Calgary, Alberta: Fire officials cordoned off a 2-block area and evacuated businesses after a backhoe punctured a 4-inch gas main. A gas company spokesman was quoted by news media as urging excavators to expose gas lines by hand before digging around them with machinery.

Spirit River, Alberta: A bulldozer operator died of burns after his machine struck a high-pressure natural gas pipeline. Reports indicate he was digging a farm pond when he hit the line. He was found some 200 feet away from his dozer, apparently having been thrown that far by the blast. A pickup truck parked further away had a melted radiator. The 31-year-old victim had not called Alberta One-Call for a locate before starting the work.

Toronto Ontario: A contractor cut a telephone cable, leaving some 5,000 homes without phone service for over a day. The phone company brought in trailer-mounted phone systems for local calls. Vans equipped with cellular phones for emergency use patrolled the area.

SUBSURFACE **UNDERGROUND** ENGINEERING

"THE NEXT BEST THING TO X-RAY VISION"

Notre Dame de Grace, Quebec: Some 300 people, including 60 children from a daycare centre, were forced to flee after a backhoe struck a gas main. The leak was under control in about an hour. To help avoid the possibility of ignition, power was shut off to some 3,200 homes and businesses. A Fire Department Spokesman said that the excavator had requested a locate and the line had been marked. "They should have been using hand shovels, not a backhoe," the spokesman said. This was the third major gas line hit in the Montreal area in a week.

** Reported by Underground Focus Magazine, The Magazine of Below-Ground Damage Prevention*

'Out of sight, out of mind' is a fair characterization of buried utility lines. Records are often less than accurate, abandoned lines forgotten, field adjustments undocumented.

Designer engineers do their best, says John Harter, but they don't have x-ray vision. "We think SUE is the next best thing."

Subsurface utility engineering is, simply put, an engineering process that accurately locates and characterizes buried utilities. And it does so, as Harter explains, not just in two dimensions. Using a variety of geophysical prospecting technologies and non-destructive vacuum excavation, SUE also defines the depth of buried lines, accurately placing a utility in all three dimensions.

SUBSURFACE UNDERGROUND ENGINEERING

continued from page 9

It is, its proponents claim, a highly efficient and effective process. A recent highway project in Virginia, for example, used SUE techniques at 156 locations where the highway and utilities might conflict. Sixty-one potential conflicts were found and eliminated at the design stage. The cost of the SUE services was US$93,533. The saving in utility relocations was estimated at more than $700,000.

Introduced in the US in the mid-80s, SUE has been widely adopted by state departments of transportation and widely promoted by the US Federal Highway Administration.

How SUE Works

"Most construction projects starting as far back as the design phase rely on existing utility records. At most, there may be a cursory survey to identify visible utility fixtures such as manhole covers or valve boxes," explains Harter, national engineering and operations manager for the TBE Group Inc, a Florida-based engineering company with 25 offices across the US specializing in subsurface utility engineering.

"According to the Federal Highway Administration, engineers relying on this quality of information will find up to 30% of the utility lines are either missing or mislocated by two feet or more."

Indeed, it is the quality of information that is at the heart of SUE. Since highway plans typically contain disclaimers about the quality of utility information, the use of defined quality levels in the SUE process allows designers to certify that a certain level of accuracy and comprehensiveness has been provided.

The most basic level, Quality Level D, uses existing records at the earliest stage of the planning process to provide a general overview of utility congestion. Quality Level C adds a ground survey of visible utility facilities (manhole covers, for example).

"In the US, every state has a one-call statute in place and generally requires contractors to call all the utility owners before construction begins. One-call certainly helps but you are still dealing with low quality information," says Harter. "When the utility representatives put a paint line on the pavement or the grass, they are allowed a fairly wide tolerance so the precise accuracy is in question. And those lines only define which way the line runs – not how deep it is. Remember, too, that One-Call response is designed to protect the utilities at the time of construction. It offers no benefit to the design process."

Quality Level B provides additional two-dimensional mapping using SUE to address problems of inadequate or missing records. The most detailed and accurate information, Quality Level A, uses a complete SUE analysis to provide precise three-dimensional mapping of utilities and underground structures.

