

Pipelines 2012

**Innovations in Design,
Construction, Operations,
and Maintenance – Doing
More with Less**

**Miami Beach, Florida, USA
19-22 August 2012**

Volume 1 of 2

Editors:

**Robert J. Card
Michael K. Kenny**

ISBN: 978-1-62276-338-2

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2012) by the American Society of Civil Engineers
All rights reserved.

Printed by Curran Associates, Inc. (2012)

For permission requests, please contact the American Society of Civil Engineers
at the address below.

American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191

Phone: (800) 548-2723
Fax: (703) 295-6333

www.asce.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

Volume 1

ADVANCES IN TECHNOLOGY

Performance Testing of Underground Storage Tank Against Buckling	1
<i>Wayne Geyer, Robert J. Card</i>	
Organizing and Managing the Implementation of Large Diameter Tapping and Plugging Technology for a Major Sanitary Improvement Project in Ho Chi Minh City, Vietnam	11
<i>Charles Herckis</i>	
Ductile Iron Corrosion Theories and Science.....	21
<i>Michael J. Szeliga</i>	
Design and Development of a Web-Based National Database for Water and Wastewater Pipeline Infrastructure Systems.....	28
<i>Sunil Sinha, Walter Graf</i>	
Fatigue of Plastic Water Pipe: A Technical Review with Recommendations for PE4710 Pipe Design	
Fatigue	38
<i>K. Oliphant, M. Conrad, W. Bryce</i>	
Novel Resilience Assessment Methodology for Water Distribution Systems.....	61
<i>Leon F. Gay, Sunil K. Sinha</i>	
Contingency and Emergency: Prior Planning, "Real Live" Execution, and Post Mortem of the Results	70
<i>Scott Christensen, Mark Russo, Greg Kodweis, John Plattsmier</i>	
Water Transmission Main Condition Assessment in the Last Frontier: A Magnanimous Endeavor for the Anchorage Water and Wastewater Utility	84
<i>Stephen Nuss, Bruce Robson, Myron Shenkiryk</i>	
Protection of Petroleum and Natural Gas Pipelines Crossing Debris Flow Watersheds—A Case Study in the Qinling Mountains, Western China	102
<i>Y. G. Ge, Y. Zhao, J. Mou, D. J. Li, Q. Li, D. Y. Wang, Z. M. Su</i>	
Meeting the Challenge of Pipeline Emergency Repair	118
<i>Michael R. McReynolds, Tao Peng</i>	
PressureCast Steel Pipe Combined Load Test Set-Up and Execution.....	128
<i>Michael Murphy, Qizhong Sheng</i>	
Unidirectional Flushing (UDF): It's Not Just about Cleaning the System Anymore—Benefits and Advantages That West Springfield, Massachusetts, Achieved with Their Program.....	136
<i>Jeff Auer, William Jappy, Cliff Jones</i>	
Transmission Main and Plastic Pipe Leak Detection Using Advanced Correlation Technology: Case Studies.....	147
<i>Marc Bracken, Bill Cain</i>	
Installation of a 42 Inch HDPE Pipeline at Seminole County's Regional Water Treatment Facility at Yankee Lake.....	158
<i>Carol Hunter, Hector Casablanca, William Meredith, Dean Garcia</i>	
Risk Management in Real Time—Transient Control Testing on a Large Conveyance System.....	167
<i>Peter Pfister, Scott Williams, Shahin Rezania, Doug Lubben</i>	
Integration of HDPE 4710 Materials for Potable Water Distribution Systems.....	177
<i>Greg Scoby</i>	
Five Years and Counting: The Evolution of WSSC's PCCP Management Program	186
<i>Travis B. Wagner, David M. Burke, Mike Woodcock, Gregory Fick</i>	
City of Westminster's Sewer Collection System Assessment Program: A Case Study	198
<i>Keith Bushdiecker, Bryon Wood, Matt Gough</i>	
GIS: A Decision Making Tool for Pipeline Asset Management in Atlanta	209
<i>Eric L. Glover, Raymond J. Wilke, Michael Flinn, Sriram Krishnan</i>	
Intake Screen Alternatives for the IPL Project—Planning for Mussels and Variable Intake Depths	218
<i>Jerry W. Snead II, Shelly Hattan</i>	
Variability of Pipe Coating Pull-Off Adhesion Measurements on Cylindrical Steel Pipelines.....	231
<i>S. G. Croll, C. A. Vetter, B. D. Keil</i>	
Evaluation of Statically-Loaded Large Diameter Steel Pipe Embedded with Lime Stabilized Native Clay Soils	242
<i>Jwala Raj Sharma, Mohammad Najafi, David Marshall, Abhay Jain</i>	

