



# wastewater infrastructure

*Carollo has provided engineering services for over two million linear feet of wastewater pipeline and more than 500 pump stations.*

Carollo has worked with cities, public utility districts, and community groups to provide planning and/or design for more than 1,000 wastewater infrastructure projects. We match the needs of our clients with the latest technology to achieve innovative and cost-effective results. We have provided engineering solutions for wastewater pipelines and pump stations capable of handling flows ranging from less than 1 mgd to more than 600 mgd in capacity. Successfully managing these projects has required developing measures to identify and procure environmental documentation, maintain facility operation during construction, and find ground-breaking ways to reduce costs and maintain schedules. We are also experienced in coordinating public awareness programs to minimize disruption of business and residential activities during construction and in providing transportation planning and control.

## Wastewater Pipelines

We have provided engineering services for more than two million linear feet of wastewater pipeline. Carollo's wastewater conveyance facility projects have included important considerations such as evaluating alternative alignments, utility research, encroachment permits, roadway/paving replacement, pipe selection, challenging crossings, and coordinating with various impacted parties. Our pipeline rehabilitation projects have incorporated traditional cut-and-cover and jack and bore construction methods, as well as microtunneling, horizontal directional drilling, tunnel boring machines, pipe bursting, fold and form pipe, cured in place pipe, and sliplining techniques. We have worked with pipe diameters ranging from four inches to 120 inches and with pressures from 0 psi (gravity flow) to 600 psi.



## Wastewater Pump Stations

Carollo has planned, designed, and/or assisted in the construction of more than 500 wastewater pump stations. These pumping facilities serve a number of specific functions, including influent, effluent, return activated sludge (RAS), waste activated sludge (WAS), combined sewer overflow, storm water, and No. 3 water pumping.

Our pump station designs range in size from 1 mgd to 650 mgd and with individual horsepower capacities of up to 2,500. These facilities have included various types of pump configurations including wet pit (propeller, mixed flow, and turbine type); dry pit; submersible; self cleaning; vertical; horizontal; solids handling; and screw pumps. Pump drives include constant-speed and multi-speed electric motors and various types of variable-speed drives including variable frequency drives (VFDs); gas, diesel, and dual-fuel engines; gear drives; and V-belt drives.

Many of these projects have involved special considerations for minimizing community and environmental impacts such as special architectural treatments and odor and noise control measures.

## Representative Projects - Wastewater Pipelines

Agency/Project	Pipe Diameter (inches)	Length (feet)
City of Phoenix, Arizona - Reclaimed Water Pipeline	16-34	35,000
City of Phoenix, Arizona - Southern Avenue Interceptor	48-90	264,000
Central Contra Costa Sanitary District, Pleasant Hill, California - A-Line Relief Interceptor Project	60	29,800
County Sanitation Districts of Los Angeles County, California - Joint Outfall "A" Relief Sewer	54-90	42,000
County Sanitation Districts of Los Angeles County, California - Trunk Relief Interceptor Project	48-102	36,000
East Bay Municipal Utility District, California - Adeline Street/South Foothill Interceptors	42-84	32,000
East Bay Municipal Utility District, California - North Interceptor Relocation	60-105	3,400
Town of Hillsborough, California - Sanitary Sewer Improvement Project	24	90,000
Livermore-Amador Valley Water Management Agency, California - Export Pipeline	24-42	84,480
Orange County Sanitation District, California - Interplant Interceptor	120	18,300
Orange County Sanitation District, California - On-shore Portion of Ocean Outfall	120	3,000
Sacramento Regional County Sanitation District, California - Folsom East Interceptor Section 1B and Folsom Boulevard Improvements	54-72	13,000
Sacramento Regional County Sanitation District, California - Bradshaw Interceptor Section 3	90	5,320
Sacramento Regional County Sanitation District, California - Northwest Interceptor	30-90	116,000
City of San José, California - Monterey-Riverside Sanitary Sewer Improvements	42	2,000
South Tahoe Public Utility District, California - A-Line and B-Line Export Pipeline Replacement Projects	24-30	34,800
City of Stockton, California - South Stockton Interim Sewer Improvement	33-66	45,000
City of Stockton, California - Westside Sewer Improvements Project	18-42	55,870
City of Shady Cove, Oregon - Force Main	8	15,000

