Citizen Toolkit: Monitoring and Advocating for Clean Water in Arizona and New Mexico

Southwest Rural Policy Network

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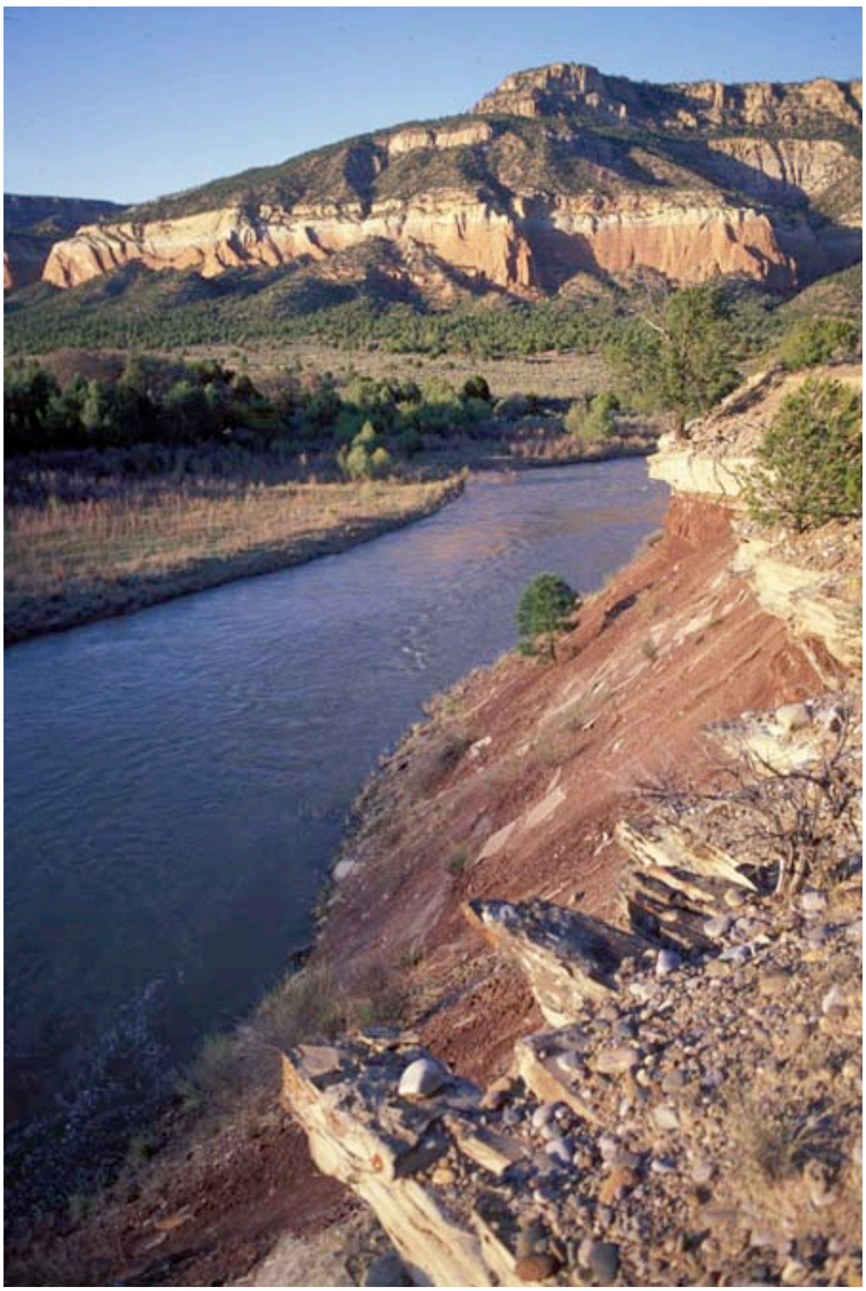
AMIGOS BRAVOS



Introduction

The availability of clean water will define the future of all communities in the Southwestern United States – not to mention the health of its residents. Currently, New Mexico and Arizona are consuming more water than the two states receive from precipitation each year. At the same time that the region is mining water from its aquifers at unsustainable levels, pollution, Climate Change, and population growth are adding pressures to the scant supplies of available clean water. With ever increasing thirst and diminishing supplies of available water, urban areas drive up the price of water, which in turn dries up farmland and places rural communities at risk. Rural communities of the Southwest are in the midst of a water crisis that will not be solved without proactive and visionary action by its residents.

This publication is designed to provide the residents of the area with a basic toolkit for protecting water quality in their communities – the rivers, streams, lakes and wetlands that sustain all life.

First, we provide basic information about water quality in the region, and how you can get more detailed information about pollutants in your community. Secondly, we provide a check list with which residents can identify sources of pollution. Thirdly we provide contact information for reporting sources of contamination. Fourthly, we detail how you can set up a community water quality monitoring program, and we provide a basic overview of the costs associated with such a program. Lastly, we outline some basic policy recommendations for the protection of water quality together with two proactive suggestions: 1. Making the best use of stormwater controls, and 2. Developing a water impact assessment for proposed new land and water developments.

This publication is a product of the Southwest Rural Policy Network (SWRPN) Environmental Action Team and is funded through a grant from Rural Strategies and the Kellogg Foundation. The primary author of this publication is Rachel Conn, Projects Director of Amigos Bravos, Inc., a New Mexico statewide non-profit water protection and advocacy organization. The section on the Water Impact Assessment policy recommendation was taken from a paper prepared for the SWRPN by Marlene Dermody, MPH, at the University of Arizona. Amigos Bravos and the SWRPN provide technical assistance and advocacy trainings to people interested in protecting waters in their communities. For more information about topics outlined in this toolkit please contact us through our web page and/or Facebook.