Seismic Fragility Evaluation of Water Pipelines: Part 1—Current Practice.....	257
<i>Sri Rajah, Souheil Nasr, Keith Ferguson, J. Christopher Ey</i>	

COASTAL ISSUES

Galveston's Life Line—Considerations When Designing an Aerial Crossing.....	268
<i>John Martinez, Rafael Ortega, Rachel Leclair</i>	

CONDITION ASSESSMENT

Who Says You Need Multiple Wire Breaks for a PCCP Pipe to Fail?.....	278
<i>John J. Galleher Jr., Andrew E. Romer</i>	
Condition Evaluation of Asbestos Cement Water Mains.....	288
<i>Rudaba Chowdhury, Yafei Hu, Dunling Wang</i>	
Numbers Don't Lie: PCCP Performance and Deterioration Based on a Statistical Review of a Decade of Condition Assessment Data	298
<i>Michael S. Higgins, Allison Stroebel, Sana Zahidi</i>	
From Pilot to Permanent: Evolution of LWC's PCCP Condition Assessment Program.....	307
<i>Andrew F. Williams, Eric R. Pruitt, Michael J. Livermore</i>	
A Methodology for Condition Assessment of Pressure Water Mains	319
<i>S. G. Farrelly, P. H. Ferguson</i>	
Implementation of Sustainability Initiatives and the Envision™ Rating System on the Omaha CSO Program.....	329
<i>Derek Gardels, Mike McMeekin, Marty Grate, Scott Aurit, Tom Heinemann, Nancy Pridal</i>	
PCCP Condition Assessment Methodology: What Is Right for You?.....	339
<i>Michael D. Gossett, Graham E. C. Bell, Steven R. Fox, Keith R. Bushdiecker, Richard Pousard Jr.</i>	
Enhancing Asset Management Priority Ranking—A Case Study	345
<i>Rafael Ortega, Ashley D. Ross</i>	
Condition Assessment of 23 Lift Stations.....	356
<i>Jose L. Villalobos</i>	
Integrated Monitoring Strategy for Large Diameter Pre-Stressed Concrete Pipelines—A Case Study at Waternet, the Netherlands.....	378
<i>Margit Eggebrecht, Marco Dignum, Geert Jan Van Heck</i>	
Protecting the Magic City	388
<i>Rod J. Lovett, Jayson Page, Bryan Fletcher, Steve Sandstrum</i>	
Pilot Large Diameter Pipeline Seismic Fragility Assessment	396
<i>Yogesh Prashar, Roberts McMullin, Bill Cain, Xavier Irias</i>	
Restoring Water Network Reliability and Control in the City of Baltimore	408
<i>David C. Lewis, Cliff Jones, Cliff Wilson, Opinder Singh</i>	
New Approaches to Inspect Water Pipelines Running under Rivers, Lakes, Levies, and Critical Transport Infrastructure	413
<i>J. B. Conant, Cliff Jones, Ryan J. Reynolds</i>	
Reducing the Cost of Failure: Time Is the Unforgiving Enemy during Pipeline Ruptures	421
<i>Cliff Wilson, Cliff Jones</i>	
The Problem of Leakage Detection on Large Diameter Mains	432
<i>S. Hamilton, D. Krywyj, Cliff Jones</i>	
Condition Assessment of a Ductile Iron Force Main Using Guided Wave Technology: Case Study of Underwood Creek Force Main, Milwaukee Metropolitan Sewerage District.....	442
<i>Bryon Livingston, Urbain Boudjou, Roger Royer</i>	
Failure Risk of Bar-Wrapped Pipe with Broken Bars and Corroded Cylinder	457
<i>Ali Alavinasab, Muthu Chandrasekaran, Edward Padewski III</i>	
Sewer Main Condition Assessment in the Last Frontier	467
<i>Mark Corsentino, Jack Burnam, Mark Wade</i>	
LRFD Approach to CFRP Renewal of Prestressed Concrete Cylinder Pipes	481
<i>Naiyu Wang, Mehdi S. Zarghamiee</i>	
Rehabilitation of Large Diameter PCCP: Relining and Sliplining with Steel Pipe	494
<i>Shah Rahman, Greg Smith, Richard Mielke, Brent Keil</i>	
Miami-Dade Case Study: Managing and Minimizing Pipeline Outages through the Use of Carbon Fiber.....	505
<i>R. A. Terrero, R. Coates, Luis Aguiar, A. B. Pridmore, J. Alexander</i>	

