An Overview of 2019 IMPROVE Sampler Technical System Audits

February 27, 2020
CIRA
Derek Day

Introduction

Technical System audits (TSAs) are conducted to ensure the Interagency Monitoring of Protected Visual Environments (IMPROVE) sampling sites are being operated in accordance with the Quality Assurance Project Plan (QAPP; http://vista.cira.colostate.edu/improve/wp-content/uploads/2020/02/IMPROVE-QAPP-Signed_3_2016_updated.pdf) and all relevant standard operating procedures (SOPs; http://vista.cira.colostate.edu/Improve/particulate-monitoring-network/).

The complete TSA consists of verifying that each sampler's coordinates, elevation, date, time, vacuum pressure, temperature, and the flow rate of each module are consistent with audit devices. The sampler stand is checked for safety, structural integrity and that it is configured for proper sample collection. Pictures of the sampler modules, sampler stand/building, and surroundings are taken. When the operator is available, the operator's sample change technique is observed to ensure that (s)he has adequate sampler and sample change knowledge. The site operators are asked about sampling safety concerns and about whether the current IMPROVE Operations Contractor (UC Davis) is providing adequate support to help the operator maintain high quality sampling at the site. The sampler siting criteria is reviewed to ensure the samples collected represent local ambient background conditions, as outlined in SOP 126: http://vista.cira.colostate.edu/improve/wp-content/uploads/2019/06/IMPROVE-SOP-126_Site-Selection_06.2019.pdf.

In 2016 personnel from the Cooperative Institute for Research in the Atmosphere (CIRA) at Colorado State University began conducting and overseeing the TSA program for the IMPROVE network. Personnel from EPA Region 2, and state personnel from CO, AZ, MO, DE, and WY have gone through an auditor training/certification program, which ensures audit consistency throughout the network. Certified auditors conduct audits in their respective states/regions. Since 2016, CIRA, EPA and state auditors have conducted 148 audits at 110 different IMPROVE sites (Figure 1). Audits at nearly all IMPROVE sites in the continental US are expected to be completed by the end of 2020.

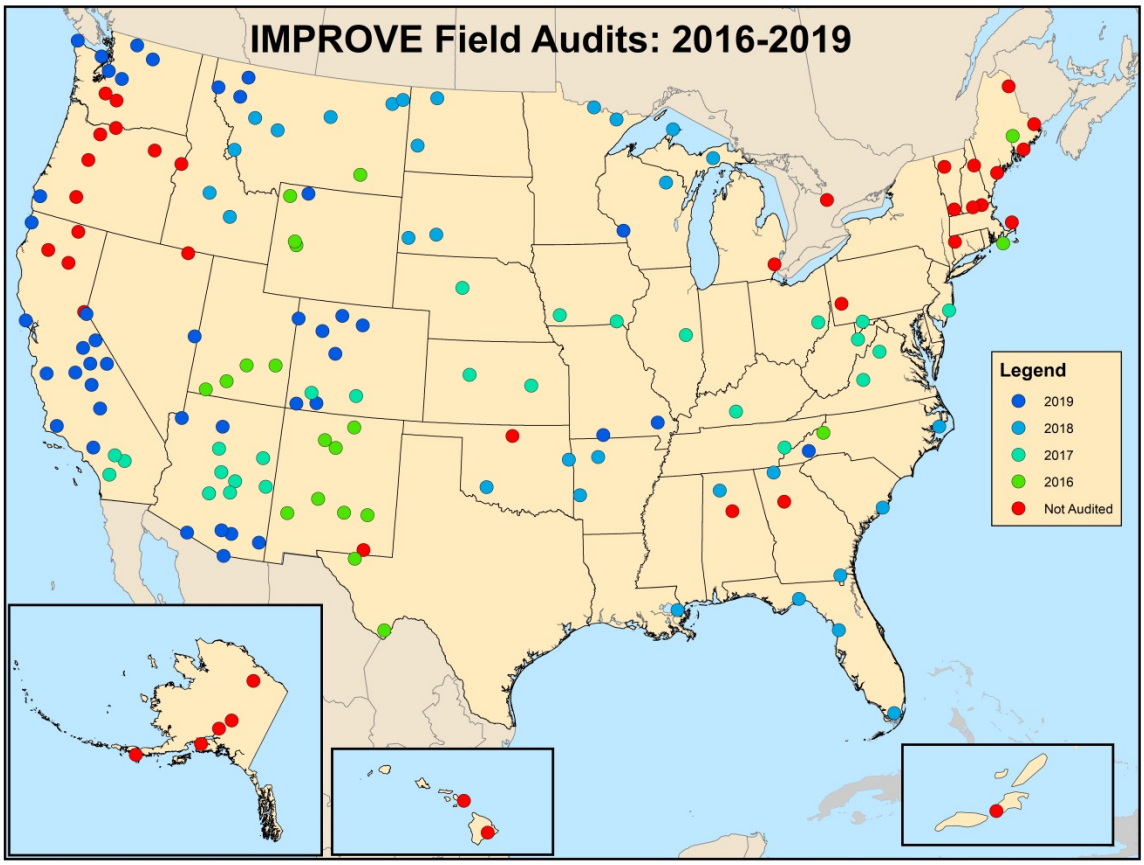

Figure 1. Map of all IMPROVE sampling sites. Shown are the year each site was audited and in red are the sites which have not yet been audited.

Results

During 2019, audits were conducted at 43 sites. The results of these audits are discussed in the following sections.

