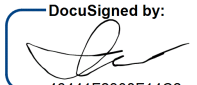


UCD IMPROVE Standard Operating Procedure #126

Site Selection

*Interagency Monitoring of Protected Visual Environments
Air Quality Research Center
University of California, Davis*

*July 15, 2022
Version 2.6*

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1. PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the site selection and preparation procedures for the installation of IMPROVE aerosol samplers, and covers the following topics:

- locating potential sites
- evaluating potential sites
- selecting the most appropriate site from the potential sites
- finalizing and authorizing the selected site
- preparing the site
- selecting the site operator

2. SUMMARY OF THE METHOD

The IMPROVE aerosol sampler collects ambient aerosols on a variety of substrates for the analysis of elemental, ion, and carbon species involved in visibility impairment. The data collected provide information for calculating trends in visibility and tracking sources of visibility impairment in Class 1 areas such as National Parks and Wilderness Areas.

The IMPROVE aerosol sampler collects ambient PM_{2.5} and PM₁₀ aerosol samples every third day, beginning at midnight and sampling for 24 hours. The sampler is designed simply and ruggedly in order to withstand ambient field conditions and to make operation and maintenance easy.

To assure consistent quality data and to minimize data loss, aerosol sampling sites are selected to meet most if not all of the following criteria. The site must —

- Be removed from local sources, such as diesel, wood smoke, automobile emissions, road dust, or construction.
- Adhere to siting requirements conducive to regional aerosol sampling; including inlet height, an absence of interference in air flow from trees or buildings in a 30° cone above the sampler, and a minimum of 270° of free air flow around the sampler.
- Be located at a site where aerosols are representative of regional, not local, visibility conditions.
- Be secure from potential vandalism.
- Have an operator available to service the site.
- Be accessible during all months of the year.
- Be near ambient outdoor temperature (e.g., no air conditioning or active heating).

After the site is selected, the local Federal Land Manager (FLM) will normally obtain permits and have power, as well as a shelter or a rack, installed at the site. UC Davis will ship the sampler to the site. Once these tasks are completed, UC Davis personnel will

travel to the site, install the sampler, and train the site operators. The sample changing by the site operator will require about 20 minutes per week, plus transit time to the site.

3. DEFINITIONS

- FLM: Federal Land Management
- IMPROVE: Interagency Monitoring of Protected Visual Environments; Federal PM_{2.5} and PM₁₀ sampling network directed by the National Park Service, with sites located principally in remote rural areas.
- NEC: National Electric Code
- PM: particulate matter
- SOP: standard operating procedure
- UCD/UC Davis: University of California, Davis

4. HEALTH AND SAFETY WARNINGS

Be aware that various stinging insects, venomous creatures, and large mammals (such as bears) can be found at many of the IMPROVE sites. Be cautious when stepping in tall grass surrounding a site or when opening pump boxes.

Inclement weather is often an issue at many IMPROVE sites. If severe weather is impending, wait it out in the vehicle or reschedule visiting the site.

Always carry a first aid kit when working in the field.

Many IMPROVE sites are located in restricted or limited access areas. Be sure to communicate visit to the site with the proper local authorities.

Some IMPROVE sites are remote and require hiking to the site or driving off-road. Be sure to have detailed maps of the area when walking or off-road driving.

Many IMPROVE sites do not have cellular reception. Take this into consideration when planning visits.

5. CAUTIONS

IMPROVE Sites are expected to be visited at least once a week by the Site Operator. The chosen location must be easily accessible all year, even in snow and rain.

IMPROVE Sites require stable grid power 24/7. All electrical installations must meet NEC guidelines for safety and be code compliant.

Any structure built for the purpose of housing the air samplers must be securely anchored to the ground. Several improve sited have been destroyed due to falling over in high wind events.

6. INTERFERENCES

Local sources of particle emissions will cause large relative errors in sampling concentrations, especially at sites with low total conventions. Care must be taken during site selection to avoid local pollution sources as much as possible. Sites next to maintenance yards, active campgrounds, parking lots, and busy highways should be avoided as much as possible.

7. PERSONNEL QUALIFICATIONS

This section describes the responsibilities of the individuals involved in Site Selection for the IMPROVE Aerosol Sampling Network.

7.1 Project Manager

The project manager will —

- Prepare project specific siting and operational objectives, guidelines, and considerations.
- Select the most appropriate site for the aerosol samplers based on the criteria described in the SOP.

7.2 Field Specialist

The field specialist will —

- Initiate the search for potential sites by sending pertinent siting criteria and associated siting materials to a local contact.
- Maintain communications with the local contact during the field survey of potential sites, verifying that all potential sites have been identified and thoroughly evaluated and that all materials are returned for review in a timely fashion. The actual field survey may be performed by the local contact, the field specialist, or both.
- Review potential sites with the project manager.
- Work with the local contact to obtain permission from private or public landowners for permanent access to the aerosol sampling site.
- Work with the local contact to obtain permission to perform any special site preparation that may be required.
- Work with the local contact to identify a local site operator to service the equipment.

- Maintain careful records in permanent files and in the site database on all site selection information.
- Provide detailed specification and guidance to the local contact in selecting, planning, and constructing the sampler mount.

7.3 Local (on-site) Contact

The local contact will —

- Review the technical and monitoring requirements provided by the field specialist.
- Identify potential sites.
- Maintain communication with the field specialist during the field survey of potential sites.
- Photograph and document potential sites, providing a set of digital photos showing each potential site, as well as the views from the sampling site toward the north, south, east, and west.
- Document the selected site location(s) on a topographic map; measure the latitude, longitude, and elevation using an electronic GPS device.
- Identify and contact local landowners, primary contacts, and operators regarding site installation and routine maintenance requirements.
- Prepare a list of known local sources affecting the air in the area of interest.
- Provide information about the availability of AC power and telephone service in the area of interest.
- Provide information regarding available internet service at site (if any) including cellular service, wired, and wireless connections.
- Prepare the selected site, including arranging for electrical power at the site, and provide a shelter or mounting rack to house the sampler.

