Forward with Trenchless Technology
Challenging Sewer Bypass and Rehabilitation of King County’s 96-Inch-Diameter Eastside Interceptor

Brian Sliger, PE
Erik Waligorski, PE
Carollo Engineers

Matoya Darby
Bob Isaac
King County Wastewater Treatment Division

King County’s Eastside Interceptor (ESI) collects the majority of wastewater flows from the Puget Sound cities of Kirkland, Bellevue, Mercer Island, Sammamish, Issaquah, New Castle, and Renton, and conveys it to the County’s South Treatment Plant. This aging reinforced concrete pipe (RCP) interceptor was constructed over 50 years ago, and corrosion caused by hydrogen sulfide (H2S) gas has begun to take its toll on the pipe’s interior. Sections of the pipe are experiencing mild to
severe corrosion that causes the concrete interior to crumble, exposing rebar and affecting the structural integrity of the pipe. The County has developed a proactive approach to deal with the degradation of the pipe by identifying sections of pipe experiencing corrosion, prioritizing rehabilitation needs based on severity, and developing projects to carry out rehabilitation.

The Eastside Interceptor Section 2 (ESI2) Rehabilitation Phase II Project was developed to rehabilitate approximately 3,700 feet of a severely corroded 96-inch-diameter section of the ESI interceptor line located in Renton. This section of pipe runs through an urban area between Boeing's 737 commercial airline facility and the Renton Landing, a busy mixed-use development. King County performed an alternatives analysis that looked at various rehabilitation options for the project, including cured-in-place pipe (CIPP), spiral-wound PVC liner, and Linabond. Linabond was selected as the most appropriate rehabilitation method for this section of pipe as it maintained the greatest existing capacity.

Linabond is a corrosion-resistant polyvinyl chloride (PVC) liner that is applied to wall surfaces with a high-strength thermosetting polymer resin. The resin expands in an exothermic reaction to form a section of rigid cellular plastic that firmly bonds with the concrete. Prior to the application of Linabond, the concrete surface to be coated is hydro-blasted to remove loose concrete and debris. Temporary platforms are constructed within the pipe just below the proposed liner termination point to perform the work. Flows that are not bypassed are able to flow beneath this platform.

**FLOW ANALYSIS, BYPASS PUMPING STUDY & CONSTRUCTION FOOTPRINT**

The first step in the project design process was to determine the required bypass system capacity. The goal was to provide an optimized, cost-effective design capacity that covers the majority of recorded flows within the pipe. A previous study conducted by the County called for a bypass system capacity of 70 million-gallons-per-day (mgd). Carollo utilized two years of flow-monitoring data collected at the project site to conduct its own design capacity determination. Frequency curves were developed to assist in establishing the bypass pumping flow rate, and associated probability of exceedance during wet and dry seasons. The frequency curve in Figure 1 illustrates that the maximum recorded dry-weather flow of approximately 57 mgd was well below the previously proposed bypass flow of 70 mgd; 96 percent of the time, flow was below approximately 40 mgd. A design bypass capacity of 45 mgd was therefore selected, providing a 5 mgd factor of safety for the system.

The results of the flow analysis were then used to determine the various pumping requirements to be specified in the contract documents. Based on the flow analysis, the contractor would be required to pump a minimum of 10 mgd and a maximum of 45 mgd for 24 hours a day, seven days a week. Because there was a possibility of higher
flows, an emergency pipe evacuation plan and a means for allowing emergency flow release would need to be provided, as well as two standby pumps for mechanical redundancy. Due to the bypass suction pit’s location near residential properties, the contractor was required to use electric driven bypass pumps and have standby noise attenuation to meet local noise ordinances.

These preliminary design requirements were used to move forward with the final design of the project. It was determined early on that the design of the bypass system would be left to the selected contractor, but some preliminary design and sizing of the system components were required to ensure all project elements requiring a long lead time would be in order and available prior to bid. The culmination of this preliminary design work was summarized in a Basis of Design Report that addressed the bypass
intake pit design, the bypass pipe routing and discharge, and the work and staging areas along the alignment.

