Hunting for buried water

A study of an ancient buried river valley may lead to water sources for growing communities

By Dave Schultz
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The landscape of the Grand River watershed – the hills, valleys, sandy soils and clay plains we see today – are the legacy of glaciers that pushed and scraped their way across the surface thousands of years ago.

But there are older landscapes buried deep below the surface. Drill down and you can take a geological time trip, encountering old lakebeds, river deltas, hills, valleys and other long-lost features, some of them dating back hundreds of millions of years.

Exploring ancient valley

For the past three years, scientists from the Grand River Conservation Authority and the Ontario Geological Survey have been exploring that underground world to learn more about an ancient feature known as the Dundas Buried Bedrock Valley.

Geologists call these types of formations "thalwegs." That's a word used to describe the bottom of a river valley.

Many years ago – no one knows when – a river flowed on top of bedrock that is at least 420 million years old. The bedrock valley goes from today's Lake Huron, cuts across southwestern Ontario through the middle of the Grand River watershed, and then east to Hamilton where it plunges deep below Lake Ontario. In some places the valley is 40 metres below the surface, in others it's 160 metres or more.

Between 10,000 and 50,000 years ago, the river valley was filled with sand, soil, and gravel. In some cases, advancing glaciers pushed stuff into the valley. At other times, torrents of melting water from retreating glaciers deposited the material.

GRCA hydrogeologist Gregg Zwiers examines a core sample taken from the Dundas Buried Bedrock Valley.

It's important to understand the shape and structure of the buried valley because it provides insights into the way groundwater moves under today's landscape, says Gregg Zwiers, a hydrogeologist with the GRCA and one of the project's leaders.

And the information from the study can be used by municipalities as they search for water supplies for their growing cities and towns, added Zwiers.

"It's a fascinating thing to track this feature and find out about something hidden," said Zwiers.

The Ontario Geological Survey covered the cost of the $600,000 project. The GRCA contributed the time and expertise of Zwiers and other staff who worked on the project. The Region of Waterloo, City of Hamilton and McMaster University also played a role.

According to Zwiers, the project met its goals.

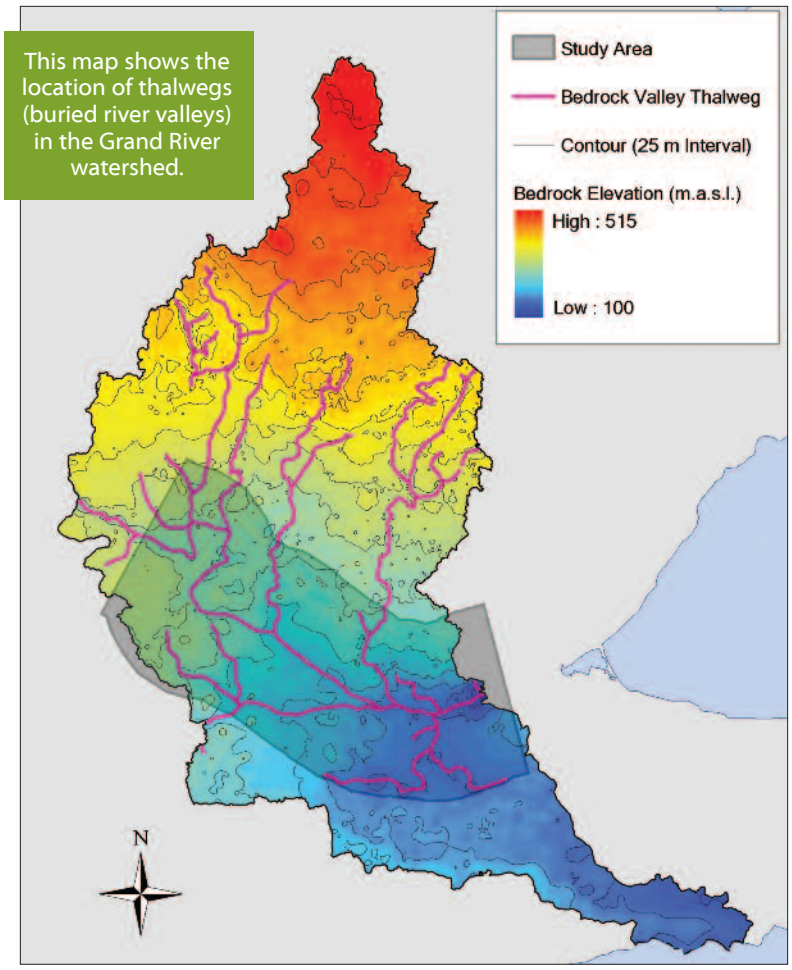
Productive area

"There's very productive material," in the buried valley, said Zwiers. "You could pump quite a bit of water from it."

Whether that will happen will depend on the needs of municipalities along the length of the valley, added Zwiers. (See related story on Page 9.)

A follow-up study could answer questions about whether water is seeping from the buried valley into the Grand near Glen Morris, contributing to an improvement in water quality in the stretch between Cambridge and Paris.

The buried valley takes its name from the Dundas Valley near Hamilton. The town of Dundas is cradled in the valley, which is a notch in the Niagara Escarpment. In the 1880s, Dundas geomorphologist J.W. Spencer studied the Dundas Valley and theorized it was the visible extension of a much bigger valley buried beneath the modern day surface.