8. EQUIPMENT AND SUPPLIES

The following materials are required to complete the site selection process:

- maps
- a digital camera to photograph the proposed site and surrounding areas
- an electronic GPS device with an elevation readout
- a list of monitoring requirements and the associated IMPROVE monitoring equipment
- a list of local sources affecting the air in the area of interest
- information about the availability of AC power, telephone service, internet, and cellular coverage for associated monitoring equipment

9. PROCEDURAL STEPS

9.1 Description of the IMPROVE Sampler

The IMPROVE sampler is designed to obtain a complete signature of the composition of the airborne particles affecting visibility. PM_{2.5} particles are collected on Teflon[®], nylon, and quartz filters and PM₁₀ particles on a Teflon[®] filter. Each filter is in a separate module, as shown in Figure 1. The PM₁₀ module is on the right with the larger inlet head, and the inlets are normally 24 inches apart. The controller module is the box with no inlet. The analytical measurements are shown in Table 1.

Figure 1. Photo of the IMPROVE Aerosol Sampler.



Table 1. IMPROVE aerosol measurements.

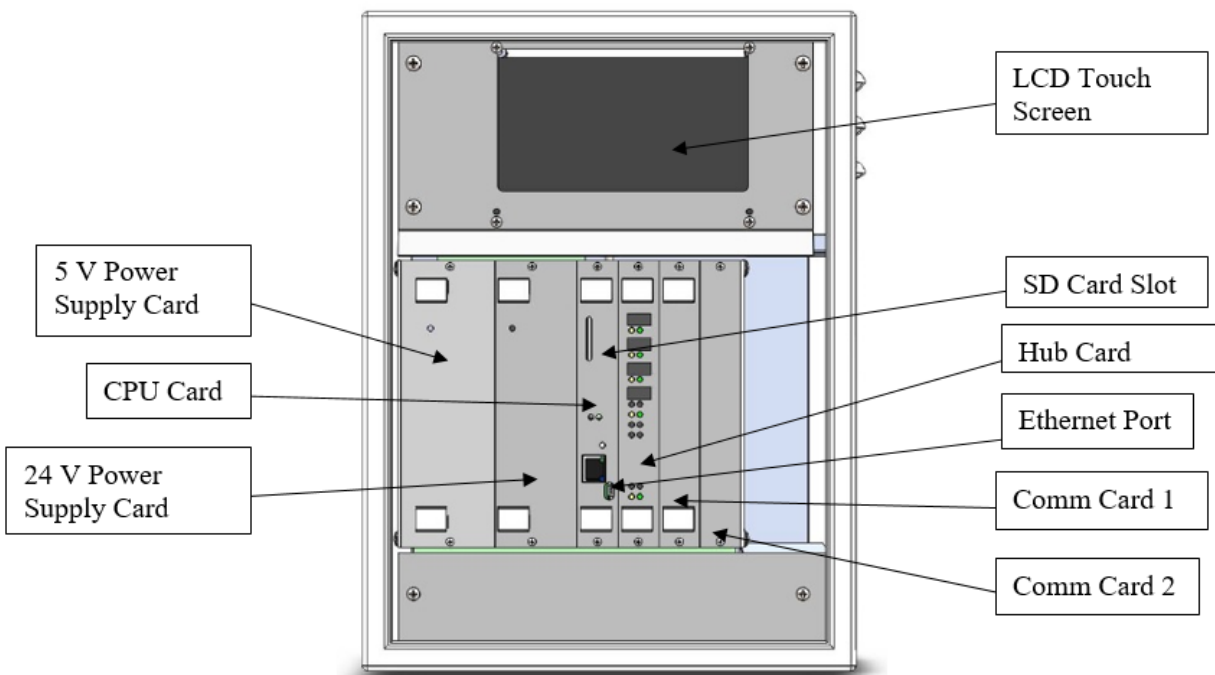
| Module | Particle Size | Filter | Analytical Measurement |
|--------|-----------------------------|---------------------|---|
| 1A | PM _{2.5} particles | Teflon [®] | mass, optical absorption, elemental (H, Na-Pb) |
| 2B | PM _{2.5} particles | nylon with denuder | nitrate, sulfate, chloride |
| 3C | PM _{2.5} particles | quartz | organic and elemental carbon |
| 4D | PM ₁₀ particles | Teflon [®] | PM ₁₀ mass |

The IMPROVE aerosol sampler consists of the following —

- A controller. The controller module contains a microprocessor to start and stop sample collection and record the flow rates for each module continuously. The controller module measures 16” x 12” x 7” and weighs 30 pounds. The controller has an LCD touchscreen, a slot for a removable SD memory card and four panel mount USB interface slots. Included with each controller is a USB network

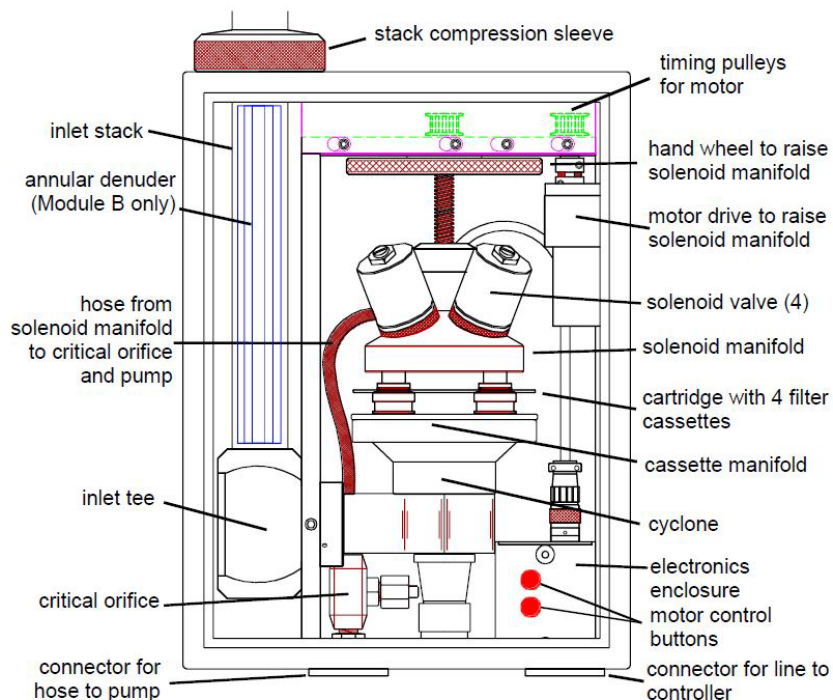
interface device specific to the service available at the site. A schematic of the controller module with the cover open is shown in Figure 2.

