Recommendations and Guidance for EPA to Develop Monitoring Programs in Communities

August 2017

A Report Prepared by the

National Environmental Justice Advisory Council

A Federal Advisory Committee to the U.S. Environmental Protection Agency

ACKNOWLEDGEMENTS

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NATIONAL ENVIRONMETNAL JUSTICE ADVISORY COUNCIL

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- Sacoby Wilson, PhD, University of Maryland
- Beverly Wright, PhD, Dillard University
- Kelly C. Wright, Shoshone-Bannock Tribes

Monitoring Programs in Communities Work Group

- Dennis Randolph, City of Grandview Missouri (Work Group Chair)
- Jill Witkowski Heaps, JD, Vermont Law School (Work Group Co-Chair)
- Deidre Sanders, PhD, Pacific Gas & Electric Company
- Sacoby Wilson, PhD, University of Maryland

Monitoring Programs in Communities Work Group Continued

- Melissa McGee-Collier, Mississippi Department of Environmental Quality
- Jamie Hampton, MIXTE Communications
- Howard Page, Steps Coalition
- Rebecca Newberry, Clean Air Coalition
- Jasmin Muriel, Workgroup Designated Federal Officer, Office of Environmental Justice, U.S. EPA, Washington, DC
- Loan Nguyen, Attorney, Office of Administration and Policy, U.S. EPA, Washington, DC

September 29, 2017

Scott Pruitt
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Dear Administrator Pruitt:

The National Environmental Justice Advisory Council is pleased to submit the report, *Recommendations and Guidance for EPA to Develop Monitoring Programs in Communities*, for the Agency's review. The NEJAC developed this report in response to the Agency's charge of October 2015. In that charge, EPA asked the NEJAC to provide advice and recommendations on how EPA can address the needs of communities when providing monitoring data through negotiated enforcement settlements or permits. EPA also sought recommendations from NEJAC on how best to provide environmental data in a way that is meaningful and relevant to communities and empowers them to improve environmental conditions in their communities.

The NEJAC's Monitoring Workgroup diligently considered the EPA's four charge questions and developed several recommendations. Communities living with or near one or more facilities have a right to know what pollutants those facilities are exposing the community to and what impact those pollutants may be having on their health. These recommendations seek to provide guidance to the EPA on how it can ensure that monitoring information required by a permit or settlement is accessible by the local community and useful to it. In order to facilitate community trust with the regulatory process and to ensure meaningful community engagement with and consideration of community concerns, the NEJAC believes a good community monitoring program will do the following:

- *Collect Timely and Useful Data*

- *Provide Accessible and Accurate Data*

- *Deliver Monitoring Reports in Ways Most Accessible to the Affected Community*

- *Build Community Capacity*

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Fuller details and explanations of our recommendations are included in the attached report. Once again, thank you for this opportunity to provide recommendations for enhancing environmental justice in EPA's programs, and we look forward to hearing the Agency's response to these recommendations and receiving updates on their periodic implementation.

Sincerely,

Richard Moore
Chair

Attachment

cc: NEJAC Members
Mike Flynn, Acting Deputy Administrator
Lawrence Starfield, Acting Assistant Administrator for the Office of
Enforcement and Compliance Assurance
Samantha Dravis, Associate Administrator for the Office of Policy
Matthew Tejada, Director for the Office of Environmental Justice
Karen L. Martin, Designated Federal Officer and NEJAC Program Manager

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Executive Summary

Low income communities and communities of color located with or near polluting facilities often coexist with these facilities without knowledge of who the operators of these facilities are beyond the name of the facility posted on the building or gate. They may see steam, or smoke, or flaring; smell odors, hear noises. Dust and other debris may become airborne and leave the site. Surface water or well-water may be used by the facility. The facility may use hazardous chemicals as part of its production or maintenance processes. Community members see people and equipment enter and exit from the facility, but oftentimes they are not themselves in communication with the facility operators or employees. They may not know anyone who works there or who has ever been inside. The facility is in the community, but not of the community. Community members are told that the facility is important to the tax base of the city/county/region. They are told that the facility provides jobs and is important to the local economy. They are told that the facility is compliant with all laws and regulations.

But since they often do not know the owners, operators, or employees there may be a sense that the owners, operators, and employees are indifferent to the concerns of their fenceline neighbors. Or if the facility operators do communicate, it is mostly one way as part of a facility public affairs effort that may not really address community concerns regarding the facility's operation. Moreover, even if a facility does share information about its safety programs, operations, and regulatory compliance it is often presented in ways that are very vague, or highly technical and either not organized, or organized in ways that make them incomprehensible to non-subject matter experts.

Circumstances like these do not facilitate transparency, trust, and mutual acceptance. These circumstances are exacerbated when a facility is defensive about its operations or out of compliance with its permits on items that potentially impact the health and safety of nearby community members. What can be done to provide community members information about operations of facilities within their communities so they can understand what impact the facility may be having on community health?

Communities living with or near one or more facilities have a right to know what pollutants those facilities are exposing the community to and what impact those pollutants may be having on their health. EPA's community monitoring program should seek to ensure that air and water monitors provide accurate and timely reports of community exposures to regulated pollutants. EPA should also ensure that community air and water monitor reports are presented to the community in ways that provide meaningful information to help community members understand the implications of the data in the context of the overall health of the community.