Polluted Waters in New Mexico and Arizona

Each state is required under the federal Clean Water Act to develop a report that contains an assessment of water quality in the state and summarizes efforts to address water quality problems. This report is called the §303d/§305b Integrated Report.

In New Mexico this report can be found at:
http://www.nmenv.state.nm.us/swqb/303d-305b/

In Arizona this report can be found at:
http://www.azdeq.gov/environ/water/assessment/assess.html

These reports present general information about the condition of water quality in the state as well as specific information about individual waterbodies and whether or not they are meeting water quality standards. To find out if your river or stream is meeting water quality standards go to the 303d list component of the report (sometimes the 303d list is also called the impaired waters list).

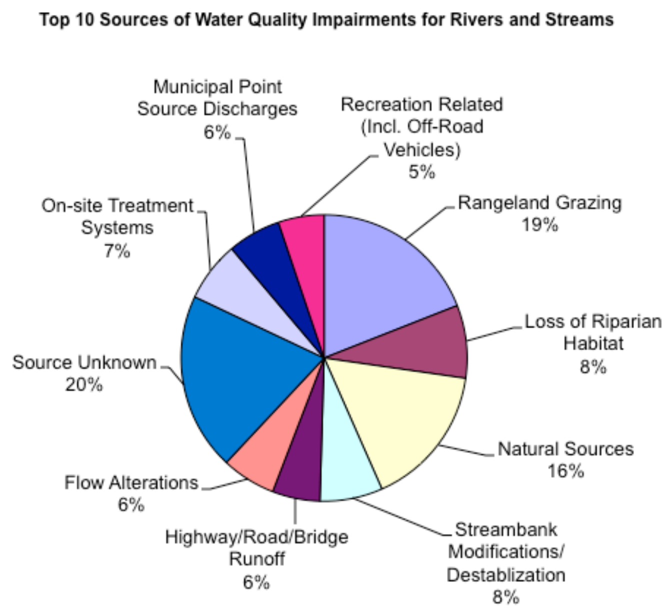
The following is a summary of the water quality issues in each state:

New Mexico:

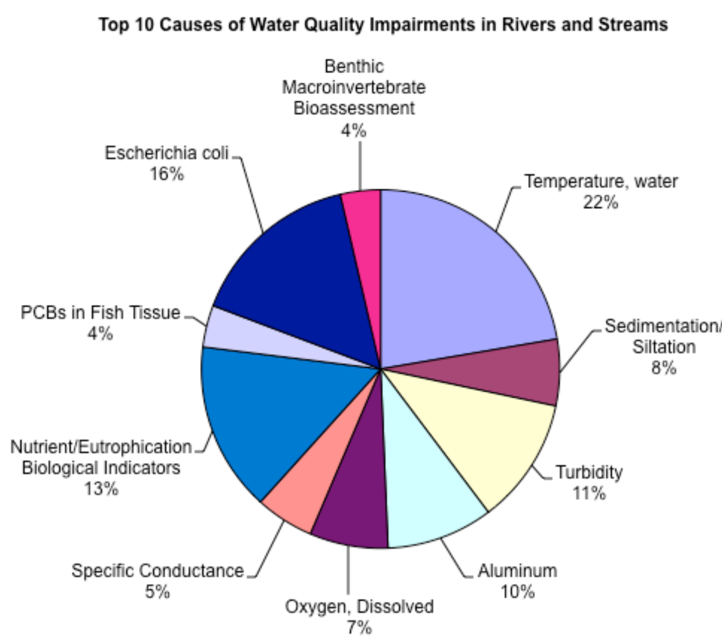
In New Mexico the most common pollution issues in rivers and streams are temperature (rivers and streams are too hot); nutrient/eutrophication (too many nutrients leading to crashes in dissolved oxygen); and E. coli. Rangeland grazing, natural sources, and loss of riparian habitat are the leading sources of pollution in New Mexico's rivers and streams. Mercury and PCBs (polycholrinated biphenyls) in fish tissue and temperature are the most common pollution issues in lakes and reservoirs. Atmospheric deposition, contaminated sediments, natural sources and rangeland grazing are the leading sources of pollution in New Mexico's lakes and reservoirs. Just 6,590 miles of the 108,649 miles New Mexico's rivers and streams are perennial (flow all the time).

Fish Advisories: Unfortunately many of New Mexico's Lakes and Reservoirs and some rivers have fish consumption advisories. This means that some of the fish found in New Mexico's waters are not safe to eat over long extended periods of time. The contaminants of concern are Mercury, PCBs, and DDT (Dichloro-Diphenyl-Trichloroethane). To find a full list of fish advisories for New Mexico go to: http://www.nmenv.state.nm.us/swqb/advisories/. The table found at this website lists the waterbodies with advisories as well as how many of each type of fish it is safe to eat.

