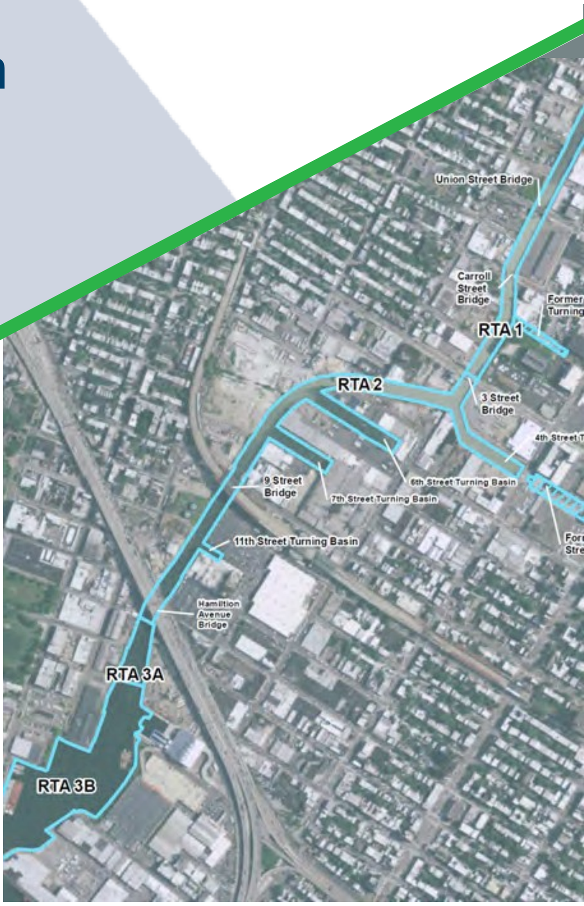
Community Air Monitoring Plan

GOWANUS CANAL SUPERFUND SITE
Remedial Target Area 1
BROOKLYN, NY



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updated to include Amendments I - V

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1. Glossary

BTEX	A subset of VOCs including benzene, toluene, ethyl benzene, and xylenes
CAAL	*Concentration Above Action Level, as a 15-minute average of TVOC or* PM_{10}
CAMP	Community Air Monitoring Plan
COC	Contaminants of Concern
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FPFD	Pulse Flame Photometric Detector
GC	Gas Chromatograph or Gas Chromatography
H_2S	The molecular formula of hydrogen sulfide
NAAQS	National Ambient Air Quality Standard
NH_3	The molecular formula of ammonia
NIST	National Institute of Standards and Technology
NPR	Non-project related activities responsible for CAAL
NWS	National Weather Service
NYSDOH	New York State Department of Health
PHA	Public Health Assessment
PID	Photo Ionization Detector
PM	Particulate Matter, specifically PM_{10} (less than 10 microns in diameter) for this plan
ppb	Parts per billion, a unit of measure for concentration
ppm	Parts per million, a unit of measure for concentration
PR	Project related activities responsible for CAAL
QA/QC	Quality Assurance and Quality Control
RTA1	Remediation of Target Area 1
SOP	Standard Operating Procedure
TVOC	Total Volatile Organic Compounds
$\mu g/m^3$	Micrograms per cubic meter, a unit of measure for concentration
µm	A micrometer (aka micron); 1 millimeter (mm) = 1000 micrometers (µm).
VOC	Volatile Organic Compounds

2. Introduction

Perimeter air monitoring activities will be performed in association with remediation activities related to the remediation of target area 1 (RTA1) at the Gowanus Canal Superfund Site located in Brooklyn, King's County, New York. RTA1 remedial activities will include the following:

- Mobilization of equipment and staging of materials at the Staging Site currently located at 459 Smith Street on the corner of Smith and Huntington Street.
- Mechanical dredging along the entirety of RTA1
- Installation of bulkhead and bridge supports
- In-situ stabilization in designated areas
- Capping along the entirety of RTA1

Collectively, the work zones are located in an urban area with numerous residences, businesses, and industrial operations in the close proximity to the canal.

The following Community Air Monitoring Plan describes the methodology that will be employed in association with active remediation. The Community Air Monitoring Plan (CAMP) is organized into ten sections as follows: Section 1 Glossary, Section 2 Introduction, Section 3 Contaminants of Concern, Section 4 Objectives of the perimeter monitoring program, Section 5 air sampling and analyses Methodology, Section 6 sample collection Frequency , Section 7 Action Levels, Section 8 proposed perimeter Monitoring Locations, Section 9 QA/QC protocols for use with each of the measurement methods, and Section 10 Data Management, Validation and Reporting. This CAMP was developed using guidance from the New York State Department of Health (NYSDOH) Generic CAMP (2010)[1].

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[1] DER-10 / Technical Guidance for Site Investigation and Remediation. May 3, 2010. Prepared by New York State Department of Environmental Conservation. Albany, NY 12233.

3. Contaminants of Concern (COC)

A Public Health Assessment (Final Release January 11, 2017)[2] examined the health risks associated with exposure via inhalation to organic contaminants present in outdoor ambient air near the canal. The NYSDOH evaluated compounds with maximum concentrations greater than their EPA residential air regional screening levels based upon data found in the EPA Remedial Investigation Report. These contaminants included benzene, chloroform, ethyl benzene, methylene chloride, xylenes (o,m,p) and naphthalene.

Previous pilot programs in Turning Basin 4 also served to guide the selection of Contaminants of Concern for the remediation of RTA1. Contaminants to be monitored in ambient air as part of the CAMP include the same parameters that were monitored during CAMP programs conducted during previous pilot programs in calendar years 2017 and 2018. These contaminants included primarily volatile organic compounds such as benzene, toluene, ethylbenzene, xylenes (o,m,p) and hydrogen sulfide.

The following parameters will be monitored as part of this CAMP for RTA1:

- TVOC (15-min)
- PM_{10} (15-min)
- VOCs, including benzene, chloroform, ethyl benzene, methylene chloride, toluene, and xylenes (o,m,p)
- Hydrogen sulfide
- Ammonia
- Odors (during work hours)
- Naphthalene
- Mercaptans & Reduced Sulfur Compounds

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[2] Public Health Assessment Final Release Gowanus Canal EPA Facility ID: NYN000206222. January 11,2017. Prepared by New York State Department of Health under a Cooperative Agreement with the US Department of Health and Human Services Agency for Toxic Substances and Disease Registry Division of Community Health Investigations Atlanta, Georgia 30333

4. Objectives

The purpose of this monitoring program is to continuously measure particulate matter and Total Volatile Organic Compounds (TVOC) in the air around the perimeter of various work zones associated with RTA1 at the Gowanus Canal Superfund Site. Other Contaminants of Concern (COC), including ammonia (NH_3) and hydrogen sulfide (H_2S), will be monitored periodically along the perimeter of active work zones. Continuous air monitors will be equipped with alarm capabilities, at predefined Alert and Action Levels. TRC will notify the Owner's Representative if an Alert Level is reached serving as a pre-alarm notification. This should serve to reduce the occurrences of Concentrations Above the Action Level (CAAL)and resultant corrective actions or mitigation measures associated with these occurrences. TRC will collect bag samples and perform a GC analysis for benzene, toluene, ethyl benzene and xylenes (BTEX) when the TVOC Action levels are exceeded for any 15-minute average period. Additionally, TRC will collect bag samples for speciation of select reduced sulfur compounds and naphthalene when warranted by odors. A gas chromatograph fitted with a photo ionization detector (PID) will be on site to allow for on-site measurement of BTEX and naphthalene on an as needed basis during the entire term of the remediation program. Additionally, a second on-site GC will be equipped with a pulsed flame photometric detector (PFPD) for measurement of reduced sulfur compounds, such as H_2S, and mercaptans.

A meteorological station will be established on-site to measure and record wind speed, wind direction, relative humidity, barometric pressure, and temperature. The station will provide the basis for determining upwind and downwind directions relative to the remediation work zones.

Air quality will be monitored at appropriate locations along the perimeter of the work zones in a manner that will provide an early warning to project management that control measures might be needed. Continuous monitoring will be conducted at twelve (12) locations along the perimeter of the canal and at two (2) locations within the Staging Site. Each station will continuously measure TVOC, quantified and reported as benzene, and particulate matter as respirable dust (10µm or less in diameter-PM_{10}); 24 hours a day, seven (7) days a week. Additionally, periodic air sampling for a target group of VOCs, in accordance with US EPA Method TO-15, will be conducted weekly at two monitoring stations, during the first six months of the program. After which, data will be evaluated to determine the TO-15 sampling frequency for the remainder of the monitoring program.

5. Methodology

5.1. Program Overview

This CAMP contains provisions for the continuous monitoring of ambient TVOC and PM_{10} along the perimeter of the canal, as well as semi-continuous monitoring/sampling for other Contaminants of Concern (COC), including: BTEX, naphthalene, H_2S, NH_3, mercaptans and other reduced sulfur compounds. Each monitoring station, installed at fixed locations, will be comprised of monitoring instrumentation for TVOC and PM_{10}. The following sections describe the monitoring approach including instrumentation and methodology, monitoring and sampling frequency, as well as associated QA/QC and program reporting requirements.

An overview of the perimeter monitoring approach is as follows:

- Each sampling station will consist of a Met One ES-642 particulate monitor inside of an enclosure with the air inlet at breathing zone height. Data will be collected on a continuous basis, as 15-minute averages, at each station and transmitted by wireless telemetry to the central command data-logger for direct comparison to the 150 ug/m^3 PM_{10} Action Level.
- Visual alarms will be activated and displayed on the screen of the base station computer monitor in the on-site trailer if a 15-minute average PM_{10} concentration reaches an Alert Level of 100 µg/m^3, or if a 15-minute average TVOC concentration reaches an Alert Level of 750 ppb.
- These self-imposed alerts serve to notify on-site personnel so that corrective actions / emission mitigation measures can be taken prior to reaching Action Levels.
- Visual alarms will also be activated if a PM_{10} concentration is recorded above the Action Level of 150 µg/m^3.
- TVOC will be monitored using Baseline's piD-Tech eVx Photoionization Sensor calibrated with Benzene (NIST traceable Standard Calibration Gas; see Appendix C) and data collected on a continuous basis, as 15-minute averages, for comparison to an Action Level of 1,000 ppb.
- Chemical speciation of air samples (Tedlar® bag sample collection) will be performed using an on-site gas chromatograph (GC) as warranted by TVOC concentrations measured above the Action Level and/or reduced sulfur odors.
- The community air monitoring network will be comprised of twelve (12) battery powered monitoring stations around the canal and two (2) monitoring stations at the staging site. This fourteen (14) station network will be in place during the background phase of the program, as well as, the three-year RTA1 program.
- On site wind direction data will be collected using a meteorological station operating on a continuous basis during the term of the remediation program. This data will provide the basis for the identification of stations as upwind and downwind perimeter locations during the course of the program. The meteorological station will be located near the central command trailer and will include sensors for wind direction, wind speed, relative humidity, barometric pressure, and temperature.
- Continuous contact ("walkie-talkie"/cell phone) will be maintained between TRC personnel and the Owner's Representative. In this manner the Owner's Representative can notify all appropriate site personnel should measured concentrations reach an Alert Level such that corrective actions can be taken to avert a CAAL.
- TRC will prepare reports on a weekly basis that document all CAALs as well as responses and/or corrective actions taken as a result.

- TVOC and PM_{10} data will be transmitted by wireless telemetry on a continuous basis from each of the fourteen (14) monitoring stations to a central on-site computer.
- If any TVOC reading exceeds the Action Level of 1000 ppb for a sustained period of 15 minutes, increased mitigation measures will be implemented. Additional measurements will also be taken including collection of a Tedlar® bag sample (15-min composite) at each affected station followed by gas chromatographic analyses for BTEX.
- If PM_{10} levels exceed the Action Level of 150 µg/m^3 for a sustained period of 15 minutes additional mitigation measures will be implemented.
- Odor surveys will be performed on a daily basis by the TRC field engineers. These will be performed at the same locations and times as the H_2S and NH_3 measurements while driving/walking along the site perimeter. Odor observations and relevant other information will be recorded during each survey on odor survey forms (see Figure 1).
- If significant odors are detected, a Tedlar ®bag sample will be collected at the affected location and analyzed on-site for reduced sulfur compounds.
- Each occurrence of a CAAL, its cause and corrective actions taken (if needed) will be documented by entry in the field logbook.

5.2. Air Monitoring Methodology

The objectives of this CAMP will be met by employing a variety of monitoring procedures. A summary of the Contaminants of Concern (COC) and monitoring/sampling methodologies are provided Table 1. Details of each method are provided in the sections to follow.

Table 1: ***Summary of Gowanus RTA1 CAMP Monitoring Parameters***

Continuous Monitoring Parameters	**Alert / Action Levels**	**Detection Limit**	**Equipment Model**
TVOC (15-min) – 24/7	750 / 1,000 ppb	5 ppb	Baseline piD-TECH eVx Photoionization Sensor
PM10 (15-min) – 24/7	100 / 150 µg/m^3	5µg/m^3	Met One ES-642
Periodic Monitoring Parameters	**Frequency and Location**	**Detection Limit**	**Equipment Model**
TO-15	During the first six months: Once weekly at 2 locations*	< 1 ppb	Summa Canisters /Flow Regulators
Hydrogen sulfide (H_2S)	1x daily at all locations	3 ppb	Arizona Instruments Jerome Model J605
Ammonia (NH_3)	1x daily at all locations	10 ppb	ATO-SKY2000-NH_3
BTEX	As needed triggered by a TVOC CAAL	25-50 ppb	Bag Sampling and analyses by GC/PID SRI Model 8610 GC
Odors (during work hours)	1x daily at all locations	0 – 5	Olfactory survey field staff
• **Naphthalene**	As needed triggered by odor event	25-50 ppb	Bag Sampling and analyses by GC/PID SRI Model 8610 GC
• **Mercaptans & Reduced Sulfur Compounds**	As needed triggered by off-site/on site odor event	5-10 ppb	Bag Sampling and analyses by GC/Pulsed Flame Photometric Detector (PFPD) SRI Model 8610 GC

* Analyses will be conducted for the volatile Contaminants of Concern, including naphthalene, identified in Section 3. These data will be evaluated after six months to determine if a reduction in the number of samples collected is warranted for the remainder of the program.

5.2.1. Meteorological Monitoring

A meteorological station will be erected on the roof of the central command trailer location, or on a tower. The station will be equipped with an RM Young Response One system to measure wind speed, wind direction, relative humidity, barometric pressure and ambient temperature on a continuous basis. The Response One utilizes ultrasonic sound waves for determining wind speed and direction and has no moving parts. Ultrasonic sensors have improved sensitivity and accuracy over mechanical sensors and require no maintenance. Real-time data from the met station will be displayed by an RM Young translator and 15-minute averages for all met parameters will be stored to the field PC and sent to TRC's server and project database.

5.2.2. Particulate Monitoring

PM_{10} will be monitored using a Met One ES-642 at each station on a real-time basis. The 15-minute average data values will be used for comparison to an Alert Level of 100 $\mu g/m^3$, as well as, an Action Level of 150 $\mu g/m^3$. Data will be collected and archived during the course of each day and transmitted via telemetry to the base station computer housed in the on-site trailer.

5.2.3. TVOC Monitoring

Total Volatile Organic Compounds (TVOC) data will be monitored at each of the stations on a continuous basis via the use of a PID Instrument (Baseline piD-TECH eVx Photoionization Sensor). The TVOC monitors are calibrated daily with a NIST traceable benzene standard of approximately 1,000 ppb (see Appendix C).

Data will be logged and archived at each TVOC monitor and transmitted using wireless telemetry to the field PC. The 15-minute averaged data values will be used for comparison to Alert Levels of 750 ppb as well as an Action Level of 1,000 ppb. Data will be stored locally on the field PC housed in the on-site trailer and sent to TRC's server and project database.

5.2.4. On-Site Chemical Speciation (Tedlar® Bag Sampling)

Two gas chromatographs will be installed on-site for chemical speciation of BTEX and reduced sulfur compounds via analyses of bag samples. Both will be equipped with 2-mL injection loops and capillary columns to effectively separate individual compounds. One gas chromatograph will be fitted with a PID detector for analysis of BTEX and naphthalene, while the other will be fitted with a pulsed flame photometric detector (PFPD) for H_2S and mercaptans. Detection limits in the 10-50 ppb (v/v) are typically achieved.

BTEX

On-site chemical speciation of air samples may be triggered when TVOC concentrations are measured above the TVOC Action Level. When a 15-minute average exceeds the proposed Action Level of 1,000 ppb, a Tedlar® bag sampling event will be automatically triggered at the affected station, while TVOC monitoring is continued. The automated sampling system will collect ambient air in the bag over a 15-minute period, unattended. Should the 15-minute period following the initial sampling event also exceed 1,000 ppb, an additional sample will be collected for that 15-minute period and the process continued until PID readings have decreased below 1,000 ppb. Tedlar® bags will be retrieved by the TRC field engineers and analyzed for BTEX in the on-site trailer by GC/PID (SRI Model 8610)

Reduced Sulfur Compounds and Naphthalene

Air sampling for reduced sulfur compounds and/or naphthalene may be warranted due to one or more of the following:

- persistent odors are observed by on site personnel, or
- odor complaints are received from off-site residents, or
- elevated concentrations of hydrogen sulfide are recorded during periodic sampling events

If needed, an air sample will be collected using a personal sampling pump connected to a Tedlar® bag. Samples collected as a result of an odor event will be analyzed in the TRC on site trailer laboratory employing gas chromatography. Concentrations for reduced sulfur compounds will be detected by a PFPD, while concentrations of naphthalene will be detected by an PID/FID. For the purpose of this monitoring program, reduced sulfur compounds include hydrogen sulfide, methyl mercaptan and ethyl mercaptan.

5.3. Periodic Monitoring

Hydrogen sulfide and ammonia will be monitored at least once daily at all monitoring stations utilizing portable hand-held monitoring devices to take short term measurements. Hydrogen sulfide will be measured using a Jerome J605 (Arizona Instruments) H_2S detector. The Jerome J605 is capable of achieving detection limits of 3.0 ppb. TRC will use an ATO-SKY2000 handheld ammonia gas detector to monitor for ambient ammonia concentrations on a periodic basis. The ATO-SKY2000 is capable of achieving detection limits of 10 ppb. Additionally, H_2S measurements will be collected and odor surveys will be conducted in the vicinity of active work areas on a daily basis. This will consist of taking H_2S measurements and odor surveys at 3-4 locations (stations) in the immediate vicinity of a daily work area along the canal. The same 3-4 stations locations will be monitored at the start of the workday and again during the day as work progresses. These data will be downloaded and archived daily utilizing a direct USB connection to the base station computer in the on-site trailer. TRC will note any trends in observed concentrations to determine if site activities could be contributing to any fluctuations in daily readings. Results of periodic monitoring will be documented in field logs/forms.

5.4. VOC Sampling – EPA Method TO-15

Air samples will be collected for VOCs during both the Background Phase and the Remedial Phase of the project. These samples will be collected routinely for a subset of VOCs identified in the 2017 PHA, during the remediation program. These COCs are as follows: benzene, chloroform, ethyl benzene, methylene chloride, toluene and xylenes (o,m,p). Initially, two monitoring stations will be selected, determined by wind direction and remediation activities, for VOC sampling every week. In this manner, sampling locations will rotate among the stations along the canal to collect data representative of the community around the canal.

VOCs will be collected using a 6-liter evacuated stainless steel Summa canister. A calibrated regulator (flow controller with a critical orifice) connected to the inlet of the canister ensures the air flow into the canister is maintained at a constant rate to fill the canister over a 24-hour period. The field sampling SOP is provided in Appendix B. VOC samples will be shipped to Con-Test Analytical Laboratory in East Longmeadow, MA for analysis in accordance with EPA Method TO-15 employing gas chromatography/mass spectrometry (GC/MS). The laboratory's SOP is provided in Appendix A.

5.5. Odor Monitoring

In addition to periodic monitoring for H_2S and NH_3, odor surveys will be performed on a regular basis by the TRC monitoring network operator. These will be performed at the same frequency and at the same locations and times that H_2S and NH_3 measurements are taken. Odor observations and relevant other information will be recorded during each survey on odor survey forms (an example odor survey form is shown in Figure 1).

While the intensity of odors is subjective, and odor threshold concentrations vary from person to person, nuisance odors are expected during the course of the remediation program. Odor observations will be classified following the odor classification scale below:

- "0" – No odors are detected at the perimeter location.
- "1" – A slight odor is present at the perimeter location. The odor is intermittent and not steady. Minimal impact to off-site community receptors downwind of the location. Odor control measures at the site are adequate and activities may continue.
- "2" – Odors at the perimeter are stronger than "1" condition and relatively steady. There is no indication that the off-site community receptors downwind of the location have been affected. In order to mitigate potential community impacts additional odor control measures will be implemented including vapor-suppression foam, covering (tarping) of exposed face or water spray.
- "3" – "2" condition still exists after additional odor control measures have been applied. The community has become aware of the situation and is reacting. Most likely on-site odor-generating activities will cease, and full odor control measures will be applied (see condition "2"). The situation will be re-evaluated prior to resuming odor-generation activities.

If the odor classification is a "0" or "1", activities will continue. If the odors are classified as a "2", odor control measures will be implemented. If odors are classified as a "3", activities will be halted, and full odor control measures implemented. A follow-up odor assessment will be performed and deemed acceptable (Classified as a "2" or below) prior to resumption of on-site activities that most likely generated the odors.

Figure 1: Odor Survey Form

Project Name:	Gowanus Canal Superfund Site
Project Location:	Brooklyn, NY
Wind Direction & Speed:	/
Project Activities:	

TIME	LOCATION (STATION #)	ODOR CLASSIFICATION (0, 1, 2, or 3)*	H2S (ppb)	NH3 (ppb)	OBSERVATIONS
:	ST-1				
:	ST-2				
:	ST-3				
:	ST-4				
:	ST-5				
:	ST-6				
:	ST-7				
:	ST-8				
:	ST-9				
:	ST-10				
:	ST-11				
:	ST-12				
:	ST-13				
:	ST-14				

Conducted By:	
Signature:	
Date:	

* See odor key included in Odor / NH_3 / H_2S Binder

6. Frequency

6.1. Background

Background monitoring will take place during the network installation phase of the program several weeks prior to commencement of active remediation in the canal (eg. trenching). Five (5) consecutive days of perimeter monitoring will be performed employing the complete fourteen (14) station network. Continuous monitoring for TVOC and PM_{10} will take place on a 24 hour/day basis. Additionally, VOC samples will be collected on a time weighted basis (approximately 24 hours) at two stations, including collocated sampling at one station, in accordance with US EPA Method TO-15. These data will collectively represent the background data base characteristic of the site environs prior to the start of active remediation.

6.2. Remediation

Air monitoring, along the canal and at the staging site, will take place during remediation activities related to RTA1, which are planned to continue through January 2024. TVOC and PM_{10} will be monitored continuously at each of the fourteen (14) monitoring stations. Periodically, grab samples or short-term measurements will be collected at least twice daily at each of two (2) the stations for additional COCs, as summarized in Section 5.3.

Sampling and analyses for VOCs in accordance with EPA Method TO-15 will continue on a weekly basis during the first six (6) months of the remediation program. Similar to the background sampling, weekly sampling will occur at two stations, including a collocated pair. The sampling locations will be determined based on wind direction and rotated so that all stations are represented over the course of the remediation program. These data will be evaluated after six months to determine if a reduction in the sampling frequency is warranted for the remainder of the program.

6.3. Measured Concentrations Above Action Levels

TVOCs and particulates will be monitored continuously at all network monitoring stations 24 hours a day, seven (7) days a week, for comparison to site-specific Alert and Action Levels. Upwind and downwind directions will be determined on an on-going basis by evaluating the real-time meteorological data recorded at the site. If predominant wind direction cannot be determined (e.g., wind speeds less than 2 mph or the direction variable), then all locations will be considered downwind locations.

If a measured TVOC concentration (15-minute average value) exceeds the TVOC Action Level (1,000 ppb) at any station, an automated system will initiate the collection of a BTEX bag sample at the affected location. If the next consecutive 15-minute average exceeds the TVOC Action Level, a second BTEX bag sample will be collected. Analysis via gas chromatography will be performed on the most recent sample first. In the event that two consecutive 15-minute TVOC concentrations are greater than the Action Level, the site activity determined to have contributed to the CAAL may be halted until a 15-minute measurement at that location is restored below the Action Level of 1,000 ppb.

If a measured PM_{10} concentration is greater than the 15-minute Action Level (150 ug/m^3), mitigation measures will be initiated. If the next consecutive 15-minute measurement is also greater than the Action Level, the site activity determined to have contributed to the CAAL Level of 150 $\mu g/m^3$ may be halted until a 15-minute measurement at that location is restored below the Action Level.

In the event of TVOC and/or PM_{10} concentrations reaching Action Levels, every effort will be made to immediately identify the source of elevated concentrations. Due to the unique nature and urban location of the Gowanus Canal site, there is the potential for non-project related activities to impact air quality in the vicinity of network stations. A non-project related (NPR) CAAL is one that is attributable to off-site activities or occurring during non-work hours and not attributable to project activities. A project related (PR) CAAL would be one directly attributable to site activities including remediation and support work.

7. Action Levels

The Alert and Action Levels selected for use in this community air monitoring program were developed considering potential risks to off-site receptors. Alert Levels are self-imposed and serve as a warning or pre-notification that concentrations are nearing Action Levels and allow for mitigation measures to be taken as a means to maintain concentrations below the Action Level. Action Levels represent the highest acceptable ambient concentration (AAC) where, if recorded for 15-minutes or more, would require enhanced mitigation measures and potentially work stoppages.

The Action Levels for the perimeter monitoring program are as follows:

Table 2: Site Specific Alert and Action Levels

Parameter	Alert Level	Action Level
TVOC	750 ppb	1,000 ppb
PM_{10}	100 µg/m^3	150 µg/m^3 *
*Equivalent to the National Ambient Air Quality Standard (NAAQS) for PM_{10}. The NAAQS represents a 24-hour time weighted average concentration for PM_{10} in ambient air.		

7.1. Derivation of Action Levels

PM_{10}

The PM_{10} Action Level in place for this CAMP is the equivalent of the NAAQS for PM_{10}, and was dictated by Appendix 1A of NYSDOH's DER-10 guidance document, which reads:

> "The action level will be established at 150 ug/m^3 (15 minutes average). While conservative, this short-term interval will provide a real-time assessment of on-site air quality to assure both health and safety. If particulate levels are detected in excess of 150 ug/m^3, the upwind background level must be confirmed immediately. If the working site particulate measurement is greater than 100 ug/m^3 above the background level, additional dust suppression techniques must be implemented to reduce the generation of fugitive dust and corrective action taken to protect site personnel and reduce the potential for contaminant migration."

