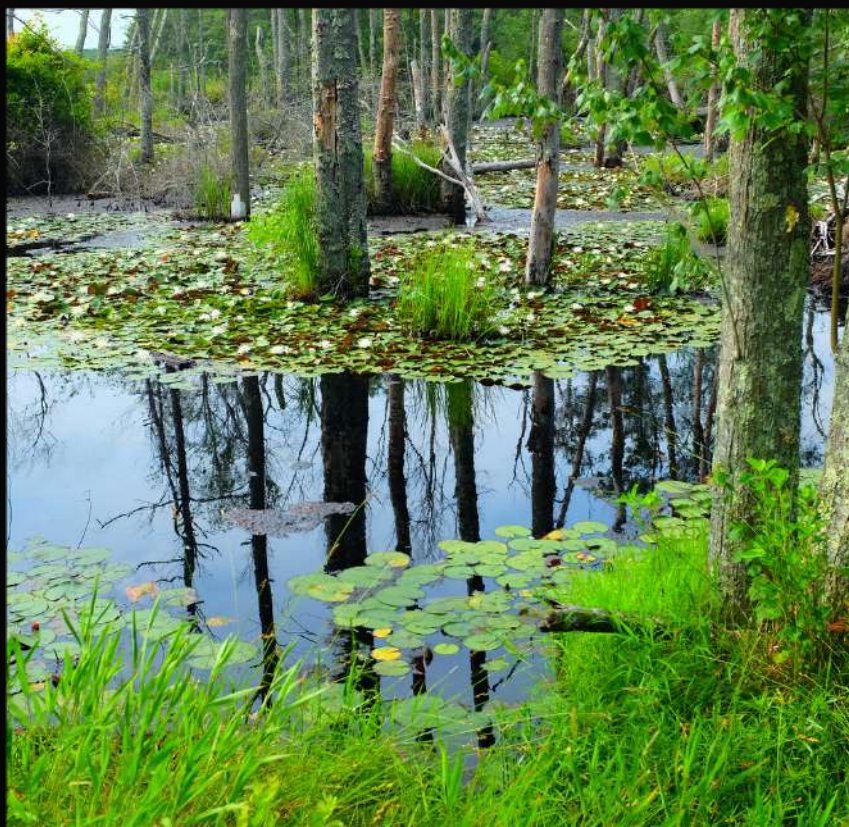


Core Module #6: Water

Enrichment Module





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Water

Enrichment Module

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Themes

1. Water is life: all of society requires and uses water for many different purposes, the most fundamental of which is hydration of our bodies.
2. Nearly all the world's water is not available for human use. What we see as usable fresh waters (lakes, rivers, groundwater) is a tiny fraction of all water, and even a small fraction of all freshwaters.
3. Water moves in cycles, making life possible when it falls as rainfall, moistens the soil, fills surface waters and groundwater systems, and eventually moves to the ocean. Portions of the water move back to the atmosphere to become precipitation once again.
4. Human use of water changes natural systems. This is inevitable, and so the key question is, what level of change are we willing to tolerate?
5. Drinking water treatment and delivery systems, as well as wastewater collection and treatment systems, are critical to the support of densely populated areas, such as cities. This water infrastructure is very expensive to build, maintain, and restore as it ages. It also uses a lot of energy, which in turn can harm both the environment and people.

Background

Water speaks to our bodies (which are mostly water) and minds. Who hasn't found it relaxing to sit by and watch water, to bathe/shower, or to use water for recreation? Water is in our music, poetry, and other writing, our physical and performance art.

Historically, access to water has been important to everything, from desert camel trains to empires. No major society has been built that did not place water as a high priority, for everything from agriculture and manufacturing to public use.