Field Comparison of the Axis Vacuum Microtunneling Technology vs. Open Cut Excavation in Glenview, Illinois	515
<i>S. T. Ariaratnam, K. R. Piratla, A. Cohen</i>	
Technology—How Far Can We Go?.....	523
<i>Stuart Hamilton, Cliff Jones</i>	
Southeast Collector Trunk Sewer Route Selection: The Regional Municipalities of York and Durham, Ontario, Canada	531
<i>M. Swan, W. Green, J. Whittard</i>	
Consideration of Embodied Energy in Sustainability Evaluation of Pipeline Projects	544
<i>N/A</i>	
Chemical Amendment of Excavated Trench Material for Sustainable Reuse.....	552
<i>Anand J. Puppala, Bhaskar Chittoori, Shelly Hattan, David Marshall</i>	
Condition Assessments Using Pipe Penetrating Radar: The Metro Wastewater Reclamation District, Denver, CO—Harvard Gulch Interceptor Case Study.....	562
<i>Csaba Ékes, Jeff Maier</i>	

CONSTRUCTION

Route Selection for a \$2.2 Billion Pipeline	576
<i>Alan Hutson, Jeff Payne, Zachary Huff</i>	
Replacement of a Critical Water Supply Pipeline in a Dense Urban Landscape	592
<i>Amanda Powers, David Bennett</i>	
M-DWASD Design-Build Procurement for Government Cut Pipeline Replacement Project.....	602
<i>R. B. Dill, K. Watson, C. Williams, E. A. Vega</i>	
Stockton Delta Water Project Construction Challenges	613
<i>Bruce J. Corwin</i>	
A New Generation of FRP Laminates for Repair of Pipelines in the Gas Industry	626
<i>Mo Ehsani</i>	
Design and Construction Challenges for a 36 Inch Diameter 18 Mile Reclaimed Water Pipeline.....	634
<i>S. M. McGrew, M. Tobon</i>	
Two Successful Installations of Large Diameter Rigid-Design Concrete Pressure Pipelines in Very Soft Soils	644
<i>Henry Bardakjian, Michael Murphy</i>	
Augmenting Owner's Staff with As-Needed Contracts for Large Diameter Pipeline Construction Management.....	655
<i>Gary W. Bousquet</i>	
Pipeline Infrastructure Renewal at Miami-Dade Water and Sewer Department	661
<i>Ralph Terrero, Luis Aguiar, Richard Coates, Mike Garaci</i>	
Delivering a Critical Raw Water Transmission Line Using Design-Build: The Perspective from Gilbert, AZ	672
<i>Glen W. Roth, Jeff Kramer</i>	
From Tiny Hole to Huge Problem Overnight—Emergency Culvert Pipe Repair.....	682
<i>Joseph A. Strauch</i>	
Lessons Learned from the Commissioning of a 21,000 HP Pump Station in San Diego.....	691
<i>Jeremy Crutchfield, Jose Martinez</i>	
Hiding a 96 Inch Pipeline in Your Neighbor's Backyard	700
<i>Greg A. Harrison, Nicholas B. Cooper, Rudolph A. Chen</i>	
Pipe Collapse in an Amusement Park—Now What Do You Do?	713
<i>Jonathan Shirk, Karen Stafford-Brown</i>	
San Francisco Public Utilities Commission's Water System Improvement Program: Bay Division Pipeline 5 East Bay Reaches—Construction Contract Challenges in a Difficult Economy.....	723
<i>Joe Ortiz, Johanna Wong, Luann McVicker, Jack Santos, Roger Hatton</i>	
60" Demonstration Installation of PressureCast Steel Pipe for the Tarrant Regional Water District.....	737
<i>Shelly S. Hattan, David McPherson, Richard I. Mueller</i>	
Replacing Live Pipelines—Planning for Construction Issues and Sequencing Can Keep Your System Up and Running.....	746
<i>Dennis A. Demuth, Erica Jacobs</i>	
Recycled Water for the Thirsty High Desert.....	757
<i>Stephen Shumaker, Randall Hill, Jason Yoshimura, Genevieve Osmena, Sami Kabar</i>	