TVOC

Action Levels selected for use in perimeter air monitoring should reflect potential risks to off-site receptors. These risks are to be based on a residential exposure scenario that consists of the following components:

- Exposure period of three years
- Target risk level of $1x10^{-5}$
- Target quotient of 1

The risk-based analysis resulted in a calculated TVOC Action Level of 2,620 ppb (based on benzene). To be conservative, an Action Level of 1,000 ppb was selected, with a 75% Alert Level of 750 ppb. These same Alert and Action Levels for TVOC were employed during both CAMP programs performed during the pilot programs conducted in the Gowanus Canal Turning Basin.

7.2. Real Time Alarm Notifications

PM_{10} and TVOC concentrations will be measured on a continuous basis at each of the monitoring stations. These data will be logged as 15-minute averages at each station and also transmitted by wireless telemetry to the central data management system housed in the on-site trailer. In the event measured concentrations reach Alert or Action Levels, the following actions will be taken.

- Visual alarms will be activated and displayed on the screen of the base station computer monitor if 15-minute average TVOC or PM_{10} concentrations reach an Alert level (60 - 70% of Action Level) and appropriate notification will be given to on-site personnel such that corrective actions/emission mitigation measures can be implemented.
- TRC field engineers will be immediately notified when concentrations reach Alert Levels by receipt of an automated e-mail and/or cell phone text message. The field engineers will validate the concentration above the Action Level and immediately notify the Owner's Representative.
- In the event that concentrations are recorded above the Action Level for TVOC or PM_{10} the affected value will be adjusted for background, for reporting purposes. Background is defined as the difference between upwind and downwind airborne concentrations of TVOC or PM_{10}. The procedure for background adjustment is described in Section 7.3.
- If upwind concentrations are recorded above Action Levels no corrective action is required, as they are typically attributable to off-site activities.
- Simultaneous occurrences of concentrations above an Action Level at downwind and upwind stations will be considered to have originated from an off-site source. In those rare instances when this occurs the numerical concentration for the most upwind location is subtracted from the downwind concentration. TRC will make every effort to determine the offsite cause of concentrations reaching Action Levels.

In order to maximize responsiveness to concentrations reaching self-imposed Alert Levels, continuous radio/cell phone contact will be maintained between TRC personnel and the Owner's Representative. In this manner the TRC Field Engineers can notify all appropriate site personnel, should measured concentrations reach an Alert Level, such that corrective actions can be taken to avert concentrations reaching Action Levels.

For CAALs that are deemed project related, TRC will notify the Owner's Representative, who will facilitate communication to the Trust, the Project Coordinator, and the on-site EPA representative. The Project Coordinator will notify the EPA Project Manager of the CAAL on the day of the CAAL event, to the extent practical.

TRC will document all actions taken by the remediation contractor in response to concentrations above Alert Levels and Action Levels for TVOC and PM_{10}. These actions will be documented in field logs and summarized in daily/weekly reports as appropriate.

7.3. Background Adjustment of CAALs

As previously stated, CAALs will be adjusted for background concentrations for reporting purposes. Upwind concentrations represent background conditions, however due to the geography of the site a simple upwind and downwind comparison may not always be practical. The procedure for the background adjustment of CAALs to be employed at the Gowanus Canal remediation site is as follows:

1. Confirm location of remedial activities at time of CAAL.
2. Record wind direction at time of CAAL from on-site meteorological sensors.
3. Attempt to identify one station located most upwind of site activity, if possible. This location will serve as the background station to be used in background adjustment.
4. If the CAAL is recorded at the most upwind station location, the CAAL will be considered non-project related.
5. If a single station cannot be identified as the most upwind of site activity, an average concentration will be calculated from two stations upwind of the affected station.
6. If it is not possible to determine an upwind location suitable as the background station, adjustment will be performed using the lowest concentration in the network as the background concentration.

8. Monitoring Locations

The network will be comprised of fourteen (14) monitoring stations as follows: two (2) monitoring stations will be located within the staging area, and twelve (12) monitoring stations will be located along the perimeter of the canal. Measures will be taken in advance of remedial/construction activities to secure the perimeter of each work zone such that there are no homes, occupied buildings or potentially exposed populations within a 20-foot distance from the perimeter of the work zone. Further, engineering controls will be employed on site to control airborne contamination attributable to remedial/construction activities from entering the ventilation systems of occupied buildings.

The approximate locations of these monitoring stations, the on-site command center/trailer and the meteorological station are shown in Figure 2.

A survey of the Gowanus Canal was conducted jointly by TRC and GZA on September 3, 2020. The purpose of this survey was to identify candidate locations for each of the fourteen (14) monitoring stations. Prior to the background monitoring program these locations were confirmed and are shown in Figure 2, descriptions of each station location along with GPS coordinates are presented in Table 3.

Figure 2: Monitoring Station Locations

S:\1-PROJECTS\Gowanus Environmental Remediation\Aprx\Camp Monitoring20201002.aprx

Table 3: Coordinates and Descriptions of Monitoring Locations

Site Number	Latitude N	Longitude W	Location Description
1	40° 40’ 30.97”	73° 59’ 47.59”	SE Corner Citizens Site Staging Area
2	40° 40’ 34.45”	73° 59’ 48.87”	NE Corner Citizens Site Staging Area
3	40° 40’ 34.18”	73° 59’ 25.33”	West Side 3rd St. Bridge (Preferred Site)
4	40° 40’ 38.57”	73° 59’ 21.94”	Bond Walkway at 1st St
5	40° 40’ 42.02”	73° 59’ 21.70”	Northwest Carroll St. Bridge
6	40° 40’ 46.68”	73° 59’ 18.40”	Northwest Union St. Bridge
7	40° 40’ 48.76”	73° 59’ 17.19”	End of Sackett St.
8	40° 40' 53.73"	73° 59' 13.87"	Flushing Tunnel SW Corner
9	40° 40' 54.29"	73° 59' 11.66"	Flushing Tunnel NW Corner
10	40° 40' 50.56”	73° 59' 14.19"	Degraw St. East Side (Under Construction)
11	40° 40’ 46.21”	73° 59’ 17.63”	NE Union St. Bridge
12	40° 40’ 41.06”	73° 59’ 20.42”	SE Carroll St. Bridge
13	40° 40’ 35.62”	73° 59’ 22.05”	NE Corner Verizon Property
14	40° 40’ 33.63”	73° 59’ 24.23”	SE Corner 3rd St. Bridge (Preferred)

9. Quality Assurance and Quality Control

The quality assurance and quality control (QA/QC) procedures for this program are described in this section. The QA/QC procedures associated with the air quality monitoring program are designed to ensure that data collected at the perimeter and proximate to the work area are of defined precision and accuracy. The QA/QC procedures will be conducted so as not to interfere with routine onsite activities.

The overall QA objective is to develop and implement data validation and reporting procedures for continuous PM_{10} and TVOC monitoring, air sampling for VOCs, and periodic grab short-term sampling for other COCs, to provide results that are scientifically valid, and defensible to applicable US EPA standards.

- All data shall be of a known and documented quality. Two major measurements used to define quality are precision and bias.
- All data shall be comparable. This means all data shall be produced in a similar and scientific manner. The use of the standard methodologies for sampling, calibration, auditing, etc. should achieve this goal.
- All data shall be representative of the parameters being measured with respect to time, location, and the conditions from which the data are obtained. The use of approved standard methodologies will ensure that the data generated are representative.

9.1. TVOC Monitors

A portable TVOC/PID organic vapor monitor (Baseline piD-TECH eVx Photoionization Sensor) will be used to monitor perimeter TVOC concentrations at each monitoring station. Calibration checks will be performed daily (all workdays) using a zero and span benzene gas standard (certified and NIST traceable). Calibrations will be recorded on instrument calibration data sheets. Results from the daily calibration checks are recorded on Calibration and Maintenance Data Sheets. If the unit fails to meet calibration check criteria (± 10% difference), the instrument calibration will be adjusted, and rechecked with the span level gas standard. If it is determined that the instrument has a problem that cannot be resolved by adjustment, the unit will be replaced with one of the spare units on site.

9.2. Particulate Monitors

A MetOne Model ES-642 Particulate Monitor will be used to monitor perimeter PM10 concentrations at each monitoring station. The ES-642 performs optical system zero self-tests once per hour of operation. During the self-test operation, a separate zero air pump activates and circulates clean air through the optical system. The ES-642 filters the air through a 0.2-micron pore size, 99.99% efficient filter element before it enters the sensor. The ES-642 zeros itself based on this clean air condition. During the zero portion of the automatic periodic self-test cycle, the main sample pump is turned off and the purge pump is turned on. The air is filtered by the purge filter and circulated through the laser module at a higher flow rate. The air in the laser module is 100% filtered during this process, and no scattered light should enter the detector. The ES-642 takes a zero reading and establishes a new signal baseline. A check valve prevents air from back-flowing through the purge pump during the normal sampling.

The ES-642 contains a comprehensive system of error and alarm codes that are used to alert the operator of any problems with the unit. These error codes may be generated during normal operation or during a self-test routine. The errors appear on the ES-642 display and in the status output if the serial communications are used. Certificates of manufacturer calibrations for the particulate monitors are included in Appendix D.

9.3. VOC Sampling

Periodic VOC sampling will be conducted as described in Section 3 of this plan, using a VOC sampler system consisting of a batch-certified Summa canister equipped with a calibrated flow regulator. The VOC sampler system will be calibrated in the laboratory and operated according to EPA Method TO-15.

Following collection of the sample, the canisters will be packaged in a shipping container and sent to the analytical laboratory under Chain of Custody for immediate analysis. Method blanks, and laboratory control samples will be analyzed with all field samples. All samples will be spiked with surrogate compounds prior to sample analysis as per EPA Method TO-15. Accuracy and acceptance limits are specified in the method and laboratory SOPs (see Appendix A).

9.4. On-Site Gas Chromatograph

The initial calibration of the gas chromatograph will be conducted with a blank (hydrocarbon free air) and gaseous calibration standards. Standards for calibration of the GC that are stored in the TRC trailer include: mixed BTEX, naphthalene, hydrogen sulfide, carbonyl sulfide, dimethyl sulfide, methyl mercaptan, and ethyl mercaptan. Certificates of Analysis for the calibration gas standards are provided in Appendix C. Stock standards will be diluted to prepare the calibration curve. Calibration curves will be prepared at the start of the program and verified daily with a mid-calibration standard. The calculated concentration of the mid calibration standard must be within ± 20% of the certified concentration. A new calibration curve will be prepared if the daily calibration check falls outside this criterion.

All calibration data will be recorded in the instrument logbook. The instrument logbook will be specific to GC operation and maintained on-site throughout the duration of site activities.

9.5. Meteorological Sensors

The R.M. Young Response One system has no moving parts and will be calibrated by the manufacturer prior to installation on site. The certification of calibration will last for one year, so the system will be swapped out annually with a freshly calibrated system. The quality control checks for the Response One System include:

- Visually inspecting (from ground level) the meteorological system daily;
- Weekly comparison of on-site data to regional conditions (JFK and LaGuardia International Airport’s NWS data)
- Daily checks for data completeness and valid values from the data logger; and
- Inspecting the Response One sensor for any damage if the data appear suspect.

9.6. Documentation

Field sampling documentation will be maintained during the Site air monitoring program and are anticipated to include:

- Daily and weekly summary reports
- Daily calibration check sheets for ambient monitoring stations
- Equipment maintenance logs
- Analytical sample tracking
- Laboratory data packages
- Sample chain-of-custody forms

All hardcopy information (especially field notes and records) shall be filled out in indelible ink. Corrections shall be made by inserting one line through the incorrect entry, initialing and dating this correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly or by providing the information on a new line if the above is not possible. Copies of all field sampling data sheets and forms will be retained by TRC. Completion of data entry forms, associated with all routine environmental data operations, are required even if logs or notebooks contain all appropriate and associated information required for the routine operation being performed.

10. Data Management Validation and Reporting

Continuous monitors (TVOC and PM_{10}) and meteorological sensors will be wirelessly connected to a PC-based data logging system. The PC logger will poll the monitors at one-minute intervals to calculate 15-minute averages. All values will be backed up and transmitted to a Microsoft SQL database for secure, off-site storage. Data collected from periodic field sampling will be downloaded daily, directly from the monitors and loaded in the project database. Laboratory generated data packages and electronic data deliverables will be saved on TRC's secure servers.

Field generated data will be validated daily by the field manager prior to issuing daily summary reports. Data generated by the laboratory will be initially reviewed by the laboratory QA manager before data packages are forwarded to TRC's data manager. The data manager will verify that the data package is complete and contains all requested analyses, QC results, and raw data. In all cases, the TRC data manager will identify any missing information and will contact the laboratory project manager or the field manager to obtain this information. All QA/QC data will be compared to the data quality objectives and numerical control limits listed within SOPs. Any outliers will be identified and impacts on data quality and utility described.

Daily Reports

TRC will prepare data summary reports on a daily basis. These reports will summarize all data collected on a station specific basis. Measured concentrations above Action Levels (if any) will be noted, as well as, responses or corrective actions taken as a result of those elevated concentrations. The effectiveness of the response actions taken will also be addressed. These reports will be distributed to on-site staff (e.g. remediation contractor, oversight engineer etc.) as directed by the Owner's Representative. A template detailing the format for daily reports is presented as Figure 3.

Weekly Reports

Weekly Community Air Monitoring Reports will be generated summarizing the previous week's data collected, construction activities occurring on site during the period, concentrations above Action Levels, elevated measurements, meteorological data and corrective actions performed. These weekly reports will include all of the daily reports issued during each weekly reporting period. Tables and graphs will be included in the report that illustrate actual measurements (both daily maximum and average values) as compared to Action Levels. Volatile organics results from analyses of SUMMA canister samples will also be included in weekly reports as laboratory data are received and validated by TRC.

Figure 3: CAMP Monitoring Daily Report Template

Gowanus Canal RTA1 Community Air Monitoring Program - Brooklyn, New York
Daily Station Report - Summary of Continuous TVOC and PM_{10} Concentrations
Saturday, January 2, 2021
Data Collected 00:00 - 23:45

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12	Station 13	Station 14
TVOC (ppb) **Maximum Conc.**														
Average Conc.														
# of Project Related CAAL														
# of Non-Project Related CAAL														
PM_{10} (ug/m^3) **Maximum Conc.**														
Average Conc.														
# of Project Related CAAL														
# of Non-Project Related CAAL														

Notes:
TVOC: Total Volatile Organic Compounds
PM_{10}: Particulate Matter < 10 um in diameter
Maximum: The highest daily recorded 15-min average concentration
Average: The average of all recorded 15-min average concentrations each day
CAAL: The total number of recorded 15-min average concentrations above the Action Level - after background correction
Action Levels:
TVOC = 1,000 ppb
PM_{10} = 150 ug/m^3
The detection limits for PM_{10} and TVOC are 1 ug/m^3 and 5 ppb, respectively.
Non-detected concentrations are shown as < 1 for PM_{10} and < 5 for TVOC.

Appendix A – Laboratory Standard Operating Procedures for EPA Method TO-15

COMPENDIUM METHOD TO-15

Determination of Volatile Organic Compounds (VOCs) in air Collected in specially-prepared canisters and analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)

Approved:

Tod Kopyscinski

Tod Kopyscinski
Technical Director

Katherine F. Allen

Katherine F. Allen
QA Officer

Revision Number: 21

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Change Record

Revision	Date	Responsible Person	Description of Change
1A	11/16/02	Pradeep Mysore	Original
1B	01/06/04	Pradeep Mysore	As per AZ and NJ TO15 specs.
2	05/19/05	Tod Kopyscinski	Update
3	9/08/05	Tod Kopyscinski	Update AZ Audit
4	04/07/06	E. Denson/ S. Slesinski	Revisions as a result of an internal audit
5	08/20/06	E. Denson	Revisions based on corrective actions from internal audit
6	08/02/07	T. Kopyscinski/ S. Slesinski	Edits due to annual SOP review.
7	12/2/08	J. Morrow	Edits due to annual SOP review: Sec.2.0 15inches of Hg changed to 10-15 inches. Sec.7.6: 7890A/HP5975C (system G) added. Sec.9.0: 2ppbv changed to 1.0 and 3-4pts added to replace 1st 3 pts. Sec.9.1: Initial calibration std and amount updated. Sec.9.2 & 9.3: 10ppbv changed to 5-10ppbv. Sec.10.1.2: 29.5ng changed to 28.6 and system G added. Sec 10.2: section added on cold trap dehydration. Sec. 10.2: System F section ; column program updated to including run time, and 230ºC for 12 min removed. System B section updated to include System G and column program updated. Sec. 10.3 & 10.4: updated Sec 10.3: section added (manual integration section moved from sec 11.0) Sec. 12.2.3 & 12.2.7: calibration check updated to 5-10ppbv.
8	02/23/10	Tom Hnitecki	Updates from NJ January 2010 Audit: Sec.9.4 (changed 1month to 3month), Sec 10.3 (removed Difficult criteria, added to narrate), Sec. 12.2.2 (removed Difficult criteria), Sec 12.2.3 (removed Difficult criteria, added to narrate), and Sec. 12.2.7 (removed Difficult criteria).
9	01/14/11	J. Morrow	Updates from internal audit: can-cleaning section now states 95ºC for temperature; pollution prevention and waste management section added. 50 ppbv std added to curve. Sec 5.3 Restek replaces Entech. Sec 7.0 & 10.2 column information updated. Sec 8.3 62 changed to 65. Sec 8.4 gas mix added. Sec10.2 instrument conditions updated. Sec10.3 <15Hg changed to <10Hg.
10	08/03/12	Katherine Allen	Updates from internal audit: Sec. 9.1 (add 0.025 ppbv cal point), Sec's 9.2, 9.3, 12.2.3, and 12.2.7 (remove 10 ppbv concentration), Sec. 10.3 (take out leak check), Sec 10.4 (include 5975 MSD) and Sec 13.0 (can cleaning criteria change).
11	08/15/13	Katherine Allen	Updates from annual SOP Review and internal audit: Sec 1.0 (inclusion of Acrylonitrile and some RL changes), Sec 9.0 (addition of 1.0 cal pt), Sec 10.2 (run time 24-27 min), and Sec 10.3 (addition of subsections).
12	09/16/13	Thomas Hnitecki	Updates from 2013 AIHA audit: Sec 10.4 added (step by step procedure) and addition of Appendix A (step by step screen shots of software).
13	7/31/14	Thomas Hnitecki	Updates from annual Internal Audit: Sec 2.0 (addition of where to record pressurizations and how long samples stores), Sec 3.0 + 7.5 (addition of new static diluter), Sec 9.1 (new diluter and new procedure along with 2 new cal points), Sec 9.4 (new procedure), Sec 10.3.2 + 10.4 (new diluter and procedure), and Appendix 1 + 2 (new diluter snap shots added).
14	09/25/14	Katherine Allen	Updates from 2014 NJ Audit: Sec 12.2.1 (LMB unused can that never left the lab added) and Sec 13.0 (Propene added to compounds with RL of 2ppbv).
15	06/25/15	Katherine Allen	Update from annual internal audit: Section 10.3.4 (updated temp's)
16	03/15/17	Katherine Allen	Update from annual SOP review and difficult compound assessment: Sec 1.0 (add 4-PCH)Sec 2.0 and 10.3.2 , Sec 10.3.7 + 12.2.3 (add MCP criteria for Naphthalene) (delete humidified and change to 1.5X pressurization), Sec 3.4 (delete humidification), Sec 5.1 (change to 50mTorr), Sec 10.1.1 (change temp to idle), Sec 10.2 (change conditions) , Sec 12.2.1 (change 30psia to 35psia), Sec 12.2.4 (change criteria to 25), Sec 12.2.7 (For samples other than for NJ and CT RCP new difficult LCS limits assigned to 11 compounds of 50-150% and corr. action to be taken added), Sec 13.0 (minor changes).
17	09/11/17	Katherine Allen	Updates from annual Internal Audit: Sec 7.0 (add Sys "H", add windows XP, and remove sys "A"), Sec 8.5(add Air Gas), Sec 9.1 (20ppbv not 2ppbv), Sec 10.0 (add Sys "H", replace word trap with module, and update Appendix #'s), Sec 12.2.1 (4700 not 7600 static diluter), and Sec 19.0 (addition of MCP and RCP methods).
18	1/18/18	CMR	Update from NY 2017 audit: Add 12.2.9 Annual RL verification. And add Qualifiers 12.2.10
19	3/19/2019	KFA	Update from 2019 NJ electronic audit: Sec 1.0 (added compounds to table), Sec. 6.0 and Sec 10.3.1 (added note that Tedlar bags for TO-15 is not permitted for NJ samples), Sec 10.5 (edits to scan mode and take out SIM references), and Sec 12.2.9 (added new MDL procedure).
20	08/16/2019	KFA	Updates from annual internal audit: Sec 2.0 (addition of location of pressure log), Sec 7.0 (column for Sys "B" added), Sec's 7.9+7.10 (calibrate gauges every 5 years), Sec 9.1 (Cal points 40, 90, and 180 not always run), Sec 12.2.2 (add linear criteria and ICV criteria), and Sec 13.0 (add location of clean check log).
21	04/15//2020	CMR	Updates from March 2020 NY audit: Sec 8.0 Note Holding Time of Standards only 30 days, Sec13.0 Cleaning check Acetone >0.2ppbv, and 12- hour aging hold

Distribution/Training List

See Employee Training Record File for signed training statements for trained users.

1.0 SCOPE AND APPLICATION

This method documents sampling and analytical procedures for the measurement of subsets of the 97 volatile organic compounds (VOCs) that are included in the 189 hazardous air pollutants listed in Title III of the Clean Air Act Amendments of 1990. The Air is collected in specially prepared canisters (silco steel, silonite or summa), separated by a gas chromatograph and measured by mass spectrometry. The VOCs in this method have been tested and determined to be stable in pressure and sub ambient canisters at low ppbv ranges.

The following compounds can be determined by this method:

Propene *	Cyclohexane *
Dichlorodiflouromethane	1,2-Dichloropropane
Chloromethane	Bromodichloromethane
Freon 114	Trichloroethene
Vinyl Chloride	Heptane *
1,3-Butadiene	MIBK
Bromomethane	Cis-1,3-Dichloropropene
Chloroethane	Trans-1,3-Dichloropropene
Acetone *	1,1,2-Trichloroethane
Trichlorofluoromethane	Toluene
Ethanol *	2-Hexanone (MBK) *
1,1-Dichloroethene	Dibromochloromethane
Methylene Chloride	1,2-Dibromomethane
Freon 113	Tetrachloroethane
Carbon Disulfide	Chlorobenzene
Trans-1,2-Dichloroethene	Ethylbenzene
Methyl tert-butyl-ether	M/P-Xylenes
Isopropyl Alcohol *	O-Xylene
2-Butanone (MEK)	1,1,2,2-Tetrachloroethane
Cis-1,2-Dichloroethene	4-Ethyltoluene *
Vinyl Acetate	1,3,5-Trimethylbenzene
Hexane	1,2,4-Trimethylbenzene
Ethyl Acetate *	1,3-Dichlorobenzene
Chloroform	Benzyl Chloride
Tetrahydrofuran *	1,4-Dichlorobenzene
1,2-Dichloroethane	1,2-Dichlorobenzene
1,1,1-Trichloroethane	1,2,4-Trichlorobenzene
Bromoform	Styrene
Benzene	Hexachlorobutadiene
Carbon Tetrachloride	1,1-Dichloroethane
Acrylonitrile *	*4-phenylcyclohexane(4-PCH)
Acrolein	Naphthalene
1,4-Dioxane	

Reporting limit = 0.05 - 0.2 PPBv
SIM Reporting Limits = 0.025 – 0.05PPBv

Note: M/P Xylene co-elute, Standard Reporting Limit is X 2

* Not listed in Method TO-15 Table 1, considered "difficult analytes"
Reporting limits subject to change based on calibration.

2.0 SUMMARY OF METHOD

Air samples are collected in precleaned, evacuated Summa passivated stainless steel canisters either by sub-atmospheric pressure or pressurized sampling modes. Once the air sample is collected, the canister valve is closed and labeled and sent to the laboratory for analysis. Upon receipt of the sample, the sample is logged into the LIMS and delivered to the Air lab for analysis.

The pressure in the canister is checked and documented. All cans are pressurized 1.5X with compressed ultra zero air and recorded in the air dilution logbook located at F:\Lab\Air\Airlogbooks\4700 Pressure Log as an excel spreadsheet. (Summa cans are pressurized 1.5X unless lower RL's are needed. Some summa cans may need to be more pressurized more than 1.5X if below 10in. of Hg. Target pressure to run from can is 14-18psia). A specified amount of sample is then withdrawn from the canister and introduced on to the gas chromatograph for separation of the volatile organic compounds. The VOCs thus separated, are detected by a quadruple low-resolution mass spectrometer in full scan mode, or SIM or simultaneous SIM/SCAN. Upon completion of analysis and data review, the sample is removed from the auto sampler and held for at least two weeks. When ready to clean, it is hooked up to the can cleaner for cleaning and then stored away for future use.

3.0 DEFINITIONS

3.1 Gauge Pressure: Pressure measured with reference to the surrounding atmospheric pressure, usually expressed in psig.

3.2 Absolute Pressure: Pressure measured with reference to absolute pressure, usually expressed in psia.

3.3 Cryogen: A refrigerant used to obtain sub-ambient temperatures in the VOC concentrator 7100 from Entech. The cryogen used is Liquid Nitrogen.

3.4 Fill gas: Is ultra-zero air. Usually used to dilute the air samples and blanks.

3.5 Dynamic dilution: Is a process by which Calibration mixtures are prepared by blending fill gas continuously with standard gases from pressurized cylinders so that a flowing stream of calibration mixture is available at the inlet of the analytical system. We use Entech's 4700 Static Dilution System.

3.6 MS-Scan: Is the mass spectrometric mode of operation in which a mass spectrometer is programmed to scan all ions over a specified mass range.

4.0 INTERFERENCES

Interferences may be caused by the following sources of contamination:

- purge gas
- contaminated sampling canister
- sample cross contamination: column or trap (bake-out to eliminate contamination)
- high methane and/or carbon dioxide levels in the sample

5.0 SAMPLE COLLECTION

Samples can be collected in the canisters by two techniques namely sub-atmospheric sampling and pressurized sampling.

5.1 Sub-atmospheric Sampling: In preparation to the sub-atmospheric sampling the canister is evacuated to 50mTorr. When the can is opened to the atmosphere containing the air to be sampled, the differential pressure causes the sample to flow into the canister. This technique could be used to collect grab samples or time-weighted average samples through a flow restrictive inlet with a critical orifice flow restrictor regulator.

5.2 Pressurized Sampling: Pressurized sampling is used when longer-term integrated samples or higher volume samples are required. The sample is collected in a canister using a pump and flow control arrangement to achieve a typical final canister pressure.

5.3 Time-Weighted-Average samples with flow regulators: Passive air sampling kits designed by Restek are used to collect time-weighted-average samples. These regulators are pre cleaned in the air laboratory by passing ultra high pure Nitrogen at 10 psig and the flows are preset for various times from 1-24 hrs of sampling depending upon the volume of the canister.

