Purifying water

In Toronto, drinking water is taken from Lake Ontario. It is easier to treat than water from sources such as rivers because it is comparatively still, and it's cleaner than you might think.

1 LAKE WATER

- The water intake pipe extends from the plant into Lake Ontario
- In the summer a minuscule amount of chlorine is added to stop zebra mussels from growing inside the pipe
- Every three years divers enter the pipe to clear debris like twigs and seaweed
- The flow intake is from one to two litres per second

2 SCREENING

- Water is filtered by screens to remove twigs and seaweed and the occasional fish
- On average, a pail of objects is filled about once a week

3 PRE-CHLORINATION

- Once inside the plant, water is pumped up nine metres so the rest of the filtration process works by gravity
- pH – the acidity or alkalinity – is checked
- Temperature is taken
- Turbidity, or cloudiness is measured
- Particle count is made
- Chlorine is added to kill micro-organisms

4 SEDIMENTATION

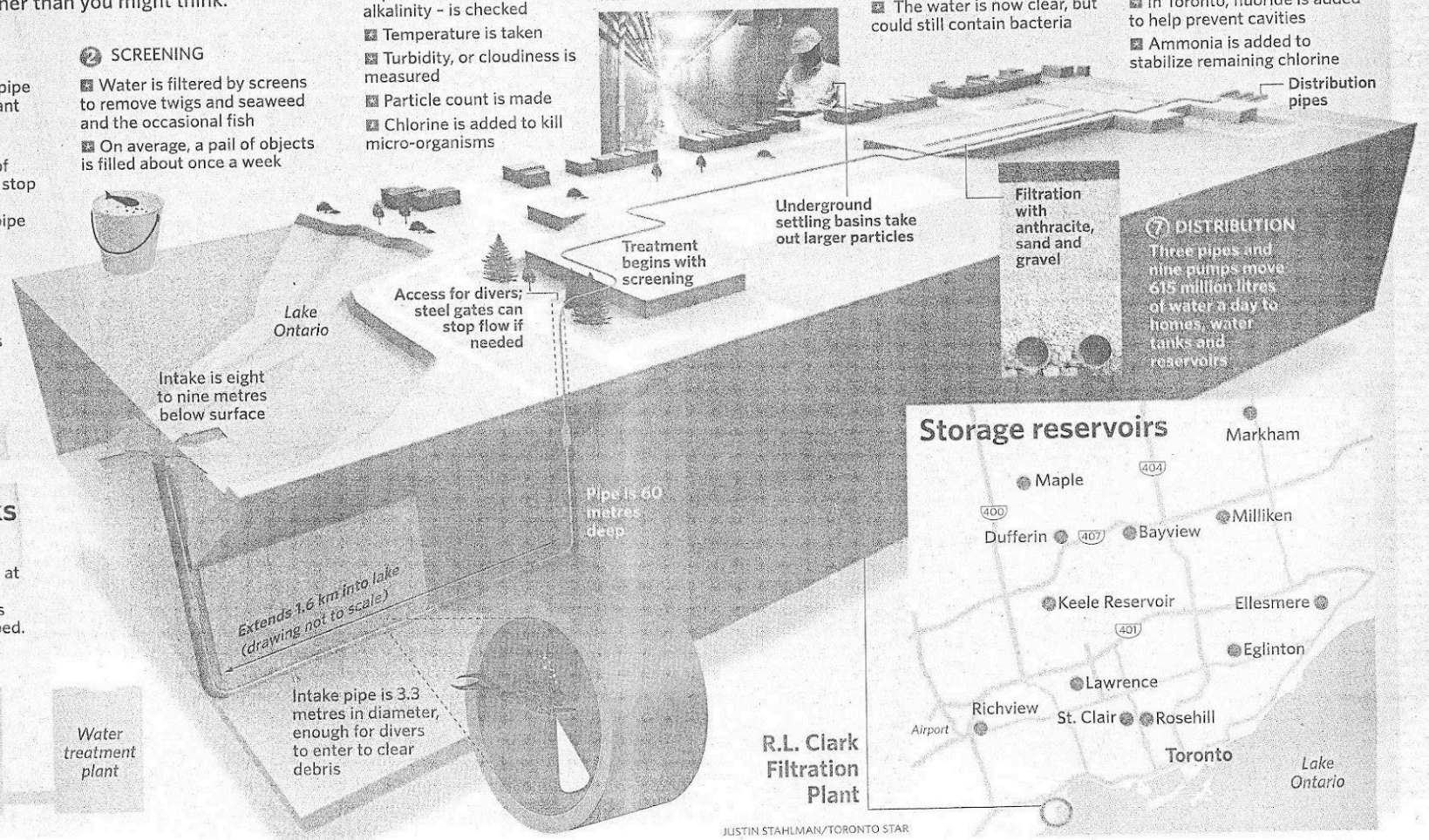
- Alum added at settling basin
- Particles stick to alum, creating "flocs"
- Heavy flocs sink to the bottom and the remaining water is sent to one of 18 filters

