



Working Together to Improve Citizen Science Data Quality

A Guide for Government Agencies



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Front Cover: Students with the San Diego Zoo's Wildlife Rangers program learn about algae on the San Diego Bay National Wildlife Refuge, Sweetwater Marsh. (Photo: Lisa Cox/US Fish and Wildlife Service)



ASSOCIATION OF PUBLIC HEALTH LABORATORIES

The [Association of Public Health Laboratories \(APHL\)](#) works to strengthen laboratory systems serving the public's health in the US and globally. APHL's member laboratories protect the public's health by monitoring and detecting infectious and foodborne diseases, environmental contaminants, terrorist agents, genetic disorders in newborns and other diverse health threats.



US ENVIRONMENTAL PROTECTION AGENCY

The [US Environmental Protection Agency \(EPA\)](#) works to protect public health and the environment. This orientation guide was supported by EPA's Office of Research and Development (ORD). ORD is the scientific research arm of EPA. Its leading-edge research informs Agency decisions and supports the emerging needs of EPA stakeholders, including the Agency's state, tribal and community partners.

INTRODUCTION

The Importance of Collaboration and Quality Assurance in Citizen Science

Citizen science—also known as community science, volunteer monitoring and public participation in scientific research, among other terms—uses the collective strength and knowledge of the public to gather and analyze data to answer environmental and public health questions.

Answering these questions has long been the responsibility of federal, state, local and tribal agencies and laboratories, but citizen science provides a gateway for the public to do this independently, or in collaboration with these and other organizations. Meanwhile, government agencies are recognizing that citizen science can help to maximize resources and community knowledge while expanding public engagement and scientific knowledge. Collaborative citizen science projects can be initiated by either the agency or citizen science groups.

For citizen-generated data to have a meaningful impact, quality assurance during data gathering is critical. Citizen science groups need to systematically plan, carry out and document their project through project plans. The [US Environmental Protection Agency \(EPA\)](#) created the [Quality Assurance Handbook and Guidance Documents for Citizen Science Projects \(EPA QA Handbook\)](#) to help meet this need. The EPA QA Handbook provides a framework for citizen science groups to follow, but the project is best positioned to reach its goals when it is conducted in collaboration with environmental and scientific professionals. When citizen science groups develop and follow a project plan in collaboration with government and other professional scientific organizations, the chances are increased that the data will be of known quality and the projects will meet their goal of informing environmental education, research and policy in their community.

About This Guide

Government agencies can use this guide to foster mutually beneficial partnerships with citizen science groups.

This orientation guide specifically speaks to state, local and tribal environmental and public health agencies and laboratories, illustrating how your agencies can be a valuable resource to citizen science groups so they can be a valuable asset to you and the communities you serve. This guide is part of a larger set of resources created by the [Association of Public Health Laboratories \(APHL\)](#) in collaboration with EPA, called the “Citizen Science Quality Assurance Toolkit.” See the “Resources for Facilitating Citizen Science” section of this guide to learn more about these tools.

INSIDE THE EPA QA HANDBOOK

The EPA created the [Quality Assurance Handbook and Guidance Documents for Citizen Science Projects \(EPA QA Handbook\)](#) to help citizen science groups improve their data by developing project plans.




Benefits of Creating a Project Plan

Project plans serve two purposes:

1. To help citizen science groups systematically organize and plan their project and;
2. To help potential data users, regardless of the data use category (Table 2), more easily evaluate and understand the project’s data quality.

Project Plan Development Resources

The EPA QA Handbook provides an easy-to-follow, step-by-step project development process based upon three types of citizen science goals (See [EPA QA Handbook, page 7](#)):

-  **Education:** Increase public awareness
-  **Science:** Support scientific studies and research
-  **Policy:** Support legal action or policy making

The EPA QA Handbook is supplemented with templates for and examples of citizen science project plan quality assurance and documentation. The templates are available in an editable format and provide instructions, tables and questions to answer while users prepare their project plan.

Use the EPA QA Handbook to Create Usable Data

Together, these documents can help citizen science groups successfully complete a project plan, providing agencies, laboratories and the community the information needed to evaluate the data’s quality.



Look for this hyperlinked icon to the [EPA QA Handbook](#) throughout the guide!

AGENCIES AND CITIZEN SCIENCE GROUPS: A MUTUALLY BENEFICIAL PARTNERSHIP

Benefits for Agencies

Government agencies and laboratories can benefit greatly from involvement with citizen science projects. The decentralized nature of citizen science offers an opportunity to expand your agency's environmental monitoring work through increased sample collection and observations. This broader range of data may give you greater study robustness and confidence that your agency's monitoring plans are effectively responding to community environmental protection and public health needs. Citizen scientists may also have knowledge of the area's current or historical uses and have an inside perspective on community concerns. Results collected through citizen monitoring could help your agency pinpoint areas for further study, prioritize resource allocation and justify samples needed for regulatory or legal purposes.