5.4 Sample Collection: As explained earlier, samples are collected either by opening the valve on the summa canister (grab sample) and listen to a hissing noise (when air enters into the evacuated zone) and closing the valve once the hissing noise stops or attaching a precleaned, preset flow regulator onto the canister and keeping the valve open for the duration of the sampling period. At the end of the sampling period the valves are closed, regulators are detached from the setup and the can and the regulator are both sent back to the lab via a courier service. Flow regulators are calibrated before sending out to clients with flow meters and checked when received back in the laboratory.

6.0 SAMPLE PRESERVATION/STORAGE/HOLDING TIME

No preservation or storage precautions are necessary. The canisters are logged in and delivered to the air lab for analysis.

Holding time: Summa Canister samples must be analyzed within 30 days of collection.
Tedlar bags must be analyzed as soon as possible, preferably within 72 hours of sampling. There is no documented holding time for Tedlar bags.

Note: Sample collection in Tedlar bags for TO-15 is not permitted for New Jersey samples.

7.0 EQUIPMENT & SUPPLIES

7.1 Summa Canister-6L, 3L, 1L and 0.4L
7.2 Passive Flow Controllers
7.3 Concentration System: Sys "B", "G", "F" - Entech 7100 Preconcentrator/ Sys "H" Entech 7200 Preconcentrator
7.4 Autosampler: Entech 16 position 7016 CA Canister Autosampler – for Systems "B", "F", and "G". Entech 7016D Autosampler for System "H"
7.5 Entech 4700 Static Diluter
7.6 GC/MS System: HP 6890/ HP5973(System F), HP 6890/ HP5972(System B), 7890A/HP5975C (sys G), Agilent 7890A/5975C (Sys H)
7.7 GC/MS Data System: Enviroquant/Windows NT/2000/Windows XP
7.8 GC Column: Restek RTX-1 60m x 0.32mm x 1µm (or equivalent) and for system "B" Restek Column RTX-VMS 30m x 0.25mmID x 1.4wm df capillary column is used.
7.9 Ashcroft NIST-certified test gauge (send out for calibration at least every five years)
7.10 Flow meters – Primary Flow Meter (Bios Dry Cell) is sent out for calibration at least every five years. Other flow meters are calibrated against the primary flow meter at least annually as well as every time the battery is changed.

8.0 REAGENTS & STANDARDS

8.1 Liquid Nitrogen
8.2 Chromatographic grade Helium
8.3 Calibration Mix: Spectra Gases TO-15 mix containing 65 compounds conc. 1 ppm, cat # 34436
8.4 Internal Standard/Surrogate Stock: certified gas mix from Restek containing 4 compounds cat# 34408
8.5 Quality Control Std. – Purchased from Air gas – a mix with different vendor and different lot than calibration standards 1 ppm.

Note: Working standards prepared in canisters are to only be stored for 30 days.

9.0 CALIBRATION AND STANDARDIZATION

9.1 Static Dilution of Calibration standards for the initial calibration

Three precleaned canisters are picked for preparing the working standards. One canister is blended with the calibration mix to represent a lower concentration at 1.0ppbv one is the 20ppbv standard and one is the 90ppbv standard using the Entech4700 Static Diluter. (other levels may be used). These three cans will be used to run the calibration curve. The first 4-5 points of the curve are run from the canister blended with the standard at 1.0ppbv level and the remainder from the 20ppbv and 90ppbv cans. These standards are prepared by opening the 4700 software. Once in the program open the saved files and use 90std, 20std and 1.0std for the appropriate stock standard. Attach the Summa canister to the 4700. Open the valve and fill the can up to 35psia. The following amounts are used for each instrument.

All Systems (A minimum of five points used to establish initial calibration.)

STD.	AMOUNT
0.025ppbv	10 mL of 1.0 ppbv
0.05ppbv	20 mL of 1.0 ppbv
0.10ppbv	40 mL of 1.0 ppbv
0.20ppbv	80 mL of 1.0 ppbv
0.5 ppbv	200 mL of 1.0 ppbv
1.0 ppbv	20 mL of 20 ppbv
2.0 ppbv	40mL of 20 ppbv
5.0 ppbv	100 mL of 20 ppbv
10 ppbv	200 mL of 20 ppbv
20 ppbv	400 mL of 20 ppbv
40 ppbv	800 mL of 20 ppbv
50 ppbv	1000mL of 20 ppbv
90 ppbv	400 mL of 90 ppbv
180 ppbv	800mL of 90 ppbv

Note: Larger volumes may be injected to reduce RL's for samples.
Note: Calibration points 40, 90, and 180ppbv not always analyzed.

9.2 A 5 ppbv Standard is used for the daily continuing calibration.

9.3 QC Check/ LCS
The LCS is a separate secondary source TO-15 canister that has been prepared exactly like the 5ppbv standard used for calibration. It is analyzed at the 5ppbv level.

9.4 Internal Standard/ Surrogate

Statically dilute the standard by adding 60uL of purged H2O and filling with ultra- zero air; final pressure 35 psia, final concentration 40 ppbv. Expires three months from preparation.

10.0 METHOD PERFORMANCE

10.1 MS Calibration and Tuning

10.1.1 Auto-tune with PFTBA with Instrument idle at 35°C.

10.1.2 Tuning is performed by injecting 28.6 ng of BFB in the gaseous state(like a regular sample) with column temperature ramped from 35°C to 220°C or 230°C depending on system "B" and "F", "G" and "H" respectively, with the following acceptance criteria:

Mass	m/z Abundance Criteria
50	8 to 40 % of Mass 95
75	30 to 66% of Mass 95
95	Base Peak, 100% relative abundance
96	5 to 9% of Mass 95
173	<2% of Mass 174

174	>50% but <120% of Mass 95
175	4 to 9% of Mass 174
176	>93% but <101% of Mass 174
177	5 to 9% of Mass 176

The mass spectrum of BFB that is evaluated against the acceptance criteria is obtained in the following manner: three scans (the peak apex and the scans immediately preceding and following the apex) are averaged, and a single scan no more than 20 prior to the BFB peak is subtracted. No part of the BFB peak itself may be background-subtracted. This is done through the software program "Autofind BFB"

The BFB relative abundance criteria must be met before any standards, samples, or quality control samples are analyzed at least once every 24 hours.

10.2 Instrument Conditions

Entech 7100 Preconcentrator

	Micro Scale Purge and Trap	**Cold Trap Dehydration**
.Module 1:	Trap at –130 °C to -160°C	Trap at –20 °C to -50°C
	Preheat to 0 °C to 20°C	Preheat to 0 °C to 10°C
	Desorb at 0 °C to 20 °C	Desorb at 0 °C to 10 °C
Module 2:	Trap at –40 to -10 °C	Trap at –50 to -60 °C
	Desorb at 180 °C to 190 °C	Desorb at 180 °C to 190 °C
	Bake at 190 °C	Bake at 190 °C
Module 3:	Focus at –180 to –150 °C	
	Inject for 2 min to 4 min	
	Bake for 3-10 min	
	Wait 20-28 minutes before starting next analysis	
Column:	Restek RTX-1, 60m x 0.32mm x 1μm	

All Systems

<u>GC 5890-7890</u>
Oven equilibration time: 0.5 min

System "F", MS 5973
Column program → 35°C for 4 min., ramp at 9°C/min to 175°C, 40°C/min to 220°C for 3.32 min.

Run time: 24 min – 27 min
Split ratio: 20:1
Sampling rate: 2
Threshold: 100
Mass Range: 35-300 amu
Scans per second: 5.19
Scan start time: 4.2 min
Number of A/D samples: 4

System "B" MS 5972 / System "G" MS5975
Column program → 35°C for 4 min., ramp at 8°C/min to 170°C, 30°C/min to 220°C for 4.45 min

Run time: 24 min - 27 min
Split ratio: 20:1
Sampling rate: 2
Threshold: 200
Mass Range: 35-300 amu
Scans per second: 2.82
Scan start time: 4.0 min
Number of A/D samples: 4

System "H" MS 5975C
Column program → 35°C for 4 min., ramp at 8°C/min to 170°C, 30°C/min to 220°C for 5.0 min

Run time: 24 min - 28 min
Split ratio: 20:1
Sampling rate: 2
Threshold: 150
Mass Range: 35-300 amu
Scans per second: 2.73
Scan start time: 4.2 min
Number of A/D samples: 3

10.3 Analysis

10.3.1 Samples upon receipt are logged into the laboratory LIMS by the sample management department. Once the Summa canisters and or the Tedlar bags are labeled, they are transported to the air laboratory for storage. Containers are generally shipped by courier or express service. Note: Tedlar bags are not permitted for New Jersey work by EPA TO-15.

10.3.2 Each canister pressure is recorded upon arrival in psia. The pressure in the canister should be between 0-15 inches of Hg to obtain a significant amount of sample for analysis by the 7100 preconcentrator. All cans are pressurized 1.5X with compressed ultra-zero air and recorded in the air dilution logbook. (Summa cans are pressurized 1.5X unless lower RL's are needed. Some summa cans may need to be more pressurized more than 1.5X if below 10in. of Hg. Target pressure to run from can is 14-18psia). The canister will be pressurized with the fill gas through the 4700 Entech static dilutor and the resulting dilution factor is recorded for result calculations in (F:/CTAL Laboratory/Air/Air logbooks/Airdilutionlogbook.xl). Prior to analysis all positions are flushed with purge gas to prevent contamination of lines. The canisters or tedlar bags are then attached to a 16-position auto-sampler for analysis.

10.3.3 Analysis of samples begins after an acceptable performance standard, calibration, blanks and QCs are run. A sequence for the 7100 system is written and saved to the Entech operating system. This is done by opening the 7100 through the smartlab menu. Put in sample description, sample volume and method. All systems are based on a 400ml injection. A GC run sequence is also needed to be written and saved in the HP Chemstation/Enviroquant software.

10.3.4 Initially, Module 1 on the 7100 is cooled down to approximately –40 to -20 deg C, the empty SC Trap for Cold Trap Dehydration (see section 10.2 for CTD parameters) and 100ml of the Internal Standard and Surrogate mix is collected and the defined volume of air sample (400ml for standard injections) is trapped. The concentrated sample is then transferred to Module 2 (Tenax) at approximately -30 to –50 degrees C. The cryogenic trapping system acts as the third module prior to the GC. Water is removed at the transfer from Module #1 to Module #2. CO2 is removed at Module #2 to Module #3. The third Module is cooled to approximately -160 to -180 degrees C and also focuses the plug onto the column improving chromatography. The GC temperature is ramped for separation of components. Prior to switching from autosampler#1 to autosampler#2 a cleanup blank is run on the auto-sampler being switched too. (clup)

10.3.5 All the sample results are checked for Surrogate, Internal Standard criteria and saturation of compounds following analysis. If targeted compounds exceed linear range of the curve, a dilution of the sample is necessary.

10.3.6 A minimum 5-point calibration curve is used to calibrate the system for all target analytes and surrogates. The low concentration initial calibration standard must be <u>less than or equal to the reporting limit (</u>RL). Target analytes detected in a sample at concentrations below the concentration of the low initial calibration standard should not be reported as quantitative results. If reported, they must be qualified as estimates.

10.3.7 The percent relative standard deviation (%RSD) for all target analytes over the working calibration range must be <30% (with an allowance for up to two analytes to have %RSDs as high as 40%) for the average relative response factor (RRF) to be used for subsequent calculations. All analytes that do not meet the <30% RSD criteria will be narrated. (MA MCP allows %RSD for Naphthalene to be ≤40%).

10.3.8 If %RSD is >30% for any target analyte, then a linear regression must be established using the calibration data for that compound. For the linear regression to be acceptable for quantitative purposes, the correlation coefficient must be greater than or equal to 0.99. If this criterion is met, the linear regression analysis must be incorporated into the curve used to calculate results. If these criteria are not met, the analytes that do not meet these criteria will be narrated.

10.3.9 If any initial calibration standard analysis is determined to be unusable (e.g., a bad injection), the standard may be re-analyzed within eight hours of the last initial calibration standard analyzed and before any samples are run. The re-analysis results may be incorporated into the initial calibration in their entirety, in place of the original analysis. If the initial calibration still does not meet acceptance criteria, even with the replacement standard, then the entire initial calibration should be performed again.

10.3.10 If the initial calibration still does not meet acceptance criteria for a particular analyte, the analyst may consider dropping the lowest or highest point for that analyte and recalculating the average RRF and %RSD or linear regression. Note that ONLY the lowest or highest data point may be dropped – a data point from the middle of the calibration range may NOT be dropped. Note also that if the low standard is dropped, the RL for that analyte must be adjusted so that the lowest standard used for the calibration is less than or equal to the RL.

10.3.11 When the instrument data system is updated to reflect the new initial calibration, the analyst verifies that it has been properly set up to calculate each target analyte according to the actual model used to establish the initial calibration (i.e., average RRF or linear regression) and to reflect any abbreviated ranges established for individual analytes.

10.3.12 At the start of each 24-hour analysis sequence, before any samples are analyzed, a 5-10ppbv calibration check standard is analyzed to check the calibration curve. The percent difference or percent drift must be ≤30% for all target analytes.

10.3.13 If the minimum percent difference/drift criteria are not met for any target analyte, then the analytical system should be evaluated for problems and corrective action taken as appropriate (change septa, compressed gas cylinders, syringes, column fittings, etc.; clean the MS source, changing an injector port or filament, cleaning the inlet, etc.). If corrective action that may affect instrument response is taken, then the calibration verification standard must be rerun before samples are analyzed. If the corrective actions do not resolve the problem(s) with the calibration verification standard, then a new initial calibration must be performed.

10.3.14 If two calibration check standards are run in succession, one immediately following the other, and neither is deemed to have been a bad injection, then the one closest in injection time to the associated sample analyses, or both standards, must be evaluated for and pass method performance criteria for sample analyses to continue. In addition, the two calibration check standards are documented by the analyst for evaluation of reproducibility.

10.3.15 The use of selected ion monitoring (SIM) is acceptable in situations requiring detection limits below the normal range of full EI spectra. However, SIM may provide a lesser degree of confidence in the compound identification unless multiple ions are monitored for each compound, and compounds quantitated by SIM must be noted in the final report.

10.3.16 When performing manual integration of any peak in a calibration standard, client sample, or quality control sample, the integration must be performed in conformance with the procedures outlined in the SOP for chromatographic integration procedures. In summary:

10.3.16.1 The most appropriate instrument parameters should be used during method development to allow for automatic integration by the data system in most cases.

10.3.16.2 All data must be integrated consistently for all standards, samples and QC samples.

10.3.16.3 In those instances when the automated software does not integrate a peak correctly, manual integration may be used to correct the improper integration performed by the data system. Manual integration should always be performed to create the analyst's best estimate of the actual peak area discerned from the chromatogram.

10.3.17 All manual integrations must be documented by printing, initialing and dating the manual integrations as well as by recording the reasons for the manual integrations.

10.3.18 A minimum signal-to- noise ratio of 3:1 (based on peak height) must be achieved for any peak used in a calibration standard, client sample, or quality control sample.

10.4 Step-by Step

10.4.1 Pressurizing Samples: 1) open 4700 software 2) open Air, He or N2 valve 3) select pressurize 4) attach sample to 4700 5) Flush if necessary 6) select pressure by factor or pressure to asbsolute 7) select Start tab and wait until done. Record initial and final pressure in the Air Dilution Logbook 9) Be Sure to note the pressurization in the Misc Info in the GC sequence. (See Appendix 1-2)

10.4.2 Setting up GC Sequence: 1) open GC software 2) open sequence 3) save as current date 4) edit in sequence vial #, sample name, method, file ID# and misc info/comment 5) save sequence 6) select position and run 7) select line to start on 8) change Data File Directory to current date 8) select Run Sequence to start and select No to run key-words. (See Appendix 5-11)

10.4.3 Setting up 7100 Concentrator: 1) open 7100 software 2) load last sequence 3) save sequence as current date 4) edit in sequence Sample Name, Samp Inlet #, Auto Pos #, Samp Vol, Method and Internal Std Vol 5) save sequence 6) highlight starting position 7) select Start(GO) tab 8) select View tab to see current state of 710concentrator. (See Appendix 3-4)

10.5 SCAN Analysis Summary

TABLE 1

Compound Name	Ions Used	Compound Name	Ions Used
Propene	41,42,39	Cyclohexane	84,69,41
Dichlorodiflouromethane	85,87	1,2-Dichloropropane	63,62,76
Chloromethane	50,52	Bromodichloromethane	83,85,129
Freon 114	85,135,87	Trichloroethene	95,130,132
Vinyl Chloride	62,64	Heptane	57,71,100
1,3-Butadiene	54,53,50	MIBK	43,57,100
Bromomethane	94,96	Cis-1,3-Dichloropropene	75,110
Chloroethane	64,66	Trans-1,3-Dichloropropene	75,110
Acetone	43,58	1,1,2-Trichloroethane	97,83,85
Trichlorofluoromethane	101,103	Toluene	91,92
Ethanol	45,46	2-Hexanone(MBK)	43,57,100
1,1-Dichloroethene	61,63,96	Dibromochloromethane	129,127,131
Methylene Chloride	49,84,86	1,2-Dibromomethane	107,109
Freon 113	101,151	Tetrachloroethane	166,168,129
Carbon Disulfide	76,78	Chlorobenzene	112,77,114
Trans-1,2-Dichloroethene	61,96,98	Ethylbenzene	91,106
Methyl tert-butyl-ether	73,57	M/P-Xylenes	91,106
Isopropyl Alcohol	45,43,59	O-Xylene	91,106
2-Butanone(MEK)	43,72,57	1,1,2,2-Tetrachloroethane	83,131,85
Cis-1,2-Dichloroethene	61,98,96	4-Ethyltoluene	105,120
Vinyl Acetate	43,86	1,3,5-Trimethylbenzene	105,120
Hexane	41,56,86	1,2,4-Trimethylbenzene	105,120
Ethyl Acetate	61,70,88	1,3-Dichlorobenzene	146,148,111
Chloroform	83,85	Benzyl Chloride	91,126
Tetrahydrofuran	71,72	1,4-Dichlorobenzene	146,148,111

1,2-Dichloroethane	62,64,98	1,2-Dichlorobenzene	146,148,111
1,1,1-Trichloroethane	97,99,61	1,2,4-Trichlorobenzene	180,182,145
Bromoform	173,175	Styrene	104,78
Benzene	78,51,77	Hexachlorobutadiene	225,260
Carbon Tetrachloride	117,119	1,1-Dichloroethane	63,65,83
Acrylonitrile	53,52	*4-phenylcyclohexane(4-PCH)	104,158
Acrolein	56,55	Naphthalene	128,102
1,4-Dioxane	88,58,43		

Full scan parameters:

Low Mass: 35.0
High Mass: 300.0
Threshold: 200
Sample Number: 2
A/D samples: 4

11.0 CALCULATIONS

All calculations are based on the internal standard technique.
Results must be reported in ppbv as well as ug/m3

Cx = AxCisDF/AisRRF

Cx = Compound concentration, ppbv
Ax = Area of the characteristic ion for the compound to be measured, counts
Ais = Area of the characteristic ion for the specific internal standard, counts
Cis = Concentration of the internal standard spiking mixture, ppbv
RRF= Relative Response Factor is the average Response factor for the compound from the initial calibration
DF = Any applicable dilution factors

Relative Retention Times (RRT). Calculate the RRTs for each target compound over the initial calibration range using the following equation:

$$RRT = \frac{RTc}{RTis}$$

Where: RTc= Retention time of the target compound, seconds
Rtis= Retention time of the internal standard, seconds.

Mean of the Relative Retention Times $(\overline{RRT})$ Calculate the mean of the relative retention times $(\overline{RRT})$ for each analyze target compound over the initial calibration range using the following equation:

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

Where: $\overline{RRT}$ = Mean relative retention time for the target compound for each initial calibration standard.
RRT= Relative retention time for the target compound at each calibration level.

Mean Retention Times (RT). Calculate the mean of the retention times (RT) for each internal standard over the initial calibration range using the following equation:

$$\overline{RT} = \sum_{i=1}^{n} \frac{RTi}{n}$$

Where: $\overline{RT}$ = Mean retention time, seconds
RT= Retention time for the internal standard for each initial calibration standard, seconds.

CONVERSIONS

ppbv to ug/m3

ug/m3 = (ppbv)(MW)/24.45

12.0 QUALITY CONTROL

12.1 Definitions

For definitions and explanations of quality control measures, refer to the Con-Test Analytical Quality Assurance Manual.

12.2 Quality Control Measures & Acceptance Criteria

An analytical batch is defined as up to 20 client samples of a similar matrix for the same analysis. All quality control samples are assigned to and associated with a particular analytical batch, which is designated at the time client samples are logged-in or at the time of sample preparation. All quality control samples must be traceable to the associated analytical batch for review and evaluation purposes.

12.2.1 Laboratory Reagent Blank (LMB)

A Laboratory Method Blank is prepared by hooking up a clean evacuated canister to the 4700static diluter and pressurizing it with fill gas to a final pressure of 35psia. This is pressurized from the canister cleaner.

The Laboratory Method Blank must be an unused certified canister that has not left the laboratory. It must contain the same amount of Internal Standard as the samples. One LMB must be run every 24 hours or per batch of analysis.

The LMB is analyzed with each batch prior to sample analysis to prove that the instrument is free of any contamination. Any background contamination should be <MDL. Low levels of <2ppbv (less than 5 times the MDL) for common laboratory contaminants (Methylene chloride, Ethanol, Acetone) are acceptable.

12.2.2 Calibration Curve

A minimum 5point calibration curve is used to calibrate the system. Please refer to section 9.1 of this document for exact concentrations. An extra point at the low (MDL) level (0.5 ppbv) is also run for demonstration purposes and all NJ-based clients. The lowest point in the curve is used as the RL. The response factor variation over the working range must be ≤30 %RSD, with two compounds allowed to 40%. (MA MCP allows Naphthalene to be <40%) If linear calibration is used for any compound it must be ≥ 0.99 or better. The relative retention time (RRT) for each target compound must be within 0.06 units of the mean RRT for the compound over the initial calibration. The area response for each Internal Standard at each calibration level must be within 40% of the mean area response over the initial calibration range. An ICV, second source is analyzed immediately after the calibration and all compounds must recover 70-130%.

12.2.3 Calibration Check Standard

Each working day, a 5ppbv calibration check standard is analyzed to check the calibration curve. The calibration check standard is inspected and the response factor for each analyte must be within ±30% for the calibration curve. The retention time shift of each of the internal standards in all calibration check standards must be within 20 secs of the mean response over the Initial Calibration for each Internal Standard. If these criteria are not met, the analytes that do not meet these criteria will be narrated. MA MCP allows 20% of the list compounds to be outside criteria, needs to be qualified.

12.2.4 Sample Duplicates

Duplicates are analyzed with every sequence. Results will be reported in LIMS with RPD values. The allowable criterion for an acceptable duplicate is the percent RPD being ≤ 25.

12.2.5 Surrogates

4-Bromofluorobenzene at 8 ppbv is the single surrogate spike added to each analysis. A combined mix of three internal standards and a surrogate (4-BFB) are added to each analysis automatically at the beginning of the purge cycle of the 7100 run. The recovery of this spike must be within ±30%.

12.2.6 Internal Standards

Three Internal standards namely Bromochloromethane, 1,4- Difluorobenzene and Chlorobenzene-D5 are used to quantitate the blanks and samples. Internal standards are monitored through out the analysis. Acceptable criteria for the internal standard area responses are ± 40% of the most recent calibration standard. The retention time criteria for all the internal standards are + or – 0.33min from the mean retention time of the most recent calibration.

12.2.7 Quality Control Sample (QCS)/(LCS)

Daily a 5ppbv QC Check standard, prepared from a different stock, is analyzed to check the calibration curve. All compounds must be within the ±30% for NJ and CT RCP samples. All other samples follow 70-130% except for the deemed 11 difficult compounds which have limits of 50-150%. (Difficult compounds include Acetone, 1,4-Dioxane, Hexachlorobutadiene, Naphthalene, 1,2,4-Trichlorobenzene, Propene, Isopropanol, Ethanol, 2-Hexanone, 1,2-Dichloro-

1,1,2,2-tetrafluoroethane, and Cyclohexane) QC Check samples are analyzed after the continuing calibration and before samples.

An LCS that fails on the low side or fails on the high side with samples having detections must be rerun. If LCS still fails, then qualify the outlier. Analyst should perform corrective actions to ensure failure doesn't happen again. Any LCS that fails on the high side, with all samples being non-detected can be qualified.

12.2.8 **Mechanical Pressure Gauges**

All pressure on outbound and inbound canisters (before and after sampling) are checked and the pressures recorded in the Outbound-Inbound log.

12.2.9 MDL and On-going RL/LOQ verifications

An MDL study must be performed as per 40 CFR 136 Appendix B. The MDL Definition is as follows, "The method detection limit (MDL) is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results" The value calculated from the spike samples is called the MDL_S. The MDL_S calculation is the same as the MDL calculation in Revision 1.11. The method blank samples are used to calculate the MDL_b, which is a very similar calculation that also calculates 99% confidence level that the result is derived from the sample rather from contamination/noise. The MDL is the higher of the two values (either the MDL_s calculated using spiked samples or the MDL_b, calculated using method blanks). EPA considers this change important because as detector sensitivity improves, the background contamination of the laboratory, consumable supplies, and equipment can be more important in determining the detection limit than the sensitivity of the instrument.

1) The MDL now requires that the samples used to calculate the MDL are representative of laboratory performance throughout the year, rather than on a single day.
2) A laboratory has the option to pool data from multiple instruments to calculate one MDL that represents multiple instruments.
3) Additionally, a streamlined approach to determine whether a new instrument can be added to a group of instruments with an already established MDL, and Laboratory have the option to use only the last six months of method blank data or the fifty most recent method blanks, whichever yields the greatest number of method blanks to calculate the MDL value derived from method blanks (MDL_b)
4) After initial MDL is established, every year thereafter quarterly 2 RL/LOQ samples are performed. At the end of the year the points are tabulated in an MDL-S, and compared to current MDL.

Note: For method EPA TO-15 the calculated MDL must be $\leq$ 0.5ppbv for each analyte listed in the method.

*For AIHA-LAP, LLC a daily RL/LOQ verification is analyzed with limits of 50-150%. Quarterly, each canister type has an RL/LOQ verification performed that is analyzed just like a sample would be run. This shall be spiked at the reporting limit.

12.2.10 **Qualifiers**

Any data that fails to meet method requirements will be qualified. For example, if cans return with a pressure of zero.

13.0 CANISTER CLEANING

All canisters are cleaned after sample analysis and prior to reusing them. They are cleaned on a 10-position heated Nutech Canister Cleaner 3650A, or a 24-position Holman Engineering Canister Cleaner. The canisters are heated to 95°C on the 24-slot cleaner, or 95°C on the 10-slot cleaner, valves are opened and canisters are evacuated with a roughing pump. The roughing pump and molecular drag pump are both vented into hood ducting.

