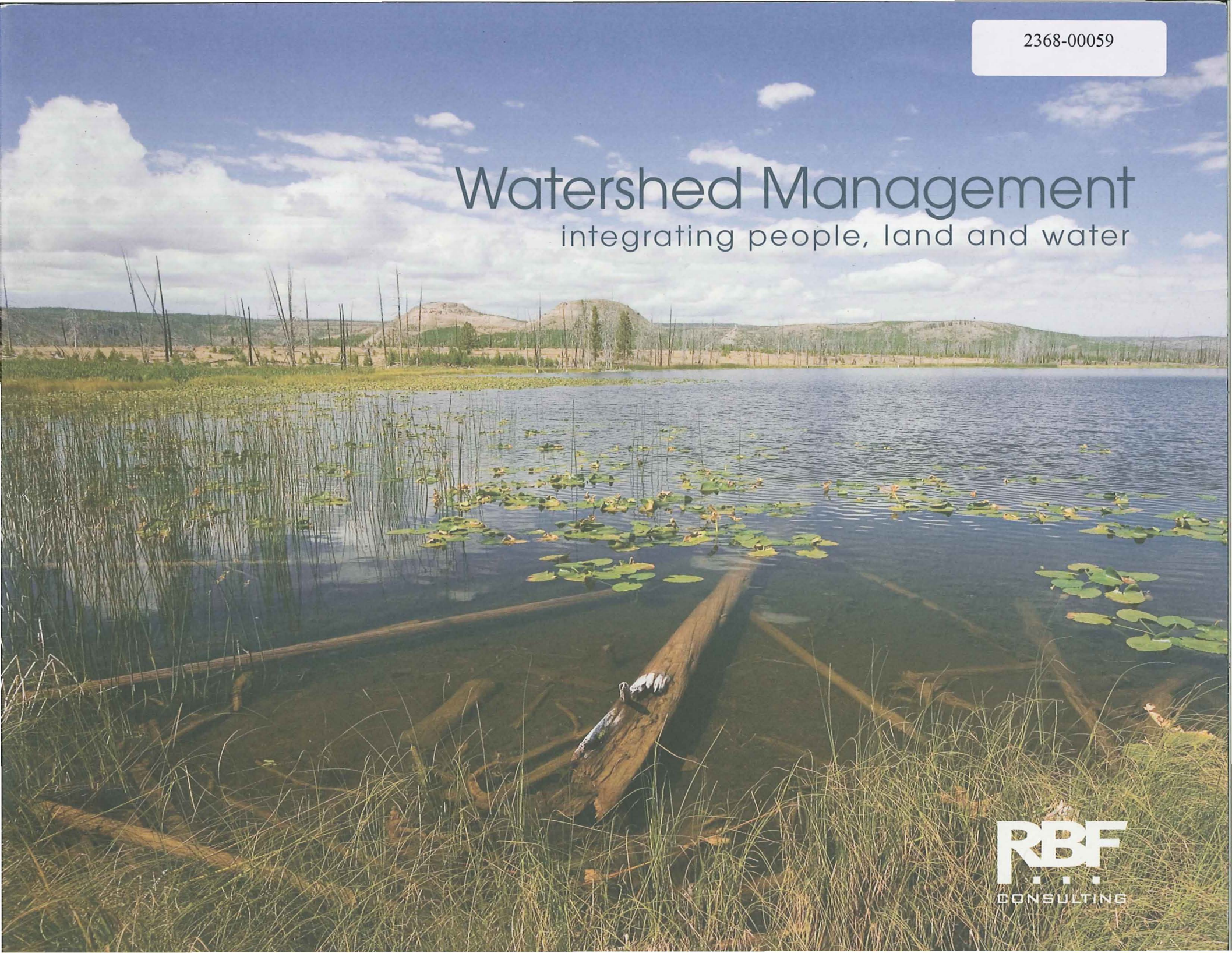
Watershed Management

integrating people, land and water



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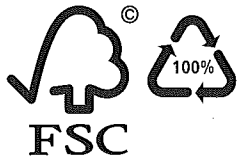

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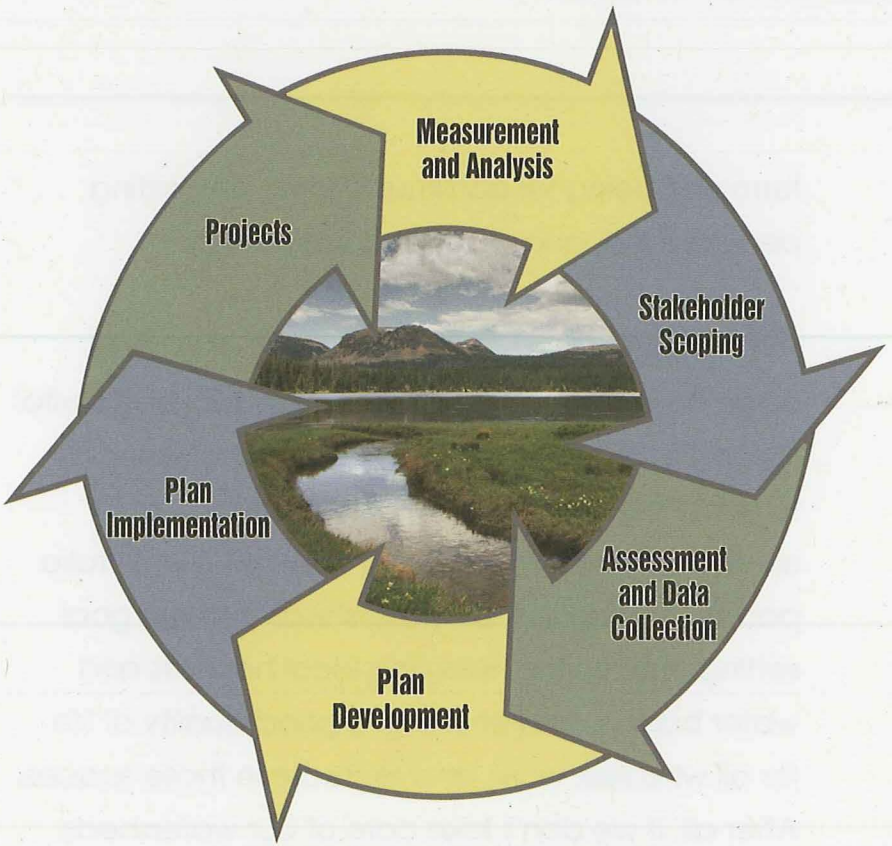
Watershed Management

Integrating people, land and water

Watershed management's underlying principle is that people, land, and water are connected. People use land in a variety of ways, and affect ecosystems, and ultimately, their own communities for better or worse. Managing and protecting the environment while providing a high quality of life for people is a complex process that is most successful when governing bodies, community members and experts in various fields are true partners in the planning process. Navigating local, state, and national regulatory standards can also be a daunting task for many watershed management groups. The watershed management approach brings all these factors together to provide long-term well being for communities by integrating people, land, and water in a watershed.