## Representative Projects - Wastewater Pumping Projects

Agency/Project	Capacity, mgd
Sacramento Area Flood Control Agency, California - Natomas Pump Station	646
Orange County Sanitation District, California - Ocean Outfall Booster Pump Station	600
City of West Sacramento, California - Main Drain Pump Station	380
City of Portland, Oregon - Columbia Boulevard Wastewater Treatment Plant Pump Station	300
Orange County Sanitation District, California - Headworks C/Plant No. 2	288
Orange County Sanitation District, California - Headworks 2/Plant No. 1	280
City of Portland, Oregon - Swan Island CSO Pump Station	220
Orange County Sanitation District, California - Headworks B/Plant No. 2	160
Central Contra Costa Sanitary District, California - Orinda/Moraga Pump Station	124
King County, Seattle, Washington - Matthews Park Pump Station	120
East Bay Municipal Utility District, California - Point Isabel Pump Station	100
City of San Bernardino, California - Influent Pump Station	90
East Bay Municipal Utility District, California - Storage Basin Pump Station	80
City of Portland, Oregon - Swan Island Pump Station	80
City of Watsonville, California - Pajaro River Pump Station	65
Vallejo Sanitation and Flood Control District, California - Influent Pump Station	56



## Southern Avenue Interceptor

Carollo prepared the original conceptual design report and route study for the 20-mile Southern Avenue Interceptor, designed the segment which connects to the Phoenix 91st Avenue Wastewater Treatment plant, and provided management services and construction coordination for the nine project segments. During construction phase, services included master scheduling control of the nine contracts, coordinating with utility companies, mitigating traffic impacts, providing a master interface for system start-up, and preparing monthly construction progress reports.

The entire project was constructed over a 30-month period. The project consisted of gravity sewer piping from 48 inches to 90 inches in diameter, connecting the southern portions of the metropolitan area to the Regional 91st Avenue Wastewater Treatment Plant.

The project included 10 major tunnels for street/utility crossings, 11 junction and metering structures, an inverted siphon across the Salt River, numerous intercepts of existing sewers ranging up to 48 inches in diameter, and numerous utility relocations.

HIGHLIGHTS

160,000 feet of 48-inch to 90-inch pipe.

Ten major tunnels for street and utility crossings.

Eleven junction and metering structures.

Inverted siphon across the Salt River.

Numerous intercepts of existing sewers ranging up to 48-inch in diameter.

Several utility relocations.



*Carollo provided routing, design, and construction services for Phoenix's Southern Avenue Interceptor.*

# CENTRAL CONTRA COSTA SANITARY DISTRICT, PLEASANT HILL, CALIFORNIA

## A-Line Relief Interceptor Project

Carollo is nearing completion of design of 30,000 feet of “T-lock” reinforced concrete pipeline for the Central Contra Costa Sanitary District. This pipeline includes 3,100 feet of 96-inch-diameter, 15,500 feet of 66-inch diameter, and 11,200 feet of 60-inch-diameter pipeline. Large portions of this pipeline will be tunneled under sensitive areas including an active golf course, the busy streets of three cities, the west bank of the Walnut Creek Channel, Caltrans freeway bridges, a reach of the Contra Costa Canal, and an elevated section of the Bay Area Rapid Transit (BART) system near the Pleasant Hill BART station. Construction will take place in phases over a five to ten-year period.

The most important goal of the predesign was to present a practical and constructible project. The project’s focus was to establish alignment and grade for the interceptor and minimize any potential problems or unnecessary inconvenience brought about by identified project constraints.

The alignment required easements or permits from several entities including the Contra Costa Flood Control and Water Conservation District; Contra Costa County; the Pleasant Hill Parks and Recreation District; the Mt. Diablo Unified School District; the Contra Costa Community College District; private property owners; the cities of Concord, Walnut Creek, and Pleasant Hill; BART, the East Bay Municipal Utility District; Caltrans; the California Department of Fish and Game; Pacific Gas & Electric Company; Pacific Bell; Televents; UA Cable Systems; the California State Lands Commission; and the U.S. Army Corps of Engineers.

**HIGHLIGHTS**

- 29,800 feet of 60-inch to 96-inch-diameter pipe.
- Tunneling under sensitive areas.
- Constructability issues.
- Multiple-agency coordination.
- Phased construction over five to ten-year period.



