

OCT 4 – 6, 2015 • Queens University • Kingston, ON Canada

Challenges and Innovations in Tunnelling

Advancement of Trenchless Technologies

Dr. Mark Knight

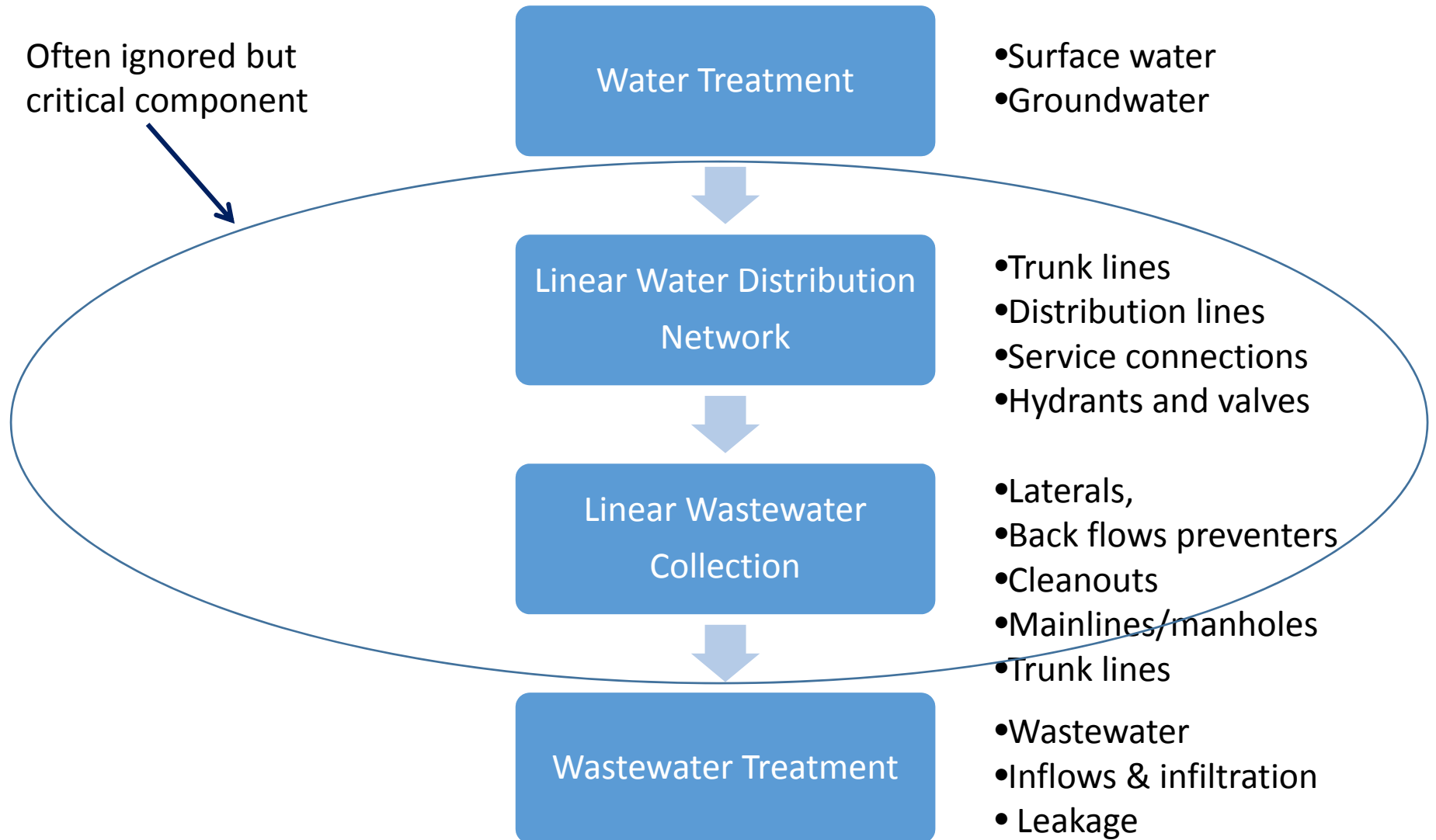
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Centre for Advancement of Trenchless Technologies (CATT)

Tunnelling Association of Canada
Association Canadienne Des Tunnels



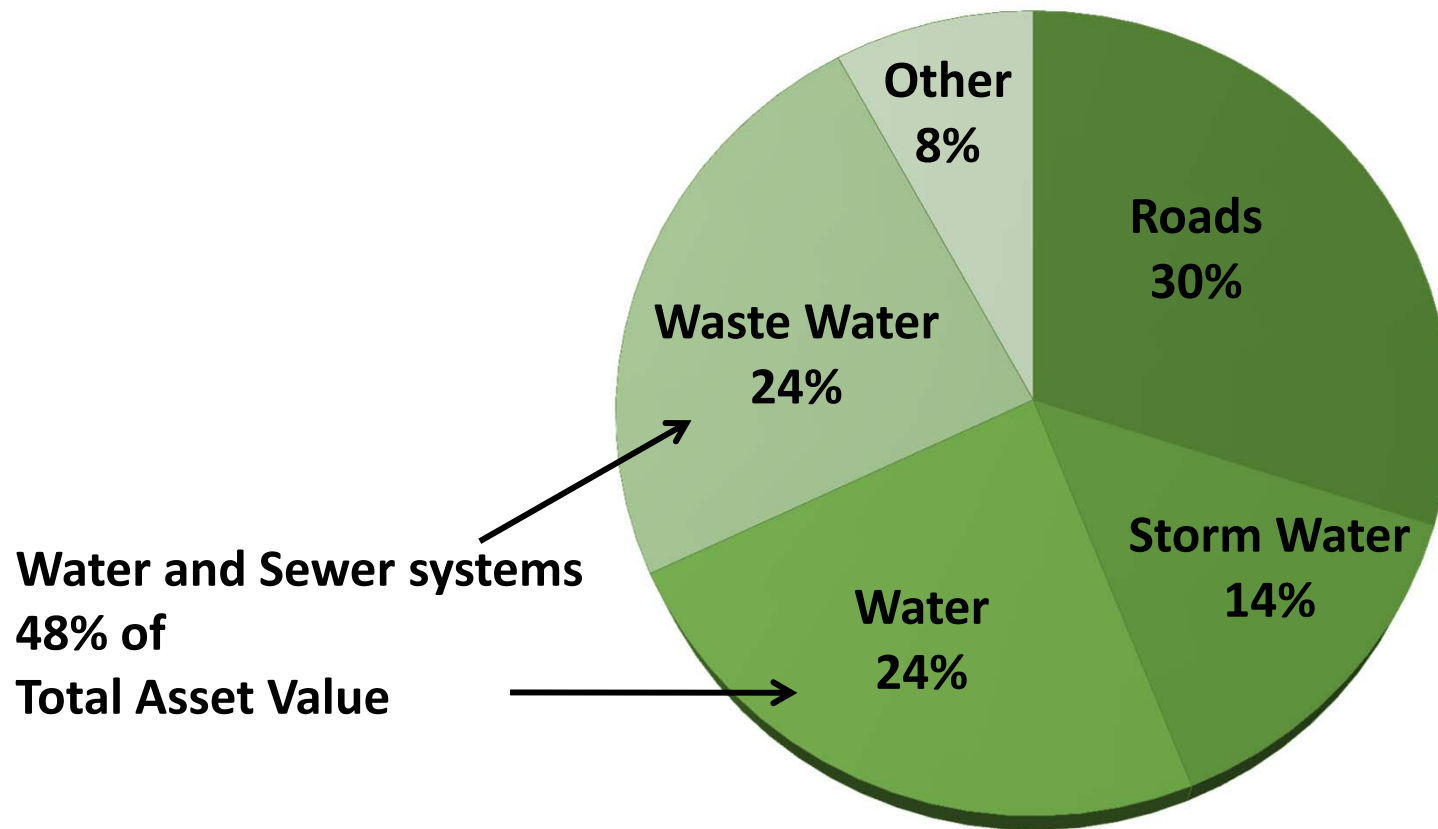
Municipal Pipelines



Municipal Infrastructure Assets

Asset Category	Quantity	Replacement Value	Typical Life (yrs)
Parking Lots	25	\$1,522,780	20
Storm Ponds	62	\$87,433,507	50
Walkways	100	\$4,138,861	40
Road & Sidewalk	980 lane*km	\$371,190,374	30
Bridges	24	\$8,025,000	50
Culverts	61	\$5,977,164	35
Dams	2	\$2,000,000	50
Sewer System	480 km	\$298,530,301	65
Drainage System	320 km	\$185,210,195	65
Water System	490 km	\$294,619,300	70
		\$1,258,647,483	

Infrastructure Asset Value Distribution



Construction of Water Distribution Networks

- Approx. 1880's construction of water distribution networks start
 - Fire protection
- Use as potable water was an after thought
- As population density increases in cities constructed wastewater collection systems

HISTORY OF PIPE MATERIALS

- **1850's: oak trees (wired and tarred)**
- **1880's: pit cast cast iron (lead joints)**
- **Early 1900's: steel (tarred)**
- **1920's: spun (grey) cast iron (lead joints)**

HISTORY OF PIPE MATERIALS *Cont'd.* .