EXPAND YOUR SCOPE

Citizen science groups can help extend your agency's reach by providing flexibility in:

Sample Collection

- Atypical or more frequent collection times
- Remote or under-studied locations
- Environmental matrices not typically analyzed by your agency

Topic or Project Type

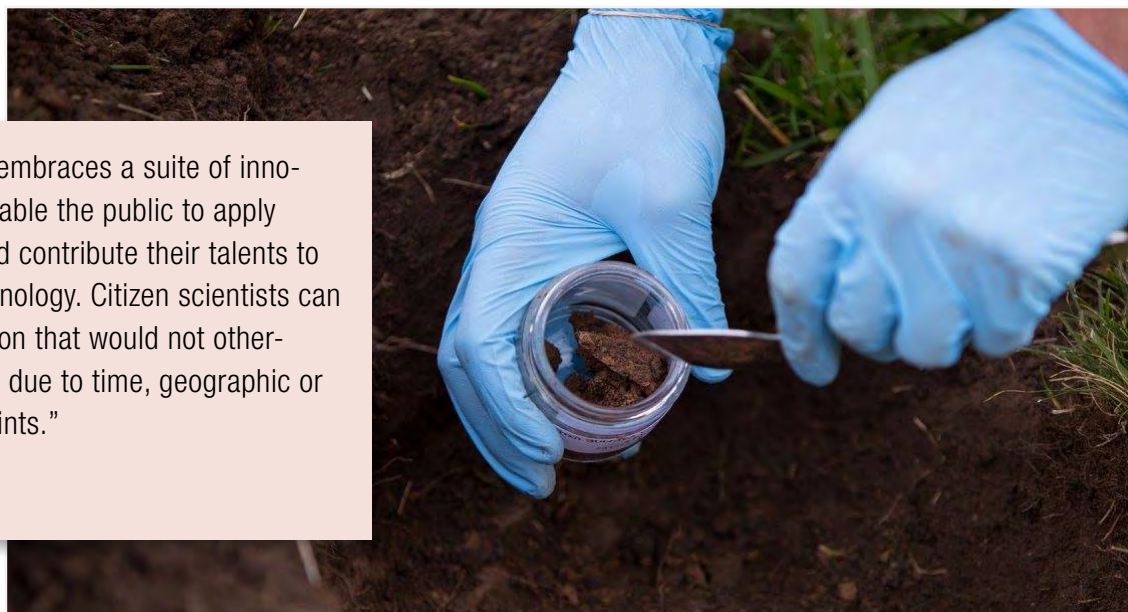
- Unexpected environmental events or hazards
- Community environmental justice issues
- Exploratory projects or pilot studies

Benefits for Citizen Science Groups

When citizen science groups partner with government agencies, they may be able to greatly expand the scope and impact of their project. By engaging with and supporting citizen science groups from a project's onset, agencies and laboratories can provide resources and expertise to help these groups plan and implement their project to produce valuable, high-quality data with a purpose. Areas where government agencies can help include: 1) access to monitoring equipment, 2) an understanding of governmental environmental and public health priorities, and 3) the scientific expertise to ensure the group's data can be used for its intended purpose.

“Citizen science embraces a suite of innovative tools to enable the public to apply their curiosity and contribute their talents to science and technology. Citizen scientists can provide information that would not otherwise be available due to time, geographic or resource constraints.”

—US EPA



CITIZEN SCIENCE CAN PRODUCE VALUABLE INFORMATION

Recent studies have shown that, with proper guidance and planning, citizen science projects can collect reliable and actionable information:


- Analysis of long-term data collected by the Texas Stream Team citizen science program from 1992–2016 found **strong data agreement between citizen- and professionally-collected samples**, even with multiple sampling techniques, numerous citizen scientists, many years and a large geographic area.¹
- Examination of 83 citizen science case studies found that **consistent and continuous training appeared to be the key contributor to enhancing citizen science performance**.²
- Comparison of citizen- and professionally-collected monitoring data in Southern California found **sufficient guidance and supervision, combined with a rigorous sampling scheme, facilitated comparable professional and citizen scientist data**.³



A Texas Stream Team member tests water conductivity at White Rock Lake in Dallas, TX. (Photo: Alexander Neal)

Besides these studies, **Table 1** outlines citizen science projects that achieved high impact because of collaborations that supported strong quality assurance. A particularly important role agencies can play to ensure this impact is to help write the project plan. A [list of additional projects](#) with these characteristics is also available.