Recommendations for Developing Monitoring Guidance

This paper seeks to provide guidance to the EPA on how it can ensure that monitoring information required by a permit or settlement is accessible by the local community and useful to it.   In order to facilitate community trust with the regulatory process and to and ensure meaningful community engagement with and consideration of community concerns, the NEJAC believes a good community monitoring program will do the following:

- **Collect Timely and Useful Data**. EPA should develop procedures that allows for the swift collection, analysis, verification, and reporting of monitoring data. This may involve monitors placed in the community by regulators or community members and organizations. The monitors should also be capable of collecting data on pollutants of concern.

- **Provide Accessible and Accurate Data**. For data to be useful more than one collection source is preferred. Facility monitoring data should be assessed with that collected by community monitors and reported in a clear, concise and accessible manner focused on addressing key community concerns about health and safety.

- **Deliver Monitoring Reports in Ways Most Accessible to the Affected Community**. EPA should assess how community members access information (e.g., through the internet? Newspapers? Community leaders? etc.)

- **Build Community Capacity**. Communities will likely need access to some technical training or experts and other resources to help them to understand the information and its implications for their concerns.

    - *Community Based Research*. Develop processes and protocols to enable meaningful and credible research;
    - *Useful Analysis* that informs the community and produces results that are accepted by regulators and regulated entities

When writing new permits or when negotiating a settlement to bring a facility into compliance, EPA and state agencies require regulated facilities to monitor and report their pollution levels to regulatory agencies, and some facilities share that information with surrounding communities. Communicating such complex scientific information so communities can understand and use it is a challenge and there needs to be a way to ensure the information is communicated in ways that address community concerns about potential health or environmental impacts. This would also require more resources be available to communities to provide "translation" or analysis of the data. This is a key component of an effective monitoring program that needs to be addressed.

Facility monitoring data that will be shared with community members on a website should consider the following factors:

- Pollutants;
- Frequency/timing of the monitoring;
- Risk Assessment;
- Data Source Trustworthiness
- Monitor location;
- Inclusion of influencing variables;
- Website location/visibility
- Background (ambient) pollution levels (the point of cumulative impacts)
- Other ambient contributors (including unregulated)
- Public Health Reference Standards/Ranges/Levels

While research shows that websites are generally a good way for community members to access information, optimal web designs will:

- Allow access on both computers and mobile devices
- Provide information in multiple languages, if needed
- Present information in bite-sized chunks
- Be visually interesting
- Provide a deeper level of data for more advanced users
- Coordinate with pushed communications
- Facilitate audience-specific visualization tools
- Allow adaptive system improvement

In some communities, however, the internet may not be the best way for communities to get information. Community-specific research must be done to determine if a website will be effective before the website is created. Other effective methods to reach community members may include: regularly mailed newsletters, hotlines that community members could call to get information, emails, text message alerts, and information dissemination through places of worship, community centers, and libraries.

For websites, EPA should consider additional interpretive formats for data when feasible and scientifically valid. Indicators that incorporate risk assessment are most useful (green = safe, yellow = sensitive populations should exercise caution, red = unsafe). Special alerts should be used and text or email messages can be effective. Sirens can and should be used when pollution levels are dangerous. Permanent message signs can be used for air warnings, and portable, variable message sign units can also be posted at water access points when water is contaminated and is unsafe for swimming or other recreational activities (i.e., boating, rowing, fishing).

Community members can learn more about the significance of environmental data through training programs offered in conjunction with local non-profits.

Finally, it would be very useful to propose an engagement process that allows for community input on how the systems are designed (to address any concerns up front and ensure data is being collected and relayed in meaningful ways). This would address the concerns with trust, education, and potential subject matter expert dismissal of community concerns.

Charge Questions:

1. Does the data made available under settlement agreements or permits allow the community to better understand the facility's environmental impact and act on the information to improve outcomes and advance environmental justice?

Community access to monitoring data from nearby facilities is always preferable to having data that is inaccessible or only accessible through a public records request. However, the availability of monitoring reports currently required as a part of air or water permits, varies from state to state. For example, Louisiana's EDMS system provides public access to electronic versions of all discharge monitoring reports (DMRs) and air emissions reports required under a facility's permit. On the other hand, in Maryland, access to DMRs and other reports is only available through public records requests.

 Especially for states that do not already post monitoring reports on a public website, providing immediate electronic access to these reports is an appropriate beginning to better sharing and analysis of information. However, merely making data available on a website does not make it meaningful or useful to a community. Most people need training or help to be able to fully understand and gain useful knowledge from monitoring data. This training should help them understand and apply the information to their problems or concerns. Thus, several points should be kept in mind when posting data, including the following:

- Pollutants: Reports should include any pollutant that could impact public health. However, in including all this data, there may be too much for many community members to easily digest. One option would be to develop a system to allow users to "zero-in" on pollutants of interest through a series of simple questions related to their "concerns." Such a system could be based on artificial intelligence algorithms or knowledge based technology that would relate general concerns (or symptoms) to specific pollutants. Another option would be to have information about the pollutants easily available alongside the monitoring data. For example, on San Diego Coastkeeper's water quality monitoring page, they have an explanation of each pollutant they are monitoring and why people might care about the pollutant. *See* http://www.sdcoastkeeper.org/learn/swimmable/san-diego-water-quality.

