Western Regional Trenchless Review 2016

12th Annual Western Regional No-Dig Conference & Exhibition
October 17 & 18, 2016
Las Vegas, NV
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FEATURES

Twelfth Annual Western Regional No-Dig Conference and Exhibition........................................10
WESTT Chapter Volunteer Spotlight ..................................................................................13
Best Gamble in a Decade ..................................................................................................14
SSC Completes 16 Bores in UPRR Expansion Project ......................................................18
NASTT’s 2017 No-Dig Show ..............................................................................................19
Miksis Services Gets Creative With Corrugated Steel .......................................................20
Lake Tahoe Steel Water Main Replacement via Pipe Bursting ........................................24
HDD Allows Water Pipeline Construction Across Pearl Harbor ......................................28
Caltrans Culvert Rehabilitation in San Diego County .........................................................40

DEPARTMENTS

Chairman’s Message ..........................................................................................................6
Message from NASTT ........................................................................................................8
Reach Our Advertisers .......................................................................................................42
Success in Growing our Trenchless Industry

WESTT, the Western Chapter of NASTT, has been growing and is quickly becoming a reputable and familiar organization serving to advance education, outreach and networking for trenchless industry professionals within our region. Our members and Board of Directors are committed to continue building our organization to broaden and enhance this reputation. This year, WESTT’s Western Regional Trenchless Review celebrates its 10th year in publication. The Board of Directors and those that have come before us are very excited for this milestone and look forward to many more years of learning and sharing knowledge as new technologies are created and old boundaries are pushed in ways that we cannot even imagine.

Last year WESTT, with the help of NASTT, held our first membership-wide Board of Directors election. Electronic nomination requests and ballots were sent out to all members. We were excited with the responses that we received and we look forward to getting even more members involved moving forward. The new Board of Directors is already active in WESTT activities, events, outreach, and organization management. Our Board of Directors and officer positions are as follows:

- Cindy Preuss, HydroScience Engineers – Concord, CA Chair
- Craig Camp, Mott MacDonald – San Diego, CA Immediate Past-Chair
- Brian Avon, Golder Associates – Walnut Creek, CA Vice-Chair
- Lisa Arroyo, City of Santa Barbara – Santa Barbara, CA Secretary
- Matt Wallin, Bennett Trenchless – Folsom, CA Treasurer
- Normal Joyal, McMillen Jacobs – Walnut Creek, CA Treasurer-in-Training*

*I Informal officer position

WESTT’s general meeting held at the National No-Dig Conference in Dallas, TX, saw the largest turnout of members to date. Here we organized our schedule to ensure rollout of our magazine, conference planning, and execution of general administration items in a timely manner. Given that our Board members and officers are volunteers, we were encouraged to see additional volunteers from our membership sign up to help with the effort. As a way to show our appreciation for their support, these member volunteers are spotlighted on page 13 of this magazine.

Volunteering with WESTT activities is a great way to get more involved in our region and gain familiarity with our trenchless industry successes (and lessons learned), not to mention our trenchless industry professionals. It’s also a fair amount of work. To this end, I would like to thank the WESTT Board and officers for their efforts in leading this chapter, building our organization, and ensuring continued value to our members!

I would like to thank the WESTT Board and officers for their efforts in leading this chapter, building our organization, and ensuring continued value to our members! And I would be remiss if I didn’t give a shout-out to the tremendous help and support of the NASTT staff (Mike Willmets, Michelle Hill, Jenna Hale, and Molly Margosian) and NASTT Chairman (Kim Staheli). If you are interested in contributing, please reach out to any of the Board members to find out how you can help.

I couldn’t close without a quick mention of our upcoming Western Regional No-Dig Conference this October. We have an excellent technical program and reception lined out for our first day, and NASTT Good Practices training courses offered for the second day. We also have several exhibitors serving as great resources to enhance your technical toolbox. We hope to see you there! More information is available on our website: www.westt.org.

I am proud to be a part of this terrific organization! Thank you all for your support and participation.

Cindy Preuss, P.E.
Chairman, WESTT

“I would like to thank the WESTT Board and officers for their efforts in leading this chapter, building our organization, and ensuring continued value to our members!”
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MESSAGE FROM NASTT

Stronger Than Ever

Greetings WESTT Chapter Members! NASTT is having another great year, and I’m excited for our future during my term as Chair of the Board of Directors and beyond. As I’m sure you know, NASTT’s 2016 No-Dig Show in Dallas was a huge success as we experienced a sold-out exhibit hall and had excellent attendance. One of the biggest reasons for this success was the leadership provided by the 2016 No-Dig Show Program Vice Chair, Jennifer Glynn, from this very chapter! I would personally like to thank you Jennifer, for your time and dedication to the conference. We are looking forward to having you as the Chair of the 2017 No-Dig Show in Washington, D.C. next April.

NASTT would never be where we are today without the dedication and support of all of our volunteers and our 11 regional chapters. I would like to thank the following WESTT Chapter Members who served on our No-Dig Show Program Committee and volunteered their time and expertise to peer-review each and every abstract submittal to ensure the technical presentations were up to the standards we are known for: Samuel Ariaratnam, Brian Avon, Glenn Boyce, Craig Camp, Jennifer Glynn, Sarah Johnson, Collins Orton, Cindy Preuss, Cory Street, and Matthew Wallin. I would also like to extend a special thank you to Brian Avon and Jennifer Glynn for serving as Session Leaders in addition to serving on the Program Committee.

This year’s 15th Annual Educational Fund Auction was a rockin’ success, due in great part to the Auction Committee! Brian Avon, Michelle Beason, and Cindy Preuss are WESTT Chapter Members who serve on our Auction Committee and volunteer their time to make this event so great. The Rock n’ Roll themed event raised more than $90,000 for NASTT’s educational initiatives. Beyond that, it was a blast for all the attendees! Thank you for your dedication.

In addition to the annual No-Dig Show, NASTT provides many trenchless training courses. We are focused on trenchless education and our highly experienced instructors are dedicated to trenchless education, providing their expertise strictly on a volunteer basis. They donate personal time to travel around North America to provide high-quality training on a host of trenchless technologies. The WESTT Chapter boasts many of our instructors! I would like to thank these WESTT members who volunteered as instructors this year: Dr. Sam Ariaratnam, Dr. David Bennett, Dr. Glenn Boyce, Craig Camp, Aaron Cohen, Jennifer Glynn, Mary Neher, Collins Orton, and Matthew Wallin.

We are very excited about this year’s WESTT Regional Chapter event – the 12th annual! – in Las Vegas in October.

“We are very excited about this year’s WESTT Regional Chapter event – the 12th annual! – in Las Vegas in October.”

NASTT has a very promising future and the WESTT Chapter is stronger than ever. Thank you again for your continued support and dedication to NASTT and the trenchless technology industry.

Dr. Kimberlie Staheli
NASTT Chair

“We are very excited about this year’s WESTT Regional Chapter event – the 12th annual! – in Las Vegas in October.”

Dr. Kimberlie Staheli
NASTT Chair
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EVENT DETAIL
The Western Society for Trenchless Technology (WESTT) is proud to present the 12th Annual Western Regional No-Dig Conference, Exhibition, and Short Course, Monday & Tuesday, October 17th & 18th, 2016 in Las Vegas, NV.

Register today and enjoy all the benefits of a national conference program in a smaller forum with a personalized touch! Come to exciting Las Vegas and learn about the latest in trenchless technology from experts in the field. Registration for the first day of the conference includes an informative technical program and product exhibition area. On the second day of the conference, attendees can choose to attend either NASTT’s New Installation Methods Good Practices Course or NASTT’s Pipe Bursting Good Practices Course. Attendees may choose to participate in either or both days of the conference (see rates). For more information on course content and instructors, please visit www.nastt.org/training.

HOTEL INFORMATION
Attendees are responsible for making their own lodging arrangements. A limited block of rooms has been reserved for WESTT at a rate of $70 per night at the South Point Hotel. Call (866) 791-7626 and ask for the WESTT group rate or book online. The address is 9777 Las Vegas Boulevard South, Las Vegas, NV 89183. Special room rate is guaranteed until September 23, 2016.

For questions about the program content or registration information, please contact Craig Camp at (619) 410-6328 – craig.camp@mottmac.com or Noel Guercio at (602) 438-2200 – noel.guercio@stantec.com.

