CONSTRUCTION MANAGEMENT SERVICES
Black & Veatch’s Dams and Reservoirs Practice

At the earliest stages of your project, Black & Veatch’s construction management teams already have the successful endpoint in view. We’re approaching 100 years as engineers and constructors; today we’re managing and building more than $3.6 billion in Critical Human Infrastructure™ facilities around the world. Clients rely on us for responsible stewardship of capital projects with reliable technology, cost confidence, savings, scheduling and quality.

We help you take the chaos out of construction and delivery with a strong focus on serving your interests from start to finish through our state-of-the-art CM systems. Our proactive approach to construction lowers costs, improves quality and minimizes claims during construction.

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CALAVERAS DAM REPLACEMENT PROJECT
San Francisco, California

The Calaveras Reservoir represents a critical element of local storage and water supply for the city and county of San Francisco. However, since 2001, the reservoir has been drawn down to about 40 percent of normal storage due to seismic safety concerns with the existing dam.

Black & Veatch is overseeing the construction of the new 220-foot-high zoned earth and rockfill embankment dam. The new, robust dam will have a centrally-located clay core, wide filters and external drainage. It will be located immediately downstream of the existing dam, which will be used as a cofferdam during construction.

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SAN VICENTE DAM RAISE
San Diego County, California

By adding 117 feet to the current 220-foot-tall concrete gravity dam structure, the San Diego County Water Authority gained flexibility, by virtue of an additional 152,000 acre-feet of water storage for the San Diego region, especially in an emergency such as a major earthquake or an extended drought. Black & Veatch, in a joint venture, is providing construction management for this $449.2 million project, the largest roller-compacted concrete dam raise project of its kind in the world. The project more than doubled the capacity of the San Vicente Reservoir.

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SEVEN OAKS DAM
San Bernardino County, California

Black & Veatch was retained to manage the construction of the Seven Oaks Dam, a zoned earth and rockfill dam 550 feet above the canyon floor, on the Santa Ana River as part of a flood control project. This multi-phased project, completed in 1999 at a cost of $500 million, featured a field testing laboratory for quality assurance testing. Black & Veatch developed a computer-based management system to track and report all field and laboratory test data and transfer the data to the Corps of Engineers and the DSOD for review before issuing test reports.
CONSTRUCTION MANAGEMENT ELEMENTS

Major construction management project elements include:

- Coordination between numerous consultants that are currently providing services to the project.
- Technical coordination between the dam, inlet/outlet works, downstream control facility, outlet pipelines, saddle dams, roads and bypass pipeline connection among other construction packages.
- Reviews of design documents, bid documents, shop drawings and submittal reviews.
- Independent construction cost estimates and schedules to verify engineer’s estimates and provide a baseline for evaluating contractors’ submittals.
- Site coordination of the multiple concurrent contracts.
- Document and project record control.
- Photographic and video recordings of pre-construction, construction and post-construction activities.
- Monthly progress meetings with contractors.
- Operation and management on-site laboratory.
- Resident engineering and field inspection during construction.
- Public relations services, such as answering resident inquiries, stakeholder meetings, public and board tours, etc.
- Review contractor’s monthly progress pay request and supporting documentation against actual progress.
- Claims management based on extensive front end contract review, tracking of contractor performance and schedule, early identification of potential project issues and pre-claim resolution of issues.
- Preparation of operations and maintenance manuals and equipment warranty records during contract close out.
DAM DESIGN AND CONSTRUCTION
Black & Veatch’s Dams and Reservoirs Practice

With a large staff of engineers and scientists, Black & Veatch provides the full spectrum of services related to dams and reservoirs and is prepared to help with all types of projects, including the design and construction of new structures. Our reservoir of experience, extending from Southern California to Saudi Arabia, features a myriad of services on more than 100 dams—18 of them more than 100 meters high—in 20 countries.

Our extensive experience in using all types of materials can optimize decisions related to cost and constructability, and we can foresee and proactively address many common construction problems, minimizing delays, budget overruns and the potential for litigation.

