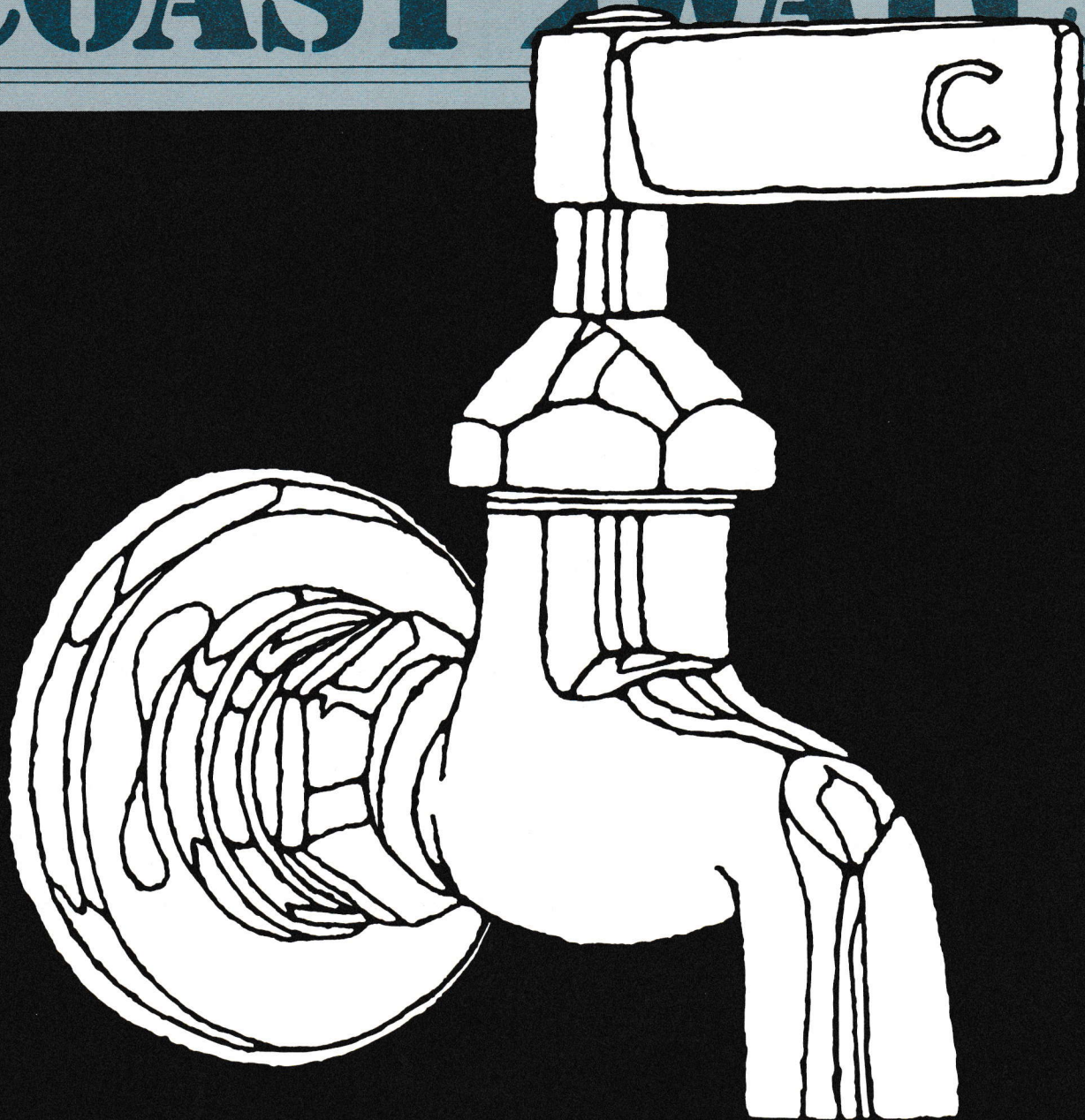
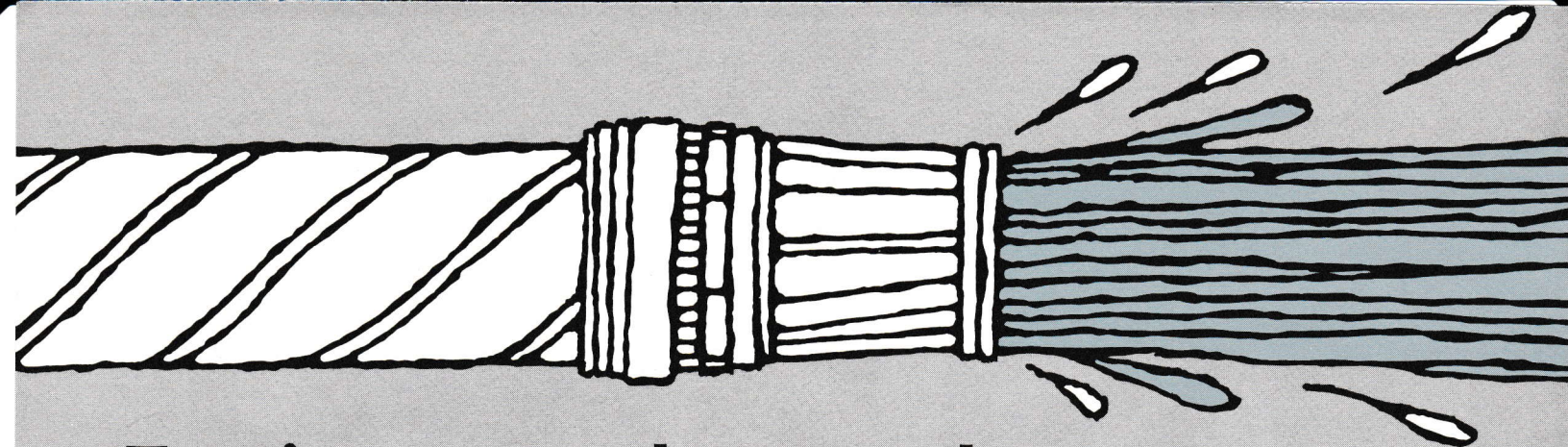