- Frequency/timing: Communities seek timely communication of exposure data. Providing communities with air or water quality data weeks or months after community members have been exposed is not helpful and could lead to missed opportunities to identify asthma triggers or reactions to toxicants. Real-time monitoring can provide more useful and immediate information to the community and the possibility of more timely action. While some facility operators may oppose providing real-time data for various reasons (for example, atmospheric conditions

can create emissions anomalies that inaccurately indicate facility non-compliance), some community members may distrust the results of time-delayed reporting and believe the results have been inappropriately altered. Legitimate technical concerns of industry and communities on timeliness, accuracy, completeness, and complexity need to be addressed to not only ensure timeliness, but data quality.

For monitoring required in a permit, the monitoring frequency should be based on the permit limit so that the monitoring is sufficient to demonstrate permit compliance. For example, if a permit limit is written as a daily average, a facility should be required to take multiple samples during the day and then average the samples to demonstrate compliance with the limit. Requiring a facility to only test once a day or once a week cannot demonstrate compliance with a daily average permit limit.

- Data Comprehension: Data should be focused on the sources of community concerns regarding a facility. Extraneous data that is not relevant to, for example, public health impacts, may be reported as supplemental data. A pure "data dump", while critical to the idea of "open and transparent" engagement, can in some instances be more confusing than helpful by obscuring priority data. It is also most important that scientist-regulators and facility owners refrain from considering potential public users as "incapable of understanding" such data, or worse, that only "trained" insiders are capable of understanding technical data. Through training exercises and educational materials, we can improve the scientific literacy of impacted community members. We need to acknowledge, however, that there may be a steep learning curve for community members before they can be equal discussants on the implications of the specific data.

  Besides making "raw" data available, other data and information should accompany it, including:

  - A facility's permit limits or any violation(s) of those limits. This information will help people understand how the emission or discharge may relate to them.

  - Any explanations or comparative analyses that can help people understand the potential threat to their health from the emissions or discharge. For example:

    - A discharge monitoring report showing that *E. coli* levels in a sample violates a facility's permit may be more helpful than a report indicating that the levels are 200/100 mL.

- Reporting an emission within the context of the ambient conditions. For example, a pollutant emission of 15 ppb may be seen as significant if it is not noted that the ambient background presence of that pollutant is 800 ppb.

- Similarly, it may be even more helpful if simple, direct language is used in presenting cautionary information. For example, in the case where a monitoring sample taken at the nearby beach shows sample levels at 100/100 mL on a sign, the sign also indicates the beach is closed because levels above 86/100 mL are unsafe for swimming. Extensive work has been performed in communicating messages in simple and plain language on our nation's highways, which can be used as a guide for other types of public message displays.

- To understand monitoring data, much more than qualifying statements will be needed, i.e. units and what they mean- ppb, ug/L, ppm, etc.

- <u>Communication:</u> To ensure timely communication of exposures that can lead to potential health impacts, it would be helpful to develop communication procedures that use media most accessible to community members such as text message alerts, email alerts, or phone messages. Sharing information with schools and other community gathering points like senior citizen centers should also be considered.

- <u>Trustworthiness</u>: Communities may distrust information provided by facility operators. In cases characterized by contentious relationships between facilities and communities, both sides may be reluctant to be responsive to the concerns of the other. Thus, many communities would likely prefer that regulators rely on monitored data provided by the community (a form of citizen science), if there are resources to support that type of monitoring. However, just as the community may distrust data provided by a facility, facilities/operators may likely resist accepting data provided solely by community sources.

  Communities may also distrust information from regulatory agencies. Establishing trustworthiness is easier said than done for many overburdened communities. The manpower that goes into creating mutual trust between parties requires dedicated staff. If EPA is sincere about community monitoring of data captured by facilities or regulatory agencies, then there must be training at all levels.

  Distrust also plays a part in discussions related to exposure-disease relationships and interpretation of data. If monitors do not provide data relevant at the proper spatial

resolution, location (at the facilities, at the fence line, or at other critical locations), or in a form useful for assessing exposure-disease dynamics in the community, then interpretation may be clouded or hindered. The community should be comfortable that data they receive from facilities is robust and appropriate. Similarly, scientist-regulators and facility owners should also be open to receiving data supplied to them by citizen scientists.

Permits should consider incorporating and supporting community-based monitoring with financial support and training for citizen scientists. By training community members to monitor their air and water and financially supporting those community-based monitoring programs, it empowers people to better understand the conditions of their air and water. Steps should be taken to categorize the quality of the data collected by these sensors through citizen science.   A system that incorporates third party verification of the rigor/validity of community-based monitoring results will also help all parties be comfortable with the data.

- Community-Based Monitoring: End-of-pipe or stack gas monitoring may be easiest for a facility to provide. However, such monitoring may not give the community:

  o useful data to assess exposure to one or more pollutants (frequency, duration, and magnitude);

  o a clear picture of cumulative pollution exposures related to the facility of concern or multiple sources- both stationary and mobile; and

  o facility-based monitoring may not provide data that can be used to assess exposure-disease associations at the residential, household, or individual level. For this reason, the community may prefer fenceline monitoring or community-based monitoring. In any case, it is important that a broader view of area conditions be available to the community so that data can be considered to illustrate their pollution burden in order to fully contextualize their exposure profile.

- Citizen Science: Citizen Science is the public involvement in inquiry and discovery of new scientific knowledge with or without academic research partners.[1,2] Citizen science is an approach that helps to engage, educate, and empower members of the public to help advance science and technology through open collaboration.[3] There are a number of related terms and approaches including civic or community

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1 Farah J. Crowdsourced monitoring, citizen empowerment and data credibility. *International Conference on Computational Science and Its Applications*. Springer International Publishing, 2014.