CONTACT INFORMATION
Craig Camp, Board Member
Phone (619) 410-6328 or
Email: craig.camp@mottmac.com

Noel Guercio, Board Member
Phone (602) 438-2200
Email: noel.guercio@stantec.com

PAYMENT INSTRUCTIONS
To register online, go to https://www.regonline.com/Register/Checkin.aspx?EventId=1859863
If you would prefer to pay by check, please click “Register Online” for online registration and then select “Check” as the payment option on the Checkout page.
If paying by check, please send payable to:
WESTT
Attn: Matthew Wallin
950 Glenn Drive, Suite 115
Folsom, CA 95630
Phone: (916) 294-0095
matthew.wallin@bennetttrenchless.com

PUBLIC-SECTOR ATTENDEE
Technical Program
and Product Exhibition
Monday, October 17, 2016
7:30 AM - 5:00 PM
$125.00 (Standard) | $100.00 (Early)

Monday Evening
Networking Reception
Monday, October 17, 2016
5:00 PM - 7:00 PM
Location: South Point Hotel

New Installations GP Course
Tuesday, October 18, 2016
7:30 AM - 5:00 PM
$275.00 (Standard) | $250.00 (Early)

Pipe Bursting Course
Tuesday, October 18, 2016
7:30 AM - 5:00 PM
$275.00 (Standard) | $250.00 (Early)

PRIVATE-SECTOR ATTENDEE
Technical Program
and Product Exhibition
Monday, October 17, 2016
7:30 AM - 5:00 PM
$300.00 (Standard) | $250.00 (Early)

Monday Evening
Networking Reception
Monday, October 17, 2016
5:00 PM - 7:00 PM
Location: South Point Hotel

New Installations GP Course
Tuesday, October 18, 2016
7:30 AM - 5:00 PM
$475.00 (Standard) | $425.00 (Early)

Pipe Bursting Course
Tuesday, October 18, 2016
7:30 AM - 5:00 PM
$475.00 (Standard) | $425.00 (Early)
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<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>7:30</td>
<td>Sponsored Breakfast and Registration</td>
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<tr>
<td>8:30</td>
<td>Welcome Address and Exhibitor/Sponsor Introductions, by Noel Guercio, Stantec Consulting Services Inc. (2016 WESTT Conference Chair)</td>
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<tr>
<td>8:55</td>
<td>NASTT Welcome, by Matthew Wallin, Bennett Trenchless Engineers (NASTT Board Member)</td>
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<tr>
<td>9:10</td>
<td>Keynote, by Allen E. Pavelka, P.E., City Engineer, City of Las Vegas</td>
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<tr>
<td>10:00</td>
<td>Extended Sponsored Refreshments in Exhibit Area</td>
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<tr>
<td>10:45</td>
<td>Slilining a 90-inch Host Pipe with 87-inch &amp; 84-inch Steel Can Liners, by David Markert, Kiewit Infrastructure West Co, Phoenix, AZ and Cole Kratochvil, Kiewit Infrastructure West Co, Phoenix, AZ</td>
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<tr>
<td>11:10</td>
<td>Trenchless Technology: A Key Component in Railroad Expansion, by Abe Veidmark, SSC Global, Phoenix, AZ</td>
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<tr>
<td>11:35</td>
<td>Preemptive Actions Lead to the Successful Horizontal Directional Drill (HDD) Crossing of a Congested Corridor, by Aaron Perkins, Long Beach Gas &amp; Oil; Steve Bateman, Long Beach Gas &amp; Oil; Ed Ayala, ARB Inc, PSC; Lew Magnone, ARB Inc, PSC; Tom Van Dyke, T&amp;D Services, Inc.; Craig Camp, Hatch Mott MacDonald; and Trent Cohen, Hatch Mott MacDonald</td>
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<tr>
<td>12:00</td>
<td>Sponsored Luncheon in Exhibit Area</td>
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<tr>
<td>1:30</td>
<td>Carbon FRP Breaths Life into 90-Year-Old Riveted Steel Penstock, by Mo Ehsani, PipeMedic, LLC, Tucson, AZ; Craig Hurley, Salt River Project, Phoenix, AZ; and Joshua Ahumada, FRP Construction, LLC, Tucson, AZ</td>
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<tr>
<td>1:55</td>
<td>108-Inch Storm Culvert Replacement Pipe Ram on CA-1 Coast Highway, by Kathryn Wallin, Bennett Trenchless Engineers, Folsom, CA and David Bennett, Bennett Trenchless Engineers, Folsom, CA</td>
</tr>
<tr>
<td>2:20</td>
<td>Risk-Based Condition Assessment of Downtown Interceptor Phase 2, by Mike Fleury, P.E., BCCE, Carollo Engineers, Inc., Las Vegas, NV; Greg Gould, P.E., Carollo Engineers, Inc., Las Vegas, NV; Blake Gonska, P.E., Carollo Engineers, Inc., Las Vegas, NV; Tim Parks, P.E., City of Las Vegas, Las Vegas, NV; and Randy McConnell, P.E. City of Las Vegas, Las Vegas, NV</td>
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<td>2:55</td>
<td>Sponsored Refreshments in Exhibit Area</td>
</tr>
<tr>
<td>3:40</td>
<td>Pipe Bursting Overcomes High Risk Project, by David C. Mathy, C.E., G.E., DCM Consulting, Inc., Lafayette, CA; Jigar D. Shah, C.E., WaterWorks Engineers LLC., Roseville, CA; Corri Vandiver, C.E., City of Redding, Redding, CA; and Rob Morrow, Mocon Construction, Indio, CA</td>
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<tr>
<td>4:05</td>
<td>Lessons Learned During Installation of Large Diameter CIPP Lining in an Environmental Mitigation Area, by Jennifer Glynn, RMC Water &amp; Environment, Walnut Creek, CA and Madison Casserly, RMC Water &amp; Environment, San Jose, CA</td>
</tr>
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<td>4:30</td>
<td>HDD Allows Water Pipeline Construction across Pearl Harbor, by Devin Nakayama, PE, Yogi Kwong Engineers, LLC, Honolulu, HI and Richard (Bo) Botteicher, PE, Underground Solutions, Inc., Denver, CO</td>
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<tr>
<td>4:55</td>
<td>Sponsored Reception</td>
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**DAY TWO – TUESDAY, OCTOBER 18, 2016**

<table>
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<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>7:30</td>
<td>Sponsored Breakfast and Course Registration</td>
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<tr>
<td>8:00</td>
<td>Short Course – Morning Session</td>
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<tr>
<td>10:00</td>
<td>Break – 15 minutes</td>
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<tr>
<td>12:00</td>
<td>Sponsored Luncheon</td>
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<tr>
<td>1:00</td>
<td>Short Course – Afternoon Session</td>
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<tr>
<td>3:00</td>
<td>Break – 15 minutes</td>
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<tr>
<td>5:00</td>
<td>Conference Adjourns</td>
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Today’s forest industry is working hard to become one of the greenest industries on earth.

- What other industry plants hundreds of millions of trees every year?
- What other industry actually grows more of its main resource than it consumes?
- What other industry generates most of its own energy needs from renewable resources, including waste biomass, biogas, hydro and wind?
- What other industry uses a renewable resource and recycled stock as its main ingredients?
- What other industry has worked harder on improving its environmental performance with partners and advocates including governments, customers and environmental groups?

Paper is an essential part of human civilization. While we all use and depend upon electronic communications, it is easy to ignore that it comes at an environmental cost. Worldwide spam email traffic creates greenhouse gases equivalent to burning two billion gallons of gasoline yearly, with numbers rising. More than 200 million items of toxic e-waste are thrown away every year in the US alone, with a recycling rate of only 18% compared to 57% for paper. Estimates are that North Americans throw out more than 500,000 toxic computers and cell phones every day.

No industry is perfect. But the paper industry has made, and continues to make, huge investments in environmental responsibility. Specifying and buying paper from certified sources ensures the continuation and growth of carbon-absorbing forests. Using paper with appropriate amounts of recycled fibre helps preserve forests, conserve energy, and maximize fibre usage through paper lifecycles.

Paper is a powerful communications medium. Use it responsibly… and recycle the paper that you use.
WESTTT Chapter Volunteer Spotlight

The WESTTT Board of Directors would like to recognize the valuable contributions to the trenchless industry from two of our members: Michael Lien and Dave Bennett.

Thank you both for your time and your dedication to NASTT and to the Western Chapter!

Michael Lien
Controller & CFO at TRIC Tools Inc.

Michael Lien wears a number of hats at TRIC. Since joining the company in 2000, Michael has been the CFO and Operations Director for the company. In addition to finance and operations, Michael coordinates annual trade shows and works to build new relationships to continue to grow TRIC’s brand and technology. Michael writes the press releases for the company and works closely with Director of Marketing & Technical Support John Rafferty on Marketing/Advertising, and with Director of Sales Gregg Abbott on international sales development.

Michael has been involved in the WESTTT Chapter of Trenchless Technology for two years. Michael explains, “I work with the WESTTT Chapter to organize white paper presentations. NASTT has been a great organization for our industry and company; I look for ways to give back to the industry and provide support for upcoming events.”

DAVID BENNETT, PhD, PE
Principal Partner at Bennett Trenchless Engineers, LLP

Bennett Trenchless Engineers, LLP, is a certified SBE specialty consulting engineering firm located in Folsom, CA, that focuses 100% on trenchless technology. The principal partner of the firm, David Bennett, is a recognized industry leader who brings extensive experience to bear in developing innovative, cost-effective solutions to complex, real-world problems.

Dave’s engineering practice includes expertise in geotechnical evaluations, microtunneling, tunneling, HDD, and pipe bursting. He conducts feasibility studies, preliminary designs, design/constructability reviews, provides permit assistance, prepares plans and specifications, prequalification packages, and instrumentation and monitoring plans, and plans and supervises geotechnical investigations.

