Vol. 3 Issue 2
Engineer's Edition

Good Connections

Information on Watertight Storm Sewers

Water Facts

How Much Water Do We Use?

- The United States uses more water on a per-capita basis than most other developed countries.
- Average Water Use per Capita: 525,000 gallons annually (10% residential; 90% agricultural use)
- Family of Four Use on Public Distribution System: 350 gallons per day
- Family of Four Use on Private Well: 200 gallons per day

Common Non-Point Sources of Ground Water Contamination

- Municipal sanitary and storm sewer systems
- Oil and gas pipeline distribution systems
- Application of herbicides, pesticides, and fertilizers to agricultural crops and golf courses
- Land application of wastes
- Road salting operations

INSIDE

KEEPING OUR GROUND WATER SUPPLY SAFE

By Gillian L. Nielsen & David M. Nielsen

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Every day you turn on your tap at home or at work and draw what you believe to be a supply of "clean" water that is safe for drinking or other needs. But have you ever considered where your water supply actually comes from? Is your water provided by a public water system? If so, is the supply from ground water, surface water or a combination? Can you taste chemicals such as chlorine that have been added to your water to make it "safer"? If you live in the country, do you have your own private well? If so, do you know anything about that well? Where is it? How has it been constructed? How much water is available from the well? Do you notice any seasonal changes in the taste or amount of water available from your well? Do you know whether your public or private water supply is being affected by some source of contamination? Despite our dependence on safe and abundant water, very few people can answer these basic questions about their water supply. As a consequence, most people do not understand how sensitive a resource their water supply is to contamination, particularly if it is from ground water.

WHY IS GROUND WATER SUCH AN IMPORTANT RESOURCE?

Ground water is one of our most valuable natural resources. Americans have long depended upon ground water for many uses, but its primary importance is as a source of drinking water. More than 150 million Americans – nearly 53 percent of the population – depend on ground water resources to supply their drinking water on either a public distribution system or private home owner well basis.[1] More than 75 percent of the

Continued Inside

nation's public water supplies, more than one-third of the nation's largest cities, and nearly 95 percent of all domestic water needs in rural areas are served by ground water resources. In addition, ground water is used extensively in the western and central states for irrigation, in the northern states for residential and commercial heating, in the southern states for air conditioning, and across the nation for a variety of industrial purposes. National reliance on ground water has increased dramatically over the past few decades – at a rate nearly three times that of surface water, particularly in rapidly developing urban areas in arid climates (such as Las Vegas, Nev., and Phoenix, Ariz.). This reliance will continue to increase as national consumption and use of water increase in the future and will be underscored if surface water shortages caused by prolonged regional and national drought conditions continue to occur.

HOW ARE GROUND WATER RESOURCES CONTAMINATED?

Despite the overwhelming evidence of the vital importance of ground water, until relatively recently in our history, ground water has been provided with little protection from myriad potential sources of organic, inorganic, biological and radiological contamination. There are literally millions of point and non-point sources of contamination which, when they release waste materials or chemicals into the environment, can directly impact ground water quality. The massive national pollution cleanup efforts of the early 1970s focused heavily on surface water protection but largely ignored ground water. In fact, ironically, by strictly regulating discharges into surface water and air, some of our early environmental laws actually encouraged land disposal and underground injection of wastes, thus exacerbating contamination of ground water supplies. Only since about 1980 has the public become aware of the dangers of ground water contamination and the many ways that it can occur. Even so, new problems are discovered on a daily basis across the U.S., some resulting in the complete shutdown of large public water supplies. Such a situation occurred in Santa Monica, Calif., in 1997 when multiple underground storage tank leaks impacted first one, then two, then three of the city's public water supply wells, forcing the city to close an entire well field and turn to the city of Los Angeles for its water supply needs, at significant expense.

OUT OF SIGHT, OUT OF MIND?

Probably the major reason that ground water has historically received so little attention is that it is out of sight and its existence, movement and susceptibility to contamination is not readily understood by most people. Many people, for example, still believe that ground water occurs in "veins" or "underground rivers" that transport water over great distances quickly, or vast "underground lakes" that store unimaginable quantities of water that are readily tapped by wells for limitless water supplies. These images and beliefs are far from reality!

