Questions and Background for Oral History Interview with Owen Randall,  
Chief Engineer, Utilities, City of Fort Collins

August 2, 2019

Interviewer: Dr. Ruth M. Alexander, Public Lands History Center, CSU 
Subject: Michigan Ditch 
Location: Michigan Ditch, near Cameron Pass

Oral History Questions for Owen Randall:

We’re going to focus today on your work on the Michigan Ditch, especially after the 2015 mudslide, but I want to start by going back to your job working on the Joe Wright Reservoir in 1977. Since the reservoir collects water from the Michigan Ditch, this seems like a good place to begin.

1. In the summer of 1977, as a young civil engineer, you were hired by McCall, Ellingston & Morrill, a design engineer company, which had contracted with the city to construct a new Joe Wright Reservoir. Both the original Joe Wright reservoir and Michigan Ditch had been built at the turn of the 20th century to bring water over Cameron Pass and into the Poudre River watershed. They were owned by a succession of ditch and irrigation companies but were eventually purchased by the city of FC in about 1971. Subsequent to the purchase the dam was condemned and taken out of service. A new dam needed to be built and you were hired as part of the project.

   a) What did the construction of the new Joe Wright Reservoir entail? What were your job responsibilities?

   b) As you worked on the construction of Joe Wright, what did you learn about changes in engineering materials and methods, as well as about the durability of old methods and materials?

   c) How did your work that summer shape your understanding of the relationship between contractors and a municipal entity like Fort Collins Utilities?

2. After you were hired by FC Utilities in 1979, you worked on a wide variety of water, wastewater and stormwater capital projects, eventually becoming Chief Engineer. Along with
work on large capital projects, were you also involved in the on-going maintenance and repair of the Michigan Ditch?

a) What did you learn over these decades about the challenges of maintaining the ditch?

b) Tell us about the rehabilitation of the Michigan Ditch.

c) To what extent did the ditch become a combination of old and new materials and technologies?

d) Can you explain why Michigan Ditch has been essential to the City’s water system and to maintaining its water rights?

3. How and when did Utilities become aware of the 2015 mudslide?

a) Can you describe the precise nature of the damage the mudslide did to the Michigan Ditch?

b) How did this event compare to earlier instances of damage to the ditch?

4. Once you understood the severity of the damage, how did you go about devising a plan for repair?

a) What were the crucial steps in getting approval for the project from the City?

b) How did you use the Alternative Product Delivery System (APDS) for both design services and construction contracting?

5. What effect did the closure of the ditch have on water levels in the Joe Wright Reservoir?

6. The Michigan Ditch Road is used by hikers, mountain bikers, and skiers. Was their access to the road curtailed by the rebuilding project?

a) Were you and other people in Utilities concerned about public buy-in?

b) What did Utilities do you gain public support for the project?

7. What were the biggest challenges you faced as the ditch rebuilding project moved forward?

a) How were these challenges related to weather/altitude? To available technologies and materials?

b) How did you work around these challenges?

8. What were the most important innovations involved in the Michigan Ditch project?
9. Is the ditch still a combination of old and new materials and technologies? How is the old stuff holding up?

10. As you reflect upon your long and distinguished career with the city, where does work on the Michigan Ditch figure in importance?

11. What are the most important lessons that the history of the Michigan Ditch has for a new generation of Utilities employees and engineers?

Background:

I. From the Public Lands History Center project on the Poudre:  

In 1903, John McNabb and William Rist collaborated to file for a water rights claim for a snow ditch over Cameron Pass. The ditch started at Lake Agnes or Island Lake and reached the Michigan River about halfway to the pass, where it carried the water over the pass and into the Poudre River watershed. Records indicate they had already begun work on the ditch on July 10, 1902. On January 7, 1904, having constructed one mile of the ditch, the men sold the ditch to Francis C. Grable, who then transferred it to Mountain Supply Ditch Company on June 24, 1904. However, McNabb and Rist continued construction of the ditch on behalf of the company, until they finally transferred all rights to Mountain Supply on October 22, 1906. This company constructed the ditch to its full length of seven miles.

On September 23, 1908, Mountain Supply sold Michigan Ditch and Joe Wright Reservoir to the North Poudre Irrigation Company. In 1923, the J. E. Grinstead company was awarded a contract to extend the ditch to Agnes Creek, which they did by installing 2,000 feet of wooden stave pipe, some sections of which are still in operation today.

Tunneling at Altitude: Colorado’s Michigan Ditch Tunnel Secures Water Delivery for Fort Collins

BY J RUSH ON NOVEMBER 21, 2016

In the American West, water is a valuable and potentially scarce commodity, so when the City of Fort Collins, Colorado, was faced with a potentially costly repair to its water supply infrastructure, the mandate was simple: Fix it!