..

- **1950's +:**

- **Ductile iron**
 - **Lining: Asphalt, coal tar bitumen, cement, epoxy, Polyurethane**
- **Asbestos-Cement**
- **Reinforced Concrete**
- **HDPE**
- **PVC**
- **Fusible PVC**

The Sewer Design Paradigm Shift

1880 to 1970's - 80's (Pre wastewater treatment)

- Dump untreated waste into the receptors
- Dilution is the solution
- Combined storm and sanitary system



The Sewer Design Paradigm Shift

Post wastewater treatment

- Cost \$ to treat every litre of wastewater
- Reduce infiltration/inflows
- Separate storm and sanitary systems



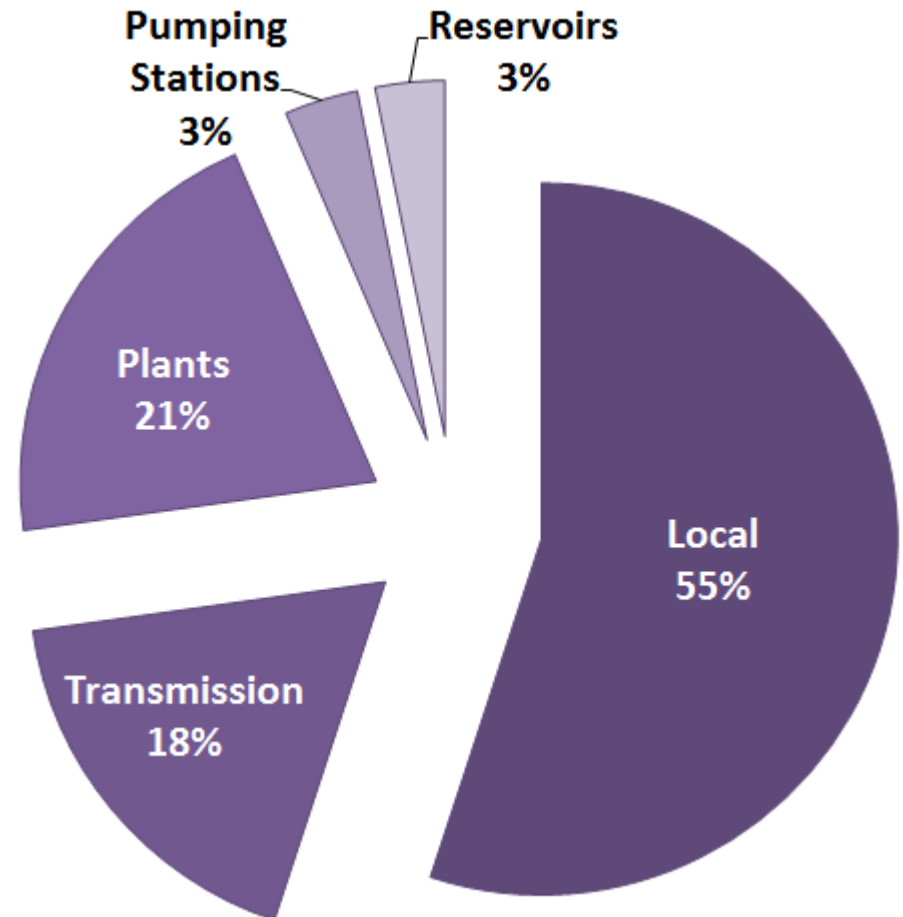
Water Infrastructure Replacement Cost=\$68.6Billion

Replacement value: linear assets (pipes)

Local	\$37,748,856,532
Transmission	\$12,165,631,491
Total	\$49,914,488,023

Replacement value: non-linear (discrete) assets

Plants	\$14,199,688,757
Pumping stations	\$2,293,994,013
Reservoirs	\$2,159,600,862
Total	\$18,653,283,631



Linear Assets = 73%

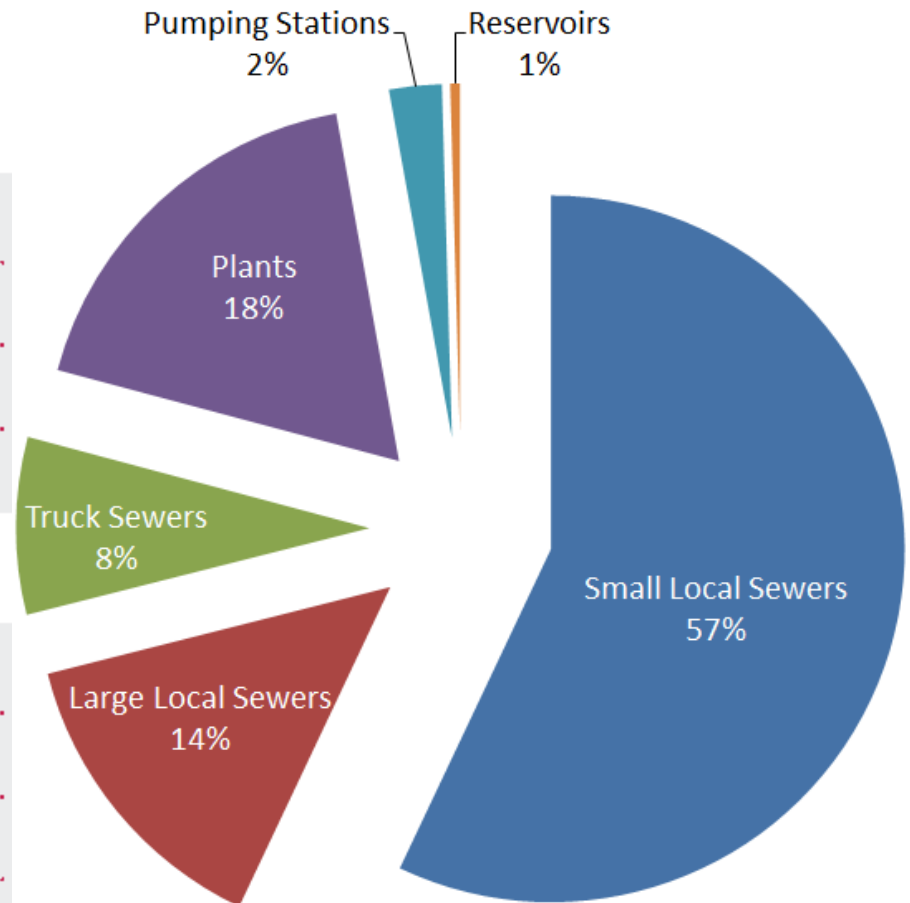
Wastewater Infrastructure Replacement Cost=\$70.1Billion

Replacement value: linear assets (pipes)

Small Local Sewers	\$39,976,283,477
Large Local Sewers	\$9,823,709,769
Trunk Sewers	\$5,678,053,860
Total	\$55,478,047,107

Replacement value: non-linear (discrete) assets

Plants	\$12,610,005,910
Pumping stations	\$1,685,933,044
Reservoirs	\$315,159,971
Total	\$14,611,098,926