PROTECTING GROUND WATER RESOURCES

That the nature and occurrence of ground water is misunderstood is especially regrettable because, in many ways, preventing ground water contamination is crucial. Ground water contamination is particularly serious because it is difficult to detect and monitor. A great deal of scientific effort and money must be expended in characterizing the subsurface, to discern the flow pathways that ground water follows through the geologic materials that make up the earth's surface. Ground water samples must be collected during site characterization to determine if contaminants are present. If contaminants are detected, ground water monitoring wells or other sampling points must be constructed in the zones determined to be contaminated and additional ground water samples must be collected for laboratory analysis to monitor the direction and rate of movement of contaminants. These monitoring points, and the samples collected from them, must provide the answers to many important questions that should be asked, and also provide the basis for many important and potentially far-reaching and expensive decisions.

Reference

1 US EPA, 1997, Water on Tap: A Consumer's Guide to the Nation's Drinking Water, Office of Water (4601), EPA Publication #815-K-97-002, Washington DC, 22pp.

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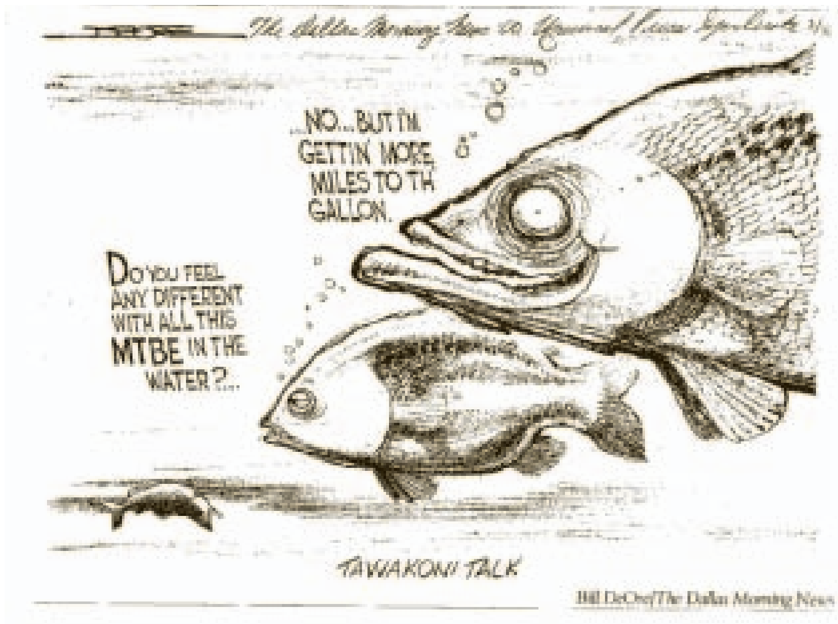
From the Editors…

In this issue of "Good Connections" we reprint an article which briefly reviews the state of ground water and some considerations for testing this. Since our newsletter generally focuses on the need for sealed stormwater systems, you might ask what the connection is between these. As it turns out, there are several connections.

First, ground water is critical to the drinking water supply in many communities. Although it is somewhat more protected from stormwater contamination than surface water sources, eventually contamination from stormwater runoff may reach ground water supplies because the storm system itself takes surface run-off and conveys it underground, where it is much more likely to mix with ground water. When this happens, treatment and remediation become far more complex and expensive.



Second, ground water frequently becomes introduced into conventional stormwater systems through their excavation and construction. When this happens, there is a co-mingling of these waters, at times to the detriment of both. Stormwater systems must carry volumes greater than what they were designed to carry, and groundwater is subjected to whatever contaminates are in the storm flows.

Finally, existing groundwater can be removed from its natural location through conventional construction practices. Traditional unsealed stormwater systems allow this ground water to enter the stormwater system and be carried away. The net result can be failure of supply systems which have used this ground water as their source.

Protecting something as valuable as ground water starts with doing things right from this point forward. It is neither feasible nor possible to eliminate the problems outlined above in existing systems, other than those which are creating obvious problems and require dramatic intervention. Engineers and designers, however, owe it to themselves and their clients to make sure that they practice good stewardship of resources from this point on, and that includes designing sealed storm sewer systems which do not contribute further to the problems. The thanks will come from future generations which will be able to enjoy a standard of living which could otherwise be in doubt.▪

How Clean Is A Safe Water Supply?