Sampler Flow Rate

The IMPROVE sampler consists of four separate channels which are commonly referred to as modules A, B, C, and D. Modules A, B, and C operate at a nominal flow rate of 22.8 liters/minute (lpm) and utilize a cyclone to achieve a 2.5 micron size cut. Module D operates at a nominal flow rate of 16.9 lpm and utilizes an impactor at the inlet to achieve a 10 micron size cut. Pressure transducers are used to measure the pressure drop across the cyclone for modules A, B, and C. Module D vacuum pressure is measured below the critical orifice/needle valve. The pressure transducers used in the network have been characterized and calibration curves generated to linearly relate measured pressure drops to sampler flow rates.

During an audit the IMPROVE sampler flow rate is compared to a NIST traceable reference standard. Most auditors use trical or tetraCal flow meters. For audits conducted by CIRA the flow rates were measured using a tetraCal flow meter which had been calibrated and certified by Mesa Labs. All audit devices undergo certification annually.

Modules fail the flow rate test if the audit device flow rate differs from the nominal flow rate by more than 10% as shown by the equations below.

NomDiff > abs[(22.8 - audit device flow rate)] / 22.8 * 100%. (For Channels A, B, and C)

NomDiff > abs[(16.9 - audit device flow rate)] / 16.9 * 100%. (For Channel D)

Modules will also fail the flow rate test if the audit device flow rate differs from calculated sampler flow rate by more than 10%.

%Diff > abs[(audit device flow rate - sampler flow rate)] / audit device flow rate * 100%

Results of audit flow rate checks are shown in Tables 1-4 and Figures 2-5. These figures show the nominal flow rate (solid blue lines), a 1:1 line between the audit device flow rate and the IMPROVE sampler flow rate (also shown in blue), and the allowed deviations from NomDiff and %Diff calculations shown in red. Note that any points outside the red polygon are failed flow rate checks. Statistics for each of these variables are given in the tables. Note that statistics are sorted separately for each variable, and do not represent the same sites. For example, in Table 1, the minimum percent difference (0.09647) and nominal difference (0.000) do not coincide with the minimum audit flow rate measured (20.61 LPM) or cyclone flow rate measured (20.33). These four values may represent four different sites.

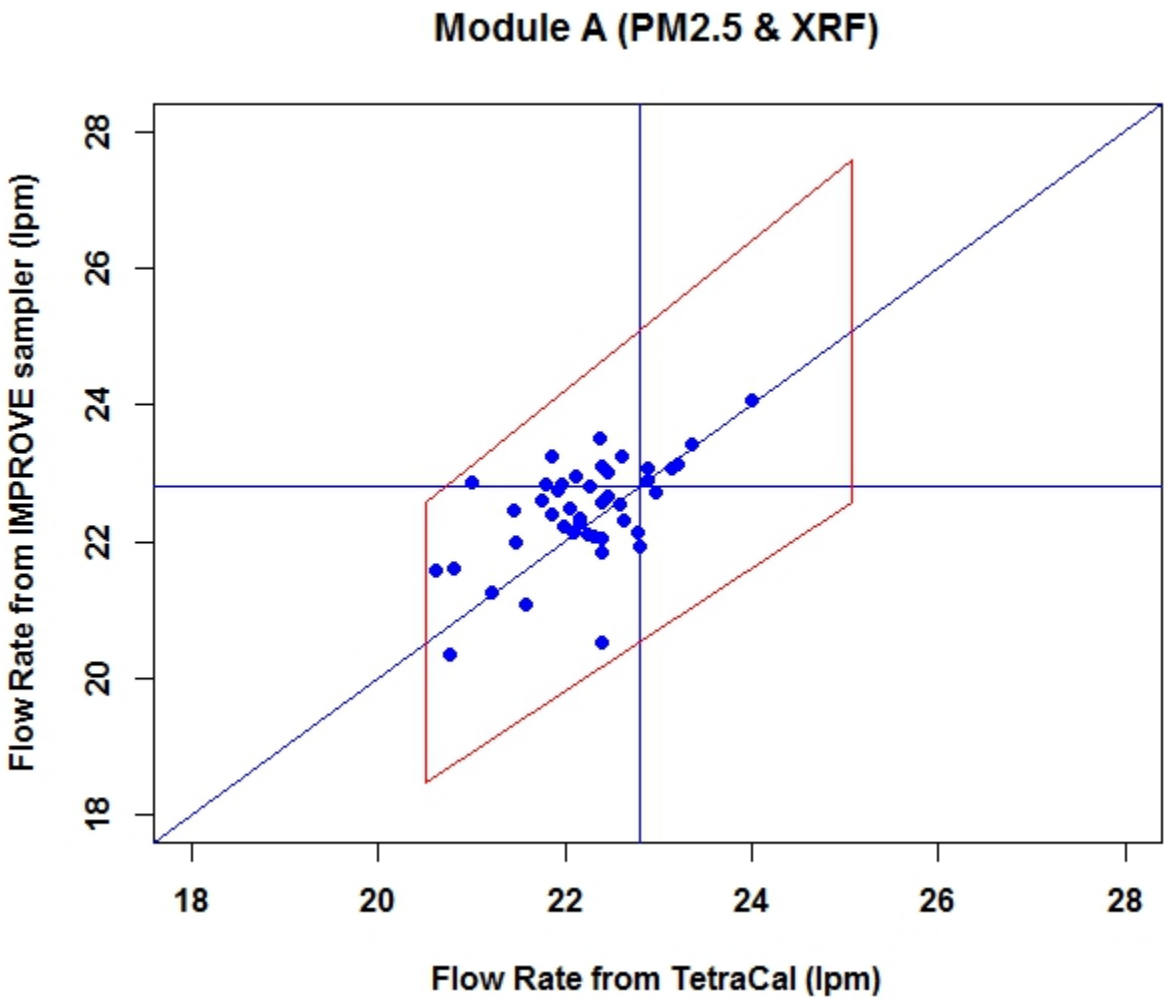

Figure 2. Module A flow rate comparisons between audit device and IMPROVE sampler for audits conducted in 2019.