LAKE WOHLFORD DAM REPLACEMENT
Escondido, California
Black & Veatch is managing the planning, environmental permitting, investigation and design of a replacement dam for the existing Lake Wohlford Dam. The existing dam was determined to be susceptible to liquefaction during the design earthquake. Rather than rehabilitate the existing structure, the City elected to construct a replacement dam immediately downstream. Through an alternatives evaluation, a new RCC dam was selected as the preferred option. The new structure will have several unusual characteristics, including the crest orientation and facing options. The project will be completed in 2017.

DIAMOND VALLEY RESERVOIR
Riverside County, California
This landmark project doubled surface water storage capacity in Southern California while providing drought protection and supplies for the peak summer months. Through eight years of involvement, Black & Veatch provided conceptual design alternatives, hydraulic structure design, and technical, cost and environmental analysis. With a capacity of 800,000 acre-feet, Diamond Valley is the largest off-channel reservoir in Southern California.

CATAWBA RIVER RESERVOIR
Union County, North Carolina
To provide greater operational flexibility for water delivery and an emergency water supply source, Black & Veatch provided environmental documentation, design, construction management and startup services for a new storage reservoir adjacent to the Catawba River Water Treatment Plant. The reservoir, one billion gallons in capacity, is impounded by a 110-foot-high embankment dam. Other associated equipment included a 90-foot-high intake tower, a 100 million gallons per day pump station and integration piping for flexibility and redundancy.
## BLACK & VEATCH DAM DESIGN AND CONSTRUCTION

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<th>DAM NAME</th>
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### LITTLE SENECA LAKE

**Montgomery County, Maryland**

Black & Veatch performed the project development study and design of the Little Seneca Lake for the Washington Suburban Sanitary Commission. The project included design of a 90-foot-high earth and rockfill dam, spillways, outlet works, highway and utility relocations, and other appurtenant facilities. The scope of services was subdivided into three phases. Phase One required preparation of a project development report, including permit requirements, coordination of various agencies, and preliminary design. Phase Two involved preparation of final engineering plans and specifications. In Phase Three, the Black & Veatch team provided consultation and construction phase services.
Many utilities and government agencies around the world are re-evaluating their aging dams and associated infrastructure for optimization. Some are looking to raise the height of the dam for increased reservoir capacity. Others are considering seismic stability enhancements, seepage control and increased spillway capacity.

For your many rehabilitation needs, look to Black & Veatch. We offer the complete range of engineering capabilities and design services to rehabilitate or replace existing dams and hydraulic structures, including spillways or gates. We bring extensive experience in the analysis, feasibility study, problem solving, permitting and design of remedial repairs and/or replacement of existing concrete, earthfill or rockfill dams.

LAKE HOLIDAY SPILLWAY REHABILITATION
Winchester, Virginia

- The prior principal spillway could only pass 15 percent of the required design storm.
- New spillway is a 120-foot, 4-cycle labyrinth capable of passing 60 percent of probable maximum flood.

Black & Veatch performed a comprehensive general engineering analysis of required spillway upgrades to meet regulatory standards in Virginia. Black & Veatch prepared a feasibility study to evaluate spillway alternatives, energy dissipation configurations, and bridge profiles. Black & Veatch engineers utilized state-of-the-practice techniques to size the appropriate labyrinth weir to pass flows through the limited space on the left abutment for the new spillway.

MORRIS DAM INLET/OUTLET PROJECT
Azusa, California

- Detailed design of complete rehabilitation of inlet/outlet features, new sluice tunnel, new control system and new control house.

Nestled in the San Gabriel Mountains, this concrete gravity dam rises 245 feet above the streambed and has a crest length of 800 feet. It is owned and operated by the Los Angeles County Department of Public Works. Black & Veatch provided construction drawings and specifications for the complete rehabilitation of the inlet and outlet features, the design of a new sluice tunnel, a new control system and a new control house. Three spillway drum gates regulate discharges over the existing 80,000-cfs ogee spillway. A new 84-inch-diameter, steel-lined tunnel was excavated through the concrete dam.
## Black & Veatch Dam and Spillway Rehabilitation

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<tr>
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<td>New York Power Authority</td>
<td>G</td>
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<td>Twin Lakes Spillway, CO</td>
<td>Pueblo Board of Water Works</td>
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<td>Table Rock Dam, SC</td>
<td>Greenville Water System</td>
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<td>Clear Creek Dam, CO</td>
<td>Pueblo Board of Water Works</td>
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<tr>
<td>Lake Holiday, VA</td>
<td>Lake Holiday, Inc.</td>
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<tr>
<td>San Vicente Dam, CA</td>
<td>San Diego County Water Authority</td>
<td>G/RCC</td>
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**Type of Dam**
- E = Earthen Embankment
- R = Rockfill
- G = Concrete Gravity
- RCC = Roller Compacted Concrete

## Condit Hydroelectric Project
**Underwood, Washington**
- Detailed design and construction engineering support services.
- Enhanced operations and maintenance with installation of Obermeyer Gate.