He provides claims evaluation and expert witness services to Owner agencies, engineering firms, contractors, and other parties. He trains construction inspectors and develops construction guidelines and practice standards for microtunneling, HDD, and pipe bursting.

Dave has authored more than 60 technical papers on trenchless technology, tunneling, and geotechnical engineering. He serves on the Editorial Advisory Board for Trenchless Technology Magazine. Dave was selected by a panel of peers as “2005 Trenchless Technology Person of the Year,” and was honored by induction into the Trenchless Technology Hall of Fame in 2013.

Dave served on the NASTT Board of Directors for a full 12 years, and has been a valued member of the No-Dig Program Committee since 1992. In addition, Bennett Trenchless has a very active role in the WESTTT Chapter. Specifically, Matthew Wallin and Kate Wallin have given generously of their time and expertise to organize the annual conferences. Matt has served as treasurer since the Chapter’s inception and is now on the Board of Directors. BTE staff have given numerous paper presentations at the annual WESTTT conferences.

“I’ve always felt that as Professional Engineers we have a responsibility to give back to the practice and profession that has given so much to us,” says Dave. “Once you get involved in trenchless technology it becomes addictive and contagious,” he explains. “You want to be around this group of people who are so energetic and enthusiastic about trenchless.”

Dave feels it is important to encourage people to get involved in NASTT and WESTTT in any way they can. “I feel like the WESTTT Board of Directors and officers are a highly enthusiastic group with great ideas – it’s a terrific role model for other chapters to emulate. The leadership and the organization are in good hands.”
The Clark County Water Reclamation District (CCWRD) doesn’t serve Las Vegas proper, that international tourist mecca. The city’s public works department handles sewage generated by the millions of people who flock to the city every year, plus residents and businesses.

Collecting and treating the sewage generated by rest of the county, including unincorporated areas and five outlying towns, is the responsibility of the CCWRD. Every day, the district collects and treats 100 million gallons via 2,000 miles of pipelines and seven treatment plants.

The wastewater-collection network was established in 1954 and, like many of this age, requires eventual upgrades. To increase capacity, in 2014 the district broke ground on the largest expansion project in its history: 13 miles of new gravity sewer interceptor broken into three sections that are being placed simultaneously.

As the map below shows, the $150 million Paradise Whitney Interceptor snakes through residential areas and around McCarran Airport and ends at the district’s main facility, the 150 mgd Flamingo Water Resource Center. The sawtooth alignment crosses three interstates along the way (see map).

To minimize disruption to homeowners, businesses, and traffic, roughly half the new pipelines are being installed with microtunneling and earth pressure balance (EPB) equipment. Ultimately, 32 alignments of 60-to-74-inch pipe will be placed to depths of 45 feet using these methods. Scheduled for completion in 2018, the project comprises the largest concentration of trenchless-installed pipelines in the U.S. in more than a decade.

The Clark County Water Reclamation District new 13-mile interceptor is being installed in three segments, each awarded to a different design and construction team. From right to left, Eastern segment design: Carollo Engineers Inc. with Denver-based Brierley Associates as sub-consultant; prime contractor: Las Vegas Paving. Central segment design: Black and Veatch Corp.; prime contractor: Contri Construction of Las Vegas. Western segment design: MWH; prime contractor: Southland Contracting of Roanoke, Texas. The prime contractors are responsible for all cut and cover installations, shafts for tunneling operations, and general construction. Graphic: Clark County Water Reclamation District.
CONSTRUCTION METHODOLOGY
Also known as slurry microtunneling, microtunneling is a remote-controlled, laser-guided, continuously supported pipe-jacking method for installing gravity-flow pipelines requiring precise line and grade in poor soil. It’s typically used in ground conditions below the water table where workers aren’t permitted.

Soil is infused with slurry at the face of the bore to minimize ground surface settlement. Cuttings are forced into slurry inlet holes in the microtunnel boring machine’s (MTBM) crushing cone for circulation to and from a closed slurry system to a separation plant (see diagram).

The method is used primarily with reinforced concrete, steel casing, fiberglass, centrifugally cast fiberglass reinforced polymer mortar, polymer concrete, clay, and ductile iron ranging in diameter from 30 inches to 114 inches.

With EPB, spoil is removed from the pressurized cutting chamber through a screw conveyor and placed into a haul unit system. EPB systems install pipe by pipe jacking or segment-erecting methods.

The method is often used for large-diameter tunnels, typically 102 inches and larger, where continuous pressure is necessary to balance groundwater and earth pressures. Common pipe types are reinforced concrete, steel casing, fiberglass, centrifugally cast fiberglass, reinforced polymer mortar, polymer concrete, clay, ductile iron, concrete segments, liner plate, and ring beam and lagging tunnels.

CCWRD is an award-winning utility whose assets are critical to maintaining a desert region’s water supply. The district’s used both trenchless methodologies before, but this project required the use of a new material for the first time: Flowtite fiberglass reinforced pipe (FRP). Manufactured by Thompson Pipe Group of Zachary, La., the pipe is strong enough to withstand jacking via EPB or MTBM equipment through the extremely hard sedimentary rock – called caliche – found in desert regions that morphs into a clayey consistency when mixed with water.

At 26,143 feet, the new interceptor represents the third and most extensive installation of Flowtite FRP in the U.S. “Fiberglass pipe has been widely accepted throughout the world for decades as a solution to corrosion, but adoption in North America has lagged behind,” says Thompson Pipe Group Executive Vice President Mike Leathers. “This interceptor is a powerful commitment to sustainability from CCWRD and the engineering teams. They’re leading the way in navigating the most complex infrastructure challenges of today and we’re proud to produce a non-corrosive pipe that aligns with both their budget and infrastructure goals.”

EXTREMELY CHALLENGING SUBSURFACE CONDITIONS
A joint venture of Pipe Jacking Unlimited Inc., San Bernardino, Calif., and Frontier-Kemper Constructors Inc., Sylmar, Calif. – Pipe Jacking/Frontier-Kemper Joint Venture (PJ/FK) is performing all trenchless installations on two of the three project segments.

Pipe Jacking Unlimited is using their own 64-, 66-, and 78-inch outside diameter (OD) EPB systems to install 19,543 feet of 60-to-76-inch FRP and steel casing in 24 drives ranging from 20 to 45 feet deep.
Frontier-Kemper is using an Akkerman 60-inch OD, SL60 MTBM that has a 63-inch increase kit to match the outside diameter of the 62.9-inch Flowtite pipe. They are also using an Akkerman MT875K keyhole jacking frame and a slurry separation plant manufactured by Houston-based Derrick Equipment Co. The company will install 6,600 feet in eight drives ranging from 520 feet to 1,500 feet to depths of 20 feet to 40 feet.

The most difficult task on the project is managing logistics – equipment and pipe staging, traffic diversion, and maintaining work flow – while abiding by ordinances and noise and shift restrictions. Coordinating these tasks between two separate prime contractors amps up the challenge. At any given time, up to three reaches were under simultaneous construction.

“It’s so important to have the right people doing the work and using the correct equipment to best suit the ground conditions,” says Bob Marshall, PJ/FK project manager and operations vice president at Frontier-Kemper Constructors. “It’s very common for us to perform additional soil borings before a drive to select the right cutter head. Incorrect head selection could cause a delay of weeks or even longer. To maintain project schedules and complete the work on time, we have up to three tunnel headings and four crews going at the same time.”

In addition to 10,000 psi caliche, the geotechnical report showed soft, collapsible, low blow count soils and sticky clay, with great variations along each reach.

“Like in Vegas, the trenchless work is a gamble,” Marshall says. “Sometimes the ground will change from one extreme to another on the same drive.”

Frontier-Kemper used its new SL60 MTBM for the first time in March 2015 to install 750 feet in the project’s Eastern segment. The launch shafts were constructed with secant piling and a pit seal. The crew used a MT875K jacking frame capable of 800 tons of thrust capacity to move the pipe string. Depending on the drive’s anticipated soil conditions, the equipment used soft ground and disc cutter heads alternately.

A typical microtunnel boring machine (MTBM) system: electrically powered machine with a variable frequency drive, aboveground control container, remote hydraulic power pack, keyhole jacking frame, pumps, laser, water cooling tank, slurry trunk and additional lines, and slurry separation plant. The launch shaft is outfitted with a pit seal to prevent flooding of the shaft and a project-specific thrust block to distribute jacking force. An active laser guidance system inside the machine reports alignment statistics to the operator, who manages the microtunneling process from the control container alongside the shaft.
In addition to low blow count soil, the Eastern segment also has high ground water.

To provide in situ support for the machine and completed alignments, the design specified compaction grout columns on seven of the eight alignments, totaling 5,800 feet. Subcontractor Malcolm Drilling Co. Inc. of Salt Lake City conducted this ground improvement technique where a specialty rotary drilling rig injected columns of fluid grout five feet below the pipe invert via three, 12-inch-diameter columns spaced every eight feet.

