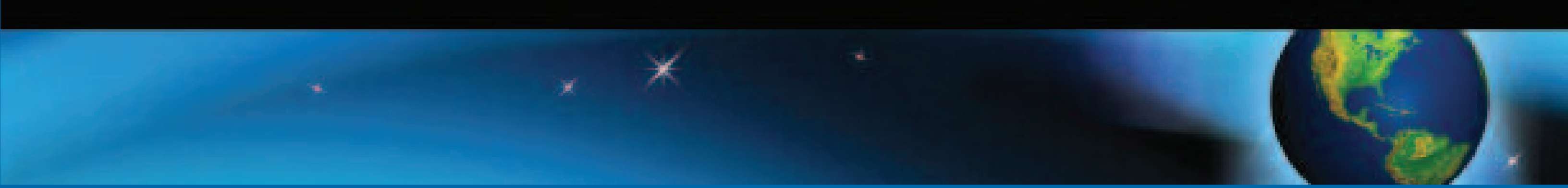

The Calgary Story

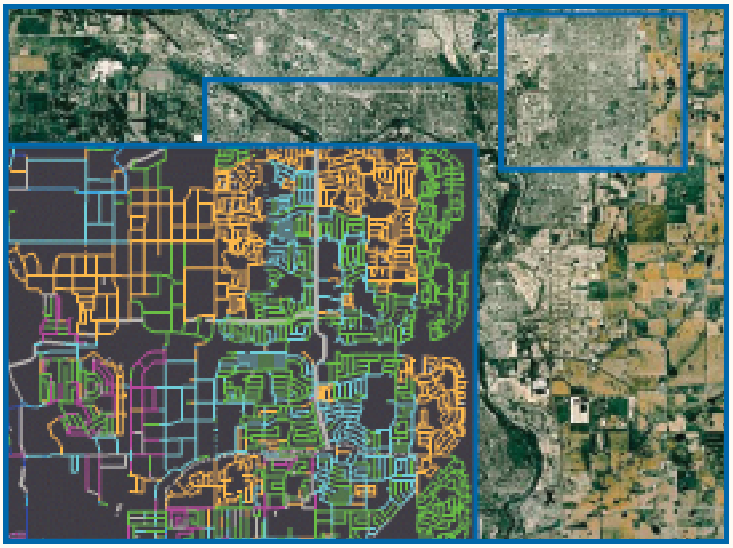

Figure 2: A satellite photograph of Calgary with the northeast section of the City highlighted in blue.

THE 1970S THE TEMPEST

Question One: "Discuss Calgary's openness to change and its willingness to try new pipe materials. Your graph of distribution pipe materials installed by year shows (Figure 5 in this article) seven different types of distribution pipe installed in the 1970s. Why do you suppose Calgary was more willing to experiment than other utilities?"

To address this question, Mr. Brander pulls up a figure on his computer screen, which he calls Old Faithful. (See Figure 1.)

He notes that breaks climbed from 500/year in beginning of the 1970s and rose to 1800/year by the end of the 1970s. He states this resulted in a tripling of the budget, and he further stressed that it was not just a budgetary issue. He commented that, "the break pattern was very concentrated in a dozen odd square miles in the northeast corner of the City, where almost all the extra breaks occurred." Figure 2 shows a satellite photo of the City and a close-up of a particular area in the northeast section of the City.

The different colors in the lower left of Figure 2 show the different pipe materials now serving those customers. To understand the situation in the 1970s, Figure 3 zooms in to an area badly affected by corrosion. The red dots shown in the upper right of Figure 3 represent breaks in the water mains between 1960 and 2000.

Figure 4 shows the same area as the upper right of Figure 3. Instead of 40 years worth of breaks, just the breaks occurring in the 1970s are pictured. Also, the visual distraction of the pipe system has been removed. The breaks are color coded in two-year intervals. Mr. Brander stated some of the pipe in this area had up to half-a-dozen breaks on the same block and that some sections became uneconomical to continue to repair within seven years after their installation date in the worst case, and in ten to twelve year range in many cases.