The 125-foot-high concrete gravity dam has a crest length of 471 feet and is set in a narrow, steep canyon on sound basalt. Due to operations and maintenance considerations, the former flashboards section of the dam was replaced with a 167-foot-long Obermeyer Gate. The gate was designed to enable to majority of the gate sections to act as one unit. However, one section was designed to act independently to pass trash and floating debris regularly.

## Lower Carno Reservoir Improvements
**South Wales, UK**
- Remediate severe leakage and dam settlement to restore vital water supply source to full service.
- Review, inspection and investigation and design-build delivery.

The Lower Carno Reservoir stands as a critical source of drinking water for much of South Wales. Its impounding structure, a 90-foot-high earthen dam completed in 1911, had a history of leakage. In 2005, the structure showed substantial settlement, resulting in the urgent drawdown and decommissioning of the reservoir.

Through its review, inspection, investigation and design-build delivery method, Black & Veatch was able to properly diagnose, design and install the 140-foot-deep slurry wall and restore the reservoir to full service in 2009.
FLOOD CONTROL/CSO RESERVOIRS
Black & Veatch’s Dams and Reservoirs Practice

Flood control refers to any means and methods used to reduce or prevent the harmful effects of flood waters. Flood can be caused by failure of dams, levees, retention ponds or other structures that retained the water.

Black & Veatch is a leader in the design and construction of flood control facilities, including dams, tunnels, levees, canals, retention ponds, hydraulic gates and pump stations.

USACE DEER CREEK RESERVOIR
Cook County, Illinois
- Black & Veatch prepared plans and specification documents and provided engineering services during construction.
- The 232 acre-foot reservoir was designed to control flooding in southern Cook County and reduce damage from a 100-year storm event.
- Project included construction of the reservoir, channel clearing, channel modifications and ecosystem restoration.

In the late 1990s, the Chicago District of the U.S. Army Corps of Engineers completed a reconnaissance study for Deer Creek in the village of Ford Heights and adjacent areas in southern Cook County; during wet weather periods, the Ford Heights area often experienced overbank flooding from Deer Creek with 40 percent of the community’s residences damaged. The study’s findings revealed the need for a new flood control reservoir.

Black & Veatch provided engineering services and assistance from field reconnaissance to a conceptual fish enhancement plan and ecosystem restoration area for the fast-track project.

THORNTON COMPOSITE RESERVOIR
Cook County, Illinois
- Design and construction phase services for the groundwater protection system and design of the final reservoir preparation project components.
- Reservoir will provide 7.9 billion gallons of storage capacity.

The Thornton Composite Reservoir is part of the Metropolitan Water Reclamation District of Greater Chicago’s Tunnel and Reservoir Plan, which was created to minimize waterway pollution by combined sewer overflows (CSO) and provide an outlet for floodwater. When completed, the Thornton project will provide 7.9 billion gallons of storage capacity, of which 4.8 billion gallons is for CSO and 3.1 billion gallons is for flood water.

The Black & Veatch designed groundwater protection system consists of a 550-foot-deep grout curtain to protect local bedrock and groundwater resources once the reservoir is operational. Black & Veatch also designed final reservoir components, including 1100 feet of 22-foot-diameter storm water tunnel to redirect flow from an existing tunnel to the reservoir.
**MCCOOK RESERVOIR**

*Chicago, Illinois*

- Ongoing reservoir design and construction activities includes tunnels, shafts, gate chambers, gates, valves and a groundwater protection system, including a cutoff wall and a grout curtain around the perimeter of the reservoir.
- Comprehensive planning, investigation, design and construction inspection.