Table 1. Citizen science projects that achieved high impact through strong collaboration and quality assurance.

Project Type	Project Name	Project Goal	Project Quality Assurance Measures & Impact
 Education	Missouri Department of Natural Resources (DNR) Volunteer Water Quality Monitoring Program	The Missouri DNR uses citizen science data to inform and educate Missouri residents and identify water quality problems. The program’s goal is to foster cooperation between the department, watershed management committees and highly-trained citizen scientists to perform sampling projects.	Highly-trained citizen scientists collect data using quality assurance project plans in accordance with DNR’s quality management plan . These data educate Missourians and help the agency establish baseline data on rarely-sampled streams.
 Scientific Studies & Research	New York Community Air Screen Program (CAS)	The CAS program partners with the Department of Environmental Conservation (DEC) to assist communities to conduct air quality surveillance. Toxic air pollutant identification helps determine emission sources and supports toxin-reduction solutions.	DEC’s laboratory participates in US EPA’s National Air Toxics Trends System and follows required QA/quality control procedures. In 2018, community members helped collect 38 samples in ten New York counties that identified 268 toxic pollutants. This information was used to determine the effectiveness of air toxin emitter regulation.
 Legal and Policy Action	Save the Sound: Unified Water Study (UWS)	UWS supports local monitoring groups to collect standard data across 40 different sampling areas. These data are used to inform and support community and policy actions to preserve and protect the Sound.	UWS collaborates with science advisors and regulatory agencies to provide local monitoring groups equipment, training, standard operating procedures, a project plan and other resources. UWS has many legal and legislative victories , including helping to secure \$2.5 billion for water infrastructure investments.
Learn more about projects with strong quality assurance and a big impact!			

1 Albus, KH, Thompson, R, Mitchell, F, Kennedy, J, and Ponette-González, AG. (2020). Accuracy of long-term volunteer water monitoring data: A multiscale analysis from a statewide citizen science program. Plos One, 15(1). doi:10.1371/journal.pone.0227540

2 Aceves-Bueno, E, Adeleye, AS, Bradley, D, *et al.* (2015). Citizen Science as an Approach for Overcoming Insufficient Monitoring and Inadequate Stakeholder Buy-in in Adaptive Management: Criteria and Evidence. Ecosystems. 18. doi:10.1007/s10021-015-9842-4

3 Gillett DJ, Pondella DJ, Freiwald J, *et al.* (2012). Comparing volunteer and professionally collected monitoring data from the rocky subtidal reefs of Southern California, USA. Environ Monit Assess. 184(5):3239-3257. doi:10.1007/s10661-011-2185-5

SOLUTIONS TO COMMON CITIZEN SCIENCE CHALLENGES

The following are some of the most commonly seen challenges in citizen science projects. Solutions to these challenges can be relatively straightforward given time, persistence and collaborative efforts between citizen science groups, agencies and laboratories. Adequately addressing these challenges can lead to usable data.

