33rd Street Outfall Project

Jeff Holste, PE, CFM, Wilson & Company
Steve Choi, PE, City & County of Denver

Presentation Overview

• Project stakeholders and background
• City’s drainage goals
• Walk through the segments
• Key construction elements of each phase
Existing Storm Sewer Systems

• 100-yr old existing brick systems
• Relatively deep
• Detailed brickwork
• Very good condition
• Undersized for today’s flow requirements

33rd Street Outfall Overview

• South Platte River to Marion St (4,400’)
• Connects to existing systems
  • Walnut (72”x 48”)
  • Champa (90”x60”)
  • Downing (63”)
• Blake Street Lateral
  • 54” lateral extending south to 31st/Blake sump
• MLK Jr Lateral
  • 60” lateral extending east along MLK Jr Blvd
• Marion Street System
  • Connect to existing 84” storm sewer at 21st Ave
  (currently being constructed)
Conduit Sizes:
20’ x 4’     18’ x 3’
11’ x 8’     10’ x 8’
53” & 120” dia Hobas
60” dia & smaller RCP

Phase 1 – South Platte River to Union Pacific RR

• Property acquisition
  • Five private parcels were impacted by construction
  • Interruption of business function
  • Union Pacific RR and RTD ROW access
• Private development conflicts with project construction
• Challenges to build
  • Fast changing area and infrastructure
Outfall at the South Platte River

- River outfall structure
- Partnering opportunity with MHFD for funding and management of design and construction
  - Muller Engineering
  - Stream Design
  - Pinyon Environmental

Metro sanitary sewers
70" brick and 78" RCP
Dual 18’ x 3’ box culverts used to cross over the Metro sanitary sewer interceptors

Arkins transition structure
Impacts of Adjacent Development

- Corridor restrictions
- Interaction between multiple contractors on a site
- Milestone dates within each phase
Slide rail system was critical for success

Storm sewer corridor after construction
Phase 2 – Union Pacific Railroad to Blake St

- Four individual tunnels
- Public relations is essential
- Colorado Rockies conflicts
  - Easement and access agreements (UPRR, RTD, Rockies)
- Challenges to build
  - Coordinating with developments
  - Scale of the tunneling operation
  - Railroad permit delays

Railroad tunnel jacking pit excavation
Tunnel guide installation

• Railroad and RTD approvals

• Nine guided horizontal bores along the tunnel alignment

• Two 12" diameter steel pipes to guide and support the 120" diameter tunnel

• Tunnels extend across UPRR and RTD ROW (~250')

Tunnel head – 120"–diameter tunnel under Union Pacific RR and RTD
Hand removal of material at the tunnel head – 50 days

Jacking 10’-diameter sections of pipe
Dual 96”-tunnels under Blake St

Blake junction structure
53" Hobas pipe microtunnel along Blake St
Project Communication

- Public relations takes center stage
- Weekly project meetings
- Weekly public email distribution
- Door-to-door notifications
- City website updates
- www.denvergov.org
  - Search “33rd Street Outfall”

Phase 3 – Blake Street to Curtis Street

- 1,800' length
- Excavation depth varied from 20' to 30'
- Challenges to build
  - 30’-deep excavation
  - Installation of a large concrete box culvert in a small residential street
  - Utilities – overhead and underground
  - Tree trimming and removals
Bring in the Big Boy!
Extended reach for progression of the slide rail system

Box placement
Deep installation – 30'

Utilities
Full corridor reconstruction

Phase 4 – Curtis Street to Lafayette Street

• Phase Highlights
  • Two storm junction structures
  • Massive transition structure in Downing
  • Suspension 33” sanitary sewer

• Challenges to build
  • Closing the intersection of Downing/Martin Luther King Jr Blvd
  • Coordinating with neighborhood schools & businesses
  • New traffic signals
  • Water quality trash vaults
Downing Junction Structure
Downing Junction Structure

Wrap up...