Sources of Water Quality in Impairment in New Mexico Rivers and Streams	Stream Miles Impaired
Rangeland Grazing	1,898.87
Loss of Riparian Habitat	822.1
Natural Sources	1,606.94
Streambank Modifications/destablization	708.03
Highway/Road/Bridge Runoff	538.3
Flow Alterations	610.4
Source Unknown	1,999.80
On-site Treatment Systems	676.8
Municipal Point Source Discharges	599.44
Recreational Related (incl Off-Road Vehicles)	517.07
Total	9,977.75



Cause of Water Quality Impairment in New Mexico Rivers and Streams	Stream Miles Impaired
Temperature, water	1,406.61
Sedimentation/Siltation	378.16
Turbidity	718.85
Aluminum	605.81
Oxygen, Dissolved	446.65
Specific Conductance	332.57
Nutrient/Eutrophication Biological Indicators	962.22
PCBs in Fish Tissue	238.28
Escherichia coli	984.96
Benthic Macroivertebrate Bioassessment	228.11
Total	6,302.22



Source – NMED 30d/305b Report

Arizona:

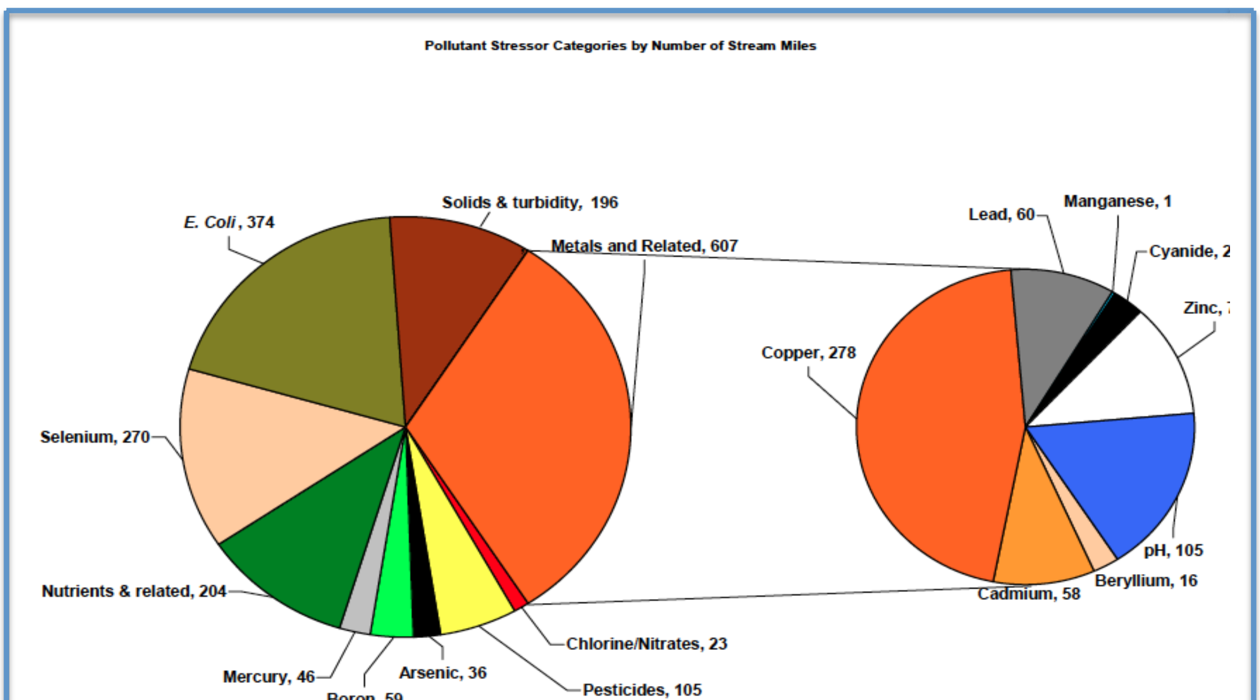
In Arizona the most common pollution issues in rivers and streams are metals and E.coli. Nutrients impair the greatest number of lakes in Arizona and Mercury impairs the greatest number of lake acres.

Only 2.8% of all stream miles in Arizona have been sampled (or assessed) to determine if they are meeting water quality standards. This is due largely to the fact that the majority of stream miles are ephemeral (don't flow all the time) and are difficult to sample. Of the perennial streams, 57% have been sampled. This is still low and should be improved, especially since Arizona does not have that many miles of perennial streams. Only 3,530 miles of Arizona's 90,375 miles of rivers/streams are perennial. A total of 24% of lake acres and 24% of streams miles that were assessed are currently meeting water quality standards.

Fish Advisories: Fish consumption advisories have been issued on 14 lakes and portions of several rivers in Arizona. The pollutants of concern are Mercury and DDT. For a complete listing of which waterbodies have fish consumption advisories go to: http://www.azdeq.gov/environ/water/assessment/download/fca.pdf

POLLUTANTS OR STRESSORS CAUSING IMPAIRMENT - 2010

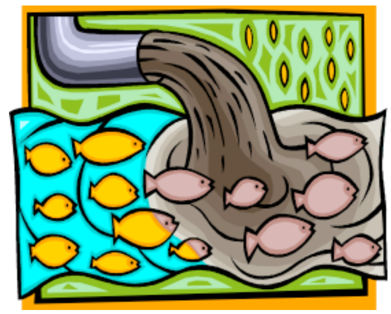
Pollutant Stressor Category	# Lakes	Acres	# Reaches	Miles
Nutrients & related (N,P,D.O.pH)	34	7783	18	204
Metals & related (excluding Hg)	0	0	102	608
Selenium	1	27045	14	270
Arsenic	0	0	4	36
Mercury	13	31693	3	46
Boron	0	0	3	59
Solids (turbidity, sedimentation)	0	0	15	196
E. coli (& biological - lakes)	2	27	19	374
Pesticide (DDT, chlordane, toxaphene)	2	286	10	105
Other (Nitrate and chlorine)	0	0	4	23



Source – ADEQ 305b/303d Report

Detecting Discharges to Rivers and Streams

Understanding the permitting process for discharges to rivers, streams and lakes is crucial when working to protect the waters of your state. There are two types of discharge permits regulated under the Clean Water Act, 402 permits and 404 permits. These permits control water pollution by regulating sources that discharge pollutants into the waters of the US. Section 402 permits, also called NPDES (National Pollutant Discharge Elimination System) permits, regulate point-source discharges, typically from pipes, such as at wastewater treatment plants or industrial facilities. Section 402 permits also regulate stormwater discharges from industrial sites, construction sites, and cities. Section 404 permits are used to regulate the discharge of dredged or fill material into waters of the US. You can find Frequently Asked Questions about 404 permits at the U.S. Army Corps of Engineers website: http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/FrequentlyAskedQuestions.aspx



Both 402 and 404 permits are issued in two types: general (covering multiple discharges engaged in similar activity) and individual (covering a specific facility), each with their own requirements and public review opportunities.