Linear Assets = 79%

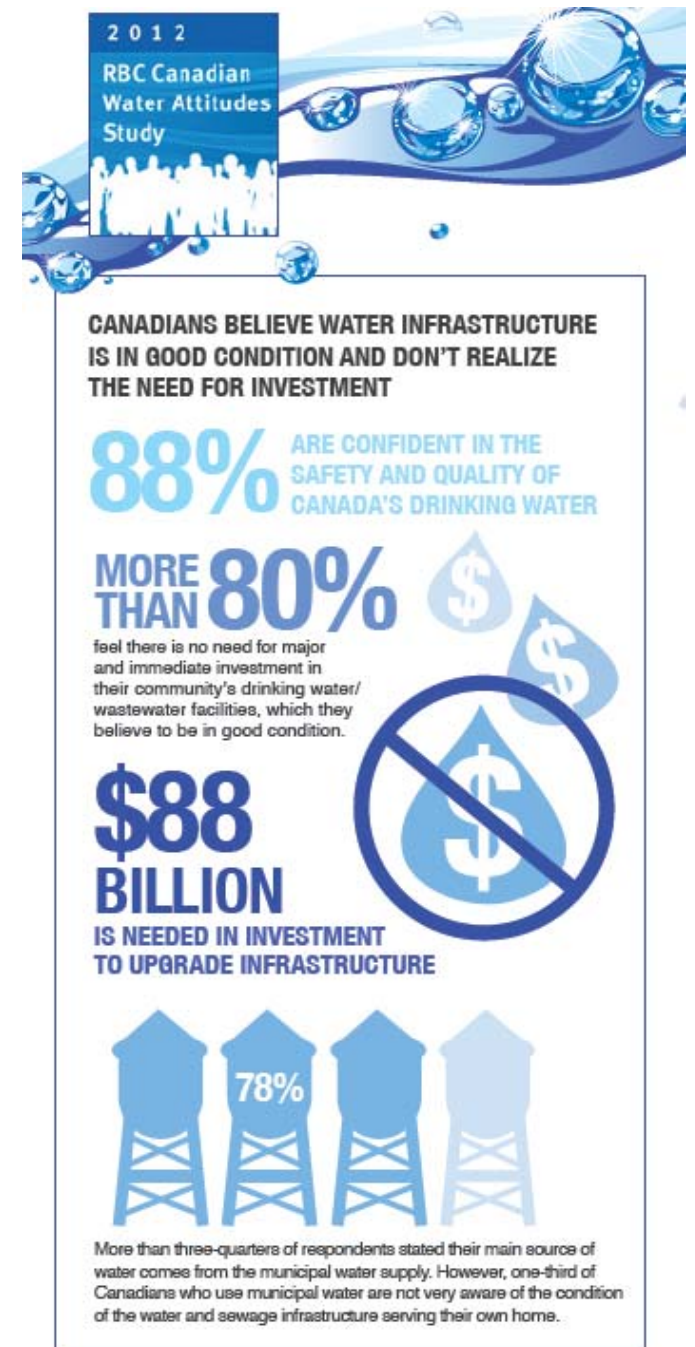
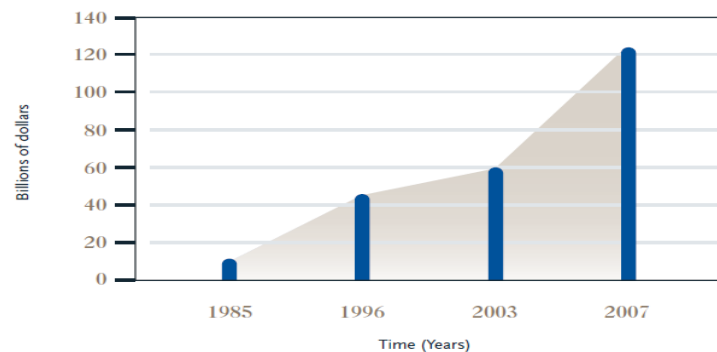
PLANTS VS PIPES

- Plants = 20 to 30 % replacement cost
- Linear Pipes = 70 to 80 % replacement cost

Cost to Fix Canada's Water Infrastructure

- Total estimated replacement cost
 - **\$138.9 Billion**
 - \$88 Billion needed for upgrades
- Need = 63% replacement cost**
- Infrastructure deficit continues to grow

Municipal Infrastructure Deficit: Total Growth

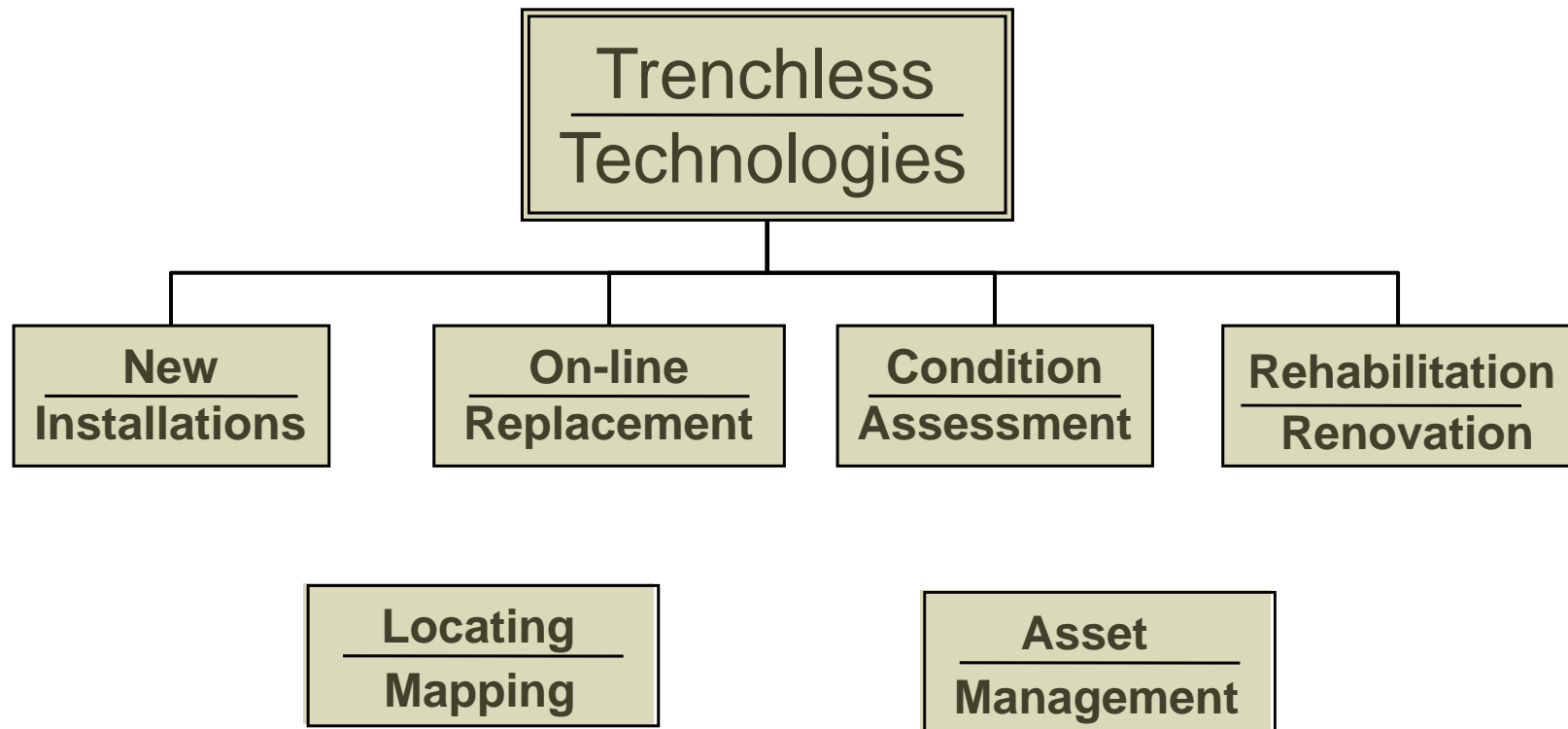


The Canadian Water Utility Problem

- **Water rates have been traditionally set to cover operation costs only**
- **Water utilities in Ontario and across North America have a big infrastructure deficit/backlog**
 - No or limited funds for capital works
 - 1 to 5 year financial plans developed
 - Long-term (10 to 50 years) financial sustainability not considered

Smoking gun could be coming....