The watershed approach is growing at a rapid pace on a national and international level. It is vital for communities and management professionals to understand this move toward integration. In addition, it's important for all communities to take part in managing their watersheds through goal setting, monitoring, restoring local habitats and water bodies, and ensuring a good quality of life for all who live, work, and recreate in those spaces. After all, if we don't take care of our watersheds, who will?

Watershed Management Toolkit ©



This watershed toolkit is intended to serve as a convenient reference for participants of all types in a watershed or integrated resources planning process. In addition to describing the watershed management approach, it provides basic technical tools and information to assist anyone who is starting or participating in a watershed effort. As water quality and water quantity are often key drivers of watershed plans, this toolkit includes key facts and information about these areas of watershed management, as well as a basic glossary.

It is our desire in providing this toolkit, that engineering, planning and architecture professionals, elected officials, public agency personnel, private developers and all those involved in elements of watershed management will begin to take part in this way of looking at people, land and water.

Contents

Watershed Management

integrating people, land and water

People. Housing. Recreation. Economy. Health.

Land. Agriculture. Open Space. Development.

Water. Rivers. Oceans. Streams. Lakes. Wetlands.

What is Watershed Management?

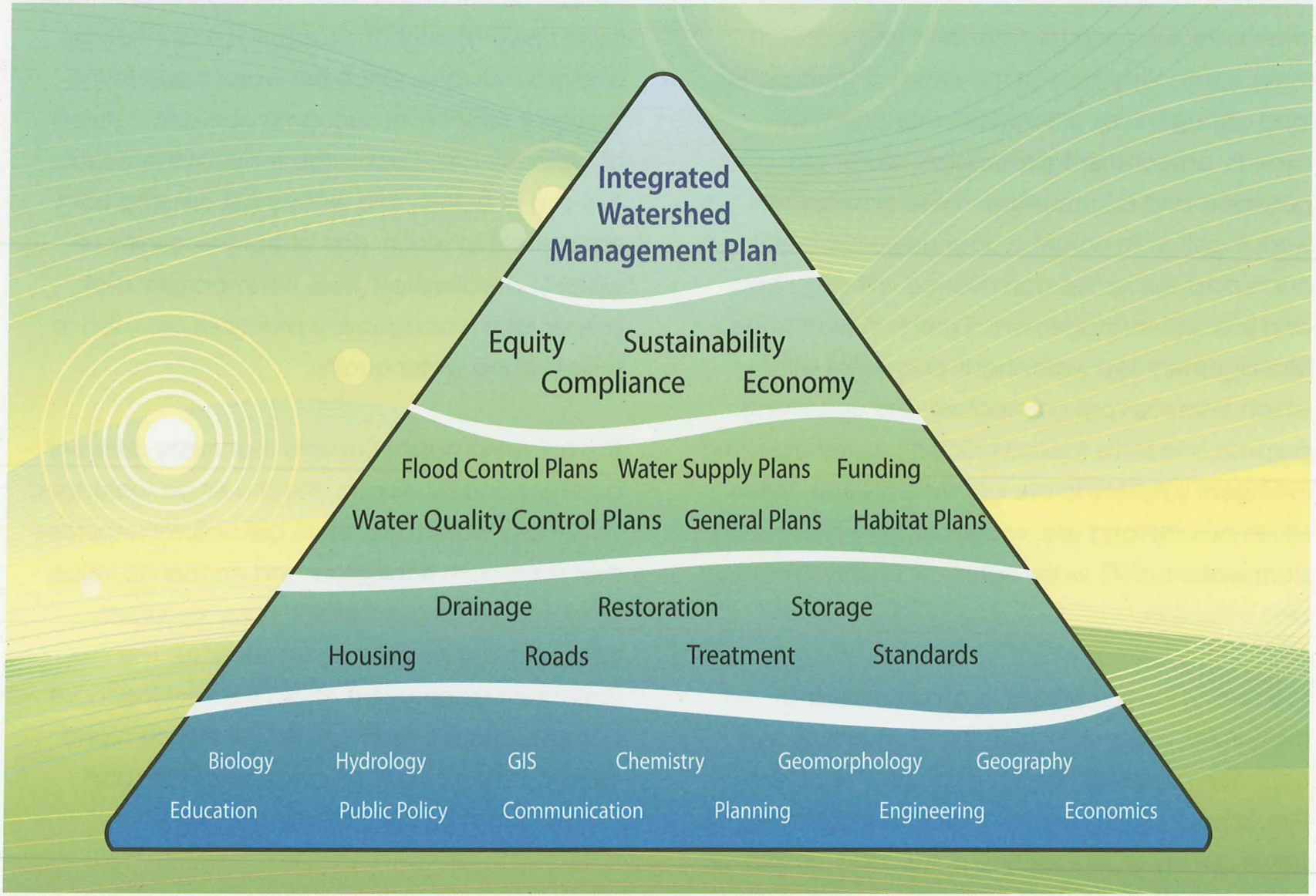
Watershed management is a way of looking at relationships among people, land and water. Its focus is the integration of the efforts of landowners, land use agencies, stormwater management experts, environmental specialists, water use purveyors and communities. These stakeholders work together to ensure proper stewardship of our natural resources, compliance with regulation and efficient management. Experts in Watershed Management see watersheds as systems within which resources are connected. The underlying purpose is to strive toward efficient, sustainable and intelligent solutions to our watershed issues. These issues include land use, water supply, water quality, stormwater runoff, water rights, air quality, planning and utilization.

The term watershed refers to an area of land that drains water from rainfall and snowmelt to a common point such as a stream, lake or ocean. Precipitation falling on any part of a watershed can travel quickly on the surface of the land, known as surface runoff, or permeate the ground and travel more slowly through the subsurface as interflow and groundwater. Once the water reaches the stream, it may travel through a complex network of channels until it ultimately reaches the ocean. Any sort of activity in a watershed, ranging from agricultural to urban, can affect the quality of water in a watershed. Thus, it is important that proper land management practices are used to ensure good water quality.

The following pages illustrate that many different activities and issues can affect a single watershed. Within any watershed, there are natural resources that have both ecological and economic value. Human activities can affect those resources, often with unintended consequences. The watershed approach is about recognizing those consequences by seeing the entire system and creating strategies to manage resources and human activities in a coordinated way.