The canister cleaner is cycled four to six times of pressurization of the canisters with humidified synthetic air followed by evacuation of the canisters. At the completion of the final cycle, the molecular drag pump is activated and the canisters are brought to a vacuum of < 50 millitorr. The pump-down with the molecular drag pump is typically 1.5 hrs to 3 hrs.

At the completion of the process, one or more canisters are chosen for batch certification analysis as per the method. These cans are pressurized to 35psia on 4700 Precision Static Diluter with ultra-pure air, and sit for 12hours before being analyzed to age them. If there are no compounds detected above 0.2ppbV for a 400- ml sample, (except for ethanol, IPA, propene, and acetone as these are not on the TO-15 list, which must be below the reporting limit of 2.0ppbv, but are still documented if over 0.2ppbv); the batch is considered clean and the cleaning check can is put on the cleaner and pulled to < 50millitorr to be certified clean. However, if there are compounds above 0.2ppbv (or the reporting limit for acetone, ethanol and IPA) the cans go for a second round of cleaning and will be cleaned until all the targeted compounds in the can are below the detection limit. Once certified, clean the cans are labeled, documented in the cleaning log, and placed in storage at <50mTorr to await future sampling. Before cans are sent out they are leak checked. All clean checks are documented at F:\Lab\air\Logbooks\Clean Check Log in an excel spreadsheet.

14.0 DATA PROCESSING

14.1 Reporting Package

The reporting package that is delivered to clients consists of the sample results, the surrogate results, and any quality control measures that the client has specifically asked for.

14.2 Data Filing

14.2.1 Data to be saved on CD

All of the runs, methods and standards, from each day of analysis.

14.2.2 Data to be filed in Data Boxes

14.2.2.1 BFB tuning files
14.2.2.2 Daily method blanks
14.2.2.3 Calibration curves
14.2.2.4 Daily calibration checks
14.2.2.5 Surrogate recoveries
14.2.2.6 Lab spikes
14.2.2.7 Matrix spikes
14.2.2.8 Duplicate results
14.2.2.9 Quality control spikes

15.0 CORRECTIVE ACTIONS/CONTINGENCIES OF HANDLING OUT-OF-CONTROL DATA

15.1 Refer to Con-Test Quality Assurance Manual.

15.2 Corrective action is performed any time acceptance criteria are not met, as described throughout this document. All corrective actions are fully documented by the analyst on a Corrective Action Form, as described in the corrective action SOP. Corrective Action Forms are a part of the QA record and copies are included with the data for the analyses.

16.0 SAFETY

See Material Safety Data Sheets (MSDSs) and Con-Test Chemical Hygiene Plan.

17.0 POLLUTION PREVENTION

Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Many opportunities of pollution prevention exist in laboratory operation. EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address waste generation. When it is not feasible to reduce wastes at the source, recycling is recommended as the next best option.

18.0 WASTE MANAGEMENT

It is the laboratory’s responsibility to comply with all federal, state, and local regulations governing the waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Also, compliance is required with any sewage discharge permits and regulations.

19.0 REFERENCES

19.1 Compendium of methods for the determination of toxic organic compounds in Ambient Air, 2nd Edition, USEPA JAN 1999, Method TO-15.

19.2 Con-Test Analytical Chemical Hygiene Plan.

19.3 Con-Test Analytical Quality Assurance Manual.

19.4 HP 5890/6890/7890 Series Gas Chromatograph Operating Manuals.

19.5 Con-Test Analytical Corrective Action SOP

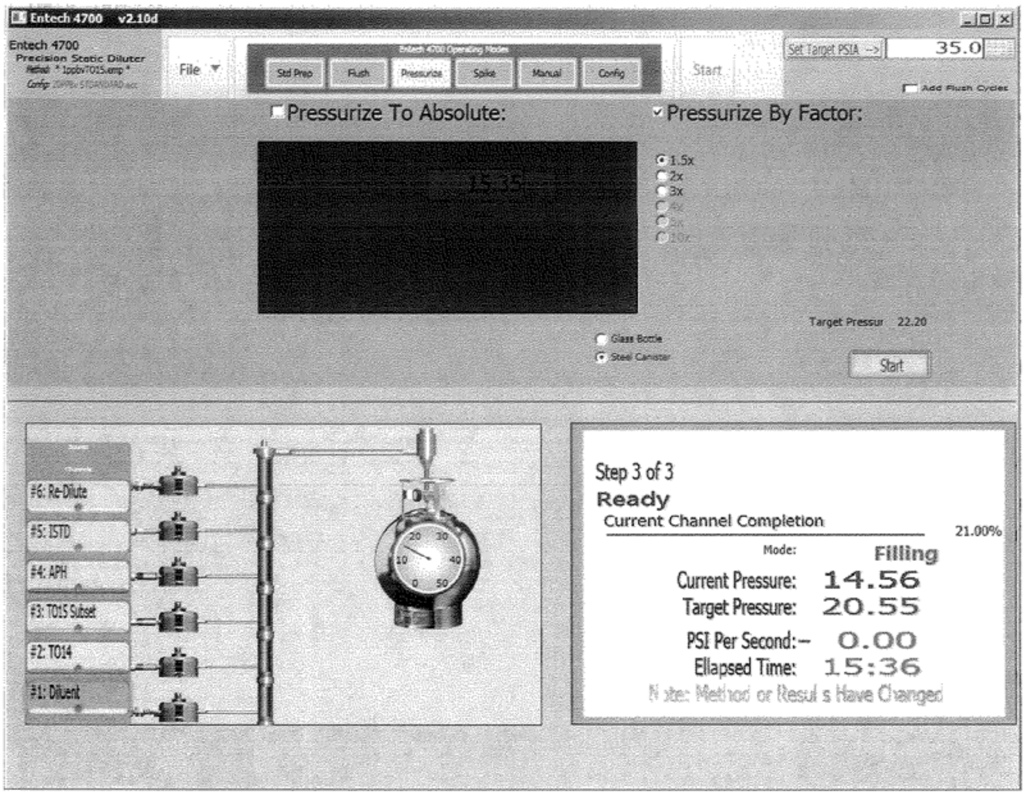
19.6 Con-Test Analytical Procedure for Maintaining Controlled Documents SOP

19.7 Con-Test Analytical Manual Integration SOP

19.8 MA DEP Bureau of Waste Site Cleanup, “Quality Control Requirements and Performance Standards for the Analysis of Volatile Organic Compounds in Air Samples (TO-15) by Gas Chromatography/Mass Spectrometry (GC/MS) in Support of Response Actions under the Massachusetts Contingency Plan (MCP”, Rev 0, July 1, 2010.

19.9 CT DEP QA/QC Work Group, “State of CT Dept. of Environmental. Protection Recommended Reasonable Confidence Protocols Quality Assurance and Quality Control Requirements Volatile Organics by Method TO-15”, Version 2.0, December 2006.

Appendix 1



Method: * 1ppbvTO15.emp *
Config: 20PPBv STANDARD.ecc

Set Target PSIA --> 35.0

☐ Pressurize To Absolute:

☑ Pressurize By Factor:

PSIA 15.35

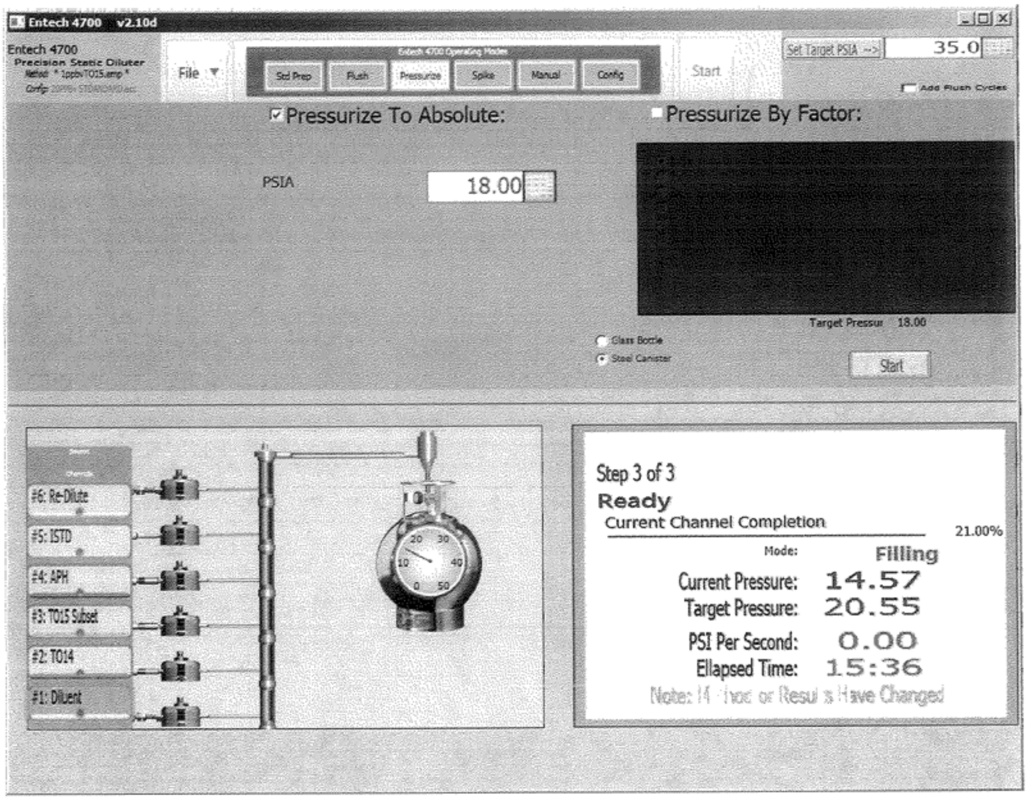
● 1.5x

● Steel Canister

Target Pressur 22.20

Step 3 of 3
Ready
Current Channel Completion 21.00%
Mode: Filling
Current Pressure: 14.56
Target Pressure: 20.55
PSI Per Second:-- 0.00
Ellapsed Time: 15:36
Note: Method or Results Have Changed

Appendix 2



Entech 4700 v2.10d

Entech 4700
Precision Static Diluter
Method: * 1ppbvTO15.amp *

Set Target PSIA --> 35.0

☐ Add Flush Cycles

☑ Pressurize To Absolute:

PSIA 18.00

☐ Pressurize By Factor:

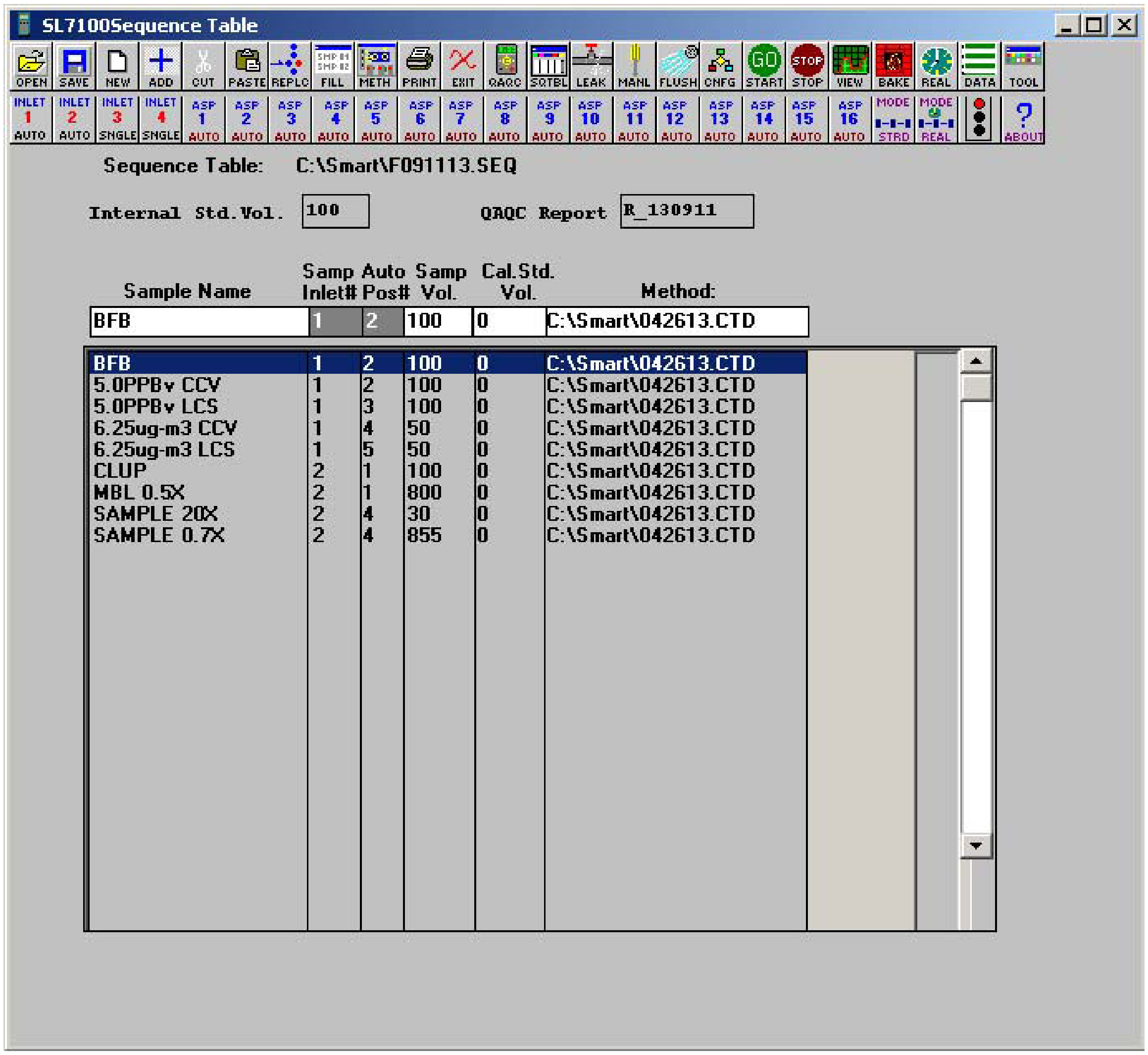
Target Pressur 18.00

○ Glass Bottle
● Steel Canister

Step 3 of 3
Ready
Current Channel Completion 21.00%

Mode: Filling
Current Pressure: 14.57
Target Pressure: 20.55
PSI Per Second: 0.00
Ellapsed Time: 15:36
Note: M thod or Resul s Have Changed

Appendix 3



Sequence Table: C:\Smart\F091113.SEQ

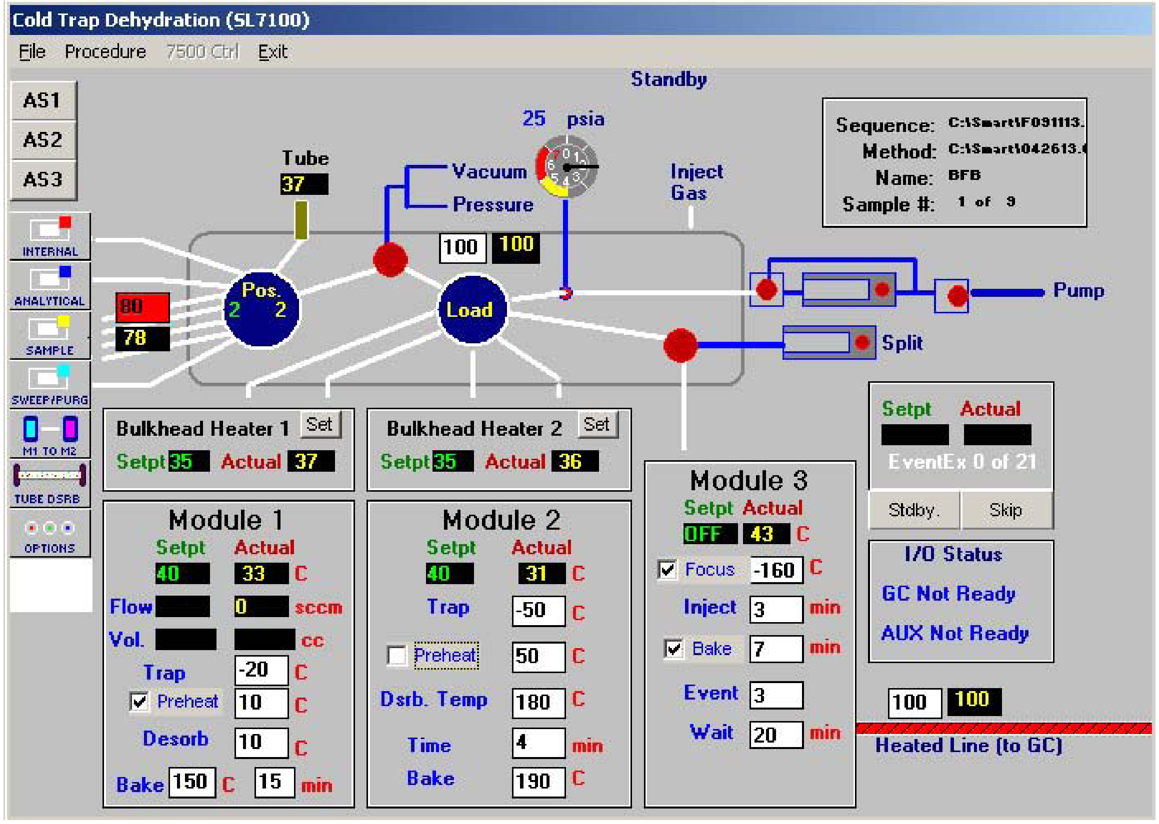
Internal Std.Vol. 100

QAQC Report R_130911

Sample Name	Samp Inlet#	Auto Pos#	Samp Vol.	Cal.Std. Vol.	Method:
BFB	1	2	100	0	C:\Smart\042613.CTD

BFB	1	2	100	0	C:\Smart\042613.CTD
5.0PPBv CCV	1	2	100	0	C:\Smart\042613.CTD
5.0PPBv LCS	1	3	100	0	C:\Smart\042613.CTD
6.25ug-m3 CCV	1	4	50	0	C:\Smart\042613.CTD
6.25ug-m3 LCS	1	5	50	0	C:\Smart\042613.CTD
CLUP	2	1	100	0	C:\Smart\042613.CTD
MBL 0.5X	2	1	800	0	C:\Smart\042613.CTD
SAMPLE 20X	2	4	30	0	C:\Smart\042613.CTD
SAMPLE 0.7X	2	4	855	0	C:\Smart\042613.CTD

Appendix 4



Standby

Sequence: C:\Smart\F091113.
Method: C:\Smart\042613.
Name: BFB
Sample #: 1 of 9

Bulkhead Heater 1: Setpt 35, Actual 37

Bulkhead Heater 2: Setpt 35, Actual 36

Module 1

	Setpt	Actual	
	40	33	C
Flow		0	sccm
Vol.			cc
Trap		-20	C
☑ Preheat		10	C
Desorb		10	C
Bake	150 C	15	min

Module 2

	Setpt	Actual	
	40	31	C
Trap		-50	C
☐ Preheat		50	C
Dsrb. Temp		180	C
Time		4	min
Bake		190	C

Module 3

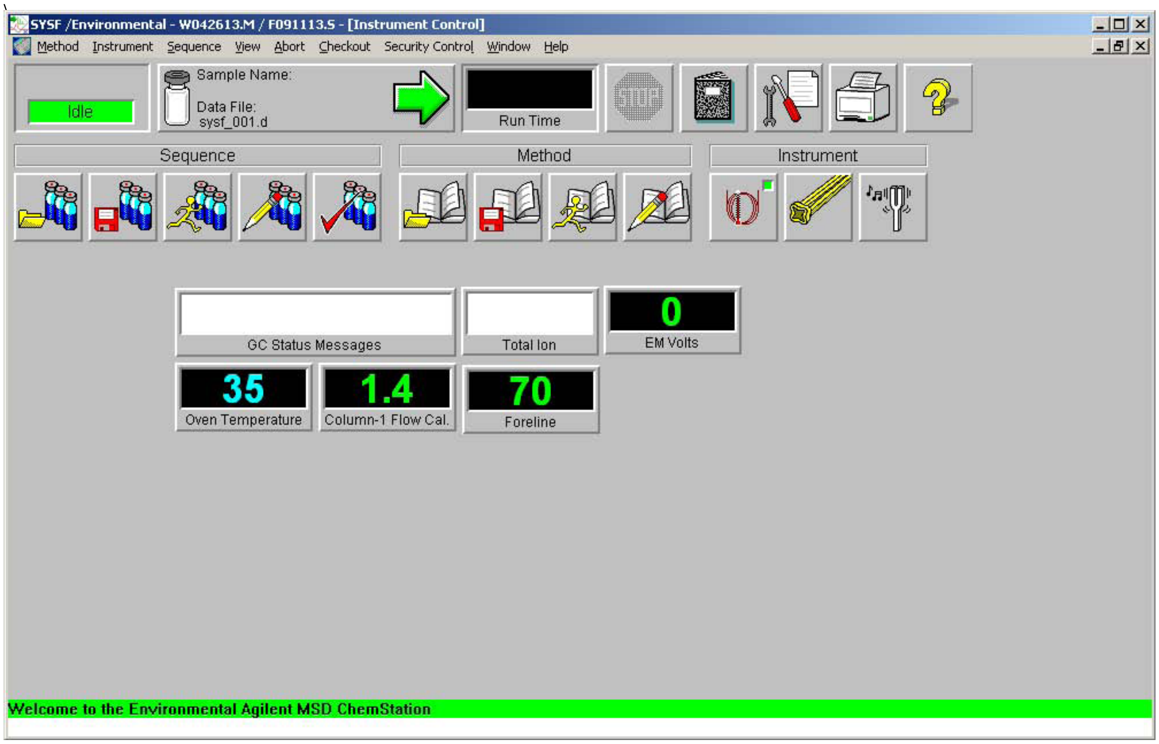
	Setpt	Actual	
	OFF	43	C
☑ Focus		-160	C
Inject		3	min
☑ Bake		7	min
Event		3	
Wait		20	min

Setpt Actual
EventEx 0 of 21

I/O Status
GC Not Ready
AUX Not Ready

Heated Line (to GC): 100 100

Appendix 5



SYSF /Environmental - W042613.M / F091113.S - [Instrument Control]

Idle

Sample Name:

Data File: sysf_001.d

EM Volts: 0

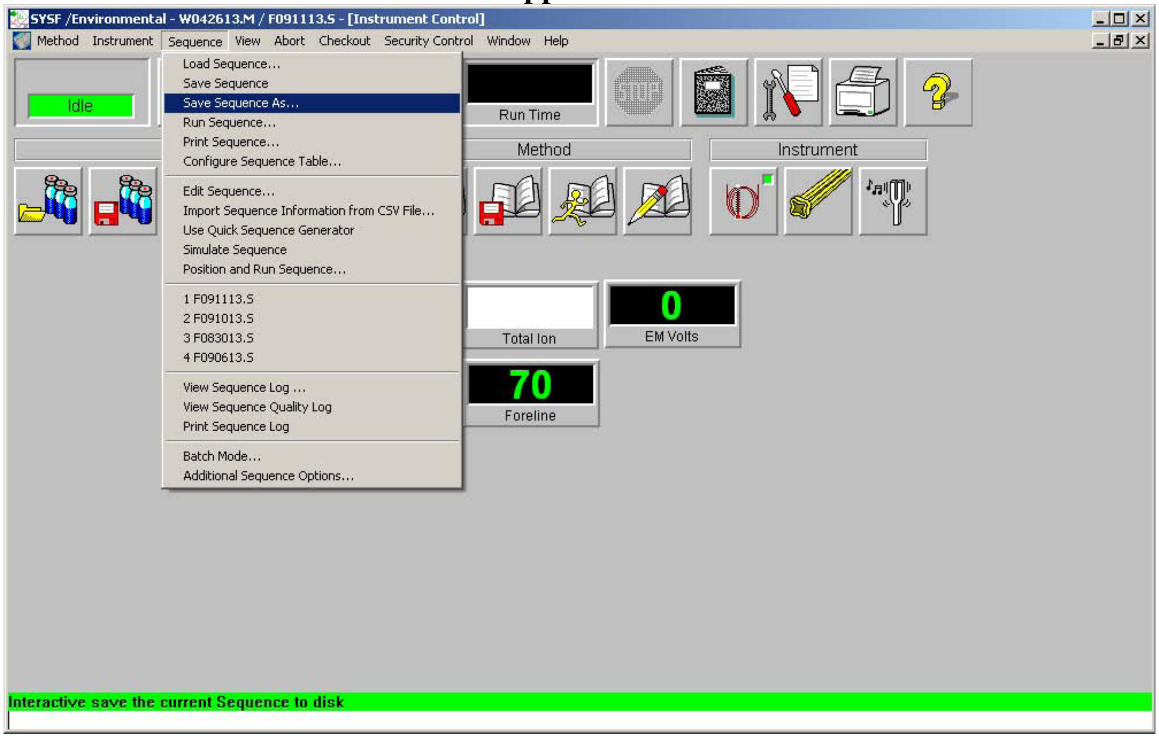
Oven Temperature: 35

Column-1 Flow Cal.: 1.4

Foreline: 70

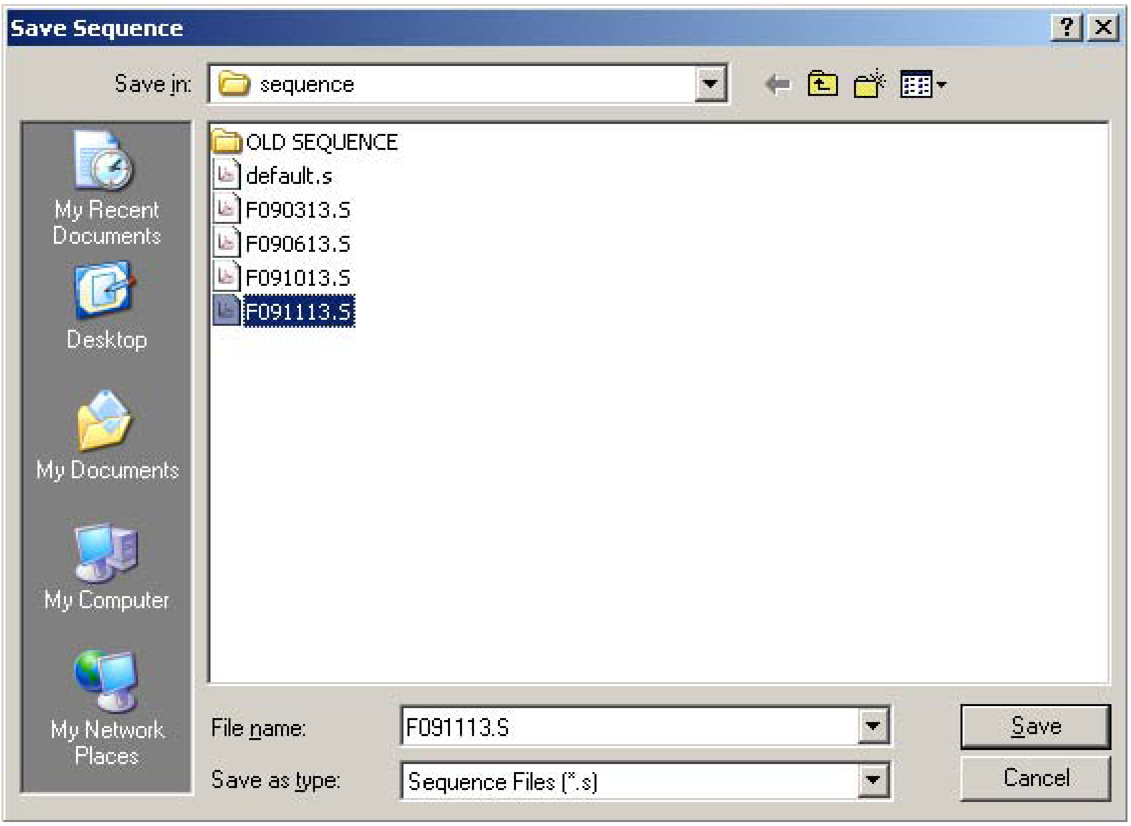
Welcome to the Environmental Agilent MSD ChemStation