Table 1. Summary statistics of Module A flow rates measured during audits conducted in 2019. A_Audit is the flow rate measured by the audit device, A_CYC is the flow rates measured by the IMPROVE sampler, %Diff designates the percent difference between the IMPROVE sampler and the audit device. Nomdiff designates the percent difference between the audit device flow rate and the nominal flow rate of the sampler.

Stat	A_Audit (lpm)	A_CYC (lpm)	%Diff	Nomdiff
Min	20.61	20.33	0.09647	0.000
1st Qu	21.86	22.10	0.78088	1.645
Median	22.27	22.54	2.36792	2.500
Mean	22.20	22.44	2.45908	3.213
3rd Qu	22.59	22.92	3.80528	4.276
Max	24.00	24.07	8.91033	9.605

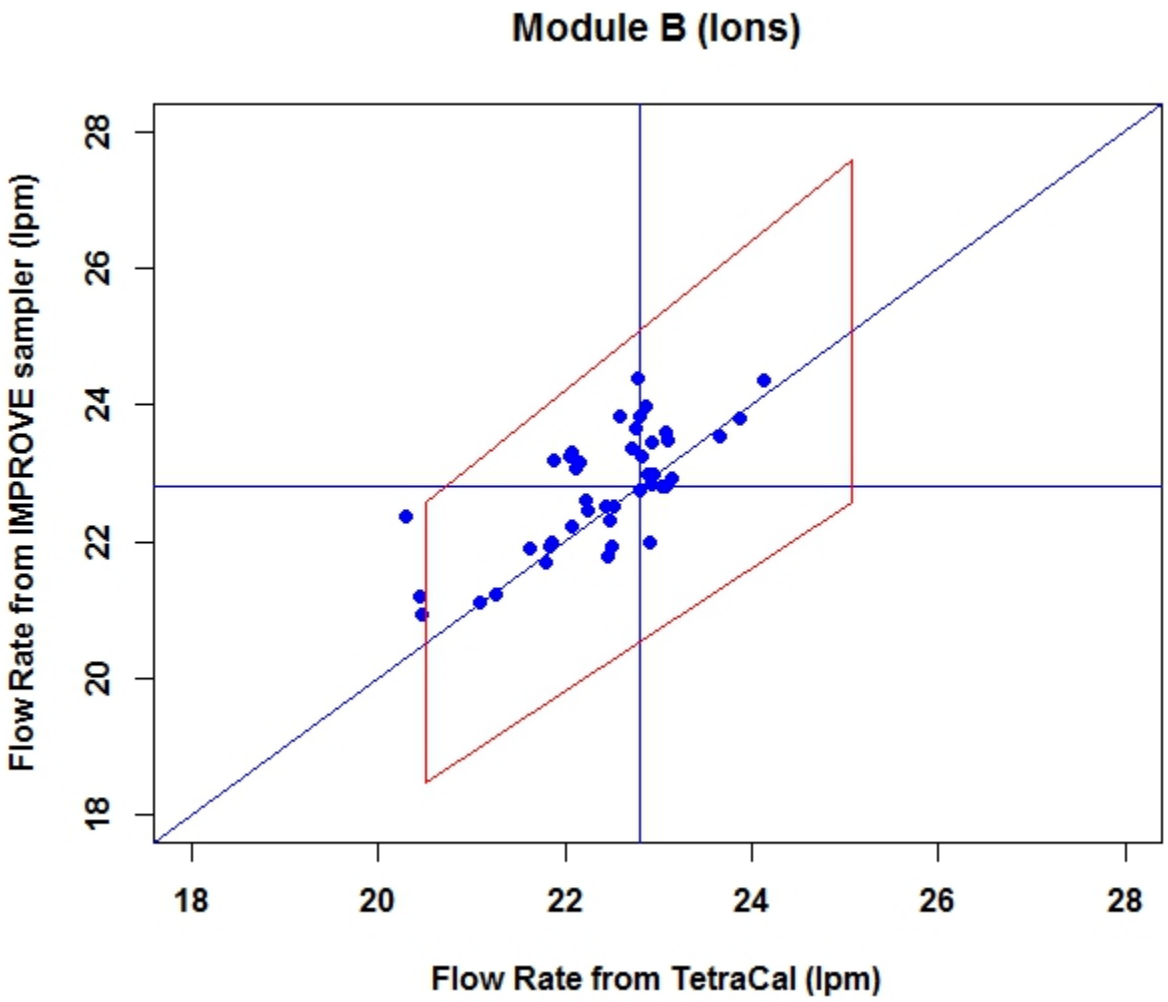

Figure 3. Module B flow rate comparisons between audit device and IMPROVE sampler for aud its conducted in 2019.

Table 2. Summary statistics of Module B flow rates measured during audits conducted in 2019. B_Audit is the flow rate measured by the audit device, B_CYC is the flow rates measured by the IMPROVE sampler, %Diff designates the percent difference between the IMPROVE sampler and the audit device. Nomdiff designates the percent difference between the audit device flow rate and the nominal flow rate of the sampler.