- Five year construction schedule for $40 million project
- Drainage service brought up to 5-yr capacity
- Collaboration between the City, engineer, and contractor was key
- New challenges for each phase
- Laid the groundwork for 27th Street Outfall and Marion Street System
  - Both projects are under construction
- Time lapse video of the Downing intersection condensing 10 months of construction into 2 minutes!
Questions?  jeffrey.holste@wilsonco.com
steve.choi@denvergov.org
Outline

• Project Location
• Project Setting
• Project Issues
• Project Purpose
• Design Constraints and Solutions
• Hydrology
• Hydraulics
• LOMR
Introduction & Team

• Bohannan Huston, Inc.
  – Craig Hoover, PE
  – Rifka Wine, PE, CFM

• Bernalillo County, New Mexico
  – Rodrigo Eichwald, PE
Project Location
Project Setting

Figure 1. Diagrammatic Cross Section - Bernalillo County Bioregions
Project Issues

- Developed in 1940s
- Flat valley areas
- FEMA Zone AH
Project Issues

- Flat Terrain – Roads higher than adjacent lots, runoff trapped on private property
Project Issues

• Protected by Rio Grande Levee System
Project Issues

- Sanchez Farm Open Space & Pond
Project Purpose

- Develop long-lasting, environmentally friendly, resilient alternatives to drain the area and remove the homes from the floodplain.
Design Constraints

- Flat terrain
- Numerous utility conflicts
- Limited ROW
Design Constraints

- Flat terrain
- Numerous utility conflicts
- Limited ROW
Design Solutions

- Over 19,000 LF of new storm drain pipe (from 18” to 66” diameter)
- Over 13,000 LF of utility relocations
- Over 22,000 LF of roadway
- Water Quality Features
- Multi-Use Trail around 16 AF Pond
- Pump station (pictured at right)
- 2,000 LF of 8” force main
Design Solutions

- Roadway profiles lowered
- Performance specifications
- Special couplings
- First use of DuroMaxx pipe by BCPW
- Cost savings of over $120,000 compared to AUB
- In-line WQ Manholes
- Utility Relocations
Design Solutions

• Recycled pavement
• Multi-use facilities at Ponds
  – Trails
  – Community Gardens
  – Open Space Activities
Hydrology

- Impervious Area Analysis
Hydraulics

- SWMM model
  - Dynamic Wave
  - Bi-directional flow
  - Multiple ponds
  - Multiple pump stations
LOMR

• Before:

• After:
Questions

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Dedication and Determination to Overcome Difficulty

Teresa Patterson
Watershed Manager
Mile High Flood District

DAHLIA OUTFALL PIPE
Dedication and Determination to Overcome Difficulty
PEOPLE
OVERCOMING
ADVERSITY

Building Pipe

Building Relationships
CHALLENGES

• 20-ft Deep
• Landfill
• Narrow corridor
• ROW Acquisition
• Overhead Electric
• Canal Crossing
- O’Brian Canal
- Runs year round
- Diversion channel

- Potential shutdown!?
- Ready to build in 6 months?
CANAL CROSSING

- FRICO
- Runs year round
- Diversion channel

- Potential shutdown!?
- Ready to build in 6 months?
Tunneling alternatives

BT Construction

Diversion required
Limited to 2 48-hr shutdowns

Open Cut

Oct 22nd
(1 week to mobilize)

Construction Contract

MHFD: Phase 1
Adams County: Phase 2

Separate Phases

SHUTDOWN complications

FRICO Meeting

OCT.

Negotiate Shutdown
$300,000 for 3 weeks

FRICO Agreements

Oct 24th
(Easements, Approved Plans)

CANAL CROSSING
in 7 months

Construction at Canal

3 weeks
(Nov 4th-24th)

Construction Contract

Oct 22nd
(1 week to mobilize)

Construction at Canal

3 weeks
(Nov 4th-24th)

Construction Contract

Oct 22nd
(1 week to mobilize)
PROJECT PARTNERS

Contractual Partners

Stakeholders
PROJECT PARTNERS

• Collaboration
• Trust
• Commitment
• Communication
• Dedication
WHY DOES IT WORK?

• People like to be heard and understood
• Supports curiosity
• Everyone contributes
• Win-win solutions
PROJECT PARTNERS
Conduit for Better Relationships

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What to Expect When You’re Expecting... A Metro District

Mark Schutte, Project Engineer, MHFD
History of Metro Districts

- **1949**: Authorizing Act of the Colorado General Assembly
- **1981**: The Special District Act is codified
- **1991**: Tax Payer’s Bill of Rights (TABOR) is passed
- **1970**: Less than 20 Metro Districts established
- **1990**: Over 170 Metro Districts established
- **2010**: Over 1100 Metro Districts established
Taxation

Debt Issuance

Lean and Foreclosure

Provide Services and Facilities
Developer determines District boundaries and submits application to city/county in which the District sits.