Appendix 6



Interactive save the current Sequence to disk

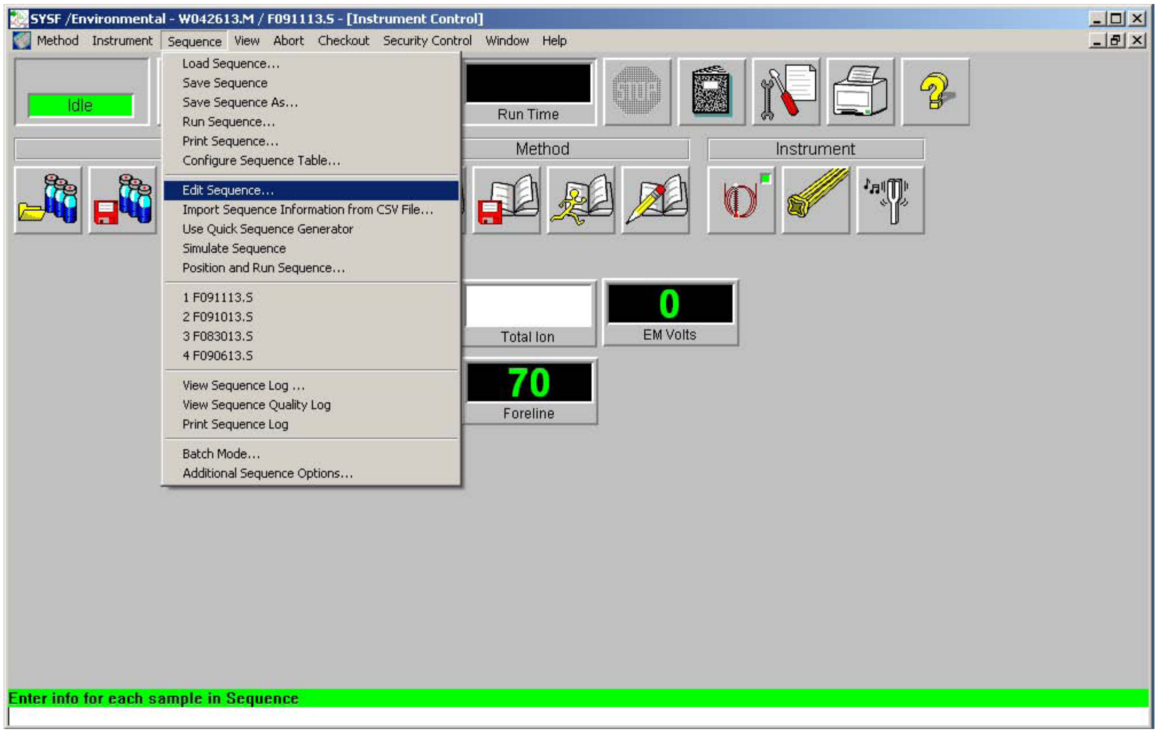
Appendix 7



OLD SEQUENCE
default.s
F090313.S
F090613.S
F091013.S
F091113.S

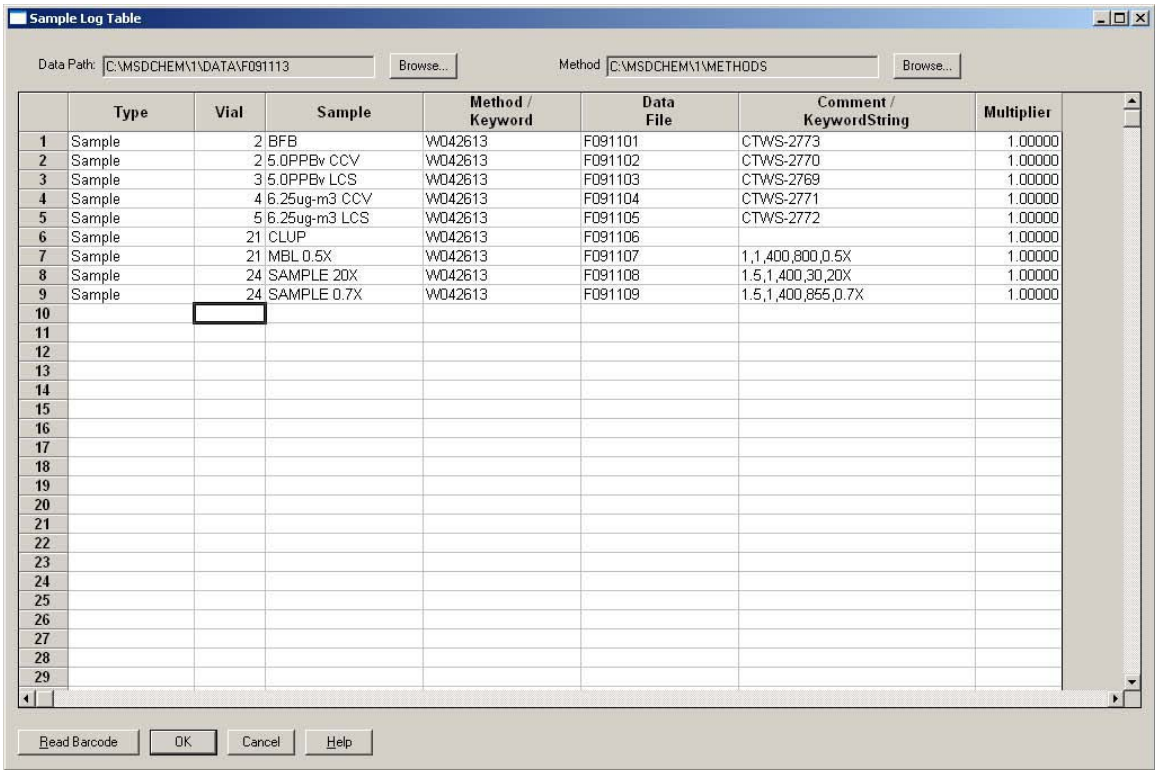
File name: F091113.S
Save as type: Sequence Files (*.s)

Appendix 8



Enter info for each sample in Sequence

Appendix 9

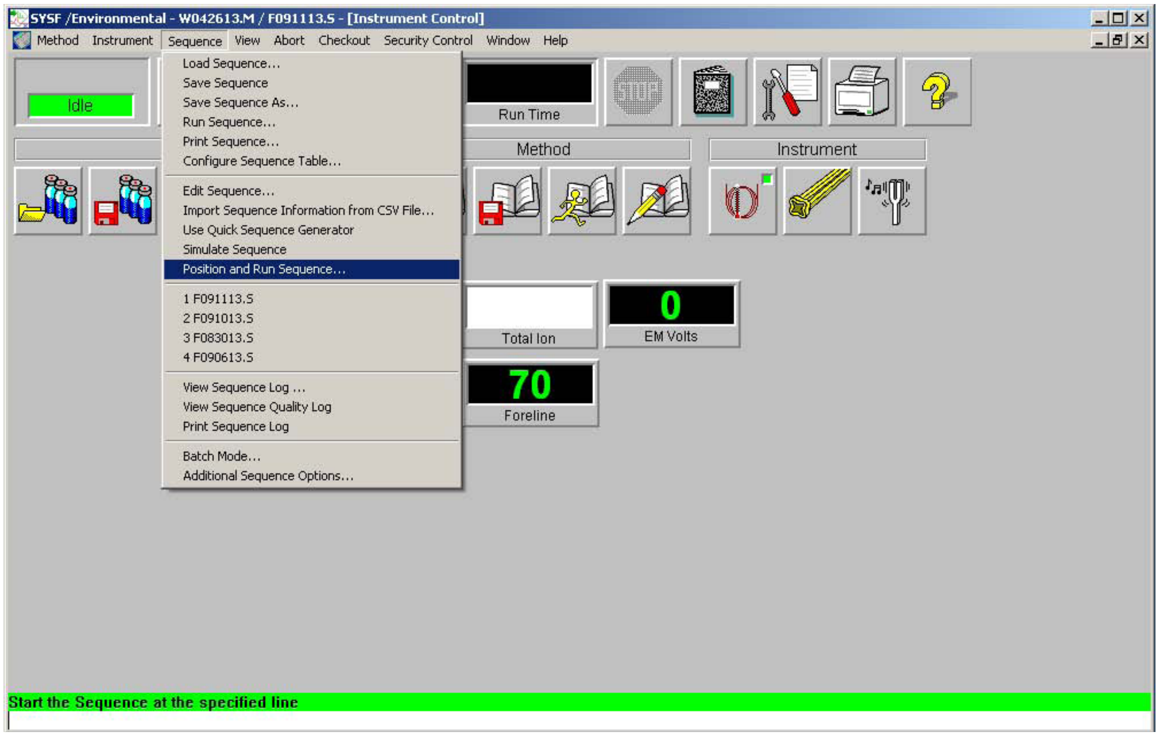


Data Path: C:\MSDCHEM\1\DATA\F091113

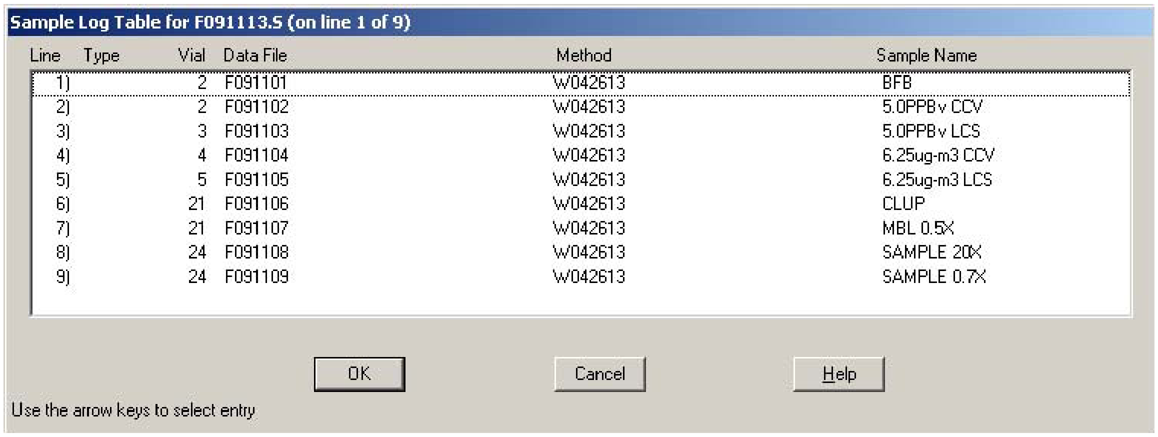
Method C:\MSDCHEM\1\METHODS

	Type	Vial	Sample	Method / Keyword	Data File	Comment / KeywordString	Multiplier
1	Sample	2	BFB	W042613	F091101	CTWS-2773	1.00000
2	Sample	2	5.0PPBv CCV	W042613	F091102	CTWS-2770	1.00000
3	Sample	3	5.0PPBv LCS	W042613	F091103	CTWS-2769	1.00000
4	Sample	4	6.25ug-m3 CCV	W042613	F091104	CTWS-2771	1.00000
5	Sample	5	6.25ug-m3 LCS	W042613	F091105	CTWS-2772	1.00000
6	Sample	21	CLUP	W042613	F091106		1.00000
7	Sample	21	MBL 0.5X	W042613	F091107	1,1,400,800,0.5X	1.00000
8	Sample	24	SAMPLE 20X	W042613	F091108	1.5,1,400,30,20X	1.00000
9	Sample	24	SAMPLE 0.7X	W042613	F091109	1.5,1,400,855,0.7X	1.00000
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							

Appendix 10



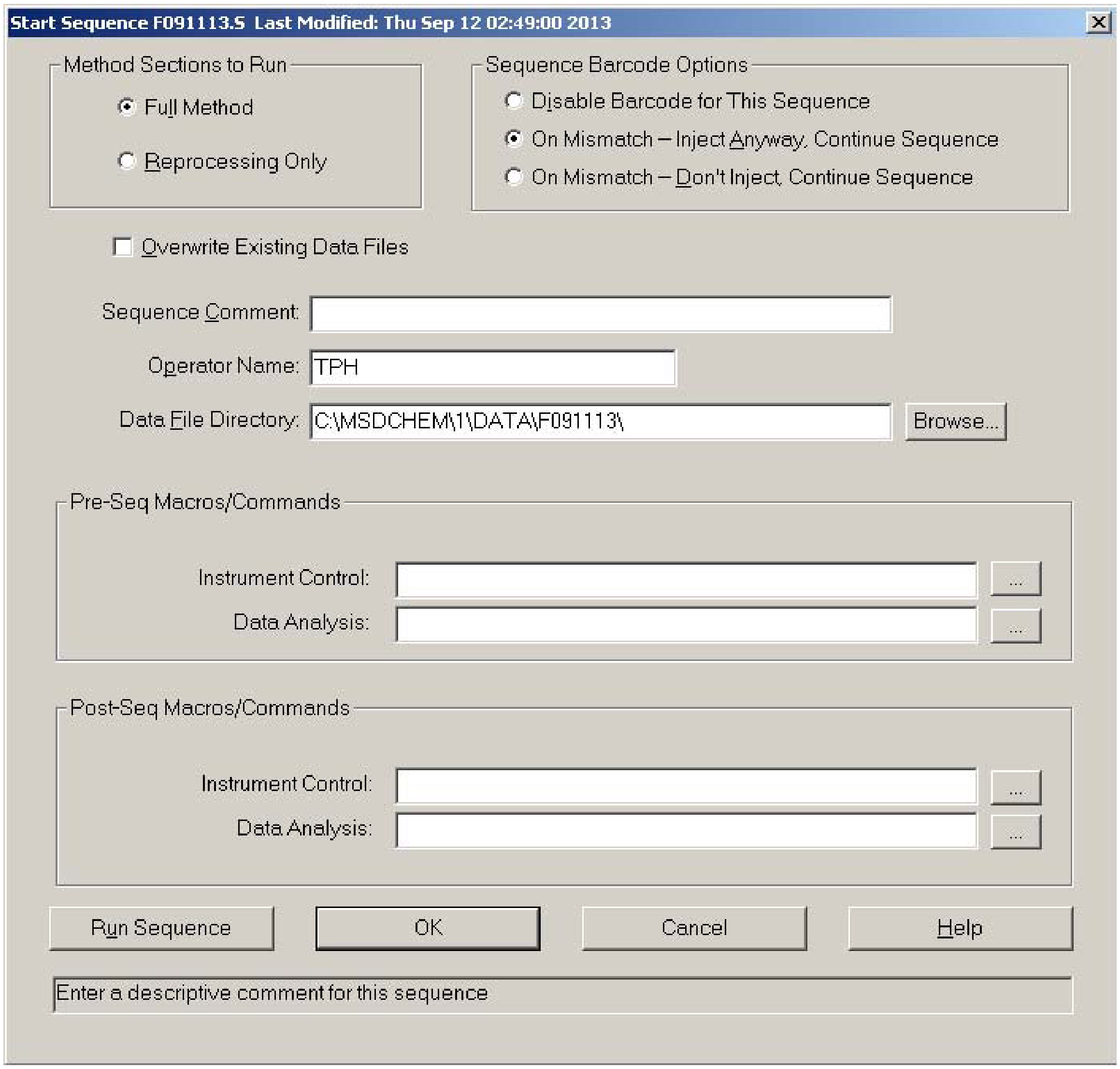
Start the Sequence at the specified line


Sample Log Table for F091113.S (on line 1 of 9)

Line	Type	Vial	Data File	Method	Sample Name
1)		2	F091101	W042613	BFB
2)		2	F091102	W042613	5.0PPBv CCV
3)		3	F091103	W042613	5.0PPBv LCS
4)		4	F091104	W042613	6.25ug-m3 CCV
5)		5	F091105	W042613	6.25ug-m3 LCS
6)		21	F091106	W042613	CLUP
7)		21	F091107	W042613	MBL 0.5X
8)		24	F091108	W042613	SAMPLE 20X
9)		24	F091109	W042613	SAMPLE 0.7X

Use the arrow keys to select entry

Appendix 11



Start Sequence F091113.S Last Modified: Thu Sep 12 02:49:00 2013

Method Sections to Run
● Full Method
○ Reprocessing Only

Sequence Barcode Options
○ Disable Barcode for This Sequence
● On Mismatch – Inject Anyway, Continue Sequence
○ On Mismatch – Don't Inject, Continue Sequence

☐ Overwrite Existing Data Files

Sequence Comment:
Operator Name: TPH
Data File Directory: C:\MSDCHEM\1\DATA\F091113\

Pre-Seq Macros/Commands
Instrument Control:
Data Analysis:

Post-Seq Macros/Commands
Instrument Control:
Data Analysis:

Enter a descriptive comment for this sequence

Appendix B – TRC Standard Operating Procedures- Canister Sampling

Title: **Indoor and Ambient Air Sampling**	Procedure Number: **ECR 024**
	Revision Number: **1**
	Effective Date: **January 2020**

Authorization Signatures

		Elizabeth Denly	
Technical Reviewer Stacy Metz	Date 1/1/20	Environmental Sector Quality Director Elizabeth Denly	Date 1/1/20

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ATTACHMENTS

Attachment A	Example Field Sampling Data Sheets
Attachment B	Example Chain-of-Custody Form

1.0 INTRODUCTION

1.1 Scope and Applicability

This Standard Operating Procedure (SOP) was prepared to provide guidance to TRC personnel in the logistics, collection techniques, and documentation requirements for collecting representative indoor air and ambient air samples for volatile organic compounds (VOCs) using sampling canisters. These are standard (*i.e.*, typically applicable) operating procedures that may be changed, as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. In addition, other local, state or federal regulatory requirements may be above and beyond the scope of this SOP and should be followed, if applicable. In all instances, the actual procedures used should be thoroughly documented and described in the field notes. The project-specific work plan (or equivalent) should be consulted to verify sampling requirements and details as specified by the contractual agreement with the client.

There are other methods that can be used for the collection of indoor and ambient air samples for VOCs and other parameters including Tedlar® bags and sorbent tubes. In addition, some canisters can be used for the collection of analytical parameters other than VOCs (*e.g.*, fixed gases, non-methane organic compounds, methane, etc.). However, this SOP focuses only on the use of sampling canisters for VOCs.

1.2 Summary of Method

The objective of indoor and ambient air sampling is to obtain a representative sample of air for laboratory analysis of chemical constituents of interest at a given site. This objective requires that the sample be of sufficient quantity (*i.e.*, volume) and quality for analysis by the selected analytical method. Indoor and ambient air samples are typically collected with sampling canisters for VOC analysis. Sampling canisters under vacuum are commonly fitted with flow controllers to restrict the air intake to a pre-determined rate.

This sample collection method involves the use of a flow controller or a sampler containing a flow controller to slowly meter the flow of air entering a canister. With this method, a sample is collected over a longer period of time than with a grab sample. If a constant flow rate is maintained, the resulting sample will have a constituent content that is the average of the constituent concentrations during the sampling interval.

1.3 Equipment

The following list of equipment may be utilized when conducting indoor or ambient air sampling for chemical constituents. Project-specific conditions or requirements may warrant the use of additional equipment and/or deletion of items from this list.

- Appropriate level of personal protective equipment (PPE), such as nitrile gloves and safety glasses, as set forth in a site-specific health and safety plan (HASP) or job safety analysis (JSA).
- Barometric Pressure Meter – Extech® Instrument, or equivalent (optional – see site-specific work plan).

- Clean 5-gallon buckets, tripod, or box – For elevating sampling equipment to the breathing zone.

- Portable organic vapor analyzer equipped with a photoionization detector (PID) and/or flame ionization detector (FID) (optional).

- Air Flow Velocity Meter – TSI® 964 Straight Air Velocity Probe for use with Q-Trak™ Indoor Air Quality Monitor Model 7575, or equivalent (optional).

- Pre-cleaned, evacuated, passivated stainless-steel canister (hereafter - sampling canister), at least one extra for every 20 samples recommended in case of leakage.

- Flow controller(s)/regulators are generally pre-calibrated by the laboratory to regulate flow for sample collection times of 1-hour, 3-hours, 8-hours, 12-hours, or 24-hours as requested. Sample collection time is typically set based on project objectives. For example, 24 hours to evaluate residential exposure versus 8 hours or 12 hours to evaluate non-residential exposure.

- Vacuum gauge to verify readings on canister's flow controller (should be supplied by the laboratory and connected to the flow controller/regulator).

- Stainless-steel, Teflon®, or nylon tubing (sometimes used to extend equipment into the breathing zone).

- Moisture filter (may be needed for ambient air sampling).

1.4 Definitions

Individual Certification	A laboratory will clean several sampling canisters at once. Each canister from the batch is certified as clean.
Batch Certification	A laboratory will clean several sampling canisters at once. One randomly selected canister from that group of canisters, *i.e.*, the batch, is used to certify that all of the canisters in that batch are clean.

1.5 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. TRC personnel will use appropriate PPE. The Project Manager, Office Safety Coordinator (OSC), TRC ECR Safety Manager, or TRC National Safety Director can address questions or safety concerns. Project-specific safety considerations should be documented in the project-specific work plan (or equivalent).

1.6 Cautions and Potential Problems

- When collecting air samples having high constituent concentrations, try to stay upwind of vapors during sample collection to minimize exposure. Respiratory protection may be required in certain instances depending upon site conditions and concentrations encountered.

- Sampling canisters should not be used for the collection of outdoor ambient air samples in moderate to heavy rain, as the moisture may compromise the sample. If the sampling event must occur when rain is forecasted, then the laboratory should be consulted to evaluate the limitations of the equipment.

- Factors, such as atmospheric conditions or dust/dirt blockage, can affect the actual flow rate through the calibrated flow controllers. Conditions should be properly noted in the field notes.

- For time-weighted sampling periods, it is important that the sample canister vacuum not equilibrate with atmospheric pressure in order to demonstrate that the sampling apparatus was functioning properly and collecting a representative sample over the prescribed time period.

- It is also important that the vacuum on the sample canisters does not exceed a maximum vacuum at the conclusion of the sampling period. Typically, if the vacuum is greater than 10 inches Hg, the laboratory will need to pressurize the samples with clean air, resulting in a slight dilution factor and, thus, elevated reporting limits.

1.7 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that may entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project-specific work plan. These requirements may include:

- Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers and 8-hour annual HAZWOPER refresher training.
- OSHA 10-hour Construction Industry Outreach Training.
- Site-specific safety training.

2.0 PROCEDURES

2.1 Pre-sampling Activities

1. Review regulatory requirements to ensure program requirements meet local regulations, which may specify collection of a concurrent ambient outdoor air sample, certain quality control (QC) samples, and/or specific ancillary measurements.

2. Based on project needs, a prescreening survey with a portable organic vapor analyzer may be helpful in determining preferential pathways or areas with high concentrations of VOCs.

3. Conduct a building condition assessment including a visual survey of basements, crawl spaces, slab-on-grade configurations and conditions; determine if sumps, wells, or cisterns are associated with the structure; evaluate the condition of floors and walls; and describe the HVAC system and operating status/conditions.

4. Verify if a pre-sampling survey of the building is required and if products containing compounds on the analyte list can be removed from the building in advance of sampling. Complete an Indoor Air Sampling Inventory using a form specified by the applicable regulatory agency (where applicable).

5. Verify if batch certification of sampling canisters is sufficient or if one or more sampling canisters require individual certification. This will be dependent on project objectives.

6. The flow controller sampling period should be specified in the sampling plan or project-specifc work plan and confirmed with the Project Manager. Sample collection time is typically set based on project objectives. For example, 24 hours to evaluate residential exposure versus 8 hours or 12 hours to evaluate non-residential exposure.

7. Perform site reconnaissance to plan potential ambient outdoor air sampling locations. If collecting an ambient outdoor air sample for background purposes, place the sampling apparatus upwind of the study area, and set the intake of the flow controller in the breathing zone (3 to 5 feet above the ground). Safety, access, and security variables should be considered.

8. Typically, the intake of the sampling apparatus should be within the breathing zone (3 to 5 feet above the floor) so the sampling apparatus should be placed on an elevated surface. If a sufficient elevated surface is not present in the sampling area, one should be mobilized to the site (*e.g.*, buckets, tripod or cardboard boxes without VOC-containing tape). NOTE: Review regulatory requirements for the proper height of the samplers; New Jersey guidance recommends the intake be biased near cracks or openings and not the breathing zone when sampling in basements.

   CAUTION: Be sure that the elevated surface is secure and stable, especially in active work areas. Sampling canisters are fragile and are likely to break if knocked to the ground, costing time (especially if damage occurs near the end of the sampling period) and money (sampling canisters cost thousands of dollars).

9. Verify the required sampling volume, minimum/maximum flow rates, minimum/maximum sampling duration, and the number and location of samples needed. These variables will be dependent upon project objectives, sampling method limitations, and required reporting limits. Consult with the Project Manager or the project-specific work plan.

10. Determine the appropriate sampling canister size with the selected analytical laboratory and ensure the laboratory will have enough volume to perform reanalyses and dilutions, if required. Note that smaller volume canisters limit the volume of sample available to laboratories. However, large sampling canisters can be expensive to ship and difficult to manage and transport in the field, particularly for large scale projects.

11. Field Measurement Equipment: If ancillary measurements are required, the associated equipment must be calibrated appropriately. Check with the Project Manager to establish whether ancillary measurements are required.
    a. Temperature and humidity: If erratic measurements are observed, consult the manufacturer for calibration requirements.
    b. Barometric pressure: If erratic measurements are observed, consult the manufacturer for calibration requirements.

c. Air flow velocity: Equipment should be pre-calibrated by the rental company. If erratic measurements are observed, consult the rental company or manufacturer for calibration requirements. Records of calibrations should be provided by the rental company and maintained in the project file.