Figure 2. Schematic of the IMPROVE controller module.



- Three PM_{2.5} modules (1A, 2B, 3C). Each module measures 16 inches by 12 inches by 7 inches and weighs 40 pounds. A schematic of a PM_{2.5} module with the cover open is shown in Figure 3.
- One PM₁₀ Module (4D). This module is the same as a PM_{2.5} module, except the internal components are rearranged to remove the cyclone and the inlet is replaced by a commercial PM₁₀ impaction inlet.
- Four vacuum pumps to provide air flow through the filters. Each pump measures 12 inches by 7 inches by 9 inches, weighs 25 pounds, and draws about 3.2 amperes of power at 120 volts. The pumps will generally be on the floor of the shelter or in a closed compartment for outdoor stands. The complete sampler requires 120-volt, 60-hertz AC power on two 20-ampere circuits.
- An additional module (at selected sites) for quality assurance. Additional modules will require additional vacuum pumps rather than the standard four.

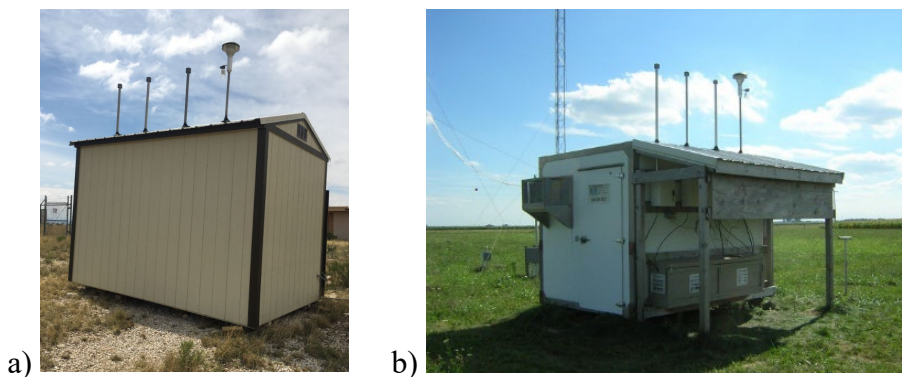
Figure 3. Schematic of a PM_{2.5} module.



A shelter or mounting rack to house the sampler is to be provided by the host agency. UC Davis will supply detailed specifications and guidance to the local staff in selecting, planning, and constructing the sampler mount. IMPROVE samplers are typically mounted in one of three configurations, as shown in Figure 4 and labeled accordingly:

- ambient temperature shelter like a Tuff[®] shed (not heated or air conditioned)
- outside, mounted on the side of an existing shelter or building.
- outside, on a rack built expressly for the IMPROVE sampler

Figure 4. Three possible mounting configurations for the IMPROVE sampler.





9.2 Operator Interaction with the Sampler

The samples for all sites in the IMPROVE network are changed every Tuesday by a local site operator and takes approximately 15 to 30 minutes. The site operator receives a box with all the necessary filters, an SD memory card, and a field log sheet. For more detail, see *UCD SOP #201: Sampler Maintenance by Site Operators*. The steps for the change are as follows —

1. The operator presses the appropriate buttons on the touchscreen to read and display the flow rates for the exposed filters in the sampler. The operator records the displayed values on the log sheet.
2. The operator removes the cartridges of exposed filters from each module, seals them in the provided bag, and places the bag in the shipping box for these samples. The operator removes the memory card from the controller every three weeks and places it in the same shipping box.
3. The operator inserts the cartridges of clean filters in each module and a new memory card every three weeks in the controller.
4. The operator presses the appropriate buttons on the touchscreen to read and display the flow rates for the clean filters. The operator records the displayed values on the log sheet.
5. The operator verifies that the readings are reasonable. The controller will also check sensor values and flow rates and flash a warning if there are problems.
6. The operator records any relevant notes on the log sheet (fires, missed sample changes, bad sample changes, dropped filters, and problems).
7. The operator then returns the shipping box with exposed filters, the completed log sheet, and the old memory card to UC Davis.

If problems are encountered, the operator will be asked to call the IMPROVE hotline at (530) 752-1123 immediately while at the site and troubleshoot the samplers with the assistance of a UC Davis technician. It may be necessary for the operator to visit site more than once a week in the event of an equipment issue.

9.3 Methods

This SOP is sent to the local contact to initiate the site selection process. The local contact fills out the photographic log and the site evaluation form in Appendices A and B. A digital camera and a GPS device can be sent to the local contact if these devices are not available.

9.3.1 Location of Prospective Sites

The lead role in the selection of prospective sites is normally assumed by the local FLM and the state and/or local air quality agency, but the national or regional FLM may want to participate.

Site selection begins with the process of locating potential sites in the monitoring area of interest. Specific siting criteria should be obtained from the project manager. This information may include regional or site-specific program objectives and meteorological conditions of the monitoring area, as well as other considerations. Potential sites may be located from maps and through consultation with a local contact familiar with the monitoring area of interest.

The site should not be located in areas subject to unusual aerosol transport conditions. There should be no local pollution sources or unusual meteorology. The aerosols at the site should be representative of the regional air mass.

The site criteria fall into three categories: (1) the site must represent nearby Class I areas; (2) the site should be regionally representative, avoiding local pollution sources or areas with unusual meteorology; and (3) the site must avoid nearby obstacles that could affect sample collection. In most cases, the criteria are based on EPA guidelines. The criteria are not absolutes; a site that falls slightly outside a criterion may be the best choice. Significant variances from any criterion should be well documented and will be reviewed by the IMPROVE steering committee before the site is installed. The following criteria should be used as guidelines in selecting the specific location of a sampling site.

