **IDD**=IDW Solid, IDS=IDW soil, **IDW**=IDW Water, **LF**=Free Product, **MA**=Mastic, **PC**=Paint Chips, **SC**=Cement/Concrete, **SE**=Sediment, **SL**=Sludge, **SO**=Soil, **SQ**=Soil/Solid quality control, **SSD**=Subsurface sediment, **SU**=Surface soil (<6 in), **SW**=Swab or wipe, **TA**=Animal tissue, **TP**=Plant tissue, **TQ**=Tissue quality control, **WG**=Ground water, **WL**=Leachate, **WO**=Ocean water, **WP**=Drinking water, **WQ**=Water quality control, **WR**=Ground water effluent, **WS**=Surface water, **WU**=Storm water, **WW**=Waste water

(2) **Sample Type: AB**=Ambient Blk, **EB**=Equipment Blk, **FB**=Field Blk, **FD**=Field Duplicate Sample, **IDW**=Investigative-Derived Waste, **MIS**=Incremental Sampling Methodology, **N**=Normal Environmental Sample, **PE**=Performance Eval., **TB**=Trip Blk

(3) **Preservative added: HA**=Hydrochloric Acid, **NI**=Nitric Acid, **SH**=Sodium Hydroxide, **SA**=Sulfuric Acid, **AA**=Ascorbic Acid, **HX**=Hexane, **ME**=Methanol, **SB**=sodium bisulfate, **ST**=Sodium Thiosulfate, If **NO preservative** added leave blank

Sample Handling, Storage, and Shipping of Low Level Environmental Samples

Procedure 3-04A

1.0 Purpose and Scope

1.1 This Standard Operating Procedure (SOP) sets forth the methods for use by personnel engaged in handling, storing, and transporting low level environmental samples.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 To avoid lifting injuries associated with heavy coolers, use the large muscles of the legs, not the back. Use dollies if possible.

2.2 When using tools for cutting purposes, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.

2.3 Wear proper gloves, such as blue nitrile and latex, as defined in the site-specific project health and safety plan, when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

3.0 Terms and Definitions

DOT — Department of Transportation

4.0 Training and Qualifications

4.1 The **Contract Task Order** (CTO) **Manager** is responsible for verifying that these procedures are performed prior to the initiation of active subsurface exploration.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that sample handling, storage, and shipping are performed in accordance with this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Procedures

5.1 Handling and Packaging

Environmental samples should be packaged prior to shipment using the following procedures:

1. Allow sufficient headspace in all bottles (except volatile organic analysis containers with a septum seal) to compensate for any pressure and temperature changes (approximately 1 percent of the volume of the container).

2. Ensure that the lids on all bottles are tight (will not leak).

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3. Glass bottles should be wrapped in bubble wrap — preferably sealable bubble wrap sample bags, if available. Place bottles in separate and appropriately-sized polyethylene bags and seal the bags.

4. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape inside and outside. Line the cooler with a large heavy-duty plastic bag.

5. Place cushioning/absorbent material in the bottom of the cooler, if available, and then place the containers in the cooler with sufficient space to allow for the addition of cushioning between the containers.

6. Put "blue ice" (or ice that has been "double bagged" in heavy-duty polyethylene bags and properly sealed) on top of and/or between the containers. Fill all remaining space between the containers with bubble wrap or other suitable absorbent material.

7. Securely fasten the top of the large garbage bag with packaging tape.

8. Place the completed Chain-of-Custody (COC) Record into a sealed plastic bag, and tape the bag to the inner side of the cooler lid.

9. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. COC seals should be affixed to opposing sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

5.2 Shipping

Follow all appropriate DOT regulations (e.g., 49 Code of Federal Regulations, Parts 171-179) for shipment of air, soil, water, and other samples. Elements of these procedures are summarized in the following subsections.

5.2.1 Non-hazardous Materials Shipment

If the samples are suspected to be non-hazardous based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as non-hazardous.

When a cooler is ready for shipment to the laboratory, prepare standard air bill paperwork for shipment of the samples to the laboratory. Write the shippers tracking/airbill number on the COC form. Place two copies of the COC form inside a self-sealing bag and tape it to the inside of the cooler. Seal the cooler with waterproof tape and label it with “Fragile,” “This-End-Up” (or directional arrows pointing up), or other appropriate notices. Affix a label stating the destination (laboratory address) to each cooler. Personnel should be aware of carrier weight or other policy restrictions.

5.2.2 Hazardous Materials Shipment

Shipment of Hazardous Material is not covered in this SOP; all samples handled under this SOP are anticipated to be non-hazardous or not dangerous goods. The CTO Manager, or designee, is responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample is collected of a material that is listed in the Dangerous Goods List, Section 4.2, of International Air Transport Authority (IATA), then that sample must be identified, packaged, marked,

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labeled, and shipped according to the instructions given for that material. If the composition of the collected sample(s) is unknown, and the project leader knows or suspects that it is a regulated material (dangerous goods), the sample may not be offered for air transport. If the composition and properties of a waste sample or a highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

6.0 Records

Maintain all copies of chain of custodies and air bills with the project file. .

7.0 Attachments or References

International Air Transport Authority (IATA). Dangerous Goods Regulations

http://www.iata.org/whatwedo/cargo/dangerous_goods/Documents/DGR52-significant-changes.pdf

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Ben Brantley	Tina Cantwell	Rev 0 — Initial Issue
Program Manager	QA Officer	

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Standard Operating Procedure SOP-3-05-TX
Investigation-Derived Waste Management for Texas

1.0 PURPOSE

This standard operating procedure (SOP) describes the activities regarding the management of investigation-derived waste (IDW) at project sites in the state of Texas. The purpose of this procedure is to provide guidance for the minimization, handling, labeling, temporary storage, inventory, classification, and disposal of IDW. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of remedial actions. If there are procedures whether it is from Resolution Consultants, state and/or federal, that are not addressed in this SOP and are applicable to IDW, then those procedures may be added as an appendix to the project-specific Sampling and Analysis Plan.

2.0 SCOPE

This procedure shall serve as management-approved professional guidance for and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager.

This procedure was developed to serve as management-approved professional guidance for the management of IDW in the state of Texas. It focuses on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure. This procedure was developed based on the rules promulgated in Title 30, Texas Administrative Code (TAC), Chapter 335, and Title 40 Code of Federal Regulations (CFR), Subchapter I.

3.0 DEFINITIONS

3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

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3.2 Hazardous Waste

A waste is defined as hazardous by the U.S. Environmental Protection Agency (USEPA) if it is one of over 400 wastes listed in the CFR as hazardous or if it exhibits one or more of four hazardous characteristics; i.e., it is ignitable, corrosive, reactive or toxic. (40 CFR 261.3)

3.3 Class 1 Industrial Waste

A waste that, because of its concentration or physical or chemical characteristics, is toxic; corrosive; flammable; a strong sensitizer or irritant; a generator of sudden pressure by decomposition, heat or other means; or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored , transported, disposed of or otherwise managed. (30 TAC 335.1[14])

A waste that contains specific constituents which equal or exceed the levels listed in 335.521(a)(1) is a Class 1 waste. Generators should document that a waste with significant concentrations of Table 2 constituents is not Class 1 (335.521 Table 2). A waste is classified as Class 1 if a liquid has a flash point of less than 65.6 degrees Celsius (150 degrees Fahrenheit), or is a solid or semi-solid capable of causing fires through friction, or retained heat from process, or ignited readily and burns vigorously and persistently, creating serious hazard. A waste is classified as Class 1 if it is a semi-solid or solid which when mixed with distilled water produces a solution with pH less than 2 or greater than 12.5; if total recoverable cyanides are greater than 20 parts per million; if absence of analytical data and/or process knowledge which proves waste is Class 2 or Class 3; if identified as Class 1 in 335.508 (Specific Wastes); or if not a hazardous waste and generator chooses to classify as Class 1.

3.4 Class 2 Industrial Waste

Any waste that cannot be described as a hazardous waste or as a non-hazardous Class 1 or Class 3 waste. (30 TAC 335.1[15]) A generator can choose not to classify waste as Class 3.

3.5 Class 3 Industrial Waste

A waste that is inert and essentially insoluble, usually including materials such as rock, brick, glass, dirt, certain plastics, rubber, and similar materials that are not readily decomposable. (30 TAC 335.1[16])

4.0 RESPONSIBILITIES

The CTO Manager is responsible for identifying instances of non-compliance with this procedure and ensuring that IDW is properly handled and managed in accordance with this SOP and any site-specific or project-specific planning documents. The CTO Manager is responsible for ensuring that all personnel involved in IDW management shall have the appropriate education, experience, and training to perform their assigned tasks. The QA Manager or CTO Manager is responsible for ensuring overall compliance with this procedure. The Field Manager is responsible for ensuring that all IDW is managed according to this procedure. Field personnel are responsible for the implementation of this procedure and will be accountable for the comprehension and implementation of this SOP during all field activities, as well as obtaining the appropriate field logbooks, forms, labels, records and equipment needed to complete the field activities.

5.0 PROCEDURE

5.1 Equipment/Supplies

The equipment and supplies required for implementation of this SOP include the following:

- Containers for waste (e.g., U.S. Department of Transportation (DOT) approved 55-gallon open or closed top drums) and material to cover waste to protect it from weather (e.g., plastic covering)
- Equipment (i.e., pumps, generators, water/interface level indicators, safety monitoring equipment, drum sampling equipment, wrenches to secure drum bungs or lids)
- Hazardous/non-hazardous waste drum labels (weatherproof)
- Permanent marking pens
- Inventory forms for project file
- Plastic garbage bags, zip lock storage bags, rolls of plastic sheeting
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the site-specific Site Health and Safety Plan (SHSP).

5.2 Drum Handling

IDW shall be containerized using DOT-approved drums. The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids or bungs (i.e., United Nations Code 1A2 or 1H2). Typically, 55-gallon drums are used; however, smaller drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums.

Recycled drums should not be used for hazardous waste, polychlorinated biphenyl compounds or other regulated shipments. For sites where large quantities of liquids will be generated, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system or offsite disposal versus longer-term drum storage.

When DOT-approved drums with removable lids are used, verify the integrity of any foam or rubber sealing ring located on the underside the drum lids prior to sealing drums containing IDW liquids. If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.

To prepare IDW drums for labeling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum and segregate the paper towel or rag used to remove the material with visibly soiled PPE and disposable sampling equipment. Label all IDW drums and place them on pallets or within secondary containment in the designated storage area.

5.3 Labeling

Containers used to store IDW must be properly labeled. Two general conditions exist: 1) waste characteristics are known to be either hazardous or nonhazardous from previous studies or onsite data; or 2) waste characteristics are unknown until additional data are obtained.

For situations where the waste characteristics are known, the waste containers should be packaged and labeled in accordance with appropriate state and federal regulations that may govern the labeling of waste.

The following information shall be placed on all non-hazardous waste labels:

- Description and source of waste (i.e., purge water from MW-1, soil cuttings from HA-2)
- Contact information, including name and telephone number
- Date when the container becomes full

The following information shall be placed on all hazardous waste labels:

- Description and source of waste (i.e., purge water from MW-1, soil cuttings from HA-2)
- Generator information (i.e., name, address, contact telephone number)
- USEPA identification number and Texas Solid Waste Registration number (supplied by onsite client representative)
- Date when the container becomes full

When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" and the following information included on the label:

- Description and source of waste (i.e., purge water from MW-1, soil cuttings from HA-2)
- Contact information, including name and telephone number
- Date when the container becomes full

Once the waste has been characterized, the label should be changed as appropriate for a non-hazardous or hazardous waste.

Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering. However, when multiple containers are accumulated together, it also may be helpful to include labels on the top of the containers to facilitate organization and disposal.

Each container of waste generated shall be recorded in the logbook used by the person responsible for labeling the waste. After the waste is disposed, either by transportation offsite or disposal onsite in an approved disposal area, an appropriate record shall be made in the same logbook to document proper disposition of IDW.

5.4 Types of Site Investigation Waste

Several types of waste are generated during site investigations that may require special handling. These include soil and drilling fluids, groundwater, decontamination water, and used PPE, as discussed further in the following subsections.

5.4.1 Soil and Drilling Fluids

Soil cuttings from boreholes can be shoveled back into the borehole after drilling is complete, if feasible. If all of the soil cuttings cannot be returned to the borehole, soil cutting should be placed in an open-top 55-gallon drum. Drilling mud generated during investigation activities shall be collected in 55-gallon drums as well. Containers must remain closed at all times unless waste is being added. The containers shall be labeled in accordance with this SOP. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

5.4.2 Groundwater or Decontamination Water

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Wastewater generated during decontamination of field and sampling equipment will be collected and containerized in drums. Using bung style drums helps prevent leaks when drums are moved. Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labeled in accordance with this SOP.

5.4.3 Personal Protective Equipment

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags. If the solid or liquid waste that was being handled is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as Texas Class 2 non-hazardous waste in municipal sanitary landfill. Trash that is generated as part of field activities may be disposed in a municipal sanitary landfill as long as the trash was not exposed to hazardous media.

5.5 Waste Accumulation Onsite

IDW generated during investigation activities may be subject to storage times dictated by the site's hazardous waste generator status. Hazardous waste can either be stored in the designated waste management unit either 90 days (large quantity generator), 180 days (small quantity generator), or 12 months (conditionally exempt small quantity generator). This information can be obtained from the site or client point of contact. Until final offsite disposal, such containers should be inventoried, stored as securely as possible, and inspected weekly, as a general good practice.

The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labeling of waste
- Secondary containment to contain spills
- Spill containment equipment must be available
- Fire extinguisher
- Adequate aisle space for unobstructed movement of personnel

More requirements may be enforced by the client or site point of contact based on generator status. Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

5.6 Waste Disposal

IDW will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.

All waste generated during field activities will be stored, transported, and disposed according to applicable state, federal, and local regulations. In Texas, IDW will be classified as hazardous, Industrial Class 1, Industrial Class 2, or Industrial Class 3 based on the waste

determination process. Hazardous waste must be handled and disposed offsite at an approved hazardous waste disposal facility. Class 1 non-hazardous waste must be disposed at a facility permitted to accept Class 1 waste. Class 2 waste can be disposed at a municipal landfill, Class 1 landfill, or hazardous waste facility. All wastes classified as industrial Class 3 or general rubbish will be disposed at a municipal sanitary landfill, or in the case of construction and demolition (C&D) debris, must be disposed of at a facility that can accept C&D material.

In general, waste disposal should be carefully coordinated with the client or site point of contact, which would be considered the "generator" of the waste. Waste profiles should be carefully reviewed to ensure accuracy, as well as waste manifests prior to transportation offsite for disposal. In addition, facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements during the profile approval process.

5.7 Regulatory Requirements

The following federal and state regulations shall be used as resources for determining waste characteristics and requirements for waste storage, transportation, and disposal:

- CFR, Title 40, Part 261
- CFR, Title 49, Parts 172, 173, 178, and 179
- 30 TAC, Title 30, Chapter 335

5.8 Waste Transport

A state-licensed and DOT-registered hazardous waste hauler shall transport all wastes classified as hazardous, or DOT hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed in accordance with all Resource Conservation and Recovery Act (RCRA)/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client's designee.

6.0 RECORDS

Describe all IDW management activities in the field logbook. This should include all handling activities from when a container becomes full until it is transported offsite for disposal. Tracking of IDW will include applicable dates and weekly inspections.

7.0 HEALTH AND SAFETY

The CTO Manager or designee shall prepare a site-specific health and safety plan. All onsite personnel shall adhere to the site-specific SHSP.

8.0 REFERENCES

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U.S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf.

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9.0 ATTACHMENTS

None.

Land Surveying

Procedure 3-07

1.0 Purpose and Scope

1.1 The purpose of this document is to define the standard operating procedure (SOP) for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites.

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.

1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

1.5 If there are procedures, whether it be from Resolution Consultants, state and/or federal, that are not addressed in this SOP and are applicable to land surveying then those procedures may be added as an appendix to the project specific Sampling and Analysis Plan (SAP).

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to conducting fieldwork. All **field sampling personnel** must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the specific field tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.

2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.

2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.

2.4 The health and safety considerations for the work associated with land surveying include:

- Slip, trips and falls associated with work in the field;

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- Biological hazards associated with work in the field; and,
- Potential hazards associated with contaminants of concern (COC) that may be located in the survey area,

3.0 Terms and Definitions

3.1 Boundary Survey

Boundary surveys are conducted by Certified Land Surveyors in order to delineate a legal property line for a site or section of a site.

3.2 Global Positioning System (GPS)

A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

4.0 Interferences

4.1 Commercially available GPS units typically have a level of precision of (±) 3 to 5 meters. Field corrections can be made as described in Section 8.3 below.

5.0 Training and Qualifications

5.1 Qualifications and Training

5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that land surveying activities comply with this procedure. The CTO Manager is responsible for ensuring that all field sampling personnel involved in land surveying shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field personnel follow these procedures. In virtually all cases, subcontractors will conduct these procedures. The FM or designee is responsible for overseeing the activities of the subcontractor and ensuring that sampling points and topographic features are properly surveyed.

6.0 Equipment and Supplies

6.1 The following equipment list contains materials that may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (PPE) and other safety equipment, as required by the HASP;
- Commercially available GPS unit; and,
- Field Logbook.

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7.0 Calibration or Standardization

7.1 An authorized manufacturer's representative shall inspect and calibrate survey instruments in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall be calibrated no more than six months prior to the start of the survey work.

7.2 Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration standards and, at a minimum, with accuracy standards set forth below. The horizontal accuracy for the location of all grid intersection and planimetric features shall be (±) 0.1 feet. The horizontal accuracy for boundary surveys shall be 1 in 10,000 feet (1:10,000). The vertical accuracy for ground surface elevations shall be (±) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (±) 0.01 feet.

8.0 Procedure

8.1 Theodolite/Electronic Distance Measurement (EDM)

Follow the procedures listed below during theodolite/EDM land surveying conducted under the NAVFAC CLEAN Program:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.
- Reference surveyed points to Mean Sea Level (Lower Low Water Level).
- Jointly determine appropriate horizontal and vertical control points prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified by the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing or well riser that is surveyed by filing grooves into the casing/riser on either side of the surveyed point, or by marking the riser with a permanent ink marker.

8.2 Global Positioning System (GPS) to Conduct Land Survey

Follow the procedures listed below during land surveying using GPS:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.

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- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified in the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points (as applicable) to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing that is surveyed by filing grooves into the casing on either side of the surveyed point.

8.3 Global Positioning System (GPS) to Position Sample Locations or Locate Site Features

Experienced field personnel may use a GPS system unit to position sample locations (e.g. grid positioned samples, soil boring locations) at a site. The decision to use field personnel or a licensed land surveyor will depend on the objectives of the survey (e.g. vertical elevation is not required) and the levels of precision required. Typically when a level of precision greater than (±) 3 to 5 meters is required, a licensed surveyor will be required. When a level of precision of (±) 3 to 5 meters is sufficient to meet project requirements (i.e. when laying sampling grids, identifying significant site features, or locating features identified in GIS figures) experienced field personnel may use commercially available, consumer-grade GPS units. Follow the procedures listed below to locate samples or site features using GPS:

- A commercially available GPS unit with Wide Angle Averaging System (WAAS), topographic map display, and waypoint storage capabilities should be used.
- If waypoints are to be imported into a GIS database, the same grid projection system should be used.
- If a permanent reference point near the site is available, it is recommended that a waypoint at this location be taken every day waypoints are stored.
- When laying out a sampling grid from a GIS map, upload the coordinates from GIS to the GPS unit, including coordinates for an easily identified, permanent, nearby feature (i.e. building corner, roadway intersection, or USGS benchmark).
- If during the initial site walk, the permanent feature identified does not overlay within (±) 5 meters as identified in the GPS unit, field corrections of the waypoints should be made.
- Field corrections can be made by adding/subtracting the difference in x,y coordinates between the field measurement of the permanent site feature and the anticipated x,y coordinates. This correction should then be applied to the x,y coordinates for each sampling location to be marked. Corrected x,y coordinates can then be uploaded into the GPS unit.
- Sampling points and site features can then be located in the field using the GPS units “Go To” function. When the distance to the sampling point or feature remains close to zero, the location can be marked.
- If no field corrections to the sampling location need to be made, or if sampling locations are to be surveyed by a licensed surveyor at a later date, no additional waypoints need to be taken. If significant changes to the sampling location are made, GPS coordinates at the corrected location shall be stored and labeled.

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- It is recommended that GPS coordinates be uploaded to a storage device such as PC at the end of each day.
- Field logs shall indicate manufacturer and model number for GPS unit used, map datum and projection used, and any field corrections made. If the GPS unit cannot lock onto a WAAS system at the site, this should also be noted.

9.0 Quality Control and Assurance

None.

10.0 Data and Records Management

The surveyor shall record field notes daily using generally accepted practices. The data shall be neat, legible, in indelible ink, and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and placed in the project files.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey;
- General weather conditions;
- The name of the surveying firm;
- The names and job titles of personnel performing the survey work;
- Equipment used, including serial numbers; and,
- Field book designations, including page numbers.

A land surveyor registered in the state or territory in which the work was done shall sign, seal, and certify the drawings and calculations submitted by the surveyor.

Dated records of land surveying equipment calibration shall be provided by the surveyor and placed in the project files. Equipment serial numbers shall be provided in the calibration records.

11.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	*Reviewer*	*Revisions (Technical or Editorial)*
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

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Direct Push Sampling Techniques

Procedure 3-17

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) provides guidance on the use of direct push techniques for the United States Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command, Atlantic (NAVFAC Atlantic).

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager or Technical Director, and documented.

1.4 If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to direct push sampling then those procedures may be added as an appendix to the project specific SAP.

2.0 Safety

2.1 Field personnel shall perform work in accordance with the site-specific health and safety plan (HASP). During monitoring well installation, subcontractors in direct contact with potentially contaminated media shall wear the proper personal protective equipment (PPE) as outlined in the site-specific health and safety plan. Failure to comply will result in disciplinary action.

2.2 If circumstances warrant, a real-time immediate response instrument, such as a Miniram Dust Monitor, organic vapor analyzer, HNu, Thermo, Draeger or Sensidyne tubes, or explosimeter, should be used to monitor the work area. When real/time instrument response exceeds the permissible exposure limit, personnel shall don the appropriate PPE and alternate control measures to ensure personnel safety. If safe control measures are not achievable, field activities shall be discontinued immediately. Company-specific HASPs offer guidelines on air surveillance and on selection of PPE. In addition, the site-specific HASP includes an air monitoring program and suggested PPE.

2.3 In addition to the aforementioned precautions and depending upon the type of contaminant expected, employ the following safe work practices:

Particulate or Metal Compounds

1. Avoid skin contact and/or incidental ingestion of soil.
2. Wear protective clothing, steel-toed boots, gloves, safety glasses, and hearing protection as warranted.

VOCs

1. Avoid breathing constituents venting from holes by approaching upwind, and/or by use of respiratory protection.

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2. Pre-survey the area with a flame ionization detector (FID) or photoionization detector (PID) prior to sampling.
3. If monitoring results indicate organic vapors that exceed action levels as specified in the site-specific HASP, sampling activities may need to be conducted in Level C protection. At a minimum, skin protection will be required by use of gloves and Tyvek or other media that is protective against the media being encountered.

Flammable or Explosive Conditions

1. Monitor explosive gases as continuously as possible using an explosimeter and oxygen meter.
2. Place all ignition sources upwind or crosswind of the borehole.
3. If explosive gases exceed the designated action levels as specified in the site-specific HASP, cease operations and evaluate conditions.

Physical Hazards Associated With Soil Sampling

1. To avoid possible back strain associated with sample collection, use the large muscles of the legs, not the back, when retrieving soil samplers.
2. Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
3. To avoid slip/trip/fall hazards, be wary of open trenches, pits, or holes.
4. Be aware of restricted mobility due to PPE.
5. To avoid hand, wrist, arm, shoulder, and back trauma due to the use of slide hammers or hand augers, rotate sampling among field personnel

3.0 Terms and Definitions

3.1 Direct push techniques are methods for subsurface sampling or monitoring that involve the application of downward pressure (usually supplied through hydraulic means) without the benefit of cutting tool rotation to enter soil. A variety of systems are available under several trade names, such as GeoProbe®. Equipment may be skid-mounted, trailered, or mounted directly on the frame of a vehicle.

4.0 Interferences

4.1 Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross contamination will occur through the following:

- The use of clean sampling tools at each location as necessary.
- Avoidance of material that is not representative of the media to be sampled.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The **CTO Manager** is responsible for ensuring that these standard direct push technique procedures are followed during projects conducted under the ER Program and that a qualified individual conducts or supervises the projects. A qualified individual for subsurface sampling or monitoring using direct push techniques is defined as a person with a degree in geology, hydrogeology, or geotechnical/civil engineering with at least 1 year of experience supervising soil boring construction using conventional drilling or direct push techniques. The CTO Manager

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or designee is responsible for ensuring that all personnel involved in direct push sampling techniques shall have the appropriate education, experience, and training to perform their assigned tasks as specified in Chief of Naval Operations Instruction 5090.1c (DON 2007).

5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.

5.2.3 The Field Manager is responsible for ensuring that all field personnel follow these procedures.

5.2.4 All Field Personnel are responsible for the implementation of this procedure.

5.2.5 The Field Personnel and/or Field Manager is responsible for directly supervising the direct push sampling procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected during sampling.

6.0 Equipment and Supplies

In addition to those materials provided by the subcontractor, the project **Field Manager/Field Personnel** will require:

- Boring Logs;
- Spoons or scoops;
- Sample kit (bottles, labels, custody records and tape, cooler, ice), if laboratory analysis is required;
- Sample collection pan;
- Folding rule or tape measure;
- Plastic sheeting;
- Utility knife;
- Equipment decontamination materials (as described in SOP 3-06, *Equipment Decontamination*);
- Health and safety equipment (as required by HASP); and
- Field project notebook/pen.

7.0 Procedure

Direct push techniques may be used as a cost-effective alternative to conventional drilling techniques for obtaining subsurface soil and groundwater samples and for monitoring subsurface conditions.

7.1 Method Selection

Base the decision to use direct push techniques on: (1) their ability to achieve the required information at the required level of quality control and (2) their cost-effectiveness compared to conventional drilling methods. Major limitations of direct push techniques are their inability to penetrate rock or cobbles and a shallow maximum depth of penetration. The capabilities of direct push systems vary significantly among vendors. Consider these differences in capabilities when evaluating the method for a subsurface exploration program.

Use direct push techniques to obtain groundwater samples for confirmatory analyses only if the screen placement method protects the screen from clogging during installation and allows the installation of a sand-pack around the exterior of the well screen.

7.2 Inspection of Equipment

Inspect direct push equipment prior to use for signs of fluid leakage, which could introduce contaminants to the soil. If, at any time during equipment operation, fluid is observed leaking from the rig, cease

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operations and immediately repair or contain the leak. Collect, containerize, and label soil and other materials affected by the leak for proper disposal (see SOP 3-05, *IDW Management*).

7.3 Preparation of Work Site

Inspect the work site prior to commencing operations to ensure that no overhead hazards exist that could impact the direct push equipment, and the work area should cleared and/or marked by the local underground utility locating service (e.g., DigSafe). In addition, clear locations planned for subsurface exploration using either geophysical methods and/or hand excavate locations to a depth of 2 to 3 feet prior to soil penetration, unless it is certain (by virtue of subsurface clearing activities) that no utilities or other hazardous obstructions will be encountered in the first 2 to 3 feet. Hand excavation may be waived when it is not practical.

Locate the direct push rig so that it is downslope from the penetration point, if the work is to be performed on a grade. Locate the rig downwind or crosswind of the penetration point, if possible. Cover the area surrounding, and in the vicinity of, the penetration point with plastic. Establish required exclusion zones using plastic tape or cones to designate the various areas.

7.4 Equipment Decontamination

To avoid cross-contamination, thoroughly decontaminate equipment used for direct push exploration and sampling as described in SOP 3-06, *Equipment Decontamination*. Decontaminate sampling tools and downhole equipment between each sampling event and between penetration points. At a minimum, steam clean or wash and rinse the equipment. Collect, containerize, and label all wash and rinse water for proper disposal. Clean equipment (e.g., drive rods and samplers) shall not come into contact with contaminated soils or other contaminated materials. Keep equipment on plastic or protect it in another suitable fashion. Store push rods and other equipment removed from a hole on plastic sheeting until properly decontaminated.

7.5 Soil Sampling

This SOP assumes that the subcontractor will perform sampling; therefore, detailed procedures regarding sample acquisition are not provided. Vendors of direct push equipment offer a variety of sampling systems designed specifically for their equipment. Both continuous and discreet soil samples may be obtained using sampling equipment similar to that described in Procedure 3-21, *Surface and Subsurface Soil Sampling*. The preferred methods for soil sampling using direct push techniques use brass or stainless steel split-tube samplers that are driven through the horizon to be sampled. Use plastic sample tubes (e.g., Macro-Core Samplers) only for screening purposes or, in the case of confirmatory sampling, if samples will not be analyzed for volatile organic compounds (VOCs) or semivolatile organic compounds (SVOCs).

7.6 Groundwater Sampling

Direct push vendors offer numerous methods for obtaining groundwater samples. Key differences among methods involve: (1) the maximum well diameter achievable; (2) the ability to protect the well screen from exposure to contaminated overburden soils during installation; (3) the ability to install packing around the screen; (4) flexibility in the size, materials of construction, and design of well screens; and (5) the ability to convert sampling points into permanent monitoring wells. The limitations and abilities of a given system must be thoroughly understood and matched to the needs of the project before committing to the collection of groundwater samples using direct push techniques.

Use direct push techniques only to collect screening samples unless it is confirmed that the system:

1. Effectively protects the well screen from exposure to contaminated overburden soils during installation
2. Allows the installation of effective packing around the well screen

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3. Allows the well screen to be effectively sealed against the downward infiltration of overlying groundwater or surface precipitation
4. Is constructed of materials compatible with the intended sampling and analysis goals of the project
5. Allows the use of a well screen properly sized and slotted for the needs of the project

Additional information on the collection of groundwater samples can be found in SOP 3-14 Monitoring Well Sampling.

It is the responsibility of the **CTO Manager** to evaluate and determine the appropriateness of direct push systems prior to committing to their use on any project involving groundwater sampling. As part of this evaluation, it is recommended to obtain concurrence from regulatory authorities in advance for the method selection.

7.7 Borehole Abandonment

Methods for abandoning boreholes created with direct push systems will vary among vendors. Coordinate the desired method for abandonment with the vendor in the planning stages of the project to ensure proper abandonment.

Some direct push boreholes will close naturally as the drive rods and sampling tools are withdrawn. This may occur in loose, unconsolidated soils, such as sands. Close all boreholes using one of the procedures described in this procedure, unless natural caving precludes such closure.

The three methods for closing direct push boreholes are:

1. Add granulated or pelletized bentonite and hydrate in layers, proceeding from the bottom of the hole to the surface.
2. Pour premixed cement/water (or cement/water/bentonite) mixture into the hole.
3. Fill the entire hole with granular or pelletized bentonite and hydrate by means of a previously emplaced water tube that is gradually withdrawn as water is supplied to the bentonite.

The second method is recommended. For shallow holes less than 10 feet in depth, pour a cement/water/bentonite mix directly into the opening using a funnel. For deeper holes, use a conductor (tremie) pipe to carry the grout mix to the far reaches of the borehole. Lower the conductor pipe to within 2 inches of the bottom and gradually withdraw it as grout is added, keeping the lower end of the pipe submerged in grout at all times.

The recommended grout mixture for well abandonment is 7 to 9 gallons of water per 94-pound bag of Portland cement, with 3 percent to 5 percent by weight of powdered bentonite added to the mixture. Commercial products, such as Volcay are acceptable with pre-approval of the **CTO Manager**.

Seal boreholes to within 0.5 to 2.0 feet of the surface. Inspect the abandoned borehole after 24 hours to ensure that grout shrinkage does not occur. If significant shrinkage has occurred, re-grout the borehole. Fill the remaining portion of the hole with local topsoil or appropriate paving materials.

8.0 Quality Control and Assurance

8.1 Collection of representative samples will be ensured through adherence to the procedures in this SOP and the sampling strategy outlined in the SAP. The field quality control samples identified in the SAP must be collected. These samples may include field duplicates, equipment rinsate blanks, trip blanks, and matrix spike/matrix spike duplicates

9.0 Records, Data Analysis, Calculations

9.1 Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:

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- Boring logs;
- Field logbook;
- Sample collection records;
- Chain-of-custody forms; and
- Shipping labels.

9.2 Boring logs (Attachment 1) will provide visual and descriptive information for samples collected at each soil boring and are often the most critical form of documentation generated during a soil sampling program.

9.3 The field logbook is kept as a general log of activities and should not be used in place of the boring log.

9.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.

9.5 Shipping labels are required is sample coolers are to be transported to a laboratory by a third party (courier service).

10.0 Attachments or References

10.1 Attachment 1 – Boring Log

10.2 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

10.3 Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

10.4 Department of the Navy (DON). 2007. *Navy Environmental and Natural Resources Program Manual*. OPNAV Instruction 5090.1c. October.

10.5 SOP 3-05, *IDW Management.*

10.6 SOP 3-06, *Equipment Decontamination.*

10.7 SOP 3-21, *Surface and Subsurface Soil Sampling.*

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

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Attachment 1
Boring Log

RESOLUTION CONSULTANTS

Boring ID:

Page 1 of _____

Project Name:	Drilling Company:	Type of Surface Material:
Project Number:	Drilling Method:	Patching Material:
Date Started Drilling:	Rig Type:	Drilling Water Level:
Date Finished Drilling:	Core Size:	Boring Total Depth (bgs):
Physical Location:		Logged By:

(Note: bgs = below ground surface)

Depth Range	Re covery ft/ft	PID (ppm)	Moisture Content	GA Class.	USCS	GA Class: Garfield Avenue Sites classification & Modified Unified Soil Clasiffication System	
						Ground Surface Cover and Thickness:	Sample name & #:
0-1							
1-2							
2-3							
3-4							
4-5							
5-6							
6-7							
7-8							
8-9							
9-10							
10-11							
11-12							
12-13							
13-14							
14-15							
15-16							
16-17							
17-18							
18-19							
19-20							

Stratigraphic Unit Intervals:		Comments:
1.)	5.)	
2.)	6.)	
5.)	6.)	

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Operation and Calibration of a Photoionization Detector

Procedure 3-20

1.0 Purpose and Scope

1.1 Purpose and Applicability

1.1.1 This standard operating procedure (SOP) describes the procedures that will be followed by field staff for operation and calibration of a photoionization detector (PID). The PID is primarily used by Resolution Consultants personnel for safety and survey monitoring of ambient air, determining the presence of volatiles in soil and water, and detecting leakage of volatiles.

1.1.2 PIDs routinely used by field personnel include the Photovac Microtip, Thermoelectron 580EZ, and MiniRAE 2000. Personnel responsible for using the PID should first read and thoroughly familiarize themselves with the instrument instruction manual.

1.2 Principle of Operation

1.2.1 The PID is a non-specific vapor/gas detector. The unit generally consists of a hand-held probe that houses a PID, consisting of an ultraviolet (UV) lamp, two electrodes, and a small fan which pulls ambient air into the probe inlet tube. The probe is connected to a readout/control box that consists of electronic control circuits, a readout display, and the system battery. Units are available with UV lamps having an energy from 9.5 electron volts (eV) to 11.7 eV.

1.2.2 The PID analyzer measures the concentration of trace gas present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule (in electron volts (eV)) is less than the energy of the photon. The source of photons is an ultraviolet lamp in the probe unit. Lamps are available with energies ranging from 9.5 eV to 11.7 eV. All organic and inorganic vapor/gas compounds having ionization potentials lower than the energy output of the UV lamp are ionized and the resulting potentiometric change is seen as a positive reading on the unit. The reading is proportional to the concentration of organics and/or inorganics in the vapor.

1.2.3 Sample gases enter the probe through the inlet tube and enter the ion chamber where they are exposed to the photons emanating from the UV lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive- biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This current is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.

1.2.4 In service, the analyzer is first calibrated with a gas of known composition equal to, close to, or representative of that to be measured. Gases with ionization potentials near to or less than the energy of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials greater than the energy of the lamp will not be detected. The ionization potentials of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to 15.6 eV and are not ionized by any of the lamps available. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

1.3 Specifications

1.3.1 Refer to the manufacturer's instructions for the technical specifications of the instrument being used. The operating concentration range is typically 0.1 to 2,000 ppm isobutylene equivalent.

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2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.

2.2 Only PIDs stamped Division I Class I may be used in explosive atmospheres. Refer to the project HASP for instructions pertaining to instrument use in explosive atmospheres.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.

4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

5.0 Training and Qualifications

5.1 **Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 **Responsibilities**

5.2.1 The CTO Manager is responsible for ensuring that the operation and calibration activities comply with this procedure. The CTO Manager is responsible for ensuring that all personnel involved in the operation and calibration shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The Program Quality Manager is responsible for ensuring overall compliance with this procedure.

5.2.3 The Field Manager is responsible for ensuring that all operation and calibration activities are conducted according to this procedure.

5.2.4 All Field Personnel are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated;

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- Regulator for calibration gas cylinder;
- Approximately 6 inches of Teflon® tubing;
- Tedlar bag (optional);
- Commercially-supplied zero grade air (optional);
- "Magic Marker" or “Sharpie” or other waterproof marker;
- Battery charger;
- Moisture traps;
- Spare lamps;
- Manufacturer’s instructions; and
- Field data sheets or logbook/pen.

7.0 Procedure

7.1 Preliminary Steps

7.1.1 Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

7.2 Calibration

7.2.1 The PID must be calibrated in order to display concentrations in units equivalent to ppm. First a supply of zero air (ambient air or from a supplied source), containing no ionizable gases or vapors is used to set the zero point. A span gas, containing a known concentration of a photoionizable gas or vapor, is then used to set the sensitivity.

7.2.2 Calibrate the instrument according to the manufacturer’s instructions. Record the instrument model and identification number, the initial and adjusted meter readings, the calibration gas composition and concentration, and the date and the time in the field records.

7.2.3 If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 7.4).

7.3 Operation

7.3.1 Turn on the unit and allow it to warm up (minimum of 5 minutes). Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify on the readout display that the UV lamp is lit.

7.3.2 Calibrate the instrument as described in Section 7.2, following the manufacturer’s instructions. Record the calibration information in the field records.

7.3.3 The instrument is now operational. Readings should be recorded in the field records.

7.3.4 When the PID is not being used or between monitoring intervals, the unit may be switched off to conserve battery power and UV lamp life; however, a “bump” test should be performed each time the unit is turned on and prior to taking additional measurements. To perform a bump test, connect the outlet tubing from a Tedlar bag containing a small amount of span gas to the inlet tubing on the unit and record the reading. If the reading is not within the tolerance specified in the project plan, the unit must be recalibrated.

7.3.5 At the end of each day, recheck the calibration. The check will follow the same procedures as the initial calibration (Section 7.2) except that no adjustment will be made to the instrument. Record the information in the field records.

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7.3.6 Recharge the battery after each use (Section 7.4).

7.3.7 When transporting, ensure that the instrument is packed in its stored condition in order to prevent damage.

7.4 **Routine Maintenance**

7.4.1 Routine maintenance associated with the use of the PID includes charging the battery, cleaning the lamp window, replacing the detector UV lamp, replacing the inlet filter, and replacing the sample pump. Refer to the manufacturer's instructions for procedures and frequency.

7.4.2 All routine maintenance should be performed in a non-hazardous environment.

7.5 **Troubleshooting Tips**

7.5.1 One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant reading should readily be observed.

7.5.2 Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

7.5.3 A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings. The PID should never be operated without the moisture trap in place.

7.5.4 Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.

7.5.5 A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the PID are limited to those compounds that will be ionized by the particular probe used.

7.5.6 Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

7.5.7 When high vapor concentrations enter the ionization chamber in the PID the unit can become saturated or "flooded". Remove the unit to a fresh air environment to allow the vapors to be completely ionized and purged from the unit.

8.0 Quality Control and Assurance

8.1 The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific workplan or Sampling and Analysis Plan (SAP), hereafter referred to as the project plan.

8.2 Calibration of the PID will be conducted at the frequency specified in the project plan. In the absence of project-specific guidance, calibration will be performed at the beginning of each day of sampling and will be checked at the end of the sampling day or whenever instrument operation is suspect. The PID will sample a calibration gas of known concentration. The instrument must agree with the calibration gas within ±10%. If the instrument responds outside this tolerance, it must be recalibrated.

8.3 Checks of the instrument response (Section 7.5) should be conducted periodically and documented in the field records.

9.0 Records, Data Analysis, Calculations

Safety and survey monitoring with the PID will be documented in a bound field logbook, or on standardized forms, and retained in the project files. The following information is to be recorded:

- Project name and number;
- Instrument manufacturer, model, and identification number;

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- Operator's signature;
- Date and time of operation;
- Calibration gas used;
- Calibration check at beginning and end of day (meter readings before adjustment);
- Span setting after calibration adjustment;
- Meter readings (monitoring data obtained);
- Instances of erratic or questionable meter readings and corrective actions taken; and
- Instrument checks and response verifications – e.g., battery check, magic marker response (Section 7.5) or similar test.

10.0 Attachments or References

United States Environmental Protection Agency. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). USEPA, Region 4, SESD, Enforcement and Investigations Branch, Athens, GA. November 2001.

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

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Procedure RC-VI-01
Indoor and Ambient Air Sample Collection with Tedlar Bags

1.0 Introduction

This Standard Operating Procedure (SOP) identifies procedures to collect samples from indoor and ambient (outside) air using Tedlar bags. Tedlar bag samples may be analyzed onsite or shipped/couriered offsite to an analytical laboratory.

Note: The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager <u>prior to implementation</u>.

2.0 Materials

- If using the Vac-U-Tube method:
  - SKC Vac-U-Tube
  - 0.7-liter Tedlar bag (with single polypropylene septum fitting)
- Lung box
  - Xitech 1060 or similar lung box (with battery charger) **<u>OR</u>** field-constructed lung-box, personnel pump, rotometer (to gauge flow), and Teflon tubing
  - 6-inch section of ¼-inch outer diameter (⅛-inch inner diameter) Tygon or nylon (e.g., Nylaflow) tubing
  - Short segment of Tygon tubing (approximately 1 inch) to use as a connector with the Tedlar bag. **Note:** Tygon is recommended only for making connections between semi-rigid tubing and other devices; the length of Tygon connectors should be kept to a minimum.
  - Tedlar bag (size will depend on project but 1 liter is the most common)

3.0 Sampling Procedures

Selection of the Sampling Location

1. Locations will be identified by project personnel.
2. Upon selection of a sampling location, evaluate the area to identify potential sources for VOCs (e.g., combustion engines, exhaust vents, chemical storage lockers).

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3. Pertinent information will be documented on a field sampling form (Attachment 1):
   a. Sampling location
   b. Sample time
   c. Building number
   d. Operations at the time of sampling
   e. VOC sources adjacent to the sampling site
   f. Floor conditions (cracks, joints, drains, presence/absence of sealant, etc.)

Sampling using Vac-U-Tube Method

1. If using the Vac-U-Tube apparatus, follow the manufacturer's instructions (see SKC's *Vac-U-Tube Operating Instructions* and *Operating Instructions — Single Polypropylene Fitted Bags* [SKC-3781]).
2. Insert the 0.7-liter Tedlar bag into the inside of the front lid, ensuring the valve-side stem is inserted into the PTFE tubing on the inside of the front lid.
3. Open the bag valve by rotating the entire upper portion of the valve fitting (including the septum cap and septum body) counterclockwise one revolution.
4. Insert the bag into the Vac-U-Tube; see Appendix A for additional details and diagrams.
5. Flush the sample bag at least 3 times.
6. Remove red cap from intake port on front lid.
7. Slowly collect the sample until the bag is 70 to 80 percent full. Rate should be kept below 200 ml/minute.
8. Replace red cap on the intake port of the front lid.
9. Open the front lid; close the bag valve by turning the valve fitting clockwise one revolution.
10. Disconnect the bag.
11. Record any pertinent sampling information in field book and/or form.
12. Label sample and record on the chain-of-custody.

Sampling using Lung Box Method

CAUTIONS:

- **Only use a lung box which has disposable/replaceable tubing. Do not use apparatus which has permanent fittings which cannot be cleaned, or fittings which require decontamination in the field.**
- **Do not over-fill sample bag. The vacuum pump is strong enough to rupture the bag; samples being shipped offsite should only be filled approximately 80% full.**
- **Ensure pump is charged prior to use.**

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If using the lung box apparatus, follow the manufacturer's instructions (see Xitech's *Operating Instructions for Model 1060 1-Liter Bag Sampler (Rev 6-08)*). **Note: a field-constructed lung box is acceptable. Data quality objectives should be developed prior to selection of the field equipment and tubing.**

In **GENERAL** the procedures will be as follows:

1. Insert a short section (less than one foot) of tubing (Teflon or nylon [e.g., Nylaflow]) which is normally ¼-inch outer diameter (⅛-inch inner diameter) through the inlet tube fitting; adjust so half the tubing is inside the sampler.
2. Tighten the inlet fitting just enough to create a seal around the tubing.
3. Attach the inside portion of the tubing to the inlet valve on the Tedlar bag.
4. Open the sample valve on the sample bag and close the sampler lid. See Operating Instructions for equipment for appropriate diagrams.
5. Make sure the purge valve is closed (closed for fastest fill rate, open to slow fill rate).
6. Turn on the sample pump.
7. To prep the bag, empty and fill the Tedlar bag three times before collecting the final sample:
    a. To empty the bag, disconnect the tubing at the outlet vacuum port
    b. Attach a short piece of tubing to the pump discharge port to the outlet vacuum port to create a pressure inside the sample chamber
    c. Repeat 3 times to prep bag.
    d. When sampling indoor/ambient air, it is appropriate to discharge the Tedlar to indoor/ambient air. Do not discharge sub-slab vapor collected in a Tedlar bag inside a building; collect, screen, and discharge sub-slab vapor in accordance with RC-VI-06 and RC-VI-07.
8. Fill pre-purged sample bag for collection and analysis.
9. Turn off sample pump, open purge valve, open sampler lid.
10. Close sample bag valve and remove bag from inlet tubing.
11. Seal sample port.
12. Discard inlet tubing.
13. Record any pertinent sampling information in field book and/or form.
14. Label sample and record on the chain-of-custody.

Attachment 1
Vapor Intrusion Sampling Form

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	Conditions at Start of Sampling:	Conditions at End of Sampling:
Site:_____	Date / Time:_____	Date /Time:_____
Sample Point:_____	Outside Temp:_____°C or F	Outside Temp:_____°C or F
Building ID:_____	Wind____mph. Out of the _____	Wind_____mph. Out of the _____
Room ID:_____	Precip._____	Precip._____
Personnel:_____	Inside: Temp:_____°C or F	Inside: Temp:_____°C or F
Personnel:_____	HVAC:_____	HVAC:_____
	Operations:_____	Operations:_____

Type of Points (Circle all that apply):

Indoor Air Ambient Air Sub-Slab Vapor Soil Gas

Sample Type:

VOCs Radon

Sample type:

Summa Canister (6 liter) Summa Canister (1 liter) Tedlar bag (___ liter) HAPSITE

24-hr sample 12-hr sample 8-hr sample Grab other _____

Breathing Zone / Indoor Sample Intake Height from Floor: _____ Feet **or** Inches

Sub-Slab Data

Type of Sub-slab Point: NA Temporary Permanent Type of Probe:_____

Was shut-in test performed? Yes No

Leak testing performed? Yes No If yes by helium testing or Water or _____

Description of Sub-Slab System Purge:_____

Purge Rate: _____mL/min Amount Purged: _____ L

PID Screen: Ambient: _____ppm Purge Gas: _____ppm **or** Not Applicable

GEM 2000 Screen: Not Applicable

Ambient: ____ O_2% _____ CO_2% _____ CH_4% Purge Gas: ____ O_2% _____ CO_2% _____ CH_4%

Canister Sampling Records								
Zone	**Sample ID**	**Analytical Methods**	**Start Time/Date**	**Canister #**	**Flow Controller #**	**Initial Vac. (in Hg)**	**Stop Time/ Date**	**End Vac. (in Hg)**

Tedlar Bag Records						
Zone	**Sample ID**	**Analytical Methods**	**Sample Date/Time**	**Tedlar Bag Size**	**Approx. Volume Collected (cc/ml)**	**Percent Full**

Notes: SS = Sub-Slab BZ=Breathing Zone/Indoor AA=Ambient Air/Outdoor

Floor conditions: Concrete Wood Tile Carpet
Other:

Any cracks or utility breaches in this floor? Y / N
If Yes mark locations on sketch.

VOC Sources in area? Y / N
If Yes mark locations on sketch.

Other comments:

Was area photographed? Yes / No

Sketch of Sample Location

Procedure RC-VI-02
Collection of Indoor and Ambient Air Samples Using Sampling Canisters

1.0 Introduction

The objective of this Standard Operating Procedure (SOP) is to describe the approach for the collection of volatile organic compounds in indoor air and ambient (outdoor) air samples using stainless steel evacuated sampling canisters (e.g., Summa, TO-Can, Silco-Can, etc.).

It is the responsibility of the project team to make sure this SOP meets all applicable regulatory standards and receives approval from the applicable regulatory agency for the project.

CAUTIONS:

- **The duration of sampling must be determined prior to canister procurement. Sampling is typically performed for 24-hour, 12-hour, or 8-hour intervals, depending upon the exposure scenario.**
- **Note that 6-liter cans are used for indoor air and ambient air sampling.**

Note: The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager <u>prior to implementation</u>.

2.0 Equipment and Materials

2.1 Indoor Air Sampling

- Canister, stainless steel, **<u>individually certified clean</u>**, and evacuated (Summa canisters are the most common type of sampling canister). The canisters are cleaned and evacuated by the laboratory that provides them.
- Sampling manifold, **<u>individually certified clean</u>**, which includes
  - Flow controller set at desired sampling rate. They are cleaned and set by the laboratory that provides them. **<u>Note that field personnel cannot change sampling rates once in the field.</u>**
  - Canister gauge, which indicates starting and ending vacuums.
  - **<u>Note: the manifold is certified and tagged to be used with a specific canister and are not interchangeable.</u>**

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- Stainless-steel duplicate tee fitting (Swagelok union tee, part #SS-400-3) for collecting duplicate samples. **Individually certified clean** and provided by laboratory.
- Teflon or nylon (e.g., Nylaflow) tubing, ¼-inch outer diameter (DO NOT use any other tubing material, such as polyethylene).
- Miscellaneous fittings (Swagelok nut and ferrule, part #SS-400-NFSET) to connect tubing to canister.
- Wrenches and screwdrivers (clean and free of contaminants) of various sizes as needed for connecting fittings and making adjustment to the flow controller. 9/16-inch and ½-inch wrenches fit the ¼-inch Swagelok fittings (most canisters and flow controllers have these). Note: tools can be cleaned by washing with detergent and water and allowing to air dry.
- Collapsible tripod or other object to elevate sampler into the breathing zone (3 to 5 feet above the ground). Sampling canes are also available, but must be requested from the laboratory and certified clean with the canister and manifold.
- Analog pressure (vacuum) gauge, oil-free and clean, to check canister vacuum. The vacuum gauges are cleaned by the laboratory that provides them. Gauges sent by the laboratory are for field use only and are an approximate measure of the actual vacuum. Note: gauges may be a potential source of cross contamination between canisters.
- Field logbook and/or forms (e.g., Vapor Intrusion Sampling Form, Attachment 1) to record information in.
- Zip tie
- Laminated sampling canister sign (Attachment 2)

2.2 Ambient Air Sampling

- All of the above, except the collapsible tripod
- If canister is exposed (not under roof), and precipitation is expected, aluminum foil or additional Teflon tubing/zip ties to protect the flow controller inlet (to prevent precipitation from entering the canister). Candy canes are also available, but must be requested from the laboratory and certified clean with the canister and manifold.
- Bike lock or chain with padlock

3.0 Sampling Procedures

Clean sampling protocols must be followed when handling and collecting air samples. Cleanliness of personnel who come in contact with the sampling equipment is important: no smoking, eating, drinking, perfumes, deodorants, dry cleaned clothing, etc. Canisters should not be transported in vehicles with gas-powered equipment or fuel cans. Sharpie-type markers should not be used for labeling or note-taking during sampling.

3.1 Assemble the Sample Canister

1. Identify the tagged sample canister and sampling manifold pair. If the gauge is built into the canister, record the vacuum.
2. Ensure that the sample canister value knob is finger-tight shut before removing the canister cap.
3. Remove the canister cap from the top of the canister.
4. Attach the sampling manifold using a wrench. If the gauge is part of the manifold setup, cap the end of the manifold and open value knob on the canister and record the initial vacuum. If the gauge is part of the manifold, then close the canister valve knob and observe the gauge for 20 to 60 seconds to see if the vacuum holds. If the vacuum does not hold, check all the fittings and retest. **Note:** Ideal initial vacuums should be between 30 and 26 inches of mercury (Hg). Be advised that sampling data may be flagged or rejected from canisters with low initial vacuum (less than 26 inches Hg). Low initial vacuum could create a low bias in analytical results due to air leakage. Do not use a canister with an initial vacuum of 25 inches Hg or less. If vacuum is less than 26 inches, return canister to laboratory unused, noting low vacuum issues.
5. When collecting a duplicate sample, connect two sampling canisters using a stainless steel Swagelok tee fitting supplied by the laboratory, (2) Swagelok nut and ferrule sets, and (2) pieces of Teflon tubing.
6. Affix the laminated sampling canister sign (Attachment 2) to the canister with a zip tie.
7. **For Indoor Air samples**, either: a) place the canister on a chair, desk, or table; b) use a collapsible stand and Teflon tubing and a nut and ferrule set attached to the flow controller, to ensure that the indoor air intake is within the breathing zone (between 3 and 5 feet above the floor). A candy cane extension fitting may also be used, but must be requested from the laboratory and certified clean with the canister and manifold.
8. **For Ambient (outdoor) Air samples**, attach the canister to an immovable structure (e.g., fence or pole) to ensure canister security. A bike lock or a chain and padlock can be used. Do not chain to or close to a living tree. The inlet to the flow controller must be protected from precipitation. Either: a) place the canister and flow controller under a shelter/enclosure; b) use a clean piece of aluminum foil to build a tent over the flow controller inlet; c) bend the inlet so it faces down; or d) connect Teflon tubing with a Swagelok nut and ferrule set and use a zip tie to tie it downward. A candy cane extension fitting may also be used, but must be requested from the laboratory and certified clean with the canister and manifold.