*The alignment of Central Contra Costa Sanitary District’s A-Line Interceptor will transverse several sensitive areas, including this trail along the Contra Costa Canal.*

# COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY, CALIFORNIA

## Trunk Relief Interceptor Project

This project for the County Sanitation Districts of Los Angeles County included preliminary planning, including alignment selection, for approximately 36,000 linear feet of 48-inch to 102-inch-diameter trunk interceptor sewer. Key project aspects included scheduling, constructability, easement acquisition, major siphons, a railroad crossing, a golf course crossing, and intertie junction structures. Also included were geotechnical investigations, utility locations, surveying, and mapping.

Major segments of the project required placing large diameter pipelines to depths of 40 feet through residential areas, parks, and golf courses in the City of Torrance, requiring directional drilling and tunneling construction techniques. The project team also designed special junction boxes and inserts to convey existing wastewater flows during construction. Placement of these structures allowed flow diversion to the new pipeline without disrupting flow from the existing system.

The original design and proposed construction schedules were modified to allow early completion of key portions of the project in order to provide partial flow relief. The project also required coordinating with multiple agencies, acquiring several permits, and detailed construction sequencing to allow multiple concurrent phased construction.

### HIGHLIGHTS

36,000 feet of 48-inch to 102-inch pipe.

Significant tunneling.

Successful resolution of constructability and scheduling issues.

Residential, park, and golf course easements.

Multiple-agency coordination/permitting.

Fast-track design.



*Los Angeles County's Trunk Relief Interceptor project required significant tunneling beneath city streets.*

# EAST BAY MUNICIPAL UTILITY DISTRICT, OAKLAND, CALIFORNIA

## Adeline Street and South Foothill Interceptor Sewers

Carollo, in joint venture, prepared the preliminary and final design and provided services during construction for two major interceptor sewer projects for the East Bay Municipal Utility District (EBMUD). These projects, with a combined construction cost of \$16 million, are designed to intercept wet weather combined sewer flows from a diversion structure. The design included approximately 32,000 linear feet of sewer ranging in size from 42 inches to 84 inches in diameter. The Adeline Street Interceptor includes 2.5 miles of 84-inch-diameter pipe to carry wet weather flows from Martin Luther King Jr. Way in Berkeley to EBMUD's main wastewater treatment facility in Oakland. The South Foothill Interceptor includes three miles of 48-inch to 60-inch-diameter pipeline to carry wet weather flows from 92nd Avenue in Oakland to the Oakport Wet Weather Treatment Plant. Comprehensive preliminary and final design included:

- ▶ Evaluating alternate routes.
- ▶ Evaluating critical route constraints including community disruption during construction, traffic and parking impacts, and interferences.
- ▶ Determining the size and hydraulic grade line for the new interceptors based on design and maximum flow conditions.
- ▶ Evaluating alternative construction methods and construction sequencing requirements.
- ▶ Analyzing corrosion control measures.
- ▶ Considering pipe prepurchase.

### HIGHLIGHTS

32,000 feet of 24-inch to 84-inch pipe.

Construction in widely varying soil conditions, including bay mud.

Successful resolution of route constraints.

Urban construction.

*Construction of the South Foothill and Adeline Street Interceptors involved mitigating community, traffic, parking, and utility impacts.*



Construction took place in a heavily-urbanized area with many utility conflicts. The pipeline alignment was located almost entirely in Oakland, Emeryville, and Berkeley city streets, requiring extensive utility research and coordination throughout all phases of the project. The project team successfully resolved issues relating to widely varying soils conditions and, through careful routing studies, avoided areas of contaminated soils. Areas that indicated potential hydrocarbon contamination were evaluated further.

The team also resolved traffic control issues and required the contractor to conduct exploratory potholing during construction. Some utilities were relocated and short lengths of bored and jacked pipe were used where necessary.

## Crystal Springs Sewer Improvement Project Phases I and II

### HIGHLIGHTS

Evaluation and rehabilitation/repair recommendations for approximately 90,000 feet of sewer suffering capacity deficiencies as a result of rain-dependent infiltration/inflow.

Flow monitoring to determine base flow, peak dry weather flow, and peak wet weather flow in eight “mini basins.”

Two-phase design to upsize nearly 15,000 feet of existing 12-inch to 15-inch trunk sewer to 24 to 27 inches in diameter.

Pipeline rehabilitation using innovative pipebursting construction methods.

Concentration of rehabilitation in high problem areas resulting in significant cost savings to the client.

Design considerations for preserving large oak trees and minimizing construction impacts to home sites.