Table 2. Common challenges in citizen science and their solutions

Challenge	Solution	Example
Defining research goals	<p>Work with partners to frame the question(s) your project will answer.</p> <p> Template #3 in the EPA QA Handbook template document helps define the problem, organize background information and solidify the project description.</p> <p> Pages 6-10 of the EPA QA Handbook provide more detail on framing the project's purpose.</p>	<p>In Alaska, the United States Geological Survey (USGS), University of Alaska-Fairbanks and the Indigenous Observation Network collaboratively defined research goals to set up a long-term Yukon River water quality project. Clear goals enabled the partners to turn their focus to continuous quality improvement, ensuring the correct parameters are measured and the data can be used as indicators of watershed health.</p>
Implementing adequate quality assurance measures	<p>Create a quality assurance project plan.</p> <p>By writing and applying a project plan, an organization builds data quality procedures, methodologies and data use plans into the project from the beginning. The organization will be more confident the data will meet the specific project needs.</p> <p> Page 9 of the EPA QA Handbook provides more detail on crafting a project plan.</p>	<p>Michigan Department of Environmental Quality provided an example project plan for Michigan's Inland Lake Water Quality Assessment. It is a comprehensive documentation of the program's planning, implementation and assessment; it includes the elements of program management, data generation and acquisition, assessment and oversight, and data validation and usability.</p>
Utilizing quality assurance expertise	<p>Work closely with professionals with quality assurance experience.</p> <p>Agencies and laboratories have experienced professionals that could help citizen science groups on project plan development. This helps ensure all key sections are included and the detail is sufficient based upon project type.</p>	<p>In Pennsylvania, the Alliance for Aquatic Resource Monitoring (ALLARM) provides needed technical assistance and advice to citizen science groups that conduct monitoring. ALLARM's tools and technical resources are available online.</p>
Assigning responsibilities	<p>Map out participants' roles.</p> <p>Project organization charts help clearly outline the project's communication and reporting structure and each individual's role, responsibilities and tasks throughout the project.</p> <p> See Templates #17 and 18.</p>	<p>The Chesapeake Bay Monitoring Collaborative developed a project plan that clearly defines roles and responsibilities for multiple organizations involved in water quality monitoring.</p>
Collecting representative samples using the correct techniques	<p>Get expert help to develop a sampling plan.</p> <p> Template #9 helps establish an appropriate sampling design before collection takes place. The design should specify the number, locations and times the samples should be collected to produce data that will answer your research question(s).</p> <p> Template #16 outlines a data review process to ensure data were collected using the right methods and from the correct locations to meet the project goals.</p>	<p>The US EPA Air Sensors Toolbox Air Sensor Guide Book provides technical advice on developing site-specific monitoring plans for air pollution using low-cost sensors.</p> <p>The Cyanobacteria Monitoring Collaborative allows citizen scientists to identify types of cyanobacteria via a reference manual that can later be verified by experts.</p>
Training citizen scientists	<p>Develop a standardized training program.</p> <p> Template #6 helps standardize training for all citizen scientists throughout the project, ensuring measuring techniques are uniform.</p> <p> Template #17 helps maintain consistency despite possible citizen scientist turnover by establishing clear lines for communication.</p>	<p>The SC Adopt-a-Stream program protects South Carolina's waterways through stream water quality and habitat monitoring. Citizen scientists can take trainings and certifications to monitor freshwater systems via physical, chemical, bacterial and macro-invertebrate population parameters.</p> <p>The Lakes of Missouri Volunteer Program (LMVP) trains citizen scientists to use equipment to determine lake ecology and water quality issues. Citizen scientists learn how to store samples until LMVP staff can collect and send them to Missouri University for analysis.</p>
Bias against citizen science data	<p>Develop and follow a project plan to increase data transparency.</p> <p>Collaboration helps citizen science groups develop a comprehensive project plan that will provide data users proof that the data collection process followed appropriate quality assurance procedures.</p>	<p>The state of Virginia maintains a close relationship with the citizen scientist organizations that collect any data the state uses.</p>

A PATHWAY TO IMPROVED DATA QUALITY: POTENTIAL ROLES FOR AGENCIES IN CITIZEN SCIENCE



US Fish and Wildlife Carlsbad Office biologist, Clark Winchell, instructs University of California San Diego student intern, Stella Yuan, as they survey the hill side for San Bernardino flying squirrels. (Photo: Joshua Allen Ray/USFWS)

From using citizen science data for education to scientific studies and research to decision making, there is a wide spectrum of roles your agency or laboratory could assume to integrate citizen science into your organization’s mission. You could play an advisor role, lend out equipment, be hands-on throughout the entire project, and ultimately use the data to supplement your agency’s sampling or monitoring strategy. You could even develop statewide programs with quality assurance training and standard protocols.

This section outlines a pathway of a high-involvement role that an agency might take on to help or implement a citizen science project (Figure 1). It references the EPA QA Handbook throughout, which agencies can leverage to help citizen science groups design and execute projects with increased data quality for mutual benefit.

In practice, agencies should pick and choose the tasks that make the most sense to meet their agency’s current mission. Visit www.aphl.org/cit-sci for interactive, downloadable versions of the individual steps and an editable, plain text version to customize the steps to match your agency’s desired level of engagement.

Figure 1. Pathway to agency involvement.



You should communicate that your involvement does not necessarily mean endorsement of the project or its results. Data could be used to sue your state or locality or pursue an agenda that is counter to your mission or goals. If issues arise, confer with your legal department to ensure your agency is protected.

1

Step 1: Pre-planning for a Proactive Approach

Determine the ways citizen science may be integrated into your agency's mission or to help further your own projects.

Develop a running list of potential citizen science project ideas from which your agency might benefit.

Engage and recruit citizen science groups to participate in these projects, or keep this running list as a resource if you are approached by citizen science groups with their own ideas.

Speak with your supervisor to get permission to incorporate citizen science projects into your work. Point them to the resources in this document for examples on how agencies and laboratories can benefit.

Work with leadership and scientific staff to develop agency guidelines for becoming engaged in citizen science.

Establish an agency citizen science point-of-contact.

Determine if your agency has funding that can be allocated for citizen science projects. Consider how you might compensate citizen scientists for their time, particularly for projects that may have environmental justice implications. This could be accomplished through memoranda of understanding and joint grants with community partners. If funds are provided, a project and its project plan may have additional requirements that need to be met.