Broad Categories



Where are those utilities?





Asset Management

- Fixing the right asset at the right time
- Making sure you have \$\$ to fix and operate water systems
- Develop defensible and realistic infrastructure programs...not just projects

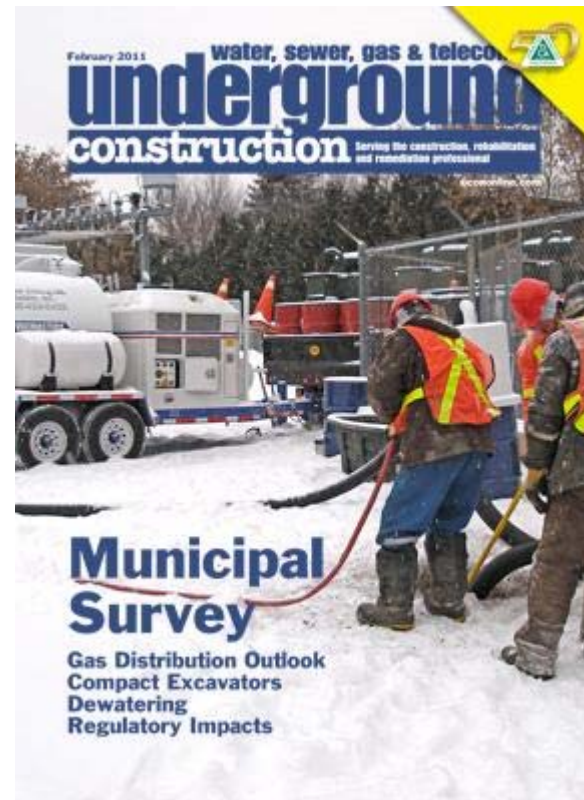
Trenchless Technologies

Tools in a Tool box



Trenchless Market

14th Annual Municipal Survey



Percent Of Cities That Have Used The Following Trenchless Methods



How Municipal Personnel View Various Trenchless Techniques

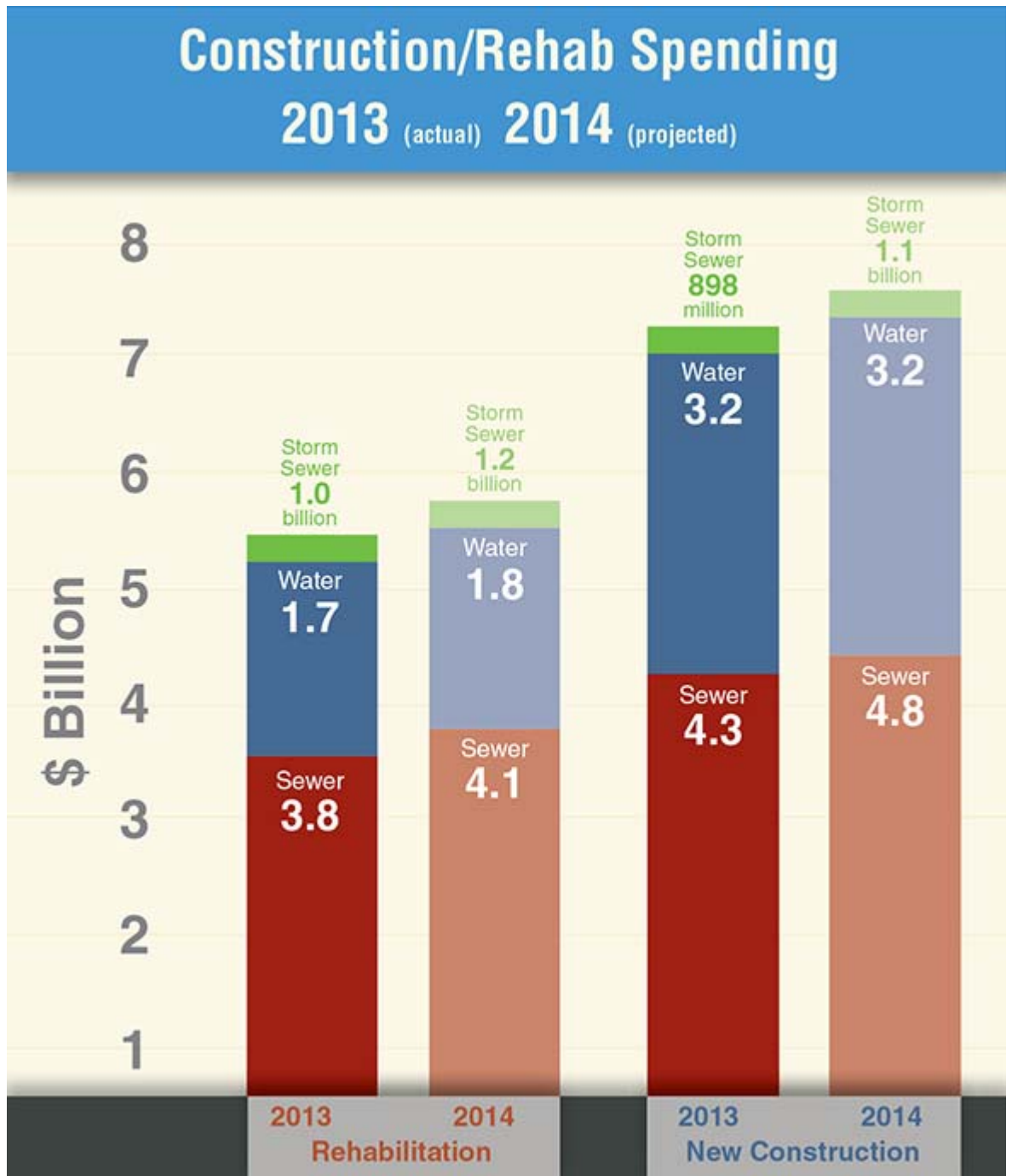
5= very beneficial 4= beneficial 3= somewhat beneficial 2= low benefit 1= no benefit