The Town of Hillsborough has long recognized the large volume of infiltration/inflow (I/I) in its sewer system. Located on the San Francisco peninsula west of the San Francisco Airport, Hillsborough is an “upscale” community characterized by steep terrain and large oak-covered lots. Hillsborough completed an I/I study of its trunk sewer system, covering 4,000 acres and serving approximately 12,000 residents. The study concluded that its primary sewer trunk line was capacity-deficient partially as a result of rain-dependent infiltration inflow (RDI/I). The study also concluded that reduction of I/I flows in some sewer sub-basins would be cost effective. These sewer sub-basins have ratios of wet weather flow to dry weather flow as great as 15 to 1.

In an effort to control RDI/I, Hillsborough retained Carollo to evaluate two collection system sub-basins containing approximately 90,000 feet of sewer and recommend and design cost-effective rehabilitation/repairs. The evaluation divided the two sub-basins into eight “mini” basins of approximately 10,000 feet each for flow monitoring. Carollo installed a total of eight flow monitors and recorded data during wet weather. Initial results of the RDI/I analysis indicated that two of the eight mini-basins were the source of the highest contribution of the RDI/I. Hillsborough was able to realize a significant cost benefit by concentrating its rehabilitation efforts in these specific high I/I areas.

Phase I of the design consisted of upsizing approximately 4,000 linear feet of 15-inch vitrified clay trunk sewer adjacent to Crystal Springs Road and San Mateo Creek to 27-inch, high-density polyethylene (HDPE) pipe. Approximately 2,700 feet of the existing sewer was located immediately adjacent to an extremely environmentally sensitive creek habitat that is home to two known endangered species. To reduce environmental disturbance, Carollo specified three-diameter upsizing using pipebursting. The successful completion of this project was in large part a result of a comprehensive permitting process made possible by using this environmentally-friendly trenchless construction method. Additional considerations included preserving large heritage oak trees and minimizing construction impacts of sewers crossing home sites.

Phase II consists of replacing an additional 10,500 feet of single and parallel 12-inch to 15-inch sewers with a single 24-inch to 27-inch sewer. Maintaining existing service while replacing the existing sewer and abandoning the parallel sewer is essential. Since the existing sewer runs parallel to Crystal Springs Road in El Ceritos, an alignment that also contains portions of two City of San Francisco aqueducts, the design also contains provisions for widening the existing trench to allow installation of the new sewer while avoiding any grade issues with the aqueducts.



*Rehabilitation of Hillsborough’s mini basins and trunk sewer involved pipe bursting, fold-and-form, and conventional pipeline replacement methods.*

# SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT, CALIFORNIA

## Folsom East Interceptor Section 1B and Folsom Boulevard Improvements

The Sacramento Regional County Sanitation District (SRCSD) has been focusing on the completion of the Bradshaw/Folsom Interceptor System since the acceptance of the Sewerage Expansion Study Update in 1994. Major interceptor segments are under design, construction, or have been completed at both ends of this system. SRCSD is completing the remaining segments, including the Folsom East 1B Interceptor Project (FE1B), as system capacity is needed. An important consideration is to coordinate these segments with the construction of projects by other county and regional agencies.

SRCSD selected Carollo to design the FE1B project, which includes 13,000 lineal feet of 54-inch and 72-inch gravity sewer pipeline. A key feature of the project included the design of a vortex drop structure that allows the pipeline to go over a major concrete box culvert then under an access tunnel while maintaining flow velocity and limiting odor concerns. The project also included the design of large junction structures for future interceptor connections. In order to coordinate this project with a county road widening project and construction of a light rail system, Carollo worked closely with the Sacramento County Department of Transportation, Sacramento Regional Transit, and the Sacramento County Department of Water Resources.

Work involved incorporating the plans and specifications completed by the County Department of Transportation into the contract documents to complete the joint project by the spring of 2004. The construction of the widened roadway also required that connections to the FE1B interceptor be extended outside of the roadway widening project. This included a connection to the future new Sunrise Interceptor. Elements of the transportation project included new and revised traffic signals, turn lanes, rubberized asphalt, curbs and gutters, culvert extensions, and drainage improvements.

Design of 13,000 feet of 54-inch and 72-inch gravity sewer pipeline.

Vortex drop structure that allows the pipeline to go over a major concrete box culvert and under an adjacent access tunnel.

Large junction structures to accommodate future interceptor connections and projects by others.

Deep construction in cobble filled soils.