Stat	B_Audit (lpm)	B_CYC (lpm)	%Diff	Nomdiff
Min	20.30	20.94	0.0444	0.000
1st Qu	22.06	22.10	0.4695	0.636
Median	22.53	22.85	1.6916	1.491
Mean	22.41	22.77	2.3584	2.800
3rd Qu	22.91	23.41	3.9591	4.035
Max	24.14	24.40	10.1091	10.965

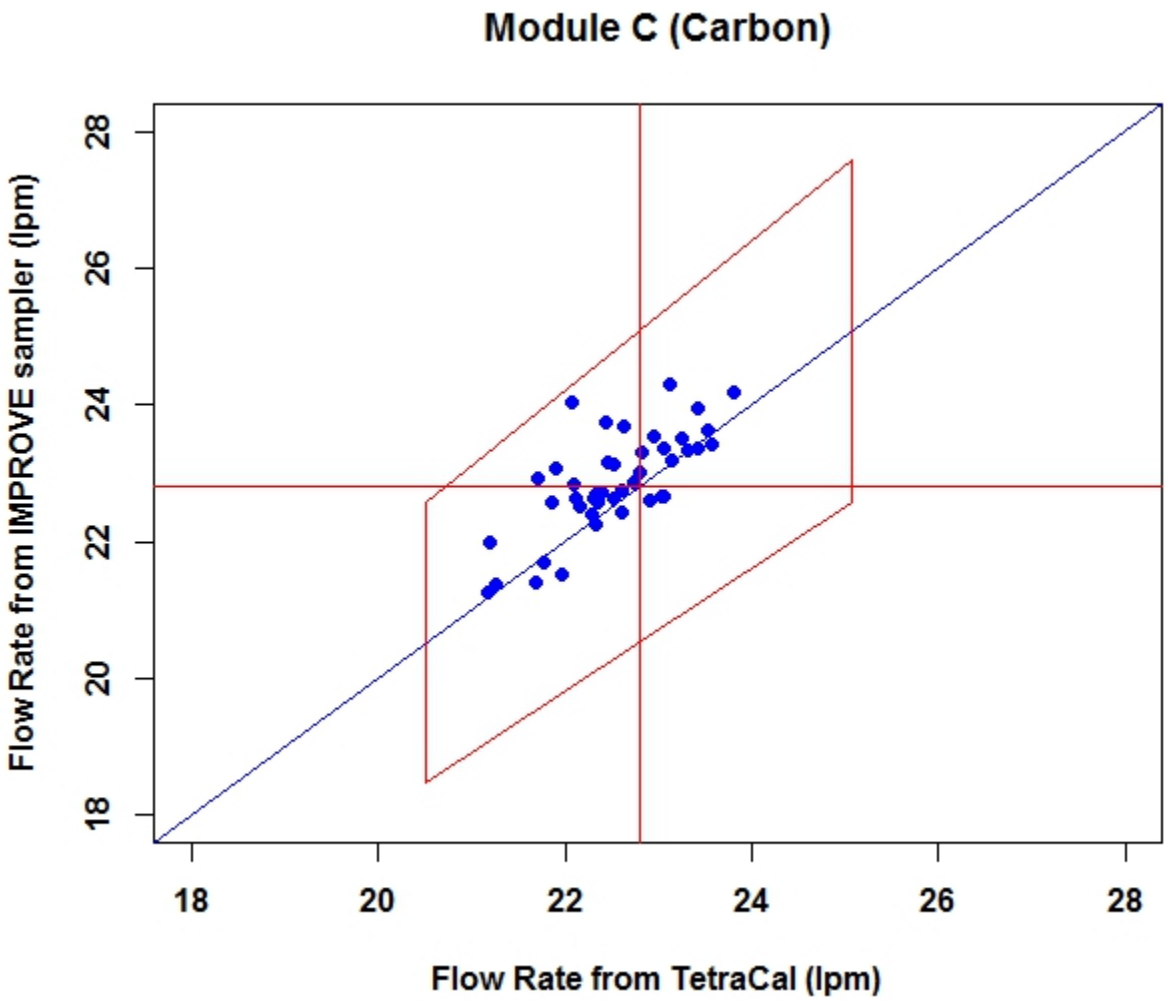

Figure 4. Module C flow rate comparisons between audit device and IMPROVE sampler for aud its conducted in 2019.

Table 3. Summary statistics of Module C flow rates measured during audits conducted in 2019. C_Audit is the flow rate measured by the audit device, C_CYC is the flow rates measured by the IMPROVE sampler, %Diff designates the percent difference between the IMPROVE sampler and the audit device. Nomdiff designates the percent difference between the audit device flow rate and the nominal flow rate of the sampler.

Stat	C_Audit (lpm)	C_CYC (lpm)	%Diff	Nomdiff
Min	21.18	21.25	0.01864	0.04386
1st Qu	22.11	22.58	0.55207	1.18421
Median	22.52	22.83	1.48968	2.06140
Mean	22.53	22.87	2.02109	2.50408
3rd Qu	23.04	23.36	2.60041	3.31140
Max	23.80	24.30	8.81928	7.10526