Help citizen science groups develop a timeline for the different stages outlined in this pathway.

Connect citizen science groups to other partners or provide them with the resources found later in this document to help move their project forward if it does not align with your goals. Perhaps you may be able to partner with these other organizations to take on a citizen science project together.

Direct the citizen scientists to groups leading duplicate efforts to determine if they could amplify that effort.

There are a variety of ways citizen science projects originate. Projects typically fall into two broad categories:

Science-oriented (top-down)

A more traditional approach, where lab scientists and subject matter experts define research questions and lead project development.

Community-oriented (bottom up)

Community members raise research questions and may want to collaborate with agencies and laboratories to further their project's impact.



Members of Uintas Pika Watch use a transect to conduct species monitoring. (Photo: Erin Moulding)



High school student Lauren Magdaleno providing US Fish and Wildlife Service biologist Michael Glenn weather measurements with the Kestrel weather meter. (Photo: Hazel Rodriguez/USFWS)

2

Step 2: Project Planning

At this stage, a citizen science group will develop a basic research question, determine project objectives, establish sample collection locations, protocols and scope, think about how to train citizen scientists and minimize variables which may affect results, establish data verification processes, and consider how the data will be used.

Take time to plan and participate in the planning and design of the project as a whole. Planning is essential to:

- Solidify the research goals
- Clarify project participants' roles
- Establish strong communication
- Identify processes for citizen scientist training and sampling



A certified SC Adopt-a-Stream volunteer prepares to collect a conductivity sample. (Photo: SC Adopt-a-Stream)

To help the group solidify the citizen science group's plans:

Clarify to the group what your role will be and what that means to the project. Determine the “sensitivity” of the project and how it relates to public sentiment. Are confidentiality agreements needed? Should results not be discussed with the public or the media before an agreed-upon time? Legal/administrative approval of involvement should precede any agency or laboratory engagement.

Consider how your agency's data quality needs can be met by integrating the EPA QA Handbook and other data quality resources into the project's scope.

Help citizen scientists refine their research question so it tests a defined environmental area in an unbiased way, using the right equipment to measure the correct parameters. Help them consider the EPA QA Handbook's “Just Getting Started” planning questions (📖 [page 9](#)) in more depth.

Determine the citizen science group's knowledge of and experience in organizing citizen science projects and developing project plans.

Clearly express any concerns about using citizen-collected data so the group understands the necessity of taking extra steps to ensure their data is of the appropriate quality for its intended use. Discuss common biases of the collection process and ways to avoid them to maintain integrity. Highlight success stories from **Tables 1 and 2**.

Assist with project plan development by pointing the group to the Citizen Science Quality Assurance Toolkit's video series, “Make Your Data Count,” on the [EPA](#) or [APHL Citizen Science webpages](#) for a quick start on how to approach their project planning process.

If the project is not already funded, discuss or determine ways to secure funding and resources.

Assign distinct roles early on in the process. Create organization charts to outline roles like project lead, quality assurance manager, trainers and field collectors. As the project evolves, this will help preserve the lines of communication and reporting.

📖 **Templates #17, 18, and 19** in the [EPA QA Handbook templates document](#) help outline this process.

Determine the citizen science group's ability to train citizen scientists. (See 📖 [page 17](#)).

📖 **Template #6** outlines how to develop a plan to train citizen scientists to the quality assurance level required for their project.


! One of the most important aspects of working with citizen science groups is communication and establishing clear expectations and responsibilities.

3 Step 3: Project Plan Development


Once the citizen science team is identified and project goals are outlined, a project plan is necessary to ensure data quality, standardize sampling processes and help guarantee that citizen-collected data can be used for its intended purpose. Be available to either execute training on citizen science project development or to answer questions during this stage on appropriate sampling methods, data management or documentation.

Taking the time to develop a project plan helps ensure citizen science data can be used for its intended purpose by:


- Outlining data quality measures
- Standardizing sampling procedures

Determine the project’s data use category (education, science or legal). See **Figure 2** and  **page 7**.

Based on this data use category, discuss with the group the level of quality assurance and documentation needed to meet their project goals. It is important that this level be appropriate to ensure that data can be used for its intended purpose without being overly prescriptive.


 **Page 12** highlights which templates need to be included based on this data use category.

Be transparent during the project plan development process to help citizen science groups understand the “why?” behind quality assurance requirements so they understand how the data they produce can be used by your agency or laboratory.

 **Template 4** provides detailed information on the data quality objectives and data quality indicators.

Ensure the citizen science project plan includes sufficient details so the study can be recreated.