The Chicagoland Underflow Plan’s McCook Reservoir project is one of three large combined sewer overflow (CSO) storage reservoirs that are part of the Chicago Tunnel and Reservoir Plan (TARP). The McCook Reservoir will provide approximately 7.2 billion gallons of storage of flood waters and CSOs conveyed from the TARP Mainstream and Des Plaines Deep Tunnel systems.

Black & Veatch and the U.S. Army Corps of Engineers New Orleans District developed load cases and stability criteria for gate closures and floodwalls. The design considered loads from waves, barges/boats, wind, earthquake, construction and unbalanced soil.

**UPPER LAS VEGAS WASH DETENTION BASIN**

*North Las Vegas, Nevada*

- Coordination with the Clark County Regional Flood Control District, the Nevada Division of Water Resources, the Bureau of Land Management and the U.S. Fish and Wildlife Service.
- Environmental mitigation plans used for protection of endangered species and archaeological/cultural resources throughout the project.

This Black & Veatch-designed project provides 1760 acre-feet of flood water storage capacity to control flash flooding in North Las Vegas. Completed on schedule at a construction cost of $7.2 million, the project features a 6,600-foot-long zoned embankment dam that stands 45 feet high. It also includes a 750-foot-long broad-crested weir spillway channel capped with roller-compacted concrete and a concrete culvert designed to discharge more than 4000 cubic feet per second.

**JEFFERSON PARISH HURRICANE PROTECTION SYSTEM FEASIBILITY STUDY**

*New Orleans, Louisiana*

To help the city of New Orleans manage flood risk for future conditions, Black & Veatch performed a feasibility study to evaluate upgrades to all of the Jefferson Parish Hurricane Protection System. The project included preliminary engineering and design to recommend the most suitable alternative to manage flood risk using post-Hurricane Katrina criteria.

Black & Veatch and the U.S. Army Corps of Engineers New Orleans District developed load cases and stability criteria for gate closures and floodwalls. The design considered loads from waves, barges/boats, wind, earthquake, construction and unbalanced soil.

**ELMHURST QUARRY FLOOD CONTROL PROJECT**

*Elmhurst, Illinois*

- Black & Veatch provided conceptual design, final design and construction phase services.
- Project features a 200-foot-deep, 8300-acre-foot reservoir.
- ASCE Illinois Section Outstanding Project Achievement Award winner.

The Elmhurst Quarry Flood Control Facility is one of the largest, non-federally-funded, off-line flood control reservoirs in the United States. Following an August 1987 flood event that caused $200 million in damages, the DuPage County Stormwater Management Division recommended a flood control plan that included the construction of the reservoir. The project minimizes flood damage to downstream communities, benefitting more than 100,000 people and saving more than $1 million per year.
Roller-compacted concrete (RCC), developed in the 1980s, was a significant breakthrough in the design and construction of dams, and its use for new dams and the rehabilitation of existing structures has quickly evolved since the 1990s. Durable and strong, cost effective and rapidly constructible, RCC dams have earned acceptance worldwide.

Through its involvement with one of the first applications of RCC as overtopping protection – at the Ashton Hydroelectric Plant in Idaho, USA – to the expert level advice provided for the Longtan Hydroelectric Project in China, Black & Veatch has been at the forefront of RCC development across the globe.

Experience, expertise and depth enable us to understand the big picture and take on difficult, complex projects. The tougher the challenge for your dams and reservoirs projects, the more you need Black & Veatch.

WADI DAYQAH WATER SUPPLY PROJECT
Sultanate of Oman
Black & Veatch was the lead partner in the Wadi Dayqah Dam joint venture project, formed to undertake detailed design and construction supervision of the US$120 million water supply scheme. The project includes a main 75-meter-high main dam formed within a limestone gorge made of roller-compacted concrete. Work was completed in 2009.

LAKE WOHLFORD DAM REPLACEMENT
Escondido, California
Black & Veatch is managing the planning, environmental permitting, investigation and design for a new 125-foot-tall RCC dam for the City of Escondido. Rather than rehabilitate the existing Lake Wohlford Dam, the City elected to construct a replacement dam immediately downstream. Through an alternatives evaluation, a new RCC gravity dam was selected as the preferred option. This structure will contain more than 100,000 cubic yards of RCC, and it will have a unique bent axis to take greatest advantage of the subsurface conditions. The project will be completed in 2017.