Basic guideline: Any activity that could be discharging pollutants into a waterbody, either from a pipe or through flow of water across the surface of the ground after a rain event (or snowmelt) most likely requires a discharge permit.

Checklist for detecting discharges in your watershed:

- ☐ Talk to people! Call your local watershed group and ask them about their concerns. Call your state environmental agency, Environmental Protection Agency (EPA), or US Army Corps of Engineers (USACE) and ask them about discharges in your watershed (contact numbers for New Mexico and Arizona found below).

- ☐ Go to EPA Envirofacts website: http://www.epa.gov/enviro/facts/topicsearch.html#water and enter your city/town and state in the box after the prompt "What facilities have permits to discharge waste water in my area of interest?" This will bring up a map and list of facilities that have NPDES permits.

- ☐ Go out on a watershed tour. Bring a notepad, pen, camera, GPS unit, and a friend.

- ☐ Look for:
    - Pipes that are discharging into waterbodies.

- Construction sites that are disturbing more than an acre of land that don’t appear to have any mechanism in place to stop muddy water from precipitation events from flowing off the site and into adjacent properties, streets, or waterbodies. (These construction sites don’t have to be near a river or stream to still be required to have a discharge permit).
- Industrial sites such as auto yards, manufacturing facilities, landfills, or other industrial activities. (These industrial sites don’t have to be near a river or stream to still be required to have a discharge permit).
- Large scale feedlots (usually greater than 300 animals).
- Activities that are resulting in dirt or any fill material being placed in a river (this is often the case in road projects) or any situation where material is being removed from the bottom of a stream or river. Hint, if you see heavy machinery in a waterbody it is often a sign that there should be permit coverage for any related potential dredge or fill impact.

- [ ] Once you have found one of the above - take a photo(s), a GPS reading, and write down some notes including a general description of the location and the concerns you have.

- [ ] You can send these photos and concerns to your state environmental regulatory agency, your regional EPA office, your USACE district office, or all three. Be sure to ask specific questions and request a reply. You can call numbers below and ask for an email address or fax number to send photos and questions.

Contact Information

To ask questions about water quality and discharges in your watershed or to report a spill or source of contamination contact the following state or federal agencies:

In New Mexico contact:

New Mexico Environment Department - Surface Water Quality Bureau
505-827-0187

New Mexico is part of EPA Region 6. The number to call about discharges to water is: 214-665-6464

US Army Corps of Engineers Contact for New Mexico:
Albuquerque Office: 505-342-3171 or caspa-pa@usace.army.mil
Sacramento Office: 415-503-6517 or spd-pao@usace.army.mil

In Arizona contact:

Arizona Department of Environmental Quality
(602) 771-2300
(800) 234-5677 - Toll Free

EPA Contact for Arizona: Arizona is part of EPA Region 9. The number to call about discharges to water is: (415) 972-3464

US Army Corps of Engineers Contact for Arizona:
Albuquerque Office: 505-342-3171 or caspa-pa@usace.army.mil
Sacramento Office: 415-503-6517 spd-pao@usace.army.mil

Other Contacts:

Amigos Bravos
575-758-3874
bravos@amigosbravos.org

Southwest Rural Policy Network
http://southwestruralpolicynetwork.com/about-us/about-swrpn/

Water Quality Monitoring – Taking Your Own Samples

What do you do if the river or stream is one of the many that your state hasn't gotten to monitor yet, or if you are concerned that it has been a long time since they last monitored? Or, as is often the case, they only monitored at one location in your stream and you would like more comprehensive information about water quality that can tell you more about problem areas and potential sources of contamination?

You can do your own water quality monitoring!

States will typically accept third party (that's us/you) monitoring results and include them in their own surface water quality reporting if they are confident that the outside party has followed proper sampling protocols and that the laboratory used for analysis has proper quality assurance methods in place. A state will thoroughly review and critique the process used by the third party before this can happen. It can take a couple of years of back-and-forth of comment and third party tweaking before the data is officially accepted. Regardless of whether the state officially incorporates the data into the official regulatory process, the information you gather can be used from day one to inform the public, locate potential pollution hot spots in your watershed, and to advocate for local, state, and federal officials to act to address contamination issues.

Citizen Monitoring Volunteer – Taos NM

Quality Assurance Project Plan

If you want your data to be accepted by state or federal agencies and used to make regulatory decisions you will need to draft a Quality Assurance Project Plan (QAPP). These plans can take some time and thought in developing. Prior to spending a lot of time figuring out how to draft one on your own, contact your state agency or the EPA and ask them what they require to accept third party data. In addition, you can contact Amigos Bravos or Sierra Club's Water Sentinel program to ask for assistance. Again, if you are sampling to gather information and use it to inform the public, developing a QAPP is not always necessary – see above for uses of water quality data collected without a QAPP.

Typical Contaminants to Monitor

There are many constituents or analytes of concern that people monitor, as well as water conditions like temperature, pH, and TDS (Total Dissolved Solids), which can tell you a lot about the health of a river and can be analyzed in the field with field equipment. Amigos Bravos has field equipment to lend out to groups. Please contact bravos@amigosbravos.org to ask about the lending protocol.