**BYPASS INTAKE PIT DESIGN & EMERGENCY FLOW RELEASE**

The bypass system’s intake pit was located on an open piece of Boeing property through which the ESI2 pipe runs. To access the pipe, an approximately 10-foot-deep excavation, approximately 65 feet long and 20 feet wide, was dug to just below the crest of the pipe. This excavation faced some challenges as it was located in high groundwater and directly adjacent to a railroad spur track that transported Boeing 737 fuselages to the Boeing Renton plant. The existing pipe was also supported on piles due to poor soil conditions. To address these issues, the soils surrounding the pipe and excavation were chemically grouted to provide additional support for the pipe and aid in preventing groundwater leakage into the excavation. Steel sheet piles were hydraulically pressed-in to limit vibrations that could affect the adjacent railroad spur and pipe during the installation process.

A total of eight 12” x 12” skid-mounted pumps were required to meet the 45-mgd bypass capacity, bringing the total pumps installed to 10 including the two redundant pumps. After excavating down to the pipe, five 3-foot-by-1.67-foot coupons were cut from the top of the pipe for insertion of the ten 12-inch-diameter bypass pump suction lines. An additional 8-foot-by-5-foot coupon was removed for the installation of a custom-designed temporary bulkhead. The steel bulkhead consisted of two semicircular plates with guide rails anchored into the existing pipe, and two gate sections that slid down the center of the pipe along the guide rails. These gates were fitted with lifting hooks that allowed for their removal in an emergency situation.

**BYPASS PIPE ROUTING & DISCHARGE**

The preliminary design included an assumption for the bypass piping sizing of three 24-inch-diameter HDPE pipes. This was seen as a conservative sizing and used to develop design plans illustrating a piping route, potential utility conflicts, a trench design where required, and any restoration efforts that would be required. Topographic survey, existing utility research, and extensive potholing were conducted to aid this effort. The developed route included approximately 3,125 LF of overland pipe and 1,075 LF of trenched piping, for a total of 4,200 LF of pipe. These design plans were then used to facilitate project permitting and temporary easement acquisition.

During construction, the contractor proposed the use of a single 36-inch-diameter HDPE pipe and provided calculations and a route design showing the proposed piping would work. Custom-made utility crossing assemblies were constructed by the contractor to avoid utility crossing conflicts that were identified during design. After a thorough review the use of the single 36-inch HDPE pipe was deemed acceptable and was allowed.

A maintenance hole just downstream of the project limits was situated on a local, less-traveled street that could be closed for the duration of the project. To discharge the bypass flows the reducing riser was removed from the top of the existing maintenance hole, a temporary 48-inch riser section was installed, and the 36-inch bypass pipe was inserted directly into the 48-inch maintenance hole. The void between the pipe and the maintenance hole wall was temporarily sealed and a round cap was constructed around the existing pipe.

**WORK & STAGING AREAS ALONG THE ALIGNMENT**

Carollo worked directly with Linabond and associated contractors to determine the work and staging areas that would be required for the pipe preparation and Linabond installation process. A total of eight maintenance holes along the project alignment were identified for use as access points, equipment staging areas, ventilation installations, and odor-control installations. These areas were included on the design plans and the anticipated work and duration of work at each location was presented in a construction footprint technical memo. These documents were critical during permitting and property negotiations to provide a clear picture of the impacts to the community and property owners in the area, including traffic impacts, noise concerns, and potential odor issues.

The ESI2 Rehabilitation Phase II Project utilized flow monitoring data and statistics to provide an optimized bypass system that cut back on construction costs and overall project impacts. This optimized system design was utilized in the development of a sewer bypass plan that addressed as many issues as possible prior to construction. This up-front work minimized risks and project overruns, providing a smooth rehabilitation project that will extend the life of a critical piece of infrastructure for decades to come.