People often ask, "What should a watershed plan include?"

The better question is, "How can each of our activities help realize the vision we have for our watershed?"



The Watershed Approach

The watershed approach changes the fragmented approach we have used in the past. Historically, we have managed resources within specific disciplines, and within spheres of influence created by people, not by the laws of nature. We have developed separate laws to protect water, air, soils, fisheries, forests and communities. We have also created separate agencies to administer these laws at federal, state, and local levels and on public and private lands. Property and political boundaries are usually unrelated to watershed boundaries. Of particular note, many of our resources management programs are driven by regulation and enforcement, creating a mindset of seeking the minimum necessary compliance as the best way to "optimize" activities.

The watershed approach changes this mindset to develop a recognition among members of a community of the value of their own resources, and to guide a holistic, balanced program of stewardship that achieves community goals while complying with rules. A watershed approach integrates biology, chemistry, hydrology, economics, and social considerations into decision-making. It recognizes needs for water supply, water quality, flood control, navigation, hydropower generation, fisheries, biodiversity, habitat preservation, recreation, and development; and it recognizes that these needs can compete. It establishes local priorities, accounts for state and national goals, and coordinates public and private actions.

Thus, while traditional approaches are reactive, precautionary, regulatory, single-purpose, and driven by enforcement, ***watershed management is proactive, scientific, uses agreement-based approaches to achieve multiple benefits, and is driven by the self-interest of stakeholders.***

Watershed protection measures seek to stop or reduce pollution and prevent degradation. ***Measures that prevent degradation before it occurs typically cost less*** than restoration measures implemented after watersheds are impaired.

When restoration is required, it is more challenging to establish acceptable and measurable goals. This is where stakeholder collaboration is most essential. Some will see restoration as the re-establishment of pre-disturbance aquatic functions, but others may focus more on recreation, flood protection, or water use efficiency. It is critically important that stakeholders work out a balance among competing "public goods", which no single discipline is equipped to achieve.

A key skill needed for any watershed process is ***facilitation:*** the ability to draw honest viewpoints out from stakeholders and assist the group in finding agreement, identifying and respecting disagreements, and charting a positive course. The process depends on productive participation of stakeholders who have enthusiasm for the task and who may have opposing viewpoints, which makes the assistance of an experienced facilitator essential.

Because ***water quality*** is one of the key drivers of many watershed efforts, the following pages provide some key information about water pollutants and resource management that may prove helpful in a proactive watershed process.

We have provided a series of ***pictures of a hypothetical watershed*** to illustrate the kinds of resource issues and strategies that a watershed plan can address.

A Watershed process needs a strong outreach program, which should include:

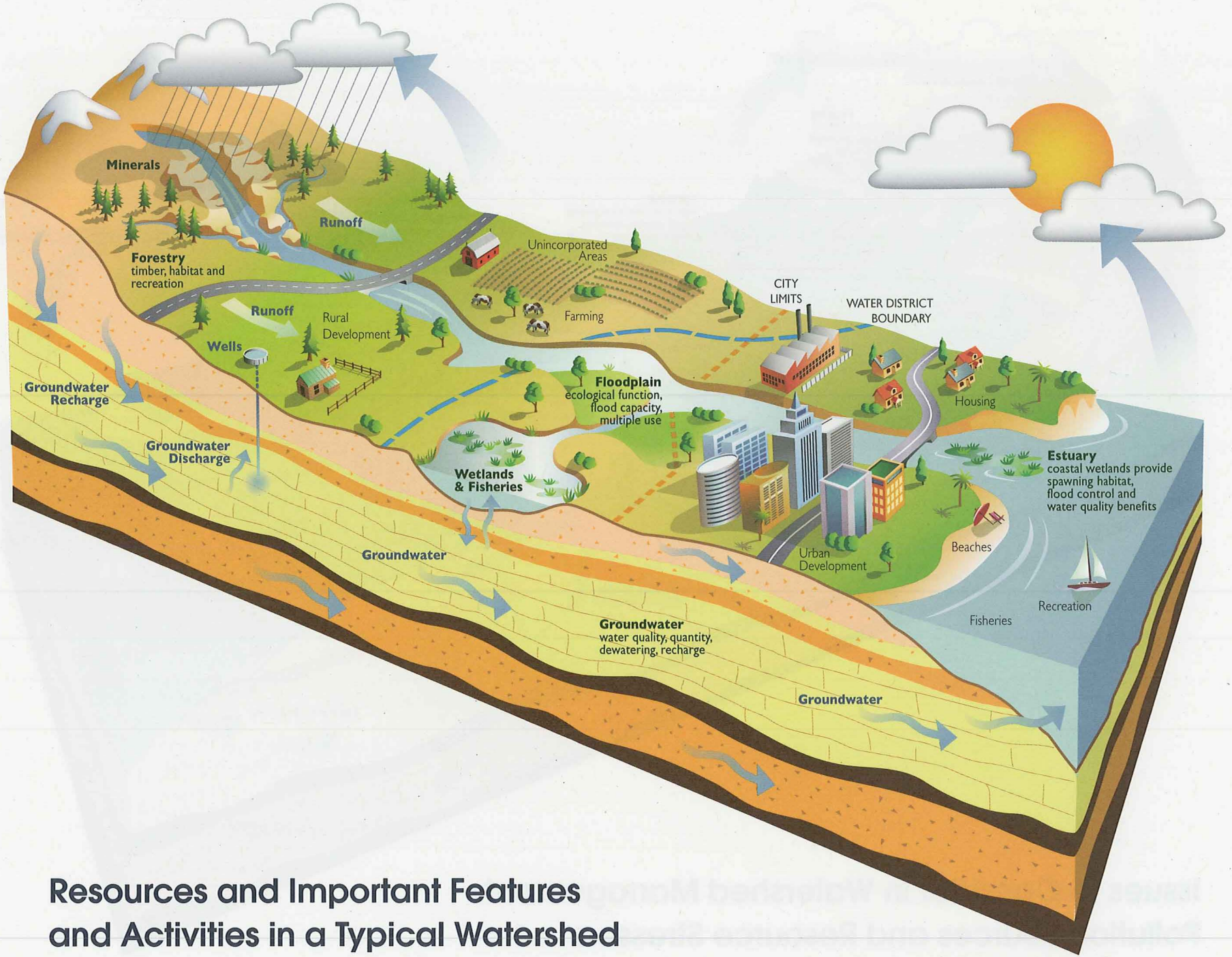
Outreach Materials
- schedules and outlines
- flyers and posters
- comment forms
- web tools

