HALEY ALDRICH

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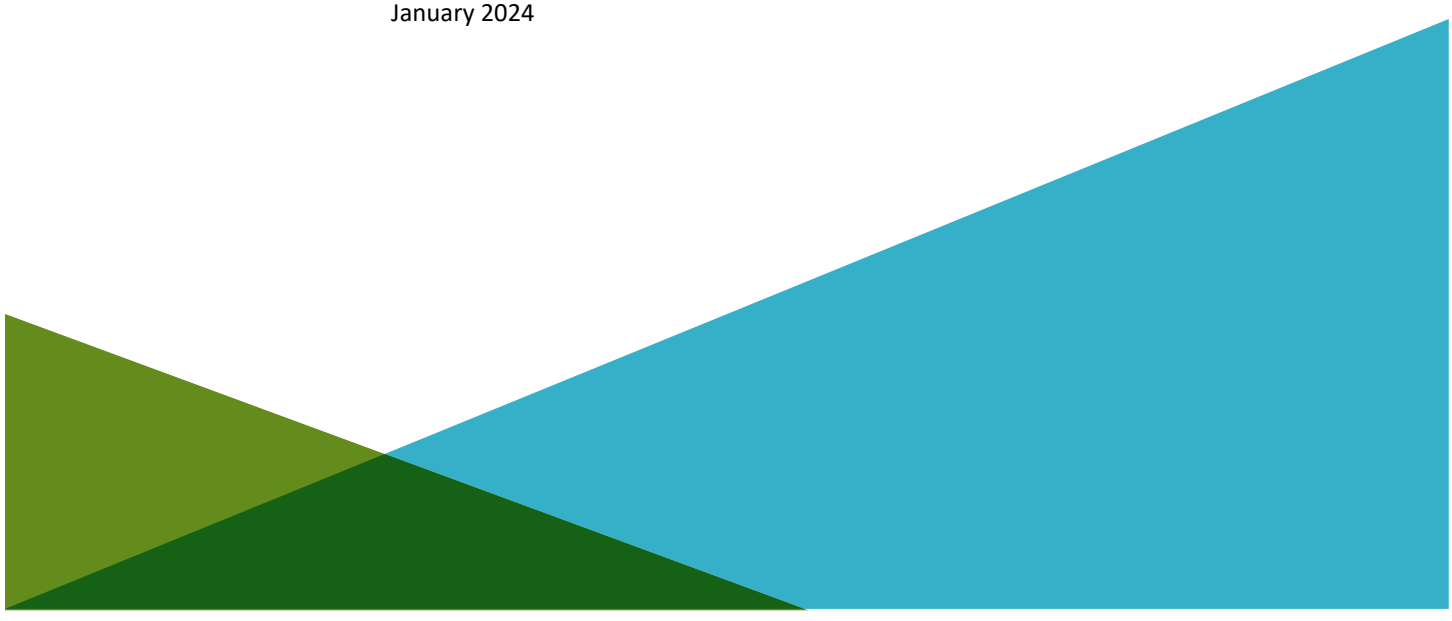
CLEANUP ACTION PLAN
FOR SPOKANE GUN CLUB
SPOKANE VALLEY, WASHINGTON

by
Haley & Aldrich, Inc.
Spokane, Washington

for
Central Valley School District
Spokane Valley, Washington

File No. 0202349-001
January 2024



HALEY & ALDRICH, INC.
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29 January 2024
File No. 0202349-001

Central Valley School District
2218 N Molter Road
Liberty Lake, Washington 99019

Attention: John Parker, Superintendent

Subject: Cleanup Action Plan for Spokane Gun Club, Spokane Valley, Washington

Dear Mr. Parker,

Haley & Aldrich, Inc. (Haley & Aldrich), has prepared this Cleanup Action Plan (CAP) on behalf of the Central Valley School District for the Spokane Gun Club property located at 19615 E Sprague Avenue in Spokane Valley, Washington. We prepared this document to meet the cleanup requirements of the Washington Department of Ecology's Model Toxics Control Cleanup Act (MTCA) under Chapter 173-340 of the Washington Administrative Code and the 5 July 2023 letter from the Washington Department of Ecology (Ecology) providing an opinion on the proposed Cleanup. This site-specific CAP outlines the planned remedial action intended to meet MTCA cleanup levels and allow future development of the subject property.

Sincerely yours,
HALEY & ALDRICH, INC.

Blane Dale, PE
Project Manager / Civil Engineer

John Haney, PE
Senior Environmental Engineer

Attachments
Cleanup Action Plan for Spokane Gun Club, Spokane Valley, Washington

c: Central Valley School District; Attn: Jay Rowell
Washington Department of Ecology; Ted Uecker

https://haleyaldrich.sharepoint.com/sites/CentralValleySchoolDistrict356/Shared Documents/0202349.Gun Club - Bid and Tech Support/Deliverables/CAP/2024-0129 Cleanup Action Plan F.docx

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SIGNATURE PAGE FOR

CLEANUP ACTION PLAN
FOR SPOKANE GUN CLUB
SPOKANE VALLEY, WASHINGTON

PREPARED FOR
CENTRAL VALLEY SCHOOL DISTRICT
SPOKANE VALLEY, WASHINGTON

PREPARED BY:

Blane Dale, PE
Project Manager / Civil Engineer
Haley & Aldrich, Inc.

REVIEWED AND APPROVED BY:

John Haney, PE
Senior Environmental Engineer
Haley & Aldrich, Inc.

Executive Summary

This document presents the Cleanup Action Plan (CAP) for the Spokane Gun Club (Gun Club) located at 19615 E Sprague Ave in Spokane Valley, Washington (subject property). Haley & Aldrich, Inc. (Haley & Aldrich) prepared this CAP in collaboration with the Washington State Department of Ecology (Ecology) and the Central Valley School District (CVSD) to meet the requirements of Ecology's Model Toxics Control Act (MTCA) under Chapter 173-340 of the Washington Administrative Code (WAC). This CAP describes the proposed cleanup action for this subject property and sets forth the cleanup standards for the project. The cleanup will be conducted under Ecology's Voluntary Cleanup Program (VCP); the subject property is listed as Cleanup Site 14851, Facility Site ID 50340.

BACKGROUND

The Gun Club reportedly was constructed in 1948 and operated as a skeet and trap range until July 2021. During operations as a gun range, the subject property was impacted by lead and polycyclic aromatic hydrocarbons (PAHs); lead contamination is the result of the accumulation of lead shot and the PAHs are the result of the accumulation of clay target debris (PAHs in clay targets originate from coal and petroleum binders used in their manufacture) (Hart Crowser, 2018b). PAHs included naphthalene, benzo[a]pyrene (BaP), and carcinogenic PAHs (cPAHs).

The subject property was purchased by CVSD in 2018 and the Gun Club leased and continued to operate the property as a trap and skeet range until July 2021. At the time of purchase, the property consisted of undeveloped grass fields, the Gun Club building, associated infrastructure, and shooting stations located in the southwest corner. CVSD completed an interim action to remove a minor amount of stockpiled, contaminated soil from the northwest portion of the subject property and subdivided the cleaned northwest parcel from the subject property. CVSD subsequently received a "no further action" determination from Ecology on the northeast parcel and built Ridgeline High School on the property.

Hart Crowser, Inc. (Hart Crowser, now Haley & Aldrich) conducted Phase I and Phase II Environmental Site Assessment (ESA) activities between July 2018 and March 2021 and prepared a Remedial Investigation (RI) and Feasibility Study (FS) report on behalf of the CVSD and submitted the report to Ecology for review. The RI summarizes the findings and results of site assessment activities conducted by Hart Crowser and describes the nature, magnitude, and extent of contamination at the subject property. The FS provides an evaluation of cleanup alternatives and a recommendation for a feasible remedy that is protective of human health and the environment. Results of the RI/FS were used to inform this CAP.

During operations as a gun range, the Gun Club periodically recovered and recycled lead shot from the range areas northeast of the shooting stations. Following the closure of the gun range in 2021, the Gun Club conducted a final recovery and reclamation effort for recycling lead shot before permanently vacating the property. The Gun Club has since vacated the property. Lead shot, clay pigeon debris, and soil contaminated with lead and PAHs are still present and will require cleanup.

CLEANUP ACTION OVERVIEW

This CAP outlines the remedial action intended to bring the subject property into compliance with Ecology's MTCA Method A Cleanup Criteria for unrestricted land use and allow for future development. Contaminants of concern (COC) include lead, PAHs, and arsenic. The selected remedy for the subject

property consists of excavating and consolidating media containing COCs greater than MTCA Method A cleanup levels into an on-site repository constructed in the northwest corner.

In some portions of the gun range, lead concentrations exceed the Toxicity Characteristic Leaching Procedure maximum concentration of 5 milligrams per liter (mg/L) in soil and therefore are designated in the State of Washington as Dangerous Waste. These soils will be treated in situ to stabilize leachable lead below the Dangerous Waste toxicity criteria maximum contaminant levels prior to placement in the repository. Excavated soils impacted by COC also will be placed in the repository.

The proposed repository will be capped with a high-density polyethylene (HDPE) liner that extends to an anchor trench to encapsulate the COC-contaminated soils. The HDPE liner will be covered with soil generated from repository subgrade construction and then capped with a vegetative cover and possibly asphalt for a small parking lot. The on-site repository allows for the containment of soils in a controlled environment and minimizes potential exposure pathways with a physical barrier. CVSD will subdivide the subject property so the repository is separated from the remaining developable land and CVSD will obtain a restrictive covenant for the repository parcel to restrict future land use and provide for long-term management of the repository.

To confirm cleanup standards are met and to document the effectiveness of the remedy, Haley & Aldrich will collect confirmation samples. This includes sampling to confirm soils are treated to below the Dangerous Waste criteria concentration of 5 mg/L leachable lead prior to placement in the repository and confirmation sampling for arsenic, lead, and PAH concentrations in surface soils following remedial excavations. Haley & Aldrich will compare analytical results against MTCA Method A cleanup levels for unrestricted land use. If confirmation sample analytical results indicate further soil treatment and/or excavation is necessary to meet cleanup standards, additional treatment will be conducted and/or excavations will be deepened until confirmation sample analytical results indicate cleanup standards are met. A detailed sampling analysis plan to demonstrate and confirm compliance with WAC 173-340-410 and the proposed cleanup standards is provided in the “Confirmation Sampling Work Plan for Spokane Gun Club,” in Appendix A.

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List of Acronyms and Abbreviations:

Abbreviation	Definition
mg/m^3	milligrams per cubic meter
ARARs	applicable, relevant, and appropriate requirements
bgs	below ground surface
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
COC	contaminants of concern
cPAHs	carcinogenic PAHs
CSM	conceptual site model
CVSD	Central Valley School District
Ecology	Washington State Department of Ecology
ESA	Environmental Site Assessment
FS	Feasibility Study
ft	feet
Gun Club	Spokane Gun Club
Haley & Aldrich	Haley & Aldrich, Inc.
Hart Crowser	Hart Crowser, a Division of Haley & Aldrich
HDPE	high-density polyethylene
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MTCA	Model Toxics Control Cleanup Act
OSHA	Occupational Safety and Health Administration
PAHs	polycyclic aromatic hydrocarbons
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SEPA	Washington State Environmental Policy Act
TCLP	Toxicity Characteristic Leaching Procedure
VCP	Washington State Department of Ecology Voluntary Cleanup Plan
WAC	Washington Administrative Code
Work Plan	Confirmation Sampling Work Plan

1. Introduction

This document presents the Cleanup Action Plan (CAP) for the Spokane Gun Club (Gun Club) located at 19615 E Sprague Avenue in Spokane Valley, Washington (subject property); the location of the subject property is shown in "Site Vicinity Map," Figure 1. Haley & Aldrich, Inc. (Haley & Aldrich) prepared this CAP in collaboration with the Washington State Department of Ecology (Ecology) and the Central Valley School District (CVSD) to meet the requirements of Ecology's Model Toxics Control Act (MTCA) under Chapter 173-340 of the Washington Administrative Code (WAC) and the 5 July 2023 letter from the Washington Department of Ecology (Ecology, 2023). This CAP describes the proposed cleanup action and sets forth the cleanup standards for the project. The cleanup will be conducted under Ecology's Voluntary Cleanup Program (VCP); subject property is listed as Cleanup Site 14851, Facility Site ID 50340.

This CAP was prepared at the request of Ecology and is intended to comply with the requirements of Ecology's MTCA Cleanup Regulations found in the WAC, Chapter 173-340. The purpose of the CAP is to describe the proposed cleanup action for the subject property, including:

- Description of the subject property;
- Summary of current subject property conditions;
- Description of the selected cleanup action;
- Site-specific cleanup levels and points of compliance for each hazardous substance and medium of concern for the proposed cleanup action;
- Applicable state and federal laws for the proposed cleanup action;
- Location of residual contamination remaining on the subject property after cleanup;
- Restrictions on future uses and activities at the subject property to ensure continued protection of human health and the environment;
- Compliance monitoring requirements; and
- The schedule for implementing the cleanup.

1.1 PREVIOUS STUDIES

Hart Crowser, Inc. (Hart Crowser, now Haley & Aldrich) conducted a Phase I Environmental Site Assessment (ESA) on the Gun Club property, which included the subject property, in August 2018. Results of the Phase I ESA are documented in Hart Crowser's *Phase I Environmental Site Assessment, North Henry Road and East Sprague Avenue* (Hart Crowser, 2018a). Haley & Aldrich conducted Phase II ESA activities at the subject property between July 2018 and February 2021. Assessment activities conducted in 2018 are detailed in the *Focused Phase II Environmental Site Assessment: North Henry Road and East Sprague Avenue, Greenacres, Washington* technical memorandum (Hart Crowser, 2018b). Additionally, an interim action was completed to remove contaminated soil stockpiles and address lead-contaminated soil near the southern boundary of parcel 55176.9206 in September 2018. The interim action was completed to expedite the construction of Ridgeline High School on land east of the subject property. Activities related to the interim action are detailed in the 4 January 2019, *Interim Action Report, Former Spokane Gun Club Property* (Hart Crowser, 2019).

Site assessment and remedial investigation (RI) activities included: excavating 98 test pits, advancing 19 direct-push borings, and drilling 20 sonic borings; locations of these assessment locations are shown on "Site Plan," Figure 2. Findings from assessment activities are provided in the *Spokane Gun Club Remedial Investigation/Feasibility Study* report (Hart Crowser, 2021). Results of the RI/Feasibility Study (FS) were used to inform this CAP for the subject property. Based on the results of the assessments, contaminants of concern (COC) at the subject property include lead, polycyclic aromatic hydrocarbons (PAHs) and, to a lesser extent, arsenic. These COC are present at variable locations and depths ranging between ground surface and approximately 10 feet (ft) below ground surface (bgs). Lead and PAHs concentrations in soil relative to depth are shown on "Magnitude and Extent of Contamination," Figure 3. Locations where arsenic concentrations in soil exceed cleanup levels are sporadic and collocated with lead-contaminated soil; therefore, not shown on the figure.

In certain portions of the gun range, soils contain leachable lead concentrations greater than 5 milligrams per liter (mg/L) when extracted using the Toxicity Characteristic Leaching Procedure (TCLP). Lead concentrations that exceed the threshold of 5 mg/L characterize as Washington State Dangerous Waste under the toxicity criteria and are subject to the Land Disposal Restrictions in WAC 173-303-140. They must be treated to below the threshold prior to on-site containment. Until stabilized, these materials require more robust handling, storage, transportation, and record-keeping requirements once excavated, unless stabilized in situ. A screening level for stabilization of 3,250 milligrams per kilogram (mg/kg) was proposed in the draft Cleanup Action Plan (dCAP) and supported further in the Dangerous Waste Screening Level Assessment Report (Haley & Aldrich, 2024).

1.2 REGULATORY FRAMEWORK

This CAP addresses subject property soil contaminants in accordance with the MTCA cleanup levels for unrestricted land use for metals and PAHs. Cleanup action activities will comply with the Dangerous Waste regulations in WAC 173-303, applicable county and local regulations, state and federal laws, and legally applicable requirements and those requirements that Ecology determines are relevant and appropriate.

2. Subject Property Description

The subject property was purchased by CVSD in 2018 and the Gun Club continued trap and skeet range operations under lease until July 2021. At the time of purchase, the property consisted of undeveloped grass fields with infrastructure for the Gun Club building and trap and skeet shooting stations located in the southwest corner. The subject property consists of Spokane County parcel numbers 55174.9208, 55174.9210, 55174.9211, and the southern portion of parcel 55176.9206.

2.1 SUBJECT PROPERTY HISTORY

Historic aerial photographs from 1938 indicate the subject property was used as farmland prior to operation as a gun range. Historical aerial photographs indicate there were slight changes in the delineation of fields and unpaved roads within the subject property boundaries, but the property remained undeveloped until sometime between 1946 and 1950; the Gun Club reportedly was constructed in 1948, which aligns with the aerial photographs. Throughout operations as a gun range, the subject property has been impacted by lead and PAHs; lead contamination is the result of the accumulation of lead shot and the PAHs are the result of the accumulation of clay pigeon target debris (PAHs originate from coal and petroleum binders used to manufacture clay pigeon targets) (Hart Crowser, 2021). PAHs included naphthalene, benzo[a]pyrene (BaP), and carcinogenic PAHs (cPAHs). The source of arsenic is unknown.

During operations as a trap and skeet range, the Gun Club periodically recovered and recycled lead shot from the range area northeast of the shooting stations; the Gun Club also conducted a final lead recovery and recycling effort before permanently vacating the property. A minor amount of lead shot/fragments likely remain on the subject property along with clay pigeon debris and soil contaminated with lead and PAHs.

2.2 HUMAN HEALTH AND ENVIRONMENTAL CONCERNS

This CAP provides a summary of planned activities CVSD intends to conduct to reduce the potential risk to human health and the environment from COCs present at the subject property: arsenic, lead, and PAHs (i.e., naphthalenes, benzo(a)pyrene, and cPAHs). Both lead and PAHs are found throughout the gun range with lead- and PAH-impacted soils occurring near to the ground surface and PAH-impacted soils extending to greater depths. In general, lead is present in the upper 3 ft of gun range soil and PAHs are present to approximately 7 ft bgs in front of the clay target launching stations (Hart Crowser, 2021). Arsenic was detected at concentrations greater than the MTCA Method A cleanup level for unrestricted land use in four of the 31 samples analyzed. Lead exposure can increase cancer risks and be hazardous to the nervous system; PAHs are considered cancer-causing chemicals, and arsenic is a known carcinogen.

Haley & Aldrich prepared a conceptual site model (CSM) to identify and assess potential contaminant sources, fate and transport of chemical substances, media exposure pathways (i.e., surface water, groundwater, surface soil, etc.), and potential receptors. The potential receptors at the subject property include human (site workers, trespassers, etc.), terrestrial plant (grass and shrub vegetation), and ecological (birds, small mammals, etc.). The most likely exposure route is through direct contact with, inhalation of, and/or ingestion of COC-contaminated materials. Potential contaminant transport mechanisms include infiltration through soil during precipitation and snow melt events, erosion through stormwater runoff, wind, and/or anthropogenic means, and bioaccumulation. The CSM is presented in more detail in the RI.

2.3 CLEANUP STANDARDS

The COCs at the subject property include arsenic, lead, and PAHs. The subject property is currently zoned Light Industrial "LI" by Spokane County; however, it is anticipated that the land will undergo a zoning change to allow residential development and/or incorporation into the City of Liberty Lake. Therefore, the proposed cleanup levels for contaminated soil at the subject property are MTCA Method A for unrestricted land use. The MTCA Method A cleanup levels for unrestricted land use for COCs found at the subject property include:

- 250 mg/kg lead
- 20 mg/kg arsenic
- 0.1 mg/kg benzo(a)pyrene
- 0.1 mg/kg total toxic equivalent soil concentrations (cPAHs)
- 5 mg/kg total naphthalenes

Some soils at the subject property contain leachable lead concentrations that characterize the material as Dangerous Waste and will designate as Dangerous Waste if generated by excavation. These materials are subject to the Land Disposal Restrictions in WAC 173-303-140 and must be treated prior to disposal following generation. However, these materials can be stabilized in situ to reduce leachability to below the toxicity criteria concentrations, so they no longer are considered Dangerous Waste following excavation.

3. Cleanup Action Alternatives Analysis

Elevated metal and PAHs concentrations in soil are the primary risk drivers for both human and ecological receptors. Candidate remedial technologies and techniques were identified and screened to develop potential cleanup alternatives for further evaluation in the RI and FS report (Hart Crowser, 2021). This CAP aligns with those recommendations as summarized in the following section of this report. Refer to the RI/FS for more detailed documentation of the decision process and criteria.

4. Description of Selected Remedy

This CAP applies to the boundaries of the subject property shown on Figure 2, and the cleanup area shown on Figure 3. The selected remedy consolidates contaminated materials and debris (e.g., clay target and concrete) in an engineered, capped, on-site repository within a new parcel of land that will have a restrictive covenant recorded against it at the completion of the cleanup. This will allow for divestment and/or reuse of the remaining subject property without the encumbrances of environmental contamination. Additionally, an on-site repository allows for the consolidation of COC-contaminated materials in a controlled environment and minimizes or eliminates exposure pathways and transport of contaminants by installing a physical barrier.

The proposed repository will be in the northern portion of the subject property, approximately 4 acres in size, and will be excavated to a maximum depth of about 30 ft bgs (approximately 60 ft above the groundwater table). Materials excavated from the repository will be stockpiled and used as backfill for remedial excavations in a balanced cut-and-fill scenario. A visible barrier will be placed at the bottom of the repository to distinguish native soils from contaminated materials and other materials placed in the repository. The COC-contaminated materials and debris will be excavated, placed, and compacted in the repository. Materials that exceed the TCLP leachable lead concentration of 5.0 mg/L, and are characterized as Dangerous Waste, will be stabilized in situ to below 5.0 mg/L prior to being placed in the repository. Concrete and asphalt sidewalks, pathways, and concrete bunkers will be placed at the bottom of the repository prior to the placement of COC-contaminated materials. No trees, dimensional lumber, pipe, electrical wire, or other materials will be allowed in the repository.

After the COC-contaminated materials have been used to backfill the repository, they will be covered with a non-woven geotextile and a 60-mil, high-density polyethylene (HDPE) top liner that extends to an anchor trench beyond the limits of the deposited materials. The HDPE liner will be covered with a composite drainage net, and cover soil. Most of the cover soil will then be overlaid with topsoil and hydroseeded and/or sodded; a small portion of the repository may be overlaid with a future asphalt parking lot. The finished surface of the engineered cap will be planted with native, Washington grasses, and a gravel pedestrian path; alternatively, the finished surface could be used for a regulation-size soccer field surrounded by native grasses and a pedestrian path. Prior to placing the embankment soil, CVSD will install an irrigation system to help establish and maintain vegetation. Future plans may also include adding vehicle access from East Laberry Drive.

Remedial excavations will be backfilled with materials excavated from the repository; however, the excavated areas likely will not be backfilled to their original grades. Any remedial excavations not backfilled to original grades will be sloped for stability/safety. The backfilled and/or sloped remedial excavations and disturbed areas of the subject property will be hydroseeded with native, Washington grasses.

Based on the CSM, there are three potential contaminant transport mechanisms or pathways for COCs, including: 1) infiltration through soil during precipitation and snow melt events, 2) erosion through stormwater runoff, wind, and/or anthropogenic means, and 3) bioaccumulation. Based on previous environmental investigations, site assessments, and sampling, the most plausible transport mechanisms of COCs at the subject property are infiltration and erosion through wind and anthropogenic transport mechanisms (i.e., foot and vehicle traffic) (Hart Crowser, 2021). However, empirical analytical data from site assessment activities indicates that, despite operating as a gun range for 73 years, lead contamination does not extend deeper than about 3 ft bgs and PAHs do not extend beyond 7 to 10 ft bgs. This data

indicates the rate of migration from infiltration is minimal; therefore, it is unlikely COC materials will migrate into the subsurface after the material is placed in the repository, capped, and no longer subjected to infiltration. After contaminated soils are consolidated within the on-site repository, adverse impacts to groundwater are improbable given the proposed depth of soil placement (30 ft bgs) and the depth to groundwater beneath the subject property (98 ft bgs).

The physical barrier (engineered cap) will not only control contaminant transport from infiltration, it also will control erosion and bioaccumulation. CVSD will conduct the following to address exposure pathways as part of the selected remedy:

- Treat materials with lead concentrations greater than 3,250 mg/kg to stabilize leachable lead.
- Construct an on-site repository for consolidating contaminated materials.
- Excavate COC-contaminated materials until confirmation sampling results indicate COC concentrations are less than MTCA Method A unrestricted land use cleanup levels.
- Encapsulate stabilized materials, COC-contaminated materials greater than MTCA Method A unrestricted land use cleanup levels, and previously mentioned debris in the repository.
- Cover consolidated materials in the repository with an engineered cap consisting of a non-woven geotextile, 60-mil HDPE geomembrane, composite drainage net, on-site borrow materials, topsoil, and grass. A small portion of the engineered cap may be overlaid with asphalt.
- Backfill and grade remedial excavations with surplus native borrow soil excavated from the repository.
- Maintain dust control during earthwork and soil treatment activities.
- Place a restrictive covenant on the repository property.

During construction, a CVSD representative will: monitor and document the corrective action, monitor compliance with engineering design and construction specifications, coordinate and communicate activities with regulators, obtain confirmation samples from excavated areas, collect performance samples of treated soils to document leachable lead has been stabilized, and prepare a report documenting closure activities completed.

4.1 CLEANUP STANDARDS AND POINT OF COMPLIANCE

Confirmation soil samples will be at or below the following concentrations following treatment/remedial excavation:

<u>Dangerous Waste threshold:</u>

- Greater than 3,250 mg/kg lead (total lead screening concentration expected to exceed TCLP)
- Less than or equal to 5.0 mg/L lead TCLP

Soils will be stabilized until confirmation samples are below the TCLP threshold prior to placement in the repository, a detailed description of confirmation sampling is provided in the Confirmation Sampling Work Plan in Appendix A.

Soils with COC concentrations greater than MTCA Method A cleanup levels for unrestricted land use will be excavated and placed in the repository.

MTCA Method A unrestricted land use cleanup levels:

- 20 mg/kg arsenic
- 250 mg/kg lead
- 0.1 mg/kg benzo(a)pyrene
- 0.1 mg/kg total toxic equivalent soil concentration of benzo(a)pyrene for PAH mixtures
- 5 mg/kg total naphthalenes

General Site monitoring will involve the use of real-time particulate air monitoring throughout construction and the implementation of best management practices to control fugitive dust . Two air monitoring locations will be placed downwind. These monitoring locations will be determined daily and adjusted as site conditions change based on wind direction and construction activities. The results will be recorded for documentation that dust control measures were implemented correctly and, in the event of any exceedances, to document the magnitude and extent of the exceedance.

Air Monitoring Point of Compliance:

- 2.5 milligrams per cubic meter (mg/m^3) respirable dust (50 percent of the OSHA Permissible Exposure Limit of 5.0 mg/m^3).

4.2 APPLICABLE, RELEVANT, AND APPROPRIATE REQUIREMENTS

The applicable, relevant, and appropriate requirements (ARARs) that apply to this CAP include:

Federal Regulations:

- RCRA Title 40 of the code of federal Regulations (CFR) – Protection of the Environment.
  - Part 239 – 259 (non-hazardous waste)
  - Parts 260 – 273 (hazardous waste)
- Occupational Safety and Health Administration (OSHA) requirements, detailed in Title 29, CFR (29 CFR) § 1910.120 – Hazardous Waste Operation and Emergency Response
- CFR (29 CFR) § 1926 – Safety and Health Regulations for construction.

Washington State Regulations:

- Washington State Environmental Policy Act (SEPA) (Revised Code of Washington 43.21C and WAC 197-11)
- Dangerous Waste Regulations (WAC 173-303)
- MTCA – Cleanup (WAC 173-340)
- Compliance monitoring requirements (WAC 173-340-410)

County and Local Regulations:

- Code of General Ordinance of Spokane County, Washington
- Spokane Valley Municipal Code

In general, the federal and state regulations apply to the construction and treatment of waste during cleanup activities while county and local regulations apply to deed restrictions and the restrictive covenant placed on the repository as well as land use after construction.

4.3 RESTORATION TIMEFRAME

The remedy proposed is expected to achieve cleanup standards once the remedial excavation is complete and the repository has been capped. Construction of the repository is scheduled to be completed by fall 2024.

4.4 COMPLIANCE MONITORING

Compliance monitoring following the remedial excavation will include collecting confirmation soil samples. Samples will be submitted for analysis for applicable COCs, depending on location, and in accordance with compliance monitoring requirements in WAC 173-340-410. CVSD will use confirmation sampling and analysis to confirm soils with leachable lead have been stabilized to below the Dangerous Waste characteristic concentration maximum contaminant level and to confirm soils with COC concentrations greater than the cleanup standards have been removed and placed within the repository. A detailed description of the proposed confirmation sampling, sampling analysis plan, and the methods used to demonstrate and confirm compliance with WAC 173-340-410 are provided in "Confirmation Sampling Work Plan for Spokane Gun Club," in Appendix A.

Air will be monitored throughout construction and will consist of monitoring using a DustTrak™ DRX Aerosol Monitor 8533 or equivalent monitor downwind of the active work area. A detailed description of the proposed air monitoring and the methods to be used are provided in "Air Monitoring Work Plan for Spokane Gun Club," in Appendix B.

4.5 SCHEDULE FOR IMPLEMENTATION

The proposed remedy is scheduled to be constructed between March 2024 and October 2024. Construction is anticipated to take several months and may begin prior to March 2024, weather permitting.

4.6 INSTITUTIONAL/ENGINEERING CONTROLS

CVSD will implement both interim and permanent institutional controls as part of this corrective action. Interim controls will consist of restricted access prior to and during construction, dust control during construction and earthmoving activities, and perimeter fencing. Because residual contamination will remain within the on-site repository after completion of the cleanup action, CVSD will record permanent institutional controls against the repository parcel in accordance with WAC 173-340-440. Permanent institutional controls will include covenant/deed restrictions to restrict certain uses of the repository parcel, prohibit certain activities, restrict certain leases, and restrict uses of the land that could compromise the integrity of the repository. Examples of engineering controls that must be maintained include the HDPE liner, soil cap, vegetative cover, asphalt cover (if applicable), and surface grading to promote positive drainage away from the repository.

CVSD will prepare a long-term operation and maintenance plan for the repository. Ongoing maintenance of institutional and engineering controls is expected to be limited; however, what maintenance is required will be addressed in accordance with WAC 173-340-440(11) – Financial Assurances. Ongoing maintenance would include maintaining the engineered cover over the repository.

Ecology and its designated representatives will have the right to enter the property at reasonable times for the purpose of evaluating compliance with this CAP and other required plans (e.g., Stormwater Pollution Prevention Plan), including the right to take samples, inspect any remedial actions taken at the subject property, and to inspect records. Additionally, city and county departments with land use planning authority for real property will be contacted regarding the restrictive covenant and asked to provide comments.

Following the cleanup action, no controls will be placed on lands outside the repository confirmed to meet the proposed cleanup levels for contaminated soil at the subject property (i.e., those areas where COCs have been removed and COCs confirmed to be less than MTCA Method A cleanup levels for unrestricted land use).

References

1. Haley & Aldrich, Inc. (Haley & Aldrich), 2024. Dangerous Waste Screening Level Assessment, Former Spokane Gun Club.

2. Hart Crowser 2018a. Phase I Environmental Site Assessment; North Henry Road and East Sprague Avenue Green Acres, Washington. 28 August.

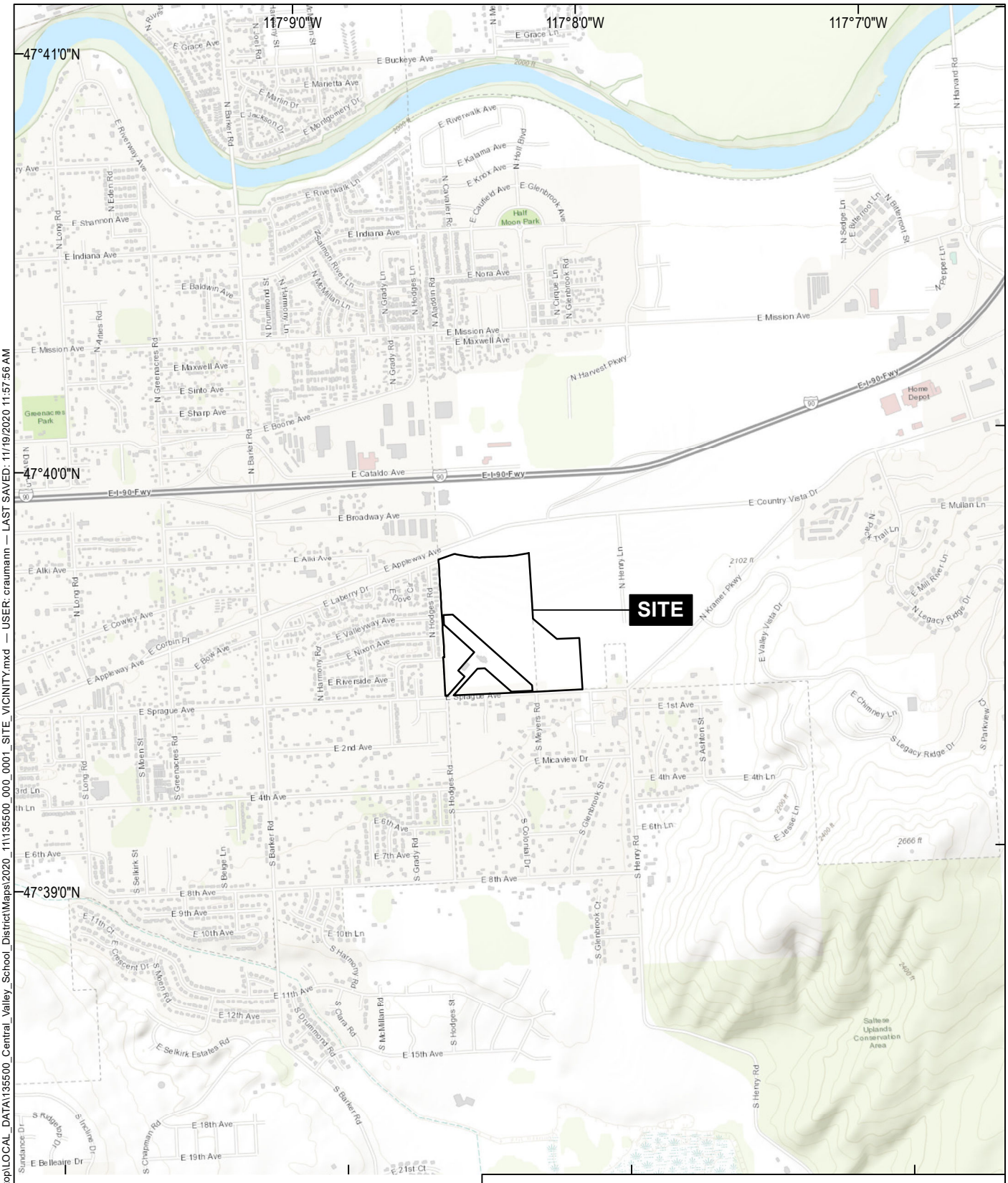
3. Hart Crowser 2018b. Focused Phase II Environmental Site Assessment: North Henry Road and East Sprague Avenue, Greenacres, Washington technical memorandum. 22 October. .

4. Hart Crowser 2019. Interim Action Report, Former Spokane Gun Club Property. January 4, 2019).

5. Hart Crowser. 2021. Spokane Gun Club Range Remedial Investigation/Feasibility Study. Prepared for Central Valley School District by Hart Crowser, a Division of Haley & Aldrich, Spokane, Washington.

6. Washington Department of Ecology (Ecology), 2023. Letter to John Parker of CVSD, "Opinion on Proposed Cleanup of the Following Site: Site Name: Spokane Gun Club Site Address: 19615 E Sprague Ave #9656, Spokane Valley Cleanup Site ID: 14851 Facility/Site ID: 50340 VCP Project ID: EA0374." 5 July.

FIGURES



HALEY ALDRICH

SPOKANE GUN CLUB
GREENACRES, WASHINGTON

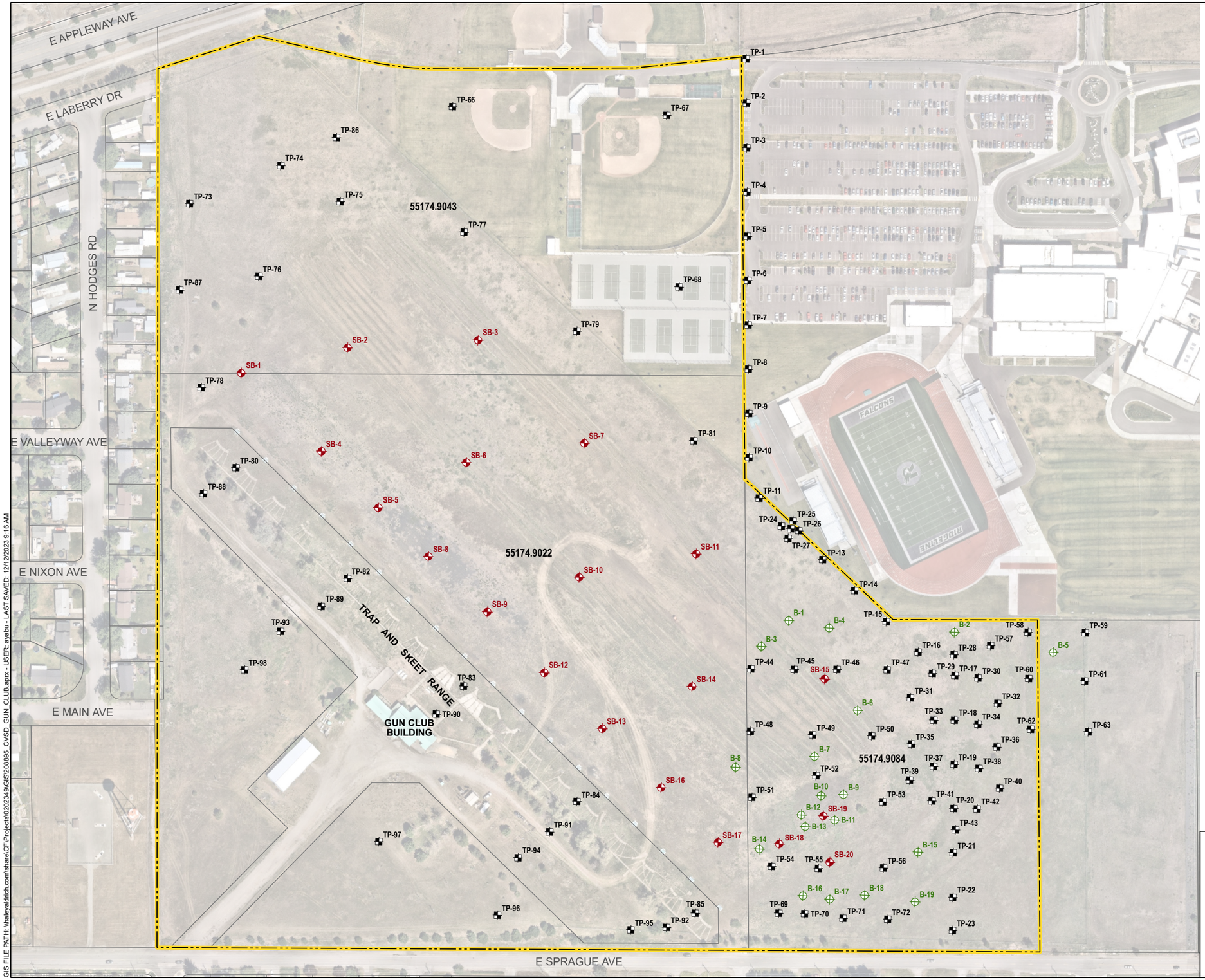
SITE VICINITY

MAP SOURCE: ESRI
SITE COORDINATES: 47°39'34"N, 117°08'22"W

APPROXIMATE SCALE: 1 IN = 2000 FT
NOVEMBER 2020

FIGURE 1

GIS FILE PATH: C:\Users\craumann\Desktop\LOCAL_DATA\135500_Central_Valley_School_District\Maps\2020_11\135500_000_0001_SITE_VICINITY.mxd — USER: craumann — LAST SAVED: 11/19/2020 11:57:56 AM



LEGEND

- PUSH PROBE BORING
- SONIC BORING
- TEST PIT
- SITE BOUNDARY
- PARCEL BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ASSESSOR PARCEL DATA SOURCE: SPOKANE COUNTY
3. AERIAL IMAGERY SOURCE: NEARMAP, 18 MAY 2023

N

0 230 460

SCALE IN FEET

HALEY ALDRICH

SPOKANE GUN CLUB
GREENACRES, WASHINGTON

SITE PLAN

DECEMBER 2023

FIGURE 2

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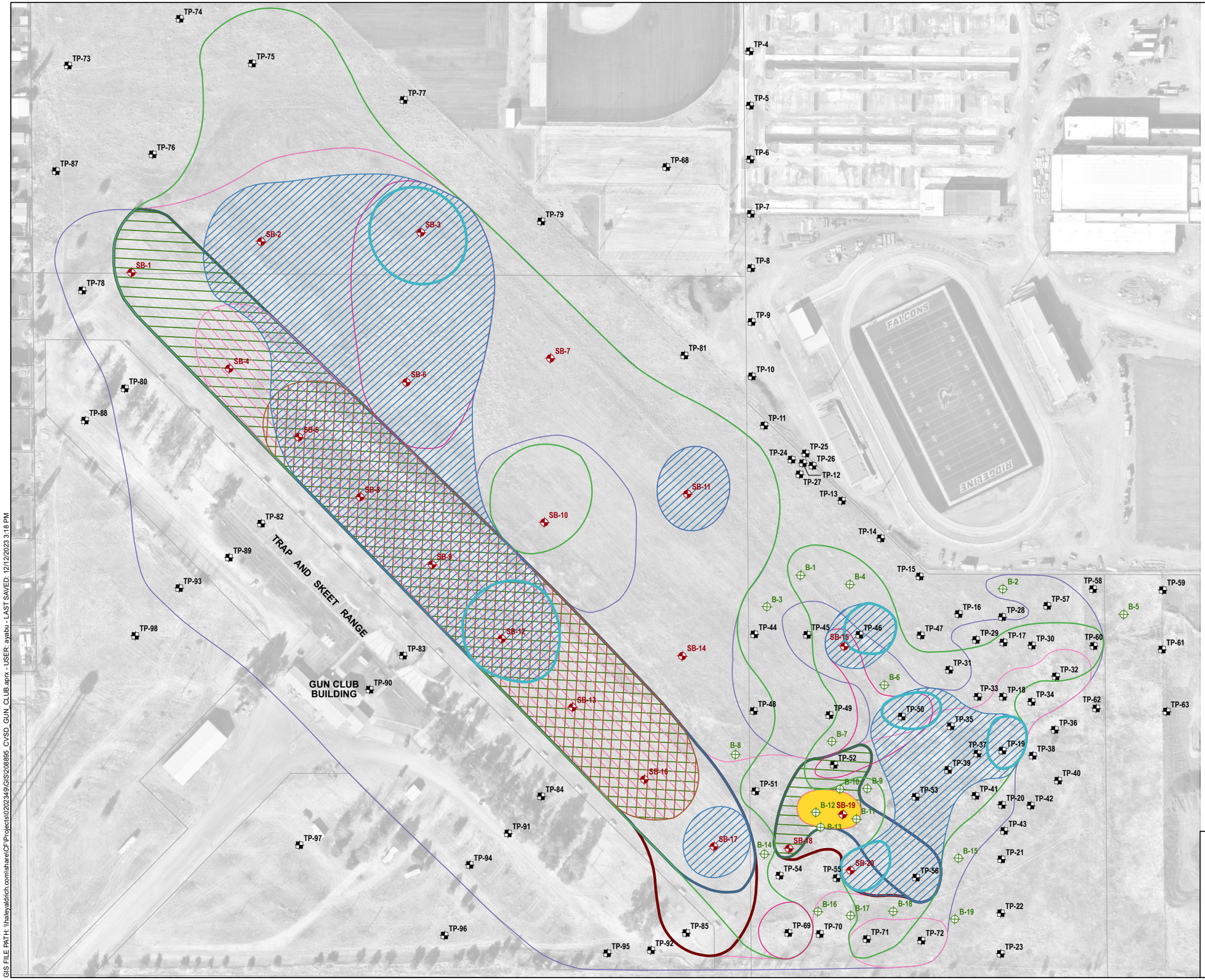

LEGEND

- PUSH PROBE BORING
- SONIC BORING
- TEST PIT
- LEAD, 0 TO 1 FT BGS,HAZARDOUS
- LEAD, 0 TO 1 FT BGS,NON-HAZARDOUS
- LEAD, 1 TO 2 FT BGS,NON-HAZARDOUS
- LEAD, 2 TO 3 FT BGS,NON-HAZARDOUS
- PAHS, 0-1 FT BGS, NON-HAZARDOUS
- PAHS, 1-2 FT BGS, NON-HAZARDOUS
- PAHS, 2-3 FT BGS, NON-HAZARDOUS
- PAHS, 3-4 FT BGS, NON-HAZARDOUS
- PAHS, 4-5 FT BGS, NON-HAZARDOUS
- PAHS, 5-6 FT BGS, NON-HAZARDOUS
- PAHS, 6-7 FT BGS, NON-HAZARDOUS
- PAHS, 7-10 FT BGS, NON-HAZARDOUS
- PARCEL BOUNDARY

NOTES
1. FT BGS = FEET BELOW GROUND SURFACE
2. AERIAL IMAGERY SOURCE: NEARMAP, 30 SEPTEMBER 2020

THIS IS A MULTI-LAYER PDF; TURN MAP LAYERS ON/OFF IN THE LAYERS PANEL

N

0 180 360
SCALE IN FEET

HALEY ALDRICH

SPOKANE GUN CLUB
GREENACRES, WASHINGTON

MAGNITUDE AND EXTENT OF CONTAMINATION

DECEMBER 2023

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0202349\GIS\208895_CVSD_GUN_CLUB.aprx - USER: ayabu - LAST SAVED: 12/12/2023 3:18 PM

APPENDIX A
Confirmation Sampling Work Plan for Spokane Gun Club

HALEY ALDRICH

www.haleyaldrich.com

CONFIRMATION SAMPLING WORK PLAN
FOR SPOKANE GUN CLUB
SPOKANE VALLEY, WASHINGTON

by

Haley & Aldrich, Inc.
Spokane, Washington

for
Central Valley School District
Spokane Valley, Washington

File No. 0202349-001
January 2024

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1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich), has prepared this Confirmation Sampling Work Plan (Work Plan) on behalf of the Central Valley School District (CVSD) for the former Spokane Gun Club (Gun Club) property located at 19615 E Sprague Avenue in Spokane Valley, Washington (Site), shown on Figure 1. The Site is listed by the Washington State Department of Ecology (Ecology) as Cleanup Site 14851 and has Facility Site ID 50340.

The Site has been impacted by lead and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) from use as a trap and skeet shooting range. The lead contamination was released as pellets from shotguns and the cPAHs were released from clay targets and associated debris, both from shooting activities. The selected remedy to address this contamination consolidates the contaminated materials and debris (e.g., clay target and concrete) in an engineered, capped, on-site repository within a new parcel of land that will have a restrictive covenant recorded against it at the completion of the cleanup. This will allow for divestment and/or reuse of the remaining subject property without the encumbrances of environmental contamination. Additionally, an on-site repository allows for the consolidation of contaminated materials in a controlled environment and minimizes or eliminates exposure pathways and transport of contaminants by installing a physical barrier.

The purpose of this Work Plan is to provide a detailed Sampling Analysis Plan to demonstrate and confirm compliance with Washington Administrative Code (WAC) 173-340-410 and the proposed cleanup standards in the *Remedial Investigation/Feasibility Study Spokane Gun Club* report (Hart Crowser, 2021). Air monitoring activities will be guided by the *Air Monitoring Work Plan for Spokane Gun Club (*Haley & Aldrich, 2024) and are not detailed in this Work Plan. This Work Plan, and associated work conducted by CVSD, are subject to review and approval by Ecology. Upon approval, the methods and procedures described will be used for confirmation sampling during construction activities removing lead- and cPAH-impacted soils and placing them in an on-site repository (Figure 1).

2. Background

The Site was purchased by CVSD in 2018 and the Gun Club (the former owner since 1948) leased the property and operated the trap and skeet range until July 2021. At the time of purchase, the property consisted of undeveloped grass fields with infrastructure for the Gun Club building and trap and skeet shooting stations located in the southwest corner. CVSD has since built Ridgeline High School in the northeast corner and opened the school in the fall of 2021.

The Gun Club periodically has recovered and recycled lead shotgun pellets from the range area northeast of the shooting stations and conducted a final lead recovery and recycling effort before vacating the property. However, lead-contaminated soil, clay pigeon debris, and cPAH-contaminated soil remain in the range area, near the shooting stations, and around the clubhouse.

Hart Crowser, Inc. (Hart Crowser, now Haley & Aldrich) conducted a Phase I Environmental Site Assessment (ESA) on the Gun Club property, that included the subject property, in August 2018. Results of the Phase I ESA are documented in Hart Crowser's *Phase I Environmental Site Assessment, North Henry Road and East Sprague Avenue* (Hart Crowser, 2018a). Haley & Aldrich conducted Phase II ESA activities at the subject property between July 2018 and February 2021. Assessment activities conducted in 2018 are detailed in the *Focused Phase II Environmental Site Assessment: North Henry Road and East Sprague Avenue, Greenacres, Washington* technical memorandum (Hart Crowser, 2018b). Additionally, an interim action was completed to remove contaminated soil stockpiles and address lead-contaminated soil in September 2018 to expedite the construction of Ridgeline High School on land east of the subject property. Activities related to the interim action are detailed in the 4 January 2019, *Interim Action Report, Former Spokane Gun Club Property* (Hart Crowser, 2019).