2013 2014



Growing Trenchless Industry

Source: Underground
Construction Feb. 2014



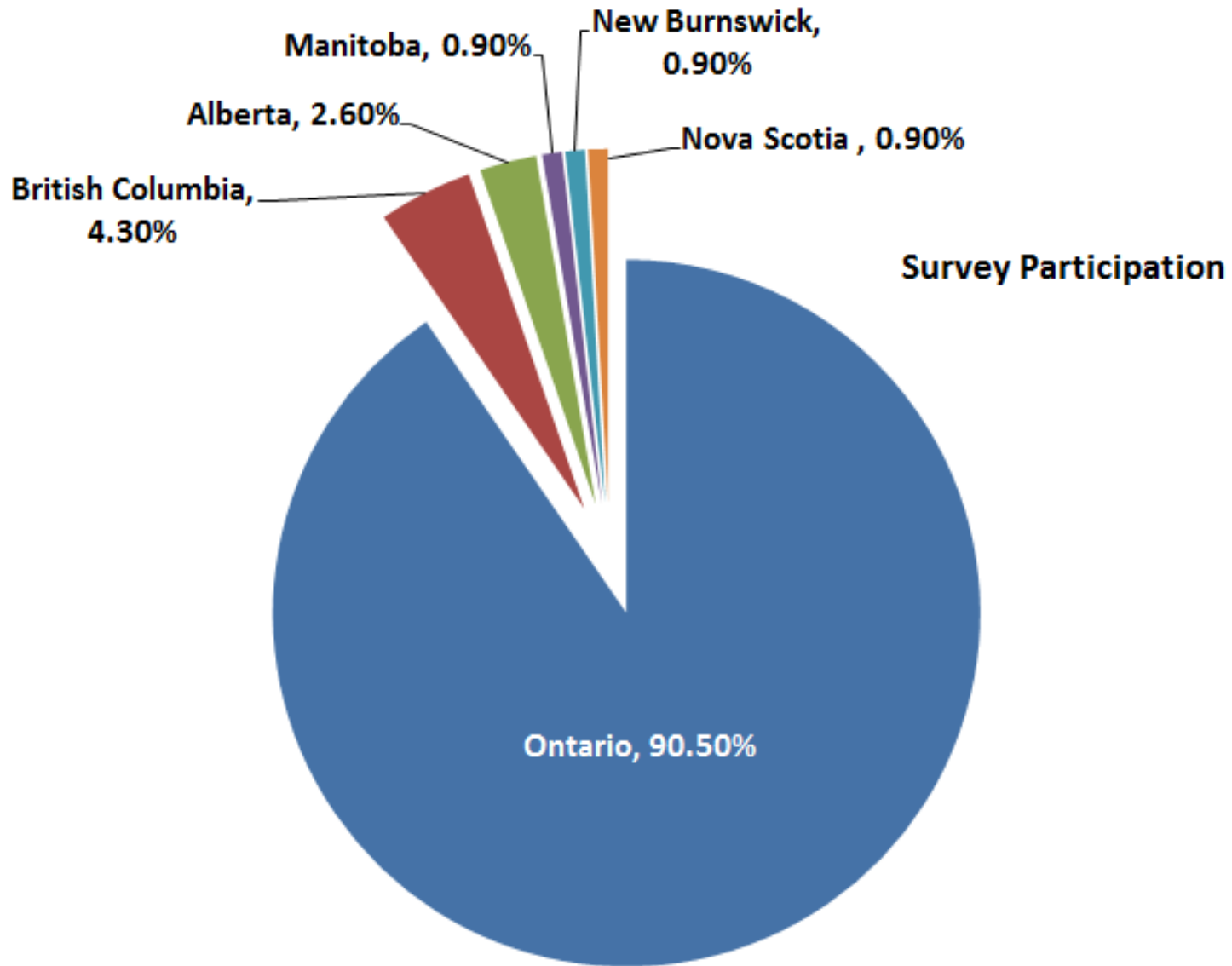
Personnel Performance Rating (per municipalities)



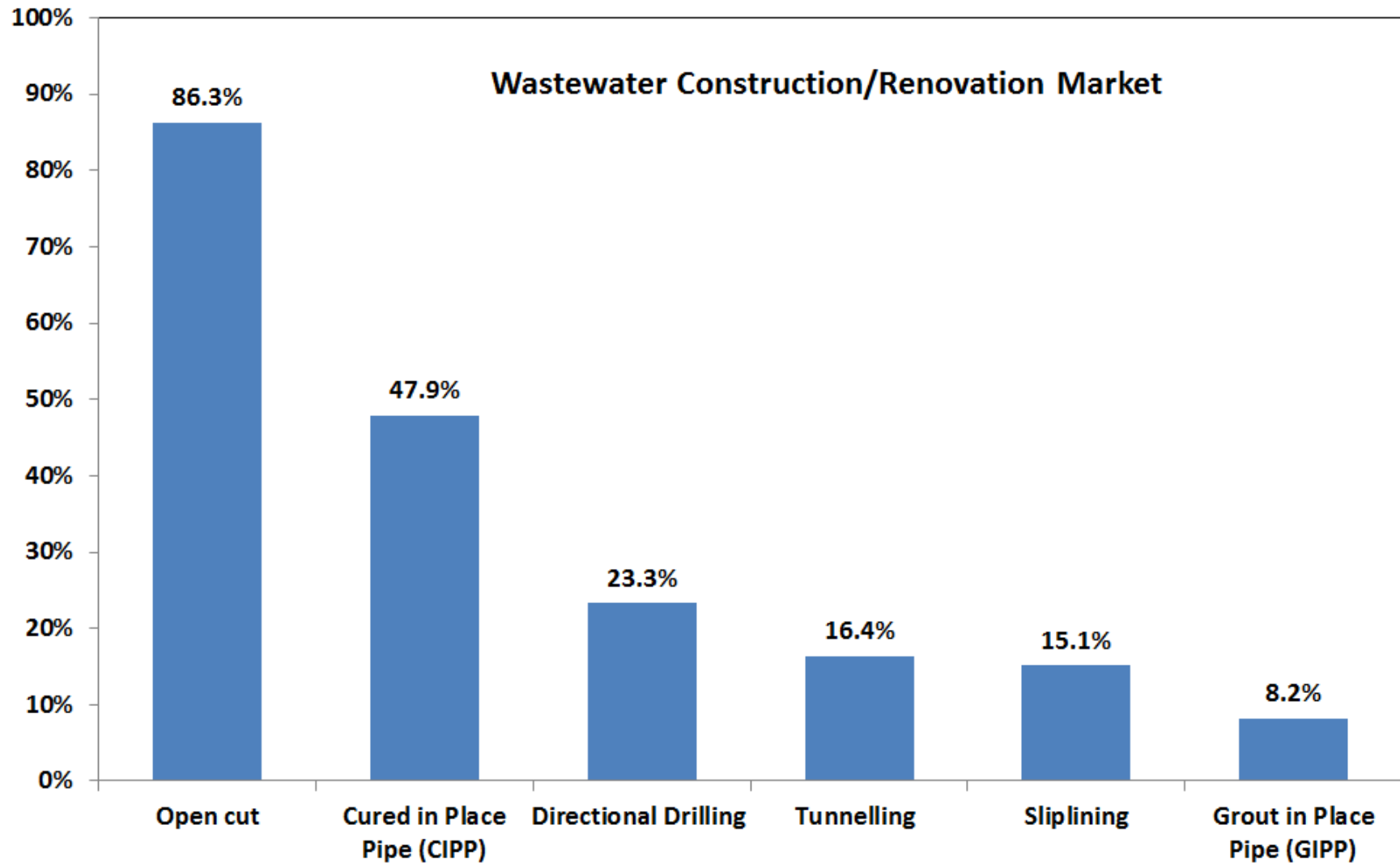
Municipal Performance Rating

Survey respondents also overwhelmingly (84.2 percent) cite 'quality' as the top characteristic they want from consulting engineers followed by 'understanding of new technology' at 47.6 percent and 'productive relationships with contractors' cited by 46 percent.