In New Jersey, as elsewhere, we get our water from multiple sources. Easiest are the surface waters, such as streams, rivers, and lakes. These waters are located and interconnected within watersheds, the land area from which all surface waters exit through a single stream (see Figure 1). However, available water varies from season to season, year to year, and so we often build reservoirs to hold water from wet periods for use during drier periods. The ability to provide water during drought is called, "the safe yield". New Jersey's reservoir systems support a total of 781 million gallons per day (mgd); these reservoirs are all located in Central and North Jersey (see Figure 2). Each reservoir is required to ensure releases to downstream waters to support aquatic ecosystems and downstream supplies.

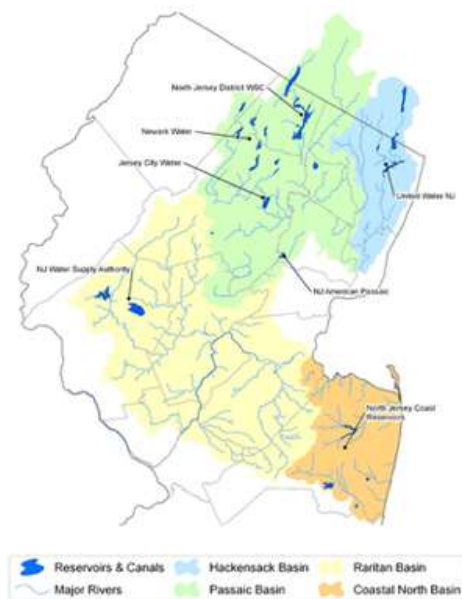
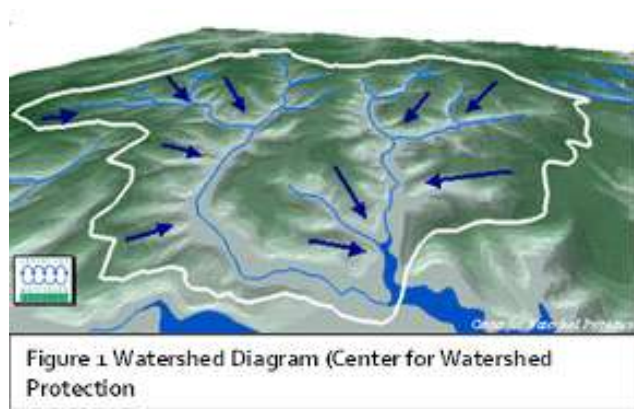


Figure 2. Major New Jersey Reservoirs (NJDEP, 2017)

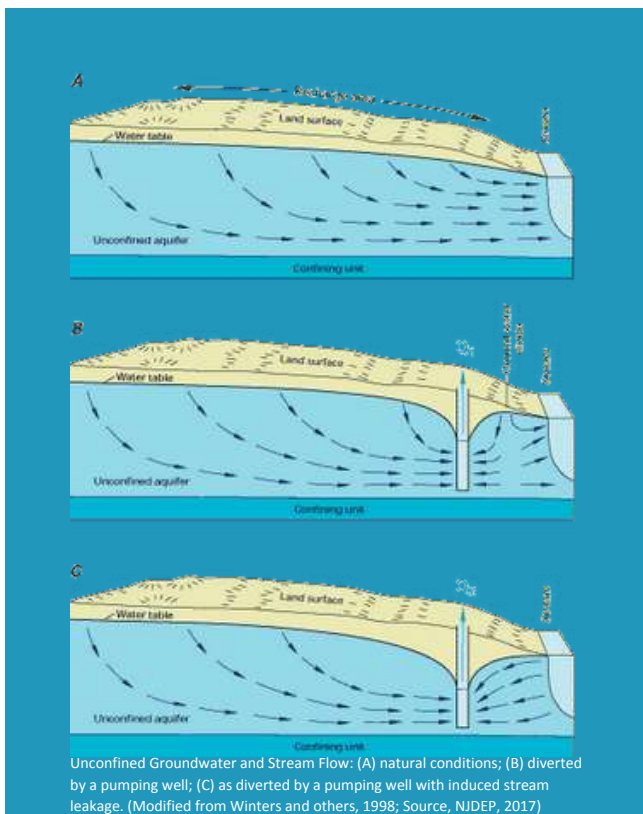
The second major water source is groundwater. Groundwater is a result of rain that slowly infiltrates downward to a point where all the pore spaces are filled with water (the water table) (see Figure 3). Some aquifers known as “unconfined aquifers” are easy to recharge but also easy to pollute. New Jersey started drilling wells into these aquifers in the 1800s, as soon as drilling and pumping technology was allowed. Some have been depleted by past demands and so are regulated to limit harmful impacts, and some have been lost to contamination. “Confined aquifers” in southern New Jersey are deep units that are less easy to pollute.