COAST WATCH



Quenching our thirst with  groundwater



Tapping our underground resource

You walk to the faucet, turn the knob and out pours cup after cup of water.

But where does that water come from?

At first thought, you'd probably answer the county reservoir or your backyard well.

But that's only an intermediate stop in the water's path to your faucet.

Where does it really come from?

For 55 percent of North Carolina's residents, it's drawn from the ground and is aptly called "groundwater."

To drink, flush, wash and rinse, North Carolinians withdraw about 770 million—over three quarters of a billion—gallons of water from below the earth's surface each day.

That's a large amount of a limited resource.

Less than 3 percent of the earth's trillions of gallons of water is fresh. And three-fourths of that 3 percent is frozen in polar ice caps and glaciers.

About one-half of 1 percent of the world's fresh water is groundwater. And 1/50th of 1 percent empties into rivers, lakes and streams.

Sure, rainfall replenishes groundwater supplies. But perhaps not fast enough.

Rain must trickle through foot after foot of soil to reach natural storage areas. It can take days,

weeks or months, depending on the topography, soil characteristics, vegetation, land use and precipitation amounts.

But in just minutes a pump and well can send gallons of this collected moisture shooting to the surface for industrial, agricultural, municipal and residential use.

A breakdown of groundwater use in North Carolina follows this pattern: 64 percent industrial, 18 percent residential, 9 percent agricultural and 9 percent municipal.

Along the state's Outer Banks and Coastal Plain, most municipalities, industries and residents quench their needs with groundwater.