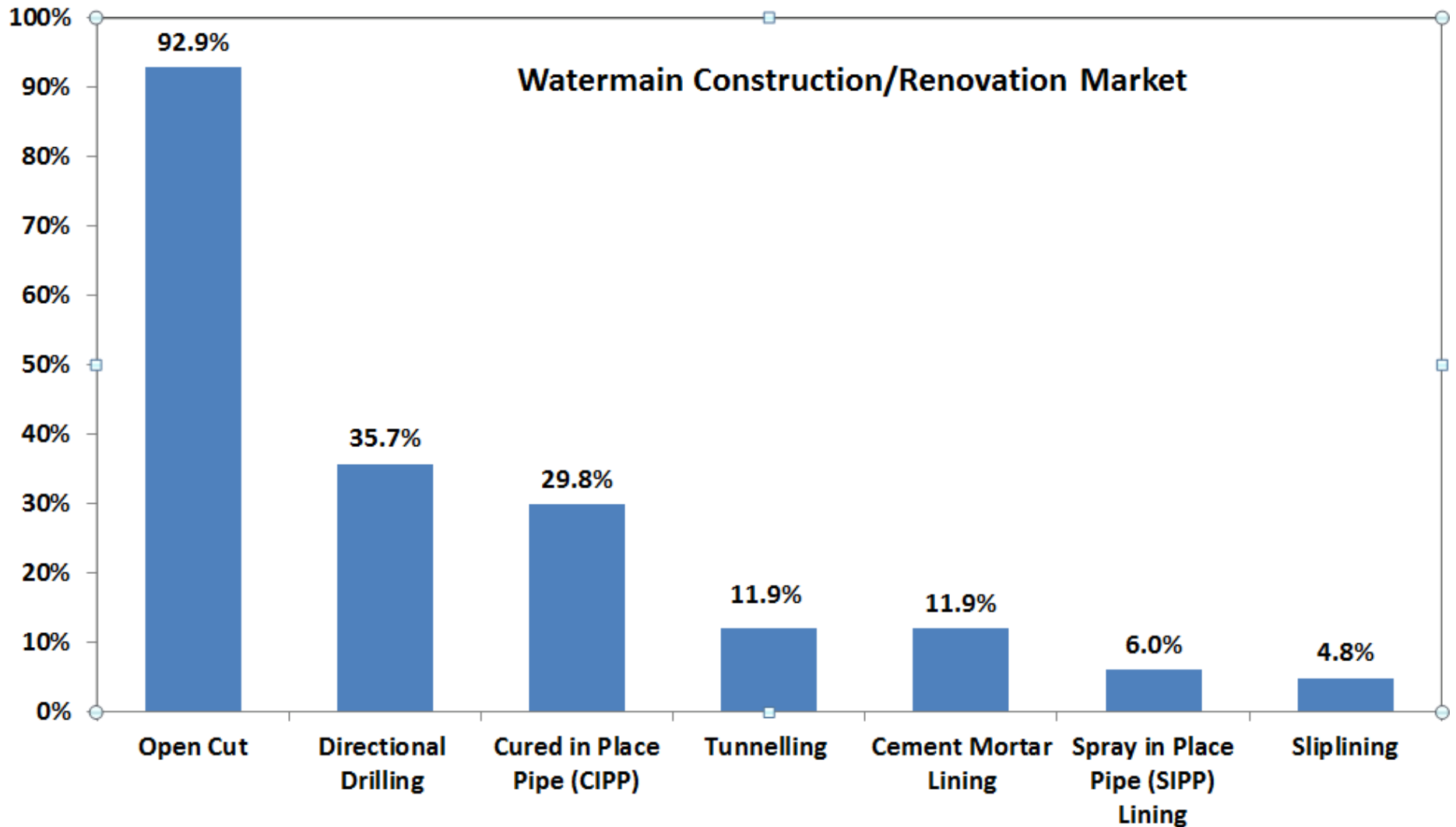
CATT 2013 Municipal Survey



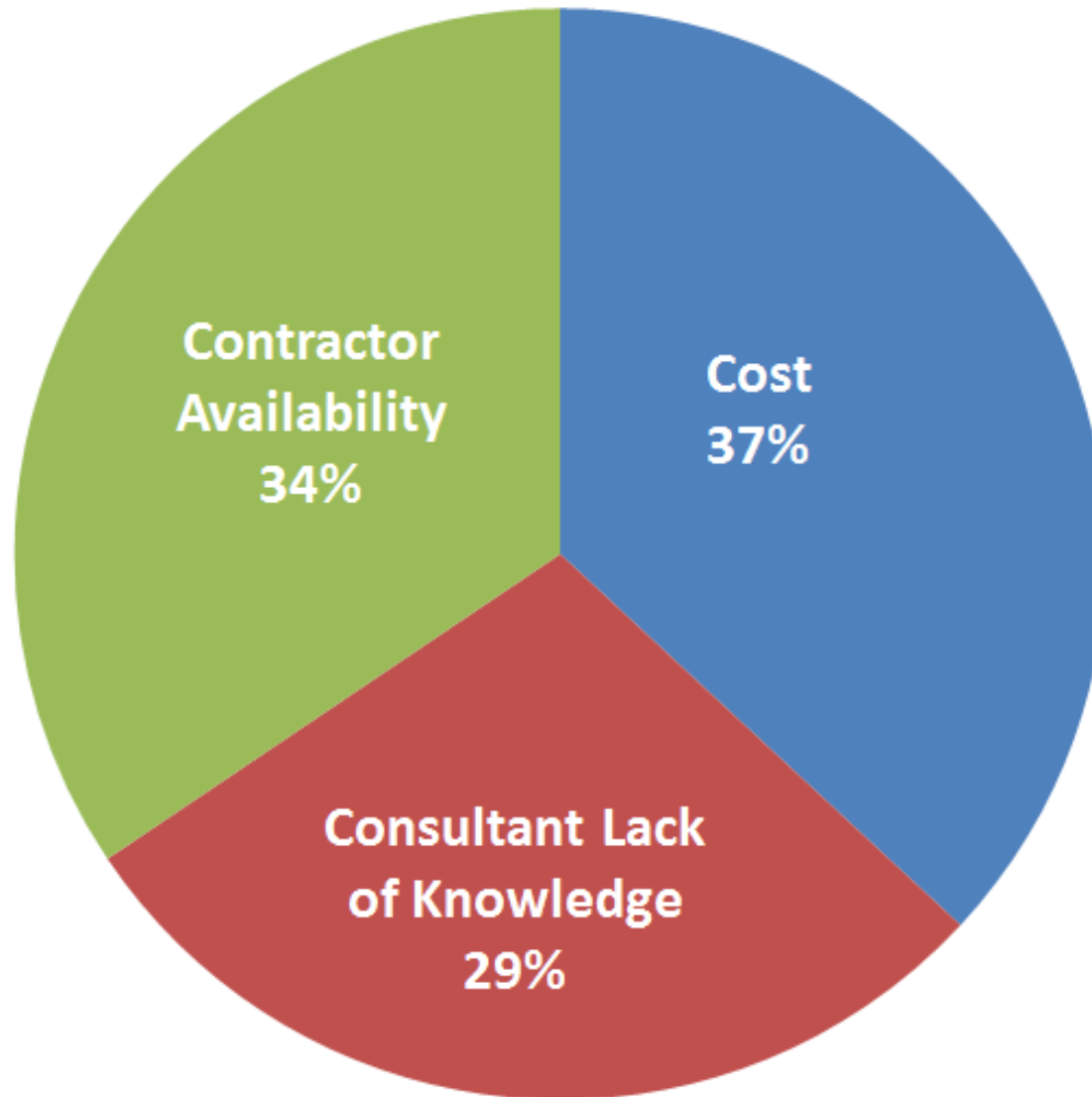
CATT 2013 Municipal Survey



CATT 2013 Municipal Survey



Barriers To Trenchless Construction Methods



http://www.undergroundconstructionmagazine.com/hdd-evolves-match-new-market-dynamics

HDD Market

underground
construction

October 2014, Vol. 69, No. 10

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HDD Evolves To Match New Market Dynamics

16th Annual Horizontal Directional Drilling Survey

By Robert Carpenter, Editor | June 2014, Vol. 69, No. 6



It's a big, new world. At least big in terms of horizontal directional drilling rigs (HDD).

Contractors – and even owners – continue to increase the size of their rig fleet both in terms of actual physical size and number of units as project requirements become more demanding and key markets continue to display long-term health.