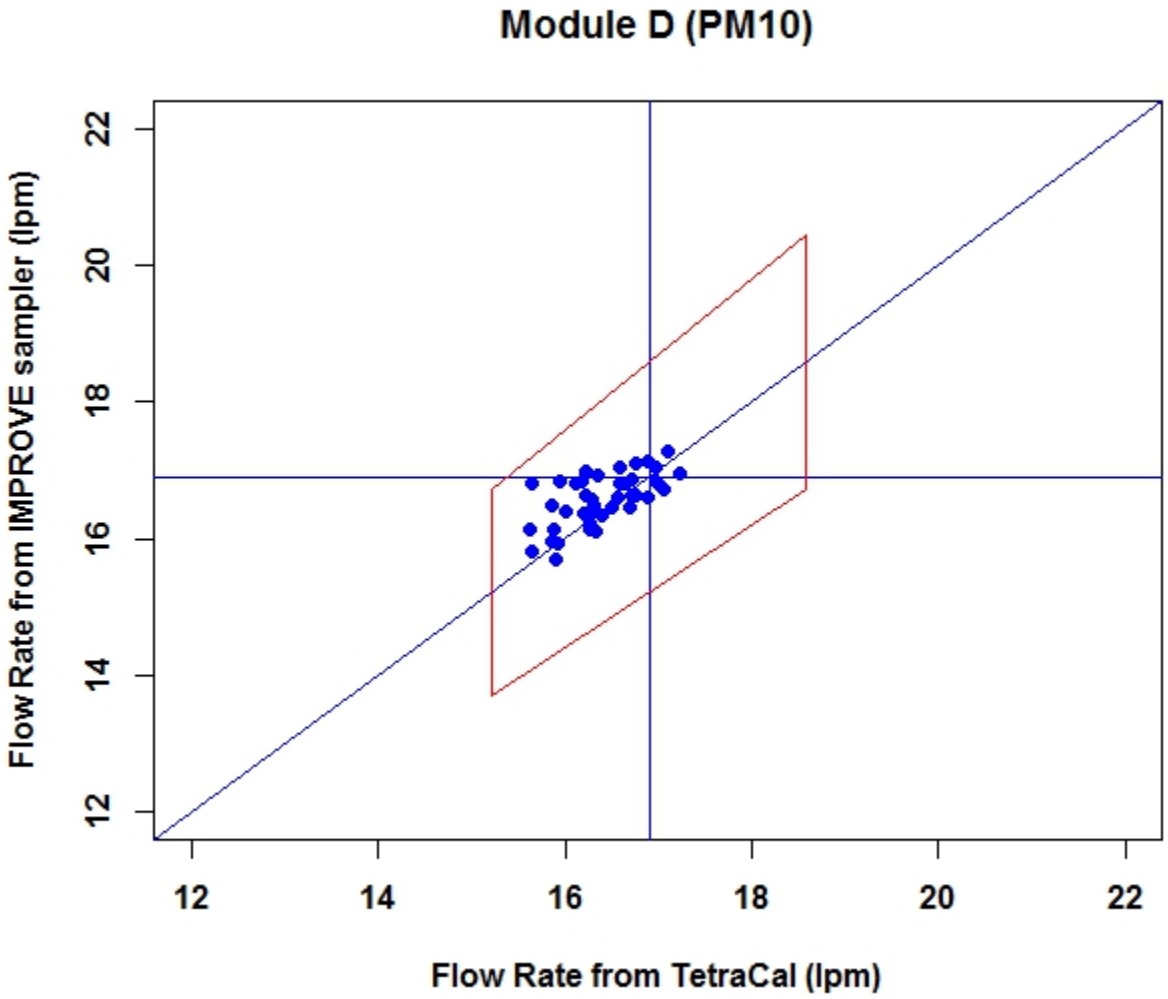

Figure 5. Module D flow rate comparisons between audit device and IMPROVE sampler for audits conducted in 2019.

Table 4. Summary statistics of Module D flow rates measured during audits conducted in 2019. D_Audit is the flow rate measured by the audit device, D_CYC is the flow rates measured by the IMPROVE sampler, %Diff designates the percent difference between the IMPROVE sampler and the audit device. Nomdiff designates the percent difference between the audit device flow rate and the nominal flow rate of the sampler.

Stat	D_Audit	D_CYC	%Diff	Nomdiff
Min	15.63	15.68	0.03233	0.05917
1st Qu	16.14	16.36	0.80161	1.21302
Median	16.33	16.63	1.39467	3.37278
Mean	16.40	16.57	1.78487	3.20077
3rd Qu	16.71	16.83	2.16508	4.46746
Max	17.23	17.27	7.29840	7.51479

Sampler Vacuum

The vacuum pressure is measured by starting a particular module's pump, closing a ball valve, which prevents air flow through the system, and then reading the orifice (ORI) transducer. This measurement is labeled MaxORI on the TSA form. It is indicative of pump strength, air leakage through the system, and proper transducer operation. The TSA test fails if the MaxORI pressure drop is less than 3.5 PSI; pressure drops of < 1 PSI are not uncommon. The TSA measurement is different from the MaxORI readings obtained during routine sample changes because the TSA test measures pressure drop through the entire sample train, while during routine sample changes the pressure drop is measured from the solenoids to the pump. There were vacuum pressure failures at Saguaro, Saguaro West, Meadview, and Olympic in 2019. In all cases, the IMPROVE MaxORI passed, while the TSA MaxORI test failed.

Temperature

The IMPROVE sampler temperature is monitored to accurately calculate sampler flow rates. During TSAs the sampler temperature is compared to the NIST traceable temperature of a BGI tetraCal Air Flow Calibrator. The TSA temperature fails if the temperature of the sampler and the tetraCal differ by more than 10 ˚C. There were no temperature failures for the 2019 TSAs.

Sampler Time

The sampler time is compared to cell phone time and is adjusted if the difference is greater than 5 minutes. There have been no time failures since the new controllers have been installed.

Sampler Integrity and Siting Criteria

The TSAs ensure the sampler stands are maintained such that routine access does not pose a risk to the operator, the IMPROVE modules are protected from direct sunlight, and sample changes are protected during inclement weather. The IMPROVE modules are checked to ensure they are fastened securely to the structure, and inlet stacks are seated properly into each module. Electrical wiring and connections are visually examined and photos are taken. Problems are reported to the proper regional personnel and noted in the TSA notes section. The IMPROVE sampler siting criteria are thoroughly explained in SOP 126 (http://vista.cira.colostate.edu/improve/wp-content/uploads/2019/06/IMPROVE-SOP-126_Site-Selection_06.2019.pdf) and are not reiterated here. In general, the TSA process notes and documents site properties which could impede sampling aerosol of a regional background nature. Impediments include significant local sources of particulates (automotive, wood smoke, dust, etc.), or obstructions such as trees or buildings which could hamper air flow to the sampler inlet. Problems are reported on the TSA form and the site operator is notified if corrective action is needed (e.g. trees trimmed or brush cleared).

