**CASFM 2018 Annual Conference**

**Water Medley Sessions:**

**Session1: Oh No! We’ve got to go under it!**  
Becky Brock (Brierley Associates), Chris Knott (Btrenchless)

**Session2: Planning and Siting of Recreational Whitewater Features**  
Brooke Seymour & Richard McLaughlin (UDCFD)

**Nature Play Design Guidelines: Techniques for Including Nature Play within Floodplains**  
Cassie Kaslon & Susan Brown (Valerian), Frans Lambrechtsen (CH2M)
Oh No!
We've got to go under it!

2018 CASFM – Snowmass

Chris Knott
chris.knott@btrenchless.com

Becky Brock, PE
rbrock@brierleyassociates.com
Agenda

- Criteria for Stormwater Tunnels
- Subsurface Conditions
- Contracting Preferences
- Trenchless Comparisons
- Trenchless Methods
- Pipe Materials

Oh No! We’ve got to go under it!
Fixed Criteria:

- Flow requirements:
  - Depth, length, diameter, and grade
  - Maintaining grade is critical for gravity flow
- Limited access / Impacts to 3rd parties
- Subsurface conditions
Subsurface Conditions

Design Approach:

- Project Layout
- Subsurface Conditions
- Ground Behavior/Ground Control
  - Design Criteria
  - Construction Methods
  - Third Party Impacts
  - Contract Documents
Subsurface Conditions

Ground Behavior Dictates!!!
Subsurface Conditions

Ground Behavior Dictates!!!
Subsurface Conditions

Subsurface Investigation:

- Crucial to project success
- Challenges of limited access
- Cost – Benefit ratio
- Quality investigation
Subsurface Conditions

Adverse Conditions:

• Difficult Steering
  – Mixed-face condition
  – Cobbles and boulders

• Settlement
  – Unstable soils
  – Shallow cover

• Utility conflicts / obstructions
Mitigation Measures:

- Improves unfavorable ground conditions and reduce risk of damage
- Technique dependent on soil type and gradation
Contracting Preferences

*The owner owns the ground:*

- Contractor pre-qualification
- Geotechnical Baseline Report (GBR)
- Typical Specifications:
  - Trenchless Construction
  - Contact Grouting
  - Shaft Excavation and Support
  - Geotechnical Instrumentation and Monitoring
Contracting Preferences

Geotechnical Baseline Report:

- Establishes a contractual baseline of subsurface conditions for bidding:
  - Baselines are contractual assumptions and not necessarily geotechnical fact
  - Anticipated physical and behavioral conditions
  - Included in the contract documents
Contracting Preferences

Geotechnical Baseline Report:

• Manages risk allocation
• Bids are comparable
• Provides a basis for DSC claims
• Commonly used in trenchless projects

WITHIN THE BASELINE
CONTRACTOR’S RISK

BEYOND THE BASELINE
OWNER’S RISK
<table>
<thead>
<tr>
<th>Method</th>
<th>Diameter (in)</th>
<th>Length (ft)</th>
<th>Usable Under Water?</th>
<th>Line &amp; Grade Control</th>
<th>Cost</th>
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<tbody>
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<td>Auger Bore</td>
<td>8” - 72”</td>
<td>250’</td>
<td>N</td>
<td>Vertical</td>
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<td>McLaughlin</td>
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<td>Hand Tunnel</td>
<td>42” – 15’</td>
<td>100’ &gt;</td>
<td>N</td>
<td>Y</td>
<td>$$$</td>
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<td>Pipe Ramming</td>
<td>12” – 144”</td>
<td>400’</td>
<td>Y</td>
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<tr>
<td>TBM Pipe Jacking</td>
<td>51” – 129”</td>
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<td>N</td>
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<td>Microtunneling</td>
<td>36” – 96”</td>
<td>1000’</td>
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Auger Bores

**Advantages:**

- Relatively inexpensive
- Suitable for a variety of soil types
- Drives up to 250 ft, capable of longer drives with reduced accuracy
- Wide range of sizes: 12” – 72” diameter casing – (non-welded casing option for larger diameters and bores with ground water)
Guided Boring Machine

Advantages:

- Grade and alignment precision
- Can increase the length and accuracy of other trenchless methods, such as Auger, Hand Tunnel and Hammer, for varying soil and grade concerns.
McLaughlin Head

Description:

McLaughlin steering head is used to install bore for drives up to 400 feet. Its guidance system is equipped with a water level for checking and maintaining grade, along with the ability to check and maintain the line throughout the bore with twin line projection halogen lights enclosed in the steering head.