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3.2 Sampling

1. Slowly open the canister's knob counter clockwise one full turn.
2. Record the initial canister vacuum on the canister gauge, the start time, canister identification (ID) number, the flow controller/critical orifice ID number, and the canister gauge ID number in the field logbook and on the *Vapor Intrusion Sampling Form* (Attachment 1). **Note:** Check the canister gauge at some point(s) in time before the expected completion time to ensure that the canister is collecting at the expected rate. Normally after approximately 10 percent of the time has elapsed.
3. Once the appropriate amount of time has passed and/or the canister has reached a final vacuum on the canister gauge of 2 to 5 inches Hg, close the knob on the canister clockwise finger tight.
4. Record the final canister vacuum on the canister gauge, the end date and time, and other observations pertinent to the sampling event in the field logbook and on the *Vapor Intrusion Sampling Form*. Also, record the weather conditions during the sampling period. **Note:** Ideal final vacuums should be between 2 and 5 inches Hg. The project chemist should be notified of a canister with less than 2 inches Hg. If the project chemist gives permission for submission, notify the analytical laboratory project manager of the final pressure and note it on the chain-of-custody (COC). **Elevated canister vacuum will result in elevated detection limits and may compromise project data quality.** If the final vacuum is greater than 10 inches Hg, notify the project chemist and if the project chemist gives permission for submission, notify the analytical laboratory project manager of the final pressure and note it on the COC. Sample canisters with 0 inches Hg should not be analyzed. Contact the project chemist for appropriate course of action. One option is to verify the final vacuum with the analytical laboratory. If, according to the laboratory vacuum gauge, there is vacuum remaining in the sample canister, then the sample can be analyzed. If there is no vacuum (i.e., 0 inches Hg), then the sample should not be analyzed and the sample should be re-collected.
5. Fill out the appropriate documentation (i.e., sample labels, COC, sample tags) in accordance with SOP 3-03A *Sample Labeling and Chain-of-Custody Procedures*.
6. Package sample canisters in the sturdy cardboard box they arrived in and ship according to the procedures set forth in SOP 3-04A *Sample Handling, Storage, and Shipping of Low Environmental Samples*.

4.0 References and Attachments

ALS Environmental, 2015. Canister Sampling Instructions and Shut In, Simi Valley.

Eurofins/Air Toxics, 26 June 2014. Guide to Air Sampling: Canisters and Bags.

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Attachment 1
Vapor Intrusion Sampling Form

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	Conditions at Start of Sampling:	Conditions at End of Sampling:
Site:_____	Date / Time:_____	Date /Time:_____
Sample Point:_____	Outside Temp:_____°C or F	Outside Temp:_____°C or F
Building ID:_____	Wind____mph. Out of the _____	Wind_____mph. Out of the _____
Room ID:_____	Precip._____	Precip._____
Personnel:_____	Inside: Temp:_____°C or F	Inside: Temp:_____°C or F
Personnel:_____	HVAC:_____	HVAC:_____
	Operations:_____	Operations:_____

Type of Points (Circle all that apply):

Indoor Air Ambient Air Sub-Slab Vapor Soil Gas

Sample Type:

VOCs Radon

Sample type:

Summa Canister (6 liter) Summa Canister (1 liter) Tedlar bag (___ liter) HAPSITE

24-hr sample 12-hr sample 8-hr sample Grab other _____

Breathing Zone / Indoor Sample Intake Height from Floor: _____ Feet **or** Inches

Sub-Slab Data

Type of Sub-slab Point: NA Temporary Permanent Type of Probe:_____

Was shut-in test performed? Yes No

Leak testing performed? Yes No If yes by helium testing or Water or _____

Description of Sub-Slab System Purge:_____

Purge Rate: _____mL/min Amount Purged: _____ L

PID Screen: Ambient: _____ppm Purge Gas: _____ppm **or** Not Applicable

GEM 2000 Screen: Not Applicable

Ambient: ____ O_2% _____ CO_2% _____ CH_4% Purge Gas: ____ O_2% _____ CO_2% _____ CH_4%

Canister Sampling Records								
Zone	**Sample ID**	**Analytical Methods**	**Start Time/Date**	**Canister #**	**Flow Controller #**	**Initial Vac. (in Hg)**	**Stop Time/ Date**	**End Vac. (in Hg)**

Tedlar Bag Records						
Zone	**Sample ID**	**Analytical Methods**	**Sample Date/Time**	**Tedlar Bag Size**	**Approx. Volume Collected (cc/ml)**	**Percent Full**

Notes: SS = Sub-Slab BZ=Breathing Zone/Indoor AA=Ambient Air/Outdoor

Floor conditions: Concrete Wood Tile Carpet
Other:

Any cracks or utility breaches in this floor? Y / N
If Yes mark locations on sketch.

VOC Sources in area? Y / N
If Yes mark locations on sketch.

Other comments:

Was area photographed? Yes / No

Sketch of Sample Location

Attachment 2
Sampling Canister Sign

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CAUTION!

AIR TEST IN PROGRESS

CLOSED BUILDING CONDITIONS MUST BE MAINTAINED:

ALL WINDOW AND DOORS
<u>MUST</u> BE CLOSED EXCEPT FOR BRIEF DOOR OPENING FOR ENTRY AND EXIT.

HEATING AND AIR CONDITIONING SYSTEMS SHOULD BE OPERATED IN THE AUTO MODE DURING CLOSED BUILDING CONDITIONS.

PLEASE CALL NUMBER BELOW FOR ADDITIONAL INFORMATION CONCERNING TESTING OF THIS BUILDING

RESOLUTION CONSULTANTS

Primary Tester:

_____

Telephone:

_____

AIR TESTING IN PROGRESS

Closed Building Conditions Must be Maintained

ALL Windows **MUST** remain Closed.
All External Doors **MUS**T Remain Closed Except for Entry or Exit.

Heating and Air Systems Should be Operated Normally In the Auto Mode During the Test

Contact the Number below for Additional Information.

Primary Tester:_____

Telephone:_____

RESOLUTION CONSULTANTS

5724 Summer Trees Drive
Memphis, TN 38134
800-588-7962

AIR TESTING IN PROGRESS

Closed Building Conditions Must be Maintained

ALL Windows **MUST** remain Closed.
All External Doors **MUS**T Remain Closed Except for Entry or Exit.

Heating and Air Systems Should be Operated Normally In the Auto Mode During the Test

Contact the Number below for Additional Information.

Primary Tester:_____

Telephone:_____

RESOLUTION CONSULTANTS

5724 Summer Trees Drive
Memphis, TN 38134
800-588-7962

Procedure RC-VI-03
Indoor and Ambient Air Screening using the HAPSITE

1.0 Introduction

This Standard Operating Procedure (SOP) identifies procedures to screen indoor and ambient air using a direct-reading field gas chromatograph such as the HAPSITE.

Note: The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager <u>prior to implementation</u>.

2.0 Materials

- HAPSITE instrument or similar
- Sampling forms

3.0 Sampling Procedures

Selection of the Sampling Location

1. Locations will be identified by project personnel.
2. Upon selection of a sampling location, evaluate the area to identify potential sources for VOCs (e.g., combustion engines, exhaust vents, chemical storage lockers).
3. Pertinent information will be documented on a field sampling form (Attachment 1):
    a. Sampling location
    b. Sample time
    c. Building number
    d. Operations at the time of sampling
    e. VOC sources adjacent to the sampling site
    f. Floor conditions (cracks, joints, drains, presence/absence of sealant, etc.)

Direct Reading by the HAPSITE

4. The HAPSITE will be calibrated and operated in accordance with its SOP.
5. The intake port of the HAPSITE will be positioned within the breathing zone (approximately 3-5 feet above ground surface) and a sample collected. This sample will vary from 150 to 300 milliliters.
6. The screening results will be documented appropriately by the field chemist.

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Attachment 1

Vapor Intrusion Sampling Form

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	Conditions at Start of Sampling:	Conditions at End of Sampling:
Site:_____	Date / Time:_____	Date /Time:_____
Sample Point:_____	Outside Temp:_____°C or F	Outside Temp:_____°C or F
Building ID:_____	Wind____mph. Out of the _____	Wind_____mph. Out of the _____
Room ID:_____	Precip._____	Precip._____
Personnel:_____	Inside: Temp:_____°C or F	Inside: Temp:_____°C or F
Personnel:_____	HVAC:_____	HVAC:_____
	Operations:_____	Operations:_____

Type of Points (Circle all that apply):

Indoor Air Ambient Air Sub-Slab Vapor Soil Gas

Sample Type:

VOCs Radon

Sample type:

Summa Canister (6 liter) Summa Canister (1 liter) Tedlar bag (___ liter) HAPSITE

24-hr sample 12-hr sample 8-hr sample Grab other _____

Breathing Zone / Indoor Sample Intake Height from Floor: _____ Feet **or** Inches

Sub-Slab Data

Type of Sub-slab Point: NA Temporary Permanent Type of Probe:_____

Was shut-in test performed? Yes No

Leak testing performed? Yes No If yes by helium testing or Water or _____

Description of Sub-Slab System Purge:_____

Purge Rate: _____mL/min Amount Purged: _____ L

PID Screen: Ambient: _____ppm Purge Gas: _____ppm **or** Not Applicable

GEM 2000 Screen: Not Applicable

Ambient: ____ O_2% _____ CO_2% _____ CH_4% Purge Gas: ____ O_2% _____ CO_2% _____ CH_4%

Canister Sampling Records								
Zone	**Sample ID**	**Analytical Methods**	**Start Time/Date**	**Canister #**	**Flow Controller #**	**Initial Vac. (in Hg)**	**Stop Time/ Date**	**End Vac. (in Hg)**

Tedlar Bag Records						
Zone	**Sample ID**	**Analytical Methods**	**Sample Date/Time**	**Tedlar Bag Size**	**Approx. Volume Collected (cc/ml)**	**Percent Full**

Notes: SS = Sub-Slab BZ=Breathing Zone/Indoor AA=Ambient Air/Outdoor

Floor conditions: Concrete Wood Tile Carpet
Other:

Any cracks or utility breaches in this floor? Y / N
If Yes mark locations on sketch.

VOC Sources in area? Y / N
If Yes mark locations on sketch.

Other comments:

Was area photographed? Yes / No

Sketch of Sample Location

Procedure RC-VI-04
Installation of Permanent Sub-Slab Probes, Leak Check, and Purge

1.0 Introduction

The objective of this Standard Operating Procedure (SOP) is to describe the approach for installing semi-permanent sub-slab soil gas probes (i.e., Cox-Colvin & Associates, Inc. Vapor Pin). It includes instructions on sub-slab probe installation, leak checking, and probe abandonment. The Vapor Pins will be installed, leak tested, and extracted/abandoned as described below and in accordance with the Cox-Colvin SOPs: *Installation and Extraction of the Vapor Pin* and *Leak Testing Vapor Pin Via Mechanical Means* available on the Cox-Colvin website (http://vaporpin.coxcolvin.com/resources/).

Comparable probes may be commercially available and may be used on the project; the steps outlined herein should be generally applicable to installation of all sub-slab vapor probes.

It is the responsibility of the project team to make sure this SOP meets all applicable regulatory standards and receives approval from the applicable regulatory agency for the project.

Note: This Standard Operating Procedure for the installation of permanent sub-slab probes such as Vapor Pins. It does not address the installation of temporary points such as tubing and clay.

Note: The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager <u>prior to implementation</u>.

2.0 Equipment and Materials

2.1 Sub-slab Probe Installation

- Hammer drill
- Drill bit 1½ -inch if flush mount probes are to be installed)
- Drill bit 5/8-inch diameter and 18 inches long (Note 36 inch long may be required for areas with thicker concrete such as airports, loading docks and heavy commercial areas).
- Vacuum cleaner (shop-vac type or handheld, with both a dust bag and high-efficiency particulate air [HEPA] filter) for removing concrete dust generated while drilling through the slab. Continuously vacuum the dust as it is generated during the drilling process.

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- Power extension cord with multiple outlets and ground fault current interrupter (GFCI). **Note** if an extension cord less than 50 feet is required the cord should be 14 gauge or lower. If the cord is longer than 50 feet is required the cord should be 12 gauge or lower.
- Cox-Colvin Vapor Pin Kit
  - Assembled Vapor Pin (Vapor Pin and silicone sleeve) (can be purchased in kit as a multi-pack)
  - Vapor Pin Installation/Extraction Tool (provided with Vapor Pin kit)
  - Vapor Pin ¾-inch bottle brush (provided with Vapor Pin kit)
  - Vapor Pin white protective caps (provided with Vapor Pin kit)
  - Vapor Pin Stainless Steel Secure Cover
- Vapor Pin Spanner Screwdriver for Secure Cover
- Dead-blow hammer or rubber mallet
- Large cotton swabs or paper towels and non-chlorinated (de-ionized or distilled) water for cleaning the concrete dust out of the hole
- Tape measure to measure the thickness of the slab (measured off of a long screwdriver, bent pin flag, or drill bit)

2.2 Water Leak Check

- Vacuum device such as
  - 50 cubic centimeter (cc) or larger syringe or
  - Pump with rotameter to control flow to 200 milliliter per minute (mL/min) or less or
  - Sacrificial Summa
- 2 to 3 feet of ¼ inch diameter Teflon or nylon (e.g., Nylaflow) tubing.
- 1 to 3 inches of Tygon tubing. **Note:** Tygon is recommended only for making connections between semi-rigid tubing and other devices; the length of Tygon connectors should be kept to a minimum.
- 2 inch section of 2-inch diameter PVC or 2-inch PVC coupling
- Non-chlorinated (de-ionized or distilled) water
- Paper towels
- Turkey baster or syringe (for removing water from the water dam)
- 2-inch PVC pipe couple/union
- Non-VOC Modeling clay

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2.3 Shut-in Test

- Vacuum device such as
  - 50 cc or larger syringe or
  - Pump with rotameter to control flow to 200 milliliter per minute (mL/min) or less or
  - Sacrificial Summa
- 2 to 3 feet of ¼ inch diameter Teflon or nylon (e.g., Nylaflow) tubing
- 1 to 3 inches of Tygon tubing. **Note:** Tygon is recommended only for making connections between semi-rigid tubing and other devices; the length of Tygon connectors should be kept to a minimum.
- 2 inch section of 2-inch diameter PVC or 2-inch PVC coupling
- Non-VOC Modeling clay

2.4 Probe Abandonment

- Vapor Pin Installation/Extraction Tool (provided with Vapor Pin kit)
- Concrete patch (urethane caulk and either pre-mixed cement patch or Portland cement). **Note: do not sample indoor air after application of urethane caulk, as it may be a short-term source of volatile vapors (e.g., acetone, toluene, or others).**
- Trowel for applying cement patch or cement

3.0 Probe Installation

Purpose: To install a sample point that allows the sub-slab soil gas to be sampled without allowing a path for vapor enter building. **Notes:**

- All utility clearance activities will be followed in accordance with appropriate work plans/sampling and analysis plans and SOP 3-01 *Utility Clearance*.
- A utility clearance must be performed in coordination with facility personnel prior to drilling through the slab, as with all intrusive site work, to identify utilities, wire mesh, and/or rebar in the slab prior to drilling. The sampling team should also look around the building to locate where utilities come into the building. Utility shut-off valves should be located in case an underground utility is encountered.
- Sampling locations will be installed as defined in appropriate work plan/sampling and analysis plan documents. Note the location of the probe, locations of significant features (walls, cracks, sumps, drains, and so forth), and condition of the slab. Sub-slab probes should be placed at least 5 feet away from exterior walls and penetrations in the slab (large cracks, sumps, drains, utilities, etc.). Document field conditions and any changes in sampling locations in the field logbook or form (Attachment 1 – Vapor Intrusion Sampling Form).

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Figure 1 provides examples of flush mount and non-flush mount completion.

1. For flush mount application, drill a 1½-inch diameter hole to a depth of 1¾ inches to allow room for installing the Vapor Pin. See the Cox-Colvin SOP *Installation and Extraction of the Vapor Pin* for the following steps. **Note:** If the vapor pit is a temporary installation, and does not require a counter-sunk installation, complete the installation with a ⅝-inch drill bit, as described below.
2. Change out the drill bits and place the ⅝-inch drill bit in the center of the 1½-inch hole. Drill a ⅝-inch-diameter hole through the remainder of the slab and approximately 3 inches down into the material beneath the slab. Drilling into the sub-slab material creates a void free of obstructions that might plug the probe during sampling. Using the drill bit, a long screwdriver, or a bent pin flag, measure and record the slab thickness, the total depth of the slab, and the depth drilled into the material beneath the slab in the field logbook or forms.
3. Clean out the drilled hole with a ¾-inch bottle brush, paper towels, and the shop-vac with a HEPA filter (**Note:** AVOID pulling too much of a vacuum on the hole as the vacuum will discharge into the breathing zone of the building). This removes any remaining dust, allowing the silicon sleeve on the Vapor Pin to seal properly to the wall of the probe hole.
4. Screw the barb fitting portion of the Vapor Pin into the hole at the bottom of the extraction/installation tool. Place the lower end of the assembled Vapor Pin into the ⅝-inch drilled hole. Tap the Vapor Pin into place using a dead-blow hammer. During installation, the silicon sleeve will form a slight bulge between the slab and the Vapor Pin shoulder.
5. Place the white protective cap on the Vapor Pin to prevent sub-slab soil gas loss prior to sampling.
6. If the installation is a stick-up, temporary installation, skip this step and continue to #8. However, if the installation is flush mount, place the stainless steel secure cover onto the Vapor Pin and tighten using the spanner screwdriver by rotating it clockwise. Rotate the spanner screwdriver counterclockwise to remove the secure cover.
7. Wait at least 1 hour before beginning sub-slab soil gas purging and sample collection activities to allow equilibration following probe installation.

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Figure 1

Flush Mount Completion

Non-Flush Mount Completion

4.0 Probe Leak Test

Purpose: To test for leaks around the sample probe to prevent ambient air from being introduced into the sub-slab sample.

Notes: A leak test of the probe is **required** prior to sampling each time that probe is sampled.

1. **For a Flush-Mount Installation:** Using de-ionized or distilled water and a turkey baster or syringe, fill up the 1½ -inch depression containing the barbed portion of the Vapor Pin to almost the top. Make sure the water level is above the bottom portion of the Tygon tubing. Note: The water level may drop slightly due to the absorption of the water into the concrete.
2. **For a Temporary, Above-Grade Installation:** Clean the concrete surface within 2 inches of the pin of any residual dust from installation. See Figure 2. Avoid wetting the concrete. Using non-VOC modelling clay, create a 7-inch snake; create a circle around the vapor pin. Set the PVC couple/union firmly into the clay to create a dam around the vapor pin. Do not break the clay seal. Note that the clay should not be water soluble (e.g., PlayDoh).
3. Connect syringe to probe with Teflon or Nylon tubing and slowly (rate < 200 ml/min) withdraw 60 cc of sub-surface vapor and then reinject the vapor to the sub-surface. Repeat this procedure at least 2 times.
4. If the water level does not change and no bubbles are noted the seal will be considered good.
5. If leaks are identified, remove Vapor Pin and re-install using a new unit.
6. If no leaks are identified, proceed with purge and sampling.

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Figure 2

Non-Flush mount completion with water dam

5.0 Shut-in Test

Purpose: Test for leaks in sample train.

Notes: Different laboratories use different configurations. Refer to the laboratory instructions. The following is a general description of the most common configuration

1. Assemble sampling train as described by the laboratory. Figure 3 provides a general setup.

   Option 1 – Vacuum applied by purge device

   a. Close the valve or apply a clamp at tygon tubing before the sample end.
   b. Open the purge point valve. DO NOT OPEN THE VALVE ON THE SAMPLING CANISTER
   c. Apply a vacuum that is readable on the gauge with the purge device (syringe, pump or spare summa).
   d. Close the purge point valve and watch the gauge for approximately 30 seconds to see if the vacuum holds.
   e. If the vacuum is maintained this indicates there are no leaks. If the vacuum drops, this indicates there are leaks the train needs to be checked and the process repeated.

   Option 2 – Vacuum applied by sample summa

   a. Close the purge valve or cap the purge port and close the valve or apply a clamp at tygon tubing before the sample end.
   b. Open the summa to apply a vacuum to the train then close the valve
   c. Watch the gauge for approximately 30 seconds to see if the vacuum holds.
   d. If the vacuum is maintained this indicates there are no leaks. If the vacuum drops, this indicates there are leaks the train needs to be checked and the process repeated.

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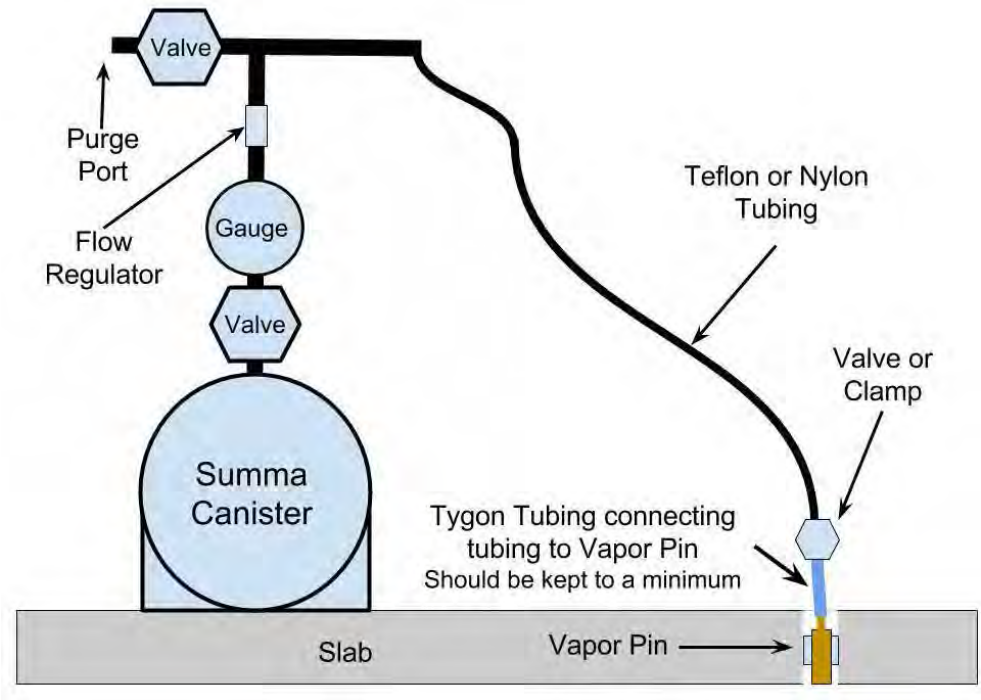
Figure 3
Sample Train Example



7. Purge

Purpose: Remove ambient air from sampling train.

1. After conducting the shut-in test, connect the purge device (syringe, pump, or sacrificial summa) to the purge port.
2. Open the valve or clamp from the Tygon tubing at the sample port.
3. Open the valve at the purge port.
4. Start the vacuum and ensure the rate is below 200 ml/min. Note: if a pump is being used, pump the purge gas into a Tedlar bag. **Do not** allow the purge gas to enter the breathing air of a building.
5. Purge at least three volumes of the purge train.
   a. **Note:** One foot of ¼-inch inner diameter tubing is 10 cc.
   b. **Note:** If the purged sub-slab soil gas is going to be screened, additional volume may be required. Collect the purged soil gas into a Tedlar bag. If a syringe is used, use a 3-way valve so the avoid having to disconnect syringe.
6. After the purge is completed, seal off the purge port.
7. If screening concentrations in purged sub-slab soil gas, use the procedures outlined in SOP RC-VI-07, *Tedlar Bag Screening Using Portable Screening Equipment.*

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6.0 Probe Abandonment

Purpose: To seal the boring and prevent a pathway for sub-slab soil gas to enter the building.

Caution: Urethane caulk will contain VOCs as solvent. No indoor air sampling should be conducted within approximately 5 days of abandoning a location with urethane caulk

1. To remove the Vapor Pin, remove the protective silicone cap and thread the installation/extraction tool onto the barbed portion of the Vapor Pin. Continue turning the tool to aid in extraction, then pull the Vapor Pin from the hole. See the Cox-Colvin SOP *Installation and Extraction of the Vapor Pin.*
2. Fill the hole with urethane caulk, cement patch, or Portland cement mix and return the surface as near to pre-sampling conditions as possible. Note: urethane caulk will provide a good seal that does not shrink. If the surface is concrete, fill the bottom portion of the hole with urethane caulk and the top half with concrete.

7.0 References and Attachments

Cox-Colvin & Associates, Inc., 2015. Vapor Pin SOP. 3 April 2015.

Cox-Colvin & Associates, Inc., 2013. SOP Leak Testing Vapor Pin Via Mechanical Means. December.

Email correspondence between David Doyle of EnSafe and Martin (Mort) Schmidt mort_schmidt@coxcolvin.com of Cox Colvin on 12 October 2015 regarding hole abandonment.

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Attachment 1
Vapor Intrusion Sampling Form

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	Conditions at Start of Sampling:	Conditions at End of Sampling:
Site:_____	Date / Time:_____	Date /Time:_____
Sample Point:_____	Outside Temp:_____°C or F	Outside Temp:_____°C or F
Building ID:_____	Wind____mph. Out of the _____	Wind_____mph. Out of the _____
Room ID:_____	Precip._____	Precip._____
Personnel:_____	Inside: Temp:_____°C or F	Inside: Temp:_____°C or F
Personnel:_____	HVAC:_____	HVAC:_____
	Operations:_____	Operations:_____

Type of Points (Circle all that apply):

Indoor Air Ambient Air Sub-Slab Vapor Soil Gas

Sample Type:

VOCs Radon

Sample type:

Summa Canister (6 liter) Summa Canister (1 liter) Tedlar bag (___ liter) HAPSITE

24-hr sample 12-hr sample 8-hr sample Grab other _____

Breathing Zone / Indoor Sample Intake Height from Floor: _____ Feet **or** Inches

Sub-Slab Data

Type of Sub-slab Point: NA Temporary Permanent Type of Probe:_____

Was shut-in test performed? Yes No

Leak testing performed? Yes No If yes by helium testing or Water or _____

Description of Sub-Slab System Purge:_____

Purge Rate: _____mL/min Amount Purged: _____ L

PID Screen: Ambient: _____ppm Purge Gas: _____ppm **or** Not Applicable

GEM 2000 Screen: Not Applicable

Ambient: ____ O_2% _____ CO_2% _____ CH_4% Purge Gas: ____ O_2% _____ CO_2% _____ CH_4%

Canister Sampling Records								
Zone	**Sample ID**	**Analytical Methods**	**Start Time/Date**	**Canister #**	**Flow Controller #**	**Initial Vac. (in Hg)**	**Stop Time/ Date**	**End Vac. (in Hg)**

Tedlar Bag Records						
Zone	**Sample ID**	**Analytical Methods**	**Sample Date/Time**	**Tedlar Bag Size**	**Approx. Volume Collected (cc/ml)**	**Percent Full**

Notes: SS = Sub-Slab BZ=Breathing Zone/Indoor AA=Ambient Air/Outdoor

Floor conditions: Concrete Wood Tile Carpet
Other:

Any cracks or utility breaches in this floor? Y / N
If Yes mark locations on sketch.

VOC Sources in area? Y / N
If Yes mark locations on sketch.

Other comments:

Was area photographed? Yes / No

Sketch of Sample Location

Procedure RC-VI-05
Collection of Sub-slab Soil Gas Samples using Canisters

1.0 Introduction

The objective of this Standard Operating Procedure (SOP) is to describe the approach for collecting soil gas samples from sub-slab sample locations using stainless steel evacuated sampling canisters (e.g., Summa, TO-Can, Silco-Can, etc.).

It is the responsibility of the project team to make sure this SOP meets all applicable regulatory standards and receives approval from the applicable regulatory agency for the project.

NOTES:

1. The Standard Operating Procedure for probe installation, probe leak testing, shut-in testing, purging and abandonment can be found in RC-VI-04.
2. Probes should be leak tested prior to each sampling event.
3. The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager prior to implementation.

2.0 Equipment and Materials

- Canister, stainless steel, **individually certified clean**, and evacuated (Summa canisters are the most common type of sampling canister). The canisters are cleaned and evacuated by the laboratory that provides them.
- Sampling manifold, **individually certified clean**, which includes
  - Swagelok gas-tight fittings
  - Flow controller or critical orifice, and set at desired sampling rate. They are cleaned and set by the laboratory that provides them. **Note that field personnel cannot change sampling rates once in the field.**
- Stainless steel duplicate tee fitting (Swagelok union tee, part #SS-400-3) for collecting duplicate samples. **Individually certified clean** and provided by laboratory.
- Tubing (Teflon or nylon [e.g., Nylaflow]), ¼-inch outer diameter.
- Short segments (2 to 3 inches) of flexible Tygon tubing (¼-inch outer diameter, ⅜-inch inner diameter) to connect Teflon/nylon tubing to the Vapor Pin (available from Cox-Colvin, Tygon R-3063). **Note:** Tygon is recommended only for making connections

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between semi-rigid tubing and other devices; the length of Tygon connectors should be kept to a minimum.

- 2 tubing clamps per location (possible source: www.usplastic.com Item # 59200)
- PID Meter for health and safety to ensure breathing zone VOC concentrations remain below levels specified by the Health and Safety Plan. May also be used to screen total VOCs from the purged soil gas. Follow the procedures set forth in the SOPs 3-20 *Operation and Calibration of a PID*.
- Miscellaneous fittings (Swagelok nut and ferrule, part #SS-400-NFSET) to connect tubing to canister.
- Wrenches and screwdrivers (clean and free of contaminants) of various sizes as needed for connecting fittings and making adjustment to the flow controller. 9/16-inch and ½-inch wrenches fit the ¼-inch Swagelok fittings.
- Pressure (vacuum) gauge laboratory provided, oil-free and clean, to check canister vacuum.
- Power extension cord and ground fault current interrupter (GFCI) (for vacuum pump that is not battery operated).
- Field logbook or sampling form (Attachment 1) to record information in.
- Zip Tie
- Laminated sampling canister sign (Attachment 2)

3.0 Summa Canister Sampling

Purpose: To collect a representative sample of the sub-slab soil gas.

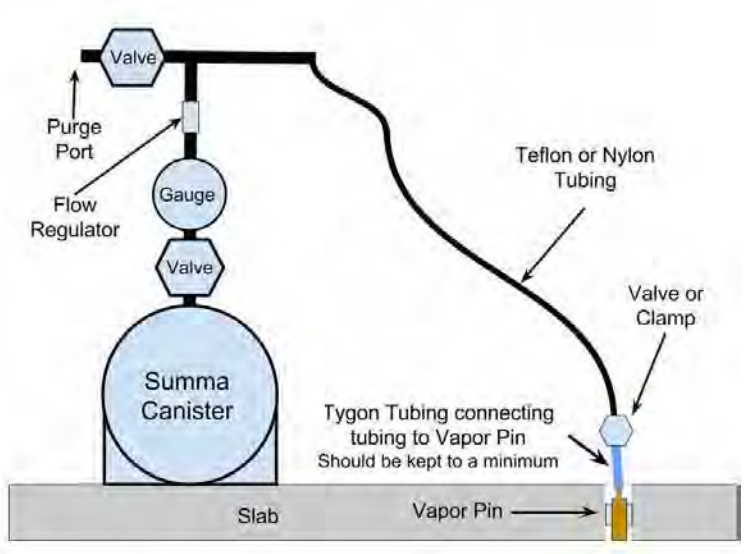
Notes:

- Probe leak testing, shut-in testing, and purging must be conducted before each sample is collected. These are addressed in RC-VI-04.
- Figure 1 provides an example of a typical sub-slab sample configuration.

1. Seal the purge port on the sample manifold using valve, cap, or clamp.
2. Un-clamp the Tygon tubing on the Vapor Pin or open the value.
3. Slowly open the canister's knob counter clockwise one full turn.
4. Record the initial canister vacuum on the analog vacuum gauge, the start time, canister identification (ID) number, the flow controller/critical orifice ID number, and the analog vacuum gauge ID number in the field logbook and on the *Vapor Intrusion Sampling Form* (Attachment 1).
5. After approximately 5 to 10 percent of the time has elapsed, check canister to insure vacuum is dropping and sample is being collected.

6. Once the approximately 90 to 95 percent of the time has elapsed, check the canister to see if it has reached a final vacuum on the analog gauge of 2 to 5 inches of mercury (Hg). If so, close the knob on the canister clockwise finger tight. If not, allow more time.
7. Record the final canister vacuum on the analog vacuum gauge, the end date and time, and any other observations pertinent to the sampling event in the field logbook and on the *Vapor Intrusion Sampling Form*. Also, record the weather conditions during the sampling period. **Note:** Ideal final vacuums should be between 2 and 5 inches Hg. The project chemist should be notified of a canister with less than 2 inches Hg. If the project chemist gives permission for submission, notify the analytical laboratory project manager of the final pressure and note it on the chain-of-custody (COC). **Elevated canister vacuum will result in elevated detection limits and may compromise project data quality.** If the final vacuum is greater than 10 inches Hg, notify the project chemist and if the project chemist gives permission for submission, notify the analytical laboratory project manager of the final pressure and note it on the COC. Sample canisters with 0 inches Hg should not be analyzed. Contact the project chemist for appropriate course of action. One option is to verify the final vacuum with the analytical laboratory. If, according to the laboratory vacuum gauge, there is vacuum remaining in the sample canister, then the sample can be analyzed. If there is no vacuum (i.e., 0 inches Hg), then the sample should not be analyzed and the sample should be re-collected.
8. Disassemble the sampling manifold and place cap onto the cansister.
9. Remove the Tygon tubing and Teflon/nylon tubing tubing from the Vapor Pin and sampling canister.
10. Replace the white cap on the Vapor Pin.
11. Replace the secure cover on the probe with the spanner screwdriver tool.
12. Fill out the appropriate documentation (i.e., sample labels, COC, sample tags) in accordance with SOP 3-03A *Sample Labeling and Chain-of-Custody Procedures*.
13. Package sample canisters in the sturdy cardboard box they arrived in and ship according to the procedures set forth in SOP 3-04A *Sample Handling, Storage, and Shipping of Low Level Environmental Samples*.

Figure 1
Example of Typical Sub-Slab Sample Configuration



4.0 References and Attachments

ALS Environmental, 2015. Canister Sampling Instructions and Shut In, Simi Valley.

Eurofins/Air Toxics, 26 June 2014. Guide to Air Sampling: Canisters and Bags.

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Attachment 1
Vapor Intrusion Sampling Form

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	Conditions at Start of Sampling:	Conditions at End of Sampling:
Site:_____	Date / Time:_____	Date /Time:_____
Sample Point:_____	Outside Temp:_____°C or F	Outside Temp:_____°C or F
Building ID:_____	Wind____mph. Out of the _____	Wind_____mph. Out of the _____
Room ID:_____	Precip._____	Precip._____
Personnel:_____	Inside: Temp:_____°C or F	Inside: Temp:_____°C or F
Personnel:_____	HVAC:_____	HVAC:_____
	Operations:_____	Operations:_____

Type of Points (Circle all that apply):

Indoor Air Ambient Air Sub-Slab Vapor Soil Gas

Sample Type:

VOCs Radon

Sample type:

Summa Canister (6 liter) Summa Canister (1 liter) Tedlar bag (___ liter) HAPSITE

24-hr sample 12-hr sample 8-hr sample Grab other _____

Breathing Zone / Indoor Sample Intake Height from Floor: _____ Feet **or** Inches

Sub-Slab Data

Type of Sub-slab Point: NA Temporary Permanent Type of Probe:_____

Was shut-in test performed? Yes No

Leak testing performed? Yes No If yes by helium testing or Water or _____

Description of Sub-Slab System Purge:_____

Purge Rate: _____mL/min Amount Purged: _____ L

PID Screen: Ambient: _____ppm Purge Gas: _____ppm **or** Not Applicable

GEM 2000 Screen: Not Applicable

Ambient: ____ O_2% _____ CO_2% _____ CH_4% Purge Gas: ____ O_2% _____ CO_2% _____ CH_4%

Canister Sampling Records								
Zone	**Sample ID**	**Analytical Methods**	**Start Time/Date**	**Canister #**	**Flow Controller #**	**Initial Vac. (in Hg)**	**Stop Time/ Date**	**End Vac. (in Hg)**

Tedlar Bag Records						
Zone	**Sample ID**	**Analytical Methods**	**Sample Date/Time**	**Tedlar Bag Size**	**Approx. Volume Collected (cc/ml)**	**Percent Full**

Notes: SS = Sub-Slab BZ=Breathing Zone/Indoor AA=Ambient Air/Outdoor

Floor conditions: Concrete Wood Tile Carpet
Other:

Any cracks or utility breaches in this floor? Y / N
If Yes mark locations on sketch.

VOC Sources in area? Y / N
If Yes mark locations on sketch.

Other comments:

Was area photographed? Yes / No

Sketch of Sample Location

Attachment 2
Sampling Canister Sign

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CAUTION!

AIR TEST IN PROGRESS

CLOSED BUILDING CONDITIONS MUST BE MAINTAINED:

ALL WINDOW AND DOORS
<u>MUST</u> BE CLOSED EXCEPT FOR BRIEF DOOR OPENING FOR ENTRY AND EXIT.

HEATING AND AIR CONDITIONING SYSTEMS SHOULD BE OPERATED IN THE AUTO MODE DURING CLOSED BUILDING CONDITIONS.

PLEASE CALL NUMBER BELOW FOR ADDITIONAL INFORMATION CONCERNING TESTING OF THIS BUILDING

RESOLUTION CONSULTANTS

Primary Tester:

_____

Telephone:

_____

AIR TESTING IN PROGRESS

Closed Building Conditions Must be Maintained

ALL Windows **MUST** remain Closed.
All External Doors **MUS**T Remain Closed Except for Entry or Exit.

Heating and Air Systems Should be Operated Normally In the Auto Mode During the Test

Contact the Number below for Additional Information.

Primary Tester:_____

Telephone:_____

RESOLUTION CONSULTANTS

5724 Summer Trees Drive
Memphis, TN 38134
800-588-7962

AIR TESTING IN PROGRESS

Closed Building Conditions Must be Maintained

ALL Windows **MUST** remain Closed.
All External Doors **MUS**T Remain Closed Except for Entry or Exit.

Heating and Air Systems Should be Operated Normally In the Auto Mode During the Test

Contact the Number below for Additional Information.

Primary Tester:_____

Telephone:_____

RESOLUTION CONSULTANTS

5724 Summer Trees Drive
Memphis, TN 38134
800-588-7962

Procedure RC-VI-06
Collection of Sub-Slab Soil Gas Samples using Tedlar Bags

1.0 Introduction

This Standard Operating Procedure (SOP) identifies procedures to collect soil gas samples from sub-slab sample locations using Tedlar bags.

NOTES:

- The Standard Operating Procedure for probe installation, purging, leak testing, and abandonment can be found in RC-VI-04.
- Probes should be leak tested prior to each sampling event.
- The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager prior to implementation.

2.0 Materials

2.1 Vac-U-Tube Approach

- Vac-U-Tube Approach
  - SKC Vac-U-Tube
  - 0.7-L Tedlar bag (with single polypropylene septum fitting)
  - Personnel pump to purge tubing
- Tubing (Teflon or nylon [e.g., Nylaflow]) – approximately 5 feet
- Scissors or tubing cutter
- Labels and writing tool to mark samples
- Forms and/or fieldbook (a vapor intrusion sampling form is included as Attachment 1)
- Bubble wrap for cushioning samples during shipment

2.2 Lung Box Approach

- Xitech 1060 or similar lung box (with battery charger) **OR** field-constructed lung-box,
- Vacuum source such as a personnel pump with rotometer (to gauge flow) or syringe
- Tubing (Teflon or nylon [e.g., Nylaflow])
- 6-inch section of ¼-inch outer diameter (⅛-inch inner diameter) Tygon tubing
- Tubing (Teflon or nylon [e.g., Nylaflow]) – approximately 5 feet
- Scissors or tubing cutter

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- Labels and writing tool to mark samples
- Forms and/or fieldbook
- Bubble wrap for cushioning samples during shipment
- Tedlar bag 0.7 or 1 liter size

3.0 Sampling Procedures – Vac-U-Tube Apparatus

1. If using the Vac-U-Tube apparatus, follow the manufacturer's instructions (see SKC's *Vac-U-Tube Operating Instructions* and *Operating Instructions – Single Polypropylene Fitted Bags* [SKC-3781]).
2. Insert the 0.7-liter Tedlar bag into the inside of the front lid, ensuring the valve-side stem is inserted into the PTFE tubing on the inside of the front lid.
3. Open the bag valve by rotating the entire upper portion of the valve fitting (including the septum cap and septum body) counterclockwise one revolution.
4. Insert the bag into the Vac-U-Tube; see Appendix A for additional details and diagrams.
5. Connect Vac-U-Tube to soil vapor probe tubing.
6. Flush the sample bag at least 3 times with soil gas (the flow rate should be <200 ml/min). If the point is inside a building, the expelled soil gas must be collected into another Tedlar bag to be released outside a building
7. Slowly collect the sample (the rate should be <200 ml/min).
8. Replace red cap on the intake port of the front lid.
9. Open the front lid; close the bag valve by turning the valve fitting clockwise one revolution.
10. Disconnect the bag.
11. Record any pertinent sampling information in field book and/or form.
12. Label sample and record on the chain-of-custody.

4.0 Sampling using Lung Box Method

Notes:

- Only use a lung box which has disposable/replaceable tubing to avoid cross contamination. Do not use apparatus which has permanent fittings which cannot be cleaned, or fittings which require decontamination in the field.
- Do not over-fill sample bag. The vacuum pump is strong enough to rupture the bag; samples being shipped offsite should only be filled approximately 80% full.

General procedures:

1. If using the lung box apparatus, follow the manufacturer's instructions (see Xitech's *Operating Instructions for Model 1060 1-Liter Bag Sampler (Rev 6-08)*).

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2. Place the sample bag inside sampler.
3. Thread Teflon/nylon tubing from soil gas probe through inlet tube fitting to lung box. Use 1- to 2-inch Tygon tubing as connector between semi-rigid Teflon tubing and Tedlar bag intake. **Note:** Tygon is recommended only for making connections between semi-rigid tubing and other devices; the length of Tygon connectors should be kept to a minimum.
4. Tighten the inlet fitting just enough to create a seal around the Teflon/nylon tubing.
5. Open the sample valve on the sample bag and close the sampler lid. See Operating Instructions for equipment for appropriate diagrams.
6. Make sure the purge valve is closed (closed for fastest fill rate, open to slow fill rate).
7. Apply a vacuum by turning on the sample pump or using a syringe (the flow rate should be <200 ml/min.
8. To prep the bag, empty and fill the Tedlar bag three times before collecting the final sample:
    a. To empty the bag, disconnect the tubing at the outlet vacuum port
    b. Attach a short piece of ¼-inch outer diameter (⅛-inch inner diameter) Tygon tubing to the pump discharge port to the outlet vacuum port to create a pressure inside the sample chamber. **Note** if inside a building the expelled gas must be captured and disposed of outside the building
    c. Repeat 3 times to prep bag.
9. Fill pre-purged sample bag for collection and analysis.
10. Turn off vacuum source, open purge valve, open sampler lid.
11. Close sample bag valve and remove bag from inlet tubing.
12. Discard inlet tubing.
13. Record any pertinent sampling information in field book and/or form.
14. Label sample and record on the chain-of-custody.

5.0 References

Vac-U-Tube Operating Instructions (available online):
http://www.skcinc.com/catalog/pdf/instructions/37101.pdf

Xitech's *Operating Instructions for Model 1060 1-Liter Bag Sampler (Rev 6-08)* (available online):
https://www.geotechnical.net/manuals/Xitech_1060_Manual.pdf

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Attachment 1
Vapor Intrusion Sampling Form

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	Conditions at Start of Sampling:	Conditions at End of Sampling:
Site:_____	Date / Time:_____	Date /Time:_____
Sample Point:_____	Outside Temp:_____°C or F	Outside Temp:_____°C or F
Building ID:_____	Wind____mph. Out of the _____	Wind_____mph. Out of the _____
Room ID:_____	Precip._____	Precip._____
Personnel:_____	Inside: Temp:_____°C or F	Inside: Temp:_____°C or F
Personnel:_____	HVAC:_____	HVAC:_____
	Operations:_____	Operations:_____

Type of Points (Circle all that apply):

Indoor Air Ambient Air Sub-Slab Vapor Soil Gas

Sample Type:

VOCs Radon

Sample type:

Summa Canister (6 liter) Summa Canister (1 liter) Tedlar bag (___ liter) HAPSITE

24-hr sample 12-hr sample 8-hr sample Grab other _____

Breathing Zone / Indoor Sample Intake Height from Floor: _____ Feet **or** Inches

Sub-Slab Data

Type of Sub-slab Point: NA Temporary Permanent Type of Probe:_____

Was shut-in test performed? Yes No

Leak testing performed? Yes No If yes by helium testing or Water or _____

Description of Sub-Slab System Purge:_____

Purge Rate: _____mL/min Amount Purged: _____ L

PID Screen: Ambient: _____ppm Purge Gas: _____ppm **or** Not Applicable

GEM 2000 Screen: Not Applicable

Ambient: ____ O_2% _____ CO_2% _____ CH_4% Purge Gas: ____ O_2% _____ CO_2% _____ CH_4%

Canister Sampling Records								
Zone	**Sample ID**	**Analytical Methods**	**Start Time/Date**	**Canister #**	**Flow Controller #**	**Initial Vac. (in Hg)**	**Stop Time/ Date**	**End Vac. (in Hg)**

Tedlar Bag Records						
Zone	**Sample ID**	**Analytical Methods**	**Sample Date/Time**	**Tedlar Bag Size**	**Approx. Volume Collected (cc/ml)**	**Percent Full**

Notes: SS = Sub-Slab BZ=Breathing Zone/Indoor AA=Ambient Air/Outdoor

Floor conditions: Concrete Wood Tile Carpet
Other:

Any cracks or utility breaches in this floor? Y / N
If Yes mark locations on sketch.

VOC Sources in area? Y / N
If Yes mark locations on sketch.

Other comments:

Was area photographed? Yes / No

Sketch of Sample Location

Procedure RC-VI-07
Tedlar Bag Screening using Direct-Reading Instrumentation

1.0 Introduction

This Standard Operating Procedure (SOP) identifies procedures to screen Tedlar bag samples using direct-reading instrumentation such as a field gas chromatograph/mass spectrometer (GC/MS) such as the HAPSITE, photoionization detector (PID), combustible gas meter, or other instrumentation.

NOTES:

- Operate all direct-reading instrumentation in accordance with the users' manual. The purpose of this SOP is not to provide step-by-step instructions for instrument operation. The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager prior to implementation.

2.0 Materials

- Tedlar bag sample, collected from the selected location
- Direct-reading instrumentation, including (but not limited) to any of the instruments below:
  - HAPSITE
  - PID
  - Flame-ionization detector (FID)
  - Combustible gas meter and /or landfill gas meter
  - Radon gas screening
  - Helium meter as part of a leak test
    - Sampling forms

3.0 Sampling Procedures

Selection of the Sampling Location

1. Locations will be identified by project personnel.
2. Upon selection of a sampling location, evaluate the area to identify potential sources for VOCs (e.g., combustion engines, exhaust vents, chemical storage lockers).

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3. Pertinent information will be documented on a field sampling form (Attachment 1):
4. Samples will be collected from the location (ambient air, sub-slab, etc.) using appropriate SOPs (e.g., RC-VI-01 and RC-VI-06), or using the purge procedures outlined in RC-VI-04.

4.0 Screening of Indoor Air (Direct Readings)

Purpose: To field screen areas for possible VOC sources

Notes:

- SOP RC-VI-03 identifies indoor air screening procedures for HAPSITE (or similar) equipment.
- Screening of indoor air can be conducted by utilizing direct read instruments and following the manufacturer's guidance. No sample device (Tedlar bag, Summa canister) is required.
- Areas of chemical storage (cabinets, closets, work stations) should be screened.
- Some chemicals my not show up on chemical inventories. For example common brake cleaner often contains tetrachloroethene and/or trichloroethene.
- Areas where vapors may migrate though the slab should be screened (cracks, conduit, drains)

5.0 Screening Procedures — Tedlar Bags

Purpose: To field screen samples collected in Tedlar bags

Notes:

- Because high VOC samples can saturate the columns of GC/MS it is recommended to first screen the sample with a PID or FID.
- Screening must be performed outdoors so that it does not introduce VOCs from beneath the slab to the indoor air that may pose as a health and safety risk or influence concurrent indoor air samples.

Note: Collect an ambient reading. Note: this does not have to be done for every sample but should be done to have a general understanding of what the background concentrations are.

1. Calibrate and ready the direct-reading instrument following procedures set forth appropriate users' manual. If using a PID, reference SOP 3-20 *Operation and Calibration of a Photoionization Detector*.

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2. Open the Tedlar bag containing the purged sub-slab soil gas by twisting the knob counterclockwise one full turn. If more than one direct-reading instrument will be used, the following order will be used:

PID/FID	Data will be used to gauge presence/absence and relative magnitude of VOC contamination relative to background. PID/FID data will always be collected first as a screening.
HAPSITE (or equivalent field gas chromatograph)	Data will be used to speciate specific VOCs and obtain screening level concentration data. **Note: IF PID/FID data show elevated concentrations, it may be necessary to dilute the sample to prevent saturation of the gas chromatograph instrumentation. Multiple dilutions may be required to obtain desired results.**
Secondary meter readings	Other meters, such as combustible gas meters, helium meters, radon meters, etc. may be used at the discretion of the project team. These data will be collected last if sufficient sample volume remains in the Tedlar bag.

3. Attach the Tedlar bag to the end of the direct reading instrumentation using a short piece of Tygon tubing. **Note:** Tygon is recommended only for making connections between devices; the length of Tygon connectors should be kept to a minimum.
4. Let the VOCs reading stabilize, then record the reading in the field book and on the field sampling form.
5. If there are no more readings that need to be taken from the Tedlar bag (see prioritization table, above), then let the pump of the PID evacuate the remaining soil gas from the Tedlar bag. When the Tedlar bag is almost empty, remove the Tedlar bag. Evacuate the remaining soil gas manually.

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Attachment 1
Field Sampling Form

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	Conditions at Start of Sampling:	Conditions at End of Sampling:
Site:_____	Date / Time:_____	Date /Time:_____
Sample Point:_____	Outside Temp:_____°C or F	Outside Temp:_____°C or F
Building ID:_____	Wind____mph. Out of the _____	Wind_____mph. Out of the _____
Room ID:_____	Precip._____	Precip._____
Personnel:_____	Inside: Temp:_____°C or F	Inside: Temp:_____°C or F
Personnel:_____	HVAC:_____	HVAC:_____
	Operations:_____	Operations:_____

Type of Points (Circle all that apply):

Indoor Air Ambient Air Sub-Slab Vapor Soil Gas

Sample Type:

VOCs Radon

Sample type:

Summa Canister (6 liter) Summa Canister (1 liter) Tedlar bag (___ liter) HAPSITE

24-hr sample 12-hr sample 8-hr sample Grab other _____

Breathing Zone / Indoor Sample Intake Height from Floor: _____ Feet **or** Inches

Sub-Slab Data

Type of Sub-slab Point: NA Temporary Permanent Type of Probe:_____

Was shut-in test performed? Yes No

Leak testing performed? Yes No If yes by helium testing or Water or _____

Description of Sub-Slab System Purge:_____

Purge Rate: _____mL/min Amount Purged: _____ L

PID Screen: Ambient: _____ppm Purge Gas: _____ppm **or** Not Applicable

GEM 2000 Screen: Not Applicable

Ambient: ____ O_2% _____ CO_2% _____ CH_4% Purge Gas: ____ O_2% _____ CO_2% _____ CH_4%

Canister Sampling Records								
Zone	**Sample ID**	**Analytical Methods**	**Start Time/Date**	**Canister #**	**Flow Controller #**	**Initial Vac. (in Hg)**	**Stop Time/ Date**	**End Vac. (in Hg)**

Tedlar Bag Records						
Zone	**Sample ID**	**Analytical Methods**	**Sample Date/Time**	**Tedlar Bag Size**	**Approx. Volume Collected (cc/ml)**	**Percent Full**

Notes: SS = Sub-Slab BZ=Breathing Zone/Indoor AA=Ambient Air/Outdoor

Floor conditions: Concrete Wood Tile Carpet
Other:

Any cracks or utility breaches in this floor? Y / N
If Yes mark locations on sketch.

VOC Sources in area? Y / N
If Yes mark locations on sketch.

Other comments:

Was area photographed? Yes / No

Sketch of Sample Location

Procedure RC-VI-08
Differential Pressure Measurements for VI Investigations

1.0 Introduction

The objective of this Standard Operating Procedure (SOP) is to identify procedures to provide data for measuring pressure differences between a building interior and beneath the building slab (i.e., sub-slab).

Note: The procedures outlined in this SOP should be reviewed prior to field activities. Any field modifications to this SOP should be reviewed to determine potential impacts on data quality objectives, documented by the Field Team Leader, and approved by the Project Manager <u>prior to implementation</u>.