Water Demands and Issues in New Jersey

The NJDEP closely tracks freshwater demands for all purposes that require more than 100,000 gallons per day, as required by the Water Supply Management Act.

Centralized potable water [DJVA1] systems serve 90% of the state’s population; the remainder rely on domestic wells. Both residential water and agricultural/irrigation demands tend to be lowest in the winter and peak in summer months when outdoor uses are more common. This is also the time when water supplies are most stressed, resulting in an increased potential for droughts.

New Jersey periodically suffers from shortfalls in precipitation. The most severe droughts occurred in the mid-1960s, 1981-82, 1995, and 2002.



Water and Energy

Two resources are fundamental to a developed society, as they make so much else possible. One is energy, and the other is water. They support manufacturing, our ability to build housing, the growing of food, and much more. In the last 150 years, most energy resources have required the use of water (e.g., thermal electricity generating stations, hydroelectric power), and even renewable energy requires water for manufacturing wind turbines and solar energy cells. The use of water, on the other hand, requires the use of energy. These two resources are intertwined in nearly every aspect of society.

One of the most important uses of water, of course, is for drinking water that we use for household and office uses of all sorts. Even those who don't drink tap water, do drink water, whether as bottled water or as part of our coffee, tea, soft drinks, or alcohol. And when we use water, we create wastewater that must be collected and treated before it is discharged back into the environment. In New Jersey, the largest use of freshwater by far is for drinking water through public water systems.

What people don't often realize is that our nation's agricultural system is the dominant user of water, roughly 75 to 80% of all water demands, but nearly all that use occurs outside of New Jersey.

Our increasing populations and industrialization of food and manufacturing have placed immense pressure on natural water resources. There is no formula for making water – we have what we get. We can use it efficiently and effectively, we can reuse it, but we cannot invent more. In addition, climate change is altering where and when precipitation occurs, often making dry periods drier and wet periods wetter.

Human Values of Water Supply

Fresh waters are by State law a public resource, managed on behalf of the public by the NJ Department of Environmental Protection. The 1981 Water Supply Management Act provides guidance for how these waters are allocated among potential users to protect other users and the environment. Unlike western states, water resources cannot be privatized, but the right to use waters for beneficial purposes can be approved. The nature of water, however, raises some complicated issues of value.

Water is often managed and sold as a commodity; you get what you pay for, and people can have approved rights to water, which others cannot take from them. Water is also a service, supporting developed land uses, such as homes, commercial businesses, offices, and industry. The service concept is important, as it recognizes that water supplies to individual users also benefits society in general.

Finally, water is a right – nobody has the right to prevent people from accessing water that is fundamental to their very lives. These three views of water – commodity, service, and right – are often in conflict. For example, if everyone has a right to sufficient water to live, but they can't pay for that service, who will pay instead? If water is a service, then how should the price of water be managed to ensure that its function as a commodity doesn't damage its societal value or prevent people from exercising their right to water?

Think of roads as an example. We support the creation and maintenance of roads using gasoline taxes, as a service supporting society. Vehicle fuels such as gasoline, diesel, and electricity are commodities, available only to those who can afford them. However, most roads are available for anyone to walk or bicycle on them, as a right. In many ways, water works the same way – a mix of commodity, service and right, none of which are always absolute.