Site assessment and remedial investigation activities included: excavating 98 test pits, advancing 19 direct-push borings, and drilling 20 sonic borings. Findings from assessment activities are provided in the *Remedial Investigation/Feasibility Study Spokane Gun Club* report (Hart Crowser, 2021). Results of the Remedial Investigation/Feasibility Study (RI/FS) were used to inform a Corrective Action Plan (CAP) for the subject property. Based on the results of the assessments, contaminants of concern (COC) at the subject property include lead, cPAHs and, to a lesser extent, arsenic. These COC are present at variable locations and depths ranging between ground surface and approximately 10 feet (ft) below ground surface (bgs). Locations where arsenic concentrations in soil exceed cleanup levels are sporadic and collocated with lead-contaminated soil.

In certain portions of the gun range, soils contain leachable lead concentrations greater than 5 milligrams per liter (mg/L) when extracted using the Toxicity Characteristic Leaching Procedure (TCLP). Lead concentrations that exceed the dangerous waste maximum contaminant level (MCL) of 5 mg/L or greater, characterize as Washington State Dangerous Waste (dangerous waste) under the toxicity criteria and are subject to the Land Disposal Restrictions in WAC 173303-140. Federal law uses the term "hazardous waste" and hazardous is used interchangeably with dangerous within this Work Plan. They must be treated to below the MCL threshold prior to disposal to stabilize the leachable lead. Until stabilized, these materials require more robust handling, storage, transportation, and record-keeping requirements once excavated, unless stabilized in situ.

2.1 LOCAL GEOLOGY AND MINERALOGY

The Site is located on the eastern side of the Spokane Valley that, geologically, is an area predominantly characterized by Pleistocene flood deposits resulting from multiple episodes of outbursts from glacially dammed Lake Missoula. These deposits consist of poorly to moderately, well-sorted, stratified deposits of boulders, cobbles, gravel, and sand with interbedded silt lenses. According to the Washington Department of Natural Resources, Washington Geologic Information Portal https://www.dnr.wa.gov/geologyportal, the majority of the Site consists of these flood deposits.

The northeastern section of the Site is underlain by Paleozoic heterogeneous metamorphic rock, defined by the United States Geological Survey (USGS) as Hauser Lake Gneiss. Geotechnical borings in the area indicate the presence of sand with trace gravel near the surface, underlain by sandy gravel and bedrock at approximately 60 ft bgs. Soil encountered during Phase II ESA activities generally consisted of silty gravel with sand, trace clay, and occasional cobbles to a depth of at least 9 ft.

Groundwater was recorded at a depth of approximately 98 ft bgs in adjacent property supply wells. Based on USGS Scientific Investigations Report 2007-5044, the Site is located near the boundary of the Spokane Valley-Rathdrum Prairie (SVRP) Aquifer, an EPA-designated, sole-source aquifer that underlies the Spokane Valley, and an alluvial aquifer that underlies the toe of the Carlson Hill to the south. The inferred groundwater flow in the SVRP aquifer in this part of the valley is to the west-southwest; however, the alluvial aquifer at the nearby Greenacres Landfill to the southeast reportedly has inferred flow components that are more to the north-northwest (Hart Crowser, 2021).

3. Quality Objectives and Study Goals

Systematic planning using the seven-step, Data Quality Objectives (DQO) process listed below has been utilized within this Work Plan to establish performance and acceptance criteria for collecting data to estimate mean concentrations of COCs to make decisions. DQOs are quantitative and qualitative criteria that clarify study objectives, define appropriate types of data to collect, and specify the tolerable levels of potential decision errors developed in general accordance with US Environmental Protection Agency (USEPA, 2000 and 2006) guidance to provide a systematic planning process. The seven steps include:

1) State the problem.
2) Identify the goal of the study.
3) Identify information inputs.
4) Define the boundaries of the study.
5) Develop the analytical approach.
6) Specify performance or acceptance criteria.
7) Develop the detailed plan for obtaining data.

The first five steps focus on identifying qualitative criteria, the sixth step establishes performance or acceptance criteria, and the seventh step puts the performance and acceptance criteria in steps one through six together into a sampling design.

3.1 PROJECT GOAL: CHARACTERIZE CONCENTRATIONS OF LEAD AND CPAHS IN SOILS AT THE SITE TO CONFIRM THE PROPOSED CLEANUP STANDARDS ARE MET

Throughout the subsequent sections, each step of the DQO process is described in detail as it applies to the project goal.

3.1.1 Step 1: State the Problem

The first step in the DQO process is to state the problem, establish the planning team, prepare a Conceptual Site Model (CSM), and identify available resources, constraints, and deadlines. The problem is how to document that soils remaining in place after removal activities are below Ecology's Model Toxics Control Act (MTCA) Method A cleanup levels for unrestricted land use (cleanup levels). Additionally, CVSD needs to document that materials placed in the on-site repository are stabilized for leachable lead to concentrations less than the MCL. This Work Plan was based upon the CSM in the RI/FS (Hart Crowser, 2021) and the planning team include Ecology, Haley & Aldrich, and CVSD. Haley & Aldrich have the resources available in its Spokane, Washington office to perform the work described herein following approval to proceed by Ecology and intends to implement this Work Plan on behalf of CVSD. CVSD has started the process of selecting a contractor to perform construction in 2024 in accordance with the CVSD Gun Club Cleanup Project Drawings dated 24 October 2023. The associated Bid Documents have a substantial completion date of 31 October 2024.

3.1.2 Step 2: Identify the Goal of the Study

The study goal is to define mean concentrations of Site COC in surface soils following treatment and/or removal, to confirm concentrations of treated soil are less than the MCL prior to placement in the on-site repository, and to confirm COC contaminated materials have been removed and the remaining soils meet cleanup levels.

Principal study questions:

- What are the mean concentrations of lead, cPAHs, and arsenic in surface soils following removal activities and prior to backfilling/grading?
- Are lead concentrations in stabilized soils less than the MCL prior to being placed in the on-site repository?

Alternative actions:

- Collect and analyze additional samples.
- Continue to excavate surface soils.
- Stop excavation.
- Treat soils to stabilize leachable lead prior to disposal; re-treat, if necessary.
- Place material in on-site repository.

Specifying the decision statement:

- Surface soils meet the cleanup levels; no further removal is required.
- Surface soils do not meet the cleanup levels; remove additional material, collect and analyze samples from the new excavation limits, compare to cleanup levels, repeat as necessary until excavation limits meet cleanup levels.
- Lead concentrations in treated soil is less than the MCL; transport and place treated soil in the on-site repository.
- Lead concentration in treated soil is greater than the MCL; re-treat the soil, sample and analyze treated soil and compare it to MCL. If lead concentrations are less than the MCL, transport and place treated soil in the on-site repository. If lead concentration in re-treated soil is greater than the MCL, repeat the process.

3.1.3 Step 3: Identify Information Inputs

The information to address the principal study questions listed above will come from past investigations, data summarized in the RI/FS (Hart Crowser, 2021), and additional analyses performed on soils prior to, during, and following remedial excavation and placement in the on-site repository. Sample collection procedures are described in the *Field Sampling Plan* section of this Work Plan and the laboratory methods and analyses are presented in the *Laboratory Analysis* section of this Work Plan.

3.1.4 Step 4: Define the Boundaries of the Study

The Site, including the magnitude and extent of contamination, is shown on Figure 2. Confirmation sampling units are based on the approximate size of residential lots (0.25 acres) and treated soil sampling units are slightly larger (up to about 0.6 acres). The proposed boundaries and location of sampling units are shown in Figure 2, along with the size in acres of each sampling unit. The figure includes both treated soil and Incremental Sampling Methodology (ISM) confirmation sampling units. The sampling unit boundaries are based on the extents and depths of COC as informed by previous investigations and summarized in the RI/FS. Temporal boundaries and other constraints are limited to the classification of dangerous waste and analytical method hold times provided by the laboratory. Other constrains, such as building surface treatments (e.g., concrete slabs, pavers) and utilities, may physically exclude certain areas from sampling and soil removal activities. The Gun Club Building, shooting stations, and correlating sidewalks and concrete pathways will be removed.

3.1.5 Step 5: Develop the Analytical Approach

Population parameters for making decisions are based on Ecology's MTCA cleanup levels and dangerous waste regulations for lead in TCLP leachate. ISM or multi-increment sampling (MIS) will be used for confirmation sample collection following excavation to provide a structured composite sampling and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a specific volume of soil. The standard operating procedures (SOPs) for ISM by Eurofins and MIS by Pace Analytical, are provided in Attachment A. The ISM/MIS sampling methods proposed are described in further detail in subsequent sections of this Work Plan.

To further reduce the chances of a decision error, 80 percent of the cleanup levels have been set as the threshold of no further action for cPAHs and lead when making a decision based on one ISM/MIS sample. Confirmation sampling units will be equal in size to decision units. For concentrations between 80 and 100 percent of the cleanup levels, either the entire sampling/decision unit area will be excavated another 6 inches (in.) bgs and the process will repeat, or two additional ISM/MIS samples will be collected within the decision/sampling unit. The evaluation of achieving cleanup levels will then be based on the mean of means (average of all three values). If the average of all three ISM/MIS sample values exceeds the cleanup levels, the entire sampling/decision unit area will be excavated another 6 in., and the process will be repeated.

Soils that exceed the MCL for lead will require treatment for the stabilization of leachable lead prior to placement in the on-site repository. In situ stabilization will be conducted until TCLP lead extract concentrations are less than the MCL as confirmed by composite soil sampling and analysis. No ISM/MIS sampling or processing will be completed for media sampled/analyzed for leachable lead.

Lead-contaminated soil requiring stabilization is based on total lead concentrations. An analysis has been completed comparing total lead concentrations against leachable lead concentrations to estimate the minimum total lead concentration that likely would exceed the MCL. Results of this analysis indicate that a total lead concentration of 3,550 milligrams per kilogram (mg/kg) or greater likely would exceed the MCL. However, the threshold for treatment by stabilization will be reduced from 3,550 mg/kg to 3,250 mg/kg as a margin of safety, as described in the *Contaminants of Concern* section of the RI/FS. The limits of soil that will be stabilized prior to placement in the on-site repository are shown on Figure 2.

3.1.6 Step 6: Specify Performance or Acceptance Criteria

The acceptance criteria for COC concentrations achieving cleanup levels and stabilization will be as follows:

One ISM/MIS confirmation sample per sample unit:

- 16 mg/kg arsenic (20 mg/kg x 0.8 = 16 mg/kg)
- 200 mg/kg lead (250 mg/kg x 0.8 = 200 mg/kg)
- 0.08 mg/kg benzo(a)pyrene (BaP) (0.1 mg/kg x 0.8 = 0.08 mg/kg)
- 0.08 mg/kg cPAHs total toxic equivalent soil concentration (0.1 mg/kg x 0.8 = 0.08 mg/kg)
- 4.0 mg/kg total naphthalenes (5 mg/kg x 0.8 = 4 mg/kg)

Three ISM/MIS confirmation samples per sample unit:

- 20 mg/kg arsenic
- 250 mg/kg lead
- 0.1 mg/kg BaP
- 0.1 mg/kg cPAHs total toxic equivalent soil concentration
- 5 mg/kg total naphthalenes

Dangerous waste threshold to stabilize leachable lead:

- Greater than 3,250 mg/kg lead (total lead screening concentration expected to exceed TCLP)
- Less than 5.0 mg/L TCLP lead

3.1.7 Step 7: Develop the Detailed Plan for Obtaining Data

To achieve the quality objectives and study goals, sampling will be performed as summarized in the following paragraphs and subsequently described in further detail within this section for each sample type: surface samples and/or stockpile samples for dangerous waste classification and remedial excavation confirmation samples.

Soil samples have been collected for the classification of dangerous waste as described in the RI/FS report (Hart Crowser, 2021). Ongoing classification of hazardous waste could include the sampling of both surface soils and/or soil stockpiles created during construction activities, if the selected Contractor decides to treat soil ex situ. Areas already delineated in the RI/FS that exceeded the dangerous waste screening threshold of 3,250 mg/kg total lead will undergo soil treatment to stabilize leachable lead. To determine if soil treatment is complete or additional treatment is necessary, a 10-point composite soil sample will be collected from each delineated area and/or treated soil stockpile at a frequency of one sample per approximately 1,000 cubic yards (cu yd) of material and analyzed for leachable lead. Following successful treatment of soils classified as dangerous waste and their subsequent removal, the underlying soils will be sampled to confirm they do not classify as hazardous waste and require treatment and meet cleanup levels, or do not meet cleanup levels and must be removed and placed in the on-site repository.

Following soil stabilization and treatment, or concurrently, the remedial excavation will advance to the depths shown on Figure 2, followed by ISM/MIS confirmation sampling. The criteria for the spatial distribution of confirmation sampling units shown on Figure 2 is based on Phase I and Phase II ESA activities summarized in the RI/FS (Hart Crowser, 2021). The analytical methods and hold times that will be used are described in the *Laboratory Analysis* section of this Work Plan. Details on sample collection and decontamination procedures are described in the *Field Procedures* section of this Work Plan.

In situ treated soil will be sampled to confirm stabilization criteria have been achieved. A 10-point confirmation composite soil sample will be collected from the treated depth at a frequency of one sample per approximately 1,000 cu yd, or less, and analyzed for leachable lead within each hazardous lead sampling unit shown on Figure 2. Sampling units for the classification of dangerous waste will be equal in size to decision units. There are seven hazardous waste sampling units for lead (0.61 acres in size or less). If analytical results following treatment for any individual sampling unit are equal to or greater than the MCL (5.0 mg/L lead) the volume of the entire sampling until will be re-treated and re-sampled to confirm stabilization.

Stockpile samples – classification as hazardous waste: if during construction activities soils suspected to exceed the hazardous waste threshold are stockpiled, a 10-point composite soil sample will be collected at a frequency of one sample per approximately 1,000 cu yd, or less, of material stockpiled. Each stockpile sampled will be a decision unit; however multiple small stockpiles may be combined prior to sampling if the combined volume is less than 1,000 cu yd. If the analytical results for any individual sampling unit (stockpile sampled) are greater than the MCL, the entire stockpile will be treated to stabilize leachable lead.

Hazardous waste leachable lead concentrations in treated soil stockpiles: if the contractor decides to treat lead-contaminated soil ex situ, an on-site representative will assess if a stockpile has been adequately mixed with the stabilizing reagent. The on-site representative will collect a 10-point composite soil sample from the stockpile. For larger piles between 500 to 1,000 cu yd, the Contractor will subdivide the stockpile into four approximately equal sections by cutting trenches north to south through the pile with an excavator. The dividing trench must be deep enough and wide enough to allow safe access for sampling; however, the subdivided piles may still be in contact with one another at the base.

After the stockpile has been prepared for confirmation sampling, five composite confirmation samples will be collected:

- One 10-point composite sample from the entire pile; and
- One 10-point composite sample from each of the four sub-piles.

To further confirm adequate mixing has been achieved, the field pH of each increment aliquot will be recorded during sampling. The 10-point composite sample for the entire pile will be labeled with correspondence to the sampling unit and stockpile number. The sub-piles will be labeled with correspondence to the sampling unit, stockpile number, and their position in the pile; "A" northwest, "B" northeast, "C" southeast, and "D" southwest. The sample collected from the entire pile will be analyzed for leachable lead on an expedited turn-around while the other four samples are held in reserve. If the composite sample for the entire stockpile meets the acceptance criteria, the stockpile will be transported to the on-site repository for disposal. If the composite sample does not meet the acceptance criteria, the four sub-pile samples will be analyzed for leachable lead. Any sub-pile that meets the acceptance criteria will be transported to the on-site repository. Any sub-piles with leachable lead concentrations of 5.0 mg/L or greater will be treated again, and the process will be repeated until all stockpiles meet disposal requirements. Each batch of treated soils shall not exceed 1,000 cu yd and at minimum one sample will be collected from each batch.

ISM/MIS – confirmation samples: a sampling approach using systematic random sampling will be used within each confirmation sampling unit shown on Figure 2 following removal of contaminated soil. Field planning will include the use of geographic information system (GIS) tools to grid each sample unit and randomly distribute 30 sample locations. There are 146 ISM/MIS confirmation sampling units that average about 0.27 acres in size and vary between 0.13 to 0.39 acres, so each sample unit will have a unique grid. Soil samples will be collected at the surface (between 0 to 2 in. bgs) from each incremental location using a trowel, stainless-steel spoon, or soil coring device and following the collection procedures described in the *Sampling Tools and Collection* Procedures section of this Work Plan. Sample increments will be comprised of approximately the same mass as determined by volume and the 30 discrete sample increments will be combined into one composite sample not to exceed 1 kilogram. An on-site representative will transport or ship the composite sample to the laboratory for analysis. The laboratory will use the ISM/MIS processing methods provided in Attachment A to minimize sampling error prior to analysis. Samples will be air-dried, sieved, and milled by the laboratory to improve precision. Sample collection tools will be decontaminated or discarded after collecting incremental samples within a sampling unit and before moving to the next sample unit.

Key assumptions supporting the selected design:

1) Contaminant transport mechanisms include stormwater runoff and erosion, transport by wind and/or anthropogenic means, and contaminant transport through the soil and into groundwater by leaching.

2) Since the Gun Club was constructed, lead contaminants have migrated a maximum of approximately 3 ft bgs and cPAHs contamination has migrated a maximum of approximately 7 ft bgs, based on previous investigations which are summarized in the RI/FS (Hart Crowser, 2021).
3) Lead concentrations greater than approximately 3,550 mg/kg likely would exceed the dangerous waste MCL (Hart Crowser, 2021). Therefore, 3,250 mg/kg is an appropriate and conservative screening threshold to determine areas that may be designated as hazardous waste.
4) 10-point composite samples at a frequency of one sample per approximately 1,000 cu yd of material will be sufficient for the designation of dangerous waste and to determine the leachable lead concentrations in soils following treatment.
5) ISM/MIS samples with 30 increments will be sufficient to address any non-uniform distributions of COCs within the sampling units for arsenic, cPAHs, and lead confirmation sampling following the remedial excavations.
6) The sampling unit boundaries have been selected to reduce the natural variability of the population by subdividing it into areas providing better homogeneity based on previous investigations.
7) Soils impacted by lead, arsenic, and cPAHs outside of the sampling unit boundaries meet MTCA Method A cleanup levels for unrestricted land use based on previous investigations.
8) Lead and cPAH confirmation samples will produce a conservative estimate of the decision unit mean because of the sampling depth proposed from 0 to 2 in. bgs; concentrations decrease with depth.
9) Each lead and cPAHs confirmation sampling unit will equal a decision unit and decisions can be conservatively based on one sample at the thresholds described because the ISM/MIS sample itself is an estimate of the decision unit mean.
10) The single-sample decision threshold of 80 percent of the cleanup level for single ISM/MIS confirmation samples for arsenic, lead, and cPAHs will be conservative.
11) When concentrations are between 80 and 100 percent of the cleanup level, using a set of three samples will be representative of the sampling unit mean concentration.
12) Temporal constraints are limited to the classification of hazardous waste and the individual analysis hold times provided by the laboratory.
13) Laboratory ISM/MIS sample milling is expected to improve precision.
14) One laboratory subsample will be randomly collected from every 10 confirmation samples with concentrations of cPAHs or lead 50 percent or greater of the cleanup standard. This will evaluate the sample processing by the laboratory, variability within the sample area, analytical precision, and confirm the subsample selected for analysis is representative of the entire sample collected.
15) Air drying and milling of samples by the laboratory will not impact the results because the cPAHs of concern are strongly absorbed into the soil particles and will not be lost to air drying. Also, based on the CSM, these particles have already been extensively exposed to the air and weathering conditions at the Site and it is unlikely any additional air exposure in the lab will result in measurable losses of cPAHs.
16) The samples will not require extensive air drying therefore the 14-day holding time for cPAHs will not be exceeded while processing ISM/MIS samples.
17) Buildings, surface treatments (e.g., concrete slabs, pavers) and utilities to remain will physically exclude specific areas from sampling and soil removal activities. These areas are small enough as not to reduce the effectiveness of the cleanup action.

4. Field Work Preparation

Field work preparation activities are conducted to provide for the health and safety of personnel and the surrounding area before the start of field activities, to establish safe site access, and to confirm readiness for the planned sampling activities. The components of field work preparation are discussed in the following sections.

4.1 SITE-SPECIFIC HEALTH AND SAFETY PLAN

Prior to conducting field work, Haley & Aldrich will prepare a Health and Safety Plan (HASP) that describes necessary health and safety protocols for field personnel. A physical copy of the HASP will be readily accessible to personnel while in the field. Field activities will be performed in Level D personal protective equipment (PPE), as defined in the HASP and by the Occupational Safety and Health Administration (OSHA) requirements, detailed in Title 29, Code of Federal Regulations (29 CFR) § 1910.120. Individuals performing field activities are required to have completed OSHA training in accordance with 29 CFR § 1910.120, including 40-hour and current annual 8-hour refresher training.

4.2 UTILITY LOCATION

Utility locating will be required for all soil sampling and excavation activities. As part of the field preparation, the Washington utility notification center and private utility locator will be contacted to request the physical demarcation of utilities. Samples shall not be collected within 2 ft of either side of a marked utility or as otherwise specified within the HASP.

5. Field Sampling Plan

The sampling and analysis methods, and laboratory analytical procedures proposed, are described in further detail in this section. These methods and procedures are designed to reduce sample collection errors and improve the decision-making process by using a combination of planning, sample preparation, sampling, subsampling, and replicate sampling to address the heterogenous nature of soil and determine the spatial distribution of the COC. The goal is to provide a reasonably unbiased estimate of the mean concentration of contaminants in soil within a defined area (i.e., sampling unit), to support decisions.

5.1 FIELD PROCEDURES

This section provides sample collection procedures that are specific to the three types of sampling and analysis required:

1) **Confirmation samples:** ISM/MIS for arsenic/lead/cPAHs;
2) **Hazardous waste classification samples:** leachable lead; and
3) **Confirmation samples following soil treatment for lead stabilization:** leachable lead.

Particulate and dust sampling is addressed in our *Spokane Gun Club Air Monitoring Sampling Work Plan* (Haley & Aldrich, 2024) and is not considered part of this Work Plan.

The primary objective for ISM/MIS confirmation samples will be estimating the mean contaminant concentrations within each sampling unit to make decisions regarding compliance with the cleanup levels. ISM/MIS samples will include 30 discrete sample increments per sample.

Dangerous waste classification samples and confirmation samples following soil treatment for lead will be 10-point composite samples with no ISM/MIS processing. Those samples will be collected from either the surface or subsurface (when sampling stockpiles) at the discretion of the sampling team. Visual inspections and pH measurements of the treated media will be conducted to assess if adequate mixing with the selected stabilizing reagent has been achieved prior to sample collection. Samples will be collected from treated soil and analyzed to assess if stabilization has been achieved. Samples collected as part of this Work Plan will be placed in laboratory-provided glass jars or approved sample containers (new, resealable plastic bags, when appropriate). Field notes will include descriptions of pertinent observations of the sample location and conditions, such as soil and rock descriptions.

The layout of each ISM/MIS sampling unit is based on previous investigations which are summarized in the RI/FS (Hart Crowser, 2021) and shown on Figure 2. Surface samples will be collected using systematic random sampling from 30 discrete sample increments to allow statistical inferences. Each increment will consist of approximately the same mass based on volume before being combined with all the other sample increments in a resealable plastic bag and submitted to the laboratory for further processing and analysis. The target maximum amount of material for ISM/MIS processing is 1 kilogram; however, the laboratory can process more material if necessary, so mass reduction will not be required to ensure the total composite sample mass submitted to the laboratory does not exceed any predetermined maximum. The entire sample increment based on volume will be submitted to the lab excluding rocks greater than ½-in. diameter, vegetation, and debris which shall be removed and not included.

Field planning will include the use of GIS tools to distribute the 30 discrete sample increments within each sampling unit. To reduce decision errors, 80 percent of the cleanup levels have been set as the threshold of no further action for cPAHs, arsenic, and lead based on one ISM/MIS sample, and the threshold for dangerous waste with respect to total lead concentrations has been reduced as previously described. Because each ISM/MIS sample itself is considered an estimate of the mean, the exact location of each increment within the sampling unit will not be documented as is typical with discrete samples, but the boundaries of each composite sampling area (CSA) will be recorded as will the individual sampling locations generated using GIS tools. It is expected that each incremental sample collected will be within 15 ft of the point generated.

Sampling procedures for the specific methods of sample collection proposed are described in the following sections.

5.1.1 Field Replicate Samples and Laboratory Subsamples

It is anticipated field replicate samples could be required during confirmation sampling. If concentrations are between 80 and 100 percent of the cleanup standards, either an additional 6 in. will be excavated from the entire sampling unit and the area will be resampled, or two replicate samples will be collected using the same ISM/MIS methods. A new and distinct systematic random sampling layout will be generated and used for each replicate ISM/MIS sample collected. The mean of means (average of all three sample concentrations) will be compared to the cleanup standards to decide if additional excavation is necessary. No additional field replicate samples are anticipated.

Subsamples of composite samples will be collected in the laboratory during sample processing to evaluate the laboratory's methodologies, variability within the sample area, analytical precision, and to assess if the subsample selected for analysis is representative of the entire sample collected. If laboratory subsamples do not provide sufficient confidence (less than 30 percent variation) for decision-making, alternatives may include reducing the size of the sampling units or increasing the number of discrete sample increments collected, or a combination thereof. Laboratory subsamples will be randomly collected from one of every 10 confirmation samples with concentrations of cPAHs or lead 50 percent or greater of the cleanup standard. If there are not 10 confirmation samples with concentrations of cPAHs or lead 50 percent or greater of the cleanup standard, no laboratory subsamples will be collected.

5.1.2 Sampling Tools and Collection Procedures

Surface soil samples will be collected using a soil coring device, stainless-steel trowel, or stainless-steel spoon. At the discretion of the sampling team, soil samples collected from stockpiles may require exposure with the aid of earthmoving equipment such as an excavator bucket (e.g., stockpile samples), prior to sample collection. Sample collection procedures are described below.

The following procedures will be used to collect soil samples:

1) A trowel, stainless-steel spoon, or soil coring device will be used to collect soil samples. Surface samples will be collected from 0 to 2 in. bgs and stockpile samples will be collected at a depth determined to be appropriate by the sampling team.
2) Gloved hands will be used to break the soil into small pieces as necessary to facilitate the manual removal of rocks greater than ½-in. diameter, vegetation, and debris which shall be

removed. If encountered, lead shotgun pellets will not be removed when collecting dangerous waste designation samples or leachable lead samples following soil treatment. Confirmation samples will not be collected if lead shotgun pellets and/or clay pigeon debris is observed until further excavation is completed.

3) When collecting ISM/MIS samples, the entire sample will be placed in a container of a known volume that correlates to an incremental sample mass of approximately 20 to 30 grams, so the total mass of 30 increments when combined does not exceed 1 kilogram. This will be tested on Site with the container to be used and a digital scale prior to the beginning of sample collection activities.

   a. Sampling unit sizes are shown on Figure 2, along with the anticipated contaminant depth based on previous investigations. The direct push probe borings, sonic borings, and test pit locations from those investigations are also shown on the figure.

   b. Sample increment locations for each sampling unit will be downloaded onto a handheld GPS device for locating during sampling. Sample increments will be collected from within approximately 15 ft of this location. Because each ISM/MIS sample itself is considered an estimate of the mean, the exact location of each increment within the sampling unit will not be recorded, but any variations greater than 30 ft in sample collection from the predetermined locations when collecting confirmation samples will be noted in the field book and documented.

   c. When collecting ISM/MIS samples, a container of known volume that correlates to the target mass will be filled with soil from each incremental location and combined into a 1-gallon resealable plastic bag for laboratory processing.

4) When collecting leachable lead TCLP samples following treatment for stabilization, the entire sample will be placed directly into jars provided by the analytical laboratory or in approved sample containers.

5) Each sample will be labeled in accordance with the *Sampling Identification and Labeling* section of this Work Plan.

6) Field notes will include descriptions of the specific sample collection methods, description of the material sampled (e.g., coarse sand and 6 in. minus rounded gravel), and if earthmoving equipment was used prior to or during sample collection.

5.1.3 Decontamination Procedures

Decontaminating equipment is important to prevent cross-contamination between individual sample locations by any contaminant from the previous sample. Decontamination will not be completed nor be necessary between sampling increments, only between individual sampling units and between replicate samples collected from the same sampling unit. This is because the sample increments will be combined into one container and submitted as one sample. Decontamination of equipment will be verified by visual inspection (there should be no residual soil particles remaining on sampling equipment following decontamination). Prior to initiating sampling, reusable sampling equipment, with the exception of the backhoe bucket or other heavy equipment, will be washed and cleaned using a standard two-step decontamination procedure:

1) Wash with potable water or deionized water and Alconox solution (or equivalent); and
2) Rinse with deionized water.

5.1.4 Sampling Identification and Labeling

Samples will be identified based on the sample type, location number, and sample depth (when applicable). Samples collected during the field work will be labeled clearly and legibly on sample containers with a unique alphanumeric sample identification number.

Sample identification numbers will be of the form AA_BB_CC, where:

- AA – Sample Type
  - CL – Confirmation lead and arsenic only
  - CP – Confirmation cPAHs only
  - C – Confirmation all COC: cPAHs, arsenic, and lead
  - T – TCLP
- BB – Unique sample location number (sampling unit number, capital letter or number identifier or stockpile number) with “a” and “b” letter identifier for replicate samples from the same sampling unit (e.g., 14a, 14b, or Ka, Kb).
- CC – Depth, depth interval (C-C) in inches, or stockpile number. For example, a sample interval between 0 to 2 in. would be 0-2 and a sample depth of 24 in. would be 24. Stockpiles would be preceded by the letter “P” followed by a stockpile number and their position in the pile; “A” northwest, “B” northeast, “C” southeast, and “D” southwest (e.g., Stockpile 3 would be P3, 0-2 would be 0 to 2 in. bgs, and 36 would be 36 in. bgs).

For example, sample identification C_14b_0-2 would refer to a confirmation soil sample for cPAHs, arsenic, and lead from sampling unit number 14 from a depth of 0 to 2 in. bgs and the letter “b” indicates it was the third replicate sample collected from that sampling unit. Sample identification T_A_P1A would refer to a TCLP sample collected from hazardous lead sampling unit A stockpile 1 sub-pile A (northwest quarter).

Sample labels will be made of self-adhering, waterproof material and an indelible pen will be used to fill out each label. A label with the required information uniquely identifying the sample location will be placed on the sample container. Each sample label will contain:

- Project name;
- Sample identification number as previously described;
- Date and time of collection;
- Analysis;
- Preservative if applicable; and
- Company name and sampler initials.

When using new, resealable plastic bags for samples, the labels will be either attached to the bag by a self-adhesive label and protected by double bagging the original bag and label in another resealable plastic bag or written in indelible ink on the bag, then double bagged. When using glass sample containers, bubble wrap will be used to protect the jar and label information. Label information may be either written in indelible ink on top of the lid or attached to the jar with a self-adhesive label, then wrapped in bubble wrap and placed in a resealable plastic bag, which may include multiple jars.

5.1.5 Sample Preservation and Handling

Samples will be stored in insulated coolers and preserved by cooling with ice to temperature required by the analytical method. Some samples are not anticipated to require cooling. Field personnel and the analytical and testing laboratories will adhere strictly to the maximum sample holding and extraction times. Samples will be hand-couriered to a shipping center at completion of sample collection and accompanied by the chain-of-custody that identifies the contents. The chain-of-custody will be signed by the individual relinquishing the samples and they will retain a copy of the chain-of-custody. The laboratory will confirm the samples were received in good condition (and within temperature, if required). In the event samples require an expedited turn-a-round time they will be marked for a RUSH analysis on the chain-of-custody.

5.2 FIELD LOGBOOKS

Sampling activities will be recorded in a bound field logbook of water-resistant paper during field work. All entries will be made legibly, in indelible ink, and will be dated. Information recorded will include the following:

- Date, time, and location of sampling;
- Weather;
- On-site personnel and visitors;
- Daily safety discussion and any safety issues;
- Observations about the Site, location, and samples (e.g., odors, appearance, sample media, sample depth, comments);
- Number of samples collected;
- Locations sampled (stockpiles, surface samples); and
- Any deviations from this Work Plan.

5.3 LABORATORY ANALYSES

The COCs for the Site include lead, arsenic, and cPAHs (BaP, total toxic equivalent soil concentration, and total naphthalenes). While arsenic is not originally considered a COC, it has been added to the laboratory analysis based on previous detections (Hart Crowser, 2021).

Laboratory ISM/MIS confirmation sample processing will include sieving, milling, and subsampling (Attachment A). Confirmation soil samples will be processed as ISM/MIS samples and analyzed for arsenic and lead using either EPA Test Method 6010 or EPA Test Method 6020 and cPAHs will be analyzed using EPA Method 8270 SIM. Soil samples for the designation of dangerous waste (both surface and stockpile samples) will be processed as composite samples and analyzed for leachable lead using TCLP extraction EPA Test Method 1311, followed by lead analysis by EPA Method 6010 or EPA Method 6020. Confirmation samples collected from soils treated to stabilize leachable lead prior to disposal will be analyzed for leachable lead using TCLP extraction EPA Method 1311, followed by lead analysis by EPA Method 6010 or EPA Method 6020. The analytical methods proposed and corresponding hold times are presented in Table 1 below. Laboratory subsamples will be randomly collected as previously described in this Work Plan. Laboratory data collected pursuant to this Work Plan will be reviewed and validated by Haley & Aldrich. Laboratory analytical results will be reviewed to evaluate whether they are useable for their intended purpose, as defined by the *Quality Objectives and Study Goals* section of this Work Plan.

Table 1. Analytical Methods, Preservation, and Holding Times

Matrix	Analytical Parameters/Method	Sample Preservation	Holding Time	Sample Container(s)
Solid	Total metals[a] EPA 6010 or 6020	N/A	180 days	New, resealable plastic bag (<1 kg, 10 grams minimum)
Solid	cPAHs[b] 8270 SIM	Cool to 6°C	14 days	New, resealable plastic bag (<1 kg)
Solid	TCLP Lead EPA 1311/6010 or 6020	N/A	180 days	On, 4-ounce wide-mouth glass jar or zip-lock plastic bag (100 grams)

Notes:

[a] Total metals includes arsenic and lead

[b] cPAHs includes 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, and pyrene

°C = degrees Celsius

EPA = US Environmental Protection Agency

N/A = not applicable

References

1. Haley & Aldrich, 2024. Spokane Gun Club Air Monitoring Sampling Work Plan, Site Code: 512817-00, Spokane Valley, Washington, January.

2. Hart Crowser, 2018a. Phase I Environmental Site Assessment; North Henry Road and East Sprague Avenue Green Acres, Washington. 28 August.

3. Hart Crowser, 2018b. Focused Phase II Environmental Site Assessment: North Henry Road and East Sprague Avenue, Greenacres, Washington Technical Memorandum. 22 October.

4. Hart Crowser, 2019. Interim Action Report, Former Spokane Gun Club Property. 4 January.

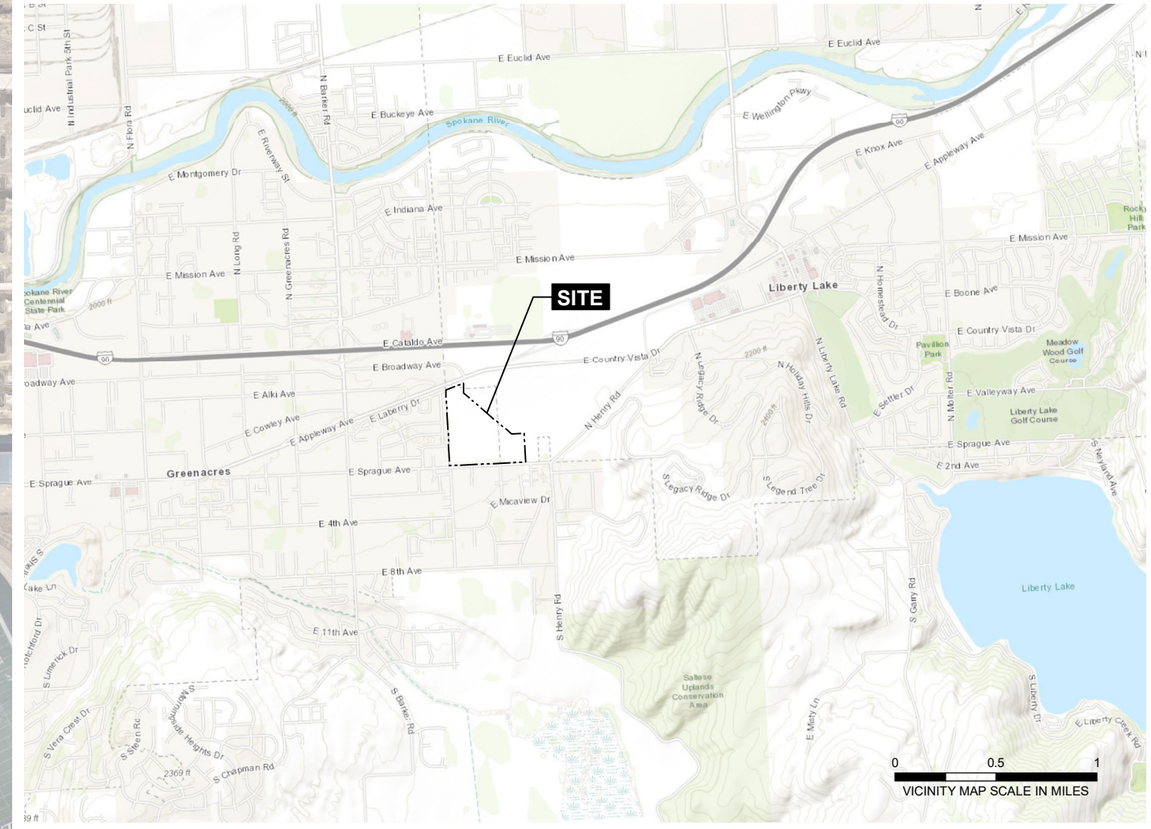
5. Hart Crowser, 2021. Remedial Investigation/Feasibility Study Spokane Gun Club. Prepared for Central Valley School District by Hart Crowser, a Division of Haley and Aldrich, Spokane, Washington.

6. US Environmental Protection Agency (USEPA), 2000. Guidance for Data Quality Assessment, Practical Methods for Data Analysis. EPA QA/G-9, QA00 Update. July.

7. USEPA, 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4. EPA/240/B-06/001. February.

8. Washington Department of Natural Resources, Washington Geologic Information Portal https://www.dnr.wa.gov/geologyportal, accessed 22 December 2023.

FIGURES



LEGEND

- REPOSITORY FOOTPRINT
- LIMITS OF EXCAVATION
- SITE BOUNDARY
- PARCEL BOUNDARY

0 220 440
SITE PLAN SCALE IN FEET

NOTE

AERIAL IMAGERY SOURCE:
NEARMAP, 30 SEPTEMBER 2020

HALEY ALDRICH

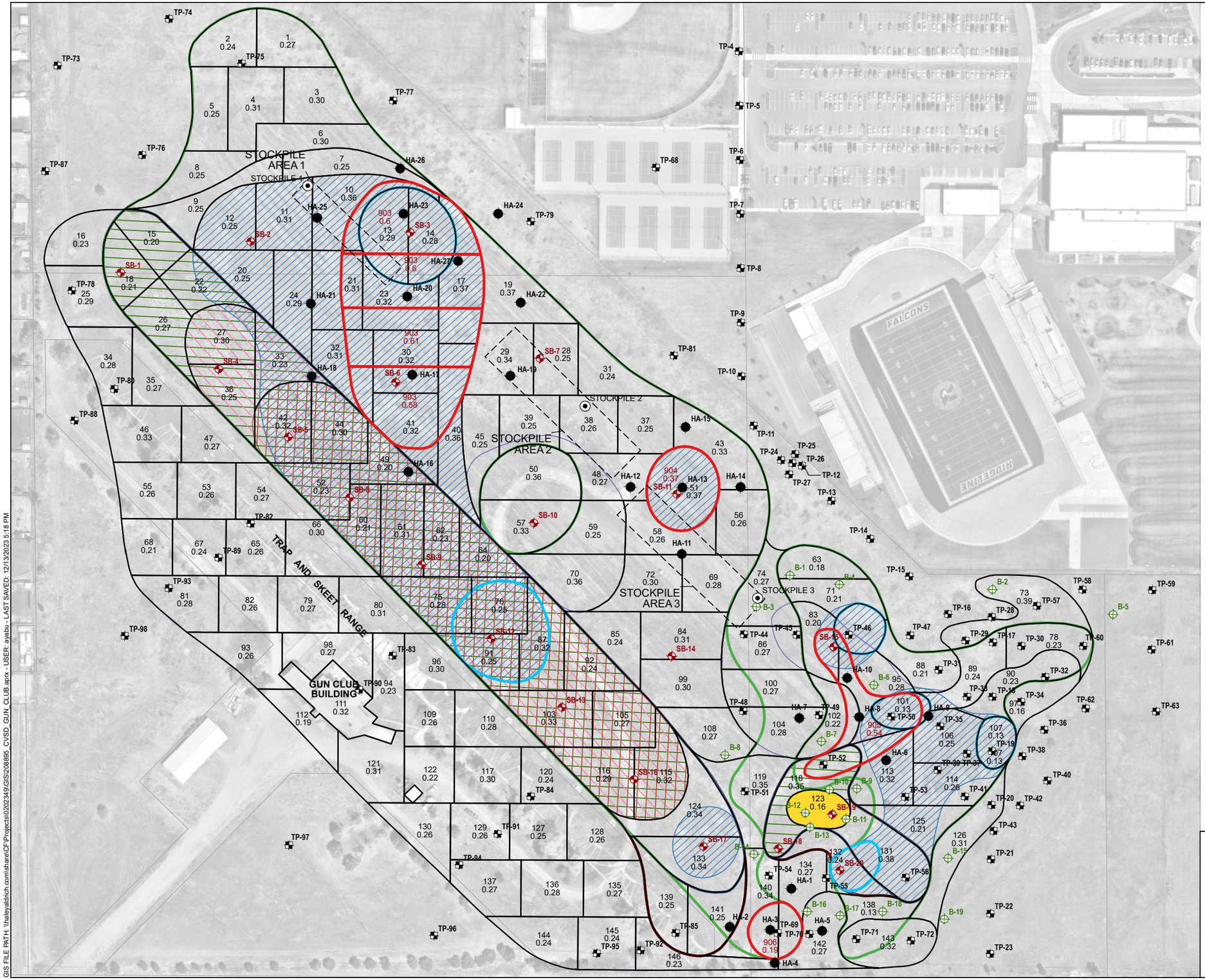
SPOKANE GUN CLUB
GREENACRES, WASHINGTON

VICINITY MAP AND SITE PLAN

AUGUST 2021

FIGURE 1

GIS FILE PATH: C:\Users\craumann\Desktop\LOCAL_DATA\135500_Central_Valley_School_District\Maps\2021_08_CAP\135500_000_0001_SITE_VICINITY_AND_SITE_PLAN.mxd — USER: craumann — LAST SAVED: 8/25/2021 10:32:54 AM



LEGEND

- PUSH PROBE BORING
- SONIC BORING
- TEST PIT
- STOCKPILE SAMPLE
- HAND AUGER SAMPLE
- STOCKPILE AREA
- HAZARDOUS LEAD SAMPLING GRID
- CONFIRMATION SAMPLING GRID, UNIT ID AND ACREAGE SHOWN
- LEAD, 0-1 FT BGS,HAZARDOUS
- LEAD, 0-1 FT BGS,NON-HAZARDOUS
- LEAD, 1-2 FT BGS,NON-HAZARDOUS
- LEAD, 2-3 FT BGS, NON-HAZARDOUS
- PAHS, 0-1 FT BGS, NON-HAZARDOUS
- PAHS, 1-2 FT BGS, NON-HAZARDOUS
- PAHS, 2-3 FT BGS, NON-HAZARDOUS
- PAHS, 3-4 FT BGS, NON-HAZARDOUS
- PAHS, 4-5 FT BGS, NON-HAZARDOUS
- PAHS, 5-6 FT BGS, NON-HAZARDOUS
- PAHS, 6-7 FT BGS, NON-HAZARDOUS
- PAHS, 7-10 FT BGS, NON-HAZARDOUS
- PARCEL BOUNDARY

NOTES
1. FT BGS = FEET BELOW GROUND SURFACE
2. AERIAL IMAGERY SOURCE: NEARMAP, 18 MAY 2023

THIS IS A MULTI-LAYER PDF; TURN MAP LAYERS ON/OFF IN THE LAYERS PANEL

N

0 180 360
SCALE IN FEET

HALEY ALDRICH

SPOKANE GUN CLUB
GREENACRES, WASHINGTON

PROPOSED SAMPLING UNITS

DECEMBER 2023

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0202349\GIS\208895_CVSD_GUN_CLUB.aprx - USER: ayabu - LAST SAVED: 12/13/2023 5:18 PM

ATTACHMENT A
Laboratory ISM/MIS Procedures

ATTACHMENT A1
Laboratory ISM Procedures

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Title: INCREMENTAL SAMPLING METHODOLOGY FOR SOILS AND SEDIMENTS [ASTM D 6323]

Approvals (Signature/Date):

Sarah Choyke 3/1/2023	Reed Pottruff 3/1/2023
Sarah Choyke Date	Reed Pottruff Date
Technical Specialist	Health & Safety Coordinator
Amy Herrera 2/22/2023	Anthony Grimaldi 3/1/2023
Amy Herrera Date	Anthony Grimaldi Date
Quality Assurance Manager	Business Unit Manager

Facility Distribution No. _____ Distributed To:_____

1.0 Scope and Application

1.1 The purpose of this procedure is to obtain sub-samples from client provided samples which represent the concentration of the analytes of interest in the entire parent sample. This is based on the guidance in ASTM Standard D-6323 "Laboratory Subsampling of Media Related to Waste Management Activities," and the DoD/DOE Quality Systems Manual (QSM).

1.2 This procedure applies to soils, sediments, and other particulate matter. This method is highly dependent on client provided Data Quality Objectives. This procedure presents the laboratory's standard approach, but details at all stages of this procedure can vary from project to project. All project-specific variations must be documented and approved in writing before the start of a project. It is important that the analyst always check special project instructions in the Eurofins Denver (TALS) before proceeding.

1.3 Eurofins Denver uses incremental sampling methodology (ISM) for non-volatile and semi-volatile organic, and inorganic analyses (e.g., explosives residues by Method 8330B and metals digestion by method 3050). The procedure described in this SOP are not suitable for volatile analyses.

1.4 This SOP addresses the pre-preparation of samples. The details of the twelve QC Elements, not otherwise addressed, are described in the associated preparation and/or analytical SOPs.

2.0 Summary of Method

2.1 The entire sample received from the client is air dried to a constant weight. Large non-representative pieces (rocks and twigs that will not pass through the sieve) may be removed manually. Other extraneous materials are removed by sieving. The sample may be disaggregated, either by hand, mortar and pestle, or mechanical means prior to drying as needed. Depending on the analytical method to be used after multi-incremental subsampling, and project objectives, the sample may be milled. The preferred milling option available at the laboratory is the ring-and-puck mill.

2.2 ISM for Metals Analysis - the routine approach is to air dry, sieve to sub-10 mesh (2.1 mm), and collect subsamples using 30 increments totaling approximately 200g when sample volume allows. The expectation is that the variability due to subsampling error will then be no more than 15% relative standard deviation (RSD) (see ASTM D-6323 for explanation and guidance for other acceptable variations).

2.3 ISM for Explosives Analysis - the routine approach is to air dry, sieve to sub-10 mesh, collect subsamples using 30 increments totaling approximately 200g when sample volume allows, and mill (if logged for milling). If the samples are from firing points, then ring-and-puck milling is required. The goal is to achieve 10% or less RSD from subsampling variability.

2.4 If a sample requires multiple analytical methods through the same pre-prep procedure, they can all take volume from the same incremental subsample. If

different pre-prep procedures are required, a separate incremental subsample aliquot will be generated.

2.5 The basic formula to use when working with clients to select the optimal approach for other methods or other precision objectives is given in Attachment 1 to this SOP. The Attachment defines the tradeoff between subsample size, particle size, and the desired level of precision.

3.0 Definitions

3.1 Refer to the Glossary of the Eurofins Denver Quality Assurance Manual (QAM) and Policy DV-QA-003P *Quality Control Program* for definitions of general analytical and QA/QC terms.

3.2 Constant Weight Analysis (CWA) – Process used to determine if samples have been sufficiently dried prior to further processing.

3.3 Disaggregation – The process of breaking up agglomerates or clumps of soil, rocks, and vegetation.

3.4 Grind / Grinding – synonym of mill / milling. A process involving particle size reduction. The ASTM and EPA 8330B source methods refer to grinding as the same thing as milling without a specific final particle size, however, DoD QSM 5.4 refers to grinding as the particle size reduction to a size of 75µm or smaller. In this SOP the term grind/grinding will only be used to refer to specific QC (i.e. Grind Blank or Grinding LCS). The term disaggregation will be used when referring to particle size reduction to a final size larger than 75µm, and mill/milling will be used to refer to particle size reduction of 75µm or smaller.

3.5 Mill / Milling – The process for particle size reduction in a sample using a device such as a ring-and-puck mill (typically to a final particle size of 75µm or smaller [200 mesh sieve or finer]).

3.6 Milling Batch: A group of up to 20 samples plus a grinding blank processed through the same milling procedure.

3.7 Non-soil Material – The material removed from the client sample during the disaggregation/sieving step of the ISM procedure.

3.8 Sample or Client Sample – refers to the entire quantity of material delivered to the laboratory for testing.

3.9 Sieving – The process of using a sieve to separate particles of a sample by size.

3.10 Subsample – refers to the portion of sample taken in the laboratory for a given analysis. The objective of this procedure is to ensure that the subsample is a reasonably accurate representation of the entire sample.

4.0 Interferences

4.1 If multi-incremental or equivalent systematic sampling processes are not employed in the field, then the extra laboratory effort entailed in this SOP may add little or no improvement in results.

4.2 Potential loss of lighter semi-volatile compounds (e.g., naphthalene) through the drying and milling process has not been well studied. Before employing the procedure for such compounds, the possible loss of lighter compounds should be discussed with the client and if possible, investigated before the procedure is performed.