NOTE: Weather Underground (www.wunderground.com) or other online weather service providers can also be used as a potential resource for atmospheric condition measurements.

2.2 Sampling Procedures

1. The connection between the air-flow controller and the sampling canister is likely to vary between laboratories. Be sure to follow the laboratory-provided directions when connecting the flow controller to the sampling canister. Quick-connect fittings are typically simple and trouble-free, whereas compression type fittings are more common, but may also be more troublesome due to preexisting imperceptible damage, *i.e.*, minor abrasions caused by dust/dirt and/or deformation caused by overtightening. Common suggestions for connecting the flow controller to the sampling canister using compression-type fittings are as follows:

   (a) Confirm the valve is closed (knob should already be tightened clockwise) before unthreading the stainless-steel plug from the top of the canister.

   (b) Check to see that the O-ring is still in place prior to making the connection. Ensure extra O-rings and ferrules are shipped with the flow controller in case they are damaged or missing.

   (c) If present, remove the plastic cap from the flow controller outlet (male threads) before attempting to connect to the inlet on the sampling canister.

   (d) Do not over-tighten compression fittings.

2. Set the sampling apparatus intake in the breathing zone (3 to 5 feet above the floor). Do not set canister on a structure or materials that may off-gas constituents of potential concern. NOTE: Review regulatory requirements for the proper height of the samplers; New Jersey guidance recommends the intake be biased near cracks or openings and not the breathing zone when sampling in basements. Record the sample collection location and height.

3. Open the sampling canister valve to begin sampling. Record the start time, flow controller rate, initial vacuum, and sampling canister size. Also record the flow controller and sampling canister identification numbers.

4. Observe the sampling apparatus for 5 to 10 minutes to verify that the vacuum is dropping at a reasonable rate based on the target flow rate. If access is available, check the vacuum gauges at regular intervals over the sampling duration to ensure the vacuum is dropping appropriately.

5. To the extent feasible, ensure that the sampling apparatus remains undisturbed during prolonged sampling. At residential properties, ask occupants to not disturb the sampling apparatus and to avoid using chemicals in the area of the sampling apparatus that could affect sample results. In industrial settings, periodically check the sampling apparatus to ensure it remains undisturbed.

6. Close the sampling canister valve after the designated time period has been completed, and replace the cap. Record the final vacuum and the time sampling was completed prior to disconnecting the flow controller. It is typically recommended that the canister vacuum not be allowed to drop to zero and a residual vacuum should remain in the canister. The final canister vacuum should typically be between 5- and 8-inches Hg. This vacuum, when verified by the analytical laboratory upon receipt, provides evidence that the sample canister did not leak during the return shipment.

7. Complete the chain-of-custody (COC) form. See Attachment B for an example COC form.

8. Transport the samples to the analytical laboratory for processing. Note that sampling canisters do not need to be stored on ice. Consequently, overnight shipment is not required to maintain sample integrity. Using 2-day shipping or even ground transport can substantially reduce project costs.

2.3 Ancillary Measurements

Field measurements may be required in association with indoor air sampling. Continuous temperature, barometric pressure, and/or humidity measurements may be required at each sampling location using appropriate sensors and logging devices. Air flow velocity measurements may be required for supply and exhaust (or return) air vents in each room.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

The following list is a summary of quality assurance/quality control (QA/QC) procedures that can be used to help ensure the accuracy and precision of the sampling method. The process and requirements for the collection of specific field QC samples will be specified in the project-specific planning documents.

3.1 Field Duplicates

Field duplicates are collocated samples. Collocated samples are two samples collected next to each other in the same position at the same location, at the same time, and for the same amount of time. Field duplicates are used to assess the precision of the sampling and analytical methodologies. Field duplicates, when required, are typically collected at a frequency of one per day of sampling or one per 20 samples.

3.2 Media Certification Checks

Media for all analyses are typically certified as clean from the laboratories. The certifications are performed as batch checks, and results are stored in the project files.

Sampling canisters that are individually certified should have the certification attached to the final laboratory report.

4.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

Information relevant to the indoor sampling location should be recorded during each sampling period (*e.g.*, number of interior and exterior doors and windows, number of windows open and closed, type of ventilation system and its status during each sampling period, room temperature, and any other conditions that might affect concentrations in air over time, such as site operations, material storage, or motorized vehicle storage and/or operation).

If ancillary measurement equipment is used, the applicable calibration information (*i.e.*, date, times, equipment make/model/serial number, and calibration results) should also be recorded.

Record the following information:

- Sampling location;
- Sampling canister size;
- Pre-set flow rate on flow controller;
- Height of sampling canister;
- Laboratory canister ID;
- Laboratory flow controller ID;
- Atmospheric conditions (*e.g.*, dusty, dirty);
- Sampling start time and vacuum (inches of Hg);
- Sampling end time and vacuum (inches of Hg); and
- Indoor and outdoor barometric pressure (optional).

Example Field Sampling Data Sheets and an example COC form are presented in Attachments A and B, respectively.

5.0 REFERENCES

American Society for Testing and Materials (ASTM). November 2014. ASTM D1945-14. *Standard Test Method for Analysis of Natural Gas by Gas Chromatography*.

United States Environmental Protection Agency (USEPA). January 1999. Compendium Method TO-10A: *Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using Low Volume Polyurethane Foam (PUF) Sampling Followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)*. EPA/625/R-96/010b.

USEPA. August 2017. Method 25C. *Determination of Nonmethane Organic Compounds (NMOC) in Landfill Gases*.

6.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
0	FEBRUARY 2019	NOT APPLICABLE.
1	JANUARY 2020	TRC RE-BRANDING

Attachment A

Example Field Sampling Data Sheets

PAGE _____ OF _____

AIR / VAPOR SAMPLE LOG

PROJECT NAME:	PREPARED		CHECKED		
PROJECT NUMBER:	BY:	DATE:	BY:	DATE:	

SAMPLE INFORMATION		
SAMPLE TYPE:	☐ COMPOSITE ☐ GRAB	**SAMPLE ID:**
SAMPLE MEDIA	☐ INDOOR AIR ☐ SOIL VAPOR ☐ SYSTEM PERFORMANCE ☐ OTHER	LOCATION:
		LOCATION COORDINATES: N: E:
SAMPLE DURATION:		SAMPLE HEIGHT / (DEPTH):
SAMPLE CONTAINER TYPE:	☐ SUMMA CANISTER ☐ TEDLAR BAG ☐ OTHER:	
FLOW VALVE ID / SERIAL NUMBER:		CANISTER SERIAL NUMBER:

READING	TIME	VACUUM (INCHES - Hg / PSIG)	DATE	INITIALS	COMMENTS
INITIAL VACUUM CHECK					
INITIAL FIELD VACUUM					
FINAL FIELD VACUUM					

SAMPLE START TIME:	**SAMPLE STOP TIME:**

NOTES AND OBSERVATIONS

MOTORIZED VEHICLE STORAGE :

MOTORIZED VEHICLE TRAFFIC:

OPERATIONS (e.g., painting, oil recovery):

CLEANERS / SOLVENTS IN USE:

MATERIAL STORAGE (e.g., paint, gasoline):

NOTICEABLE ODORS:

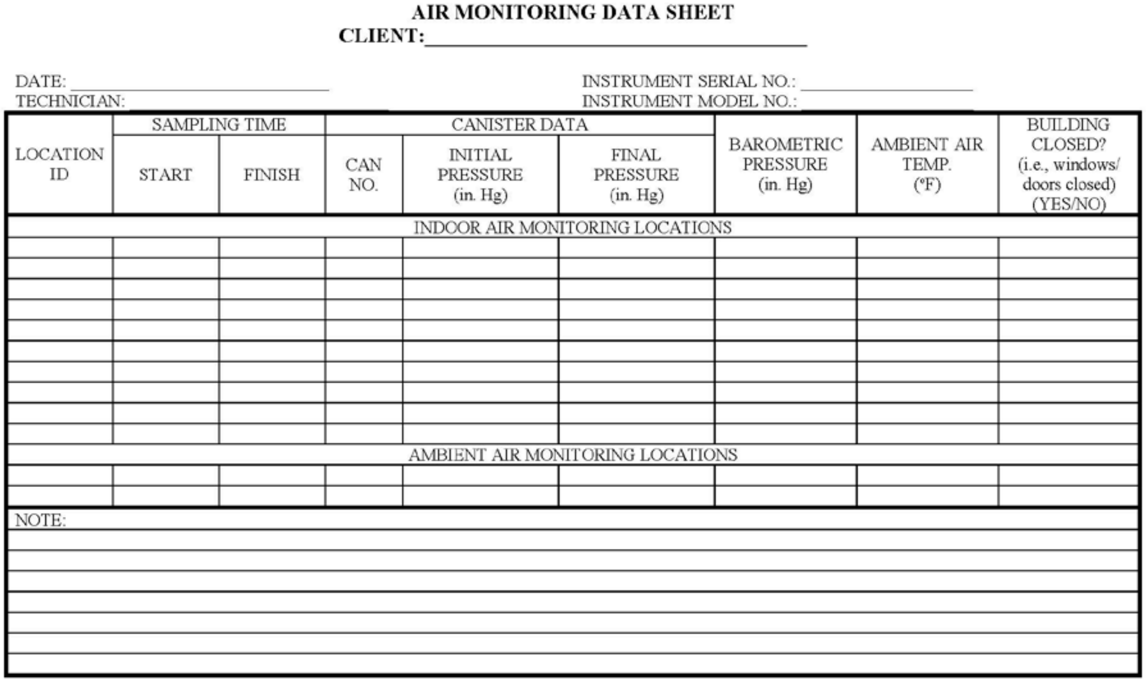
AUDIBLE OR NEARBY HVAC OPERATION:

OTHER:

ADDITIONAL COMMENTS:

SHIPPING METHOD: _______________	DATE SHIPPED: _______________	AIRBILL NUMBER: _______________
COC NUMBER: _______________	SIGNATURE: _______________	DATE SIGNED: _______________

REVISED 06/2011



AIR MONITORING DATA SHEET

CLIENT:____________________________________

DATE: ____________________________

TECHNICIAN: ____________________________

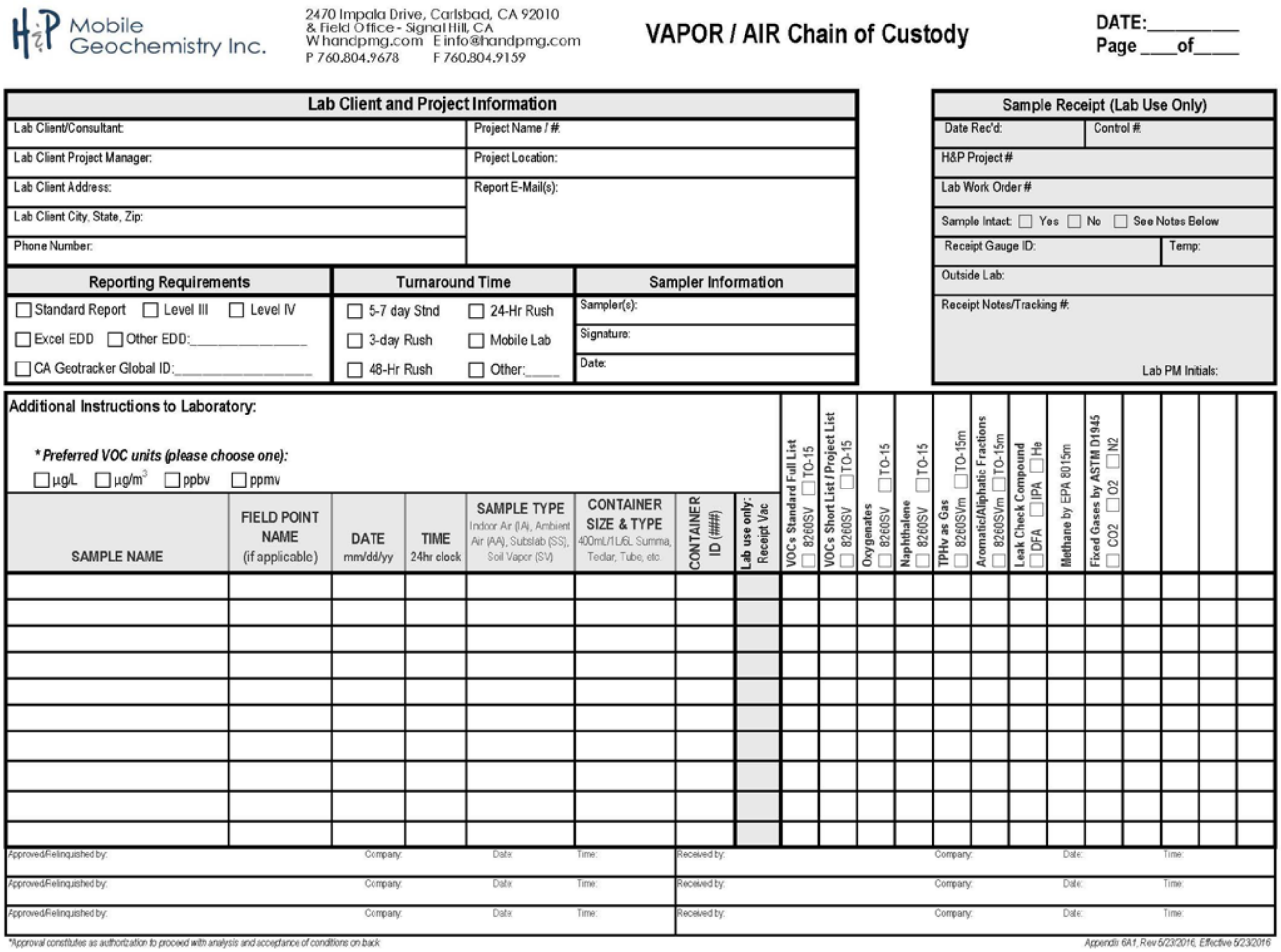
INSTRUMENT SERIAL NO.: ____________________

INSTRUMENT MODEL NO.: ____________________

LOCATION ID	SAMPLING TIME		CANISTER DATA			BAROMETRIC PRESSURE (in. Hg)	AMBIENT AIR TEMP. (°F)	BUILDING CLOSED? (i.e., windows/ doors closed) (YES/NO)
	START	FINISH	CAN NO.	INITIAL PRESSURE (in. Hg)	FINAL PRESSURE (in. Hg)			
INDOOR AIR MONITORING LOCATIONS								
AMBIENT AIR MONITORING LOCATIONS								
NOTE:								

Attachment B

Example Chain-of-Custody Form



H&P Mobile Geochemistry Inc.

2470 Impala Drive, Carlsbad, CA 92010
& Field Office - Signal Hill, CA
W handpmg.com E info@handpmg.com
P 760.804.9678 F 760.804.9159

VAPOR / AIR Chain of Custody

DATE:________
Page ____of____

Lab Client and Project Information	
Lab Client/Consultant:	Project Name / #:
Lab Client Project Manager:	Project Location:
Lab Client Address:	Report E-Mail(s):
Lab Client City, State, Zip:	
Phone Number:	

Sample Receipt (Lab Use Only)	
Date Rec'd:	Control #:
H&P Project #	
Lab Work Order #	
Sample Intact: ☐ Yes ☐ No ☐ See Notes Below	
Receipt Gauge ID:	Temp:
Outside Lab:	
Receipt Notes/Tracking #: Lab PM Initials:	

Reporting Requirements	**Turnaround Time**	**Sampler Information**
☐ Standard Report ☐ Level III ☐ Level IV	☐ 5-7 day Stnd ☐ 24-Hr Rush	Sampler(s):
☐ Excel EDD ☐ Other EDD:______________	☐ 3-day Rush ☐ Mobile Lab	Signature:
☐ CA Geotracker Global ID:________________	☐ 48-Hr Rush ☐ Other:_____	Date:

Additional Instructions to Laboratory:

** Preferred VOC units (please choose one):*
☐ µg/L ☐ µg/m^3 ☐ ppbv ☐ ppmv

SAMPLE NAME	FIELD POINT NAME (if applicable)	DATE mm/dd/yy	TIME 24hr clock	SAMPLE TYPE Indoor Air (IA), Ambient Air (AA), Subslab (SS), Soil Vapor (SV)	CONTAINER SIZE & TYPE 400mL/1L/6L Summa, Tedlar, Tube, etc	CONTAINER ID (###)	Lab use only: Receipt Vac	VOCs Standard Full List ☐ 8260SV ☐ TO-15	VOCs Short List / Project List ☐ 8260SV ☐ TO-15	Oxygenates ☐ 8260SV ☐ TO-15	Naphthalene ☐ 8260SV ☐ TO-15	TPHv as Gas ☐ 8260SVm ☐ TO-15m	Aromatic/Aliphatic Fractions ☐ 8260SVm ☐ TO-15m	Leak Check Compound ☐ DFA ☐ IPA ☐ He	Methane by EPA 8015m	Fixed Gases by ASTM D1945 ☐ CO2 ☐ O2 ☐ N2				

Approved/Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:
Approved/Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:
Approved/Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:

**Approval constitutes as authorization to proceed with analysis and acceptance of conditions on back*

Appendix 6A1, Rev 5/23/2016, Effective 5/23/2016

Appendix C – Calibration Gas Standard Certificates

Airgas East region
Airgas USA LLC
1910 Old Cuthbert Rd.
Cherry Hill, NJ 08034-0000
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: ULTRA HIGH PURITY-PURE

Part Number:	HE UHP15A	Reference Number:	90-401983487-1
Cylinder Number:	CC452163	Cylinder Volume:	134.0 CF
Laboratory:	116 - Cherry Hill (SAP) - NJ	Cylinder Pressure:	2000 PSIG
Analysis Date:	Dec 09, 2020	Valve Outlet:	580
Lot Number:	90-401983487-1		

ANALYTICAL RESULTS

Component	**Requested Purity**		**Certified Concentration**
HELIUM	99.999 %		99.999 %
CO + CO2	1 PPM	<LDL	0.07 PPM
Moisture	1 PPM		0.012 PPM
Oxygen	1 PPM		0.19 PPM
Nitrogen	5 PPM		0.026 PPM
THC	0.5 PPM	<LDL	0.02 PPM

Impurities verified against analytical standards traceable to NIST by weight and/or analysis.

Signature on file

Approved for Release

Airgas
an Air Liquide company

Airgas East region
Airgas USA LLC
1910 Old Cuthbert Rd.
Cherry Hill, NJ 08034-0000
Airgas.com

CERTIFICATE OF BATCH ANALYSIS

Grade of Product: ULTRA ZERO

Part Number:	AI UZ15A	Reference Number:	90-402384331-1
Cylinder Analyzed:	CC45181	Cylinder Volume:	146.0 CF
Laboratory:	116 - Cherry Hill (SAP) - NJ	Cylinder Pressure:	2000 PSIG
Analysis Date:	Mar 08, 2022	Valve Outlet:	590
Lot Number:	90-402384331-1		

ANALYTICAL RESULTS

Component	**Requested Purity**		**Certified Concentration**
AIR			
THC	0.1 PPM	<LDL	0.015 PPM
CO + CO2	1.0 PPM	<LDL	0.037 PPM
Moisture	2.0 PPM		0.048 PPM
Percent Oxygen	20-22 %		21.39 %

Cylinders in Batch:

CC41323, CC45181, CC478005

Impurities verified against analytical standards traceable to NIST by weight and/or analysis.

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X02NI99C15A0817	Reference Number:	160-402349993-1
Cylinder Number:	CC434424	Cylinder Volume:	144.3 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Feb 14, 2022	Valve Outlet:	350
Lot Number:	160-402349993-1		

Expiration Date: Feb 14, 2025

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	500.000 PPB	546.000 PPB	+/- 10%
NITROGEN	Balance		

Notes:PO number: C397720

Signature on file

Approved for Release

an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X02NI99C15AC925	Reference Number:	160-402211198-1
Cylinder Number:	CC43517	Cylinder Volume:	144.3 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Sep 21, 2021	Valve Outlet:	350
Lot Number:	160-402211198-1		

Expiration Date: Sep 21, 2024

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	1.000 PPM	1.051 PPM	+/- 5%
NITROGEN	Balance		

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X02NI99C15AC925	Reference Number:	160-402211198-1
Cylinder Number:	CC140009	Cylinder Volume:	144.3 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Sep 21, 2021	Valve Outlet:	350
Lot Number:	160-402211198-1		

Expiration Date: Sep 21, 2024

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	**Req Conc**	**Actual Concentration (Mole %)**	**Analytical Uncertainty**
BENZENE	1.000 PPM	1.052 PPM	+/- 5%
NITROGEN	Balance		

Signature on file

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP		
Part Number:	X07NI99C15ACFW8	Reference Number:	160-402349991-1
Cylinder Number:	ALM061560	Cylinder Volume:	144.3 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Feb 14, 2022	Valve Outlet:	350
Lot Number:	160-402349991-1		

Expiration Date: Feb 14, 2025

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	500.000 PPB	549.000 PPB	+/- 10%
ETHYL BENZENE	500.000 PPB	522.000 PPB	+/- 10%
M XYLENE	500.000 PPB	530.000 PPB	+/- 10%
O XYLENE	500.000 PPB	520.000 PPB	+/- 10%
P XYLENE	500.000 PPB	524.000 PPB	+/- 10%
TOLUENE	500.000 PPB	558.000 PPB	+/- 10%
NITROGEN	Balance		

Notes:PO number: C397720

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Part Number:	X05NI99C15AC045	Reference Number:	160-402211197-1
Cylinder Number:	CC210342	Cylinder Volume:	129.3 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2016 PSIG
Analysis Date:	Sep 23, 2021	Valve Outlet:	350
Lot Number:	160-402211197-1		

Expiration Date: Sep 23, 2024

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	1.000 PPM	1.040 PPM	+/- 5%
ETHYL BENZENE	1.000 PPM	1.100 PPM	+/- 5%
O XYLENE	1.000 PPM	1.100 PPM	+/- 5%
TOLUENE	1.000 PPM	1.100 PPM	+/- 5%
NITROGEN	Balance		

Signature on file

Approved for Release

Airgas Specialty Gases
Airgas USA LLC
6141 Easton Road
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	TRC ENVIRONMENTAL CORP,		
Part Number:	X07NI99C15A0016	Reference Number:	160-402374503-1
Cylinder Number:	CC421880	Cylinder Volume:	144.0 CL
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
Analysis Date:	Mar 23, 2022	Valve Outlet:	350
Lot Number:	160-402374503-1		

Expiration Date: Mar 23, 2025

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
BENZENE	2.000 PPM	2.243 PPM	+/-5%
ETHYL BENZENE	2.000 PPM	2.235 PPM	+/-5%
M XYLENE	2.000 PPM	2.243 PPM	+/-5%
O XYLENE	2.000 PPM	2.256 PPM	+/-5%
P XYLENE	2.000 PPM	2.248 PPM	+/-5%
TOLUENE	2.000 PPM	2.228 PPM	+/-5%
NITROGEN	Balance		

Signature on file

Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	SO61 AIRGAS - GAINESVILLE , FL		
Part Number:	X05NI99C15ACFP7	Reference Number:	126-401782165-1
Cylinder Number:	CC424399	Cylinder Volume:	144.3 CF
Laboratory:	124 - La Porte Mix - TX	Cylinder Pressure:	2000 PSIG
Analysis Date:	Apr 28, 2020	Valve Outlet:	350
Lot Number:	126-401782165-1		

Expiration Date: Apr 28, 2023

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration (Volume %)	Analytical Uncertainty
BENZENE	7.500 PPM	7.133 PPM	+/- 5%
ETHYL BENZENE	7.500 PPM	7.084 PPM	+/- 5%
O XYLENE	7.500 PPM	7.091 PPM	+/- 5%
TOLUENE	7.500 PPM	7.169 PPM	+/- 5%
NITROGEN	Balance	Balance	

Notes:

SO61 AIRGAS

Signature on file

Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Part Number:	X02NI99C15A0925	Reference Number:	160-401910906-1
Cylinder Number:	CC152781	Cylinder Volume:	7.1 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	85 PSIG
Analysis Date:	Sep 29, 2020	Valve Outlet:	350
Lot Number:	160-401910906-1		

Expiration Date: Sep 29, 2023

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration (Volume %)	Analytical Uncertainty
NAPHTHALENE	7.500 PPM	8.170 PPM	+/- 5%
NITROGEN	Balance	Balance	

Permanent Notes:TRACES OF SOLVENT MAY BE PRESENT IN FINAL PRODUCT.

Notes: Approximately 1342 ppm methanol as solvent.

Signature on file

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E02NI99E15A04F1	Reference Number:	54-402211199-1
Cylinder Number:	CC744327	Cylinder Volume:	144.3 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12021	Valve Outlet:	705
Gas Code:	NH3,BALN	Certification Date:	Sep 17, 2021

Expiration Date: **Sep 17, 2022**

Certification performed in accordance with “EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)” document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted. The results relate only to the items tested. The report shall not be reproduced except in full without approval of the laboratory. Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
AMMONIA	10.00 PPM	9.714 PPM	G1	+/- 2% NIST Traceable	09/08/2021, 09/17/2021
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
GMIS	401422841101	CC711559	9.566 PPM AMMONIA/NITROGEN	+/- 1.2%	Feb 19, 2024
RGM	12355	CC326284	14.56 PPM AMMONIA/NITROGEN	+/- 1.2%	Jun 07, 2021

The SRM, NTRM, PRM, or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
MKS Multigas 017707558	FTIR	Aug 19, 2021

Triad Data Available Upon Request

Signature on file

Approved for Release

Appendix D – Manufacturer Calibration Verifications

(ES642s, Jerome Meter & SKY-2000-NH_3)

INSTRUMENTATION & SPECIALTY CONTROLS DIVISION
11 Commerce Blvd. | Middleboro, MA 02346
P: 508.946.6200 | F: 508.946.6262

CERTIFICATE NUMBER 313014

CUSTOMER NAME AMETEK BROOKFIELD (AZI)
ADDRESS 3375 N DELAWARE ST
CHANDLER AZ 85225
USA

CERTIFICATE OF INSTRUMENT CALIBRATION

MODEL	SERIAL NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
J605-0001	60500008	8/9/2022	8/8/2023

To the NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY within the limitations of the Institute's calibration services, or have been derived from accepted values of natural physical constants, or have been derived by the ratio type of self-calibration techniques. Disclaimer: Any unauthorized adjustments, removal or breaking of QC seals, or other customer modifications on your Jerome Analyzer WILL VOID this factory calibration. Because any of the above acts could affect the calibration and readings of the instrument, their certification will no longer be valid and, further, AMETEK Brookfield WILL NOT be responsible for any liabilities created as a result of using the instrument after such adjustments, seal removal, or modifications. This document shall not be reproduced, except in full, without the written approval of AMETEK Brookfield.