Constant breaks in this area meant constant interruptions of water service, many return trips with heavy construction equipment, and all the inconveniences associated with construction work. These neighborhoods were growing increasingly upset, and they were growing bolder and bolder about sharing their frustrations with their local elected officials. Something had to be done and NOW!

Mr. Brander explains that this was the City's first encounter with highly corrosive soils. The resistivity of these soils was far lower than the older parts of the City. Mr. Brander comments that the water utility quickly realized that "bare ductile iron in these soils was economically unfeasible. You could not charge enough for the water to pay for

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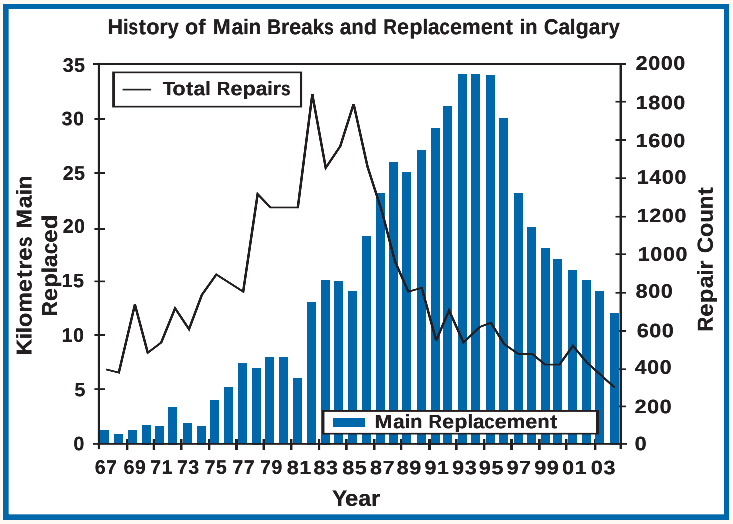


Figure 1: Mr. Brander refers to this figure as "Old Faithful".

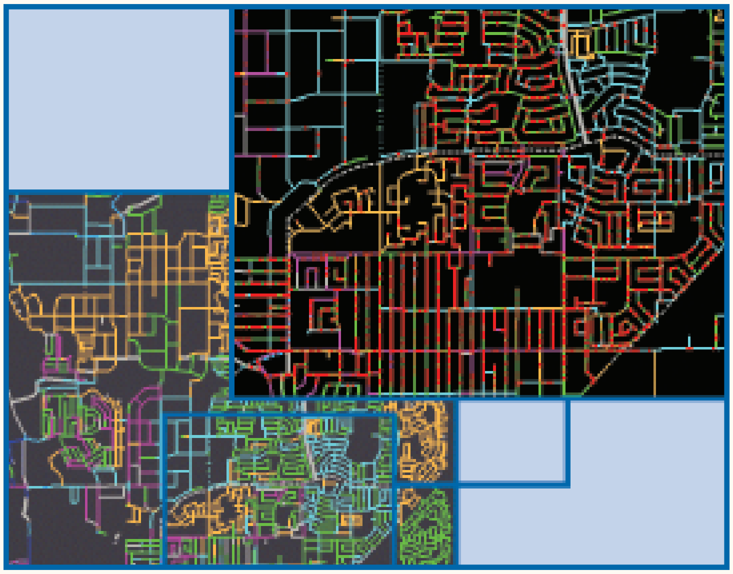


Figure 3: Northeast section of the City (left) and an area in that section with extremely corrosive soils (right)

CONTINUED FROM PAGE 3

replacement pipe before it was needed."

Figure 5 shows the seven different types of pipe products that the City experimented with in order to solve the corrosion problem they encountered in the 1970s. After bare ductile, Calgary tried polyethylene encased ductile iron (PDI) and then taped-urethane ductile iron (TUDI). They found both options "unsustainable". The life cycle was too short, breaks were too frequent, the pipe needed to be replaced before the utility had accumulated sufficient funds to replace the original pipe and pay for all the maintenance required. At which point, they veered off the traditional water utility path, and they started talking to corrosion engineers and pipeline engineers in the oil industry.