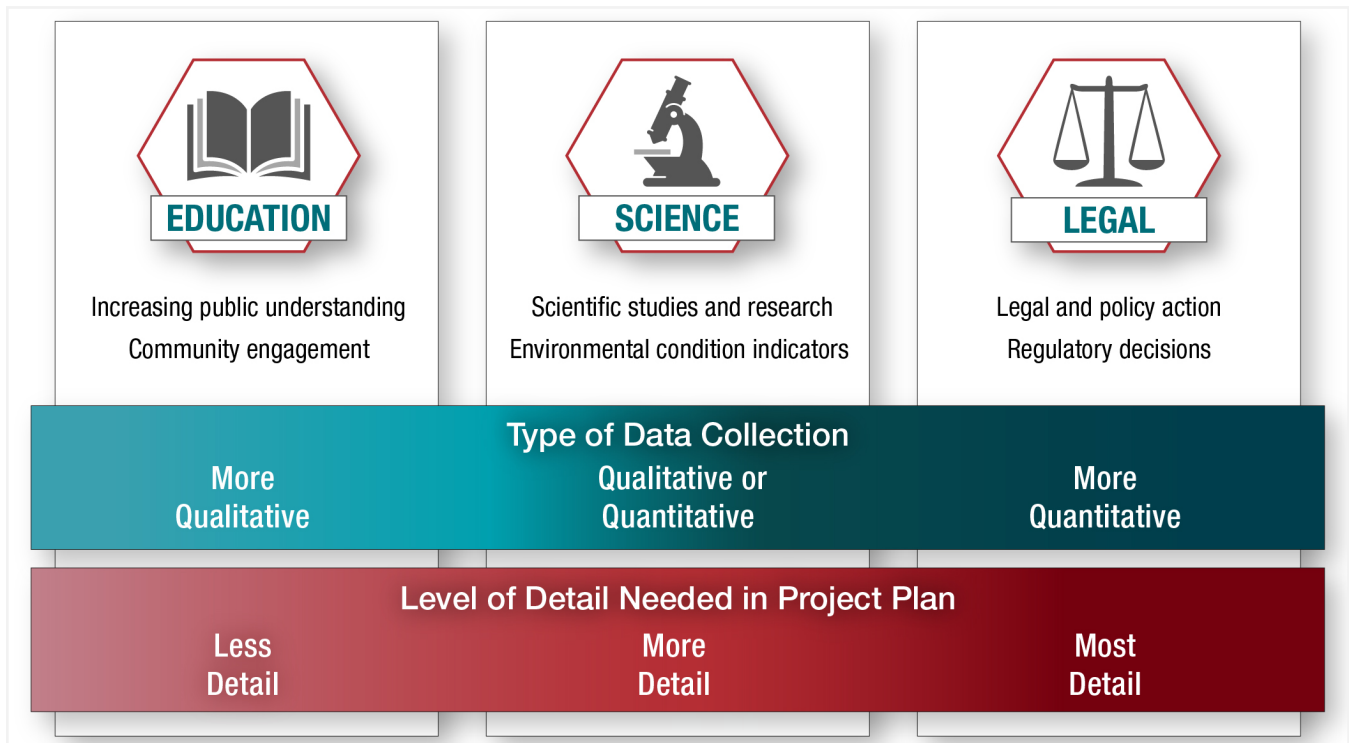
Communicate any agency or laboratory project plan development specifications to ensure the project plan is detailed enough to support data use. Consider making a document similar to the Florida DEP’s [Quick Guide to QA for Volunteer Programs](#) to clearly state data quality expectations for various agency programs.

Communicate your agency’s or laboratory’s sampling and data documentation requirements ( **page 22**).

Work with the citizen science group to determine how the data they produce will be reviewed, verified and validated to ensure it is usable.

 **Template 16** in the **EPA QA Handbook templates document** can help map out this process.

Figure 2. Determine the project’s purpose and data collection method to identify the level of detail needed for the project plan.



4


Step 4: Sampling/Data Collection

Now that the project is planned, help citizen science groups with sampling methodologies through trainings and collaborating on development of or providing standard operating procedures (SOPs) to establish and streamline sampling and analytical methods.

Help citizen science groups understand the opportunities and limits of testing.

Consider developing certification or training programs and/or SOPs for citizen scientists. These programs can be used to test citizen scientists' ability to collect and analyze samples while meeting certain data quality standards.

Help train citizen scientists in sample collection methodologies for [air](#), soil, and [water](#) monitoring.

 **Page 19** has an additional list of resources on monitoring methods.

Discuss temporary sample storage and agency transfer logistics and requirements.