The cutting path—grade and lateral movement of the steering head is controlled by hydraulic actuated flaps that open and close to keep the head on the intended path.
Hand Tunnel

Description:
Utilizes manual labor for excavating material while hydraulic jacks advance the tunnel.
Hammer or Pipe Ramming

Advantages:

- Well suited for cobbles and running sands
- Lowest probability of surface subsidence
Pipe Jacking (TBM)

**Advantages:**
- Suitable for a wide variety of soil types
- Drives of over 1000 ft possible
- Allows for removal of obstructions
- Adaptable to changing soil conditions

**Limitations:**
- Ground water
- Cobble
- Minimum tunnel diameter of 51”
**Advantages:**

- Large Diameters (>36”)
- All Ground Types
- Continuous Face Support
- Long Distances
- Above or Below Water Table
- EXTREMELY Accurate
- Can be used in areas with hazardous materials/soils with minimal exposure to personnel
Microtunnel

Akkerman Jacking Frame
Microtunnel

Slide Rail System

Exit / Entry Seal
Permalok

The Permalok Interlocking Pipe Joining System features a precision machined joint connection which is completed in the field using the existing jacking frame on trenchless equipment or the force from the ramming machine. It eliminates the need for welding the steel pipe, and uses a time-saving 5-step installation process.
HOBAS (CCFRPM) Pipes are centrifugally cast, glass-fiber-reinforced, polymer mortar.

These large diameter pipes are ideally suited for nearly all corrosive piping applications.

HOBAS pipes may be installed by a variety of installation methods. HOBAS pipes can be economically designed for non-pressure and pressure service by varying the quantity, placement, and orientation of the glass-fiber reinforcements.
RCP
(Reinforced Concrete Pipe)
Join Us!

Trenchless Elevated 2018

Date: November 1, 2018
Time: 7:30am – 5:00pm
Location: PPA Event Center - 2105 Decatur Street, Denver 80211

Who should attend?

Owners, utilities, municipalities, as well as engineers and contractors involved in the repair and replacement of aging underground infrastructure.
Questions?
Planning and Siting of Recreational Whitewater Features

Presented to

CASFM

2018 Annual Conference

September 2018
Presentation Outline

1. Why Whitewater?
2. Planning
3. Design
Why Whitewater

Quality of Life
Economic Impact
Public Safety
Quality of Life
Quality of Life
Quality of Life
Economic Impacts
South Platte

1. In 1970, properties within a ½ mile of the South Platte River and Cherry Creek were valued 17% lower than the property values outside that boundary in Denver.

2. $18 BILLION PROPERTY VALUE
As of FY 2017, approximately $18 Billion in property value has been created that would not exist if the conditions of 1970 persisted today along Denver’s waterways.

3. Additonal Funds Received
- $64 Million
- $100 Million
As a result of this increased property value, the City and County of Denver receives $64 Million in additional annual funding and Denver Public Schools receives $100 Million in additional annual funding.

4. Almost $14 Billion in Additional Annual Benefits Received From
- Tourism
- Transportation
- Recreation
- Health Benefits
These benefits are attributable to the improved condition of the waterways.

Denver realizes Cost Savings from the Ecosystem Services provided by the improved landscapes, like
- Natural Stormwater Filtration
- Air Pollutant Capture
- Water Pollutant Capture
- Heat Capture
That otherwise would require non-natural and expensive solutions.
Economic Impacts
Chattahoochee River Restoration

- Economic Impact
  - 50,000 paying rafting customers and zip line customers a year
  - $74m in capital investment
  - 42 new businesses; several university extensions
  - $24m in gross revenues.
  - 400 new jobs
  - Gross tax receipts 2012 to 2017 up 45%.
Public Safety

Overly retentive hydraulics of a conventional dam

Clear Creek drop of 1.8 feet was proven fatal

Union Avenue Dam
Selected “milder” sloped proved hazardous
Presentation Outline

1. Why Whitewater
2. Planning
   - Who are the Users
   - Site Factors
   - Recreational Intent
3. Design
Who Uses Whitewater River Parks?
Cooling Off in Engineered River Parks
User Survey Results