What follows are the most common contaminants that can be analyzed by collecting samples and sending them into a lab.

E.coli – This very common bacteria is now the standard for testing for the presence of fecal waste products. Much *e.coli* found in rivers and streams is from wildlife and livestock (cows, birds and mammals), but a study on the Rio Grande in Albuquerque found a large percentage was from human waste (septic tanks) and from domestic animals (cats and dogs and horses and livestock).

Nutrients – So-called because plants use them (especially nitrate and ammonia). They result from runoff by dairy and crop production, as well as from leaking septic tanks. Most labs will test a suite of nutrients that includes ammonia, nitrate, nitrite, phosphorus, and total nitrogen.

Metals – These come from industrial processes and can be deposited from discharges into water or through air deposition (from coal-fired power plants, for example, mercury and some other metals, as well as radionuclides are discharged). Most labs test for a suite of metals, typically including aluminum, antimony, arsenic, beryllium, cadmium, chromium, lead, nickel, selenium, silver, thallium, and zinc. Sometimes the suite is pre-defined for a set price and other metals can be added for a nominal charge; sometimes you can just pick what you want. All of the above metals are analyzed as dissolved metals, so the sample is filtered by the lab first to remove any suspended solids (many metals attach to small sediment particles in the water).

Mercury – This is another metal and very common because it often comes from coal-fired power plants and is deposited over long distances (China's coal plants contribute to mercury deposition in the US, for example). It is analyzed separately from other metals because it is analyzed as total mercury (and therefore not filtered). Mercury is also analyzed in fish tissue.

PCBs (polychlorinated biphenyls) – This is a group of 209 related chlorine and benzene-based chemicals used extensively in industrial processes. Their use was banned in the US in 1979, but they are persistent and widespread in the environment.

Pharmaceutical and Personal Care Products (PPCPs) – This group includes everything from caffeine to ibuprofen to methadone to heart medications. Typically, a laboratory will have several groupings of PPCPs that it will analyze for. A subset of PPCPs is Endocrine Disrupting Compounds, such as BPA, which is used in some plastics. These chemicals mimic the human endocrine (hormone) system and are believed to have an impact on growth and development (other chemicals not within the PPCP lists can also impact the endocrine system).

Radionuclides – This includes both alpha- and beta-emitting elements (reported as "gross alpha" and "gross beta"). Common alpha emitters are isotopes of americium, plutonium, uranium, thorium, radium, radon, and polonium. The most common man-made beta emitters are strontium-90 and cesium-137, both of which may still appear as a result of past atomic/nuclear weapon testing. Other common beta emitters (there are a lot) are isotopes of tritium, cobalt, iodine, technetium.

To give you some idea of pricing, here is a table prepared in 2009/10 for a long-term water quality monitoring project Amigos Bravos carried out on the drains and ditches in the Albuquerque area:

ANALYTE	Description	Cost per sample
Total Dissolved Solids	The combined content of all inorganic and organic substances contained in a freshwater system	15.00
Nutrient Group	Includes Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen (TKN), Total Phosphorus; main sources are wastewater treatment plants and agricultural runoff	125.00
Metals Group	Includes: Antinomy (Sb), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Lead (Pb), Nickel (Ni), Selenium (Se), Silver (Ag), Thallium (Tl), Zinc (Zn)	235.00
Total Mercury	Highly toxic; volcanoes and coal-fired power plants are primary sources	55.00
TRPH	Total Recoverable Petroleum Hydrocarbons; underground storage tanks, leaking fuel delivery systems, stormwater runoff, etc. Also analyzed as GRO/DRO which are gasoline and diesel related organics	30.00
Gross Alpha & Beta	Particles are a type of ionizing radiation ejected by the nuclei of some unstable atoms; both natural and human-made; The **Alpha** particles of most interest are typically Americium-241, Plutonium, and Uranium; Radium and Radon are generally treated separately; **Beta** particles of interest are typically tritium, strontium, and cesium, although potassium can also be an issue at times	180.00
E. coli	*Escherichia coli* is a bacteria found in the lower intestine; most *E. coli* strains are harmless and can benefit their hosts by producing vitamin K or by preventing the establishment of harmful bacteria within the intestine; their ability to survive for brief periods outside the body makes them an ideal indicator organism to test environmental samples for the likelihood of other kinds of fecal contamination	55.00
SVOCs	Semi-Volatile Organic Compounds (an organic compound which may vaporize when exposed to temperatures above room temperature); examples are paints, thinners, solvents, some pesticides, etc	1725.00
EDCs / PPCPs	Endocrine Disrupting Compounds / Pharmaceuticals and Personal Care Products; things like birth control pills, diabetes medication, heart medication, steroids, painkillers, anti-depressants, anti-seizure medication, sunscreen, insect repellant, plasticizers (some of which mimic hormones in the body), etc.	563.00

Contacting a Laboratory

Once you have an idea of what you would like to sample for contact a laboratory (search for water analysis laboratory online to find the closest one) and ask them the specifics about pricing and about how to get sample bottles. Usually you can either pick up or have them ship you sample bottles with the appropriate preservative. For precise results – with certified quality assurance on the results, that state or federal agencies will accept for its own use – you need to use a laboratory that meets EPA standards because each constituent has specific analytical methods whose results the EPA will accept.