1. If a site is intended to represent Class I areas, it must meet the following criteria:
 - a. The distance between the site and the closest portion of all Class I areas should not be greater than 100 kilometers. A smaller distance would be desirable. Note that the closest site may not be the best site.
 - b. The elevation of the site should lie between the highest and lowest elevations of all Class I areas to be represented. Site exceedances that meet this criterion can be up to 10% of site elevation or plus or minus 100 feet, whichever is greater. Larger exceedances can be permitted if agreed to by the state(s) and FLM(s).

2. The site must avoid small valleys with non-representative meteorology. Valleys with towns or other emission sources should be avoided. Valleys without emission sources, but with significant inversions, should also be avoided. The site should not be located on ground that is not typical of the region.
3. The site must avoid all local sources of pollution.
 - a. Automotive sources:

| vehicle usage | distance between road and sampler |
|--------------------------------|-----------------------------------|
| < 10,000 vehicles per day | > 25 m between road and sampler |
| 10,000-20,000 vehicles per day | 50 m between road and sampler |
| 20,000-40,000 vehicles per day | 75 m between road and sampler |
| > 40,000 vehicles per day | > 100 m between road and sampler |

- b. Combustion sources:

Avoid any areas influenced by diesel generator emissions, wood smoke, or incinerators.

- c. Dust sources:

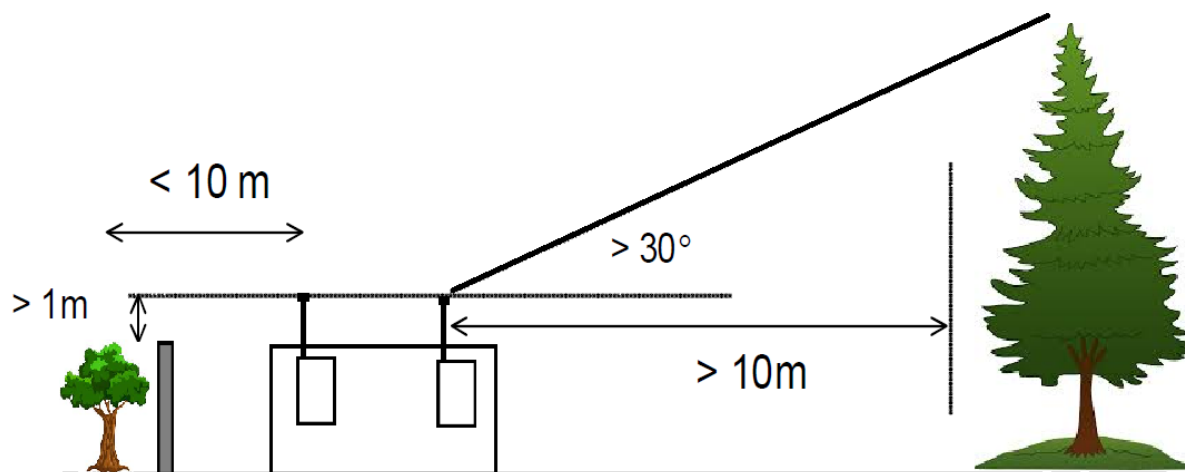
At least 400 meters from a large potential source of dust, such as a landfill, agricultural operations, or an unpaved road with more than 400 cars per day.

4. The site must not have large obstructions such as trees or buildings that would hinder the sampling of regional representative aerosols. If necessary, the sampler could be placed on a platform to clear obstructions or to stay above any snow pack.¹
 - a. There should be unrestricted airflow for an arc of at least 270 °. The predominant wind direction must be in the unrestricted 270 °. In practice, having unrestricted flow in all directions is preferable.
 - b. ***Within 10 meters*** of the sampler, any solid barriers or trees should be at least 1 meter below the inlet, as shown on the left side of Figure 5.

¹ Raising the height of the inlet by increasing the length of the stack beyond the standard 2 m is not recommended, although theoretical calculations show no significant loss of particles on the wall of a stack much longer than 2m. (For a 1% loss of particles larger than 0.3 µm, the stack length would have to be over 250 m.)

- c. In general, a pole or meteorological tower will not be a solid barrier. A solid barrier is defined as any object that subtends more than 10°. (Example: hold a ruler at arm's length [24 inches]; if the object subtends more than four inches, it is a solid barrier.)
 - d. ***Beyond 10 meters*** of the sampler, the solid barriers or trees should not be higher than 30° above the horizontal with respect to the inlet, as shown on the right side of Figure 5. (Example: hold a ruler at arm's length [24 inches]; 30° is a height of 14 inches.)
- 5. If possible, all other samplers located at the site should use brushless pump motors (high-volume samplers often use motors with brushes that can result in high copper emissions). If brush pumps exist, the Project Manager should be notified and provided with the sampler specifications and the sampling schedule. The Project Manager will devise a site-specific approach for minimizing the effects of pump emissions.
- 6. The site must have electrical power (2 circuits; 120-volt, 60-hertz, 20-amperes). If new power must be installed, it is anticipated that the local FLM will be able to obtain the necessary financial resources. The Steering Committee will consider exceptions.
- 7. The site must be accessible for a weekly sample change in all but the most severe weather conditions.
- 8. The site should be located near existing particulate monitoring stations to provide continuity to the data set whenever possible.
- 9. The sampler inlets must be located between 3 and 4 meters above the ground, and at least 1 meter above the shelter roof or above any other obstruction within 10 meters of the inlets. The spacing between inlet stacks must be at least 24 inches.
- 10. There must be an available and reliable site operator.
- 11. The site should be secure from potential vandalism.
- 12. The sampler modules should be at ambient temperature and humidity (no active heating or cooling).
- 13. There should be local land manager or landowner cooperation.

Figure 5. Schematic of location with respect to trees and solid barriers.



9.3.2 Documentation of Prospective Sites

Once potential sites meet the siting criteria listed above, the local FLM manager – or other persons leading the initial search – will send photos, sketches, internet/cellular coverage, and siting information for each potential site to UC Davis. A summary will be distributed to all parties involved in the selection.