The longest alignment on the project, which is also the longest microtunnel, is scheduled to begin at the end of February on the Eastern segment. Frontier-Kemper will be using Akkerman’s new AZ100 Total Guidance System for the extended length.

At one point, Frontier-Kemper crews installed 90 feet of 20-foot pipe via microtunneling in 11 hours, an impressive production rate.

CHANGE OF PLANS: OPEN CUT TO TRENCHLESS

There have been several instances where alignments that were originally going to be placed via traditional open cut were converted to trenchless.

When residents in the Central segment were notified of pending construction on a 2,700-foot stretch on Eldorado Street, they were alarmed by how the work would affect their livelihood due to property access limitations.

That segment’s prime contractor, Las Vegas-based Contri Construction, and PJ/FK met with district employees and came up with a plan to convert the runs to trenchless. After identifying the least disruptive location for the shafts, the district issued a change order – all within three days.

Project commitments made using one of the EPB systems most logical, and the stretch was divided into three alignments of 800, 900, and 1,000 feet. Pipe Jacking Unlimited began installation within three weeks of the change order date and finished ahead of schedule.

The first launch was kicked off with an open forum and tour of the project site to educate residents on the method. This extra effort instilled trust.

“Contri Construction installed the first double-jacking shaft, PJ/FK mobilized to the site on July 13, 2015, and demobilized on Oct. 7,” says Marshall. “This was ahead of the anticipated schedule and within the confines of five workday, single-shift restrictions.”

To alleviate traffic impacts, an additional 830 feet of 60-inch FRP in the Central segment also was converted to EPB installation. A 76-inch open-cut casing alignment was redesigned for an EPB installation and extended from 462 feet to 1,200 feet to avoid interference with a utility. Total converted alignment was 4,200 feet.

The project’s success can be attributed to record footage, thorough geotechnical findings, exceptional designs, competent contractors, experienced operators, quality equipment and pipe, and the district’s commitment to its customers. The common thread among all players has been mutual expertise, ambition, and integrity.

“The district stepped up and spent additional money to minimize negative impacts to residents,” Marshall says. “Not many agencies will make that kind of decision in such a short time frame.

“I’m particularly proud of how Frontier-Kemper and Pipe Jacking are able to work as a team with the same goal. If we do what’s best for the project and what’s best for the team, we’ll have a successful project. At 70% complete, our philosophy is working. So far, so good.”

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The railroad system continues to be a major component in the transportation of raw materials used in construction projects nationwide, and of both imported and exported products. A particularly high volume section of UPRR track located in far southwestern Arizona is currently being widened to allow for increased locomotive traffic in this key area that connects ports in San Diego with inland hubs. As part of the widening process, the culverts that run underneath the tracks for drainage from one side to the other need to be reconstructed in order to span the increased width.

SSC was contracted by Skanska to perform horizontal auger bores underneath the live railroad tracks to install steel casing that would be incorporated into the new culverts. The project started on August 18, 2014 and called for 16 bores, installing steel casing ranging from 36” to 60” in diameter for 40’ to 60’ depending on the location. Once the casing was installed via horizontal auger boring under the tracks, additional footage of casing was welded on to each side to create the required span for the new bridges and culvert structures to be built around.

In order to perform work of this type on active rail lines, SSC’s crews underwent extensive training and background checks before being permitted on site. Daily meetings were conducted pre-shift to communicate the day’s work plans with the railroad representatives and coordinate work with anticipated rail traffic. A dedicated railroad flagger was present at all times with SSC’s crews and when a train approached and crossed, all workers would have to move 25’ away from the tracks until the train had passed. This constant interruption, combined with the challenging soil conditions of flowing sand and the remote work location, could have caused this project to have significant delays. However, SSC’s dedicated crews with their combined decades of experience working in all soil types were able to complete the work on schedule, turning over 16 completed crossings on October 6, 2014 for Skanska to then incorporate into their completed project.
NASTT’s 2017 No-Dig Show will be hosted in Washington, D.C., from April 9–13, 2017.

**Schedule of Events**
There’s no substitute for NASTT’s No-Dig Show when it comes to staying in touch and informed! Grow your network of business connections and stay on top of the latest trenchless developments at NASTT’s 2017 No-Dig Show!

**Sunday, April 9, 2017**
- 7:00 am – 5:00 pm: Attendee & Exhibitor Registration
- 8:00 am – 12:00 pm: Trenchless Technology Short Course – New Installation
- 8:00 am – 12:00 pm: Trenchless Technology Short Course – Rehabilitation
- 1:00 pm – 2:00 pm: Annual General Meeting
- 1:00 pm – 5:30 pm: NASTT’s Regional Chapter Meetings
- 4:00 pm – 7:30 pm: Student Orientation Meeting

**Monday, April 10, 2017**
- 7:00 am – 5:00 pm: Attendee & Exhibitor Registration
- 7:30 am – 9:15 am: NASTT’s No-Dig Show Kick-Off Breakfast & Entertainment
- 9:30 am – 11:35 am: Technical Paper Sessions
- 11:45 am – 3:45 pm: Exhibit Hall Open
- 3:45 pm – 6:15 pm: Technical Paper Sessions
- 5:30 pm – 6:15 pm: NASTT’s Pre-Auction Reception
- 6:15 pm – 7:30 pm: NASTT’s 16th Annual Educational Fund Auction

**Tuesday, April 11, 2017**
- 7:00 am – 5:00 pm: Attendee & Exhibitor Registration
- 8:00 am – 12:00 pm: Technical Paper Sessions
- 12:00 pm – 3:30 pm: Exhibit Hall Open
- 3:30 pm – 5:35 pm: Technical Paper Sessions
- 6:00 pm – 7:00 pm: NASTT’s Pre-Gala Awards Dinner Reception
- 7:00 pm – 11:00 pm: NASTT’s No-Dig Show Gala Awards Dinner (ticketed event)

**Wednesday, April 12, 2017**
- 7:00 am – 1:00 pm: Attendee & Exhibitor Registration
- 8:00 am – 10:05 am: Technical Paper Sessions
- 10:00 am – 12:30 pm: Exhibit Hall Open
- 10:30 am – 12:30 pm: Student Poster Competition in Exhibit Hall
- 12:30 pm – 2:00 pm: NASTT’s No-Dig Show Closing Luncheon & Entertainment
- 1:30 pm – 5:00 pm: Post-Event Course Registration Check-in
- 2:30 pm – 5:30 pm: NASTT’s Pipe Bursting Good Practices Course (Day 1)
- 2:30 pm – 5:30 pm: NASTT’s Sewer Laterals Good Practices Course (Day 1)
- 2:30 pm – 6:00 pm: NASTT’s Cured-In-Place Pipe (CIPP) Good Practices Course (Day 1)
- 2:30 pm – 6:00 pm: NASTT’s New Installation Methods Good Practices Course (Day 1)
- 2:30 pm – 6:30 pm: NASTT’s Horizontal Directional Drilling (HDD) Good Practices Course (Day 1)
- 2:30 pm – 6:30 pm: NASTT’s Gas Good Practices Course

**Thursday, April 13, 2017**
- 7:30 am – 12:00 pm: NASTT’s Horizontal Directional Drilling (HDD) Good Practices Course (Day 2)
- 8:00 am – 12:00 pm: NASTT’s Cured-In-Place Pipe (CIPP) Good Practices Course (Day 2)
- 8:00 am – 12:00 pm: NASTT’s New Installation Methods Good Practices Course (Day 2)
- 8:30 am – 12:00 pm: NASTT’s Pipe Bursting Good Practices Course (Day 2)
- 8:30 am – 12:00 pm: NASTT’s Sewer Laterals Good Practices Course (Day 2)

For the latest information and updates, visit [www.nodigsow.com](http://www.nodigsow.com).
Tiburon, California is named for the sharks that cruise just offshore of this hilly peninsula in San Francisco Bay. Contractor Gary Miksis, President of Miksis Services Inc. of Healdsburg, CA, may have been thinking of their destructive jaws when he saw gaping rot voids in a 500-foot run of 12-inch corrugated metal pipe with his TrakSTAR mainline inspection camera system from R.S. Technical Services, Inc. during a troubleshooting inspection he was called out to perform in conjunction with a repair for a desperate local homeowner.

The homeowner feared her home might collapse into the steep hillside rapidly eroding beneath it, as water gushed from the fifty-year-old corroding storm drain. One hundred feet of residential line off a Y-connection from the main line about 400 yards uphill was rotting out beneath her, threatening her foundation, retaining walls, and driveway.

UGLY SCENARIO
A local contractor had tried to televise the line, but kept losing the camera into large voids, so they called Miksis and his crew to rehabilitate the bottom rot. With a restored floor, they could create a host shell for pipe rehabilitation and televise the whole line using Miksis’ R.S. Technical TrakSTAR Camera on a TranSTAR Tractor, to determine the best method for rehabilitation. They pushed a one-inch PVC pipe through the line underneath and ahead of the camera and tractor. At the first void encountered, they began feeding a slurry of Quadex Restore grout

Miksis Services Gets Creative With Corrugated Steel

By Mary Shafer
The problem with this ‘fold and form’ method is that the steamed, pliable pipe is very delicate, vulnerable to punctures from any snags in the pipe. After grouting cured to allow the full video inspection, the Miksis team discovered just such a hazard they’d have to fix before moving forward with the pipe-within-a-pipe repair.