The Michigan Ditch is a 5.2-mile conveyance system that brings water from the high mountains into the Joe Wright Reservoir, one of the City’s two water sources. Over the years the Michigan Ditch, a combination of pipeline and open channel originally built around 1900 and bought by Fort Collins in the 1970s, was subject to the whims of Mother Nature. Specifically, one portion of the water supply route that crosses an area known as “the mudslide” was subject to periodic damage when the slides occurred.
The City was accustomed to making simple repairs that involved digging up the pipe and moving or replacing it when the slide moves. But in September 2014 crews noticed something unusual. The pipe, which typically moved only during snowmelt in the spring, had moved substantially since its repair that summer. The following spring, even more movement showed that a more permanent fix was needed.

“It was apparent that this wasn’t something that we could simply dig up and put back in place like previous years,” said Owen Randall, chief engineer for Fort Collins Utilities. “We knew we needed a long-term solution that could cost upwards of $10 million dollars. When I told the city managers their response was: ‘The water is worth $180 million, so go fix it.’”

In summer 2015, the City got to work with a geotechnical assessment that included seismic refraction as well as vertical and horizontal borings. Meanwhile, the City put together a team of consultants and contractors to help ascertain the best way forward. After exploring the options, the team decided that a tunnel that would re-route the aqueduct through the mountain in stable rock was the best solution.

During the winter of 2015-16, the team – comprising City staff, Stantec (prime engineer), Lithos Engineering (tunnel design and construction manager) Hydro Construction (general contractor) and BT Construction (tunnel contractor) – began the process of finalizing the alignment and design. The end result was a 766-ft long, 98-in. OD, rib-and-board tunnel with a 60-in. ID carrier pipe grouted into place. The tunnel was built with a 630-ft radius curve to maintain an alignment in competent rock throughout its length.

The tunnel option provided the long-term solution that the City was looking for while having the added benefits of less maintenance, less environment impact and a construction cost comparable to other options.

Key to determining the final alignment were the horizontal borings, which were completed by Crux Subsurface, according to Robin Dornfest of Lithos Engineering. “Having the information from the cores helped us determine that a straight tunnel was not an option. The horizontal core
along a straight alignment showed that the path crossed into the landslide materials. The additional cores along the curved alignment proved that the tunnel would stay in the rock profile.”

From the start is was apparent that this Michigan Ditch Tunnel was not your ordinary project. First and foremost, working at 10,000-plus feet elevation in the mountains meant that construction was largely dependent on the weather.

“The amount of snow in the mountains in the springtime basically determines when you are able to start construction,” Randall said. “Similarly, how soon its starts snowing in the fall determines how long we are able to work. The weather was potentially a huge issue as we were needed to get the ditch system online as soon as possible.”

The logistics of working on the side of a mountain also presented challenges. The project site was located 2.5 miles up a narrow, winding path that dictated the weight and the dimensions of the equipment that could be safely transported. Additionally, the nearest town (Walden, Colorado; population 3,000) was located 30 miles away, with Fort Collins 70 miles away. Even cell phone service had to be brought in.

“Due to the nature of the road, we were limited to about an 11-ft wide load,” said John Beckos, project manager for BT Construction. “We were unable to get a crane to the site, and the biggest excavators we could bring in were nearly hanging off the edge of the mountain on the way up.”

The site access also dictated the type of tunnel boring machine that could be used to excavate the tunnel. After evaluating the options, the project team elected to use an Akkerman hard-rock TBM that had a mixed face cutterhead to deal with the highly fractured, hard rock and abundant fault and shear zones.
The machine was compact enough to accommodate the limited space at both the launch and retrieval pits, light enough to be handled by the available equipment, and had enough power to drill through rock that reached strengths of 15,000 psi.

“It was apparent that a neither conventional rock TBM or a conventional soft-ground TBM would be able to complete the drive, so we used a rock machine with a mixed-face cutterhead,” Beckos said.

“Additionally, we were limited to about 40,000 to 45,000 lbs in terms of what we could lift with our excavators.”

The TBM was launched in June 2016 from a sheet pile with a thrust plate built using I beams keyed into rock and steel sheeting. The TBM was jacked into the tunnel followed by a section of steel casing that was grouted into the place and served as the starting point for the rib-and-board tunnel.