Having sufficient water in the natural environment, such as streams and groundwater, is similarly a right where everyone has reason to expect that our water demands won't destroy the water resource, a service that provides benefits to society because of its natural functions, and a commodity that can be tapped for water demands ranging from agriculture to manufacturing to urban uses.

Challenges

Water is naturally limited, and those limitations change with the season and the year, as precipitation increases or decreases and plants in the environment use more water in the summer than the winter. Human uses tend to increase in the summer (for lawns, pools, and other outdoor activities) and decrease in the winter. For this reason, we build storage reservoirs to capture water in wet times for use in dry times. Summer demands for agricultural irrigation and outdoor residential uses have been increasing even as indoor demands decline, and these summer demands occur when water supplies and aquatic ecosystems are most stressed.

Increasing water demands over the last 150 years are linked to population growth, industrial uses, and irrigation for food production. The result is that many areas have reached or exceeded the available supplies of water, even where reservoirs have been built.

A major challenge we face is that some areas have degraded water resources because of historic development and industrial practices, the age and construction of water infrastructure, and new findings regarding public health effects of contaminated drinking water and natural waters. Urban streams are almost uniformly polluted and damaged by excessive development along the streams (the riparian area) and stormwater discharges into the streams, causing stream erosion.

Urban water infrastructure is often old and requires major expenditures for rehabilitation and upgrades, and the issue of lead service lines harming children (and adults) is a major concern. Associated with this issue is the need for improved treatment as new contaminants are discovered, such as the recent concerns with the PFAS family of so-called “forever chemicals.”

Climate change will force new attention on water supply, as New Jersey has been receiving increased rainfall (useful for water supply but not for flooding), but through stronger storms. We also anticipate that more frequent droughts will stress our water supply systems as increased temperatures drive greater demands for agricultural irrigation and lawn watering.

Finally, all these issues will drive costs higher, which raises an issue of increasing concern: affordability. Water and sewer utility costs have been rising faster than the general consumer price index (i.e., inflation) since the 1980s when federal laws greatly increased expectations for clean drinking water and improved wastewater effluent. A recent study for Jersey Water Works indicates that perhaps one-fifth of all New Jersey households could be affected by these affordability issues.