THE LATE 1970S THE TURNING POINT

In this case, oil and water did mix. The Chief Engineer for Calgary's water department during the 1970s was Jim Bouck, and he was the one who found a way to get a handle on Calgary's corrosion problem. The corrosion engineers and oil pipeline engineers told him the same thing, that Calgary's water system needed cathodic protection. The coating's (or encasement's) purpose was to reduce the demand on a pipeline's cathodic protection system. In Calgary's case, that meant fewer anodes were needed per length of pipe installed. The heavy YDI jacket reduced the anodes they needed by 90% when compared to bare DI or PDI. The corrosion engineers and oil pipeline engineers also stressed that a coating without a cathodic protection system does not solve the corrosion problem; it only concentrates the corrosion at the imperfections of the coating or encasement. This explanation fit perfectly with Calgary's experience.

Mr. Brander continued:

Calgary is an oil town. An extremely well known product in the oil industry is YDI or yellow-jacketed ductile iron. It absolutely nailed the corrosion problem for the oil industry forty years ago. As opposed to the PDI, which is loose and only 8 mils, YDI is a 40 mil thick coating bonded to the outside of the ductile iron pipe. (See Figure 7.) The combination of a bonded coating and a cathodic protection system dropped our break rates to an economically sustainable range. (Part of the cost of installing YDI is accounting for the time needed to annually inspect the cathodic protection system and checking whether or not it is time to replace the sacrificial anodes.)

Our break rates on YDI was about one tenth that of bare ductile iron and PDI. That provided a long enough life cycle on the pipe that the utility could cover the cost of replacing that asset when its useful life was over, as well as the maintenance and inspection needed to get that asset to the end of its useful life.

AFTER BARE DUCTILE, CALGARY TRIED POLYETHYLENE ENCASED DUCTILE IRON (PDI) AND THEN TAPED-URETHANE DUCTILE IRON (TUDI). THEY FOUND BOTH OPTIONS "UNSUSTAINABLE".

Figure 6 further justifies the use of YDI over PDI and bare DI by comparing their break rates.

Figure 7 has two photos of YDI. The right half pictures the preparation for electrical connectivity at the joint.

A tenfold reduction in the break rate was not free. Installing YDI instead of DI roughly doubled the developer's cost. Apparently, Mr. Bouck was also a skillful politician. It took a great deal of political willpower on the part of the aldermen to

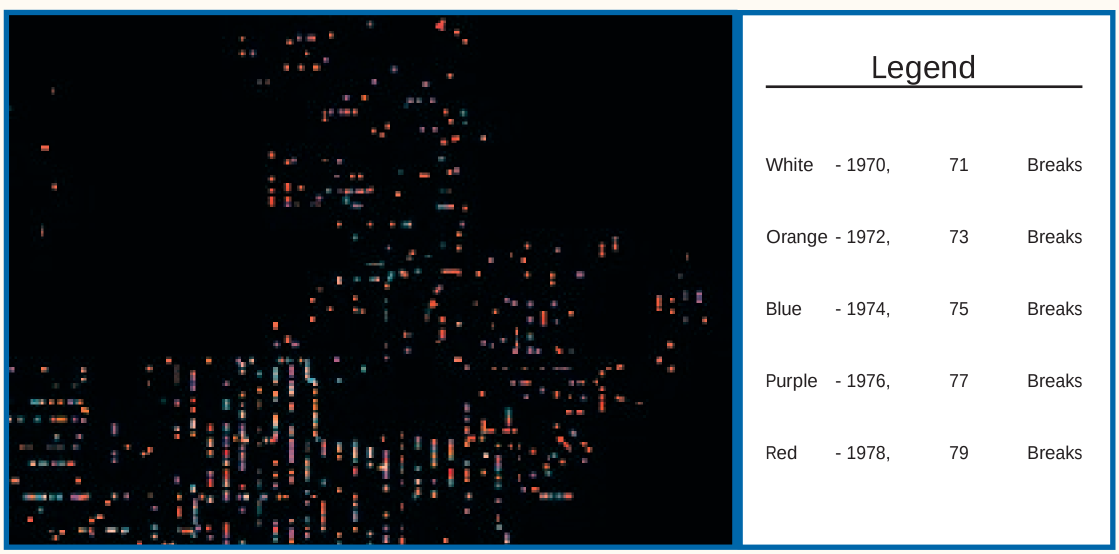
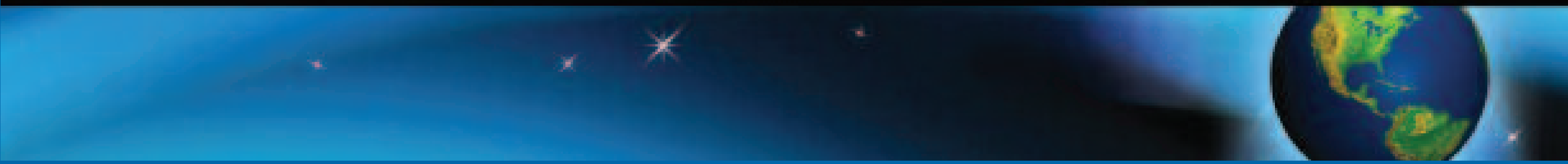