Volume 2

Longest Polyurethane Lined and Coated Steel Pipeline in North America: The Provo Reservoir Canal Enclosure Project.....	771
<i>Jeff Budge, Shah Rahman</i>	
Experimental Examination of Selected Limit States of Structural Liners at Locations of Ring Fracture.....	783
<i>Erez Allouche, Shaurav Alam, Mir Al-Masud, Rajesh Dulam</i>	
Reconstruction in an Urban Environment: Kimberley Lane 8" Water Line HDD and 54" Sanitary Sewer CIPP Rehabilitation	795
<i>Christine H. Kirby, Rachel A. Leclair</i>	
Basis of Design for Proposed 42 Inch Reclaimed Water Main.....	805
<i>Arnelio Alfonso, Erik Sibila</i>	
Repair of a Punctured 48 in. Diameter Prestressed Concrete Cylinder Pipe on a Sixty Degree Slope.....	816
<i>Brent J. Bass, Rasko P. Ojdrovic, Brian M. Haemmerle</i>	
Getting Ready for a Larger Panama Canal—Assessing a Critical Large Diameter Force Main	827
<i>Vince Arrebolta, Julio Amoedo, Rod Lovett, Eduardo Vega, Mike Garaci</i>	
Buried Flexible Pipes: Deflections and Stresses Caused by an Increase in Soil Cover—Highway Crossing.....	836
<i>Reynold K. Watkins, Robert J. Card</i>	
Proactive Upgrade of Steel Pipelines during Scheduled Plant Outages	846
<i>M. Cribb, A. B. Pridmore</i>	
Case Study of Productivity Analysis for Horizontal Directional Drilling.....	857
<i>Mohmd. Sarireh, Mohammad Najafi, Lawrence Slavin, Abhay Jain</i>	

DESIGN MANAGEMENT

The Effects of Pipe Stiffness on HDD Pull Loads.....	869
<i>Lawrence M. Slavin, Mohammad Najafi</i>	
Sustainable Flowable Fill	879
<i>Amster Howard</i>	
How to Accelerate Design and Construction for Large Water Supply Projects.....	889
<i>Russell Gibson</i>	
Collaborative Bidding Approach for the Tollgate Creek Interceptor	901
<i>S. Nyirenda, J. A. Wesley</i>	
Three Heads Are Better Than One: Efficient Solutions to Achieve the Best Value for a 6 Mile Water Main in an Urban Setting.....	908
<i>Christopher Roschek, Dana Gillette, James Penkosky, Phil Dover</i>	
Planning and Modeling Solutions for a Complex Collection System: The Baton Rouge SSO Control and Wastewater Facilities Program	918
<i>Jennifer D. Baldwin, Amy E. Schulze</i>	
Pipe Materials and Joint Selection for Trenchless Construction.....	928
<i>Philip K. Ryan, Andrew J. Finney</i>	
Classification and Specification of Bedding and Backfill for Buried Pipelines	940
<i>Sri Rajah, Martin McCabe, John Plattsmaier</i>	
Tangent Outlet Design for Welded Steel Pipe	952
<i>Chris Sundberg</i>	
Molecular Design of High Density Polyethylene for Pipes	964
<i>Sarah E. Patterson, Mark A. Spalding</i>	
Reinforced Concrete Pipe Design under Extreme Loading Conditions Using ASCE Standard 15-98 and Beyond.....	974
<i>Chris Macey, Ryan Cadieux, Adam Braun</i>	
Untangling the Mysteries of Air Valves	983
<i>David L. McPherson, Christopher Haeckler</i>	
Hydraulic Modeling for Emergency Water Supply and Disaster Planning	990
<i>N. Olayiwola, D. Winters, R. Ahmad, E. Glover</i>	
Finite Element Analysis of Combined-Load Performance of PressureCast™ Steel Pipe.....	996
<i>Mehdi S. Zarghamee, Christine Roy, Michael P. Murphy</i>	
Dynamic Behavior of Buried Flexible Pipes of Varying Thickness Using the Shaking Table Test.....	1015
<i>T. Kawabata, Y. Sonoda, Y. Mohri, M. Ariyoshi, Y. Iwasaki</i>	