5 FILTRATION

- Filters are made up of gravel, fine sand and the coal-like mineral anthracite
- The top few inches removes 95% of the remaining floc, algae and silt.
- The water is now clear, but could still contain bacteria

6 STORAGE

- Purified water goes into holding basins
- Chlorine is added to kill any remaining micro-organisms, and then removed with sulphur dioxide
- In Toronto, fluoride is added to help prevent cavities
- Ammonia is added to stabilize remaining chlorine



7 DISTRIBUTION

Three pipes and nine pumps move 615 million litres of water a day to homes, water tanks and reservoirs

Storage reservoirs

Water seeks its level

Because the plant is at the same level as the lake, water flows without being pumped.

SOURCE: R.L. Clark Filtration Plant

JUSTIN STAHLMAN/TORONTO STAR

Toronto Star : "The Weight of Water"
Catherine Porter , July 24, 2005

It uses 5,500 kilometres of pipe, 120 pumps and 50 million watts of electricity. In an age of water advisories and drought, the journey of a single litre of water is a tale of drama and non-stop action, writes Catherine Porter

Up above the 401, in the northwest pocket of the city, buildings wilt under a blazing sun. There isn't a tree in sight. Heat sizzles off the pavement, which is deserted but for an unwise or unfortunate few, such as the city worker combing steaming asphalt over a new patch of Islington Ave.

This far from the lake, the only water in view trickles down your temples and the back of your knees. It's been the hottest summer in Toronto's recorded history (about 167 years), with the mercury already bubbling above 30 degrees 26 times. It's also the driest summer since 1949, at least since we started keeping records, in 1937.

There's been barely a half centimetre of rain since the beginning of May — a fourth of what usually falls. The city has been issuing heat alerts like parking tickets and offering reprieve at its pools till almost midnight, since no water has come from the sky above. The word "drought" has been cropping up in newspaper headlines. The province has begged us to cut down on air conditioning; the city has begged us to cut back on water. It's almost as if all the apocalyptic environmental prophecies are proven true, and we're running out of water.

But if you could burrow your hand down through the asphalt on this same stretch of road, and then through 1.5 metres of earth, 30 centimetres of concrete and a thin wall of steel, you'd hit a geyser of water that, within minutes, would flood the street around you.

That's true not just here but anywhere in Toronto. Peel back the top layer of the city, and you will discover a whole other organized world buzzing beneath us. The workings of this world are dizzying: On an average summer day, 2 billion litres of water course from the lake, beneath the city and into homes and businesses — enough to overflow the SkyDome. They travel through 5,500 kilometres of pipe, that if stretched together in one straight line, would reach almost all the way to England. They are pushed uphill from the lake around the city by 120 pumps using 50 million watts of electricity — enough to brighten 500,000 light bulbs. The operation's hydro bill alone is $25 million a year.

It's an elaborate system of engineering wizardry, all aimed at delivering free running water anywhere, anytime. Few of us realize it's there, let alone appreciate it. We just turn on the tap. But day after day it churns, taking water to the city's faucets, toilets, drinking fountains, swimming pools, and splash pads — places like Rexdale Park.

Tucked between a rock of neat bungalows near Islington and Elmhurst Dr., Rexdale Park is an oasis in the middle of the desert. On a scorching afternoon in July, 17-year-old Stetson Ford has brought his group of 9- and 10-year-old campers here for a reprieve from the heat. They run squealing through the geysers shooting water up from different holes in the ground. They bound beneath two towering taps pouring water.