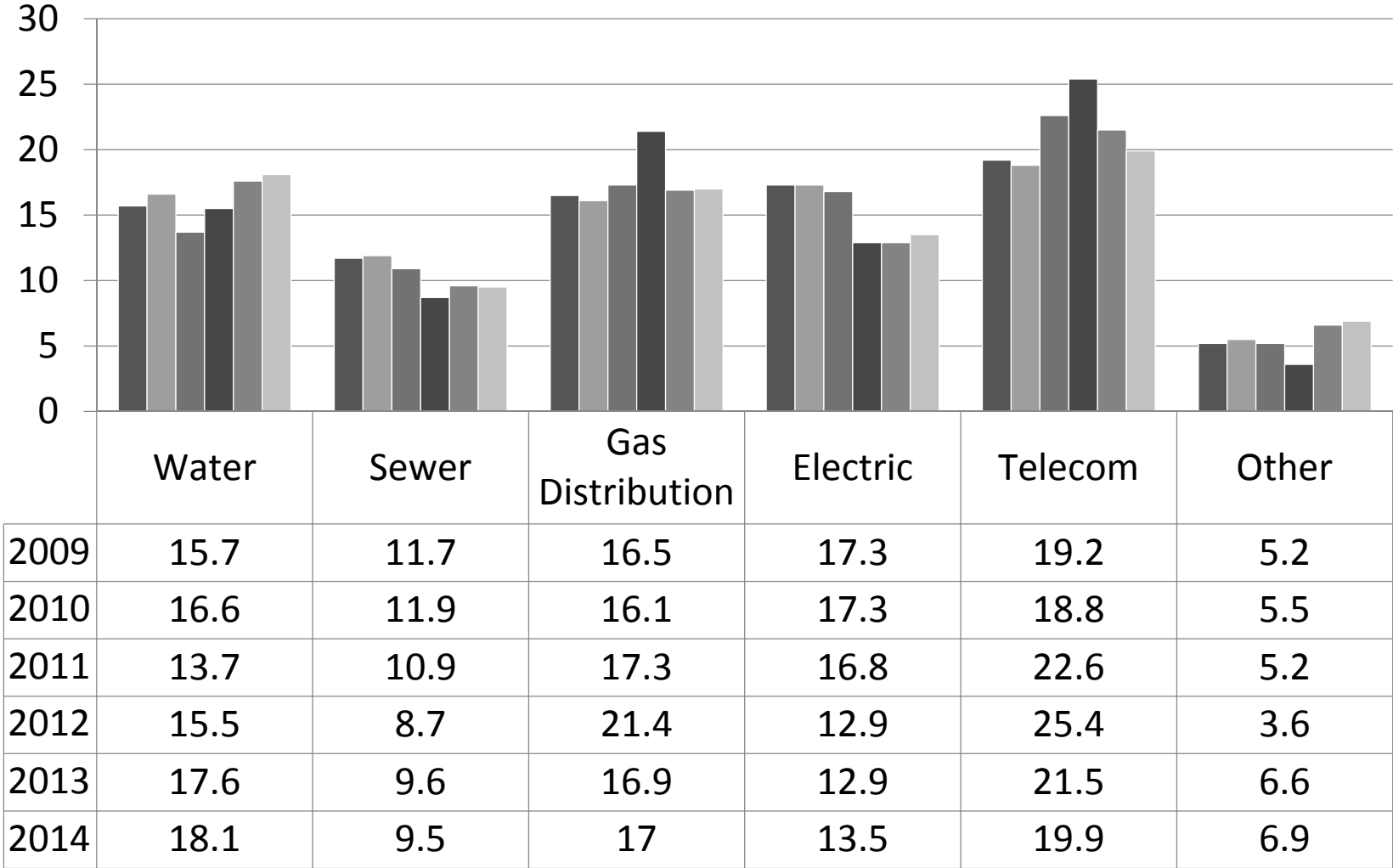
This information and much more are detailed in the 16th Annual Underground Construction 2014 HDD Survey of the U.S. market. This exclusive industry

research was conducted during March and April. Surveys were sent via both U.S. Postal Service and email to contractors and organizations that actively own and operate HDD drilling units. The number of completed surveys allowed for an accurate statistical portrayal of the market. Survey responses came from all 50 states plus Puerto Rico.