Meeting facilitation

Presentations to local organizations

Education and training

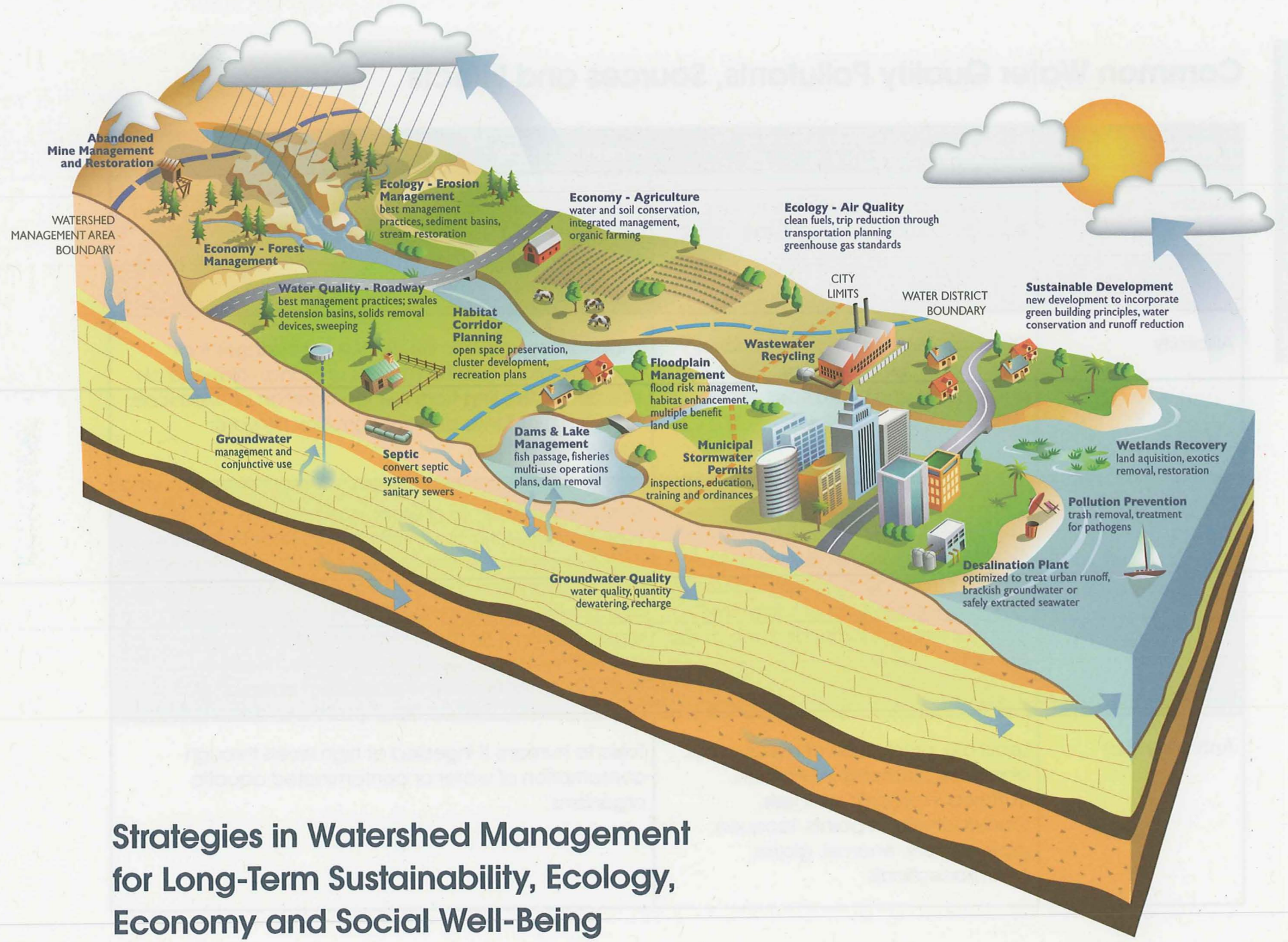
Coordination with local media



Resources and Important Features and Activities in a Typical Watershed

fire, climate change

Issues to Consider in Watershed Management: Pollution Sources and Resource Stressors



Strategies in Watershed Management for Long-Term Sustainability, Ecology, Economy and Social Well-Being

Common Water Quality Pollutants, Sources and Effects

Pollutant	Possible Sources	Potential Effects
Acidity	Cleaners, landscaping, earthmoving, acid rain, acidic compounds in runoff	In ecosystems that cannot buffer acidity from a variety of sources: Decrease in vegetation growth over time due to blockage of nutrient uptake from soil, death of fish and other organisms in water bodies.
Alkalinity	Cleaners, landscaping, earthmoving; carbonates, bicarbonates, phosphates and hydroxides	Important for aquatic life. Buffers pH changes that occur naturally (photosynthesis of plants, rain) and pH alterations resulting from human addition of chemicals to water in order to prevent corrosion of water distribution systems.
Ammonia (NH_3)	Refrigeration, blueprinting machines, and as a neutralizing agents in the petroleum industry wastewater. Also used in the manufacture of fertilizers, nitric acid, explosives, plastics, fuel cells, rocket fuel, synthetic fibers, dyes, and other chemicals.	Ammonia is naturally present in watersheds, but can be toxic to freshwater organisms in high concentrations, and can affect normal development and reproductive processes of fish in low concentrations. Exposure to high concentration in humans can cause eye and respiratory tract irritation, conjunctivitis, laryngitis, pulmonary edema, and a feeling of suffocation, particularly for those who suffer from asthma.
Antimony (Sb)	Lead ore, production of metal alloys, abrasives, pigments, plasticizers, catalysts in organic synthesis, manufacturers of paints, lacquers, glass, pottery, enamel, glazes, pharmaceuticals	Toxic to humans if ingested at high levels through consumption of water or contaminated aquatic organisms.

Pollutant	Possible Sources	Effects
Arsenic (As)	Wood preservatives, herbicides, fungicides, desiccants, ceramics and glass, electrical semiconductors, pharmaceuticals, corrosion inhibitors for steel, additives to motor fuel. Natural in some soils	Carcinogenic to humans if ingested. Long-term exposure can lead to cancer and has adverse effects on cardiovascular, pulmonary, immunological, neurological and endocrine systems.
Asbestos	Clutch and brake lining wear; Adhesives, masonry/concrete, demolition of buildings	Potential carcinogenic effects for humans through ingestion of water or contaminated organisms.
Bacteria	Humans, livestock, wildlife	May cause human illness or serve as indicators of the likely presence of pathogenic viruses or protozoa.
Benzene	Adhesives, yard operation and maintenance, gasoline, solvents	Potential carcinogenic effects for humans through ingestion of water or contaminated organisms.
Bis(2-ethylhexyl) phthalate	Plasticizers, pesticides	Can accumulate in aquatic organisms, and is more likely to be broken down in soil. Recognized carcinogen, developmental and reproductive toxicant. Suspected endocrine, gastrointestinal, liver, respiratory, and skin toxicant.
Cadmium (Cd)	Tire wear, insecticide application; electro-plating, galvanizing, fungicides, insecticides, protective coating for iron, steel and copper smelting, nematocide, structural metal fabrication, polymerization catalysts, pigments and paints, glass, photography products, fertilizers, fluorescent lamps, semiconductors; gasoline, rubber, motor oil; sewage sludge	Acute toxicity increases as salinity decreases. Diminishes plant growth, is a potential carcinogen for humans, and toxicity can have negative effects on kidneys, bones, blood pressure, and reproduction.