Designing a Critical Interceptor in an Earthquake Prone Floodplain with Limited Access: The Santa Ana River Interceptor Relocation Project.....	1025
<i>James Cathcart, Steven Agor, Hardat Khublall, David Philips</i>	
Selecting Water Main Materials for the Los Angeles Department of Water and Power.....	1036
<i>Jonathan Leung, Dan Ellison, Graham Bell, Don Ballantyne</i>	
Common and Challenging Questions in Water System Infrastructure Management	1046
<i>Dan Ellison, Graham Bell, Andy Romer</i>	
Emergency Relocation of 20 Inch Sewer Force Main (HDD).....	1073
<i>Arnelio Alfonso, Erik Sibila</i>	
Introducing a New Honeycomb-FRP Pipe.....	1084
<i>Mo Ehsani</i>	
Structural Design of Buried Pipes.....	1092
<i>Robert J. Card</i>	
Surge in a Bi-Directional 48" Steel, Potable Water Pipeline.....	1104
<i>Steve Mackellar</i>	

FAILURE MECHANISMS

Design to Prevent Long Running Cracks in Plastic Pipe for Water Applications.....	1115
<i>Karen S. Lively</i>	

OPERATIONS AND MAINTENANCE

Scoring and Selecting Rehabilitation Methodologies: How to Pick the Winning Number?	1122
<i>Hatem El-Sayegh</i>	
Proven Pipeline Rehabilitation System Using Steel Liners for the San Diego County Water Authority	1129
<i>Dennis Shearer, Mike Kenny</i>	
Pipe Performance and Experiences during Seismic Events in New Zealand over the Last 25 Years.....	1136
<i>Frank W. O'Callaghan</i>	
Steel Cylinder Reinforcement (SCR) for Pipeline Repair or Upgrades	1147
<i>B. Nash Williams</i>	
Determining the Effectiveness of Chlorine-Based Biofilm Control in Large Diameter Pipelines	1156
<i>Shelly S. Hattan, Erin McGuire, Andrew P. Kruzic, John McEnergy</i>	
Large Steel Penstock Relining: The Blue Ridge Dam Rehabilitation.....	1168
<i>B. Nash Williams, Brad Sando</i>	
Cathodic Protection of Ductile Iron and Steel Water Pipelines.....	1176
<i>Michael J. Szeliga</i>	
The Design and Construction Considerations for PCCP Rehabilitation Using FRP Composites	1182
<i>Tarek Alkhrdaji, Matthew Frye, Silvia Rocca</i>	
The Development of a Novel Steel Reinforced Composite (SRC) Liner for the Rehabilitation of Deteriorated PCCP.....	1192
<i>Tarek Alkhrdaji, Silvia Rocca, Jay Thomas</i>	
Can It Handle the Pressure? Condition Assessment, Structural Evaluation, and Repair of an Existing 72 Inch PCCP Pipeline.....	1203
<i>Alan Hutson, Steve Long, Jeff Payne, Mehdi Zarghami</i>	
Beyond the Wires: A Sustainable Approach to Prestressed Concrete Cylinder Pipe Management	1214
<i>Nathan D. Faber, Martin R. Coghill, John J. Galleher</i>	
Redeveloping Phoenix's PCCP Assessment Program: A Pragmatic Approach	1223
<i>Mike Ambroziak, Aimee Conroy, Bethany McDonald</i>	
Interaction of Water Transport Pipelines with Their Surroundings and Third Party Activities	1233
<i>Geert Jan Van Heck, Sanne Hillegers, Ingrid Haazebroek</i>	
Innovative Condition Assessment of Strategic Aqueducts	1245
<i>Sandra Rolfe-Dickinson, Martin Berry, Adrian Davies-Jordan, Guy Cleveland</i>	
Study on the Applicability of Currently Used Soil-Pipe Interaction Equations for Segmented Buried Pipelines Subjected to Fault Movement.....	1256
<i>Mohammad Hossein Erami, Masakatsu Miyajima, Shougo Kaneko</i>	
Answering 5 Basic Asset Management Questions for Pre-Stressed Concrete Water Transport Mains.....	1265
<i>Geert Jan Van Heck, Sanne Hillegers</i>	
Refurbishment of the Vyrnwy Large Diameter Trunk Main.....	1279
<i>Michael Holme, Martin Berry</i>	