Ford fills and refills a blue bucket with a litre of water at a time to attack the dry and unsuspecting. "Oh, you're going to get it," he hollers.

The kids, like most people in this city, don't know what a miracle the water is — how far that litre has travelled, all the way from the middle of Lake Ontario, and for hundreds of kilometres and years before that. The story of a singe litre of water in the city is a tale of drama and non-stop action.

One night in March some 300 years ago, snow fell gently in the woods a few kilometres from Lake Nipigon, north of Thunder Bay. That spring, when the sun gained momentum, the hard film coating the snow slumped like a fallen soufflé. Slowly, it began to melt, and the water swelled the earth beneath it and trickled towards a nearby creek. That water bubbled quickly down toward the lake, where it stayed for a few months, before following the tug into Lake Superior. It could have been here that at least some of our litre of water began its journey.

If you could seal Lake Superior so no more water could enter, it would take around 191 years to drain — so it's likely our water stayed swirling there for at least a century and a half before flowing down through the Straits of Mackinac into Lake Huron. From there, it made its way down below the canoes by Manitoulin Island, past the cottages of Georgian Bay, the bathers lounging on Sauble Beach, before seeping into Lake St. Clair and Lake Erie. About 85 per cent of Lake Ontario's water comes from Lake Erie, so our water might have helped to carry a ship through the Welland Canal. Or it may have coursed over Niagara Falls, watched by tourists and lovers leaning over rusty railings.

And then, two days before Ford scooped it up in his blue bucket, it may have gathered with the droplets from last week's rainfall, and the water that meandered for years up the Saginaw River and through Lake Michigan, and with that brown murky water from Toronto's streets that flooded into the Humber River, and undulated just below the surface of the lake, precisely 1.6 kilometres from the Etobicoke shoreline.

That's where the R. L. Clark Filtration Plant's intake pipe opens. The Clark is one of four filtration plants that treat the city's water. All the water spraying out of taps and car washes across this city starts its journey outside the intake pipe of one of these.

The best-known of the four plants is the art deco R. C. Harris, rising from the shores of the city's Beach neighbourhood. Toronto writer Michael Ondaatje immortalized it as the "palace of purification" in his book *In the Skin of a Lion* — a place built with the sweat of Italian immigrant labourers in the 1930s.

The oldest, at least in its original form, is on Centre Island. The city built the first sand-filtration plant here in 1908, after a typhoid epidemic killed many Torontonians and raised fear about the water supply. Until then, they had simply been pumping water to homes from a wooden pipe running from the lake. After another outbreak a few years later, it became one of the first plants in North America to disinfect the water using chlorine.

Over the years, as the city grew, so did the size of the water supply system, with new water reservoirs being erected, and eventually, additional filtration plants. The R. L. Clark was opened in 1968, replacing an older plant in the area.

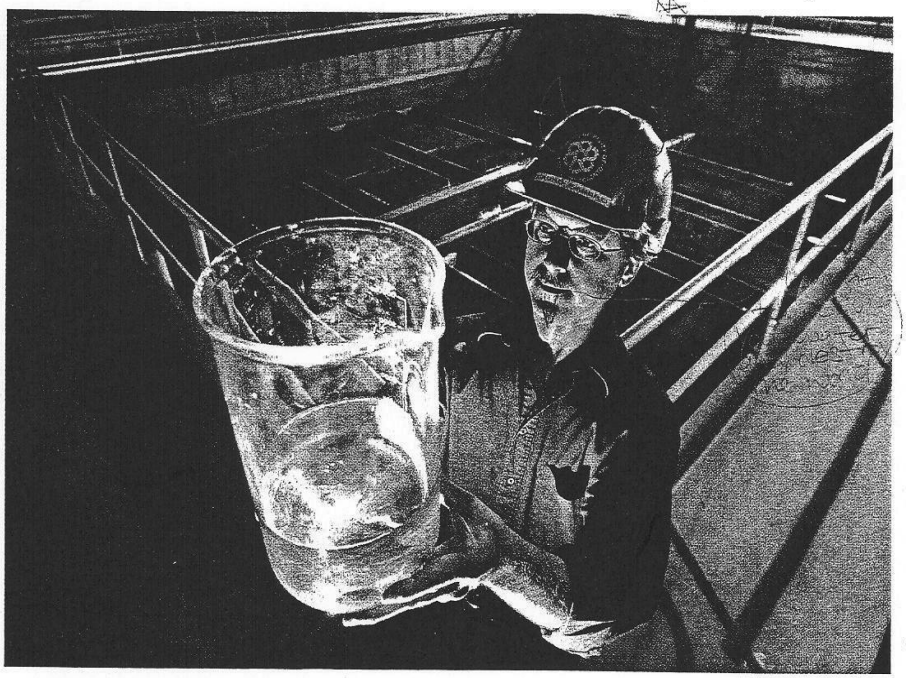
Tucked at the end of a residential street in New Toronto, the plant looks like a cross between a light-industrial factory and a war bunker from the outside. It's long and thin, shaped like a hot dog, with two ends poking out from under a berm of sun-bleached grass. Locals living in the surrounding bungalows use it as a park for their dogs. Its interior has been closed to the public since the terrorist attacks of Sept. 11, 2001. This is a rare glimpse.