Figure 4: Breaks by year in the area with corrosive soils



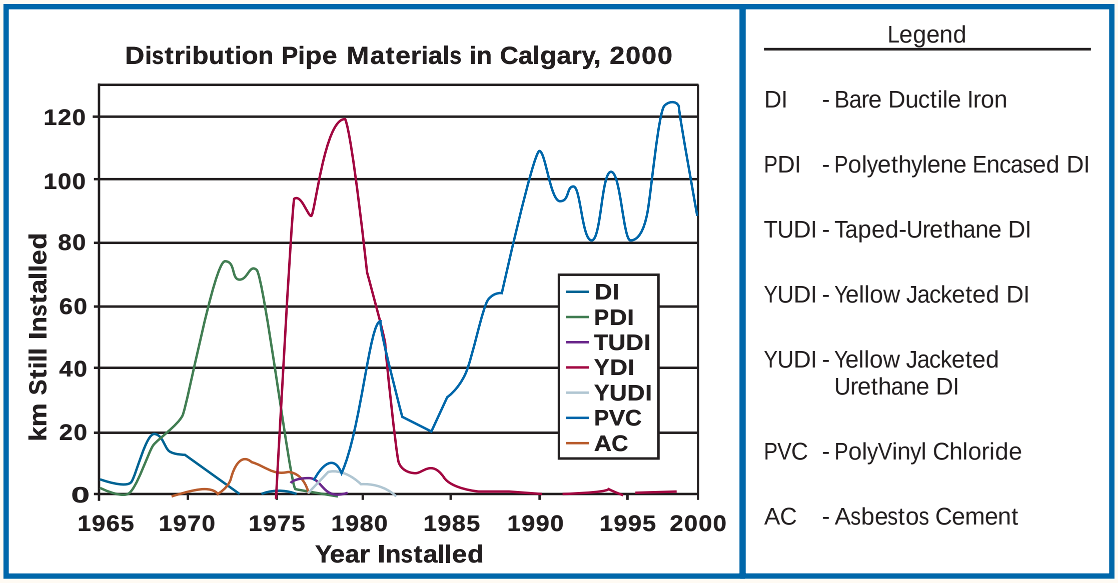


Figure 5: Calgary's pipe preferences by year installed

that YDI was stored on tires, not on the ground. (See Figure 8.) YDI was checked for imperfections in the coating by "jeeping" prior to installation. "Jeeping" is checking the coating of the pipe with test equipment. Imperfections are revealed by an arc of electricity from the test equipment to the point of imperfection. Even the chain on the direct tapping machine was modified to protect the YDI coating. (See Figure 8.) Other changes were that embedment for YDI was limited to sand or pea gravel. These changes, and the added cost of the coating, resulted in the doubling of cost as mentioned earlier.

say yes to the water utility's Chief Engineer to switch to YDI and no to the developers and contractors that wanted to stick with bare Ductile Iron, PDI, or even TUDI. Mr. Brander attributes the steadfastness of the aldermen to the volume of their constituency's complaints about the corrosion problem they were experiencing in northeast Calgary and the escalating maintenance costs.