4.3 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or contamination causing misinterpretation of results. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by running blanks.

4.4 Contamination by carryover can occur when a low concentration sample is processed immediately following a high concentration sample. For this reason, special care must be taken to follow the equipment cleaning steps.

4.5 As described in this SOP, the lab does not routinely mill samples for metals testing. It is expected that detection limits and reporting limits for some metals would have to be elevated based on long-term blank results if milling is required. Milling is known to contaminate samples with significant amounts of some frequently requested metals analytes (i.e. Chromium).

4.6 TNT is reportedly prone to adhering to steel surfaces. To minimize the risk of this occurring, all mill bowls, sieves, and similar metal tools are wiped dry after solvent rinsing.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Eurofins Denver Addendum to the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 The equipment listed below may produce harmful noise levels. All personnel operating or working near this equipment must be enrolled in the Hearing Conservation Program, and hearing protection must be used. See DV-HS-0010 *Hearing Conservation Program* for details.

5.3.1.1 Ring and Puck Mill

5.3.1.2 Humboldt Mechanical Disaggregator

5.3.1.3 Air Compressor

5.3.1.4 Humboldt Sieve Shaker

5.3.2 Operations involving the handling of samples outside of sealed containers, e.g., sieving, are conducted in ventilation hoods to avoid exposure to dust. Dust masks are available for use, but are optional.

5.3.3 Operations involving the milling of radioactive samples can be particularly hazardous due to the increased potential for exposure from airborne dust. If a sample is labeled as "CAT 2", "CAT 3" or "CAT 4" and requires milling through the ring and puck, contact the Radiation Safety Officer (RSO) immediately.

5.3.4 Soil samples with explosive concentrations greater than 2% cannot be accepted by the laboratory unless they have a moisture content of 25% or greater. Under no circumstance shall a soil sample with an explosive concentration greater than 10% be accepted by the laboratory. Refer to DV-OP-0018 *Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples* for further guidance in handling samples with high explosives content.

5.3.5 Any samples containing metal fragments, powders, waxy appearing pieces, or other suspicious items should be brought to attention of the group leader and the EH&S Coordinator before proceeding with the procedure. Unusual material may indicate an elevated level of explosive compounds or other hazardous contaminants.

5.3.6 The procedure described in this SOP may require the analyst to handle heavy objects such as mill bowls. Proper lifting and handling technique should be used when working with these objects. Steel toe or reinforced footwear is highly recommended but is not required.

5.3.7 The mechanical disaggregator is a potential ignition source. No solvents should be present in the hood while the disaggregator is in use. Care should also be taken to ensure that all solvents used to clean and rinse the disaggregator have fully dried before use.

5.3.8 To minimize risk of injury, the mechanical disaggregator must never be operated without the hopper firmly mounted in place and with the cover over the top opening. Failure to do so may allow users to come into contact with the hammers or rapidly moving rock fragments.

5.4 Primary Chemical and Material Hazards –

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This does not include all the materials used in the method. The table contains a summary of the primary hazards listed in the SDS for**

each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

MATERIAL	HAZARDS	EXPOSURE LIMIT (1)	SIGNS AND SYMPTOMS OF EXPOSURE
Acetonitrile	Flammable Poison	40 ppm – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Acetone	Flammable	1,000 ppm – TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Ottawa Sand	Carcinogen	50 µg/m^3 TWA	Dust inhalation may lead to lung damage
(1) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Equipment

6.1.1 Balance, capable of measuring ± 0.01 g. Calibration checked per SOP DV-QA-0014 *Selecting and Using Balances*.

6.1.2 Balance, capable of measuring ± 0.0001 g. Calibration checked per SOP DV-QA-0014 *Selecting and Using Balances*.

6.1.3 Sieve Shaker – used to facilitate the sieving of large sample volumes.

6.1.3.1 Receiver pans and lids – Receiver pans are cleaned after each use by washing with soap and water, rinsing with hot tap water, rinsing with DI water. Prior to use, the receiver pans are rinsed with a 10% acetonitrile in acetone and wiped dry with a laboratory tissue.

6.1.4 ESSA LM2 mill and associated Ring and Puck bowls – or equivalent - The mill bowl and puck are cleaned after each use by washing with soap and water with a plastic brush or scouring pad, rinsing with hot tap water, rinsing with DI water, and then placed in a hood to dry. Finally they are rinsed with a 10% acetonitrile solution in acetone. A final wipe down of the bowl and puck while still wet with solvent is done with a laboratory tissue.

NOTE: For Method 8330: TNT is prone to adhere to steel surfaces (see section 4.6 for details). In addition, sand blanks are used to monitor potential carry-over for each batch of samples (see Section 9.2 for details).

NOTE: Some samples may adhere strongly to the sides of the mill bowl. When washing the bowl after one of these samples, milling sand for several minutes may help remove the accumulations.

6.1.5 Sample Drying Systems

6.1.5.1 Drying Tower – custom built tower similar to “baker’s rack” type stack for air drying, including fans and air filters.

6.1.5.2 Trays – full size or half size “baker’s rack” or “bun pan” type for air drying soils. Aluminum or stainless steel may be used. These are washed with soapy water and a cloth, then rinsed with hot water.

6.1.6 Sieves - 10 and 30 mesh, brass for general use, stainless steel for metals testing. Sieves are cleaned after each use by washing with soap and water with a green plastic scouring pad (be careful not to damage the mesh). They are then rinsed with hot tap water followed by DI water. If rocks or debris remains caught in the mesh after washing, tweezers or a similar implement may be used to gently push them out. Prior to use, the sieves are rinsed with 10% acetonitrile in acetone and wiped with a laboratory tissue. Sieves are allowed to dry in a hood prior to use.

6.1.6.1 Before use, sieves should be carefully inspected for damage including broken wires and torn or distorted mesh. Damaged sieves should be removed from service.

6.1.6.2 Unless otherwise specified, this document uses the U.S. Standard mesh scale to specify sieve size.

6.1.7 Mortar and pestle – Porcelain or ceramic, various sizes cleaned after each use by washing with soap, water and a scouring pad, rinsing with hot tap water, and then rinsing with DI water. The mortars and pestles are rinsed with 10% acetonitrile in acetone, wiped with a laboratory tissue, and allowed to dry in a hood prior to use.

6.1.8 Mechanical Disaggregator – Humbolt Manufacturing Part Number H-4199. Used in place of a mortar and pestle to quickly reduce cakes of dry soil. The stainless steel disaggregator reduces soil agglomerates and sieves the soil through a 10 mesh sieve. The mechanical disaggregator is used to break up soil agglomerates but it is not an alternative to the Ring and Puck. The mechanical disaggregator is cleaned after each sample by removing the hopper. The hopper is washed with soap and water, rinsed with tap water, rinsed with DI water, and then rinsed with 10% acetonitrile in acetone. The Hopper is then wiped dry with a laboratory tissue. The hammers and body of the disaggregator are cleaned after each sample by spraying with a 10% bleach solution, wiping dry with a laboratory tissue, rinsing with DI water and wiping dry with a laboratory tissue.

6.1.9 Stainless steel spatulas or butter knives – used to remove particularly difficult samples form the sample containers. These are cleaned after each use by washing with soap and water using a scouring pad. They are then rinsed with hot tap water followed by DI water. Prior to use these are rinsed with 10% ACN in Acetone and wiped dry using a laboratory tissue.

6.2 Expendable Supplies

6.2.1 Subsampling tools:

6.2.1.1 Scored paper scoops (TAL-0150 and TAL-0150 LARGE from Commodity Management Services)

6.2.1.2 Plastic sample scoops – square-ended

6.2.2 Aluminum Pan – “cake pan” or “pie pan”

6.2.3 Parchment paper (quilon treated) to line trays

6.2.4 Alconox detergent or equivalent

6.2.5 Ottawa Sand – baked at 400 °C for a minimum of four hours. This is used as a blank media for grind blank samples

6.2.6 Weight boats – aluminum or plastic

6.2.7 Tongue Depressors

6.2.8 Re-sealable plastic bags

6.2.9 Assorted sample containers for storage of sample aliquots

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Grinding LCS Reference Material – a standard is that contains the available analytes of interest at an appropriate concentration. This standard is stored as specified by supplier. After milling, the ground LCS is stored at 25 °C or less.

10% Acetonitrile in Acetone – mix 400 mL of acetonitrile with 3600 mL of acetone. This solution is used for rinsing purposes only so exact measurements are not required.

Note: If acetone is unavailable, undiluted acetonitrile may be used instead.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 A typical sample should weigh approximately 1kg or less. If a sample is larger than 2kg an NCM should be written documenting the sample's weight and indicating that it is oversized.

8.2 See specific Method SOPs (CA-Q-WI-025, and WI-DV-0124) for Container Type, Preservation, and Holding time. Note that the ISM process does not change hold times.

8.3 After air drying, samples can be stored at room temperature (25°C) or lower. Samples which have not been dried should be kept refrigerated from 0°C to 6°C.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in Eurofins Denver policy DV-QA-003P *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in Eurofins Denver Policy DV-QA-024P *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM unless otherwise stated. Any deviation or exceptions from QSM requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031 *Non-Conformance and Corrective Action System*. This is in addition to the corrective actions described in the following sections.

9.2 Grinding Blanks: Ring and Puck Grinding Blanks.

Before each sample is processed through the ring and puck mill, the ring and puck will be cleaned per Section 6.1.4. Then approximately 200 g of Ottawa sand will

be ground. This ground sand will be saved and labeled with the sample ID of the next sample to be ground with the suffix "grind blank". After a batch of samples has been processed through the ring and puck, a composite will be generated using sub-aliquots from all blanks ground before the samples. This is done by placing an approximately equivalent amount of material from each of the individual sample blanks in a clean re-sealable plastic bag. The bag is then sealed and the material is homogenized by shaking and kneading the bag. An appropriately sized aliquot is then removed from the bag and labeled as the batch grinding blank. This composite is extracted and analyzed in the same manner as the field samples.

Corrective Action: If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. Samples associated with a contaminated grinding blank with positive results for the same contaminant must be reprocessed and reanalyzed. If un-ground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative

9.3 Grinding LCS (LCSSRM): for DOD projects only unless specified by client:

DOD QSM requires that a Grinding LCS be analyzed with each batch of samples that are processed through the ring and puck. The Grinding LCS must contain all reported analytes, and must be carried through the entire analytical procedure. The Grinding LCS is prepared by milling a 200-300 g aliquot of the Grinding LCS Bulk Material described in Section 7.2 without having air-dried the material beforehand. The Grinding LCS must be milled using the same milling apparatus (ring and puck) as the samples were milled. The Grinding LCS is used to monitor the effects of the milling process on the analytes of interest. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Corrective Action: If the Grinding LCS fails the acceptance criteria, samples associated with the Grinding LCS must be reprocessed and reanalyzed. If un-ground sample is not available, then the results of the grinding LCS must be described in a non-conformance memo and discussed in the final report case narrative.

Note: For DoD methods in which a reference material (see section 7.2) is not available, document this deficiency with an NCM.

9.4 Sample Duplicate (Du)

A duplicate sample is required after subsampling is performed according to DOD QSM 5.4.

A sample duplicate is a second aliquot of one of the samples in the batch. Field blanks cannot be used for duplicate testing. The results for duplicates are reported separately, and cannot be averaged when reporting results. Sample duplicate results are used to evaluate the precision of the method. As such, results should

be greater than or equal to the RL for a valid statistical comparison.

9.5 Sample Triplicate (Trl)

A triplicate sample is required after subsampling for 8330B according to DOD QSM 5.4.

A sample triplicate is a third aliquot of the sample from which the duplicate was taken.

9.6 Precision

9.6.1 On a project basis, the lab will discuss precision objectives with the client prior to initiating work. If evaluation of the RSD is needed, the laboratory will need to analyze at least one set of triplicate samples in every preparation batch. In other cases, the lab will employ duplicate matrix spikes and control limits will be expressed as relative percent difference (RPD).

9.6.2 If the client supplies multiple field samples to use for replicate testing, then the laboratory will compare results to acceptance limits and qualify data if the precision limits are not met. If the replicates are prepared from the single field sample that is dried, ground, and sieved, then the acceptability of each milling batch can be controlled based on the precision objectives established for the project.

9.7 While no spiking is done in the ISM batch, the QC samples are included in the ISM batch unless otherwise noted so that an appropriately sized aliquot can be provided for extraction.

9.7.1 All ISM batches must include an MS/MSD pair unless the method being batched specifies that a sample duplicate (Du) can be used instead.

10.0 <u>Procedure</u>

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031 *Non-Conformance and Corrective Action System*. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 The following sections describe all the possible steps of the process. Not all may be required for a given project. Be sure to reference method comments and project notes to determine which steps are required for a given sample. In general, if a sample requires ISM, all steps are required up to milling, which is done on a project-by-project basis. For samples that require Drying only, or Dry and Grind only (No

ISM, No Sieving), the relevant parts of the following procedure are to be followed while omitting the ISM specific steps.

10.4 Dry the Samples

10.4.1 The entire contents of the sample container must be laid out.

10.4.1.1 If additional tests are logged and the client only sent one container, the Project Manager should be notified and an NCM should be written if the whole sample volume was not able to be laid out.

10.4.1.2 If separate containers are provided for the parent sample and client-assigned MS/MSD, all containers should be combined and laid out together.

Note: If the parent, MS, and MSD samples are different in appearance, the Project Manager should be notified prior to combining them, and an NCM should be created.

10.4.2 Weigh the sample prior to processing. See section 8.1 if sample weight exceeds 2kg.

10.4.3 Depending on the sample size, the samples are laid out in aluminum pans, or on trays lined with parchment to dry. If metals analysis is requested, samples must be laid out on parchment paper.

10.4.4 Spread the samples out in a thin layer to facilitate drying. Use a spatula, gloved hands, or any other suitable tool in order to break up any clumps and agglomerates if present. It is particularly important to break up clay samples by hand at this stage, prior to drying.

10.4.5 The tray or pan that the sample is laid out into is labeled with the sample ID. An analyst checks to make sure that the labels on the tray or pan match the labels on the client sample container to ensure samples are not accidently mixed up. This check is documented in TALS.

10.4.5.1 If samples are logged for an “as-received” ISM method (i.e. ISM_R_SS), samples should be aliquotted following the procedure described in section 10.6 prior to drying the sample.

10.4.6 Place the samples in a drying tower, hood or well-ventilated area at room temperature. Document in TALS the date and time the samples were laid out to dry, and the ID of the tower in which they were laid out. If the samples are very wet, a fan can be used to help facilitate the drying process, but care should be taken so that the air flow is not strong enough to cause cross-contamination between samples. An electronic temperature recording device records the temperature of the room and the data is downloaded weekly.

10.4.7 When the samples appear to be dry enough that they can be sieved without caking, subsample approximately 15 grams into an appropriate weighing vessel and record the exact weight, the date, and the time (see Attachment 3 Constant Weight Analysis). Set this 15 gram aliquot (still in the weighing vessel) next to the rest of the drying sample. Take care to use an appropriate weighing vessel for the analytical methods requested, as the aliquot removed in this step will still be included in the volume used for ISM (i.e., Do not use an aluminum weigh boat for samples requiring metals analysis).

10.4.8 After at least 2 hours, reweigh the aliquot in the same weighing vessel and record the exact weight, the date, and the time. If the weight of the sample is within 10% of the previous weight, proceed to section 10.5, otherwise repeat this process until the weights are within 10% of the previous.

10.4.8.1 Following the Constant Weight Analysis, a copy of the temperature log mentioned in 10.4.6 should be saved and attached to the batch. See Attachment 4 for instructions on how to save the temperature log.

Note: If the temperature log indicates that the temperature exceeded 25°C for 4 hours or longer, an NCM should be written documenting this excursion.

10.5 Sieve the Samples

10.5.1 Clean the sieves prior to use following the instructions in section 6.1.6.

10.5.1.1 Samples logged for an ISM pre-prep method (any method that contains “ISM” in the method code) should be sieved using a 10 mesh sieve.

10.5.1.2 Samples logged for a Dry_Sample or Dry_Grind pre-prep do not get sieved unless logged for an 8330A analytical method.

Note: Regardless of the ISM pre-prep, if the sample is logged for prep method “8330_P_2g” then a 30 mesh sieve should be used.

10.5.1.3 Some clients will request metals analyses to be performed on the sieved sample. In those cases, a stainless steel sieve should be used. Brass sieves should be avoided.

10.5.1.4 If the client requirements specify a particular sieve size, those instructions take precedence.

10.5.2 Some samples may require the use of a gloved hand, mortar and pestle, mechanical disaggregator, or other appropriate implement to break up dried clumps.

10.5.3 Record the weight of the entire dried sample. This is a requirement for 8330B in the DoD/DOE QSM.

Sieve the entire dried sample through the appropriate sized sieve. If necessary, the soil can be broken into small pieces with a gloved hand or another instrument (a wooden spatula for example). If a gloved hand is used, care should be taken to change out gloves in between samples to prevent cross-contamination.

10.5.4 Remove large rocks, vegetation, twigs, and other material that is clearly not part of the sample and that do not pass through the sieve. Mosses and other types of fine vegetation should be physically shredded while sieving to release trapped soil and residues. Be sure to break up all soil agglomerations that is possible with a gloved hand. The only materials that should be eliminated by sieving are rocks and vegetation, or soil that cannot be reduced by hand. Note that clay-like samples may require use of a mortar and pestle to break up agglomerations formed during drying, but it is not necessary to disaggregate to a powder-like consistency.

10.5.4.1 For Method 8330, place any soil that does not pass through the sieve into a clean mortar. Break up soil agglomerates using the pestle. Or as an alternative use the mechanical disaggregator. Be sure to break up all soil so that it can pass through the sieve. Only extraneous material such as rocks and vegetation should be removed with the sieve.

10.5.5 Describe all extraneous material that did not pass through the sieve in an NCM. Document the weight of any material that does not pass through the sieve. Document this weight in the aliquot spreadsheet (see attachment 2), or in an NCM. Label and retain this material that does not pass through the sieve.

10.5.6 Collect all of the material that passes through the sieve on a clean piece of foil or parchment paper.

10.5.7 An automatic sieve shaker can be used to help facilitate the sieving of samples. A receiver pan is placed under a sieve and the sample is added to the sieve. Then a lid or another receiver pan for a second sample is placed on top. The stack is then clamped inside the sieve shaker for no more than 30 minutes.

Inspect the samples to ensure that only extraneous material such as rocks and vegetation should be removed with the sieve. If needed use a mortar and pestle to break up soil agglomerates. Describe all extraneous material that did not pass through the sieve in an NCM. Document the weight of any material that does not pass through the sieve. Document this weight in the aliquot spreadsheet (see attachment 2), or in an NCM. Label and retain this material that does not pass through the sieve.

10.6 Incremental Sampling Methodology for All Methods

10.6.1 Select an appropriate subsample container. Standard use of a soil jar is preferred.

10.6.2 Remove the cap from the appropriate subsample container and place on a balance and tare. The entire sample is spread out to approximately 1 cm thickness.

10.6.3 Using a subsampling tool (described in section 6.2.1), take an appropriately sized subsample by collecting at least 30 increments from random locations through the entire thickness, top to bottom, of the layer of sample.

10.6.3.1 If samples are logged for Dry_Sample or Dry_Grind, follow standard subsampling procedures listed in DV-QA-0023 *Subsampling*.

Note: If 8330B is logged for Dry_Sample or Dry_Grind, an SOP deviation NCM should be written noting that incremental subsampling was not performed as required.

10.6.3.2 If milling is required, a separate aliquot should be created. Subsample appropriate material based on volume needed for each test, and to allow sufficient material in the puck mill bowl, typically 200g.

10.6.3.3 Sub-out ISM samples will need to aliquotted into an appropriate sample container and delivered to the sample sub-out shelf with the appropriate paperwork. Aliquot size will vary and depends on the analysis needed.

10.6.4 Record the aliquot weight in the ISM Aliquot Worksheet described in Attachment 2.

10.7 Ring and Puck Mill Grinding

The instructions in this section are to be used as a general procedure when milling is requested prior to extraction and analysis for any method.

10.7.1 See Section 6.1.4 on how to clean the ring and puck mill bowls.

10.7.2 If the sample is logged for ring and puck milling, a grinding blank per Section 9.2 consisting of baked Ottawa sand will be processed through the ring and puck dish before each sample. These individual blanks will be composited into one grinding blank for the associated samples and will be analyzed in addition to the normal extraction blank.

10.7.3 After a grinding blank has been processed through a ring and puck dish, that blank is labeled as the grind blank associated to the next sample processed through that same dish. Do not clean the ring and puck dish after the grind blank.

10.7.4 For DoD samples logged for 8330B, non-explosives methods, or non DoD samples which request a grinding LCS, prepare a grinding LCS per Section 9.3 with every batch. The grinding LCS will be analyzed in addition to the normal extraction LCS and may be aliquotted repeatedly as long as the grinding LCS is recovering within acceptable limits.

NOTE: A grinding batch will consist of no more than 20 client samples, plus QC, that have been milled through the same milling procedure. A grinding batch must contain at least one Grinding Blank. If more than one Grinding Blank is prepared, it must be very clear on the benchsheet which individual sample blanks were used to build each Grinding Blank

10.7.5 Transfer the sample into a clean ring and puck dish. Do not overfill the dish (approximately 200-300g of sample can fit in one dish). Place the dish securely in the holder and close the door on the machine. Mill the sample for one 60-second period. Remove the dish and open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between two fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, mill for additional 60 second cycles, with a one-minute cooling time in between, repeating this process until milling is complete and the sample has the desired consistency. The specific number of cycles can be adjusted based on analyst experience with a specific project. Once the sample has been milled, it should be transferred to an appropriate, labeled, container and stored for analysis.

NOTE: During the one-minute cooling time, the dish can be placed in a shallow ice water bath to facilitate cooling but is not necessary for most samples. This should only be used for samples that have multiple mill cycles or methods with heat sensitive analytes. Be sure the bath is shallow enough so that water does not get inside the dish.

NOTE: For explosives methods it has been shown that certain analytes (i.e. Tetryl and TNT) are particularly heat sensitive. Freezing the mill bowls has been shown to minimize the loss of such analytes during the milling process.

NOTE: For metals methods care should be taken to use the correct mill bowls to minimize contamination of certain elements (i.e. Cr, Sb, V, Co, Mn, Mo). Standard steel mill bowls should be used when Cr is a requested analyte, otherwise, chrome steel bowls should be used.

10.7.5.1 If multiple 300g increments are used for milling and the sample is recombined, it has been shown through Duplicate/Triplicate QC results that the sample is non-homogenous.

11.0 Maintenance

11.1.1 Approximately once a month, the cover on the Ring and Puck should be removed and any dirt should be cleaned up.

11.1.2 When excessive wear is noted, replace the hammers in the Mechanical Disaggregatorer.

11.1.3 The o-rings in the Ring and Puck dishes should be replaced when worn.

11.1.4 Mill bowl pucks may become deformed through standard use. Pucks should be reformed using a file or dremel.

11.1.5 Drying tower filters should cleaned or replaced when dirty (indicated by discoloration) or damaged.

12.0 Troubleshooting

Low recoveries for Tetryl in the explosives grinding LCS may be indicative of high temperatures during milling. Review the cooling step noted in section 10.7.5 in order to minimize the effect of the heat generated during the milling process.

13.0 Calculations

Relative Standard Deviation

$$RSD = \frac{S}{\overline{X}}$$

Where: S = standard deviation

$\overline{X}$ = mean

14.0 Method Performance

14.1 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024 *Training*.

15.0 Pollution Control

The use of organic solvents to complete the equipment cleaning steps is minimized. Quantities are typically limited to residues on equipment that quickly evaporate in a hood.

16.0 Waste Management

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in Section 13 of the Corporate Environmental Health and Safety Manual, *Waste Management and Pollution Prevention*.

16.2 The following waste streams are produced when this method is carried out:

- Solid Waste – Waste Stream S
- Flammable Solvent Waste – Waste Stream C

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

NOTE: Quarantined soil waste must be segregated from non-quarantine waste as appropriate. Refer to DV-QA-0019 *Quarantine Soils Procedure*.

17.0 References / Cross-References

17.1 "Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples," USEPA, November 2003.

17.2 "Standard Guide for Laboratory Subsampling of Media Related to Waste Management Activities" ASTM D 6323-98 (Reapproved 2003)

17.3 DoD/DOE Quality Systems Manual Version 5.4, 2021.

17.4 U.S. EPA. 2006. "Method 8330B (SW-846): Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography (HPLC)," Revision 2. Washington, DC

17.5 U.S. EPA. 2007. "Method 8330A (SW-846): Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)," Revision 1. Washington, DC

18.0 Method Modifications

Item	Method	Modification
10.7.3.2/ 10.8.5	8330B	EPA method 8330B requires the whole sample which passes through the sieve be milled. This has been modified to subsample after sieving and mill a representative portion of the sample.
10.8.5	8330B	EPA method 8330B specifies that milling is to be stopped after 5 cycles. This has been modified to have the milling stopped after the sample has reached a fully milled condition

10.8.5	8330B	EPA method 8330B specifies 5 1-minute milling cycles with a 2-minute cooldown period. This has been modified to 1 1-minute cycle with a 1-minute cooldown period in an ice bath.

19.0 Attachments

Attachment 1: Consideration of Fundamental Error in Selecting MIS Options
Attachment 2: ISM Worksheet
Attachment 3: ISM Constant Weight Worksheet
Attachment 4: Use of the Logtag Recorder for ISM Batches
Attachment 5: ISM Sample Processing Flowchart

20.0 Revision History

This section has been added beginning with Revision 0. Only details of the last two revisions are incorporated into this SOP. Prior revisions are documented in the QA files and available upon request.

Revision 16, date 15 February 2023

- Changed grinding to milling throughout document
- Removed references to SOP DV-OP-0018 as all information has been moved into the current SOP
- Section 1.3: remove section of volatile analysis
- Section 3.0: added definitions
- Section 5.3: added information about safety requirements.
- Section 5.4: added Ottawa Sand as a potential hazardous material
- Section 6.1: added information for clarity on cleaning procedures
- Section 6.2: added consumable supplies
- Section 7.2: added information regarding the LCS Reference material
- Section 8.0: Updated for clarity
- Sections 9.3, 9.4, 9.6: grinding LCS (LCSSRM), sampling duplicate, and sample triplicate requirements are moved to SOP DV-OP-0013 from DV-OP-0018
- Section 9.7: updated for clarity
- Section 10.0: Updated for clarity and added details from DV-OP-0018. Including
    - Section 10.4: added information about drying the entire sample is dried and details on the drying process and performing the Constant weight Analysis
    - Section 10.5: added details about specific sieving method chains
    - Section 10.6: added details about specific ISM Method chains
    - Section 10.7: added details about the grinding LCS and associated QC. Updated milling time to 1 60-second period and notes about treating high explosive containing samples.
- Section 11.0: added maintenance and safety checks for mill bowl pucks and drying towers
- Section 16.0: added Note on quarantined soil waste per DV-QA-0019
- Section 17.0: Updated references
- Section 18.0: Updated Method modification
- Section 19.0: Updated Attachments

- Updated language and formatting throughout

Revision 15, date 27 April 2022

- Updated copyright information
- Changed Eurofins TestAmerica Denver to Eurofins Denver throughout
- Removed requirement to use mortar and pestle as part of sieving stage.
- Per QSM and DOD guidance, the requirement to grind the entire sample volume was removed.
- Updated language and formatting throughout

Attachment 1

Consideration of Fundamental Error in Selecting ISM Options

The following formula given in ASTM D-6323 was used to produce the table that follows.

$$S^2 = 18 * f * e * d^3 / M_s$$

where,

S^2 = the relative variance of the contaminant concentration due to the fundamental error

f = shape factor, a dimensionless number, a value of 0.5 can be taken as typical (Pierre Gy, 1982)

e = the population's average density (g/cm^3). For this table a typical soil density of 2.5 g/cm^3 was used.

d = the diameter of the largest particle in centimeters, and

M_s = the mass of the sample in grams

Sample Mass and Maximum Particle Size to Achieve a Desired RSD

Subsample Mass (g)	Sieve Size (US Standard Mesh)	At 5% RSD Max Size (cm)	At 10% RSD Max Size (cm)	At 15% RSD Max Size (cm)
0.1	35	0.02	0.04	0.05
1	18	0.05	0.08	0.10
2	13	0.06	0.10	0.13
5	12	0.08	0.13	0.17
10	10	0.10	0.16	0.22
30	7	0.15	0.24	0.31
50	6	0.18	0.28	0.37
100	5	0.22	0.35	0.46

Attachment 2

ISM Worksheet

Located: \\tafs\Lab2\Denver\Admin\QA\Edit\FORMS\Organic Prep Forms\DV-F-0085_Rev3_05-04-2022_ISM_aliquot_worksheet

BATCH:

DV-F-0085 rev 2022-04-26. **Use this spreadsheet to document sample weights during the ISM process.**

	Method --->	gross weight	container tare weight	initial sample weight	dried sample weight	nonsoil material	min aliquot size needed	aliquot weight		Comments
	Balance ID --->			calculated			NA			
Login	**Sample**	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	
				0						
				0						
				0						
				0						
				0						
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Attachment 3

ISM Constant Weight Worksheet

Located: \\tafs\Lab2\Denver\Admin\QA\Edit\FORMS\Organic Prep Forms\DV-F-0070_Rev 2_01-07-2020_ISM constant weight spreadsheet

ISM Batch Number:

DV-F-0070_Rev 2_01-7-2020 Use this spreadsheet to document drying samples to a constant weight.

balance ID:			Date/time 1	Date/time 2	Dry?		Date/time 3	Dry?	
			analyst initial	analyst initial			analyst initials		
Login	Sample	Tare weight (weight of weighing vessel)	Gross weight (g) (weight of aliquot and weighing vessel)	Gross weight (g) (weight of aliquot and weighing vessel)	Change in weights 1, 2	Proceed with ISM?	Gross weight (g) (weight of aliquot and weighing vessel)	Change in weights 2, 3	Proceed with ISM?
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Attachment 4

Use of the Logtag Recorder for ISM Batches

1. If not already open, launch the LogTag Analyzer program.
2. Insert the logtag into the interface cradle and wait for the program to load the data from the logtag.
3. Select the “Chart” tab near the bottom left corner of the screen.
4. Right-click on the graph and select “Manual Scaling.”
5. Make sure the “Range of readings option near the top of the dialogue window is selected.
6. Change the start (from) time to the date and time when the samples were laid out.
7. Change the end (to) date and time to the date and time when the samples passed CWA, then click “OK”
8. Select the “Report” tab near the bottom left corner of the screen.
9. Print the resulting chart to a PDF. The file name should consist of the batch number(s) followed by the logtag name and ending with ‘log’. This should end up looking like “561516_561519_annex_log.pdf.” Save the file in the appropriate subdirectory of the ISM folder.

   Note: If the report tab isn’t available, use the Chart tab instead.
10. If there are no other batches drying, the LogTag should be cleared and reconfigured. Follow the instructions below.
11. If there are still batches that are drying, remove the LogTag from the cradle and replace it in its normal location.

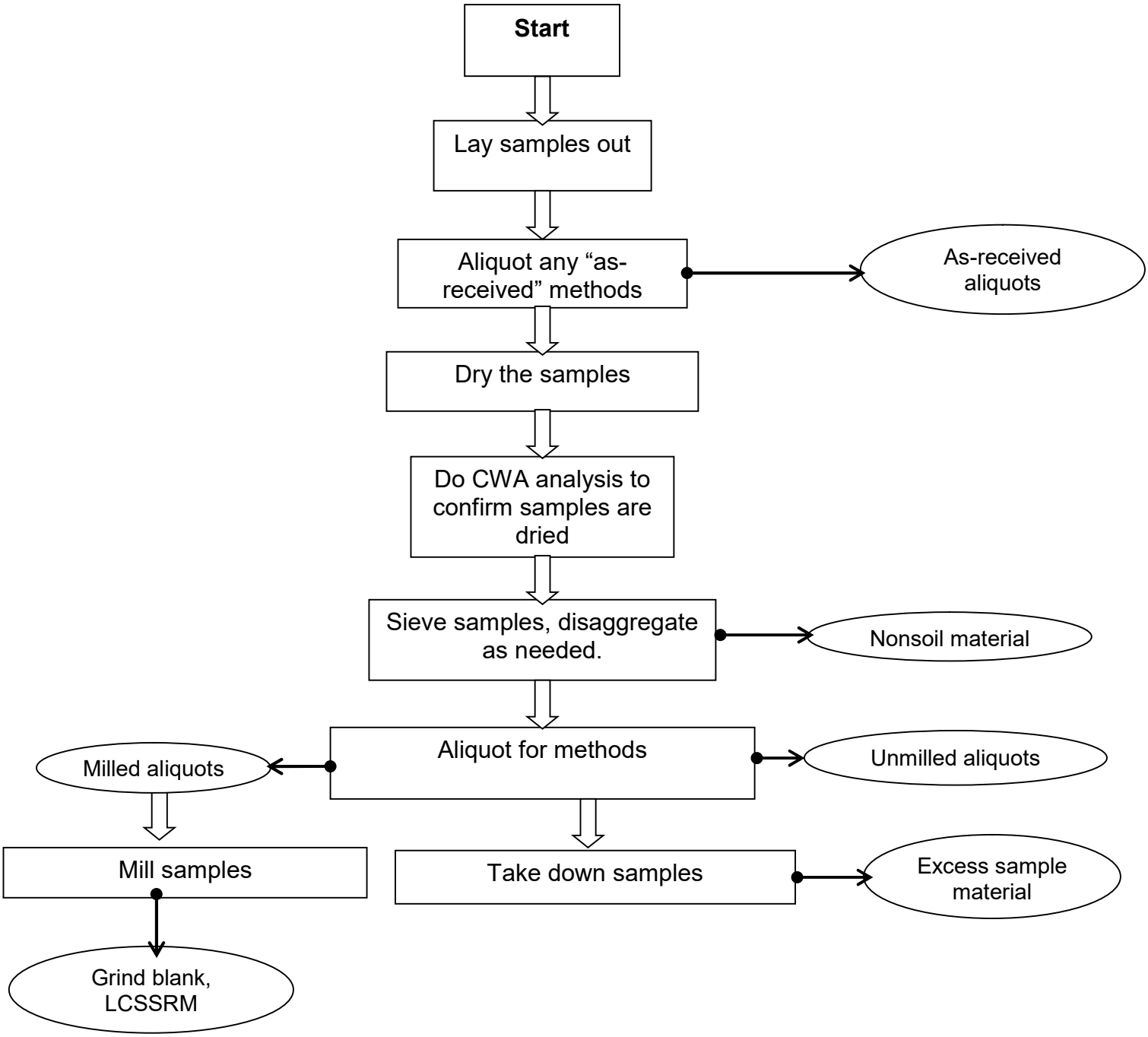
Clearing and reconfiguring the LogTag

If there are no other batches still drying, the LogTag should be cleared and reconfigured after you have obtained the needed reports.

1. Click on the “Wizard” button near the top left corner of the window. A dialog box will open up, and the software will take a few seconds to access the LogTag.
2. When it becomes available, click on the “Configure” button near the bottom of the dialog box, then click it a second time. Do not change any of the settings.
3. After the program has finished configuring the LogTag, close the wizard and remove the LogTag from the interface cradle.
4. Press and hold the “Start” button on the LogTag until the lights on the front flash several times. The LogTag may now be returned to its usual location.

Attachment 5

ISM Sample Processing Flowchart



ATTACHMENT A2
Laboratory MIS Procedures

Pace Analytical®
ENVIRONMENTAL SCIENCES

Document Information

Document Number: ENV-SOP-MTJL-0112 **Revision:** 05

Document Title: Multi-Increment Sampling

Department(s): SVOA

Date Information

Effective Date: 17 Feb 2022

Notes

Document Notes:

All Dates and Times are listed in: Central Time Zone

Signature Manifest

Document Number: ENV-SOP-MTJL-0112 **Revision:** 05

Title: Multi-Increment Sampling

All dates and times are in Central Time Zone.

ENV-SOP-MTJL-0112

QM Approval

Name/Signature	Title	Date	Meaning/Reason
Rebecca King (010125)	Manager - Quality	17 Feb 2022, 11:42:57 AM	Approved

Management Approval

Name/Signature	Title	Date	Meaning/Reason
Kyle Moore (006492)	Supervisor	14 Dec 2021, 03:29:55 PM	Approved
Michael Jones (006596)	Quality Analyst 3	17 Dec 2021, 12:44:45 PM	Approved

Pace Analytical™

TEST METHOD STANDARD OPERATING PROCEDURE
TITLE: Multi-Increment Sampling
TEST METHOD: NA

ISSUER: Pace Analytical National Center for Testing & Innovation

1.0 Scope and Application

1.1 Appendix A of EPA Method 8330B (SW-846) specifically addresses field sampling. The appendix provides guidance for explosive residue sample collection, handling, and laboratory processing techniques. Method 8330B recommends the use of multi-increment (MI) sampling, which involves the extraction of a representative portion of material from within a single decision unit which will adequately address potential compositional and distributional heterogeneity. In MI sampling, several increments from the same decision unit are combined to form one sample that is submitted for laboratory analysis. The procedures for MI sampling are specifically designed to minimize sampling error and provide a more scientifically-representative mean concentration of the contaminant(s) present in the decision unit.

1.2 Initial demonstration for achieving samples size below 75µm per DOD/DOE QSM is on file in the QA department.

2.0 Summary of Method

2.1 Samples are dried, ground, and homogenized before subsamples are taken for sample preparation.

3.0 Interferences

3.1 Care must be taken to not cross-contaminate samples during the drying, sieving, and grinding procedures. Grinding blanks are required to verify procedure is free from cross contamination.

3.2 The drying process may result in quantitative losses of some analytes. Project Managers may consider eliminating the drying process prior to analysis or removing poor performers from the target analyte list if drying is required.

4.0 Definitions

4.1 Sieve: A device made of wire mesh held in a frame through which finer particles of a mixture of various sizes may be passed to separate them from coarser ones or through which soft materials may be forced for reduction to fine particles.

4.2 Shatterbox: A device for mechanically pulverizing a sample or material.

4.3 Ball Mill: A device using ceramic pellets and rotation in a closed container to pulverize the contents.

4.4 Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

5.0 Health and Safety

5.1 The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.

5.2 The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (HSE) policies and procedures specified in this SOP and in the Pace National Chemical Hygiene / Safety Manual.

5.3 Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.

5.4 Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. Use these acids in a fume hood whenever possible with additional PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. Any processes that emit large volumes of solvents (evaporation/concentration processes) must be in a hood or apparatus that prevents employee exposure.

5.5 Contact your supervisor or local HSE coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

6.0 Sample Collection, Preservation, Holding Time, and Storage

6.1 Samples should be collected in accordance with a sampling plan and procedures appropriate to achieve the regulatory, scientific, and data quality objectives for the project.

6.2 Pace National will typically receive samples in 4-8oz containers for processing.

7.0 Equipment and Supplies

7.1 Sieve: 10mesh

7.2 Grinder: Shatterbox or equivalent capable of reducing particle size to <75µm

7.3 Drying rack

7.4 12-inch brass pans

7.5 Aluminum baking sheets

8.0 Reagents and Standards

8.1 All reagents and standards must be recorded in the appropriate preparation log and assigned a unique number. See ENV-SOP-MTJL-0041, *Standard Logger – Tree Operation*. Additional information regarding reagent preparation can be found in the Standards Logger (Tree) digital archive system. All spiking solutions and surrogate standard solutions should be replaced at least every six months or sooner if a problem is detected unless otherwise noted.

9.0 Procedure

9.1 All sample contents within the container are emptied into a pan/weigh boat and dried to a constant weight.

9.1.1 A Blank matrix must be dried with samples.

9.1.2 Obtain a clean pan/weigh boat and record the tare weight.

9.1.3 Empty the entire contents of the sample container into the pan/weigh boat.

9.1.4 Using gloved hands break the soil into small pieces as necessary to facilitate the drying process. Use fresh gloves for each sample to prevent cross contamination.

9.1.5 Record the initial weight of the entire sample.

9.1.6 After the initial weight is obtained, dry the sample at room temperature in a hood for approximately 24 hours. Then obtain a 2nd sample weight.

9.1.7 Continue the drying process for approximately 12 hours and obtain a 3rd sample weight.

9.1.8 Two consecutive weights of less than 10% difference, taken approximately 12 hours apart, is considered to be dried to a constant weight.

9.1.9 Dates/Times are recorded as well as the ambient temperature with each weighing of samples.

9.2 For all methods or when client-specific data quality objectives (DQOs) require grinding, dried sample is introduced into the shatterbox or equivalent. The entire sample must be ground. If multiple portions are ground separately, the aliquots must be combined prior to subsampling for extraction. Samples are ground up to three-minute intervals. Intervals and duration are dependent on the sample matrix and analytes of interest for the specific project. The Blank and weekly check sample must also proceed through this step.

9.3 Dried sample material is passed through a 10mesh (2mm) sieve (may be assisted using gloved hands). Do not intentionally include vegetation unless project specifications include this requirement. Depending on sample matrix, sieving may be performed initially to facilitate the drying process.

9.4 The Blank matrix is ground at the end of each batch. A blank will also be ground after any sample of known concentration above detectable limits, including quality control samples.

9.5 Each sample/QC is spread into a pan in order to perform sufficient subsampling of the final sample aliquot. At least 30 sample increments must be taken for the subsampling procedure. The sample volume extracted for analysis should represent the entire ground sample.

NOTE: If sample volume does not allow 30 aliquots, a note will be made on the extraction log.

9.6 See the specific method extraction SOP for further processing information.

10.0 Data Analysis and Calculations

10.1 See the Laboratory Quality Assurance Manual for equations for common calculations.

11.0 Quality Control and Method Performance

11.1 Analyst Qualifications and Training

11.1.1 Employees that perform any step of this procedure must have a completed Read and Acknowledgment Statement for this version of the SOP in their training record. In addition, prior to unsupervised (independent) work on any client sample, analysts that prepare or analyze samples must have successful initial demonstration of capability (IDOC) and must successfully demonstrate on-going proficiency on an annual basis. Successful means the initial and on-going DOC met criteria, documentation of the DOC is complete, and the DOC record is in the employee's training file. Refer to ENV-SOP-MTJL-0015, *Technical Training and Personnel Qualifications for Chemistry* for more information.

12.0 Data Review And Corrective Action

12.1 Data Review

12.1.1 Pace National's data review process includes a series of checks performed at different stages of the analytical process by different people to ensure that SOPs were followed, the analytical record is complete and properly documented, proper corrective actions were taken for QC failure and other nonconformance(s), and that test results are reported with proper qualification.

12.1.2 The review steps and checks that occur as employees complete tasks and review their own work is called primary review.

12.1.3 All data and results are also reviewed by an experienced peer or supervisor. Secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented in accordance with the Pace National's SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

12.1.4 A third-level review, called a completeness check, is performed by reporting or project management staff to verify the data report is not missing information and project specifications were met.

12.1.5 Refer to ENV-SOP-MTJL-0014, *Data Handling and Reporting* and ENV-SOP-MTJL-0038, *Data Review* for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

12.2.1 Corrective action is expected any time QC or sample results are not within acceptance criteria. If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

13.0 Pollution Prevention and Waste Management

13.1 Pace National proactively seeks ways to minimize waste generated during our work processes. Some examples of pollution prevention include but are not limited to: reduced

solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

13.2 The EPA requires that laboratory waste management practices be conducted consistent with all applicable federal and state laws and regulations. Excess reagents, samples and method process wastes must be characterized and disposed of in an acceptable manner in accordance with Pace National's Chemical Hygiene Plan / Safety Manual.

14.0 Modifications

14.1 Pace National is set up currently to process from 4oz/8oz/16oz/32oz jars that have been prepared in the field from bulk containers. Pace National cannot currently process bulk samples for this method.

14.2 Due to limited sample volume received as listed in 14.1:

14.2.1 Duplicate subsampling is performed rather than triplicate

15.0 Responsibilities

15.1 Pace National employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement in their training file for this version of the SOP. The employee is responsible for following the procedures in this SOP and handling temporary departures from this SOP in accordance with Pace National's policy for temporary departure.

15.2 Pace National supervisors/managers are responsible for training employees on the procedures in this SOP and monitoring the implementation of this SOP in their work area.

16.0 Attachments

16.1 Not applicable to this SOP

17.0 References

17.1 Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography (HPLC), SW-846 Method 8330B, Revision 2, October 2006, Appendix A.

17.2 Quality Systems Manual (QSM) for Environmental Laboratories, Department of Defense (DoD), Version 5.1, 2017.

TEST METHOD STANDARD OPERATING PROCEDURE
TITLE: Multi-Increment Sampling
TEST METHOD: NA
ISSUER: Pace Analytical National Center for Testing & Innovation

18.0 Revision History

This Version:

Section	Description of Change
7.3, 7.4, 7.5, 9.2. Removed 8.2, 9.6, & 14.3.	Process update and removal of 8330 prep steps.

This document supersedes the following document(s):

Document Number	Title	Version
ESC Lab Sciences SOP #330377	ESC Lab Sciences SOP #330377	1
ESC Lab Sciences SOP #330377	ESC Lab Sciences SOP #330377	2
ESC Lab Sciences SOP #330377	ESC Lab Sciences SOP #330377	3
ENV-SOP-MTJL-0112	Multi-Increment Sampling	01
ENV-SOP-MTJL-0112	Multi-Increment Sampling	02
ENV-SOP-MTJL-0112	Multi-Increment Sampling	03
ENV-SOP-MTJL-0112	Multi-Increment Sampling	04

APPENDIX B
Air Monitoring Work Plan for Spokane Gun Club

HALEY ALDRICH

www.haleyaldrich.com

AIR MONITORING WORK PLAN
FOR SPOKANE GUN CLUB
SPOKANE VALLEY, WASHINGTON

by
Haley & Aldrich, Inc.
Spokane, Washington

for
Central Valley School District
Spokane Valley, Washington

File No. 0202349-001
January 2024

Table of Contents

List of Figures

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List of Attachments

1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) has prepared this Air Monitoring Work Plan (Work Plan) on behalf of the Central Valley School District (CVSD) for the former Spokane Gun Club (Gun Club) property located at 19615 E Sprague Avenue in Spokane Valley, Washington (Site), shown on Figure 1. The Site is listed by the Washington State Department of Ecology (Ecology) as Cleanup Site 14851 and Facility Site ID 50340.

The Site has been impacted by lead and polycyclic aromatic hydrocarbons (PAHs) from use as a shooting range; lead contamination originates from the accumulation of lead shot and PAHs originate from clay target debris. Coal and petroleum binders are used to manufacture clay targets and include several PAHs including: naphthalenes, the carcinogenic PAH (cPAH) benzo[a]pyrene (BaP), and other cPAHs regulated by Ecology. The purpose of this Work Plan is to provide air monitoring protocols to demonstrate and confirm fugitive dust is controlled during construction activities and to promptly address fugitive dust if detected. This Work Plan, and the results of any work conducted by CVSD pursuant to this Work Plan, are subject to review and approval by Ecology. Upon approval, the methods and procedures described herein will be used for air monitoring during construction activities and to set work stoppage thresholds based on airborne particulate levels.

This Work Plan is to minimize the amount of fugitive dust emissions that may contain toxic air contaminants, it is not intended to monitor exposure to airborne concentrations of asbestos or other airborne contaminants which may be present during building demolition or construction activities. Asbestos exposure and monitoring are the responsibility of the asbestos abatement contractor and shall be in accordance with Washington Administrative Code (WAC) 296-65.

2. Background

The Site was purchased by CVSD in 2018 and the Gun Club (the former owner since 1948) leased the clubhouse and range portion of the property for recreational shooting activities until July 2021. At the time of purchase, the property consisted of undeveloped grass fields with infrastructure for the Gun Club building and trap and skeet shooting stations located in the southwest corner. CVSD subdivided the property, built, and opened Ridgeline High School northeast of the gun range in the fall of 2021. Now that the Gun Club has vacated the property, CVSD intends to conduct cleanup activities to address the lead and PAH contamination at the Site.

Historically, the Gun Club periodically recovered and recycled lead shot from the range area northeast of the shooting stations. They also conducted a final lead recovery effort for recycling lead before vacating the property after the close of shooting on the range. However, lead- and PAH-contaminated soil is present on-Site along with clay pigeon debris.

3. Air Monitoring

To minimize fugitive dust emissions during construction activities CVSD requires their contractor to implement strict dust control measures. Additionally, CVSD will monitor for dust emissions using a Aeroqual™ AQS Air Quality Monitor, or equivalent real-time particulate air monitoring device, downwind of the active work area(s). The Aeroqual™ AQS Air Quality Monitor Operation and Service Manual is provided in Attachment A.

CVSD representatives will deploy up to two air monitors downwind of active construction activities to assess fugitive dust emissions from the Site. The air monitoring stations will be re-positioned, as necessary, throughout the day as site conditions change (e.g., wind direction, construction activities). In the event respirable dust levels exceed the point of compliance, work will be stopped, and additional engineering controls will be implemented to reduce the amount of dust being generated. In the event background particulate levels could be the cause of an exceedance, upwind monitoring will be conducted to establish a background (upwind) particulate concentration and that concentration will be subtracted from the downwind concentration to determine compliance. If no upwind monitoring is implemented the background particulate level will be assumed to be zero. Upwind air monitoring likely would only be required during non-Project-related events such as wildfires.

Locations of the air monitoring stations will be determined by a CVSD representative and modified as conditions change. The monitoring stations will have data logging capabilities with alarm notifications for the field personnel maintaining the systems. Field personnel will conduct periodic checks of the monitoring units to verify they are working properly. Each air monitoring station will record daily peak and 120-minute rolling average maximum concentrations to verify that the contractor's dust control measures are effective. A record of air monitoring particulate logs throughout the project will be maintained to document dust control measures were implemented correctly and, in the event of any exceedances, to document the magnitude and extent the exceedance.

For this project, the single measurement peak air monitoring Point of Compliance (peak POC) will be 2.5 milligrams per cubic meter (mg/m^3) total particulate, which includes a particle mass range of approximately 0 to 5,0000 micrograms (µg) and the 120-minute rolling average maximum concentration will be 25 $µg/^3$ of PM_{10} (PM_{10} includes particles 10 micrometers and smaller).