Your agency or laboratory likely has access to air, water, and soil monitoring equipment while many citizen scientists do not. Consider lending or renting out this equipment to assist citizen scientists and encourage participation by eliminating cost. This process should involve additional citizen scientist training on how to calibrate, use and maintain your equipment properly. [Mesa Public Library's lending library for citizen science](#) is a great model.

Depending on availability, agencies and laboratories can work alongside the citizen science group to provide oversight.

Citizen science groups can benefit greatly from your agency's expertise in sampling and monitoring techniques and access to tools and resources.



Left: School maintenance staff helps the IVAN Air Monitoring Network install an air quality monitor on the roof of Brawley Union High School in Imperial County, CA. (Photo: Comitè Civico del Valle) Right: Citizen scientists conduct watershed monitoring. (Photo: Srishti Gupta/Penn State)

5

Step 5: Data Documentation and Review

By following the written project plan at this point, you can work with the citizen science groups to ensure the data have been collected according to plan, documented correctly and can be used for their intended purpose.

Work closely with the citizen science group to ensure proper data documentation, both through the project plan and data user requirements. Help answer the following questions when reviewing the data with the citizen science group to verify and validate it:

- Were the right types of data collected? (time, location, collection method, etc.)
- Are the data usable? Do datasets meet quality requirements? Are the data traceable for quality?
- What quality control issues were encountered? What will be done with the outliers?
- Do additional measurements need to be taken to inform decision making?

Partner with citizen scientists to interpret their data and determine next steps. Local knowledge combined with scientific expertise can be powerful in data interpretation.

Determine if, based upon the conclusions, the data identify further actions or a follow-up project to collect more specific or confirmatory data.

Help determine the most efficient ways to present data based on the anticipated audience. How can this data be accessible and usable to all stakeholders?

Agencies can assist citizen science groups with:

- Checking data
- Interpreting data
- Presenting data

RESOURCES FOR FACILITATING CITIZEN SCIENCE

Citizen Science Quality Assurance Toolkit

To make project plan development more straightforward, APHL has developed several resources to facilitate the use of the EPA QA Handbook by both citizen science groups and state and local environmental and public health agencies and laboratories, known collectively as the [Citizen Science Quality Assurance Toolkit](#). These resources include:

- **Make Your Data Count Training Videos** (citizen science groups)
This series of six short videos outlines the importance of data quality in citizen projects, highlights the main steps citizen science groups can take to make their data count.
- **Fact Sheets** (citizen science groups)
 - [Essential Elements of a Citizen Science Project](#)
This fact sheet is a companion document to the “Make Your Data Count” training videos.
 - [5 Steps to Improve Citizen Science Data Quality](#)
This fact sheet outlines the quality assurance steps in field- and laboratory-based citizen science projects.
- **Webinars** (one each for citizen science groups and agencies/laboratories)
 - *Make Your Citizen Science Project Count: Strategies to Produce Quality Data*
 - *Make Their Data Count: How Government Agencies Can Work with Citizen Science Groups to Improve Data Quality*

This orientation guide can be used alongside the training videos, fact sheets and webinars to help provide agencies, laboratories and citizen science groups with information, strategies and resources to collaboratively develop a project plan using the EPA QA Handbook. Access all of these resources and more at www.aphl.org/cit-sci or www.epa.gov/citizen-science.

Other Citizen Science Resources

A number of resources are available to promote citizen science success:

US EPA Citizen Science

- [EPA QA Handbook](#), template and examples (and downloadable editable template document)
- [EPA Citizen science resources](#)

Project Development

- Cornell Laboratory of Ornithology [Developing a Citizen Science Program: A Synthesis of Citizen Science Frameworks](#): Outlines the key components needed to develop a citizen science project
- [FedCCS toolkit](#): Provides a walk-through of project design and development

Quality Assurance

- Citizen Science Association [Comprehensive Data Quality Resource Library](#)
- [SciStarter data quality resources](#) for citizen science
- Florida Department of Environmental Protection (FDEP) [Quick Guide to QA for Volunteer Programs](#): States various FDEP program data quality objectives and/or expectations so citizen science groups know what is needed for the state to be able to use their data
- California State Water Resources Control Board Surface Water Ambient Monitoring Program [quality assurance resource](#) archive
- University of Massachusetts—Amherst and Massachusetts Department of Environmental Protection [Massachusetts Guidebook to Quality Assurance Project Plans](#): Provides a thorough list of steps to produce a successful project plan