City/county staff review the application to determine if the District requests are appropriate.

City Council or County Commissioner will approve the application and then district court will rubber stamp.

Metro District then is free to conduct its TABOR elections to elect a board and authorize debt.
Service Plan

Description of Proposed Services
Service Plan

Financial Plan
Service Plan

District Boundary Map
Service Plan

Construction Plan
Service Plan

Inter-Governmental Agreements
Why does it matter?

- Carves out services
- Determines infrastructure scope
- Determines the total amount of authorized debt
- Determines how to repay that debt
Local Government Perspective: Aurora

- Maximum debt mill levy of 50 mills
- Maximum term for debt repayment of 40 years
- Total debt issuance limitation
- Reasonable debt structure and interest rates

Early Years, Pre-1990
City staff focused on individual, detailed reviews of Metro Districts

Post-1990
Aurora adopts Model Service Plan to provide guidelines for Metro Districts

Post-2000
Update to Model Service Plan and begins "guardrails" approach
## Local Government Perspective: Aurora

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant Change to Original Plans</td>
<td>Provide Limits to District Service Plans</td>
</tr>
<tr>
<td>Small, Doesn't Reach Build Out</td>
<td>Match Services to Community Needs</td>
</tr>
<tr>
<td>Miscommunication of Responsibilities</td>
<td>Clearly Define and Document Ownership</td>
</tr>
</tbody>
</table>
Local Government Perspective: Parker

- **Early Years**
  - Adopted Model Service Plan;
  - Single mill levy cap

- **Post-2010**
  - Development Liaison Committee;
  - Mill levy covers expanded scope of services

- **Recent Years**
  - Increased mill levy cap; Detailed review of plans and mill levy

- Maximum debt mill levy of 57 mills for general service debt, was 20 mills

- Operations and Maintenance Mill Levy of 5-10 mills, Town Capital and Maintenance Mill Levy of 5 mills

- Maximum term for debt repayment of 40 years

- Requirement to provide regional public improvements
<table>
<thead>
<tr>
<th>Issue</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill Levy Out of Sync with Costs</td>
<td>Development Liaison Committee</td>
</tr>
<tr>
<td>Misperception of Metro District Duties</td>
<td>Review of Mill Levies and Costs</td>
</tr>
<tr>
<td>No Support for Regional Improvements</td>
<td>Clearly Define Scope in Service Plan</td>
</tr>
</tbody>
</table>
Highlands Ranch Metro District

Keys to Success:

- Dedicated Staff
- Long-term planning
  - Adaptive Management
- Multiple Revenue Sources
  - System Development Fee
- One Mill Levy for All

Improvements and Costs
High Prairie Farms Metro District

Issues and Successes:

- Unique Situation for Service Plan and Debt
- Underfunded O&M Mill Levy
- Need for Clear Cut Delineation of Responsibilities and Costs
- Difference in Goals in Developer-Run Board vs Citizen-Run Board
- Collaboration with County and MHFD
What does this mean for our industry?

1. Overly limited channel improvement budgets
2. Understaffed Districts and lack of planning
3. Mismanagement of operations and maintenance
Key Takeaways

- Make sure the Service Plan is a good plan
- Be mindful of what the District can manage
- No Metro District is equal; cost should match goals
Resources

• DOLA
  • Local Government Information System – Special Districts List
    (https://dola.colorado.gov/lgis/)
  • Special Districts GIS Map
    (https://demography.dola.colorado.gov/CO_SpecialDistrict/)
  • If information unavailable at Metro District website or on
    LGIS, contact dlg.helpdesk@state.co.us

• Metro District Education Coalition
  (https://metrodistricteducation.com/)

• Special District Association of Colorado
  (https://www.sdaco.org/)
How to Partner with the Army Corps:
An Overview of USACE Programs and Authorities

Melissa Weymiller
Project Manager
Flood Risk Management Program
Sacramento District

Erin Maloney, P.E.
Project Planner
Sacramento District
U.S. Army Corps of Engineers

- Flood Risk Management
- Coastal Storm Risk Management
- Water Supply
- Water Quality
- Navigation
- Ecosystem Restoration
- Emergency Response
- Recreation
- Cultural Resource Protection
- Technical/Planning Assistance
USACE District Boundaries