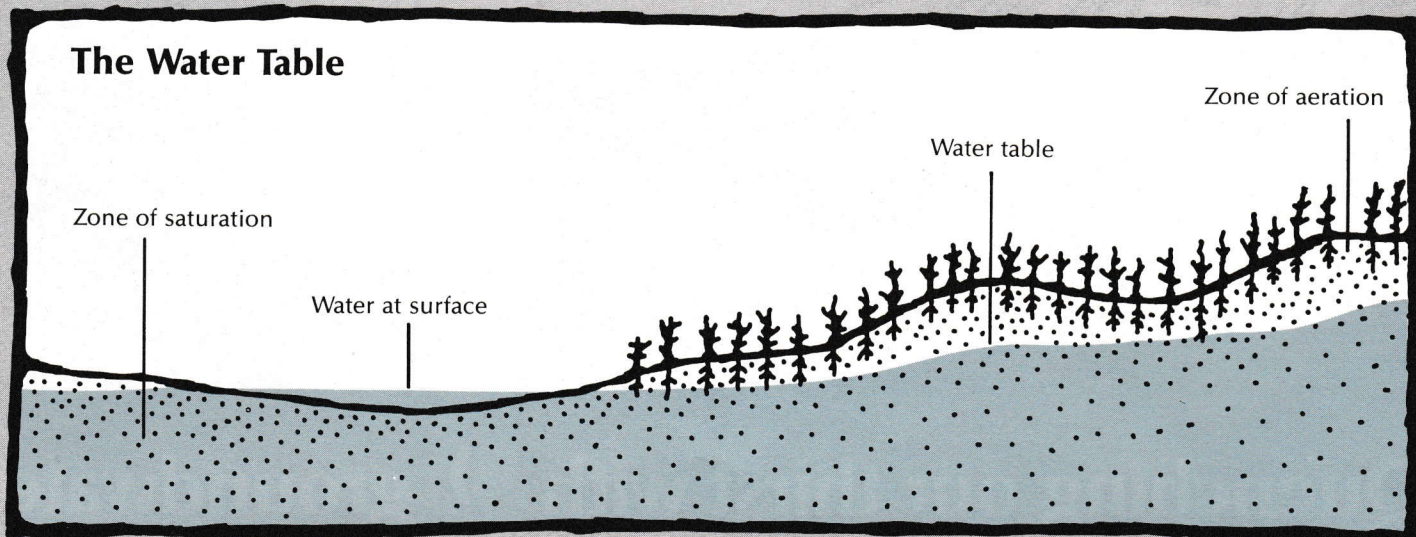
In the Coastal Plain, wells suck water from large underground aquifers. Aquifers are layers of porous rocks that yield water.

Contrary to popular belief, there is no subterranean lake or river flowing beneath our feet.

Instead water collects between and inside porous rocks such as limestone. It moves vertically and horizontally as it slips and slides in contour with the earth's surface.

Geologically speaking, underground water divides into two zones.

The zone immediately beneath the land's sur-



By Kathy Hart

Adapted from "Basic Elements of Ground-Water Hydrology"

face is the aeration zone. Water and air bubble through this zone.

Underneath is a zone where all of the rock openings are full of water. This zone is the saturated zone, and the water taken from it is groundwater.

The water table marks the top of the saturation zone. The depth of the water table varies with the topography of the land, the climate and the amount of rainfall.

The water table rises above the ground's surface in lakes, streams and swamps. But it may fall hundreds of feet below a desert.

Along the barrier islands and nearshore coastal areas, the groundwater system acts differently. Salt water infiltrates the aquifers.

When this occurs, the water that collects from rainfall forms a freshwater lens which floats on the underlying, denser salt water.

From Ocracoke north along the Outer Banks, this freshwater lens is the only source of drinkable water with the exception of a small lake near Nags Head.

The lens, which begins only a few feet below the land's surface, may be 25 to 100 feet deep and is solely dependent on rainfall for replenishment.

"On the Outer Banks you have a very finite amount of resource because there's not a lot of land for infiltration of rain," says Allan Dietemann of the N.C. Division of Water Resources.

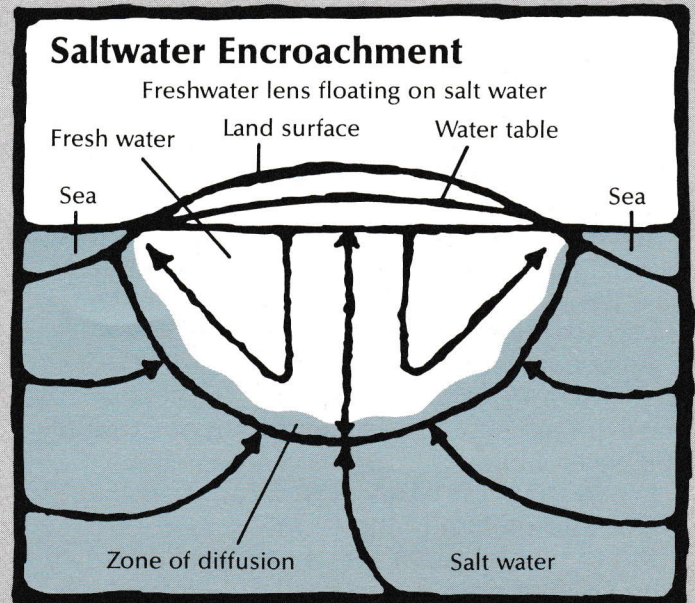
And Dietemann says this limited resource is quenching the thirst of an expanding population that swells by sixfold during the hottest, driest season of the year.

Therein lies the problem.

As more houses and businesses suck water from the lens, it diminishes. And when water supplies decrease, problems are created that are characteristic to barrier islands everywhere.