HIGHLIGHTS



*Sacramento Regional County Sanitation District's Folsom East Interceptor involved several innovative design features to accommodate construction challenges and future projects.*

Deep construction in cobble filled soils posed challenges for the installation of the interceptor. Using the soils investigation completed for this project, Carollo mapped the cobble zone and provided it for bidding contractor information. In addition, Carollo recommended hydraulically operated shoring systems based on their success in previous SRCSD projects in cobble.

# SOUTH TAHOE PUBLIC UTILITY DISTRICT, SOUTH LAKE TAHOE, CALIFORNIA

## Wastewater Export System

The South Tahoe Public Utility District (STPUD) maintains and operates a complex mechanical wastewater export system that conveys treated final effluent approximately 25 miles from the wastewater treatment plant to the Harvey Place Reservoir in Alpine County. Carollo completed an evaluation of the export facilities that included developing and evaluating alternatives for the repair, rehabilitation, relocation, and/or replacement of four pump stations; 12 miles of 24-inch force main; and 11 miles of 18- and 21-inch gravity mains. The evaluation considered pipeline rehabilitation using insitu liners such as Insituform and sliplining, developing cost estimates for each alternative, and identifying feasible project alternatives for environmental impact statements. Carollo has designed several of the repairs/improvements recommended in the completed study including:

Horizontal directional drilling and jack-and-bore operations.

Evaluation of repair, rehabilitation, relocation, and/or replacement of four pump stations, 12 miles of force main, and 11 miles of gravity main.

Design of three pump stations and approximately 75,000 feet of high-pressure, ductile iron pipe.

Construction along narrow mountain roads and residential streets.

HIGHLIGHTS

**A-Line Export Pipeline.** This work involved three projects to design and construct 52,800 feet of 30-inch-diameter, 150 to 250 psi pressure rated ductile iron force main along residential streets and State Highway 50. The project included 200 lineal feet of horizontal directional drilling to install a .5-inch steel, 30-inch-diameter pipe, pressure rated at 250 psi, beneath a creek and a meadow. It also included three jack-and-bore operations ranging from 200 to 300 feet in length to install the pipeline beneath the highway.

**B-Line Export Pipeline.** This involved three projects to design and construct 22,000 feet of 24-inch-diameter, 150 to 600 psi pressure rated restrained joint, ductile iron pipe along narrow mountain roads and Highway 89. In addition to traditional cut-and-cover construction techniques, the project required blasting to install the new pipe in rocky terrain.

**Luther Pass Pump Station.** This project involved design and construction of an 8-mgd, 3,400-hp pump station with a vertical rise of 1,240 feet. The design also included a new surge tank, piping modifications, and emergency standby power.

These projects included agency coordination with the Tahoe Regional Planning Agency, the Lahontan Regional Water Quality Control Board, El Dorado County, the U.S. Forest Service, the State Attorney General, and citizens groups. In addition, Carollo coordinated work with other projects in the area being completed by outside agencies and contractors.



Horizontal directional drilling to install 30-inch-diameter pipe, pressure rated at 250 psi was instrumental in the construction of the South Tahoe Public Utility District's A-Line Export Pipeline.



## Westside Sewer Interceptor Improvements Project

Carollo provided planning and design services to the City of Stockton for the Westside Sewer Interceptor Improvements Project. Construction of the project was awarded in two separate contracts, one for pipelines and one for pump stations.

**Pipelines.** The design involved a total of 41,000 feet of pipeline from 18 inches to 72 inches in diameter, including 1,400 linear feet of bored-and-jacked casing for 14 separate crossings under railroad tracks, sloughs, and utilities. Carollo designed the force main to facilitate the installation of a parallel force main in 30 years as Stockton’s population increases. Cathodic protection and surge control were important design elements.

The project also included San Joaquin River and Stockton Deep Water Channel crossings. Crossing the San Joaquin River required installing dual 36-inch-diameter force mains five feet beneath the existing river bottom. The Stockton Deep Water Channel crossing required installing dual 36-inch-diameter force mains 10 feet beneath the future dredging limits of the channel. The crossing had levees on both sides under the jurisdiction of the State Reclamation Board. During the construction, the channel had to remain open and operational to allow major shipping to continue.

**Pump Stations.** The pump station contract included the new 7.7-mgd Brookside Wastewater Pump Station and improvements to the interim 14-Mile Pump Station. The Brookside Pump Station includes four submersible pumps with variable frequency drives (VFDs), an odor control scrubber, and sodium hypochlorite storage and feed facilities. A standby generator is sized to operate three of the four pumps, since the fourth pump is a standby unit. The 14-Mile Pump Station has three 3.75-mgd

existing submersible pumps. This project adds new VFDs, a new standby generator, and sodium hypochlorite feed facilities for odor control.