SAN VICENTE DAM RAISE
San Diego County, California
In a joint venture with Parsons, Black & Veatch provided construction management services on this $449.2 million dam raise project. The San Vicente Dam Raise project was the largest height increase of a concrete dam in the United States and the highest raise in the world using the RCC method. The original 220-foot concrete gravity dam, constructed in the early 1940s, will be raised 117 feet to maximize water storage by more than doubling the capacity of the San Vicente Reservoir.
Can-Asujan Dam
Philippines
The first faced symmetrical hardfill dam in the Philippines, this dam impounds the Can-Asujan River to provide irrigation water for an area of 950 hectares on the island of Cebu. Black & Veatch provided design, engineering services, technology transfer and construction management advice throughout the construction period of the 44-meter-high soil-cement structure.

Lake Blalock Dam & Reservoir
Spartanburg, South Carolina
To meet future water supply demand, the normal pool elevation of Spartanburg Water System's Lake Blalock was raised by 10 feet, requiring upgrades to the spillway crest, dam and outlet works. The existing 74-foot-high and 710-foot-long earthen dam was overlaid with 3-foot-layer of roller-compacted concrete. Black & Veatch provided design engineering services and construction management services for the project.
With the advancing age of the world’s dams, performing regularly scheduled inspections of dams and all associated facilities are a crucial component in their operation and maintenance. Inspecting embankment dams for early signs of piping or other potential failure modes is a key element in mitigating the risk of dam failure.

Black & Veatch has extensive experience on the inspection of existing dams, regularly performs FERC Part 12 safety inspections, and is familiar with many state dam safety rules and regulations of existing dams. Our keen understanding of the technical, environmental, risk and regulatory issues at stake can help you ensure the safety of your facilities with sustainable solutions.

**FAIRFAX WATER DAM SAFETY ENGINEERING**
Fairfax, Virginia

Fairfax Water engaged Black & Veatch for comprehensive dam engineering safety compliance services related to the condition of the Upper and Lower Occoquan Dams and their compliance with FERC and state regulations.

The services have included: emergency action plans, exercises and drills; surveillance monitoring; operation and maintenance plans; FERC five-year dam safety inspections; repair designs; construction oversight; dam break analyses; flood emergency planning; hydraulic analyses; and dam rehabilitation design.

**ALLIANCE CONTRACTS**

Black & Veatch has provided engineering and relicensing services to a number of major hydroelectric clients under long-term strategic Alliance type contracts. Services have generally included investigations, studies, FERC Part 12 dam safety inspections, detailed design, relicensing services and construction inspection and management. These clients include:

**Pacificorp** Since 1997, Black & Veatch has provided engineering services for 32 hydroelectric plants in Oregon, Washington, Idaho, Utah and Montana.

**We Energies** Since 1993, Black & Veatch has provided engineering services on 14 hydroelectric plants in Wisconsin and Michigan.

**Pacific Gas & Electric** Black & Veatch has provided a variety of multidisciplinary engineering services in support of PG&E operation, maintenance and relicensing projects in California.
After a dam safety assurance study showed that the Bluestone Dam would be overtopped during a probable maximum flood event, Black & Veatch provided plans and specifications and performed engineering during construction for the Bluestone Dam Safety Project. The project featured an 8-foot raise in height of the existing concrete gravity dam, which extends 165 feet above the streambed. The modeled PMF event was the result of rainfall from hurricanes that travel inland and situate over the 4,565-square-mile drainage area.

The Wolf Creek Dam impounds one of the largest reservoirs, Lake Cumberland, in the United States. The dam and reservoir provided numerous measurable benefits, including power generation, flood control, water supply and recreation. But since the late 1960s, the earthen section of the structure had experienced seepage problems. To combat these issues, the district looked to Black & Veatch for a concept study, aimed at determining if a roller-compacted concrete dam could be constructed downstream of the existing earthen embankment without endangerment.

Through much data collection, evaluation, and analysis, and identification of impacts, Black & Veatch developed an RCC dam concept, coupled with a foundation cutoff wall and foundation grouting. The district is using this information to further develop a risk analysis and economic evaluation of all the repair alternatives.