Wells can go dry. Or they can draw salt water from the aquifer below or partially treated sewage from the septic tanks nearby.

These problems haven't reared their heads along North Carolina's barrier islands. Outer Banks city



and county planners are making sure they don't by planning for the future (see story, page 4).

On the barrier islands south of Ocracoke, water supplies are more abundant. A deep freshwater aquifer exists beneath these islands.

"There's plenty of groundwater available to the south," Dietemann says.

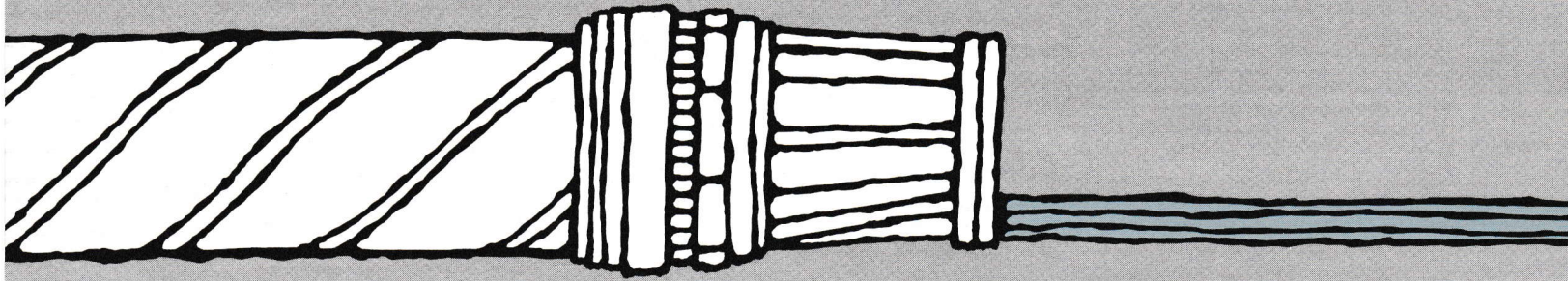
"There, it's just a matter of how to pump it, who pays for it and how to handle the fluctuating needs caused by tourists."

But quantity isn't the only concern among residents in coastal North Carolina. Quality is also a worry.

People are realizing that the wastes that are pumped and dumped into our soils are potential contaminants for our water supply.

"At meetings and hearings, people express strong opinions about the quality and quantity of their water supplies," says Perry Nelson of the N.C. Division of Environmental Management.

"That's why it's important now to make a careful evaluation of those supplies and a careful evaluation of what affects those supplies. Water definitely affects our quality of life."



Outer Banks plans for tomorrow's thirst

Nobody has to tell John Bone how important water and tourism are to the Outer Banks.

Most of the jobs there depend on that successful combination.

So when Dare County imposed a moratorium on new water hook-ups two years ago, his office was flooded with phone calls.

"People were saying, 'I heard you don't have any water. Should we still come on our vacation?'" says Bone, executive vice president of the Outer Banks Chamber of Commerce.