Question Two: "Take us back to the transition period and the implementation of the switch to YDI. Discuss Calgary's learning curve. Share with us how Calgary managed and implemented this change."

Mr. Brander replies:

The switch from PDI and various other wraps to YDI in the 1970s was handled by bringing in consultants from the oil industry. These consultants brought in a whole new attitude about construction. Instead of the attitude, 'It has to go in cheaply'; it was 'It has to go in right.' That is understandable. If a gas pipeline fails, it blows up. If a water line fails, it leaks. These individuals brought in an extraordinarily high standard of installation.

Business as usual in water system infrastructure changed completely for Calgary during this transition. Some examples are

THESE CONSULTANTS BROUGHT IN A WHOLE NEW ATTITUDE ABOUT CONSTRUCTION. INSTEAD OF THE ATTITUDE, 'IT HAS TO GO IN CHEAPLY'; IT WAS 'IT HAS TO GO IN RIGHT.'

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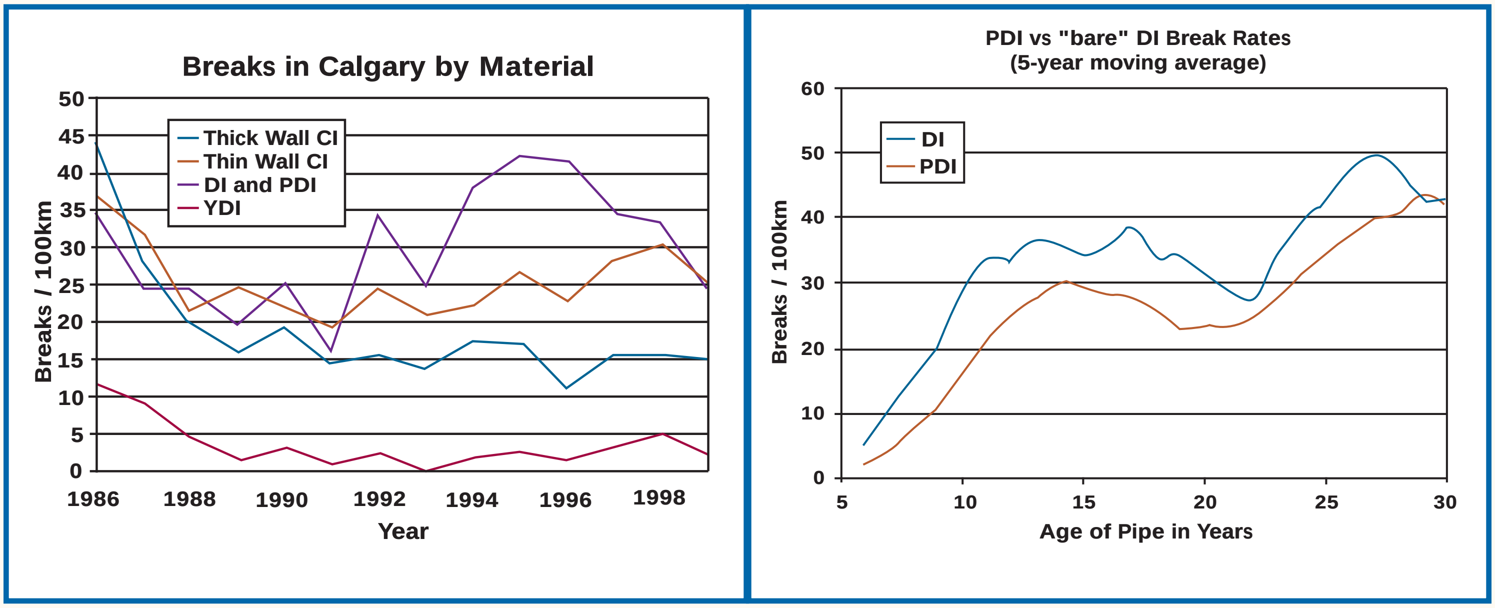

Figure 6: Break rates for all iron products (left) and a comparison of break rates for bare ductile iron (DI) and polyethylene encased ductile iron (PDI) (right)

Figure 7: "Yellow-Jacketed" ductile iron (YDI)

CONTINUED FROM PAGE 5

The higher construction standards were enforced with higher quality inspection. "Inspection Basics, Prairie Style" in the next edition of the News will give the details.