2.0 Materials

- Differential Pressure Recorder (Note: While VelociCalc Model 9565-P is described in this document the OmniGuard 4 Differential Pressure Monitor is also included.)
  - VelociCalc Model 9565-P Air Velocity Meter (specify when ordering that the meter can be operated by an AC power source) http://www.tsi.com/uploadedFiles/_Site_Root/Products/Literature/Manuals/9565-VelociCalc-6004851-web.pdf.
  - OmniGuard 4 Differential Pressure Monitor (this are AC powered only and record differential pressure only)
- An extension cord to connect the VelociCalc to an electrical outlet (note that batteries can also be used as a power source but typically will last less than 10 hours of operation with the standard batteries in the unit).
- The following equipment to connect the VelociCalc to the sub-slab probe (i.e., Vapor Pin):
- Tygon tubing
- Scissors or tubing cutter to cut tubing

3.0 Sampling Procedures

1. Install the sub-slab probe (i.e., Vapor Pin) in accordance with SOP RC-VI-04 *Sub-slab Soil Gas Probes Installation and Leak Check* (Resolution Consultants 2015) and the Cox-Colvin & Associates, Inc. *Installation and Extraction of the Vapor Pin* (Cox-Colvin 2015).
2. Differential pressure data logging (using the VelociCalc 9565-P instrument) can be performed at one or more locations in a building. Set up the pressure monitor in accordance

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with the manufacturer's instructions. Also ensure the time and date on the meter are set to the time zone of the site.

3. Attach tubing from the sub-slab sampling probe (i.e., Vapor Pin) to the **negative** inlet port. The **positive** inlet port will remain open to indoor air and does not require tubing.
4. Follow the manufacturer's instructions to set up the VelociCalc for data logging. After startup, the pressure monitoring will record the minimum and maximum pressures. The logging interval can be set from 1 second to 1 hour. For most 24-hour sampling tests, the logging interval should be set at 15 minutes. Also, ensure the following parameters are being recorded:
   - Differential Pressure (inches of water [in H_2O])
   - Barometric Pressure (inches of mercury [in Hg])
   - Temperature (degrees Fahrenheit [^oF])
   - Humidity (%rh)
5. After pressure monitoring is complete, follow the manufacturer's instructions to download the differential pressure log, barometric pressure log, temperature log, and humidity log to a personal computer for data reduction. Data reduction is discussed in the following section.

4.0 Data Reduction and Evaluation

The VELOCICALC Model 9565 comes with special software called TRAKPRO Data Analysis Software. The VELOCICALC Model 9565 also includes downloading software called LogDat2. LogDat2 software transfers the stored data from the Model 9565 to a computer as a spreadsheet file. Follow the manufacturer's instructions to install the software on the computer. Different software is available for different equipment; see the manufacturer's instructions.

To download data from the Model 9565, connect the supplied computer interface USB cable to the Model 9565 and to a computer USB port. Any USB port can be used.

Once the data is downloaded, follow manufacturer's instructions for data reduction and evaluation.

5.0 References

VelociCalc Model 9565-P manual available online:
http://www.tsi.com/uploadedFiles/_Site_Root/Products/Literature/Manuals/9565-VelociCalc-6004851-web.pdf
Omniguard 4 Differential Pressure Monitor manual available online: http://omnitecdesign.com/wp-content/uploads/2014/05/OG4man.pdf

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Standard Operating Procedure Installation and Extraction of the Vapor Pin™

Updated April 3, 2015

Scope:

This standard operating procedure describes the installation and extraction of the Vapor Pin™ for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin™ for the collection of sub-slab soil-gas samples or pressure readings.

Equipment Needed:

- Assembled Vapor Pin™ [Vapor Pin™ and silicone sleeve(Figure 1)]; Because of sharp edges, gloves are recommended for sleeve installation;
- Hammer drill;
- 5/8-inch (16mm) diameter hammer bit (hole **must** be 5/8-inch (16mm) diameter to ensure seal. It is recommended that you use the drill guide). (Hilti™ TE-YX 5/8" x 22" (400 mm) #00206514 or equivalent);
- 1½-inch (38mm) diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch (19mm) diameter bottle brush;
- Wet/Dry vacuum with HEPA filter (optional);
- Vapor Pin™ installation/extraction tool;
- Dead blow hammer;
- Vapor Pin™ flush mount cover, if desired;
- Vapor Pin™ drilling guide, if desired;
- Vapor Pin™ protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel for repairing the hole following the extraction of the Vapor Pin™.

Figure 1. Assembled Vapor Pin™

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch (38mm) diameter hole at least 1¾-inches (45mm) into the slab. Use of a Vapor Pin™ drilling guide is recommended.

4) Drill a 5/8-inch (16mm) diameter hole through the slab and approximately 1-inch (25mm) into the underlying soil to form a void. Hole **must** be 5/8-inch (16mm) in diameter to ensure seal. It is recommended that you use the drill guide.

Vapor Pin™ protected under US Patent # 8,220,347 B2

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of Vapor Pin™ assembly into the drilled hole. Place the small hole located in the handle of the installation/extraction tool over the Vapor Pin™ to protect the barb fitting, and tap the Vapor Pin™ into place using a dead blow hammer (Figure 2). Make sure the installation/extraction tool is aligned parallel to the Vapor Pin™ to avoid damaging the barb fitting.

Figure 2. Installing the Vapor Pin™.

During installation, the silicone sleeve will form a slight bulge between the slab and the Vapor Pin™ shoulder. Place the protective cap on Vapor Pin™ to prevent vapor loss prior to sampling (Figure 3).

Figure 3. Installed Vapor Pin™

7) For flush mount installations, cover the Vapor Pin™ with a flush mount cover, using either the plastic cover or the optional stainless-steel Secure Cover (Figure 4).

Figure 4. Secure Cover Installed

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to re-equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the Vapor Pin™. This connection can be made using a short piece of Tygon™ tubing to join the Vapor Pin™ with the Nylaflow

tubing (Figure 5). Put the Nylaflow tubing as close to the Vapor Pin as possible to minimize contact between soil gas and Tygon™ tubing.

Figure 5. Vapor Pin™ sample connection.

10) Conduct leak tests in accordance with applicable guidance. If the method of leak testing is not specified, an alternative can be the use of a water dam and vacuum pump, as described in SOP Leak Testing the Vapor Pin™ via Mechanical Means (Figure 6). For flush-mount installations, distilled water can be poured directly into the 1 1/2 inch (38mm) hole.

Figure 6. Water dam used for leak detection

11) Collect sub-slab soil gas sample or pressure reading. When finished, replace the protective cap and flush mount cover until the next event. If the sampling is complete, extract the Vapor Pin™.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the Vapor Pin™ (Figure 7). Continue turning the tool clockwise to pull the Vapor Pin™ from the hole into the installation/extraction tool.

2) Fill the void with hydraulic cement and smooth with a trowel or putty knife.

Figure 7. Removing the Vapor Pin™.

3) Prior to reuse, remove the silicone sleeve and protective cap and discard. Decontaminate the Vapor Pin™ in a hot water and Alconox® wash, then heat in an oven to a temperature of 265° F (130° C) for 15 to 30 minutes.

The Vapor Pin™ to designed be used repeatedly, however, replacement parts and supplies will be required periodically. These parts are available on-line at VaporPin.CoxColvin.com.

Standard Operating Procedure Leak Testing Vapor Pin™ Via Mechanical Means

December 3, 2013

Scope:

The operating procedure describes the methodology to test a Vapor Pin™ or equivalent sub-slab sampling device and sample train for leakage of indoor air. Mechanical leak testing is generally simpler and less costly than testing with tracer gases such as helium, but relevant state, program, or other guidance documents should be consulted to determine if a specific type of leak test is needed.

Purpose:

The purpose of this procedure is to ensure that indoor air does not leak past the Vapor Pin™ or associated tubing and hardware and dilute the sub-slab soil gas sample with indoor air.

Equipment Needed:

Stick-up installation: 2-inch diameter plastic pipe couple, Play-Doh, Sculpey, or modeling clay (clay) free of volatile organic compounds (VOCs). Stick-up and flush-mount installations: distilled water; Vapor Pin™; vacuum pump (hand-operated or peristaltic); vacuum gauge; stopcock; and sample train, including sample tubing, tee fittings, vacuum gauge and other hardware, and sample container.

Procedures:

1. Drill a 5/8" diameter hole in the concrete slab and install the Vapor Pin™ as per the Standard Operating Procedure (SOP). For a flush-mount installation, drill the 1-1/2" diameter hole first, and follow Use of the Vapor Pin™ Drilling Guide and Secure Cover. Testing evacuated ("Summa") canisters and regulators in accordance with ASTM standard D7663-11 or Restek Corporation's *A Guide to Whole Air Canister Sampling* prior to starting field work eliminates most risk of leakage when sampling with the Vapor Pin™.

2. Install the Vapor Pin™ as described in the SOP Installation and Extraction of the Vapor Pin™.

3. Clean the slab within a 2-inch radius of the Vapor Pin™ to remove all dust. Avoid wetting the concrete or wait until the concrete is dry before proceeding, and avoid cleaning with VOC-containing substances. A whisk broom or shop vacuum is recommended. Remaining dust can be picked up with a scrap of clay.

4. For a flush-mount installation, water is poured directly into the 1-1/2" depression without the need for a water dam - proceed to the next step. For a stick-up installation, roll a 1-inch diameter ball of clay between your palms to form a "snake" approximately 7 inches long and press it against the end of the 2" pipe couple. Push the couple against the slab to form a seal between the pipe and the concrete. Notice that water soluble clays such as Play-Doh may absorb enough water to be unsuitable for tests lasting more than one hour.

5. Assemble the sample train (tubing, sample canister, tee fittings, stopcock, vacuum pump, etc.) separately from the Vapor Pin™ and impose a vacuum of 15" mercury equivalent (in Hg). Close the stopcock and verify that the sample train can hold a vacuum for one to five minutes with no more than 0.5 in Hg loss of vacuum. Depending on sample configuration, the stopcock might or might not remain in the sample train during sampling. An example is shown in Figure 1.

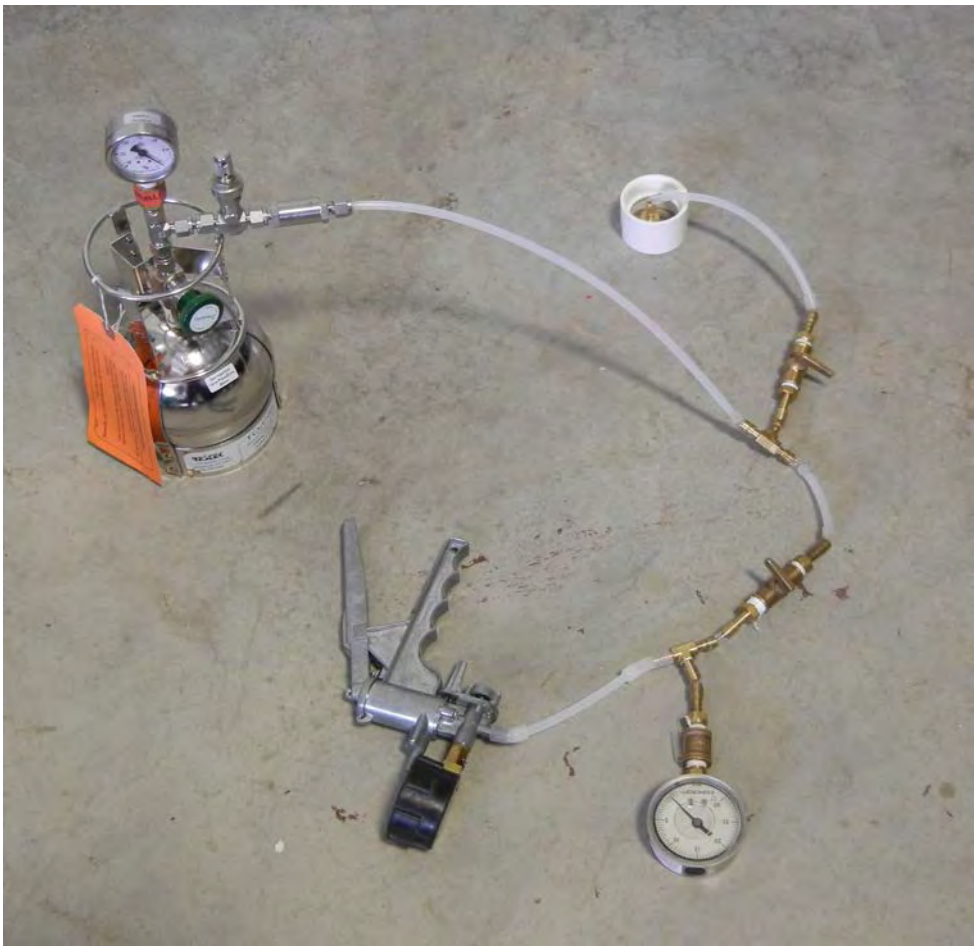

Figure 1. Example of Sub-Slab Sampling and Leak-Test Setup

6. Attach the sample tubing to the top of the Vapor Pin™ and pour enough distilled water into the pipe couple or flush-mount depression to immerse the tubing connection to the Vapor Pin™.

7. Purge and sample the sample point as required by the data quality objectives. Water level might drop slightly due to absorption into the concrete, but if there is a sudden drop in water level, the appearance of water in sample tubing, or other indication of water entering the sub-slab, remove the distilled water from the couple or depression, and reposition the Vapor Pin™ to stop the leakage before resuming the leak test and sampling. In Figure 1, the stopcocks are used to isolate the Vapor Pin™ during vacuum testing and subsequently to allow the vacuum gauge and hand pump to be removed prior to sampling.

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Summary of the Methods

For analysis, the start button on the sampling wand is pressed, the internal pump pulls the sample through the instrument for 30-60 seconds to purge the lines. After the purge is complete, the valve is automatically switched to the fill position which sweeps the sample across a microtrap concentrator. The microtrap concentrator uses a small bed of absorbent material to trap VOCs. The length of time the sample is swept over the concentrator will be determined prior to field deployment, and will be sufficient to achieve the reporting limits listed in the table below. Airflow through the trap is then reversed as it is heated at a rate of 800°C/min. and then the trapped analytes are flash desorbed onto the GC column for separation and identification.

Gas chromatography provides separation of a wide range of chemicals that may be present in a single sample. Following separation, the compounds are sent through a mass spectrometer that provides definitive identification of each compound in the sample by breaking the compounds into ions, and comparing the ion fingerprint using the NIST library.

The instrument also has a survey mode that bypasses the GC and concentrator for direct MS screening. This allows the instrument to constantly pull a sample and scan for specific chemicals of concern in a ppmv range.

TABLE 1: HAPSITE APPROXIMATE REPORTING LIMITS

Compound	CAS Number	Quant Mass	Hapsite Reporting Limit (ppbv)
Vinyl Chloride	75-01-4	62	1.0
1,1,2,2-Tetrachloroethane	79-34-5	83	0.20
cis-1,2-Dichloroethene	156-59-2	61	0.20
Methylene Chloride	75-09-2	49	1.0
Trichloroethylene	79-01-6	95	0.20
1,1-Dichloroethylene	75-35-4	61	0.20
1,1,2-Trichloroethane	79-00-5	97	0.20
1,2-Dichloroethane	107-06-2	62	0.20
Chlorobenzene	108-90-7	112	0.20
Benzene	71-43-2	78	0.20
1,3-Dichlorobenzene	541-73-1	146	0.20

Initial Calibration

The initial calibration will contain a minimum of 3 levels consisting of the analytes of interest listed in Table 1. The low level will be 1 ppb which is equal to the reporting limit for this project. The highest level should encompass the linear range of the instrument or the highest concentration of the samples expected. Acceptance criteria for the initial calibration are 30% relative standard deviation (%RSD).

Corrective action for the initial calibration is to investigate the outlying level and reanalyze that level. If the problem is not corrected, it may be necessary to remake the standard or correct the problem with the instrument and reanalyze all levels.

Detection Limits

To determine the method detection limits, a low level calibration standard will be analyzed as part of the initial calibration.

Proper QA/QC Procedures

Table 2: Quality Control

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tune Check	Every 12 Hours	Ion Abundance Criteria as Determined by Manufacturer	Adjust Tune Until Meets Criteria
3 – Point (Minimum) Calibration	Prior to start of project or as required for acceptance criteria	%RSD ≤ 30%	Re-run Levels Which Do Not Meet Criteria
Lab Duplicates (If Requested)	10% of the Samples	Relative Percent Difference ≤ 30%	1) Analyze a third Aliquot 2) Flag Reported Data
Method Blank	Before Beginning of Day	Concentrations for All Calibrated Compounds < PQL	Re-run Blanks until Criteria are Met

Beginning of Day Tune Verification

The tune verification should meet manufacturer specifications, and repeated every 12 hours before the analysis of any samples. The tune verification will be repeated each time the instrument is moved or powered down for any reason.

Corrective action for the tune verification is to reanalyze the tune. If it continues not meet criteria, then the tune will be adjusted and saved manually.

Method Blank

The method blank should be analyzed before any samples. A blank should also be analyzed after any sample with concentrations exceeding the calibration range by 10%. The blank acceptance criteria are that no compounds are detected above the reporting limit.

Corrective action for the method blank is to reanalyze the blank. If the system is still not clean, take actions to remove the contaminants and reanalyze the blank. The blank must be clean before proceeding unless agreed upon with the client.

Duplicates

Laboratory duplicates should be performed on a frequency of 10% of the total samples. The sample chosen to duplicate should contain concentrations of targets if possible.
The acceptance criteria are 30% relative percent difference (% RPD).
Corrective action for the duplicate is to reanalyze the sample. If criteria are still not met, results must be flagged.

SUGGESTED OPERATING PROCEDURE

HIGH VOLUME SUB-SLAB SOIL GAS SAMPLING

Geosyntec Consultants, Inc.

Rev: August 2015

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1 INTRODUCTION

This document describes a suggested operating procedure (SOP) for High Volume Sampling (HVS) sampling. HVS consists of extracting a large volume of soil gas from beneath the floor slab of a building to improve the conceptual understanding of total volatile organic compound (TVOC) distribution in soil gas as well as the pneumatic properties of the sub-slab material and the slab itself. Extracted soil gas is screened periodically throughout the purge to assess the trend of concentration as a function of the volume removed to provide insight into the spatial distribution of vapors at progressive distances away from the point of extraction. This approach minimizes the risk of failing to identify discrete VOC sources that may exist between discrete sample locations, and can be used to focus a soil gas investigation in a large building with many fewer holes drilled through the floor when compared to traditional investigation techniques. The new method also involves monitoring the extraction flow rate and transient vacuum response for mathematical analysis to help interpret the vapor concentration data and to support an optimal design for a sub-slab mitigation system, if needed.

2 SYSTEM CONSTRUCTION FOR SUB-SLAB PROBES

The HVS test equipment will be assembled as shown on Figure 1. The extraction fan may vary in size depending on the permeability of the sub-surface material, but will be capable of flow rates up to about 3 m3/min (100 standard cubic feet per minute (scfm)) (high flow radon fans and Shop-Vac fans are generally appropriate). A sample port and vacuum gauge will be located near the inlet of the system.

An in-line flow-through cell or sample port can either house a passive quantitative sampler or connect to a Summa canister to collect a sample for laboratory analysis. A four-foot section of 2-inch diameter PVC pipe extends from the flow-through cell to provide measurement of the flow rate with an anemometer. A bleed valve is located before the extraction fan, and can be opened to meter the flow and vacuum on the probe. The extracted gas is discharged outside of the building via a discharge line. Carbon vessels may also be used to treat the extracted gas. Details on the proper installation of SSP can be found in the suggested operating procedure for Soil Gas Probe and Sub-slab Probe Installation.

3 SYSTEM OPERATION

The HVS test consists of pumping at consistent flow rate from a sub-slab probe for a period sufficient to remove soil gas from the region surrounding the probe to a significant distance and monitoring the concentration of extracted VOC vapors as a function of time. In the case where leakage is minimal, the radius (r) to which gas is withdrawn can be estimated assuming that the flow comes from all directions through the gravel layer as $r = (V/(\pi\ h\ \theta a))^{0.5}$, where V is the

volume of gas extracted, h is the vertical thickness of the granular fill layer, and θa is the air-filled porosity of the granular fill. Assuming a standard 6-inch thick gravel layer and an air-filled porosity of 30% beneath a relatively intact concrete floor slab yields most of the soil gas flow, a HVS test can extract soil gas from a radius of about 10 to 20 meters (m) from the point of extraction within about one to two hours.

The duration of each test depends on the radius of interest (which depends on the size of the building, and spacing between sampling points) and the flow rate, which depends on permeability of the soil beneath the slab. These factors vary for each test, so the duration also varies. For example, if the radius of interest is 10 m, the target extraction volume would be about 14,000 liters, which can be removed in less than a half-hour at flow rates of 470 liters per minute (about 17 standard cubic feet per minute (scfm)), which is typically achievable with a high flow radon fan. Research has shown that TVOC concentrations in sub-slab soil vapor are relatively insensitive to the flow rate during sampling (Creamer and McAlary, 2006); therefore, high flow rates are not considered incompatible with accurate measurement of concentrations.

4 SOIL GAS SAMPLE COLLECTION AND ANALYSIS

Samples of the extracted soil gas extracted periodically throughout the purge will be screened using a portable photoionization detector (PID), calibrated according to manufacturer's instructions. The calibrations should be confirmed at least once during; if the PID shows more than 10% drift against the standard gas, or more than +/- 1 ppmv on the zero gas, the instrument should be recalibrated. Samples can also be screened for carbon dioxide, oxygen and methane using a landfill gas meter.

Soil gas samples will be collected by attaching a lungbox to the sample port and filling a 1-liter Tedlar bag. The field screening reading will be collected by connecting the Tedlar bag to the meter and allowing the meter to draw a sub-sample at ambient pressure.

Samples may be collected for laboratory analysis to supplement the field-screening data. This can be accomplished several ways: 1) a composite sample (discrete portions or aliquots collected intermittently during the test), 2) a slip-stream sample (a continuous flow drawn as a small fraction of the extracted gas throughout the test), or 3) a passive sample (permeation sampler in a flow-through cell collected continuously throughout the test).

5 TRANSIENT ANALYSIS

Leakage of air through discontinuities in the floor slab (e.g., unsealed cracks, expansion joints, patches, and floor drains) will reduce the radius of influence and dilute the extracted soil gas, therefore, it is important to quantify the amount of leakage. This can be accomplished by collecting and analyzing transient vacuum response data (cycling the extraction fan or blower on

and off, while recording vacuum response and recovery at a nearby sub-slab probe using a pressure transducer with a data-logger). This process takes only a few minutes and provides sufficient information to assess slab leakage and provide design parameters for a mitigation system, if desired.

At least one monitoring point is needed—typically in the range of 3 to 10 m from the extraction point. The monitoring point can be a small diameter drilled hole, which penetrates the slab and the gravel layer, and allows a tube to be sealed into the floor with an air-tight seal of swelling cement or modeling clay. Additional monitoring points at various distances (e.g., 1, 3 and 10 m in various directions) are valuable for an independent line of evidence to verify the mathematical model. It may also be beneficial to install monitoring points in different directions from the point of extraction in order to assess whether the response to vapor extraction is symmetrical or is influenced by barriers (e.g. footings), preferential pathways (e.g. utility lines), or other heterogeneities in the sub-slab.

Transient analysis data is collected by attaching a micromanometer with data-logging capabilities to a monitoring point. The extraction fan is then cycled on and off a few times to record the vacuum response. Data is then assessed using the semi-confined (leaky) aquifer model (Hantush and Jacob, 1955) which provides the transmissivity of the gravel layer and the leakance into the sub-slab gravel layer.

6 CHAIN OF CUSTODY AND SAMPLE HANDLING

Sample media will be re-packaged in the shipping materials provided by the laboratory. Information to record includes: site name, sample ID #, sampler's name, project code, date and sample start time and end time, sample flow rate, and analysis requested. A chain of custody (COC) form will be completed with each sample shipment. The COC will include the sample ID, sampler ID, analysis requested, and sample duration, and special instructions. Passive quantitative samplers and Summa canisters do not need to be refrigerated, but should be shipped with sufficient padding to prevent damage if the container is accidentally dropped.

7 DOCUMENTATION

Field documentation should include: instrument calibration, date, time and location(s) of readings, static pressure readings, purging rate and vacuum induced, number of Summa canisters filled, sampler's name(s), chain-of-custody forms for samples collected and a description of the equipment used for each location. Photographs will aid in recording equipment set-up.

For each sampling day, the following information will be recorded on the field forms:

- name and number of project;

- name of field personnel;
- date and time of sampling event;
- list of the primary activities performed;
- identification of probes tested;
- field screening readings on purged gas;
- time when soil gas screening samples were collected;
- relevant attendant information (e.g., weather, attendees, equipment problems, departures from procedures and the reasons and responses);
- field instrument information and calibration data; and
- time and reading for each instrument calibration check.

8 REFERENCES

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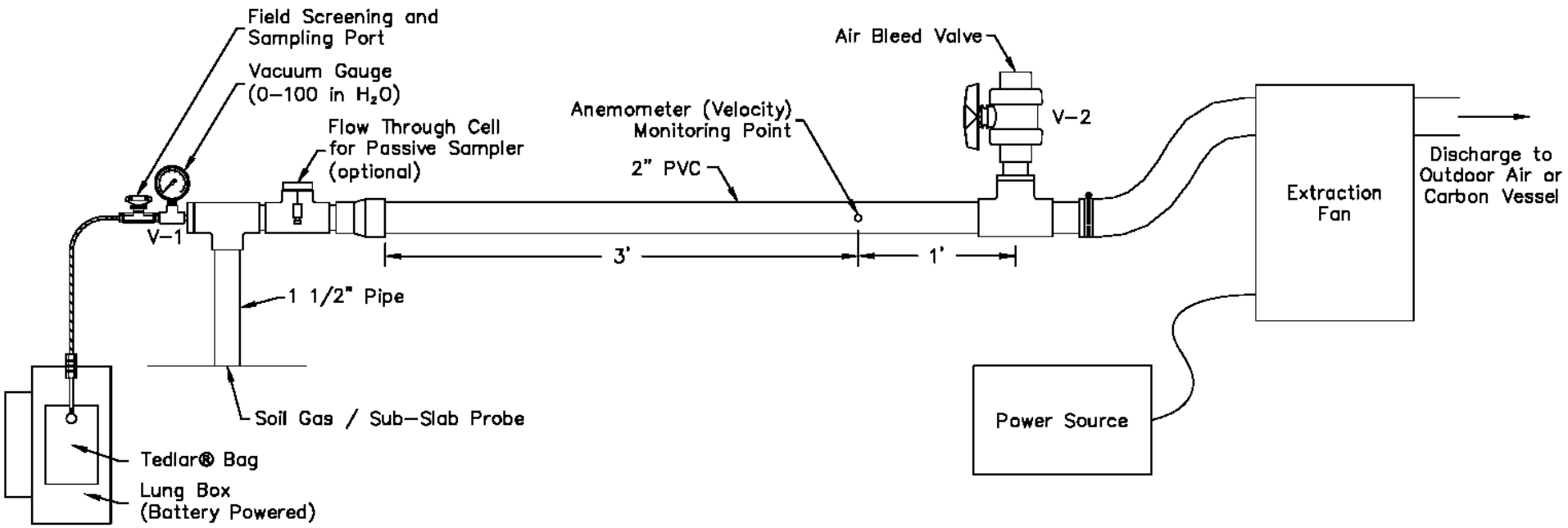

Legend

Ball Valve

New Nyloflow® Tubing

High Purge Volume Test Assembly

Geosyntec consultants

Guelph | August 2009

Figure 1

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Appendix B
Laboratory Standard Operating Procedures

ALS Standard Operating Procedure

DOCUMENT TITLE:	CLEANING AND CERTIFICATION OF SUMMA CANISTERS AND OTHER SPECIALLY PREPARED CANISTERS
REFERENCED METHOD:	N/A
SOP ID:	SMO-CAN_CERT
REV. NUMBER:	16.0
EFFECTIVE DATE:	04/30/2015

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ALS Environmental

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STANDARD OPERATING PROCEDURE

CLEANING AND CERTIFICATION OF SUMMA CANISTERS AND OTHER SPECIALLY PREPARED CANISTERS

SOP ID:	SMO-Can_Cert	Rev. Number:	16.0	Effective Date:	04/30/2015

Approved By: _____ Date: 4/21/15
Operations Manager – Chris Parnell

Approved By: _____ Date: 4/21/15
QA Manager – Chaney Humphrey

Approved By: _____ Date: 4/21/15
Laboratory Director – Kelly Horiuchi

Archival Date: _____ Doc Control ID#: Non-Controlled Editor: _____

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CLEANING AND CERTIFICATION OF SUMMA CANISTERS AND OTHER SPECIALLY PREPARED CANISTERS

1) Scope and Applicability

1.1 This document describes the procedures required to prepare all passivated containers, including stainless steel canisters and glass bottles, for sample collection and use within the laboratory. It outlines the steps necessary to internally clean the containers (all volumes) and document their acceptability for re-use. Also included are procedures for leak checking, evaluation of the condition of canisters, canister repair, and maintenance of the cleaning apparatus. Canister cleaning and certification is needed to ensure that each sampling container is free of contaminants and leaks that could jeopardize the integrity of the analytical data. The process must uniformly and consistently render each canister clean enough to meet the criteria for all of the relevant test methods.

2) Summary of Procedure

2.1 After all analyses are complete on the canister sample in question, the analyst records the identification and concentration level of the most prominent compounds found in the sample on the sample identification tag. This includes not only target compounds from the analytical methods, but tentatively identified compounds and any anomalous observations. Only after the corresponding data is reviewed and approved including verification that all reporting and QA/QC requirements are met are the canisters released for cleaning and certification.

2.2 First, the canisters are pre-purged to remove the bulk of the sample from each canister. Then they are placed on a cleaning manifold (the manifold may be located inside an oven), canisters not placed in the oven shall be fitted with heating bands at 120˚C to 140ºC. All canisters connected to the cleaning manifolds shall be evacuated to under 100 millitorr. The canisters are then serially filled and evacuated with humidified nitrogen. Following the cleaning process, a minimum of one canister per batch (10 to 16 canisters) is selected as the quality control (QC) canister. The canister(s) is analyzed by EPA Method TO-15 in accordance with the *SOP for Determination of Volatile Organic Compounds in Air Samples Collected in Specially Prepared Canisters and Gas Collection Bags by Gas Chromatography/Mass Spectrometry (GC/MS).*

2.3 Following the cleaning procedure, the canisters are pressurized to approximately 10 psig and held for a minimum of 24 hours to determine if any leaks exist. The pressure of each canister is evaluated using a calibrated pressure/vacuum gauge and the results recorded. All canisters that pass both the batch analyte concentration QC and individual leak check are certified and ready for use.

3) Definitions

3.1 Summa Canister A stainless steel air sampling canister whose inner surface has been electropolished by the proprietary "Summa" process to provide chemical inertness.

3.2 Silonite® Canister A stainless steel canister that has had the interior passivated with a fused-silica coating (Entech Instruments).

3.3 psig pounds per square inch gauge

3.4 GC/MS Gas Chromatography/Mass Spectrometry

3.5 ppbv parts per billion, volume

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3.6 ppmv parts per million, volume

3.7 Pressurized Air Zero grade with <0.1ppmv of total hydrocarbons

3.8 QC Canister This is a quality control canister selected and analyzed in order for the cleaning batch to be certified as clean. There may be more than one canister selected within a cleaning batch to serve as a QC canister and this is dependent on a number of factors each of which are included in this standard operating procedure.

3.9 Standard Canister This is a canister labeled for containing standards; they are segregated from source and ambient canisters and are not to be sent to clients. Standard canisters may only be cleaned with other standard canisters on the manifolds. The most contaminated canister is analyzed in order to determine if the cleaning batch is to be certified as clean. There may be more than one canister selected within a cleaning batch to serve as a QC canister and this is dependent on a number of factors each of which are included in this standard operating procedure.

4) Health and Safety Warnings

4.1 Burns

Caution must be exercised when working around the canister cleaning system because of the potential for burns from the canister heating bands and the manifold tubing heating coil as these temperatures are often near 100˚C. The oil from the vacuum pumps is also hot enough to cause burns when operating at normal system temperatures. The operator should wait for the oil to cool prior to attempting to change the pump oil.

4.2 Contaminated Pump Oil

Besides the burn hazard, contact with used oil from the vacuum pumps should be avoided since it becomes contaminated during normal use with toxic organic residues from the summa canisters. Proper attire must be worn when working with used pump oil that must be disposed of as hazardous waste in accordance with the *SOP for Waste Disposal* and applicable regulations.

4.3 Electrical Shock

All electrical wiring should be periodically checked for insulation cuts and chafing as electrical shock can occur from exposed wires. If an exposed metal wire is discovered, it must be repaired immediately.

4.4 Fires

All flammable materials, especially solvents, shall be kept clear of the cleaning manifold and pumps since the canister heaters generate considerable heat. Also, all plugs must be securely seated in their receptacles.

4.5 Hydrochloric acid (HCl)

When Hydrochloric acid is used to prepare acidified water for manual cleaning, special care must be taken. Always wear protective eyewear and gloves when handling. Prepare mixture in a hood and keep tightly capped when transporting. Hydrochloric acid is a severe health and contact hazard.

4.6 Pollution Prevention and Waste Management

Activated Alumina and pump oil is considered hazardous waste and must be disposed of in accordance with the *SOP for Waste Disposal.* Air purged from canisters via the vacuum pumps is discharged to an outside hood.

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5) Cautions

5.1 Preventive maintenance is one of the best ways to keep the conditioning systems running optimally. Maintenance log entries made into LIMS must be made each time work is performed on a system no matter the extent. Types of maintenance activities include: changing pump oil, changing in-line foretrap activated alumina media, and replacing worn ferrules.

LIMS stores system maintenance information which must remain current. An entry shall be made into LIMS every time maintenance is performed (no matter the extent). The log entry must include:

(a) The date of maintenance
(b) Who did the maintenance
(c) Description of the maintenance
(d) Proof that the maintenance activity was successful

A notation of a successful QC may serve as proof that the maintenance is complete and the system is in working order. The extent of the maintenance is not important, however, it is important that a notation be included for each maintenance activity.

5.2 Vacuum System

The mechanical vacuum pumps used in the canister cleaning system require periodic maintenance. The pump oil must be changed regularly, every *three months* or when the pump will no longer evacuate the system efficiently, whichever is more frequent. The pumps may also need to be returned to the manufacturer for rebuilding if they fail to perform to the necessary specifications.

Preventive Maintenance Schedules are as follows:

Rotary Vane Vacuum Pumps/Change Oil.....3 MONTHS
Foretraps/Change activated alumina media.....3 MONTHS

Diaphragm Dry Pumps/Replace diaphragms.....1 YEAR or as needed
Molecular Drag Pumps/Replace bearings.....As needed

5.2.1 Procedure for Changing Pump Oil

- Make sure there is a sufficient amount of fresh pump oil before the oil change begins.
- Wear safety glasses and gloves when changing oil.
- Set the control software to “EVAC ON”
- Open one position on the manifold so that air is pulled through the pump.
- Turn vacuum pump power switch to the off position and remove the power cord from the electrical outlet.
- Vent the pump from above the foreline trap.
- Detach the inlet and exhaust tubing from the pump.
- Place pump on a sturdy level surface and remove both fill and drain plugs.
- The pump oil is extremely hot and can cause severe burns. If possible, turn the pump off and let it sit for approximately 20 minutes to let the heat dissipate from the pump.
- Drain the oil into an appropriate hazardous waste container. Lift the motor end of the pump to get most of the used oil from the pump housing.
- Check for oil leaks at the pump seals and gaskets (*between the motor and the pump*), also at the drain and fill plugs.
- Install the drain plug and slowly refill with fresh vacuum pump oil.

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- The vacuum pumps use a sight glass to measure the amount of oil in the pump. Fill to the designated mark on the sight glass and install the fill plug.
- Apply vacuum and exhaust tubing. Plug in the power cord into the electrical outlet and turn on power switch.
- The vacuum pump will take about an hour to prime to full vacuum.

5.2.2 Procedure for Changing Activated Alumina

- Make sure there is a sufficient amount of fresh activated alumina before the change begins.
- Wear gloves when handling the fore trap and the activated alumina.
- Set the control software to "EVAC ON"
- Open one position on the manifold so that air is pulled through the pump.
- Turn vacuum pump power-switch to the off position and remove the power cord from the electrical outlet.
- Vent the manifold from one of the canister positions with the evacuation valve open.
- Detach the inlet and exhaust tubing from the pump.
- Unscrew the cap from the fore trap and extract the activated alumina media holder. Unscrew the wing nut and remove the cover.
- Dispose of the used activated alumina as hazardous waste and refill the holder with fresh media.
- Install the cover and tighten the wing nut to the top of the holder. Place the media holder back inside of the fore trap and tighten the cap to the fore trap.
- Apply vacuum and exhaust tubing.
- Plug in the power cord into the electrical outlet and turn on power switch.
- The vacuum pump will take about an hour to prime to full vacuum.

5.3 Dry Pump Diaphragm Replacement

- Refer to the manufacturer's user's manual for detailed repair procedures. Replacement kits are available from VWR Inc.

  Models used: Vacuubrand MZ2, MZ2NT, and MD4

5.4 Oil Contamination

When canisters are cleaned on the conditioning manifolds, contaminates tend to remain in the pump oil and the activated alumina fore trap. This is normal and will not affect the normal workings of the pump and the conditioner. Occasionally, a canister will be conditioned that has high concentrations of a compound and will overwhelm the conditioning system. When this contamination occurs, the pump oil and the fore trap media must be changed. Additional conditioning cycles may be needed to purge the remaining contamination from the system. High contamination scenarios must be entered into LIMS.

5.5 Gas Source with Hydrocarbon Trap and Humidifier

- The step down pressure from the bulk nitrogen tank should be set to a minimum of 15psig.
- The water level in the humidifier should always be visible in the tubing and filled with ASTM Type II water or equivalent, such as boiled deionized water. When the water is low it shall be filled to the point where at least one inch of water is showing in the tubing.

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6) Interferences

6.1 Not Applicable

7) Personnel Qualifications and Responsibilities

7.1 It is the responsibility of all canister cleaning department technicians to accurately perform the procedures of this SOP and to complete applicable training documentation. Documented training plans must be completed by the trainee and trainer before submitting to the Quality Assurance department for final approval. This paperwork will be maintained by the QA department in an employee training file.

7.2 Training shall be conducted in accordance with the *SOP for Training Policy*. The training plan, which includes all of the responsibilities and requirements included in this SOP, must be completed for each trainee. In addition, an initial demonstration of proficiency (IDP) shall be performed prior to independent performance of the procedures detailed in this document. The IDP must consist of two successful QC canisters, from two separate batches utilizing the acceptance criteria specified in this document.

8) Sample Collection, Handling, and Preservation

8.1 There are no requirements for sample collection in this document. The following are a list of canisters that may be cleaned, certified and maintained by this procedure. This list is not intended to be all-inclusive as it contains only the most requested and current canister types.

- Six-liter Summa passivated stainless steel canisters
- Six-liter Silonite® passivated stainless steel canisters
- Three-liter Silonite® passivated stainless steel canisters
- One-liter Summa passivated stainless steel canisters
- 400-millilter mini passivated stainless steel canisters
- One-liter Bottle-Vacs

All canisters must be stored on the clearly designated portable shelves with the caps securely placed on the valves (unless the canister is being leak checked).

9) Equipment and Supplies

9.1 The number and capacity of the pre-purge and cleaning manifolds may be increased or expanded depending on necessity as long as they are clearly identified. As long as the minimum requirements for identification, cleaning, certification and maintenance are met, additional manifolds may be added at any point during the effective dates of this document. Additionally, the equipment listed in this section may be modified as long as the performance of the equipment selected is at least equivalent and this may include the size of heating bands, pump horsepower, etc.

9.2 <u>Pre-purge System</u>

Each pre-purge manifold system consists of a vacuum pump and compressed nitrogen gas supply tube connected to a ten position manifold. The manifold is made of 1/4" 316 stainless steel and Teflon tubing with stainless steel or brass fittings. Pressure is read with an in-line pressure gauge. The canister valve fitting is attached to the manifold using a brass Swagelok nut and ceramic-filled Teflon ferrule.

The purge cycles are controlled automatically with a three-way solenoid valve; one position connects to the nitrogen source, the second position connects to the pump,

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and the third position connects to the manifold. The canisters are pre-cleaned by serial evacuation and dilution with nitrogen. The solenoid valve is connected to a relay timer that can be programmed with the desired evacuation and fill time intervals and number of cycles. Programming is done using the keypad on the controller. The instruction for programming and starting the controller are found at the canister purge station.

9.3 Canister Cleaning System

The canister cleaning system is comprised of cleaning manifolds, nitrogen source with humidifiers, high vacuum pumps, digital vacuum/pressure gauges (in millitorr), electric heating bands/ovens, and electronic control units each described below.

9.3.1 Canister Manifolds

Currently, there are six cleaning manifolds. The cleaning manifolds are split into three groupings with the sample type or size serving as the source of the manifold designation for cleaning.

Cleaning Manifolds #1 and 2	(12) Source Canisters Each
Cleaning Manifold #3	(14) Ambient Canisters
Cleaning Manifold #4 (oven)	(14 total) 1L Canisters
Cleaning Manifold #5	(16) Ambient Canisters
Cleaning Oven #6	(6) Ambient/Source Canisters
Cleaning Oven #7 and 8	(12) Source Canisters Each

The manifolds are constructed of 1/2" or 3/8" 316 stainless steel tubing and fittings, except for manifold 4 which uses ¼" PFA or FEP plastic tubing. Canisters are attached to the manifold with a Swagelok brass nut and soft ferrule or canisters are attached to the oven manifold with a Swagelok brass nut or Swagelok stainless steel nut with aluminum finger-tight body and graphite/vespel ferrule. The proper fittings reduce the chance of damaging the stainless steel canister valve. Each manifold has its own pump and vacuum gauge, but shares a common gas source.

9.3.2 Gas Source with Hydrocarbon Trap and Humidifier

The manifolds use the gas from the auxiliary vapor outlet on the bulk liquid nitrogen tank. It is plumbed into the building with copper pipe, filtered through a hydrocarbon trap (if necessary), reduced in pressure, humidified, and connected to the gas inlet valves. Tubing is ¼" copper, stainless steel, or PFA Teflon. The fittings, humidifier, and single-stage regulator are 304 or 316 stainless steel. The vapor from the bulk tank ranges from 50 to 80psig, and is dropped to between 10 and 15psig before entering the humidifier via a regulator. The hydrocarbon trap may not be needed since this gas is typically ultra-clean.

9.3.3 Vacuum Pumps

The vacuum pumps are dual-stage direct driven rotary-vane type, made by Alcatel Co. and Edwards Mfg. Co. Each is rated at 285 liters per minute and is capable of achieving a vacuum of <10mtorr. An activated alumina filled foretrap is used to protect vacuum pump oil from system impurities and to prevent oil vapors from backstreaming into the canisters. The exhaust port of each pump is vented to the hood with Tygon tubing.

Manifold #5 and the Entech 3100A systems for manifolds 1, 2, 4a and 4b, 6, 7, and 8 use a two-stage oil-less pumping system comprised of a molecular drag pump backed by a diaphragm-type roughing pump. The rough pump evacuates the system to less than 2psig before activating the drag pump. The system on

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manifold #5 is a DriVac model BH200 (Vacuubrand MD4 roughing pump and Alcatel MDP 5011 drag pump combination) with integrated vacuum controller. The Entech systems use a Vacuubrand MZ2 or MZ2NT roughing pump and an Alcatel MDP 5011 drag pump combination.

9.3.4 Conditioner Vacuum Gauges

The gauges used to read the system pressure on each manifold are the Pirani digital type, capable of measuring between 0 and 2000 millitorr.

9.3.5 Electric Ovens and Heating Bands

During the cleaning process, each canister is heated to 100˚C using an electric oven or heating band. The bands are made of fiberglass-reinforced silicone rubber, and range in size depending on the canisters to be cleaned. They are rated at 5 watts per square inch, and operate on 120 VAC.

9.3.6 Controller Unit

The canister cleaning manifolds are controlled through a remote I/O board and a custom designed PC-based software program. All electronic components of the system (except the power leads of the heating bands) are connected to an I/O board including solenoid valves, thermocouples, and vacuum gauges. The board is housed in a computer-style chassis with a 120 VAC, 60 Hz power supply. It is connected to the PC via a serial data port, and the interface software allows the operator to enter all the parameters necessary for automatic control of the cleaning process.

9.3.7 Laboratory Information Management System (LIMS)

The system (LIMS) has a number of essential functions including container history and maintenance, canister status (ready to be cleaned, etc.), cleaning set-up, post analysis information, and reports.

9.4 Pressure/Vacuum Gauge

A pressure/vacuum gauge that is calibrated and capable of measuring -14.7 psig (30 inHg) to 100psig is used to provide a more accurate reading of vacuum/pressure, so that the initial leak check reading can be monitored and recorded.

10) Standards and Reagents

10.1 Edwards 450g Charge Activated Alumina
Purchased from Scientific Instrument Services

10.2 Vacuum Pump Oil #19
Purchased from VWR

10.3 Hydrochloric Acid

11) Method Calibration

11.1 Not Applicable

12) Sample Preparation/Analysis

12.1 IMPORTANT:

1. Canister Conditioning Technicians Canister barcodes are *not* to be hand entered into LIMS unless the barcode cannot be scanned, in which case a new barcode label must

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be generated. If this procedure is unavoidable the hand entered canister barcode must be verified by a secondary reviewer. Additionally, complete comments must be entered for all changes and/or additions (after the fact) made in LIMS.

2. Analysts and Canister Conditioning Technicians If during analysis or attempted analysis, a canister is identified as leaking refer to Section 13.1.3 for the specific requirements.

12.2 Release of Canisters for Cleaning/Disposal

Canisters are grouped by job number and are shelved accordingly. Canisters ready for cleaning and disposal are released according to the *SOP for Laboratory Storage, Analysis, and Tracking*. Each canister in a group of canisters must include at least the concentrations of the primary or highest level compound(s) or a short description of the sample matrix.

12.3 Pre-Purging

All canisters, except canisters returned to the laboratory as unused, are evacuated and purged prior to cleaning. An exception may be made for canisters with very low analyte concentrations (<100 ng/L). When pre-purging is performed, the operator selects a group of released canisters of similar analyte levels and places them on the pre-purge manifold. The pre-purge process may be performed according to the following procedure.

- Use a 9/16" wrench to attach the canisters to the manifold
- When the timer is off, the manifold is connected to the pump. Turn the manual three-way valve to the 'down' position to open the manifold to the solenoid valve.
- Turn on the pump and timer power strips.
- Open the canister valves, and the canisters will begin to evacuate.
- Set the current time on the timer to 1 AM (or whatever time has been programmed as the start time). Hold the CLOCK button down and use the HOUR and MIN buttons to set the time.
- Use the MANUAL button to select AUTO OFF. This activates the timer. The canisters will evacuate and fill according to the program entered into the timer.
- When the cycles have finished, close the canister valves.
- Turn the manual three-way valve to the 'closed' position.
- Turn off the pump and timer power strips.
- Remove the canisters from the purge manifold and place them onto the cleaning manifold and follow the procedure detailed in 11.4 below.

12.4 Canister Cleaning

12.4.1 Cleaning Cycles

The oven temperature of the Entech 3100A systems should be set **no higher than 100C**. This is sufficient to remove contaminants from all but the highest-level samples and will prevent damage to the canister valves.

The number of cleaning cycles needed to sufficiently clean a canister is dependent on the concentration of the sample previously in the canister. The exact number of cleaning cycles is not significant as a canister is only accepted as clean upon passing the QC check criteria outlined in section 16.2.

Canisters are typically cleaned for twenty cycles as this is the number of cycles that can be performed during the overnight cleaning session. Shorter cleaning cycles are sufficient for low level canisters as these canisters do not require extensive cleaning in order to meet the QC check criteria. The following are

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examples of canisters where a minimum of five cleaning cycles may be sufficient:

- Canisters used for ambient air sampling
- Canisters that have been cleaned for sixteen cycles but still contain low levels of compounds
- Standard canisters
- Canisters returned by clients as unused

Cleaning cycles may also be cut short as long as the QC check criteria are met. Forty or more cycles are used for weekend canister conditioning to minimize the time canisters sit evacuated on the conditioner following the procedure.

If a QC canister fails to meet the QC requirements stated in Section 16.2 another set of conditioning cycles must be performed on the entire batch of canisters. The operator and/or supervisor should determine if the problem is due to a high level canister in the set and decide whether to remove that canister (or canisters) before proceeding. Following the second reconditioning process, the canister that initially failed the QC must be analyzed unless that canister was removed from the set in which case the second highest canister must be analyzed. If the batch fails a second time, then either a third set of cleaning cycles may be performed or the entire batch taken off the conditioner and tagged for maintenance and manually cleaned. See Attachment 3 for a QC canister flow-chart and Section 16.2 for QC canister acceptance criteria and corrective action details.

12.4.2 Evacuation and Fill Setpoints

Typical cycle setpoints are 20 minutes for evacuation time and 10 minutes for fill time. The evacuation and fill times combined with the number of cycles necessary to sufficiently clean a canister are dependent on the sample previously in the canister. The evacuation and fill times may vary as long as the batch passes the QC check criteria in Section 16.2. The Entech 3100A systems use pressure setpoints as well as times. The canisters are filled to 15 psia (0 psig) and typically evacuated to 1 psia using the rough pump and then below 500 mTorr with the molecular drag pump. Weekend setpoints will typically be longer as to minimize the time canisters sit evacuated on the conditioner following the procedure. Shorter setpoints may be used for the following:

- Canisters used for ambient air sampling
- Canisters that have been cleaned for sixteen cycles but still contain low levels of compounds
- Standard canisters
- Canisters returned by clients as unused

12.4.3 Quality Control Canister Selection and Analyses

The following are strict guidelines that must be followed in order to ensure cleaning approval and that all documentation is complete and accurate.

- All canisters used for standards must be cleaned separately and the highest concentration standard selected as the QC canister.
- The canister or canisters, depending on the number of canisters within the batch (minimum of one per batch of 16 or fewer; two per batch of 20), selected for QC, must contain the highest level of contaminants as indicated on the back of the sample identification tag. When analyte concentrations in different canisters are within approximately 10%, the

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canister containing the analyte with the highest boiling point should be chosen as the QC canister. See Attachment 2 for TO-15 compounds listed in order by boiling point. If compound concentrations in different canisters are greater than approximately 10%, then the canister with the highest individual analyte concentration should be selected as the QC canister.

- Based on the analysis to be requested by the client, as may be indicated on the media request, the batch may be analyzed specifically for TO-15, sulfur compounds, methane (% level), or other analytes or methods not covered by TO-15. However, if the canisters are to be used for TO-15 analyses, they must be checked using this method and the acceptance criteria listed in Section 16.2 (as specified for the specific canister request, LIMS "Approved Container Orders").
- If the TO-15 analysis covers another method compound list, the QC canister may be analyzed by TO-15 for those compounds.
- A notation of the method and analytes or specific reference to the compound list that the batch is approved for must be noted in the log (*TO-15 is the default method; therefore, any method utilized other than TO-15 must be specified).*
- Make a notation in LIMS (Section 12.4.4) as to the canister or canisters selected as a QC canister.
- Make a notation on the sample identification tag that that canister was selected as the QC can, the manifold number and LIMS batch number.
- A hard copy of the quantitation report and chromatogram along with the acceptability of the batch (example, 75 + TICS states that the canister batch passed for the TO-15 75 compound list as well as tentatively identified compounds) must be kept by the laboratory and be available for review. IMPORTANT - A failing or passing result is to be entered into batch comments with name of data file as well.

Note: Refer to Section 16.2 for alternative uses for canisters that pass for specific compound lists.

12.4.4 LIMS

Once canisters are ready to be cleaned, they shall be placed on a conditioning manifold and the following steps taken to set-up and complete the cleaning procedure with respect to the Laboratory Information Management System (LIMS).

The container cleaning section in LIMS is located under:

-Under "Resource Manager" on console, select "Materials Manager"
-Select "Reusable Containers" on console
-Select "Container Cleaning" button on "Reusable Containers" screen
-Under the "Build/Update Batch" tab; select "Summa Canister" and the "New Batch" tab

1) Select container type
2) User
3) Conditioner
4) # of cleaning cycles (Section 12.4.1)
5) Scan canister barcodes in order of position on manifold
6) Select QC canister (Section 12.4.3)
7) Enter contaminants of QC canister
8) Add any additional comments (per canister)

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9) Add any batch comments by selecting comments "Batch Comments" button on right of screen
10) Select "Submit" button on right of screen, which creates a unique sequential batch ID (based on the total batches created)

12.4.5 Manifold Cleaning

Upon placement on the cleaning manifold, the canisters must be entered into LIMS.