1. **Photographic:** The local FLM manager will complete and return the requested documentary photographs along with the attached photographic log (see Appendix A: Photo Log). The following photos will facilitate site selection:
 - a. Photographs taken from north, south, east, and west; with the prospective site in each view.
 - b. A photograph of the 120-volt power source in relation to the proposed site.
 - c. Close-up photographs of the location proposed as a sampler site.
 - d. Photographs of the four walls inside the existing building, if an existing building is proposed to shelter the sampler.
 - e. Photographs of any air quality or meteorological monitoring equipment located nearby.
 - f. Any additional photographs that may be beneficial in preparation for the sampler installation.
2. **Written:** The local FLM manager will complete and return the site evaluation form for each potential site, using a separate copy of the blank form for each potential site (see Appendix B: Site Evaluation Form for Potential Sites).

- a. The local FLM manager should fill out the information at the top of the form. Include as much information as possible.
- b. The local FLM manager should provide a sketch of the proposed sites on the reverse side. List approximate dimensions (including height). Also include distances between buildings, fenced compounds, obstructions, etc.
- c. The local FLM manager should provide a map or sketch of how to get to each potential site from a main road.
- d. If possible, the local FLM manager should include a copy of a topographic map with all potential sites indicated.

When UC Davis receives the documentation and photographic log, UCD will check for completeness, evaluate the information for compliance with IMPROVE siting guidelines, and obtain any missing information from the local contact.

9.3.3 Final Selection of the Site Location

A joint decision must be made by all concerned parties as to where to locate the sampling site. The concerned parties will be the local FLM, the national and/or regional FLM, the state and/or local air quality agency in which the site is located, and UC Davis. If significant disagreements exist between the concerned parties, UC Davis will prepare a summary for the IMPROVE steering committee, discussing each siting alternative and the tradeoffs among them. The IMPROVE steering committee will work with the parties to reach a decision.

1. The UC Davis field specialist will prepare a packet on the site with the documentation for each of the potential sites.
2. UC Davis will provide this packet and recommendations to all concerned parties.
3. The UC Davis field specialist will coordinate the final selection of the site location. This will generally be done with individual telephone calls or a conference call. If this is unsatisfactory, the UC Davis field specialist will coordinate an on-site visit with all concerned parties.

9.3.4 Authorization for Site Use

The local FLM will complete the necessary paperwork required to use the site, install power, and build structures. Their duties will also include —

1. Obtaining any needed permission to use the property.
2. Preparing and submitting any necessary Environmental Impact Reports.
3. Obtaining any needed authorization to install and use electrical power. The FLM will normally be expected to pay for the electrical power used (an annual usage of approximately 7000 kilowatt hours is expected).

9.3.5 Site and Shelter Preparation

Once the specific location of an individual site has been agreed upon, the site must be prepared for installation of the sampling equipment. This primarily involves providing a structure and adequate electrical power. The local FLM manager will —

1. Supervise the installation of the shelter, or another agreed upon alternative (the cost of the shelter will be paid for by the local agency; the design specifications for the shelter will be provided by UC Davis).
2. Supervise the installation of the required electrical power (two 120-volt, 60-hertz, 20-amp circuits) at the site; the electrical line should be terminated with two fourplex outlets.
3. Notify UC Davis field specialist of approximate date when the site will be ready for sampler installation, with mandatory updates on electrical and structure completion.
4. Fill out and return the site information summary sheet. (See Appendix C: Site Information Form.) This is only for the final specific location.
5. Receive and record UPS shipments of the sampler and any additional installation equipment.
6. Arrange for transportation of equipment to the site before UC Davis personnel arrive.

The shelter for the IMPROVE sampler may take the form of a purpose-built shelter, a rack on the side of a pre-existing structure, or a free-standing rack. With each of these configurations, the sampling inlets should ideally be between 3 and 4 meters above ground, although exceptions are sometimes made when local conditions dictate. Each type of installation is described below.

9.3.5.1 *Mounting Within a Shelter*

IMPROVE samples are intended to be collected under conditions as close to ambient temperature as possible. Many sites experience severe weather or wind and it is preferable to mount the samplers within a shelter to minimize equipment damage and to protect the operator and samples from rain, wind, and cold during the weekly sample changes. The parameters for the shelter are as follows:

- The inside dimensions will be at least 6 feet by 8 feet and the shelter shall meet any requirements by the local FLM for appearance
- The shelter will be very well-ventilated and not heated or air conditioned. Exhaust fans on thermostats are recommended for summer months.

- The building must be anchored securely to the ground. Sites with high wind will need additional anchors and bracing to survive storms. The building roof should be able to support heavy snow loading if applicable.
- At some sites, with deep snow pack, the shelter may have to be installed on a platform, and extended inlets may be required to keep the inlets at least 1m above the typical winter snow pack. The siting criteria allow for this possibility.
- The shelter roof where the inlet stacks extend should be easily accessible from a ladder.

9.3.5.2 *Mounting On the Side of a Pre-Existing Shelter or Building*

Where a shelter or building already exists, it is sometimes convenient to mount the samplers on the side of the shelter. The parameters for this type of mounting are as follows:

- The sampler should be located just below the roof level, with the inlets extending at least 1 meter above the peak of the roof. The sampler should be at eye level or lower or a platform or ladder should be in place to permit sampler servicing.
- The sampler inlets should be easily accessible from a ladder at time of site maintenance. High roofs with steep pitches can be a safety issue for the technicians who clean the stacks.
- It is recommended that the roof extends 1 meter over the samplers to cover the operator when performing sample changes in the rain. If not, it is recommended to extend the roof or install an awning or cover.
- The inlets should be at least 24 inches from any other equipment located at the site.

9.3.5.3 *Mounting On an Outdoor Rack*

Where no existing structure exists, an outdoor wooden rack can be constructed. UC Davis can provide the plans for a rack, built from commonly available lumber and typically mounted on concrete post bases. The parameters for this type of mounting are as follows:

- The footprint of the rack is 4 feet by 8 feet, and an experienced carpenter would be able to assemble it in roughly 2 to 3 days.

- The rack includes an enclosure designed to house the vacuum pumps for the sampler. It is critical that this enclosure is built water resistant, but also well vented.
- The rack should be assembled according to the detailed specifications provided in Appendix E although adjustments can be made to best fit building practices in that area.