Spectators
✓ Most visitors recreated on the streambanks (76%)

Children
✓ (43%) Recreating in the water compared to teens (27%), adults (20%), or seniors (4%)

Kayakers
✓ Represented only 2% of summer park activities
Site Evaluation or Site Factors

1. Available Flow
2. Vertical Drop
3. Adjacent Area/Access
Site Factor 1 - Flow
Site Factor 2 – Vertical Drop

Often conflict between developing the hydraulic drop and impacting the floodplain.
Site Factor 2 – Vertical Drop

Look for existing dams, diversions, and drop structures.
Flow and Drop are Related

FLOW (CUB FEET/SECOND) vs VERTICAL DROP (FEET)

- INTERNATIONAL ATTRACTION
- NATIONAL ATTRACTION
- REGIONAL ATTRACTION
- LOCAL ATTRACTION

PREVIOUS OLYMPIC COURSES

CONFLUENCE PARK, DENVER
SOUTH BEND IN
CHARLES CITY IA
YORKVILLE, IL
Flow and Drop are Related

- **LOCAL ATTRACTION**
- **REGIONAL ATTRACTION**
- **NATIONAL ATTRACTION**
- **INTERNATIONAL ATTRACTION**

**Previous Olympic Courses**
- Confluence Park, Denver
- Charles City, IA
- South Bend, IN
- Yorkville, IL

**Typical Drop on South Platte**

**River Run/River Surfing Breaks Trend**
Whitewater parks are for spectators.
Site Factors - Others

- Floodplain
- River Morphology
- Fish Habitat and Passage
- Water Quality
Recreational Intent
Water trails

Creation of a Water Trail
Early Whitewater Bypasses, South Platte
The Adventure Sports Course in Maryland has hosted both slalom and freestyle world cups yet is mostly enjoyed by the general public.
Recreational Intent
Surfing
Presentation Outline

1. Why Whitewater?
2. Planning
3. Design
   • Types
   • Durability
   • Engineering Aspects
   • Safety Considerations
   • Costs
Types of Whitewater Courses and Parks

1. Riffle Pool
   - Route Full River Through Low Gradient Drop or "Rapid"

2. Stepped Dam
   - Route Low & Moderate Flows Through Bypass Around Adjacent Stepped Dam

3. Control Gate
   - Whitewater Bypass
   - Route Controlled Flow Through HydraulicallyDisconnected Side Channel
Durability

Nantahala – 2013 World Cup Venue

Newly-changed Calgary weir still dangerous for rafters

Harvie Passage repair to cost millions

Calgary's weir facing massive repair bill due to massive damage from high flood waters

1996 Olympic Venue
Engineering Aspects

- Safety and Recreational Performance
- Floodplain Impacts and Conveyance
- Functioning of Integrated Purpose
- Structure Stability
- Lowest Life-Cycle Costs
- Permitting
- Fish Passage
- Natural Appearance
CFD Modeling
River Run Park
Safety – No Surprises
## Costs

Estimated Percent Increase in Costs Related to Safety and Recreation*.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Percentage Increase Based upon Entire Project Costs.</th>
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<tr>
<td>Conventional Drop (Hazardous Hydraulics)</td>
<td>Base</td>
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<tr>
<td>Low-Hazard Drop</td>
<td>10%</td>
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<tr>
<td>Recreational/Aesthetic Drop (River Run) – Non Adjustable</td>
<td>13%</td>
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<tr>
<td>WaveShaper Surf Feature</td>
<td>18%</td>
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*Based upon costs from River Run Project: 2017-2018, South Platte River.*
Thank You!
Misc slides
### Site Factor 1 – Available Flow

#### USGS Surface-Water Monthly Statistics for the Nation

The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, [click here](#).