Through the Mountain

The tunnel was mined from the downstream portal to the upstream portal. The first 40 ft of the alignment was straight before it transitioned into the 630-ft radius curve spanning 726 ft. The TBM was equipped with a conveyor system and dual muck boxes to remove the spoil. Spoil was stockpiled near the site to be used by the City for future repairs to the ditch and pipeline, as well as the access road, which it maintains.

To achieve the curve, crews used shims between the ring beams and boards along the outer radius. The amount of curve was dictated not be by the TBM, but the deflection capabilities of the joints of the Hobas carrier pipe.

For the approximately the first half of the tunnel, production went well as no changes to the cutting tools were needed. However, advance ground nearly to halt about midway through the tunnel, requiring a series of tooling changes that left the team scrambling for spares.

“We hit a section of ground in which we were advancing inches per day,” Randall said. “It was a very frustrating situation because we knew that winter was coming and we needed to get the TBM through the mountain.”

Randall said the ground made tunneling a challenge. “The only thing consistent about the ground was that the rock was inconsistent,” he said. “We would find hard zones 2-3 inches thick, 2-3 feet thick and 30-feet thick. We knew we were going to get into difficult geology, but it still posed a challenge.”

The team had hoped to achieve an advance rate of about 20 ft per day. At the end of the job that number was 8 ft per day, but the TBM holed through successfully on Sept. 29. And, despite the challenging ground, the TBM holed through precisely on target. Project team members credited
not only the TBM operators, but the VMT guidance systems, typically used for larger and longer tunnels, in keeping the tunnel on line and grade.

Planning for Success

One of the keys to any successful tunnel project is proper planning. In the case of Fort Collins, its unique project delivery approach helped to implement a team quickly, and bring all parties to the table during the planning, design and construction phases.

Over the last 20 years, Fort Collins has implemented and refined its delivery system known as the Alternative Product Delivery System (APDS). Fort Collins retains a group of prequalified contractors and consultants on an annual contract basis – known as master service agreements – and when a project is needed, the City can call on its team of service providers with expertise in a particular area to negotiate a contract. This allows the City to quickly develop a team in developing the project from start to finish.

In the case of the Michigan Ditch Tunnel, the project team was brought on board to determine the best solution for the problem. As the project began to take shape as tunnel, the City negotiated further contracts for tunnel design, construction and TBM procurement. The project team additionally developed a risk register to help identify and mitigate potential occurrences that could impact the project.

“Rather than trying to write a contract for the whole project up front, we can write contracts that are very well defined knowing what our scope of work is going to be as planning and design progresses,” Randall said.

The added benefit of having the project team in place was that the project goals were defined by the team, rather than by an individual party or parties. “This was a very challenging and difficult project, but when you have everybody working toward the same goal it makes all the difference in the world,” Randall added.

“The team functioned at a very high level and with great communication,” Dornfest said. “It was extremely challenging, but there was never any finger pointing and we were able to get the job done on schedule and under budget.”

Thanks to planning, teamwork and determination, the Michigan Ditch Tunnel project was successfully completed approximately $1 million below the initial budget of $8.5 million. The aqueduct is now online, assuring citizens of Fort Collins a reliable source of water for the years to come.
III. From *Engineering News-Record, Mountain States*

**Viewpoint: Michigan Ditch Tunnel Project Overcomes High-Altitude Contracting Challenges**

Crews extract a custom-built tunnel boring machine from Akkerman Inc. in Minnesota. The 96-in.-diameter Akkerman 720 Series II TBM was outfitted with a mixed-face cutterhead that uses 13 disc cutters, 40 scraper teeth and four scraper bars.  
*Photo courtesy of BT Construction*

*March 3, 2017*

High in the Never Summer Mountains of Colorado sits a critical piece of infrastructure for the city of Fort Collins Utilities Dept. known as the Michigan Ditch. The 5.2-mile-long ditch was originally constructed in the early 1900s to convey water from the west side of the mountain.
range to the east. The city purchased the ditch system 40 years ago and has maintained it ever since, placing a $150-million to $300-million value on the collected water it provides.

Although slope instability has plagued the ditch throughout its history, a previously piped section of the ditch through an area known as “the mudslide” moved 21 ft horizontally and 7 ft vertically during the 2014-15 winter. Since the majority of the collected water flows through the landslide area at 100 cu ft per second, the Michigan Ditch was going to be out of service for the foreseeable future and a permanent solution was needed.

**Degree of Difficulty**

Site logistics at 10,300 ft above sea level make for a challenging and short construction season. The city of Fort Collins used its alternative product delivery system (APDS) in a design-build, team-oriented approach to solve the problem. The program allows the city to quickly move forward on assembling a team.