2 United States Environmental Protection Agency (USEPA). Air Sensor Toolbox for Citizen Scientists. https://www.epa.gov/air-research/air-sensor-toolbox-citizen-scientists

[3] National Advisory Council for Environmental Policy and Technology (NACEPT). Environmental Protection Belongs to the Public. A Vision for Citizen Science at EPA. December 2016. EPA 219-R-16-001.

science, community-based monitoring, participatory sensing, crowdmapping, public participation in scientific research (PPSR), public science, community environmental policing, street science, do-it-yourself (DIY) science, participatory science, crowd science, open science, and crowdsourcing.[3] In addition, popular epidemiology, community-owned and managed research, participatory action research (PAR), and community-based participatory research (CBPR) have elements of citizen science.

These approaches often are rooted in different disciplines[3] such as geography, ecology, environmental science, urban planning, ornithology, astronomy, computer science, or public health or emphasize different objectives such as tracking of migration patterns of birds, monitoring of water quality, or achieving environmental justice. Across all forms of citizen science is an emphasis on openness, democratization of science, research, and policymaking, and the mobilization of diverse stakeholders, populations, and communities.[3]

Citizen science is an approach that actively encourages and solicits public input in the scientific process and incorporates information generated outside of traditional scientific institutions such as academia and governmental regulatory bodies (i.e., the United States EPA).[3] Citizen science is a movement that is changing the way that government and institutions interact with the general public.[3]

EPA has engaged in citizen science primarily by working with community-based organizations engaged in *community citizen science[3]* including through projects funding by the CARE Program, EJ Small grants program, and the Collaborative Problem-Solving Model (CPS) Program. Community citizen science is very similar to community-based participatory research (CBPR). Community-based organizations and other partners collaborate on scientific studies to address community-defined questions, allowing for engagement of community members across stages of the research process from development of questions, study design, analysis, dissemination, and translation to action.[3] Compared to traditional citizen science, community citizen science may or may not include partnerships with professional scientists, emphasizes the community's ownership of research and data results (as emphasized in the community-owned and managed research (COMR) framework), and orients toward community goals and using science for collaborative learning, civic engagement, and community empowerment.[3] "The importance of community citizen science… and the power of this type of methodological process are in providing people with the tools to ask their own questions, collect their own data, and advocate for themselves."[3]

Citizen science air quality monitoring initiatives have enabled communities disproportionately impacted by environmental harms (particularly communities that are near ports, refineries, coal-fired plants, and heavily trafficked roadways) to collect their own data and use this data to understand and address the cumulative

impacts of environmental hazards on local air quality and human health.[4,5, 6] The USEPA has developed a great resource with information on citizen science, low cost sensors for measuring air pollution, and how to interpret the data. This information can be found at the following website: https://www.epa.gov/air-sensor-toolbox.

A recent NACEPT report[3] provides a comprehensive overview of citizen science and the opportunities and benefits for the United States EPA and the general public. The report states the United States EPA should do the following in regards to citizen science[3]:

- **Embrace citizen science as a core tenet of environmental protection**

    1) Articulate and implement a vision for citizen science at the EPA

    2) Take a collaborative approach to citizen science

    3) Define and communicate EPA's role in citizen science

- **Invest in citizen science for communities, partners, and the Agency**

    1) Dedicate funding for citizen science

    2) Improve technology and tools and build technical capacity

- **Enable the use of citizen science data in support of the Agency's mission**

    1) Adopt a positive, cooperative agenda that increases the utility of citizen science data

    2) Adopt standards for citizen science data

    3) Provide guidance and communicate data quality needs for different data uses

- **Integrate citizen science into the full range of EPA's work**

    1) Support citizen science for environmental protection beyond regulations

    2) Support community citizen science

    3) Integrate citizen science into EPA science

    4) Expand EPA's regulatory mission to include citizen science.

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4 O'Fallon L, Finn S. Citizen Science and Community-Engaged Research in Environmental Public Health. Lab Matters.

http://digital.aphl.org/publication/?i=279800#{%22issue_id%22:279800,%22page%22:6}

5 Center for Health, Environment, and Justice (CHEJ). Citizen science resources advance environmental justice. http://chej.org/2015/09/16/citizen-science-resources-advance-environmental-justice/

6 Ottinger G.Buckets of resistance: Standards and the effectiveness of citizen science. *Science, Technology & Human Values* 35, no. 2 (2010): 244-270.

- Low-Cost Sensors: Low-cost sensors have become of increasing interest recently as new technology has allowed concerned citizens to take environmental concerns into their own hands[7]. The primary advantage of low-cost sensors is that they change the way that air monitoring can be performed, as regulatory monitors are not typically well-suited to address local concerns, such as near-roadway gradients, fenceline monitoring, or concentrations at the residential level. In brief, low-cost sensors offer the potential to increase air pollution understanding at the local scale because monitoring can be conducted at many more locations. This better reflects spatial variation in air pollution while also providing a better understanding of exposure at the individual level and potentially relevant health impacts[8].

- Other data: In some cases (the BP Whiting monitoring information, for example), there may be a wide range of data that is collected, including data on meteorological conditions (i.e., temperature, pressure, relative humidity, wind speed, wind direction, and rainfall). However, it's not clear whether all of those pieces of information are useful or understood by the community. We believe that monitoring and the timely communication of collected data are key to protecting communities from pollutants emitted and discharged from facilities they host. While we recognize there are some limits to public participation in permitting and settlement negotiation processes, we also believe EPA and its delegated agencies should encourage early community engagement to help communities gain favorable outcomes. Also, training should be available to show the relationship between different data that is available, so that citizen-scientists can make the best use of all the data that is available, and also understand why it is included in the data package.