Monitoring Methods

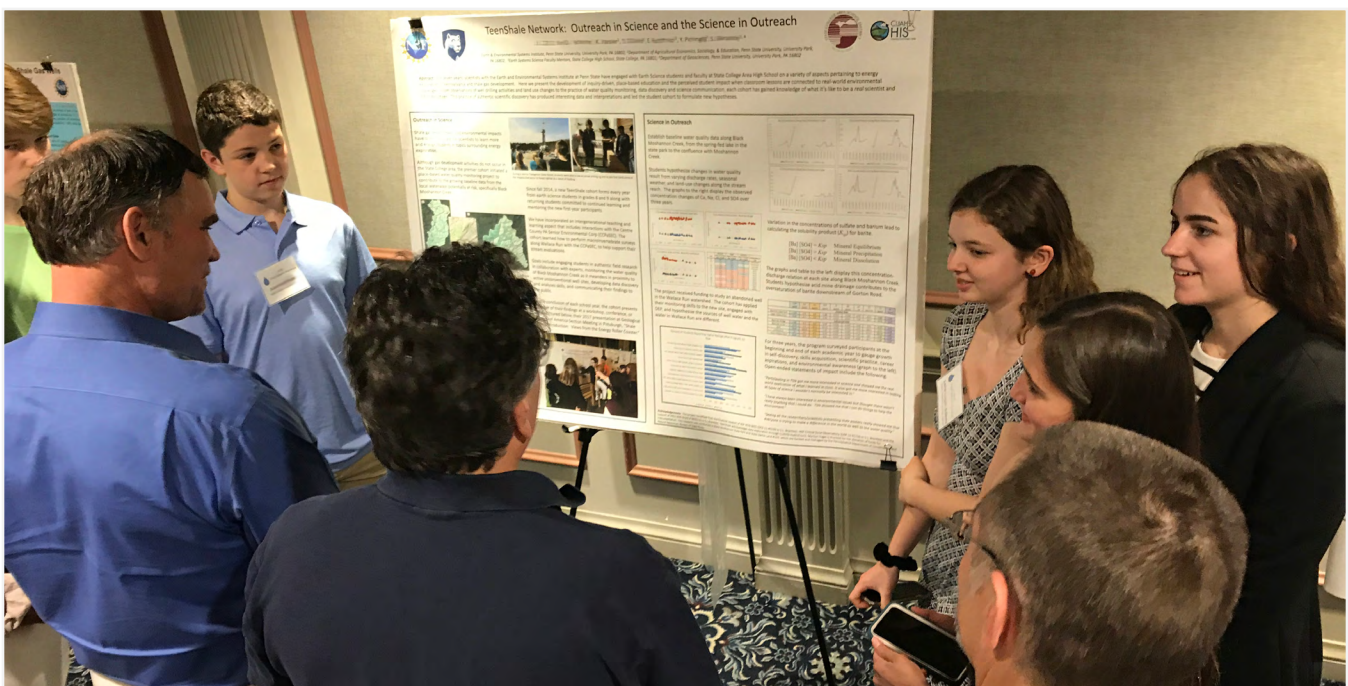
- [SciStarter Tools Database](#): Provides a comprehensive database of observation and data recording tools, categorized by project type
- Alabama Mobile Bay National Estuary Program [How-to Guide for Water Quality Monitoring](#): Provides information and documents to plan and implement a citizen science water quality monitoring program
- Arizona Department of Environmental Quality [Water Watch Program Handbook](#): Includes information on collecting field data, sampling, and calibrations for citizen science water quality monitoring
- Maine Department of Environmental Protection [Stream Survey Manual](#): Provides stream monitoring information, project initiation steps and water quality protection methods
- Virginia Citizen Water Quality Monitoring Program and Virginia Department of Environmental Quality [Methods Manual](#): Provides resources to start a project, develop a project plan, and use correct monitoring methods
- USGS [guidelines and standard procedures](#) for continuous water monitoring
- US EPA nonpoint source pollution [citizen science monitoring methods](#)
- US EPA [air sensor toolbox](#)

Existing Projects

- [SciStarter](#) is an online community dedicated to improving the citizen science experience for project managers and participants. It helps researchers manage projects through resources such as best practices for engaging participant partners.
- [Zooniverse](#) has a compendium of ongoing citizen science projects looking for citizen scientists.
- [FedCCS](#) has a catalog of [federally-supported citizen science projects](#) and [resources](#).

Other Resources

- [Citizen Science Association](#): A member-driven organization that connects people from a wide range of experiences around one shared purpose: advancing knowledge through research and monitoring done by, for, and with members of the public.
- [FedCCS: CitizenScience.gov](#) is an official government website designed to accelerate the use of crowd-sourcing and citizen science across the US government. Resources include a [webinar series](#) on federal crowd-sourcing.



Students from State College High School present results of their participation in the TeenShale Network, a collaboration with Pennsylvania State University, the National Science Foundation and other partners. (Photo: Francisco Tutella/Penn State)