Perform the following procedure to clean canisters using manifolds 3 and 5:

- Remove canisters from the pre-purge manifold and secure on the cleaning manifold with a 9/16" wrench.
- Tighten the brass swagelok nuts ¼ turn past finger tight
- Wrap a heating band around the middle of the canister and secure.
- Close manifold valves on any unused positions.
- Perform a leak check prior to proceeding by:
  - Make sure the canister valves are closed; evacuate the manifold by using the manual control buttons on the main software window.
  - Activate the evacuation solenoid valve by clicking the "Evacuate" button, which will remain on until the "Evacuate Off" button is clicked.
  - With this valve on, the gauge reading should rapidly decrease to less than 100 millitorr within a few minutes. If the vacuum does not drop there is either a leak somewhere in the system, or there is a problem with the vacuum pump.
  - The problem must be isolated and fixed before proceeding. If there is a leak found refer to Section 13.1 for the appropriate maintenance activity.
  - If it is necessary to remove a canister (or cap) from the manifold, turn off the evacuation valve first.
  - If the leak check is successful, power on the canister heaters and open the canister valves.
  - Start the automated sequence at this point.
- Enter the parameters to be used for the automated sequence.
- Start the program by using the shortcut on the Windows 95 desktop or by locating and running the "clean.exe" file on the local hard drive. This should be located in the c:\vivid subdirectory. The setpoint window is accessed by clicking the "Show Dialog Window" button in the lower left corner of the main window.
  - Step 1 is the vacuum reading down to which the manifold pumps before going on to step 2. This should be set to less than 100 millitorr (as long as the requirements of this document are met the vacuum may be less).
  - Step 2 is the time (using a 24 hour clock) that the program will wait before starting the cleaning cycles. This is used when a humidification step is necessary. Make sure the PC clock time is set accurately.
  - Step 3 includes the number of fill/evacuate cycles to be performed. It also includes the times (in minutes) for each fill and evacuation period. Refer to Section 12.4.2 for this information.
  - Step 4 is the final evacuation vacuum reading to be achieved, typically <100 millitorr. These setpoints are based on past experience, but other combinations may also be used if they can be demonstrated to achieve the QC criteria used to evaluate the canisters after cleaning.
- Start the sequence by clicking the "start/stop" button on the main window.

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- After the cycles are completed and the canisters have been evacuated down to less than 100 millitorr, close the canister valves.
- Stop the sequence by clicking the "start/stop" button again.
- Follow the QC canister and leak check procedures detailed in Section 16.2 and 16.3 of this document.

Perform the following procedure to clean canisters using the Entech 3100A systems:

- Attach each canister using a brass nut with a graphite/vespel ferrule. Tighten no more than ¼ turn past finger tight. **Do Not Overtighten!** Make sure the canister valves are closed tightly.
- Using the software interface, evacuate the manifold manually by first clicking the **Rough Pump** button. If the pressure will not go below 1 psia check for leaks and then retry. If the pressure drops below 1 psia click the **H.V. Pump** button. The vacuum should drop below 2000 mtorr within about ten seconds and continue dropping to below 100 mtorr; if not, check for leaks and retry.
- Click the **All Off** button to isolate the manifold from the pumps.
- Load the desired cleaning method or edit the currently loaded method.
- Open the canister valves and turn on the oven.
- Click the **Go** button to start the cycles.
- When cycles are finished, turn the oven off and open the oven doors. Wait for the canisters to cool.
- Close the canister valves.
- Click the **Stop** button to terminate the method and isolate the manifold from the pumps.
- See section 12.5 for instructions to initiate the leak check procedure.

12.4.6 Manual Cleaning of Contaminated Canisters

If a canister is deemed too *highly contaminated* to be cleaned on a conditioner, or if it will not meet the QC cleaning criteria by the standard procedure, it may be necessary to manually rinse the can with acidified water. The analyst will make this determination from the analytical data obtained for a canister. The manual rinse is followed by a drying step, before once again placing it on the cleaning manifold. This method will help remove semi-volatile compounds and particulates that may have entered the canister during sampling, as well as to dissolved salts which could have been deposited from condensed vapors. It may also help remove surface “lacquer” formed when the canisters are heated and contain condensed vapors.

1. Prepare a slightly acidic aqueous solution by diluting 3 or 4 drops of concentration hydrochloric acid (HCl) in a liter of distilled water. The pH will be approximately 3.
2. Using the appropriate pre-purge manifold, evacuate the canister to be cleaned (25”Hg is sufficient).
3. Attach a length of ¼” PFA Teflon tubing to the first canister using a brass nut and ferrule. It may be a removable type ferrule, such as Teflon or M-4.
4. The amount of acidified water used should be about 10% of the canister volume, i.e., 600mL for a 6L canister.
5. Place the free end of the tubing into the water, then open the can valve until the desired volume has be drawn into the can. Close the valve and leave under partial vacuum.

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6. Remove the tubing and shake the can for at least one minute, making sure the entire inner surface come in contact with the liquid.
7. Place the canister in an oven set to approximately 80°C overnight (or at least 12 hours).
8. Remove the can from the oven and pressurize to about 20psig with zero air, nitrogen or helium.
9. Hold the canister upside down over the sink and open the valve, allowing the pressure to blow out the liquid.
10. If liquid is discolored or there were a lot of particulates, repeat steps 4 through 6 using non-acidified distilled water.
11. Repeat step 8 and 9 until no more water comes out of the canister
12. Evacuate the can on the pre-purge manifold, leaving it under vacuum for at least 30 minutes.
13. Purge the canister two more times, which should remove enough residual liquid to allow the canister to be placed on the cleaning manifold.
14. Put the canister through the normal cleaning cycles. QC each canister that was manually cleaned.

12.5 Leak Check

The leak check is an individual canister certification. The two procedures listed in this section must be completed following the cleaning procedure detailed in Section 12.4.

- All canisters should be at full vacuum (less than 100 mtorr) before removing from the manifold except for laboratory standard canisters which should be left under positive pressure.
- A batch QC canister may be removed prior to evacuating the remaining canisters if it is in a position with its own isolation valve. Close all the other valves first and then evacuate the QC canister.
- Using LIMS, finish each respective cleaning batch by noting the date, time, and initial pressure of all canisters under the "Initial Vacuum" tab of "Build/Update Batch". Note: all non-QC canisters should have an initial pressure of -14.3 psig.
- Disconnect all of the canisters from manifold.
- Pressurize the QC canister(s) with humidified zero grade air (>20% RH) using the pressure/vacuum gauge to achieve the appropriate pressure (15psig).
- Alternatively, these canisters may be pressurized utilizing a canister zero grade air fill station with humidifier.
- Submit the QC canister(s) for analysis.

Note 1: If a stable reading is not achievable, then each canister pressure must be evaluated individually and the reading recorded accordingly.

- Allow each canister to sit for a minimum of 24 hours (Refer to Note 2 below).
- Measure the final pressure (using a calibrated digital pressure/vacuum gauge) and record the reading (under the "Final Vacuum" tab of "Build/Update Batch" in LIMS) as well as the time of the measurement.
- Acceptance criteria – a vacuum change of <2.0psig.
- If any canister is deemed to be leaking per this procedure then follow the steps in Section 16.3.

Note 2: All canisters including the QC canisters must be leak checked. If the leak check procedure is either not performed or cut short on any canister, it must done with the prior approval of the appropriate Project Manager. The person authorizing this departure from stated procedures as well as the specific reason for the departure must be noted in LIMS.

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12.6 Batch Approval

Refer to Section 16.2 for information on batch approval requirements and approval with conditions.

Once the QC results have been submitted by the analyst, access the "QC Results" tab under "Build/Update Batch" in LIMS.

1) Select Batch
2) Select User
3) QC results button
   a) Select the appropriate passed for components
   b) Add any necessary comments
   c) Select the applicable update (batch or individual canisters)
   d) Select the canister IDs, where appropriate
   e) Select the analytes, where appropriate
   f) Next
4) Add QC results, where appropriate
5) Update QC results

13) Troubleshooting

13.1 Troubleshooting

13.1.1 Leaking Conditioning Manifold

By far the most common cause for the manifold to fail to fully evacuate is a faulty canister valve. If a leak develops in the canister cleaning manifold, and it is not due to a leaking canister, then the manifold must be systematically checked until the leak is found. The most obvious symptom of leaking manifold is when the system will not pump down to its normal ultimate vacuum and the pirani gauge reading rises steadily after the pump isolation valve is closed.

- With a full set of canisters attached, close all the canister valves tightly. Open the pump isolation valve (Evac. on). The gauge should read <100mtorr. If it does not, close the manifold valves one at a time while watching the gauge display. If the reading drops quickly after one valve is closed, the leak is at that position; proceed to the next step.
- Recheck the canister valve to be sure it is tightly closed. If the vacuum still does not go down to <100mtorr when that manifold valve is opened, the most common problem is a bad canister valve.
- Remove the canister from the leaking position and cap the end with a brass cap. Reopen the manifold valve and watch the gauge display. If it drops to <100mtorr, the problem was the canister valve. If it still does not drop, proceed to the next step.
- Close the manifold valve and replace the ferrule at the end of the flex hose. Recap the end and then open the valve. If this does not solve the problem, close the valve, remove the flex hose, and plug the valve fitting with a brass plug.
- Reopen the valve. If the vacuum still does not drop, replace the valve. Otherwise replace the flex hose and brass nut.
- For the Entech 3100A systems it is important to replace the graphite/vespel ferrules used to secure the cans to the manifold if they have been overtightened and become cracked. It may be necessary to replace the 3/8" graphite ferrules on the manifold pieces if a leak is isolated to the manifold itself.

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If the system will not pump down even with all of the manifold valves closed, the leak must be in the manifold itself or the problem may be a faulty pressure isolation valve. This is an extremely rare situation. Diagnose the problem using the following steps:

- Disconnect the gas inlet tubing from the manifold. This will eliminate the solenoid valve from the system. Open the pump isolation valve and check the vacuum gauge. If it pumps down to <100mtorr, replace the pressure isolation valve.
- If the manifold still does not pump down, carefully tighten each fitting on the manifold using the appropriate wrenches. If this does not solve the leak, it may be necessary to reconnect the gas source and replace the nitrogen gas with helium. Pressurize the manifold with helium and use an electronic leak detector to check each fitting. Replace any leaking pieces with new tubing and ferrules.
- For the Entech 3100A systems it may be necessary to replace the 3/8" graphite ferrules on the manifold pieces if a leak is isolated to the manifold itself. Be very careful not to overtighten these fittings.

13.1.2 Contaminated Conditioning Manifold

- Clean the manifold by closing all of the manifold valves and clicking the "fill on" button on the screen. This will pressurize the system with UHP Nitrogen gas and can purge the stainless steel lines of the contaminant.
- Next use a heat source, i.e. heat gun, and start heating the fittings and the tubing at position one (1).
- Open the manifold valve at position one (1).
- Leave open for about one (1) minute and keep heating the tubing and the fittings surrounding the valve. This process will purge the contaminants from that valve's outlet and the heat will help volatilize the compounds from the inner surface of the stainless steel tubing.
- Close valve and move to the next valve.
- Continue this process for valves two (2) through remaining valves on the manifold in question.
- Refer to Section 12.3 for the pre-purging and canister cleaning procedure.

13.1.3 "Leaking" Canisters (Identified by Analysts or Other Such Sources)

This section is for those canisters that are suspected of leaking as identified by analysts using the AUTOCAN, during pressurization, or by other means and other individuals. This section is NOT for those canisters identified by the Canister Conditioning Department during the leak check or identified as leaking on the conditioner as those are required to go straight on Maintenance Hold.

Identified canisters are to be handled according to the following instructions and number 1 is to be completed first. This is regardless of the PM's or client's instructions to proceed.

1) Obtain a leaking canister or maintenance tag, place it on the canister and label as leaking, add initials and date.
2) Initiate a NCAR and write the NCAR # on the tag.
3) Also, make a note on the tag whether or not the analysis proceeded (e.g. "Analyzed" or "Canceled")

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4) If canceled, then the Canister group can proceed and place the can on Maintenance Hold to perform a formal leak check or clean and perform the required 24hr leak check.
5) If analyzed, then the canister should be placed with the other canisters in the job and when cleaning is to take place then put the canister in question on Maintenance Hold.

IMPORTANT: All canisters that are suspected of leaking MUST have a tag stating such and NO canister that is deemed to be leaking is to go without the *full* 24hr leak check.

14) Data Acquisition

14.1 Logbooks and Analytical Records All logbooks and records (electronic or hardcopy) must be completed in accordance with the requirements specified in this document and the *SOP for Making Entries onto Analytical Records*.

14.2 Documentation

14.2.1 Canister Conditioning

Information regarding each cleaning batch is maintained in LIMS. A notation is entered into LIMS for each cleaning batch regarding its QC status (Pass, Fail, etc.).

14.2.2 Canister Maintenance

The LIMS container tracking system must be utilized to track canister maintenance. An entry must be made to place a canister on maintenance hold, the maintenance to be performed and when maintenance is performed. The information must include the bar code number of the canister, date for the repair, a detailed description of the repair, and the initials of the repairer.

14.2.3 Manifold Maintenance

Manifold maintenance is tracked through LIMS. Information must be entered into LIMS for scheduled and non-scheduled projects.

15) Calculation and Data Reduction Requirements

15.1 All applicable data from this procedure must be documented through LIMS, and may also be found in physical logbooks.

16) Quality Control, Acceptance Criteria and Corrective Action

16.1 All corrective action plans must be developed in accordance with the *SOP for Nonconformance and Corrective Action*.

16.2 QC Canister Criteria

Once the cans have gone through the cleaning process, it is necessary to verify that all previous contaminants have been removed. This is accomplished by selecting a minimum of one canister per manifold/batch (10 or 16 or fewer) and two for a 20 canister batch (or fewer) to be analyzed for VOCs by GC/MS. However, all canisters that are to be analyzed for TO-15 (SIM mode) are individually analyzed/QC checked for the Client's specific compound list.

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In order for a canister to be considered acceptable no analyte concentration may be at or exceed the canister cleaning requirement of 0.2ppbv. If the required reporting limit is lower than 0.2ppbV refer to the note below.

Analyte Exceptions	
Acetone	<1.26ppbv
Vinyl acetate	<0.85ppbv
Ethanol	<1.59ppbv
IPA	<0.31ppbv
1-Butanol	<0.30ppbv
2-Butanone	<1.0ppbv
Carbon Disulfide	<0.96ppbv
Acrolein	<0.65ppbv

- There must be no compound detected as a tentatively identified compound above the level specified in the associated TO-15 method SOP.
- If the canister has target contaminants above 0.2 ppbv or the MRL (if lower than the canister cleaning requirement), the entire batch is rejected and the cleaning process repeated.
- All canisters selected as QC canisters (all canisters for TO-15 SIM) for a cleaning batch must meet the requirements detailed above in order for the batch to be certified as "clean".

IMPORTANT NOTE: Method Reporting Limit – A client may request a certain method reporting limit for TO-15 that is lower than the 0.2ppbV canister cleaning requirement. In this case, it must be conveyed to the analyst. All TO-15 SIM reporting limits are lower than this canister cleaning requirement; therefore, they are all individually analyzed and approved.

Passed with Conditions

Depending on what the QC canister fails for, the laboratory may be able to use it or the batch for other media requests. For example, if the canister (SIM) or batch (SCAN) passes for BTEX only it may be entered into LIMS as "passed with conditions" and labeled accordingly. In this case, the canisters may be used to fulfill a media request for canisters for the BTEX compound target analyte list.

- A notation must always be made in LIMS if the QC canister(s) passed or failed.

16.2.1 Corrective Action for Failed QC Canister

If one QC canister has failed to meet the QC requirement stated above, or the batch may not be used for another analytical method, another set of conditioning cycles must be performed on the entire batch of canisters in question in accordance with Section 12.4.1. Follow the corrective action guideline detailed in the flow chart in Attachment 3. The operator and/or supervisor should determine if the problem is due to a high level canister in the set and decide whether to remove that canister (or canisters) before proceeding. This second run should clean the batch sufficiently. However, following the reconditioning process the canister that initially failed the QC must be analyzed (if it has not been removed from the set, in which case the second highest must be evaluated). If the batch fails again, then either all of the canisters are taken off of the conditioner and put in a "Maintenance Hold"

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position, where they are tagged as needing to be manually cleaned or a third set of cleaning cycles is performed. Otherwise, if the canisters pass the QC check, the batch is released for use.

If it is suspected or determined that the conditioning manifold is contaminated follow the cleaning procedure detailed in Section 13.1.2 and the corrective action in Section 16.4.

Note 1: The requirements listed above are the minimum actions that must be taken. There must be sufficient evidence (number of QC canisters analyzed within a single batch) to ensure that the entire batch of canisters meets the analyte concentration requirement of this document.

Note 2: No batch (SCAN) or canister (SIM) may be released unless all QC canisters have passed the analyte concentration requirements or it is safely selected for use for another method and analyte list.

16.3 Leak Check Criteria

There is no defined requirement for the initial reading; however, the initial reading for the vacuum should not be less than –28.0”Hg (i.e., 27.9, 27.8, etc.). The change in the initial and final readings must be <2.0”Hg.

16.3.1 Corrective Action for Failed Leak Check

Once a canister has failed the leak check, it must be placed on maintenance hold in the container tracking system until repaired. All canister maintenance must be noted in LIMS as detailed in Section 14.2.2.

The most common cause is a leaking valve seat, which may be caused by repeated over-tightening or debris falling into the valve and preventing it from closing. Another possibility is that the valve is not sufficiently tightened onto the canister. It may be necessary to find the exact position of the leak by utilizing one or more of the following procedures:

- It possible to find leaks by pressurizing the canister to 20 psig and submerging it in water and looking for a stream of air bubbles.
- A leaking canister may also be detected by pressurizing the canister to 20psig with UHP Helium gas and using a Helium gas leak detector to “sniff” out a leak. The operator will use the detector probe around the valve head, valve seat, valve body, valve stem and the fastener nut fitting of the canister to allow the detector to find the leak.

16.3.2 Corrective Action for Leaking Valve

If it is determined that a canister valve is leaking and needs to be replaced, a Entech TO-V or Nupro "H" Series stainless steel bellows seated valve should be used. The valve body has 1/4" male Swagelok end fittings and the only tools needed for changing a valve are a 13/16" and a 9/16" wrench.

16.3.3 Corrective Action for Leaking Valve Stem

If the leak is found at the valve stem, it may be replaced.

- Remove the valve body with a 9/16” wrench.
- Remove the valve stem with 11/16” wrench from the canister inlet nut.
- Use jewelers pick to remove any residual Teflon tape from the threads of the inlet nut.
- Wrap the new valve stem with Teflon tape, about 4 turns.

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- Install the valve stem to the canister inlet nut and tighten with an 11/16" wrench.
- If the leak is from the center seam weld, the canister must be sent out for repair and the supervisor notified.

16.3.4 Corrective Action for Leaking Summa Canister

If a leaking valve is identified, it should be replaced with an identical or equivalent valve. The canister is put in the "Maintenance" section in LIMS and tagged as such and repairs are specified on the tag. The laboratory supervisor should be contacted regarding this type of repair. After replacing the valve, the canister shall be put in "to be cleaned" mode in the tracking database. It must be part of a cleaning set and pass batch QC before being put back in service.

16.4 Corrective Action for Contaminated Manifold

If it is determined that a manifold is contaminated, changing the pump oil and foreline trap adsorbent will usually solve the problem. After maintenance is performed on the system (Section 13.1.2), the canister or set of canisters which caused the contamination should be removed and cleaned by the procedure described in Section 12.4.1. A minimum of two canisters shall be QC checked and meet the criteria in Section 16.2 before that set may be certified and further batches cleaned on that manifold.

16.5 Corrective Action for Leaking Manifold

If there is a leaking manifold, it must be repaired and any canister affected shall be reconditioned and a QC check performed. A leak check shall be performed (Section 13.1.1) following any maintenance to determine if the maintenance was successful.

Replacement fittings and tubing may be obtained in house. However, if parts must be ordered for the manifold, the unit will be in a "Lock Out" or unusable mode and a notation of the "Lock Out" status entered into LIMS.

17) Data Records Management

17.1 All data is stored hard copy and electronically (if applicable) for a minimum of 5 years. Refer to the *SOP for Records Management Policy* for additional details.

18) Contingencies for Handling Out of Control Data

18.1 In the case of unacceptable data being produced on a batch or specific canister, it shall be re-cleaned or put on maintenance hold for repair. In certain cases a canister may become reclassified for use (ex. ambient to source).

19) Method Performance

19.1 Not Applicable

20) Summary of Changes

Table 20.1 Summary of Changes

Revision Number	Effective Date	Document Editor	Description of Changes
16.0	04/30/2015	C. Parnell C. Humphrey	Section 8.1 – Included Bottle Vacs
			Section 9.3.3 (2nd paragraph, 1st sentence) –

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			Included manifolds 1 and 2
			Section 12.3 – Added 2nd sentence
			Section 12.4.1 – Added 1st paragraph
			Section 12.4.2 – Added addition information
			Section 12.4.5 – Identified manifold numbers; added information on Entech 3100A systems
			Section 12.5 – Updated
			Section 13.1.1 – Added 1st sentence; added 6th and 9th bullets
			Section 21.1 – Updated SOP ID

21) References and Related Documents

21.1 *SOP for Waste Disposal,* SOP ID: ADM-WASTE

21.2 *SOP for Determination of Volatile Organic Compounds in Air Samples Collected in Specially Prepared Canisters and Gas Collection Bags by Gas Chromatography/Mass Spectrometry (GC/MS)*, SOP ID: VOA-TO15

21.3 *SOP for Nonconformance and Corrective Action,* SOP ID: CE-QA008

21.4 *SOP for Preventive Action*, SOP ID: CE-GEN004

21.5 *SOP for Training Policy*, SOP ID: CE-QA003

21.6 *SOP for Laboratory Storage, Analysis, and Tracking,* SOP ID: ADM-LabSAT

22) Appendix

22.1 Attachments

Attachment 1: Training Plan

Attachment 2: TO-15 Compounds Ordered by Boiling Point

Attachment 3: QC Canister Corrective Action Flow Chart

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Attachment 1

Training Plan

Training Plan for Cleaning and Certification of Summa and Other Specially Prepared Canisters

Trainee _____ Trainer _____ Date _____

1. Read SOP — Trainer ____ Trainee ____ Date _____

2. Demonstrated understanding of the scientific basis of the Conditioning and Certification of Canisters — Trainer ____ Trainee ____ Date _____

3. Demonstrated familiarity with related SOPs — Trainer ____ Trainee ____ Date _____
   - SOP for Making Entries onto Analytical Records
   - SOP for Laboratory Storage, Analysis, and Tracking
   - SOP for Nonconformance and Corrective Action

4. Observe performance of SOP — Trainer ____ Trainee ____ Date _____
   - ___Canister selection
   - ___Pre-purging of highly concentrated samples
   - ___Conditioning batches and placement of canisters
   - ___LIMS batch setup
   - ___Using conditioning manifold and conditioning program
   - ___QC canister selection and documentation
   - ___Batch certification
   - ___Leak check procedure and documentation
   - ___LIMS approval and labeling
   - ___Logbook documentation
   - ___Racking canisters back into available inventory

5. Perform SOP with supervision — Trainer ____ Trainee ____ Date _____
   - ___Canister selection
   - ___Pre-purging of highly concentrated samples
   - ___Conditioning batches and placement of canisters
   - ___LIMS batch setup
   - ___Using conditioning manifold and conditioning program
   - ___QC canister selection and documentation
   - ___Batch certification
   - ___Leak check procedure and documentation
   - ___LIMS approval and labeling
   - ___Logbook documentation
   - ___Racking canisters back into available inventory

6. Independent performance of the SOP — Trainer ____ Trainee ____ Date _____
   - ___Canister selection
   - ___Pre-purging of highly concentrated samples
   - ___Conditioning batches and placement of canisters
   - ___LIMS batch setup
   - ___Using conditioning manifold and conditioning program
   - ___QC canister selection and documentation
   - ___Batch certification
   - ___Leak check procedure and documentation
   - ___LIMS approval and labeling
   - ___Logbook documentation
   - ___Racking canisters back into available inventory

7. Instrument operation and maintenance — Trainer ____ Trainee ____ Date _____
   - ___Manual canister cleaning
   - ___Canister maintenance and logbook entries
   - ___Vacuum pump and manifold maintenance and logbook entries

8. Troubleshooting — Trainer ____ Trainee ____ Date _____
   - ___Finding leaks in manifold system
   - ___Detecting leaks in canisters

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Attachment 2

TO-15 Compounds Ordered by Boiling Point

TO-15 Compounds Ordered by Boiling Point					
1	Propene	33	Ethyl tert-Butyl Ether	65	Styrene
2	Dichlorodifluoromethane (CFC 12)	34	1,2-Dichloroethane	66	o-Xylene
3	Chloromethane	35	1,1,1-Trichloroethane	67	n-Nonane
4	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	36	Isopropyl acetate	68	1,1,2,2-Tetrachloroethane
5	Vinyl Chloride	37	1-Butanol	69	Cumene
6	1,3-Butadiene	38	Benzene	70	alpha-Pinene
7	Bromomethane	39	Carbon Tetrachloride	71	n-Propylbenzene
8	Chloroethane	40	Cyclohexane	72	3-Ethyltoluene
9	Ethanol	41	tert-Amyl Methyl Ether	73	4-Ethyltoluene
10	Acetonitrile	42	1,2-Dichloropropane	74	1,3,5-Trimethylbenzene
11	Acrolein	43	Bromodichloromethane	75	alpha-Methylstyrene
12	Acetone	44	Trichloroethene	76	2-Ethyltoluene
13	Trichlorofluoromethane	45	1,4-Dioxane	77	1,2,4-Trimethylbenzene
14	Isopropyl Alcohol	46	Isooctane	78	tert-Butylbenzene
15	Acrylonitrile	47	Methyl Methacrylate	79	n-Decane
16	1,1-Dichloroethene	48	n-Heptane	80	Benzyl Chloride
17	tert-Butanol	49	cis-1,3-Dichloropropene	81	1,3-Dichlorobenzene
18	Methylene Chloride	50	4-Methyl-2-Pentanone	82	1,4-Dichlorobenzene
19	Allyl Chloride	51	trans-1,3-Dichloropropene	83	sec-Butylbenzene
20	Trichlorotrifluoroethane	52	1,1,2-Trichloroethane	84	p-Isopropyltoluene
21	Carbon Disulfide	53	Toluene	85	1,2,3-Trimethylbenzene
22	trans-1,2-Dichloroethene	54	2-Hexanone	86	1,2-Dichlorobenzene
23	1,1-Dichloroethane	55	Dibromochloromethane	87	d-Limonene
24	Methyl tert-Butyl Ether	56	1,2-Dibromoethane	88	n-Butylbenzene
25	Vinyl Acetate	57	Butyl Acetate	89	1,2-Dibromo-3-Chloropropane
26	2-Butanone (MEK)	58	n-Octane	90	n-Undecane
27	cis-1,2-Dichloroethene	59	Tetrachloroethene	91	1,2,4-Trichlorobenzene
28	Diisopropyl Ether	60	Chlorobenzene	92	Naphthalene
29	Ethyl Acetate	61	Ethylbenzene	93	n-Dodecane
30	n-Hexane	62	m- & p-Xylene	94	Hexachlorobutadiene
31	Chloroform	63	Bromoform		
32	Tetrahydrofuran	64	Cyclohexanone		

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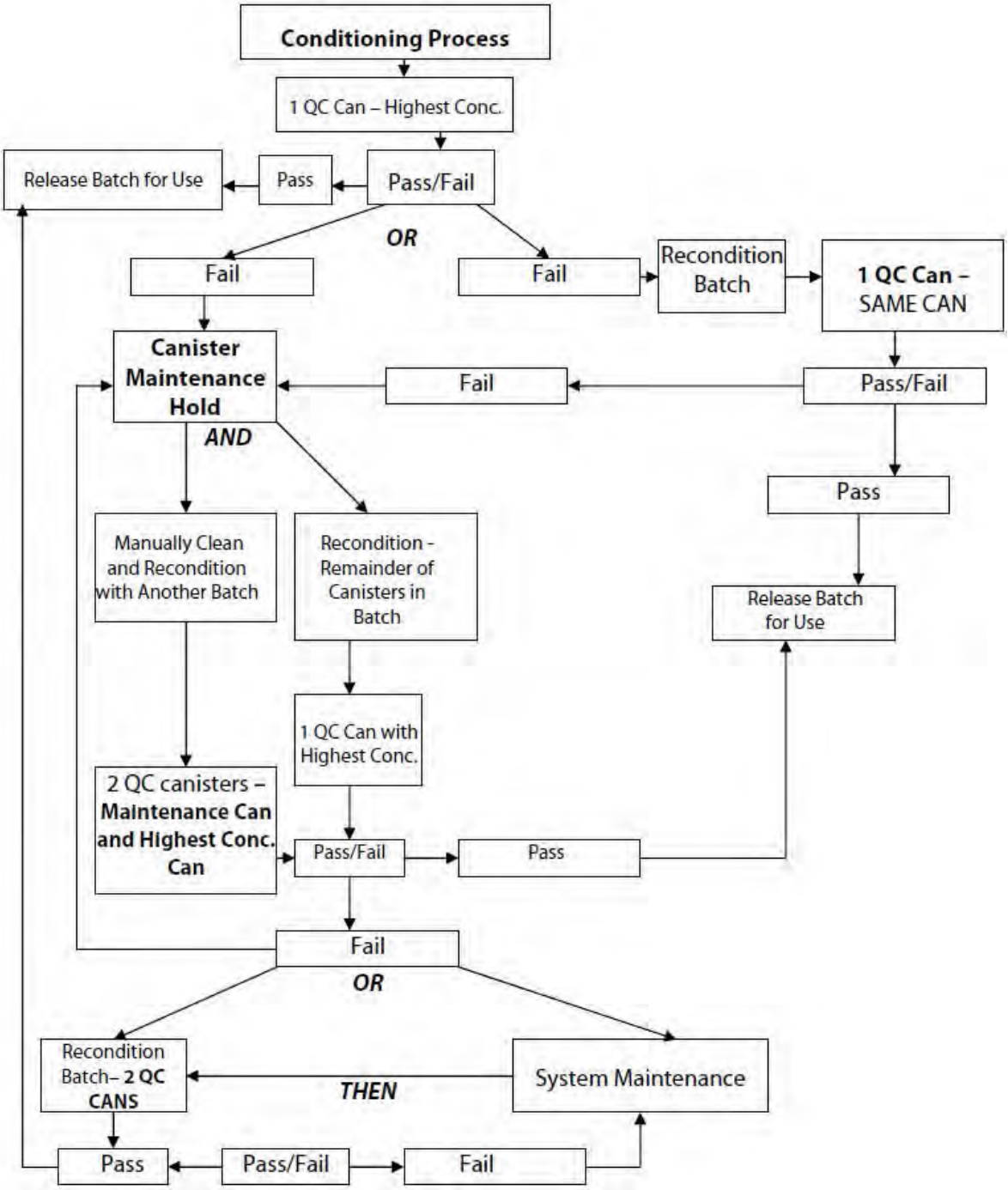
Attachment 3

QC Canister Corrective Action Flow Chart



Note: This flow chart is designed for SCAN analyses, for SIM the number of QC canisters must include all of the canisters designated for SIM reporting. The 24 hour leak check is not included in this chart; however, the batch is to be released after all of the canisters have passed this check. Any canister failing the leak check is to be placed on maintenance hold in LIMS.

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ALS Standard Operating Procedure

DOCUMENT TITLE:	DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN AIR SAMPLES COLLECTED IN SPECIALLY PREPARED CANISTERS AND GAS COLLECTION BAGS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)
REFERENCED METHOD:	EPA TO-15
SOP ID:	VOA-TO15
REV. NUMBER:	22.0
EFFECTIVE DATE:	03/21/2015

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ALS Environmental

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STANDARD OPERATING PROCEDURE

DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN AIR SAMPLES COLLECTED IN SPECIALLY PREPARED CANISTERS AND GAS COLLECTION BAGS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

EPA TO-15

SOP ID:	VOA-TO15	Rev. Number:	22.0	Effective Date:	03/21/2015

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DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN AIR SAMPLES COLLECTED IN SPECIALLY PREPARED CANISTERS AND GAS COLLECTION BAGS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

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1) Scope and Applicability

1.1 This procedure is based on and incorporates the requirements detailed in EPA Compendium Methods TO-15 and TO-14A and is used to quantify a wide range of volatile organic compounds (VOCs) in gaseous matrices collected in gas collection bags (method modification) and specially prepared stainless steel canisters or glass bottles. This method typically applies to ambient concentrations of VOCs 0.50ug/m3 (down to 0.10ug/m3 for low level ambient analyses) and above for the SCAN mode and 0.010ug/m3 and above for the SIM mode; however, refer to Tables 3 and 3A for the specific laboratory initial calibration ranges for each target compound. The method requires VOC enrichment by concentrating up to one liter of a sample volume, with a virtually unlimited upper concentration range using dilutions from source level samples.

In this document, Tables 2 and 2A (see Note 1 below) list compounds that can be determined by this procedure along with their corresponding laboratory method reporting limits (MRLs) and method detection limits (MDLs). The reported MRL may be adjusted higher; however, the capability of achieving lower MRLs for specific project requirements must be thoroughly demonstrated (by an acceptable initial calibration and method reporting limit check standard) and documented as long as the MRL is higher than the current method detection limit for each compound. Additional compounds may be analyzed according to this procedure as described in the referenced methods as long as the requirements of this document are adhered to; however, if a compound is not listed in the TO-15 method, refer to Note 1 below. The number of samples that may be analyzed in a 24-hour period is about twenty. The number of sample results that may be reduced in an eight-hour day is approximately twenty.

2) Summary of Procedure

2.1 The analytical method involves using a high-resolution gas chromatograph (GC) coupled to a mass spectrometer (MS). The GC/MS utilizes a linear quadrupole system, which allows for it to be operated by either continuously scanning a wide range of mass to charge ratios (SCAN mode) or by Select Ion Monitoring mode (SIM), which consists of monitoring a small number of ions from a specified compound list.

An aliquot of an air sample is concentrated on a solid adsorbent trap (either cryogenically or fan cooled glass beads or stronger adsorbents at higher temperatures) to collect the analytes of interest. To remove co-collected water vapor, the concentrated sample then goes through a water removal (dry purge) step. After the sample is pre-concentrated on a trap, the trap is heated and the VOCs are thermally desorbed onto a refocusing cold trap. The VOCs are then thermally desorbed onto the head of a capillary column once the cold trap is heated. The oven temperature (programmed) increases and the VOCs elute and are detected by the mass spectrometer.

Mass spectra for individual peaks in the total ion chromatogram are examined with respect to the fragmentation pattern of ions corresponding to various VOCs including the intensity of primary and secondary ions. The fragmentation pattern is compared with stored spectra taken under similar conditions, in order to identify the compound. For any given compound, the intensity of the primary fragment is compared with the

system response to the primary fragment for known amounts of the compound. This method utilizes the internal standard calibration technique; refer to Section 3.16 for a complete definition.

3) Definitions

3.1 Cryogen A refrigerant used to obtain sub-ambient temperatures in the VOC concentrator and/or on front of the analytical column. Liquid nitrogen (cryogen) is used for this purpose and it has a boiling point of –195.8°C.

3.2 Gauge Pressure Pressure measure with reference to the surrounding atmospheric (barometric) pressure, usually expressed in units of psig. Zero gauge pressure is equal to atmospheric pressure.

3.3 MS-SCAN Mass spectrometric mode of operation in which the gas chromatograph (GC) is coupled to a mass spectrometer (MS) programmed to SCAN all ions repeatedly over a specified mass range.

3.4 MS-SIM Mass spectrometric mode of operation in which the GC is coupled to a MS that is programmed to scan a selected number of ions repeatedly [i.e., selected ion monitoring (SIM) mode].

3.5 Analytical Sequence The analytical sequence describes exactly how the field and QC samples in an analytical batch are to be analyzed.

3.6 Neat Stock Standard A purchased, single component assayed reference material having a stated purity used to prepare working calibration standards.

3.7 Stock Standards Solution A concentrated solution of one or more target analytes at a known concentration purchased from a reputable commercial vendor. Stock standard solutions are used to prepare working calibration standards.

3.8 Intermediate Calibration Standard A solution of one or more target analytes at a known concentration prepared either from one or more neat stock standards or from one or more stock standards solutions.

3.9 Working Calibration Standard A solution of all the target analytes at a known concentration prepared either from one or more intermediate calibration standards and/or from one or more stock standard solutions.

3.10 Calibration or Standard Curve A calibration or standard curve is a graph which plots the concentration of a compound (or an analyte) versus the instrument response to the compound.

3.11 Initial Calibration Verification (ICV) Standard A solution prepared in the laboratory containing known concentration(s) of analytes of interest. The solution is prepared from neat stock standards and/or stock standards solutions which are from a different source than the standards used to prepare the working calibration standards.

3.12 Continuing Calibration Verification (CCV) Standard A working calibration standard which is analyzed at specific intervals in order to verify that the instrument continues to meet the calibration criteria.

3.13 Field Sample A sample collected and delivered to the laboratory for analysis.

3.14 Manual Integration This term applies to a data file in which setpoints have been changed and reintegration has occurred under the changed setpoints; baselines have been adjusted; peak integration start and stop “ticks” have been changed; peak area, or peak height, are changed after the time of data collection and data file generation.

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3.15 Batch Quality Control (QC) Batch QC refers to the QC samples that are analyzed in an analytical batch of field samples and includes the Method Blank (MB), Laboratory Control Sample (LCS) and Laboratory Duplicate (LD).

3.16 Internal Standard Calibration Compares the instrument responses from the target compound in the sample to the responses of specific standards (called internal standards), which are added to the sample or sample preparation prior to analysis. The ratio of the peak area (or height) of the target compound in the sample or sample preparation is compared to a similar ratio derived for each calibration standard.

3.17 May This action, activity, or procedural step is neither required nor prohibited.

3.18 Must This action, activity, or procedural step is required.

3.19 Shall This action, activity, or procedural step is required.

3.20 Should This action, activity, or procedural step is suggested, but not required.

3.21 SOP Standard Operating Procedure

3.22 Service Request A form generated, at the time of sample receipt, which details pertinent information such as client name, address, contact, client and laboratory sample identifications, sampling and receipt dates and times, requested analyses, sample type, canister pressures (initial and final), and the service request number (unique number for each submitted job) and serves as an inter-laboratory "custody" form which accompanies all samples throughout the laboratory.

3.23 Selectivity Selectivity of a method refers to the extent to which it can determine particular analyte(s) in a complex mixture without interference from other components in a mixture. Another definition is the extent to which a particular method can be used to determine analytes under given conditions in the presence of other components of similar behavior.

3.24 Limit of Detection (LOD) The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate (Type II error) is 1%. (DoD Clarification). For consistency purposes, the LOD may be referred to as the MDL once it is reported; however, full verification will be on file in the laboratory per the procedures detailed in this document.

3.25 Limit of Quantitation (LOQ) 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. (DoD Clarification). For consistency purposes and since the LOQ and MRL are equivalent with regards to laboratory procedure, the LOQ will be referred to as the MRL in this document and once it is reported. Full verification will be on file in the laboratory per the procedures detailed in the document.

3.26 Detection Limit (DL) / Method Detection Limit (MDL) The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. At the DL, the false positive rate (Type 1 error) is 1%. (DoD Clarification). For consistency purposes, the DL may be referred to as MDL. Also, as far as reporting is concerned the MDL will be raised up (where necessary) to the verified LOD per the procedures defined in this document and reported accordingly.

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4) Health and Safety Warnings

4.1 Refer to the laboratory's Environmental, Health and Safety Manual as it makes reference to the safe handling of chemicals, Safety Data Sheet (SDS) location, and the laboratory waste management plan for the safe disposal of chemicals and samples.

4.2 Pollution Prevention and Waste Management

All waste disposals shall be carried out in accordance with the requirements detailed in the *SOP for Waste Disposal.* In addition, canisters must be cleaned in accordance with the requirements detailed in the *SOP for Cleaning and Certification of Summa Canister and Other Specially Prepared Canisters.*

4.3 This procedure may include CHEMICAL, OPERATIONAL and/or EQUIPMENT hazards. Employees must review and understand the following hazards and their preventive measures prior to proceeding with this activity.

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HAZARD ASSESSMENT		
Job Task #1: Standard and Sample Preparation	**Hazards**	**Preventative Measures**
Compounds, mixtures of compounds, standards, surrogates, and samples.	Exposure to potential health hazards through absorption through skin. Inhalation hazards.	Reduce exposure through the use of gloves and fume hoods. Safety glasses must be worn when working in the prep lab. Care should be taken when handling standard material in a neat or highly concentrated form. Personal protective clothing (safety glasses, gloves, and lab coat) are required when handling standard material in neat form. Consult Safety Data Sheets (SDS) for compounds being handled in this procedure, and be familiar with proper safety precautions.
Job Task #2: Working with Liquid Nitrogen	**Hazards**	**Preventative Measures**
Turning valves and handling tubing and fittings that have been in contact with the cryogen.	Can cause serious tissue damage (frostbite) with only a few seconds of contact.	Wear neoprene or leather gloves. Valves on cryogen dewars should be opened slowly so leaky fitting can be identified.
Job Task #3: Working with Pressurized Gases	**Hazards**	**Preventative Measures**
Using and moving compressed gas cylinders.	Gas leak, fire, and explosion. Personal injury due to falling during transport.	All cylinders must be secured in an upright position to a wall or immovable counter with a chain or a cylinder clamp when not in use. Keep safety caps on when cylinders are not in use. A handcart must be used when transporting cylinders. The cylinder must be secured to the handcart with a chain or belt. The regulator should never remain on small "D" size cylinders following use. Full cylinders must be kept separate from empty cylinders. Flammable gases (i.e. pressurized hydrogen) must be clearly labeled. Flammables and oxidizers must be separated by a ½-hour fire wall or by at least twenty feet.
Job Task #4: Glass Syringes	**Hazards**	**Preventative Measures**
Glass syringe use	Skin lacerations and punctures.	The proper use of syringes should be part of employee training for this SOP. Care should be taken to avoid personal injury as a result or improper handling techniques.

Hazard information related to this activity which is not included or referenced in this document, should be immediately brought to the attention of the Department Supervisor.

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5) Cautions

5.1 A maintenance log will be kept documenting maintenance performed on each analytical system. The serial numbers of each instrument shall be recorded, and each log entry must include a description of the maintenance performed and be initialed by the analyst performing or observing/authorizing maintenance by an outside contractor.

The instrument maintenance log must be kept current. An entry shall be made in the appropriate log every time maintenance is performed (no matter the extent). The entry in the log must include.

(a) The date of maintenance
(b) Who did the maintenance
(c) Description of the maintenance
(d) Proof that the maintenance activity was successful

A notation of a successful tune and continuing calibration or initial calibration and the file number that accompanies the data will serve as proof that the maintenance is complete and the instrument is in working order.

The extent of the maintenance is not important, however, it is important that a notation be included for each maintenance activity such as changing a column, tuning the instrument, changing the pump oil, cleaning the source, ordering a part. In addition, a notation should be made in the logbook stating that no samples were analyzed during the days that the instrument was down and no active maintenance was being conducted (i.e., where no other notation was made in the logbook for those days).

5.2 <u>Concentrating Trap</u>

Routine maintenance includes periodic solvent cleaning of the Silco steel lines in the valve oven if contamination is suspected. Also, periodic replacement of the multi-sorbent or partial replacement of the trap if analyte specific deterioration is detected is required. For specific trap information refer to the instrument maintenance logbook and electronic method manual.

After repacking, the trap should be baked at 265°C for a minimum of two hours (or until a clean blank is generated) and a partial repacking requires baking (at 265°C) the trap for a minimum of 20 minutes (or until a clean blank is generated).

5.3 <u>GC System</u>

Column performance is monitored by observing both peak shapes and column bleed. Over time, the column will exhibit a poor overall performance, as contaminated sample matrices are analyzed. The length of time for this to occur will depend on the samples analyzed. When a noticeable decrease in column performance is evident and other maintenance options do not result in improvement, the column should be replaced (see Section 9.5). Whenever GC maintenance is performed, care should be taken to minimize the introduction of air or oxygen into the column.

Clipping off a small portion of the head of the column often improves chromatographic performance. When cutting off any portion of the column, make sure the cut is straight and “clean” (uniform, without fragmentation) by using the proper column-cutting tool. When removing any major portion of the column, which will affect the retention times and elution characteristics, a change in instrument conditions may be required to facilitate nominal analytical activity.

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Declining performance can also be due to ineffective column ferrules, which should be replaced when a tight seal around the column is no longer possible. This can be detected with the use of a leak detector.

5.4 Mass Spectrometer

The Mass Selective Detector (MSD) ion source requires periodic cleaning to maintain proper performance. Symptoms of a dirty ion source include difficulty keeping the MSD in tune and fluctuating internal standard areas. The vacuum system should be serviced every six months, including changing the pump oil and checking the molecular sieve in the back-streaming trap.

5.5 Instrument Tuning

The instrument is tuned with guidance from the procedure described in the HP Operations Manual, when necessary.

5.6 Computer Troubleshooting

Computer care and troubleshooting is conducted by the IT department. Refer to Section 9.6 for the computer hardware and software requirements.

Computers are selected to meet or exceed operating system and or acquisition software requirements. Periodic upgrades of memory are performed to maintain or improve system performance and reliability. Upgrades may be performed on systems until instrument hardware configurations become the limiting factor.

Basic Troubleshooting Outline:

1) Document occurrence and severity in IT Log
2) Interview user(s)
3) Investigate any available logs (Event Logs, Acquisition Logs, etc.)
4) Determine if problem is isolated (single user or acquisition) or widespread (multi user or network).
5) If multiple possibilities exist for cause, then eliminate in systematic manner.
6) Hardware issues are addressed with component replacement (beginning with most suspect portion).
7) Software issues are addressed first with internet investigation (user blogs, software source updates/findings).
8) Network issues are investigated from the Server, to Switch, to Network Card; utilizing all available managed devices to help discover possible failure points.
9) In some cases, system corruption may require reload or complete system replacement.
10) Finalize documentation in IT Log with actions taken
11) Perform periodic follow-up with User and review any log found to have suspect events that suggested source of issue.

6) Interferences

6.1 Summa Canisters

Canisters shall be stored in a contaminant free location and shall be capped tightly during shipment to prevent leakage and minimize any compromise of the sample. The pressure/vacuum is checked prior to shipment and upon receipt from the field. Any problems with the sample from the field are noted and the Project Manager contacted.

Also, canisters must be cleaned and certified to be free from target analytes before being shipped to the field for sample collection. The procedure is described in detail in the *SOP for Cleaning and Certification of Summa Canister and Other Specially*

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Prepared Canisters (refer to this procedure as well as Section 16.7 for the acceptance criteria).

Current laboratory practice entails the segregation of 6L canisters into ambient (low) level and source levels. All the ambient canisters are used for low level (indoor air, ambient air) projects and not intentionally for soil gas, SVE monitoring, or other higher level applications. It may be necessary to "retire" an ambient canister and re-assign for source level use if high concentrations are encountered. This decision will be made by management based on analytical concentrations and what compounds were encountered at these levels. If the level of any analyte is detected above 5,000ug/m*3* in the ambient can, then the supervisor/team leader must be contacted to determine if the canister(s) is to be retired. If retirement is decided upon, make a notation on the sample tag (or other color coded tag) of each canister in question. The notation must contain the analyte, threshold levels and retirement from ambient use (initial and date notation) so that the canister conditioning/management department may properly execute the retirement.

6.2 Analytical System

The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running humidified zero air blanks. The use of non-chromatographic grade stainless steel tubing, non-PTFE thread sealants, or flow controllers with buna-N rubber components must be avoided.

6.3 Carbon Dioxide

Excessive levels of carbon dioxide present in a sample may interfere with analysis by freezing up the cryogenic trap. A smaller aliquot must be analyzed to eliminate this problem, or the sample should be analyzed using the higher temperature multi-adsorbent trapping technique which allows carbon dioxide to pass.

6.4 Gas Collection Bags

This procedure covers the use of gas collection vessels such as Tedlar® or Mylar® bags. However, due to the nature of these types of bags it is not recommended that clients use this option for ambient air samples. Sample collection bags made out of ®Tedlar have contaminants that are inherent to the manufacturing process. The two main contaminants are phenol and N,N-Dimethylacetamide. However, this only becomes a problem when the concentration levels in the sample are low ppbv such as ambient air monitoring samples where more of the sample usually has to be concentrated and analyzed. To minimize the loss of sample integrity, a 72-hour hold time has been incorporated into the procedure.

6.5 Glassware

Interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware results in discrete artifacts and/or elevated baselines in the detector profiles should be minimized. All glassware associated with this method must be scrupulously cleaned to avoid possible contamination. The cleaning shall be performed in accordance with the procedure outlined in the *SOP for Glassware Cleaning*. The use of high purity water, reagents, and solvents helps to minimize these problems.

7) Personnel Qualifications and Responsibilities

7.1 It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP

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may perform analysis, interpretation and peer review of the results. Data reduction and/or peer review may be performed by another qualified employee. This employee must be familiar with the analytical technique and have completed a data review training plan to ensure familiarity with specific analysis and requirements.

7.2 The supervisor/manager must ensure that method proficiency is documented initially and whenever significant changes in the instrument type, personnel, and matrix or test method are made.

7.3 The department supervisor/manager or designee shall perform final review and sign-off of the data.

7.4 Demonstration of Capability

All analysts must be trained in accordance with the guidelines detailed in the *SOP for Training Policy*. Demonstrations shall also be performed in accordance with the 2009 TNI Standards (Volume 1 Module 4 Section 1.6) and DoD Quality Systems Manual 5.0. Attachment 1 shall be used to document the training plan for new analysts' initial demonstration. Additionally, these demonstrations are performed anytime there is a change in instrument type, personnel or method.

Once performance is found to be acceptable, a required certification statement must be completed by the QA Manager and either the immediate supervisor or Laboratory Manager and retained on file as a demonstration of compliance.

7.4.1 Quarterly Demonstration A demonstration of method sensitivity must be performed *quarterly on each instrument* performing this method.

1) A spike at the current LOD must be analyzed.

2) Verification of precision and bias at the LOQ must be performed.

Refer to Section 11.1.4.2 (LOQ) and 12.14.1 (LOD) for additional information on how these demonstrations are to be performed as well as the acceptance criteria.

7.4.2 Annual Demonstration Each analyst must perform this demonstration both initially and annually. Analyze four LCS standards at 1-4x the MRL (LOQ) either concurrently or over a period of days as a verification of precision and bias of the quantitation range. The standard deviation (n-1) and average percent recovery of the four replicates are compared against the method requirement for precision (±25%) and current laboratory control limits for bias/LCS.

7.4.3 Change in Personnel, Instruments, Method and/or Matrix The requirements in Sections 7.4.1 and 7.4.2 must be performed per the schedule noted and when there is a change in personnel, instruments, method or matrix. "Change" refers to any change in personnel, instrument, test method, or sample matrix that potentially affects the precision and bias, sensitivity, or selectivity of the output (e.g., a change in the detector, column type, matrix, or other components of the sample analytical system, or a method revision).

All completed attempts at this demonstration must be completed and turned into the QA department for retention.

8) Sample Collection, Handling, and Preservation

8.1 Air samples are collected in the field and delivered to the laboratory and shall be collected in either a specially prepared, leak-free, stainless steel pressure vessel (with valve) of desired volume (e.g., 6L), a glass sampling bottle (Bottle Vac, Entech

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Inntruments) or a sample collection bag (Tedlar). Canister samples may either be grab or time integrated (using a variable flow controller, refer to the *SOP for Flow Controllers and Critical Orifices*) utilizing the canister vacuum to draw the sample. Bags require the use of an upstream pump or a "lung machine."

8.2 There are no special preservation requirements for either canisters, Bottle Vacs or bags. However, bags should be stored in an environment free from puncture or deterioration sources (by hanging them from clips), labeled with the specific service request number, in accordance with the *SOP for Laboratory Storage, Analysis and Tracking*. Canisters and bottles should be stored on the appropriate shelves until they are to be analyzed.

8.3 Sample collection bags must be analyzed within 72 hours from the confirmed time of sampling. Samples received by the laboratory shall be analyzed within 30 days of sampling or sooner if project specific requirements dictate. Programs, which have shorter recommended or required hold times, include the Department of Toxic Substances Control (DTSC), which advises a 72 hour hold time. The Minnesota Pollutions Control Agency (MPCA) and EPA Region 9 both require a 14 days hold time. Additionally, the MPCA does not allow the use of Tedlar bags for sampling or sample dilution. The DTSC requirement is an advisory notice, but the laboratory shall make every effort to comply. However, the following statement shall be added to each report where sample analyses do not meet the 72 hour hold time and the client project is intended to comply with DTSC requirements. "The recommended 72-hour hold time for the analysis of TO-15 was exceeded per the DTSC and LARWQCB Advisory – Active Soil Gas Investigations document dated January 28, 2003; however, this specific hold time statement is advisory and not considered as regulation. In addition, the samples were analyzed within the EPA Method TO-15 stated requirement of 30 days."

9) Equipment and Supplies

9.1 Additional instruments and/or differing models may be utilized as long as they are equivalent and meet the minimum requirements of this document.

9.2 Gas Chromatograph (GC)

An instrument capable of temperature programming, with a column oven that may be cooled to sub-ambient temperature at the start of the gas chromatographic run to result in the resolution of the VOCs.

Hewlett Packard 5890 Series II Plus
Hewlett Packard 6890 Series
Hewlett Packard 6890A Series
Agilent 6890N Series
Agilent 7890A Series

9.3 Autosampler

Tekmar-Dohrmann AUTOCan Autosampler:	14-ACAN-074
Concentrating Trap (cryogenic trap, built-in):	14-6938-020
Cryofocusing Module w/split valve:	14-6520-A00
GAST Vacuum Pump:	DOA-P104-AA or equivalent

9.4 Mass Spectrometer (MS)

A MS capable of scanning from 34 to 350 amu every second or less, using 70 volts

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(nominal) electron energy in the electron impact ionization mode. The mass spectrometer must be capable of producing a mass spectrum for Bromofluorobenzene (BFB) which meets all of the criteria when 50ng or less of BFB is injected onto the GC/MS system.

Hewlett Packard 5972 Series
Hewlett Packard 5973 Series
Agilent 5973N
Agilent 5973 *inert*
Agilent 5975B *inert*
Agilent 5975C *inert*

9.4.1 Ionization Gauge Controller

- Agilent: 59864B
- Granville-Phillips 330 Ionization Gauge Controller: 330001/2/3
- Hewlett Packard Ionization Gauge Controller: 59864B

9.5 Analytical Column

Any analytical column capable of separating the compounds of interest may be used. The capillary column should be directly coupled to the source of the mass spectrometer. The following are suggested columns; an alternative column may be used as long as sufficient peak resolution and separation is achieved.