- Extent of Monitoring: Monitoring should be done consistent with scientific norms of optimal data collection practices and that address community concerns. This may mean that the number of monitors and monitoring locations be larger and more varied than would be likely with a single facility approach. The extra cost of added monitoring may be off-set by increased trust and reduced risk of litigation by the stakeholders who host or live near the facility of concern.

  Moreover, since in the end, the cost for monitoring is either directly paid for by communities (if it is regulatory monitoring) or by citizen-customers (if it is operator

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[7] Snyder EG, Watkins TH, Solomon PA, Thoma ED, Williams RW, Hagler GS, Shelow D, Hindin DA, Kilaru VJ, Preuss PW, 2013. The changing paradigm of air pollution monitoring. *Environmental Science & Technology*, *47*(20), pp.11369-11377.

[8] An example of one popular low-cost sensor used in participatory air monitoring is the Airbeam (Habitat Map, Brooklyn, New York). Airbeams are nephelometers that use a light scattering method to measure $PM_{2.5}$ via Bluetooth. Airbeam measurements can be communicated approximately once a second to smartphone via a mobile phone app and sent to a host website (AirCasting). Another example of a low-cost sensor is the Purple Air. The Purple Air sensors (PAS) are nephelometers that also use a light scattering method to measure $PM_{10, 2.5, and 1}$ via Bluetooth. PM readings can be communicated approximately once a second to smartphone via a mobile phone app and sent to a host website.

monitoring), then it is entirely appropriate to increase the extent of monitoring if citizen/customers feel the attendant increased cost is appropriate.

- Web location of the data: Where data is posted on the internet can make a difference in its usefulness. Burying the data deep in a facility's website does not make it easy for interested community members to find. For example, the data from the BP Whiting settlement is posted under a confusing website name:

http://raqis.radian.com/pls/raqis/bpw.whiting.

While this website was the first result of a Google search "BP Whiting data," it did not show up in the first page of results for a Google search of "BP Whiting pollution." It would be much more effective if the website had an easy to remember, descriptive name in plain language, like:

www.bpwhitingairinfo.com, or

www.bpwhitingairpollution.com, or

www.bpwhitingcleanair.com

Settlement funds and other resources such as permit fees should be used to create websites for the community to use with the data in readily accessible and useable formats. In addition, protocols should be developed for naming URLs that make them understandable.

In summary, data made available under settlement agreements or permits should be intended to allow the community to better understand the facility's environmental impact and act on the information to improve environmental quality and public health and advance environmental justice. Every effort should be made to make the data understandable and informative. Furthermore, programs should be established to provide support and training to help community members use and understand the monitored data.

2. Do communities have ready access to data posted to a website?

According to Pew Research Center's June 26, 2015 study on Americans' Internet access[9], 84 percent of American adults use the Internet. Its analysis of 15 years of data shows that older adults, those with less education, and those living in low-income communities are showing a steady increase in their adoption rates, especially in the past few years.

The study also shows these top-line major trends:

- **Class differences:** "Still, the class-related gaps [among Internet users] have shrunk dramatically in 15 years as the most pronounced growth has come among those in lower-income households and those with lower levels of educational attainment."

- **Racial and ethnic differences:** "Today, 78% of blacks and 81% of Latinos use the Internet, compared with 85% of whites and 97% of English-speaking Asian Americans."

- **Community differences:** "78% of rural residents are online."

In an earlier analysis of three surveys that examined Latinos and technology adoption[10], Pew Research Center uncovered that "Latinos own smartphones, go online from a mobile device and use social networking sites at similar—and sometimes higher—rates than do other groups of Americans."

Some key findings from this analysis related to Internet use include that:

- Nearly all Hispanics from families with annual incomes of $50,000 or more (95%), Hispanics from families with annual incomes between $30,000 and $50,000 (93%) and Hispanics ages 18 to 29 (93%) say they go online at least occasionally."

- "Half of Latino Internet users are native born and half are foreign born."

- "Among Latino Internet users, 72% are either English dominant (31%) or bilingual (41%), and 28% are Spanish dominant."

It is important to understand how populations in the U.S. get their news and how much they trust those sources. According to 2014 research conducted by the Media Insight Project — an initiative of the American Press Institute and the Associated Press-NORC Center for Public Affairs Research[11], survey results dispelled myths that minorities might lag behind whites in digital habits.

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[9] http://www.pewinternet.org/2015/06/26/americans-internet-access-2000-2015/

[10] http://www.pewhispanic.org/2013/03/07/closing-the-digital-divide-latinos-and-technology-adoption/

[11] https://www.americanpressinstitute.org/publications/reports/survey-research/african-american-hispanic-news-consumers/

This survey revealed that similar proportions of whites, African Americans and Latinos discover news in a variety of ways – from word of mouth to social media, and all the ways in between.

"The majority of Americans report getting news directly from news organizations either on television, via print, audio, or digitally each week, including 92% of African Americans and 84% of Hispanics."

Also, of particular interest to communities with environmental justice issues and pollution alert systems, "nearly a third of American adults say they get news through alerts for which they have signed up, including 35% for African Americans and 26% of Hispanics." Most important to our communities, the survey revealed that "news alerts people sign up for yield the highest level of trust, across all groups."