9.4 Selection of a Site Operator

Only one primary site operator is required but backup operators must be trained and available to cover for the primary operator in cases of planned and unplanned absences. The operator(s) should have some technical expertise, but this does not mean that any operator must have had previous experience in aerosol monitoring. The most important qualification is that the operators be motivated and responsible. It is essential that the operators have adequate time to pay particular attention to the sample changing duties every week. Sometimes this may involve using local personnel in unrelated work areas or contracting the work duties to an outside contractor. This type of arrangement offers the best recovery rate in situations in which air quality personnel are far away from the site, required to travel often, or already perform too many duties.

IMPROVE site operator duties include —

- Reviewing the IMPROVE sampler manual and attending a one-hour training session at the site on the day of sampler installation.
- Meeting with UC Davis personnel during the biennial site maintenance trip. The site maintenance visit will generally occur in the spring or summer. Site operators will be contacted directly two to three weeks before a visit by UC Davis personnel.
- Receiving and inventorying the blue transport boxes (containing the filter cassettes), which are shipped by UPS to and from the sampling site and the filter handling laboratory at UC Davis. The boxes are labeled by site and sample week date with prepaid mailing labels.
- Shipping the used filter cassettes back to Davis via UPS in their blue transport box after they are exposed in the sampler.
- Performing weekly sample changes. This requires 15-30 minutes at the site every Tuesday. The changing can be done at any time during the 24-hour day. The time estimate includes troubleshooting and documentation duties, but does not include travel time to site. In some cases, troubleshooting could require up to two hours, perhaps with multiple visits to the site, to diagnose and repair problems. Telephone assistance will be provided by the UC Davis laboratory whenever there are problems. Multiple visits in one week may be required in the
- Performing a flow rate flow check or flow adjustment of each filter module can be required for troubleshooting purposes. This takes approximately 30-60 minutes. Instructions and equipment will be provided by mail.

- Performing necessary repairs, usually in the form of replacing problem equipment and/or replacing problem components.
- Keeping the site adequately clean to avoid filter contamination and to discourage wildlife from nesting at the site.
- Maintaining the structure in good working order. Over time minor building maintenance will be necessary such as replacing roof shingles, fixing door hinges, and painting or patching wall panels of the shelter. Major structural issues need to be reported to the host agency for repairs.

9.5 Installation and Operation of Samplers

- The local FLM manager and the UC Davis field manager will arrange a two-day time period when UC Davis personnel can install the IMPROVE sampler at the site.
- The local FLM will direct the UC Davis technician to the location of the shelter and the previously shipped sampling equipment.
- After the site set-up is completed, the site operator(s) will attend a one-hour training session on sampler operating procedures at the site.
- The operation of the site will typically begin immediately.

9.6 Relocating IMPROVE Sampling Sites

Occasionally it will become necessary to relocate an IMPROVE sampling site. The rationale and procedures for site relocation are described in Appendix D. In some cases, the site will need to be renamed once it is moved. The convention for renaming, using the nomenclature in Appendix D, is:

- A site that had a minor site relocation keeps its four-letter code and number.
- A site that had a moderate site relocation gets a new number but keeps the same four-letter code.
- A site that had a significant site relocation gets a new name and a new four-letter code.

10. DATA AND RECORDS MANAGEMENT

10.1 Local FLM Documentation

The local FLM is responsible to keep all paperwork associated with the land and operator. These include but are not limited to:

- Any contract with landowner regarding the use of the land.
- Written contract with site operator if the site is serviced by an independent contractor.

- Keep updated contact information for all personnel related to the air monitoring. UC Davis must be updated with any organizational or personnel changes when they occur.

10.2 UC Davis Documentation

UC Davis is responsible for storing all documentation related to the sampling set up at the site. This includes:

- All photographs taken at the site during site set up and updated photographs taken at site maintenance. These are to be clearly labeled and organized by year.
- Contact information for the site operator and backups including email and phone numbers. UC Davis is responsible for updating this information when notified of changes.
- Equipment information for site after installation and maintenance. This includes serial numbers, inventory tags, calibration forms, and detailed descriptions for the equipment layout of the site. This topic is covered in more detail in TI 226A: Site Maintenance for Field Technicians.

11. QUALITY ASSURANCE AND QUALITY CONTROL

Not applicable.

12. REFERENCES

See attached forms below.

PHOTO LOG

POTENTIAL SITE #1 NAME: _____

| Photo # | Date | Time | Description/Comments |
|---------|------|------|---|
| | | | Photo from N. including site |
| | | | Photo from E. including site |
| | | | Photo from S. including site |
| | | | Photo from W. including site |
| | | | Photo toward N. from site |
| | | | Photo toward E. from site |
| | | | Photo toward S. from site |
| | | | Photo toward W. from site |
| | | | Photo of power source relative to site; include circuit breaker |
| | | | Photo of electrical outlets available |
| | | | Close-up of building or location from N. |
| | | | Close-up of building or location from E. |
| | | | Inside of building facing N. |
| | | | Inside of building facing E. |
| | | | Inside of building facing S. |
| | | | Inside of building facing W. |
| | | | Photo of nearby air sampling/meteorological equipment |
| | | | Photo of nearby air sampling/meteorological equipment |
| | | | Photos of any potential problems |
| | | | |

POTENTIAL SITE #2 NAME: _____

| Photo # | Date | Time | Description/Comments |
|---------|------|------|---|
| | | | Photo from N. including site |
| | | | Photo from E. including site |
| | | | Photo from S. including site |
| | | | Photo from W. including site |
| | | | Photo toward N. from site |
| | | | Photo toward E. from site |
| | | | Photo toward S. from site |
| | | | Photo toward W. from site |
| | | | Photo of power source relative to site; include circuit breaker |
| | | | Photo of electrical outlets available |
| | | | Close-up of building or location from N. |
| | | | Close-up of building or location from E. |
| | | | Inside of building facing N. |
| | | | Inside of building facing E. |
| | | | Inside of building facing S. |
| | | | Inside of building facing W. |
| | | | Photo of nearby air sampling/meteorological equipment |
| | | | Photo of nearby air sampling/meteorological equipment |
| | | | Photos of any potential problems |
| | | | |

