SPRINGFIELD WATER AND SEWER COMMISSION:

Connecticut River Crossing Project

By: Gus O'Leary, Kleinfelder

INTRODUCTION

The Springfield Water and Sewer Commission (the "Commission") operates roughly 460 miles of collection system piping in Springfield, Massachusetts and treats combined and sanitary sewer flows from Springfield and six other nearby communities – Agawam, West Springfield, Longmeadow, East Longmeadow, Wilbraham and Ludlow – at the Springfield Regional Wastewater Treatment Facility (SRWTF) in Agawam, Massachusetts. Roughly 30 percent of the Springfield collection system is comprised of combined sewers and the Commission maintains 23 combined sewer overflows.

The Commission is in the process of completing one of the first "horizontal" (non-building) alternative delivery projects in the Commonwealth of Massachusetts. The York Street Pump Station (YSPS) and Connecticut River Crossing Project ("the Project") is being implemented by the Commission as part of a United States Environmental Protection Agency (US EPA)-approved Long Term Control Plan and Integrated Wastewater Plan ("LTCP\IWP") for management of the Commission's combined sewer system. The Project, Phase 2 of the LTCP\IWP, is the largest phase from both a monetary perspective and in terms of reduction of combined sewer overflow ("CSO") volume and frequency conveying an additional 30 million gallon per day (MGD) to the SRWTF. Phase 2 also creates operational flexibility and redundancy of critical infrastructure in order to allow for rehabilitation and replacement of existing infrastructure in future phases of the LTCP\IWP. It includes construction of the new 62 MGD YSPS on the east side of the Connecticut River in Springfield, installation of two new 42-inch combined sewer force mains and a new 72-inch combined sewer siphon crossing of the Connecticut River, and connection to a new influent structure at the SRWTF on the west side of the Connecticut River in Agawam. Kleinfelder is the Engineer of record for the SRWTF upgrade, the River Crossing pipelines, and the work on the east bank of the Connecticut River and teamed with Stantec to fulfill the role of Designer on the project. Daniel O'Connell's Sons (DOC) was selected as Construction Manager At-Risk in 2018.

Figure 1 - Aerial photograph of the project area indicating major elements of the LTCP\IWP Phase 2 project

EXISTING CONDITIONS AND HISTORY

An existing US Army Corps of Engineers (USACE) Flood Damage Reduction System (FDRS), existing Amtrak Commuter Railroad, the Connecticut Riverwalk and Bikeway, and the Connecticut River lie between the new YSPS and the SRWTF, see Figure 2. Integral to conveying those additional flows to the SRWTF is the crossing of these features while protecting them and maintaining the FDRS and the Railroad in operation. The Commission and Kleinfelder identified very early in the planning of the Phase 2 project that a trenchless crossing would be required in order to cross, at a minimum, the FDRS and Railroad.

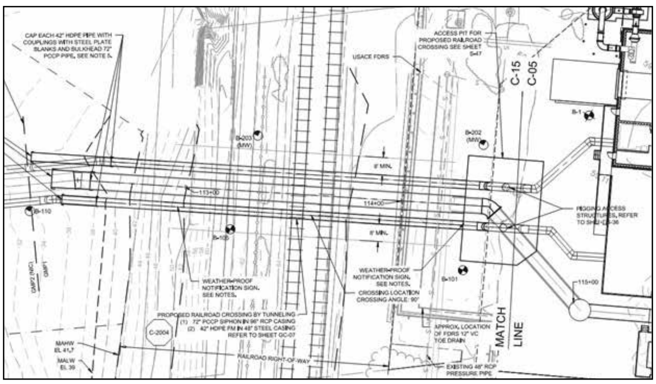


Figure 2 - Excerpt from project plans showing trenchless crossing below FDRS and Amtrak Railroad

The USACE FDRS consists of a flood wall, groundwater cut off sheeting, and a toe drain in the area of the crossing. Top of wall is approximately elevation 65.08, existing grade behind the wall varies in the range of elevation 60, and bottom of steel sheeting is approximately elevation 44.83. The proposed pipelines are 72-inch and 42-inch, requiring casings of 96 and 48 inches respectively. Holding a minimum of one casing diameter clear from the bottom of steel sheeting leads to an invert of approximately elevation 29.00, approximately 30 feet below grade behind the wall and roughly 36 feet below the top of rail. The length of the crossings under the FDRS and Railroad would be between 150 and 200 feet depending on how the transition to the River Crossing portion of the work was to be done.