We must carefully consider how we design websites to suit the needs of diverse audiences, in particular acknowledging the vast array of education and knowledge levels in our communities. A tracking study aimed at aiding visually impaired users of the Internet[12] also revealed design principles that can help all Web users. It found that "visually complex web pages lead to more scattered and disordered eye scanning paths than those with fewer elements."[13] In an analysis of this data by the CEO of Vanseo Design, it becomes clear that "complex information is difficult in part because it comes with so much information. Showing everything at once requires a lot of cognitive processing, which can reduce comprehension and cause viewers to feel overwhelmed." His recommendation is to break down the information into bite-sized chunks to increase a reader's comprehension of complicated topics.

Furthermore, as early as 1912, Gestalt School of Psychology made one of the first contributions to the science of perception when it embarked on uncovering how we perceive pattern, form, and organization in what we see.[14] The Interaction Design Foundation says that "the founders observed that we organize what we see in particular ways in an effort to make sense of it."

Additionally, according to the United Nations Economic Commission for Europe, all of the analytical work of highly specialized experts can go to waste if the results of that work aren't effectively communicated, creating a scenario where those in society who need the information may not understand it.[15]

The data is encouraging – our low-income communities of color are using the Internet, more and more, nearly in line with early adopters. With so many people using the internet to access

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[12] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.117.8982&rep=rep1&type=pdf

[13] http://vanseodesign.com/web-design/visually-complex-information/

[14] https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/data-visualization-for-human-perception

[15] http://www.unece.org:8080/index.php?id=32705

information, it is critical to make sure websites are designed in a way that inform, alert, inspire, and protect our communities.

Whether for national systems or local efforts, these qualities of website design should be considered. These are listed below without prioritization.

- **Design for access on both Computers and Mobile Devices** – The data show that our communities use both computers and mobile devices to access the Internet. Given the increasing number of users moving to mobile in a rapid pace, any web-based effort should incorporate responsive design so that Internet users of any device can access the information.

- **Language and Cultural Considerations** – The data also show that users likely have English-language skills, but not necessarily. To effectively communicate to communities with environmental justice issues, we must consider language skills as a basis for understanding, and this must intersect with cultural and lifestyle competency as well Having information accessible in multiple languages should be strongly considered, based on the target audience.

- **Bite-Sized Chunks** – Research shows diminishing returns when asking an individual to comprehend and process large amounts of technical data. We know that for all communities, presenting complicated information in layers of smaller pieces will greatly aid in information understanding and retention.

- **Visual Presentation** – Lots of numbers and long reports are not useful for communities of concern. Our communities will benefit from websites that visually analyze and display complicated data. These variations can include color-coded or graded analysis, visual presentations in a multitude of forms and/or a qualitative rating system such as 1 – 10 to show relative comparisons.

- **Deeper Level of Data** – Our communities won't solely rely on high-level, easily digestible bites of information. Many of our community members have considerable background in environmental and policy issues and will want and need more access to detailed data. Therefore, our websites should present complicated data in levels of detail, moving from the digested visual presentation to a middle-level analysis and then to the full set of raw data.

- **Coordinate with a Push Communication System** – Research shows that our users of the Internet put high levels of trust into alert systems to which they sign up. This means that a monitoring website should be coupled with email, text, or phone call alerts and a system to utilize the news outlets or other community-specific methods to reach more

people. In some communities, people might get news at a community center, place of worship, school, or other community gathering place.

- **Design Audience-Specific Visualization Tools** – While it may be cost effective to create a nation-wide system or portal that can be used by all reporting facilities, different needs in each community weigh towards customizing the information and display based on the community and its needs. Furthermore, if the community already has tools it regularly uses (see IVAN, www.ivanonline.org), any reporting site should aim to be incorporated into the tools already available and being used by community members.

- **Try, Test, Change, and Repeat** – Creating a website and an associated alert system should not be the end game. Ideally, any system created should be published, tested, and adapted until the website communication system effectively reaches and supports all members of our communities. [16]

The following websites contain some or all of the elements of a website that is useful for communities in understanding environmental issues they face.

1. **Mobile Air Alerts:** The Sierra Club creates a zip code-based texting alert system to inform families about air quality issues in their community. http://content.sierraclub.org/coal/mobile-air-alerts

2. **Air Quality Index:** The EPA's AirNow Air Quality Index breaks down complicated daily air quality reporting into color-coded, plain language categorical levels of concern and numbered ratings to easily communicate air quality warnings and associated health concerns by zip code. https://airnow.gov/index.cfm?action=aqibasics.aqi. Unfortunately, much of this data is only available for 8-hour averages or 24-hour averages for specific criteria air pollutants. For communities impacted by environmental justice issues, particularly cumulative exposures related to multiple air pollutants and pollution sources, the USEPA will need to update the Index to reflect health concern for acute exposures (1, 5, 10, 15, 30, and 60-minute averages).