Near a joint about 40 feet into the pipe, the original metal tube had been punctured by a backhoe tooth on its ceiling, which was now protruding about two inches into the pipe. This was almost directly under the driveway near the retaining wall, likely a main cause of the massive erosion.

SEAT OF THE PANTS
Miksis decided that a Porta-Power hydraulic jack would do the trick, but how to get it into place? They built a football-shaped skid and pushed it into place with 4 1/4 rigid steel sewer rods connected and extended as needed.

It took several hours to create the carrier on a shop workbench – designing, cutting, and welding the 10-inch tall carrier on a roughly 2x3-foot base with a push shoe. The jack head was about 1.5-inch dia. on a 4” dia. base about 9 inches tall. It was mounted sturdily to the carrier and its 10-foot hydraulic fluid hose connected using regular couplers to a 1/4-inch jetting hose for power. Once onsite, it only took about ten minutes to move it into position and force the deformed corrugated host pipe back into place.

Total project duration for approximately 500 feet of rehabilitation was about three weeks, including installation of a manhole behind the house to access the cul de sac inlet connection. Grouting and fold-and-form took about a week. Miksis enjoyed the challenges, especially engineering the jack carrier.

“You’re always making it up as you go,” he says. “You have to be okay with taking each step at a time. Inspection technology helps tremendously, on tough projects like this. A trenchless rehabilitation might not have even been attempted, let alone accomplished, without the aid of our RST inspection systems. This technology has opened up a whole new area of opportunities for us in the world of pipeline assessment and renewal.”

“It was clear to Miksis there would be just one no-dig repair option.”

LIMITED OPTIONS
It was clear to Miksis there would be just one no-dig repair option. CIPP wouldn’t have fit tightly enough, pipe-bursting doesn’t work on corrugated steel pipe, and slip-lining wouldn’t have been possible with the three major bends in the line. Miksis decided on a PVC fold and form solution, ordering a reel of 12” flattened PVC pipe, which would be steamed to 220°F to make it pliable. His team would winch it through the host pipe, still flattened, then heat the ends enough to insert a pig (plug) in each end. Finally, it would be heated and inflated to its full diameter.

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Abstract
Incline Village General Improvement District (IVGID) out of Lake Tahoe, NV designed a 2,500 linear feet steel water main distribution system replacement project. The project included pipe bursting (splitting) existing 6- and 8-inch steel water mains and replacing with new 8-inch Fusible C900 PVC pipe. The pipe bursting system used specialty cutters and expanders to safely and predictably split and expand the old, thin wall steel pipe. The static (hydraulic) pipe bursting method was utilized to provide positive power without using elastic cable. Splitting steel pipe requires pulling cutter with the elastic effect found using cable. The project is a typical residential water distribution system.

Numerous water services, fire hydrants, gate valves will be removed and reconnected. The paper will demonstrate the practicality of pipe bursting in areas with these features. Steel pipe was widely used in many parts of the West after WWII. In the mountains, steel pipe was cut and welded together as needed to get around boulders and tree stumps. This is the reality of pipe bursting in mountainous areas.

Introduction: Static Pipe Bursting
While pneumatic pipe bursting has become a widely accepted and utilized
trenchless pipe replacement method, bursting ductile iron and steel pipes has always been a limitation of the pneumatic method. The development of hydraulically operated static bursting systems with bladed rollers has provided an alternative to pneumatic pipe bursting that has become valuable in a wide range of pipe replacement situations. These static bursting systems are able to burst/split and replace ductile iron and steel pipes.

In the static process exit and launch pits are used in the same way they are for pneumatic bursting. First, the hydraulic bursting unit is positioned in the exit pit. Then the bursting rods are pushed through the host pipe and into the launch pit. Patented Quicklock bursting rods are linked not screwed together like traditional drill stems or other static systems. This system speeds up the installation process as well as the breakdown procedure. The rods can be quickly removed one at a time at the exit pit as bursting is in operation. A flexible guide rod helps the bursting rods navigate through host pipe as shown in Figure 1.

The flexible guide rod allows the bursting rods to navigate the typical imperfections found on the inside of the host pipe such as sags, humps, dropped joints, debris and other obstacles. At the launch pit, the flexible guide rod is removed. The bladed rollers, bursting head, expander and new pipe are then attached as shown in Figures 2 and 3. The specially designed bladed rollers actually split the host pipe instead of ripping or tearing it.

The entire configuration is pulled back through the host pipe by the hydraulic bursting unit. The bladed rollers split the existing pipe, while the bursting head and expander displace the fragmented host pipe into the surrounding soil. The new pipe is pulled into place simultaneously.

Other pipe materials may be installed in certain situations. Potential pipe materials include: restrained joint ductile iron pipe, restrained joint PVC pipe, among others.

**Background**

The Incline Village General Improvement District (IVGID) is a quasi-public agency established under Nevada Revised Statute, Chapter 318 and chartered to provide

"The project had a smaller footprint than an open cut job. This is quite important to the residents of this largely upscale community."
Lake Tahoe Steel Water Main Replacement via Pipe Bursting

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inside of the actual pipe bursting expander. In fact, for bursting applications with fusible PVC, the pipe manufacturer and the bursting equipment manufacturer work together to ensure that the pulling head and adapter configuration are properly sized for each particular project.

The cutter head, expander train configuration was 14 feet in length. The pulling head was equipped with a special eye to accommodate tracer wires (Figure 4).

A special sleeve was fabricated to help prevent the existing pipe from stacking. As the thin-walled steel pipe is split, it has a tendency to want to buckle and collect or stack up in front of the cutter head and expander train. The four-foot sleeve helps the existing pipe split evenly and maintain as much of its circular shape as possible, allowing the pipe to remain in the ground as it is replaced (Figures 5 and 6).

During the excavation of the exit and launch pits, crews discovered that the existing steel pipe was encased in a special wrap. This wrap was composed of 20 to 30% asbestos. As such, crews needed to take special precautions when dealing with any of the existing pipe exposed during the excavation of launch and exist pits. In addition, Washoe County ordered special testing to be done on pipe samples at a lab specializing in asbestos materials.

The lab determined from samples provided from the jobsite that the asbestos contained in the pipe wrap was not friable, meaning that it could not be pulverized under hand pressure, hence limiting the potential that the asbestos could become airborne. However, the contractor proceeded to take every precaution when dealing with pieces of the existing pipe (Figure 7).

During bursting operations, Q&D Construction installed a four-inch HDPE temporary bypass water supply for affected residents. Soil in the area was hard, with sand, as well as large rocks, 24- to 36-inch in diameter (Figure 8).

Average bursting runs ranged between 400 and 500 feet with several intermediate pits for services and to pre-cut any pipe couplers. Pull readings on the static pipe bursting unit on typical runs ranged from 125 bar to 200 bar. Runs took approximately two hours to complete. For several runs, crews need to remove a certain amount of existing steel pipe that stacked up on the bursting rods as the process took place (Figures 9–11).

**Conclusion**

This project experienced a short delay due to environmental concerns about the pipe wrap on the existing pipe. Washoe County analyzed the material that contains asbestos and determined that it was not friable. This decision allowed the project to move forward.

The existing 6.00” O.D. and 8.00” O.D. steel pipe was split successfully. Special consideration for the thin wall thickness of the existing pipe required use of an elongated cutter assembly to ensure that the pipe would be split but not collapse along its length. This is a very critical advancement for working with thin wall steel pipe.

The new C-900 fusible PVC pipe was installed without difficulty. Water services were reconnected, new valves and fire hydrants were installed. The temporary water system was installed tested, chlorinated, and maintained by the contractor throughout the project.

The first phase of the project was in the street and the second phase was in an easement area between buildings. The project had a smaller footprint than an open cut job. This is quite important to the residents of this largely upscale community. Pit excavations were economized and resulted in a total water main replacement project that was about 80% trenchless. Due to the trenchless option there was much less disruption to the neighborhood. IVGID plans more projects of this type going forward. The contractor, Q&D Construction, is a first-class company and executed the project in very professional manner.

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www.nastt.org
Abstract
The Pearl City Peninsula to Ford Island Waterline Crossing Project involved the replacement of roughly 3,800 linear feet of deteriorated 24-inch cast iron waterline, of which approximately 2,500 linear feet was underwater. The new waterline serves as a primary potable water artery connecting the existing Pearl Harbor Complex with its primary source in Waiawa. The project supports the mission of COMNAVREG Hawaii to supply an adequate, efficient, and safe transmission line for potable and fire protection water for Ford Island, Pearl Harbor Naval Shipyard Area, and Hickam Air Force Base.