Inside, the Clark plant smells like a public swimming pool. That's from the chlorine. The air is cold — the same temperature as the water, at around 7 degrees. There's a high-pitched squealing sound of rusty mixers that slowly lift and lower logs into the water; these help stir the water during the purification process. This is not a place you'd want to be trapped in overnight.

To get to the plant, that litre of water passed layers of zebra mussels clustered around the lips of a giant bell-shaped funnel at the end of the intake pipe. The pesky mussels are kept from attaching inside the pipe by recurring bursts of chlorine as water enters the giant pipe, spanning about 3.3 metres — the height of an average storey.

Within the pipe, the water plummeted into the lake bottom, and burrowed under the bedrock until it reached the shoreline, where it rose up and into the plant, propelled by the pressure of the lake. It then poured through one of three giant metal screens, which removed the odd twig or small fish

Our litre of water may have started as a snowfall 300 years ago near Lake Nipigon. Or it may have coursed over Niagara Falls, watched by tourists and lovers



BERNARD WEIL/TORONTO STAR

TOP: Water sprays against a tree standing in an Annex garden.
ABOVE: Mauro Fabbro, plant manager of the R. L. Clark Filtration Plant, holds a litre of water near a large tank in the final filtering stage.

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that had joined the voyage.

It was then pumped up nine metres above to one of three giant, dark concrete pools that always glow an aqua green. That's from the smidgen of alum — about one-twentieth of an aspirin pill — that's sprayed into each litre on its way in. Alum, or aluminum sulphate, acts like a magnet for the dirt, clumping it together in little groups called "flocs." The flocs were left to settle, then gleaned from the water by metre-high filters made up of anthracite, sand and gravel.

Once the dusting was finished, the water was ready for a tiny dose of chlorine, which killed all the naked pathogens — stripped from their silty hiding places — in the water. But before it could be pushed up through the city by one of nine pumps, the water was treated with ammonia, which acts like shellac on wood, protecting the chlorine from the wear of elements along its travels. That way it can last for up to five days, or all the way up to its farthest possible destination, in Woodbridge.

Eight hours after it entered the intake pipe, the water was converted from "raw" to "treated." It now had that small zing of chlorine, and a trace more aluminum sulphate and fluoride. And the few dangerous microbes bobbing among its particles had been killed — but 1.6 kilometres out from shore, there aren't that many of those, anyway.

In fact, contrary to what you might assume driving past Hamilton harbour, pollution levels in Lake Ontario have dropped considerably over the past three decades. Since Lake Erie was pronounced dead in the 1970s, and the Great Lakes Water Quality Agreement signed by both the Canadian and American governments, the levels of PCBs and dioxin found in Lake Ontario have plummeted. Pesticides like toxophene and chlordane are also down. And populations of eagles that were once dying from contaminated fish have rebounded.

On an average summer day, 2 billion litres of water course from the lake, beneath the city and into homes and businesses

"I know people find it hard to believe, but Lake Ontario is quite clean," says Mike Lukich, chief chemist at the city's central lab, where workers test water samples every four hours. A kilometre and a half into the water — the home, for a time, of that litre of water and of every other litre of water that eventually ends up in Etobicoke's pipes — even the dreaded E. coli bacteria that cluster along the beaches after a big storm, causing throat infections and diarrhea for any who risk bathing there, aren't present. They don't make it out that far in the lake. While testers found 51 colonies of E. coli in a 100 millilitre sample taken from Marie Curtis beach last week, they would find only one colony in a similar sample around the intake pipes.