**Permitting.** Carollo completed all work required to obtain permits and licenses from 13 separate permitting agencies. The project also required coordination with the East Bay Municipal Utility District (EBMUD) because the force main passes beneath an important EBMUD aqueduct.

**HIGHLIGHTS**

- 41,000 feet of 18-inch to 72-inch pipe.
- New 7.7-mgd pump station and improved 11.25-mgd pump station.
- Extensive utility research and potholing.
- Successful negotiation of several easements and encroachment permits.
- Multi-agency coordination.
- Fourteen separate crossings.



*Stockton’s Westside Sewer Interceptor alignment crosses developed urban areas, underdeveloped farmland with some peat deposits, a river, a deep water channel, and a military facility.*

## Lift Station No. 2 and Force Main

The City of Shady Cove is situated along the banks of the beautiful Rogue River in the Pacific Northwest, one of the most treasured and popular recreational rivers in America. To prevent overflows into the river during severe wet weather flows, Shady Cove hired Carollo to provide planning, preliminary design, final design, and construction management services for a project to increase the capacity of its largest raw sewage lift station.

Part of the project involved upgrading the lift station force main that conveys flow to Shady Cove's gravity interceptor. Potential alignments for the upsized force main included the existing 6,500-foot alignment or a sub-river crossing beneath the Rogue River very near the lift station. Following an evaluation of the costs and benefits of each alternative, the team chose a sub-river crossing using horizontal drilling technology. The new 1,500-foot sub-river force main is five times shorter and has less elevation rise than the original force main, reducing pumping energy and operating costs. Additional benefits included less construction disturbance and odor generating potential, and lower capital costs.

Horizontal directional drilling beneath the Rogue River was by far the most challenging aspect of the project. The river banks and subsurface soils consist of coarse alluvium, sand, gravel, and cobble materials that are typical for this setting but disadvantageous to directional drilling techniques. This required a thorough and detailed geotechnical evaluation and directional drilling feasibility assessment to help mitigate potential construction problems.

Careful planning resulted in several measures to streamline construction, minimize environmental impacts, and address public sensitivity regarding drilling on private property, including:

- ▶ Setting entry and exit bore pits back away from river shoreline to protect the sensitive habitat.
- ▶ Constant monitoring of drilling fluid pressure and flow rates.
- ▶ Using washover casings to minimize the risk of drilling fluid escape.
- ▶ Installing a casing through the alluvial cobbles to prevent caving of entry and exit pits.
- ▶ Gradual steering corrections to prevent borehole caving.
- ▶ Back-reaming of the bore prior to pipe pullback.

Each of these measures contributed to the project's successful outcome, which met Shady Cove's needs for increased capacity while preserving a valuable natural resource.

HIGHLIGHTS

Horizontal directional drilling of 624-foot length of 8-inch diameter, high density, polyethylene DR 9 pipeline.

1,500-foot force main installed under the Rogue River at depths up to 32 feet.

Four-day installation time.

Sewage pump station with VFDs.

Designed, bid, and constructed on tight schedule.



*A sub-river crossing using horizontal directional drilling proved to be the most cost-effective and environmentally-friendly construction alternative for replacement of Shady Cove's Lift Station No. 2 force main.*

# METRO WASTEWATER RECLAMATION DISTRICT, DENVER, COLORADO

## Riverdale and Thornton-North Washington Force Main Expansion Study

The Metro Wastewater Reclamation District (MWRD) retained Carollo to perform the Riverdale and Thornton-North Washington Force Main Expansion Study and subsequent Brantner Gulch Lift Station Expansion Design. The project included field testing for a pump station capacity analysis, projecting existing and future flows, analyzing alternative pump selections, and the testing of three alternative polymers for a potential force main capacity increase. Field testing of three different polymers provided data showing that polymer use in high-flow situations can increase the overall capacity of the pump station force mains.

Carollo replaced two existing 4-mgd pumps with new 8-mgd pumps including variable frequency drives (VFDs) and a polymer feed system. The polymer system allows MWRD to increase the pump station peak flow capacity and delay the large capital expenditure required to construct a new force mains and pump station.

### HIGHLIGHTS

Pump station and force main capacity analysis.