The action level or peak POC is based on 50 percent of the respirable dust Permissible Exposure Limit of 5.0 mg/m^3 established by Occupational Safety and Health Administration (OSHA, 2014). If the Peak POC particulate action level of 2.5 milligrams mg/m^3 is reached, work will be stopped, and additional engineering controls will be implemented to reduce the amount of dust generation before work resumes. If the particulate 120-minute rolling average maximum concentration of 25 $µg/ m^3$ of PM_{10} is reached or visible dust adjacent to or crossing the property line is observed, the Contractor will be notified to apply additional dust control measures as described in the Contractor's approved Dust Control Plan, within a five-minute period of notification from the Construction Manager. The sampling methods and instrument specified for air monitoring are presented in Table 1.

Table 1. Air Monitoring Requirements

Instrument	Measurement Type/Units	Location and Frequency	Purpose
Aeroqual™ AQS Air Quality Monitor	Total airborne particulate (dust) in mg/m^3 of air within a particle mass range of approximately 0 to 5,000 µg. Real-time and cumulative average results with particulate counts: 0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, and 10 microns.	Two monitoring stations on the property line located downwind of construction activities. Monitors will continually record air conditions and are equipped with alarm notifications for dust emissions that are greater than the POC or the rolling average. Monitors will be manually checked a minimum of twice per day and be programmed to record measurements every minute.	To minimize fugitive dust emissions and monitor the effectiveness of dust control best management practices (BMPs). To provide a record of the particulate generated throughout construction.

4. Dust Suppression and Stockpile Management

Water will be used to control dust at active work areas, on access routes, and where backfill or waste materials are staged. Haul trucks carrying waste materials will be covered and secured with tarps to control dust if materials are transported off Site. Onsite loads do not have a mandatory load covering requirement but will require dust suppression measures to control fugitive dust (e.g., watering) and load covering could be necessary if other measures of dust suppression are not adequate. Temporary gravel construction entrances or the equivalent, will be installed as needed to eliminate off-Site tracking of soil and will be used as decontamination pads. Haul trucks carrying waste materials will be visually inspected prior to leaving the Site to verify that waste materials are secured and will not discharge from the truck.

Water for use as dust suppression will be obtained from a municipal or potable water source.

To limit the generation of dust the following dust suppression measures are anticipated during excavation activities:

- Minimize the area of exposed soil when possible.
- Apply water to dirt roads and access points when conditions are dry or when visible dust is observed at those locations.
- Apply water where needed based on site observation (visible dust) and real-time air monitoring.
- Minimize the drop distance of soil when loading.
- Cover all offsite loads before leaving the Site and cover onsite loads if dust suppression methods are not meeting project requirements.
- Temporary stockpiles will be covered with plastic sheeting and/or monitored for visible dust. If visible dust is observed emanating from a stockpile, the stockpiles will be covered or stabilized.
- Contractor shall cover or stabilize work areas and stockpiles that are inactive for more than 10 days.
- Designate a speed limit and/or reduce the speed of construction vehicles as needed to control fugitive dust.
- Contractor will provide a Dust Control Plan which will include additional dust control measures in the event water application alone is not sufficient. This may include non-toxic chemical stabilizers and dust suppressants approved for use by Ecology as well as modifications to construction activities to reduce fugitive dust.

Construction entrances will be constructed to minimize track out. If tracking of materials is observed, additional control measures will be implemented, and the tracked material will be removed by the Contractor. Contract specifications and requirements for dust control measures are included in Attachment B, Section 01 81 16 Environmental Requirements.

5. Site-Specific Health and Safety Plan

Prior to conducting field work, Haley & Aldrich will prepare a Health and Safety Plan (HASP) that describes necessary health and safety protocols for field personnel; the contractor also will prepare a HASP for their employees within 14 days of the notice of award. A physical copy of the HASPs will be readily accessible to personnel while in the field. Field activities will be performed in Level D personal protective equipment (PPE), as defined in the HASP and by the OSHA requirements, detailed in Title 29, Code of Federal Regulations (29 CFR) § 1910.120. Individuals performing field activities are required to have completed OSHA training in accordance with 29 CFR § 1910.120, including 40-hour and current annual 8-hour refresher training.

6. Compliance Documentation

Planned documentation demonstrating compliance controlling offsite fugitive dust emissions is described in the following sections.

6.1 RECORDKEEPING REQUIREMENTS

Throughout construction all records applicable to the reduction of fugitive dust particulate emissions will be maintained and CVSD shall make such records available to Ecology upon request. At a minimum, records shall include:

1. All dust monitoring station data recorded and maintenance records.
2. Stormwater Pollution Prevention Plan (SWPPP) inspection reports including the implementation and maintenance of stormwater, erosion and sediment controls and BMPs associated with the SWPPP.
3. Stockpile inspections.
4. Soil stabilization and treatment activities for excavated soil with lead concentrations designated as hazardous waste.
5. Summary of weekly work activities.
6. Daily construction reports.
7. Any complaints received, including the name or source of complainant and contact information, date and time, on-site earth-moving activities occurring at the date and time, complaint, and action taken to mitigate the source of the complaint.

6.2 FIELD LOGBOOKS

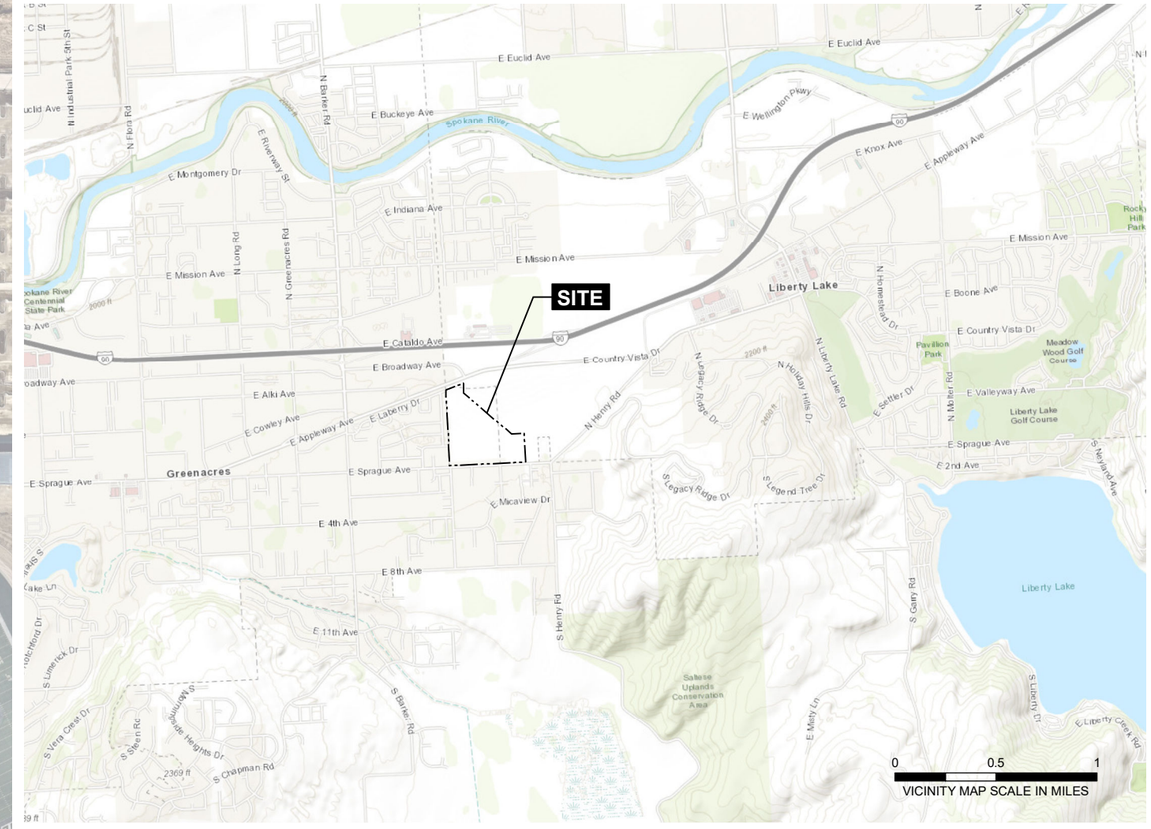
Air monitoring activities will be recorded in a bound field logbook of water-resistant paper during field operations (or as electronic pdfs). All entries will be made legibly and will be dated. Information recorded will include the following:

- Date, time, and location of air monitoring stations
- Weather conditions
- On-Site personnel and visitors
- Daily safety discussion and noted safety issues
- Observations about the Site (e.g., odors, appearance, visible dust, stockpiles, comments)
- Deviations from this Work Plan

References

1. Occupational Safety and Health Administration (OSHA), 2014. Permissible exposure limits–annotated tables. United States Department of Labor. Washington, DC. https://www.osha.gov/annotated-pels/table-z-1

FIGURE



LEGEND

- REPOSITORY FOOTPRINT
- LIMITS OF EXCAVATION
- SITE BOUNDARY
- PARCEL BOUNDARY

0 220 440
SITE PLAN SCALE IN FEET

NOTE

AERIAL IMAGERY SOURCE:
NEARMAP, 30 SEPTEMBER 2020

HALEY ALDRICH

SPOKANE GUN CLUB
GREENACRES, WASHINGTON

VICINITY MAP AND SITE PLAN

AUGUST 2021

FIGURE 1

GIS FILE PATH: C:\Users\craumann\Desktop\LOCAL_DATA\135500_Central_Valley_School_District\Maps\2021_08_CAP\135500_000_0001_SITE_VICINITY_AND_SITE_PLAN.mxd — USER: craumann — LAST SAVED: 8/25/2021 10:32:54 AM

ATTACHMENT A

Aeroqual™ AQS Air Quality Monitor Service Manual

aeroqual

DUST SENTRY/PRO AQS

USER GUIDE

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User Guide Revision History

Date	Revision number	Description of change	Affected Sections
June 2017	1	First release	-
September 2017	2	NO2 and VOC added	1, 1.1
May 2018	3	Calibration section updated	5.0
February 2019	4	Combining AQS, Dust Sentry, Dust Sentry Profiler	All
October 2019	5	New internal components and layout, handle Updated specifications Added US power cable New 3rd party sensor power and data interface Added Sierra modem New “lease mode” Updated location of pumps	1.0 1.6 2.5 2.7 4.2 5.0 12.2
November 2019	6	Direct-read NO_2 module replaces Ox module. Calibration steps updated for NO_2 module.	7 12.1 12.5
February 2020	7	NO2 and VOC specs Pole mounting options updated Reset Network USB updated VOC flowrates corrected	1.5 3.1 4.4 7
August 2020	8	Surveyor’s tripod mounting	3.5

Alternative sources of information and help

In addition to this user guide, Aeroqual offers other sources of information which can assist in the operation of the monitors. The Aeroqual website contains brochures, technical notes, frequently asked questions, and user guides.

https://www.aeroqual.com/support/resources

Aeroqual’s training website contains a comprehensive document library of technical notes and service and calibration templates to download and print. The training website has detailed descriptions of service activities and calibration and installation examples and is updated regularly. Video tutorials are featured heavily.

www.training.aeroqual.com

For technical support, contact the Aeroqual distributor in your local country. If local technical support is not available contact the Aeroqual support team: technical@aeroqual.com.

Where possible, references to further material will be provided throughout this document

	Online reference	training.aeroqual.com
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

Table of Contents

1 Dust Sentry / Dust Sentry Pro / AQS 1 Introduction

1.1 Overview

Dust Sentry / Dust Sentry Pro / AQS 1 (collectively referred to herein as 'monitors') are tools for air quality professionals to target specific applications of interest in industrial, urban environment and regulatory applications. It is a flexible air quality monitoring system that can be configured for a range of uses.

Key technology features of the monitors enable them to deliver data with very strong correlation to EPA-approved monitors – 'Near Reference' – over extended periods of time; several years with appropriate maintenance.

Housed in a rugged, lockable weatherproof (IP 65) enclosure, the monitors include an embedded PC and full software system for remote technical support, data management and analytics.

Users can make use of the embedded PC running proprietary **Aeroqual Connect** instrument operating system, or optional **Aeroqual Cloud** instrument monitoring, management and technical support via secure cloud servers, accessed via web browser (IE, Firefox, Chrome, Safari).

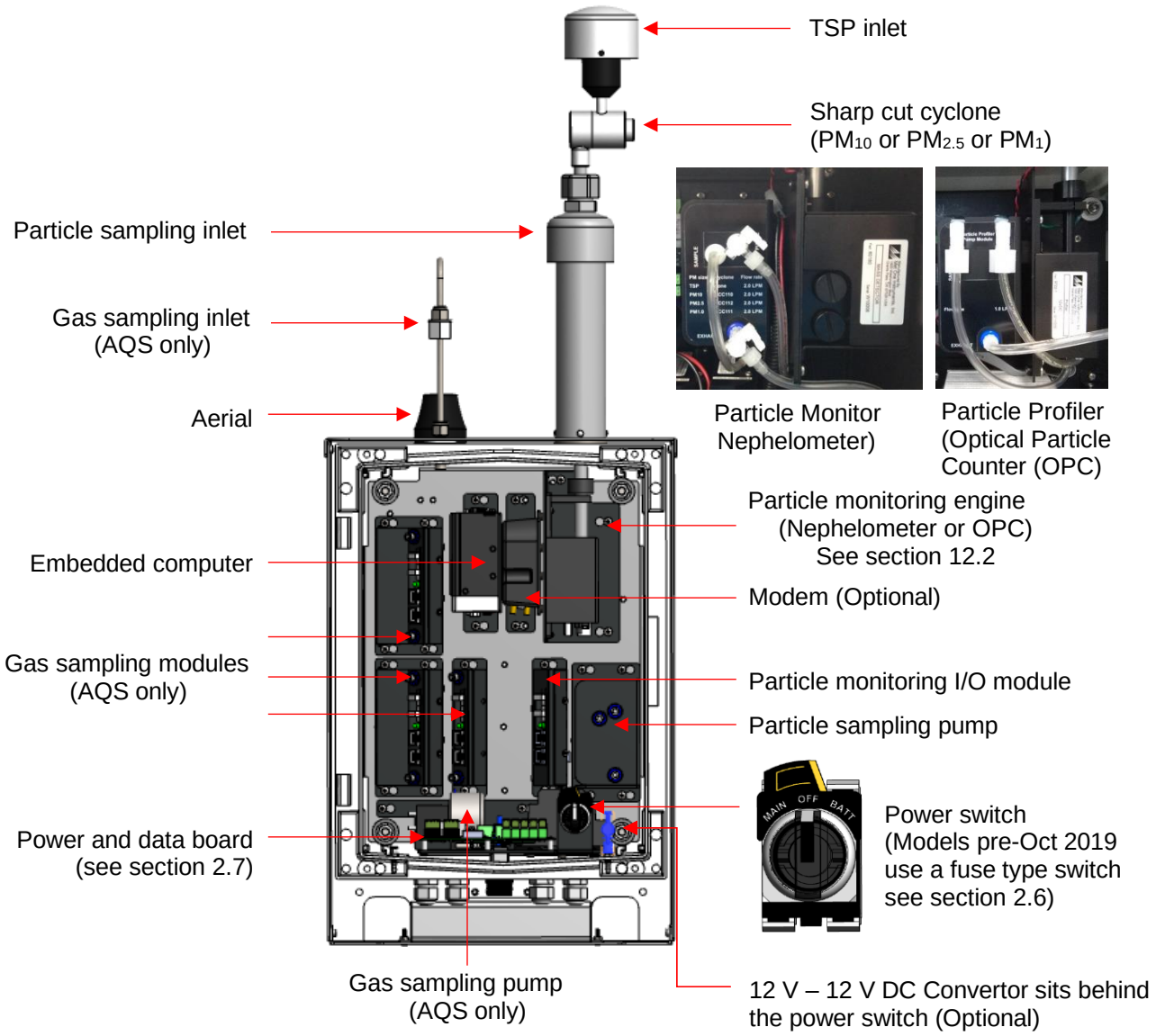


Figure 1-1 Key components – wiring and gas lines not shown

1.2 Product comparison

Dust Sentry and **Dust Sentry Pro** both measure particulate concentrations using laser light scattering but the methodology and optics design are different, this means that the Dust Sentry measures a single size fraction selected by the user but the Dust Sentry Pro measures four size fractions simultaneously.

AQS 1 also measures gases in addition to particulate, up to three gas modules may be integrated.

Product	Particulate Measurement	Gas Measurement
Dust Sentry	TSP *or* PM_{10} *or* $PM_{2.5}$ *or* PM_1	None
Dust Sentry Pro	TSP *and* PM_{10} *and* $PM_{2.5}$ *and* PM_1 *and* 8 size counts	None
AQS 1	TSP *or* PM_{10} *or* $PM_{2.5}$ *or* PM_1	O_3, NO_2 VOC
	TSP *and* PM_{10} *and* $PM_{2.5}$ *and* PM_1 *and* 8 size counts	

For specifications see section 1.5.

Applications by product

Applications for Dust Sentry

Designed for those who need to monitor and manage specific outdoor dust and particulate emissions continuously and in real-time.

The Dust Sentry is a nephelometer-based monitor that delivers defensible and accurate mass measurement for PM_{10}, $PM_{2.5}$, PM_1, or TSP.

The Dust Sentry PM_{10} is MCERTS certified and SCAQMD 1466 pre-approved.

For more detail see: https://www.aeroqual.com/product/dust-sentry-pm10-monitor

Applications for Dust Sentry Pro

Designed for those who need to monitor and manage multiple outdoor dust and particle size fractions simultaneously and in real-time.

The Dust Sentry Pro delivers simultaneous measurement of PM_{10}, $PM_{2.5}$, PM_1, TSP, and particulate counts for 8 channels; 0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10 microns.

For more detail see: https://www.aeroqual.com/product/dust-profiler-particle-counter

Applications for AQS 1

Designed for those who need to monitor and manage specific outdoor dust and particulates, and gases continuously and in real-time.

The AQS 1 delivers affordable and defensible measurement of PM_{10}, or $PM_{2.5}$, or PM1, or TSP, and up to three gases, all simultaneously.

For more detail see: https://www.aeroqual.com/outdoor-air-quality/aqs-mini-air-quality-stations

1.3 Optional external sensors

The monitors can integrate several external sensors such as weather sensors, solar radiation and noise sensors. These sensors are mounted outside the monitor enclosure. The external sensors below are available factory tested and ready to connect to the monitors.

MetOne MSO weather station

Cirrus MK427 noise meter

Vaisala WXT536 weather station

Gill Instruments Windsonic

Li-Cor LI-200 Pyranometer

See Section 2.7.3.1 for wiring external sensors.

1.4 Dimensions

These dimensions are for a visual representation only, for full details see section 1.5 Specifications.

Dimensions are in millimetres and (Inches) and are the same for DS, AQS1 and DS pro.

1.5 Specifications

Specifications are subject to change, please check www.aeroqual.com for the current specifications.

	Dust Sentry	Dust Sentry Pro	AQS
Particulate Measurement			
Measurement technology	Near forward angle laser scattering nephelometer	Right angle laser scattering particle counter	The AQS 1 can be specified with either a Near forward angle laser scattering nephelometer OR Right angle laser scattering particle counter Particulate measurement specifications will reflect the measurement technology chosen – see panels to the left.
Particle Counts	N/A	Optional Particulate Counts: 0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10 microns (counts range: 0-100,000 counts/L)	
Particle Mass Measurement **PM1** **PM2.5** **PM10** **TSP** **Simultaneous?**	**Range / ug/m³** 0 – 60,000 0 – 60,000 0 – 60,000 0 – 60,000 No – requires cyclone	**Range / ug/m³** 0 - 200 0 - 2000 0 - 5000 0 - 5000 Yes	
Accuracy	±(2 µg/m³ + 5 % of reading)	± (5 µg/m³ + 15 % of reading)	
Resolution	0.1 µg/m³	0.1 µg/m³	
MCERTS certified	PM_{10}	No	
SCAQMD Rule 1466	Pre-approved	No	
Auto zero check	Yes	No	
Sample flow	2 LPM	1 LPM	
Factory calibration interval	24 months	12 months	
Operating temperature [1]	-10 °C to +50 °C (14 °F to 122 °F)	-10 °C to +45 °C (14 °F to 113 °F)	
Heated inlet	Yes	Yes	
Gas Measurement			(Measurement Resolution)
Ozone	-	-	0 - 500 ppb (0.1 ppb)
Nitrogen Dioxide	-	-	0 - 500 ppb (0.1 ppb)
Volatile Organic Compounds Low	-	-	0 - 500 ppb (0.1 ppb)
Volatile Organic Compounds High	-	-	0 - 30 ppm (0.01 ppm)
Gas calibration interval	-	-	As required
Other			
Connect / Cloud software [2]	Yes	Yes	Yes
Power consumption [3]	30 W [4]	30 W [5]	36.6 W [6]
Additional sensors	Weather station / Wind Speed and Direction / Noise / Solar incidence		
Dimensions [7] H x W x D (Inches)	483 x 330 x 187 mm (19 x 13 x 7.4 “)	483 x 330 x 187 mm (19 x 13 x 7.4 “)	483 x 330 x 187 mm (19 x 13 x 7.4 “)
Weight	<13 kg (28.6 lbs)[4]	<13 kg (28.6 lbs)[4]	<14 kg (30.9 lbs)[6]

[1] Above 40 °C (104 °F) the laser may require more frequent servicing.
[2] Software platform: https://www.aeroqual.com/product/air-monitoring-software
[3] Power consumption based on configuration, excludes 3rd party sensors.
[4,5] Base specification, nephelometer with heated inlet, modem.
[6] Base specification, nephelometer with heated inlet, modem, 3 gas modules.
[7] Dimensions are for enclosure. PM sampling inlet with cyclone adds 360 mm (14.17”) to total height.

2 Quick Setup Guide

2.1.1 Before the monitor arrives (for full pre-planning details see section 2.2)

1. Visit the site and assess monitor location and suitability

- ☐ Site will be representative of the pollutants you intend to measure.
- ☐ Site is secure but with adequate access.
- ☐ Site is appropriately open to all wind directions.
- ☐ If you are planning a permanent deployment, check that there is nothing nearby which could change and affect your project – like trees, planned buildings or new roads and other potential interferences.

2. Ensure power is available on site

- ☐ Ensure power is available. Both Mains and Solar power can be used, but these will need to be available and/or installed before the monitor arrives.
- ☐ When installing power outlets (110 VAC to 230 VAC) for the monitor, they should be weatherproof and installed safely.
- ☐ Allow for 2 power outlets, one for the monitor and one for calibration equipment.

NOTE: *Outside the United States a power lead with local plug will need to be supplied and wired to a connector supplied with the monitor.*

3. Install any additional infrastructure required for the installation

- ☐ Mounting location and method has been identified. Most sites will require a way of securely mounting the monitor. Pole Brackets (50.8 mm / 2 " 304 Stainless U-Bolt) are included to mount the monitor on a pole, anchored to the ground. Small platforms have also been used successfully too.
- ☐ If you have ordered Auxiliary sensors (Weather, noise etc.) you will need to provide a means of mounting these also. You will need to supply a pole and fixings to mount the sensor. Siting may be subject to local regulations.
- ☐ Check you have the required tools.

4. Confirm communications specification (WIFI and/or cellular)

- ☐ Check communications specifications and how the monitor software will be accessed on site
- ☐ For cellular access, purchase a dynamic IP network SIM card with at least 1 GB data / month.

5. Plan for your time on site

- ☐ When setting up for the first time allow at least four hours on site.
- ☐ Allow for travel time to and from the site.
- ☐ Confirm site operation times available for access.
- ☐ Confirm personal protective equipment (PPE) that may be required on site.

6. Read the user guide

- ☐ Familiarise yourself with the assembly steps.
- ☐ Confirm the method of data access that will be supplied with the monitor (e.g. Aeroqual Connect or Aeroqual Cloud).
- ☐ Send any questions about things you are unsure about to technical@aeroqual.com

7. Write a checklist

- ☐ Write your own checklist to ensure a smooth installation and setup.
- ☐ Include any reporting requirements that will be required.

2.1.2 After the monitor arrives

1. Unpack the monitor and inspect

- ☐ Inspect the packaging and monitor for damage. — Section 2.3
- ☐ Check all items have been supplied

NOTE: *Outside the United States a power lead with local plug will need to be supplied and wired to a connector supplied with the monitor.*

2. Mount monitor

- ☐ Mount the monitor to your platform or pole. — Section 2
- ☐ Attach the PM inlet. — Section 2.4.1
- ☐ Attach the gas inlet. — Section 2.4.3
- ☐ Open the door and check that all tubing, power and data connections are secure.

3. Power on the unit

- ☐ Turn on the unit. — Section 2.6
- ☐ Check that the Status LEDs on the modules, Embedded PC and Modem (if fitted) are on and green.
- ☐ Check that the sampling pump (PM only) or pumps (PM and Gas) are running.

4. Set up Wi-Fi / Modem and connect to the monitor

- ☐ Connect to Aeroqual Connect — Section 4.1
- ☐ Connect to Aeroqual Cloud — Section 4.2

5. Check sampling flow rates

- ☐ Put the monitor into Service mode — Section 5.1
- ☐ Write a comment in the Journal that you are on site for monitor commissioning. — Section 6.4
- ☐ Check the sampling system for leaks, rectify any leaks. — Section 6.5.4
- ☐ Check and adjust gas module flow rates to specification. — Section 6.5.4.2
- ☐ Check PM inlet flow rates and adjust if required. — Section 6.5.4.3

6. Attach optional auxiliary sensors

- ☐ If you have purchased any auxiliary sensors (Weather, Noise) mount these and run the cabling through the external glands and connect to the AUX module. — Section 2.7

7. Document setup in Journal

- ☐ Note in the Journal that commissioning is complete. — Section 6.4
- ☐ Exit Service mode. — Section 5.1

2.1.3 Installation and commissioning

Commissioning is the process of setting up a new monitor to work correctly on site. It is important that the correct procedure for commissioning the monitors is followed to ensure reliable monitor operation and to meet or exceed your data quality objectives. All monitors are supplied with a traceable factory calibration. This calibration is applicable to the commissioning phase and accordingly Aeroqual does not recommend an initial calibration as part of monitor commissioning.

Aeroqual provides a commissioning procedure which should be completed during this period. This report details the tasks carried out during commissioning and can be used to demonstrate correct commissioning to end customers.

The commissioning procedure is available from: https://www.aeroqual.com/support/resources/aqm-65

NOTE: *Please allow at least 30 min for the monitor to warm up to counter the effects of humidity.*

2.1.4 Complete the Commissioning report and provide to customer

This report details the settings of the monitor at the time of commissioning. The completed report should be provided to the customer, along with the factory logbook which is provided with every monitor.

2.2 Pre-planning

The monitors require only basic assembly out of the box.

- Wire a mains AC power cable
- Attach Particle Monitor inlet
- Attach gas inlet (AQS only)
- Attach third party sensors (where supplied)
- Configure modem (where supplied)

Aeroqual recommends these steps be performed in an office or laboratory as part of a quality control check of the monitor to make sure the monitor has arrived undamaged and the flow system, electrical system and communication system are working as expected.

Some of the steps described here will be repeated in the field as part of the installation and commissioning process.

After these steps have been carried out, the Monitor can be safely transported to the monitoring site for installation and commissioning.

Key points to consider for assembly and first power up:

- The monitors run on single-phase mains AC power 100 - 260 VAC (standard), or if required a regulated 12 VDC. For more details see section 2.5.

  Configuration used for power calculations: base unit, nephelometer, PM_{10} sharp cut, O_3 module, modem, heater off / heater on.

- Outside of the United States you need to supply a mains power cable and local plug, Aeroqual recommends a residual current device (RCD) be used to protect against power spikes.
- You will need a Phillips head screwdriver, and if you have an external sensor you will also need a small flat blade screwdriver.
- There is no software to download and install, and no cables are required for communication. Communication to the monitor is through your web browser on your laptop, tablet or smart phone using WIFI.
- If you have purchased a modem, this needs a local SIM (dynamic IP) same as you would have in your smart phone, but you must know the APN of your chosen telecommunications provider, you can look this up: www.apnchanger.org

2.3 Unpacking

The monitors are packaged in a cardboard carton with moulded protective inserts.

Dimensions (L x W x H): 62 x 32 x 55 cm (24.4 x 12.6 x 21.6 “)

Weight: < 14 kg (30.8 lbs) (Configuration used for weight calculations: base unit, nephelometer, PM_{10} sharp cut, O_3 module, modem, heater off / heater on.

Additional components such as weather or noise sensors will be packaged in additional boxes.

a) Examine the ShockWatch® label on the side of the shipping box. If the indicator is red do not refuse the shipment. Make a notification on delivery receipt and inspect for damage. If damage is discovered, leave item in original packaging and request immediate inspection from carrier within 15 days of delivery date (3 days international).

b) Verify the serial number label on the documentation matches the serial label on the monitor – the label is located inside the monitor on the bottom right side.

c) Verify that all components have been shipped as per the packing slip. Contact your Distributor or Aeroqual if you suspect any parts are missing.

2.4 Assembly

	Online reference	https://training.aeroqual.com/mod/page/view.php?id=624
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

2.4.1 Assemble the PM inlet

The particle sampling inlet is easy to assemble by push fitting the various supplied parts together. If no sharp cut cyclone has been ordered, then only a sampling inlet assembly and TSP head will need to be assembled.

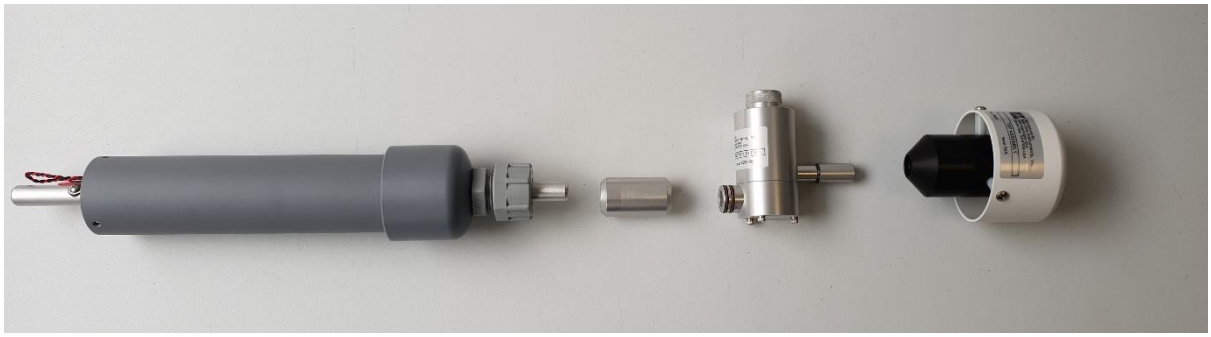


Figure 2-1 Particle sampling inlet parts including (L-R): inlet tube, cyclone adaptor, cyclone, TSP head.

2.4.2 Attach PM inlet

- Turn off power to the monitor during this process – see section 2.6.
- If not already fitted, attach a PM inlet O-ring to the aluminium retaining ring and apply a small amount of lubricant.

Figure 2-2 Add the O-ring and a small amount of lubricant.

- Inside the sampling inlet assembly has a sampling tube extending out of it. The sampling tube has a thin film heater further up the shaft which is powered by the black and red cable exiting the bottom of the assembly with white plug on the end.
- Carefully thread the white plug through the PM inlet port on the roof of the monitor.

Continued next page.

IMPORTANT The Particle Monitor ships from the factory with a thin film of tape or coloured cap which protects the inlet, this must first be removed as shown in Figure 2-3.

Figure 2-3 Remove the protective tape or cap from the PM inlet

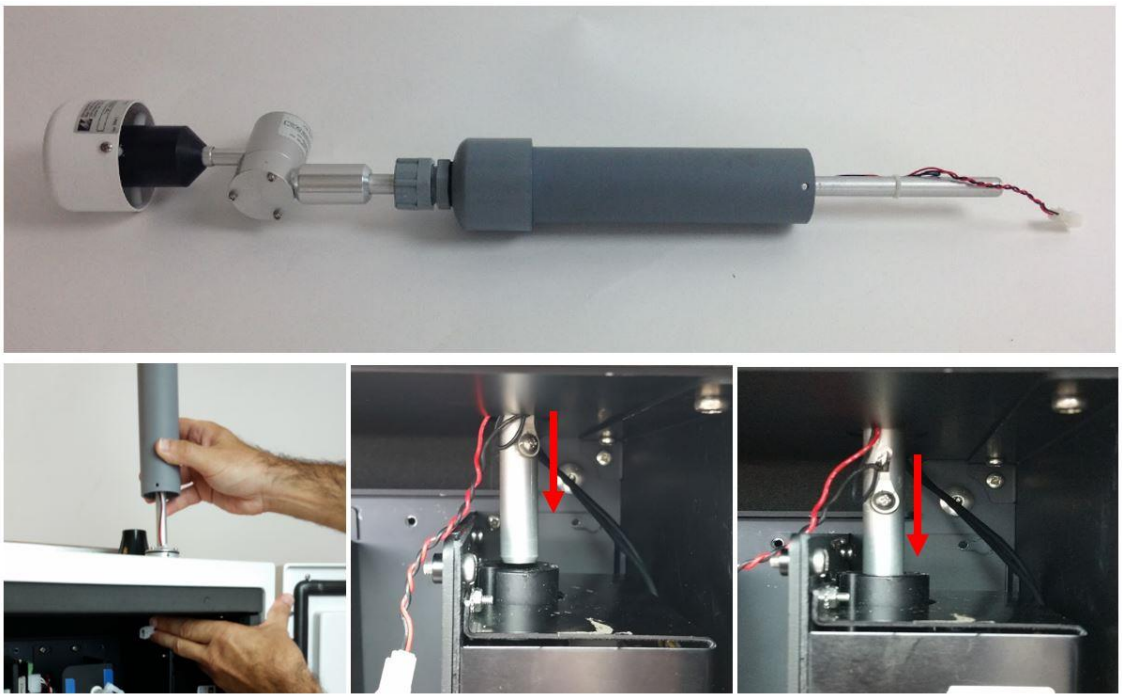


Figure 2-4 Gently feed in the power cable and over the particle engine mounting bracket on the left. The aluminium tube must push all the way into the PM module.

IMPORTANT Ensure sure that the aluminium inlet tube is pushed all the way into the optical engine block.

- If the aluminium tube does not fully push down into the optical engine block, then create more length in the aluminium tube by removing the grey retaining nut and then sliding up the rubber grommet on the top of the inlet. Replace the nut after you have done this.

Figure 2-5 Create more length to the inlet by sliding the black rubber grommet up the tube.

- You need to make sure you have correctly and securely inserted the aluminium tube fully into the optical engine block.
- When you are satisfied the inlet is fully pushed into the engine block, then connect the heater plug on the inlet to the plug coming from the adjacent particle engine control module.
- Insert the three supplied #6-32 UNC retaining screws to secure the inlet to the aluminium retaining ring
- Push the fuse holder in to the “On” position to begin flowing air through the inlet.
- Then perform a leak check and flow check - see Section 6.5.6 and 6.5.7.

Figure 2-6 During field installation, secure the PM inlet using the retaining screws, then plug in the heater

2.4.3 Attach gas inlet (AQS Only)

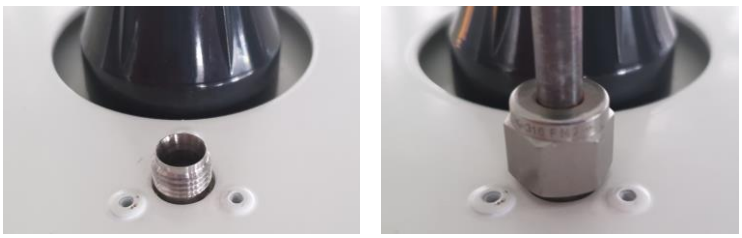


Figure 2-7 Dust Sentry, Dust Sentry Pro and AQS are supplied with a Swagelok fitting (From Oct 2019).

- The gas inlet is held by a ¼ inch Swagelok compression fitting.
- Attach the gas sampling inlet and perform a flow check to make sure the inlet is fitted correctly, and the sample pump is working properly.
- Fit the supplied Kynar inlet filter to the Swagelok nut at the end of the sample cane.

2.5 Power Requirements

Caution: The high voltage mains supply must be wired by a certified electrician in compliance with local electrical regulations.

The internal power requires regulated 12 VDC to maintain a constant pump speed. An external mains to 12 VDC power supply is fitted under the enclosure and is supplied with either;

a) **a lead with IP rated electrical connector – wiring of mating connector and lead is required, or**
b) **a wired mains lead and plug (United States only).**

Where possible, visit the site and assess monitor location and access to power source.

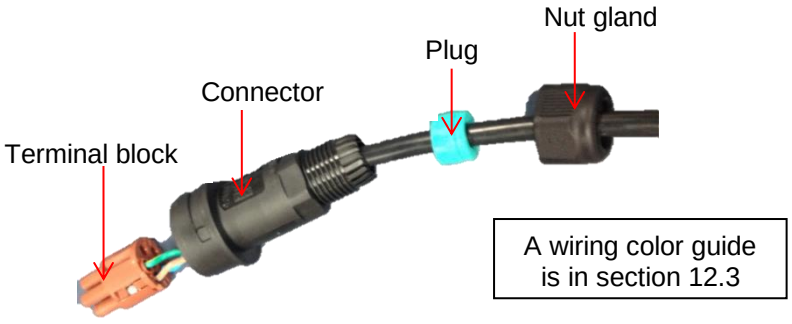
2.5.1 AC power source

Both Mains and Solar power can be used, but these will need to be available and installed before the monitor arrives When installing power outlets (110 VAC to 230 VAC) for the monitor, they should be weatherproof and installed safely. Install two power outlets, one for the monitor and one for calibration equipment.

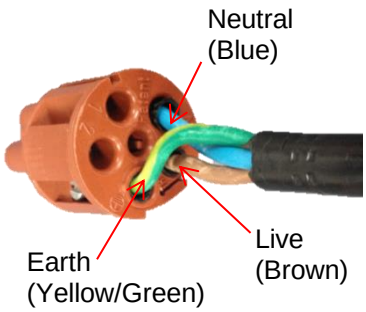
NOTE: *Outside the United States a power lead with local plug will need to be supplied and wired to a connector supplied with the monitor – see section 2.5.2.*

2.5.2 Wiring the power supply connector

1. Locate the power connector terminal which is situated outside the enclosure at the bottom. The power supply will already be wired to the connector however the cable to connect to mains power needs to be wired.

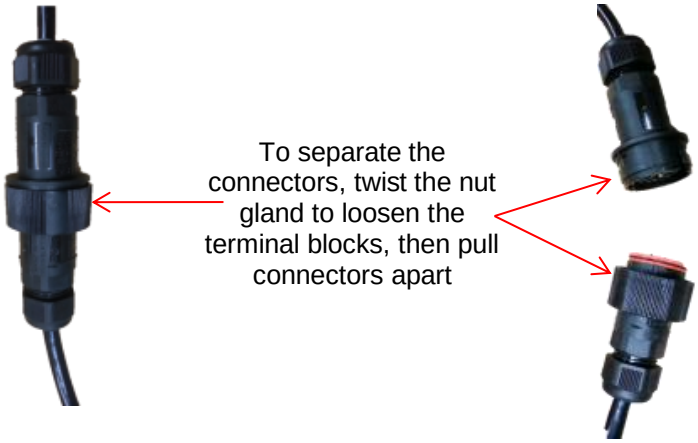


A wiring color guide is in section 12.3



2. Feed the power cable through the nut gland plugs and connector and wire the cable to the terminal block according to the diagram.

3. Reconnect into the connector ensuring the plugs are fitted securely and the nut gland tightened.



2.5.3 DC power source

Occasionally mains AC power is not available at the site where the Monitor is installed, and battery ..

When specified, a DC-DC convertor and battery voltage monitor for battery powered projects are supplied connected to the power and data chassis.

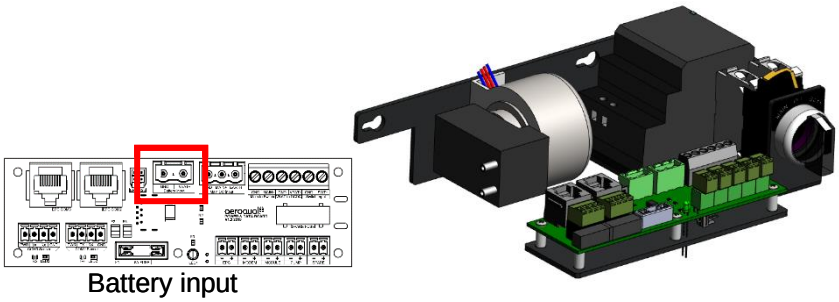


Figure 2-8 DC-DC convertor and battery voltage monitor

2.6 Powering On/Off

The monitor can be easily powered on or off using the rotary switch located at the bottom right hand corner inside the enclosure. Older units use a fuse switch – see section 2.6.1.

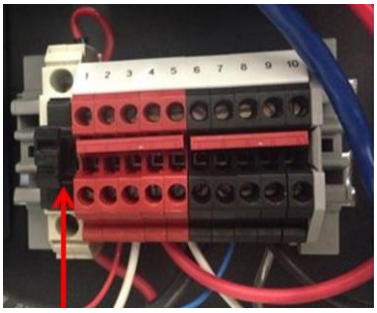
The rotary power switch was introduced in October 2019. It is used to turn the power off, power the monitor by AC mains supply, or power the unit by a DC source such as battery solar.

Figure 2-9 The rotary switch in the off position

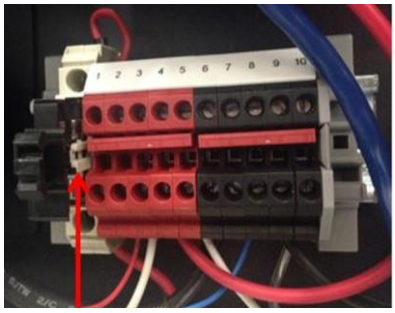
2.6.1 Fuse switch (Pre-Oct 2019)

NOTE: *Pull the 12 VDC fuse out from the fuse holder "off position" before testing the mains connection. See Figure 2-10.*

www	Online reference	http://training.aeroqual.com/mod/page/view.php?id=623
YouTube	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist



12 V DC fuse pushed in, the "on" position



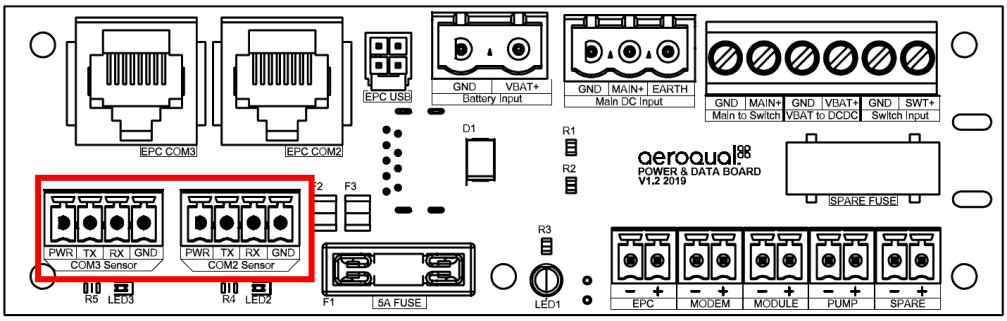
12 V DC fuse pulled out, the "off" position

Figure 2-10 The 12V DC fuse can be pulled out to turn off the monitor or pushed in to power the monitor

Push in the 12 DC fuse to the "on" position as shown on the left in Figure 2-10. The pump/s will start and the ePC will boot up with a series of beeps. The green power LED lights should light up on the modules when power is applied, this confirms the power is being correctly delivered to the modules.

2.7 Connecting auxiliary sensors

External third-party sensors such as weather stations and noise meters are easily connected to the monitor. To connect third party sensors, feed the sensor cable through a free cable gland on the underside of the monitor and wire it to a plug in an available COM port (indicated below). third party sensors need to be configured through Aeroqual Connect or Cloud – see section 2.7.2.



2.7.1 Auxiliary sensor wiring diagrams

NOTE: *To check the operation of the third-party sensor in your office or laboratory prior to site installation it is not required to feed the cable through the gland.*

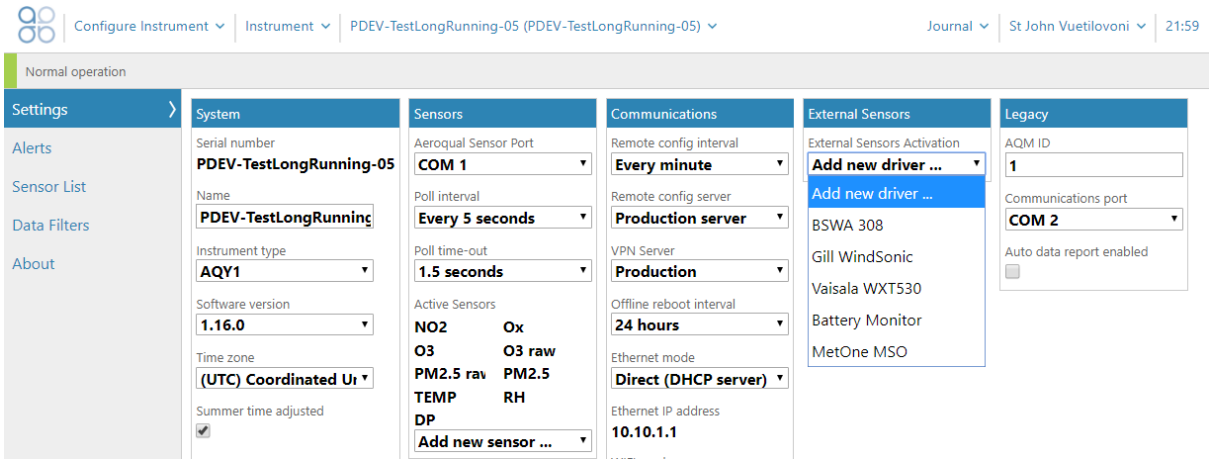
				
Gill Instruments Windsonic	MetOne MSO weather station	Vaisala WXT536 weather station	Cirrus MK427 noise meter	Li-Cor LI-200 Pyranometer
Green (V supply +) Yellow (TXD) Brown (RXD) White (V supply -), Braid (Signal)	Red (+12V DC) White (RS-232 TX) Brown (RS-232 RX) WHT/BRN (Shield), GRN (Signal common), BLK (Pwr com)	Brown (Vin+ for operating) Yellow (Vin+ for heating) Blue (Data out TxD) White (Data in RxD) Red (GND for Vin+), Green (GND for data), Pink (GND for Vh+)	Separate AUX module required, see section 2.7.3	Separate AUX module required, see section 2.7.3
WHT	WHT WHT / BRN	WHT		
PWR TX RX GND	PWR TX RX GND	PWR TX RX GND		
PWR TX RX GND COM2 Sensor	PWR TX RX GND COM2 Sensor	PWR TX RX GND COM2 Sensor		

2.7.2 Configuring auxiliary sensors using vAUX

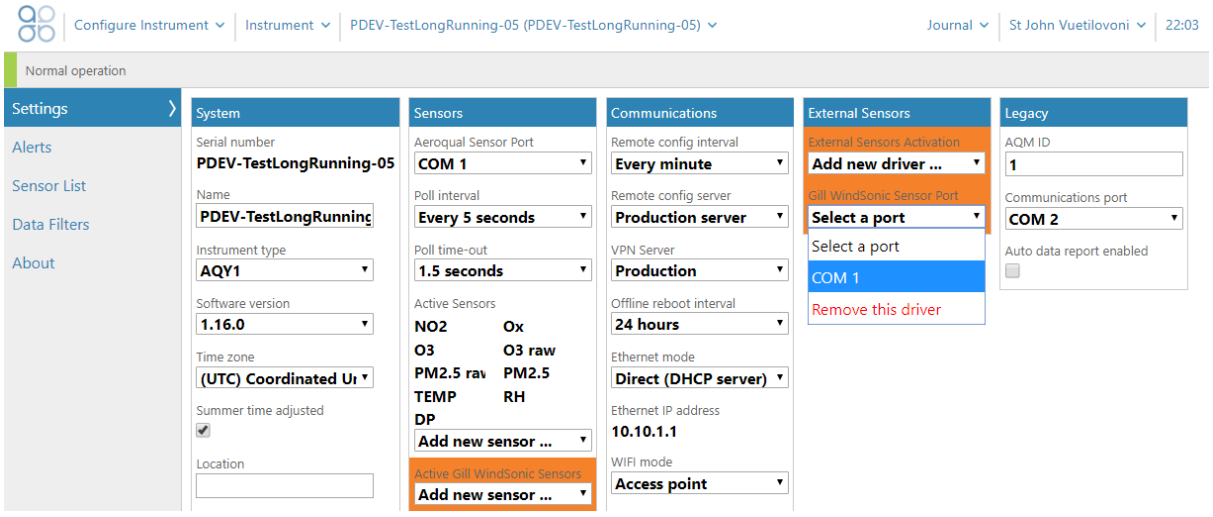
In the past, all third-party sensors were connected to an AUX module. From October 2019 the AUX was replaced with a vAUX (Virtual AUX) solution. With these changes, third party sensors need to be configured through Aeroqual Connect or Cloud.

Configuration Steps

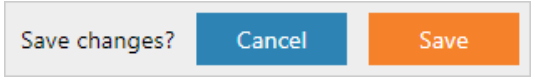
In the Configure Instrument screen, choose a sensor driver from the drop-down list under External Sensors.



After selecting the driver, a new section with the driver will appear in column four and all sensors supported by the driver are added into active sensor list in the Sensors column. Choose the serial port that the sensor is connected to from the drop-down list under External Sensors.



Click the Save button at the bottom of the page to save the configuration.



2.7.3 Connecting auxiliary sensors (Monitors pre-Oct 2019)

	Online reference	http://training.aeroqual.com/mod/page/view.php?id=625
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

On monitors' pre-Oct 2019, external sensors such as weather stations and noise meters need to be wired to the green connector plug on the front of the auxiliary module. To connect third party sensors, feed the sensor cable through a free cable gland on the underside of the monitor and wire it to the required auxiliary module according to the wiring diagrams – see section 2.7.3.2.