San Francisco District

Sacramento District

Walla Walla District

Los Angeles District

Albuquerque District

Omaha District

Kansas City District

Honolulu District
## PROJECT AUTHORITIES

<table>
<thead>
<tr>
<th>Congressionally Authorized</th>
<th>Delegated Authorities</th>
<th>Tech. Assistance Programs</th>
<th>Assistance only: No construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>• General Investigation Studies (GI)</td>
<td>• Continuing Authorities Program (CAP)</td>
<td>• Flood Plain Management Studies (FPMS)</td>
<td>• General Technical Services</td>
</tr>
<tr>
<td>Projects typically large &amp; complex</td>
<td>Smaller Projects: Start quickly &amp; build sooner</td>
<td>• Planning Assistance to States (PAS)</td>
<td>• General Planning Assistance</td>
</tr>
<tr>
<td>• Study &amp; construction authorizations based in law (from Congress)</td>
<td>• Projects of limited scope and complexity</td>
<td>• Emergency Preparedness &amp; Response</td>
<td>• No project construction</td>
</tr>
<tr>
<td>• Requires appropriations for funding</td>
<td>• Congress does not need to specifically authorize projects or provide project-specific funding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Typically 5+ years from initial funding of study to start of construction</td>
<td>• Typically 3-5 years from initial funding of study to start of construction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Delegated Authorities
USACE Continuing Authorities Program (CAP)
DELEGATED AUTHORITY

Continuing Authorities Program (CAP)

- Nine authorities that allow the Chief of Engineers to construct projects of limited scope and complexity
- Congress does not need to specifically authorize projects or provide project-specific funding
- Start quickly – implementation sooner
- Accelerated planning process ...level of detail is consistent with risk
- CAP Projects typically take 3-5 years from initial funding to start of construction
## DELEGATED AUTHORITY – Summary of CAP Program

<table>
<thead>
<tr>
<th>Authority (Section)</th>
<th>Project Type</th>
<th>Design &amp; Implementation Cost Share (Federal / Non-Federal %)</th>
<th>Federal Limit (Project)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Emergency Stream Bank and Shoreline Protection</td>
<td>65% / 35%</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>103</td>
<td>Hurricane and Storm Damage Reduction; Beach Erosion</td>
<td>65% / 35%</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>107</td>
<td>Navigation Improvements</td>
<td>Varies, based on depth</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>111</td>
<td>Mitigation to Shore Damage Attributable to Navigation Works</td>
<td>Shared in same proportion as project causing damage</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>204</td>
<td>Regional Sediment Management</td>
<td>65% / 35%</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>205</td>
<td>Flood Damage Reduction</td>
<td>65% / 35%</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>206</td>
<td>Aquatic Ecosystem Restoration</td>
<td>65% / 35%</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>1135</td>
<td>Project Modifications for Improvements to the Environment</td>
<td>75% / 25%</td>
<td>$10,000,000</td>
</tr>
</tbody>
</table>

*Only includes the statutory federal limit
Feasibility cost is part of total allowable project cost
Highlighted Projects: CAP Section 205
Small Flood Damage Reductions Projects

- Project: Forest View Levee, Forest View Illinois
- Levee assessments identified stability and seepage issues with the structure in its current condition
- Repair and improve the existing Lyons Levee along its entire 4,200 foot alignment
- Estimated Costs:
  - Total Project Cost: $5,900,000
  - Federal Cost: $3,825,000
  - Non-Federal Cost: $2,075,000
- Feasibility Study Started: July 2015
- Feasibility Study Completed: January 2017
- Construction Completed: May 2020
Highlighted Projects: CAP Section 206
Aquatic Ecosystem Restoration Projects

Project: Eugene Field

Sponsor: Chicago Park District

12.75-acre restoration of river and riparian zones along the Chicago River.
Bank naturalization to facilitate reconnection of the floodplain and restore native landscape of the site.