This map shows the location of thalwegs (buried river valleys) in the Grand River watershed.

From the time of Spencer's speculation in the 1880s, it took more than a century before the buried parts of the valley were mapped.

That happened in the 1990s when a major study was done of the groundwater system of the Grand River watershed.

As part of the study, water well records collected by the province since the 1940s were examined to learn more about the characteristics of subsurface soils and bedrock.

What they found, said Zwiers, were areas where there was a sudden drop-off in the depth to the bedrock layer.

The researchers plotted the locations on a map and it was a "matter of connecting the dots to trace the buried valley back from Dundas," said Zwiers.

However, there were still some unanswered questions: What shape was the valley? What kind of material was in it? Did it hold useable amounts of water? Was the water quality good enough for human use?

Finding the answers required getting out into the field, said Zwiers.

The research team identified three sections for more study: between Paris and Lynden; southwest of Kitchener to Roseville; and near the village of Wellesley.

In 2007, sophisticated equipment was used to measure tiny changes in gravity caused by changes in the depth to bedrock. That gave the researchers a better

Gilles Bergeron and Luc Houle use a device that measures tiny changes in gravity caused by changes in the distance from the surface to bedrock.

Buried valley study provides useful info for Waterloo Region

Could the Dundas Buried Bedrock Valley be a future source of municipal drinking water?

The information from the Dundas Buried Bedrock Valley study is one piece of information being used by the Region of Waterloo to identify sites for potential new water supply wells, said Richard Wootton, a senior hydrogeologist with the Region.

The Region operates the largest groundwater-based municipal water system in the country. It has more than 120 wells that draw about 80 per cent of the water used to supply about 520,000 people in Kitchener, Waterloo, Cambridge and the surrounding townships. The remaining 20 per cent comes from an intake on the Grand River.

Right now, the Region is updating its long-range water supply master plan, which is expected to take about a year. The previous plan, completed in 2007, says the Region will continue to use the river intake, Aquifer Storage and Recovery, its existing wells and some new or upgraded wells until about 2035, when a Lake Erie pipeline would be brought on line.

However, any water supply master plan is based on future water demand and right now those projections are under scrutiny.

The water consumption trends have shown a continuous decline over the last 10 years, which is attributed to active conservation programs and changes in water use by industry. As a result, the need for new sources isn't as pressing as it was a few years ago, said Wootton.

If it turns out that new wells are needed to meet overall water demand growth, or to meet demand in high-growth areas, the areas spotlighted by the Dundas Valley study could be looked at for potential new well sites.

Long process

But it's not a quick or easy process, cautioned Wootton. The process of bringing a new well online can take three to five years.

Ideally, new wells should be located close to where new growth is taking place and, importantly, close to existing infrastructure – pipes and treatment plants – to keep costs under control.

Data from the Dundas Valley study, along with other hydrogeological work done by the GRCA, the Region, the Ontario Geological Survey and other agencies would be examined to find the best locations where water might be available in the quality and quantity required to meet the Region's needs.

Once a site is identified, a test well is drilled and pumping tests are done to verify the volume and quality of water that would be available.

An Environmental Assessment would be required to ensure the new well would not pose any harm to the natural system or other well owners in the area.

And, finally, the Region would have to get a Permit To Take Water and other approvals from the province in order to operate the well and associated equipment.

picture of the route of the valley and its depth.

Then, in 2008 and 2009, test wells were drilled at eight locations. About 535 metres of core samples were pulled out of the earth, carefully packaged and sent to the OGS lab in Sudbury for analysis.

Elizabeth Priebe, a hydrogeologist with the OGS and another member of the study team, said the results were encouraging. They found sand and gravel soils, which are often rich aquifers because water can easily fill the space between the grains.

Elizabeth Priebe

The core samples yielded some other interesting information, said Priebe. They contained tiny wood chips that carbon dating showed to be about 46,000 years old.

At Lynden they found tiny shards of Queenston shale – one of the materials that makes up the Niagara Escarpment – which suggest that at some point glaciers pushed the material westward up the escarpment, said Zwiers.

The study also produced evidence of what might have been a huge waterfall near Copetown, a village midway between Brantford and Hamilton.

West of Copetown, the drill hit bedrock 40 metres below the surface, explained Zwiers. However, east of the village the drill went down 200 metres and never did hit rock, for a drop of at least 160 metres. Niagara Falls, by comparison, is about 50 metres high.

During 2009 and 2010 the study team looked at the potential of the valley as a source of municipal water. Pumping tests at several locations showed "you could pump quite a bit of water," said Zwiers. Whether it would be enough to meet municipal needs would require more study.

Examined water quality

When the research team studied the quality of the water, they found, to little surprise, that the water was hard and contained sulphates, iron and dissolved solids. That's true for many wells in this part of Ontario, said Zwiers, and is a result of the nature of the bedrock.

However, they also found signs of contamination from human activity. High levels of sodium and chloride were found in the Lynden area, probably a result of decade's worth of road salt making its way from the surface down to the aquifer.

Some wells also showed elevated nitrate levels. Nitrates are found in animal waste with common sources being manure or fertilizer spread on farm fields or leakage from septic systems.

Yet, said Zwiers, most of the Dundas Buried Bedrock Valley has a potential to be a good supply of drinking water. In fact, many private wells already tap into it.