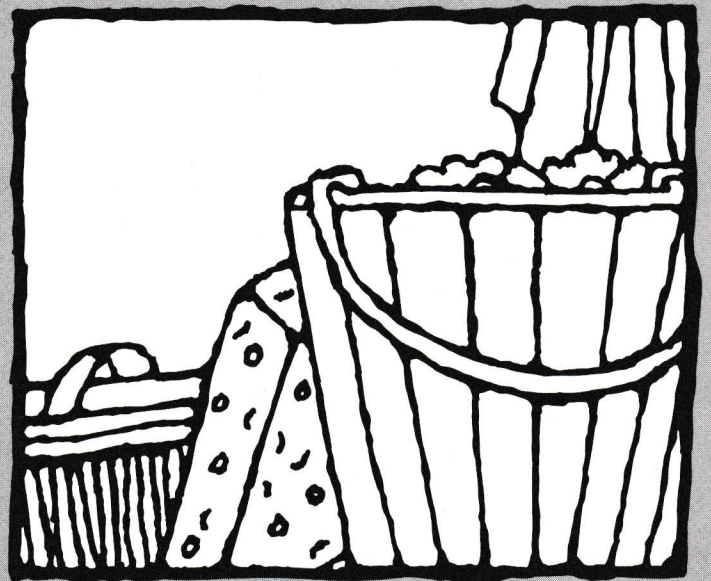
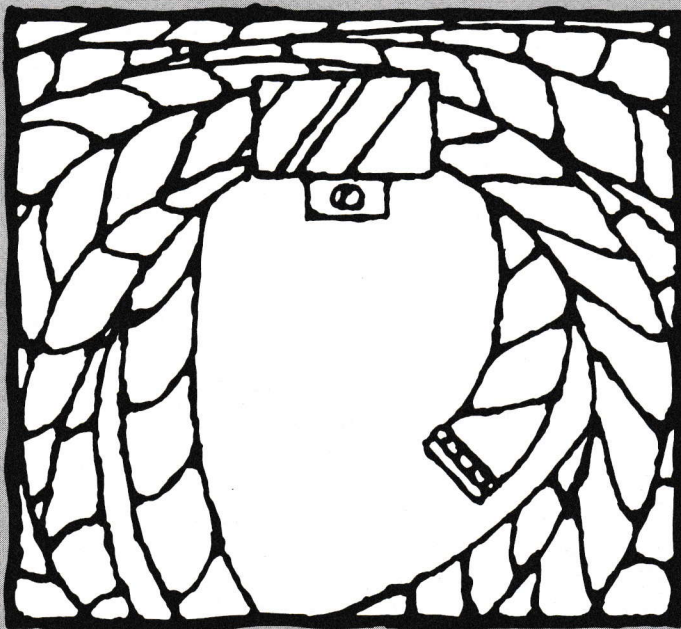
Bone convinced the tourists that faucets weren't dry. The moratorium was simply a protective measure to keep development from outstripping the water supply.

When the season was over, vacationers had spent \$303 million in the county.

But the moratorium sent a message to everyone who visits or lives at the coast.

Water is a finite resource, and we can't wait until we're out of it to start planning for the future.

That philosophy is especially true for North Carolina's Outer Banks, where the only drinkable groundwater is a very thin layer of fresh water.



The building boom presents an added threat to that fragile system, says Perry Nelson of the N.C. Division of Environmental Management.

According to census figures, Dare County's population increased 28.9 percent from 1980 to 1985. That's the fastest growth rate in the state, exceeding rates in metropolitan areas such as Mecklenburg and Wake counties.

The increased development worries Nelson. He and other hydrologists predict that it will be water, not land, that may eventually limit development on the Outer Banks.

Bone emphasizes there is no lack of water now. But he admits the economy of the area could shrivel without careful planning for the future.

Now Dare County relies on three sources of water.

A regional system serves the county from a well field in Wanchese. And a freshwater pond operated by Nags Head supplements the regional system. Each town in the county is allotted a certain percentage of the water.

The Hatteras Water Association serves residents south of Avon. And individual wells are dotted throughout the county.

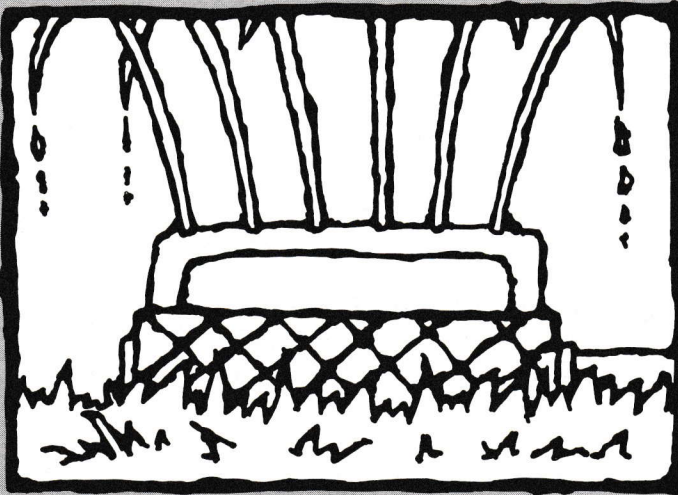
By Nancy Davis

Now the regional water system has a production capacity of about 6 million gallons of water per day.

But a study conducted by an engineering firm estimates the demand for water could increase by as much as 15 million gallons per day by the year 2000.

In the winter, there is plenty of water. But on a peak summer weekend, tourists push the population to as much as six times its off-season level.

While they're there, they use a lot of water. They swim in it, bathe in it, guzzle it and flush it.



Allan Dietemann, of the N.C. Division of Water Resources, says it's like thousands of people putting straws into the same soda. Pretty soon, the glass is no longer full.

And there are no free refills.

Webb Fuller, town manager of Nags Head, has grappled with the water issue for the last five years.