- Restek Rxi-1ms Fused Silica Capillary Column; 30m x 0.25mm ID 1.0µm film thickness

  OR

- Restek Rxi-1ms Fused Silica Capillary Column; 60m x 0.25mm ID 1.0µm film thickness

9.6 Data Systems

IBM-compatible PC with Windows 95/98/NT/XP/7 (Microsoft Office EXCEL version 2003 or newer) and Hewlett Packard Chemstation software including EnviroQuant with Extracted Ion Current Profile (EICP), National Institute of Standards and Technology (NIST) library (2002 version or newer) or equivalent.

9.7 Canister Pressurization Station

Vacuum/Pressure Gauge [0 to –30 inHg; 0-90 or 100 psig]

9.8 Canister Sampling Devices

Refer to the *SOP for Flow Controllers and Critical Orifices* for specific calibration and other pertinent information.

- VICI Condyne Model 300 Flow Controller
- Critical Orifices (Laboratory manufactured)

9.9 Gas Collection Devices

- Lab Commerce, Aerosphere Model S6L, 6.0L Summa Passivated Canisters or equivalent
- Lab Commerce, Stabilizer Model 22.4L, 2.4L Canisters or equivalent
- Restek Corporation, #24203, 3.0L Silco Canisters or equivalent

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- Tedlar bags – 0.5L, 1L, 3L, 5L, 10L, 25L, and 40L (other sizes are available; however, the volumes that are listed encompass the majority of the bags supplied and the samples submitted to the laboratory).

9.10 Dynamic Dilution System

- Entech Dynamic Diluter Model 4620A
- Toshiba laptop computer Model 2210CDT/6.0 and Software NT460

10) Standards and Reagents

10.1 Reagents and Equipment

10.1.1 UHP Grade Helium (99.999%) (GC carrier gas, preconcentrator purge/sweep gas, pressurization gas)

10.1.2 Cryogen - Liquid nitrogen from bulk tank or 50 psig dewars (used to cool preconcentrator traps)

10.1.3 UHP/Zero Grade Air (canister pressurization)

10.1.4 ASTM Type II Water, DI water or equivalent

10.1.5 UHP Grade Nitrogen (99.999%) (additional pressurization gas, based on other methods requested – modification to method)

10.2 Standards

Standards are prepared for both SCAN and Selective Ion Monitoring (SIM) modes according to the procedures detailed in this section. The preparation of standards for the analysis of air samples is carried out by following the procedure, "Preparation of Gas Phase Standards for Ambient Air Analysis", Application Note, Spring 96, Vol. 6.5, *Tekmar*-DOHRMANN AutoCan User's Manual. Neat standards that are used for making trace gas standards must be of high purity; generally a purity of 98 percent or better is commercially available.

10.2.1 Instrument Performance Check, Internal Standard and Surrogate Spiking Mixture Prepare a standard solution of p-Bromofluorobenzene (BFB-used as both a tune check and surrogate compound), bromochloromethane, chlorobenzene-d5, and 1,4-difluorobenzene, 1,2-dichloroethane-d4(surrogate), and toluene-d8(surrogate) at 500µg/m^3 each in humidified zero air (Section 9.2.1.2). Prepare this standard according to the procedure outlined in Volume 6.5 of the *Tekmar*-DOHRMANN Application Note. This standard may also be prepared from a neat cocktail as in Section 10.2.2.2.1 or as stated in Section 10.2.1.3.

10.2.1.1 An intermediate standard is prepared from neat compounds in a glass static dilution bottle (SDB). After the volume of the SDB is determined, calculate the mass of each compound to be spiked to achieve a final concentration of 5.0µg/ml. Then use the density of each neat compound to calculate the microliter amount to be spiked into the SDB. The SDB is then heated for a minimum of one hour at ~60˚C to completely volatilize all components.

Concentration of the intermediate standard prepared in a SDB is 5.0µg/mL. The amount required to achieve this concentration is determined through the use of the following equation.

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$$A = \frac{(C)(V)}{D} \qquad \text{(Equation 1)}$$

Where:

A Amount of each compound required to achieve the desired concentration of the standard in the SDB (µL)
C Desired concentration of SDB (µg/mL)
V Actual volume of the SDB (mL)
D Density of the compound in question (µg/µL)

Example:

Calculate the amount of neat bromochloromethane needed to achieve the final concentration of 5.0µg/mL of that compound in the SDB.

V = 2010mL
D = 1934.4µg/µL
C = 5.0µg/mL

$$A = \frac{\left(5.0\frac{\mu g}{mL}\right)2010mL}{1934.4\frac{\mu g}{\mu L}} = 5.2\mu L$$

Density (µg/µL)	Compound
1934.4	Bromochloromethane
1170.1	1,4-Difluorobenzene
1157	Chlorobenzene-d5
1307	1,2-Dichloroethane-d4
943	Toluene-d8
1593	BFB

10.2.1.2 The Working standard is prepared in a Summa canister by spiking an aliquot of the stock SDB standard (Section 10.2.1.1) using a heated gastight syringe. Connect a cleaned, evacuated Summa canister to a source of pure diluent gas (humidified zero air) using a Teflon line with a stainless steel tee directly above the canister valve. One port of the tee is fitted with a septum. Spike the SDB stock and following removal of syringe a small flow of diluent gas to flush the spike into the can. Pressurize the can to positive 83.3 psig with humid zero air, and allow the contents to equilibrate for approximately 24 hours before using.

Concentration of the working standard prepared in a Summa canister is 500ng/L. The final pressure of the canister is 83.3psig; therefore, the pressurized volume is 40L, which is obtained through the use of the following equation.

PV = PDF(V) (Equation 2)

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Where:

PV Pressurized canister volume (L)

PDF Pressure Dilution Factor, where PF = $\frac{P_{atm} + P_f}{P_{atm} + P_i}$

P_f Final Canister Pressure

P_i Initial Canister Pressure

V Volume of canister at 1atm

P_{atm} Atmospheric Pressure = 14.7psig

Example:

$$\frac{14.7 + 83.3}{14.7 + 0}(6L) = 40L$$

In order to prepare the canister with a concentration of 500ng/L, it must be determined how much of the intermediate standard is required. This is achieved through the use of the following equation.

$$A = \frac{(F)(V)}{(C)\left(1000\frac{ng}{\mu g}\right)} \qquad \text{(Equation 3)}$$

Where:

F Desired concentration of working standard (ng/L)

V Pressurized Volume of Canister (L)

C Concentration of prepared SDB (µg/mL)

A Amount of standard (mL) of the SDB required to obtain the desired working standard concentration

Example:

$$A = \frac{500\frac{ng}{L}(40L)}{\left(5.0\frac{\mu g}{mL}\right)\left(1000\frac{ng}{\mu g}\right)} = 4mL$$

10.2.1.3 Currently the working standard is purchased in a cylinder at a certified concentration of 500ng/L (prepared by Linde SPECTRA Environmental Gases, Alpha, NJ).

10.2.1.3.1 For SCAN analyses, the working standard is filled directly into a summa canister to a pressure of 70 to 80 psig.

10.2.1.3.2 For SIM analyses, the working standard is diluted and pressurized with humid zero air to the desired concentration

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using Equation 2 in Section 10.2.1.2. Typical concentrations will be 20ng/L, 40ng/L or 50ng/L.

10.2.2 Initial Calibration (ICAL) Standard Prepare the primary source calibration standards in Summa canisters with nominal concentrations of 1ng/L (optional), 20ng/L and 200ng/L for analyses in SCAN mode and 0.1ng/L, 5.0ng/L, and 200ng/L for analyses in Selective Ion Monitoring (SIM) mode for each of the target analytes. Differing injection volumes will create the standard concentrations listed in Tables 3 (SCAN) and 3A (SIM) of this document. The full list of analytes which are analyzed according to this method can also be found in Tables 2 (SCAN) and 2A (SIM).

Standards are prepared by diluting the stock standard with humid zero air into a Summa canister. The stock standard is a certified custom-blended cylinder (prepared by Linde SPECTRA Environmental Gases, Alpha, NJ). Refer to Tables 3 and 3A for the list of analytes and certified concentrations in the purchased cylinder.

10.2.2.1 Working standards are prepared into Summa canisters using the Entech Dynamic Diluter. Turn on the power to the diluter one hour prior to using to allow for the components to come to thermal equilibrium. Connect the computer and start the software. Connect a Zero Air source to the humidification chamber (flow controller #1). Connect stock standard cylinder#1 to flow controller #2 inlet. Open the cylinder valves. Adjust the inlet pressures to 50 to 60psig.

Standard Concentration Selection: The concentration of the three working standards prepared in Summa canisters should be 200ng/L, 20ng/L and 1ng/L (depending on the dynamic range of the initial calibration include 1ng/L if a 0.08ng and 0.4ng on column standard is desired or this standard may be used for the 0.5ng/L concentration as well) for SCAN and 0.2ng/L, 4.0ng/L, and 200ng/L for SIM.

Position 1 – Total Air Flow (Zero Air)
Position 2 – Standard Flow (Purchased Standard One)
Position 3 – Standard Flow (Purchased Standard Two if Applicable)
Position 4 – Total Air Flow (Zero Air) (utilized if preparing a two dilution standard)
Position 5 – Diluted Standard Flow (utilized if preparing a two dilution standard)

Step1: Determine the required flow rate of the stock standards (positions #2 and #3). The range must be from 5 to 50sccm (standard cubic centimeters per minute, same as ml/min). The flows listed below are guidelines to be used for the default standard flow (based on the desired standard concentration) and were chosen based on the ultimate final dilution required and limitations of the Dynamic Diluter (flows must be from 150 to 2000ml/min.).

Desired Standard Conc.	Default Standard Flow
200ng/L	50ml/min
100ng/L	50ml/min
20ng/L	20ml/min
5.0ng/L	10ml/min
4.0ng/L	8ml/min

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1ng/L	50ml/min; 20ml/min (See Note 1 below)
0.2ng/L	10ml/min; 20ml/min (See Note 1 below)

Note 1: For the 1ng/L and 0.2ng/L standards (or any standard requiring more than a 400X dilution of the stock), a slightly different procedure is performed. In order to prepare these standards, a double dilution must be performed which involves taking the primary dilution flow and making a secondary dilution of that using the diluent gas. Unscrew the cover of the dilutor and connect the first mass flow controller as well as the tubing to re-route the first dilution output from the final standard Summa canister to the 2nd dilution chamber. Refer to example 2 for the calculation guidelines to prepare a two dilution standard.

Example 1: Prepare a 200ng/L working standard. The concentration of each stock standard is 1000ng/L.

Step 2: Determine the required dilution factor for each stock.
Dilution factor = Stock Conc. (ng/L) / Desired Standard Conc. (ng/L)
Dilution Factor = 1000ng/L / 200ng/L = 5

Step 3: Calculate Total Flow
Total Flow= (stock std. flow-see table above)*(Dilution Factor)
Total Flow=50ml/min*5 = 250ml/min

Step 4: Calculate Diluent Air Flow
Air Flow=Total Flow-(Sum of stock std. flows-purchased cylinders)
Air Flow=250ml/min-(50+50)ml/min = 150ml/min

Example 2: Prepare a 0.2ng/L working standard. The concentration of each stock standard is 1000ng/L.

Step 2: Determine the required total dilution factor for the 0.2ng/L standard.
Dilution factor = Stock Conc. (ng/L) / Desired Standard Conc. (ng/L)
Dilution Factor = 1000ng/L / 0.2ng/L = 5,000

The two dilutions must be performed which total the dilution factor calculated above. Since the flow for the Diluter is restricted to a maximum of 2000ml/min, the total flow (as calculated in Step 3 below) cannot exceed 2000ml/min; therefore, the dilutions must be chosen accordingly.

Step 3: Calculate Total Flow
Total Flow = (stock std. flow-see table above)*(Dilution Factor)
Total Flow (Dilution 1) = 10ml/min*200 = 2000ml/min

For the 2nd dilution take the stock standard flow selected for dilution 1 for the two purchased cylinders (10ml/min each based on the desired final concentration) and add them together (10ml/min + 10ml/min for 20ml/min) to get the stock standard flow for the 2nd dilution.

2nd Dilution Factor Needed = Total Dilution/1st Dilution
2nd Dilution Factor = 10000/200(1st dilution) = 50

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Total Flow (Dilution 2) = 20ml/min*50 = 1000ml/min

Step 4: Calculate Diluent Air Flow
Air Flow=Total Flow-(Sum of stock std. flows-purchased cylinders)
Air Flow=2000ml/min-(10+10)ml/min = 1980ml/min (Dilution 1)
Air Flow=1000ml/min-20ml/min = 980ml/min (Dilution 2)

Position 1 = 1980ml/min
Position 2 = 10ml/min
Position 3 = 10ml/min
Position 4 = 980ml/min
Position 5 = 20ml/min

Step 5: Enter flow rates in the appropriate fields in the Entech software. Start flows by clicking the "GO" button in the top right of the window. Allow flows to equilibrate for at least fifteen minutes, then attach an empty canister to the outlet port and open the valve. The outlet pressure will be displayed in the lower right of the window, in units of psia. Close the canister valve when the pressure reaches 30psia. There is a relief valve on the diluter that will open when the pressure reaches 35psia, so the canister will still be usable if the valve is not closed in time.

10.2.2.2 When analysis of additional (extra) compounds are requested which are not in the purchased stock cylinders, the following preparation instructions should be used. In addition, the internal standard / surrogate standard may also be prepared in this manner (Sections 10.2.2.2.1 – 10.2.2.2.2) as mentioned in Section 10.2.1.

10.2.2.2.1 *Equi-mass "soup"* (contains compounds in equal mass amounts) or *cocktail* prepared from the neat compounds for a large number of components. If additional SIM compounds are requested, the same cocktail may be used.

Cocktail Preparation:

Step 1: This cocktail is prepared by combining 25mg of each neat compound into a small glass vial. Use a microliter syringe to transfer each compound, cleaning with solvents in between. Put the vial in the freezer between aliquots to minimize volatilization. Take the density of each compound into account to determine the actual amount of each compound to spike into the cocktail by using the following equation.

$$S = \frac{A}{D} \qquad \text{(Equation 4)}$$

Where:

S Actual spike amount (μL)
A Desired amount for each compound (mg)
D Density (mg/μL); refer to Table 2 for the density

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Example: The actual volume of acrolein to add to the cocktail is calculated by the following.

$$S(\text{Acrolein}) = \frac{25mg}{\left(0.840\frac{mg}{\mu l}\right)} = 29.8\mu L$$

Step 2: The concentration of each compound in the cocktail is determined by the following equation.

$$C = \frac{A}{V}\left(1000\frac{\mu g}{mg}\right) \qquad \text{(Equation 5)}$$

Where:

C Concentration of cocktail (μg/μL)
A Amount of each compound (mg)
V Final volume of cocktail (total spike volumes of each compound) (μL)

Example:

$$C = \frac{25mg}{631.8\mu L}\left(1000\frac{\mu g}{mg}\right) = 39.569\mu g/\mu L$$

10.2.2.2.2 *An intermediate standard* is prepared from neat compounds by spiking individual compounds into a glass static dilution bottle (SDB) as described in Section 10.2.1.1 or spiking an aliquot of a cocktail into the SDB. The spike amount of a cocktail is determined by using the following equation.

$$S = \frac{C_1 V}{C_2} \qquad \text{(Equation 6)}$$

Where:

S Spike amount required in order to obtain the desired concentration (μL)
C_1 Desired concentration of SDB (μg/mL)
C_2 Concentration of cocktail (μg/μL)
V Volume of SDB (L)

Example: Determine the spike amount of the cocktail required to achieve the desired intermediate standard concentration.

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$$S = \frac{\left(1\frac{\mu g}{ml}\right)(2010ml)}{27.81\frac{\mu g}{\mu L}} = 72.28\mu L$$

10.2.2.2.3 *Intermediate Standard Preparation (Gaseous Compounds)* As an alternative to the glass SDB method, if the extra compounds needed to be analyzed are gases at room temperature, use a gastight syringe to prepare an intermediate standard in a 1L Tedlar bag filled with humidified zero-grade air. Use the molecular weight of the compound to calculate the microliter amount to be spiked into the bag to achieve desired concentration. The spike amount is determined by using the following equation.

$$S = \frac{C * V * 24.46}{M * \left(1000\frac{ng}{\mu l}\right)}$$

S	Spike amount required in order to obtain the desired concentration (µl)
C	Desired concentration (ng/L)
V	Volume of the Tedlar Bag (1L)
M	Molecular Weight of the compound
24.46	Molar Volume of gas at 25°C, 1atm

Example:

Make a 100,000ng/L intermediate standard of Chloro-difluoromethane (Freon22) in a Tedlar Bag, where M=86

$$S = \frac{100{,}000\frac{ng}{L} * 1L * 24.46}{86 * \left(1000\frac{ng}{\mu l}\right)} = 28.44\mu l$$

10.2.2.2.4 *The Working standard* for extra compounds is prepared in a Summa canister by spiking an aliquot of the intermediate standard (glass SDB or Tedlar bag) using a heated gastight syringe. The preparation of these standards shall follow the instructions detailed in Section 10.2.1.2. The concentrations for working standards are usually 20 and 200ng/L, however different concentrations can be chosen which work best for a particular project.

10.2.3 Initial Calibration Verification (ICV) - (Laboratory Control Sample - LCS) Prepare a secondary source standard (either a different manufacturer or different lot from the same manufacturer as the initial calibration standard) using the same procedures as the primary source. The ICV/LCS working standard should

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contain each target analyte present in the calibration working standard. Prepare the ICV/LCS working standard at a concentration of 200ng/L. Differing injection volumes account for the allowed concentrations listed in Table 4 for SCAN and 4A for SIM. The preparation of this standard shall follow the instructions detailed in Section 10.2.2, using the certified second-source standard cylinder.

10.2.4 Continuing Calibration Verification (CCV) Standard The CCV is the same as the initial calibration working standards detailed in Section 10.2.2.

10.2.5 Screening Standards Recommended procedure: Prepare a 0.5ug/mL and/or a 3.0ug/mL concentration standard so that the GC may be calibrated utilizing a few levels (may include approximately 0.5ng, 150ng and 600ng). However, other concentrations can be prepared depending on the desired range.

Any of the desired standard concentrations (primary and secondary) may change as long as the equations and the appropriate densities remain the same.

10.3 Storage and Expiration Dates

All standards that are to be stored in a freezer shall be stored at ≤-10˚C for DoD projects.

- Neat Stock Liquids are stored at < -10˚C (-10˚C to -20˚C) as specified by the manufacturer or for a period of five years.
- Equi-Mass Primary Stock Standard is a cocktail or soup of neat compounds (containing compounds in equal mass amounts) used to in preparing intermediate gas phase standards and shall be stored in the freezer at < -10˚C (-10˚C to -20˚C) for up to six months. This is assuming that the soup is sealed with a septum-containing screw cap or Mininert™ valve. The selection of the compounds for the soup should be performed in accordance with the guidelines in Volume 6.5 of the *Tekmar*-DOHRMANN Application Note.
- Purchased Stock Standards Cylinders must be stored at laboratory temperature for a period of 2 years or as specified by the manufacturer before vendor re-certification or purchase of new standards.
- Intermediate Calibration Standards prepared by static dilution must be stored in an oven at a temperature of approximately 60°C to ensure analyte vaporization. Every time a standard is prepared from the static dilution bottle (SDB), the concentration changes. To increase the useful lifetime of an SDB standard, remove volumes of 25mL or less. The volume removed can be manipulated by increasing the SDB concentration or by adjusting the canister final volume/pressure. Depending upon the volume removed, an SDB intermediate standard is stable for approximately two months as long as new working standards made from this standard continue to meet acceptance criteria. These bottles must be in the oven for a minimum of one hour prior to use in preparing working standards. The guidelines for the storage and expiration date for the intermediate calibration standards are stated in Volume 6.5 of the *Tekmar*-DOHRMANN Application Note.
- Prepared Stock / Intermediate Calibration Standards prepared in Summa canisters (1000ng/L) may be stored at laboratory conditions for up to three months in an atmosphere free of potential contaminants. Upon preparation, canister standards should be allowed to sit for approximately 24 hours prior to use in order for equilibration to take place. Shorter equilibration periods may be necessary and acceptable as long as performance criteria are met.

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- Calibration or Working Calibration Standards prepared in canisters may be stored at laboratory conditions for one month in an atmosphere free of potential contaminants. Upon preparation, canister standards should be allowed to sit for approximately 24 hours prior to use in order for equilibration to take place. Shorter equilibration periods may be necessary and acceptable as long as performance criteria are met.

11) Method Calibration

11.1 Initial Calibration

The initial calibration is performed to determine instrument sensitivity and the linearity of the GC/MS response for the target compounds.

Initial calibration requirements are as follows:

1. A minimum of 5 concentrations must be used to calculate the calibration curve.
2. An initial calibration must be performed at a minimum initially per instrument, annually thereafter or whenever the continuing calibration verification standard does not meet the acceptance criteria.
3. Highest concentration, together with the lowest concentration, defines the calibration range.
4. The method reporting limit for any reported analyte must be at >/= the lowest calibration point.
5. The initial calibration event may not be interrupted by maintenance.
6. Only one value per concentration may be used.
7. Analyze calibration standards from lowest to highest concentration.
8. All ICAL analyses must be completed within the 24-hour tune window.
9. If 5 calibration standards are in the ICAL, one standard may be re-analyzed. If 6 to 10 calibration standards are in the ICAL, two calibration standards may be re-analyzed.
10. One of the calibration points from the initial calibration curve must be at the same concentration as the continuing calibration verification standard.
11. The upper end of the calibration range must not exhibit any peak saturation for any analyte or the range must be lowered accordingly.
12. The initial calibration model must be linear calibration using average of response factors and cannot be changed for any reason.
13. Point dropping policy
    - Minimum of 5 consecutive concentrations must be used to calculate the calibration curve.
    - Lowest concentration must be at or below the MRL (LOQ) and may not be dropped unless the MRL is changed to the concentration of the remaining lowest standard.
    - Points at the high end may be dropped, but doing so lowers the calibration range.
    - Points may not be dropped from the interior of the curve unless an assignable cause (i.e., gross dilution error, missing internal standards, purge malfunction, standard preparation error, or instrument malfunction) is accounted for and documented. In these instances, all the analytes in that calibration standard must be dropped from the calibration curve as the corrective action (the reason must be documented and the results maintained with the documentation for the final ICAL).
    - Dropping individual compound points from the upper or lower end of the calibration range to improve linearity is not considered an error correction. The reason for dropping these points does not need to be documented but

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the ICAL documentation must state the revised calibration range if the MRL must be adjusted or the calibration range is lowered for a particular compound. This must be documented on the ICAL Review Checklist.

- A calibration standard may be re-analyzed if the first analysis of the standard has been dropped and other requirements in this policy are met (i.e., still within 24 hours).
- Once the ICAL has been used to calculate and report sample results it MUST not to be changed for any reason.
- It is recommended that if an analyte has a higher MRL than the lowest concentration analyzed that the low standard be automatically dropped from the curve (i.e., acetone MRL is 5, drop at least the 0.4ng point).

11.1.1 Calibration Points Analyze the calibration standards (analyze low to high) that span the monitoring range of interest of the samples. For SCAN, the range is typically 0.4ng-100ng on column; however, 0.08ng on column may be added if low level analyses are requested. For SIM, the range is 10pg on column to 50,000pg on column. The dynamic range is dependent on the sensitivity of a particular instrument as well as the required reporting limit for a given project and may be adjusted accordingly. Refer to Table 3 (SCAN) and Table 3A (SIM) for the concentrations of the compounds of interest in the initial calibration at each particular calibration concentration level.

Note: Refer to the EXCEL TO-15 Standard Concentration templates, located on the network at Q:\\TO15 Std. Concentrations\Std. Conc. Templates for both the SIM and SCAN templates. These templates must be utilized for the documentation of the standard canister concentration selection, final ICAL level concentrations and the determination of the correct injection volumes for the selected standard canister concentrations. If the primary or secondary stock standard cylinder concentrations are revised (upon re-certification or new purchases), the EXCEL spreadsheet templates, injection amounts and the ICAL concentrations in each instrument method must be adjusted accordingly. Other templates may be employed as long as they are validated and provide at least the same information.

SCAN

1. Determine if the lower end of the calibration range is to be 0.08ng or 0.4ng on column. If the low end is 0.08ng, then the 1ng/L standard must be utilized.
2. Determine if the 1ng/L or 20ng/L standard canister is to be used for the 0.4ng on column point.
3. Follow the instructions in the spreadsheet and save the file under the correct instrument folder and the initial calibration method identification.
4. Print the final ICAL concentration sheets and place into the corresponding ICAL folder

11.1.2 Recalibration Each GC/MS system must be recalibrated following any instrument maintenance which may change or effect the sensitivity or linearity of the instrument, if the continuing calibration verification acceptance criteria are not met and at least annually. The following procedure must be followed when updating an initial calibration method.

1. Open the most recent method.
2. Save the method with the new ICAL method ID using the “Save Method As” option. Date used in the method ID must be the date files were analyzed.

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3. Quantitate midpoint standard and check retention times and integrations. Update retention times if necessary using QEdit or Easy ID (Tools → Easy ID). Requant if any changes are made and verify all peaks are identified correctly. Print.
   a. While midpoint standard is loaded update reference spectra (Continuing Calibration → Update Reference Spectra).
   b. With midpoint standard loaded update qualifier ion ratios and retention times (Initial Calibration → Update Levels → Select Update Level and then select Retention Times (Replace) and Replace Qualifier Ion Relative Responses).
   c. If necessary adjust integration parameters prior to processing remaining ICAL points.
4. Quantitate remaining ICAL standards. Review each peak for retention time, integration, and print. Review low level standards for acceptable signal to noise ratios and high level standards for saturation.
5. All responses must be cleared from ICAL before updating (Initial Calibration → Clear All Calibration Responses).
6. Update responses for each standard level (Initial Calibration → Update Levels) or (Initial Calibration → Quick Levels Update). If Quick Levels Update is used do not requant datafiles.
7. Save method.
8. Check Response Factor Report and evaluate whether any points should be dropped following the criteria outlined in this SOP.
9. Save method if any changes are made.
10. Verify calibration files listed on Response Factor Report are correct.
11. Verify file ID, acquisition time, quant time, update time, and last update information is correct on the Calibration Status Report.

11.1.3 Analytical Window If time remains in the tune window after meeting the acceptance criteria for the initial calibration, samples may be analyzed according to the procedure described in this document (see Section 12.3.2). If time does not remain in the analytical window, a new sequence shall commence with the analysis of the instrument performance check compound (BFB) and the continuing calibration verification standard.

11.1.4 Procedure The system should be operated using temperature and flow rate parameters equivalent to those in Section 12.4. Use the standard prepared in accordance with Section 10.2.2 of this SOP. Attach the calibration standard and internal standard/surrogate canisters to the designated inlets on the preconcentrator and open the canister valves. Analyzing different volume aliquots of the calibration standards produces differing concentrations.

Analyte responses (target ion areas) are tabulated and recorded using the Enviroquant program. Quantitation ions for the target compounds are shown in Table 2 and 2A and the primary ion should be used unless interferences are present, in which case the secondary ion may be used, but the reason documented in the initial calibration file and all subsequent quantitations utilizing that ICAL must be performed using the same ion selections. Refer to Section 15.2 for the required calculations and Section 16.4 for the acceptance criteria.

11.1.4.1 Additional Requirements The procedure for performing and generating a new initial calibration method must follow a few additional requirements.

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1. If any analyte lacks the appropriate sensitivity (3 to 1 signal to noise ratio) at the low end of the calibration range, this point must be dropped from the curve and the MRL/LOQ raised accordingly.
2. No detector saturation may occur for <u>any</u> compound; the upper calibration level must produce no saturated peaks. Exhibited by:
   - The flattening of the response for the higher concentration standards as shown on the plot;
   - The presence of a reverse tail or rise on the front part of the peak;
   - The observed actual percent ratio of the secondary ion presence is lower than the expected percent ratio; or
   - The presence of a flat topped peak and again by the decline or saturation of the secondary ion compared with the expected % recovery.

11.1.4.2 <u>LOQ Establishment, Verification and Acceptance Criteria</u>

1. The LOQ must be set within the calibration range (≥ low std. of the current passing ICAL) prior to sample analysis.
2. The LOQ for each analyte must be ≥ the analyte's LOD.
3. Initially a passing demonstration of precision and bias must be performed at the LOQ.
4. Run CCV 2 times at LOQ and:
   a. Generate a duplicate report for precision using ±25% as the criteria.
   b. Check the %Rec using laboratory generated control limits.
   c. Check the signal to noise ratio (S/N) using the software. The S/N ratio must be at least 3:1 for each analyte.
   d. All ion abundances must be acceptable per the requirements set forth in this document.
5. If any compounds fail, verify at a higher level and notify reporting. Also, make a note in the ICAL documentation.
6. Turn in <u>all</u> LOQ verification data (quant reports and software reports/checks) to QA (regardless of pass/fail).
7. Verify the LOQ on each instrument quarterly.

11.1.5 <u>Initial Calibration Review</u> Analyst's calculation and assessment along with a peer review of all ICAL data and documentation as stated in Attachment 2 is required before the ICAL may be used to analyze samples. In the case where samples are placed on the autosampler and allowed to run overnight, the sample results may only be reported if the ICAL is reviewed and found to be acceptable. The ICAL checklist in Attachment 2 must be used to document the review and approval process.

Perform a review of specific aspects of the calibration which might compromise data quality such as inappropriate extension of the calibration range with detector saturation and/or a lack of sensitivity for any analyte. Analyte concentrations which do not meet the signal to noise ratio or exhibit saturation are not to be reported and must be eliminated from the initial calibration. These instances should be followed by a short explanation regarding the reason for the omission.

11.1.6 <u>Initial Calibration File</u> An ICAL file is to be created for each initial calibration performed per instrument into which is placed the following ICAL documents. The file shall remain in the laboratory and be filed by instrument and date.

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- ICAL Checklist filled out, reviewed and approved
- BFB tune analysis report
- Calibration status report (aka Calibration History)
- Relative Response Factor Report / Percent Relative Standard Deviation
- Quantitation report for each calibration standard (including manual integration documentation – before and after manual integration)
- ICV quantitation report and % recovery report.
- TO-15 Standard Concentration Spreadsheet (exact ICAL level concentrations and ICV concentrations)
- Any manual integration documentation

11.2 Initial Calibration Verification Standard

Verify the initial calibration by analyzing an initial calibration verification standard (ICV). This standard shall be obtained or prepared from materials acquired from a different manufacturer or lot from that of the initial calibration and prepared according to Section 10.2.3.

Analyze 50ng or less (refer to Table 4 for the secondary source standard concentrations) of the ICV standard depending on the dynamic range of a given instrument and refer to Section 15.4 for the required calculations.

12) Sample Preparation/Analysis

12.1 Sample Preparation

The pressure/vacuum is checked and the canister pressurized upon receipt by the laboratory, as needed. When necessary, canisters shall be pressurized with humidified zero grade air. However, if the samples are to be analyzed in accordance with EPA Method 3C then the samples must be pressurized with UHP Helium (refer to Section 12.9 for additional information). The client must be made aware of this in advance and given the option of either submitting two canisters for analysis or receiving a report with qualified results (TO-15 Modified).

Depending on the size of the canister and location of sampling and as specified in the SOP below, samples may be pressurized to approximately 1.0psig to 3.5psig. Additional information may be found in the *SOP for Evaluation and Pressurization of Specially Prepared Stainless Steel Canisters*. Initial and final pressures are recorded in LIMS and should be repeated on the back of the sample tag. The dilution factor created by filling the sample canister is calculated using equation number 12 in Section 15.7.

12.2 Screening

The analyst must screen a sample or subset of samples if the source is of unknown origin. Typically, if the source is known to be indoor or ambient outdoor air, no screening is necessary. However, if screening is required make sure that the instrument is calibrated. A single point calibration is sufficient; however, the instrument may be calibrated utilizing a two point calibration. The ICAL points are recommended to be at approximately 0.5ng, 150ng and/or 600ng spanning the desired dynamic range. Refer to Section 10.2.5 for additional information.

Inject a 1mL or smaller aliquot of each sample into a GC/flame ionization detector (FID) system that has been calibrated with a standard containing a subset of the target analytes. This subset represents the most commonly found compounds in air samples, such as acetone, trichloroethylene, and toluene. Use the results to determine the maximum volume of sample to be analyzed by TO-15 by utilizing the following equation. Dilutions may be prepared as necessary according to Section 12.9.1.

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$$I = \frac{C}{H}$$

Where:

I Injection volume (mL)
C Maximum calibration level (ng on column)
H Compound screening concentration (ng/mL)

Example: Select the compound with the highest concentration (toluene = 1.0ng/mL). If the upper calibration level is 100ng on column, then the following calculation determines the maximum injection volume to analyze.

$$\frac{100ng}{1.0ng/mL} = 100\text{mL maximum injection volume}$$

12.3 Analytical Sequence and Data System Setup

12.3.1 Data System For the Tekmar AUTOCAN, fill in the sequence log of the Teklink program with the appropriate information. Refer to the Section 12.4.1 for the operating parameters.

For HP Chemstation, load the appropriate acquisition method for the GC/MS in the top window of the Chemstation program. Suggested GC/MS operating parameters are given in Section 12.4.2.

12.3.2 Analytical Sequence The analytical sequence must be completed for the analysis of ≤20 (19 samples including dilutions with one laboratory duplicate) field samples. A method blank (MB) shall be run to monitor for laboratory introduced contamination. There must be at a minimum a laboratory duplicate (LD) analyzed in each batch to access batch precision. The following generalized analytical sequence is to be followed:

Analytical Sequence Guideline

With Calibration	Tune Check[1] Calibration Standards (5 Standards Minimum) ICV Standard[2] (Acts as the ICV and LCS) QC Canister Checks[6] MB[7] Sample(s) – 1-19 Laboratory Duplicate[4]
With Continuing	Tune Check[1] CCV Standard[5] QC Canister Checks[6] MB[7] LCS[3] MRL Check Standard[8] Sample(s) – 1-19 Laboratory Duplicate[4]

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[1] The instrument performance check solution must be analyzed initially and once per 24 hour (or as specified by the project) time period (sequence / tune window) of operation. All analyses for a sequence must be initiated (injected) prior to the expiration of the tune window.

[2] In this scenario, the ICV may also be evaluated as the LCS (differing acceptance criteria).

[3] An LCS shall be analyzed at a rate of 1 in 20 or fewer samples. The LCS is the second source calibration check standard analyzed at the lower end of the calibration curve (below the midpoint).

[4] A laboratory duplicate must be analyzed at a rate of 1 per 20 or fewer samples. The duplicate must be rotated among clients, whenever possible. Also, a duplicate laboratory control sample may be analyzed to assess precision to meet project requirements or due to sample matrix effects.

[5] A CCV must be analyzed at the beginning of every analytical sequence.

[6] Any number of QC check canisters may be analyzed in the sequence to determine a canister cleaning batch or batches acceptability.

[7] Any of the QC Check Canisters may serve as the method blank as long as the minimum requirements detailed in this document are met. A method blank shall be analyzed at a rate of 1 in 20 or fewer samples.

[8] A MRL check standard may be analyzed with each batch of 20 or fewer samples (when an initial calibration is not analyzed within the same batch). Additional information is included in Section 12.15.

Note: Client project batch specifications may require certain modifications to the analytical sequence; however, a batch may not be more lenient than that which is specified in this document.

12.4 Conditions

12.4.1 Sample Collection Conditions The suggested settings and system parameters are as follows:

Adsorbent Trap

Set Point:	35˚
Sample Volume:	up to 1L
Dry Purge:	300mL
Sampling Rate:	100mL/min (utilize for a sample injection volume of >100mL); 40mL/min (utilize for a sample injection volume of 25-100mL)
Desorb Temp.:	200˚C to 230˚C
Desorb Flow Rate:	8-10mL/min He
Desorb Time:	3.0 minutes

Refocusing Trap

Temperature:	-180˚C
Injection Temp.:	160˚C
Injection Time:	1.0 min

Adsorbent Trap Reconditioning Conditions

Temperature:	265°C

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Initial Bakeout: 2 hours or until clean blank is obtained
After each run: 5-8 minutes

Sample Run Time

Each analytical run is approximately 20 minutes long; the total cycle time is about 30 minutes between injections.

12.4.2 GC/MS System

Optimize GC conditions for compound separation and sensitivity.

Item	Condition
Carrier Gas	Helium
Flow Rate	1.0-1.6mL/minute
Temperature Program	Initial Temperature: ~20˚C Initial Hold Temperature: 3 minutes Ramp Rate: 5˚C/min to 80˚C 2nd Ramp: 10˚C/min to 160˚C 3rd Ramp: 20˚C/min to 240˚C for 5 min hold
Detector B (MSD *Interface)*	260˚C
Electron Energy	70 Volts (nominal)
Mass Range (Scan mode)	34 to 280 amu
Mass Range (SIM mode)	Scan masses corresponding to the target analytes
Scan Time	To give at least 10 scans per peak, not to exceed 1 second per scan.

Note: *The instrument may be operated in Selective Ion Monitoring (SIM) mode if requested by the client.*

12.5 Instrument Performance Check

Since the BFB tuning compound is included in the internal standard and surrogate standard canister and an autosampler is used, it is necessary to establish that a given GC/MS meets tuning and standard mass spectral abundance criteria prior to the reduction and approval of any data collection. The 24-hour time period for GC/MS instrument performance check and standards calibration (initial calibration or continuing calibration verification criteria) begins at the injection of the BFB, which shall be documented in laboratory records. Upon completion of the successful BFB tune, the tune report must be printed and retained on file for future reference.

The mass spectrum of BFB must be acquired in the following manner.

- Inject 50ng or less (on column)
- Three scans (peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged.
- Background subtraction is conducted using a single scan prior to the elution of BFB.
- All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120 percent that of m/z 95.
- The ion abundance criteria must not be changed from the requirement stated in this document (TO-15 or TO-14A, as requested).

All subsequent standards, samples and QC samples associated with a BFB analysis must use identical instrument conditions.

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12.6 Continuing Calibration Verification Standard

Verify the calibration each working day, where necessary (e.g., an ICAL was not analyzed or the tune window has closed) by analyzing a continuing calibration verification (CCV) standard from the initial calibration standard canister. The concentration of the calibration verification may be varied between the low calibration standard and the midpoint of the calibration range; however, the concentration must be at one of the levels analyzed in the initial calibration. Refer to Table 3 for the standard concentrations. Refer to Section 15.3 for the required calculations.

12.7 Canister Quality Control Check and Method Blank

The method blank must be a sample of a matrix similar to the batch of associated samples 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 procedure, and in which no target or interferences are present at concentrations that impact the analytical results for sample analyses. Prepare a canister that has not left the building by pressuring with humidified zero air. Analyze an aliquot of one liter along with the same volume of internal standard and surrogate as standards and samples. Additionally, a blank must be analyzed whenever a high concentration sample is encountered and carryover is suspected.

A Quality Control (QC) check canister pressurized with humidified zero air may serve as a method blank as long as the analyte concentration requirements stated in the canister quality control check section (Sections 16.7 and 16.8) and other requirements (refer to Section 16.12 for internal standard requirements) are met. Assuming continuing failure, another QC canister or a new canister must be prepared and analyzed in order to verify that no system contamination exists. For tracking purposes the unique laboratory barcode given to a canister shall be the information included in the sample analysis identification.

12.7.1 Sampling Systems Section 7.1 and 8.4 of Method TO-15 describe the setup and certification procedure for a specific sampling apparatus that has been used by the EPA for several of its large air monitoring programs. These systems are rarely used for the types of projects that make up the bulk of the laboratory's work. The vast majority of samples analyzed by the laboratory are taken into Summa canisters either as grab samples or using a simple time integrated sampling device (flow controller), as in Section 8.2.1 of the method, so these procedures are not part of the typical protocol for providing sampling materials to clients. The laboratory has developed an SOP for the cleaning and certification of the materials it provides its clients for obtaining air samples to be analyzed by method TO-15. Refer to the *SOP for Cleaning and Certification of Summa Canisters and Other Specially Prepared Canisters* for additional information.

It is this laboratory's interpretation that the sampler system certification procedure described in Section 8.4.4 of the TO-15 method applies to the specific sampling apparatus described in the method and not to the sampling procedures used by our clients. The laboratory does not maintain a dynamic calibration manifold or canister sampler apparatus as described in the method and thus performance of the relative accuracy certification procedure described in section 8.4.4 is not possible.

12.8 Laboratory Control Sample

The laboratory control sample is a sample matrix, which is free from the analytes of interest and spiked with a standard containing known amounts of analytes. The

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laboratory control sample is an injection of the initial calibration verification standard. Inject the LCS (ICV) at concentrations below the midpoint of the calibration curve. Make sure that all of the pertinent information is included on the quantitation report including the sample identification (LCS), concentration, standard used, and analyst.

12.9 Sample Analysis

Prior to analysis, all sample containers (canisters and bags) should be at temperature equilibrium with the laboratory.

- Attach sample canisters to Tekmar AUTOCan using a 9/16" wrench. Bottle Vacs use a proprietary quick connect fitting (Micro-QT, Entech Instruments). Tedlar bags can be connected using soft silicone tubing or a 3/16" fitting with a reusable ferrule.
- Before opening the valve, check for leaking fittings by running the leak check program in the Teklink software. Quick connect fittings must be leak checked before connecting the sample container.
- If system is leak tight, open the canister valves and start the automated preconcentration procedure. Make sure the Chemstation data acquisition software has been readied.
- Maintain the trap at an elevated temperature until the beginning of the next analysis.

Check all target compounds using the QEdit routine in Enviroquant, making sure all extracted ion chromatogram peaks are integrated properly (see Section 12.13).

Note 1: *The secondary ion quantitation is only allowed if there is sample matrix interference with the primary ion. If the secondary ion quantitation is performed, document the reasons in the instrument run logbook and/or on the quantitation report (initial and date any notation).*

Note 2: *Each female Micro-QT fitting must be purged after use to remove any remaining sample residue and prevent contamination from subsequent usage. Connect a male Micro-QT fitting to a source of ultrapure or carbon-filtered gas. Adjust the pressure to about 10 psig using an inline regulator. Connect the female fitting for several seconds, then remove and place in an oven kept at 60ºC until the next use. Do not heat the fitting higher than 80ºC.*

SCAN Mode - The instrument is normally operated in the SCAN mode, where the following procedure may be followed.

- Upon sample injection onto the column, the GC/MS system is operated so that the MS scans the atomic range from 34 to 270 amu. At least ten scans per eluting chromatographic peak should be acquired. Scanning allows identification of unknown compounds in the sample through searching of library spectra. See operating conditions in Section 12.4.
- Generate a quantitation report for each run.
- If reporting Tentatively Identified Compounds (TICs), refer to Section 12.9.2 for identification criteria.

SIM Mode - When the client requests SIM mode, select SIM instead of SCAN mode and identify a minimum of two ions per analyte of interest. Also, a minimum of two ions for each internal standard and surrogate compound should be selected.

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Helium Pressurization – If a canister is pressurized with helium, a correction factor is applied to sample volumes extracted from the canister via auto sampler. This is due to the difference in thermal properties between helium and air. A correction factor worksheet has been generated to determine the exact volume taken from a canister and may be found at J:\\A-GCMS\Helium Pressurization. Save file, print the sheet and include with the data. Refer to the instruction page in the template for all of the instructions and calculations including backfilled canisters.

AutoCAN Leak Checks – Canisters should be put on at least two different AutoCAN positions to confirm a "leak". In addition, the valve threads should be inspected for defects which may prevent a good seal with the AutoCAN. Once a canister has "failed" the leak check it must be tagged, an NCAR initiated, and the PM notified. Regardless of what the client or PM specifies as the fate of the sample, the canister must be put on maintenance hold to complete a full 24-hour leak check. A yellow sheet is to be completed in addition to, but not in lieu of an NCAR. This is a fixed QA procedure with no allowance for deviation.

12.9.1 Sample Dilution If any target analyte results are above the highest level of the initial calibration, a smaller sample aliquot should be analyzed. The dynamic range of volume aliquots for the automatic cryogenic concentrator is 20cc to 1L. If a volume smaller than 20cc is to be analyzed, a dilution should be made in a Tedlar bag, or the sample directly injected using a gastight syringe. Guidance in performing dilutions and exceptions to this requirement are given below.

- Refer to Section 12.4.1 (Adsorbent Trap Sampling Rate) for the required sampling rate if less than 100mL is to be analyzed.
- Use results of the original analysis to determine the approximate dilution factor required and get the largest analyte peak within the initial calibration range.
- The dilution factor must be documented (and included in the final report) and chosen in such a way as to keep the response of the analyte peak for a reported target compound in the upper half of the initial calibration range of the instrument.

Tedlar bag dilution:

- Make a dilution by filling a Tedlar bag with 1.0 liter of humidified zero air using a one-liter gas syringe.
- Calculate the volume of balance gas needed to obtain the required dilution.
- Remove the difference in the balance gas using a syringe.
- Add the calculated sample amount using a gastight syringe.

Direct injection:

- Make a direct injection by attaching a clean, humidified zero air filled Summa canister to the preconcentrator autosampler using 1/4" stainless steel or teflon tubing with a "tee" septum port. This canister should be the same canister that may be used as the method blank.
- Inject the sample through the septum while the preconcentrator withdraws a 200cc aliquot from the canister.

12.9.2 Tentatively Identified Compounds When requested, a mass spectral library search may be made for the purpose of tentatively identifying sample components not associated with the calibration standards. The necessity to perform this type of identification will be determined by the purpose of the

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analyses being conducted. Data system mass spectral library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Certain programs 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. The following guidelines are used for making tentative identifications.

- Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.
- The relative intensities of the major ions should agree within ±20%. For example, for an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance should be between 30 and 70%.
- Molecular ions present in the reference spectrum should be present in the sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
- 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 co-eluting peaks. Data system library reduction programs can sometimes create these discrepancies.
- The concentration of the tentatively identified compound is estimated by assuming a response factor of 1.0 and comparing the response of the tentatively identified compound to the response of the nearest internal standard.
- If non-target analytes are not Q-deleted from the quant report, the analyst must evaluate whether these compounds should be reported as TICS.

12.10 Duplicate

A duplicate must be analyzed to assess laboratory precision and samples selected for duplicate analysis shall be rotated among client samples, where applicable. Some projects or sample matrix issues may require the analysis of a duplicate laboratory control sample (DLCS).

12.11 Internal Standard (IS)

The concentration of internal standard added to each standard, field sample and QC sample must be consistent from that of each current ICAL standard.

12.12 Surrogates

Internal standards/surrogates must be added at the same volume for every standard, sample and QC sample. Surrogate compound recoveries are requested by a number of clients, but are more appropriately used as system monitoring compounds. This is due to the fact that the compounds are introduced directly into the analytical system and not into the canisters or bags. It is for this reason that they are not considered to be true surrogates and a fixed window is applied. Additionally, surrogates are not included in the ICAL because they are not required by the method and are only system monitoring compounds.

12.13 Manual Integration and Q Deletion

A list of abbreviations (codes) that may be used to give a reason for performing either of these procedures are listed in the *SOP for Data Review and Reporting*.

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12.13.1 Manual Integration The integration for each peak must be legally defensible and shall be checked to ensure that it has been integrated properly and consistently between samples, standards and QC samples. All peak reviews and manual integrations must follow the requirements specified in the *SOP for Manual Integration Policy* and the *SOP for Laboratory Ethics and Data Integrity.* The requirements in the above stated procedure include when manual integrations are performed, raw data records shall include a complete audit trail for those manipulations (i.e., chromatograms showing both the integration prior to any manual integrations and those depicting the corresponding manually integrated peaks), and notation of rationale, date, and initials of person performing the manual integration operation. In addition, manual integrations must be reviewed and approved by a second reviewer and the manual integrations maintained in the appropriate job file.

Reporting Requirements Certain project requirements including samples which are submitted under the Department of Defense (DoD) QSM require that the case narrative include an identification of samples and analytes for which manual integration is required. Refer to project requirements to determine if this is necessary.

12.13.2 Q Deletion Q deleting may be performed to either delete a false positive or delete non-target compounds.

12.14 Detection Limits and Limits of Detection

The MDL study shall be performed annually for all target analytes on each instrument (with identical configurations) for which this method is performed. The MDL shall be performed in accordance with the procedure outlined in the *SOP for Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation.* The detection limit shall be used to determine the LOD for each analyte.

Once determined on each instrument, the highest LOD (for each analyte from all instrument determinations) shall be used as the uniform LOD. However, if a lower detection limit is reported, then the samples must have been run on that specific instrument on which the lower LOD was determined.

12.14.1 Performance and Acceptance Criteria

1. The MDL must be <0.5ppbV for each analyte (Method 11.11.1).
2. Perform Limit of Detection (LOD) verification on all instruments (performing this method) immediately following the MDL study. Spike the LOD at 2-4x the MDL; the spike level establishes the LOD.
3. LOD Acceptance
   - Analyte must be detected reliably and identified by the method-specific criteria (i.e, ion confirmation) and produce a signal that is at least 3 times the instrument's noise level (3:1 signal to noise ratio).
   - It is specific to each combination of analyte, matrix, method and instrument configuration.
   - The LOD must be verified quarterly on each instrument (spiked at LOD) using the criteria listed above.
4. If the LOD verification fails (per #3), repeat the detection limit determination and LOD verification at a higher concentration or perform and pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration.
5. The laboratory shall maintain documentation for all detection limit determinations and LOD verifications (regardless of pass or fail).

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12.15 Method Reporting Limit Check Standard

It is recommended to analyze a MRL check standard at the current MRL or required MRL for the batch (per client requirements) of twenty or fewer samples if the CCV fails low for any target compound. A MRL check standard may also be required per client specifications.

This check standard can also serve as the LOQ verification if it meets the specific requirements listed in Section 11.1.4.2. Apply the requirements and retain all documentation accordingly. Refer to Attachment 4 for Minnesota specified MRL check standard criteria.

12.16 Method Modifications

Method modifications are not allowed under NELAC\TNI standards; therefore, a statement, however worded, must be included in the final report indicating that data reported does not fall under the laboratory's NELAC certificate of approval. In addition, the following items are considered to be method modifications and must be reported accordingly.

- Sample collection in gas collection bags
- The pressurization of canisters with nitrogen or helium (if EPA Method 3C is requested) refer to Section 12.9.

13) Troubleshooting

13.1 Prepare new standards, check instrument maintenance, prepare a new curve as needed, etc. Refer to the corrective actions listed in Section 16 of this SOP for additional troubleshooting details.

14) Data Acquisition

14.1 Storing Electronic Data

The initial calibration data must be stored in a quantitation method (on the server) using a unique filename and may not be overwritten at any time in order to maintain an accurate audit trail. There are multiple quantitation methods, which are subsets of the compound list in Table 2. Therefore, files will be named with an eight-character notation indicating the compound list and the date of the corresponding initial calibration. In addition, all data files including method blanks, continuing calibration verification, laboratory control samples and client submitted samples files are saved in a unique sub-directory on the server.

14.2 Sufficient raw data records must be retained on file of all laboratory analyses described in this document including passing QC canister checks, tune checks, instrument calibrations, verifications, sample analyses and dilutions, QC checks, and method detection limit studies. The information that is required includes: analysis/calibration date and time, test method, instrument, sample identification, analyte identification, analyst's initials, concentrations and responses, as well as standards used for the analysis and calibrations, all manual calculations including sample dilutions and manual integrations to permit reconstruction of analyses. Information entered and reported on the quantitation report and instrument run log must be complete and accurate. All data shall be obtained following defensible and ethical practices in accordance with the most recent Quality Assurance Manual and the *SOP for Laboratory Ethics and Data Integrity*.

Note: All data records must explicitly connect data to the initial instrument calibration. This includes all samples, continuing calibrations and QC samples.

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14.3 The essential information to be associated with analysis, such as computer data files, run logs, etc. shall include: Sample ID code, date and time (if the holding time is 72 hours) of analysis, instrument operating conditions/parameters (or reference to such data), analysis type, all manual calculations including dilutions and manual integrations, analyst's initials, sample preparation (pressure readings and balance gas if pressurized with helium), standard and reagent origin, receipt, preparation, and use, as well as calibration criteria, frequency and acceptance criteria, data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions.

15) Calculation and Data Reduction Requirements

15.1 This method has specific requirements including the use of canisters; any modification must be reported accordingly. All reports that fall under the laboratory's certificate of approval (in accordance with NELAC/TNI standards) must include a statement(s) clarifying any deviations from the scope of this certification. Refer to Section 15.10 for additional information and specific items, which require this clarification.

15.2 Initial Calibration

Tabulate each of the following:

15.2.1 Equation Number 1 - **Relative Response Factor (RRF):**

$$RRF = \frac{A_x C_{is}}{A_{is} C_x}$$

where:

A_x is the area response of the analyte quantitation ion.
A_{is} is the area response of the corresponding internal standard quantitation ion.
C_{is} Internal standard concentration, ng.
C_x Analyte concentration, ng.

Note: The equation above is valid under the condition that the volume of internal standard spiking mixture added in all field and QC samples is the same from run to run.

15.2.2 Equation Number 2 - **Average (or Mean) RRF:**

$$\overline{RRF} = \frac{\sum_{i=1}^{N} RRF_i}{N}$$

where:

RRF_i are the individual RRFs from each concentration level in the initial calibration curve.

N is the number of calibration concentration levels.

15.2.3 Equation Number 3 - **Standard Deviation, SD:**

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$$SD = \sqrt{\sum_{i=1}^{N} \frac{\left(RRF_i - \overline{RRF}\right)^2}{N-1}}$$ where:

RRF_i are the individual RRFs from each concentration level in the initial calibration curve.