REFERENCE EQUIPMENT USED TO CALIBRATE THE EQUIPMENT

TYPE/MODEL	SERIAL/LOT NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
Cal Set	DT0001926	8/17/2021	8/17/2023

TYPE/MODEL	SERIAL/LOT NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
Alicat	124604	3/22/2022	3/22/2023

TYPE/MODEL	SERIAL/LOT NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
Alicat	124602	3/22/2022	3/22/2023

TYPE/MODEL	SERIAL/LOT NUMBER	CALIBRATION DATE	CALIBRATION DUE DATE
Fluke	17680239	8/30/2021	8/30/2022

NIST TRACE # SRM 2730; 65-D-035; CAL013399 **PROCEDURE #:** 730-0099

All reference equipment used to calibrate the instrument listed upon this certificate have calibrations that are traceable to the National Institute of Standards and Technology (NIST).

APPROVAL SIGNATURE

Todd Place

TODD PLACE, QUALITY ENGINEER

CALIBRATION PERFORMED BY EC

ISO 9001:2015 CERTIFIED
BROOKFIELD
AMETEK
INSTRUMENTATION & SPECIALTY CONTROLS DIVISION

INSTRUMENTATION & SPECIALTY CONTROLS DIVISION
11 Commerce Blvd. | Middleboro, MA 02346
P: 508.946.6200 | F: 508.946.6262

CERTIFICATE NUMBER 297258
CUSTOMER NAME TRC ENVIRO
ADDRESS
245 HUNTINGTON ST
BROOKLYN NY 11231
USA

CERTIFICATE OF INSTRUMENT CALIBRATION

MODEL	**SERIAL NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
J605-0001	60500415	12/14/2021	12/13/2022

To the NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY within the limitations of the Institute's calibration services, or have been derived from accepted values of natural physical constants, or have been derived by the ratio type of self-calibration techniques.Disclaimer: Any unauthorized adjustments, removal or breaking of QC seals, or other customer modifications on your Jerome Analyzer WILL VOID this factory calibration. Because any of the above acts could affect the calibration and readings of the instrument, their certification will no longer be valid and, further, AMETEK Brookfield WILL NOT be responsible for any liabilities created as a result of using the instniment after such adjustments, seal removal, or modifications. This document shall not be reproduced, except in full, without the written approval of AMETEK Brookfield.

REFERENCE EQUIPMENT USED TO CALIBRATE THE EQUIPMENT

TYPE/MODEL	**SERIAL/LOT NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Cal Set	DT0001926	8/17/2021	8/17/2023
TYPE/MODEL	**SERIAL/LOT NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Alicat	124604	1/29/2021	1/29/2022
TYPE/MODEL	**SERIAL/LOT NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Alicat	124602	1/29/2021	1/29/2022
TYPE/MODEL	**SERIAL/LOT NUMBER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Fluke	17680239	8/30/2021	8/30/2022

NIST TRACE # SRM 2730; 65-D-035; CAL013399 **PROCEDURE #:** 730-0099

All reference equipment used to calibrate the instrument listed upon this certificate have calibrations that are traceable to the National Institute of Standards and Technology (NIST).

APPROVAL SIGNATURE

Todd Place

TODD PLACE, QUALITY ENGINEER

CALIBRATION PERFORMED BY RD

TEST CERTIFICATE

Model: SKY2000-NH3	
Serial NO.: 200915A1	**Date of issue: 2022-9-6**
Version NO.: V4.5	**Next Calibration: 2023-9-5**

Test Report

1. The detector passed all the tests.
2. The detector is calibrated correctly.
3. The detector is QC passed and allowed for shipment.

Calibration

Measurement Unit

No.	Standard gas	Standard gas concentration	Value before calibration	Value after calibration	Response time	Remark
1	NH3	9.71 ppm	9.9ppm	9.7 ppm	<30s	

Certification

We Certified that this equipment have been checked, maintained and calibrated according to manufacturer's specification.

[✓ Test Passed] Test Failed

TRC

TEST CERTIFICATE

Model: SKY2000-NH3	
Serial NO.: 200915A1	**Date of issue: 2020-9-15**
Version NO.: V4.5	**Next Calibration: 2021-9-14**

Test Report

1. The detector passed all the tests.
2. The detector is calibrated correctly.
3. The detector is QC passed and allowed for shipment.

Calibration

Measurement Unit

No.	Standard gas	Standard gas concentration	Value before calibration	Value after calibration	Response time	Remark
1	NH3	25ppm	28.5ppm	24.89ppm	<30s	

Certification

We Certified that this equipment have been checked, maintained and calibrated according to manufacturer's specification.

[✓ Test Passed] Test Failed

Engineering Department

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708-2 Firmware Rev:** *1.2.0*

Serial Number: *C10541*

Calibrated By: ***K. Rymer*** AT29 **Cal. Date:** *02/02/2022*

Quality Inspector: R. Lastari **Date:** 2/2/2022

Calibration Hrz/ug: 7.43 **Laser Current ma:** 28.5

Final Test

ES-642 Temperature Sensor: [✓ Pass] / Fail

ES-642 BP Sensor: [✓ Pass] / Fail

ES-642 Flow (2.0 L/M): [✓ Pass] / Fail

ES-642 RH Sensor: [✓ Pass] / Fail

0-10 Volts Output [✓ Pass] / Fail

4-20 ma Output: [✓ Pass] / Fail

Serial Communication: [✓ Pass] / Fail

Inlet Heater: [✓ Pass] / Fail

ES-642 Conc.: **418**

Standard Conc.: **419**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due
DMM	Fluke	189 Multimeter	94060372	April 26, 2022
RH &TEMPERATURE	Met One Instruments	083E-1-35	R17149	September 13, 2022
BAROMETRIC PRESSURE	Met One Instruments	092	A11355	May 10, 2022
Primary Flow Meter	TSI	4040H	4040 1938 002	November 10, 2022
LD-3B	SIBATA	LD-3B	6X7759	March 12, 2022

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111   Fax (541) 471-7116

Certificate of Calibration

ES-642
Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642   **80708 Firmware Rev:** 1.2.0
Serial Number: P22922
Calibrated By: Brycee Fry AT5   **Cal. Date:** 07/20/2022
Quality Inspector: AT14   **Date:**
Calibration Hrz/ug: 8.05   **Laser Current mA:** 29.2

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail   ES-642 BP Sensor: [✓ Pass]/ Fail
ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail   ES-642 RH Sensor: [✓ Pass]/ Fail
0-10 Volts Output: [✓ Pass]/ Fail   4-20 ma Output: [✓ Pass]/ Fail
Serial Communication: [✓ Pass]/ Fail   Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: 363   Standard Conc: 360

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642
Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: T22316

Calibrated By: Alice M. **Cal. Date:** Apr 20, 2022

Quality Inspector: AT1 **Date:** APR 22 2022

Calibration Hz/ug: 8.51 **Laser Current mA:** 28.9

Final Test

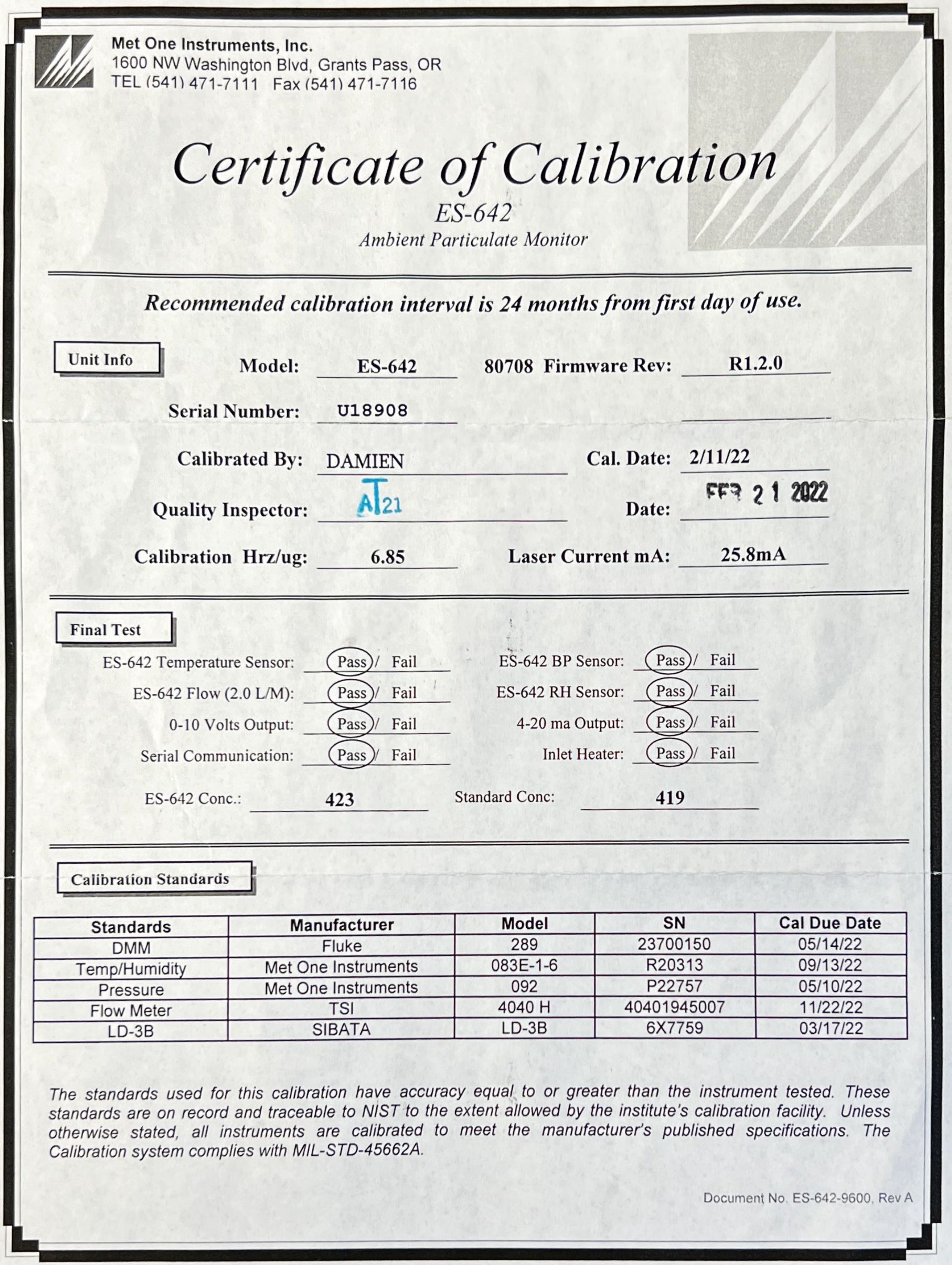
ES-642 Temperature Sensor: [✓ Pass] / Fail
ES-642 BP Sensor: [✓ Pass] / Fail
ES-642 Flow (2.0 L/M): [✓ Pass] / Fail
ES-642 RH Sensor: [✓ Pass] / Fail
0-10 Volts Output: [✓ Pass] / Fail
4-20 ma Output: [✓ Pass] / Fail
Serial Communication: [✓ Pass] / Fail
Inlet Heater: [✓ Pass] / Fail

ES-642 Conc.: 391 Standard Conc.: 387

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/10/22
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.



Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** R1.2.0

Serial Number: U18908

Calibrated By: DAMIEN **Cal. Date:** 2/11/22

Quality Inspector: AT 21 **Date:** FEB 21 2022

Calibration Hrz/ug: 6.85 **Laser Current mA:** 25.8mA

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail
ES-642 BP Sensor: [✓ Pass]/ Fail
ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail
ES-642 RH Sensor: [✓ Pass]/ Fail
0-10 Volts Output: [✓ Pass]/ Fail
4-20 ma Output: [✓ Pass]/ Fail
Serial Communication: [✓ Pass]/ Fail
Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: **423** Standard Conc: **419**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	289	23700150	05/14/22
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/10/22
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	03/17/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Document No. ES-642-9600, Rev A

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642   **80708 Firmware Rev:** 1.2.0

Serial Number: W12870

Calibrated By: Brycee Fry AT5   **Cal. Date:** 09/02/2022

Quality Inspector: AT25   **Date:** SEP 28 2022

Calibration Hrz/ug: 6.88   **Laser Current mA:** 27.7

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail   ES-642 BP Sensor: [✓ Pass]/ Fail

ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail   ES-642 RH Sensor: [✓ Pass]/ Fail

0-10 Volts Output: [✓ Pass]/ Fail   4-20 ma Output: [✓ Pass]/ Fail

Serial Communication: [✓ Pass]/ Fail   Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: 431   Standard Conc.: 432

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	04/22/23

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: **ES-642** **80708** **Firmware Rev:** **1.2.0**

Serial Number: **W12872**

Calibrated By: **Alice M.** **Cal. Date:** **Jul 1, 2022**

Quality Inspector: AT8 **Date:** JUL 0 1 2022

Calibration Hz/ug: **7.94** **Laser Current mA:** **28.8**

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail
ES-642 BP Sensor: [✓ Pass]/ Fail
ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail
ES-642 RH Sensor: [✓ Pass]/ Fail
0-10 Volts Output: [✓ Pass]/ Fail
4-20 ma Output: [✓ Pass]/ Fail
Serial Communication: [✓ Pass]/ Fail
Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: **434**
Standard Conc: **432**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0
Serial Number: X11138
Calibrated By: Alice M. **Cal. Date:** Apr 20, 2022
Quality Inspector: AT1 **Date:** APR 22 2022
Calibration Hz/ug: 7.56 **Laser Current mA:** 28.5

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail
ES-642 BP Sensor: [✓ Pass]/ Fail
ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail
ES-642 RH Sensor: [✓ Pass]/ Fail
0-10 Volts Output: [✓ Pass]/ Fail
4-20 ma Output: [✓ Pass]/ Fail
Serial Communication: [✓ Pass]/ Fail
Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: 477
Standard Conc: 473

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/10/22
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** R1.2.0

Serial Number: X11139

Calibrated By: DAMIEN **Cal. Date:** 2/11/22

Quality Inspector: AT21 **Date:** FEB 21 2022

Calibration Hrz/ug: 7.07 **Laser Current mA:** 27.5mA

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail

ES-642 BP Sensor: [✓ Pass]/ Fail

ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail

ES-642 RH Sensor: [✓ Pass]/ Fail

0-10 Volts Output: [✓ Pass]/ Fail

4-20 ma Output: [✓ Pass]/ Fail

Serial Communication: [✓ Pass]/ Fail

Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: **411**

Standard Conc: **415**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	289	23700150	05/14/22
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/10/22
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	03/17/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: **ES-642** **80708 Firmware Rev:** **1.2.0**

Serial Number: **X11140**

Calibrated By: Brycee Fry AT5 **Cal. Date:** **08/15/2022**

Quality Inspector: AT14 **Date:** AUG 16 2022

Calibration Hrz/ug: **7.89** **Laser Current mA:** **28.0**

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail

ES-642 BP Sensor: [✓ Pass]/ Fail

ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail

ES-642 RH Sensor: [✓ Pass]/ Fail

0-10 Volts Output: [✓ Pass]/ Fail

4-20 ma Output: [✓ Pass]/ Fail

Serial Communication: [✓ Pass]/ Fail

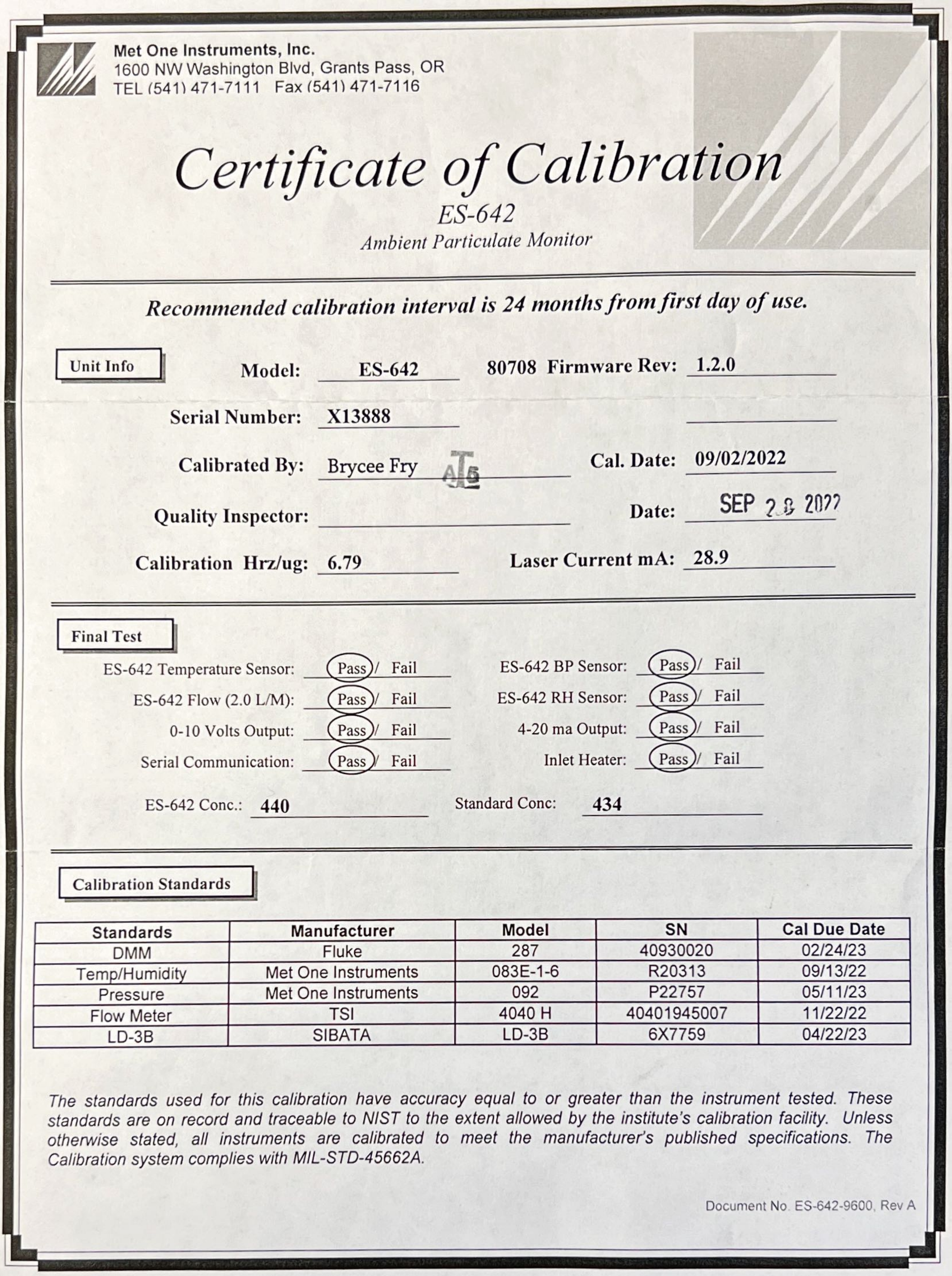
Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: **362** Standard Conc: **364**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.



Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X13888

Calibrated By: Brycee Fry AT5 **Cal. Date:** 09/02/2022

Quality Inspector: **Date:** SEP 28 2022

Calibration Hrz/ug: 6.79 **Laser Current mA:** 28.9

Final Test

ES-642 Temperature Sensor: [✓ Pass] / Fail ES-642 BP Sensor: [✓ Pass] / Fail

ES-642 Flow (2.0 L/M): [✓ Pass] / Fail ES-642 RH Sensor: [✓ Pass] / Fail

0-10 Volts Output: [✓ Pass] / Fail 4-20 ma Output: [✓ Pass] / Fail

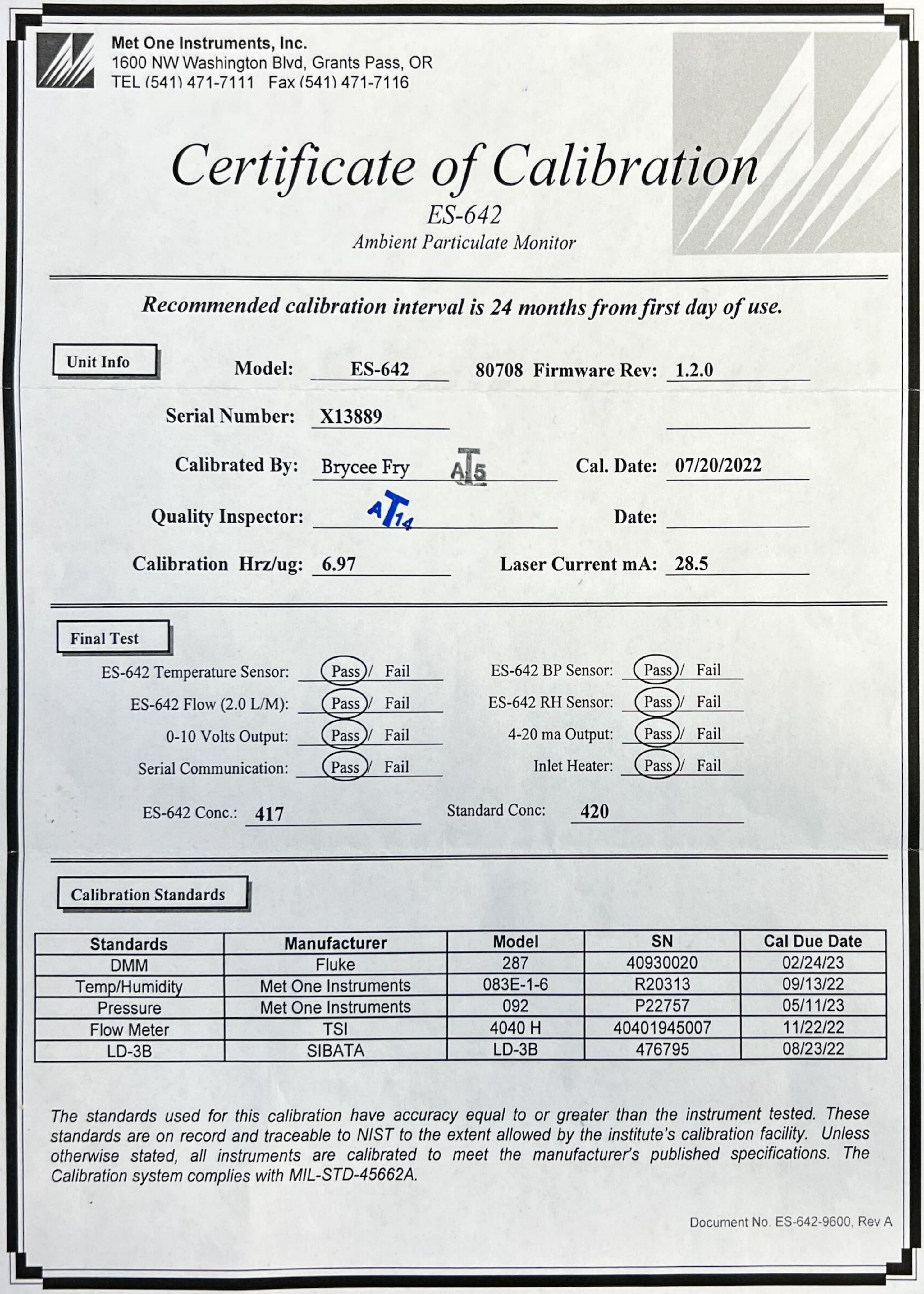
Serial Communication: [✓ Pass] / Fail Inlet Heater: [✓ Pass] / Fail

ES-642 Conc.: 440 Standard Conc.: 434

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	6X7759	04/22/23

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.



Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0

Serial Number: X13889

Calibrated By: Brycee Fry AT5 **Cal. Date:** 07/20/2022

Quality Inspector: AT14 **Date:**

Calibration Hrz/ug: 6.97 **Laser Current mA:** 28.5

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail

ES-642 BP Sensor: [✓ Pass]/ Fail

ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail

ES-642 RH Sensor: [✓ Pass]/ Fail

0-10 Volts Output: [✓ Pass]/ Fail

4-20 ma Output: [✓ Pass]/ Fail

Serial Communication: [✓ Pass]/ Fail

Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: 417

Standard Conc: 420

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111 Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642 **80708 Firmware Rev:** 1.2.0
Serial Number: X13962
Calibrated By: Alice M. **Cal. Date:** Jul 1, 2021
Quality Inspector: AT8 **Date:** JUL 01 2022
Calibration Hz/ug: 7.27 **Laser Current mA:** 28.8

Final Test

ES-642 Temperature Sensor: [✓ Pass]/ Fail
ES-642 BP Sensor: [✓ Pass]/ Fail
ES-642 Flow (2.0 L/M): [✓ Pass]/ Fail
ES-642 RH Sensor: [✓ Pass]/ Fail
0-10 Volts Output: [✓ Pass]/ Fail
4-20 ma Output: [✓ Pass]/ Fail
Serial Communication: [✓ Pass]/ Fail
Inlet Heater: [✓ Pass]/ Fail

ES-642 Conc.: **404**
Standard Conc.: **402**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Met One Instruments, Inc.
1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111   Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642   **80708 Firmware Rev:** 1.2.0

Serial Number: X13963

Calibrated By: Brycee Fry AT6   **Cal. Date:** 08/15/2022

Quality Inspector: AT14   **Date:** AUG 16 2022

Calibration Hrz/ug: 7.78   **Laser Current mA:** 28.8

Final Test

ES-642 Temperature Sensor: [✓ Pass] / Fail
ES-642 BP Sensor: [✓ Pass] / Fail
ES-642 Flow (2.0 L/M): [✓ Pass] / Fail
ES-642 RH Sensor: [✓ Pass] / Fail
0-10 Volts Output: [✓ Pass] / Fail
4-20 ma Output: [✓ Pass] / Fail
Serial Communication: [✓ Pass] / Fail
Inlet Heater: [✓ Pass] / Fail

ES-642 Conc.: **399**   Standard Conc: **398**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

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1600 NW Washington Blvd, Grants Pass, OR
TEL (541) 471-7111   Fax (541) 471-7116

Certificate of Calibration

ES-642

Ambient Particulate Monitor

Recommended calibration interval is 24 months from first day of use.

Unit Info

Model: ES-642   **80708 Firmware Rev:** 1.2.0

Serial Number: X14320

Calibrated By: Brycee Fry   **Cal. Date:** 05/19/2022

Quality Inspector: ______   **Date:** ______

Calibration Hrz/ug: 7.47   **Laser Current mA:** 28.6

Final Test

ES-642 Temperature Sensor: [✓ Pass] / Fail
ES-642 BP Sensor: [✓ Pass] / Fail
ES-642 Flow (2.0 L/M): [✓ Pass] / Fail
ES-642 RH Sensor: [✓ Pass] / Fail
0-10 Volts Output: [✓ Pass] / Fail
4-20 ma Output: [✓ Pass] / Fail
Serial Communication: [✓ Pass] / Fail
Inlet Heater: [✓ Pass] / Fail

ES-642 Conc.: **405**   Standard Conc: **404**

Calibration Standards

Standards	Manufacturer	Model	SN	Cal Due Date
DMM	Fluke	287	40930020	02/24/23
Temp/Humidity	Met One Instruments	083E-1-6	R20313	09/13/22
Pressure	Met One Instruments	092	P22757	05/11/23
Flow Meter	TSI	4040 H	40401945007	11/22/22
LD-3B	SIBATA	LD-3B	476795	08/23/22

The standards used for this calibration have accuracy equal to or greater than the instrument tested. These standards are on record and traceable to NIST to the extent allowed by the institute's calibration facility. Unless otherwise stated, all instruments are calibrated to meet the manufacturer's published specifications. The Calibration system complies with MIL-STD-45662A.