The figures he deals with are in millions of gallons. But he knows that every drop is precious.

Three years ago, Fuller and other town officials realized that if they didn't do something, there wouldn't be enough water to keep pace with all the buildings going up on the beach. (Nags Head was not affected by Dare County's building moratorium.)

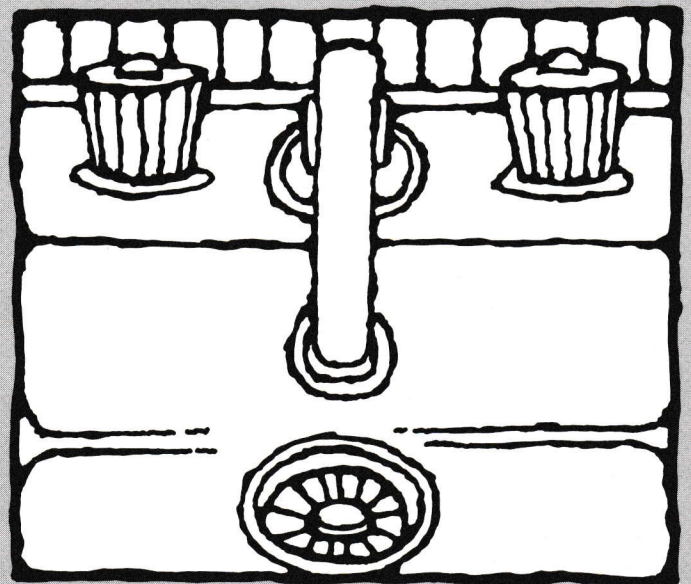
So Fuller devised a formula for doling out water to new construction projects.

"We didn't want to let growth go and use up all our water," he says.

Under the formula, residential buildings are allotted about 65 percent of the water, and commercial buildings receive about 35 percent.

Hook-ups for new residential construction are handed out on a lottery basis. Commercial hook-ups are reviewed twice a year.

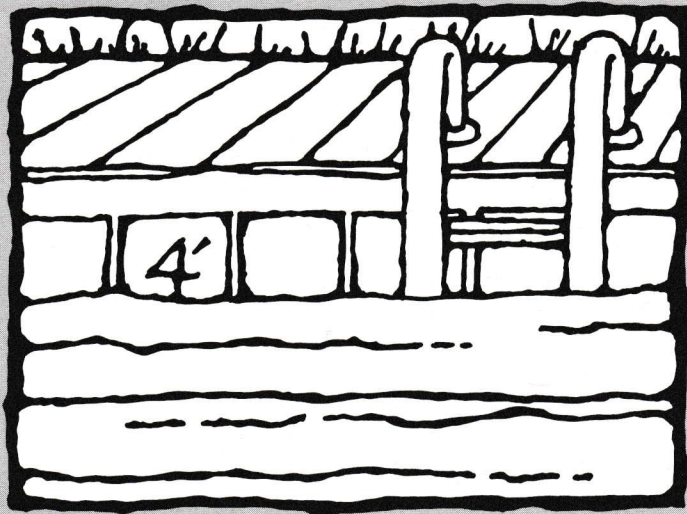
The price of water in Nags Head isn't cheap. In addition to the cost of hook-ups and labor associated with water, residents must pay a \$2,000 impact fee. Before you can turn on the water in a new home in Nags Head, you'll probably pay about \$3,000.



So far, developers have swallowed the high fees without much complaint.

Instead of hampering development, the method provides a patterned approach to development, Fuller says.

Soon residents also will be paying for a new reverse osmosis, or desalination, plant. Pumps will draw brackish water from an aquifer below



the freshwater lens. Then the water will go through a process to remove the salt.

At a cost of \$8 million to \$10 million, the plant is scheduled for completion in 1989. It will increase the region's water capacity by 8 million gallons a day.

Desalination is nothing new. In water-poor countries such as Saudi Arabia, desalination is often the only alternative.

But it's an expensive alternative. Nags Head's reverse osmosis plant may raise the cost of 1,000 gallons of water from 72 cents to an estimated \$1.30, Fuller says.

Farther south, the Cape Hatteras Water Association supplies water to Hatteras, Frisco, Buxton and Avon. In addition to expanding its pumping capacity, the association has taken steps to conserve its water supply by limiting development in its well fields.

Jack Rollinson, manager of the association, says it's more than a problem of too many people, too little water.

Some folks just don't realize that water is a premium.