$\overline{RRF}$ Average (or Mean) RRF of all concentration levels in the initial calibration curve.

N total number of calibration concentration levels

15.2.4 Equation Number 4 - **Percent Relative Standard Deviation, %RSD:**

$$\%RSD = \frac{SD}{\overline{RRF}}(100)$$ where:

SD Standard Deviation calculated in equation number 3

$\overline{RRF}$ Average or Mean RRF

15.2.5 Equation Number 5 - **Relative Retention Time (RRT):**

$$RRT = \frac{RT_C}{RT_{is}}$$ where:

RT_C Retention time of the target compound, seconds.

RT_{is} Retention time of the internal standard, seconds.

15.2.6 Equation Number 6 - **Mean Relative Retention Time ($\overline{RRT}$):**

$$\overline{RRT} = \sum_{i=1}^{n} \frac{RRT_i}{n}$$ where:

$\overline{RRT}$ Mean relative retention time (seconds) for the target compound for all initial calibration levels.

RRT_i Relative retention time for the target compound in level i.

n Number of calibration levels

15.2.7 Equation Number 7 - **Mean Area Response ($\overline{Y}$):**

$$\overline{Y} = \sum_{i=1}^{n} \frac{Y_i}{n}$$ where:

Y_i Area response for the primary quantitation ion for the internal standard for each initial calibration standard.

n number of calibration concentration levels

15.2.8 Equation Number 8 - **Mean Retention Times ($\overline{RT}$):**

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$$\overline{RT} = \sum_{i=1}^{n} \frac{RT_i}{n}$$ where:

$\overline{RT}$ Mean retention time, seconds
RT_i Retention time for the internal standard for each initial calibration standard, seconds.
n number of initial calibration levels

15.3 Continuing Calibration Verification

- Calculate the (RRF) of each target compound using equation number 1.

15.3.1 Equation Number 9 - **Percent Difference, %D:**

$$\%D = \frac{RRFx - \overline{RRF}}{\overline{RRF}}(100)$$ where, for any given analyte:

RRF_x is the RRF from the CCV being evaluated.
$\overline{RRF}$ is the mean RRF from the current calibration curve.

15.4 Percent Recovery – ICV, LCS, Surrogates, MRL Check Standard

15.4.1 Equation Number 10 - **Percent Recovery (%R):**

%R = X/TV x 100

where
X = Concentration of the analyte recovered
TV = True value of amount spiked

15.5 Duplicate Analysis

15.5.1 Equation Number 11 - **Relative Percent Difference (RPD):**

$$\frac{x_1 - x_2}{\overline{x}}(100)$$ where:

x_1 First measurement value
x_2 Second measurement value
$\overline{x}$ Average of the two values

15.6 Internal Standards (IS)

- Calculate the mean area response $\overline{Y}$ for each internal standard using equation number 7.
- Calculate the mean of the retention times for each internal standard using equation number 8.

15.7 Pressure Dilution Factor (PDF)

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15.7.1 Equation Number 12 - **PDF**, for samples collected in Summa canisters:

$$PDF = \frac{P_{atm} + P_f}{P_{atm} + P_i}$$ where:

P_{atm} is the ambient atmospheric pressure, 14.7 psi at sea level.
P_f is the final sample canister pressure, in psig.
P_i is the initial sample canister pressure, in psig. This will most often be a negative value (sub-ambient initial pressure).

15.8 Results

If a canister has been pressurized with Helium and the Tekmar AutoCan was utilized, refer to Section 12.9.

15.8.1 Equation Number 13 - For calculating analyte concentrations in a sample, the starting point is the nanogram amount generated by the HP Enviroquant software, which appears on the quantitation report.

$$ng_x = \frac{A_x ng_{is}}{A_{is}\overline{RRF}}$$ where:

ng_x is the nanogram amount of analyte *x*.
A_x is the area response of the analyte's quantitation ion.
A_{is} is the area response of the corresponding internal standard's quantitation ion.
ng_{is} is the internal standard amount, in nanograms.
$\overline{RRF}$ is the average or mean RRFs

15.8.2 Equation Number 14 - The final analyte concentration, C_x, in units of micrograms per cubic meter (µg/m³), is then calculated from the following:

$$C_x = \left(\frac{ng_x PDF}{V}\right)\left(\frac{1\mu g}{1000ng}\right)\left(\frac{1000l}{1m^3}\right)$$ where:

V is the sample volume analyzed, in liters.
PDF is the sample canister pressure dilution factor.

15.8.3 Equation Number 15 - To convert to units of parts per billion volume (ppbv):

$$ppbv = \frac{\mu g/m^3}{MW} x24.46 \qquad \mu g/m^3 = \frac{ppbv}{24.46} xMW$$ where:

MW is the molecular weight (Table 2) of the analyte, in g/mole.
24.46 is the molar volume of an ideal gas at 298 K (25 °C) and 760 mmHg (1 atm), in liters per mole (l/mol).
C_x the final analyte concentration in micrograms per cubic meter.

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15.8.4 Equation Number 16 – Helium Pressurization (Injection Amount)

Applicable to canisters pressurized with helium and injected utilizing the mass flow controller of the AutoCAN. For full instructions and calculations, refer to the 1st tab of the template located at: J:\A-GCMS\Helium Pressurization\MFC_GCF _backfill.

15.9 Data Review

The analyst must review data on a real time basis for all calibration and QC data. The QC data must be evaluated by analytical sequence following the Daily QC review checklist (Attachment 3). The data shall be reviewed and the sample results calculated and assessed by one analyst and reviewed by a second qualified analyst. The Sample Review checklist (Attachment 3) is used to document sample review per service request and once completed, initialed and dated must be filed with each job file.

Initial calibrations must be reviewed in the same manner as QC data with all ICAL documentation retained in a separate file organized by instrument and date. Refer to the initial calibration checklist in Attachment 2 for the review guideline. The ICAL file must contain all the pertinent information stated in Section 11.1.6.

15.10 Reporting

The results of each test shall be reported clearly, unambiguously and objectively, and shall include all the information necessary for the interpretation of the test results and information required by this laboratory's policy, NELAC\TNI standards, DoD Manual (applicable version, see reference section), client projects, and the TO-15 method including modifications, observances, data qualifiers, and certification information.

If the project requires that results be reported below the MRL (LOQ), but above the LOD all of the requirements specified for normal reporting apply (3:1 S/N ratio and ion abundance). This is regardless of the fact that the results will be qualified as estimated.

15.10.1 Analysis Observations / Case Narrative Summary Form

This form, which is included in the *SOP for Laboratory Storage, Analysis and Tracking*, must be generated when there are specific sample composition information or analysis issues and/or observations. In addition, during the analysis, specific identification information or problems, interferences, calibration issues, flags, and additional/expanded explanation of flags should be added to the form. This form may be modified as long as the sections and basic concepts are reserved. All data qualifiers and flags should follow those listed in the most recent Quality Assurance Manual or as defined in any client requirements.

This form is necessary as a means for documentation. This form, among other information, will be reviewed when compiling the final report and case narrative. All information regarding the job shall remain in the file, in order that sufficient documentation is available to recreate the job from sample receipt through analysis, data reduction, and reporting.

15.10.2 NELAC\TNI Requirements

The following items do not comply with NELAC\TNI standard requirements and must be reported accordingly. A statement, however worded, must be

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included in the final report indicating that data reported does not fall under the laboratory's NELAC certificate of approval.

- Reporting any compound which is not included in the second source standard (ICV or LCS) does not meet NELAC requirements.
- In addition, a report that contains a compound not included on the NELAC certificate of approval must also include the statement listed above.

15.10.2.1 Modifications

Method modifications are also not allowed under NELAC\TNI standards; therefore, a statement, however worded, must be included in the final report indicating that data reported does not fall under the laboratory's NELAC certificate of approval. In addition, the following items are considered to be method modifications and must be reported accordingly.

- Sample collection in gas collection bags
- The pressurization of canisters with nitrogen or helium (if EPA Method 3C is requested) refer to Section 12.9.

15.10.3 Surrogates

Only report surrogates at the request of the client. If any surrogate is out of control, all samples results (with surrogates requested) associated with the surrogate must be reported with the appropriate data qualifier.

15.10.4 DoD Requirements

Report results with the appropriate data qualifiers, if samples cannot be reanalyzed for any reason. In addition and at a minimum, the following situations are to be noted in the case narrative: manual integrations, CCV out of control, and results exceeding the calibration range.

16) Quality Control, Acceptance Criteria, and Corrective Action

16.1 To the extent possible, samples shall be reported only if all of the quality control measures are acceptable. If a quality control measure is found to be out of control, and the data must be reported, all samples associated with the out of control quality control measure shall be reported with the appropriate data qualifier(s).

16.2 Corrective actions shall follow the procedures outlined in the *SOP for Nonconformance and Corrective Action*, where appropriate. Any maintenance which may alter instrument sensitivity or linearity must result in the re-analysis of the entire sequence including the tune compound, ICAL or CCV or any batch QC.

16.3 Instrument Performance Check

16.3.1 Acceptance Criteria

Refer to Tables 1 and 1A for the required ion abundance criteria.

16.3.2 Corrective Action Perform auto tune or manual tune and then re-analyze BFB. If the BFB acceptance criteria are still not met, the MS must be retuned according to the procedure outlined in the instrument user's manual. Perform necessary maintenance and make notations in the instrument maintenance logbook. It may be necessary to clean the ion source, or quadrupole, or take other necessary actions to achieve the acceptance criteria. An acceptable tune is required for sample results to be calculated and reported.

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16.4 Initial Calibration

16.4.1 Acceptance Criteria Refer to the following acceptance criteria for the initial calibration.

- The RRT for each target compound at each calibration level must be within 0.06RRT units of the mean RRT for the compound.
- The calculated %RSD for the RRF for each compound in the calibration standard must be less than 30% with at most two exceptions up to a limit of 40% (this may not be true for all projects).
- For each Internal Standard the area response (Y) at each calibration level must be within 40% of the mean area response $\overline{Y}$ over the initial calibration range.
- The retention time shift for each of the internal standards at each calibration level must be within 20s of the mean retention time over the initial calibration range for each internal standard.
- All of the following information must be retained to permit reconstruction of the initial instrument calibration: calibration date, test method, instrument, analysis date, analyte identification, analyst's initials, concentration and responses, and response factors.
- All initial instrument calibrations must be verified with an acceptable ICV.

16.4.2 Corrective Action Follow the initial calibration requirements detailed in Section 11.1 for information on re-analyzing or dropping points and the restriction of maintenance performed during the analysis of the initial calibration standards.

If the initial calibration results are outside the established acceptance criteria, corrective actions must be performed and all associated samples reanalyzed, if reanalysis of the samples is not possible, data associated with an unacceptable initial calibration shall be reported as estimated with the appropriate data qualifiers.

16.5 Initial Calibration Verification Standard (ICV)

16.5.1 Acceptance Criteria The percent recovery for each compound in the ICV must be between 70%-130% for all analytes except vinyl acetate, which must be within 50-150%. Exceptions to this allowance for the vinyl acetate recovery are project specific requirements and any DoD type project, which shall adhere to the 70-130% requirement for all target compounds.

16.5.2 Corrective Action If the initial calibration verification technical acceptance criteria are not met, reanalyze and if it fails again, prepare a new canister and analyze. If the criteria are still not met inspect the system for possible sources and perform any necessary maintenance and make a notation in the maintenance logbook of any steps taken. It may be necessary to clean the ion source or change the column. Perform a new initial calibration if any performed maintenance has altered instrument linearity and/or sensitivity. Perform another initial calibration or if reanalysis is not possible, data associated with an unacceptable ICAL/ICV shall be reported as estimated with the appropriate data qualifiers.

16.6 Continuing Calibration Verification (CCV)

16.6.1 Acceptance Criteria All compounds must be evaluated prior to rounding. The percent difference for each target analyte must be within plus or minus 30% of the initial calibration average RRFs.

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16.6.2 Corrective Action If the continuing calibration verification technical acceptance criteria are not met, reanalyze and if it fails again, prepare a new canister and analyze. If the criteria are still not met inspect the system for possible sources of the problem and perform any necessary maintenance and make a notation in the maintenance logbook of any steps taken. It may be necessary to clean the ion source or change the column.

If any corrective action and/or reanalysis fails to produce continuing calibration verification within acceptance criteria (analyzed immediately following the initial failure), then either two consecutive successful verifications must be performed following corrective action or a new initial calibration must be performed; however, refer to 16.5.1 below.

16.6.2.1 Method Reporting Limit Check Standard

If the MRL check standard is unacceptable for any compound (sensitivity; ratio or %D), reanalyze at the same or higher level within the same batch and report data with the CCV flag and case narrative notes accordingly.

16.6.3 *DOD REQUIREMENT:* If a CCV fails, the laboratory must immediately analyze two additional consecutive CCVs (immediately is defined as within one hour).

- Both of these CCVs must meet acceptance criteria in order for samples to be reported without reanalysis
- If either of these two CCVs fail or if the laboratory cannot immediately analyze two CCVs, the associated samples cannot be reported and must be reanalyzed.
- Corrective action(s) and recalibration must occur if the above scenario fails. All affected samples since the last acceptable CCV must be reanalyzed.
- Flagging data for a failed CCV is only appropriate when the affected samples cannot be reanalyzed. The laboratory must notify the client prior to reporting data associated with a failed CCV.

16.7 Canister Quality Control Check

The actual cleaning procedure, number of cans to select for analysis (to release a cleaning batch) and corrective actions are covered in the *SOP for Cleaning and Certification of Summa Canister and Other Specially Prepared Canisters* and are not covered in this section. However, the procedure for analyzing and certifying a cleaning batch is included. If a canister passes as a QC canister it meets all of the requirements for a method blank (Method, NELAC\TNI, and Department of Defense Quality Systems Manual – DoD QSM, etc.).

16.7.1 Scan Analyses A canister is considered "clean" for normal SCAN analyses if the analysis shows <0.2ppbv of any target analyte (analyte exceptions listed in table below). If a canister passes as a QC canister it meets all of the requirements for a method blank (Method, NELAC\TNI, and Department of Defense Quality Systems Manual - DoD QSM, etc.).

Low Level SCAN Analyses For those analytes with a MRL of 0.1ug/m3, the QC criteria of <MRL is acceptable; otherwise, <0.2ppbV is required (analyte exceptions listed in table below).

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SIM Analyses Results <MRL will be acceptable as this complies with the <0.2ppbV method requirement.

ANALYTE EXCEPTION LIST					
Compounds	ppbV	On Column (ng)	Compounds	ppbV	On Column (ng)
Target Analytes	0.2	0.50	Acrylonitrile	0.2	0.43
Chloromethane	0.2	0.41	Acetone	1.5	3.5
1,3-Butadiene	0.2	0.44	Ethanol	1.9	3.5
Acetonitrile	0.2	0.33	Vinyl acetate	0.99	3.5
Acrolein	0.65	1.5	1-Butanol	0.23	0.70
Isopropanol	0.28	0.70	Carbon Disulfide	1.1	3.5
2-Butanone	1.2	3.5			

Document the status of the check in LIMS and return the canister to the canister conditioning room. Additionally, if the check was found to be acceptable, the quantitation report must be kept on file for future reference

16.7.2 Tentatively Identified Compounds (TIC) If the batch of canisters are to be used for tentatively identified compounds (TIC) analysis, any non-target peaks present in the QC check canister analysis must be evaluated and determined to be less than the TIC reporting limit (10% of the internal standard). The concentration is estimated by assuming a RRF of 1.0 and comparing the response of the TIC to the response of the nearest internal standard.

16.8 Method Blank

16.8.1 Acceptance Criteria

- The concentration of a targeted analyte in the blank cannot be at or above the MRL, AND be greater than 1/10 of the amount measured in any associated sample. For any project that requires reported results less than the MRL, all associated measurements found in the MB should result in a qualifier; however, project requirements may differ and must be followed. Refer to DoD requirements listed below.
- The method blank should not contain additional compounds with elution characteristics and mass spectral features that would interfere with identification and measurement of a method analyte.
- For DoD samples, the method blank will be considered to be contaminated if:

  1. The concentration of any target analyte in the blank exceeds 1/2 the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater);
  2. The concentration of any common laboratory contaminant (acetone, ethanol, carbon disulfide, and methylene chloride) in the blank exceeds the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); or
  3. The blank result otherwise affects the samples results as per the test method requirements or the project-specific objectives.

The laboratory shall evaluate whether reprocessing of the samples is necessary based on the above criteria.

16.8.2 Corrective Action If the analyte concentration results in the blank do not meet the acceptance criteria repeat analysis with remaining QC canisters until results

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are acceptable or prepare a canister per Section 12.7. If the analyte results in the blank still do not meet the acceptance criteria the source of the problem must be investigated and measures taken to eliminate the source. Each method blank must be critically evaluated as to the nature of the interference and the effect on the analysis of each sample within the batch. Determine whether the contamination is from the instrument or due to contamination in the blank container (if results from the new can are not acceptable then the system is probably contaminated). In all cases, the corrective action (reprocessing or data qualifying codes) must be documented. However, the specific corrective action depends on the type of project the blank is utilized for; therefore, refer (below) to the reporting/reprocessing requirements.

DEPARTMENT OF DEFENSE (DoD) QSM PROJECT: Any sample associated with a blank that fails the criteria shall be reprocessed in the same or subsequent analytical batch, except when the sample analysis resulted in a non-detect. If reanalysis is not performed, the results shall be reported with appropriate data qualifier.

OTHER PROJECT TYPE: Appropriate corrective measures must be taken and documented before sample analysis proceeds. However, if this is not a possibility and the results must be reported follow the reporting requirements stated in Section 18.4.

16.9 Laboratory Control Sample (LCS)

16.9.1 Acceptance Criteria Round all results to the nearest whole number prior to determining if the acceptance criteria have been met. The percent recoveries must be within the laboratory-generated limits and are referenced in the electronic TO-15 Method Manual. However, Arizona requires the percent recovery for each compound in the LCS to be 70%-130% (to match the ICV requirement). Therefore, the ICV exception for vinyl acetate stated in Section 16.5 requires the percent recovery for AZ samples to be 50-150%.

Note: Client project requirements, AFCEE and DoD requirements shall take precedence over the AZ requirement for AZ samples. Meaning if a sample is collected for a DoD project in AZ, DoD requirements specified in this document and the project specific QAPP (if supplied) are to be followed.

DoD Requirement: In the absence of client specified LCS reporting criteria, the LCS control limits outlined in the DoD QSM 5.0 Appendix C tables shall be used when reporting data for DoD projects.

16.9.2 Corrective Action If the LCS criteria are not met, determine whether the cause is instrumentation or the result of a poor injection. If the problem is instrumentation, perform maintenance and if the problem is with the injection re-analyze the LCS. DoD considers the same analyte exceeding the LCS control limits two out of three consecutive LCS to be indicative of non-random behavior; therefore, this trend should be monitored and the appropriate corrective action taken when it occurs.

16.10 Sample Results

16.10.1 Acceptance Criteria

- Sample results must be quantitated from the initial instrument calibration and may not be quantitated from any continuing instrument calibration verification.

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- The field sample must be analyzed on a GC/MS system meeting the BFB tuning, initial calibration, initial calibration verification technical acceptance criteria described in this document.
- All target analyte peaks must be within the initial calibration range, diluted or reported with the appropriate data qualifier.

16.10.2 Corrective Action

- If the retention time for any internal standard within the sample changes by more than 20 sec from the latest daily calibration or initial calibration mid-point standard, the GC/MS system must be inspected for malfunctions, and maintenance performed as required. Repeat sample analysis as needed.
- If the area for any internal standard changes by more than ±40 percent between the sample and the most recent calibration, check for possible matrix interferences and re-analyze at a greater dilution. If the requirement is still not met and matrix interference is not detected the GC/MS system must be inspected for malfunction and maintenance made where necessary.
- When corrective actions are made, samples analyzed while the instrument was not functioning properly must be re-analyzed or the appropriate data qualifiers must be attached to the results.

  To the extent possible, samples shall be reported only if all of the quality control measures are acceptable. If a quality control measure is found to be out of control, and the data must be reported, all samples associated with the out of control quality control measure shall be reported with the appropriate data qualifier(s).

16.11 Laboratory Duplicate

16.11.1 Acceptance Criteria The relative percent difference must fall within ±25%. This RPD criterion also applies to duplicate laboratory control samples (DLCS).

16.11.2 Corrective Action If the duplicate results do not meet the technical acceptance criteria, perform another duplicate analysis. If the results are still unacceptable and the associated samples are not reanalyzed then all of the sample results in the associated batch must be flagged accordingly.

16.12 Internal Standards

16.12.1 Acceptance Criteria The following acceptance criteria must be applied to each run (except the ICAL – see Section 16.4).

- The area response for each internal standard in the blank must be within ±40 percent of the area response for each internal standard in the most recent valid calibration. (CCV or mid-point from the initial calibration, whichever is most current).
- The retention time for each internal standard must be within ±0.33 minutes of the retention time for each internal standard in the most recent valid calibration. (CCV or mid-point from the initial calibration, whichever is most current).

16.12.2 Corrective Action

- Internal Standard Responses If the problem is with the instrument, perform maintenance. If the problem is with a sample, check for interferences. If the response is high, it is likely that interference is present. In this case, lower the volume or aliquot of the sample and re-analyze. If the problem persists, report the results with the best quality and qualify the results. If

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the problem is corrected with the lower volume analysis, report those results.

- Internal Standard Retention Times If the retention time for any internal standard within the sample changes by more than 20 sec from the latest daily calibration or initial calibration mid-point standard, the GC/MS system must be inspected for malfunctions, and maintenance performed as required. Repeat sample analysis where required.

16.13 Surrogates

16.13.1 Acceptance Criteria Since the matrix precludes the use of true surrogates and there is no established method criterion, acceptable surrogate recoveries are based on a fixed window of 70 - 130%. This is the typical requirement from clients. Additionally, these limits are referenced in SW-846 for use as guidance in evaluating recoveries. These limits are sufficient for evaluating the effect indicated for the individual sample results.

16.13.2 Corrective Action Poor surrogate recovery should be followed by re-analyzing a smaller aliquot to mitigate any matrix interferences. Evaluate the out of control surrogate for the effect on individual sample results.

16.14 Method Reporting Limit Check Standard

16.14.1 Acceptance Criteria Per client requirements or if the CCV is biased low for any compound, then evaluate the MRL check standard. Analyte must be detected reliably and identified by the method-specific criteria (i.e, ion confirmation) and produce a signal that is at least 3 times the instrument's noise level (3:1 signal to noise ratio). Also, a percent difference +/-50% is recommended.

16.15 Sample Holding Time Expired

The customer is to be notified that the sample's holding time was missed and the customer is to decide if the sample analysis is to continue. The documentation of missed holding time and the client's decision to proceed must be included in the corresponding job file. A statement dictating all holding time occurrences must accompany the sample results in the final report.

17) Data Records Management

17.1 All data resubmittal forms and job documentation including Service Requests, Chain of Custody forms, Sample Acceptance Check forms and hardcopy electronic mail messages must be filed in the project file. Final reports, revised reports, and final invoices are stored electronically.

17.2 All laboratory and client documentation must be retained for a minimum of five years.

18) Contingencies for Handling Out of Control Data

18.1 The following is specific information on how to report unacceptable data. If the data requires a data qualifier flag, as specified in this SOP, refer to Appendix D of the most recent version of the Quality Assurance Manual for the appropriate data qualifier.

18.2 Initial Calibration and/or Initial Calibration Verification

All results reported with an unacceptable ICAL must be reported as estimated and all data shall be reported using defined qualifiers or flags or explained in the case narrative accordingly.

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18.3 Continuing Calibration Verification

All results associated with an unacceptable CCV (other than #1 below) must be reported with the appropriate data qualifier, flag and/or explained in the case narrative.

1. When the acceptance criteria for the continuing 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 without a qualifier.
2. When the acceptance criteria for the continuing calibration verification are exceeded high, i.e., high bias, and there are associated samples with detects, then those detects must be reported with a qualifier, flag and/or explained in the case narrative.
3. If however, the acceptance criteria for the continuing calibration verification are exceeded low, i.e., low bias, and there are associated samples that are non-detects, then those non-detects must be reported with qualifiers, flags and/or explained in the case narrative as having less certainty. However, along with the data qualifiers, the case narrative may include information stating the fact that the results were not significantly affected if:
   a. *An MRL check standard was analyzed and found to be acceptable. The MRL must be the same as that analyzed in the MRL check standard for those analytes that were biased low in the CCV. Adjust MRLs (if required), flag data and state the certainty in the case narrative where the sensitivity of the instrument was demonstrated at the MRL; therefore, results were not significantly affected.*
   b. *With the reporting limit adjusted to the next level in the calibration curve (typically 5 times higher) to prove the nonexistence of a false negative and note procedure in case narrative.*
4. If the acceptance criteria was exceeded (biased high) for the CCV and there were detectable results in a sample, the results may be "qualified" if the results exceeded the regulatory/decision limit (this is to be stated in the case narrative along with the data qualifiers or flags).

18.4 Method Blank

- If an analyte in the blank is found to be out of control and the analyte is also found in associated samples, those sample results shall be "flagged" in the report and the method blank results reported.
- If the analyte is found in the blank but not in the sample then the results for the sample may be reported without a qualifier.

18.5 Laboratory Control Sample

All results associated with an out of control laboratory control sample must be reported with the appropriate data qualifier. An indication of whether the LCS was out high or low should also be included.

18.6 Surrogate

Report sample results with the appropriate data qualifier.

18.7 Laboratory Duplicate

All batch sample results associated with an out of control laboratory duplicate must be flagged with the appropriate data qualifier.

18.8 Internal Standard

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All target analytes associated with an out of control internal standard must be flagged with the appropriate data qualifier.

18.9 Estimated Sample Results

18.9.1 Sample Hold Time All occurrences of missed holding times must be included on the final report including those samples received and/or analyzed outside of the specified hold times detailed in this SOP.

18.9.2 Matrix Interference Sample data associated with matrix interference must be flagged with the appropriate data qualifier.

18.9.3 Results Outside Initial Calibration Range All sample results not bracketed by initial calibration standards (within calibration range) must be reported as having less certainty by reporting with the appropriate data qualifier.

19) Method Performance

19.1 An on-going assessment of method performance is conducted in order to ensure that the laboratory is capable of reporting results which are acceptable for its intended use. Validation of the method is confirmed by the examination and provision of objective evidence that these requirements are met.

19.2 Method Detection Limit (MDL)

The procedure used to determine the method detection limits are as stated in the *Code of Federal Regulations* (40 CFR 136 Appendix B) as defined in the *SOP for Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation*. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations are listed in Tables 2 and 2A for both SCAN and SIM modes and were obtained using spiked canisters prepared with humidified zero air, making at least seven replicate measurements of the compounds of interest, computing the standard deviation, and multiplying this value by the appropriate Student's t value for 99 percent confidence. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects. All MDLs, regardless of the mode of operation, meet the method performance criteria of <0.5ppbV.

19.3 Accuracy and Precision

Refer to Section 11.4 in the referenced method for information on replicate precision criteria for method performance. Single laboratory accuracy is presented as the second source initial calibration verification standard, which meets the method performance criteria of 30%. Additionally, laboratory generated control limit data for LCSs are presented for the analytes of interest and may be referenced in the electronic TO-15 Method Manual. Refer to Section 11.1.4.2 for the accuracy and precision requirements for concentrations at the LOQ/MRL.

19.4 Selectivity

Mass spectrometry is considered a more definitive identification technique than single specific detectors such as flame ionization detector (FID), electron capture detector (ECD), photoionization detector (PID), or a multidetector arrangement of these (see discussion in Compendium Method TO-14A). The use of both gas chromatographic retention time and the generally unique mass fragmentation patterns reduce the chances for misidentification.

It is necessary to establish that a given GC/MS meets tuning and standard mass spectral abundance criteria prior to initiating any data collection. Upon sample

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injection onto the column, the GC/MS system is operated so that the MS scans the atomic mass range from 35 to 300 amu. At least ten scans per eluting chromatographic peak must be acquired. Scanning also allows identification of unknown compounds in the sample by searching through library spectra.

The sample analysis using the GC/MS is based in part on a combination of retention times and relative abundances of selected ions. The retention time of each chromatographic peak should be ±0.10 minutes of the library/reference retention time of the compound. The acceptance level for relative abundance should be set at ±20% of the expected abundance. The data should be manually examined by the analyst to determine the reason for the # flag [(#) = qualifier out of range], if present and whether the compound should be reported as found or if there is matrix interference. A background subtraction may aid in this determination. Manual inspection of the qualitative results should also be performed to verify concentrations outside the expected range.

Specific selectivity information is provided in this section and document (such as relative retention time) as well as in the referenced method. Refer to the method for additional information on selectivity.

- Use NIST Library 98 or newer version
- The *reference spectra updates* must be performed with every new ICAL utilizing the mid-level standard (minimum). If needed, the reference spectra may be updated sooner with the continuing calibration standard.
- *Retention time updates* must be performed using EasyID and not by updating to the method (InitCal \ Update Calibration). Refer to the Help selection of the software.

19.5 Demonstration of Capability

This laboratory has continuously performed this method since before July 1999. Therefore, ongoing demonstration of capable shall be performed and documented; however, the initial demonstration of method capability is not required.

19.6 Proficiency Testing (PT) Program

The laboratory shall participate in an air and emissions PT study for TO-15. The testing shall be performed in accordance with this document and meet the frequency and proficiency requirements detailed in the DoD QSM Version 5.0.

20) Summary of Changes

Table 20.1

Revision Number	Effective Date	Document Editor	Description of Changes
22.0	03/21/15	C. Humphrey	Section 1 – Removed Note 1
			Section 4 – Revised section to include Hazard Assessment table
			Section 12.9 – Added Note 2
			Table 2A – Updated
			Table 3 – Updated
			Table 3A – Updated
			Table 4 – Updated
			Table 4A – Updated
			Attachment 3 – Added MAPH to Daily QC and Sample Review Checklists

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21) References and Related Documents

21.1 EPA Method TO-14A, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA/625/R-96/010b, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1997.

21.2 EPA Method TO-15, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA/625/R-96/010b, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1997.

21.3 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, January 1999.

21.4 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Addendum, January 17, 2002.

21.5 National Environmental Laboratory Accreditation Conference, *2003 NELAC Standard*, June 5, 2003, EPA 600/R-04/003 and 2009 TNI Standards.

21.6 *Preparation of Gas Phase Standards for Ambient Air Analysis,* Tekmar-DOHRMANN Application Note, Spring 96, Vol. 6.5.

21.7 *Department of Defense Quality Systems Manual for Environmental Laboratories*, Version 5.0, July 2013.

21.8 Arizona Administrative Code, Title 9. Health Services, Chapter 14. Department of Health Services Laboratories, December 31, 2006.

21.9 Florida Department of Environmental Protection, Chapter 62-160.

21.10 Minnesota Department of Health, 4740.2065, *Standard Operating Procedures*, Statutory Authority: MS s 144.97; 144.98; History: 31 SR 446, Posted: October 09, 2006, Revised April 16, 2010.

22) Appendix

22.1 Tables

Table 1: Instrument Tune Check Ion Abundance Criteria (TO-15)

Table 1A: Instrument Tune Check Ion Abundance Criteria (TO-14A)

Table 2: Volatile Organic Compounds, EPA Compendium Method TO-15 (SCAN)

Table 2A: Volatile Organic Compounds, EPA Compendium Method TO-15 (SIM)

Table 3: Standard Concentrations (SCAN) (Primary Sources)

Table 3A: Standard Concentrations (SIM) (Primary Sources)

Table 4: Standard Concentrations (SCAN) (Secondary Sources)

Table 4A: Standard Concentrations (SIM) (Secondary Sources)

22.2 Attachments

Attachment 1 – Training Plan

Attachment 2 – Initial Calibration Checklist

Attachment 3 – Daily QC and Sample Review Checklists

Attachment 4 – State and Project Specific Requirements

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TABLE 1

Required BFB Key Ions and
Ion Abundance Criteria for Method TO-15

Mass	Ion Abundance Criteria[1]
50	8.0 to 40.0 percent of m/e 95
75	30.0 to 66.0 percent of m/e 95
95	Base Peak, 100 Percent Relative Abundance
96	5.0 to 9.0 Percent of m/e 95
173	Less than 2.0 Percent of m/e 174
174	50.0 to 120.0 Percent of m/e 95
175	4.0 to 9.0 Percent of m/e 174
176	93.0 to 101.0 Percent of m/e 174
177	5.0 to 9.0 Percent of m/e 176

[1] All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120 percent that of m/z 95.

TABLE 1A

Required BFB Key Ions and
Ion Abundance Criteria for Method TO-14A

Mass	Ion Abundance Criteria
50	15 to 40 percent of m/e 95
75	30 to 60 percent of m/e 95
95	Base Peak, 100 Percent Relative Abundance
96	5 to 9 Percent of m/e 95
173	Less than 2 Percent of m/e 174
174	>50 Percent of m/e 95
175	5 to 9 Percent of m/e 174
176	>95 and <101 Percent of m/e 174
177	5 to 9 Percent of m/e 176

Note: The criteria listed in Tables 1 and 1A shall be met or exceeded in order for EPA Compendium Methods TO-15 or TO-14A to be referenced.

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TABLE 2 - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)								
Compound[1]	**CAS Number**	**Molecular Weight**	**Density**	**Primary Ion[2]**	**Secondary Ion(s)[2]**	**MRL[3] (µg/m³)**	**MDL[3] (µg/m³)**	**IS[4]**
Bromochloromethane (IS1)	74-97-5	-	-	130	128, 132	-	-	-
Propene	115-07-1	42.08	NA	42	39,41	0.50	0.14	IS1
Dichlorodifluoromethane (CFC 12)	75-71-8	120.9	1.329	85	87, 101, 103	0.50	0.17	IS1
Chloromethane	74-87-3	50.49	0.911	50	52	0.50	0.15	IS1
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	76-14-2	170.9	1.455	135	137	0.50	0.19	IS1
Vinyl Chloride	75-01-4	62.50	0.9106	62	64	0.50	0.17	IS1
1,3-Butadiene	106-99-0	54.09	0.6149	54	39, 53	0.50	0.22	IS1
Bromomethane	74-83-9	94.94	1.6755	94	96	0.50	0.19	IS1
Chloroethane	75-00-3	64.52	0.8902	64	66	0.50	0.17	IS1
Ethanol	64-17-5	46.07	0.7893	45	46	5.0	0.80	IS1
Acetonitrile	75-05-8	41.05	0.7857	41	40	0.50	0.18	IS1
Acrolein	107-02-8	56.06	0.840	56	55	2.0	0.17	IS1
Acetone	67-64-1	58.08	0.7845	58	43	5.0	0.77	IS1
Trichlorofluoromethane	75-69-4	137.4	NA	101	103	0.50	0.17	IS1
Isopropyl Alcohol	67-63-0	60.10	0.7809	45	43	5.0	0.42	IS1
Acrylonitrile	107-13-1	53.06	0.8060	53	52	0.50	0.17	IS1
1,1-Dichloroethene	75-35-4	96.94	1.213	96	61	0.50	0.17	IS1
tert-Butanol	75-65-0	74.12	0.7887	59	57,41,43	1.0	0.33	IS1
Methylene Chloride	75-09-2	84.94	1.3266	84	49	0.50	0.17	IS1
Allyl Chloride	107-05-1	76.53	0.9376	41	76	0.50	0.16	IS1
Trichlorotrifluoroethane	76-13-1	187.38	1.5635	151	101	0.50	0.17	IS1

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TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)								
Compound[1]	**CAS Number**	**Molecular Weight**	**Density**	**Primary Ion[2]**	**Secondary Ion(s)[2]**	**MRL[3] (µg/m³)**	**MDL[3] (µg/m³)**	**IS[4]**
Carbon Disulfide	75-15-0	76.14	1.2632	76	78	5.0	0.15	IS1
trans-1,2-Dichloroethene	156-60-5	96.94	1.2565	61	96	0.50	0.19	IS1
1,1-Dichloroethane	75-34-3	98.96	1.1757	63	65	0.50	0.16	IS1
Methyl tert-Butyl Ether	1634-04-4	88.15	0.7402	73	57	0.50	0.17	IS1
Vinyl Acetate	108-05-4	86.09	0.9317	86	43	5.0	0.65	IS1
2-Butanone (MEK)	78-93-3	72.11	0.7999	72	43	5.0	0.21	IS1
cis-1,2-Dichloroethene	156-59-2	96.94	1.2837	61	96	0.50	0.16	IS1
Diisopropyl Ether	108-20-3	102.18	0.7241	87	45,59,43	0.50	0.19	IS1
Ethyl Acetate	141-78-6	88.106	0.9003	61	70	1.0	0.35	IS1
n-Hexane	110-54-3	86.18	0.6548	57	86	0.50	0.15	IS1
Chloroform	67-66-3	119.4	1.4832	83	85	0.50	0.17	IS1
1,2-Dichloroethane-d4(S)	17060-07-0	-	-	65	67	-	-	IS1
Tetrahydrofuran	109-99-9	72.11	0.8892	72	71,42	0.50	0.20	IS1
Ethyl tert-Butyl Ether	637-92-3	102.176	0.7519	87	59,57	0.50	0.18	IS1
1,2-Dichloroethane	107-06-2	98.96	1.2351	62	64	0.50	0.16	IS1
1,4-Difluorobenzene(IS2)	540-36-3	-	-	114	88	-	-	-
1,1,1-Trichloroethane	71-55-6	133.4	1.3390	97	99, 61	0.50	0.17	IS2
Isopropyl acetate	108-21-4	102.13	0.8718	61	87,43	1.0	0.32	IS2
1-Butanol	71-36-3	74.1224	0.8098	56	41	1.0	0.48	IS2
Benzene	71-43-2	78.11	0.8765	78	77	0.50	0.16	IS2
Carbon Tetrachloride	56-23-5	153.8	1.5940	117	119	0.50	0.15	IS2

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TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)								
Compound[1]	**CAS Number**	**Molecular Weight**	**Density**	**Primary Ion[2]**	**Secondary Ion(s)[2]**	**MRL[3] (µg/m³)**	**MDL[3] (µg/m³)**	**IS[4]**
Cyclohexane	110-82-7	84.16	0.7739	84	69,56	1.0	0.29	IS2
tert-Amyl Methyl Ether	994-05-8	102.176	0.7703	73	87,55,43	0.50	0.15	IS2
1,2-Dichloropropane	78-87-5	113	1.1560	63	62	0.50	0.16	IS2
Bromodichloromethane	75-27-4	163.8	1.980	83	85	0.50	0.15	IS2
Trichloroethene	79-01-6	131.4	1.4642	130	132	0.50	0.14	IS2
1,4-Dioxane	123-91-1	88.11	1.0337	88	58	0.50	0.16	IS2
Isooctane	540-84-1	114.23	0.6877	57	41	0.50	0.15	IS2
Methyl Methacrylate	80-62-6	100.12	0.944	100	69	1.0	0.31	IS2
n-Heptane	142-82-5	100.2	0.6837	71	57,100	0.50	0.17	IS2
cis-1,3-Dichloropropene	10061-01-5	111	1.224	75	77	0.50	0.14	IS2
4-Methyl-2-Pentanone	108-10-1	100.2	0.7965	58	85	0.50	0.16	IS2
trans-1,3-Dichloropropene	10061-02-6	111	1.217	75	77	0.50	0.16	IS2
1,1,2-Trichloroethane	79-00-5	133.4	1.4397	97	83	0.50	0.16	IS2
Chlorobenzene-d5(IS3)	3114-55-4	-	-	82	117	-	-	-
Toluene-d8(S)	2037-26-5	-	-	98	100	-	-	IS3
Toluene	108-88-3	92.14	0.8669	91	92	0.50	0.17	IS3
2-Hexanone	591-78-6	100.16	0.8113	43	58	0.50	0.16	IS3
Dibromochloromethane	124-48-1	208.3	2.451	129	127	0.50	0.16	IS3
1,2-Dibromoethane	106-93-4	187.9	2.1791	107	109	0.50	0.16	IS3
n-Butyl Acetate	123-86-4	116.16	0.8825	43	56, 73	0.50	0.16	IS3
n-Octane	111-65-9	114.23	0.6986	57	114	0.50	0.18	IS3

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TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)								
Compound[1]	**CAS Number**	**Molecular Weight**	**Density**	**Primary Ion[2]**	**Secondary Ion(s)[2]**	**MRL[3] (µg/m³)**	**MDL[3] (µg/m³)**	**IS[4]**
Tetrachloroethene	127-18-4	165.8	1.6227	166	164	0.50	0.14	IS3
Chlorobenzene	108-90-7	112.6	1.1058	112	114	0.50	0.16	IS3
Ethylbenzene	100-41-4	106.2	0.8670	91	106	0.50	0.16	IS3
m-, p-Xylenes	179601-23-1	106.2	0.8642, 0.8611	91	106	1.0	0.30	IS3
Bromoform	75-25-2	252.8	2.899	173	175	0.50	0.15	IS3
Styrene	100-42-5	104.1	0.9060	104	78, 103	0.50	0.15	IS3
o-Xylene	95-47-6	106.2	0.8802	91	106	0.50	0.15	IS3
n-Nonane	111-84-2	128.26	0.7176	43	57, 85	0.50	0.15	IS3
1,1,2,2-Tetrachloroethane	79-34-5	167.9	1.5953	83	85	0.50	0.15	IS3
4-Bromofluorobenzene(S)	460-00-4	-	-	174	176	-	-	IS3
Cumene	98-82-8	120.2	0.8618	105	120	0.50	0.15	IS3
alpha-Pinene	80-56-8	136.24	0.8582	93	77	0.50	0.14	IS3
n-Propylbenzene	103-65-1	120.1938	0.8670	91	120,65	0.50	0.16	IS3
3-Ethyltoluene	620-14-4	120.2	0.8645	105	120	0.50	0.15	IS3
4-Ethyltoluene	622-96-8	120.2	0.8614	105	120	0.50	0.16	IS3
1,3,5-Trimethylbenzene	108-67-8	120.2	0.8652	105	120	0.50	0.16	IS3
alpha-Methylstyrene	98-83-9	118.19	0.9106	118	103,117	0.50	0.15	IS3
2-Ethyltoluene	611-14-3	120.2	0.8807	105	120	0.50	0.15	IS3
1,2,4-Trimethylbenzene	95-63-6	120.2	0.8758	105	120	0.50	0.15	IS3
n-Decane	124-18-5	142.28	0.7300	57	71,85	0.50	0.16	IS3
Benzyl Chloride	100-44-7	126.59	1.1004	91	126	0.50	0.11	IS3

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TABLE 2 (Continued) - VOLATILE ORGANIC COMPOUNDS, EPA COMPENDIUM METHOD TO-15 (SCAN)								
Compound[1]	CAS Number	Molecular Weight	Density	Primary Ion[2]	Secondary Ion(s)[2]	MRL[3] (µg/m³)	MDL[3] (µg/m³)	IS[4]
1,3-Dichlorobenzene	541-73-1	147	1.2884	146	148	0.50	0.15	IS3
1,4-Dichlorobenzene	106-46-7	147	1.2475	146	148	0.50	0.14	IS3
sec-Butylbenzene	135-98-8	134.2206	0.8601	105	134,91	0.50	0.16	IS3
p-Isopropyltoluene	99-87-6	134.2206	0.8573	119	134,91	0.50	0.15	IS3
1,2,3-Trimethylbenzene	526-73-8	120.1938	0.8944	105	120	0.50	0.15	IS3
1,2-Dichlorobenzene	95-50-1	147	1.3059	146	148	0.50	0.15	IS3
d-Limonene	5989-27-5	136.24	0.8402	68	93	0.50	0.14	IS3
1,2,Dibromo-3-Chloropropane	96-12-8	236.33	2.093	157	75, 39	0.50	0.099	IS3
n-Undecane	1120-21-4	156.31	0.7402	57	71, 85	0.50	0.15	IS3
1,2,4-Trichlorobenzene	120-82-1	181.5	1.459	180	182, 184	0.50	0.16	IS3
Naphthalene	91-20-3	128.17	1.0253	128	129	0.50	0.18	IS3
n-Dodecane	112-40-3	170.34	0.7487	57	71,85	0.50	0.13	IS3
Hexachlorobutadiene	87-68-3	260.8	1.556	225	227	0.50	0.14	IS3
Cyclohexanone	108-94-1	98.14	0.9478	55	42, 98	0.50	0.12	IS3
tert-Butylbenzene	98-06-6	134.22	0.867	119	134	0.50	0.15	IS3
n-Butylbenzene	104-51-8	134.22	0.867	91	134	0.50	0.17	IS3

(S) = Surrogate (IS1) = Internal Standard 1 (IS2) = Internal Standard 2 (IS3) = Internal Standard 3
NA = Not Available

Note 1: Additional compounds may be reported as long as the minimum requirements of this document are met. The compounds listed in this table are reported using TO-15 SCAN. The Selected Ion Monitoring (SIM) compounds are a subset of this list and are included in Table 2A.

Note 2: These are suggested primary and secondary ions. However, any ions in the analyte spectra that are sufficient enough in response to reach the desired reporting limit and having a limited amount of interference, is acceptable for both the primary and secondary ion selection. Analyst experience should be utilized in determining appropriate ions.

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Note 3: The laboratory performs three concentration level analyses (SIM, SCAN and Low Level SCAN). The method reporting limit listed is the standard SCAN limit (at or above lowest concentration in the initial calibration curve), but may change with each new initial calibration performed. Therefore, current reporting limits for the three analysis levels, MRLs in ppbv, and those from the Low Level SCAN should be reviewed in the electronic TO-15 Method Manual.

Note 4: The listing of the internal standard by which the compounds are quantitated is for TO-15 SCAN only. SIM compounds (SCAN subset) and their corresponding ions and internal standards are listed in Table 2A.

Note 5: m/e 101 is ~10% or less of m/e 85 (the base peak) and may not be present for low level results. Retention times must be carefully verified.

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Table 2A – Volatile Organic Compounds, EPA Compendium Method TO-15 (SIM)					
Compound	**Primary Ion[1]**	**Secondary Ion[1]**	**MRL[2] (ug/m3)**	**MDL[2] (ug/m3)**	**IS**
Dichlorodifluoromethane	85	87	0.025	0.017	IS1
Chloromethane	52	50	0.025	0.019	IS1
Vinyl Chloride	62	64	0.025	0.0076	IS1
1,3-Butadiene	54	39	0.025	0.014	IS1
Bromomethane	94	96	0.025	0.0093	IS1
Chloroethane	64	66	0.025	0.0085	IS1
Acrolein	56	55	0.20	0.039	IS1
Acetone	58	43	2.5	0.056	IS1
Freon 11	101	103	0.025	0.015	IS1
1,1-Dichloroethene	96	98,61	0.025	0.0086	IS1
Methylene Chloride	84	49	0.10	0.013	IS1
Trichlorotrifluoroethane	151	153	0.025	0.0089	IS1
trans-1,2-Dichloroethene	96	98,61	0.025	0.0073	IS1
1,1-Dichloroethane	63	65	0.025	0.0061	IS1
Methyl tert-Butyl Ether	73	57	0.025	0.0093	IS1
cis-1,2-Dichloroethene	96	98,61	0.025	0.0092	IS1
Chloroform	83	85	0.10	0.018	IS1
1,2-Dichloroethane	62	64	0.025	0.0084	IS1
1,1,1-Trichloroethane	97	99	0.025	0.0059	IS1
Benzene	78	77	0.075	0.020	IS1
Carbon Tetrachloride	117	119	0.025	0.012	IS1
1,2-Dichloropropane	63	62,76	0.025	0.0073	IS2
Bromodichloromethane	83	85	0.025	0.0069	IS2
Trichloroethene	130	132	0.025	0.0085	IS2
1,4-Dioxane	88	58	0.10	0.0085	IS2
cis-1,3-Dichloropropene	75	77,39	0.025	0.0062	IS2
trans-1,3-Dichloropropene	75	77,39	0.025	0.0055	IS2
1,1,2-Trichloroethane	83	97,61	0.10	0.0079	IS2
Toluene	91	92	0.10	0.011	IS2
Dibromochloromethane	129	127	0.025	0.0088	IS3
1,2-Dibromoethane	107	109	0.025	0.0079	IS2
Tetrachloroethene	166	164	0.025	0.0082	IS2
Chlorobenzene	112	114	0.10	0.0092	IS3
Ethylbenzene	91	106	0.10	0.0097	IS3
m-&-p-Xylene	91	106	0.10	0.019	IS3
Styrene	104	103	0.10	0.0074	IS3
o-Xylene	91	106	0.10	0.0089	IS3
1,1,2,2-Tetrachloroethane	83	85	0.025	0.0072	IS3
1,3,5-Trimethylbenzene	105	120	0.10	0.0073	IS3
1,2,4-Trimethylbenzene	105	120	0.10	0.0083	IS3
1,3-Dichlorobenzene	146	148	0.025	0.0085	IS3
1,4-Dichlorobenzene	146	148	0.025	0.0081	IS3
1,2-Dichlorobenzene	146	148	0.025	0.0083	IS3
1,2-Dibromo-3-chloropropane	157	75	0.10	0.0095	IS3
1,2,4-Trichlorobenzene	182	184	0.025	0.013	IS3
Naphthalene	128	129	0.10	0.016	IS3
Hexachlorobutadiene	225	227	0.025	0.0092	IS3

NA = Not Available
(IS1) = Internal Standard 1 (IS2) = Internal Standard 2 (IS3) = Internal Standard 3
Note 1: These are suggested primary and secondary ions. However, any ions in the analyte spectra that is sufficient enough in response to reach the desired reporting limit and having a limited amount of interference, is acceptable for both the primary and secondary ion selection. Analyst experience should be utilized in determining appropriate ions.

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Note 2: The method reporting limit listed is the standard SIM limit (lowest concentration in the initial calibration curve; must be higher than MDL), but may change with each new initial calibration performed. Therefore, current reporting limits should be reviewed. MDLs in ppbV may be reviewed in the electronic TO-15 Method Manual.