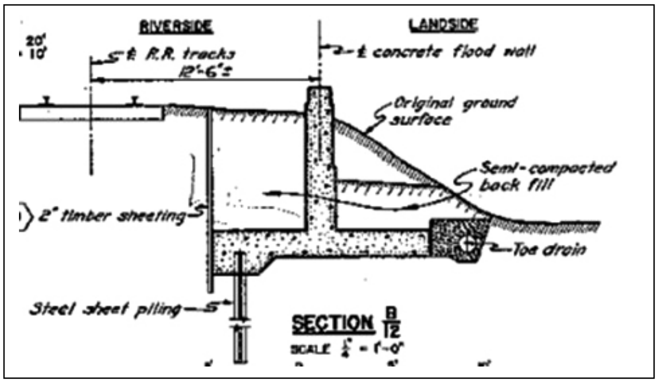


Figure 3 - Record drawing of USACE FDRS in Section

The area of the crossing is difficult geologically, see Figure 4. Based on existing information and our investigations we were able to determine that a thick strata of very hard glacial till closely underlaid the desired alignment, but that the face of any crossing tunnel would be in a mixture of alluvial sands and silts, and clays. Sand and silt layers were anticipated to be connected hydraulically to the Connecticut River. Note also in Figure 4 the slope into the river at the western end of the crossing alignment. This slope, coupled with the Railroad, made access from land to this area exceedingly difficult.

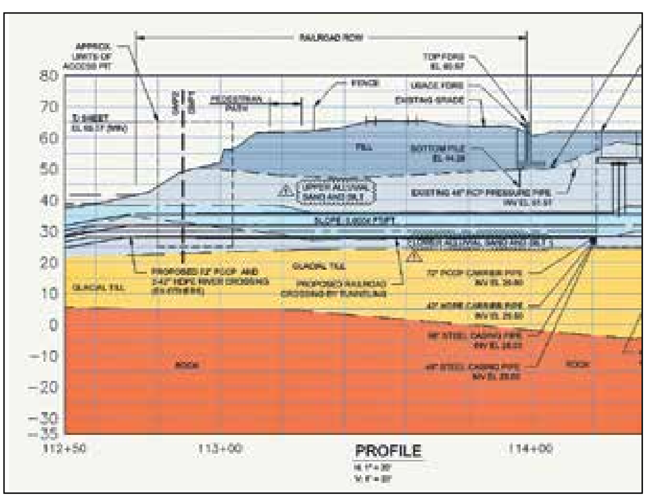


Figure 4 - Profile of crossing showing stratigraphy

The Commission maintains pipeline crossings immediately north and south of this area. To the north, the existing 42-inch cast iron force main dates to the construction of the FDRS in the 1930s and that crossing was incorporated as part of the construction of the wall. To the south, the 66-inch PCCP Main Intercepting Sewer Siphon crosses the FDRS and Railroad. This crossing was conducted in 1973 by jack and bore, and actually cut through the cutoff sheet rather than passing below it, terminating above the slope on the west side of the Railroad. Kleinfelder and the Commission interviewed the contractor who performed that jack and bore as part of the procurement process for this work. The higher elevation of this installation, relative to our own proposed crossing, mitigated groundwater issues in the alluvial sands and silts significantly.

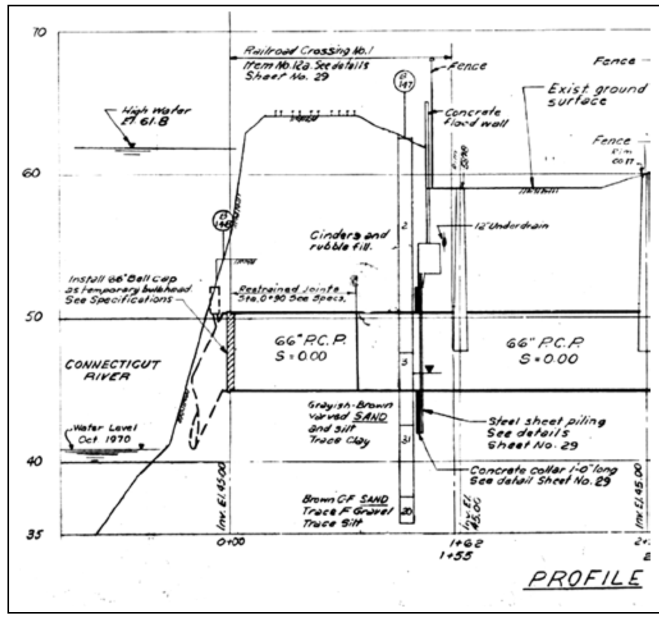


Figure 5 - Profile of the Commission's 66-Inch Main Intercepting Sewer Crossing of the FDRS and Railroad

APPROACH

Kleinfelder and the Commission identified two technologies that would be appropriate given the length and diameters of the crossings and the infrastructure involved. Jack and bore and microtunneling approaches were considered. Control of groundwater and constructing a receiving pit were the primary challenges identified for a jack and bore approach. Similarly, while use of a closed face microtunnel machine serves to mitigate groundwater issues, retrieval of the MTBMs and costs of mobilization for two different diameter tunnel boring machines for such short lengths of tunnel were anticipated to make this approach infeasible from a cost perspective. The design team also thought that a microtunnel approach would serve to mitigate ground settlement risk somewhat by allowing for greater control of the face and minimizing potential over excavation.