Rollinson has responded with a campaign to increase awareness of the water shortage. He supplies his customers with conservation tips in their

monthly bills. And some realtors have cooperated by handing out packets of information to tourists.

While managers grapple with day-to-day supplies, scientists are learning more about groundwater.

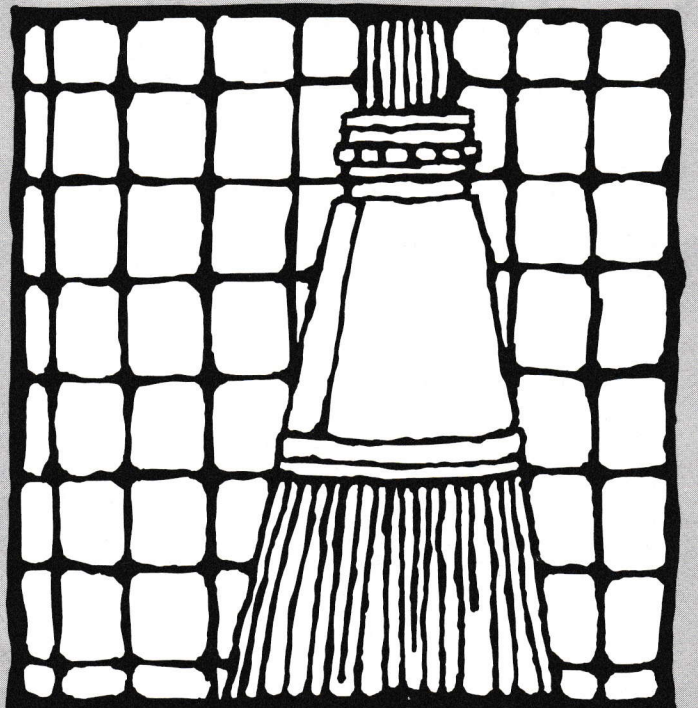
At the U.S. Geological Survey, hydrologists are using computer models to simulate groundwater flow.

With an accurate model, they may be able to predict how much water we'll have for the future, says hydrologist William Lyke.

But the bottom line of the groundwater issue may be how much we're willing to pay for water.

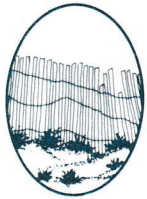
John Kuchnia, of the N.C. Division of Water Resources, says, "We've had cheap water for so long that people can't believe it costs this much. They'll pay \$50 or \$60 for cable TV, but let their water bill go up a dollar, and they'll be calling to complain."

Whatever the price, hydrologists say we're going to have to learn to sip instead of guzzle.



THE BACK PAGE

"The Back Page" is an update on Sea Grant activities — on research, marine education and advisory services. It's also a good place to find out about meetings, workshops and new publications. For more information on any of the projects described, contact the Sea Grant offices in Raleigh (919/737-2454). For copies of publications, write UNC Sea Grant, NCSU, Box 8605, Raleigh, N.C. 27695-8605.



On March 7, 1962, David Stick of Southern Shores almost drowned. The biggest northeaster of the decade was dumping rain and lifting waves over most of the Middle Atlantic Coast. Stick and many others struggled to survive as the storm unleashed its fury for 2½ days.

Fortunately, Stick and all of the Outer Banks' residents lived to tell about the now-famous "Ash Wednesday Storm."

Their stories come alive in a new book by Stick that commemorates the 25th anniversary of the storm.

The *Ash Wednesday Storm* contains 100 pages of adventure, retold by 160 people associated with the storm. And it includes photos by Walter Gresham III and Aycock Brown, a nationally known photographer who captured the Outer Banks on film for 30 years.

Copies are available in bookstores in eastern North Carolina and Virginia, or by writing Gresham Publications, P.O. Drawer 807, Kill Devil Hills, NC 27948. The cost is \$12.95. Add \$2.50 for postage and handling, and 5 percent sales tax in North Carolina.



University of Delaware Sea Grant researchers have found a use for the mounds of crab shells that are discarded each year by the crab industry.

They're turning the shells into surgical suture thread that slowly dissolves in the body and is nonallergenic. What's

more, the thread has a positive side effect—it promotes wound healing.

The shells of crabs are made of a tough material called chitin. For 50 years, chemists have known that chitin has many useful properties. But before they could find a way to dissolve the shells and turn chitin into a usable form, nylon was invented and claimed most of the glory.

Then, 10 years ago, a Delaware Sea Grant researcher found a way to turn the crab shells into a gooey liquid that could be formed into tough fibers. Now a Japanese firm is using that information to make sutures from chitin.