Table 3
Standard Concentrations (SCAN) (Primary Sources)[1]

Compound Name	0.08ng	0.2ng	0.4ng	1.0ng	5.0ng	25ng	50ng	100ng
Bromochloromethane (IS1)	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
Propene	0.0792	0.198	0.396	0.99	4.95	24.75	49.5	99
Dichlorodifluoromethane (CFC 12)	0.0760	0.190	0.380	0.95	4.75	23.75	47.5	95
Chloromethane	0.0808	0.202	0.404	1.01	5.05	25.25	50.5	101
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	0.0816	0.204	0.408	1.02	5.10	25.50	51.0	102
Vinyl Chloride	0.0800	0.200	0.400	1.00	5.00	25.00	50.0	100
1,3-Butadiene	0.0832	0.208	0.416	1.04	5.20	26.00	52.0	104
Bromomethane	0.0816	0.204	0.408	1.02	5.10	25.50	51.0	102
Chloroethane	0.0808	0.202	0.404	1.01	5.05	25.25	50.5	101
Ethanol	0.4128	1.032	2.064	5.16	25.80	129.00	258.0	516
Acetonitrile	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
Acrolein	0.0904	0.226	0.452	1.13	5.65	28.25	56.5	113
Acetone	0.4368	1.092	2.184	5.46	27.30	136.50	273.0	546
Trichlorofluoromethane	0.0864	0.216	0.432	1.08	5.40	27.00	54.0	108
Isopropyl Alcohol	0.1712	0.428	0.856	2.14	10.70	53.50	107.0	214
Acrylonitrile	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
1,1-Dichloroethene	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
tert-Butanol	0.1712	0.428	0.856	2.14	10.70	53.50	107.0	214
Methylene Chloride	0.0904	0.226	0.452	1.13	5.65	28.25	56.5	113
Allyl Chloride	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
Trichlorotrifluoroethane	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
Carbon Disulfide	0.0840	0.210	0.420	1.05	5.25	26.25	52.5	105
trans-1,2-Dichloroethene	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
1,1-Dichloroethane	0.0856	0.214	0.428	1.07	5.35	26.75	53.5	107
Methyl tert-Butyl Ether	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
Vinyl Acetate	0.4200	1.050	2.100	5.25	26.25	131.25	262.5	525
2-Butanone (MEK)	0.0888	0.222	0.444	1.11	5.55	27.75	55.5	111
cis-1,2-Dichloroethene	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
Diisopropyl Ether	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
Ethyl Acetate	0.1712	0.428	0.856	2.14	10.70	53.50	107.0	214
n-Hexane	0.0856	0.214	0.428	1.07	5.35	26.75	53.5	107
Chloroform	0.0896	0.224	0.448	1.12	5.60	28.00	56.0	112
1,2-Dichloroethane-d4 (S)	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
Tetrahydrofuran	0.0888	0.222	0.444	1.11	5.55	27.75	55.5	111
Ethyl tert-Butyl Ether	0.0864	0.216	0.432	1.08	5.40	27.00	54.0	108
1,2-Dichloroethane	0.0864	0.216	0.432	1.08	5.40	27.00	54.0	108
1,4-Difluorobenzene(IS2)	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
1,1,1-Trichloroethane	0.0840	0.210	0.420	1.05	5.25	26.25	52.5	105
Isopropyl acetate	0.1832	0.458	0.916	2.29	11.45	57.25	114.5	229
1-Butanol	0.1824	0.456	0.912	2.28	11.40	57.00	114.0	228

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Table 3 - Continued
Standard Concentrations (SCAN) (Primary Sources)[1]

Compound Name	0.08ng	0.2ng	0.4ng	1.0ng	5.0ng	25ng	50ng	100ng
Benzene	0.0904	0.226	0.452	1.13	5.65	28.25	56.5	113
Carbon Tetrachloride	0.0920	0.230	0.460	1.15	5.75	28.75	57.5	115
Cyclohexane	0.1712	0.428	0.856	2.14	10.70	53.50	107.0	214
tert-Amyl Methyl Ether	0.0856	0.214	0.428	1.07	5.35	26.75	53.5	107
1,2-Dichloropropane	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
Bromodichloromethane	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
Trichloroethene	0.0864	0.216	0.432	1.08	5.40	27.00	54.0	108
1,4-Dioxane	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
Isooctane	0.0856	0.214	0.428	1.07	5.35	26.75	53.5	107
Methyl Methacrylate	0.1712	0.428	0.856	2.14	10.70	53.50	107.0	214
n-Heptane	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
cis-1,3-Dichloropropene	0.0840	0.210	0.420	1.05	5.25	26.25	52.5	105
4-Methyl-2-Pentanone	0.0888	0.222	0.444	1.11	5.55	27.75	55.5	111
trans-1,3-Dichloropropene	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
1,1,2-Trichloroethane	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
Chlorobenzene-d5 (IS3)	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
Toluene-d8 (S)	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
Toluene	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
2-Hexanone	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
Dibromochloromethane	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
1,2-Dibromoethane	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
n-Butyl Acetate	0.0928	0.232	0.464	1.16	5.80	29.00	58.0	116
n-Octane	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
Tetrachloroethene	0.0808	0.202	0.404	1.01	5.05	25.25	50.5	101
Chlorobenzene	0.0888	0.222	0.444	1.11	5.55	27.75	55.5	111
Ethylbenzene	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
m- & p-Xylene	0.1728	0.432	0.864	2.16	10.80	54.00	108.0	216
Bromoform	0.0912	0.228	0.456	1.14	5.70	28.50	57.0	114
Styrene	0.0896	0.224	0.448	1.12	5.60	28.00	56.0	112
o-Xylene	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
n-Nonane	0.0832	0.208	0.416	1.04	5.20	26.00	52.0	104
1,1,2,2-Tetrachloroethane	0.0840	0.210	0.420	1.05	5.25	26.25	52.5	105
4-Bromofluorobenzene (S)	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
Cumene	0.0808	0.202	0.404	1.01	5.05	25.25	50.5	101
alpha-Pinene	0.0832	0.208	0.416	1.04	5.20	26.00	52.0	104
n-Propylbenzene	0.0800	0.200	0.400	1.00	5.00	25.00	50.0	100
3-Ethyltoluene	0.0840	0.210	0.420	1.05	5.25	26.25	52.5	105
4-Ethyltoluene	0.0840	0.210	0.420	1.05	5.25	26.25	52.5	105
1,3,5-Trimethylbenzene	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
alpha-Methylstyrene	0.0832	0.208	0.416	1.04	5.20	26.00	52.0	104
2-Ethyltoluene	0.0864	0.216	0.432	1.08	5.40	27.00	54.0	108
1,2,4-Trimethylbenzene	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109

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Table 3 - Continued
Standard Concentrations (SCAN) (Primary Sources)[1]

Compound Name	0.08ng	0.2ng	0.4ng	1.0ng	5.0ng	25ng	50ng	100ng
n-Decane	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
Benzyl Chloride	0.0912	0.228	0.456	1.14	5.70	28.50	57.0	114
1,3-Dichlorobenzene	0.0912	0.228	0.456	1.14	5.70	28.50	57.0	114
1,4-Dichlorobenzene	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
sec-Butylbenzene	0.0872	0.218	0.436	1.09	5.45	27.25	54.5	109
p-Isopropyltoluene	0.0856	0.214	0.428	1.07	5.35	26.75	53.5	107
1,2,3-Trimethylbenzene	0.0848	0.212	0.424	1.06	5.30	26.50	53.0	106
1,2-Dichlorobenzene	0.0888	0.222	0.444	1.11	5.55	27.75	55.5	111
d-Limonene	0.0856	0.214	0.428	1.07	5.35	26.75	53.5	107
1,2-Dibromo-3-Chloropropane	0.0880	0.220	0.440	1.10	5.50	27.50	55.0	110
n-Undecane	0.0832	0.208	0.416	1.04	5.20	26.00	52.0	104
1,2,4-Trichlorobenzene	0.0904	0.226	0.452	1.13	5.65	28.25	56.5	113
Naphthalene	0.0888	0.222	0.444	1.11	5.55	27.75	55.5	111
n-Dodecane	0.0904	0.226	0.452	1.13	5.65	28.25	56.5	113
Hexachlorobutadiene	0.0896	0.224	0.448	1.12	5.60	28.00	56.0	112
Methacrylonitrile	0.0856	0.214	0.428	1.07	5.35	26.75	53.5	107
Cyclohexanone	0.0944	0.236	0.472	1.18	5.90	29.50	59.0	118
tert-Butylbenzene	0.0864	0.216	0.432	1.08	5.40	27.00	54.0	108
n-Butylbenzene	0.0896	0.224	0.448	1.12	5.60	28.00	56.0	112

Note 1: The concentrations detailed in this table may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.

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Table 3A - Standard Concentrations (SIM) (Primary Sources)[1]

Compound Name	10pg	20pg	50pg	100pg	500pg	1000pg	2500pg	10,000pg	20,000pg	50,000pg
Freon-12	9.50	19.00	47.50	95.0	475	950	2375	9500	19000	47500
Chloromethane	10.10	20.20	50.50	101.0	505	1010	2525	10100	20200	50500
Vinyl Chloride	10.00	20.00	50.00	100.0	500	1000	2500	10000	20000	50000
1,3-Butadiene	10.40	20.80	52.00	104.0	520	1040	2600	10400	20800	52000
Bromomethane	10.20	20.40	51.00	102.0	510	1020	2550	10200	20400	51000
Chloroethane	10.10	20.20	50.50	101.0	505	1010	2525	10100	20200	50500
Acrolein	11.30	22.60	56.50	113.0	565	1130	2825	11300	22600	56500
Acetone	54.60	109.20	273.00	546.0	2730	5460	13650	54600	109200	273000
Freon-11	10.80	21.60	54.00	108.0	540	1080	2700	10800	21600	54000
1,1-Dichloroethene	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
Methylene Chloride	11.30	22.60	56.50	113.0	565	1130	2825	11300	22600	56500
Freon-113	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
trans-1,2-Dichloroethene	10.60	21.20	53.00	106.0	530	1060	2650	10600	21200	53000
1,1-Dichloroethane	10.70	21.40	53.50	107.0	535	1070	2675	10700	21400	53500
Methyl tert-Butyl Ether	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
cis-1,2-Dichloroethene	11.00	22.00	55.00	110.0	550	1100	2750	11000	22000	55000
Chloroform	11.20	22.40	56.00	112.0	560	1120	2800	11200	22400	56000
1,2-Dichloroethane	10.80	21.60	54.00	108.0	540	1080	2700	10800	21600	54000
1,1,1-Trichloroethane	10.50	21.00	52.50	105.0	525	1050	2625	10500	21000	52500
Benzene	11.30	22.60	56.50	113.0	565	1130	2825	11300	22600	56500
Carbon Tetrachloride	11.50	23.00	57.50	115.0	575	1150	2875	11500	23000	57500
1,2-Dichloropropane	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
Bromodichloromethane	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
Trichloroethene	10.80	21.60	54.00	108.0	540	1080	2700	10800	21600	54000
1,4-Dioxane	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
cis-1,3-Dichloropropene	10.50	21.00	52.50	105.0	525	1050	2625	10500	21000	52500
trans-1,3-Dichloropropene	10.60	21.20	53.00	106.0	530	1060	2650	10600	21200	53000
1,1,2-Trichloroethane	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
Toluene	11.00	22.00	55.00	110.0	550	1100	2750	11000	22000	55000
Dibromochloromethane	11.00	22.00	55.00	110.0	550	1100	2750	11000	22000	55000
1,2-Dibromoethane	11.00	22.00	55.00	110.0	550	1100	2750	11000	22000	55000
Tetrachloroethene	10.10	20.20	50.50	101.0	505	1010	2525	10100	20200	50500
Chlorobenzene	11.10	22.20	55.50	111.0	555	1110	2775	11100	22200	55500
Ethylbenzene	11.00	22.00	55.00	110.0	550	1100	2750	11000	22000	55000
m,p-Xylenes	21.60	43.20	108.00	216.0	1080	2160	5400	21600	43200	108000
Styrene	11.20	22.40	56.00	112.0	560	1120	2800	11200	22400	56000
o-Xylene	10.60	21.20	53.00	106.0	530	1060	2650	10600	21200	53000
1,1,2,2-Tetrachloroethane	10.50	21.00	52.50	105.0	525	1050	2625	10500	21000	52500
1,3,5-Trimethylbenzene	10.70	21.40	53.50	107.0	535	1070	2675	10700	21400	53500
1,2,4-Trimethylbenzene	10.90	21.80	54.50	109.0	545	1090	2725	10900	21800	54500
1,3-Dichlorobenzene	11.40	22.80	57.00	114.0	570	1140	2850	11400	22800	57000
1,4-Dichlorobenzene	10.60	21.20	53.00	106.0	530	1060	2650	10600	21200	53000
1,2-Dichlorobenzene	11.10	22.20	55.50	111.0	555	1110	2775	11100	22200	55500
1,2-Dibromo-3-chloropropane	11.00	22.00	55.00	110.0	550	1100	2750	11000	22000	55000
1,2,4-Trichlorobenzene	11.30	22.60	56.50	113.0	565	1130	2825	11300	22600	56500
Naphthalene	11.10	22.20	55.50	111.0	555	1110	2775	11100	22200	55500
Hexachloro-1,3-butadiene	11.20	22.40	56.00	112.0	560	1120	2800	11200	22400	56000

Proprietary Information

Note 1: The concentrations detailed in Table 3A may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.

Table 4 - Standard Concentrations (SCAN) (Secondary Sources)[1]

Compound Name	25ng	Compound Name	25ng	Compound Name	25ng
Bromochloromethane (IS1)	**25.0**	1,1,1-Trichloroethane	26.00	alpha-Pinene	26.00
Propene	25.00	Isopropyl acetate	54.50	n-Propylbenzene	25.25
Dichlorodifluoromethane (CFC 12)	25.50	1-Butanol	55.75	3-Ethyltoluene	26.50
Chloromethane	24.75	Benzene	27.50	4-Ethyltoluene	26.50
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	25.75	Carbon Tetrachloride	26.75	1,3,5-Trimethylbenzene	26.50
Vinyl Chloride	25.25	Cyclohexane	52.75	alpha-Methylstyrene	26.00
1,3-Butadiene	26.75	tert-Amyl Methyl Ether	26.25	2-Ethyltoluene	26.25
Bromomethane	25.25	1,2-Dichloropropane	26.50	1,2,4-Trimethylbenzene	26.25
Chloroethane	25.25	Bromodichloromethane	27.00	n-Decane	25.75
Ethanol	127.25	Trichloroethene	26.00	Benzyl Chloride	27.25
Acetonitrile	25.50	1,4-Dioxane	27.25	1,3-Dichlorobenzene	27.25
Acrolein	26.75	Isooctane	26.00	1,4-Dichlorobenzene	26.50
Acetone	135.00	Methyl Methacrylate	52.50	sec-Butylbenzene	26.75
Trichlorofluoromethane	24.75	n-Heptane	26.75	p-Isopropyltoluene	25.25
Isopropyl Alcohol	52.50	cis-1,3-Dichloropropene	28.25	1,2,3-Trimethylbenzene	26.25
Acrylonitrile	26.00	4-Methyl-2-Pentanone	27.25	1,2-Dichlorobenzene	26.75
1,1-Dichloroethene	26.75	trans-1,3-Dichloropropene	27.00	d-Limonene	26.25
tert-Butanol	52.75	1,1,2-Trichloroethane	26.50	1,2-Dibromo-3-Chloropropane	25.75
Methylene Chloride	27.00	**Chlorobenzene-d5 (IS3)**	**25.0**	n-Undecane	25.25
Allyl Chloride	27.25	**Toluene-d8 (S)**	**25.0**	1,2,4-Trichlorobenzene	26.25
Trichlorotrifluoroethane	27.00	Toluene	26.50	Naphthalene	24.50
Carbon Disulfide	24.50	2-Hexanone	27.75	n-Dodecane	25.25
trans-1,2-Dichloroethene	26.50	Dibromochloromethane	27.50	Hexachlorobutadiene	26.75
1,1-Dichloroethane	26.00	1,2-Dibromoethane	27.00	Methacrylonitrile	26.00
Methyl tert-Butyl Ether	26.50	Butyl Acetate	28.00	Cyclohexanone	27.75
Vinyl Acetate	128.00	n-Octane	26.00	tert-Butylbenzene	26.50
2-Butanone (MEK)	27.00	Tetrachloroethene	24.75	n-Butylbenzene	27.25
cis-1,2-Dichloroethene	26.75	Chlorobenzene	27.00		
Diisopropyl Ether	27.25	Ethylbenzene	26.50		
Ethyl Acetate	53.50	m- & p-Xylene	52.50		
n-Hexane	26.25	Bromoform	27.00		
Chloroform	27.00	Styrene	27.25		
1,2-Dichloroethane-d4 (S)	**25.0**	o-Xylene	25.75		
Tetrahydrofuran	25.75	n-Nonane	25.50		
Ethyl tert-Butyl Ether	26.50	1,1,2,2-Tetrachloroethane	25.25		
1,2-Dichloroethane	26.25	**4-Bromofluorobenzene (S)**	**25.0**		
1,4-Difluorobenzene(IS2)	**25.0**	Cumene	25.50		

Note 1: The concentrations detailed in this table may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.

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Table 4A – ICV/LCS Standard Concentrations (SIM) (Secondary Sources)[1]

Compound Name	500pg
Freon-12	510
Chloromethane	495
Vinyl Chloride	505
1,3-Butadiene	535
Bromomethane	505
Chloroethane	505
Acrolein	535
Acetone	2700
Freon-11	495
1,1-Dichloroethene	535
Methylene Chloride	540
Freon-113	540
trans-1,2-Dichloroethene	530
1,1-Dichloroethane	520
Methyl tert-Butyl Ether	530
cis-1,2-Dichloroethene	535
Chloroform	540
1,2-Dichloroethane	525
1,1,1-Trichloroethane	520
Benzene	550
Carbon Tetrachloride	535
1,2-Dichloropropane	530
Bromodichloromethane	540
Trichloroethene	520
1,4-Dioxane*	545
cis-1,3-Dichloropropene	565
trans-1,3-Dichloropropene	540
1,1,2-Trichloroethane	530
Toluene	530
Dibromochloromethane	550
1,2-Dibromoethane	540
Tetrachloroethene	495
Chlorobenzene	540
Ethylbenzene	530
m,p-Xylenes	1050
Styrene	545
o-Xylene	515
1,1,2,2-Tetrachloroethane	505
1,3,5-Trimethylbenzene	530
1,2,4-Trimethylbenzene	525
1,3-Dichlorobenzene	545
1,4-Dichlorobenzene	530
1,2-Dichlorobenzene	535
1,2-Dibromo-3-chloropropane	515
1,2,4-Trichlorobenzene	525
Naphthalene	490
Hexachloro-1,3-butadiene	535

Note 1: The concentrations detailed in this table may change with each standard purchased or internally prepared. Refer to the appropriate initial calibration file, where necessary for the corresponding concentrations.

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Attachment 1

Training Plan

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Training Plan for Analysis of VOCs by GC/MS

Trainee _____ Trainer _____ Instrument _____ Training Completion Date _____

1. Read SOP *Training Duration* _____ Trainer ____ Trainee ____ Date _____

2. Read Methods TO-14A & TO-15A *Training Duration* _____ Trainer ____ Trainee ____ Date _____

3. Demonstrated understanding of the scientific basis of the analysis Trainer ____ Trainee ____ Date _____
   Whole air sample preconcentration techniques
   Gas chromatography *Training Duration* _____
   Mass spectrometry

4. Demonstrated familiarity with related SOPs Trainer ____ Trainee ____ Date _____
   SOP for Batches and Sequences; Rev. ___
   SOP for Making Entries onto Analytical Records; Rev. ___ *Training Duration* _____
   SOP for Manual Integration Policy; Rev. ____
   SOP for Significant Figures; Rev. ____
   SOP for Nonconformance and Corrective Action; Rev. ____
   SOP for Performing MDL Studies and Establishing Limits of Detection and Quantitation; Rev. ____
   SOP for Cleaning and Certification of Summa Canisters; Rev. ____

5. Observe performance of SOP *Training Duration* _____ Trainer ____ Trainee ____ Date _____
   ___sample preparation/dilution and sample loading and analysis
   ___analytical sequence setup
   ___standard preparation
   ___BFB tuning evaluation
   ___initial calibration (model, calculations, manual integrations)/initial calibration verification
   ___manual integrations
   ___continuing calibration verification
   ___EnviroQuant introduction (recognizing saturation and sensitivity issues)
   ___data reduction and reporting including reporting req. for various agencies, autotexts, documentation
   ___canister and bag handling (including leakers)

6. Perform SOP with supervision *Training Duration* _____ Trainer ____ Trainee ____ Date _____
   ___sample preparation/dilution and sample loading and analysis
   ___analytical sequence setup
   ___standard preparation
   ___BFB tuning evaluation
   ___initial calibration (model, calculations, manual integrations)/initial calibration verification
   ___manual integrations
   ___continuing calibration verification
   ___EnviroQuant use (recognizing saturation and sensitivity issues)
   ___data reduction and reporting including reporting req. for various agencies, autotexts, documentation
   ___canister and bag handling (including leakers)

7. Independent performance of the SOP *Training Duration* _____ Trainer ____ Trainee ____ Date _____
   ___sample preparation/dilution and sample loading and analysis
   ___analytical sequence setup
   ___standard preparation
   ___BFB tuning evaluation
   ___initial calibration (model, calculations, manual integrations)/initial calibration verification
   ___manual integrations
   ___continuing calibration verification
   ___EnviroQuant proficiency (recognizing saturation and sensitivity issues)
   ___data reduction and reporting including reporting req. for various agencies, autotexts, documentation
   ___canister and bag handling (including leakers)
   ___initial demonstration of competency (4 Laboratory Control Samples)

8. Instrument operation and maintenance Trainer ____ Trainee ____ Date _____
   ___autosampler *Training Duration* _____
   ___GC and capillary column installation *Training Duration* _____
   ___mass spectrometer *Training Duration* _____
   ___data system *Training Duration* _____

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Attachment 2

Initial Calibration Checklist

Initial Calibration Review Checklist - EPA Compendium Method TO-15

ICAL Date:_____ ICAL ID:_____ LIMS ICAL ID:_____

Instrument: ☐ MS3 ☐ MS8 ☐ MS9 ☐ MS11 ☐ MS13 ☐ MS16 ☐ MS19 ☐ MS21

Mode: ☐ SIM ☐ Scan Scan Low Level (0.1ng): ☐ Yes ☐ No

Analyst **Reviewer**

☐ 1. Is the required documentation in the ICAL file? ..... ☐
- ☐ BFB Tune analysis Report ..... ☐
- ☐ Calibration Status Report (aka Calibration History) ..... ☐
- ☐ Response Factor Report/Percent RSD ..... ☐
- ☐ Quantitation Report for each calibration standard (including manual integration documentation) ..... ☐
- ☐ ICV Quantitation Report ..... ☐
- ☐ TO-15 Standard Calculation Spreadsheet ..... ☐

☐ 2. Was the ICAL performed continuously (not interrupted for maintenance or sample analysis)? ..... ☐

☐ 3. Have all the calibration standards been analyzed within 24 hours of each other? ..... ☐

☐ 4. Does the BFB tune check standard analysis at the start meet the tune criteria? ..... ☐

☐ 5. Are all the analytes in the blank analysis <MRL? ..... ☐

☐ 6. Does each analyte's ICAL include a minimum of 5 concentrations at 5 consecutive levels? ..... ☐

☐ 7. Were the standards analyzed from low concentration to high concentration? ..... ☐

☐ 8. For each analyte, are there no levels skipped? ..... ☐

☐ 9. For each analyte, is there only one value used for each calibration level? ..... ☐

☐ 10. For each analyte, is the lowest standard's concentration at or below the analyte's MRL? ..... ☐

☐ 11. For each analyte, is the corresponding signal to noise ratio at least 3:1 at the lowest point on the curve? ..... ☐

☐ 12. For each analyte, are the corresponding upper levels free from saturation? ..... ☐

☐ 13. If a calibration level is dropped, are all the responses for each target analyte dropped and is the information noted in the ICAL explaining the reason? ..... ☐

☐ 14. Is the average RSD ≤30% for all analytes, with no more than two exceptions ≤40%? ..... ☐

☐ 15. Is the response Y at each calibration level within 40% of the mean area response over the initial calibration range for each internal standard? ..... ☐

☐ 16. Percent recovery for each analyte in the ICV 70%-130% (50-150% for VA, unless AFCEE or DoD)? ..... ☐

☐ 17. Was the RRT for each target compound at each calibration level within 0.06RRT units of the mean RRT for the compound? ..... ☐

☐ 18. Is the retention time shift for each of the internal standards at each calibration level within 20s of the mean retention time over the initial calibration range for each standard? ..... ☐

☐ 19. If there are any manual integrations, are they performed correctly according to the corresponding SOP? If so, initial and date the appropriate pages. ..... ☐

☐ 20. Is the ICAL good at 0.5ng (or 0.1ng)–100ng (Scan) or 10-20000pg (SIM) for all compounds? ☐ Yes ☐ No
If not, note exceptions and the corresponding MRLs below – *Specify applicable range...* ..... ☐

☐ 21. Are ALL of the peak selections for each analyte correct according to retention time (all RTs must be checked by both the initial and peer reviewer)? ..... ☐

COMMENTS:

Analyst:_____ Date: _____

Secondary Reviewer: _____ Date: _____

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Attachment 3

Daily QC and Sample Review Checklists

Daily QC Review Checklist

(Note exceptions in Comments and include Analysis Observations/Case Narrative Summary Form as appropriate)

EPA Compendium Method TO-15

Method: ☐ EPA TO-15 ☐ EPA TO-14A **Analysis Date:** _____

Instrument: ☐ MS3 ☐ MS8 ☐ MS9 ☐ MS13 ☐ MS16 ☐ MS19 ☐ MS21

Mode: ☐ SIM ☐ Scan **Scan Low Level (0.1ng):** ☐ Yes ☐ No **DOD:** ☐ Yes ☐ No

Analyst **Reviewer**

☐ 1. Is the required documentation present? ..... ☐
- ☐ CORRECT BFB Tune analysis Report
- ☐ CCV analysis Quantitation Report & %D Report
- ☐ LCS analysis Quantitation Report
- ☐ MB analysis Quantitation Report

☐ 2. BFB **tune** check standard analysis meet the tune criteria for the method indicated above? ..... ☐

☐ 3. Analyses within the tune's **24-hr window or** ☐ **Client's 12hr window requirement**?..... ☐

☐ 4. Does the **CCV** have a difference ≤30% for all analytes? ..... ☐
[Note all outliers biased high and/or low]

☐ 5. All **IS** retention times within 20 seconds of the CCV RT or the RT from the midpoint (ICAL)? ..... ☐

☐ 6. All **IS** responses within ±40% of CCV or the midpoint in the ICAL? ..... ☐

☐ 7. All **surrogate** recoveries (in CCVs, MB, LCSs, etc.) within acceptance limits (70%-130%) ..... ☐

☐ 8. All analytes in the **MB** <MRL? (DoD <1/2MRL, except Acetone, MeCl2, EtOH, Carbon Disulfide)? ..... ☐

☐ 9. **LCS** %R within the lab control limits for all analytes except AZ samples (70%-130%, VA 50%-150%)? ..... ☐

☐ 10. All analytes in the **Lab Duplicate / DLCS** within ±25% or the client specified limits? ..... ☐

COMMENTS:

Air-Phase Petroleum Hydrocarbons

☐ 1. Does the **CCV** meet the following criteria? ..... ☐
- Percent difference ≤30%.
- One compound or range can be >30%, but less than 50%.
- No single analyte or range may be >50%.

[Note outliers biased high and/or low]

☐ 2. Does lab **duplicate** meet an RPD of ≤30% for results >5x MRL? Repeat analysis if: ..... ☐

RPD >30 (where both analyses are >5x RL	1st analysis detect @ >5x MRL, Dup=ND
1st analysis ≤5x RL; Dup=ND (RPD not calculable)	

☐ 3. Are the analytes in the **LCS** within 70%-130% recovery? ..... ☐

COMMENTS:

☐ LIMS Run Approval ☐ LIMS Supervisor Approval

Analyst: _____ Secondary Reviewer: _____

Date: _____ Date: _____

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Sample Review Checklist

(Note exceptions in Comments and include Analysis Observations/Case Narrative Summary Form as appropriate)

EPA Compendium Method TO-15

Method: ☐ EPA TO-15 ☐ EPA TO-14A **Analysis Date:** _____ **Project #:** _____

Instrument: ☐ MS3 ☐ MS8 ☐ MS9 ☐ MS13 ☐ MS16 ☐ MS19 ☐ MS21

Mode: ☐ SIM ☐ Scan **Scan Low Level (0.1ng):** ☐ Yes ☐ No **DOD:** ☐ Yes ☐ No

Analyst **Reviewer**

☐ 1. All analyte hits in the samples within the **calibration range** and/or noted? ..... ☐
☐ 2. All **peak integrations** acceptable? ..... ☐
☐ 3. All **manual integrations** flagged and documented? ..... ☐
☐ 4. Have **Q values** been verified for each peak? ..... ☐
☐ 6. All **calculations** correct? ..... ☐
☐ 7. Has the analyst initialed and dated each **quantitation report**? ..... ☐
☐ 8. For **TICs** are the relative intensity and other requirements met? ..... ☐
☐ 9. **Auto report** correct? ..... ☐
☐ 10. **MRL** = _____ ☐ ng ☐ pg (ethanol, acetone, vinyl acetate = 5.0ng) ..... ☐
☐ 11. Pressurized with **Helium**? Is the worksheet completed for all samples? ..... ☐
☐ 12. Report to **MDL**? ☐ Yes ☐ No ..... ☐
☐ 13. **Global Minimum Detection Limit** = _____ ☐ ng ☐ pg ..... ☐
☐ 14. **DOD:** Are **manual integrations** notated in the **case narrative?** ..... ☐

COMMENTS:

Air-Phase Petroleum Hydrocarbons

☐ 1. Are all manual **integrations** flagged and documented (except for HC ranges)? ..... ☐
☐ 2. Are all peak **integrations** acceptable? ..... ☐
☐ 3. Has the analyst initialed and dated each **quantitation report**? ..... ☐
☐ 4. Are the associated ICAL responses correct? ..... ☐
☐ 5. Are the sample responses entered into the template correctly? ..... ☐
☐ 6. Are the TO-15 target compounds entered into the template correctly? ..... ☐
☐ 7. Does the lab **duplicate** meet a RPD of ≤30% for results >5x the MRL? Otherwise, repeat analyses if: ..... ☐

RPD >30 (where both analyses are >5x RL	1st analysis detect @ >5x MRL, Dup=ND
1st analysis ≤5x RL; Dup=ND (RPD not calculable)	

COMMENTS:

☐ LIMS Run Approval ☐ LIMS Supervisor Approval

Analyst: _____ Secondary Reviewer: _____

Date: _____ Date: _____

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Proprietary - Uncontroll Copy

Attachment 4

State and Project Specific Requirements

Minnesota Requirements	
Item	**Criteria**
Holding Time (HT)	14 days
Tedlar bags	Not allowed for sampling or sample dilution
Canisters and flow controllers	Individually certified Individually leak checked before shipment
	Samples with concentrations outside of the calibration curve will have a zero canister analysis performed to check for carryover. If carryover is detected, system bake out shall be performed and documented. Additionally, in instances where the laboratory has evidence on file that a particular compound when present at a high concentration does not exhibit carry-over, the samples will not be reanalyzed. When samples are analyzed that have a higher concentration than the evidence on file, the above requirements must be followed. Also, samples that have hits below the MRL will not be reanalyzed when analyzed after a sample with concentrations over the calibration range.
Method Reporting Verification Check	Analyze a Method Reporting Verification at the beginning of the sequence prior to analyzing samples. Acceptance criteria ±40%.
Duplicates	10 percent laboratory duplicates
Record retention	MN/NELAC 5 years MPCA (Minnesota Pollution Control Agency) compliant samples 10 years
Tier level	TIII

Arizona Requirements	
Item	**Criteria**
LCS	70-130% (vinyl acetate 50-150%)

Department of Toxic Substances Control (DTSC) Requirements	
Item	**Criteria**
Holding Time (HT)	72 hour hold time for canisters

EPA Region 9 Requirements	
Item	**Criteria**
Holding Time (HT)	14 days

Proprietary - Uncontroll Copy

Protocol and Procedures Used by D, Hammond for Analysis of Rn in Indoor Air and Soil Vapor

(Updated 5/2/13)

Instrumentation:
Scintillation counters built by Applied Techniques (Model AC/DC-DRC-MK10-2) are used. This system uses Lucas type counting cells that have been built by Guy Mathieu, as noted on the Applied Techniques website. Cells are either 120 cc or 250 cc volume. For sample analysis, we evacuate a cell and use a plastic syringe to inject a sample of known volume directly into the cell, through a 5 cm long glass tube containing dririte ($CaSO_4$). For high activity (subsurface) samples, we use 20-40 cc volumes and the smaller Lucas cells. For low activity samples (above ground), we use low background cells (0.04-0.13 cpm), and either 60 cc of sample in the smaller cell or 120 cc in the larger cells. Results are corrected for the difference in atmospheric pressure in the lab (near sea level) and at the sampling site (based on altitude), although this factor applies equally to surface and subsurface samples.

Standardization:
Counting efficiency for each cell/counter pair has been determined by extracting radon from standard solutions containing 226Ra. These solutions were prepared from aliquots of a standard obtained from NBS (now NIST) during the GEOSECS program. Five of these standards in regular use, and their relative activities have remained quite stable during the years they have been in use. These standards are run at least once per year to insure stability of the counting system. In 2009, samples were run in an inter-laboratory calibration exercise for 226Ra analysis and values consistent with other well-established groups were obtained. An additional intercalibration was run with Dr. Phil Jenkins of Bowser-Morner in April, 2013, and results were in good agreement (better than the counting uncertainty of about 5%). The effect of counting in the dry air matrix has been carefully evaluated, comparing results with values in the helium matrix in which cells are calibrated, to determine the small correction (1-5%) needed for the difference in counting matrix. Cells are internally intercalibrated, using high activity subsurface samples that are run in replicates with other cells. Cells with high backgrounds are intercalibrated two or more times per year, and cells with low backgrounds are intercalibrated about once per year. Experience has shown that the cell counting efficiencies change very little over many years, unless photomultiplier tubes (PMT) deteriorate. PMT performance is periodically checked (about twice per year) by measuring activity of an internal source of 241Am mounted in a Lucas cell.

Backgrounds and blanks:
Cell backgrounds are checked 2-3 times per year. These are not very critical for subsurface samples, but are very critical for low activity measurements. Consequently, the lowest background cells are used only for low activity samples. As a result, their backgrounds have remained very stable over the past 6 years. With careful attention to backgrounds, values measured for aged air (stored for more than one month) are within the counting uncertainty of zero. Consequently, we have determined that the blank is

zero. Any blank coming from the counting cell itself is accounted for by our cell background counts. Based on criteria defined by EPA (95% confidence level as recommended by EPA 402-R-95-012, Oct. 97), the LLD calculated for a typical analysis (120 cc sample, 0.10 cpm counting background, 12 hour count, and 3 days elapsed between collection and analysis) is 0.14 pCi/L. In practice, values for outside air are sometimes obtained that are lower than this LLD.

QA/QC:
We request collection of sufficient sample volume to permit at least one replicate analysis, if needed. Typically, about one of every 8-10 samples is analyzed in duplicate, to ensure quality control and randomly check performance of cells and counting equipment. The average precision of these lab duplicates (±1 sample standard deviation) is about ±3%, although our quoted precision is ±5%. If duplicates do not agree within this precision, they are re-run. Cell backgrounds and counting efficiency are measured regularly, as noted above.

Protocol:
Sample delivery within 2-3 days of collection is recommended. After arrival, the integrity of each sample container is checked by a simple pressure test of each bag to ensure that it does not leak. Storage tests have shown that the Tedlar bags are suitable for at least 10 days of storage without a detectable change in decay-corrected radon activity. One set of sampling syringes and dririte traps is used for low activity samples, and a second for high activity samples, to avoid cross contamination. Counting cells are allowed to "rest" for at least 4 hours before re-use to avoid influence of Rn daughters left in the cell from the previous sample. With this protocol, memory effects are insignificant. Samples are generally analyzed in the order listed on the COC, with hot samples run during day, as they usually need only 1-4 hours counting time, and low activity samples counted overnight. As noted above, low background cells are used for low activity samples. High background cells may have a background up to 1 cpm, and are only used for high activity samples.

Calculation of sample Activity:
After the sample is drawn into the counting cell, it is placed in the counter. Typically 3 readings are taken at intervals depending on sample activity. The consistency of these readings allows detection of spurious electronic noise or operator error (both are rare). Background counts are subtracted from the total counts observed in each interval, based on the average cell background. Radon has 2 short-lived alpha emitting daughters that grow into secular equilibrium during the count, and this ingrowth is considered by integrating the Bateman equations describing daughter ingrowth during each counting interval, to obtain the radon activity at the time the sample was introduced into the cell. We compare the results (with associated counting uncertainty) for each interval to ensure that this function is accurate, that the counting efficiencies for parent and daughter decays are identical, and that no spurious results were obtained. Results are averaged (weighted by duration of the counting interval) to obtain an average observed activity for the sample. If one interval differs from the other two by more than 3 standard deviations, it is rejected (this occurs less than 1% of the time). This result is then corrected for cell

counting efficiency, decay between sample collection and analysis, and the difference in atmospheric pressure between the lab and the sample site. No correction is made for temperature, as we assume that the field and lab temperatures are likely to be similar. A difference of 10°C would make only a 3% difference in concentration, less than the stated analytical uncertainty. Uncertainty based on counting statistics is computed, considering uncertainty from both sample and background counts. Additional uncertainty may come from cell standardization (<3%) or sample volume used (~1%), and the uncertainty reported (±1 standard deviation) for each sample is taken to be the larger of either that based on counting statistics, or 5%.

Additional details about analysis can be found at:

Analysis of standards using solutions with 226Ra
Mathieu, G., P. Biscaye, R. Lupton, and D. E. Hammond, 1988, System for measurement of radon-222 at low levels in natural waters, Health Physics, 55, 989-992.

Analysis of soil gas
McHugh, T. E., D. E. Hammond, T. Nickels, B. Hartman (2008) Use of Radon measurements for evaluation of volatile organic compound (VOC) vapor intrusion: Method and application, Environmental Forensics, 9, 107-114, doi: 10.1080/15275920801888491.

Sample Collection Instructions:

Equipment needed
-Polypropylene Syringes with appropriate stopcocks for closing (60 cc is convenient). If syringe is disconnected from a soil gas probe and then transferred to a bag, the syringe should have a two way stopcock for closure while it is disconnected.
-Tedlar bags for each sample, 0.5 liter size. The design with polypropylene fittings is best (often SKC Inc., Model 232-02 are used).

Sampling information needed on COC or bag:
-Sample ID and type (sub-surface, room, or ambient air to indicate how hot it may be)
-Sampling date and time (within 10 minutes or so), including the local time zone.
-The approximate site location (so we can to correct results to ambient air pressure)

General Comments
Samples are easily collected by syringe and transferred to the Tedlar bags. A small piece of tygon tubing (1/8" ID) is a convenient way to connect the syringe to the bag**. Use one syringe for 'cold' samples** (building or ambient air) **and a different one for 'hot' samples** (subsurface gas). **Handle bags with some care.** Some samples have had pinhole leaks created due to abrasion against rocks or other rough surfaces.

For subsurface samples, at least 100 cc should be collected. For room air or ambient air samples, at least 200 cc should be collected**. Bags should not contain more than about 300 cc of gas**. Overfilling can lead to failure if they are exposed to low pressure during shipment.

Sample Collection Instructions
Ambient and Room Air Samples: Label bag. Fill syringe with air, connect to bag, open valve (1/2 to ¾ turn), and push gas into bag. Repeat until about 240 cc is added. Close valve. **Gently squeeze bag to check for leaks (bag would deflate).**

Soil gas: Be sure sampling path from soil probe tip to syringe has been flushed adequately. Connect sample syringe to probe. Draw sample into syringe and transfer to bag, as above. Holding time in the polypropylene syringe should be less than 1 hour. **Gently squeeze bag to check for leaks (bag would deflate).**

Ship samples within 2 days to **Doug Hammond, Earth Sciences, 3651 Trousdale Pkwy, Los Angeles, CA 90089-0740 (tel. 213-740-5837 or 310-490-7896.** A stiff cardboard box makes a satisfactory shipping container. Send an email to dhammond@usc.edu to indicate that they are on the way.

For our ongoing research efforts it is appreciated (but not required) if samples of ambient (outdoor) air are identified.

KD ANALYTICAL

CBRN INSTRUMENT TRAINING & SUPPORT FOR THE HOMELAND DEFENSE COMMUNITY

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WWW.KDANALYTICAL.COM

VOC Analysis by Field-Portable GC/MS

Standard Operating Procedures

SOP #1

Rev. # 7

Effective Date: December 12, 2014

KD ANALYTICAL

4297 Wimbledon Drive, Harrisburg, PA 17112

1.0 Introduction

This SOP is a project specific SOP for the analysis of VOC's by field-portable Gas Chromatograph coupled with a Mass Spectrometer (GC/MS). The compounds listed in Table 1 have been evaluated and are suitable for analysis with this method.

2.0 Summary of the Method

Critical decisions are being made from the field analytical results. It is critical these results be definitive. Therefore GC/MS is the only way the analysis can be performed. This data will be provided within 30 minutes of receipt. If multiple samples are delivered at the same time, the highest priority sample will be delivered within 30 minutes. All other samples within 30 minutes consecutively in order of priority.

For analysis, the start button on the sampling wand is pressed, the internal pump pulls the sample through the instrument for 60 seconds to purge the lines. After the purge is complete, the valve is automatically switched to the fill position which sweeps the sample across a microtrap concentrator. The microtrap concentrator uses a small bed of absorbent material to trap VOCs. The length of time the sample is swept over the concentrator will be determined prior to field deployment, and will be sufficient to achieve the reporting limits listed in the table below. Airflow through the trap is then reversed as it is heated at a rate of 800°C/min. and then the trapped analytes are flash desorbed onto the GC column for separation and identification.

Gas chromatography provides separation of a wide range of chemicals that may be present in a single sample. Following separation, the compounds are sent through a mass spectrometer that provides definitive identification of each compound in the sample by breaking the compounds into ions, and comparing the ion fingerprint using the NIST library.

The instrument also has a survey mode that bypasses the GC and concentrator for direct MS screening. This allows the instrument to constantly pull a sample and scan for specific chemicals of concern in a ppmv range.

TABLE 1: HAPSITE ANALYTES AND REPORTING LIMITS

Compound	CAS Number	Quant Mass	Hapsite Reporting Limit (ppbv)
Vinyl Chloride	75-01-4	62	1
Chloroethane	56-23-5	117	1
cis-1,2-Dichloroethene	156-59-2	61	0.50
trans-1,2-Dichloroethene	156-60-5	61	0.50
Trichloroethene	79-01-6	95	0.50
1,1-Dichloroethylene	75-35-4	61	0.50
1,1,1-Trichloroethane	71-55-6	97	0.50
1,1-Dichloroethane	75-34-3	63	0.50
Tetrachloroethene	127-18-4	166	0.50
Benzene	71-43-2	78	0.50
Toluene	108-88-3	91	0.50
Ethylbenzene	100-41-4	91	0.50
m-Xylene *	108-38-3	91	0.50
p-Xylene *	106-42-3	91	0.50
o-Xylene	95-47-6	91	0.50
	127-18-4	128	0.50

*m- and p-Xylene co-elute and are quantified together

3.0 Interference

Compounds which are not baseline-resolved (co-elute) with the other target analytes or internal standards/surrogates listed in Table 1 may be interferents. Generally, these co-eluting compounds can be separated by their mass fragmentation patterns. However, some compounds may have fragment ions in their mass spectra, which are identical to the quantitation ion of a target analyte. This may produce a false positive or error in the reported concentration.

The software provides both a fit and purity measurement in full scan, GC/MS mode to indicate possible co-elution. If compounds co-elute and cannot be separated by their mass spectra, two remedies are possible: (1) the compounds are so similar that they may be reported as a total number. This is the case for m&p-Xylene (i.e. m&p-Xylene co-elute and have identical spectra). (2) A modification to the GC temperature may be sufficient to resolve the individual peaks. Co-elution has not been determined to be a problem with the halogenated compounds listed in the method. Compounds that would present a problem are the aliphatic and olefin compounds found in petroleum products.

4.0 Safety

Safety is of utmost importance during all projects. On-site safety procedures established by the client will be adhered to at all time. It is the responsibility of KD Analytical personnel to ensure they are aware of all safety procedures and hazards they may encounter on-site.

Proper personal protective equipment (PPE) including safety glasses, hard hats and steel- toed shoes will be worn when working.

In addition to site specific and general field safety procedures, KD Analytical personnel must adhere to standard safe laboratory practices. This includes:

- Maintenance and availability of Material Safety Data Sheets (MSDS)
- Use of appropriate PPE during the handling and preparation of standards
- Safe high pressure cylinder handling practices

Note: All hazardous, neat materials stored on-site must have a copy of the MSDS maintained on-site as well. This does not include working standards and standard mixtures.

5.0 Equipment and Supplies

5.1 Instrumentation

Inficon Hapsite GC/MS
Supelco SPB 1, 30m x .32mm id x 1.0um film column
Peripherals (Computer, Printer, Consumables, etc.)

5.2 Materials

1 Liter Tedlar Bags
Neat Liquid Standards
Nitrogen Regulator
1/8" Stainless Tubing
DI Water
Syringes: - 1ml, 5ml, 10ml, 50ml Teflon Luer Lock gastight

5.3 Gases

Carrier: Nitrogen 99.999% purity (for portable mode Inficon # 930-430)
Mass Calibration: Internal Standard 1 Inficon # 930-431 (50ppmv) Bromopentafluorobenzene,

100ppmv 1,3,5 tris (trifluoromethyl) benzene

6.0 Instrument Parameters

6.1 Tri-Bed Concentrator

6.2 GC Conditions

Column Temp.	60° C (ramped to 180°)
Head Pressure	104 pa
Inlet Temp.	60° C
Probe Temp.	40° C
Valve Temp.	60° C
Run Time	< 15 Min.

6.3 MS Conditions (also used in survey mode)

Scans/Sec.	1.04 scans/sec.
Getter Pump Temp.	400 - 480° C
Scan Range	45 - 250 amu

7.0 QA/QC Procedures

Table 2: Quality Control

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Tune Check	Every 12 Hours	Ion Abundance Criteria as Determined by Manufacturer	Adjust Tune Until Meets Criteria
3 – Point (Minimum) Calibration	Prior to start of project or as required for acceptance criteria	%RSD ≤ 25%	Re-run Levels Which Do Not Meet Criteria
Beginning of Day Continuing Calibration Check	Beginning of Each Day	± 30% Difference of the Initial Calibration	1) Repeat Analysis 2) Prepare and Run New Standard from Stock 3) Recalibrate
Lab Duplicates (If Requested)	10% of the Samples	Relative Percent Difference ≤ 30%	1) Analyze a third Aliquot 2) Flag Reported Data
Internal Standards	Co-injected in every sample	-50% to 200% Recovery from Beginning of Day	1) Re-run sample 2) Flag Reported Data
Method Blank	Before Beginning of Day	Concentrations for All Calibrated Compounds < PQL	Re-run Blanks until Criteria are Met

7.1 Initial Calibration

The initial calibration will contain a minimum of 3 levels consisting of the analytes of interest listed in Table 1. The low level will be 1 ppb which is equal to the reporting limit for this project. The highest level should encompass the linear range of the instrument or the highest concentration of the samples expected. Acceptance criteria for the initial calibration are 25% relative standard deviation (%RSD).

Corrective action for the initial calibration is to investigate the outlying level and reanalyze that level. If the problem is not corrected, it may be necessary to remake the standard or correct the problem with the instrument and reanalyze all levels.

7.2 Beginning of Day Tune Verification

The tune verification should meet manufacturer specifications, and repeated every 12 hours before the analysis of any samples. The tune verification will be repeated each time the instrument is moved or powered down for any reason.

Corrective action for the tune verification is to reanalyze the tune. If it continues not meet criteria, then the tune will be adjusted and saved manually.

7.3 Beginning of Day Continuing Calibration Verification

All compounds have a $\pm$ 30% Difference from the Initial Calibration.

Corrective action for the Continuing Calibration is to reanalyze the standard. If it continues not meet criteria, remake the standard from the stock and reanalyze. If criteria are still not met, repeat the Initial Calibration.

7.4 Method Blank

The method blank should be analyzed before any samples. A blank should also be analyzed after any sample with concentrations exceeding the calibration range by 10%. The blank acceptance criteria are that no compounds are detected above the reporting limit.

Corrective action for the method blank is to reanalyze the blank. If the system is still not clean, take actions to remove the contaminants and reanalyze the blank. The blank must be clean before proceeding unless agreed upon with the client.

7.5 Duplicates

Laboratory duplicates should be performed on a frequency of 10% of the total samples. The sample chosen to duplicate should contain concentrations of targets if possible.
The acceptance criteria are 30% relative percent difference (% RPD).
Corrective action for the duplicate is to reanalyze the sample. If criteria are still not met, results must be flagged.

7.6 Internal Standards

The internal standards are co-injected automatically into each sample. Acceptance criteria for internal standards are -50% to 200% recovery of the injected mass throughout the day from the beginning of the day.

Corrective action for internal standards is to rerun the sample unless matrix effects have been previously established. If criteria are not met, the data must be flagged.

8.0 Detection Limits

To determine the method detection limits, a low level calibration standard will be analyzed as part of the initial calibration.

9.0 Procedure

9.1 Any samples that will be received should be accompanied with a chain of custody.

9.2 For analysis, the Tedlar bag is attached to the GC/MS sampling wand using a short piece of Teflon tubing and the sample information is logged into the computer. When the start button on the sampling wand is pressed, the internal pump pulls the sample through the sample loop for 30 seconds. During this time, internal standard and surrogate is also drawn into the instrument at a 1:10 ratio to the sample.

After 60 seconds, the valve is automatically switched to the inject position which sweeps the sample, surrogate and internal standard onto the pre-column. After 100 seconds any heavier (diesel range) compounds are back-flushed off of the system canister.

10.0 Data Analysis and Calculations

10.1 Quantitative analysis is performed by integrating the area of the identified quantitation ion. The quantitation ion for each target analyte, internal standard, and surrogate has been selected to provide interference free quantitation in the presence of the analytes listed in Table 1, except as noted above.

10.2 The concentration of the analytes is calculated using internal standards and the following equation.

$$ppmv = \frac{(Ax)\,(Is)}{(Ais)\,(\overline{RF})}$$

where:

Ax = Area of the quant ion for the target compound
Is = Concentration of the internal standard injected
Ais = Area of the quant ion for the internal standard
$\overline{RF}$ = Average Response factor from Initial Calibration for compound being measured.

11.0 Equations

11.1 Relative Response Factor

$$RRF = \frac{Std_{Area} \times IS_{Conc.}}{IS_{Area} \times Std_{Conc.}}$$

11.2 Relative % Difference

$$\%RPD = \frac{Samp_1 - Samp_2}{\left(Samp_1 + Samp_2\right)/2} \times 100$$

11.3 Relative Standard Deviation

$$\%RSD = \frac{STDev}{Avg} \times 100$$

11.4 Percent Difference

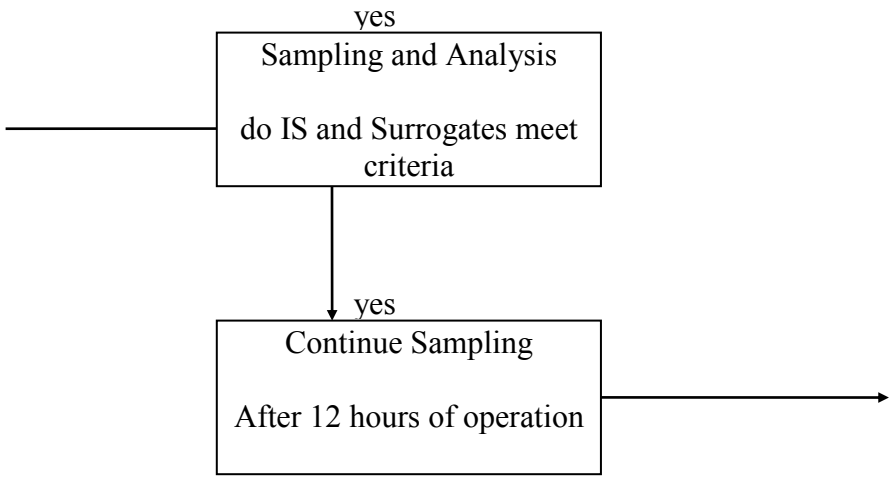
$$\%D = \frac{AvgRRF - DailyRRF}{AvgRRF} \times 100$$

11.5 Method Detection Limit

$$MDL = STDev \times 3.14$$

12.0 References

1. U.S. EPA Method 3810 Headspace
2. U.S. EPA Method 5021 Volatile Organic Compounds in Soil and other solid Matrices Using Equilibrium Headspace Analysis
3. U. S. EPA Method 8260B
4. Determination of Gaseous Organic Compounds by Direct Interface Gas Chromatography-Mass Spectrometry - May 28, 1997 Laura L. Kiner Ph.D. & James W. Peeler, Emission Monitoring Inc.
5. Quantitative Trace Analysis of VOC's in Air, Water and Soil by Equilibrium Headspace Gas Chromatography, Bruno Kolb, Perkin-Elmer Corp.