THE 1980S AND BEYOND THE LEGACY

Question Three: "Old faithful, the break rate data, and the information you have shared with us delivers a strong and persuasive argument. Calgary has an enormous arsenal of diagnostic tools: a comprehensive database on the water system, corrosion data from 2,000 meters of sandblasted

FROM 1994 TO 1996, CALGARY REPLACED 34 KM OF WATER MAINS PER YEAR AT AN ANNUAL COST OF $17 MILLION.

iron pipe exhumed during the main replacement program, and graphs from numerous hydroscope runs. How was Calgary able to have a diagnostic tool like a comprehensive database available for decision making when most utilities in the 1970s had to rely on gut instinct?"

Mr. Brander quickly corrects me. "I wouldn't say we had any of these diagnostic tools available back in the 70s. You didn't need a diagnostic tool in the 70s. All you needed to know was you had the same number of repair crews that we had a few years before, and those crews were suddenly doing twice the work."

The diagnostic tool on main breaks available at the time was mark on the maps. Fifty years of main break data was recorded in that manner.

Question Four: "When did these impressive diagnostic tools become available so that management could make informed decisions?"

Mr. Brander replies:

It has a hard and fast start date, the fall of 1996. Calgary had had three straight years of our highest level ever of main replacement - 34 km per year. That was costing 17 million dollars. That had been a tough fight for Mr. Bouck to get budgeted. Mr. Bouck recommended that main replacement budget from pure gut feel. After his retirement, Mr. Bouck's replacement (and others) were not comfortable making these multi-million-dollar decisions on gut feel alone. Everyone involved realized that they were starved for information. Depending on the assumptions one made on the useful life of all of the DI and PDI installed in the 70s, the results ranged from another wave of breaks like that experienced in the late 70s and early 80s as a 'worst case' scenario to the continuation of the present break rate on a 'best case' scenario. There just was not enough information for a good decision.

Calgary believed that it would be worthwhile to invest up to half a million dollars over a five year period to build a comprehensive, GIS connected database on all the main breaks and all the work involved with dealing with those breaks. My position was created to produce that database and information. The justification for the program and the position was obvious. To make a good decision on this multi-million-dollar annual investment on main replacements, it was worth the money to gather the data needed to make a good decision.

THE JUSTIFICATION FOR THE PROGRAM AND THE POSITION WAS OBVIOUS. TO MAKE A GOOD DECISION ON THIS MULTI-MILLION-DOLLAR ANNUAL INVESTMENT ON MAIN REPLACEMENTS, IT WAS WORTH THE MONEY TO GATHER THE DATA NEEDED TO MAKE A GOOD DECISION.

As Calgary's predictive capabilities improved, a reinforcing cycle was developed. The cost of improving the City's predictive capabilities was far less than the cost of blindly replacing mains on gut feel alone. With the benefit of better data, the main replacement program could be incrementally reduced without the fear of another rash of breaks, but some of those cost reductions were re-invested in improving the City's predictive capabilities. That cycle of main replacement reductions coupled with some reinvestment in predictive tools has funded the water system database, sandblasting, hydroscoping, and all of the other diag-

Figure 8: Examples of special construction and handling procedures for YDI

Is PVC Worth That Trouble?

($Canadian = 66 cents US)

Calgary Costs:	Pipe-lengths replaced per crew day
Bare 6” DI, 18 ft. pipe length: $207 Final Cost with Yellow-Jacket: $308	YDI: 5-8
PVC, 20’ Pipe Length: $138	PVC: 8-12

Figure 9: Cost analysis presented by Mr. Brander for PVC, DI, and YDI

nostic capabilities that Calgary has developed.