The U.S. Environmental Protection Agency has established maximum contaminant levels (MCLs) for a number of contaminants that are sometimes detected in drinking water supplies. These levels are typically measured in low parts-per-million or parts-per-billion concentrations. A few examples:

Primary Drinking Water Standards *(MCLs as mg/L)*		Secondary Drinking Water Standards *(mg/L)*	
Benzene	0.005	Chloride	250
Trichloroethylene	0.005	Copper	1.0
Nitrate	10.0	Iron	0.3
Cadmium	0.005	Total Dissolved Solids	500
Chromium (Total)	0.1	Sulfate	250

What Is A Part-Per-Million or Part-Per-Billion Anyway?

Ground water samples are often analyzed at extremely low detection levels – so low, that it is sometimes difficult to visualize just how low those concentrations really are. Think of the following equivalents:

	Part-Per-Million	***Part-Per-Billion***
Time	**1 minute in 2 years**	**1 second in 32 years**
Distance	**1 inch in 16 miles**	**1 inch in 16,000 miles**
Money	**1 penny/$10,000**	**1 penny/$10,000,000**

A part-per-billion is roughly equal to one drop of a chemical in a body of water the size of an Olympic swimming pool.

St. Louis Saves Time and Money With Flexible Connectors

Repairing and maintaining manholes used to be a real pain for the Metropolitan St. Louis Sewer District in Missouri.

Repairs took anywhere from one day to two weeks to complete, depending on the number of emergencies or poor weather conditions that interfered with the work. Leaking pipe connectors constructed with brick and mortar were costing the district between $1,000 and $6,000 in materials and labor to repair while also causing subsidence and dangerous road conditions.

Repair in progress

"The pavement would sink six inches around the manholes, causing serious problems for vehicles and pedestrians," says Ronald Moore, materials engineer for the Metropolitan St. Louis Sewer District (MSD). "The only solution was to take the time and spend the money to fix them, or risk further problems down the road."

Ten years ago, MSD found a much better solution in flexible rubber connectors. Already using them in its sanitary system, MSD began using them for its storm projects in hopes of reducing the uncontrolled inflow of water into its storm systems.

"With inflow, soil comes into the system, and that causes cave-ins," says Moore. "Without a watertight connection, the integrity of the structures are compromised and collapse occurs. To solve the problem, we opted to incorporate the flexible connectors into our storm systems."

It was a good choice, according to Moore. MSD currently installs the connectors in all new storm systems, and is gradually replacing the brick-and-mortar connections in all of its existing storm systems with flexible connectors.

"Flexible connectors save our District time, money and the hassle of inspections while also preventing soil migration and subsidence, vehicle damage and pedestrian hazards," says Moore. "Watertight systems also prevent erosion and subsidence around structures, and eliminate the high cost of repairing streets and sidewalks caused by leaks."

Such savings are significant for MSD, a public agency whose responsibilities include the collection and treatment of wastewater and stormwater management. MSD serves a population of approximately 1.4 million in a 524-square-mile region that encompasses the city of St. Louis and about 80 percent of St. Louis County for a total of 92 municipalities.

Within that area, MSD operates 10 treatment facilities that treat an average flow of 360 million gallons of sewage per day. It operates and maintains 8,585 miles of sewers, including 2,382 miles of stormwater sewers, 4,422 miles of sanitary sewers and 1,781 miles of combined sewers that handle both wastewater and stormwater flows.

Watertight rubber connector

To remove and replace manholes MSD spends $750,000 annually, including crew costs of $250 an hour. Every year, MSD adds 548 storm manholes, 1,167 inlets and nine junction chambers to the system, for which it averages 2.5 flexible gaskets per structure.

Because MSD takes over maintenance of its sewer and storm systems after installation – and because it doesn't pay for the initial installation or materials – the switch to flexible connectors has been particularly fruitful. "We're responsible for repairing any voids or cave-ins," says Moore. "Once we started using the flexible gaskets, we had a significant reduction in our maintenance costs in those areas."

Plus, says Moore, the less stormwater that gets into the sanitary system, the less time that must be spent treating that stormwater. An overloaded system requires additional sewer lines to handle the overflow. The best way to eliminate that need, says Moore, is by installing a flexible connector in every manhole in the District's sewer system.

MSD's cost savings associated with flexible connectors have been significant, and these savings are returned to the district's general revenue fund for use on other projects. According to Moore, it costs $1,000 to $6,000 to dig up the street, disrupt traffic and repair each structure.