2.7.3.1 AUX module (Monitors pre-Oct 2019)

In monitors pre-Oct 2019, an AUX module is used to provide power to an external sensor and to process data from the sensor. The AUX module uses a 12-way green connector to connect to the external sensor.

When you are happy with the wiring then apply power, and log on to the Aeroqual Connect software as described in section 4.1 Aeroqual Connect (via Direct WIFI / LAN). After some minutes you should see the parameters associated with the third-party sensor being shown in the software in the APP "Configure Instrument", view settings then the active sensor column.

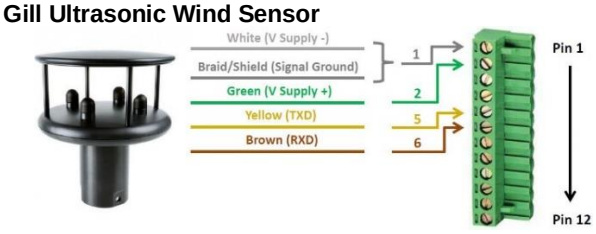
To see the data, go to "Manage Data", then Charts or Table, adjust the "Averaging Period" as required.

NOTE: *Retain the certificate of compliance that is shipped with the monitor.*

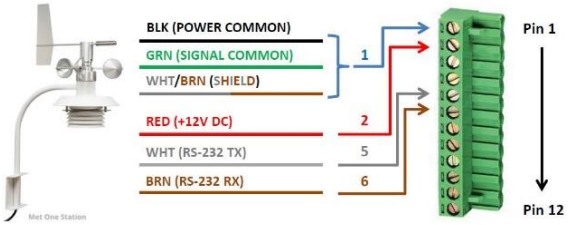
2.7.3.2 Auxiliary sensor wiring diagrams (Monitors pre-Oct 2019)

IMPORTANT The auxiliary module orientation may vary, observe the correct numbering order as labelled on the green connector.

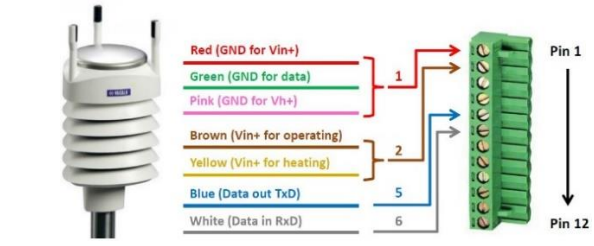
Gill Ultrasonic Wind Sensor



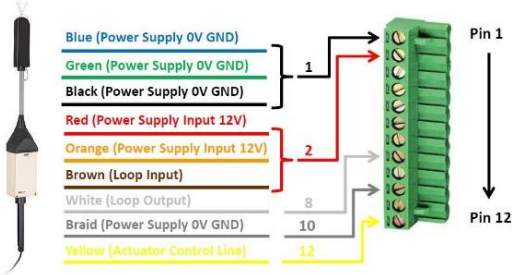
Met One MSO Weather Sensor



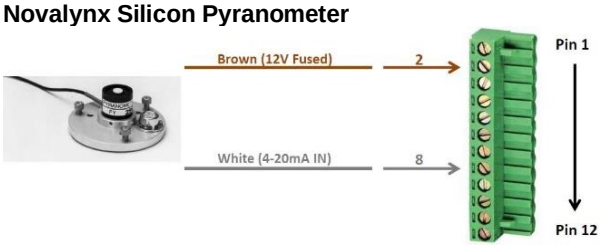
Vaisala WXT536 Weather Sensor



Cirrus MK427 Noise Sensor



Novalynx Silicon Pyranometer



	Online reference	training.aeroqual.com DM 1.3 Tech training Section 2.3

3 Mounting and Site Positioning Guidelines

It is important that the positioning of the monitor is suitable to yield data which is representative of that specific location.

3.1 Mounting

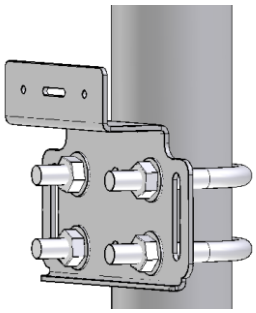
The monitor comes with; 2 x mounting brackets, 3 x U-bolts for 45 mm (1½") diameter poles, 2 x metal bands for pole diameters between 21 - 44 mm (1" - 1½"), and 2 x metal bands for pole diameters between 59 – 82 mm (2 - 3"). The same brackets are used for both pole and wall mounting. To wall mount the monitor the brackets are screwed into the wall instead of using the U-bolts.

For pole mounting:

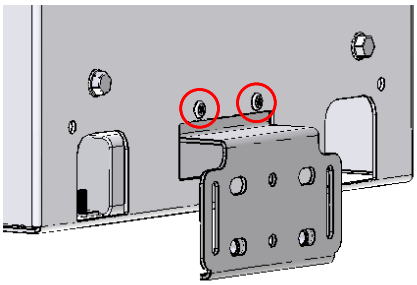
1. Secure top mounting bracket at a suitable height using the U-bolts or metal bands provided
2. Fix lower mounting bracket to the Dust Sentry chassis with screws
3. Hang the monitor on the top mounting bracket
4. Place U-bolt or metal band through lower mounting bracket
5. Secure bottom mounting bracket using the U-bolts or metal bands provided

NOTE: *Only one U-bolt or metal band is required to secure the bottom bracket.*

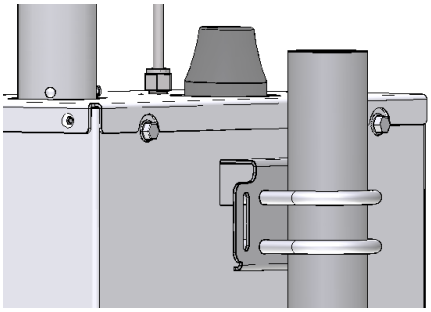
1.



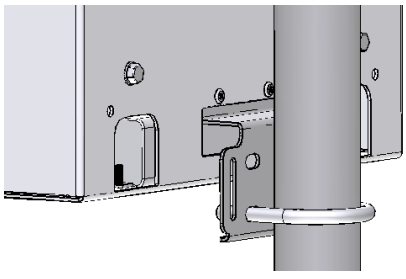
2.



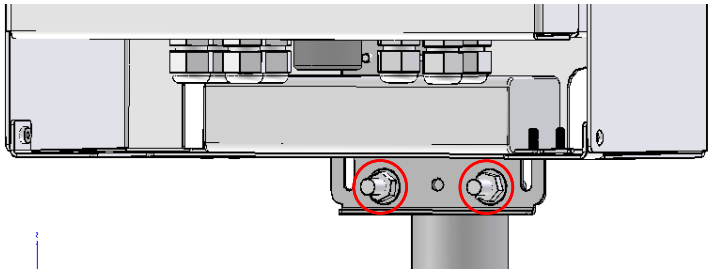
3.



4.



5.



3.2 Inlet height

- If monitoring is related to human exposure, the sampling inlet height should be positioned in the “breathing zone”. This is located between 2 and 15 m (6.6 and 49.2 ‘) above ground level.
- If monitoring is related to specific emission sources, the position of the sampling inlet can be more flexible. It is more important that there is no obstruction between the approaching air from the emission source and the sampling inlet.
- If more than one monitor, or any other particulate instrument, is being used at the site, the height of the inlets should be uniform.
- If the monitor inlet is the highest point at the site, a lightning rod must be installed to prevent damage to the unit during electrical storms.

3.3 Measurement Interference

- The meteorological conditions of the site should be taken into consideration when positioning the monitor. For example, there should be no obstruction to the air flow in the predominant wind direction. A minimum clear sky angle of 120 degrees is recommended.
- The inlet should be at least 1 meter away from any objects that could potentially influence the airflow characteristics e.g. trees, vertical surfaces or walls.
- Avoid overhead high-voltage cables which may cause electrical interference with the sampling equipment.
- Demolition/construction activities and change to normal transport patterns due to road works etc. can significantly affect the data. Ensure a record of such events is kept to account for unexpected peaks in concentration.

3.4 Safety

- The intended data capture rate should be considered when positioning the monitor. If data capture above 90 % is essential, the unit should be in an area which has 24-hour access available.
- The positioning should allow for routine maintenance checks to be performed safely by personnel.
- If using a tripod, ensure the tripod legs are bolted to the ground to prevent the unit from falling.
- Ensure the monitor is in a secure location to avoid vandalism or theft.

3.5 Surveyor’s tripod mounting

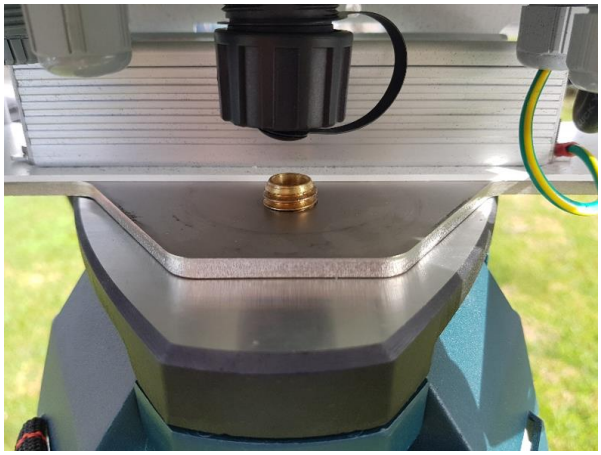
If needed, Aeroqual can supply a mounting kit that attaches the AQS 1, Dust Sentry or Dust Sentry Pro to a standard surveyor’s tripod. The kit includes one mounting plate, 8 x M4 hex head bolts and nuts, and 6 pegs. You supply your own surveyor’s tripod with standard 5/8” x 11 mounting screw.

1. Lay your monitor on a flat surface.

2. Using the 8 x M4 hex head bolts and nuts, bolt the mounting plate to the monitor through the slots in the bottom of the monitor’s solar shield.

3. Place the tripod in the desired location and secure it to the ground using the 6 provided pegs.

4. Attach the monitor to the tripod by screwing the tripod's mounting screw through the threaded hole in the mounting plate. Note: Keep the mounting screw as close to the center of the tripod as possible so that the weight of the monitor is centered over all three legs.



5. Check the tripod is firmly secured to the ground. If it's not, there is a danger of the monitor falling over due to wind. If the supplied pegs aren't suitable for the ground type, you might need to find another way to secure the legs.

6. For extra security, attach guy wires to the four holes in the corners of the mounting plate.

7. Check the tripod attachment screw is firmly tightened and that the monitor is centered on the tripod.


DUST
SENTRY
CAFE

4 Connectivity

The monitors use an industrial embedded PC (ePC) for data logging and monitor control. A cellular modem can be fitted to facilitate remote connection and support from Aeroqual technical support – see section 4.2.2 Connecting using a cellular modem.

There are two ways to connect to your monitors:

- **Aeroqual Connect (via Direct WIFI / LAN)** for initial set up and when access to the internet is limited;
- **Aeroqual Cloud (via Network WIFI / Modem)** for remote access, visibility of all your monitors, and remote technical support from Aeroqual Care.

Aeroqual highly recommends every monitor is connected to Aeroqual Cloud for the best user experience, additional data features, and Aeroqual Care.

Engineers who need to perform service or data analysts who need to view or download data can do so using a web browser on their PC, tablet or smart phone. There is no software to download and install.

Data Security

The data belongs to you. We look after it in the same way that a bank looks after your money. Who you let access your data is entirely up to you – our job is to carry out your instructions.

If you do choose to store data with us, then here are some of the security assurances we provide:

- We use only ISO 27001 approved data centres
- Infrastructure is monitored and protected 24/7
- Data is accessed via a secure website with 256-bit SSL encryption
- User defined passwords

4.1 Aeroqual Connect (via Direct WIFI / LAN)

Aeroqual Connect contains all the tools necessary to view and download the data and maintain and calibrate a single monitor.

No internet connection is required for Aeroqual Connect. Aeroqual Connect is always running on the monitor and can be accessed via WIFI through an internet browser on any device, there is no software to install.

Figure 4-1 Aeroqual Connect Home page

4.1.1 Connect to Aeroqual Connect via Direct WIFI

A few minutes after powering on, you should see a new WIFI network in your device's list of WIFI networks. The WIFI name (SSID) will match your serial number, connect to this network using the password below.

- WIFI SSID: **DS DDMMYYYY-XXX** or **AQS1 DDMMYYYY-XXX**

- Password: **Aeroqual**

NOTE: *If you are accessing the internet on your device using WIFI, you will lose your internet connection.*

4.1.2 Connect to Aeroqual Connect via LAN

The monitors can be added to a LAN, in two ways:

- Using the WIFI function to connect to a WIFI network
- Using an Ethernet cable to plug into a LAN network router

When connected to the LAN, the monitor will automatically be assigned an IP address by the LAN router.

You must find out what this IP address is so you can connect to the monitor. The WIFI or wired LAN IP address will likely be in the format: **192.168.XXX.XXX**

If your laptop also has access to the same LAN, then this IP address can be typed into a browser address bar and a connection to the monitor can be established over the LAN connection.

4.1.3 Access your monitor on Aeroqual Connect

After connecting your monitor to your device, open an internet browser window and enter **10.10.0.1** in the address bar. You should see the Aeroqual Connect login screen. Log in with the default username and password provided.

- URL: **10.10.0.1**
- Username: **administrator**
- Password: **aqmadmin**

NOTE: *Depending on your device WIFI settings, and how long you take to enter complete the steps above, your device may reconnect to the previous WIFI connection.*

After logging in to Aeroqual Connect, you will be presented with a screen with five ‘apps’; Manage Data, Calibration and Service, Configure Instrument, Diagnostics and Advanced, and Administration. You are now accessing your monitor in “Access Point” mode.

Next, open the Administration app and create a new user and secure password, then delete the default username and password.

4.2 Aeroqual Cloud (via Network WIFI / Modem)

Aeroqual Cloud is cloud-based software. It gives you and other trusted users access to all your monitors via secure third-party servers. Use Cloud to:

- Communicate with your monitor from anywhere in the world at any time
- Use advanced charting features such as wind roses and pollution roses
- Receive fast and comprehensive technical support from your Aeroqual distributor or Aeroqual technical support team.
- Automatically export data to multiple users via email or to an FTP server.
- Securely back up data in case of local data access issues.
- Maintain service records in the Cloud Journal for auditing and engineer certification.

Connection to Aeroqual Cloud makes technical support fast and efficient for the end user.

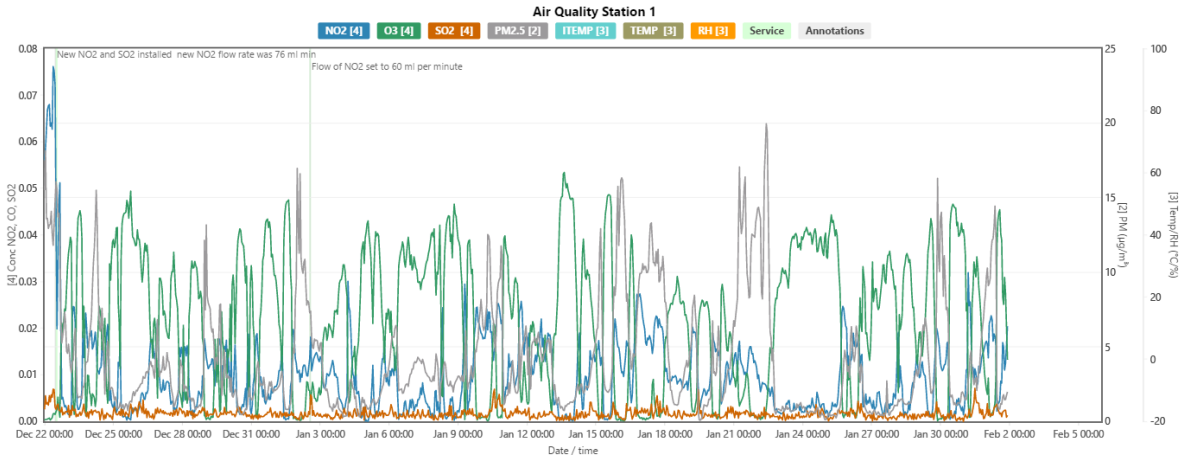


Figure 4-2 Aeroqual Cloud has many useful features such as plotting multiple channels on a single graph

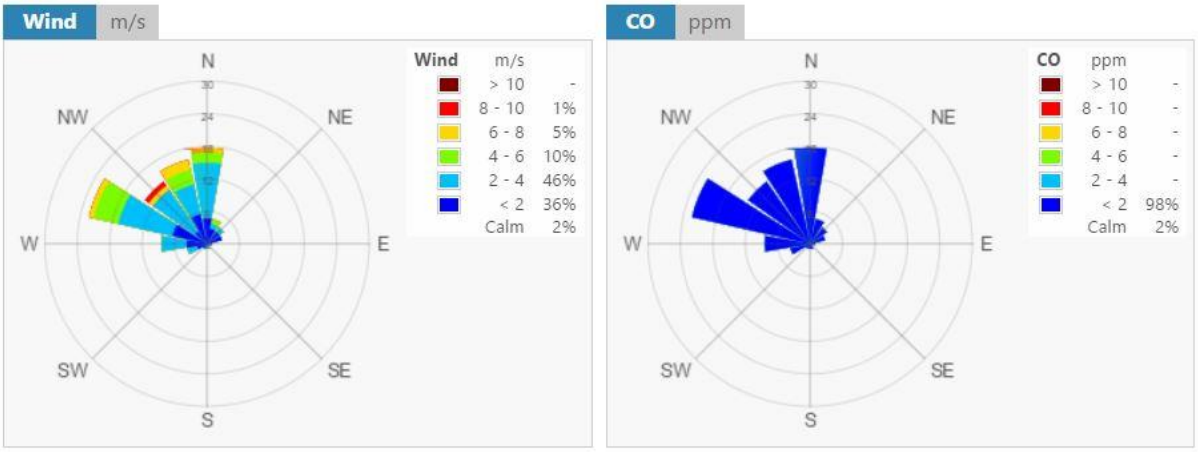


Figure 4-3 Generate advanced graphical presentations such as wind roses and pollution roses.

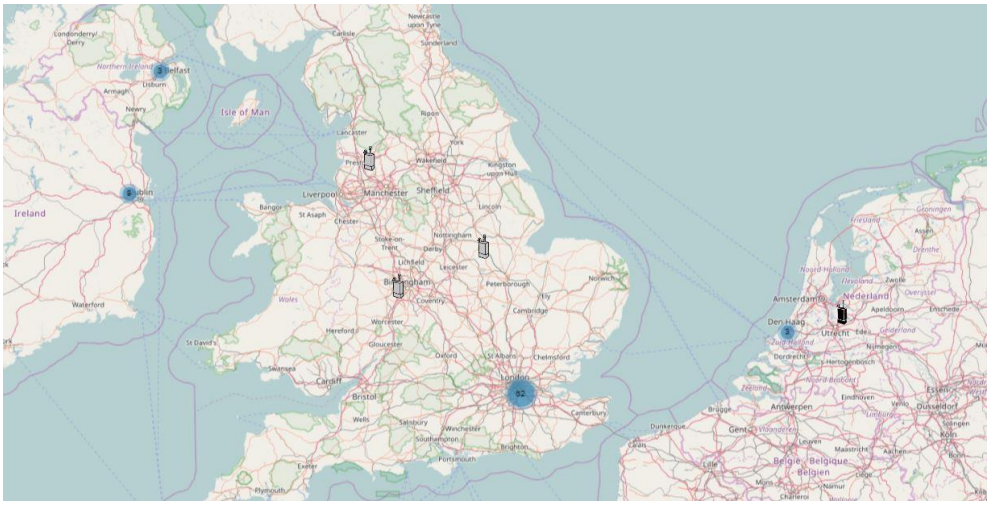


Figure 4-4 Select multiple monitors by region, and plot data from multiple different monitors on the same graph.

Figure 4-5 Receive SMS text alerts directly to your smart phone or by email.

4.2.1 Connecting over a local area network (LAN)

The monitors can be added to a LAN, in two ways:

- The WIFI function of the monitor is used to connect to a WIFI network that is connected to the internet.
- An Ethernet cable is used to connect the monitor to router that is connected to a LAN.

When this happens, the monitor will automatically be assigned an IP address by the LAN router.

You must find out what this IP address is so you can connect to the monitor and access the monitor software. The WIFI or wired LAN IP address will likely be in the format: 192.168.XXX.XXX

Figure 4-7 shows the Connect software with an assigned IP address in the address bar in the browser.

If your laptop also has access to the same LAN, then this IP address can be typed into a browser address bar and a connection to the monitor can be established over the LAN connection.

4.2.2 Connecting using a cellular modem for remote communication

The monitors can be fitted with a cellular modem connected to a built-in cellular antenna on the outside roof of the enclosure. The modem requires a SIM card and the modem must be configured.

4.2.2.1 Set up Sierra RV50X modem

Mobile Network Operator Certification for the RV50 (Pending for the RV50X)

• Verizon Wireless

• AT&T

• Sprint

• T-Mobile USA

• US Cellular

• Rogers

• Bell

• Telus

Antennas

On the Sierra RV50X, there are 3 antennas:

1. **Cellular antenna:** Major cellular antenna (connected to built-in antenna on monitor)
2. **Diversity antenna:** For 3G networks, the second antenna operates as a diversity antenna, providing a second receive path. For 4G networks, the second antenna operates as a MIMO antenna, providing a second receive path and a second transmit path.
3. **GPS antenna**

Dual SIM

The AirLink RV50X Series gateway has two SIM card slots. You can decide which slot is the Primary SIM card. When the gateway is powered on or reboots, it automatically connects to the network associated with the Primary SIM card. If no card is present in that slot, it connects to the network associated with the Secondary SIM card. If configured to do so, data usage is tracked independently on both SIM cards. SIM PIN configuration is also available for both SIM cards. This feature allows users to install SIM cards for two different network operators, use one SIM card initially and later change network operators by configuring the new SIM card to be the Primary SIM card.

Power saving features

This feature optimizes idle power consumption. Recommended for customers who require the best power consumption efficiency, for example; battery or solar powered applications. Enabling this feature saves energy by reducing performance where possible.

Interface Priority

Rank the available WAN interfaces by selecting the order of priority. The highest priority interface will become the default route for IP traffic. The default order of priority is:

• Ethernet — First

• Cellular — Second

If the highest-priority interface is not available, the gateway attempts to connect to the second-highest priority interface. Interface priority is evaluated as follows:

• Ethernet — Does the gateway have an IP address from the router?

• Cellular — Can the gateway access the Mobile Network Operator's network?

Bandwidth Throttle

This feature helps you manage your data account by allowing you to configure the AirLink gateway to restrict the real-time available bandwidth. You can:

• Place limits on traffic (uplink, downlink, or both)

• Allow for burst of traffic on the uplink, downlink, or both, while still maintaining the over-all desired bandwidth limit

Traffic that exceeds the limits is dropped. Status fields keep running tallies of data sent and received and the number of uplink and downlink packets dropped.

APN

Note: The first time you power on the AirLink device, ALEOS automatically selects the most commonly used APN for the Mobile Network Operator identified on the inserted SIM card. This APN is used if no other APN is selected or configured.

The APN the gateway is using for authentication on the mobile network is displayed.

• If a User Entered APN is configured, the User Entered APN is displayed.

• If there is no User Entered APN configured, an automatically selected APN is displayed.

• When the Backup APN is configured, the APN in Use displays the configured Backup APN when it is being used for authentication on the mobile network

Dynamic DNS

With IP Manager, the gateway's WAN IP is included in the update packet sent to the IP

Manager server, so IP Manager always links the gateway's WAN IP address to the domain

name configured on the gateway.

4.2.2.2 Set up MOXA G3111 HSPA modem

www	Online reference	http://training.aeroqual.com/mod/page/view.php?id=702

- Aeroqual supplies an optional cellular modem (MOXA G3111 HSPA) for remote communication. This is Aeroqual part number R38. This must be correctly configured to work on the local telecommunications network in your country.
- The modem requires a standard SIM card (dynamic IP) which you can buy from a cell phone store. The SIM card fits in a slot underneath the modem as shown in Figure 2-6.

- You must know the APN of your cellular provider, you can find out the APN by going to www.APNChanger.org and looking up your country and cellular provider.
- Directly connect the MOXA modem to your PC using an Ethernet cable.
- Then enter the APN into the correct field through the MOXA configuration interface shown in Figure 2-6.

Figure 4-6 The MOXA modem uses a SIM card and it must be configured for use.

The Ethernet Mode must be set to Auto DHCP client to use the MOXA modem, as shown in Figure 4-9 (c). Other options for connecting to the monitor

There are several options to establish a communication connection to the monitors. These require the communication settings to be changed in the Configure Instrument App shown in Figure 4-7. The communications settings are entered in to the third column. Details of each of these communication methods and how to set them up in the Configure Instrument App are given in the online training.

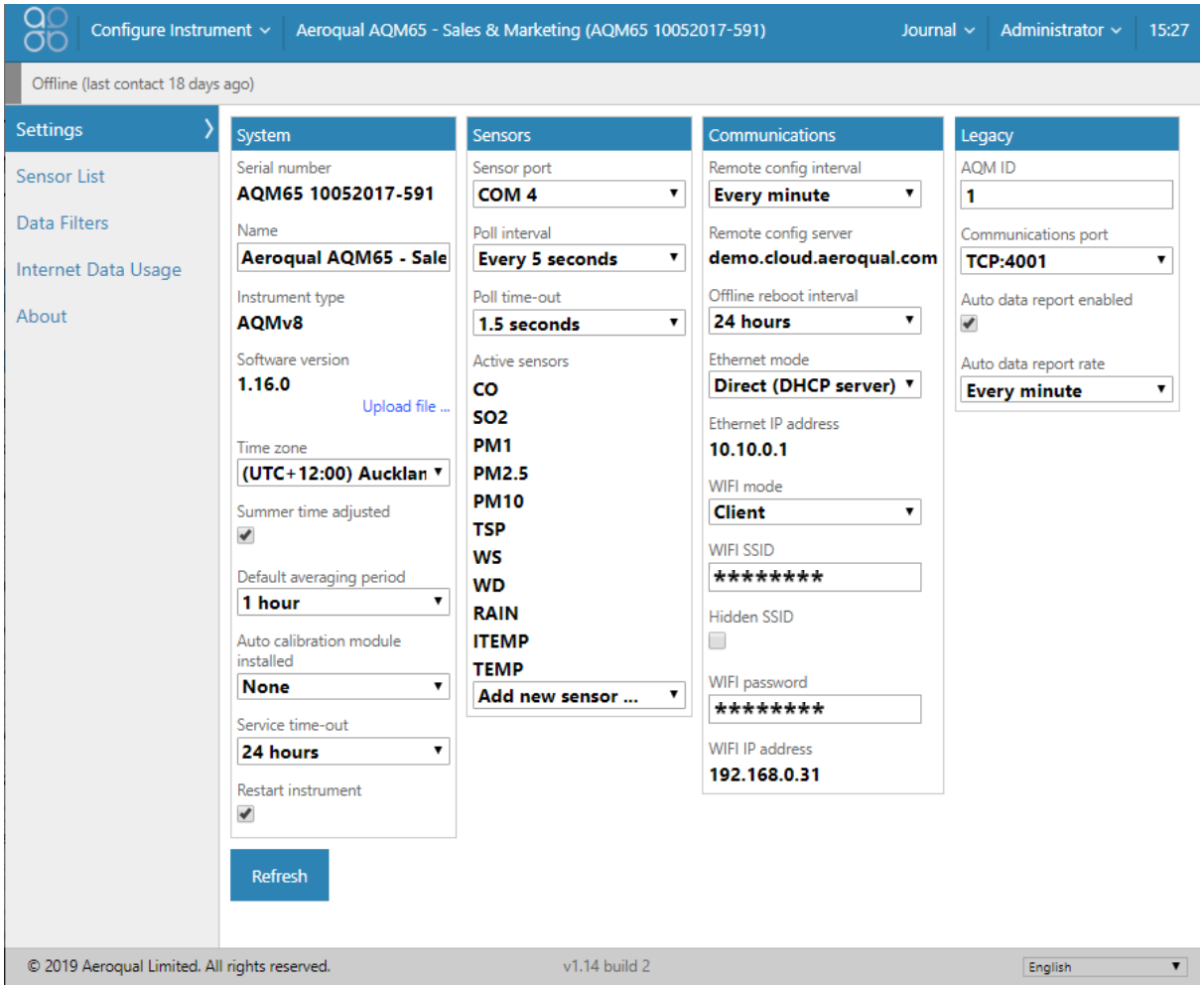


Figure 4-7 Column three in the Configure Instrument app control the communication and connection settings

4.2.3 Ethernet connection

The ePC has a separate wired Ethernet connection, this can used in several ways:

- To directly connect to a PC
- To connect to a wired LAN via a router
- To connect to an IP modem to provide cellular communication.

The WIFI connection and Ethernet connection are independent from each other, both can be used at the same time. The recommended configuration for connection is to set the WIFI mode to Access Point and the wired Ethernet to Client mode to use with the modem.

To use an ethernet cable, ensure the blue Ethernet cable from the ePC is plugged in to the Ethernet plug in the bottom of the instrument, as shown in **Figure 4-8**. Ethernet mode is set to DCHP (server) in this method.

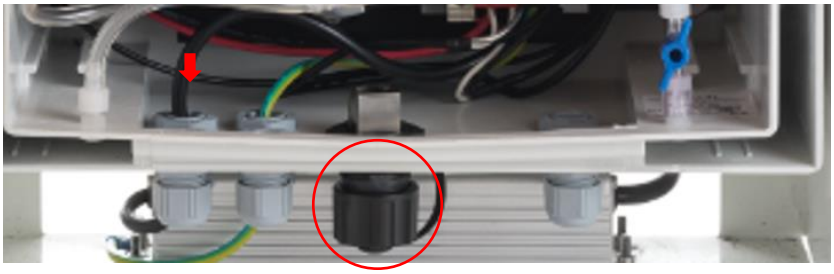


Figure 4-8 To establish a direct connection, a laptop must be connected to the ePC using an Ethernet cable

4.3 Communication settings

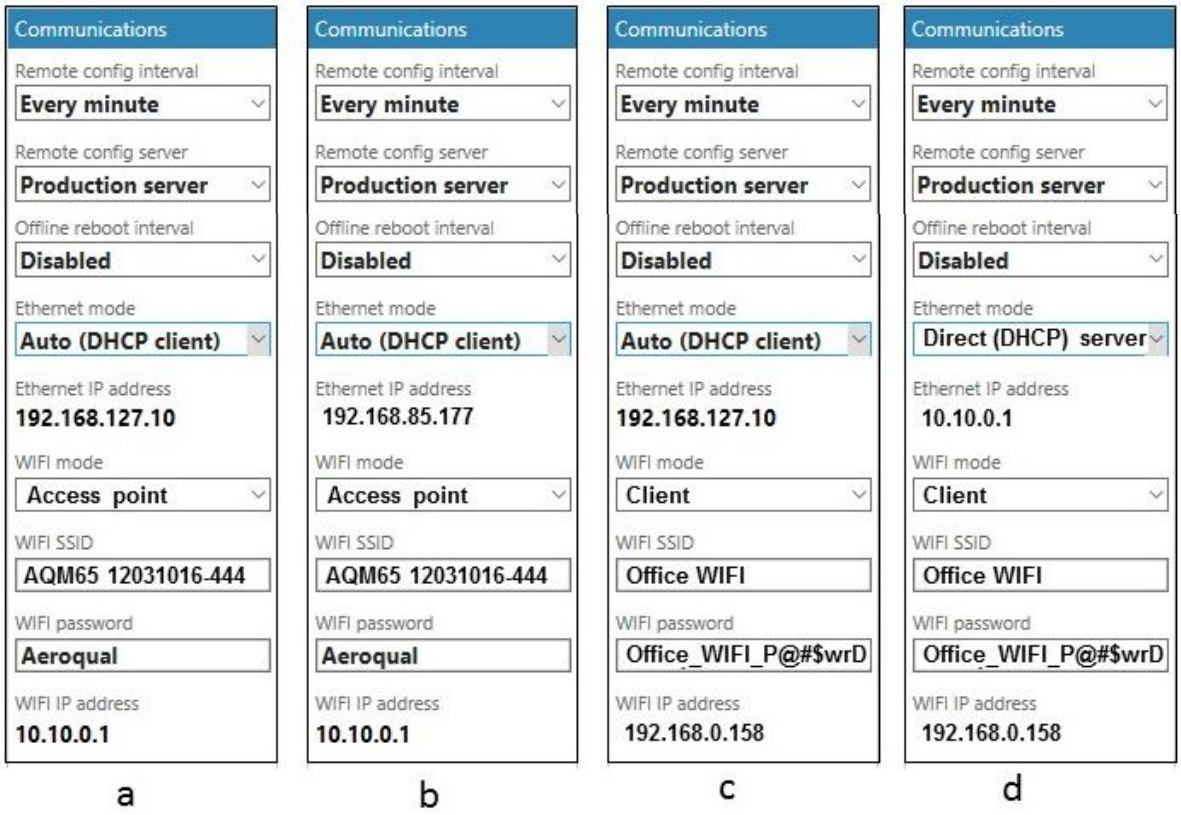


Figure 4-9 The different connection types require different settings in the Configure Instrument app

a) The Ethernet mode is set to Auto (DHCP client). In this configuration the modem can be used. The modem will assign IP address **192.168.127.10** to the ePC. The WIFI mode is set to Access Point so a direct connection to the EPC can be made over local WIFI.

b) The Ethernet mode is set to Auto (DHCP client). In this example the ePC has been plugged in an office router using an Ethernet cable. The router has assigned IP address **192.168.85.177** to the ePC.

The WIFI mode is set to Access Point so a direct connection to the ePC can be made over local WIFI, the Ethernet mode is set to Auto (DHCP client). In this configuration the modem can be used. The modem will assign IP address **192.168.127.10** to the ePC.

c) The WIFI mode is set to Client and is connected to the office WIFI network. The ePC has been given a WIFI IP address **192.168.0.158** by the router This IP address can be entered directly in the browser to connect to the monitors.

d) The Ethernet mode is set to Direct (DHCP Server). In this configuration a laptop can be directly connected to the ePC using an Ethernet cable. Enter **10.10.0.1** to connect directly to the monitors.

NOTE: *Should you need to reset the communication settings, see the following section, Section 4.4.*

4.4 Resetting the communication settings back to factory settings

The monitor communication settings can be set back to factory defaults.

One situation where this might be useful is if the WIFI SSID name or password has been incorrectly entered and therefore the ePC cannot establish a connection to the local WIFI network.

The WIFI settings can be set back to Access Point mode and the monitor will again appear as a WIFI network. Depending on the version of Aeroqual Connect you are using, the SSID name will appear as the monitor "**serial number**" or as "**Aeroqual AQM**", the reset WIFI password will be "**Aeroqual**".

To achieve this, you will need a USB flash drive.

1. Create a file on the flash drive called **.resetnetwork.aqm** (yes there is a "dot" at the beginning of the file name).

   The file extension must be **.aqm** it cannot be an .aqm**.txt** file.

   In Windows OS you can create a new .txt document and give the file name **.resetnetwork.aqm**

   Check the Type column to make sure it is an .aqm file. You might need to unhide file extensions and delete the .txt from the end of the file name. Figure 4-10 shows the correct file.

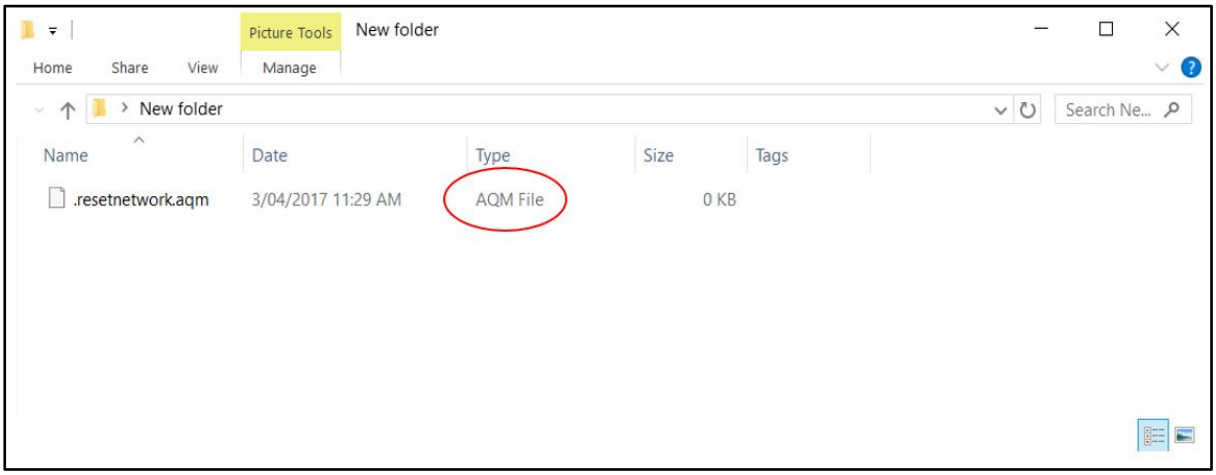


Figure 4-10 Create an empty file called .resetnetwork.aqm

2. Then insert the USB drive into any of the USB ports on the ePC.
3. Wait several minutes, the ePC will reboot automatically and then you should see a WIFI network appear called as either the monitor "**serial number**" or "**Aeroqual AQM**" with password **Aeroqual**.

   You can then remove the USB stick.

5 Operation

Data visualisation, monitor configuration, calibration and control of user access is achieved using apps which are accessible form the main page.

Access to the apps, and the individual features within each app is controlled by the monitor licence and the user privileges for the different user types, which are described in Section 5.5.

Figure 5-1 The landing page of Connect after login shows the available apps

5.1 Manage Data

The Manage Data app is used to view data within the browser and to download data (export) data for use in other software. The available features in the Manage Data app will depend upon the monitor licence and the user permission level. The features within the Manage Data app appear in a column on the left-hand side of the screen.

Feature	Aeroqual Licence	User permission required
Charts	Connect / Cloud	User or higher
Table	Connect / Cloud	User or higher
Download data	Connect / Cloud	User or higher
Auto Export	Cloud	Engineer or higher
Manual sync	Connect	Engineer or higher

Table 5-1 Software tools available to different user permissions

5.1.1 Charts

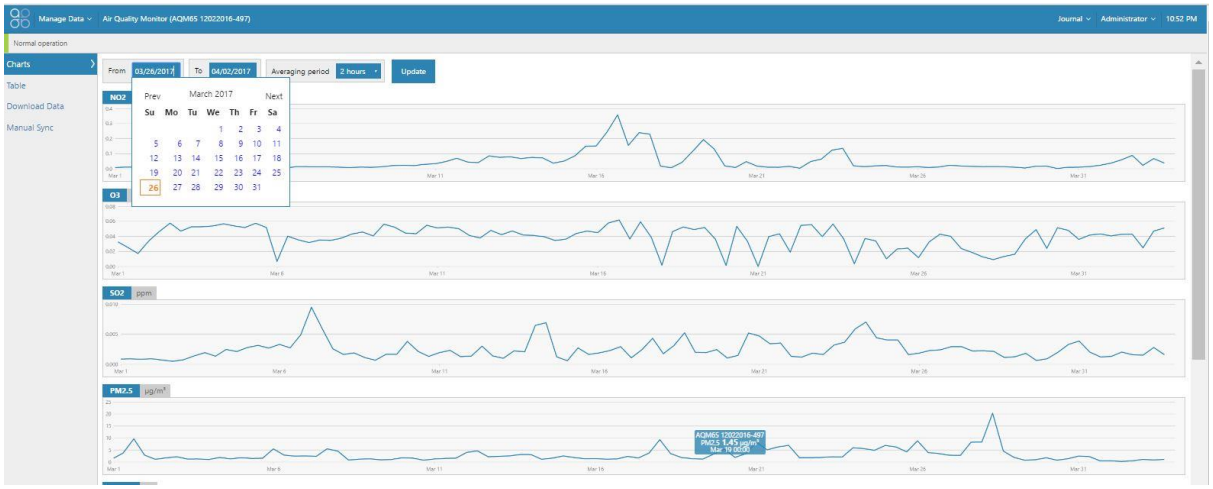


Figure 5-2 The charts tool, in the Manage Data app shows each data channel in a stack of charts

5.1.2 Table

The data from each module can be viewed on screen in a Table. The from and to dates can be selected using a calendar tool, and the averaging period such as daily, hourly or minute can also be selected.

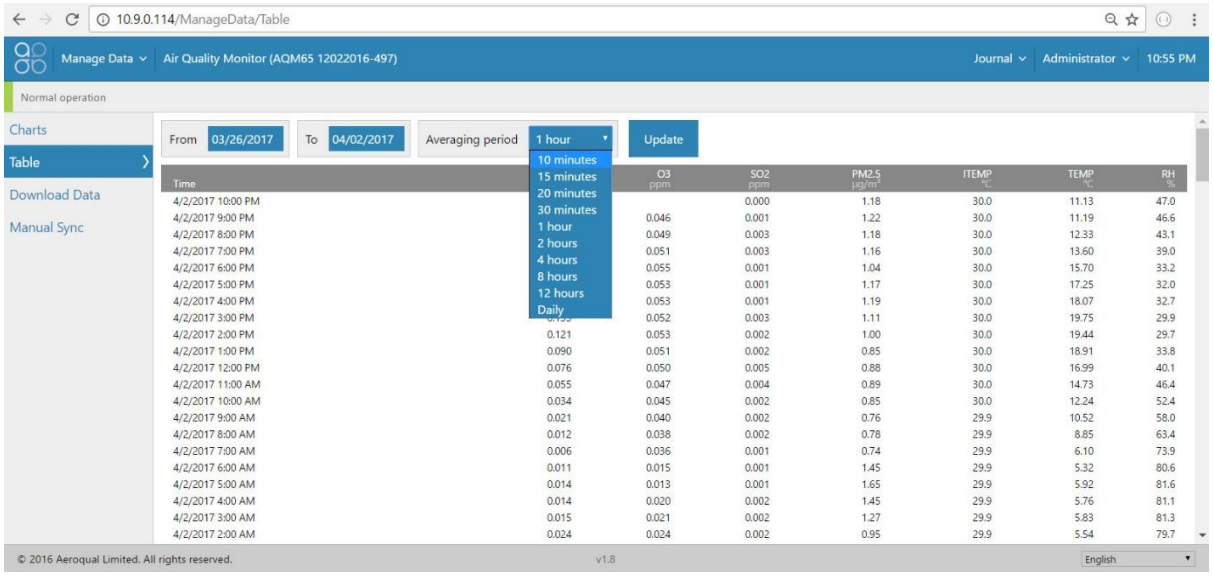


Figure 5-3 The table tool in the Manage Data app shows the data in a table with user configured date range and averaging

5.1.3 Download data

The data can be downloaded by selecting a From and To date and Averaging Period. The format is comma separated values (.csv). This file format can easily be opened in Microsoft Excel.

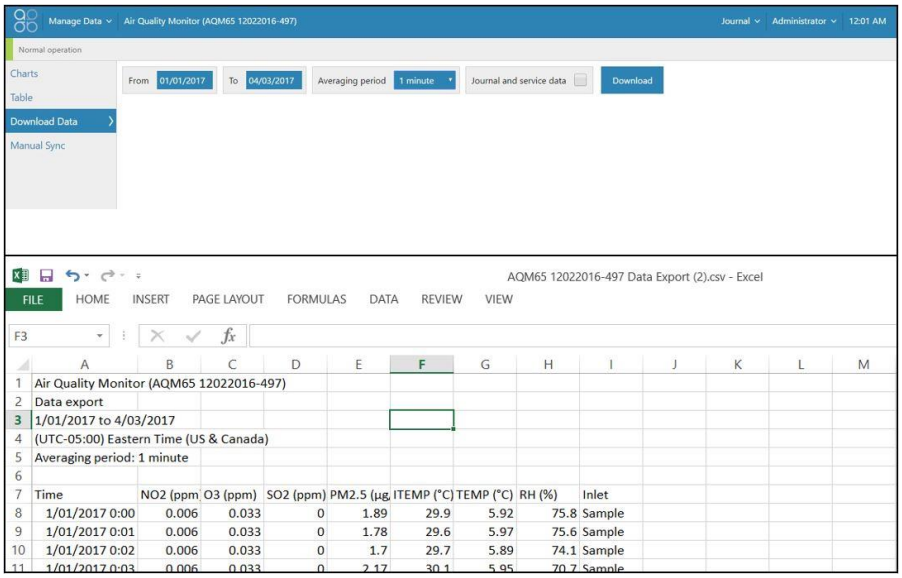


Figure 5-4 The download data tool in the Manage Data app allows the data to be downloaded at user configured date range and averaging

5.1.4 Manual sync

The manual sync feature allows all the data, and diagnostics and journal entries to be **downloaded from Connect to a PC**. The manual sync file cannot be read by any software. The manual sync file is later **uploaded from a PC to Aeroqual Cloud**.

This feature is used if the Monitor does not have an active data connection to Aeroqual Cloud at the monitoring site but the data is required to be in Aeroqual Cloud for data storage and so all stakeholders can access the data.

Figure 5-5 shows the Manual Sync download tool in Aeroqual Connect and the Manual Sync upload tool in Aeroqual Cloud.

NOTE: *You might need to manual sync multiple times. The first time the "From Date" is "1900", then it creates a file with a maximum number of records of 1 million. Therefore, the file might only*

synchronize for a limited dataset. At the end of that sync the "From Date" will show up to where the last data was downloaded. You run the sync command again and it gives you a new file starting at that date and including the max number of records. You keep running this process until you get to today's date.

These files are then uploaded one by one using the manual sync upload tool in Aeroqual Cloud.

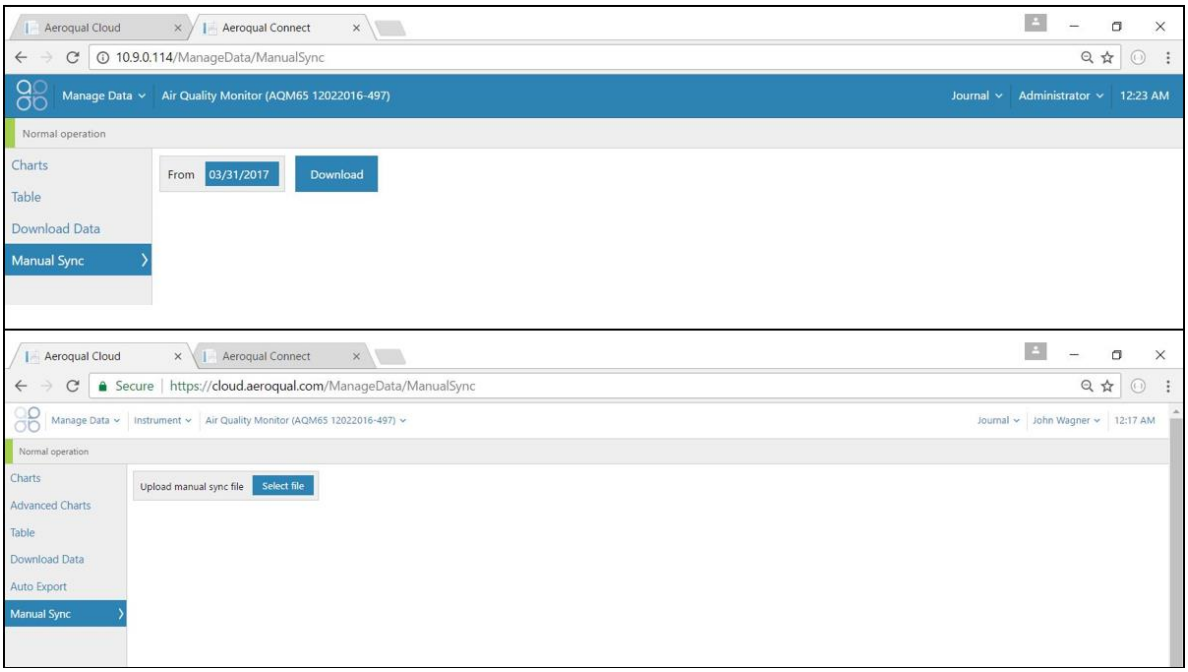


Figure 5-5 The manual sync tool in the Manage Data app allow all data from the Monitor to be manually uploaded to the Cloud if a local data connection is not available

5.2 Calibration and Service

Aeroqual Licence	User permission required
Connect / Cloud	User or higher

The Calibration and Service app has two functions, Service mode initiation, and changing gain and offset during calibration.

5.2.1 Service Mode button

When a service engineer visits the monitor to perform routine service such as filer changes or flow checks, this can cause the data to read very high or very low. During service activities the monitor can be put into Service Mode by clicking the service mode button. This will tag the data as "service data" which can later be filtered when daily or hourly averages are being calculated.

For further discussion on Service Mode see section 6.3.

5.2.2 Gain and offset adjustment

Gain and offset adjustments are made as part of the monitor gas calibration procedure.

5.3 Configure Instrument

Aeroqual Licence	User permission required
Connect	Engineer or higher

The Configure Instrument app provides useful information about the monitor, including:

- The list of configured licences.
- When data was last sent to the Aeroqual cloud database.
- The number of text alerts remaining.
  NOTE: *These come from* ***cloud.aeroqual.com*** *not from the monitor.*
- Setting measurement units to ppm, ppb, µgm-3 or mg-3, degrees °C or °F
- Set up text (SMS) and Email alerts.

- If a module is removed or added, then a software change is required. The software module configuration can be found in the Configure Instrument app.

5.4 Diagnostics and Advanced

Aeroqual Licence	User permission required
Connect	Engineer or higher

The Diagnostic and Advanced App provides access to monitor and individual module operating parameters and is used by Aeroqual technical support to troubleshoot and diagnose monitor condition. It provides real time information about the status of the modules and allows operational settings of the modules to be viewed or edited.

5.4.1 Diagnostics

Each module can be selected, and real time module operation parameters can be viewed.

5.4.2 Module settings

Each module has a set of operational parameters which control the module. These can be viewed or edited using the module settings dialogue.

IMPORTANT: These settings should not be changed without instruction from Aeroqual.