Pollutant	Possible Sources	Effects
Chloride	Imported water, recycled water, self-regenerating water softeners	Adverse effects on sensitive crops, e.g. lettuce, avocados. May affect some sensitive species.
Chromium (Cr)	Metal plating, engine parts, brake pad and lining wear; alkalinity; electroplating, metal finishing and corrosion control, pigments, tanning agents, greases, catalysts, wood preservation, drilling muds, textiles, fungicides	Toxic for aquatic organisms and humans, including algae, at high concentrations. Acute toxicity decreases as hardness and pH increases.
Copper (Cu)	Metal plating, bearing wear, engine parts, brake lining wear, fungicides and insecticides use, cigarettes; Plumbing, woods; electric wiring and motors, piping, auto radiators, brake pads, roofing, insecticides, algaecides, fungicides, pigments, catalysts, antifouling paints, electroplating boat repair, smelting; gasoline, rubber, asphalt, concrete	Toxic for aquatic animals at high concentrations.
Cyanide	Anticaking compounds used to keep de-icing salt granular, mine tailings electroplating, copper smelting, road de-icing salt	Toxic for aquatic organisms and humans at high concentrations.
Diazinon	Pesticides; frequently found in wastewater treatment plant effluent and urban and agricultural runoff	Moderately toxic to humans; neurotoxicant; can be highly toxic to birds, aquatic organisms, and wildlife, particularly invertebrates. Banned from sale.
Dichlorobenzene	Solvents, insecticides, moth repellant, resins, pharmaceuticals, metal polishers	Toxic for aquatic organisms at low concentrations. Toxic for humans through ingestion of contaminated water and organisms.

Pollutant	Possible Sources	Effects
Dichlorodiphenyltrichloroethane (DDT)	Pesticides. First absorbed into plants from the soil and into fish/shellfish in waterways	Banned for use in the United States by the EPA in 1972. Its breakdown products, DDE and DDD, are persistent, bioaccumulative, and toxic. Harmful effects to humans include cancer and damages to the liver, nervous system, and reproductive system.
Dieldrin	Pesticides, fertilizer, factory farms (largely corn and cotton)	Potential carcinogenic effects for humans through ingestion of water or aquatic organisms. Other problems are cardiovascular or blood toxicity, endocrine toxicity, gastrointestinal or liver toxicity, immunotoxicity, kidney toxicity, neurotoxicity, reproductive toxicity, and respiratory toxicity.
Fluoranthene (PAH)	Combustion of fossil fuels, dyes, asphalt, and pharmaceuticals	Toxic to aquatic organisms and humans through ingestion of contaminated water and other organisms.
Iron (Fe)	Auto body rust, steel highway structures, engine parts; motor oil, grease, antifreeze, brake linings. Natural in some soils	Water discoloration and bad taste. Damage to water equipment and reduced effectiveness for treatment of other contaminants. Corrosion of water system infrastructure.
Lead (Pb)	Leaded gasoline, tire wear, lubricating oil and grease, bearing wear, atmospheric fallout, cigarettes; plumbing, lead; batteries, paint pigments, plumbing, bearings, caulking; exhaust	Toxic to freshwater animals, saltwater organisms, and humans, even at low levels. Acute toxicity decreases as hardness increases. In humans, lead affects the nervous system, kidneys, blood, and is stored in the bones.
Manganese (Mn)	Natural in some soils	Health risks to pregnant women. Discoloration of water when chlorinated (e.g. bleach).

Pollutant	Possible Sources	Effects
Mercury (Hg)	Chlorine and caustic soda production, pesticides, disinfectants, antifouling and mildew resistant paints, process control instruments, coal-burning power plants, dental fillings, fluorescent light bulbs, diesel exhaust	Interrupts reproductive cycles of some aquatic organisms. Species of particular concern are Rainbow Trout, Coho Salmon, Bluegill, and Haddock. Toxic to humans through ingestion of water and contaminated organisms.
Methyl Chloride	Gasoline, pesticides, refrigerants, solvents	Interruption of normal reproductive cycle of some aquatic fish and insects. No demonstrated significant toxicity to mammals.
Naphthalene	Adhesives; naturally present in fossil fuels such as petroleum and coal, and is produced when wood or tobacco are burned	A volatile organic compound (VOC) . Acute toxicity to freshwater and saltwater organisms at high concentrations in humans, exposure to large amounts of naphthalene may damage or destroy red blood cells, causing hemolytic anemia.
Nickel (Ni)	Diesel fuel and gasoline, lubricating oil, metal plating, brake lining wear, asphalt paving; electroplating, ceramics, catalysts; vehicle exhaust, asphalt, concrete	Although it may be an essential nutrient for some mammals, it can be toxic for humans and aquatic organisms at high concentrations, resulting in gastrointestinal distress, respiratory effects, immune system depression, and neurological effects.
Nitrates (NO_3) and Nitrites (NO_2)	Atmosphere, fertilizer use, sediments; vehicle exhaust, power plant exhaust, leaky sanitary sewer lines and septic systems; animal waste, home and public landscaping; rodent poison	Nitrates in water can cause severe illness in infants and domestic animals. In infants, it can inhibit oxygen binding to blood cells, and can cause cancer in adults who are exposed to high concentrations. Nitrates have a high potential to migrate to ground water due to their solubility, and because they do not evaporate, nitrates/ nitrites are likely to remain in water until consumed by plants or other organisms. In water systems, nitrates contribute to eutrophication and kill fungi in terrestrial ecosystems, which can encourage the growth of invasive species.