Polymer pilot testing for capacity increase.

Replacement of two existing 4-mgd pumps with new 8-mgd pumps, including VFDs.



*Carollo's work for Metro Wastewater Reclamation District includes a force main and pump station capacity analysis and design of required pumping improvements.*



# ORANGE COUNTY SANITATION DISTRICT, CALIFORNIA

## Ocean Outfall Booster Pump Station

Carollo designed the 600-mgd Ocean Outfall Booster Pump Station for the Orange County Sanitation District. This \$25.4 million project consists of five, 2,500-hp, vertical dry pit pumps, each sized for 120 mgd at 93 feet of head. The pumps are driven by 360-rpm, 2,300-volt vertical synchronous motors with load commutated inverter (LCI) type variable frequency drives. A computer based distributed control system is also included. The Carollo design fee was \$2.5 million for this project.

Because of the size of this facility, Carollo completed a number of detailed design studies to optimize the pump station layout. These studies included:

- ▶ Use of dry pit versus wet pit pumps.
- ▶ Number and size of pumps.
- ▶ Evaluation of several types of variable frequency drives.
- ▶ Various pump/wet well and building layouts.
- ▶ Method of equipment procurement.

In addition to this project, Carollo has also designed many other pumping stations for Orange County. These include:

- ▶ Headworks "C", Plant No. 2 - Two 50-mgd pumps with electric pump drives.
- ▶ Primary Effluent Pump Station at Plant No. 2 - Two 50-mgd pumps with engine drives and two 50-mgd pumps with electric drives.
- ▶ Aeration Basin Pump Station Plant No. 1 - A 135-mgd pump station with two 45-mgd engine-driven pumps and one 45-mgd pump with an electric drive.

### HIGHLIGHTS

The largest pumping facility of its type on the West Coast.

Five 2,500-hp vertical dry pit pumps.

Detailed design studies to optimize pump station layout.

*Carollo designed Orange County's 600-mgd Outfall Booster Pump Station, which has exceeded its design standards during the most severe storms.*



## Swan Island CSO Pump Station

### HIGHLIGHTS

220-mgd pump station with dry pit/wet pit configuration.

160-foot-deep structure.

Largest self-cleaning wet well in the Pacific Northwest.

Five 2000-hp, variable-speed, vertical dry-pit pumps with 22-foot continuous intermediate shafting.

Two 800-hp, variable-speed, horizontal dry-pit pumps.

Optimized design through physical modeling.

Carollo recently completed the design of the 220-mgd Swan Island Pump Station. The pump station is currently under construction and is as a key component in Portland's combined sewer overflow (CSO) program, the largest capital construction project in the city's history. The pump station serves as the terminus of the "Big Pipe" project, consisting of two gravity flow tunnels deep beneath the city (in excess of 120-feet underground), designed to collect and store combined sewage. The circular structure is one of a kind and is believed to be the deepest of its type in the world.

The tunnel system's ability to store combined sewage in the tunnel system introduced several hydraulic considerations into the pump station design. When utilizing tunnel storage, the hydraulic grade line within the tunnel system can fluctuate by over 110 feet, creating a substantial range in pump operating performance. The design takes advantage of the hydraulic range by eliminating the need for a standby pump, thereby minimizing the overall footprint of the pump station.

The facility has many unique features, including:

- ▶ A 160-foot depth to accommodate flow from two CSO tunnels.
- ▶ A 140-foot diameter to accommodate a trench-type, self cleaning wet well.
- ▶ Two 800-hp, variable speed, horizontal dry pit pumps to accommodate average dry weather flows ranging from 8 mgd to 32 mgd.
- ▶ Five 2000-hp, variable speed, vertical dry pit pumps to accommodate wet weather flows of 220 mgd.



Currently under construction, Portland's Swan Island Pump Station is believed to be one of the deepest of its kind in the world.



Portland's 220-mgd Swan Island Pump Station will pump combined sewage to the Columbia Boulevard Wastewater Treatment Plant.

The wet well design features several special attributes that benefit pump station operation. The most distinguishing feature is its self-cleaning design, which reduces maintenance and risk to personnel by minimizing the need to enter the wet well. It is the largest self-cleaning pump station in the Pacific Northwest. Because of its uniqueness, Carollo utilized physical hydraulic modeling using a 1:7 scale to test for hydraulic inefficiencies, vortices and other adverse flow phenomena to optimize wet well and pump performance.