Kleinfelder elected to prepare the procurement documents assuming a jack and bore approach given the historic precedent and anticipated cost disparity, but leave sufficient flexibility in the project specifications to allow a contractor to propose an alternative approach in recognition of the challenges presented by groundwater conditions. In order to address groundwater challenges in the documents we incorporated permeation grouting throughout the alignment into the design. We also included provisions for establishing an at grade railroad crossing and access roadway to the receiving shaft site, as well as restoration of the bank after the completion of the crossing. We negotiated that crossing restoration of the railroad right of way with Amtrak as part of our license for construction of the new pipelines. Based on constructability feedback from DOC as the Construction Manager, Kleinfelder also ultimately designed a complex support of excavation system for the receiving shaft in the slope of the east bank that could be constructed from the Connecticut River.

During procurement of non-trade subcontracts under the Construction Manager we received three bids assuming a jack and bore approach, generally in the range of approximately $3.8 million. We also received one proposal utilizing microtunneling as an alternative to jack and bore, for approximately $5.4 million, confirming Kleinfelder and the Commission's expectation that while a microtunneling approach mitigated issues around groundwater and some of the risk associated with the work, the cost of mobilizing specialized equipment made the work cost ineffective. Note that ground improvement was not included in this bid package.

During scope review meetings with each proposer, we received feedback on the jack and bore approach:

- The receiving pit on the eastern riverbank is expensive and extremely difficult to construct due to access constraints and its location in the slope.
- Proposers considered proposing a "blind jack" in which they abandoned the jacking shield and eliminated the receiving pit – this too was difficult and expensive.
- Proposers saw significant risk in the ground improvements due to the possibility of over-improvement (ie. Making the soil too difficult to excavate), potential for frac-out due to the proximity to the river, and a high likelihood of missing a sand seam.

Feedback from the contractor proposing a microtunnel approach was also enlightening:

- Ground improvement scope could be eliminated if a microtunnel approach was used, this represented a significant cost savings for the project, outside the scope of this bid package, and addressed the risks of over improvement and missing a sand seam identified in the feedback from Jack and Bore proposers.
- The receiving pit on the eastern riverbank is the most difficult element of the work.

The potential for elimination of ground improvements puts microtunneling on a much more even cost footing with a jack and bore approach. The cost of those improvements was separately estimated at almost $1.5 million, bringing the effective microtunnel proposal cost down to $3.9 million.

The Construction Manager and the Designer set about solving the receiving pit next – that work had been separately estimated at approximately $670,000 and the team recognized the potential to gain the risk reduction benefits of a microtunnel approach for little to no added cost over the jack and bore proposals if an alternative approach could be identified there. Through further coordination with the proposer, we were able to sufficiently validate the possibility of “daylighting” the bores within the river and retrieving the MTBMs as part of the river crossing work, without the use of a receiving pit on the eastern riverbank. This resulted in the award of the FDRS and Railroad crossing contract to SECA Underground on the basis of their alternate microtunneling proposal. Prior to beginning the work, Kleinfelder revised the documents to eliminate the receiving pit and extend the microtunnel drives into the River, for execution as a change order to the contract, saving the cost of that excavation with added costs for coordination and retrieval of the microtunneling machines within the river.

Figure 6 – 96-inch MTBM awaiting the start of tunneling

Two of the primary challenges we faced in eliminating the receiving pit and “daylighting” the three proposed drives in the river were the termination of those casings and pipelines in the river and coordinating the connection in the river with operations in the jacking pit. “Daylighting” in the river required extending the bores to a point at which the MTBMs could be retrieved, which in turn had to be coordinated with restoration requirements in the River and minimum required cover on the pipelines. This led to the incorporation of short sacrificial sections of casing extending beyond the carrier pipelines which would be removed by the River Crossing contractor before connecting to the carrier pipelines and extending them across the river. Elimination of the receiving pit also required bulkheading the pipelines within the jacking pit so that connections could be made in the wet, while still isolating the jacking pit, and the landward side of the FDRS, from the River.

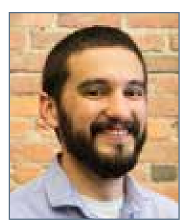
By making use of the flexibility of the Alternative Delivery process, with the coordination and cooperation of the Construction Manager, we were able to successfully deliver a contract for microtunneling this crossing for a comparable cost to a jack and bore approach.

Construction of the FDRS and Railroad crossing began in August 2021 and despite delays and issues of various types,

Figure 7 - Retrieval of the 96-inch MTBM from the Connecticut River

proceeded without major disruptive impacts to the FDRS or Railroad. The 96-inch drive and first 48-inch drive were completed in December 2021 and January 2022 and those MTBMs retrieved from the river by the river crossing contractor. After retrieval of the 48-inch MTBM, the machine was returned to the upland project site and the second 48-inch drive was completed in February 2022. That MTBM will be retrieved after restarting the river crossing work in summer of this year.

ABOUT THE AUTHOR:



Gus O’Leary *is a Principal Engineer and Project Manager with 15 years of experience in the design and construction of municipal utilities. His experience includes design of traditional water, stormwater, and sewer replacement projects as well as application of trenchless rehabilitation techniques and technologies including such as pipe jacking, microtunneling, and horizontal directional drilling to provide solutions to engineering problems in dense, urban areas. Gus is the technical lead and Engineer of Record for the Springfield Water and Sewer Commission’s Connecticut River Crossing Project.*