Question Five: “In the early 1980s, the amount of PVC installed began to exceed the amount of YDI installed. Share with the readers why Calgary prefers PVC over YDI. After all, the coating and cathodic protection system made YDI an economically sustainable option.”

To answer, Mr. Brander explains his new unit of measure for quantifying the frequency at which various water main pipe materials break. That unit is repairs/1000 km/decade. The repair rates for PDI, YDI, and PVC reported by Mr. Brander were:

PDI = 3,000 to 4,000

YDI = 300 to 350

PVC = 13 to 17

Moreover, as breaks can result in a disruption of service, the City investigates the cause of failure for every single break. In every case, PVC pipe failures were traced back to poor installation.

To further drive home the superior maintenance record of PVC, Mr. Brander provided the following information:

Calgary allowed PVC materials in 1978. The effectively all-PVC installation of new mains for 25 years, plus some 525km of metallic mains replaced with PVC since 1981, has given Calgary an inventory of almost 2,000 km of C900 PVC, almost exactly half of its water distribution main.

A similar length of metallic distribution mains sustains over four hundred repairs per year , held down to that break rate by 12 km of replacement and cathodic protection programs. This capital and operating budget is over 300 times higher than the infrastructure management budget for a similar amount of PVC.

Figure 9 gives further justification for Calgary’s preference for PVC.

PVC costs less than bare ductile iron, and more lengths of PVC can be installed per day by Calgary’s main replacement crews. PVC offers a lower cost, faster installation, lower maintenance option. In this case, Calgary is getting more for less. However, Mr. Brander said it best:

The cost and work-time advantages of PVC have been persuasive, and we would certainly continue to use PVC even if a perfect and free cure for iron corrosion appeared. In short, we’ve never looked back from going to PVC.

THIS CAPITAL AND OPERATING BUDGET [FOR METALLIC WATER MAINS] IS OVER 300 TIMES HIGHER THAN THE INFRASTRUCTURE MANAGEMENT BUDGET FOR A SIMILAR AMOUNT OF PVC.

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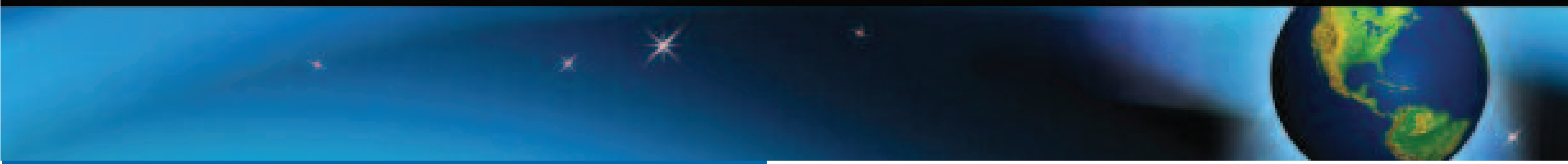

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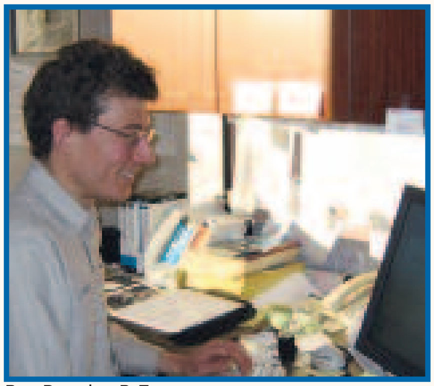
ABOUT THE CALGARY WATER PROFESSIONALS



Roy Brander, P. Eng

Roy Brander, P. Eng., joined the City in 1986. Roy is a Calgary native and has two degrees. His first degree was in Civil Engineering, with a Structural concentration. His second degree was in Computer Science. His work with the City began in the Information Technology Department. He now serves as the Senior Infrastructure Engineer in the Engineering Division of the Waterworks Department.

Gregory Kozhushner, P. Eng

Gregory Kozhushner, P. Eng., is the other half of the Infrastructure Engineering team. Gregory was born in Russia and went to University there. He worked as a consultant in Israel before coming to Canada. He now serves as an Infrastructure Engineer for the City.

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