Pollutant	Possible Sources	Effects
Nitrogen (N)	See nitrates and nitrites	See nitrates and nitrites.
Polychlorinated Biphenyl (PCB)	Spraying of highway right of ways, atmospheric deposition, PCB catalyst in synthetic leachate; Hydraulic fluids, lubricants, plasticizers, adhesives, inks.	Some chemicals in this family are recognized carcinogens. Eating contaminated fish is a major source of PCB exposure for humans, since PCBs bioaccumulate in some species of fish found in contaminated waters. Toxic for aquatic fish at high levels.
Polycyclic Aromatic Hydrocarbon Compounds (PAHs) (e.g. Phenanthrene; pyrene)	Gasoline, oil, asphalt, wood preservative, wood and coal combustion	Acutely toxic to saltwater organisms and potentially carcinogenic for humans through ingestion of contaminated water and organisms. In animals, PAHs can cause harmful effects on skin, body fluids, and the body's system for fighting disease after both short- and long-term exposure.
Phenol	Adhesives, Painting; explosives, fertilizers, paints and paint removers, wood preservatives, resins, textiles, pharmaceuticals, plastics, dyes, disinfectants	Toxic to freshwater and saltwater life forms. Chronic inhalation exposure of animals to phenol has shown central nervous systems, kidney, liver, respiratory, and cardiovascular effects. A variety of adverse health effects in humans are shown at high concentrations, including irregular breathing, muscle weakness and tremors, loss of coordination, convulsions, coma, and respiratory arrest.
Phosphorus (P)	Atmosphere, fertilizer use, sediments	Although it is a common natural element, excess phosphorus can cause excessive growth of algae (algal blooms), which can affect water quality and aquatic life.
Phthalate Esters	Plasticizers, paper production, cosmetics, lubricating oils, wire and cable, food wrapping, automotive paints, insect repellants	Concern that some compounds may be harmful to pregnant women and their unborn children, as well as the reproductive development of children who are exposed.

Pollutant	Possible Sources	Effects
Sediment	Erosion from roads and trails through open space and from construction and grading; fires, hydromodification, yard operation and maintenance, materials storage, construction sites, landfills improperly maintained	Suspended sediment can alter water chemistry, geomorphic habitat, temperature, and turbidity. Deposition of sediment may change the character of the substrate, block interstices, and reduce interstitial volume. Sediment presence may alter fish community composition through interference with run-riffle-pool sequences and by favoring olfactory feeders over visual feeders. Additionally, it may alter aesthetic quality of water. Reduces available storage or conveyance capacity in infrastructure.
Selenium (Se)	Photocopiers (toner), photo cells, light meters, solar cells, glass and ceramic manufacturing, drained wetlands soils, especially when flushed by irrigation	Biotoxicity in large doses. Causes congenital disorders in wetland birds. Toxic in high concentration for freshwater and saltwater organisms, as well as humans.
Silver (Ag)	Photographic chemicals, electrical and electronic products, jewelry, solder, catalysts, mirrors	Toxic at high concentrations for aquatic organisms and humans.
Toluene	Gasoline, asphalt, solvents	Acute and chronic toxicity can occur in freshwater and saltwater organisms and humans at relatively low concentrations.
Trash	Litterers, unsecured trash bins, debris blown from vehicles, landfills (wind and birds), improperly disposed green waste	Clogs drainage, impairs recreation, entangles wildlife, may harbor other pollutants, e.g. bacteria.
Zinc (Zn)	Tire wear, motor oil, grease, cigarettes, plumbing, demolition, galvanized products, electroplating, metal production, batteries, boat repair, car bodies, tires, asphalt, concrete, engine wear, wastewater from industrial plants	Zinc is a very common substance that occurs naturally, but in humans, too much zinc can cause stomach cramps, skin irritations, vomiting, nausea and anemia. Very high levels of zinc can damage the pancreas, disturb the protein metabolism, and cause arteriosclerosis. Zinc can endanger unborn and newborn children and may be transferred from the mother through blood or milk. Additionally, zinc-rich soils do not support abundant plant life and can interfere with normal organic breakdown in soils. Aquatic toxicity.

A Glossary of Key Watershed Terms

Acre-foot The volume of 1 acre to a depth of 1 foot; equal to 43,560 cubic feet or 325,851 gallons. The term is commonly used in measuring volumes of water used or stored.

Acute Toxicity Toxic effects (lethal or sub-lethal) due to short-term exposures to chemicals.

Advanced Wastewater Treatment Wastewater treatment that extends beyond the secondary, or biological stage, of treatment and includes the removal of nutrients and suspended solids.

Aerobic Containing oxygen. For instance: conditions that contain oxygen, organisms that require oxygen to survive or any chemical/biological processes that occur in the presence of oxygen.

Algae Members of a large group of primarily aquatic organisms that contain chlorophyll and other pigments and can carry out photosynthesis, but lack true roots, stems, or leaves and range from single cells to large multicellular structures. Examples of algae include seaweed, kelp, dinoflagellates, and diatoms.

Algal Bloom The rapid growth of algae in a system due to excessive amounts of nutrients and the appropriate physical and chemical conditions.

Alkalinity A measurement of the buffering ability of water (or the capacity of water to resist changes in pH), or the ability of a base to neutralize an acid.

Anaerobic Lacking oxygen. For instance, conditions that lack oxygen, organisms that can survive without oxygen, and any chemical or biological processes that occurs without oxygen.

Anthropogenic Of, relating to, or impacts resulting from human activity.

Aquaculture The cultivation and harvest of aquatic plants and animals.

Aquifer A stratum of rock or soil that contains groundwater.

Aquatic Corridor Areas of land and water that are important to the integrity and quality of a stream, river, or other body of water. An aquatic corridor usually consists of the actual stream or river, the aquatic buffer, and other areas which are necessarily related to the water course.

Basin A large depression in the earth's surface, or a region drained by a river system. The largest single watershed management unit for water planning that combines the drainage of a series of sub-basins.

Base flow That part of the stream or surface water discharge that is not attributable to direct runoff from precipitation or snowmelt; it is usually sustained by water draining from natural storage in groundwater aquifers, lakes or wetlands.

Beneficial Use Use of a water resource, including recreation, aquatic life, and human consumption. Beneficial uses are protected by water quality standards. (Also sometimes referred to as designated uses).

BMP Best Management Practice. A method, activity, maintenance procedure, or other management practice for reducing the amount of pollution entering a water body or for removing pollutants.

Bioaccumulation The process by which contaminants accumulate within the tissues of an individual organism or in the higher tiers of the food chain (although the latter effect is sometimes referred to as biomagnification).

Bioindicators Organisms used to determine changes in water quality and/or pollutant levels within a system.

Biological Assessment Evaluation of the condition of water bodies using surveys and other direct measurements of species diversity and species abundance (of macroinvertebrates, fish, and plants) to determine whether water bodies support survival and reproduction of desirable fish, shellfish, and other aquatic species and how aquatic life reacts to water quality.