Appendix E – Amendments I – V to the CAMP

(As of February 17, 2023)

Gowanus Canal Superfund Site Community Air Monitoring Plan for Remedial Target Area 1

Amendment I

July 15, 2021

This document serves to provide clarification and updates to the Community Air Monitoring Plan (CAMP) for the Gowanus Canal Superfund Site, Remedial Target Area 1, dated February 23, 2021.

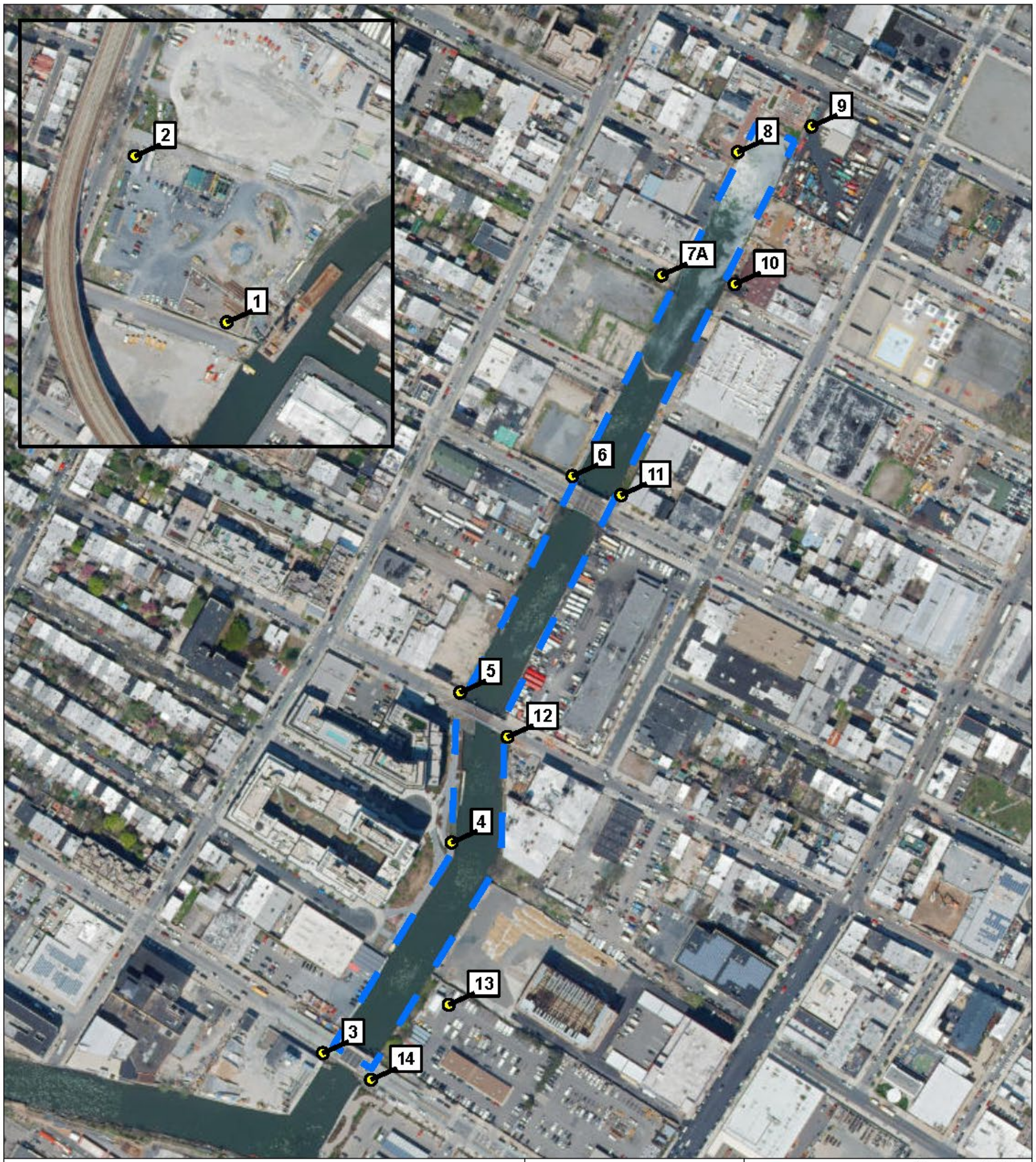
- **Frequency of Site Surveys for Odors, Hydrogen Sulfide, and Ammonia**

  The frequency of odor surveys and periodic measurements of hydrogen sulfide and ammonia in ambient is defined in Table 1, Summary of Gowanus RTA1 CAMP Monitoring Parameters, of the CAMP. The table indicates that these surveys are to be conducted once daily at all 14 station locations. Later, in Section 5.3 and 5.5, the frequency of additional surveys is further defined. Additional surveys are warranted at station locations surrounding active remediation work, especially work that is expected to generate odors. In summary - site surveys for odors, hydrogen sulfide and ammonia will be conducted daily; once at all station locations and additionally one to two more times at two to four stations in the vicinity of active remediation. This results in 18-22 measurement events daily.

- **Monitoring Station Locations**

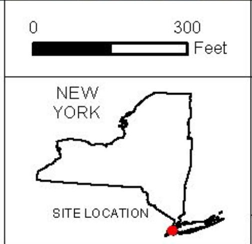
  The monitoring network, comprised of fourteen monitoring stations surrounding the canal, is described in Section 8 of the CAMP. The fourteen-station network has been in continuous operation since the project began in October 2020. On April 6, 2021 Station 7, located on the west side of the canal on Sackett Street, was relocated due to construction activities at a nearby property. Station 7 was removed from service, relocated to the west end of Degraw Street and labeled Station 7A. Table 3: Coordinates and Descriptions of Monitoring Locations, and Figure 2: Monitoring Locations, of the CAMP have been revised and included in this amendment to reflect the changes in network configuration.

Revised - Figure 2: Monitoring Station Locations



● CAMP Monitoring Station

▨ Canal Remediation Target Area 1



TRC

Wannalancit Mills
650 Suffolk Street
Lowell, MA 01854
978-970-5600

Figure 2: CAMP MONITORING STATION LOCATIONS GOWANUS CANAL, BROOKLYN, NY

FIGURE 2	APRIL 2021

Base Map: Esri and its contributors

S:\1-PROJECTS\Gowanus Environmental Remediation\Aprx\Camp Monitoring2021_04_12.aprx

Revised - Table 3: Coordinates and Descriptions of Monitoring Locations

Site Number	Latitude N	Longitude W	Location Description
1	40° 40’ 30.97”	73° 59’ 47.59”	SE Corner Citizens Site Staging Area
2	40° 40’ 34.45”	73° 59’ 48.87”	NE Corner Citizens Site Staging Area
3	40° 40’ 34.18”	73° 59’ 25.33”	West Side 3rd St. Bridge
4	40° 40’ 38.57”	73° 59’ 21.94”	Bond Walkway at 1st St
5	40° 40’ 42.02”	73° 59’ 21.70”	Northwest Carroll St. Bridge
6	40° 40’ 46.68”	73° 59’ 18.40”	Northwest Union St. Bridge
7	40° 40’ 48.76”	73° 59’ 17.19”	End of Sackett St. (removed 4/6/2021)
7A	40° 40' 50.91”	73° 59' 15.76”	Degraw St. West Side
8	40° 40' 53.73"	73° 59' 13.87"	Flushing Tunnel SW Corner
9	40° 40' 54.29"	73° 59' 11.66"	Flushing Tunnel NW Corner
10	40° 40' 50.56”	73° 59' 14.19"	Degraw St. East Side (Under Construction)
11	40° 40’ 46.21”	73° 59’ 17.63”	NE Union St. Bridge
12	40° 40’ 41.06”	73° 59’ 20.42”	SE Carroll St. Bridge
13	40° 40’ 35.62”	73° 59’ 22.05”	NE Corner Verizon Property
14	40° 40’ 33.63”	73° 59’ 24.23”	SE Corner 3rd St. Bridge (Preferred)

Gowanus Canal Superfund Site Community Air Monitoring Plan for Remedial Target Area 1

Amendment II

July 16, 2021

This document serves to provide clarification and updates to the Community Air Monitoring Plan (CAMP) for the Gowanus Canal Superfund Site, Remedial Target Area 1, dated February 23, 2021.

- **Odor Survey Forms - Monitoring Station Locations**

  The monitoring network, comprised of fourteen monitoring stations surrounding the canal, is described in Section 8 of the CAMP. The fourteen-station network has been in continuous operation since the project began in October 2020. On April 6, 2021 Station 7, located on the west side of the canal on Sackett Street, was relocated due to construction activities at a nearby property. Station 7 was removed from service, relocated to the west end of Degraw Street and labeled Station 7A. Figure 1 – Odor Survey Form, of the CAMP have been revised and included in this amendment to reflect the changes in network configuration.

Revised - Figure 1: Odor Survey Form

Project Name:	Gowanus Canal Superfund Site
Project Location:	Brooklyn, NY
Wind Direction & Speed:	/
Project Activities:	

TIME	LOCATION (STATION #)	ODOR CLASSIFICATION (0, 1, 2, or 3)*	H2S (ppb)	NH3 (ppb)	OBSERVATIONS
:	ST-1				
:	ST-2				
:	ST-3				
:	ST-4				
:	ST-5				
:	ST-6				
:	ST-7A				
:	ST-8				
:	ST-9				
:	ST-10				
:	ST-11				
:	ST-12				
:	ST-13				
:	ST-14				

Conducted By:	
Signature:	
Date:	

* See odor key included in Odor / NH_3 / H_2S Binder

Gowanus Canal Superfund Site Community Air Monitoring Plan for Remedial Target Area 1

Amendment III

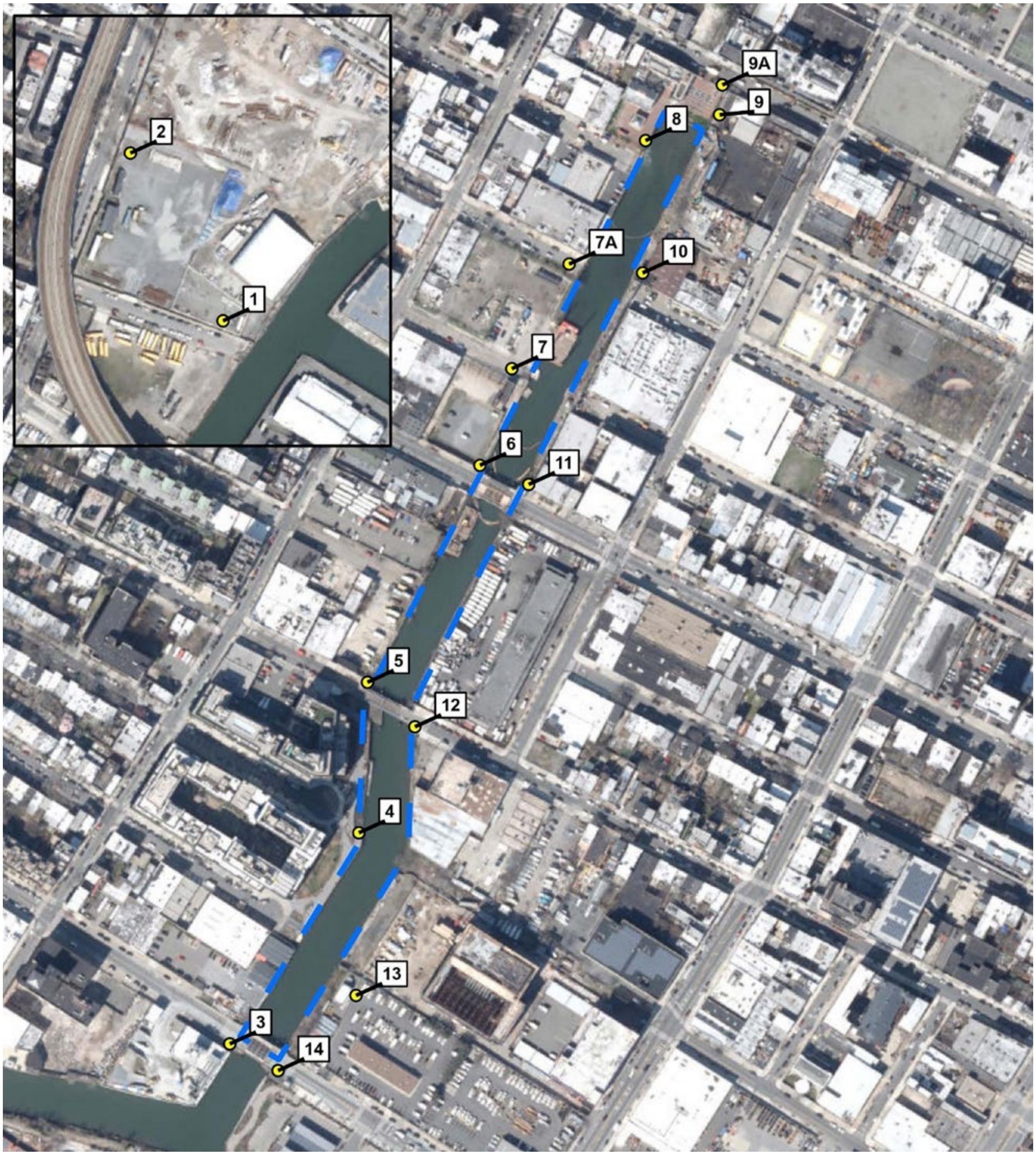
March 18, 2022

This document serves to provide clarification and updates to the Community Air Monitoring Plan (CAMP) for the Gowanus Canal Superfund Site, Remedial Target Area 1, dated February 23, 2021.

❖ Monitoring Station Locations

The monitoring network, comprised of fourteen monitoring stations surrounding the canal, is described in Section 8 of the CAMP. The fourteen-station network has been in continuous operation since the project began in October 2020. On March 16, 2022 Station 9, located on the northeast corner of the canal, was relocated due to the start of construction and demolition activities on the property. These activities are unrelated to the Gowanus Canal Superfund Project. Station 9 was removed from service, relocated to Butler Street on the northeast corner of the canal, and labeled Station 9A. Figure 2: Monitoring Locations, and Table 3: Coordinates and Descriptions of Monitoring Locations, of the CAMP have been revised and included in this amendment to reflect the changes in network configuration.

Revised - Figure 2: Monitoring Station Locations



Revised - Table 3: Coordinates and Descriptions of Monitoring Locations

Site Number	Latitude N	Longitude W	Location Description
1	40° 40’ 30.97”	73° 59’ 47.59”	SE Corner Citizens Site Staging Area
2	40° 40’ 34.45”	73° 59’ 48.87”	NE Corner Citizens Site Staging Area
3	40° 40’ 34.18”	73° 59’ 25.33”	West Side 3rd St. Bridge
4	40° 40’ 38.57”	73° 59’ 21.94”	Bond Walkway at 1st St
5	40° 40’ 42.02”	73° 59’ 21.70”	Northwest Carroll St. Bridge
6	40° 40’ 46.68”	73° 59’ 18.40”	Northwest Union St. Bridge
7	40° 40’ 48.76”	73° 59’ 17.19”	End of Sackett St. (removed 4/6/2021)
7A	40° 40' 50.91”	73° 59' 15.76”	Degraw St. West Side
8	40° 40' 53.73"	73° 59' 13.87"	Flushing Tunnel SW Corner
9	40° 40' 54.29"	73° 59' 11.66"	Flushing Tunnel NE Corner (removed 3/16/2022)
9A	40° 40' 54.88"	73° 59' 11.63"	Flushing Tunnel NE Corner on Butler Street
10	40° 40' 50.56”	73° 59' 14.19"	Degraw St. East Side (Under Construction)
11	40° 40’ 46.21”	73° 59’ 17.63”	NE Union St. Bridge
12	40° 40’ 41.06”	73° 59’ 20.42”	SE Carroll St. Bridge
13	40° 40’ 35.62”	73° 59’ 22.05”	NE Corner Verizon Property
14	40° 40’ 33.63”	73° 59’ 24.23”	SE Corner 3rd St. Bridge (Preferred)

Gowanus Canal Superfund Site Community Air Monitoring Plan for Remedial Target Area 1

Amendment IV

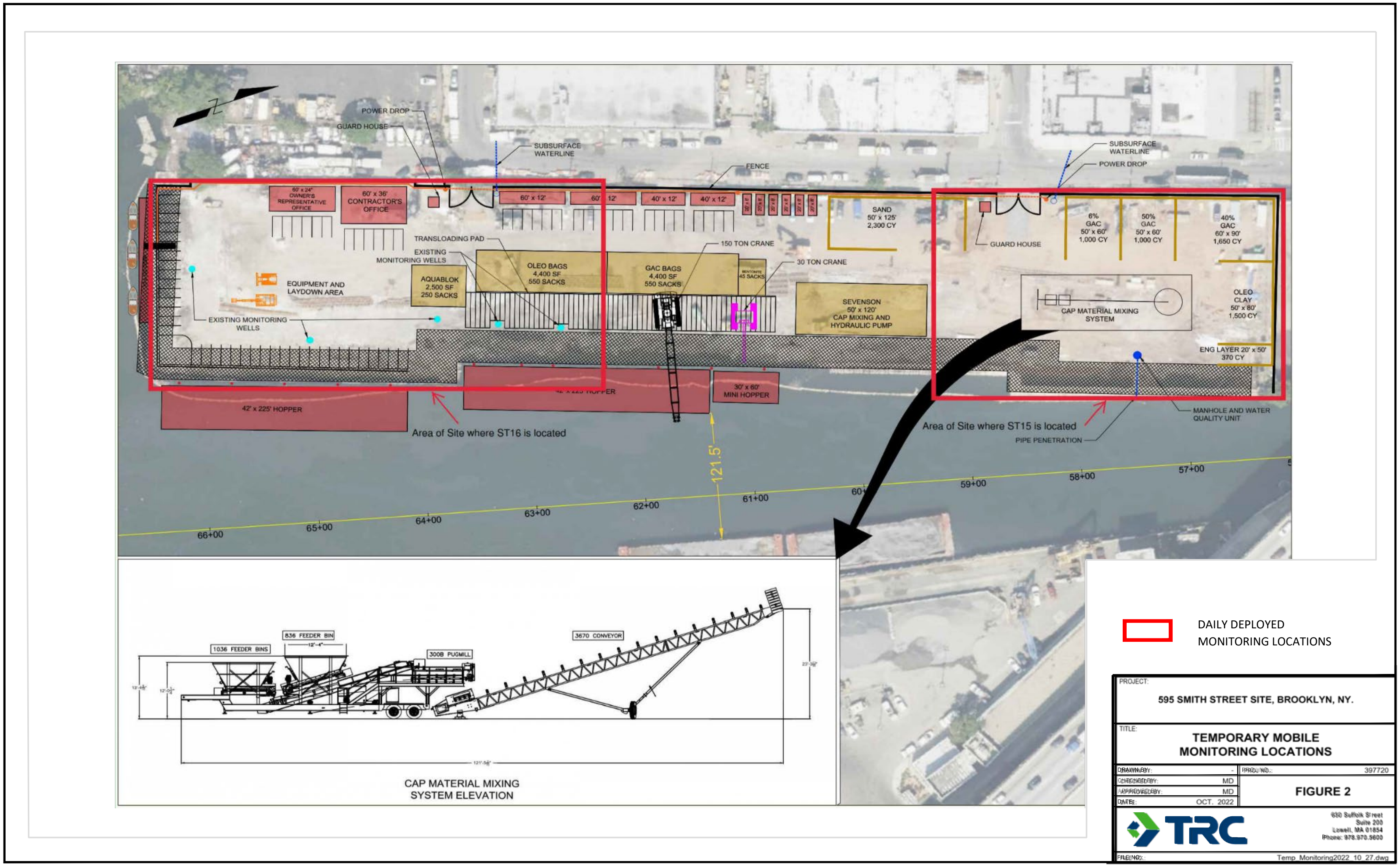
October 31, 2022

This document serves to provide clarification and updates to the Community Air Monitoring Plan (CAMP) for the Gowanus Canal Superfund Site, Remedial Target Area 1, dated February 23, 2021.

- **Additional Temporary Monitoring Station Locations**

  The monitoring network, comprised of fourteen monitoring stations surrounding the canal, is described in Section 8 of the CAMP. The fourteen-station network has been in continuous operation since the project began in October 2020. On October 3rd, 2022, TRC began additional temporary PM_{10} and TVOC monitoring at 595 Smith Street Brooklyn, NY, while the property is being prepared as the new location of the Staging Area. From October 3rd, 2022, through October 5th, 2022, TRC conducted PM_{10} and TVOC monitoring with handheld instruments. On October 6th, 2022, TRC deployed 2 mobile monitoring stations labeled Station 15 and Station 16, with Station 15 being placed daily near active work areas on the North section of the property at 595 Smith Street, and Station 16 on the South section. Stations 15 and 16 are deployed daily during active work hours to monitor TVOC and PM_{10} during various site activities. Figure 2: 595 Smith Street Temporary Monitoring Locations has been added, and Table 3: Coordinates and Descriptions of Monitoring Locations has been revised. Figure 2 and Revised - Table 3 are included in this amendment to reflect the changes in network configuration

Figure 2: 595 Smith Street Temporary Monitoring Station Locations



Revised - Table 3: Coordinates and Descriptions of Monitoring Locations

Site Number	Latitude N	Longitude W	Location Description
1	40° 40’ 30.97”	73° 59’ 47.59”	SE Corner Citizens Site Staging Area
2	40° 40’ 34.45”	73° 59’ 48.87”	NE Corner Citizens Site Staging Area
3	40° 40’ 34.18”	73° 59’ 25.33”	West Side 3rd St. Bridge
4	40° 40’ 38.57”	73° 59’ 21.94”	Bond Walkway at 1st St
5	40° 40’ 42.02”	73° 59’ 21.70”	Northwest Carroll St. Bridge
6	40° 40’ 46.68”	73° 59’ 18.40”	Northwest Union St. Bridge
7	40° 40’ 48.76”	73° 59’ 17.19”	End of Sackett St. (removed 4/6/2021)
7A	40° 40' 50.91”	73° 59' 15.76”	Degraw St. West Side
8	40° 40' 53.73"	73° 59' 13.87"	Flushing Tunnel SW Corner
9	40° 40' 54.29"	73° 59' 11.66"	Flushing Tunnel NE Corner (removed 3/16/2022)
9A	40° 40' 54.88"	73° 59' 11.63"	Flushing Tunnel NE Corner on Butler Street
10	40° 40' 50.56”	73° 59' 14.19"	Degraw St. East Side (Under Construction)
11	40° 40’ 46.21”	73° 59’ 17.63”	NE Union St. Bridge
12	40° 40’ 41.06”	73° 59’ 20.42”	SE Carroll St. Bridge
13	40° 40’ 35.62”	73° 59’ 22.05”	NE Corner Verizon Property
14	40° 40’ 33.63”	73° 59’ 24.23”	SE Corner 3rd St. Bridge (Preferred)
15	Varied	Varied	North Section of 595 Smith Street (mobile Station)
16	Varied	Varied	South Section of 595 Smith Street (mobile station)

Gowanus Canal Superfund Site Community Air Monitoring Plan for Remedial Target Area 1

Amendment V

February 9, 2023

This document serves to provide clarification and updates to the Community Air Monitoring Plan (CAMP) for the Gowanus Canal Superfund Site, Remedial Target Area 1, dated February 23, 2021.

❖ Monitoring Station Locations

The monitoring network, comprised of fourteen monitoring stations surrounding the canal, is described in Section 8 of the CAMP. The fourteen-station network has been in continuous operation since the project began in October 2020. On January 30th, 2023, Cashman finalized demobilization and cleanup at the Citizens Site and all project related equipment were relocated to the Smith Street Staging Area. Stations 1 and 2, previously located on the Citizens Site, were removed from service, and relocated to the Smith Street Staging Area. Station 1 was relocated to the west side of the Staging Area and renamed Station 17 and Station 2 was relocated to the northeast corner of the property and renamed Station 18. On January 30th, 2023, temporary mobile monitoring Stations 15 and 16 were removed from service and Stations 17 and 18 were installed in permanent locations at the Smith Street Staging Area. Figure 1: Station Location Map and Table 1: Coordinates and Descriptions of Monitoring Locations have been revised and are included in this amendment to reflect these changes in network configuration.

Revised - Figure 1: Station Location Map

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Revised – Table 1: Coordinates and Descriptions of Monitoring Locations

Site Number	Latitude N	Longitude W	Location Description
1	40° 40’ 30.97”	73° 59’ 47.59”	SE Corner Citizens Site Staging Area (removed 1/30/2023)
2	40° 40’ 34.45”	73° 59’ 48.87”	NE Corner Citizens Site Staging Area (removed 1/30/2023)
3	40° 40’ 34.18”	73° 59’ 25.33”	West Side 3rd St. Bridge
4	40° 40’ 38.57”	73° 59’ 21.94”	Bond Walkway at 1st St
5	40° 40’ 42.02”	73° 59’ 21.70”	Northwest Carroll St. Bridge
6	40° 40’ 46.68”	73° 59’ 18.40”	Northwest Union St. Bridge
7	40° 40’ 48.76”	73° 59’ 17.19”	End of Sackett St. (removed 4/6/2021)
7A	40° 40' 50.91”	73° 59' 15.76”	Degraw St. West Side
8	40° 40' 53.73"	73° 59' 13.87"	Flushing Tunnel SW Corner
9	40° 40' 54.29"	73° 59' 11.66"	Flushing Tunnel NE Corner (removed 3/16/2022)
9A	40° 40' 54.88"	73° 59' 11.63"	Flushing Tunnel NE Corner on Butler Street
10	40° 40' 50.56”	73° 59' 14.19"	Degraw St. East Side (under construction)
11	40° 40’ 46.21”	73° 59’ 17.63”	NE Union St. Bridge
12	40° 40’ 41.06”	73° 59’ 20.42”	SE Carroll St. Bridge
13	40° 40’ 35.62”	73° 59’ 22.05”	NE Corner Verizon Property
14	40° 40’ 33.63”	73° 59’ 24.23”	East Side 3rd St. Bridge
15	Varied	Varied	North Section of 595 Smith Street (mobile station removed 1/30/2023)
16	Varied	Varied	South Section of 595 Smith Street (mobile station removed 1/30/2023)
17	40° 40’ 11.77”	74° 0’ 1.09”	West side 595 Smith Street Staging Area (front of TRC trailer)
18	40° 40’ 17.05”	73° 59’ 56.40”	NE corner 595 Smith Street Staging Area