Summary

Forty three IMPROVE sampling sites were audited and one auditor training session (WY) was completed in 2019. Results from all audits dating back to 2016 are shown in Table 5. Seven leak check failures and four flow rate failures were observed in 2019. These issues were reported to UC Davis.

Trees were noted as being an issue at Grand Canyon, Mesa Verde, Great Basin, North Cascades, Olympic, San Rafael, and Redwoods. Trees were removed at Mesa Verde, Great Basin, Olympic, and San Rafael. Operators were notified at the other sites.

The sampling stack was not inserted properly at Pinnacles. This was corrected during the audit, however, the data need to be flagged to inform data users of this issue.

Table 5. Audit notes, site/sampler observations

Site	Date	Issues/Notes	Follow-Up Required	Priority (H,M,L)	Actions Taken	Follow-Up Results
Shamrock Mine, CO	12/10/2019	Module B flow rate failure (10% low). Audit by CDPHE	Y	Low	Reported tro UC Davis	
Great Sand Dunes, CO	12/9/2019	All modules pass. Audit by CDPHE.	N			
North Absaroka,WY	11/2/2019	All pass.	N			
Dinosaur NM, UT	10/26/2019	All pass.	N			
Great Basin NP, NV	10/25/2019	All modules pass. Tree needs trimmed.	N	Med	talked to site operator	Trees removed.
Lake Tahoe, CA	10/24/2019	All modules pass. Non QAPP compliance. (see TSA)	Y	Low	Reported at SC meeting	
Point Reyes, CA	10/21/2019	All pass. The sampler stand is showing some age.	N			
Redwoods, NP, CA	10/18/2019	All modules pass. Trees are starting to encroach.	Y	Low	Talked to operator about tree removal.	
Kalmiopsis, OR	10/17/2019	All modules pass.	N			
Olympic NP, WA	10/15/2019	Flow rates passed. MaxVac A and C modules failed. Some small trees were encroaching.	Y	Med	talked to site operator	Trees removed.
Makah Tribe, WA	10/14/2019	All modules pass. The shelter is showing some degradation.	N	low	none	
Puget Sound, WA	10/11/2019	All pass.	N			
Snoqualmie Pass, WA	10/11/2019	All modules pass. Non QAPP compliance. (see TSA)	Y	Low	Reported at SC meeting	
North Cascades, WA	10/9/2019	All pass. Trees are getting dense around the sampling inlets	N	low	none	
Pasayten, WA	10/9/2019	All pass	N			
Cabinet Mtns, MT	10/8/2019	All Modules pass. Sampler is not operated at ambient temp.	N		report in TSA	
Glacier NP, MT	10/4/2019	All pass.	N			
Flathead, MT	10/3/2019	All pass.	N			
Flat Tops, CO	9/19/2019	All modules pass. Audit by CDPHE	N			
Mount Zirkel, CO	9/19/2019	All modules pass. Audit by CDPHE	N			
Rocky Mountain, CO	7/18/2019	All modules pass. Audit by CDPHE	N			

White River, CO	6/27/2019	Module D MaxVac failure. Audit by CDPHE	Y	Low	Reported to UC Davis	
Mingo, MO	5/28/2019	All modules pass. Shelter in poor condition. Audit by MDNR.	N	Low		
Hercules Glades, MO	5/7/2019	All modules pass. Audit by MDNR.	N			
Mesa Verde, CO	4/24/2019	All Pass. Tree needs trimming.	**Y**	Med	contact site operator	tree removed
Shamrock Mine, CO	4/24/2019	All pass.	**N**			
Hance, Grand Canyon, AZ	4/23/2019	All Pass. Trees needs trimming.	**Y**	Med	contact site operator	no response
Meadview, AZ	4/22/2019	Module A flow rate low. Module C leak check failure.	**Y**	Med	contact UC Davis	
Owens Valley, CA	4/18/2019	All pass.	**N**			
Domeland, CA	4/18/2019	All pass. Large area of bare ground could contribute to dust.	**Y**	Med	non - compliance QAPP	informed at Steering committee meeting
Hoover, CA	4/17/2019	All pass.	**N**			
Yosemite, CA	4/16/2019	All pass.	**N**			
Kaiser, CA	4/15/2019	B module flow rate failure	**Y**	Med	report to UC Davis	
Sequoia, CA	4/12/2019	All pass.	**N**			
Fresno, CA	4/11/2019	All pass.	**N**			
Pinnacles, CA	4/10/2019	D Module stack was not inserted properly	**Y**	High	flag data	
San Rafael, CA	4/8/2019	All Modules pass. tree needs trimmed	**Y**	Low	contact site operator	tree was trimmed
San Gabriel, CA	4/7/2019	All Pass	**N**			
Organ Pipe, AZ	4/5/2019	All Pass	**N**			
Saguaro, AZ	4/4/2019	Module C leak check failure	**Y**	M	report to UC Davis	
Saguaro West, AZ	4/4/2019	Module B leak check and flow rate failure; Module C leak check failed	**Y**	M	report to UC Davis	
Nogales, AZ	4/3/2019	All Pass	**N**			
Chiricahua, AZ	4/2/2019	All Pass	**N**			
Mt Zirkel, CO	10/4/2018	All pass.	**N**			