Synthesis-Analysis of Water and Wastewater Pipeline Condition Assessment and Renewal Engineering Technologies	1289
<i>N. Thuruthy, S. K. Sinha</i>	
Effect of Wire Breaks on Prestressed Concrete Cylinder Pipe (PCCP) Reinforced with Steel Liners— A Case Study	1297
<i>Shaoqing Ge, Sunil K. Sinha</i>	
Lessons Learned from the Multi-Year Assessment of the Homestake Transmission Pipeline.....	1307
<i>Tom Vidmar, Mark Rosser, Randy Parks</i>	
Locating Water Main Leaks in Texas to Conserve Resources during Times of Drought.....	1319
<i>J. B. Conant, Cliff Jones</i>	
Estimating Residual Strength of Deteriorated 96" Interceptor and Strength Enhancement Provided by Lining Methods Using Computer Modeling and Forensic Investigation Tools.....	1328
<i>Erez N. Allouche, Shaurav Alam, Mir Al-Masud</i>	
A New Generation of Back-Reamers for HDD Installations in Cohesive and Fine to Medium Coarse Soils	1343
<i>Erez Allouche, Kranti Ponnam, Biao Shu</i>	
Physical Evaluation of the Dissipation of a Concentrated Load When Applied to Reinforced Concrete Pipe	1355
<i>Josh Beakley</i>	
CFRP Repair and Strengthening of PCCP for Thrust Restraint	1368
<i>Murat Engindeniz, Peter D. Nardini, Rasko P. Ojdrovic, Mehdi S. Zarghami</i>	
Mapping Utility Infrastructure via Underground GPS Positioning with Autonomous Telerobotics	1377
<i>G. Baiden, Y. Bissiri, S. Luoma, G. Henrich</i>	
WSSC's Systematic Approach to the CFRP Liner Installation Process.....	1391
<i>Michael Gipsov, Anna Pridmore</i>	
Santa Fe Irrigation District (SFID): Group 1 PRS and Valve Replacement Project J921	1402
<i>Michael Pollard, Karen Falk</i>	
Metropolitan Utilities District of Omaha PCCP Asset Management Advancements	1408
<i>A. B. Pridmore, D. Caughlin</i>	
Combining CFRP Lining Systems with Other Pipeline Rehabilitation Technologies.....	1418
<i>D. Rosenberg, A. B. Pridmore</i>	

Pipeline Hydraulics and Modeling

Upper Feeder and San Gabriel Canyon Valve Structure: Hydraulic Transient Analysis.....	1428
<i>David H. Axworthy, Nami Tanaka, Ernest H. Ariza</i>	

Planning and Coordination Opportunities

Progress toward a Unified Thrust Restraint Design—An Update.....	1438
<i>Stephen Shumaker</i>	
Design-Build of Wastewater Force-Main in North Bay Village: Lessons Learned from the Design- Build Team's Perspective	1450
<i>Rodney J. Lovett, Ricardo Vieira</i>	

Predictive Modeling

Two-Step Subsurface Characterization Process for Pipeline Project in Texas	1465
<i>Mark Wilkerson, Shelly Hattan, David Marshall, Matt Gaughan</i>	

Prestressed Concrete Cylinder Pipe (PCCP)

Condition Assessment of LWC's B.E. Payne 60" PCCP Pipeline.....	1475
<i>Andrew F. Williams, Eric R. Pruitt, Michael J. Livermore</i>	

PROCUREMENT ALTERNATIVES

- Minden Uses Competitive Bidding with Alternate Pipe Materials on Large Diameter Regional Water System Work.....** 1487
Tim Russell, Richard (Bo) Botteicher

REHABILITATIVE APPROACHES

- HDD Matches Installation Method to Long and Difficult Pipe Crossing in Macon, GA** 1497
Jess R. Shell, Trey Gavin, Ben Whisler, Richard (Bo) Botteicher

TRENCHLESS EVALUATION

- Comparison of Jacking Load Models for Trenchless Pipe Jacking.....** 1507
Saeed Rahjoo, Mohammad Najafi, Richard Williammee, Ghassan Khankarli
- Assessing Sustainability of Pipeline Projects Using Envision™ Rating System** 1521
Matt Gaughan
- Author Index**