Estimated Costs:
Federal Cost: $ 975,000
Non-Federal Cost: $ 535,200

Current Status: Construction completed in 2014.
**HOW TO REQUEST ASSISTANCE**

- **Contact USACE**
  - Call or email USACE to establish initial communications

- **Arrange Site Visit**
  - If needed, USACE will visit the site and determine initial eligibility for CAP

- **Send Letter**
  - If found eligible, sponsor sends a letter (template available) to the appropriate USACE District officially requesting assistance
TYPICAL NON-FEDERAL RESPONSIBILITIES FOR PROJECT CONSTRUCTION

- **Provide all lands**, easements, rights-of-way, relocations, and disposal areas (LERRDs) necessary for project construction and operation and maintenance.
- Provide any cash or work-in-kind contributions to satisfy **cost-sharing requirements** as per project agreements.
- Hold and save the United States free from damages due to the construction and maintenance of the project, except damages due to fault or negligence of the United States or its contractors.
- Comply with the provisions of pertinent Federal acts in carrying out the specified non-Federal responsibilities of the project.
- After completion, **accept ownership** of and maintain and operate the project in accordance with regulations prescribed by the Secretary of the Army.
To Learn more...

https://www.spn.usace.army.mil/Missions/Projects-and-Programs/Continuing-Authorities-Program/

• Tri-fold brochures available

• Regional CAP Production Center Program Manager: 415-503-6508
Technical Assistance Programs
Flood Risk Management Program
Planning and Technical Services

• Planning Assistance to States and Tribes Program
• Floodplain Management Services
• Silver Jackets
Planning and Technical Services – Cost-Share

• PAS
  • 50% Federal
  • 50% Non-Federal
  • Up to $484,000 Cost-share Waiver for Tribes

• FPMS
  • Can be up to 100% Federally Funded
  • Dependent on Funding Availability
  • Non-Federal Funds Can be Used to Expand Scope
Requesting a Study

1. Letter of Request
2. Scope of Work
3. Letter of Agreement
4. District/Division Approval
5. Receipt of Funds
6. Study Execution
Silver Jackets

- Interagency Program to Reduce Flood Risk
- State Led Teams
- Competitive Project Proposals
- 12-18 month Projects
Flood Risk Management Cycle

- Preparation and Training
- Response
- Mitigation
- Recovery
Project 1  Project 2  Project 3
Developing Partnerships: Skull Valley Goshute
*From Coexistence to Communication*

- Fire in the Upper Watershed
- Debris Flows and Flooding
- Support from BIA and NRCS
Developing Partnerships: Skull Valley Goshute
From Communication to Cooperation and Collaboration

- Developed Silver Jackets Proposal to Develop a Floodplain Management Plan
- Interagency Projects
Developing Partnerships: Skull Valley Goshute
Ongoing Partnerships

- Floodplain Mapping
- Tribal Mitigation Plan
- Flood Risk Mitigation Measures
Planning Studies and Watershed Assessments

- Identify water resources problems and opportunities
- Determine measures and alternatives that could reduce those problems
- Develop partnerships and identify opportunities to implement recommendations
Floodplain Mapping and Hazard Assessments

• Prioritize areas of highest risk and prioritize resources
• Conduct floodplain inundation mapping of areas at risk of flooding
• Develop partnerships with agencies with funding opportunities for mitigation projects
• Develop guides for the public and decision makers on what to do before and after a wildfire
• Support hydrologic and hydraulic modeling post-fire
• Develop technical tools to support hydrologic and hydraulic staff responding after a fire
Emergency Action Planning Guidebook

• Step-by-step instructions for developing an EAP
• Focused on small and medium sized communities
• Silver Jackets can provide support for communities developing EAPs
• Can create a tabletop exercise to practice a community’s Emergency Response Plan
Education and Outreach

- Attend outreach events at schools, museums, or fairs
- Hold training events for floodplain managers
- Develop ESRI Story Maps on flood history and preparedness
Questions

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Virtual Design and Collaboration
Adaptations for “These Challenging Times”

CASFM 2020 Virtual Annual Conference
Presenters

Jesse Clark
Principal, Landscape Architect
Stream Landscape Architecture + Planning

Chris Loftus
Associate Principal, Landscape Architect
Stream Landscape Architecture + Planning
Presentation Road Map

• COVID-19 challenges and opportunities for the work environment

• Overview of virtual tools for adapting to new conditions

• Examples of using tools throughout the design process

• Q & A
Times Have Changed
Working Amidst the Pandemic

Challenges

- Loss of in-person “face time” and ability to read body language
Times Have Changed
Working Amidst the Pandemic

Challenges

• Fewer opportunities for in-person interdisciplinary design workshops
• Inability to hold in-person public meetings
Times Have Changed
Working Amidst the Pandemic

Challenges

- Potential for team members to disengage or succumb to distractions during virtual meetings
Times Have Changed
Working Amidst the Pandemic