Bioretention An engineered process to manage storm water runoff, using the chemical, biological and physical properties afforded by a natural, terrestrial-based community of plants, microbes and soil. Bioretention provides two important functions through increased infiltration: water quantity (flood) control; and improved water quality through removal of pollutants associated with runoff.

Biota Organisms, including bacteria, plants, and animals.

Buffer A vegetated area located between development and water bodies such as stream, wetlands, and lakes, that can remove pollutants in runoff before they reach surface waters.

Channelization Hydrologic modifications and straightening of stream shape, often done to reduce risk of flood damage that may also cause dramatic changes in the stream ecosystem.

Chronic Toxicity Toxic effects due to long-term exposure to chemicals.

Clean Water Act (CWA) The Federal Water Pollution Control Act Amendments of 1972. 33 U.S.C. §§ 1251-1387. As amended in 1977 and 1987, this law became commonly known as the Clean Water Act. The Act established the basic structure for regulating discharges of pollutants into the waters of the United States.

Coastal Zone Coastal waters and adjacent shorelands that influence the uses of the ocean and its ecology, or whose uses and ecology are affected by the ocean. The Coastal Zone may include islands, transitional and intertidal areas, salt marshes, wetlands, and beaches.

Confluence The point at which two streams flow together.

Constituent(s) of Concern Specific chemicals that are identified as being potentially a stressor in a water body.

Critical Habitat Areas that are essential for the conservation of federally endangered or threatened species. Such areas may require protection or certain management practices. Critical habitat areas are formally designated by the US Fish and Wildlife Service through a rulemaking process.

Dead storage The volume in a reservoir below the lowest controllable level.

Decomposition The breakdown of organic substances by microorganisms.

Detention The slowing, collecting, or detaining of stormwater runoff prior to release into receiving waters.

Discharge The amount of water flowing out of a drainage structure or facility. It is any release, spill, leak, pump, flow, escape, dumping, or disposal of any liquid, semi-solid or solid substance.

Dissolved Oxygen The amount of oxygen present in the water column. Dissolved oxygen is important for aerobic organisms and proper biological functioning. Less then 5 parts per million of oxygen in water can cause stress to aquatic organisms. The lower the oxygen concentrations, the greater the stress.

Ecosystem The network formed by the interaction of a biological community and its surrounding interconnected physical and chemical environment.

Effluent Water that flows from a treatment facility after it has been treated.

Erosion The wearing away of rock and soil due to wind, weathering, water, ice, or other physical, chemical, or biological forces. The rate of erosion may be increased by land-use activities.

Estuary A coastal area where fresh water from rivers and streams mixes with salt water from the ocean. Bays, sounds, and lagoons along coasts may be estuaries. Segments of rivers and streams connected to estuaries are considered part of the estuary.

Eutrophication Process by which a water body undergoes an increase in dissolved nutrients, often leading to algal blooms, low dissolved oxygen, and changes in community structure. This process occurs naturally over time, but can be accelerated by human activities that increase nutrient inputs into aquatic ecosystems.

Evapo-transpiration Water withdrawn from a land area by evaporation from water surfaces and moist soil and plant transpiration.

Exotic species A recently introduced species, or a species that is living in a location that is outside of its normal or historical range.

Fecal Coliform Bacteria found in the fecal matter of warm-blooded animals. Fecal coliform is used as an indicator of possible presence of pathogens.

First Flush Stormwater runoff from an area that has not experienced precipitation recently, and that may therefore mobilize and carry pollutants that have accumulated since the last precipitation.

Floodplain The land area along a stream or river that could be inundated during storm flows. The "100-year floodplain" is the area subject to inundation by flows that have a one percent likelihood of occurring in any given year.

Gaging station	A particular site on a stream, canal, lake, or reservoir where systematic observations of hydrologic data are obtained.
GIS	Geographic Information Systems. Computer program for storing, mapping, analyzing, and displaying geographically-referenced data, that is, data identified according to location.
Groundwater	Water occurring beneath the earth's surface, typically in aquifers, that supplies wells and springs, and is a key source of drinking water.
Heavy Metals	Metals that do not degrade over time and are thus an environmental concern. Examples of heavy metals are cadmium, mercury, nickel, and lead.
Hundred Year Flood	A flood level with a one percent chance of being equaled or exceeded in any given year.
Hydric soils	Soils inundated with water long enough to become anaerobic. Hydric soils are often indicative of wetlands.
Hydrograph	A graph representing flow versus time for a given discharge point.
Hydrologic Unit Cataloging (HUC)	Cataloging of watersheds of various geographical scales, using numerical codes, developed by the USGS.
Hydrology	The science encompassing the behavior of water as it occurs in the atmosphere, on the surface of the ground, and underground.
Impaired Water	Water bodies that are only partially supporting, or do not support, their designated uses. States are required to report impaired water bodies every two years to US EPA, per section 303(d) of the Clean Water Act.
Impervious Surface	A surface that does not allow water to penetrate. Examples of impervious surfaces include asphalt, rooftops, and concrete.
Infiltration	The flow of a fluid into a substance through pores or small openings.

Influent Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant.

Intermittent Stream A stream that flows only at certain times of the year, or does not flow continuously.

Land Use The way land is used or developed. For instance, the types of buildings/structures permitted on the land and the types of activities permitted on the land. Particular land uses are often associated with different types of pollution, such as erosion and sedimentation from construction activities (Land Use Planning - Planning and creating policies to guide the way in which land and resources will be used).

Load Allocation The part of a TMDL or water quality restoration plan that assigns reductions to meet identified targets. The load may be divided by land use (rangeland, cropland), or activity (construction, timber harvest) or assigned to subwatersheds or tributaries. Load Allocation can be expressed in terms of concentration (e.g. mg/L).

Mitigation Actions taken to avoid, reduce, or compensate for the effects of human-induced environmental damage. It can include projects such as restoration and enhancement of negatively impacted ecosystems, or creation of an ecosystem.

Natural Disturbances Natural events that disturb the structure and function of an ecosystem such as floods, drought, earthquakes, fire, lightning, etc.

Non-Point Source (NPS) Pollution Pollution that enters water bodies from a variety of sources. NPS pollution is caused by runoff from rainfall or snowmelt that moves over and through the ground, washing natural and human-made pollutants into surface waters and underground sources of drinking water. Generally defined as any non-regulated (by the NPDES) source of pollution.

NPDES National Pollutant Discharge Elimination System. Established by Section 402 of the Clean Water Act, this federally mandated system is used for regulating point source and storm water discharge.