This isn't the first dissolvable suture invented. But the others often cause allergic reactions and aren't suitable for some areas of the body. Chitin sutures overcome those problems.

Now Delaware Sea Grant researchers are studying powdered chitin's wound-healing properties with an eye to developing an ointment. Early tests show that it not only speeds healing but minimizes formation of scar tissue.



At the grocer's, shrimp sell for \$4.99 to \$12.99 a pound. At those prices, it's hard to stock up on America's favorite seafood.

But what if you could fill your freezer with these delectable delicacies for only the price of few days work and some minor equipment costs.

With a boat, some effort and Sea Grant's booklet, *A Guide to Recreational Shrimping*, you can save money and catch your own shrimp in coastal waters.

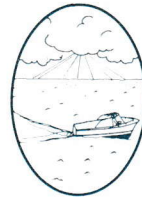
The booklet, written by Sea Grant advisory agent Wayne Wescott, provides valuable information about shrimp biology, regulations and types of trawl nets.

With the help of detailed illustrations, Wescott describes how to rig the net, prepare the boat and complete a

successful tow. He offers many tips that can save the new shrimper hours of frustrations.

And he has suggestions for culling and storing the catch.

For a copy of *A Guide to Recreational Shrimping*, write Sea Grant. Ask for UNC-SG-86-07. The cost is \$4.



Few things strike as much fear in a boater as the sight of a waterspout on the horizon. These funnel-shaped clouds are actually offshore tornadoes. And for boaters, they can be just as deadly.

National Weather Service meteorologist Wallace DeMaurice says waterspouts are often associated with summer squalls. And they're particularly prevalent near the Gulf Stream.

Because the twisters weave their way across the water in such an unpredictable pattern, the best advice is to stay off the water when severe weather threatens.

But if you get caught in an offshore squall, use common sense. If you see a waterspout, don't try to outrun it. Instead, move away from it at a 90-degree angle, DeMaurice says.

Report the sighting to the National Weather Service, and listen to your radio for advisories.

If you're in a marina when severe weather threatens, get off your boat and follow the National Weather Service's guidelines for severe weather.

The Gulf and South Atlantic Fisheries Development Foundation has awarded \$20,000 to Sea Grant and the N.C. Division of Marine Fisheries to conduct a research and demonstration project for turtle excluder devices or TEDs.

Sea Grant marine agents and DMF biologists will test two versions of the TED in the state's offshore waters to determine which version performs best. The results of the study will help fishermen decide which TED to use.

Continued on next page



People leave all kinds of things at Pettigrew State Park. But a year ago, a ranger at the eastern North Carolina reserve saw something he'd never forget.

He found two parts of a dugout canoe in Lake Phelps that Indians left behind 3,000 years ago.

The discovery spurred underwater archaeologists to take a closer look. Within months, they found 22 canoes and pottery and stone artifacts submerged in the lake.

The cypress dugouts range from 24 to 37 feet and are in unusually good condition. The acidic quality of Lake Phelps and the absence of bacteria and aquatic life preserved the wood and created a time capsule for the canoes.

Now, many of the markings from construction can be seen. Dugouts were built by burning out the middle of logs, then hollowing the insides with shell and stone tools.

So far, four canoes have been recovered. Two have been radio-carbon

dated, and vary only by 100 years.

The archaeologists hope to find funding to test the rest of the canoes. More information will help them decipher the mystery of the canoes' origins.

One dugout has been on display at the N.C. Museum of History; the others are being treated in Fort Fisher. The visitor center at Pettigrew State Park is exhibiting some of the artifacts.

Preparing seafoods in a microwave oven will do more than save you time. Microwaves cook seafoods rapidly without drying them out, making it possible to reduce fats or oils called for in many seafood recipes.

Remember that overcooking is the most common mistake in preparing seafood. Since microwaves vary in power, be sure to follow the directions in your oven's instruction manual.

Always cook a recipe for the shortest time first, test for doneness, and cook longer if needed.

You can easily convert your favorite seafood recipes to microwave oven

cooking times. Just use similar recipes from your microwave cookbook as a guide.

Sea Grant is publishing a new special-interest newsletter for people in the seafood industry. *Seafood Current* is a quarterly publication about seafood processing, marketing and retailing in North Carolina.

If you'd like to be placed on the mailing list, write: *Seafood Current*, UNC Sea Grant, Box 8605. NCSU, Raleigh, N.C. 27695-8605.

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