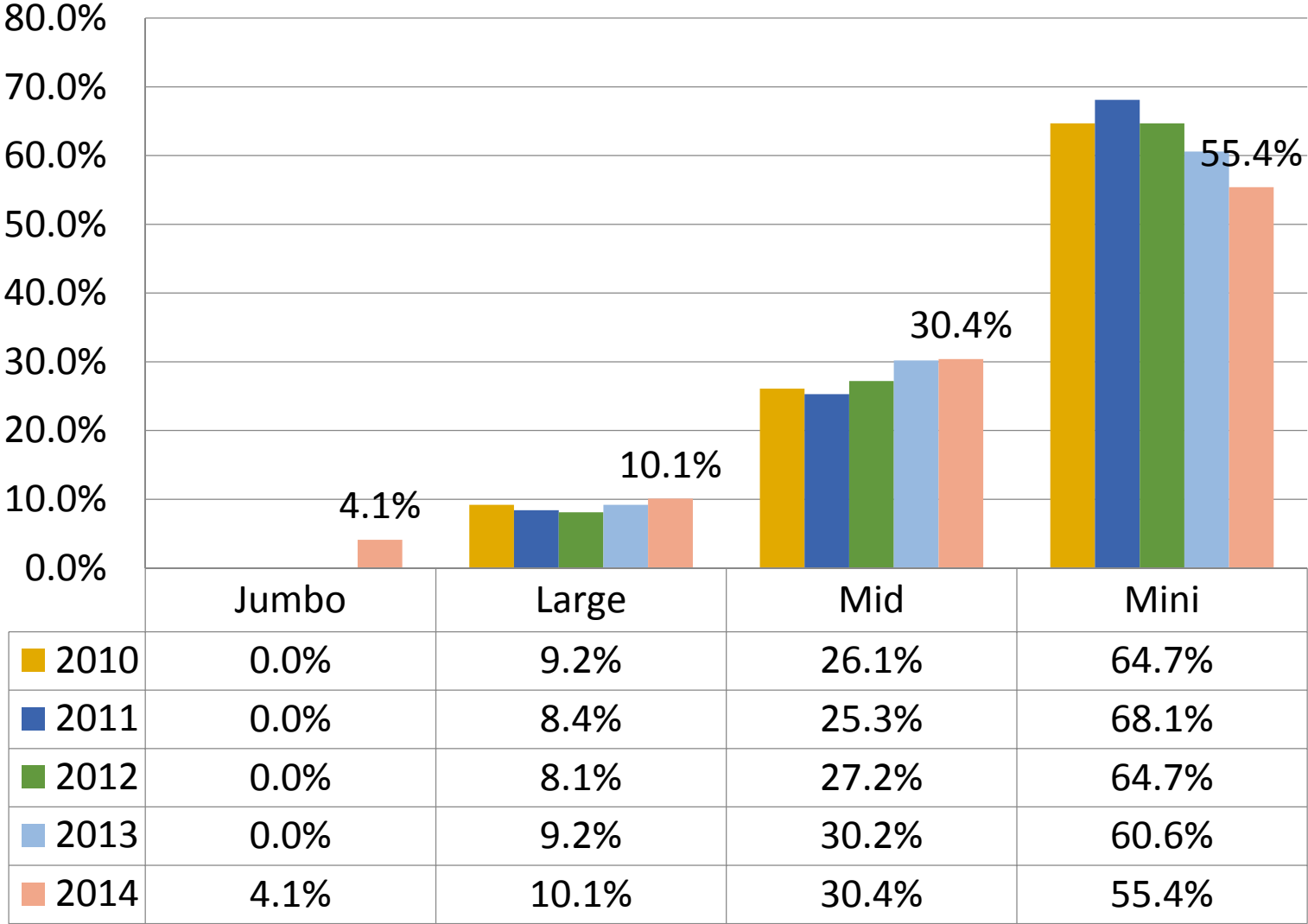
Underground Devices
Bore Spacers

UD **Click Here**
To Learn More

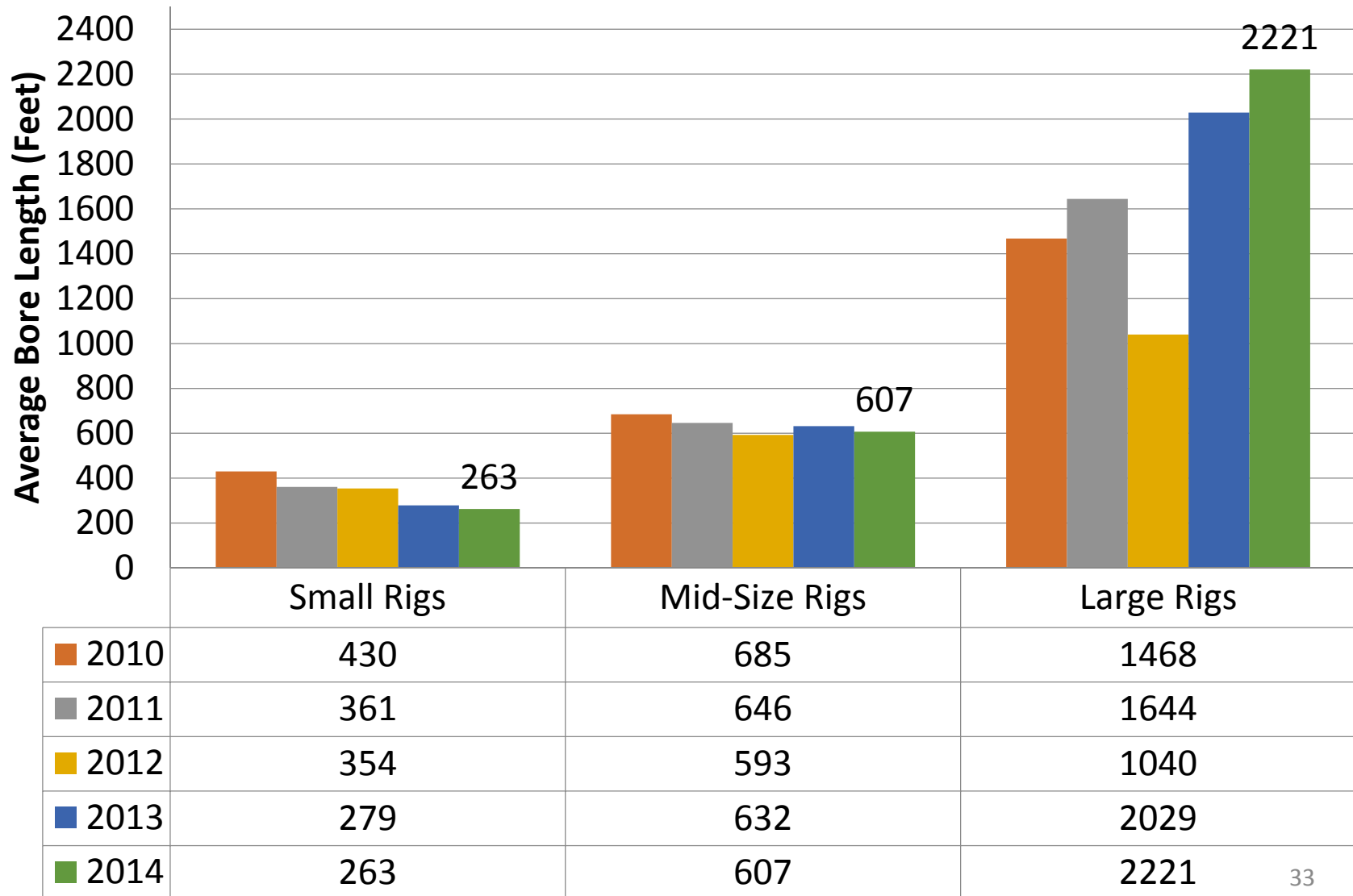
HDD Market Distribution



HDD Drill Rig Size Distribution



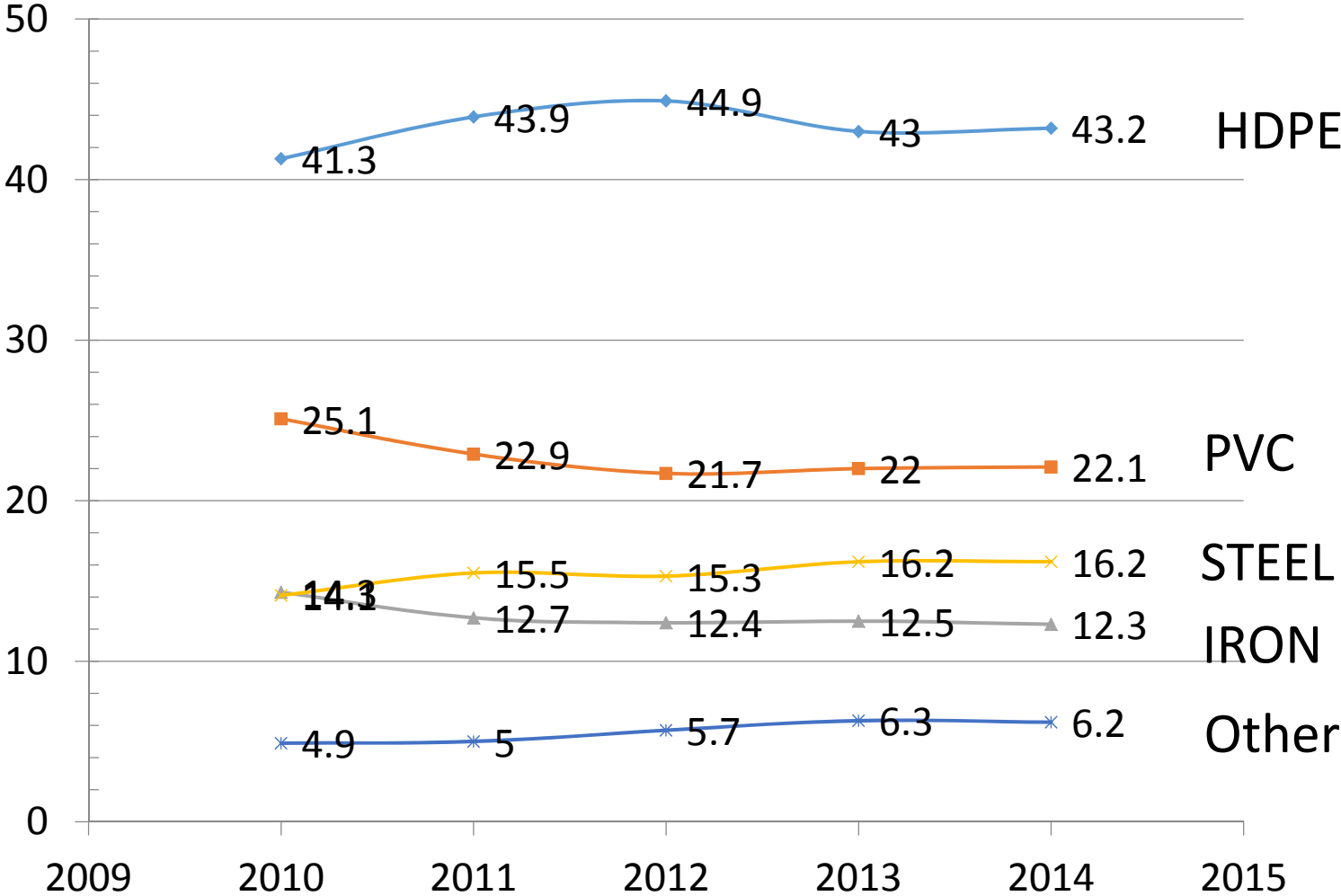
HDD AVERAGE BORE LENGTH (FEET)



Long HDD Installations

- 2,000m (6,575-ft) of 36-inch steel watermain pipe pullback installation crossing of the St. John's River in Jacksonville, Fla.
- Proposed 3,950m-long 48" steel pipe Lake Sakakawea, Missouri River basin in central North Dakota, US.
- a trenchless 24" natural gas pipeline installation project spanned 5967 feet (1818.7 m) in rock

Pipe Materials



Industry Issues

- Consulting engineers and municipalities, while vastly improving their HDD knowledge the past two years, are still woefully lacking in detailed knowledge of the technology
- Their inability to effectively inspect HDD leads to a lack of confidence in the technology and, in turn, often unnecessarily inhibits contractor management of projects by making invalid and extraneous demands.

Industry Issues

- “Our jobs are hard enough without engineers expecting us to give them on-the-job training about what they should look for on a drill,” complained a Southeast respondent.

INDUSTRY TRENDS

- HDD used to install larger diameter pipes
 - Requires the use of larger size drill rigs
- Construction of gravity sewers with low grades
- HDD industry is suffering from poor design, contract specifications and poor QA/QC
- Improved knowledge by owners and consultants

Major Frustrations

- Lack of understanding by the engineering community on HDD construction method
- engineers lack of professional understanding of how these projects are different than other traditional pipeline construction projects

Summary

- Trenchless Industry continue to grow especially in Ontario and Canada
- Canada is a leader in North America
- Water Utilities need \$\$ to build programs to drive projects
- Need improved understanding by Engineers to grow the industry...