**USGS 06710247 SOUTH PLATTE RIVER BELOW UNION AVE, AT ENGLEWOOD, CO**

**Available data for this site**
- Time-series: Monthly statistics

**Output formats**
- HTML table of all data
- Tab-separated data
- Reselect output format

#### Available Discharge Data

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</table>

**Mean of Monthly Discharge**

| Mean of Monthly Discharge | 41 | 51 | 82 | 194 | 454 | 481 | 323 | 202 | 71 |

**Notes:** No incomplete data have been used for statistical calculation.
Who Uses Whitewater Parks – New Trend Surfering
Safety

- Safety improvements – Union Avenue boat chutes; Sheridan, CO

Before

After
Recreational Intent
Performance & Engineering - Fun Equation

\[ \text{RE}(\text{fun}) \propto \int (\text{SQ}, \$, \text{Power}, \text{Design}) \]

RE= Quality of Recreational Experience
SQ= Site Quality = Access and Location
Power = Flow and Drop
$ = Life Cycle Costs
Nature Play Design Guidelines:
Techniques for Including Nature Play within Floodplains

CASFM 2018 Annual Conference Presentation
What’s in the Guidelines

- Nature Play Benefits
- Site Selection
- Public Engagement
- Inclusion in Nature Play
- Design Development
- Construction Document Guidelines
- Project Construction Period
- Post Occupancy
- Case Studies

- Over 70 pages of riveting information!
Why Nature Play Matters

Recent findings from GOCO indicate that 80% of Denver Public School students have never been to the Rocky Mountains.

Denver Office of Children’s Affairs estimates that 54% of Denver’s children live in families at or below poverty level.

Benefits include:
- Environmental Stewardship
- Socio Economic
- Developmental/Health
- Economic
Why Nature Play Matters

The Denver Parks and Recreation Game Plan outlines the following key values for future park planning:

- Sustainable Environments
- Equity
- Engagement
- Sound Economics
What Makes a Good Site

- Proximity to waterways/floodplains
- Existing mature vegetation
  - Shade trees – preserved and utilized
  - If removed, vegetation can be repurposed into seating and climbing features
- Plant inventory and weed management strategies
What Makes a Good Site

- Existing landforms – hills and slopes should be preserved or developed
  - Embankment slides, caves, or climbing areas
- Accessible to multi-modal systems
- Proximity to regional trails
What Makes a Good Site
Public Engagement Process
Community Context

Gather community input through creative measures. Include hands on and collaborative activities: asset mapping, community commitment boards, sandbox charettes.
Hidden Elements of Play
What You Won't See

- Large Play Structures
- Play Features That Require Fall Zones and Safety Surfacing
What You Won't See

- Large Play Structures
- Play Features That Require Fall Zones and Safety Surfacing
But You May See This!

- Water
- Boulders
- Logs
- Plants
- Animals
- Dirt!
Enhance the Existing

View the site from the eyes of the future user... children

Connect the element of fun into the existing site features

- Landforms
- Vegetation
- Waterways
Use The Trail System
Use Subtle Prompts
Use Landforms
Use Vegetation
Don’t Forget the Shade
Include All 5 Senses
Repurposing Material
Longevity and Maintenance
How to Make it Last (Longer)

Allegory of “The Car”

Two recent grads from a university just got their new “big boy (or girl)” job, and were buying new cars to go with their new jobs.

One grad did his research before buying the car, knew what kind of car, how much he was paying, where he was buying it, and created a maintenance plan for when to get it serviced.

The other grad did none of these things and bought the coolest imported car the salesman told him he should buy.

What happened?
Making it Last

1. Develop a planting plan to withstand heavy use appropriate to the site

2. Educate users on how to use the space

3. Work with maintenance staff to develop a maintenance plan

4. Follow through after construction and make necessary changes
Change Will Happen
The Ideal Person Who Handles Change

The first person you think about who is great with change is an Engineer right?
How to Deal With Change?

1. Know and expect change to happen

2. Identify what changes you can be okay with

3. Let change happen – the users will know, better than we will, how to use nature for play
What Can and Can’t Change

Things that CAN’T change
- Volume of the floodplain
- Locations of structures that cross the low flow channel
- Channel geometry

Things that CAN change
- Vegetation (within reason)
- Locations of nature play areas inside of the floodplain
- Alignments of secondary/tertiary trails
Educate Others

- Engage the community in the discussion of the area

- Use signage to educate users on how the area may change over time – and that’s OK
More than A Fad
Please visit the following for additional resources:

www.valerianllc.com
www.naturalplaygrounds.ca
www.goco.org
www.thegreenwayfoundation.org
https://udfcd.org/