Nutrients Nitrogen and phosphorus, required by plants and animals for growth. In some circumstances, excessive nutrient additions to surface waters may result in excessive algal/plant growth and, subsequently, the accumulation and decay of increased organic matter.

Open Space A portion of a development site that is permanently set aside for public or private use and will not be developed. The space may be used for passive or active recreation, or may be reserved to protect or buffer natural areas.

Pathogen A disease-causing organism (viruses, bacteria, or fungi can be pathogenic organisms).

Perennial Stream A stream that flows continuously throughout the year.

Pesticides Chemicals or substances designed to eliminate insects and other pests.

Point Source Any discernible, confined, and discrete conveyance or collection system, by which pollutants are or may be discharged, not including return flows from irrigated agriculture or agricultural stormwater runoff. Point sources generally require authorization under the NPDES permit system.

Precipitation As used in hydrology, precipitation is the discharge of water, in liquid or solid state, out of the atmosphere, generally upon a land or water surface. Precipitation includes rainfall, snow, hail, and sleet, and is therefore a more general term than rainfall.

Rainfall Precipitation that falls as rain only.

Receiving Waters Surface waters, whether natural or man-made, into which materials are discharged.

Restoration The management of physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions, often meaning riparian areas or wetlands.

Riparian Of, relating to, living on, or located on the banks of a watercourse such as a river, stream, lake, etc.

River Basin Area encompassing all the land drained by streams and creeks flowing downhill into a major river. All water that falls within the basin flows into these streams and rivers.

Runoff That part of the precipitation that flows off of the land surface, and which may join into surface streams.

Sediment Fragmental material that originates from weathering of rocks and soil and is transported by, suspended in, or deposited by water or air or is accumulated in beds by other natural methods.

Sedimentation The deposition of particles of soil, sand, silt, clay, or organic matter onto the bottom of any surface water body.

Soil moisture (Soil water) Water diffused in the soil, the upper part of the zone of aeration from which water is discharged by the transpiration of plants or by soil evaporation.

Streambank Stabilization Prevention of stream bank erosion and deterioration through vegetation or other stabilizing structures.

Stream Corridor Spatial scale defining the ecosystem surrounding a stream, linear in shape, that includes the stream channel, riparian vegetation, floodplains, streambanks, tributary streams, and trails, roads, and other development.

Stream Restoration The management of morphological, ecological, and hydrological characteristics of a stream with the goal of returning natural/historic functions to the stream system.

Subwatershed A smaller geographic section of a larger watershed unit with a drainage area of between 2 to 15 square miles and whose boundaries include all the land area draining to a point where two second order streams combine to form a third order stream.

Time of Concentration The time required for water to flow from the farthest point on the watershed to the gaging station or point of interest.

TMDL Total Maximum Daily Load. The maximum amount of a given pollutant that a water body can receive without exceeding water quality standards; the objective of a TMDL is to estimate, through modeling, allowable pollutant loads to be allocated to various point and non point sources so that a given stream or stream reach may be restored to its classified best use(s).

Total Dissolved Solids (TDS) The concentration in water of all organic and inorganic molecules and ions in true solution. Also commonly referred to as salinity.

Total Suspended Solids (TSS) The weight of all suspended solids in water. Suspended solids in water reduce light penetration in the water column, can clog the gills of fish and invertebrates, and are often associated with toxic contaminants because organics and metals tend to bind to particles.

Tributary A stream or river that feeds into a larger stream, lake, or river.

Waste Load Allocation (WLA)

1. The maximum load of pollutants each point source discharger is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated.
2. The portion of a stream's total assimilative capacity assigned to an individual discharge. Waste Load Allocation can be expressed in terms of concentration (e.g. mg/L).

Water Cycle

The cycle in which water evaporates from surface waters, condenses into clouds, and falls again to the earth as rain or other forms of precipitation.

Water Quality Volume (WQV)

The volume of flow associated with storm events that must be treated, according to regulations.

Water Table

The upper surface of a zone of saturation. No water table exists where that surface is formed by an impermeable body.

Watershed

All the land area that contributes runoff to a particular point along a waterway. A drainage basin or catchment area. Formerly used to denote the divide separating one drainage basin from another, but today the term drainage divide, or just divide, is used to denote this boundary.

Zoning

A set of regulations and requirements that govern the use, placement, spacing, and size of buildings and lots within a specific area or in a common class (zone).

What is needed for developing a watershed management plan?

Services utilized in developing watershed management and implementation plans and contact information:

- Watershed Characterization
- Geographical Information Systems
- Water Quality Monitoring
- Stormwater and Flood Management
- Outreach and Stakeholder Facilitation
- Decision-making and Prioritization Tools
- Policy Formulation
- Water Supply and Waste Water Engineering
- Impaired Water Bodies
- Lake Design and Management
- Environmental Planning
- Regulatory Permitting
- Water Quality
- Grants and Funding Agreements
- Visioning
- Low Impact Land Development
- Construction Service Crew Integrated with the Management Team
- Lake Design and Management
- Habitat Design and Restoration

Team members useful in developing and implementing a watershed management plan:

- Engineers
- Planners
- Community Liaison/ Outreach Specialists
- Scientists / Lake Design and Management Experts
- Policy Writers
- Grant Management Specialists
- Construction Professionals
- Visual Information Specialists
- Landscape Architects
- Environmental and Regulatory Professionals

Additional Resources

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http://en.wikipedia.org

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Distance

m = 3.28 ft
m = 1.09 yd
km = 0.621 mi
mi = 5,280 ft
mi = 1,760 yd

Mass / Weight

g = 0.0352 oz
g = 0.0022 lb
g = 0.0353 oz

Area

m^2 = 10.764 ft^2
mi^2 = 640 ac
ac = 43,560 ft^2
ha = 2.47 ac

Volume

L = 0.26455 gal
L = 1.0567 qt
ha-m = 8.1 ac-ft
m^3 = 267.17 gal
m^3 = 35.314 ft^3
1 mil. m^3 = 810.72 ac-ft
ac-ft = 43,560 ft^3
ac-ft = 325,851 gal
ft^3 = 7.48 gal

Concentration

ng/L = ppt
mg/L = ppm
mg/kg = ppm
microgram/L (µg/L) = ppb

Flow

cfs = 448.8 gpm
cfs = 646,300 gpd
cfs = 724 ac-ft/yr
1000 gpm = 4.4192 ac-ft/day
mgd = 1.547 cfs
mgd = 1120 ac-ft/yr

Useful approximations:

1 million gallons ~ 3 acre-feet
1 cfs ~ 2 acre-feet per day
1 mgd ~ 1.5 cfs
10 fps ~ 165 miles per day
1 million gallons at 500 mg/l TDS ~ 2 tons of salt

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