SITE EVALUATION FORM

One form for each potential site (send completed form to UC Davis)

Site Name: _____

Site Access Constraints (4-wheel drive road, gates/locks, time of day/week/month/year): _____

Elevation (meters): _____

Latitude (GPS reading): _____

Longitude (GPS reading): _____

How were readings determined (GPS, topo map, etc.)? _____

Nearest City or Town: _____ Distance: _____ Direction _____

Potential for Vandalism: _____

Site area uses within 200 yards (type, dates of usage): _____

Average and Maximum snow depth at proposed site: _____

Is there any nearby air monitoring instrumentation (aerosol, meteorological, nephelometer, gaseous)? _____

If yes, describe type of instrument(s) and operating schedule: _____

If yes, describe location, distance and, direction from the proposed site: _____

Is 120 volt AC power available (distance; can be wired for two independent 20 amp circuits)? _____

Reliability of electrical power (i.e. history of power outages): _____

Is a telephone available nearby (distance)? _____

Is cellular service available nearby (Provider(s) and signal strength)? _____

Is local wired internet and/or wireless internet available nearby (type of internet, provider(s), distance from sampler)? _____

Percent of Ground Cover:

Site (within 200 yards.):

| | | | | |
|-------------|----------------|----------------|-------------|-----------------|
| _____ trees | _____ shrubs | _____ grass | _____ crops | _____ bare soil |
| _____ rock | _____ pavement | _____ building | _____ water | |

Local (200 yards–10 miles):

| | | | | |
|-------------|----------------|----------------|-------------|-----------------|
| _____ trees | _____ shrubs | _____ grass | _____ crops | _____ bare soil |
| _____ rock | _____ pavement | _____ building | _____ water | |

Regional (10 miles–100 miles)

| | | | | |
|-------------|----------------|----------------|-------------|-----------------|
| _____ trees | _____ shrubs | _____ grass | _____ crops | _____ bare soil |
| _____ rock | _____ pavement | _____ building | _____ water | |

Particulate Sources: Type/Distance/Direction

Site (within 200 yards.)

Fugitive Dust: _____

Combustion: _____

Other: _____

Local (200 yards–10 miles)

Fugitive Dust: _____

Combustion: _____

Other: _____

Regional (10 miles–100 miles)

Fugitive Dust: _____

Combustion: _____

Other: _____

Comments / suggestions: _____

Other:

On the back of this page:

1. Please draw a quick sketch of the proposed site. Indicate north, and include the dimensions of nearby buildings and the distances to prominent objects seen in the photos.
2. Sketch the route taken to get from a main road to the site.

Please send a topographic map (or photocopy) of the site area when you return this form.

SITE INFORMATION FORM

Single form for final site (send copy of completed form to UC Davis)

Site Name: _____ Class I area(s): _____

| Contact | Phone Information | e-mail |
|-----------------|-------------------|--------|
| Primary | home: | |
| | cell: | |
| | office: | |
| | fax: | |
| Backup 1 | home | |
| | cell: | |
| | office: | |
| | fax: | |
| Backup 2 | home: | |
| | cell: | |
| | office: | |
| | fax: | |

Comments: _____

Mailing Address: _____

UPS/FedEx Shipping Address (cannot be a Post Office Box): _____

Freight Address: _____

Site Access Route (directions): _____

Site Access Constraints (4-wheel drive road, gates/locks, time of day/week/month/year): _____

Elevation: _____ Latitude: _____ deg. _____ Min Longitude: _____ deg. _____ min. (to tenths of minute)

How were these readings determined (GPS, topo map, etc.)? _____

Topographic Map Name (1/25,000 or other appropriate scale): _____

(Please send or photocopy the topographic map that includes the site when you return this form)

Nearest City or Town: _____ Distance: _____ Direction _____

Potential for Vandalism: _____

Site Area Uses within 200 Yards: _____

Average and Maximum Snow Depth at Proposed Site: _____

Is there any nearby air monitoring instrumentation (aerosol, meteorological, nephelometer, gaseous)? _____

If yes, describe type of instrument(s) and operating schedule. _____

If yes, describe location, distance, and direction from the proposed site. _____

SITE RELOCATION GUIDELINES

There are a number of reasons for wanting to relocate a monitoring site including: poor initial siting (i.e., samples are thought to be unduly influenced by a local source), expected changes in the vicinity of the site that would result in poor siting (e.g. a new source to be located near the site), loss of access to the location (e.g. non-renewed lease), or to improve operator access where poor access has resulted in unacceptable data recovery. To be acceptable, any new site must meet the IMPROVE siting criteria as specified in the current version of the standard operating procedures.

Except when moving a site to correct poor initial siting (see below), the primary concern in relocating a monitoring site is to maintain continuity of the data for long-term trends analysis. The relocated monitor should produce mass and species concentrations data that are within measurement precision of those at the original location. The comparability of data from the original and relocated sites is preferred as a sample period by sample period basis. However, comparable quarterly or annual averaged data is also acceptable. It is useful to classify site relocations into three categories that characterize the degree of data comparability issues that are reasonably anticipated and hence the level of assessment activities that should be applied as part of the relocation process.

A **minor site relocation** would be one where the equipment is moved a short distance (in most cases less than a kilometer) to a site with similar exposure, elevation (compared to local terrain relief), ground cover and soil type, and distance to local sources. Minor site relocation should result in data that are comparable even on a sample period-specific basis (such as collocated samplers). As an example, a site might be moved from one location in a mountain top radio relay compound to another location within the compound to accommodate other needs for the original location.

A site relocation information document (described below) should be prepared by the particle monitoring contractor (UCD) in consultation with the local site operator a least one month in advance of the move and transmitted to National Park Service (NPS). NPS will transmit the document to the rest of the IMPROVE Steering Committee and the appropriate state air quality agency. The particle monitoring contractor is authorized to relocate the site after the information review period so long as any objections concerning the relocation are satisfied. The Steering Committee will decide in cases where unresolved issues are raised by this review process.