Solutions

- **Reduction of Summer Water Demands:** Summer demands can be reduced in all areas from urban to rural, and all sectors from agricultural to energy. Some ideas are:
 - **Adapt Lawns:** Most grass lawns use cool-season grasses that don't do well in hot summer weather but will come back when temperatures decline. Residents can allow lawns to brown in summer, transition lawns to mulch areas or plantings that don't require regular watering (e.g., trees and shrubs), or shift to grasses that better tolerate high temperatures and require minimal watering.
 - **Retrofit Lawn Irrigation Systems:** How many times have we seen irrigation systems running in the middle of a rainstorm? Irrigation systems that rely on timers should be modified to rely on soil moisture or other measures that reduce irrigation use.
 - **Agricultural Efficiency:** Many farmers in New Jersey have shifted to high-efficiency irrigation techniques, but others have not. Increased temperature stresses and drought frequency are likely to push more farmers toward irrigation, and so ensuring maximum efficiency will be critical.
 - **Urban Demands:** Urban areas tend to have fewer outdoor water uses, but gardening and other uses can be significant. Both urban and suburban areas can use rain barrels and (more effectively) cisterns to capture rainfall for later use in gardens. In addition, water for street sweeping can use treated wastewater instead of drinking water.
 - **Reduction of Indoor Water Demands:** Even more water-efficient appliances (clothes washers, dishwashers) and plumbing fixtures are available that are branded through the USEPA WaterSense Programs that help low-income households and renters/landlords to reduce water demands.
 - **Protection of Water Resources:** Both existing and new land uses can introduce contaminated stormwater, lawn runoff, and other pollutants to drinking water supplies from both surface water and aquifers. Excessive stormwater runoff can also cause stream erosion that damages downstream reservoirs.
 - **New Land Uses:** New land uses are supposed to meet all State and municipal regulations for stormwater management, protection of streams, etc. Local environmental commissions, municipal Green Teams, neighborhood associations, and local watershed organizations can all play a part in making sure that local officials are knowledgeable and that applicants are fully compliant with the law.
 - **Existing Land Uses:** The more difficult issue is existing land development, as there are no rules requiring action to reduce water resource threats. In this case, cooperative efforts can work best, combining landowner interests and public interests.
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- **Aging Urban Water Infrastructure:** New Jersey will spend billions of dollars over the next 20 years to restore and replace aging drinking water infrastructure because of both system needs and the requirements of the Water Quality Assurance Act of 2017. These expenditures will provide multiple benefits. We can't afford to ignore the problem of aging infrastructure. Constant attention to drinking water treatment is also needed to ensure public health is protected. Perfection is not possible, but high-quality drinking water is certainly achievable.
 - **Lead Service Lines:** The public health damages of lead in drinking water are undeniable. One result is a 2021 State law requiring their replacement within ten years. Local conservationists and public health activists can help keep this program in the public eye and promote action.
 - **Climate Change Impacts:** Much can be said about mitigating climate change, but the emphasis here is on mitigating the impacts of climate change on water resources. Several actions are needed:
 - **Reservoir Water Quality:** With a warming climate and watersheds that contribute too many nutrients to reservoirs, we face a future with more episodes of "harmful algal blooms" (HABs) that can create toxic conditions. Two actions are needed here. First, better protection of reservoir water quality and secondly, better drinking water treatment to avoid health effects when HAB episodes do occur.
 - **Aging Water Infrastructure:** Climate change increases the potential for damages to aging infrastructure, as heat waves stress drinking water pipelines, treatment systems, and pumping stations.
 - **Storm Damages:** Whether from erosion at the Jersey Shore and along rivers, or flooding of water supply treatment plants, increased storms from climate change can cause catastrophic damage to water infrastructure. New Jersey needs to anticipate where damages may occur, plan for protection or removal of those assets, and then be prepared to act quickly when storm damages occur.
 - **Affordability:** All the actions above have one thing in common – they require money. In some cases, acting will reduce costs long-term, but the initial expenditures must be funded somehow. No matter how much money is provided by the federal and state governments, it is inevitable that drinking water utilities will need to fund most of the costs for most of these efforts. That means that consumers will pay more, which will exacerbate affordability problems for lower-income households. There are three major approaches available:
 - General support for individual households, such as Section 8 housing vouchers from the federal government.
 - Utility-based affordability programs that allow a reduced cost to households that can't afford to pay normal rates for reasonable but efficient use of drinking water.
 - Statewide programs to subsidize households with affordability problems, like the federal/state Low Income Household Energy Assistance Program (LIHEAP). While a federal Low Income Household Water Assistance Program exists, it is a temporary grant that provides forgiveness of overdue water and sewer balances, not a permanent solution.
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Training

Several training programs exist that can be helpful for people who want to be more aware of these issues:

- US Environmental Protection Agency: Online Training in Watershed Management
- US Environmental Protection Agency: Watershed Academy
- US Environmental Protection Agency: Drinking Water Training

Working With Water Issues

Water can be a complex set of issues, but people new to the field can readily become familiar with the specific issues of interest to their household, community, neighborhood, municipality, or region. The key is to start simple, learn from others already in the field, and gradually build knowledge. Many people in the field are typically very open to those who want to learn.

Facilitation Questions

1. Where does the water in your home come from?
2. Can we make more water?
3. What are surface waters?
4. What are reservoirs?
5. What is groundwater?
6. What is a watershed?
7. What is potable water?
8. What industry is the largest water user?
9. What is wrong with many urban service lines?
10. How is a changing climate impacting water supply?

Additional Resources

- American Planning Association - [Planners and Water](#)
- [US Environmental Protection Agency WaterSense](#)
- [US Geological Survey](#) - A hydrologic primer for New Jersey watershed management