Picking from a number of pre-qualified and pre-approved designers and contractors in July 2015, the city assembled a design-build team and began discussing options for permanent repairs to the ditch. Ultimately, the construction of a tunnel behind the landslide in competent rock was deemed the best long-term solution.

A thorough geotechnical investigation in late summer 2015 confirmed the tunnel alignment. Crews took eight vertical borings, along with three horizontal borings. The subsurface investigation showed a much-deeper section of the landslide than previously anticipated. Those findings, combined with the geometry of the site, meant that a curved tunnel alignment would work best to keep the ditch in solid bedrock.

Additional considerations on tunneling methods and carrier-pipe selection produced a final plan that called for a 765-ft-long, 8-ft-diameter tunnel built on a 630-ft radius curve. That allowed for installation of a 60-in.-diameter Hobas carrier pipe. An additional 200 ft of open-cut, 60-in. pipe would also be built to tie into the existing ditch.

**Key Challenges**

The first challenge was to pick a tunneling machine that the team could transport up to the jobsite. The project is located two miles up a single-track dirt road with a small launch and retrieval site on the side of a mountain, so getting a crane there to unload equipment was not an option.

The design-build team talked with multiple suppliers and decided on a custom-built tunnel boring machine (TBM) from Akkerman Inc. in Minnesota. The 96-in.-diameter Akkerman 720 Series II TBM was outfitted with a mixed-face cutterhead that uses 13 disc cutters, 40 scraper teeth and four scraper bars.
The cutterhead was built out to 98 in. to provide enough overcut to make the 630-ft radius curve. Also, the TBM weighed less than 50,000 lbs, had a relatively small setup and retrieval footprint, and could be fabricated in the six-month timeframe needed to start construction. If the TBM could handle the geology of the tunnel drive, the construction team was relatively confident it could be delivered and retrieved from the site.

The second challenge was building the tunnel accurately and safely. A state-of-the-art guidance system from VMT Technical Measurement Solutions Inc., combined with routine survey checks by two different survey teams, provided the TBM operators and on-site construction inspectors with constant feedback on the position of the tunnel construction.

The tunnel was built within 0.01 in. horizontally and 1 in. vertically of the design. Building the job safely was a large task for the field supervisory team. Every work shift included a morning and afternoon safety briefing with an open discussion of the upcoming tasks and hazards involved in the work. The project was completed with zero-recordable injuries.

Completing the tunnel within the 2016 summer construction window was the goal from the beginning. Typically, the site is accessible from mid-May through mid-October. The as-expected, mixed-face geology encountered during the tunnel construction resulted in slower than anticipated production and higher tooling changes.

The design-build team worked additional night shifts through September and completed the tunnel on September 29, 2016. Installation of the final 60-in. carrier pipe and tie-in to the ditch took place throughout October, and on October 27, 2016, water ran through the Michigan Ditch behind the landslide. A critical piece of infrastructure was back online for the city of Fort Collins.

John Beckos is a project manager with BT Construction Inc. in Henderson, Colo.

Michigan Ditch Tunnel Project

Michigan Ditch

Trans-mountain water is not running this year in the Michigan Ditch due to an ongoing landslide that covered part of the ditch in 2015. Many options were considered to repair the damage to the ditch and a tunnel was determined to be the best solution.

Weather permitting, construction will begin as soon as the snow can be cleared in May and the tunnel will be completed by late fall. The ditch road will be closed to all public access for the summer of 2016.

Project description

- An 800-foot, 96-inch diameter rock tunnel will be bored through the mountain and lined with wood planks and steel rings (known as "lag and steel").
- 60-inch diameter Hobas pipe (similar to fiberglass lining) will be placed inside the tunnel and grouted in place, with a capacity of approximately 100 cubic feet per second (cfs), the maximum water right.
- Completion of the tunnel will allow full use of all water rights by spring 2017.
- A large rock tunnel is a logistical challenge in this remote area.
- All work is weather dependent and can only be done during the summer and early fall.
Project purpose and background

- To maintain trans-mountain water rights, an invaluable City asset, repair of the distribution system is essential.

- The tunnel is an investment in invaluable water rights infrastructure with an $8.5 million budget.

- The City of Fort Collins purchased the Michigan Ditch system from North Poudre Irrigation Company in the 1970s.
  - At the same time, Utilities built Joe Wright Reservoir to complete the trans-mountain water storage and delivery system to Fort Collins.
  - 1,600 feet of 24-inch diameter wood stave pipe are still used in the system.

- The Michigan Ditch road is operated by Fort Collins Utilities. Typically, the public has been allowed access to hike, bike, ski, etc. - but not this year due to tunnel construction. The road serves as another route to Lake Agnes and American Lakes Trail.