Collecting the Sample

An out-of-state lab will send a cooler with bottles and gel packs to use when collecting the samples and sending them back (via UPS Overnight, using prepaid labels billed to your account). You will have to freeze the gel packs so they are ready for the day you collect samples so they maintain a low temperature in the cooler when you send it out that day. You will have to fill out a Chain-of-Custody form (provided by the lab) that asks for details on who collected the sample, when and where it was collected (a GPS coordinate would be excellent), what samples are included in the shipment, and how they should be treated. The lab can walk you through the form ahead of time. This makes using an out-of-state lab very convenient. Shipping costs for a standard cooler full of bottles and gelpacks runs about $50.

Citizen Monitoring Volunteer – Taos NM

There are two ways to sample:
The first is called a **“grab sample”** and consists of using a small collector on the end of a pole to dip into the water and then transfer it to either a larger container (before filling bottles) or directly into the bottle. The other method is called a **“composite sample”** and consists of entering into the water with a specialized container on a rod and slowly moving the collector up and down and also moving slowly back and forth across the water. Filling the bottles correctly is also important. Bottles with preservative have to be filled to avoid spilling the preservative. Some analytes have to be filled to the rim (without spilling) in order to prevent air from being trapped in the bottle and causing volatilization of the analyte. Bottles also have to have their labels filled out (generally, date, time, location, analyte, name of collector). The lab supplying the bottles will supply the labels. Store all the bottles in the cooler with ice packs to keep the temperature down. This is most important for the *E.coli* samples. If they are too warm, the lab will not accept them for analysis. Be sure you are aware of holding times (the time you have from collection to when it needs to be analyzed). For Bacteriological samples that is often only 6-8 hours, so plan accordingly!

Interpreting the Monitoring Results

For field tests like for pH, conductivity, and dissolved oxygen you will have the results immediately and can compare them to the appropriate water quality standard for your river. This may involve calling your state agency and asking to speak to someone who works on surface water quality standards and asking them to help you identify what standards apply. Laboratory results will be sent to you typically within a week. Again contact a state official or someone from your local watershed group to help you compare the results to the applicable standards.

Advocating for Solutions

Regardless of whether or not you have comprehensive data or "proof" that there is a water quality problem in your watershed, you can always advocate for water quality improvement measures such as better oversight of discharges in your watershed. Focusing a little community attention on the local wastewater treatment plant can go a long way towards cleaning up the water that is discharged from the plant! There are always opportunities at the local, state and federal level to advocate for water quality improvements whether it be through local stream buffer ordinances, statewide special water protections or federal clean water policy.

Stormwater Control Policy Recommendation

One area that citizens can make a difference is advocating for smart, forward thinking stormwater control in your local community. Contamination of rivers and streams from the polluted runoff that runs off the land and into our watersheds during rain and snowmelt events is a major problem all across the country. Newer approaches to controlling this contamination such as Low Impact Development (LID) and Green Infrastruture (GI) solutions are gaining momentum.

Low Impact Development (LID) and Green Infrastructure (GI)

> *Green Infrastructure* - a system that mimics natural processes in order to infiltrate, evaporate, and/or reuse stormwater. Green infrastructure uses soils, topography, and vegetation in a way that minimizes the impacts of anthropogenic disturbance and maintains pre-development hydrology and water quality.
>
> *Low Impact Development (LID)* - an approach to land development (or re-development) and management that works with nature to manage stormwater as close to its source as possible.

Green infrastructure approaches include green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, vegetated median strips, reforestation, and protection and enhancement of riparian buffers and floodplains. Green infrastructure can be used almost anywhere where soil and vegetation can be worked into the urban or suburban landscape. The effectiveness of these approaches can be supplemented with other decentralized storage and infiltration approaches, such as the use of permeable pavement and rain barrels and cisterns to capture and re-use rainfall for watering plants or flushing toilets. Green infrastructure allows stormwater to be absorbed and cleansed by soil and vegetation and either re-used or allowed to flow back into groundwater or surface water resources. These approaches can diminish flows into sewer systems, reducing sewer overflows and the amount of pollution discharged to our waters.

Examples of Green Infrastructure

Landscape

Parking lots

Around
Buildings

Walkways and
paved areas

Streets and
sidewalks

Rooftops

Photo Credits - Biohabits

Green infrastructure and urban forests have a number of other environmental and economic benefits in addition to reducing the volume of sewer overflows and stormwater discharges.

- ✓ *Enhanced Water Supplies* – Most green infiltration approaches involve allowing stormwater to percolate through the soil where it recharges the groundwater and the base flow for streams, thus ensuring adequate water supplies for humans and more stable aquatic ecosystems.

- ✓ *Cleaner Air* – Trees and vegetation improve air quality by filtering many airborne pollutants and can help reduce the amount of respiratory illness.

- ✓ *Reduced Urban Temperatures* – Summer city temperatures can average 10ºF higher than nearby suburban temperatures. Vegetation creates shade, reduces the amount of heat absorbing materials and emits water vapor – all of which cool hot air.

- ✓ *Increased Energy Efficiency* – Green space and urban trees lower ambient temperatures when incorporated on and around buildings, and help shade and insulate buildings from wide temperature swings – decreasing the energy needed for heating and cooling.

- ✓ *Community Benefits* – Trees and plants improve urban aesthetics and community livability by providing recreational and wildlife areas. Studies show that property values are higher when trees and other vegetation are present.

- ✓ *Cost Savings* - Green infrastructure may save capital costs associated with digging big tunnels and centralized stormwater ponds, operations and maintenance expenses for treatment plants, pumping stations, pipes, and other hard infrastructure; energy costs for pumping water; cost of treatment during wet weather; and costs of repairing streambank and infrastructure damage caused by high volumes of stormwater.

Citizens can advocate for the adoption of LID/GI at many different levels of community planning, private development, and government regulations. Ordinances, building codes, permitting requirements can all incorporated LID/GI approaches.