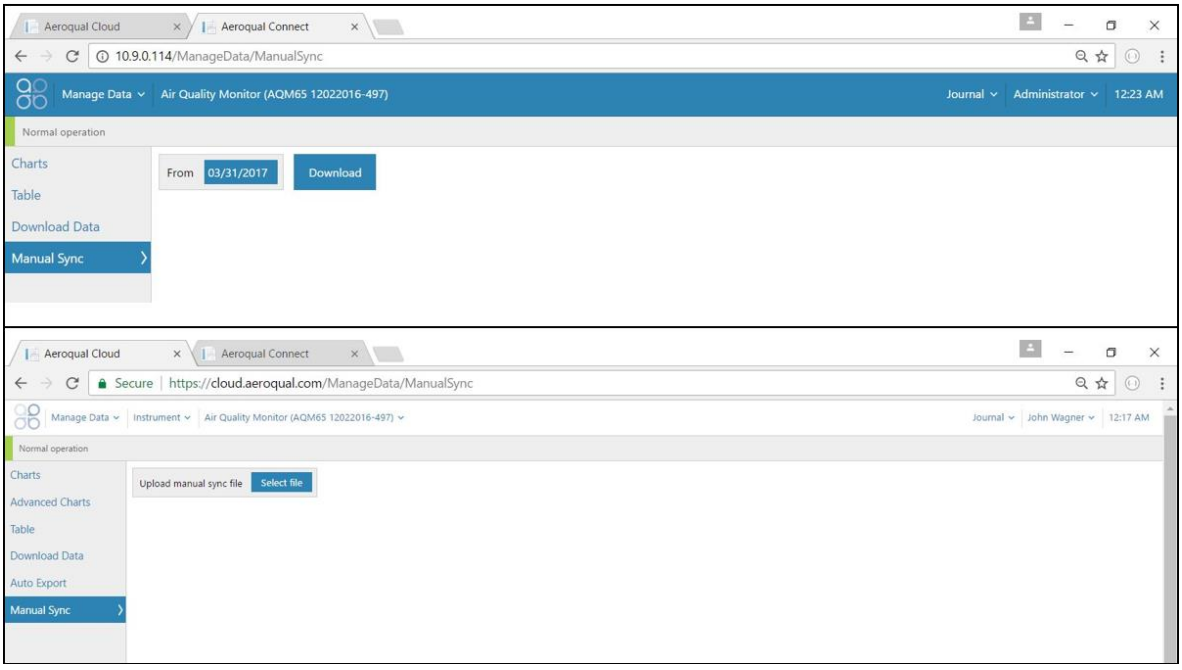


Figure 5-6 The Diagnostics and Advanced app displays real time monitor operational readings and settings which control how the modules are controlled.

5.4.3 Journal

Any changes to monitor settings are automatically recorded in the monitor journal with a date and time stamp and the username of the user who performed the change.

The journal entries are categorised to make it easier to search for specific entries. The categories are selected from the drop-down list.

Service activities such as filter replacements or flow checks are not automatically recorded by the software.

Engineers performing service or calibration can make specific user entries to describe their service activities.

NOTE: *Keeping service records is a requirement under Aeroqual's factory warranty*

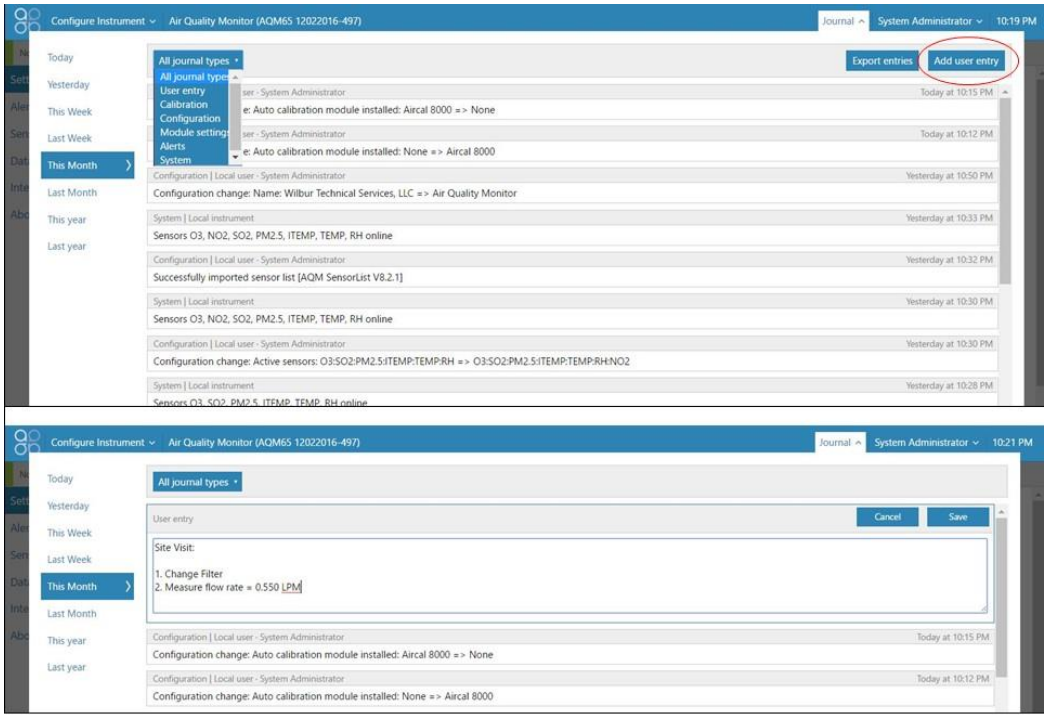


Figure 5-7 The Journal automatically logs software changes, it also allows manual user entries

5.5 Administration

The monitor ships from the Aeroqual factory with a default username and password:

Username: **administrator**

Password: **aqmadmin**

⚠ Security

These access credentials are published in multiple public documents and are only used to first connect to and configure the monitor. Aeroqual recommends that a new Administrator user is created with secure password and the default Administrator user is deleted which will make the monitor more secure.

There are three different user permissions which can be applied to individual users on the monitor. Each individual user of the monitor may be given an individual username and password to access the monitor. There is no limit to the number of users which can be created.

Access / Profile	User	Engineer	Administrator
Can view and download data.	✓	✓	✓
Can perform a calibration and change calibration settings	✓	✓	✓
Has full control over all monitor settings.		✓	✓
Can control access login and password for other users.			✓

Engineers cannot access the Administration App.

An administrator can access all the apps in Connect, and is the only user type who can access the Administration app. New users are created using the Administration App.

5.5.1 Monitor licences

The Connect software has some features which may need to be enabled through a licence, such as the application programming interface (API) feature and the FTP export feature. For information about Connect features which require a licence, contact the Aeroqual distributor in your local country for technical support.

5.5.2 Leasing instruments to Customer Organisations

- Instruments may be sold or leased to customer organisations
- Leased instruments stay with the customer organisation for a period decided by the Administrator of the parent organisation
- After a lease has ended, the instrument is moved back to the parent organisation by the Administrator of the parent organisation, there is no auto expiry of a lease.
- The data generated by the instrument during the period of the lease remans available to the customer organisation after the lease has ended.
- After the lease has ended, the instrument is then available to be leased to another customer
- The data from the previous lease is quarantined and is only available to the customer whom the instrument was leased to, subsequent customers can't see other customers data.
- The Distributor or the Customer, can (and should) erase all data from the local EPC, otherwise the data could be seen by future customers.

5.5.2.1 Procedure

When an Administrator moves an instrument under their customer's organisation, they will be asked whether they wish to "Move" or "Lease" the instrument.

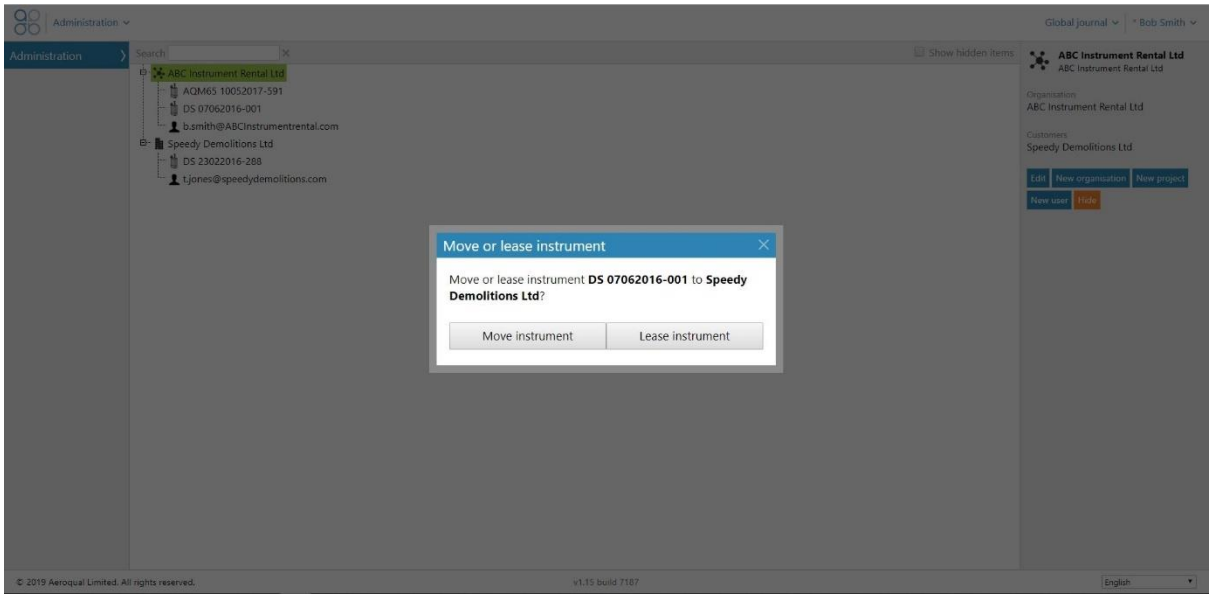


Figure 5-8 Options when moving an instrument under an organisation.

If "Move instrument" is selected the instrument is moved from the parent organisation to the customer organisation.

If "Lease instrument" is selected, the instrument is shown in two places: the instrument will still be shown under the parent organisation and will also be shown under the customer organisation.

The company which the instrument is leased to is shown next to the instrument in the parent organisation. The start date of the lease is shown next to the instrument in the customer organisation – see Figure 5-9.

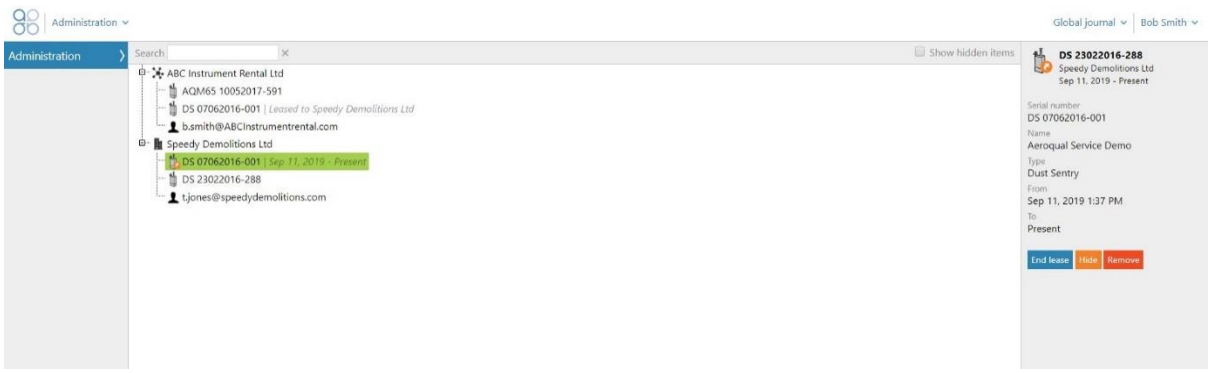


Figure **5-9** Instrument appears next to parent and leasing organisation.

After the lease is concluded the “End Lease” button is clicked by an Administrator of the parent organisation.

Under the parent organisation the *“Leased to…*” name of the customer organisation disappears from the instrument.

A symbol of the instrument remains under the customers organisation, with the start and end date of the lease shown next to the instrument– see Figure 5-10.

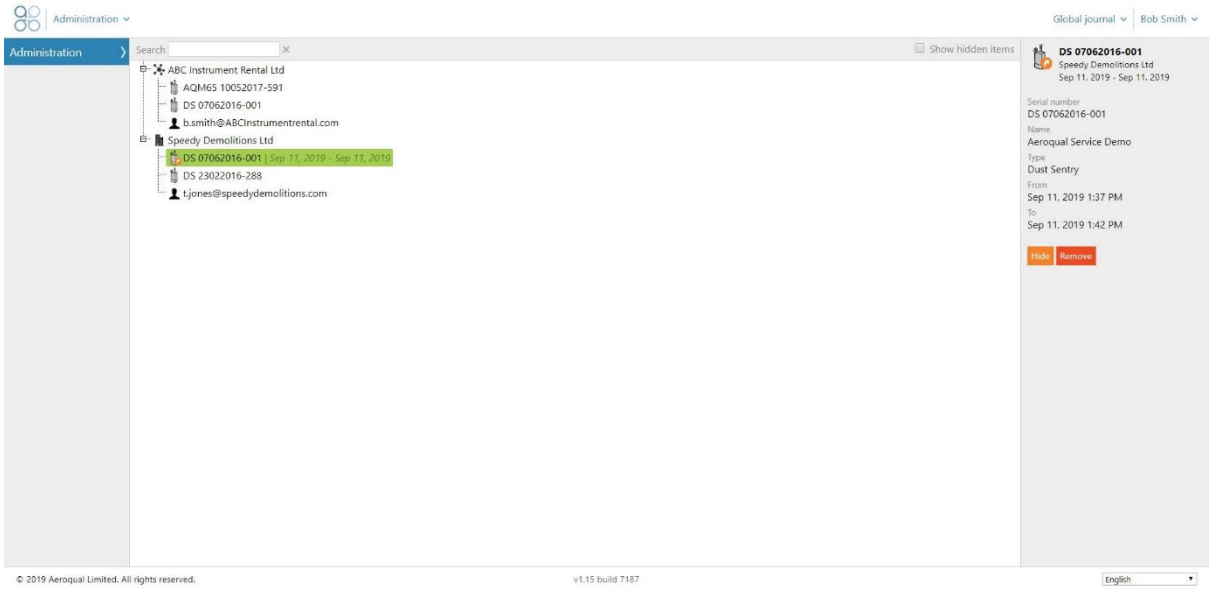


Figure 5-10 After lease ends a copy of the instrument remains under the customer with the lease dates.

The customer can still view their data by selecting the instrument however they have no control over instrument settings, or data outside of the Lease dates.

NOTE: *If the customer wishes to download the data is important the instrument have a licence to allow that (Aeroqual Care) before the lease expired.*

NOTE: *The data is not automatically deleted or quarantined in CONNECT, it is the responsibility of either the parent organisation or the customer to delete the data from CONNECT – see* Figure 5-11*.*

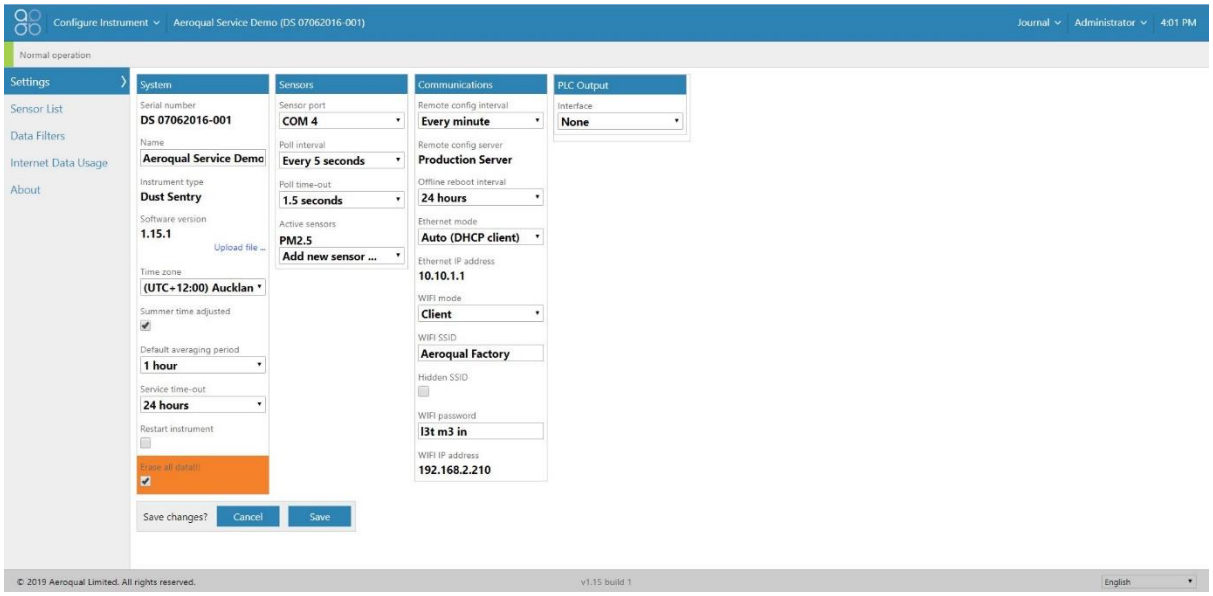


Figure 5-11 “Erase all data” is an option for the parent organization or the customer after a lease.

6 Service & Maintenance

Routine service and maintenance are required to ensure the monitor performs optimally.

The frequency of some service activities such as filter changes will depend upon local environmental conditions Environments with higher particle concentrations, for example, will require more frequent filter changes.

Other service activities such as flow checks and pump replacements can be scheduled at routine intervals and other service activities such as module replacements are performed only when required.

Recommended service frequencies for each service activity are given in Section 6.1.

Further detail on each of the service activities can be found on the Aeroqual training website:

training.aeroqual.com (The training website requires a login, please email technical@aeroqual.com)

It is very important to keep service records. The Journal is used for this purpose. See Section 4.3 for a discussion of use of the Journal for service record keeping.

For some of the service activities described a video is also available on YouTube. If a video is available, a web-link will be provided next to this symbol.

⚠ Safety requirements

- Replacement of any part should only be carried out by qualified personnel using only parts from the manufacturer
- Surfaces marked with a "Caution, Hot Surface" and an internationally recognised symbol may get hot and deliver burns
- If installed, the 82850 Particle Monitor is a Class 1 laser product and is not considered dangerous if used correctly. It should not be powered up with the cover removed.

6.1 Service frequency guidelines

The frequency of some of the service activities described above can depend upon environmental conditions and upon data quality objectives. Some service activities are required at fixed frequencies (**scheduled maintenance**), and some are performed only as required (**unscheduled maintenance).**

Service intervals will vary depending on site conditions. For instance, particulate matter levels will impact the frequency of filter changes – high PM levels = more frequent filter changes

It is important to change the filter when it gets dirty. Once the local site conditions are understood, a filter change schedule can be developed for that site.

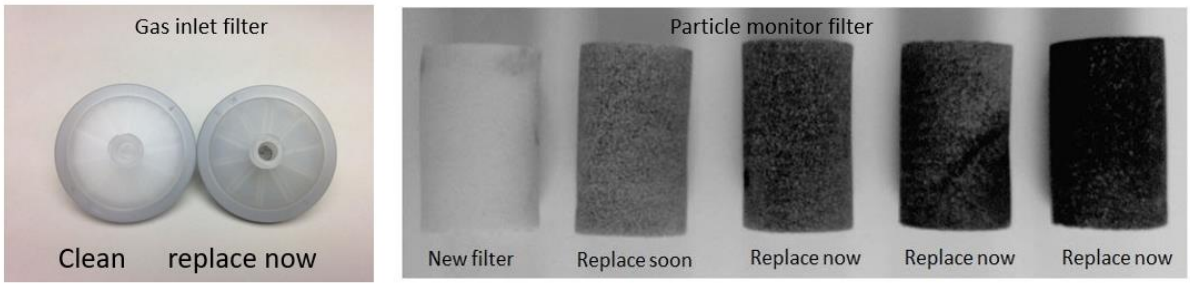


Figure 6-1 Filters should be changed before they get too dirty. The frequency of filter changes will depend upon local site conditions.

Data quality objectives will also influence the service frequencies for some operations. In monitoring situations where data quality objectives are high, for example where monitoring is performed for compliance or where a high amount of scrutiny will be placed on the data, service frequencies may be higher.

It is recommended that the monitor engineer, over time, develops an appropriate servicing schedule for a site.

6.2 Flow meters and flow measurement

Accurate and precise flow rate measurement is critical for monitor service and calibration. Flow rates can be measured and reported in several different ways. It is important to understand the terminology and equipment associated with flow rate measurement.

6.2.1 Flow meters for gas flow measurement

For gas flow measurements, Aeroqual recommends either the Bios Defender DryCal or the TSI 4040 (AQS R8 HS) flow meter. These can both be used to measure gas flow and Particle Monitor flow.

Figure 6-2 Bios Dry Cal and AQS R8 HS high specification flow meters.

6.2.2 Flow meter for PM flow measurements

For PM flow rate measurements, a 0.2 - 2.5 L/min rotameter is suitable, or the flow meters noted above. A rotameter is included in the Dust Sentry service kit (DS R20), but not the AQS service kit (AQS R20). It is also available separately (DS R8).

Figure 6-3 DS R8, 0.2 - 2.5 L/min rotameter for PM flow measurements.

6.3 Manual Service Mode

Performing service work on the monitor such as changing filters or measuring flow rates can cause the gas or particle readings to fluctuate. It is important to exclude these data from air quality reports. The monitor can be put in to “Manual Service Mode” by pushing the start button in the Calibration and Service app. This will cause the data to be labelled as “service”, normally the data is labelled as ‘sample”. This is illustrated in Figure 6-4 and allows a data analyst to easily filter out service data when performing quality control, calculating hourly or daily averages or writing air quality reports.

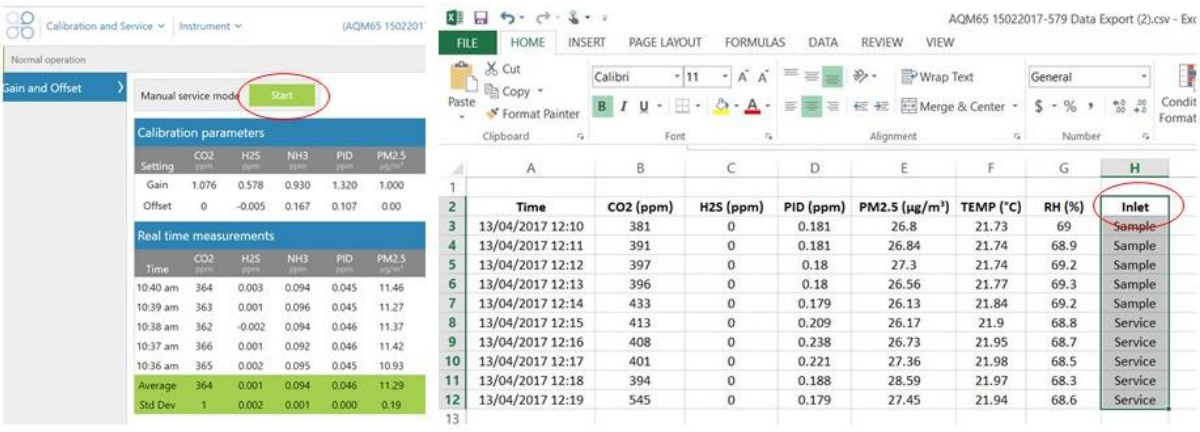


Figure 6-4 The monitor can be put into Service Mode by clicking the button in the Calibration and Service app. This will label the data as "Service" in the inlet column so the data can be filtered.

6.4 Journal

All service activities should be documented. The Journal is accessed by clicking the Journal button next to the username at the top right of the screen, then selecting user entry.

Figure 6-5 All service activities can be recorded in the Journal manually.

6.5 Maintenance procedures

The following section describes all the common service activities required to ensure good operation of the monitor.

Some of the service activities need to be performed regularly such as filter changes and flow checks, and other service actives are performed only as required. A summary of expected service activities and how often they should be performed is described in Section 6.7.

For each service activity, the tools required are listed and references to additional information on the training website or video website is also given if available.

NOTE: *Whenever these service activities are performed it is important to record the activity in the Journal using a manual user entry. See Section 6.4*

6.5.1 Tools required for regular service and maintenance

Service and maintenance of the monitor requires basic tools such as Phillips head screwdriver and adjustable spanner, and multimeter for checking electrical connections.

The Dust Sentry or AQS monitor service kits (R20) are recommended for maintenance. A description of the components of the service kits can be found on the main page of the training website www.training.aeroqual.com.

6.5.2 Recommended tools for regular servicing and maintenance

- Large and small Phillips head screwdriver and large and small flat head screwdriver
- Gas flow meter AQS R8 HS – Ordered separately, only required for AQS (see section 6.1 for a discussion of requirements for flow meters)
- Rotameter for PM flow DS R8 (included in the Dust Sentry service kit DS R20)
- Vacuum gauge R23 (Included in both Dust Sentry and AQS R20 Service Kits, also available separately)
- Electrical multi meter (Only required for troubleshooting)
- Adjustable spanner

6.5.3 Replace gas sample inlet filter (AQS only)

The gas inlet filter is held inside the enclosure at the top left. This must be changed to ensure accurate readings. The filter is disposable and can be thrown away.

The filter should be changed when it becomes dirty as shown in Figure 6-6. The frequency of filer changes depends upon local environmental conditions.

	Tools required	None
	Parts required	AQS R12 (bag of 25 filters)
	Service interval	Recommended **Monthly** (depends on local conditions) See Section 6.1 for further discussion on filter change frequencies.

Do not turn off the monitor, this procedure can be done with the monitor turned on.

NOTE: *It is very important to check the monitor inlet flow rate is correct after changing the filter to ensure there are no leaks*

Figure 6-6 The particle filter on the gas inlet can be easily replaced, it should be replaced when it gets dirty as shown in the image on the right (a new filter is shown on the left, dirty filter on the right).

6.5.4 Measure and adjust monitor inlet flowrate and module flow rate

Maintaining a consistent flow rate is very important for ensuring accurate measurements. Leaks, or an aging pump may lead to reduced flow. Regularly measuring the flow rate will ensure any changes to flow rate are identified as soon as possible.

	Tools required	AQS R8 HS, Inlet flow adaptor (comes with monitor accessories box) Small Philips head screwdriver
	Parts required	None
	Service interval	Recommended **Monthly**.
	Online reference	training.aeroqual.com: Dust Monitor technical Training Section 4.2
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

6.5.4.1 Measure main gas inlet flow rate

- Remove the white inlet fitting containing the mesh filter and attach the inlet flow adaptor.
- Attach a high-quality flow meter such as the AQS R8 HS or Bios Dry Cal. See section 6.1.
- Record the inlet flow rate in the Journal by making a manual user entry.

The gas inlet rate is controlled, for a description of the expected flow rate for the module see Table 12-1.

When the monitor is new, the inlet flow rate is recorded in the monitor logbook which is provided from the Aeroqual factory. The measured flow rate should be equal to the previously measured flow rate which is recorded in the monitor journal.

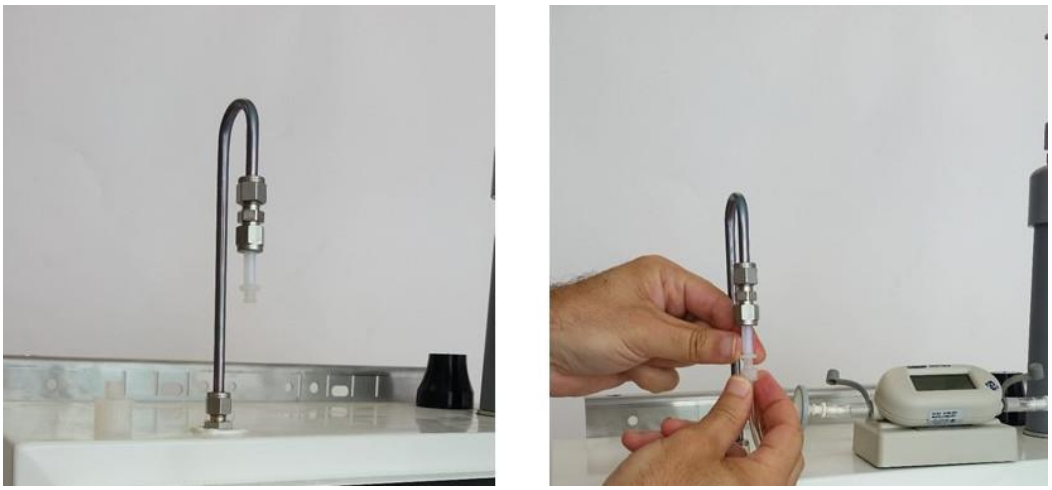


Figure 6-7 To measure the flow rate, remove the Kynar inlet filter and attach the inlet flow adaptor.

6.5.4.2 Measure the flow rate of the module

The module flow rate is measured using a high-quality flow meter such as the AQS R8 HS or the Bios Dry Cal. See Section 6.1

- Attach the flow meter to the inlet port (white ring) of the gas module
- Reconnect the inlet fitting after measuring the gas module
- Record the flow rate of the module in the Journal by making a manual user entry

6.5.4.3 Adjust the PM inlet flow rate

If the PM inlet flow rate is found to be lower than expected, it could be because one of the modules has a leak or is blocked.

To check this, perform a flow check on the individual modules as described in Section 6.5.11

If one of the modules is found to be blocked or has a leak, then this will need to be corrected.

If all the modules showed reduced flow, then it is likely that the gas flow pump is aging.

The flow adjustment valve can be used to provide more flow to the module inlets and return the flow rate to the expected flow rate.

Attach a flow meter to the inlet and begin measuring the inlet flow. Adjust pump flow adjustment valve until the monitor inlet flow rate has returned to the expected flowrate. The valve is shown in Figure 6-8.

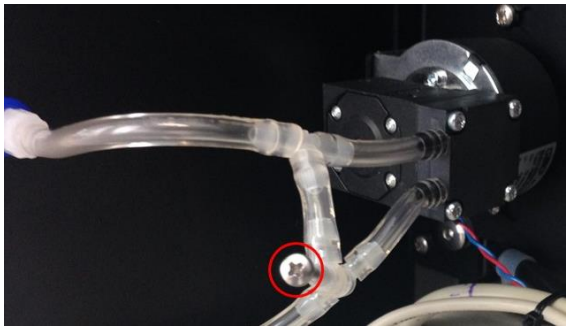


Figure 6-8 The flow adaptor valve is used to adjust the monitor inlet flow to the correct value.

If the correct flow rate cannot be set, then it may be required to replace the gas sample pump. The pump is part number **AQS R10.** The pump can easily be removed from the bracket for replacement.

IMPORTANT Use fresh Tygon Tube (CS Tube 10) when re-connecting the tube back on the pump. This is because the barbs on the pump stretch the tube.

The online training website contains details on how to replace the gas sample pump.

6.5.5 Replace filter on Particle Monitor or Particle Profiler

The Particle Monitor and Particle Profiler have filters which need to be replaced. Disconnect the pump module power when replacing the filter, see Figure 6-15.and Figure 6-16.

	Tools required	Large flathead screwdriver
	Parts required	DS R31 (Particle Monitor) DS R32 Particle Profiler
	Service Interval	Recommended **Monthly** (depends on local conditions) See Section 6.1 for further discussion on filter change frequencies.
	Online reference	training.aeroqual.com: Dust Monitor technical Training, section 5.1
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

The filters for the Particle Monitor are located inside the optical module. Use a large flat head screwdriver to unscrew the filter housing on the front panel of the optical module.

The filters for the Particle Profiler are in a filter casing outside the optical module and within the Particle Profiler Pump Module.

Figure 6-9 The Particle Monitor (shown on the left) requires AQS R31 and the Particle Profiler (shown on the right) requires AQS R32

Section 6.1 discusses frequencies for changing the filters on the Particle Monitor and Particle Profiler. However, if the filters look visibly blackened, they should be replaced, regardless of the time elapsed.

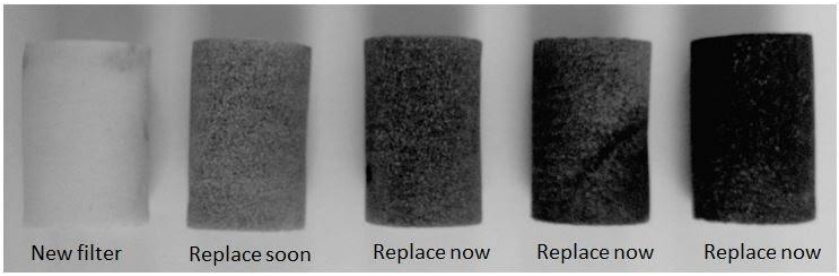


Figure 6-10 The AQS R31 sample filter should be replaced once the filter begins to blacken

6.5.6 Flow check and flow adjustment of the Particle Monitor and Particle Profiler

It is important to maintain the correct flow rate through the Particle Monitor or Particle Profiler. The flow rate of the Particle Monitor and Particle Profiler are different.

NOTE: *The flow rate of the Particle Monitor is 2.0 ± 0.05 LPM*

The flow rate of the Particle Profiler is 1.0 ± 0.05 LPM

	Tools required	Small Philips head screwdriver, AQS R56 and DS R8 or AQS R8 HS
	Parts required	None
	Service Interval	Recommended **Monthly**. (See Section 6.1)
	Online reference	training.aeroqual.com: Dust Monitor technical Training Section 4.1
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

The AQS R56 includes a flow adaptor which is fitted on the inlet, for the Particle Monitor it is fitted above the cyclone as shown in Figure 6-11.

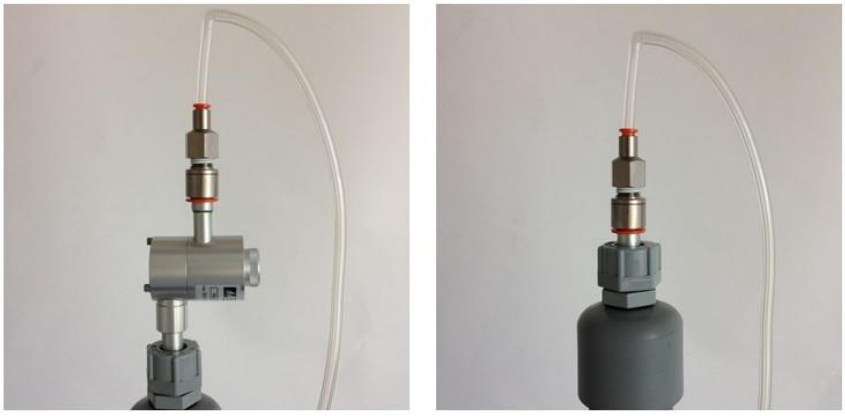


Figure 6-11 When checking the flow rate of the Particle Monitor (left) place the flow measurement adaptor above the cyclone. The position of the flow adaptor when measuring the Particle Profiler is shown on the right.

6.5.6.1 Using the buffer chamber when checking the flow of the Particle Profiler

When measuring (or adjusting) the flow rate of the Particle Profiler it is important to use the buffer chamber to ensure accurate measurement. The buffer chamber is part of the AQS R56 Zero Filter and Flow assembly. It is also part of the R20 Service kits. Figure 6-12 shows the buffer chamber installed between the flow meter and the profiler inlet.

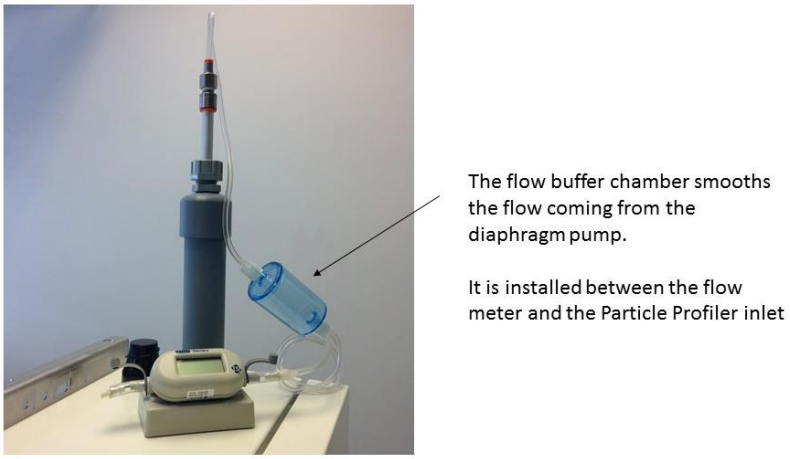


Figure 6-12 When measuring the flow on the Particle Profiler it is important to use the flow buffer chamber

6.5.6.2 Flow adjustment of Particle Monitor

The flow rate of the Particle Monitor must be 2.0 LPM ± 0.05 (between 1.95 and 2.05 LPM)

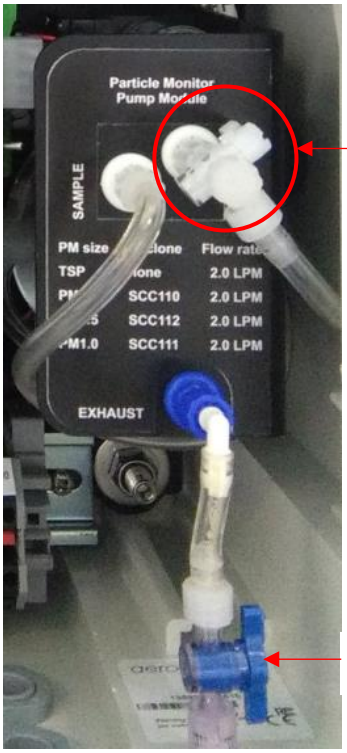


Figure 6-13 The flow rate of the Particle Monitor is set by adjusting the purge and exhaust valves

The flow rate of the Particle Monitor must be 2.0 LPM ± 0.05 (between 1.95 and 2.05 LPM)

- Fully close the purge valve by pushing the valve handle towards the module
- Adjust the exhaust valve until the flow reads 2.2 LPM
- Adjust the purge valve until the flow reads 2.0 LPM ± 0.05

The final adjustment can be a little tricky, turn the purge valve slowly. If it is not possible to reach 2.2 LPM at step 2 then there may be a leak, or the pump might need to be replaced.

6.5.6.3 Flow adjustment of Particle Profiler

NOTE: *It is important to use the buffer chamber when measuring or adjusting the flow rate of the Particle Profiler. Section 6.5.6.1*

Figure 6-14 The flow rate of the Particle Profiler is set by adjusting the flow adjustment valve

The flow rate of the Particle Profiler is adjusted to 1.0 LPM ± 0.05 LPM using the flow adjustment valve as shown in Figure 6-14.

6.5.7 Leak check Particle Monitor and Particle Profiler

If the aluminium inlet is not correctly installed (see Section 2.4.1) or if the tubing is split, then the PM can have a leak. The vacuum gauge (AQS R23) is used to check for leaks in the Particle Monitor system and should be performed as part of regular service.

	Tools required	AQS R23
	Parts required	None
	Service Interval	Recommended **Every three months** (See Section 6.1)
	Online reference	training.aeroqual.com: Dust Monitor technical Training Section 4.2
	Online video	None

6.5.7.1 Leak check a Particle Monitor

1. Remove the TSP head and install the R23 vacuum gauge above the sharp cut cyclone
2. Fully close the purge valve and fully open the exhaust valve
3. The vacuum gauge should reach at least -60 kPa
4. Then remove power (pull out black and red cable) to the electronics module to turn off the pump.
5. Count how long it takes for the pressure to change by 10 kPa.

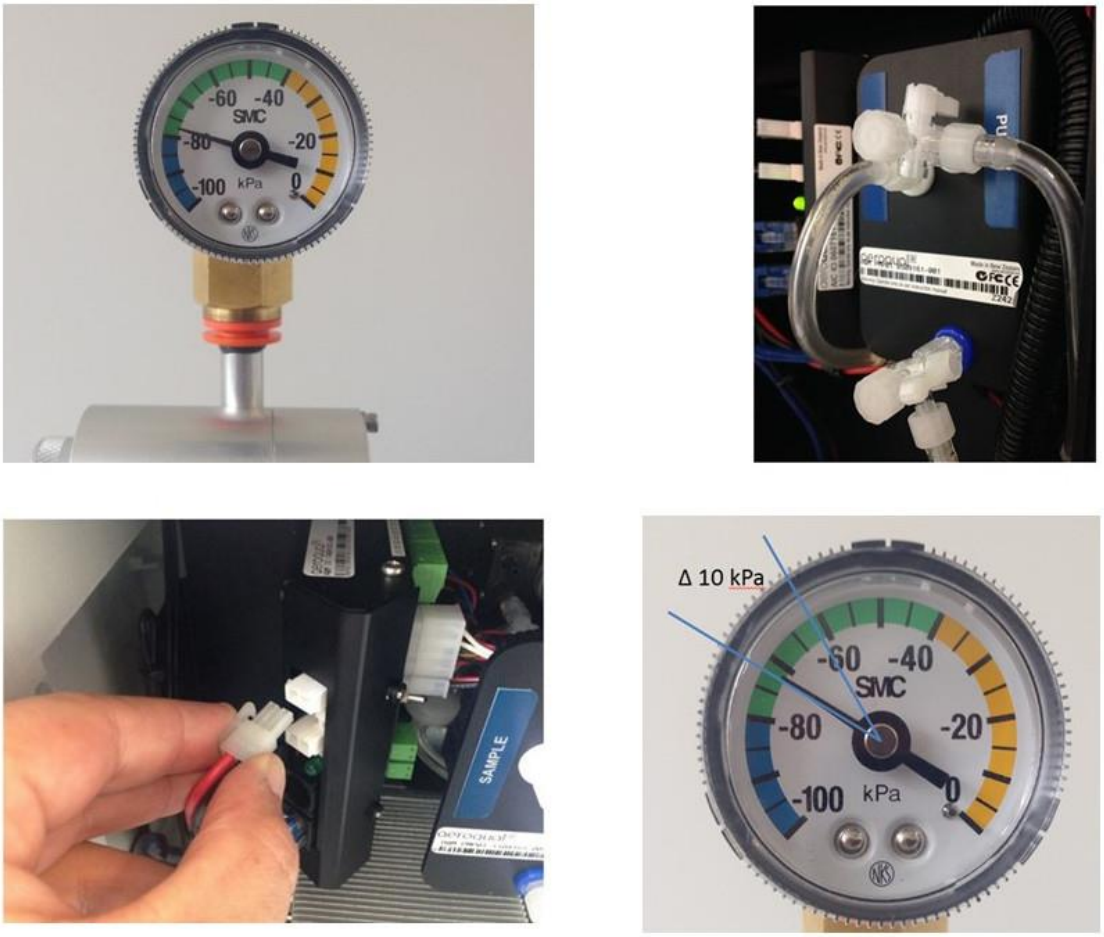


Figure 6-15 Fit the vacuum gauge, adjust the valves. Then stop the pump by removing power from the module, observe the change in pressure. If the leak rate is greater than 10 kPa in 10 seconds, then there may be a leak in the system. Check all the tube connections.

NOTE: The pressure change (leak rate) should be no more than 10 kPa in 10 seconds.

6.5.7.2 Leak check a Particle Profiler

1. Fully open the sample valve
2. The next step is to block the purge flow:
    a. For older Particle Profiler modules, disconnect the purge line and cap the purge line and purge ports with luer caps as shown in Figure 6-16
    b. For current Particle Profiler modules, pinch the tube as shown in Figure 6-17
3. Remove the TSP inlet and place the vacuum gauge on the inlet
4. Wait for the vacuum gauge to stabilise
5. Remove black and red power cable from electronics box

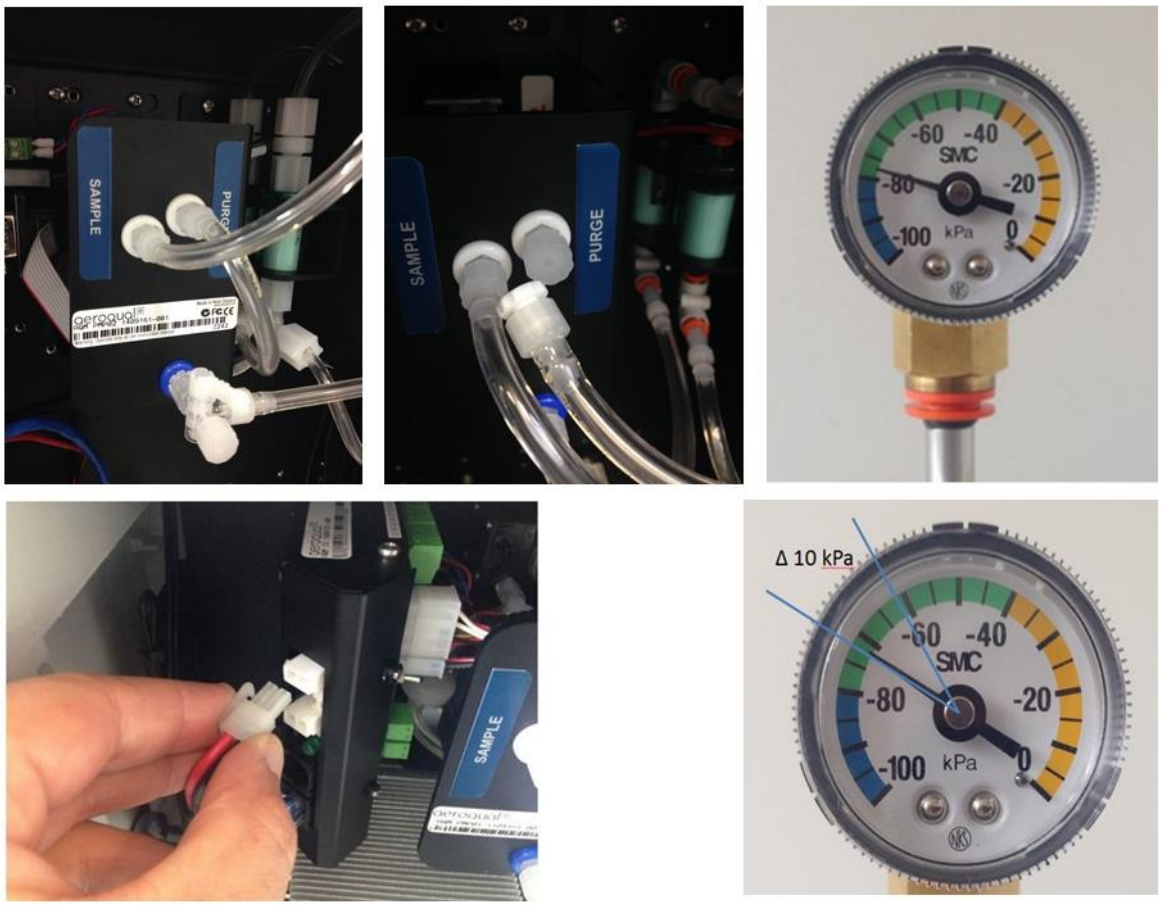


Figure 6-16 Original Particle Profiler Cap the purge and exhaust lines. Place the vacuum gauge on the inlet. Disconnect the power, observe the change in pressure.

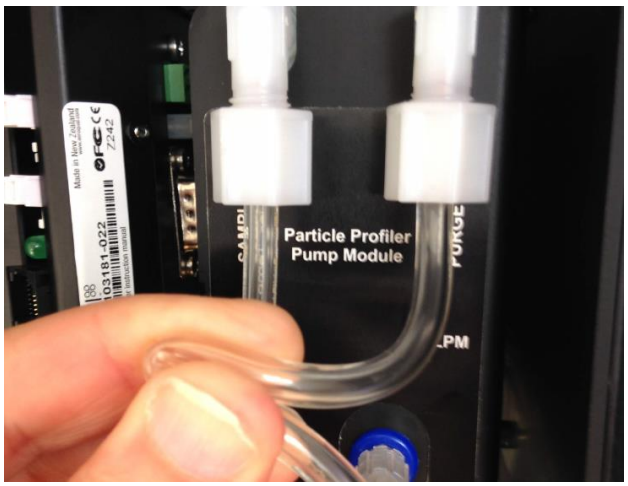


Figure 6-17 Pinch the tube with the newer Particle Profiler pump module

NOTE: *The pressure change (leak rate) should be no more than 10 kPa in 10 seconds*

6.5.8 Zero calibration check and flow check of Particle Module

	Tools required	R56, and DS R8 or AQS R8 HS
	Parts required	None
	Service interval	Recommended **Monthly**. (See Section 6.1)
	Online reference	training.aeroqual.com: Dust Monitor technical training Section 4.4
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

6.5.8.1 Check zero baseline of Particle Monitor

The Particle Monitor (nephelometer) has an automatic zero calibration function which runs every 12 hours, this procedure automatically changes the zero offset of the Particle Monitor.

The zero response of the Particle Monitor can be checked by removing the TSP head and placing the R56 adaptor and zero filter assembly on the inlet above the cyclone as shown in Figure 6-18. The Particle Monitor should read between ±3 µg m^{-3}.

If the zero check shows negative numbers, there may be a problem with the auto zero cycle. See the troubleshooting section. Troubleshooting in Section.

Check that the gain and offset values for the Particle Monitor are set to sensible settings. The gain should be between about 0.6 and 4.0. The offset should be 0.000.

See Section 7.2 for a discussion on gain adjustment of the Particle Monitor.

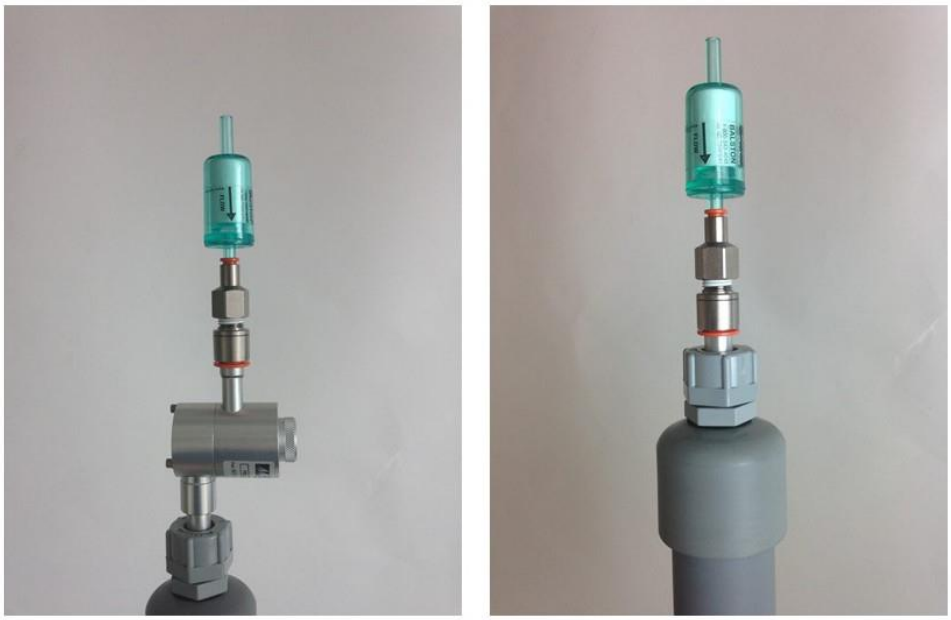


Figure 6-18 The zero filter is fitted above the cyclone for a Particle Monitor (left) and directly on the inlet for a Particle Profiler (right)

6.5.8.2 Check the auto zero calibration flow rate of the Particle Monitor

The Particle Monitor executes an automatic zero calibration every 720 minutes (12 hours). The auto zero process resets a parameter in the module's settings. The value which is changed is the H0 parameter.