So the truth is, that litre of water hadn't changed as much as you might think. It looked the same, tasted the same — still heavy from the layers of calcium-rich limestone lining Lake Ontario.

But now it was ready to graduate from the open world of mother nature, into the subterranean depths of urban Toronto. It joined the 614,999,999 other litres of water that enter the city from the R. L. Clark plant every day, propelled by one of nine pumps into a giant 2.5-metre-wide steel pipe.

The reason for all the pumping is clear when you stand outside Summerhill subway station and look north up Yonge St. The city is built on a gradual hill and, given its wont, water would flow down towards the lake and not the other way.

To get to its splash pad in Rexdale, a hundred blocks away from the Clark plant, the litre would only have been pumped twice. To get to the most distant area in Vaughan, though, water is pumped as many as five times.

It didn't necessarily travel in a straight line. The city's giant trunk water mains dogleg through neighbourhoods, dodging underground hydro corridors, Bell cables, and harder slabs of rock. Plus, they are barred from crossing beneath private property, sticking instead to public road and walkways.

Our litre rushed north, 1.5 metres beneath the roadway between rows of small, brick bungalows, before making a sharp left down another residential street and after a few blocks, turning north again. Moving at the pace of a relatively fit jogger, it passed beneath large graceful maple trees and before sleepy homes, undetected by families fanning themselves on porches, zigzagging all the way to the beginning of The East Mall. Once here, it continued north, past light industrial buildings, factory outlets, gas stations and a man in a tan car covered in yellow lettering that reads: "Want problems? Buy a Saturn."

When it dipped under the QEW, it dove 5 metres farther underground to avoid the traffic reverberations, and bobbed back up the other side.

After travelling 12.7 kilometres, it spilled into an underground reservoir tucked beneath a local sports field for the surrounding high-rises near Eglinton Ave. and Martin Grove Rd.

You've likely walked on one of the city's 10 reservoirs before, thinking they were simply raised parks. But under the grass are giant tanks of water. They are raised up above street level so gravity can pull the water down into nearby homes and buildings, which is why, during the blackout two summers ago, water still flowed into your home.

Originally, all reservoirs were open-faced, like giant, boarded outdoor skating rinks. The oldest and biggest, Rosehill reservoir, spans the size of a full city block near Yonge St. and St. Clair Ave. and stores 271 million litres — enough to fill 271 Olympic-sized swimming pools. During World War II, city leaders worried enemy fighters would poison the water and posted armed guards around the reservoirs. Two decades later, during the nuclear terror of the 1960s, the city decided to permanently cover them.

For our litre, the reservoir was a small pit stop, allowing it to rest temporarily until another pump sucked it up and pushed it farther uphill, under Martin Grove Rd.

From there, it zigzagged north again, under the nose of towering apartment buildings, ducked under highways 401 and 409, and finally reached Rexdale Blvd.

Along the route, many of the water's compatriots funnelled off the main course, down smaller pipes and into local neighbourhoods. At Islington Ave., our litre followed suit. First, it diverted into a cast-iron pipe nearly half a metre wide, that acts like an off road from the highway, shadowing the trunk line for a few blocks. Then, it turned into a slightly slimmer pipe under Elmhurst Dr. Had it continued onto one of the even smaller residential streets, it would have cascaded into another pipe half that width, before reaching the 1.9 centimetre pipe running into one of the bungalows.

But the pipe running to the splash pad in the middle of Rexdale Park is twice that thick. When it spurts out the long blue faucet and into Ford's bucket, that litre has travelled enough to work up a good sweat — 21 kilometres over two days. It should be treasured like liquid gold.

Ford takes the bucket and chases after one of his 9-year-olds, unleashing the water over the young boy's back. Soon, some of the water will evaporate into the hot, midday air. The rest will slide down his thin neck and back and wind toward a drain at the base of the splash pad.

From there, it will funnel through another maze of pipes towards a sewage treatment plant before being released back into Lake Ontario to begin the whole story again.

If you want to save the world, be a water engineer, D1
A brief history of water, D4