Method Operational Procedure

Appendix C
Laboratory Accreditation Certificates

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

ALS Environmental

2655 Park Center Drive, Suite A, Simi Valley, CA 93065

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 4.2 10/26/2010 and is accredited is accordance with the:

United States Department of Defense
Environmental Laboratory Accreditation Program
(DoD-ELAP)

This accreditation demonstrates technical competence for the defined scope:

Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Tracy Szerszen
President/Operations Manager

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
January 11, 2010	January 2, 2014	January 31, 2016

Accreditation No.:	*Certificate No.:*
65818	L14-2

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental

2655 Park Center Drive, Suite A, Simi Valley, CA 93065
Chaney Humphrey Phone: 805-526-7161

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard Method	Technology	Analyte
Aqueous	RSK 175	GC/FID	Methane
Aqueous	RSK 175	GC/FID	Ethane
Aqueous	RSK 175	GC/FID	Ethene
Aqueous	RSK 175	GC/TCD	Carbon Dioxide
Air	(ALS SOP) VOA-EPA3C	GC/TCD	Hydrogen
Air	(ALS SOP) VOA-EPA3C	GC/TCD	Oxygen
Air	(ALS SOP) VOA-EPA3C	GC/TCD	Nitrogen
Air	(ALS SOP) VOA-EPA3C	GC/TCD	Methane
Air	(ALS SOP) VOA-EPA3C	GC/TCD	Carbon Dioxide
Air	(ALS SOP) VOA-EPA3C	GC/TCD	Carbon Monoxide
Air	(ALS SOP) VOA-TPHG_TO3	GC/FID	Total Petroleum Hydrocarbons Gasoline (TPHG)
Air	(ALS SOP) VOA-TPHG_TO3	GC/FID	JP-4
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	C1 - C6+
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	Ethane
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	Ethene
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	Methane
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	n-Butane
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	n-Hexane
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	n-Pentane
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	Propane
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	Propene
Air	(ALS SOP) VOA-TO3C1C6	GC/FID	Total Volatile Petroleum Hydrocarbons (TVPH) as Hexane
Air	EPA TO-15	GC/MS	1,1,1-Trichloroethane
Air	EPA TO-15	GC/MS	1,1,2,2-Tetrachloroethane
Air	EPA TO-15	GC/MS	1,1,2-Trichloroethane
Air	EPA TO-15	GC/MS	1,1-Dichloroethane
Air	EPA TO-15	GC/MS	1,1-Dichloroethene
Air	EPA TO-15	GC/MS	1,2,3-Trimethylbenzene
Air	EPA TO-15	GC/MS	1,2,4-Trichlorobenzene

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental

2655 Park Center Drive, Suite A, Simi Valley, CA 93065
Chaney Humphrey Phone: 805-526-7161

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard Method	Technology	Analyte
Air	EPA TO-15	GC/MS	1,2,4-Trimethylbenzene
Air	EPA TO-15	GC/MS	1,2,Dibromo-3-Chloropropane
Air	EPA TO-15	GC/MS	1,2-Dibromoethane
Air	EPA TO-15	GC/MS	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
Air	EPA TO-15	GC/MS	1,2-Dichlorobenzene
Air	EPA TO-15	GC/MS	1,2-Dichloroethane
Air	EPA TO-15	GC/MS	1,2-Dichloropropane
Air	EPA TO-15	GC/MS	1,3,5-Trimethylbenzene
Air	EPA TO-15	GC/MS	1,3-Butadiene
Air	EPA TO-15	GC/MS	1,3-Dichlorobenzene
Air	EPA TO-15	GC/MS	1,4-Dichlorobenzene
Air	EPA TO-15	GC/MS	1,4-Dioxane
Air	EPA TO-15	GC/MS	1-Butanol
Air	EPA TO-15	GC/MS	2-Butanone (MEK)
Air	EPA TO-15	GC/MS	2-Ethyltoluene
Air	EPA TO-15	GC/MS	2-Hexanone
Air	EPA TO-15	GC/MS	3-Ethyltoluene
Air	EPA TO-15	GC/MS	4-Ethyltoluene
Air	EPA TO-15	GC/MS	4-Methyl-2-Pentanone
Air	EPA TO-15	GC/MS	Acetone
Air	EPA TO-15	GC/MS	Acetonitrile
Air	EPA TO-15	GC/MS	Acrolein
Air	EPA TO-15	GC/MS	Acrylonitrile
Air	EPA TO-15	GC/MS	Allyl Chloride
Air	EPA TO-15	GC/MS	alpha-Methylstyrene
Air	EPA TO-15	GC/MS	alpha-Pinene
Air	EPA TO-15	GC/MS	Benzene
Air	EPA TO-15	GC/MS	Benzyl Chloride
Air	EPA TO-15	GC/MS	Bromodichloromethane
Air	EPA TO-15	GC/MS	Bromoform
Air	EPA TO-15	GC/MS	Bromomethane
Air	EPA TO-15	GC/MS	Carbon Disulfide
Air	EPA TO-15	GC/MS	Carbon Tetrachloride
Air	EPA TO-15	GC/MS	Chlorobenzene
Air	EPA TO-15	GC/MS	Chloroethane

Certificate of Accreditation: Supplement

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ALS Environmental

2655 Park Center Drive, Suite A, Simi Valley, CA 93065
Chaney Humphrey Phone: 805-526-7161

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Matrix	Standard Method	Technology	Analyte
Air	EPA TO-15	GC/MS	Chloroform
Air	EPA TO-15	GC/MS	Chloromethane
Air	EPA TO-15	GC/MS	cis-1,2-Dichloroethene
Air	EPA TO-15	GC/MS	cis-1,3-Dichloropropene
Air	EPA TO-15	GC/MS	Cumene
Air	EPA TO-15	GC/MS	Cyclohexane
Air	EPA TO-15	GC/MS	Cyclohexanone
Air	EPA TO-15	GC/MS	Dibromochloromethane
Air	EPA TO-15	GC/MS	Dichlorodifluoromethane (CFC 12)
Air	EPA TO-15	GC/MS	Diisopropyl Ether
Air	EPA TO-15	GC/MS	d-Limonene
Air	EPA TO-15	GC/MS	Ethanol
Air	EPA TO-15	GC/MS	Ethyl Acetate
Air	EPA TO-15	GC/MS	Ethyl tert-Butyl Ether
Air	EPA TO-15	GC/MS	Ethylbenzene
Air	EPA TO-15	GC/MS	Hexachlorobutadiene
Air	EPA TO-15	GC/MS	Isooctane
Air	EPA TO-15	GC/MS	Isopropyl acetate
Air	EPA TO-15	GC/MS	Isopropyl Alcohol
Air	EPA TO-15	GC/MS	m-&, p-Xylenes
Air	EPA TO-15	GC/MS	Methyl Methacrylate
Air	EPA TO-15	GC/MS	Methyl tert-Butyl Ether
Air	EPA TO-15	GC/MS	Methylene Chloride
Air	EPA TO-15	GC/MS	Naphthalene
Air	EPA TO-15	GC/MS	n-Butyl Acetate
Air	EPA TO-15	GC/MS	n-Butylbenzene
Air	EPA TO-15	GC/MS	n-Decane
Air	EPA TO-15	GC/MS	n-Dodecane
Air	EPA TO-15	GC/MS	n-Heptane
Air	EPA TO-15	GC/MS	n-Hexane
Air	EPA TO-15	GC/MS	n-Nonane

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Air	EPA TO-15	GC/MS	n-Octane
Air	EPA TO-15	GC/MS	n-Propylbenzene
Air	EPA TO-15	GC/MS	n-Undecane
Air	EPA TO-15	GC/MS	o-Xylene
Air	EPA TO-15	GC/MS	p-Isopropyltoluene
Air	EPA TO-15	GC/MS	Propene
Air	EPA TO-15	GC/MS	sec-Butylbenzene
Air	EPA TO-15	GC/MS	Styrene
Air	EPA TO-15	GC/MS	tert-Amyl Methyl Ether
Air	EPA TO-15	GC/MS	tert-Butanol
Air	EPA TO-15	GC/MS	tert-Butylbenzene
Air	EPA TO-15	GC/MS	Tetrachloroethene
Air	EPA TO-15	GC/MS	Tetrahydrofuran
Air	EPA TO-15	GC/MS	Toluene
Air	EPA TO-15	GC/MS	trans-1,2-Dichloroethene
Air	EPA TO-15	GC/MS	trans-1,3-Dichloropropene
Air	EPA TO-15	GC/MS	Trichloroethene
Air	EPA TO-15	GC/MS	Trichlorofluoromethane
Air	EPA TO-15	GC/MS	Trichlorotrifluoroethane
Air	EPA TO-15	GC/MS	Vinyl Acetate
Air	EPA TO-15	GC/MS	Vinyl Chloride
Air	ASTM D 1946-90	GC/TCD	Hydrogen
Air	ASTM D 1946-90	GC/TCD	Oxygen
Air	ASTM D 1946-90	GC/TCD	Nitrogen
Air	ASTM D 1946-90	GC/TCD	Methane
Air	ASTM D 1946-90	GC/TCD	Carbon Dioxide
Air	ASTM D 1946-90	GC/TCD	Carbon Monoxide
Air	EPA 3C	GC/TCD	Oxygen
Air	EPA 3C	GC/TCD	Nitrogen
Air	EPA 3C	GC/TCD	Methane
Air	EPA 3C	GC/TCD	Carbon Dioxide
Air	(ALS SOP) VOA-TO15	GC/MS	1,1,1-Trichloroethane
Air	(ALS SOP) VOA-TO15	GC/MS	1,1,2,2-Tetrachloroethane
Air	(ALS SOP) VOA-TO15	GC/MS	1,1,2-Trichloroethane
Air	(ALS SOP) VOA-TO15	GC/MS	1,1-Dichloroethane

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Accreditation is granted to the facility to perform the following testing:

Matrix	Standard Method	Technology	Analyte
Air	(ALS SOP) VOA-TO15	GC/MS	1,1-Dichloroethene
Air	(ALS SOP) VOA-TO15	GC/MS	1,2,3-Trimethylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	1,2,4-Trichlorobenzene
Air	(ALS SOP) VOA-TO15	GC/MS	1,2,4-Trimethylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	1,2-Dibromo-3-Chloropropane
Air	(ALS SOP) VOA-TO15	GC/MS	1,2-Dibromoethane
Air	(ALS SOP) VOA-TO15	GC/MS	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
Air	(ALS SOP) VOA-TO15	GC/MS	1,2-Dichlorobenzene
Air	(ALS SOP) VOA-TO15	GC/MS	1,2-Dichloroethane
Air	(ALS SOP) VOA-TO15	GC/MS	1,2-Dichloropropane
Air	(ALS SOP) VOA-TO15	GC/MS	1,3,5-Trimethylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	1,3-Butadiene
Air	(ALS SOP) VOA-TO15	GC/MS	1,3-Dichlorobenzene
Air	(ALS SOP) VOA-TO15	GC/MS	1,4-Dichlorobenzene
Air	(ALS SOP) VOA-TO15	GC/MS	1,4-Dioxane
Air	(ALS SOP) VOA-TO15	GC/MS	1-Butanol
Air	(ALS SOP) VOA-TO15	GC/MS	2-Butanone (MEK)
Air	(ALS SOP) VOA-TO15	GC/MS	2-Ethyltoluene
Air	(ALS SOP) VOA-TO15	GC/MS	2-Hexanone
Air	(ALS SOP) VOA-TO15	GC/MS	3-Ethyltoluene
Air	(ALS SOP) VOA-TO15	GC/MS	4-Ethyltoluene
Air	(ALS SOP) VOA-TO15	GC/MS	4-Methyl-2-Pentanone
Air	(ALS SOP) VOA-TO15	GC/MS	Acetone
Air	(ALS SOP) VOA-TO15	GC/MS	Acetonitrile
Air	(ALS SOP) VOA-TO15	GC/MS	Acrolein
Air	(ALS SOP) VOA-TO15	GC/MS	Acrylonitrile
Air	(ALS SOP) VOA-TO15	GC/MS	Allyl Chloride
Air	(ALS SOP) VOA-TO15	GC/MS	alpha-Methylstyrene
Air	(ALS SOP) VOA-TO15	GC/MS	alpha-Pinene
Air	(ALS SOP) VOA-TO15	GC/MS	Benzene
Air	(ALS SOP) VOA-TO15	GC/MS	Benzyl Chloride
Air	(ALS SOP) VOA-TO15	GC/MS	Bromodichloromethane
Air	(ALS SOP) VOA-TO15	GC/MS	Bromoform
Air	(ALS SOP) VOA-TO15	GC/MS	Bromomethane

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental

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Matrix	Standard Method	Technology	Analyte
Air	(ALS SOP) VOA-TO15	GC/MS	Carbon Disulfide
Air	(ALS SOP) VOA-TO15	GC/MS	Carbon Tetrachloride
Air	(ALS SOP) VOA-TO15	GC/MS	Chlorobenzene
Air	(ALS SOP) VOA-TO15	GC/MS	Chloroethane
Air	(ALS SOP) VOA-TO15	GC/MS	Chloroform
Air	(ALS SOP) VOA-TO15	GC/MS	Chloromethane
Air	(ALS SOP) VOA-TO15	GC/MS	cis-1,2-Dichloroethene
Air	(ALS SOP) VOA-TO15	GC/MS	cis-1,3-Dichloropropene
Air	(ALS SOP) VOA-TO15	GC/MS	Cumene
Air	(ALS SOP) VOA-TO15	GC/MS	Cyclohexane
Air	(ALS SOP) VOA-TO15	GC/MS	Cyclohexanone
Air	(ALS SOP) VOA-TO15	GC/MS	Dibromochloromethane
Air	(ALS SOP) VOA-TO15	GC/MS	Dichlorodifluoromethane (CFC 12)
Air	(ALS SOP) VOA-TO15	GC/MS	Diisopropyl Ether
Air	(ALS SOP) VOA-TO15	GC/MS	d-Limonene
Air	(ALS SOP) VOA-TO15	GC/MS	Ethanol
Air	(ALS SOP) VOA-TO15	GC/MS	Ethyl Acetate
Air	(ALS SOP) VOA-TO15	GC/MS	Ethyl tert-Butyl Ether
Air	(ALS SOP) VOA-TO15	GC/MS	Ethylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	Hexachlorobutadiene
Air	(ALS SOP) VOA-TO15	GC/MS	Isooctane
Air	(ALS SOP) VOA-TO15	GC/MS	Isopropyl acetate
Air	(ALS SOP) VOA-TO15	GC/MS	Isopropyl Alcohol
Air	(ALS SOP) VOA-TO15	GC/MS	m-&,p-Xylenes
Air	(ALS SOP) VOA-TO15	GC/MS	Methyl Methacrylate
Air	(ALS SOP) VOA-TO15	GC/MS	Methyl tert-Butyl Ether
Air	(ALS SOP) VOA-TO15	GC/MS	Methylene Chloride
Air	(ALS SOP) VOA-TO15	GC/MS	Naphthalene
Air	(ALS SOP) VOA-TO15	GC/MS	n-Butyl Acetate
Air	(ALS SOP) VOA-TO15	GC/MS	n-Butylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	n-Decane
Air	(ALS SOP) VOA-TO15	GC/MS	n-Dodecane
Air	(ALS SOP) VOA-TO15	GC/MS	n-Heptane
Air	(ALS SOP) VOA-TO15	GC/MS	n-Hexane
Air	(ALS SOP) VOA-TO15	GC/MS	n-Nonane

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

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Matrix	Standard Method	Technology	Analyte
Air	(ALS SOP) VOA-TO15	GC/MS	n-Octane
Air	(ALS SOP) VOA-TO15	GC/MS	n-Propylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	n-Undecane
Air	(ALS SOP) VOA-TO15	GC/MS	o-Xylene
Air	(ALS SOP) VOA-TO15	GC/MS	p-Isopropyltoluene
Air	(ALS SOP) VOA-TO15	GC/MS	Propene
Air	(ALS SOP) VOA-TO15	GC/MS	sec-Butylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	Styrene
Air	(ALS SOP) VOA-TO15	GC/MS	tert-Amyl Methyl Ether
Air	(ALS SOP) VOA-TO15	GC/MS	t-Butanol
Air	(ALS SOP) VOA-TO15	GC/MS	tert-Butylbenzene
Air	(ALS SOP) VOA-TO15	GC/MS	Tetrachloroethene
Air	(ALS SOP) VOA-TO15	GC/MS	Tetrahydrofuran
Air	(ALS SOP) VOA-TO15	GC/MS	Toluene
Air	(ALS SOP) VOA-TO15	GC/MS	trans-1,2-Dichloroethene
Air	(ALS SOP) VOA-TO15	GC/MS	trans-1,3-Dichloropropene
Air	(ALS SOP) VOA-TO15	GC/MS	Trichloroethene
Air	(ALS SOP) VOA-TO15	GC/MS	Trichlorofluoromethane
Air	(ALS SOP) VOA-TO15	GC/MS	Trichlorotrifluoroethane
Air	(ALS SOP) VOA-TO15	GC/MS	Vinyl Acetate
Air	(ALS SOP) VOA-TO15	GC/MS	Vinyl Chloride

Texas Commission on Environmental Quality

NELAP-Recognized Laboratory Accreditation is hereby awarded to

ALS Environmental – Simi Valley

2655 Park Center Drive, Suite A
Simi Valley, CA 93065-6209

in accordance with Texas Water Code Chapter 5, Subchapter R, Title 30 Texas Administrative Code Chapter 25, and the National Environmental Laboratory Accreditation Program.

The laboratory's scope of accreditation includes the fields of accreditation that accompany this certificate. Continued accreditation depends upon successful ongoing participation in the program. The Texas Commission on Environmental Quality urges customers to verify the laboratory's current location(s) and accreditation status for particular methods and analyses (www.tceq.texas.gov/goto/lab). Accreditation does not imply that a product, process, system or person is approved by the Texas Commission on Environmental Quality.

Executive Director Texas Commission on Environmental Quality

Certificate Number: T104704413-15-6
Effective Date: 7/1/2015
Expiration Date: 6/30/2016

Texas Commission on Environmental Quality

NELAP - Recognized Laboratory Fields of Accreditation

Certificate:	T104704413-15-6
Expiration Date:	6/30/2016
Issue Date:	7/1/2015

ALS Environmental – Simi Valley

2655 Park Center Drive, Suite A
Simi Valley, CA 93065-6209

These fields of accreditation supercede all previous fields. The Texas Commission on Environmental Quality urges customers to verify the laboratory's current accreditation status for particular methods and analyses.

Matrix: ***Air & Emissions***

Method EPA TO-15

Analyte	AB	Analyte ID	Method ID
1,1,1-Trichloroethane	OR	5160	10248803
1,1,2,2-Tetrachloroethane	OR	5110	10248803
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	OR	5195	10248803
1,1,2-Trichloroethane	OR	5165	10248803
1,1-Dichloroethane	OR	4630	10248803
1,1-Dichloroethylene	OR	4640	10248803
1,2,4-Trichlorobenzene	OR	5155	10248803
1,2,4-Trimethylbenzene	OR	5210	10248803
1,2-Dibromoethane (EDB, Ethylene dibromide)	OR	4585	10248803
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	OR	4695	10248803
1,2-Dichlorobenzene	OR	4610	10248803
1,2-Dichloroethane (Ethylene dichloride)	OR	4635	10248803
1,2-Dichloropropane	OR	4655	10248803
1,3,5-Trimethylbenzene	OR	5215	10248803
1,3-Butadiene	OR	9318	10248803
1,3-Dichlorobenzene	OR	4615	10248803
1,4-Dichlorobenzene	OR	4620	10248803
1,4-Dioxane (1,4-Diethyleneoxide)	OR	4735	10248803
1-Propene (Propylene)	OR	4836	10248803
2,2,4-Trimethylpentane (Isooctane)	OR	5220	10248803
2-Butanone (Methyl ethyl ketone, MEK)	OR	4410	10248803
Acetonitrile	OR	4320	10248803
Acrylonitrile	OR	4340	10248803
Benzene	OR	4375	10248803
Benzyl chloride	OR	5635	10248803
Bromodichloromethane	OR	4395	10248803
Bromoform	OR	4400	10248803
Carbon tetrachloride	OR	4455	10248803

Texas Commission on Environmental Quality

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Matrix: ***Air & Emissions***

Chlorobenzene	OR	4475	10248803
Chlorodibromomethane	OR	4575	10248803
Chloroethane (Ethyl chloride)	OR	4485	10248803
Chloroform	OR	4505	10248803
cis-1,2-Dichloroethylene	OR	4645	10248803
cis-1,3-Dichloropropene	OR	4680	10248803
Cyclohexane	OR	4555	10248803
Dichlorodifluoromethane (Freon-12)	OR	4625	10248803
Ethylbenzene	OR	4765	10248803
Ethyl-t-butylether (ETBE) (2-Ethoxy-2-methylpropane)	OR	4770	10248803
Hexachlorobutadiene	OR	4835	10248803
Isopropylbenzene (Cumene)	OR	4900	10248803
Methyl bromide (Bromomethane)	OR	4950	10248803
Methyl chloride (Chloromethane)	OR	4960	10248803
Methyl isobutyl ketone (Hexone) (MIBK)	OR	4985	10248803
Methyl methacrylate	OR	4990	10248803
Methyl tert-butyl ether (MTBE)	OR	5000	10248803
Methylene chloride (Dichloromethane)	OR	4975	10248803
m-Ethyltoluene	OR	10253	10248803
n-Decane	OR	5875	10248803
n-Heptane	OR	4825	10248803
n-Hexane	OR	4855	10248803
n-Nonane	OR	5026	10248803
n-Octane	OR	5027	10248803
n-Propylbenzene	OR	5090	10248803
n-Undecane	OR	10261	10248803
o-Ethyltoluene	OR	10254	10248803
p-Ethyltoluene	OR	10255	10248803
Styrene	OR	5100	10248803
T-amylmethylether (TAME)	OR	4370	10248803

Texas Commission on Environmental Quality

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Matrix: *Air & Emissions*

Tetrachloroethylene (Perchloroethylene)	OR	5115	10248803
Toluene	OR	5140	10248803
trans-1,2-Dichloroethylene	OR	4700	10248803
trans-1,3-Dichloropropylene	OR	4685	10248803
Trichloroethene (Trichloroethylene)	OR	5170	10248803
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	OR	5175	10248803
Vinyl acetate	OR	5225	10248803
Vinyl chloride	OR	5235	10248803
Xylene (total)	OR	5260	10248803

Appendix D
Comprehensive Goals for Building 8 Supplemental Groundwater and Vapor Intrusion Investigations

Problem Statement and Study Goals
Supplemental Groundwater and Indoor Air Investigations
Building 8 - Site 5
NAS Corpus Christi Texas

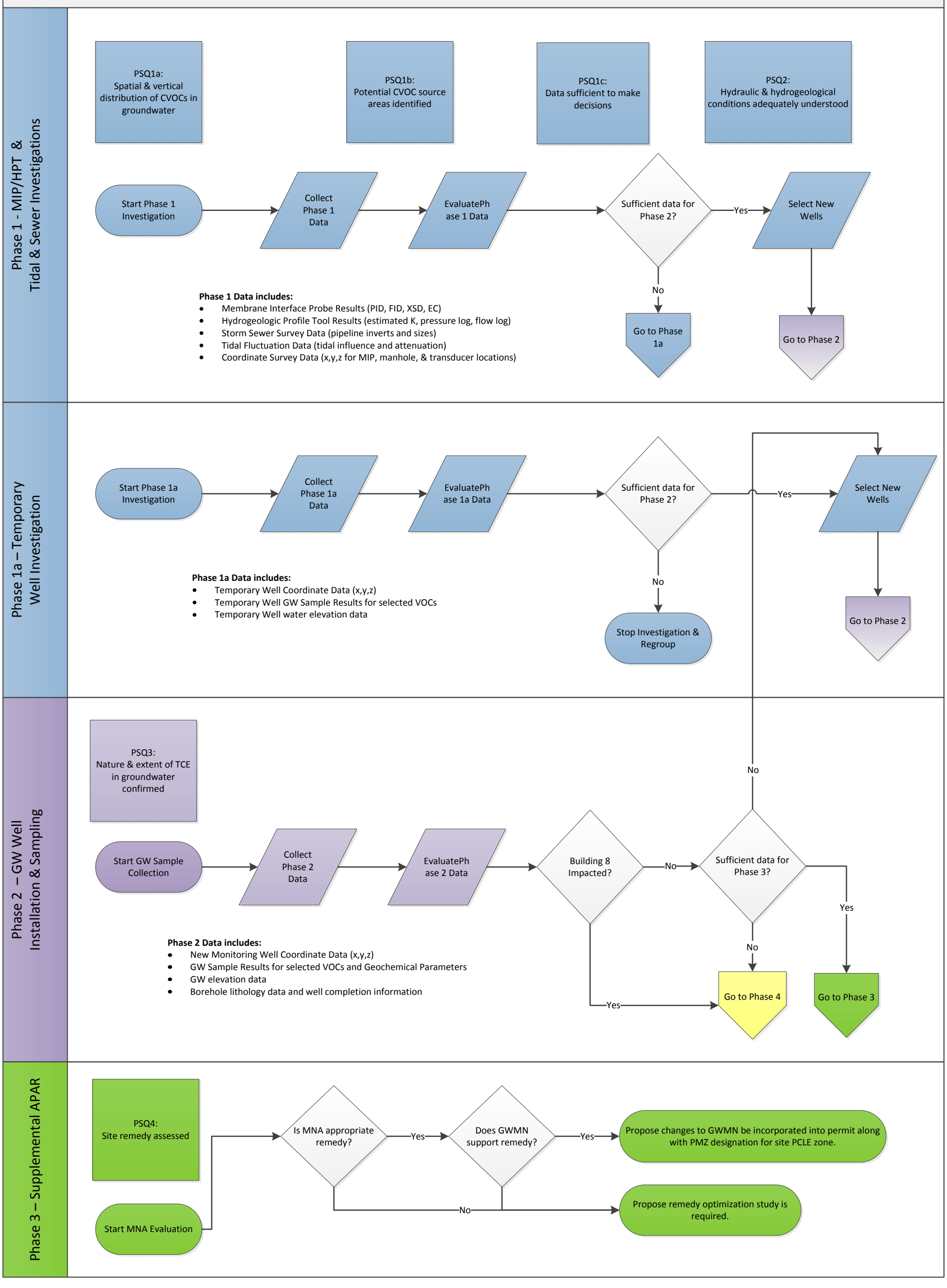
Problem Statement - GW Study	**UFP-SAP**
In the 2003 RAP, a PCLE zone was established for tricholorethene (TCE) and a well network was established to monitor natural attenuation and assess whether the TCE plume was expanding. Ten years of groundwater monitoring results from the current well network indicate increasing concentrations for both primary constituents and degradation products at point of compliance wells ES-28 and ES-29. Therefore, monitored natural attenuation (MNA) needs to be re-evaluated in the context of an optimized well network for this site because the existing well network may not be addressing the site monitoring requirements.	GW Study
A modified Triad approach utilizing membrane interface probe (MIP) and hydraulic profiling tool (HPT) technologies is proposed for rapidly characterizing the current site conditions so that decisions can be made in near real time regarding optimization of the site remedy of MNA for Site 00005 — Building 8. All field activities will be phased, so that field data can be integrated into the decision-making process for subsequent field events.	GW Study
Goals - GW Study	
Phase 1: Reevaluate the spatial and vertical distribution of chlorinated volatile organic compounds (CVOCs) in groundwater at Site 00005 — Building 8 and better define the structures within the soil that may affect contaminant transport.	GW Study
Phase 1: Assess hydraulic and hydrogeologic conditions that may be present and could influence the migration of contaminants in groundwater at Site 00005 — Building 8 (e.g., effects of storm sewer conveyances, tidal flushing, lithological features).	GW Study
Phase 2: Design and install an optimized groundwater monitoring network (GWMN) at Site 00005 — Building 8 using information obtained from Phase 1.	GW Study
Phase 2: Sample the optimized GWMN to confirm the current nature and extent of site contaminants (CVOCs) in groundwater and to assess the site remedy (MNA) by evaluating geochemistry and hydrogeological factors potentially impacting the progress of natural attenuation of TCE at Site 00005 – Building 8.	GW Study
Phase 3: Prepare a Supplemental Groundwater Investigation (SGI) report and submit this report as a Supplemental APAR for Site 00005 — Building 8. The report will present study findings and make recommendations regarding incorporation of the optimized GWMN into the site remedy and the potential for additional site remedy optimization needs.	Both
Problem Statement - VI Study	
Recent groundwater investigation results indicate that contaminant concentrations within the Site 0005 TCE plume area could have the potential for indoor air quality impacts within Building 8. Therefore, an assessment for vapor intrusion of TCE into Building 8 from potential groundwater and vapor sources beneath the building is needed to evaluate current and future risk to site workers at this facility.	VI Study
Goals - VI Study	
Phase 4a: Evaluate the spatial distribution of CVOCs in sub-slab soil gas in the vadose zone beneath the Site 00005 — Building 8 foundation to determine sub-slab soil gas and indoor air sampling locations and MIP locations.	VI Study
Phase 4b: Evaluate the spatial and vertical distribution of CVOCs in groundwater beneath the Site 00005 — Building 8 foundation and define the structures in the soil that may affect contaminant transport using information obtained from Phase 4a.	GW Study
Phase 4c: Evaluate potential risks associated with CVOC vapor intrusion to indoor air receptors using multiple lines of evidence (e.g., concurrent sub-slab soil gas, indoor, and outdoor air TO-15 results; radon data; pressure differential data; previously collected shallow groundwater data; building characteristics; high volume smpling and MIP investigation results; HAPSITE indoor air survey; chemical use history; etc.) at Site 00005 - Building 8. Notify the Navy immediately if TCE concentrations in indoor air exceeds the U.S. EPA's Industrial Urgent Response Action Level.	VI Study

Site 00005 – Building 8 Supplemental Groundwater Investigation

Problem Statement: Natural attenuation does not appear to be reducing the contaminant concentrations within the TCE PCLE zone for Site 00005 – Building 8 based on the current monitoring well network and exceedences of TRRP PCLs at the point of compliance locations; therefore, MNA needs to be re-evaluated in the context of an optimized well network for this site because the existing well network may not be addressing the site monitoring requirements.

Study Goals:

- Phase 1: Reevaluate the spatial and vertical distribution of CVOCs in groundwater at Site 00005 — Building 8 and better define the structures within the soil that may affect contaminant transport.
- Phase 1: Assess hydraulic and hydrogeologic conditions that may be present and could influence the migration of contaminants in groundwater at Site 00005 — Building 8 (e.g., effects of storm sewer conveyances, tidal flushing, lithological features).
- Phase 2: Design and install an optimized GWMN at Site 00005 — Building 8 using information obtained from Phase 1.
- Phase 2: Sample the optimized GWMN to confirm the current nature and extent of site contaminants (CVOCs) in groundwater and to assess the site remedy (MNA) by evaluating geochemistry and hydrogeological factors potentially impacting the progress of natural attenuation of TCE at Site 00005 – Building 8.
- Phase 3: Prepare an SGI report and submit this report as a Supplemental APAR for Site 00005 — Building 8. The report will present study findings and make recommendations regarding incorporation of the optimized GWMN into the site remedy and the potential for additional site remedy optimization needs.



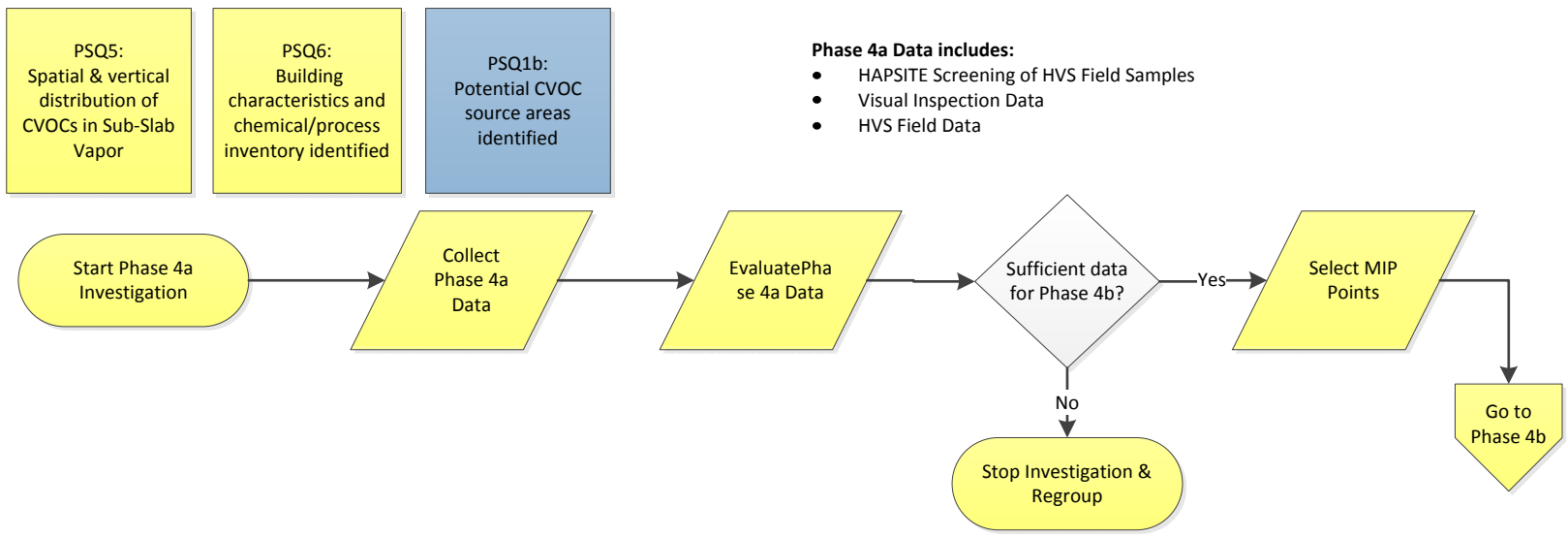
Site 00005 – Building 8 Indoor Investigations (Phase 4)

Problem Statement: Recent groundwater investigation results indicate that contaminant concentrations within the Site 0005 trichloroethylene (TCE) plume area could have the potential for indoor air quality impacts within Building 8; therefore an assessment for vapor intrusion of TCE into Building 8 from potential groundwater and vapor sources beneath the building is needed to evaluate current and future risk to site workers at this facility.

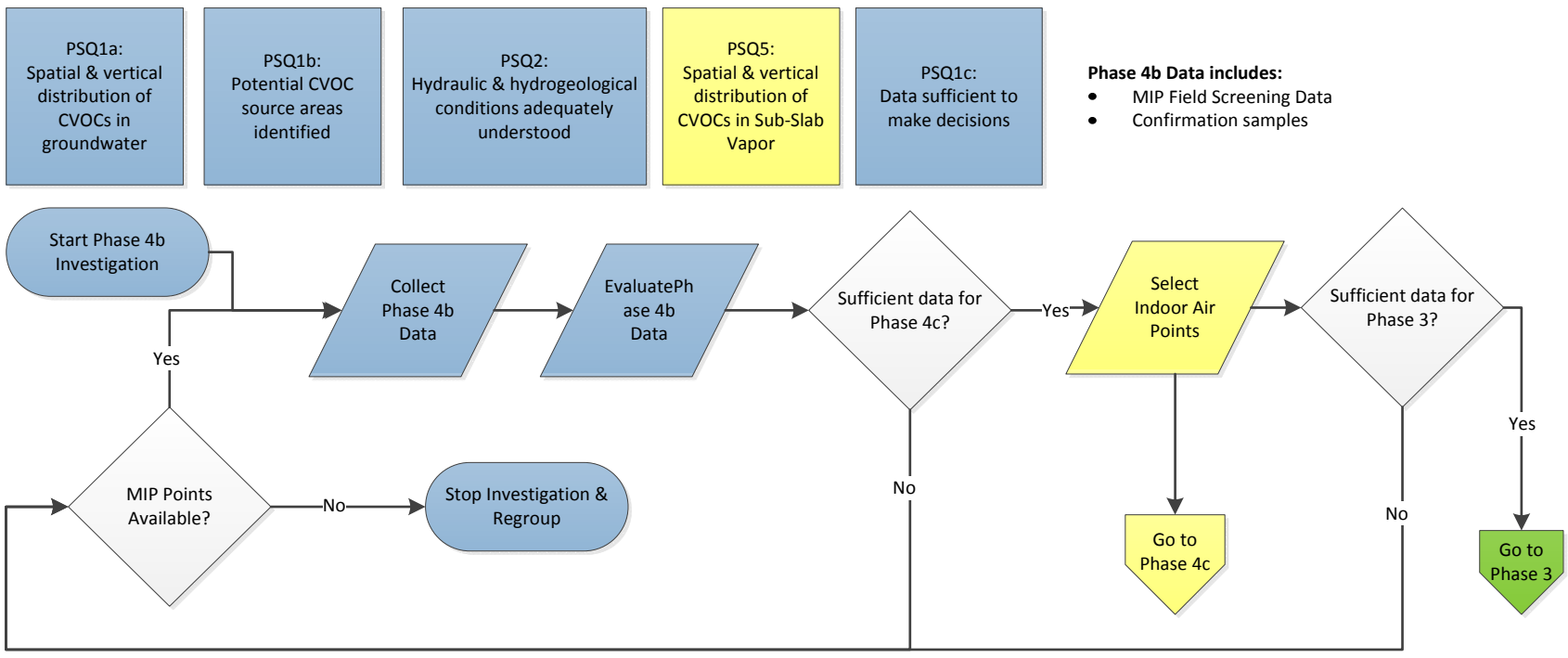
Study Goals:

- **Phase 4a:** Evaluate the spatial distribution of CVOCs in sub-slab soil gas in the vadose zone within the Site 00005 — Building 8 footprint in order to determine sub-slab soil gas and indoor air sampling locations and MIP locations.
- **Phase 4b:** Evaluate the spatial and vertical distribution of CVOCs in groundwater underneath the Site 00005 — Building 8 footprint and define the structures within the soil that may affect contaminant transport using information obtained from Phase 4a.
- **Phase 4c:** Evaluate potential risks associated with CVOC vapor intrusion to indoor air receptors using multiple lines of evidence (e.g., concurrent sub-slab soil gas, indoor, and outdoor air TO-15 results, radon data, pressure differential data, previously collected shallow groundwater data, building characteristics, HVS and MIP investigation results, HAPSITE indoor air survey, chemical use history, etc.) at Site 00005 - Building 8 and notify the Navy immediately if TCE concentrations in indoor air exceeds the EPA's Industrial Urgent Response Action Level.

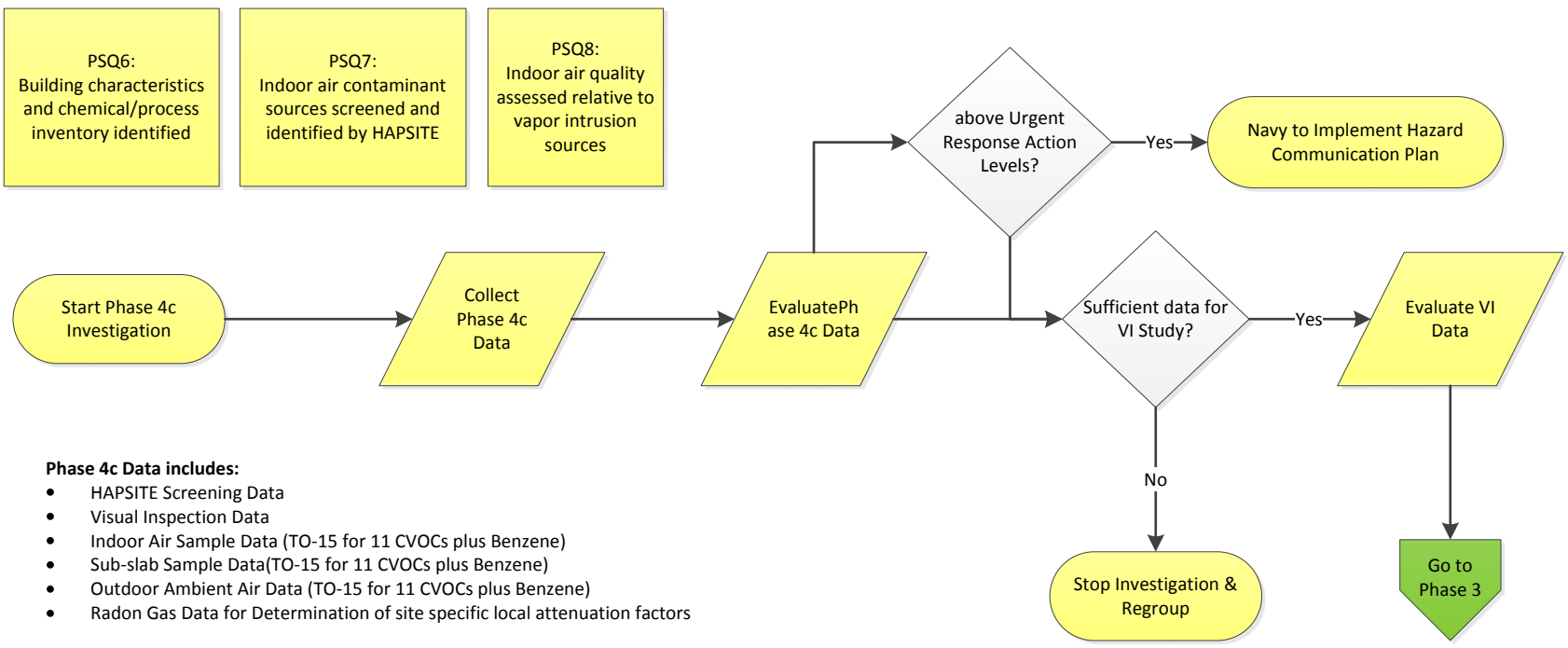
Phase 4a – HVS Sub-Slab Vapor Investigation



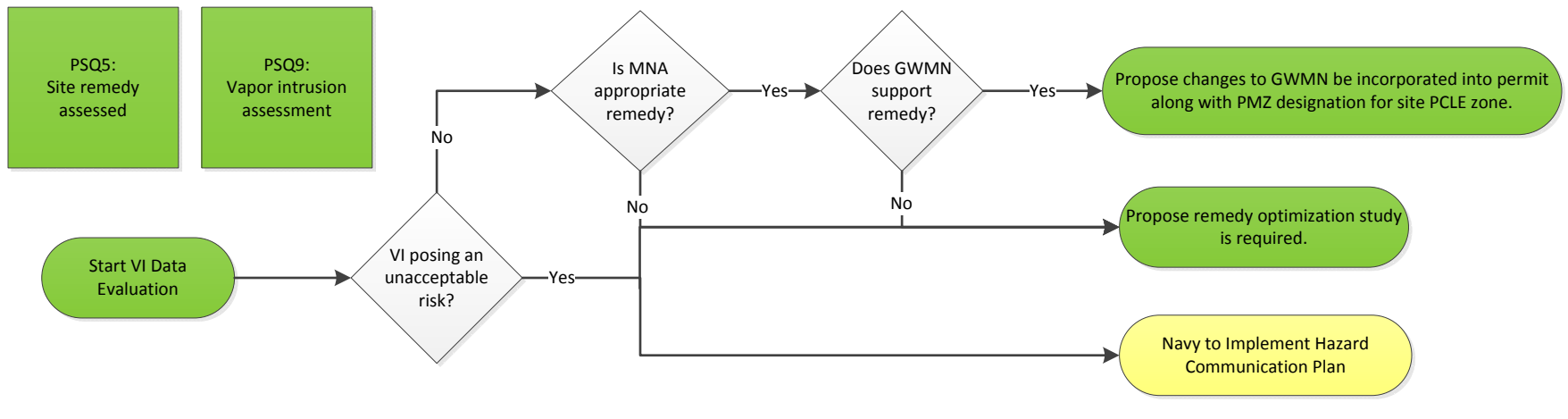
Phase 4b – Indoor MIP/HPT Investigation



Phase 4c – Indoor Air Quality/Vapor Intrusion



Phase 3 – Supplemental APAR



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Study Phase	PSQ ID	PSQ Short Name	PSQ Text	Decision Statement	Decision Rule Text	UFP-SAP
1/4b MIP-TW	PSQ1a	PSQ1a: Spatial & vertical distribution of CVOCs in groundwater	PSQ1a: Have the spatial and vertical distributions of CVOCs in groundwater been adequately defined during the MIP investigation such that the approximate boundaries of the TCE plume can be incorporated into the optimized GWMN design in Phase 2?	Assess the presence/absence of CVOC in groundwater using MIP techniques (**and temporary wells, TW**) to determine additional monitoring well locations for optimized GWMN design.	Decision Rule 1a: If CVOCs are above field-established background levels, then continue with MIP (**TW** investigations as outlined in Worksheet #17. However, if CVOCs are below field-established background levels, then select a new transect direction or grid location and continue screening along a designated transect until all planned sample locations are evaluated along that transect, or until the CVOC plume has been mapped in at least the four cardinal directions.	SGI
1/4b MIP-TW	PSQ1b	PSQ1b: Potential CVOC source areas identified	PSQ1b: Did the MIP investigation identify potential source areas that may require additional study?		Decision Rule 1b: If the CVOC plume has been mapped to background levels in at least the four cardinal directions, then stop collecting MIP screening data for plume extent and continue with MIP (**TW**) investigations as outlined in Worksheet #17, but focusing on locations where hydrogeologic structures or potential CVOC sources could be better defined.	SGI
1 MIP-TW	PSQ1c	PSQ1c: Data Sufficient to Make Decisions	PSQ1c: Does the partnering team have the information they need to provide input on the optimized GWMN design to be completed in Phase 2?	Propose and install new groundwater monitoring wells as needed to address concerns.	Decision Rule 1c: If MIP findings are complete, then compile findings and recommendations for permanent well locations into a memorandum for the partnering team. If findings indicate that the TCE PCLE zone may not be adequately assessed using the permanent wells proposed for Phase 2, then make alternate recommendations (**TW**s) to the partnering team.	SGI
1 MIP-TW	PSQ2	PSQ2: Hydraulic & hydrogeological conditions adequately understood	PSQ2: Are the hydraulic and hydrogeological conditions (e.g., effects of storm sewer conveyances, tidal flushing, lithological features) at Site 00005 — Building 8 better understood?	Evaluate hydraulic effects of storm sewer conveyances, tidal flushing, and lithological features.	Decision Rule 2: If tidal variation data and the sewer survey suggest that data gaps remain relative to understanding the hydraulic and hydrogeological conditions, document the limitations in the dataset. Any interim recommendations will be combined with the MIP recommendations previously described.	SGI
2 GW	PSQ3	PSQ3: Nature & extent of TCE in groundwater confirmed	PSQ3: Have the nature and extent of TCE and degradation products of TCE been adequately defined during Phase 2 sampling, or will additional activities be required to refine the TCE PCLE zone?	Assess the collected groundwater concentration data and determine whether nature and extent of TCE and degradation products of TCE have been adequately defined to refine the TCE PCLE zone; document any data gaps that remain.	Decision Rule 3: If collected groundwater data are sufficient to represent the nature and extent of the TCE plume, proceed with Phase 3 (remedy evaluation and reporting). If data gaps remain, document any limitations in the dataset.	SGI
3 APAR Addendum	PSQ4	PSQ4: Site Remedy Assessed	PSQ4: Is the site remedy (MNA) appropriate for this site given the information collected during Phases 1 and 2 of the SGI? Do data gaps remain that might impact the outcome this assessment?	Assess the collected data and determine whether MNA remains the appropriate site remedy; evaluate the quality of this remedy assessment with respect to any remaining data gaps.	Decision Rule 4: If collected groundwater data indicate naturally occurring conditions support the site remedy (MNA), then continue with the existing groundwater monitoring program using the optimized GWMN established during this effort. If data gaps remain, document any limitations in the dataset and note where additional studies may be required.	SGI
4a HVS	PSQ5	PSQ5: Spatial distribution of CVOCs in Sub-Slab Vapor	PSQ5: Have the spatial distributions of CVOCs in sub-slab soil gas beneath the Site 00005 - Building 8 foundation been adequately assessed during the HVS investigation such that quantitative sub-slab soil gas and indoor air sampling locations and MIP locations can be determined?	Assess the sub-slab soil gas screening data obtained by HVS techniques to determine appropriate sub-slab soil gas sampling, indoor air sampling, and MIP locations.	Decision Rule 5a: If CVOCs (as indicated by TCE) have been detected above field-established background levels and differentiated from PVOCs (as indicated by Benzene) using screening instruments (PID, GEM 2000, and HAPSITE), then continue with the HVS investigation as outlined in Worksheet #17. However, if CVOCs are below screening levels at a selected HVS test location, then advancement of the next location will focus upon a new location or suspected contaminant direction until extent of potential sub-slab impacts have been determined in at least four cardinal directions.	VI
					Decision Rule 5b: If the HVS investigation findings are complete and sufficient, then determine the appropriate locations for MIP, indoor air, and sub-slab sampling. If findings indicate that the HVS investigation did not generate the information needed to complete the goal, then make alternate recommendations to the partnering team.	VI

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4b Indoor MIP	PSQ1a	PSQ1a: Spatial & vertical distribution of CVOCs in groundwater	PSQ1a: Have the spatial and vertical distributions of CVOCs in groundwater been adequately defined during the MIP investigation such that the approximate boundaries of the TCE plume beneath the Building 8 foundation are sufficiently known to further assist in determining locations to sample sub-slab soil gas and indoor air?	Assess the presence/absence of CVOC in groundwater using MIP techniques to further assist in determining the appropriate sub-slab soil gas and indoor air sampling locations.	Decision Rule 1a: If CVOCs are above field-established background levels, then continue with MIP investigations as outlined in Worksheet #17. However, if CVOCs are below field-established background levels, then select a new transect direction or grid location and continue screening along a designated transect until all planned sample locations are evaluated along that transect, or until the CVOC plume has been mapped in at least the four cardinal directions.	SGI
	PSQ1b	PSQ1b: Potential CVOC source areas identified	PSQ1b: Did the MIP investigation identify potential source areas beneath the Building 8 foundation that may require additional study?		Decision Rule 1b: If the CVOC plume has been mapped to background levels in at least the four cardinal directions, then stop collecting MIP screening data for plume extent and continue with MIP investigations as outlined in Worksheet #17, but focusing on locations where hydrogeologic structures or potential CVOC sources could be better defined.	SGI
4b Indoor MIP	PSQ1c	PSQ1c: Data Sufficient to Make Decisions	PSQ1c: Does the investigation team have the information needed to provide input on the sub-slab soil gas and indoor air sampling locations?		Decision Rule 1c: If MIP findings are complete and sufficient, then determine the appropriate indoor air and sub-slab sampling locations. If findings indicate that the MIP investigation did not generate the information needed to complete the goal, then rely on the findings of the HVS investigation and the HAPSITE indoor air survey.	VI
4c Indoor Air	PSQ6	PSQ6: Building characteristics and chemical/process inventory identified	PSQ6: Do Site 00005 — Building 8 characteristics (construction, slab condition, HVAC system construction and operation, etc.) contribute to vapor intrusion? Have chemical inventories and a breakdown of chemical processes been obtained and reviewed for possible CVOC sources?	Request a Hazardous Materials Inventory from CCAD prior to commencement of field activities. Conduct a building survey prior to or during the HAPSITE indoor air survey to document items housed in the areas of interest within Site 00005 - Building 8 that may contribute as an indoor background source of CVOCs (cleaning products, chemicals used/stored within the building for manufacturing, etc.). Other such items, including the types and typical operation of the HVAC systems, potential preferential pathways (piping and other conduits, etc.), and the condition of the slab, will also be assessed during the building survey.	Decision Rule 6: If access is not permitted in some areas of Site 00005 - Building 8, then a CCAD representative will be asked to perform the building survey using a form within the area.	VI
4c Indoor Air	PSQ7	PSQ7: Indoor air contaminant sources screened and identified by HAPSITE	PSQ7a: Do Site 00005 — Building 8 operation and maintenance activities result in potential background sources of CVOCs?	The HAPSITE will be used in both qualitative and quantitative modes to identify background sources (cleaning products, chemicals used within the building for manufacturing, etc.). The indoor air survey will also verify and locate potential CVOC-containing items listed on the requested Hazardous Material Inventory and identify those items that are not listed.	Decision Rule 7a: If the HAPSITE unit (while in quantitative mode) detects CVOC concentrations emitting from any items or processes, then appropriate communications will be made by the Navy to the site stakeholders. If the source of background CVOCs can be removed in advance of the IA sampling event, these actions will be completed no less than 48 hours prior to initiation of the IA sampling. All identified CVOC sources and the current conditions of those sources (i.e., addressed or not addressed) prior to the IA sampling will be logged in the field notebook.	VI

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4c Indoor Air			PSQ7b: Are crack/joints/utilities inside Building 8 acting as conduits for vapor intrusion?	The HAPSITE will be used in both qualitative and quantitative modes to identify vapor entry points for VI (cracks, joints, utilities, etc.).	Decision Rule 7b: If the HAPSITE unit (while in quantitative mode) detects CVOC concentrations emitting from cracks/crevices/joints/etc., then appropriate communications will be made by the Navy to the site stakeholders. If vapor entry points are identified that can be addressed (i.e. sealed) in advance of the IA sampling event, these actions will be completed no less than 48 hours prior to initiation of the IA samples. The Navy will coordinate with CCAD to complete building repairs that can be implemented within the timeframe of this investigation. All identified CVOC sources and the current conditions of those sources (i.e., addressed or not addressed) prior to the IA sampling will be logged in the field notebook.	VI
4c Indoor Air	PSQ8	PSQ8: Indoor air quality assessed relative to vapor intrusion sources	PSQ8a: Are CVOCs present in sub-slab vapor beneath the Site 00005 — Building 8 foundation at concentrations that could result in indoor air concentrations above risk-based target levels?	Assess the collected sub-slab vapor concentration data and determine whether CVOCs in the subsurface (groundwater and/or soil) have volatilized and produced concentrations in the sub-slab vapor that could migrate into indoor air. After sub-slab soil gas samples are obtained, collect a subset of radon samples to evaluate attenuation across the slab. Use radon data with other contaminant ratios to develop a site-specific attenuation factor.	Decision Rule 8a1: If sub-slab soil gas CVOC concentrations are below risk-based target levels, then there is no significant risk of CVOC VI and no further investigation is warranted.	VI
					Decision Rule 8a2: If sub-slab soil gas CVOC concentrations exceed risk-based target levels but are not observed in corresponding indoor air samples, then there is potential to result in future exceedances of risk-based target levels in indoor air. A management plan will be recommended and discussed with the Partnering Team and CCAD.	VI
4c Indoor Air		PSQ8: Indoor air quality assessed relative to vapor intrusion sources	PSQ8b: Are CVOCs present in indoor air in Site 00005 — Building 8 at concentrations above risk-based target levels?	Collect and assess indoor air concentration data to determine whether CVOCs in sub-slab soil gas have migrated into indoor air. After indoor air samples are obtained, collect a subset of radon samples to evaluate attenuation across the slab. Use radon data with other contaminant ratios to develop a site-specific attenuation factor.	Decision Rule 8b1: If indoor air CVOC concentrations exceed risk-based target levels but are not observed in corresponding sub-slab soil gas samples, then indoor air concentrations are not related to VI and are likely due to an indoor and/or outdoor air CVOC source. These exceedances of risk-based target levels that are not related to VI will be reported to the Partnering Team and CCAD.	VI
					Decision Rule 8b2: If indoor air CVOC concentrations exceed risk-based target levels and are also observed in corresponding sub-slab soil gas samples, then it is possible that the VI pathway is complete and/or significant. Assessing the multiple lines of evidence will determine whether indoor air exceedances are due to VI and/or indoor/outdoor background sources. If possible background sources have been ruled out and a VI pathway has been completed, then a human health risk assessment will be completed as part of the VI assessment report (Phase 3 - APAR Addendum Report).	VI
4c Indoor Air		PSQ8: Indoor air quality assessed relative to vapor intrusion sources			Decision Rule 8b3: If TCE concentrations in indoor air exceed 88 µg/m3, Resolution Consultants will immediately notify the Navy of site conditions and areas of concern. The Navy will contact the Partnering Team and CCAD to discuss results and any additional appropriate actions. Required response actions will be taken by CCAD and the Navy in accordance with their policies.	VI

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4c Indoor Air		PSQ8: Indoor air quality assessed relative to vapor intrusion sources	PSQ8c: Are CVOCs present in outdoor air at Site 00005 — Building 8 impacting indoor air concentrations?	Collect outdoor air samples concurrent with sub-slab soil gas and indoor air samples and assess ambient concentration data to determine whether CVOCs outside the building are impacting the concentrations within the building. Collect a subset of radon samples after outdoor air samples are collected as part of the attenuation factor study.	Decision Rule 8c: If outdoor air CVOC concentrations are above indoor air CVOC concentrations, then conclude that ambient conditions are influencing indoor air conditions.	VI
3 APAR Addendum	PSQ9	PSQ9: Vapor intrusion assessment	PSQ9: Are the data collected sufficient to evaluate whether the vapor intrusion pathway is complete and significant enough to potentially pose a threat to indoor air receptors at Site 00005 - Building 8?	Evaluate potential risks associated with CVOC vapor intrusion to indoor air receptors using multiple lines of evidence (e.g., concurrent sub-slab soil gas, indoor, and outdoor air results, radon data, differential pressure data, historical shallow groundwater data, building characteristics, high volume sampling and MIP investigation results, HAPSITE indoor air survey, chemical use history, etc.) collected at Site 00005 - Building 8 and determine whether data gaps remain.	Decision Rule 9: If collected data are sufficient to evaluate whether the vapor intrusion pathway is complete and/or significant, then proceed with **the assessment report (Phase 3 - APAR Addendum Report)**. If data gaps remain, document limitations in the dataset and present to the partnering team.	SGI