Approximately 3,500 linear feet of the waterline was installed using horizontal directional drilling (HDD) methods. This alignment included a crossing from the Pearl City Peninsula, under the Pearl Harbor channel, before surfacing on Ford Island.

Design phase planning included selection of an alignment and profile to tie into the existing waterline, provide minimum cover below harbor mudline, and avoid utilities, pile-supported docks, buildings, and other structures and facilities. The HDD alignment included a horizontal curve through varied subsurface conditions, including very soft slurry-like estuarine deposits, coralline deposits interbedded with coral limestone, stiff alluvial deposits, contaminated fill materials, and possible submarine slope failure. To provide adequate HDD work area, the Navy allowed temporary access and staging within their area. Special traffic control including road closures was granted to facilitate assembly, staging, and pullback of the entire pipe string. This paper will review the design focus, bidding procedure, and construction results of this critical project.
Introduction
The Pearl City Peninsula to Ford Island Waterline Crossing Project is located in the Pearl Harbor Naval Shipyard (PHNS) in Hawaii (Figure 1). Two construction methods were utilized to install the new 24-inch waterline: horizontal directional drilling (HDD) and conventional open trench excavation. HDD was the primary method of pipe installation to navigate the horizontal and vertical alignment of the crossing. Of the approximately 3,800 linear feet of waterline to be replaced, 3,500 linear feet was to be installed by HDD methods, with 2,500 feet below the Pearl Harbor channel. The existing waterline consisted of 24-inch cast iron pipe, which at the channel crossing lays on the mudline surface.

The HDD alignment begins within the Navy area on the Pearl City Peninsula, approximately 1,200 feet inland. The HDD alignment crosses under the Pearl Harbor channel, with mudline, or harbor bottom elevations 30 to 40 feet below mean sea level (MSL) in the deepest parts of the alignment. The HDD alignment ends on Ford Island near Navy residential housing. A future 24-inch waterline crossing from Ford Island to Landing C in PHNS will continue the water transmission to the PHNS, and is indicated in gray on Figure 1. The operating pressure of the new waterline is 65 to 75 psi and the required hydrostatic acceptance test pressure was 150 psi.

HDD Alignment Selection
Project design began with preliminary selection of the horizontal alignment and vertical profile, which necessitated identification of alignment constraints such as buildings, structures, piers, docks, and existing utilities. Straight horizontal alignments are preferred for HDD construction. However, a horizontal curve was necessary to avoid two docks on the Pearl City Peninsula, and two piers on Ford Island (see Figure 2). The horizontal curve was also necessary to place the entry and exit points in locations accessible for the connections to the existing waterlines, and avoid buildings on both sides of the alignment. This horizontal curve resulted in compound (horizontal and vertical) curves along portions of the alignment at each end.

The preliminary alignment was also dependent on available 24-hour work and staging areas on one side of the alignment for the HDD drill rig and associated equipment, and on the opposite side of the alignment for pipe fusion, laydown, and pullback. A critical aspect of this project was obtaining these 24-hour work and

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2016 | Western Regional Trenchless Review | 29
staging locations within the Navy controlled areas on both sides of the alignment during the design phase. Consideration of the vertical bends, vaults, flow tube boxes, and expansion coupling vaults, as well as proximity of numerous existing utilities on both ends, also needed to be accounted for when determining the HDD entry and exit point.

The initial design was to replace approximately 3,330 linear feet of the existing waterline. However, the alignment was extended another 500 linear feet on Pearl City Peninsula, moving the work area further away from the Navy facilities near the shoreline, but still within the overall Navy area. This facilitated easier access for the Contractor to their work area through Navy property, and provided a larger work and staging area that would otherwise not be available if the alignment terminated closer to the shoreline, or within the Navy residential area (see Figure 3). Extending the alignment also allowed for a larger vertical radius of curvature – approximately 5,500 feet – to be designed, and for more of the existing deteriorating waterline to be replaced.

However, because the HDD staging area was now closer to the Navy residential area, requirements for sound dampening walls were placed in the specifications to alleviate noise concerns.

Similar alignment constraints were present on Ford Island, as the exit point was surrounded by Navy buildings, structures, and residential housing (see Figure 3). However, because of the location of the existing waterline that was to be connected to, there was a limit to how far the alignment could be extended. Consequently, the HDD exit point was within 250 feet of the shoreline, requiring a tighter vertical radius of curvature – approximately 2,000 feet.

Further inland and beyond the exit point was a grassy park area, sandwiched between residential homes to the west and Navy buildings to the east. This provided a corridor for the pipe fusion, laydown, and pullback area. Without such a corridor, the design may have required a pipe laydown area on the Pearl City peninsula side, along the two-lane roadway through Navy residential area. With the corridor, a pipe laydown staging area could be demarcated through the grassy park area, and along the shoulder area of Chafee Boulevard (see Figure 4).

The historic runway south of Chafee Boulevard and adjacent areas were not available during design, as the Navy initially reserved the runway for a future photovoltaic power station. However, prior to construction, these areas became available, allowing the HDD contractor to utilize the wider shoulder area between Chafee Boulevard and the runway, and a more spacious 200 foot by 200 foot area on the east end of the runway for pipe storage, assembly, and staging.

Regional Geology

Review of the geologic history of the project area aided in the selection of the preliminary project alignment and profile. In particular, based on past project experience in the area and hydraulic fracture calculations, a minimum cover of 40 feet below the mudline was selected to reduce potential for inadvertent fluid returns through the very soft estuarine deposits anticipated. Background on the regional geology of the project area also helped identify key subsurface conditions that the geotechnical exploration could expect to encounter, and at what relative depths. In particular, the subsurface investigation could expect to encounter coralline deposits at elevations higher than the current sea level, deep alluvial channels with basalt cobbles and boulders, layers of hard volcanic tuff at shallow depths, and very soft estuarine deposits extending deep into the middle of the channel.

Pearl Harbor is essentially a series of drowned river valleys (MacDonald,
1983) with a complex geologic history. The island of Oahu was built by the coalescing of two separate volcanic islands, the Waianae volcano to the west and the younger Koolau volcano to the east. A great amount of the Waianae and Koolau volcanoes were removed by fluvial and marine erosion during the Pleistocene Epoch. After these erosion cycles, the island of Oahu subsided and was submerged more than 1,200 feet, and the deep valleys that were formed through erosion were subsequently drowned and alluviated with deltaic sediments. At the same time, regressions and transgressions of the sea level occurred. This resulted in renewed erosion through the deltaic sediments during periods of lower sea level, extending alluvial channels well below the current mean sea level. Tropical rains eroded the highlands, carrying down and depositing silt and clay soils first in an alluvial environment, then transgressed into back-reef and lagoons. These alluvial deposits were encountered during the geotechnical exploration in the form of stiff to hard silts and clays, with occasional basalt cobbles and boulders.

Also encountered during the geotechnical exploration were reef deposits, marine sediments, and coral limestone, which were produced during periods of higher sea levels while the river valleys were drowned. The varying cycles of advance and retreat of the sea levels resulted in interbedding and intermixing of the terrigenous sediments, marine sediments, reef sediments, and coral limestone. The resultant river valleys were eventually submerged to form the individual lochs that are present today. Ford Island and the nearby Waipio Peninsula are the old divides between ancient valleys extended by coral reefs and marine sediments (Stearns, 1966).

Many submerged buried deep canyons exist in low-lying areas and to thousands of feet beyond the current shoreline, such as within Pearl Harbor. Where these ancient canyons eroded through fringing reefs, and were buried during interglacial sea level rises or subsidence of the island, the resultant harbor sediments were very soft to slurry-like. Past marine geophysical survey indicated possible depths of these harbor sediments on the order of 200 feet.

Finally, scattered sporadically above the Koolau basalt are lava flows and vent deposits of the rejuvenated stage of Hawaiian volcanism, the Honolulu Volcanic Series. Volcanic ash in the form of tuff from the nearby Salt Lake and Makalapa craters can be found throughout the southeast portion of Ford Island and Pearl Harbor.

Subsurface Conditions

Based on the geotechnical exploration and regional geology of the area, a geologic profile along the HDD alignment could be generated (see Figure 6). This geologic profile not only identified key geotechnical and trenchless considerations associated with the materials expected to be encountered, it provided a uniform basis for interpretation of subsurface conditions for bidding. The geologic deposits along the HDD alignment consisted primarily of:

- **Estuarine deposits**, consisting primarily of very soft to slurry-like, saturated, highly compressible, elastic silts and fat clays. Based on laboratory consolidation tests, the estuarine deposits were expected to be normally consolidated to underconsolidated, with expected settlement below the installed pipeline of approximately 10 inches during a 75-year design life for the waterline.

- **Interbedded coraline deposits and coral reef limestone**, consisting primarily of loose to dense, coraline sands and gravels, with cobbles and porous, moderately hard to hard, closely to moderately fractured, and moderately to strongly cemented reef limestone. Based on past experience on previous projects on Ford Island and the Pearl City area, local cavities and voids were expected within the coral reef limestone.