According to Moore, the switch to flexible connectors was fairly seamless for MSD. At first, concerns were raised over the cost of the connectors, but those issues were resolved once the project developers realized the costs would equalize," says Moore. "Considering the labor intensive practice of using brick and mortar to make joint connections."

MSD has achieved another goal as a result of using flexible connectors in its sanitary systems: compliance with the new EPA regulations requiring that systems be watertight and airtight. "The gasket makes the whole system watertight, which means air testing is much easier," Moore explains, adding that MSD specifies that its watertight flexible joints be able to withstand an air test.

"When the inspector sees that flexible connector in place, he's 99.9 percent confident that there's a solid seal in place," says Moore, adding that over the last 10 years flexible connectors have "become part of the standard routine" for MSD. "Everyone expects the manufacturers to know how to use them, so everyone is on the same sheet of music when it comes to installation and performance."■

Did You Know?

What percentage of the earth is covered by water?

About 80% of the world is covered by water or ice. Only about 20% is dry land.

What percentage of the world's water is readily available for humans to use?

97% of the water on earth is salty ocean and 2% is frozen. The remaining 1% is available to meet human needs.

How much water is contained in the human body?

If you're an adult, your body contains about 40 quarts or 10 gallons of water.

Does a man's body contain more water than a woman's body?

A man's body is 60-65% water while a woman's body is 50-60% water. Muscle tissue contains a large amount of water. Fat tissue contains virtually no water. Men tend to have more muscle as a percentage of body weight while women tend to have more fat.

How much water does the human body lose in a typical day?

You lose 2 ½ to 3 quarts of water per day through normal elimination, sweating and breathing. If you exercise or live in a humid climate, you may lose another quart.

What is the largest use of water indoors?

Toilets use the most, with an average of 27 gallons per person per day. Laundry averages 17 gallons per person per day and showers 14 gallons.

What is the largest use of water outdoors?

Lawn sprinkling

If you have a faucet leak that drips one drop every second, how much water are you wasting a year?

The dripping faucet will add up to approximately 2,700 gallons of water over the year. This is yet another example of how small amounts over a long period can add up to suprising numbers.

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If you would like to be added or deleted from our mailing list, fax to mailroom at 717-840-1795 or e-mail: mailroom@frankgroupinc.com. Please be sure to reference the Good Connections Newsletter in your request.

Looking for an interesting presentation to your engineering group?

Try our "Watertight Storm Sewers Save Money" Brown Bag

That's right! We'll come to your group of ten or more engineers, provide food, and leave you with a better understanding of why sealing storm sewer systems is the right thing to do.

Many of the Agencies responsible for environmental protection and regulation of water quality are implementing new and more stringent requirements for managing stormwater runoff. Separation of point sources, restriction of groundwater infiltration, and treatment requirements are moving rapidly from discussion to specifications.

The presentation will discuss the environmental and cost saving reasons for making storm sewers watertight along with design concerns, performance improvements, specifications, applications of flexible connectors, cost benefits and other tangible benefits. Our goal is to provide information on the environmental benefits and cost savings to everyone involved when using and or specifying flexible connectors in storm sewer designs.

Seminars have been held for a wide range of groups including city and county public works departments, university facilities management departments, ASCE chapters and civil engineering firms. Attendees include consulting engineers, city/county engineers, D.O.T, maintenance directors, inspectors and others interested in the design, maintenance or financing of storm sewers.

All seminar materials are provided (including the lunch, naturally) and there is no charge. Continuing Professional Development units may be available for this presentation.

Contact information: E-mail: mailroom@frankgroupinc.com or mail to Frank Group, Inc., 2555 Kingston Road, Suite 230, York, PA 17402.

PHOTO GALLERY

Wanted: Road Damage Pictures
Reward: $100.00

The old-fashioned method of using bricks and mortar to join pipes into structures in storm sewer construction gives everybody problems, from the contractor to the customer. Now you can turn one of these cracked messes into enough money for a good dinner for two, just for sharing your photos with "Good Connections". Each issue will feature photos of real-world problems caused by rigid brick and mortar joints. If your photo is selected, we'll send you a check for $100, your reward for helping us educate others about using flexible connectors in storm sewers. Please e-mail your pictures to mailroom@frankgroupinc.com or mail to Frank Group, Inc., 2555 Kingston Road, Suite 230, York, PA 17402. Please be sure to reference the Watertight Storm Sewer Group.

Congratulations to Jennifer Wood who took this picture near the Mill Village area in Greenville County, South Carolina.

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