Challenges

• Less ability to regularly check in with staff or perform “over the shoulder” design reviews
Times Have Changed
Working Amidst the Pandemic

Challenges

“Let me see if I’m misunderstanding this correctly…”

• Potential for complex ideas to get lost in translation or oversimplified in “text-only” e-correspondence
Times Have Changed
Working Amidst the Pandemic

Opportunities

- Potential to actually increase team communication and project management efficiency through adaptation and adoption of new tools and meeting rhythms
Times Have Changed
Working Amidst the Pandemic

Opportunities

- Ability to move beyond limitations of traditional design process, including new methods for public engagement, conceptual iteration, and construction administration
Opportunities

- Potential to increase productivity by reducing commutes and allowing flexible work hours
- Reduction of emissions, opportunity to “take a collective breath”
Overview of Tools for Working Remotely

- Shift toward video conference as primary communication platform (as a small consulting firm)
- Unlocking the potential of digital drawing with tablets
- Greatly improved online outreach methods
### Overview of Tools for Working Remotely

| 4 | MS Teams | Easiest with federal employees, can invite outside partners with training | Only see 9 people on a screen at one time | Free | Information | Involve | Video Conference | Chat | Project Management | DOI created a DOCUMENT detailing how to add an external user to Teams. | https://www.microsoft.com/en-us/teams/teams/pricing-teams-software | [Zoom](https://zoom.com) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Webex (Meeting and Webinar) | Host live webinars and share recordings | Not the best interface; difficult for moderator to share screen and monitor chat comments simultaneously; must save chat comments manually | Not the best interface; difficult for moderator to share screen and monitor chat comments simultaneously; | Information | Collaborate | Video Conference | Chat | Phone Bridge | Polling during webinars, NPS subscribes to Webex for webinars already. Work with IT to trial the platform | [Webex](https://webex.com) | [GoToWebinar](https://www.gotowebinar.com) |
| 7 | GoToWebinar | Host live webinars and share recordings | There is no ability to allow participants (not presenters) to speak | There is no ability to allow participants (not presenters) to speak | Information | Survey/Polling | Chat | Phone Bridge | Solely for presenting to larger audiences. Meeting platform also offered by GoTo-suit | [GoToWebinar](https://www.gotowebinar.com) | [Webex](https://webex.com) |
| 8 | Miro | Brainstorming through digital whiteboards | Starts Free | Starts Free | Information | Mapping | Project Management | Chat | [Miro](https://miro.com) | Used for Meetings/Workshops | [Miro](https://miro.com) |

**NPS virtual engagement matrix**
Process: Data and Information Gathering
Stakeholder Engagement

• Ability to engage stakeholders through better interactive features
  ◦ Separate audio feed for interpreter
  ◦ Live polls, Q&A, and surveys
  ◦ Virtual venues
  ◦ Live collaborative drawing
Process: Data and Information Gathering

Site Recon and Monitoring

- Bringing everyone ‘along’ to share site information through video conferencing and file sharing
- Drone videos, surveys, and imagery capture site conditions, construction progress, and completed projects
Cue Video #1: Split-View Drone Flight
Process: Construction Administration

- Mobile video chat (i.e. FaceTime) site visits
- Narrated drone “tours”
Cue Video #2: Cherry Creek Drone Flight Review Meeting
Process: Construction Documentation and QA/QC

- Redlining hard-copy drawings by hand
  - (+) Legible forms and view multiple sheets at one time
  - (-) Have to scan and tough to account for changes
Process: Construction Documentation and QA/QC

- Redlining PDFs with Adobe Acrobat
- (-) Difficult to draw nice forms view one sheet at a time
Process: Construction Documentation and QA/QC

- Redlining PDFs with tablet
- (+) Legible forms and view multiple (hard copy) sheets at one time
Process: Conceptual Design and Iteration

Working Drawing: The importance of hand drawing in a digital age.

- Importance of hand sketching in design
- Hand-brain connection, direct communication
- “Visual improvisation” as design exploration tool

Incorporating Assignments to Develop Hand Sketching Skills in the Civil Engineering Technology Curriculum

Abstract
Even with today’s technological advances, hand sketching is still an important communication skill in civil engineering practice. To communicate effectively, civil engineers may need to quickly prepare hand-drawn sketches to document a given problem, communicate ideas during a meeting or to convey important information to colleagues. Unfortunately, at many schools, the emphasis on drawing skills has focused on computer aided drafting and design (CADD), at the expense of hand sketching. The result is unsatisfactory and sloppy sketching by civil engineering and civil engineering technology students and graduates. Although many engineering drawing courses no longer emphasize hand sketching, engineering educators can still provide opportunities for students to develop and practice hand sketching skills. This paper presents suggestions for incorporating hand sketching assignments in the undergraduate civil engineering technology curriculum and provides assessment results for several sketching exercises used by the author.