NOTE: *The particle profiler does not have this feature.*

The auto zero procedure on the Particle Monitor causes the baseline to be adjusted. Negative readings on the Particle Monitor are often a result of the auto zero cycle failing to work correctly.

The zero cycle works by switching off the sample pump and switching on a zero pump. The flow rate during the zero cycle is reversed and is a positive flow out through the inlet. The flow rate is approximately 0.2 to 0.6 LPM.

This flow rate does not need to be set to a specific value, but it is important that the flow rate is at least 0.2 LPM positive flow out from the inlet.

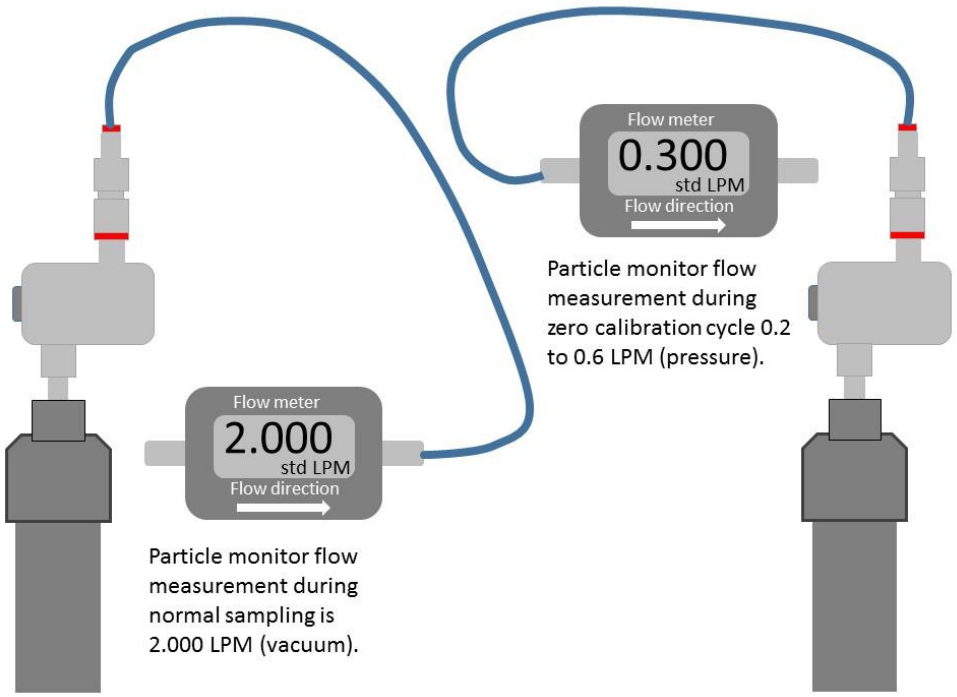


Figure 6-19 When measuring the sample flow of the Particle Monitor a vacuum is measured. When measuring the zero flow a positive pressure is measured.

The auto zero can be executed manually by temporarily changing one of the module settings. Once the auto zero cycle is complete the setting needs to be returned to the original setting.

- Go to the Diagnostic and Advanced app in Connect software.
- Select Module settings from the list on the left column
- Locate the Particle Monitor settings, these will be either PM10.0 or PM2.5
- Locate the TIMA parameter (it should be 720).
- Change this value to 1 by clicking in the cell and typing 1, then save the setting change.

This will cause the auto zero to start. The flow will change from 2.000 LPM negative flow into the inlet to approximately 0.2 to 0.6 positive flow out from the inlet.

You will need to change the port on the flow meter to measure this flow as shown in Figure 6-18.

- If no flow is measured there may be an issue with the zero cycle or zero pump. See Appendix 1 for trouble shooting.
- Measure the positive flow coming out from the inlet and record this in the journal.

The zero cycle takes approximately 6 minutes to complete.

NOTE: *Once the flow has been measured the TIMA parameter must be set back to 720.*

6.5.9 Clean the Particle Monitor TSP inlet, particle trap and cyclone.

The Particle Monitor cyclone uses a small particle trap to remove larger particles. The trap needs to be emptied and cleaned for optimum operation of the Particle Monitor. If the particle trap overfills then the entire cyclone needs to be cleaned.

	Tools required	Can of compressed air, cloth
	Parts required	None
	Service interval	Recommended 6 **Monthly**. (See Section 6.1)
	Online reference	training.aeroqual.com: Dust Sentry technical Training Section 5.1
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

The TSP head, particle trap and cyclone disassemble easily for cleaning.

Figure 6-20 The TSP head and cyclone can be disassembled for cleaning.

6.5.10 Replace pumps in pump module

The pumps in the Particle Monitor pump module and in the Particle Profiler pump module can easily be replaced.

The Particle Monitor contains a sample pump: (**AQS R10**) and a purge pump (**AQS R34**). The Particle Profiler only has a sample pump (**AQS R10**)

Typically, the pumps last between 12 and 18 months. However, the pumps should be replaced when the correct flow can no longer be maintained.

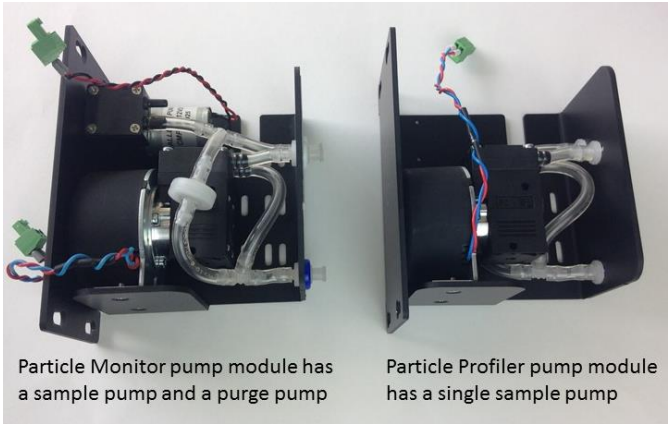


Figure 6-21 The Particle Monitor contains two pumps, the Particle Profiler has one pump.

6.5.11 Leak check gas module

If the correct flow rate cannot be achieved through a gas module, this may indicate a leak. An individual gas module can be checked for leaks by using a small diaphragm pump and a flow meter in the configuration shown in Figure 6-22

	Tools required	Diaphragm pump R10, flowmeter DS R8 or AQS R8 HS
	Parts required	None
	Service interval	Only as required. (See Section 6.1)
	Online reference	None
	Online video	None

A gas module should be leak tight.

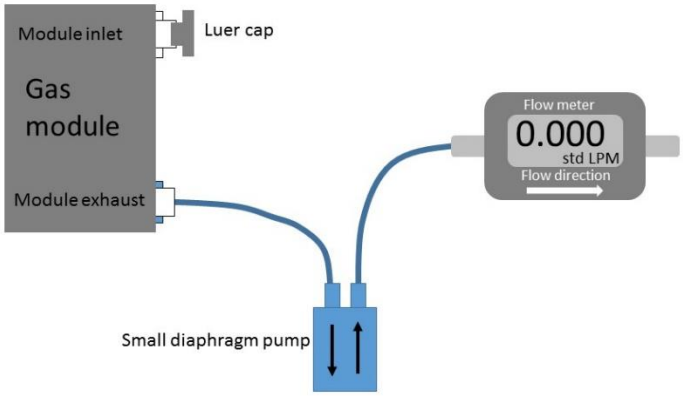


Figure 6-22 A gas module can be checked for leaks by using a diaphragm pump and R7 flow meter

NOTE: *If the module is found to have a leak, contact the Aeroqual distributor in your local country for technical support.*

6.5.12 Remove and replace a gas module

Replacing the module configuration can be done easily on site.

A change in the module can result in a change of inlet flow rate. It is important to measure the inlet flow rate after the module change and document this in the monitor journal.

	Tools required	Tube Cutter, Large Phillips head screwdriver, AQS R8 HS
	Parts required	Tubing: CS Tube10 CS Tube11, power cable, communication cable, 2x luer cap
	Service interval	As required

If a module is removed or added, then a software change is required. The software module configuration can be found in the Configure Instrument app. Sensor modules can be added or removed using this tool, shown in **Figure 6-23**.

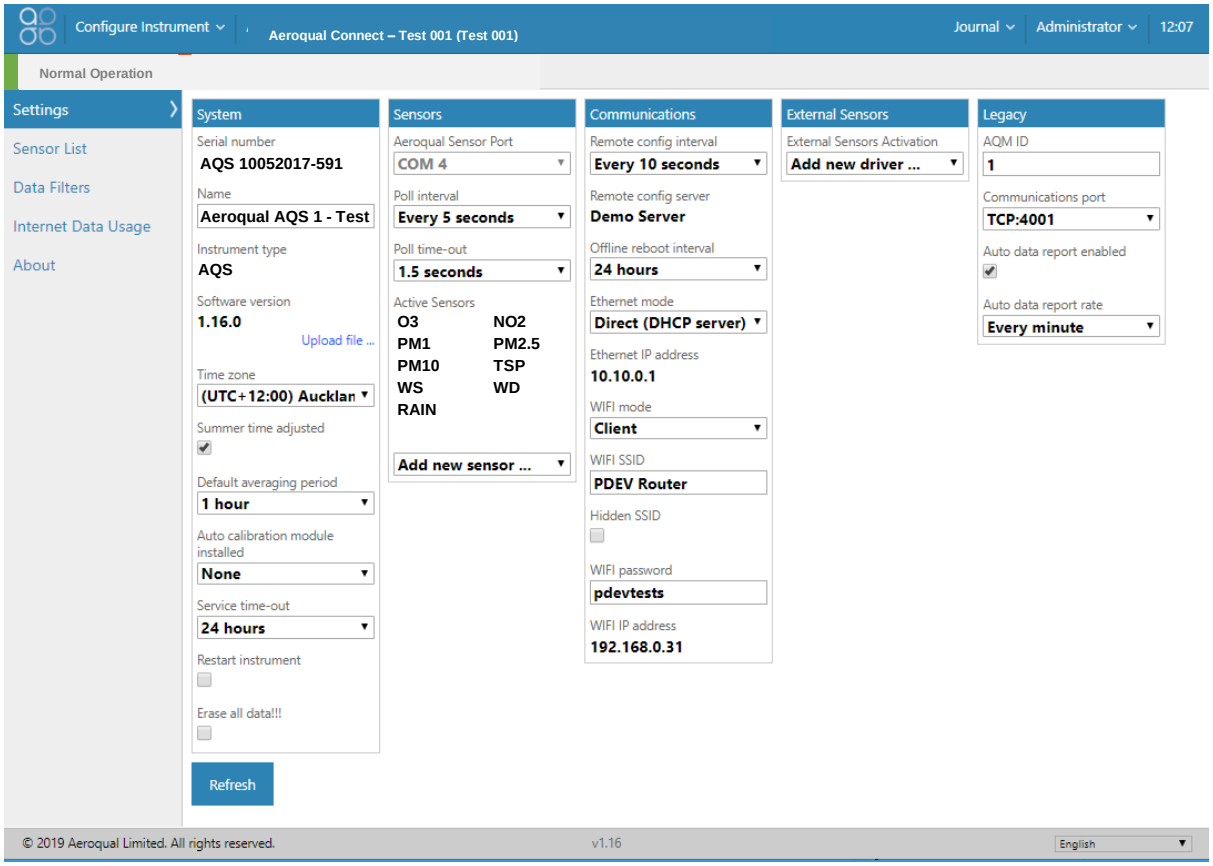


Figure 6-23 Change the module configuration in the software in the Configure Instrument app.

6.5.12.1 Replacing a module with another of the same type

This can be done with the monitor power left on. There is no software change required when removing a module.

- Disconnect the vacuum and sample lines
- Remove one blue communications cable and one red and black power cable
- Loosen the retaining screws and remove the module
- Replace the module with the new module
- Reconnect the blue communication cable and black and red power cable to ensure all r modules have power and communications.

IMPORTANT Ensure the polarity of the red and black cable is the correct orientation.

- Cap off the vacuum and sample lines using a luer cap
- Remove the module from the sensor list in the software (Configure Instrument app)
- Measure the total inlet flow rate and document this in the journal

6.5.12.2 Adding a new module

This can be done with the monitor power left on. There is a software change required when adding a module.

You will need one blue communications cable and one black and red power cable.

You need 4 x 10mm M4 screws.

It may be necessary to cut into the sample and exhaust lines in order to add additional gas fittings. For this you will need a tube cutter, do not use scissors. You will also need tee fittings and luer fitting, and tubing. It may be possible to connect a new module directly to manifold on the left side of the enclosure.

It is important to use the PFA (CS Tube 11) for the gas sampling and Tygon (CS Tube 10) for the exhaust (See Section 12.1.2 for a description of the sample and exhaust manifold).

It important to use the large barb tee for the exhaust tubing and the small barb tee for the sample tubing.

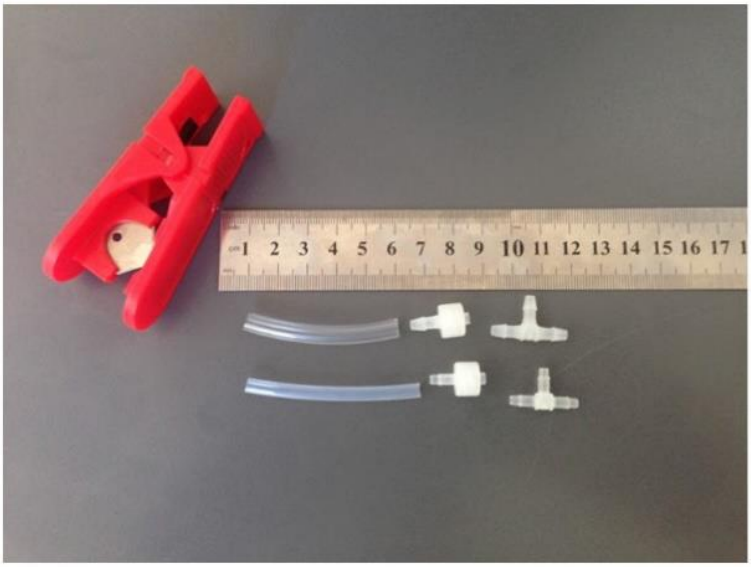


Figure 6-24 Adding a new module requires adding additional sample and exhaust lines.

6.6 Factory calibration of Particle Monitor

Dust and other debris can settle upon the internal optics of the optical engine which can lead to inaccurate readings. The laser and detector may also need to be replaced.

The Particle Monitor optical module (nephelometer) requires a factory service and calibration every two years.

For information about factory service and calibration of the Particle Monitor, please check with the Aeroqual distributor nearest to you.

6.7 Scheduled maintenance

The service frequencies should be considered conservative. Monitor operators are encouraged to develop a service schedule suitable for their local conditions and data quality objectives.

Service activity	Section	Service frequencies
Gas inlet filter change	6.5.3	4-12 weeks **Initially 4 weeks**. Later this can be modified to suit local conditions and data quality objectives
PM inlet filter change	6.5.5	4-12 weeks **Initially 4 weeks**. Later this can be modified to suit local conditions and data quality objectives
Gas inlet flow check	6.5.4.1	4-12 weeks **Initially 4 weeks**. Later this can be modified to suit local conditions and data quality objectives
PM inlet flow check	6.5.6	4-12 weeks **Initially 4 weeks**. Later this can be modified to suit local conditions and data quality objectives
Gas inlet flow adjustment	6.5.4.3	Adjust as required following gas inlet flow check
PM inlet flow adjustment	6.5.6	Adjust as required following PM inlet flow check
PM leak check	6.5.7	Every **3 months** (Quarterly)
PM zero calibration check	6.5.8	Every **3 months** (Quarterly)
PM zero calibration flow check	6.5.8.1	Every **3 months** (Quarterly)
PM inlet cleaning	6.5.9	Every **3 months** (Quarterly)
Change gas flow pump	6.5.10	Every **12 to 18 months** or if flow rate cannot be set correctly
Change Particle Monitor flow pumps	6.5.10	Every **12 to 18 months** or if flow rate cannot be set correctly
Factory calibration of Particle Monitor	6.6	Every **24 months** (2 years)
Factory calibration of Particle Profiler	6.6	Every **12 months** (1 year)
Gas module calibration	5.1	See section 7.1
Unscheduled maintenance		
Service activity	**Section**	**Service frequencies**
Measure flow rate of gas modules	6.5.4.2	As required following gas inlet flow check
Leak check a gas module	6.5.11	As required following module flow check
Add, remove, replace gas module	6.5.12	As required

Table 6-1 Service frequency guidelines for various service activities

7 Calibration

NOTE: *A calibration record is supplied with the monitor, additional copies can be requested by contacting technical@aeroqual.com*

7.1 Gas module calibration

There are three types of calibration of the gas module:

1. **Factory calibration pre-shipment**. All gas modules are calibrated and must meet rigorous performance standards before being shipped. This is captured by the factory calibration certificate. Experience shows that Aeroqual's factory calibration transfers well to the field, meaning that field calibration is not required during initial set up.

2. **Field calibration**. The monitor is designed so that the gas module can be calibrated in the monitor in the field. The field calibration set up and process is very similar to calibration of US / EU EPA approved 'reference' analyzers.
   - Field calibration is only recommended when:
     a) the gas module is clearly operating out of specification and the appropriate trouble-shooting steps have been taken, or;
   - b) periodical validation of the data is required (recommended for advanced users only).

3. **Factory calibration post-shipment.** At any time, the gas module can be removed from the monitor and returned to the factory or one of our authorised service providers for factory calibration. If the gas module has not been field calibrated, then it is recommended to have the gas module factory calibrated every 12 months

The following instructions relate to field calibration only.

Field calibration is an activity that requires attention to detail and accuracy. You should read this entire calibration section and understand it before starting, even if you are an experienced practitioner.

- The monitor is calibrated using a two-point calibration procedure, first by delivering zero air to the monitor inlet and adjusting the offset, and then delivering span gas to the monitor inlet and adjusting the gain.
- Aeroqual provides all the equipment required to perform field calibration. Aeroqual offers a portable calibrator called the AirCal 1000.
- Offset and gain adjustments are performed using the software tools provided by Aeroqual Connect or Aeroqual Cloud.
- If the AirCal 1000 is being used, there is a separate PC desktop software application which can be downloaded from the website.

Some important considerations for field calibration:

- Gas module calibration is achieved using certified calibration gas and a gas dilution calibrator.
- For ozone, an ozone generator, (ozone calibrator) must be used, Aeroqual recommends the 2B Tech Ozone generator part number AQM O3CAL.
- Aeroqual does not recommend calibration when first commissioning a new monitor. We recommend first calibrating 1-3 months after commissioning.
- The quality of the calibration gas makes a big difference to success of a calibration, only purchase calibration gas from a reputable calibration gas supplier.
- The monitor must be in a stable condition before calibration can be attempted. The monitor must have been running for at least 6 hours before calibration, ideally 24 hours.
- The zero calibration step takes approximately 30 minutes total across all modules. The span calibration takes approximately 30 minutes per-module. Therefore, a monitor with 2 gas modules will take 30 + (2 *30) minutes (approximately 1.5 hours) to calibrate.
- Record keeping is a crucial part of calibration, the journal feature in Connect and Cloud is where calibration record keeping is performed.

Calibration is discussed in detail in the online training. Several supporting videos are also available.

	Online reference	training.aeroqual.com Dust Sentry Technical Training Section 6
	Online video	YouTube Channel: Aeroqual Service and Maintenance playlist

7.1.1 Equipment required

Calibration of the gas modules inside the monitor requires specialist equipment which Aeroqual can provide.

Gas Module	Equipment	Comment
O_3	O3Cal	Tubing and gas fittings are not supplied with the O3Cal. The calibration tubing and fittings can be ordered separately using part number: AQM CALKIT.
NO_2	Aeroqual AirCal 1000	Tubing and gas fittings are supplied with the AirCal 1000.
PID	Aeroqual AirCal 1000	

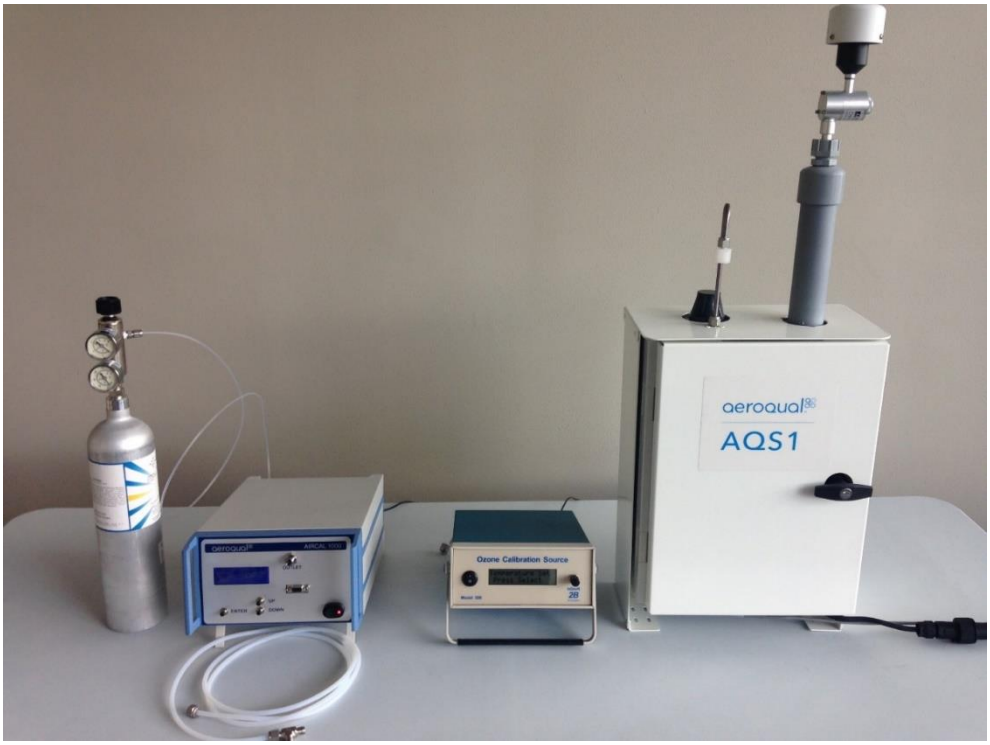


Figure 7-1 Centre: O3Cal Ozone calibrator. Left: AirCal 1000 with NO_2 cylinder from Calgaz.

NOTE: *Both the AirCal 1000 and the Ozone calibrator take time to warm up and become stable.*

- *Turn on the AirCal 1000 and switch on the pump override switch on the back panel for at least 30 min before staring calibration.*
- *Turn on the Ozone generator and set it to deliver 0.1 ppm Ozone for at least 30 min before starting calibration, this allows time for the lamp in the ozone generator to stabilise at 0.1 ppm.*

7.1.2 Calibration gases

Aeroqual cannot supply calibration gas cylinders, these must be purchased locally. Aeroqual recommends small size portable gas cylinders be purchased from Calgaz: www.calgaz.com.

Gas	Description	Calgaz Part number
NO_2 (Nitrogen Dioxide)	20 ppm NO_2 Balance AIR 8AL 58 litres C10 fitting	A0446046
C_4H_8 (Isobutylene)	Isobutylene 1000 ppm Balance Air 6D 103 litres C10 fitting	A0436843

Table 7-1 Recommended gas cylinders from Calgaz.

A two-stage pressure regulator is required for use with these gas cylinders. Aeroqual can supply the regulator, part number **AIC GASREG01**, for use with C10 fitting. The Aeroqual regulator is shown attached to the Calgaz cylinder in Figure 5-1.

7.1.3 Flow meters for gas flow measurement

It is important to have a high-quality flow meter for the gas flow measurement.

Figure 7-2 Bios Dry Cal and AQS R8 HS high specification flow meters.

7.1.4 Gas module field calibration frequency

Typically, only advanced users will need to field calibrate their monitor. All other users can depend upon 12 monthly factory calibration of the gas module.

For some monitoring applications such as compliance monitoring the calibration frequency may be regulated. Some monitoring applications may require periodical validation of the data and field calibration is the best way to achieve this.

Field calibration frequency is a balance between cost and data quality objectives. Field calibration will incur cost of time and materials. Therefore, more frequent calibration costs more because it requires more time and materials.

At the high cost end of the spectrum are national ambient monitoring networks. The US EPA Quality Assurance Handbook (see http://www.epa.gov/ttnamti1/qalist.html) is a good example of how prescriptive calibration requirements for such applications can be.

Aeroqual makes the following recommendations about calibration frequency for the monitor:

- Follow all local regulatory calibration requirements if these are defined for the monitoring activity.
- Plan routine calibrations at an interval that is consistent with the data quality objectives for your monitoring purpose.
- Field calibration may be necessary if the gas module is operating out of specification and all other trouble-shooting steps have been taken.

Record your observations and calibration results in the calibration records.

- The service and calibration forms at the end of this document in Appendix 5 are used with this procedure, information arising from the calibration should be entered into the appropriate sections of the forms.
- The Journal feature in Connect/Cloud can also be used to record observations and make comments throughout the calibration process.

Assumptions

This SOP assumes the monitor and calibration equipment are in good working condition and the monitor is “ready for calibration”.

- The monitor has been running for at least 6 hours.
- The gas lines and inlet filter are clean.
- You are familiar with the operation of all the calibration equipment.
- All calibration equipment, such as calibrators and gas bottles are working and within calibration where necessary.

You will need to know:

- The total flow rate measured last time the monitor was serviced. Record this in Table 5.
- The individual gas module flow rates last time the monitor was serviced. Record this in Table 6.
- The current gain and offset for each module. See Figure 3. Record these in Tables 7 and 8 in the Calibration form in Appendix 5.

You will need to bring:

- Gas inlet filters
- Gas dilution calibrator / Zero air generator (combined or separate ozone generator)
- Gas cylinders with suitable gas concentrations
- Flow meter: Aeroqual R7

Before you begin

NOTE: *Both the AirCal 1000 and the Ozone calibrator take time to warm up and become stable.*

- *Turn on the AirCal 1000 and switch on the pump override switch on the back panel for at least 30 min before staring the calibration.*

- *Turn on the Ozone generator and set it to deliver 0.1 ppm Ozone for at least 30 min before starting the calibration, this allow time for the lamp in the ozone generator to stabilise at 0.1 ppm.*

The Calibration screen in the Calibration and Service App in the Aeroqual software is where you will perform the calibration and change any monitor settings.

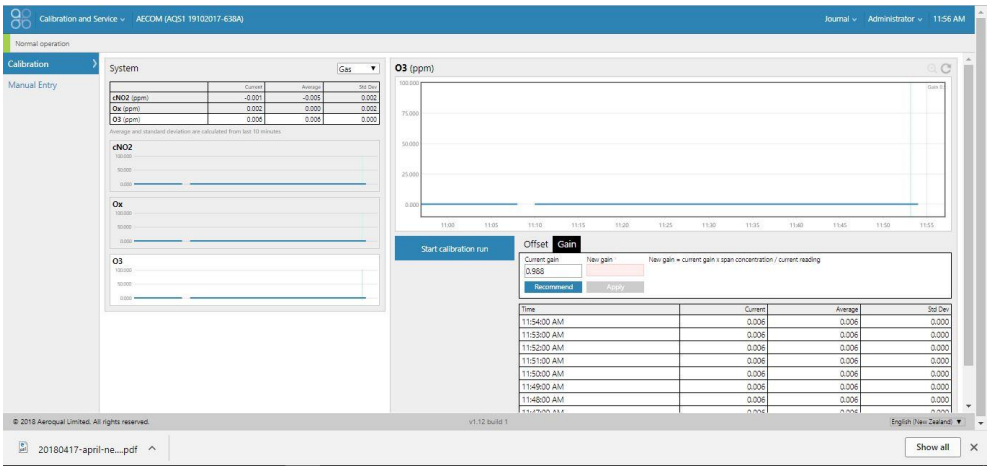


Figure 7-3 The main calibration screen is where the average and standard deviation can be read. This is also where the gain and offset can be read and set.

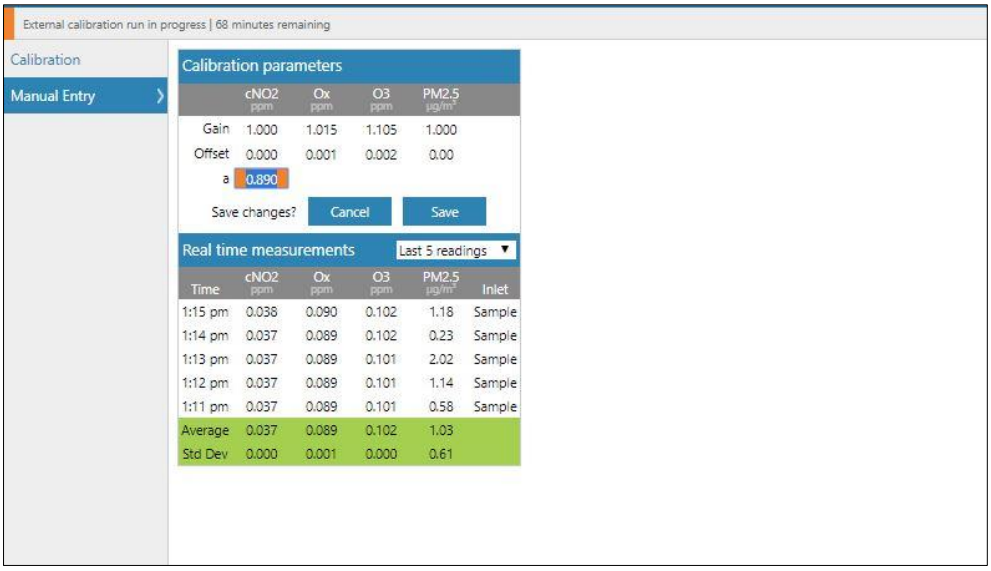


Figure 7-4 The Manual Entry section of the Calibration and Service App is where the gain and offset and the *a* value on the NO2 module is set.

NOTE: *The connection to the* monitor *inlet differs depending on whether you are using the AirCal 1000 or the Ozone calibrator. See images below for how the connections differ.*

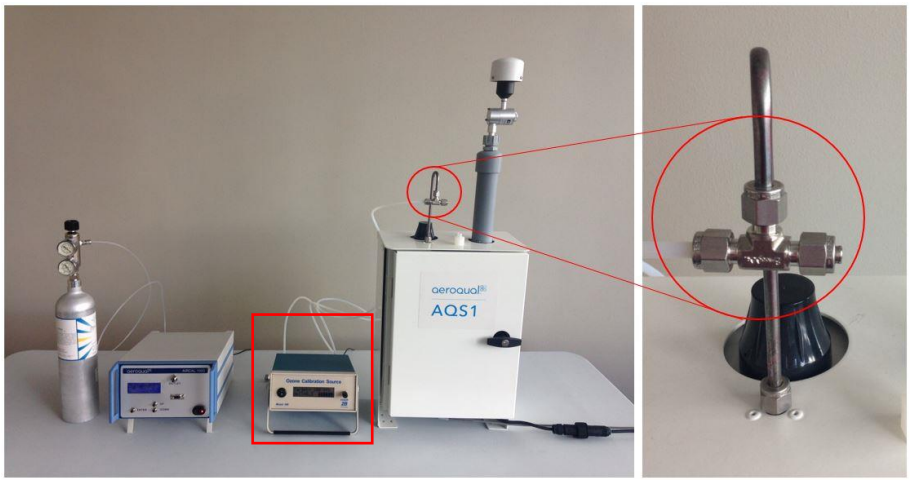


Figure 7-5 When using the Ozone calibrator, make sure the tee fitting is capped

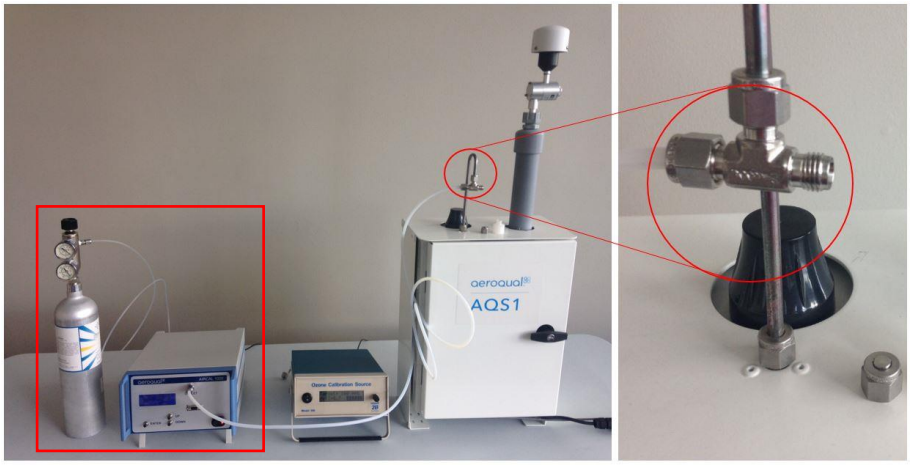


Figure 7-6 When using the AirCal 1000 make sure the tee is un-capped

7.1.5 NO_2 calibration overview (For monitors fitted with an Ox module pre-Dec 2019)

The NO_2 measurement is determined by the difference between two measurement modules; the O_x module and the Ozone module.

The O_x module responds towards both NO_2 and Ozone. The NO_2 concentration is determined by difference according to Equation 1.

$$[NO_2] = [O_x] - a[O_3]$$

The NO_2 ***a*** value is set at the Aeroqual factory and adjusts for the relative response of the O_x module towards ozone calibration gas.

The ***a*** value should be checked and adjusted as part of routine field calibration, see Figure 3b.

Note that only the ***a*** value is set for NO_2, the offset should be left at 0.000 and the gain should be left at 1.000.

NOTE: *There are two ways to determine if you have an Ox module fitted;*

1. *Open the Calibration app, if Ox appears in the parameters and there is data then it is installed. See* Figure 7-4*. If there is no data, then the module may have been removed but not deleted from the sensor list.*
2. *Check the physical module in the instrument. The module gas type can be identified by checking the barcode label on the module – the code will include the designated monitor, gas type, and unique number sequence, e.g. AQM Ox 0-10ppm 0000000-000.*

Below is a brief summary of the calibration steps for the NO_2/O_3 system. These steps must be carried out in the order described here. A detailed step by step process is described later in this document.

7.1.5.1 NO_2 calibration steps (For monitors fitted with an Ox module pre-Dec 2019)

NOTE: *Gain and value adjustments vary as follows*

- *The Ox module gain adjustment is made during the NO2 calibration gas delivery*
- *The NO2* ***a*** *value adjustment is made during the Ozone gas delivery*
- *The NO2 gain value is NOT adjusted as part of the calibration process*

1. Deliver zero air from the AirCal 1000 (or a suitable gas dilution calibrator) to the monitor.
2. Adjust the zero offset on the O_x and O_3 module is so that O_x and O_3 read zero. (Confirm NO_2 reads zero but do not adjust calibration settings on the NO_2 channel).
3. Deliver 0.1 ppm NO_2 gas from the calibrator.
4. Adjust **O_x gain** so the O_x reads 0.1 ppm.

NOTE: *The NO_2 module should be reading 0.1 ppm during the 0.1 ppm Ox span calibration. The NO_2 may read slightly less than 0.1, this is normal, do not adjust the NO_2 gain.*

5. Deliver zero air for 10 minutes to allow the sensors to return to baseline.
6. Then deliver 0.1 ppm Ozone.
7. Adjust O_3 gain so that the O_3 module reads 0.1. The Ox module will be showing a response towards Ozone during the O_3 calibration, this is expected.

   If the NO_2 shows a response during the Ozone calibration, then a new **a** value must be calculated according to equation 3 and applied as shown in Figure 5-4.

$$[NO_2] = [Ox] - [aO3] = 0.00$$

$$a = [Ox] / [O_3]_{\text{span concentration}}$$

   Set the ***a*** value in the Manual Entry dialogue in the Service and Calibration App (**Figure 5-4**). Check the NO_2 reads zero under these conditions.

8. Deliver Zero air for 10 min to purge the gas lines before returning to sampling ambient air.

7.1.6 Calibration pre-checks:

You will need to record a range of details as part of the calibration process. Use the Calibration Record document in section 12.3.

The record capture tables are listed below:

Table	Details to record
1	Monitor, customer, and calibration technician details
2	Calibration equipment used
3	Calibration gas details
4	Changes to the local surroundings which may have an impact on the measurements
5	Monitor pre check results

Before you open the door

Monitor pre-checks

5.1 Put the monitor into Service Mode.
5.2 Check that the gas inlet is secure, if yes pass
5.3 Check that the particle inlet is secure, if yes pass
5.4 Check that door locks are operational, if yes pass
5.5 Measure and record the gas inlet flow rate
5.6 Record the previously measured flow rate, this value should be recorded in the monitor journal.

Open the door

NOTE: *To keep the sensor readings stable, minimise the time the door is open.*

5.7 Replace the inlet filters
5.8 Measure and record the inlet flow rate again after changing the filter.

- If the inlet flow has changed compared to step 5.6, (but less than ± 20 %) since last time it was measured then check the gas connections for obvious leaks, then use the flow adjustment valve to correct the flow.
- If adjustment was unsuccessful then go to Step 6.
- If the inlet flow has changed (more than ± 20 %) since last time it was measured (step 5.6) then go to Step 6.

Close the door

5.9 Record the final total flow.

7.1.7 Check and adjust module flow rates

Table	Details to record
6	Monitor, customer, and calibration technician details

NOTE: *It is important to have a high-quality flow meter to perform these flow checks. See Figure 9 2.*

Flow checks in this section are performed separately for each module. One or more modules can fail the flow check, but others can pass. Calibration can continue on modules that pass, modules that fail can be removed and checked without affecting the calibration on the remaining modules.

6.1. Check all the individual gas connections for any obvious leaks.

- If a leak is found then correct it, go back to Step 5.9.

6.2 Perform a leak check on the sampling manifold.

- If a leak is found then correct it, go back to Step 5.9.

6.3 Measure the individual flow rates, then add up the flows to equal total module flow. Record the sum of the flows in the last column.

- For each module, if the flow rate measured now equals the previously measured flow rate (± 20 % LPM) then pass for that module, otherwise fail for that module.
- If no specific module is causing a problem and all module flow rates are low, then go to 6.4 otherwise go to 6.6.

6.4 Adjust the flow rate using the bypass valve, circle yes if valve adjusted
6.5 Re-measure and record module flow rates for each module.

- If the flow rate measured now equals the previously measured flow rate, then pass. Go to zero calibration.
- For those modules which do not have the correct flow rate and cannot be corrected with the bypass valve then perform a leak check or check for blockages.
- If the problem can be corrected then correct it, otherwise replace the module. Go to zero calibration.
- If the problem cannot be resolved, then remove the module and cap off the gas connections. Record fail in the calibration report. Go to zero calibration.

NOTE: *The total flow rate will be reduced because of the module which has been removed.*

7.1.8 Zero Calibration

Table	Details to record
7	Zero calibration results

Zero calibration is performed simultaneously on all gas modules. One or more gas modules may fail a criterion for calibration and others can pass completely. It is acceptable to fail a module but continue with the zero calibration on the remaining modules, and to continue with a span calibration on those modules which passed their zero calibration.

It is recommended to leave any failed modules running in the monitor throughout the zero and span calibration process. After the calibration is complete on the remaining modules, then the door to the monitor can be opened and the failed modules can be removed for inspection.

The order in which modules should be zero calibrated is:

1) NO_2, **2)** O_3, **3)** PID

Monitors fitted with an Ox module.

1) O_x, **2)** O_3, **3)** PID

NOTE: When an Ox module is fitted, NO_2 does not have a zero or gain adjustment applied.

Use the AirCal 1000 to deliver zero air, connect the monitor to the AirCal 1000 with the tee open as shown in Figure 5-6.

7.2.1 Record the current offsets in Table 7, column 7.1.1. Start the zero air flowing. Make sure there is excess flow out from the tee at the monitor inlet as shown in Figure 5-6 with the tee open.

7.2.2 Wait for the module to stabilise. This means the standard deviation is within the acceptable range listed in Table 7. Column 7.2.3 (c).

If the values have not stabilised, then write **fail** in the last column in Table 7 column 7.2.7 for this module. Move on to next module and **go back to Step 7.2.1.**

7.2.3 Record the stabilised reading in Table 7, column 7.2.3 from the 10-minute average.

If the values are within the accepted range, listed in Table 7 column 7.2.3 (b) then no offset adjustment is required, write **pass** in column 7.2.7. Move on to next module and **go to Step 7.2.1.**

7.2.4 If the stabilised value is outside the acceptable range then an offset adjustment is required. Calculate and record the new offset using Equation 4.

New offset = Current offset + (AQS gas reading / Gain)

You can use the calibration app “Recommend” button (Figure 7-3), this will perform the calculation, but you must accept this offset by pushing the “Apply” button, this will upload the new offset.

7.2.5 If the new calculated offset is within the acceptable range listed in Table 7 column 7.2.4 (b) then upload the new offset.

→ If the required offset is outside the recommend limits listed in Table 7 do not upload the offset, write **fail** in column 7.2.7. Move on to next module and **go back to Step 7.2.1.**

7.2.6 After 2 or 3 minutes record the readings after the new offset has been uploaded. Confirm the readings are within acceptable limits.

→ If yes then **pass**, if not then **fail**. Move on to next module and **go to Step 7.2.1.**

7.1.9 Span Calibration

Table	Details to record
8	Span calibration results

Span Calibration is performed separately in sequence for each gas module. Span calibration should only be performed on modules that have been successfully Zero calibrated.

It is recommended to leave any failed modules running in the monitor throughout the zero and span calibration process. After the calibration is complete on the remaining modules, then the door to the monitor can be opened and the failed modules can be removed for inspection.

8.1.1 Start here for each module. Once all modules have been span calibrated go to Step 9.

- For monitors with an Ox module fitted (pre-Dec 2019) go to section 7.1.10
- Record all initial gains in Table 8 Column 8.1.1

8.1.2 Start the calibration gas flowing at your chosen span point, Aeroqual recommends 0.1 ppm. Make sure there is excess flow out from the tee at the monitor inlet as shown in Figure 7-5.

8.1.3 Record the span gas concentration. In Table 8 column 8.1.3.

8.1.4 Wait for the module values to stabilise to the span gas, this means the readings are within the acceptable noise limits listed in Table 8 Column 8.1.5 (c).

If the values have not stabilised, then write **fail** in the column 8.1.10. Move on to next module and **go to Step 8.1.1.**

If the values are stable and within the accepted range listed in Table 8 Column 8.1.5 (b) then write **pass** in column 8.1.10. Move on to next module and **go to Step 8.1.1.**

8.1.6 If the values are stable but outside the acceptable range listed in Table 8 Column 8.1.5 (b) then a new gain must be calculated and applied.

New Gain = Current Gain x (Span concentration / Gas reading)

You can use the calibration app "Recommend" button (Figure 7-3), this will perform the gain calculation, but you must accept this gain by pushing the "Apply" button, this will upload the new gain.

NOTE: *The calibration app restricts the gain between 0.2 and 5.0. The manual entry screen will allow the gain to be set outside these limits.*

8.1.7 Calculate and record the ratio of the gain change by using Equation 6. Record the ratio in Table 8, column 8.1.7.

Gain Change Ratio = New Gain / Current Gain

8.1.8 If the calculated gain is within acceptable limits listed in Table 8 Column 8.1.5 (d), upload the new gain.

If the required gain is outside the recommend limits do not upload the gain, write **fail** in the column 8.1.10. Move on to next module and **go to Step 8.1.1.**

8.1.9 Confirm the readings are within acceptable limits.

If yes then write **pass** in column 8.1.10, if not then write **fail**. Move on to next module and **go to Step 8.1.1.**

8.1.10 Deliver zero air for 10 minutes to purge the gas lines.

NOTE: *Change the gas connection from the AirCal 1000 over to the Ozone calibrator. Make sure to cap the end of the tee as shown in* Figure 7-5*.*

8.1.11 Deliver ozone from the ozone calibrator at your chosen span point, Aeroqual recommends 0.1 ppm, make sure the tee is closed using the cap as shown in Figure 7-5.

NOTE: *It takes a while for the ozone delivery to stabilise at the chosen span point, you should have previously set the output of the ozone generator to your chosen span point and left the generator running at this span point for at least 30 min, to allow the output to stabilise.*

8.1.12 Record the ozone span concentration in Table 8 Column 8.1.3.

8.1.13 Wait for the O_3 values to stabilise towards O_3 calibration gas, as described in Table 8 Column 8.1.5 (c) If the values have not stabilised then write **fail** in the last column.

8.1.14 Record the stabilised **O_3 values** in Table 8 Column 8.1.5 from the 10-minute average. If the values are stable and within the accepted range listed in Table 8 column 8.1.5 (b), then no gain change is required, then write **pass** in column 8.1.10.

8.1.15 If the values are stable but outside the acceptable range Calculate and record new O_3 gain using Equation 5.

New Gain = Current Gain x (Span concentration / Gas reading)

You can use the calibration app "Recommend" button (Figure 7-3), this will perform the gain calculation, but you must accept this gain by pushing the "Apply" button, this will upload the new gain.

8.1.19 Turn off the Ozone gas and return the monitor sampling zero air from the AirCal 1000.

NOTE: *Change the gas connection from the Ozone calibrator over to the AirCal 1000 calibrator. Make sure to remove the cap from the end of the tee as shown in* Figure 7-6*.*

8.1.19 If your monitor contains a PID gas module, repeat steps 8.1.2 to 8.1.10 for PID.

7.1.10 Span Calibration for monitors fitted with an Ox module (pre-Dec 2019)

Table	Details to record
8	Span calibration results

When an Ox module is fitted (pre Dec 2019), the order in which modules are span calibrated is very important, see section 7.1.5

1) $O_{x\ gain}$ (using NO_2 calibration gas),

2) $O_{3\ gain}$ (using O_3 calibration gas),

3) NO_2 **a** $_{value}$ (using O_3 calibration gas),

4) PID $_{gain}$ (using Isobutylene calibration gas)

NO_2 does not have a zero or gain adjustment applied when an Ox module is fitted.

The NO_2 calibration, (**a** adjustment) should be performed at the appropriate step during the Ozone span gas delivery, Step 8.1.16

Record the initial NO_2 ***a*** value in Table 8 Column 8.1.2.

8.1.2 Start the NO_2 calibration gas flowing at your chosen span point, Aeroqual recommends 0.1 ppm. Make sure there is excess flow out from the tee at the monitor inlet as shown in Figure 5-6.

8.1.3 Record the span gas concentration. In Table 8 column 8.1.3.

8.1.4 Wait for the O_x module values to stabilise to the NO_2 span gas, this means the readings are within the acceptable noise limits listed in Table 8 Column 8.1.5 (c).

If the values have not stabilised, then write **fail** in the column 8.1.10. Move on to next module and **go to Step 8.1.1.**

NOTE: *If the O_x module fails calibration then the NO_2 measurement cannot be used. The O_3 module can calibrated even if the O_x module fails calibration.*

8.1.5 Record the stabilised O_x values in the calibration form Table 8 Column 8.1.5 from the 10-minute average

If the values are stable and within the accepted range listed in Table 8 Column 8.1.5 (b) then write **pass** in column 8.1.10. Move on to next module and **go to Step 8.1.1.**

8.1.6 If the values are stable but outside the acceptable range listed in Table 8 Column 8.1.5 (b) then a new gain must be calculated and applied. Calculate and record new Ox gain using Equation 5.

New Gain = Current Gain x (Span concentration / Gas reading)

You can use the calibration app “Recommend” button (Figure 7-3), this will perform the gain calculation, but you must accept this gain by pushing the “Apply” button, this will upload the new gain.

NOTE: *The calibration app restricts the gain between 0.2 and 5.0. The manual entry screen will allow the gain to be set outside these limits.*

8.1.7 Calculate and record the ratio of the gain change by using Equation 6. Record the ratio in Table 8, column 8.1.7.

Gain Change Ratio = New Gain / Current Gain

8.1.8 If the calculated gain is within acceptable limits listed in Table 8 Column 8.1.5 (d), upload the new gain.

If the required gain is outside the recommend limits do not upload the gain, write **fail** in the column 8.1.10. Move on to next module and **go to Step 8.1.1.**

8.1.9 Record the O_x readings after the new O_x gain has been uploaded. Confirm the readings are within acceptable limits.

If yes then write **pass** in column 8.1.10, if not then **fail**. Move on to next module and **go to Step 8.1.1.**

8.1.10 Deliver zero air for 10 minutes to purge the gas lines.

NOTE: *Change the gas connection from the AirCal 1000 over to the Ozone calibrator. Make sure to cap the end of the tee as shown in Figure 5-5.*

8.1.11 Deliver ozone from the ozone calibrator at your chosen span point, Aeroqual recommends 0.1 ppm, make sure the tee is closed using the cap as shown in Figure 5-5.

NOTE: *It takes a while for the ozone delivery to stabilise at the chosen span point, you should have previously set the output of the ozone generator to your chosen span point and left the generator running at this span point for at least 30 min, to allow the output to stabilise.*

8.1.12 Record the ozone span concentration in Table 8 Column 8.1.3.

8.1.13 Wait for the O_3 values to stabilise towards O_3 calibration gas, as described in Table 8 Column 8.1.5 (c) If the values have not stabilised then write **fail** in the last column.