Sawtooth, ID	10/3/2018	Some pumps not operating when I arrived, however all flow rates passed.	**Y**			
Craters of the Moon, ID	10/3/2018	Reset clock - all else passed.	**N**			
Sula, MT	10/2/2018	Reset time. Adjusted Module B flow rate.	**Y**	Low	report to UC Davis	
Monture, MT	10/1/2018	There are a couple trees that might be impacting sampling.	**N**	Low		
Gates of the Mountains, MT	9/28/2018	All pass.	**N**			
UL Bend, MT	9/27/2018	All pass.	**N**			
Theodore Roosevelt, ND	9/25/2018	All pass.	**N**			
Fort Peck, MT	9/25/2018	All pass.	**N**			
Lostwood, ND	9/24/2018	All pass.	**N**			
Voyageurs, MN	9/21/2018	Trees are starting to encroach on sampler.	**Y**	Low	report to site operator	
Boundary Waters, MN	9/20/2018	All pass. Trees beginning to encroach on sampler.	**N**	Low		
Isle Royale, MI	9/19/2018	The tree to the east needs to be removed. The control module needs to be lowered for safety.	**Y**	Medium	report to site operator and NPS representative	Tree removed
Seney, MI	9/18/2018	All Pass.	**N**			
Potawatomi, WI	9/17/2018	All Pass.	**N**			
Great River Bluffs, MN	9/14/2018	Sampler was not operating upon arrival (e-box issue). Trees encroaching on sampler.	**Y**	Low	contacted UC Davis - got sampler running. Talked to site operator about trees	Trees removed.
Wind Cave, SD	9/12/2018	All pass.	**N**			
Badlands, SD	9/12/2018	Module D Failed. All else looks good.	**Y**	Medium	report to UC Davis	
Wichita Mountains, OK	4/24/2018	reset clock	**N**			

Caney Creek, AR	4/23/2018	Reset clock (it was on daylight savings time); PM10 inlet glass is broken; Module B cyclone flow rate failed; brush around shelter needs trimming	**Y**	Medium	contacted to UC Davis about sampler. talked to site operator about brush	brush has been cleared
Breton Island, LA	4/19/2018	Reset clock; Module C sampler box is rusted through; it needs replacement.	**Y**	Medium	report to UC Davis	in progress
Saint Marks, FL	4/18/2018	The drip line of trees on the north side of the shelter are about 20 feet from the sampler; these trees are around 10 feet too tall for compliance with QAPP. This is not a critical issue because there is still 270 degrees of unhindered air flow around the sampler, however, it would be best to trim trees when possible.	**N**	Low	report to site operator	
Chassahowitzka, FL	4/17/2018	The drip line of trees on the south side of the sampler are about 30 feet from the encloser; these trees are around 20 feet too tall for compliance with QAPP. This is not a critical issue because there is still 270 degrees of unhindered air flow around the sampler, however, it would be best to trim trees when possible.	**N**	Low	report to site operator	
Everglades, FL	4/16/2018	The sampler screen was not operating upon arrival although there was power to the sampler - sampler stand is in need of repair.	**Y**	Medium	report to site operator and NPS representative	new stand installed
Okefenokee, GA	4/13/2018	The sampler is running well; they will soon be upgrading power to resolve outage issues do to circuit overload.	**N**			new shelter and power upgrade
Cape Romain, SC	4/12/2018	Reset clock; The drip lines of two large trees are only 12 and 16 feet from the shelter hence the site is not in compliance with IMPROVE Quality assurance project plan.	**Y**	Medium	email FWS representative	in progress
Swanquarter, NC	4/10/2018	All pass.	**N**			
Shining Rock, NC	4/9/2018	Reset clock	**N**			
Cohutta, GA	4/6/2018	Reset clock; Quite a bit of mouse droppings but samplers are running properly.	**N**			
Sypsey, AL	4/5/2018	Reset clock	**Y**			

Stilwell, OK	4/3/2018	Leak in roof over Module D	**Y**	Low	Discussed with operators	
Upper Buffalo, AR	4/3/2018	Reset clock; D module flow rate is 9% low (almost failure)	**N**			
Medicine Lake, MT	3/13/2018	Reset the clock; All pass.	**N**			
Cedar Bluff, KS	9/29/2017	Reset Clock; All flow checks pass	**N**			
Viking Lake, IA	9/29/2017	Module C stack was not seated into the cyclone T properly. Sampler stand moves (sways) too much. All module flows passed.	**Y**	Medium	email state representative	audit needs to be repeated
Tallgrass Prairie, KS	9/28/2017	Reset Clock; All modules pass.	**N**			
Mammoth Cave, KYT	9/27/2017	All Pass	**N**			
Great Smoky Mtns, TN	9/26/2017	All Pass	**N**			
James River Face, VA	9/22/2017	All Pass	**N**			
Mount Zirkle, CO	9/21/2017	All Pass	**N**			
Shenandoah, VA	9/21/2017	All Pass	**N**			
Brigantine, NJ	9/20/2017	Reset Clock; All flow checks pass; Did auditor training.	**N**			
Frostburg Reservoir, MD	9/19/2017	Reset Clock (for auditor training); All flow checks pass but the B module flow rate is high; Did auditor training. Sample day.	**N**		report to UC Davis	
Dolly Sods, WV	9/18/2017	All Pass	**N**			
White River, CO	9/18/2017	All pass.	**N**			
Quaker City, OH	9/15/2017	MaxOri failed (29.6 mv should be > 33) All else passed. The sampler MaxOri all passed.	**Y**	Medium	notified UCD via TSA	
Bondville, IL	9/14/2017	All Pass	**N**			
Lake Sugema, IA	9/13/2017	All Pass. Auditor training for MO.	**N**			
Nebraska NF	9/11/2017	All Pass	**N**			
Flat Tops, CO	9/5/2017	All Pass	**N**			
Rocky Mountain, CO	8/4/2017	All pass. New controller works well for audits.	**N**			
Meadview, AZ	7/6/2017	Module C cyc flow rate failed.	**Y**	Medium	notified UC Davis via TSA	
Hercules Glades, MO	5/24/2017	All pass.	**N**			
Mesa Verde, CO	5/24/2017	All Pass	**N**			
Weminuche, CO	5/24/2017	Time off. All pass.	**N**			