A **moderate site relocation** exceeds one or more of the criteria of the minor site relocation definition. This includes a move of moderate distance (in most cases less than 25 kilometers) to a site with similar exposure to major regional sources (i.e. generally the same direction and distance to major sources), and within the same broad drainage system (for sites in complex terrain). As an example, a site might be moved from a location near the valley bottom to another location half way up one of the surrounding mountains.

A site relocation information document should be prepared by the particle monitoring contractor in consultation with the local site operator a least one month in advance of the move and transmitted to NPS, who will in turn transmit it to the rest of the IMPROVE Steering Committee and the appropriate state air quality agency. Based upon review of the materials in the relocation information document, the Steering Committee in consultation with the appropriate state air quality agency may require a period of simultaneous sampling at both locations to determine the degree of comparability between the data sets. If the original and relocated sites meet the siting criteria, a moderate relocation should produce comparable data, with the possible exception of coarse mass and fine soil, due to differences in ground cover and soil type between locations. While efforts to minimize such differences by careful selection of the new site will be pursued, relocation to a site that may result in these differences can be approved with the understanding that the differences in the data will be assessed and documented.

A **significant site relocation** exceeds one or more of the criteria for a moderate site relocation, with a move that can be of significant distance (up to ~100km). A significant relocation will change the direction and distance from the original site's regionally important sources, the new site is considered regionally representative of the visibility-protected Class I Areas that were represented by the original site. For example, a site at one Class I Area that is supposed to represent a two or three Class I Area cluster is moved to another Class I Areas in the cluster that can be up to 100 kilometers distant. While they can be acceptable, significant site relocations are discouraged because they will likely result in incomparable data that will break any trend analysis. Comparability of data on a sample period by sample period basis is very unlikely, so quarterly and annual comparability is the goal in selecting a new site.

When a significant site relocation is anticipated, a site information document should be prepared by the particle monitoring contractor in consultation with the local site operator as early in advance of the move as possible and transmitted to NPS. NPS will transmit it to the rest of the IMPROVE Steering Committee and the appropriate state air quality agency. Simultaneous monitoring at the original and proposed new site should be conducted over a one-year period (this may be accomplished by sampling one month each quarter if cost or other concerns are raised). Final decision to relocate the monitoring site based upon the site information document as well as an assessment of the simultaneous monitoring data will be made by the Steering Committee in consultation with the appropriate state air quality agency.

Relocation for poor original siting does not require comparable data when original site samples are overly influenced by local sources. In some cases, it may be possible to remedy the situation by controlling the local source (e.g. pave the unpaved road, moving the trash burning activities much further away, etc.). If that approach is not possible, the site may need to be relocated.

There may be sites where local influence is suspected but not demonstrated (i.e., there is nothing obvious in the site's data to indicate impact from a nearby source). In such cases, if a minor site relocation can alleviate the concern, it should be accomplished following the process described above. If a moderate or a significant site relocation would be required, simultaneous monitoring at the alternative site is recommended prior to relocation as a means to determine the degree of

impact of the original site. If assessment of these data indicates that the local source has undetectable or only minor impact at the original site, then the site need not be moved.

For sites where the local source influence has been demonstrated by comparison of simultaneous monitoring data at a second site or by other means (e.g. comparison to other sites in the region), the site should be relocated to correct the poor original siting. A site relocation information document is required. The particle monitoring contractor should transmit it to the NPS, who will transmit it to the IMPROVE Steering Committee and appropriate state air quality agency at least one month prior to the relocation of the site. For significant site relocation, simultaneous monitoring at the original and new site may be required to document the differences between data from the two locations. The IMPROVE Steering Committee makes all decisions for a moderate or significant site relocation in consultation with the appropriate state air quality agency.

Site relocation information documents are prepared by the particle monitoring contractor as a means to document the need for site relocation and the likely degree of comparability of the original and proposed new site. All pertinent information concerning the original site and the reason for thinking that it should be relocated (see #1 and #2 below) is a required minimum for this document. Additional information concerning the proposed new site or sites (see #3 below) is needed as soon as possible and prior to deciding to relocate a site. In cases where simultaneous monitoring is required, a summary and assessment of this data will be added to the document (see #4 below). In some cases, this will be required before a final decision to relocate the site, while in other cases it may be added to the document after the relocation decision is made. The document will be a permanent record of the decision process that will be stored with other meta-data describing monitoring sites and equipment. All site relocations will be documented in the database and a new site name assigned.

Site Relocation Information Document Outline

1. Current site identification
 - a. Name and identification number
 - b. Operator organization
 - c. Regional map showing site location
2. Reason for relocation
 - a. Brief but complete narrative statement of the problem
 - b. Any actions taken to correct the problem prior to site relocation
 - c. Required or recommended timing for site relocation
3. Proposed new site(s) information
 - a. Regional map(s) with original and proposed new sites indicated
 - i. In areas of complex terrain, the map should include elevation contours
 - ii. If available, ground cover and soil maps should be included
 - iii. On a map that is of appropriate scale, show all known primary particle sources in the “near region” (defined as the area within circle with diameter of 4 times the distance between the current site and the proposed site centered on the point halfway between the two sites)
 - b. Give the horizontal and vertical distance between the current and proposed new site
 - c. Are the two sites in the same river drainage (acts like an air basin) and if not, how far away is a common drainage?
 - d. Soil types and land cover/use for the two sites
 - e. Characterize primary particle sources in the near region including estimates of source strengths or activity levels and key them to the source map
 - f. Requirements for establishing the new site (activities, cost & schedule)
 - g. Practical considerations for operating simultaneously with current site
 - h. Proposed site operator organization and any other operator arrangements (e.g. contract operator)
 - i. Based upon the information above, does the proposed site constitute a minor, moderate, or substantial relocation?
4. Simultaneous monitoring data summary and assessment (optional per Steering Committee decision)
 - a. Mean and standard deviation of the major reconstructed extinction components at each site by quarter and annual
 - b. Scatter plots and regression analysis of paired reconstructed extinction components for the two sites
 - c. Statistical test of significance for the difference of paired components between the two sites on a sample period specific, quarterly, and annual basis

SPECIFICATIONS FOR BUILDING AN OPEN SHELTER FOR IMPROVE MONITORING

(Appendix E is a separate PDF file)