For more resources about LID/GI in the arid southwest go to: http://www.aridlid.org/

Water Impact Assessment Policy Recommendation

Taken from a paper developed for the SWRPN by Marlene Dermody, MPH

The intent of developing a Water Impact Assessment is to provide a tool by which a community can address water quality and quantity issues when faced with potential development concerns. There is extensive information available concerning a broad range of remediation of water issues, but the goal of this effort is to provide an “upstream solution” – meaning preservation of water resources and prevention of any negative impacts due to development.

Step 1: Know, and develop relationships with stakeholders; educate each other about priorities and concerns, areas of expertise, and existing policies, regulations and ordinances around issue(s) of concern.

Developing a Water Impact Assessment will provide the information necessary to develop water sustainability and management strategies, and can inform conservation efforts. A Water Impact Assessment, which measures impact, not simply usage, is one of the most important roles for sustainable water management. Any development project would be considered as part of the local or regional water cycle, both adding and subtracting water of calculable water quantity and quality. A Water Impact Assessment should consist of:

- Identification of impact causing factors, both existing and future
- Determination of impact boundaries (geographical)
- Water Budgeting
- Prediction of water usage and recharge, determining acceptable limits, considering options
- Proposed mitigation measures for the effects occurring within determined acceptable limits
- Monitoring at determined intervals, and re-assessment as necessary

Every development event and groundwater system needs to be considered as a unique event. Water resource and impact analysis is tailored to the social, economic, and legal constraints that are taken into account. Therefore, science and policy must interface in a way to bring best practices to water management regulations. Sound management of water resources needs support from scientific data.

Watersheds do not always follow political boundaries. Watershed protection, conservation, and restoration is best seen as a cooperative effort between local and regional stakeholders, and greater levels of government, including the Environmental Protection Agency (EPA), state agencies such as the state department of water resources, and local agencies and community organizations.

Development of any regulations or policies regarding water, sustainability, and conservation becomes a collision of science and politics; the process requires consideration of environmental, economic and social desirable outcomes simultaneously.

Resources:
Stakeholder Partnerships as Collaborative Policymaking: Evaluation Criteria Applied to Watershed Management in California and Washington Journal of Policy Analysis and Management, Vol. 21, No. 4, 645–670 (2002) © 2002 by the Association for Public Policy Analysis and Management. Published by Wiley Periodicals, Inc. Available at:(www.interscience.wiley.com) DOI: 10.1002/pam.10079

Community Guide to Development Impact Analysis: Environmental Impact Analysis. Mary Edwards Available at:

http://www.lic.wisc.edu/shapingdane/facilitation/all_resources/impacts/analysis_environmental.htm

What skills and information do watershed groups require for effective watershed planning and restoration? Brent Ladd. Indiana Watershed Leadership Program. Available at: www.extension.purdue.edu/.../Factsheet_skills_info_barriers.pdf

Step 2: Be aware of resources available to assist with water science and data gathering.

These investigations will assess the existing knowledge of a groundwater system, quantify a water budget and lead to informed water management decisions, including the establishment of a monitoring system for the necessary iterative assessment of the aquifer.

If such data exist, water quality and quantity data, as well as geohydrological data, can be found at many levels. Some databases are more complete than others.

Federal resources:

- United States Geological Survey: www.usgs.gov
- United States Army Corps of Engineers: www.usace.army.mil/
- United States Department of the Interior: www.doi.gov/
- Bureau of Land Management: www.blm.gov/

- EPA watershed website: http://water.epa.gov/type/watersheds/index.cfm

- EPA watershed academy online training and publications; http://water.epa.gov/learn/training/wacademy/index.cfm

The EPA has a useful website for understanding local watershed characteristics: "Surf your Watershed" at: www.epa.gov/owow/surf/

Step 3: Develop a Water Budget.

The following concise description of the rationale behind a water budget comes from the USGS at http://pubs.usgs.gov/circ/circ1186/html/gw_dev.html)

"A ground-water system consists of a mass of water flowing through the pores or cracks below the Earth's surface. This mass of water is in motion. Water is constantly added to the system by recharge from precipitation, and water is constantly leaving the system as discharge to surface water and as evapotranspiration. Each ground-water system is unique in that the source and amount of water flowing through the system is dependent upon external factors such as rate of precipitation, location of streams and other surface-water bodies, and rate of evapotranspiration. The one common factor for all ground-water systems, however, is that the total amount of water entering, leaving, and being stored in the system must be conserved. An accounting of all the inflows, outflows, and changes in storage is called a water budget. Human activities, such as ground-water withdrawals and irrigation, change the natural flow patterns, and these changes must be accounted for in the calculation of the water budget. Because any water that is used must come from somewhere, human activities affect the amount and rate of movement of water in the system, entering the system, and leaving the system. As human activities change the system, the components of the water budget (inflows, outflows, and changes in storage) also will change and must be accounted for in any management decision. Understanding water budgets and how they change in response to human activities is an important aspect of ground-water hydrology; however, as we shall see, a predevelopment water budget by itself is of limited value in determining the amount of ground water that can be withdrawn on a sustained basis."

Much of these data need to be overlaid on maps; geographic information systems (GIS) become particularly useful to organize and understand the data (physical, environmental, and human) in relation to its location. Information about watersheds, land use, and geographic features can be integrated to better understand ecosystems and the interactions between habitats. Impact boundaries can be determined. Using GIS facilitates permitting – or regulation – related tasks in water management in the following areas:

- Population and demand projections
- Water quality monitoring
- Hazardous materials tracking/underground tank management
- Well log and data management
- Site analysis
- Bibliography (past studies)
- Development review and approval
- Right-of-way engineering
- Water flow analysis (http://www.esri.com/industries/water_resources/business/permitting.html)

Resources:

Yavapai County, Arizona's Water Advisory Committee also has informative documents available on its website. There are three "Info Series" reports, all useful, including one on water budgeting.