Mingo, MO	5/23/2017	Time off. All pass.	**N**			
Mount Baldy, AZ	5/11/2017	Reset clock. All module flow rates passed.	**N**			
Tonto National Monument, AZ	5/9/2017	All Pass; Electricity is provided to samplers via extension cord.	**N**			
Phoenix, AZ	5/8/2017	All pass. Did auditor training.	**N**			
Joshua Tree, CA	5/5/2017	All Pass.	**N**			
San Gorgonio, CA	5/3/2017	All Pass	**N**			
Great Sand Dunes, CO	4/30/2017	All Pass. Tree needs trimming. Did auditor training.	**Y**	Low	emailed operator	
Agua Tibia, CA	4/20/2017	All Pass	**N**			
Sierra Ancha, AZ	4/11/2017	All Pass	**N**			
Ikes Backbone, AZ	4/6/2017	All Pass.	**N**			
Hance, Grand Canyon, AZ	4/5/2017	Trees need to be trimmed (southeast side). All modules passed but D flow rate is 8.5% and 7% off.	**Y**	Medium	emailed operator	
Sycamore Canyon, AZ	4/4/2017	All Pass	**N**			
Petrified Forest, AZ	4/3/2017	All pass.	**N**			
Bandelier, NM	11/17/2016	Module A ORI transducer not working (MaxORI and ORI flow calculation failed).	**Y**	Medium	report to UC Davis	
White Mountain, NM	11/16/2016	MaxOri failed Mod A.	**Y**	Medium	report to UC Davis	
Salt Creek, NM	11/15/2016	Reset time.	**N**			
Big Bend, TX	11/10/2016	All pass.	**N**			
Guadalupe Mtns, TX	11/9/2016	Module B cyclone flow rate failed.	**Y**	Medium	report to UC Davis	
Gila Cliffs, NM	11/8/2016	Module B cyclone flow rate failed.	**Y**	Medium	report to UC Davis	
Bosque del Apache, NM	11/4/2016	Module C Ori flow failed. All else passed. Power line stress relief missing from elec. box.	**Y**	Medium	report to UC Davis	
San Pedro Parks, NM	11/3/2016	Mod A MaxOri failed, Mod B operating at 10% limit for flow rate failure.	**Y**	Medium	report to UC Davis	
Wheeler Peak, NM	10/31/2016	Trees are too large (no unobstructed flow to sampler). All flows pass. Sampler subjected to diesel exhaust from ski lift when not running on electricity	**Y**	High	report to site operator and Forest Service representative	

Thunder Basin, WY	10/7/2016	Reset the clock. C module failed vacuum test.	**Y**	Medium	report to UC Davis	
Northern Cheyenne, MT	10/5/2016	All pass. Lots of mouse droppings (could be cleaner)	**Y**	Low	report to site operator	
North Absaroka, WY	10/4/2016	Could not remove channel D module. All else passes.	**Y**	Low	will repeat audit at another time	
Shamrock Mine, CO	9/27/2016	State of Colorado audit - no problems reported	**N**			
Yellowstone, WY	9/27/2016	All pass.	**N**			
Bridger Wilderness, WY	9/23/2016	All pass.	**N**			
Boulder Lake, WY	9/22/2016	Wrong plug installed in B module T. It was open to atmosphere so some sample air not going through denuder. Last Maintenance 8/25/16.	**N**		need data flag 8/25/16 - 9/22/16	
Mount Zirkel, CO	9/13/2016	State of Colorado audit - no problems reported	**N**			
Sycamore Canyon, AZ	8/24/2016	State of Arizona audit - no problems reported	**N**			
Weminuche, CO	8/18/2016	Module B MaxOri failed. Sampler stand is unstable and trees are too close and too tall.	**Y**	High	contacted site operator and Forest Service representative	stand has been rebuilt; verified 4/26/19
Bryce Canyon, UT	8/16/2016	Reset clock. All else passed.	**N**			
Zion Canyon, UT	8/15/2016	Reset clock. All else passed.	**N**			
Great Basin, NV	8/11/2016	All pass. There is a tree pretty close that needs trimming.	**Y**	Low	contact site operator	
Canyonlands, UT	8/8/2016	Module A orifice transducer failed (both max vac and flow rate)	**Y**	High	report to UC Davis	
Flat Tops, CO	8/5/2016	State of Colorado audit - no problems reported	**N**			
Mount Baldy, AZ	7/27/2016	State of Arizona audit - no problems reported	**N**			
Okefenokee, GA	7/12/2016	EPA Region 4 audit no problems reported	**N**			
Saguro West, AZ	7/7/2016	State of Arizona audit - no problems reported	**N**			
Rocky Mountain, CO	7/6/2016	State of Colorado audit - no problems reported	**N**			
Rocky Mountain, CO	7/6/2016	All pass.	**N**			
White River, CO	6/22/2016	State of Colorado audit - no problems reported	**N**			
Martha's Vineyard, MA	6/22/2016	EPA Region 1 audit - module D was not removable	**N**	Low	None	Will repeat audit

Meadview, AZ	6/7/2016	State of Arizona audit - no sampler problems reported, however, there is new construction (grading a lot nearby)	**N**			
Linville Gorge, NC	5/24/2016	All pass	**N**			
Mesa Verde, CO	5/17/2016	State of Colorado audit - no problems reported	**N**			
Great Sand Dunes, CO	5/16/2016	State of Colorado audit - no problems reported	**N**			
Linville Gorge, NC	3/29/2016	EPA region 4 audit no problems reported - a tree was removed	**N**			
Capitol Reef, UT	8/3/2015	Control Module was not operating upon arrival. After getting it started all the modules passed flow checks. There is a tree relatively close.	**Y**	High	reported sampler issue to UC Davis; talked to operator about trimming tree	