- **Older alluvium**, consisting primarily of medium stiff to hard elastic silts and fat clays, with some basalt cobbles. Based on the regional geology of the project area, basalt boulders were also expected within the older alluvium, and at the base of their buried slopes.
HDD Allows Water Pipeline Construction Across Pearl Harbor

"Cooperation between the general contractor, HDD subcontractor, and the FPVCP pipe supplier during the preconstruction and construction phases was critical for the success of the project."

- Marine deposits, consisting primarily of medium stiff to very stiff, silts and clays, and loose to medium dense coralline sands and gravels with shell fragments.
- Fill materials, consisting primarily of medium dense to dense silty sands and gravels, and stiff to very stiff silts and clays.
- Volcanic tuff, consisting primarily of moderately to slightly weathered, closely fractured, hard to very hard volcanic tuff rock layers.

The overwater drilling confirmed the presence of very soft estuarine deposits at the middle of the harbor crossing, which were expected, based on the regional geology of the project area. The estuarine deposits encountered were very soft, with SPT blow counts of zero with penetration from the weight of rods and hammer, and would likely present steering difficulties during pilot hole drilling. Therefore, the HDD alignment and profile were refined to avoid vertical curves through the estuarine deposits on the Pearl City peninsula side. However, because of the project site constraints, the horizontal curve and part of the vertical curve on the Ford Island side through the estuarine deposits was necessary. The horizontal curve was kept as large as possible, at approximately 6,500 feet, but the vertical curve needed to be approximately 1,500 feet to exit at a location that enabled tie-in to the existing waterline. The preliminary profile was kept at 40 feet below mudline to mitigate inadvertent drilling fluid returns through the estuarine deposits.

Because of the site constraints on both sides of the alignment, and the limitations of the allowable bend radius of the HDD drill path, the HDD alignment also needed to pass through the possible slip arc of a suspected submarine landslide. It was not anticipated that the HDD operations would significantly affect the existing submarine landslide due to the relatively small size of the HDD reamed hole and pipeline. However, as part of the HDD work plan, the HDD contractor needed to be mindful of their fluid pump rates while drilling near the landslide to minimize potential impacts.

Trenchless Considerations and Quality Assurance & Quality Control (QA/QC) Requirements

After the geotechnical exploration and evaluation of the subsurface conditions along the HDD alignment, key geotechnical and trenchless design considerations were identified and addressed. These findings and recommendations were summarized in a geotechnical report, consisting of a geotechnical baseline portion and a geotechnical data portion, and were made available to bidding contractors.

Surface settlement from over-excavation of reamed holes and ground heave from not properly flushing the reamed hole of debris, caverned material, cobbles, or boulders, would cause damage to the numerous existing utilities in the area as well as to the overlyng pavement, roads, and unprotected structure foundations. To monitor potential surface settlement and/or ground heave, the contractor was required to perform a pre-and post-construction survey consisting of photographs and video of existing on-land site conditions. Settlement monitoring along the on-land alignment and nearby structures and facilities was also required.

Potentially contaminated soils were encountered during exploratory drilling on the Pearl City peninsula side. An environmental engineering subconsultant was contracted by the civil designer to obtain soil and groundwater samples for further testing. Because the HDD work would involve drilling through groundwater with drilling fluid returns passing through the groundwater and to the surface, requirements were included for a larger diameter steel casing to be installed to isolate possible contaminated soils and groundwater from the HDD drilling fluid returns on the Pearl City peninsula side of the alignment.

The very soft estuarine deposits presented several concerns. Based on past HDD projects through similar slurry-like material, substantial fluid loss is possible during pilot hole drilling, reaming, and pullback. To minimize the potential for this occurring, the HDD profile was kept at least 40 feet below the mudline, or the bottom of the harbor. The long-term settlement of the normally to under-consolidated estuarine deposits below the pipeline meant that the pipeline was expected to drop over time. The project team’s civil engineer designed expansion coupling vaults on both sides of the alignment to compensate for any downward movement of the pipeline and subsequent lengthening of the alignment.

Steering difficulties were also anticipated through the estuarine deposits and at the interfaces of those deposits with marine deposits, alluvial marine/deposits, and alluvial deposits on each side of the main harbor canal or channel. The coralline deposits, cobble to boulder sized coral chunks, and fractured volcanic tuff rock layers were also expected to be problematic, as they may cave into the borehole during the various reaming stages, obstructing or diverting the reaming tools, which could cause a meandering drill path with kinks or ‘doglegs’ that may substantially increase the pipe pullback stresses. Cavities and voids in the coralline limestone, reef rock ledges, and coralline deposits would also increase the potential for fluid loss during all phases of the HDD process.

The length and depth of the alignment, and the subsurface conditions, presented a difficult and challenging project, but one that was feasible for an HDD contractor and work crew experienced in this type of work. As such, the HDD contractor, and their key personnel including project manager, superintendent, drill rig operator, and tracking specialist, were required to submit to the NAVFAC construction manager for approval, their experience records and examples of past projects through similar subsurface conditions. The qualification
requirements included having an HDD pilot hole rig operator experienced in drilling and steering through extensive slurry-like soils, and an accurate tracking system capable of tracking through brine water conditions. Required pre-construction submittals included an HDD work plan that needed to demonstrate that their selected drill rig, equipment, tools, methods, procedures, drill fluid program, and tracking system were capable of drilling, reaming, steering, tracking, and installing the proposed waterline in the anticipated subsurface conditions. Furthermore, the work plan needed to include contingency measures for steering problems, inadvertent fluid returns, excessive fluid loss, caving-in of the reamed hole, ground heave, clearing obstructions, and stuck or failed product pipe during pullback. Finally, the contractor was required to retain a QC specialist, who was to be full-time, onsite during HDD operations. These requirements for qualifications, submittals, and QA/QC measures were placed in the bid documents and potential bidders would need to include these items in their construction cost. The contract documents included plan sheets and specifications. The plan sheets included pre-approved areas on both sides of the alignment for pipe laydown, staging, fusion, and pullback. The project specifications were based on the Unified Facilities Guide Specifications (UFGS), and modified for project-specific needs. In particular, fusible polyvinyl chloride pipe (FPVCP) was the sole-sourced pipe material to be directly installed by HDD methods. FPVCP was the only material that met the standardized water distribution pipe requirements of the UFGS, and that had the track record of HDD direct installation of pipe size, pullback length, and depths similar to this project. **HDD Construction** The construction contract was awarded to Watts-Healy Tibbits A JV, and construction began in April 2014.
The HDD subcontractor was Southeast Directional Drilling, out of Casa Grande, Arizona. HDD construction began with the installation of 170 feet of 48-inch steel isolation casing on the Pearl City Peninsula (drill rig) side, with the tip of casing extending below groundwater, to isolate potential contaminated soils. The HDD subcontractor used the HDD rig as a platform for the steel isolation casing to maintain the proper entry angle, and used a pneumatic hammer to drive the casing to the desired depth. Augers were used to remove spoils from within the steel casing, where potentially contaminated soils were set aside for testing and proper disposal.

The design HDD alignment was to pass near a small structure near the Pearl City Peninsula shoreline. Prior to pilot hole drilling, the contractor-retained HDD QC specialist indicated that the small structure is actually pile-supported, as he had worked on the design of the structure. The general contractor and HDD contractor made a slight field adjustment in the HDD drill path to provide more clearance from the structure and its piles.

Pilot hole drilling commenced from the Pearl City peninsula side with a 10-5/8 inch drill bit, and a gyroscopic tracking system. By using this gyroscopic tracking system, tracking wires did not need to be laid along the alignment and on the mudline at the harbor channel crossing. Tracking data was monitored and recorded every 30 feet, or at every drill rod length. The pilot hole drill bit broke through into an excavated exit pit on Ford Island, approximately three feet below target (see Figure 7). Despite the very soft estuarine deposits present along the channel crossing, the HDD subcontractor steered the pilot hole through the horizontal and vertical curves along the alignment with line and grade deviations less than the +/- 10 feet of tolerance required in the specifications.

The initial plan by the HDD subcontractor was to ream in two stages; first with a 24-inch reamer, then with a 38-inch reamer. After the pilot hole creation, however, the HDD subcontractor elected to ream the entire length in one pass with a 38-inch reamer. This decision was

![Figure 8. FPVCP pipe fusion (left) and pipe laydown and staging along roadway shoulder (right).](image1)

![Figure 9. FPVCP pipe fusion, staging, positioning, and pullback on Ford Island.](image2)

![Figure 10: FPVCP pullback on Ford Island (left) and FPVCP pullback into the insertion pit on Ford Island (right).](image3)

![Figure 11: Estimated calculated pipe pullback loads, and actual pullback loads observed during construction. Approximately 27,000 lbs. was required to move the HDD carriage, and was factored out of the observed pullback loads at the drilling rig.](image4)
primarily based on the idea that one reaming pass would limit deformation of the alignment, particularly in the curved sections in the soft estuarine deposits. Drill and spoil returns were occasionally lost during the reaming stage, in particular through the estuarine deposits, during which time the HDD subcontractor regained return by retracting drill rods and re-reaming. As a contingency measure in their HDD work plan, the HDD subcontractor devoted adequate time during reaming for the restoration of drilling fluid returns, including tripping the reaming assembly back to the entry pit until returns were restored. The HDD subcontractor also installed weeper subs at 20-joint intervals (approximately every 600 feet) to improve drilling circulation through the reamed hole. After reaming but prior to product pipe pullback, a 36-inch ball reamer was pulled through the reamed hole to ‘swab’ and condition the borehole.