3. **Interactive Water Quality Website:** San Diego Coastkeeper creates a real-time interactive countywide map with color-coded water quality scores. The website is designed for three levels of communication engagement – high level (color-coded) for those with little background, detailed scores and mid-level analysis for those with a basic understanding, and raw data for knowledgeable experts. http://www.sdcoastkeeper.org/learn/swimmable/san-diego-water-quality.html

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[16] Research examining the effectiveness of heat warning systems to reduce mortality and morbidity support reviewing and refining systems. *See* https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-12-27

4. **Interactive Beach Water Quality Information:** Santa Monica's Heal the Bay publishes an annual Beach Report Card for the West Coast of the United States. It breaks down its website communication starting with a big picture snapshot explained by a grading system and visual display and morphing into detailed data that gets into the specifics of local beaches. http://brc.healthebay.org/

5. **On-the-go Water Quality Warning System:** The Waterkeeper SwimGuide is an interactive map found online or in phone app form that pushes water quality warnings and beach closures at popular swimming holes across the county. This system uses basic warning language and color-coded visual alerts that connect to detailed reasoning provided by local authorities. https://www.theswimguide.org/

6. **Data Visualization:** DataViva is a research tool that provides official data about exportation, economic activity, locality, education and occupation in Brazil. It consists of 11 apps that combined enable more than 1 billion visualizations. http://dataviva.info/en/

7. **Visual Displays to Shape Policy:** The Urban Institute aims to open minds, shape decisions, and offer solutions through economic and social policy research. It turns key stats, graphs, and maps on economic and social policy into visually compelling stories. http://www.urban.org/data-viz

8. **Statewide Mapping Displays:** UCDavis Center for Regional Change creates interactive mapping data to showcase regional opportunity for people, place and density. http://interact.regionalchange.ucdavis.edu/roi/webmap/webmap.html

9. **Economic Data Visualization:** The Observatory of Economic Complexity is a visualization engine for trade data. This tool allows users to quickly compose a visual narrative about countries and the products they exchange. http://atlas.media.mit.edu/en/

10. **Searchable visual display of all sorts of data:** Data USA is a comprehensive visualization of U.S. public data. Instead of searching through multiple data sources that are often incomplete and difficult to access, users can search Data USA to answer their questions. It allows millions of people to conduct their own analyses and create their own stories about America – its people, places, industries, skill sets and educational institutions. Ultimately, accelerating society's ability to learn and better understand it.

11. **Systems that allow community inputs:** The IVAN reporting system from California allows users to report pollution incidents as they encounter them. It also has an alert system. Adding reporting for local facilities would ensure that the information is accessible by the community and would leverage people who are already engaged in environmental issues.

In communities where there are low levels of accessibility to the internet at home, public places to access the internet become increasingly more important. Public libraries are often where those without internet access at home go to access the internet. Supporting increased access to libraries, longer library hours, and more public access terminals at libraries would increase access to monitoring information shared on websites. In addition, there may be other assets in the community such as community centers and local K-12 schools that could act as spaces for community members to gain access to the internet and/or spaces where community members can be educated on what facilities are emitting, exposure scenarios, related health outcomes, and actions they can take to reduce negative health impacts.

As part of settlement agreements and permit fees, resources could be used to expand environmental education and literacy about the facilities and emissions, and relevant health impacts at these community assets.

2a. If not, what are other ways of providing this information to the community that would be more useful and meaningful?

Determining how an individual community gets its information should be done on a community-by-community basis. There is no one solution that will work for every community and solutions should be customized, based primarily on the sociodemographic composition of the community. In addition to web posting of information, options may include: regularly mailed newsletters, hotlines that community members could call to get information, email, or text message alerts, and information dissemination through places of worship or community centers.

To understand what works in a community, there has to be early (in the pre-permitting stage), deep, authentic, and meaningful engagement with stakeholders of concern. In discussions with a community about settlements, new permits, and other significant actions, the following questions need to be answered:

- What modes of communication work best for stakeholders?

- What resources are needed for communication structures to be established and sustained over time?

Regardless of the method of communication used, languages appropriate to the community should be used to insure that everyone has direct access to the message. Where possible, easily understood and interpreted graphics should be a significant part of the message to make understanding the message a visual exercise, rather than an interpretive exercise.

3. Is there a more usable format, than the ones mentioned above, that would make the data more understandable and accessible? For example, if red/yellow/green indicators were feasible and scientifically valid, would that be a preferable format? Should there be special alerts (text messages or sirens) in the event of high levels of pollutant?

- EPA should consider additional interpretive formats for data when feasible and scientifically valid. Indicators that incorporate risk assessment are most useful (green = safe, yellow = sensitive populations should exercise caution, red = unsafe).

- Special alerts should be used and text or email messages can be effective. For example, the Louisiana Department of Environmental Quality allows citizens from St. Bernard Parish to sign up to receive email notifications when SO_2 levels that are considered "Unhealthy for Sensitive Groups" (76 ppb or above) are measured.

- Sirens should be used when pollution levels are dangerous. Siren systems exist in many areas that can be used for these purposes. However, where weather conditions mean windows are often closed, sirens should not be a primary means of notification.

- Permanent message signs unit (like those on highways) can be used to notify people of air pollution. Portable message sign units can also be posted at water access points when water is contaminated and is unsafe for swimming. Such signs often allow real-time messaging to remote locations. These messages can also provide guidance information for viewers.

With the advent of Health IT (a health information portal, www.healthit.gov) and mobile apps like Swim Guide (providing beach water quality and weather information for 7,000 beaches across the country https: //www.theswimguide.org/), facilities can work with regulators to provide real-time information in a meaningful, timely, and user-friendly format on such devices. Environmental advocacy groups and community-based organizations across the country have used innovative ways to communicate scientific data in a clear manner to the public. For example:

- *Swim Guide* is a phone app that indicates whether water quality at a beach is safe enough for swimming.

- San Diego Coastkeeper, which runs California's largest volunteer water quality monitoring program, posts data on its website in three levels. Each level getting more technical: beginning with a color-coded graphic display, then written data analysis and finally access to downloadable raw data.