# SACRAMENTO AREA FLOOD CONTROL AGENCY, CALIFORNIA

## Natomas East Main Drainage Canal Pump Station

The Sacramento Area Flood Control agency selected Carollo to provide engineering design services, prepare contract documents, and provide services during construction of the \$10 million, 646-mgd Natomas East Main Drainage Canal Pumping Plant. The multifunction facility protects Elverta, Natomas, and the Rio Linda areas from the backwater effects of high flood stages in the canal.

Technical memoranda prepared as part of the preliminary design addressed capacity and hydraulics, site location and layout, types of pumps and drives, and startup and testing. The Carollo team also performed hydraulic modeling to determine exact wet well dimensions matched to specific pumping equipment so that cavitation and other hydraulic pumping problems would be avoided.

The finished facility includes three, 215-mgd diesel engine-driven vertical turbine pumps. It also features three mechanical trash racks, a radial gate, a cast-in-place concrete building with a maintenance area, a traveling bridge crane, acoustic louvers, telemetry equipment to match existing Sacramento County equipment, a sump pump, and special pump controls.

Issues such as access, maintenance, storage, operation, and site security were key considerations during design. Key project tasks also included geotechnical analysis, vibration analysis, value engineering and final design, traffic control permits and easements, noise mitigation, architectural review, and developing an operations and maintenance manual.

The building received architectural treatment to blend with the local area and enhance security requirements. In the event of a power outage, the pump station is capable of running for 36 hours before refueling.

### HIGHLIGHTS

Three 215-mgd diesel engine-driven vertical turbine pumps.

Very effective acoustical treatments keep noise levels at 45 decibels at residential boundaries less than 100 feet from the facility.

Completely-independent power source reduces dependence on local utility company.

Unique testing system allows pumps to be tested at full capacity in dry weather.

Architecture designed to “blend” with local residential surroundings.

*“The pump station is performing flawlessly as designed by Carollo Engineers. Your firm is highly regarded in the industry as one of the leaders in the design and construction administration of these types of projects and we are proud to have been part of the construction team.”*

*—Carl Skinner, Project Superintendent,  
Allen L. Bender, Inc. (pump station subcontractor)*



*Construction of the Natomas pump station during wet weather required designing a cofferdam with a truck access ramp. The finished pump station is located in an existing drainage canal.*

## Matthews Park Pump Station

As part of an on-call services contract to King County, Carollo developed a comprehensive program for future operational changes to this 120-mgd pump station, which was originally constructed in 1966. The age of the facility, projected changes to influent flows, and various independent projects in various stages of completion drove the need to consider the following:

- ▶ The impact of various new pumping strategies at the North Creek and York pump stations to serve the new treatment plant.
- ▶ The energy savings and impacts of using VFDs as replacements for existing electromagnetic clutches.
- ▶ The impact of changing the size of pumps on wet well and force main hydraulics.
- ▶ The level of urgency with which each project should be completed.

Carollo evaluated six alternative scenarios to accommodate the pump station's projected 15:1 flow range and designed replacement systems that include: two 500-hp pumps and two 700-hp pumps; pump motors; 18-pulse VFDs for all pumps; 4,160-volt and 480-volt electrical service, feeders, conduit and wire to major equipment; a 2,000-kW

standby generator and fuel system; a 2,000-square-foot electrical building to house switchgear and drives; pump headers, discharge check valves, and isolation valves; air/vacuum valves for surge control; odor control system modifications; and modifications to the seal water system.

Because keeping the existing pump station in operation during construction is an important consideration, Carollo developed a detailed construction sequencing plan and schedule. Central to the plan was the need to construct a new electrical room without disrupting existing equipment.

Carollo also assisted King County with permitting and public involvement during detailed design. This included research, community meetings, and submittals to the permitting agency, the City of Seattle. The site's location adjacent to a critical urban stream, required extra attention to storm water control. Carollo met these challenges by confining the footprint of the new electrical building to the allowable space without impacting the stream or flood plain setback requirements. This also simplified permitting approval by the city.

### HIGHLIGHTS

120-mgd pump station with dry pit/wet pit configuration.

2,200 kW of diesel standby power.

All new electrical, VFDs, and I&C systems.

Detailed construction sequencing plan to maintain critical operations during construction.

Community relations and permitting services.



*Carollo provided a comprehensive program for future design and operational changes and designed a capacity upgrade of King County's Matthews Park Pump Station.*