Introduction
Hand-drawn sketches have traditionally been an important part of professional engineering practice. Sketching site conditions and layout during field reconnaissance, drawing free body...
Cue Video #3: Conceptual Design Collaboration with Stream Staff
Process: Conceptual Design and Iteration

- Simultaneous live sketching with tablets to share design ideas
- Potential for future hybrid of current tools
Cue Video #4: Live Sketching>Touch-Up
PRACTICAL USES OF URBAN TUNNELING

Christi Wisleder, PE, ENV SP, Civil Project Engineer, Merrick & Company
Ryan Marsters, PE, PG, Geological Engineer, Lithos Engineering

CASFM 2020 Annual Conference
October 1, 2020
CITY AND COUNTY OF DENVER

27TH STREET STORM INTERCEPTOR

- Existing Storm Sewer Undersized
- Relieve Flooding in Five Points and Curtis Park
- Phase Construction
SITE CONSTRAINTS
RIGHT-OF-WAY

- 80’ ROW Width
- Zero Setback
- Overhead Utilities
SITE CONSTRAINTS

ADJACENT PROPERTIES

- Coors Parking
- Multi-Fam
- Business District
SITE CONSTRAINTS

ENVIRONMENTAL

- Groundwater
- Contamination
SITE CONSTRAINTS

UTILITIES
27TH STREET STORM INTERCEPTOR
PHASE 1
DESIGN ALTERNATIVES
DUAL RPMP
SCHEDULE

- Rockies Season
- St. Patrick’s Day Parade
TUNNELING DESIGN CONSIDERATIONS

- Ground Conditions
- Layout
- Third Parties
TUNNELING DESIGN CONSIDERATIONS

GEOTECHNICAL INVESTIGATION

- Test Boreholes ("Borings")
- DWR Well Records
- Past Project Data / Literature
- Aerial Photography Review

- Encountered
  - Fill (SC/SM)
  - Alluvium (SM, SP, SW) with gravel
  - Boulders, debris, or obstructions no encountered but might be present
  - Behaves as slow to fast raveling

Geotechnical investigation performed by Kumar and Associates
TUNNEL DESIGN
DESIGN CONTINGENCIES

Layout
- Guided method (steerable)
- Techniques suitable for dual 66-inch DIA, 254 LF
- Single pass
- Shaft footprint

Third Party Concerns
- Permeation grouting beneath utilities
- Schedule restrictions

Ground Conditions
- Open-faced techniques (worker access)
- Non-pressurized techniques
- Suitable for dry-moist silt, sand, gravel
- Ability to handle obstructions

Summarized in project Geotechnical Baseline Report, “GBR”
CONSTRUCTION
Open Cut

• Easy access
• Not on linear or critical path
• Can deal with obstructions or issues from multiple sides
• Can “see” issues
• More resources available
CONSTRUCTION
Permeation Grouting and Shafts

Contractors: Iron Woman/ Brannan
CONSTRUCTION
TUNNEL EXCAVATION
CONSTRUCTION

OBSTRUCTION (DIFFERING SITE CONDITION)

Images from www.historicaerials.com
CONSTRUCTION

OBSTRUCTION CONSIDERATIONS

• Earlier Identification
  • Extended aerial photography review
  • Ground Penetrating Radar
  • Boreholes/potholing

• Tunnel Design Changes
  • None – techniques were chosen because of face access and ability to access face
  • Obstruction would have been included in GBR

• End Result
  • Clearly defined DSC (no arguments)
  • Higher initial bids rather than DSC
  • Focus shifted to assessing DSC value
LESSONS LEARNED

• Choose viable tunneling techniques for realistic risks
• Incorporate a means to handle risks contractually
• Clearly delineate risks and DSCs
• Identify potential obstructions via aerial photographs prior to subsurface investigation
Learning Objectives

1. Understand the importance of locating underground utilities early in the design process
2. Understand how to mitigate risk associated with urban tunneling
3. Understand key factors for design recommendations in urban tunneling