- Louisiana Bucket Brigade's Refinery Accident Visualizer is a creative way to visualize pollutant levels from Louisiana's refineries over time.

- Other groups have developed online data visualization tools to map data and mobile apps are being created to display real-time data as part of public participatory Geographic Information Systems (PPGIS) including the Low Country for Model Communities (LAMC) EJRADAR tool. LAMC developed this tool in partnership with the University of Maryland to act as a GIS-based web visualization tool that residents in Charleston, South Carolina can use to map hazard and pollution data.[17]

Resources should be invested in communication systems that employ real-time maps with user-friendly data and communicate risk clearly and effectively for different stakeholder groups (age, race/ethnicity, low English proficiency, immigrant, etc) in a culturally competent way.

Every effort should be made to utilize existing television and radio media outlets to disseminate information and warnings. Television and radio outlets have a great deal of information on the demographics of their audiences. This information can be used to focus on specific groups of people to insure that information reaches all people at the same level or intensity.

Much of the information can be broadcast in the form of public information announcements or be treated as news items or stories. Also, weathercasts provide an ideal and focused opportunity to provide information. Many people, who may not listen to news or even sports, listen to weather forecasts. Meteorologists also have a science background, and are practiced in providing general audiences with technical information in a not-(too)-technical way.

4. What forms of technical assistance would assist communities in gaining a greater understanding of the significance of environmental data?

STEM efforts: It is important that these efforts and the results of these efforts be incorporated into any citizen-science program developed for the purpose of managing air and water quality. We should not need to, or attempt to reinvent the wheel for our purposes. Moreover, the practical aspects of air and water quality lend themselves as prime examples, case studies, and course materials for STEM programs.

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[17] Wilson SM, Jiang C, Dalemarre L, Burwell K, Murray R. Environmental Justice Radar: A Tool for Community-Based Mapping to Increase Environmental Awareness and Capacity to Address Environmental Health Issues. *Progress in Community Health Partnerships*. 9(3):439-446 (2015).

Keeping this in mind, there are a number of specific emphasis areas that should be considered in any citizen-science program including help/funding/curricula for educational institutions to use. These would include:

- **Formal education** with the idea that data availability will be a permanent fixture and so we need to train people of all ages to understand and use it. This training would be incorporated into science and math courses, but could also be incorporated into courses such as sports and physical education where the emphasis is on health.

- **Informal education** is the idea that almost any environment can support informal science learning, such as a home, a library, a park, a street, a museum, a zoo, a community center, or any game environment. Informal learning environments are, in principle, accessible to all learners, and evidence suggests they have particular potential for supporting learners from non-dominant groups.[18] These settings offer learners direct access to information which is quite important when trying to empower stakeholders of concern with scientific data. The ubiquity of tools and data, information networks, and lack of formal procedures for accreditation means that anyone, professional experts or contextual experts can facilitate STEM learning in the informal world. This should be a point of emphasis in this work to provide quality air pollution information to communities with environmental justice and health issues.[19]

- **Educational grants** available to a wide-range of organizations and organizational types including non-traditional educational organizations. In this way training and information can be disseminated to a large audience that might not be involved or comfortable with traditional educational venues.

- **Training for government officials** (federal, state, and local governments scientist-regulators) at a level that would allow graduates to:

  - Use the data that is available, and

  - Explain the data, its availability, and to some extent the limits of its use.

  Most important, training should encourage these officials to be cheerleaders for citizen users, encouraging citizen users and helping them to understand the data they are using. Thus training for government officials should also include:

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[18] National Research Council (2009). *Learning Science in Informal Environments: People, Places, and Pursuits* Washington, D. C.: The National Academies Press.
http://www.nap.edu/openbook.php?record_id=12190
[19] National Science Foundation. Advancing Informal STEM Learning. https://www.nsf.gov/pubs/2015/nsf15593/nsf15593.htm

- Training on empathy and sensitivity as well as the idea that citizens have far more "common-sense" understanding of science and scientific topics than formally educated bureaucrats normally give them credit for.

- Training on success stories of community participation in environmental decision making - use case studies as examples of how community involvement improved a project.

- Training based on the premise that local government officials, in particular, are the closest and generally the first contact that citizens have with government, so early contacts with these officials by state and federal officials should be positive, encouraging and helpful.

EPA, states, and facilities can sponsor training programs like Watershed Stewards Academy, a formal program teaching community members about water-related issues and giving them tools they can use to work with their neighbors to clean local waterways. *See www.aawsa.org* Other non-profits have training program for water quality monitoring volunteers or bucket brigade volunteers. These programs are likely to reach more people and be more successful when they partner with local non-profits who regularly work in the community.

Also, if the facility publishes a regular report (quarterly or annually), that report could explain the significance of the environmental data. Ideally, these reports should be produced in conjunction with a local non-profit who regularly communicates with the community.

End Notes:

1. State environmental agencies collect a variety of air quality data, both from outdoor air quality stations throughout the states and from facilities that emit air pollutants. This data is sent to EPA and used to determine whether states meet federal and state air quality standards and health benchmarks; to forecast and report daily air quality through the Air Quality Index; and to track trends in air pollution levels over time. Although this data is useful and provides valuable insight in the nation's regional air quality, the adequacy of the State's air quality monitoring network is questioned because of the distance between air quality monitoring stations. Communities are seeking air quality information representative of pollution concentrations in their neighborhood, not just data on a regional (state) level.