In total, the installation of the steel isolation casing took one week, the pilot hole drilling took approximately two weeks, while the reaming and swabbing stage took approximately three weeks. Based on discussion with the HDD subcontractor and review of subcontractor’s drill logs and daily reports, the drilling rates and conditions generally correlated with the subsurface conditions in the geologic profile. The settlement monitoring records indicated little to no detectable surface settlement or ground heave along the on-land HDD alignment.

**Pipe Fusion, Staging, and Pullback**

The FPVCP was supplied by Underground Solutions, Inc. of Poway, California. Pipe assembly and insertion was performed on the Ford Island side of the alignment. Due to the constraints of the project site, which were primarily related to keeping traffic access open at all times during the project, pipe assembly took place between Chafee Boulevard and the historical runway (see Figure 8) present on Ford Island. Thermal butt fusion was used to assemble the 40-foot lengths of FPVCP delivered to the site into a single length of approximately 3,500 feet. This length was staged along the historical runway until the borehole was adequately prepared and the pipe insertion operation was ready to commence (see Phase 1 of Figure 9).

In order to place the pipe in the appropriate alignment for the insertion process, extensive work was needed to facilitate the movement and assure that traffic access was maintained to all residences and facilities on Ford Island. The pipe was first pulled back away from the insertion location (see Phase 2 of Figure 9), and into a park area, to a point where the curvature of the pipe alignment could be reached as it was turned toward the insertion pit. It was then moved through a radius, through the green space between residential housing and facility buildings, across Wasp Boulevard, and finally into the insertion pit (see Phase 3 of Figure 9).

The final alignment into the borehole required the pipe to be curved both horizontally and vertically by the use of excavators and roller cradles to ensure the appropriate
alignments for insertion (see Figure 10). Throughout this effort, traffic patterns were coordinated such that no area that required access by vehicle was isolated. During the backwards movement, this included the primary roundabout entry area for all of Ford Island. As pipe was then realigned, the roundabout was opened again, while other roadways, such as Chafee Boulevard and Wasp Boulevard, which ended up being blocked along the insertion alignment, were closed off. All pipe fusing, stringing, staging, handling, and movement was coordinated with rollers or other friction reducing elements to limit drag and required pull forces and also to assure that the proper alignment was maintained.

Initial coordination and movement of the pipe began at 2 AM, and the pipe was finally hooked up to the drill stem and ready to be installed at approximately 10 AM. The pipeline reached the Pearl City Peninsula at approximately 9 PM on the same day to complete the insertion process and mark the successful completion of the crossing.

Per the specification requirements, the HDD-installed pipeline was hydrotested in accordance with the applicable AWWA standards, and passed. Subsequent construction efforts consisted of open-trench connections from the HDD-installed pipeline to existing waterlines, and construction of reaction blocks and expansion coupling vaults.

Estimated pipe pullback forces for the installation phase were calculated using a buoyancy-based with capstan effect modifier model (ASTM F1962, 2011). Comparison shows that the actual pipe pullback loads observed during pullback operations generally followed the estimated pipe pullback forces (see Figure 11). Meanwhile, the actual maximum pullback force observed of 140,000 lbs. was well within the safe pulling force of 307,100 lbs. for the 24-inch FPVCP used. Further examination of the actual pipe pullback forces revealed lower frictional resistance through the very soft estuarine deposits. For the estuarine deposits, this may be indicative of a sufficiently oversized and open reamed hole and the very soft, slurry-like nature of the estuarine deposits.

**Conclusions**

The importance of acquiring adequate, 24-hour HDD work and pipe staging areas during the design phase for this project should not be underestimated. The project was located within Navy property and near critical facilities and residential housing. A considerable amount of effort was put forth by the design civil engineer and NAVFAC’s design team to provide work and staging areas available for the contractor and provide a uniform basis of bid. If left up to the contractor and they were unable to obtain adequate staging areas, HDD would become impractical and infeasible.

The contract documents included qualification requirements for the HDD contractor to ensure that a highly trained and experienced work crew would perform the HDD work, adjust fieldwork as necessary, and be able to implement necessary contingency measures should any problems arise. The contract documents were carefully reviewed by NAVFAC during design and the requirements were strictly implemented by NAVFAC’s construction management team. NAVFAC and the project design team also reviewed the HDD work plan and design calculation submittals for conformance with the contract documents.

Finally, for all the design effort, a key contributing factor for the successful completion of the project was the construction effort from the contractor’s team. Collaboration by a group of experts in their respective fields results in unique solutions to both pre-existing design challenges and the inevitable ‘field challenges’ that pop up during construction. Cooperation between the general contractor, HDD subcontractor, and the FPVCP pipe supplier during the preconstruction and construction phases was critical for the success of the project. Watts-Healy Tibbits brought extensive experience with working on Navy projects in Pearl Harbor, and employed a QA manager to review all submittals for conformance with the project requirements. Southeast Directional Drilling provided a highly qualified work crew and support to complete the HDD work through very challenging site and subsurface conditions. Underground Solutions, Inc. provided submittal support to the contractor in the form of pipe staging, pullback, and long-term design guidance; qualified fusion services; and onsite representatives during construction to provide field consultation to the HDD contractor.

**References**


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The North Coast Corridor Transportation project is a major transportation expansion project that will be done in multiple phases over the next several years.

PROJECT OVERVIEW – 805 NORTH COAST CORRIDOR TRANSPORTATION PROJECT
Due to the highway widening that would occur on this project, most of the existing culverts would need to be extended, replaced, or lined depending on their condition. Due to site access and environmental concerns, trenchless repair methods were the preferred method of construction. Recently, SEKISUI was contacted by Caltrans District 11 regarding a 36” CMP culvert that was located during the course of construction along the 805 Freeway in San Diego, CA. SEKISUI worked with Skanska, Caltrans’ design-build contractor, and Nuline Technologies, SEKISUI’s licensed contractor for the SPR™ EX spiral-wound lining process, to provide a structural rehabilitation solution for this culvert.

THE CHALLENGES
There were numerous constructability challenges on this project. First, the headwall where the installation equipment had to be set up was located in an environmentally protected canyon with flowing water and numerous restrictions on site modification. The downstream location was a catch basin which was located in the middle of the 805 freeway in a temporary median staging area. The project then proved to be even more challenging when delays in highway construction constantly altered site access for the lining operation. Furthermore, construction debris, including concrete from prior construction projects, had been left inside the culvert, and the original as-built drawings had incorrect line lengths. SEKISUI and Nuline Technologies worked with Skanska and Caltrans District 11 to address these challenges and provided site specific solutions to execute the scope of work.
SPR EX BENEFITS
SEKISUI’s SPR™ EX liners offered Caltrans numerous advantages vs. other trenchless rehab methods to meet the constructability challenges on this project. First, SPR™ EX’s small construction footprint, plus the ability to install liners via existing access chambers without the need for bypassing, allowed the scope of work to be executed without any negative environmental impact or highway lane closures. Additionally, SPR™ EX liners provided Caltrans with a structural, cost-effective alternative to more expensive dig and replace construction practices with the added benefit of meeting their stringent environmental requirements. No other trenchless rehabilitation methods could meet all these requirements, which is why SPR EX was sole sourced for this project.

CALTRANS STATE-WIDE DRAINAGE SYSTEM INVENTORY
Caltrans inventory includes 205,000 culverts in the drainage system and 20.3 million feet total. Fifty percent of the culverts have been inspected as of January 1, 2016 with 60% of those requiring no repairs while 26,849 culverts (26% or 2.5 million feet) require preventative maintenance and 14,348 culverts (14% or 1.2 million feet) require repair/rehab/replacement.

Approved repair technologies include invert paving, patching, repair spalling, structural lining, and replacement. The remaining 50% of their system will be inspected over the next eight years.

STATE-WIDE DESIGN STANDARDS FOR CULVERT REHABILITATION
Now in its fourth edition, Design Information Bulletin No. 83 - 04 is Caltrans’ supplement to Fhwa Culvert Repair Practices Manual. The primary purpose of the Design Information Bulletin is to supplement the 1995 Federal Highway Administration Publication and to provide information, guidelines, and alternatives for the cost-effective repair and rehabilitation of culverts and storm drains. Only those products that have successfully met the evaluation and testing criteria established by Caltrans are included in this document. SEKISUI’s PVC Spiral Wound Liners successfully met these stringent testing requirements and are specified in Section 6.1.3.5 – Lining with Machine Wound PVC Liner.

“No other trenchless rehabilitation methods could meet all these requirements, which is why SPR EX was sole sourced for this project.”

Caltrans project staging area at headwall located in an environmentally protected area.
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