The United States Geological Survey (USGS) is a useful site for the following data that becomes incorporated into a water budget:

- Topographic maps showing the stream drainage network, surface-water bodies, landforms, cultural features, and locations of structures and activities related to water
- Geologic maps of surficial deposits and bedrock
- Hydrogeologic maps showing extent and boundaries of aquifers and confining units
- Maps of tops and bottoms of aquifers and confining units

- Saturated-thickness maps of unconfined (water-table) and confined aquifers
- Average hydraulic conductivity maps for aquifers
- Maps showing variations in storage coefficient for aquifers
- Estimates of age of ground water at selected locations in aquifers
- Precipitation data
- Evaporation data
- Streamflow data
- Maps of the stream drainage network showing extent of normally perennial flow, normally dry channels, and normally seasonal flow
- Estimates of total ground-water discharge to streams
- Measurements of spring discharge
- Measurements of surface-water diversions and return flows
- Quantities and locations of interbasin diversions
- History and spatial distribution of pumping rates in aquifers
- Amount of ground water consumed for each type of use & spatial distribution of return flows
- Well hydrographs and historical head (water-level) maps for aquifers
- Location of recharge areas and estimates of recharge

Yavapai County, Arizona Water Advisory Committee website: http://www.yavapai.us/bc-wac

Tillman, F.D, Cordova, J.T., Leake, S.A., Thomas, B.E., and Callegary, J.B., 2011, Water availability and use pilot; methods development for a regional assessment of groundwater availability, southwest alluvial basins, Arizona: U.S. Geological Survey Scientific Investigations Report 2011-5071. Available at: http://pubs.usgs.gov/sir/2011/5071/

Selected Publications on the Water Resources in New Mexico. Available at: *http://nm.water.usgs.gov/publications.htm*

Ground-Water Development, Sustainability, and Water Budgets. Available at: *http://pubs.usgs.gov/circ/circ1186/html/gw_dev.html*

LinY-F, J. Wang, and A. J. Valocchi. Making Groundwater Recharge and Discharge Estimate Maps in One Day - An ArcGIS 9.2 application for water resources research. Available at: http://www.esri.com/news/arcuser/0408/groundwater.html

Step 4: Estimate future use (modeling) for the Water Impact Assessment.

All sectors' usage must be considered in the assessment; all stakeholders' concerns and needs should be met. Along with those needs, the needs of the environment plus any anticipated results of climate change must be included. Future use may be considered as the following:

- Domestic
- Commercial
- Industrial
- Agricultural
- Environmental
- Climate change

Computer simulation models are used as predictive tools for the cause and effect of water usage, input, and recharge. The model represents the complex relations among the inflows, outflows, changes in storage, movement of water in the system, and other potential factors in a simpler fashion. In constructing the model, gaps in water resource data that need further investigation would be identified. The water budget, along with hydrogeological data, informs the Water Impact Assessment report.

Resources:
Climate change: http://pubs.usgs.gov/circ/circ1186/html/boxb.html
Water Quality models:
BASINS 4.0: http://water.epa.gov/scitech/datait/models/basins/BASINS4_index.cfm
Bartholow, J., J. Heasley, B. Hanna, J. Sandelin, M. Flug, S. Campbell, J. Henriksen, and A. Douglas. 2003. Evaluating water management strategies with the Systems Impact Assessment Model: SIAM version 3: U.S. Geological Survey USGS Open-File Report 2003-82. 126 p. Available at:
http://www.fort.usgs.gov/products/publications/pub_abstract.asp?PubID=10015
USGS Water Resources Groundwater Software. Available at:
http://water.usgs.gov/software/lists/groundwater/

Step 5: Form partnerships with the stakeholders to maintain viability and effectiveness of community group. Develop a plan of action that addresses all stakeholder concerns/needs.

Areas that should be included in the plan of action are as follows:

- Quality of life
- Economic viability (individual and community)
- Options
- Mitigation

Resources:
Chesapeake Bay Preservation Ordinance. Available at:
www.fairfaxcounty.gov/dpwes/environmental/cbay/
O.U.C.H., Inc. Available at:
http://www.epa.gov/reg3wapd/drinking/ssa/sevenvalleys.htm
USER'S GUIDE TO THE HERNDON ZONING ORDINANCE #33. Available at:
http://www.herndon-va.gov/Content/Zoning/Chesapeake_Bay_Preservation/default.aspx?cnlid=2651
Pima County Comprehensive Plan Policy Major Amendment. Available at:
www.rfcd.pima.gov/wrd/planning/pdfs/wrpolicyres2008_72.pdf

Examples of Regulations and Model Ordinances

An ordinance is defined as: "a law set forth by a governmental authority, specifically, a municipal regulation". (Merriam-Webster) Below are examples of local regulations relating to water quantity and quality.
Community Environmental Legal Defense Fund. Rockland Township Water Supply Protection Act. Available at: www.celdf.org/article.php?id=770
Model Ordinances to Protect Local Resources. Available at:
http://www.epa.gov/owow/NPS/ordinance/mol7.htm
Model Ordinances. Available at:
http://www.semcog.org/Water.aspx
http://www.semcog.org/Watersheds.aspx
Resource Guide to Model Ordinances. Available at:
http://www.cuyahogariverrap.org/watershedstrategies/WatershedStrategies.html