NOTE: *If the O_3 module fails calibration then the NO_2 measurement cannot be used.*

8.1.14 Record the stabilised **O_3 values** in Table 8 Column 8.1.5 from the 10-minute average. If the values are stable and within the accepted range listed in Table 8 column 8.1.5 (b), then no gain change is required, then write **pass** in column 8.1.10.

8.1.15 If the values are stable but outside the acceptable range Calculate and record new O_3 gain using Equation 5.

New Gain = Current Gain x (Span concentration / Gas reading)

You can use the calibration app "Recommend" button (Figure 7-3), this will perform the gain calculation, but you must accept this gain by pushing the "Apply" button, this will upload the new gain.

8.1.16 Wait for the **O_x values** to stabilise towards O_3 calibration gas. After the O_x values have stabilised calculate the ***a*** value. The ***a*** value is calculated according to this equation:

a = Ox reading / O3 span concentration

The ***a*** value should be in the range 0.3 to 1.5. If your calculated ***a*** value falls outside this range do not change the ***a*** value, contact Aeroqual for technical support: technical@aeroqual.com.

8.1.17 Upload the ***a*** value in the manual entry screen shown in Figure 5-4. Record the new ***a*** value in Table 8 column 8.16b.

8.1.18 **After the O_x and O_3 gains, and the *a* value have been applied**, record the NO_2 readings in Table 8 Column 8.1.9. Do not adjust any calibration settings of the NO_2 channel.

8.1.19 Turn off the Ozone gas and return the monitor sampling zero air from the AirCal 1000.

NOTE: *Change the gas connection from the Ozone calibrator over to the AirCal 1000 calibrator. Make sure to remove the cap from the end of the tee as shown in* Figure 7-6*.*

7.1.11 Post-calibration checks

Table	Details to record
9	Post-calibration checks

Follow these post-calibration checks and record the results in Table 9 from the Calibration form in Appendix 5.

9.1 Disconnect calibration equipment
9.2 Record the inlet flow rate
9.3 Replace the mesh inlet and cap
9.4 Lock door
9.5 Secure the site
9.6 Take monitor out of service mode and record the time in the form.

7.2 Particle Monitor calibration

Field calibration of monitor with Particle Monitor is typically not required.

However, in some applications that have very high data quality objectives, field calibration may be appropriate. Such applications may include:

- Supplementary monitoring to a reference network (so inter-comparison to reference is important)
- Research studies that need to demonstrate traceability to another monitor
- Consultancy projects that need to demonstrate traceability to another monitor

In summary, field calibration of Aeroqual PM monitors is recommended only when comparison or traceability to reference PM monitors is an important factor in the monitoring project.

For all other applications the Aeroqual factory calibration is enough.

All PM monitors are calibrated at the factory against a standard aerosol (NIST traceable monodisperse spheres). The factory calibration is traceable and results in good data quality when the monitor is operated in accordance with Aeroqual's servicing and maintenance procedures.

7.2.1 Factory servicing and calibration

Factory servicing includes cleaning and calibration of the PM module only. The PM module can be removed from the monitor and returned to the factory. All Aeroqual PM Modules need to be returned to the factory for service and calibration at the following intervals:

- Dust Sentry Particle Monitor: 24 Months
- Dust Sentry Particle Profiler 12 Months

NOTE: *Field calibration is not a substitute for the specified factory service intervals above. Factory servicing is essential maintenance and check the 'health' of the internal components.*

7.2.2 Field calibration

In order to perform a field calibration, your Aeroqual monitor must be located at the same site as a **Reference** PM monitor. This is called **'Co-location'** and is widely performed in ambient air quality monitoring to assess the performance of a new monitor. The two monitors are operated for a given period, and their data are compared. An adjustment factor, called **'K Factor'** is then calculated, and applied to the Aeroqual monitor **Gain**. This corrects the data to the known reference monitor.

$$\boldsymbol{K\ Factor} = \frac{\boldsymbol{Average\ PM\ (Reference)}}{\boldsymbol{Average\ PM\ (Aeroqual)}}$$

The K Factor is the applied to the monitor, using the Gain setting for each PM channel:

$$\boldsymbol{New\ Gain = Old\ Gain\ X\ K\ Factor}$$

You can also perform the adjustment in Microsoft excel or similar.

Field calibration is only as good as the reference data which is used. Using poor quality reference data for calibration will result in poor quality PM data from your Aeroqual monitor. Aeroqual recommends that calibration only be carried out using high quality Reference PM Data. If you don't have access to a reference monitor or aren't confident that you can access a well-run reference monitor, then you should always rely upon the factory calibration.

Important considerations for field calibration:

- Location of monitor: The Aeroqual monitor and the Reference monitor need to be located at the same site preferably with their inlets within 10 m of each other and must be sampling at the same height. At reference sites using a monitoring shed, on the rooftop of the shed is usually the best location.
- Monitor set up: Both the Aeroqual monitor and the reference monitor need to be set up in accordance with the manufacturer's recommendations, with correctly set flow rates and fresh filters. If you are using a gravimetric method reference monitor, you must follow appropriate filter conditioning and weighing methods.
- Duration of colocation: As a rule, longer is better, as this will give you more data points and therefore more confidence in your field calibration. It's important that the colocation is carried out during the same environmental conditions expected during deployment. 1-2 weeks is preferred and no shorter than 48 hrs.
- Reference monitor selection: Selection of the right reference monitor is critical for a successful K factor correction. Ideally, reference monitors should be operated in accordance with local reference method specification. Monitor methods are listed below, in descending order of preference:
- GRIMM / BAM / TEOM: Are best as they are continuous methods, meaning more data can be collected in a shorter period, giving a more accurate K-Factor. BAM data can be noisy at hourly averages, so consider using 24 hr averages if PM levels are low. This is Aeroqual's suggested method, as lots of data can be collected quickly, with no need for expensive lab work.
- Partisol / Low volume samplers (47mm Filter): Can also be used, however will need to be run for a longer period as they operate on 24 hr averages (i.e. 1 data point per 24 hrs). Filters must be appropriately prepared and transported. Lab and field blank filters should also be used. Balance accuracy for pre and post weighing should be better than ±0.0001 µg. High-Volume samplers
- Other Non-Reference methods (Optical, Open-Path): Existing instrumentation can be used to establish variance between Aeroqual and a known monitor. This method can be used to assess new versus old instrumentation but is not a calibration to a reference monitor.

7.2.3 Steps to performing a K factor correction

Beta Attenuation Monitors (BAM) measure PM loading on a filter tape, using a radioactive source and a detector. The amount of PM measured is proportional to the amount of beta rays which are blocked from passing from the source to detector by the PM on the filter tape. TEOMs use a high precision microbalance with a special filter to calculate PM concentration. BAM and TEOM monitors run continuously and data is available at as low as 10-minute averages. This data can be noisy, so Aeroqual recommend that 1 hour or 24 hr averages are used to minimise this noise.

Gravimetric methods (Partisol, Low volume samplers using 47 mm filters) have some additional steps. It is critical that correct filter conditioning and pre/post weighing processes are carried out.

- Install and commission your Aeroqual monitor alongside your reference monitor. Operate both monitors together. The longer you collocate the monitors, the better.
- Collect the data from both monitors. Using Microsoft Excel or similar, remove any odd spikes, error, or automated zero calibration data.
- (Gravimetric only) calculate your concentrations using the following equation:

$$\boldsymbol{Concentration = \frac{Filter\ weight\ at\ end - filter\ weight\ at\ start}{Total\ volume\ of\ air\ sampled}}$$

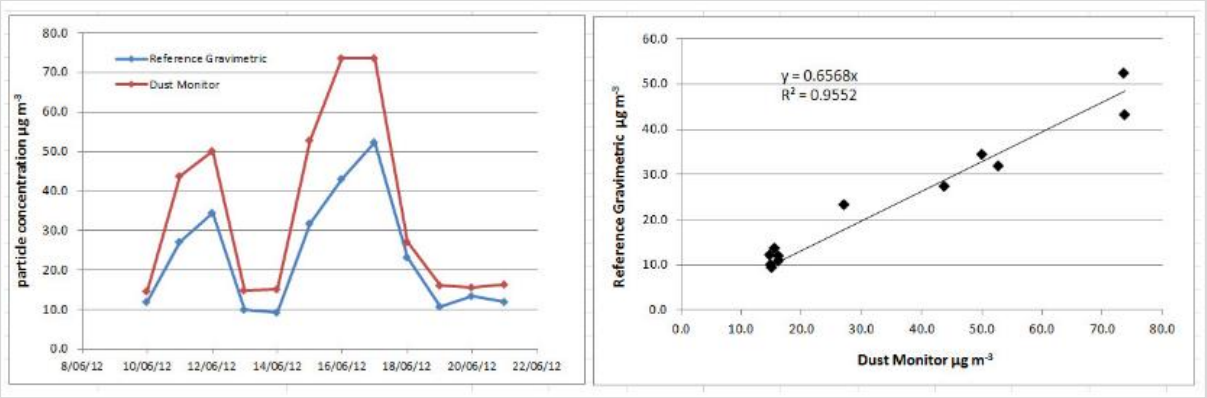
- Select an appropriate averaging period, 24 hrs is usually appropriate. Calculate your averages for both reference and Aeroqual using this formula:

$$\boldsymbol{Average = \frac{Sum\ of\ readings}{Number\ of\ readings}}$$

- The goal is to create an excel spreadsheet, with 1 column of reference data, and 1 column of Aeroqual data, in the averaging period you have selected, for instance 1 hour or 24 hour or 24 hr averages for the period of your co location.
  NOTE: *Your zero check data should be included as a point.*

Dust Monitor side-by-side calibration data 10 June to 21 June Monitoring site 1		
Date	Reference Gravimetric, daily mass ug m-3	Aeroqual Dust Monitor daily average ug m-3
10/06/12	12.0	14.8
11/06/12	27.2	43.9
12/06/12	34.5	50.1
13/06/12	10.0	14.9
14/06/12	9.3	15.1
15/06/12	31.7	52.8
16/06/12	43.1	73.7
17/06/12	52.3	73.6
18/06/12	23.2	27.2
19/06/12	10.7	16.2
20/06/12	13.5	15.6
21/06/12	11.9	16.3

- Using Microsoft excel plot your 2 data sets in an x-y scatter plot. Add a trend line and equation as below.



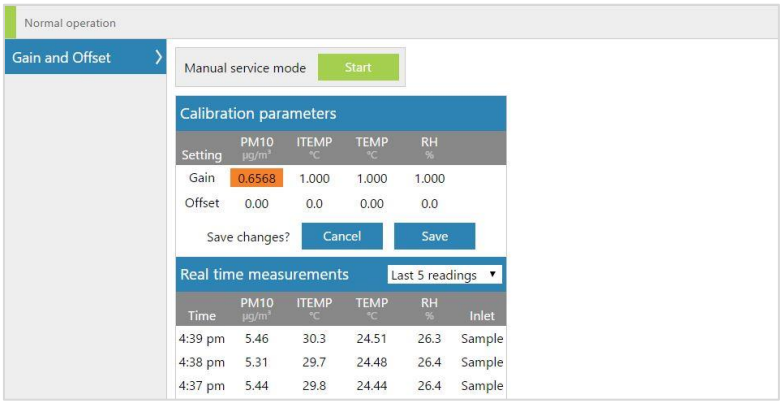
- The graph to the left below shows the time series of the two monitors. The graph to the right below shows the slope calculation. In this example the Monitor is reading higher than the reference monitor. The slope of the curve Reference vs Dust Monitor is 0.6568. So, a gain of 0.6568 needs to be applied to the monitor.

The Aeroqual monitor will need a new gain, calculated using the formula below:

$$\boldsymbol{New\ Gain = Old\ Gain\ X\ K\ Factor}$$

$$\boldsymbol{New\ Gain = \ 1 \times 0.6568 = 0.6568}$$

Upload the new gain into the gain parameter in the gain and offset table using the calibration and service app.



8 Troubleshooting

The following section provides basic troubleshooting for the monitor. Common problems, and how to solve them are given in Table 8-1

Not all known issues are listed in Table 8-1 especially if not known to Aeroqual when this user guide was written. The Aeroqual training website provides a comprehensive and up to date list of known issues and provides solutions as soon as solutions become available.

www	Online reference	training.aeroqual.com DM 1.3 Tech training

The Aeroqual technical support team are available to help when required.

www	Online reference	technical@aeroqual.com

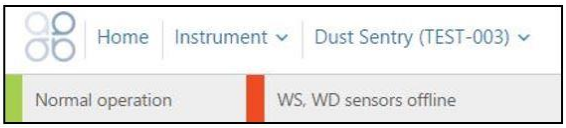
Use manual sync to assist Aeroqual technical support in troubleshooting

When the Aeroqual technical support team are required to help with troubleshooting it is necessary to see a comprehensive dataset from the Dust Sentry. This can easily be achieved if the instrument is online.

If the instrument is not online, use the Manual Sync tool (Section 5.1.4) to upload data to Aeroqual Cloud so the technical support team can provide fast and comprehensive support.

Error conditions reported by Aeroqual Connect and Aeroqual Cloud software

Connect and Cloud software will report two different types of error condition in the banner at the top of the page, these are ‘sensor offline” and “sensor failed” The error will also be listed in the monitor journal.



Sensor offline

A sensor offline error is usually caused by either a loose power connection or a loose communications connection. Check the module connections are secure. If the power connections and the communications connections are secure, then the issue may be inside the module.

Contact the Aeroqual distributor in your local country for technical support.

Sensor failure

A sensor failure error can occur for different reasons, sometimes this can be related to a sensor parameter exceeding an allowable value.

If you get a “sensor failure” error contact the Aeroqual distributor in your local country for technical support.

Communication errors:

1. Failure to see the WIFI network broadcast by the monitor

If you cannot see the monitor in your list of WIFI networks, it is most likely because the WIFI setting is set to “Client Mode” and is not broadcasting. See section 4.1.

To resolve this, connect to the monitor through the WIFI LAN and then reset the WIFI mode to “Access Point”.

Alternatively, the monitor can be reset to factory communication settings by using the USB reset procedure. See section 4.4.

2. Error 500 Database error

An error is known to occur with the internal database which causes the following error report when trying to connect to the monitor. This may be able to be resolved over a remote connection. Or a component in the embedded PC will need to be replaced.

If this error occurs contact the Aeroqual distributor in your local country for technical support.

Symptom	Possible cause	Fault isolation / Solution	Reference
Gas module troubleshooting			
Negative readings	Flow leak or incorrect flow		Section 6.5.4
	Dirty inlet gas filter	Change filter	Section 6.5.5
	Incorrect zero calibration	Perform zero calibration	Section 2
Gas readings noisy or unstable	Flow leak or incorrect flow		Section 6.5.11
	Module is aging	Replace module	Section 6.5.12
Gas readings significantly different than expected	Incorrect gain or offset applied	Check the correct gain has been applied correctly	Section 7.2
	Incorrect calibration performed	Incorrect gas cylinder used, or gain calculated incorrectly	Redo calibration or identify error and correct it
Particle Monitor and Particle Profiler troubleshooting			
$PM_{2.5}$ > PM_{10}	Cyclones fitted on the wrong side	Swap cyclones to correct side	Section 0
	Auto zero calibration failing on the PM10.0	Check baseline calibration of PM_{10}	Section 6.5.8
	Incorrect gain applied	Check gain on module	Section 6
	Leak in flow system	Check for leaks	Section 6.5.7
Negative numbers	Auto zero calibration failing...	Check baseline calibration of PM_{10}	Section 6.5.8.2
Readings lower than expected	Flow rate too low	Check flow rate change pump if required	Section Section 6.5.10
	Dirty optics	Have optical module serviced	Section 6.6
	Failed laser	Have optical module serviced	Section 6.6
	Dirty sample filters	Change filter	Section 6.5.5

Table 8-1 Common troubleshooting tasks and how to solve them

9 Copyright

Aeroqual operates a policy of continuous development. Aeroqual reserves the right to make changes and improvements to any of the products described in this document without prior notice.

Under no circumstances shall Aeroqual be responsible for any loss of data or income or any special, incidental, consequential or indirect damages howsoever caused.

The contents of this document are provided "as is". Except as required by applicable law, no warranties of any kind, either express or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose, are made in relation to the accuracy, reliability or contents of this document.

Aeroqual reserves the right to revise this document or withdraw it at any time without prior notice. The availability of particular products may vary by region. Please check with the Aeroqual distributor nearest to you.

10 Compliance

1. The Aeroqual Dust Sentry, Dust Sentry Pro and AQS 1 comply with the following standards:
   EN 61000-6-1:2001
   EN 61000-6-3:2001
   Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) these devices may not cause harmful interference, and (2) these devices must accept any interference received, including interference that may cause undesired operation.

2. The Aeroqual Dust Sentry PM_{10} has achieved MCERTs certification for indicative ambient particulate monitor

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult your Aeroqual distributor or an experienced radio/TV technician for help.

11 Warranty

The monitor warranty policy can be found on the main company website: www.aeroqual.com/support/warranty

12 Appendix

12.1 Gas module design

O_3 Ox, NO_2, VOC

Figure 12-1 Gas module sizes and key components labelled (Modules may vary from that shown)

The list of gas modules available for integration into the monitor is provided in Table 12-1.

GAS MODULE	RANGE	RESOLUTION	SENSOR TYPE	MODULE SIZE	MODULE FLOW RATE	NOISE: ZERO SPAN % OF READING	LOWER DETECTABLE LIMIT (2σ)	PRECISION	LINEARITY % OF F.S	DRIFT 24 HOUR: Zero; SPAN % OF FS	EXPECTED MODULE LIFETIME
O_3	0 – 500 ppb	0.1 ppb	GSS	Small	110 – 130 ml / min^{-1}	1 ppb; 1 %	1 ppb	2% of reading or 2 ppb	1.5 %	1 ppb; 0.2 %	2 – 3 years
NO_2 (Ox module)	0 – 500 ppb	0.1 ppb	GSE	Medium	55 – 65 ml / min^{-1}	1 ppb; 1 %	1 ppb	2% of reading or 3 ppb	2 %	2 ppb; 1 %	2 – 3 years
NO_2 (Direct-read)	0 – 500 ppb	0.1 ppb	GSE	Medium	55 – 65 ml / min^{-1}	1 ppb; 1 %	1 ppb	2% of reading or 2 ppb	2 %	2 ppb; 1 %	2 – 3 years
VOC (Low range)	0-500 ppb	0.1 ppb	PID	Medium	55 – 65 ml / min^{-1}	1 ppb; 1%	1 ppb	2% of reading or 1 ppb	1 %	1 ppb; 1 %	2 – 3 years
VOC (High range)	0 – 30 ppm	0.01 ppm	PID	Medium	55 – 65 ml / min^{-1}	0.1 ppm; 1%	0.05 ppm	<2% of reading or 0.05 ppm	2 %	0.1 ppm; 1 %	2 – 3 years

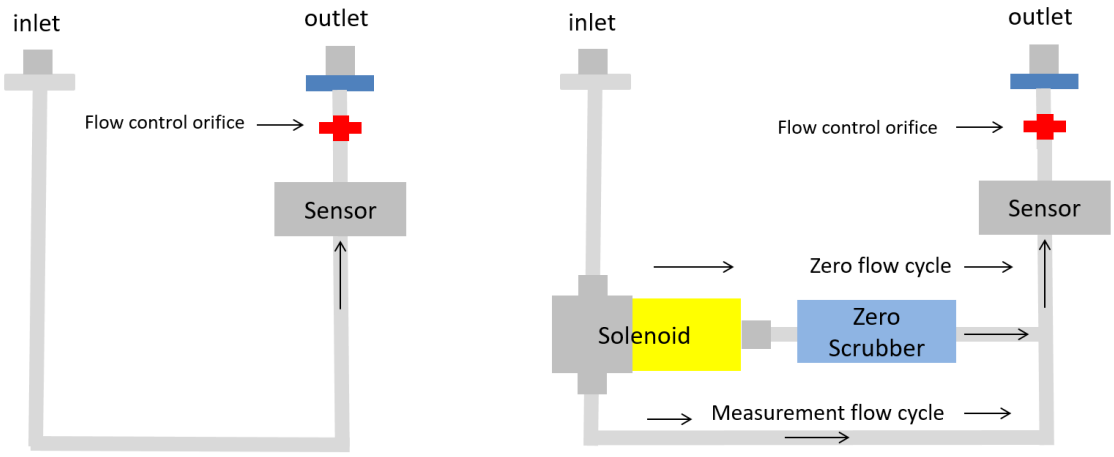
Table 12-1 Gas modules available for integration into the monitor

NOTE: *O_3,Ox and NO_2 Modules have no serviceable parts. The VOC analyzer module uses a replaceable 10.6 eV UV lamp, if the lamp needs replacing contact the Aeroqual distributor in your local country for technical support.*

12.1.1 Gas Module design

Gas modules come in two different designs. These two designs are shown schematically in Figure 12-1. A list of which gas modules use which design is given in Table 12-1.

- **Direct design** (Ozone): The gas is passed directly to the sensor continuously.
- **Zero switching design** (VOC and NO_2): The module uses a solenoid to switch between a zero path which removes the target gas and creates a “zero” or baseline measurement, and a measurement path which measures the ambient air. The final measurement in ppm is an arithmetic combination of the zero and sample measurement. This technique is referred to as Automatic Baseline Correction.



Direct design:
Ozone

Zero switching design:
Ox, NO_2, VOC

Figure 12-2 Direct and Zero switching gas module design

The gas flow rate is controlled using a critical orifice shown in red in Figure 12-2. The flow rate is listed in Table 12-1.

Each gas module contains: a gas inlet port (white ring),a gas exhaust port (blue ring), two 12 V power connectors to allow the module to be connected to a 12 V power bus, two RJ-45 connections to allow the module to be connected to the RS-485 communications bus, and a module status LED.

12.1.2 Gas flow through modules

The gas flow through all the gas modules is powered by a single diaphragm pump inside the monitor enclosure. The pump pulls sample air through the gas module. **After** it has been measured the sample air passes through the pump and is exhausted outside the monitor.

There are two different types of tubing material used to handle the gas flow.

- Before the gas reaches the sensor, all the tubing material is rigid non-reactive PFA.
- After the sample has passed the sensor all the tubing is flexible R3603 Tygon

The vacuum side of the pump is to the gas outlet (exhaust) of each module with **Tygon** tubing. This is illustrated in Figure 12-3.

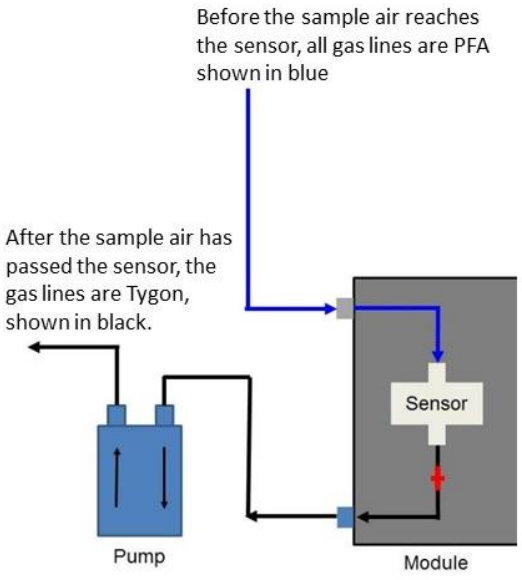


Figure 12-3 A single pump is used for all gas modules. The vacuum port of the pump is connected to the outlet of each gas module

12.2 Particulate Matter module design

The Dust Sentry can measure a range of pre-defined particulate matter (PM) such as TSP, PM_{10}, $PM_{2.5}$ or $PM_{1.}$ The sample flow for the particle measurements is separate from the gas sample flow. There is a separate pump, a separate inlet and a separate exhaust.

The Dust Sentry can measure particulate matter such as PM_{10} and $PM_{2.5}$. There are **three** separate modules:

1. for measuring the particulate (optical engine), there are two options to choose from:
2. Particle Monitor uses a nephelometer combined with a sharp cut cyclone (See Figure 12-4) and measures a single size fraction such as TSP or PM_{10} or $PM_{2.5}$ or PM_1.
3. Particle Profiler uses an optical particle counter (See Figure 12-6) and measures four size fractions simultaneously, TSP and PM_{10}.and $PM_{2.5}$ and PM_1.
4. for handling the data transfer (I/O module)
5. for controlling the flow rate (pump module)

The sample flow for the Particle Monitor and Particle Profiler is separate from the gas sample flow. There is a separate pump, a separate inlet and a separate exhaust.

12.2.1 Comparison between the Particle Monitor and the Particle Profiler

- The Particle Profiler measures particulate concentrations using particle counting, it outputs multiple size fractions at the same time.
- The Particle Profiler can measure TSP and PM_{10} and $PM_{2.5}$ and PM_1 without requiring a sharp cut cyclone.
- The Particle Monitor measures particulate concentrations by nephelometry; it measures TSP or PM_{10} or $PM_{2.5}$ or PM_1 using a sharp cut cyclone.

	Particle Monitor	**Particle Profiler**
Mass outputs	TSP **or** PM_{10} **or** $PM_{2.5}$ **or** PM_1	TSP and PM_{10} and $PM_{2.5}$ and PM_1
Particle count outputs	No	Yes
Accuracy	<± (2 µg/m^3 + 5% of reading)	<± (5 µg/m^3 + 15% of reading)
Factory calibration period	Every two years (24 months)	Every year (12 months)
Inlet flow rate	2.0 LPM	1.0 LPM

Table 12-2 Summary of the difference between the Particle Monitor and the Particle Profiler.

12.2.2 Particle Monitor module

The Particle Monitor uses a custom Met One near forward light-scattering nephelometer to measure particle concentration and a sharp cut inlet cyclone to physically select the particle size. This module is shown on the far right in Figure 12-4.

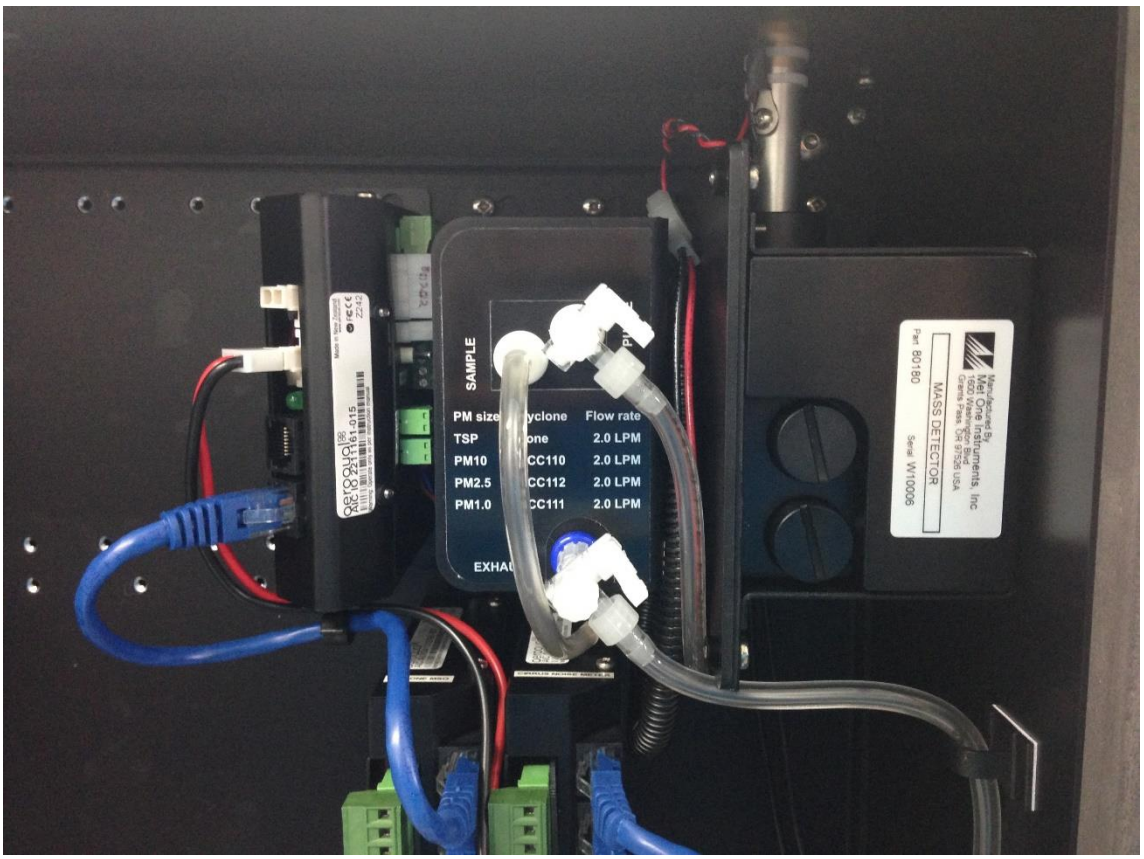


Figure 12-4 The Particle Monitor uses three modules: a) the optical engine on the far right, b) the pump module in the middle, c) the I/O module on the left (configuration is subject to change)

The particulate size selection (TSP **or** PM_{10} **or** $PM_{2.5}$ **or** $PM_{1.0}$) is determined by the sharp cut cyclone on the Particle Monitor inlet on the outside of the Dust Sentry shown in Figure 12-5.The Particle Monitor can be configured to measure either of these four size fractions simply by changing the inlet cyclone and making a small change in the software.

Figure 12-5 The size selection in the Particle Monitor is determined by the sharp cut cyclone on the inlet.

	Online reference	training.aeroqual.com DM 1.3 Tech training Section 4.5

12.2.3 Particle Profiler module

The Dust Sentry uses a custom-designed Met One optical particle counter (OPC) to measure four particle size fractions simultaneously. There is no sharp cut cyclone used in the Particle Profiler; both the concentration and size are measured inside the optical particle counter.

The three modules for the Particle Profiler are installed in the top right side of the Dust Sentry enclosure.

The Particle Profiler has the sample and purge filters mounted on the outside of the optical module, (in the Particle Monitor they are held inside).

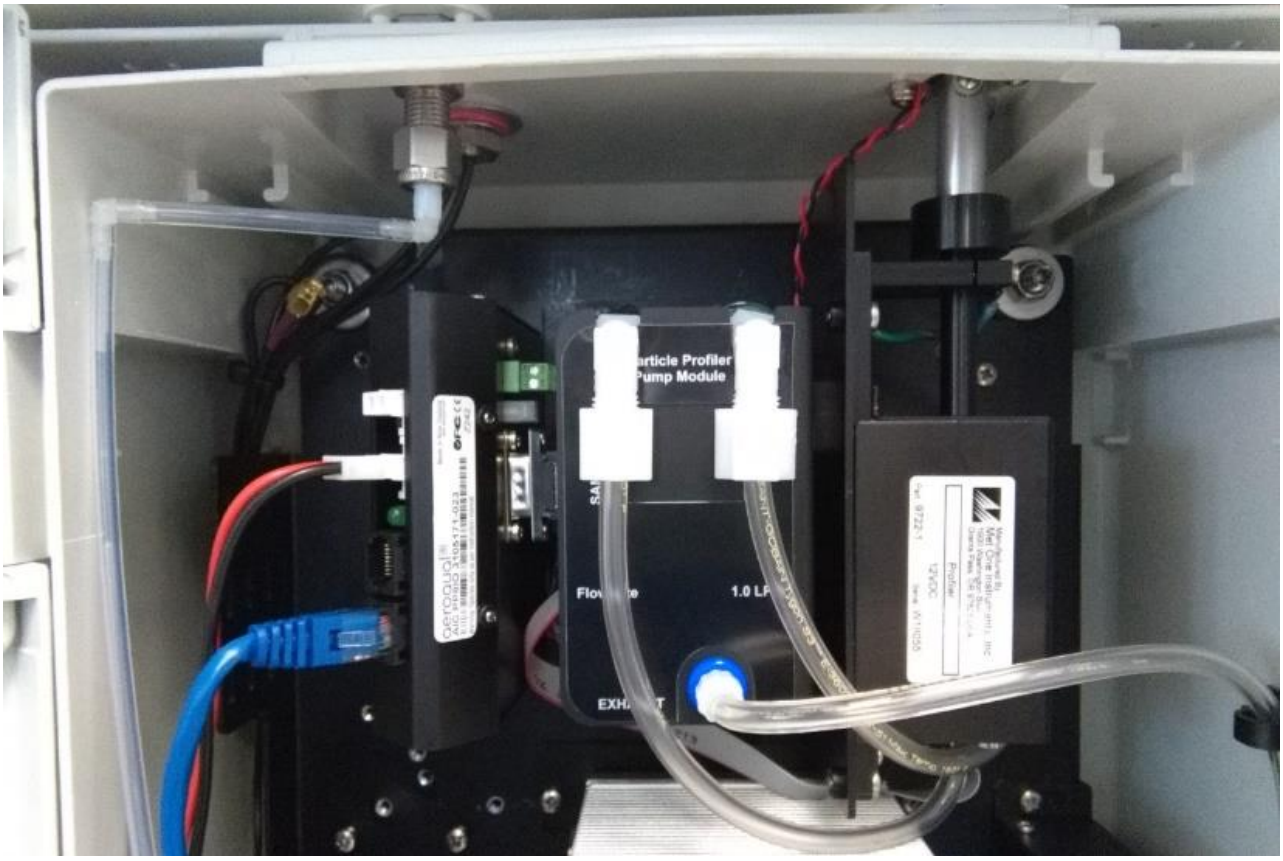


Figure 12-6 The Particle Profiler uses three modules: a) the optical module on the far right, b) the pump module in the middle, c) the electronics module on the left (configuration is subject to change)

12.3 Mains wiring color guide

Caution: The high voltage mains supply must be wired by a certified electrician in compliance with local electrical regulations.

The following table is only intended as a reminder, always check your local guidelines.

Wire	US AC power circuit wiring color codes	UK AC power circuit wiring color codes	IEC (most of Europe) AC power circuit wiring color codes
Live / Phase	Black or Red	Brown or Red	Brown or Black
Neutral	White or Grey	Blue or Black	Blue
Earth / Ground	Green or Green-yellow	Green-yellow	Green-yellow

12.5 Calibration Records

The following records should be used in conjunction with this user guide.

Table 1: Calibration details	
Date Time	
Serial number	
Date of previous calibration	
Customer name	
Site name	
Engineer name	

Table 2: Equipment details		
Equipment	**Brand / Model number**	**Serial number**
Gas dilution calibrator:		
Ozone generator		
Zero air source		
Flow meter		
Gas Regulator 1		
Gas Regulator 2		

Table 3: Gas cylinder details					
#	**Gas Type**	**Gas Balance**	**Manufacturer**	**Expiry date**	**Cylinder pressure**
1	NO_2	Air N_2			
2	Isobutylene	Air N_2			
3					
4					
5					

Table 4: Site inspection Check the local surroundings to see if anything has changed which could influence the ongoing ambient gas measurements.
Observations

Table 5: Monitor pre-checks			
Before opening the door			
ID	**SOP description**	**Observation / reading**	**Pass / Fail / Done**
5.1	Put monitor into service mode		
5.2	Gas inlet secure		
5.3	Particle inlet secure		
5.4	Door locks are operational		
5.5	Record the flow rate (before opening door)		
5.6	Previously measured flow rate		
After opening the door			
5.7	Replace the inlet filters		
5.8	Measure flow rate again		
5.9	Go to section 6 if required then record final inlet flow rate here		

Table 6: Individual module flow rates, leak check manifold and bypass valve					
6.1	Check all gas connections	Pass / Fail			
6.2	Leak check sampling manifold	Pass / Fail			
6.5	**Flow Rate**	**Ox / NO_2**	**O_3**	**PID**	**Total module flow**
	Flow rate last measured				
	Flow rate measured now				
	If flow rate is the same then **pass**, if changed then **fail**	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail
6.6	Adjust bypass valve	If all the modules show reduced flow and there is no leak, then the adjustment bypass valve can be used.		Yes / No	
6.7	Flow rate measured following adjustment				
	If flow rate is the same as section 6.3 then **pass**, if changed then **fail.**	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail
	What was the reason for the change in flow rate?				

Table 7: Zero calibration results									
Module	**Current offset From monitor settings**	**Reading after stabilisation 10-minute average**	**Acceptable reading during zero calibration (ppm) 10 min average**	**Acceptable standard deviation during zero calibration (10-minute average)**	**New Calculated offset1**	**Minimum and Maximum recommended offset (ppm)**	**Offset uploaded**	**Reading after offset changed**	**Pass / Fail**
	7.1.1	7.2.3	7.2.3 (b)	7.2.3 (c)	7.2.4	7.2.4 (b)	7.2.5	7.2.6	7.2.7
NO_2 (Ox module)	0.000				N/A	N/A	N/A	N/A	
NO_2 (Direct-read)			0.0 0.005	0.002		Max +0.050 Min -0.050			
O_3			0.0 0.005	0.002		Max +0.050 Min -0.050			
O_x			0.0 0.005	0.002		Max +0.050 Min -0.050			
PID			0.0 0.002	0.002		Max +0.05 Min -0.05			
Comments:									

Equation 4: New offset = Current offset + (AQS gas reading / Gain)

Table 8: Span calibration results

Module	Initial gain	Initial *a* value	Span point	Reading after stabilisation 10-minute average	Acceptable range during span calibration (ppm) 10-minute average	Maximum acceptable noise during span calibration 10 min std deviation	Maximum Minimum recommended gain	New gain[5]	New a value[3]	Ratio of gain change New gain / Initial gain	Gain uploaded	Reading after gain changed	Pass / Fail
	8.1.1	8.1.2	8.1.3	8.1.5	8.1.5 (b)	8.1.5 (c)	8.1.5 (d)	8.1.6	8.1.6 (b)	8.1.7	8.1.8	8.1.9	8.1.10
NO_2 (Ox module)	1.000				span ± 5 %	2 % of span	NA	NA		Reading after **an** adjustment, (should be close to 0.000)			
NO_2 (Direct-read)					span ± 5 %	2 % of span	max 5.000 min 0.2		N/A				
O_3		N/A			span ± 5 %	2 % of span	max 5.000 min 0.2		N/A				
O_x		N/A			span ± 5 %	2 % of span	max 5.000 min 0.2		N/A				
PID		N/A			span ± 5 %	2 % of span	max 5.000 min 0.2		N/A				
Comments:													

Equation 5: New Gain = Current Gain x (Span concentration / Gas reading)

Equation 3: $a = O_{x\ reading} / O_{3\ span\ concentration}$

NOTE: Ox module adjustments

The O_x module gain adjustment is made during the NO_2 calibration gas delivery

The NO_2 a value adjustment is made during the O_3 gas delivery

The NO_2 gain value is NOT adjusted as part of the calibration process

Table 9: Calibration Post-checks			
ID	**Description**	**Observation / reading**	**Pass / Fail / Done**
9.1	Disconnect calibration equipment		
9.2	Record total inlet flow rate		
9.3	Replace the mesh inlet and cap		
9.4	Lock door		
9.5	Secure the site		
9.6	Service mode		

About Aeroqual

Every day, environmental professionals around the world are working hard to protect people and planet from the impact of air pollution. Since 2001 Aeroqual has equipped environmental professionals with technology that takes the time and hassle out of air quality monitoring projects. Government, industry, researchers and environmental consultants trust us to deliver actionable data built on industry-leading sensor technology, wirelessly connected to software in a single integrated package. With thousands of successful projects delivered in 70 different countries on all seven continents, our systems process more than six million air quality measurements per day. In 2017 the U.S. Environmental Protection Agency signed a 5-year R&D collaboration agreement with us to accelerate understanding of air sensor technology.

Just a handful of customers who chose Aeroqual

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ATTACHMENT B
Section 01 81 16 Environmental Requirements

SECTION 01 81 16

ENVIRONMENTAL REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. This Section includes provisions for complying with permit conditions and requirements, specifications, and Project-specific mitigation practices defined in the Contract Documents including, but not limited to: dust control; air pollution control; stormwater; and noise control; in accordance with requirements of the Contract Documents and various permits.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 50 00 – Temporary Facilities and Controls

C. Section 02 61 00 – Waste Management, Transportation, and Disposal

D. Section 31 25 00 – Erosion and Sedimentation Control.

1.03 REFERENCES

A. OSHA Regulations 29 CFR

B. Spokane Valley Municipal Code

1.04 REGULATIONS AND PERMITS

A. The Contractor shall obtain the following permits as required:

1. Construction Stormwater General Permit (i.e., NPDES permit) including filing a Notice of Intent (NOI).
2. All necessary air and engine permits for construction vehicles and equipment for the Work.
3. Any necessary demolition and hauling permits for the Work.
4. Any other permits necessary to perform the Work.

B. The Owner shall obtain and pay for the grading permit.

C. Any work requiring other necessary permits shall be performed in accordance with the requirements of those permits and the Project permits.

D. The Construction Manager and Contractor shall adhere to the requirements of all permits.

E. If there are conflicts between the permits and the specifications, the more stringent requirement shall prevail.

F. Any violation to the conditions in any of the permits due to the Work being conducted by the Contractor and/or its Subcontractors shall be the responsibility of the Contractor.

G. Copies of all approved permits obtained by the Contractor shall be submitted to the Construction Manager upon receipt.

1.05 SUBMITTALS

A. Contractor shall submit all submittals to the Construction Manager in accordance with Section 01 33 00 – Submittal Procedures.

B. Contractor shall submit copies of all approved permits obtained by the Contractor.

C. Contractor shall submit product information on Stormwater Pollution Prevention Plan (SWPPP) Best Management Practice (BMP) products including erosion and sedimentation controls to be used by the Contractor at the Site.

D. Contractor shall submit a SWPPP Modification for proposed modifications to BMPs shown on the Drawings, described herein, and described in the SWPPP, as needed. The Contractor-proposed SWPPP modifications for the construction activities to be conducted at the Site must comply with regulations set forth by the General NPDES Permit for Construction Activities and shall adhere to all federal, state, and local requirements. The submitted SWPPP Modification will be reviewed by the Construction Manager and Engineer. The accepted submittal will be used by the Contractor to formally update the SWPPP and submit the updated SWPPP to the authority having jurisdiction.

E. Contractor shall submit weekly erosion and sediment control inspection reports prepared by a Certified Erosion and Sediment Control Lead or otherwise required by the SWPPP.

F. Contractor shall submit a Decontamination Plan describing the means, methods, and location of decontamination occurring at the Site. The Decontamination Plan should also describe how water used for decontamination will be managed.

G. Contractor shall prepare a Dust Control Plan (DCP) that details the Contractor's proposed means and methods to mitigate dust during performance of the Work.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Contractor shall furnish all materials, equipment, appurtenances, and facilities as required for installing, maintaining, and removing all environmental protection measures described in the Contract Documents.

PART 3 – EXECUTION

3.01 GENERAL

A. The Construction Manager will notify the Contractor in writing of noncompliance with the provisions of this Section and the action required to become compliant. The Contractor shall respond in writing within three business days and take immediate corrective action. Contractor shall record the submittal of written response in daily reports. Such notice, delivered at the Site, shall be sufficient for the Contractor to take action. The Construction Manager may issue an order stopping all or part of the Work for failure to comply until corrective action has been taken. No time lost or other costs, or damages due to such stop orders, shall be the subject of a claim for extension of time or for costs or damages unless it is later determined that the Contractor was in compliance.

B. Contractor shall notify the Construction Manager immediately upon observation of construction-related uncontrolled dust, other fugitive emission, or unsanctioned environmental condition.

C. Should any sudden, continuous, or intermittent release of oil or hazardous material occur during the Work, the Contractor shall notify the Construction Manager immediately and shall immediately begin actions to contain or abate the release.

D. All equipment and materials shall be used in a manner to minimize the potential for, and extent of, any unnecessary contamination.

E. Any earthwork equipment that performs intrusive activities in any part of the Site within the Work Limits or is used to handle contaminated materials shall be decontaminated prior to leaving either the area of contamination or the Site, or prior to being repurposed for use with clean construction materials.

3.02 EROSION AND SEDIMENTATION CONTROL

A. Contractor shall implement erosion and sedimentation control in accordance with Section 31 25 00 – Erosion and Sediment Control.

3.03 DECONTAMINATION

A. Contractor shall decontaminate vehicles, equipment, tools, and materials that come into contact with hazardous soil or soils impacted by contaminates of concern (i.e., lead, polycyclic aromatic hydrocarbons [PAHs], or arsenic) and manage the decontamination waste as specified in Section 02 61 00 – Waste Management, Transportation, and Disposal.

B. Contractor shall conduct thorough removal of soil from the exterior of all trucks and construction vehicles/equipment. This includes removing soil and debris from undercarriage and wheels/tracks.

C. Contractor may elect to decontaminate with water. Steam cleaners, water jets, scrub brushes, and non-phosphate detergent may be used in an approved manner to aid in the removal of solids and the decontamination of equipment.

D. Water used for decontamination shall be contained and managed in accordance with Section 02 61 00 – Waste Management, Transportation, and Disposal.

3.04 DUST CONTROL

A. The Contractor shall take measures to control dust within the Contractor's active work zone. No additional compensation will be allowed for supplemental dust control measures necessary to satisfy the performance requirement of the Construction Manager and/or Engineer.

B. The Engineer will perform perimeter air monitoring at the Work Limits. Engineer will measure total dust in a manner that is protective of human health and in accordance with the Air Monitoring Sampling Work Plan submitted to the Washington Department of Ecology by the Engineer.

C. The particulate action level will be 2.5 milligrams per cubic meter (mg/m^3) as measured within 200 feet downwind of the construction activities or on the property line, whichever is less. If the action level is reached, work will be stopped, and additional engineering controls will be implemented to reduce the amount of dust.

D. The Contractor will be notified as soon as possible if exceedances of air-born particulates (dust) occur. Upon notification, Contractor shall cease construction activities and apply dust control. Contractor shall be ready to apply wet suppression or other approved dust control measures, as described in the Contractor's approved DCP, within a five-minute period of notification from Construction Manager.

E. The Contractor shall conduct operations and maintain controls to minimize the creation and dispersion of dust. If water suppression is insufficient to control dust to acceptable levels, Contractor shall employ additional measures to control dust, including but not limited to the following: additional water trucks, tackifier, or dust palliatives.

F. The Contractor shall be responsible for any damages caused by fugitive dust emissions. If the Project is stopped because of dust emissions, the Contractor shall be responsible to implement additional mitigative measures at their own cost. Failure to meet these restrictions may result in cessation of construction activities.

G. Contractor shall immediately inform the Construction Manager of any dust or vapor conditions exceeding regulatory criteria within the work and breathing zones based on Contractor's monitoring in accordance with the Contractor's Site-Specific Health and Safety Plan (SHASP), specified in Section 01 35 29 – Health and Safety Requirements.

H. Water for dust control shall be provided by the Contractor and in accordance with Section 01 50 00 – Temporary Facilities and Controls.

I. Contractor shall manage waste generated as a result of dust control measures in accordance with Section 02 61 00 – Waste Management, Transportation, and Disposal. When the waste removal and handling activities on-Site are complete, the sweepings shall be properly disposed off-Site at an approved disposal facility, or otherwise managed as approved by the Construction Manager and Engineer.

J. General Requirements:

1. Contractor shall apply dust suppression at all active construction areas as needed to minimize and control dust. Dust control for stockpiles and the access roads shall be achieved through the application of water at least twice per day, and as necessary to prevent wind-blown dust. Water shall also be used to control dust associated with loading and hauling operations.

    a. Contractor shall utilize spraying equipment to provide complete coverage of surfaces with water prior to, during, and subsequent to soil moving activities. Apply water in a manner to prevent movement of spray beyond application area and Work Limits to minimize excess water use.
    b. Contractor shall apply water without interfering with earthmoving equipment or on-Site operations.
    c. Contractor shall keep surfaces damp without creating nuisance conditions such as ponding, runoff, erosion, or excessively wet and muddy conditions.
    d. Contractor shall provide periodic water misting/sprinkling on active stockpiles during active period when covering is not practicable. During inactive periods, cover stockpiles with weighted and anchored tarps/covers or with a soil stabilizer/tackifier approved by the Construction Manager.
    e. Contractor shall cover or stabilize areas and stockpiles that are inactive (no disturbance for more than 10 days) with application of a soil stabilizing product.

2. Contractor shall cover all trucks hauling soil, sand, aggregates, and other loose material offsite. Onsite loads do not require covering but will require dust suppression measures to control fugitive dust (e.g., watering).
3. Track-out Controls: Contractor shall remove all visible mud or dirt track-out onto adjacent public roads using wet power vacuum street sweepers within 24 hours of the generation of visible soil, and as dictated by the Construction Manager.

    a. Contractor shall maintain clean pavement surfaces within the designated work areas (within Work Limits) and Site egress routes, unless they are designated for demolition. Contractor shall not permit construction equipment to track soil outside of the active exclusion zone or the Work Limits onto East Sprague Avenue and/or all other public roads.

4. During excavation or soil movement activities, drop heights shall be kept to a minimum.

3.05 AIR POLLUTION CONTROL

A. Products, equipment, and work practices shall conform to air pollution control requirements of applicable federal, state, and local laws and regulations, and with the requirements of this Sub-Part. The Contractor shall utilize such methods and devices as are reasonably available to prevent, control, and otherwise minimize atmospheric emissions and discharges of air contaminants in accordance with relevant permits and authorizations.

B. Contractor shall provide air quality and controls for enclosed spaces and for equipment or operations that generate emissions or dust in accordance with all local, state, and federal requirements as well as any additional permit requirements.

C. Contractor shall routinely maintain construction equipment and vehicles to ensure that engines remain tuned and emission control equipment is functioning properly as required by law. Equipment and vehicles that show excessive emissions of exhaust gases, as determined by the Construction Manager, shall not be operated until corrective repairs or adjustments are made to reduce emissions to acceptable levels. The Contractor shall also limit excessive equipment idling time whenever possible.

3.06 NOISE CONTROL

A. Trucks and construction equipment shall be required to have adequate mufflers for noise suppression to comply with the sound limits set forth by the Spokane Valley Municipal Code. Equipment without noise suppression or proper maintenance will not be allowed on the Project.

B. Contractor shall adhere to Spokane Municipal Code, which states quiet hours are 10PM to 7AM.

C. It is the responsibility of the Contractor to verify sound levels and confirm compliance with noise limits.

END OF SECTION