Typically design engineers will use all four quality levels of information depending on the risk and complexity of the project. The lowest quality level is used for preliminary planning with successively more accurate information incorporated as increased utility conflicts are anticipated.

Subsurface utility engineering, practised by companies such as TBE, is designed to provide the accurate three-dimensional mapping of utilities that meets the requirements of the highest quality levels.

Conducted in advance of and during project engineering, surveys are handled by trained field staff using a variety of technologies and techniques to locate the lines. Electromagnetic methods include pipe and cable locators, ground penetrating radar, ground resistivity techniques and optical methods. Magnetic methods typically use gradiometrics to locate metal lines, underground storage tanks, and joints on otherwise undetectable non-ferrous pipes. Acoustic detection relies on resonant, active and passive sonics. Non-destructive techniques (more akin to keyhole surgery than a major exploratory operation) using small-bore holes and vacuum excavation confirm utility depths at critical points.

A complete SUE investigation involves four key activities.

Subsurface Utility Engineering: An engineering process that accurately locates and characterizes buried utilities.

SUE involves four key activities:

1. Researching records
2. Geophysical prospecting techniques to designate the horizontal position of underground utilities.
3. Non-destructive vacuum excavation at critical points to locate the utility horizontally and vertically.
4. Data management for computer aided designs and project planning.

Information about underground utilities has four quality levels, ranked for increasing accuracy.

Level D: existing records for a general overview

Level C: a ground survey of utility facilities

Level B: SUE for two-dimensional mapping

Level A: a complete SUE analysis for precise three-dimensional mapping of utilities and underground structures.

A study by Purdue University of 71 highway projects concluded that each dollar spent on SUE to accurately locate utilities can save $4.62 in construction costs, changes and delays.

Researching the records establishes the basis for further SUE work. Geophysical prospecting techniques designate the horizontal position of underground utilities. Non-destructive vacuum excavation at critical points along the line accurately locates the utility both horizontally and vertically. Data management of the survey provides computer aided designs for project planning.

Is it Worth It?

The benefits of SUE are easy to list: fewer utility relocations, reduced redesign costs, less damage to utilities, fewer contractor delay claims, less disruption of utility services, quicker project completion, less traffic disruption, and, of course, significantly reduced safety risks.

All worthwhile. But quantifying those benefits against the cost of a SUE investigation has proved to be a bit more complicated. For a more definitive analysis, the US Federal Highway Administration commissioned Purdue University to conduct a study on the use of SUE in highway projects.

The university reviewed 71 projects with a combined value of in excess of US$1 billion. Its conclusions?

The cost of obtaining Quality A and B data was less than 0.5% of the total construction costs.

Construction cost savings as a result of SUE were 1.9% - a return of $4.62 for each dollar spent.

In only three of the 71 projects were the SUE costs higher than the savings.

Qualitative savings (traffic disruptions and user delays, for example) were not included but would have added significantly to the return on investment.

Coming to Canada

TSH is an engineering consulting firm with 320 employees and 10 offices in Ontario. Two years ago, recognizing that Canada was somewhat behind the US in subsurface utility engineering, TSH formed a strategic partnership with TBE to bring SUE to Ontario.

"We were aware that the system was not being used in urban Ontario and that there was a need to improve our design and construction," says Bruce Miller, senior vice-president of TSH. "The concept is relatively simple and straightforward. SUE is a systemized approach but it requires a bundle of technologies and a significant amount of experience in the design and construction of utilities. We had the experience; TBE had the system."

Nicholas Zembillas, senior vice president for TBE, has attended many of the initial discussions with a number of Golden Horseshoe municipalities. "Intensive urban development makes the need for SUE even more pressing," Zembillas says. "We are excited about working with TSH to bring this much needed service to Canada."

"There were some initial concerns because this is an additional cost to the project," Miller adds. "However, once we explain the benefits there has been a great deal of interest and a lot of positive feedback."

"One municipality had just had a rather bad experience involving claims related to existing underground utilities and a major road reconstruction. They were very quick to pick up on the benefits. If they had used SUE they more than likely would not have had a problem."

The interest, encouragingly, has led to several demonstration projects. The first, in Toronto, was completed in August. By the end of December, two other projects were underway in York and Durham regions. Miller expects to have a full review of the projects and their cost benefit analyses available after construction is completed in 2002.