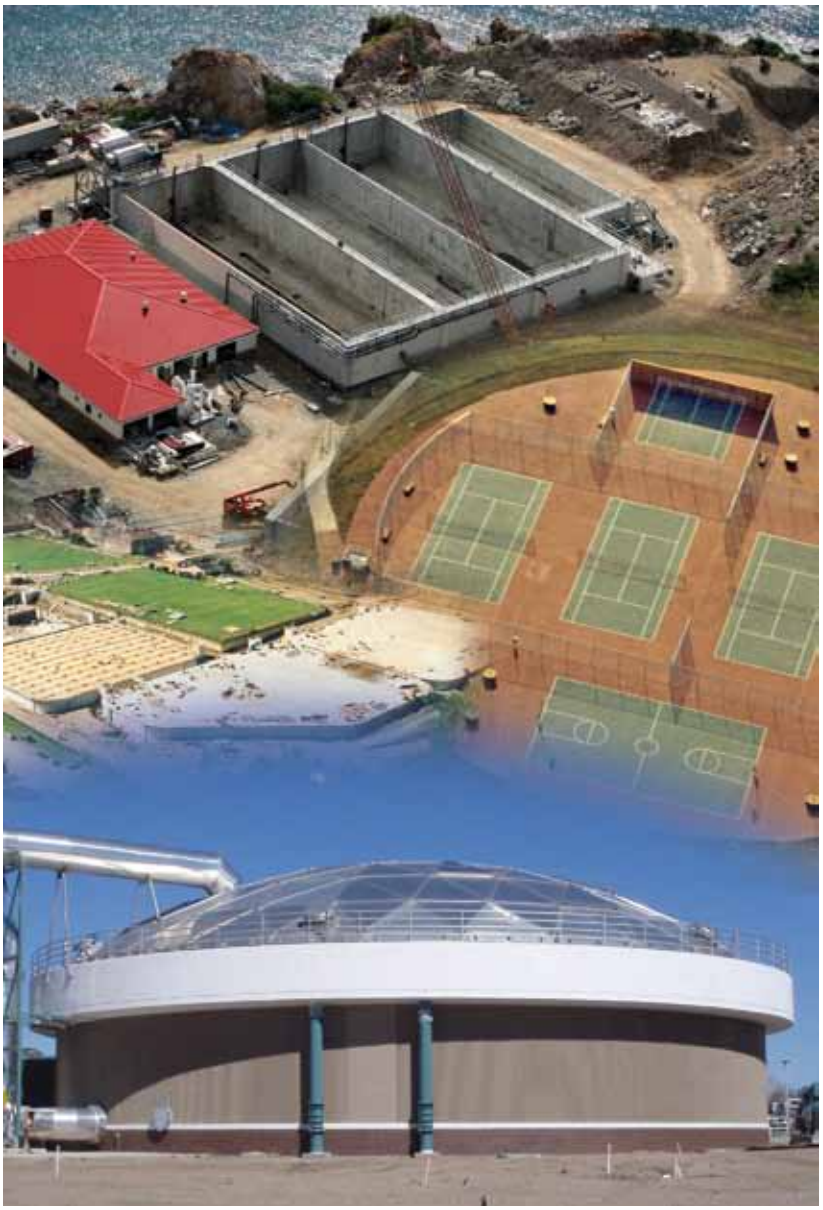
DuraStor™ Prestressed Concrete Tanks



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VSL's DuraStor™ Tanks are cast-in-place, prestressed concrete liquid storage tanks primarily reinforced with post-tensioning tendons. High-strength steel tendons apply compression to the tank floor, walls and roof to counteract the applied forces and provide residual compression. This method actively reinforces the structure and significantly enhances its watertightness and long-term durability.

The design and construction of DuraStor™ Tanks are governed by national building codes ACI 350 and AWWA D115. Additionally, the Post-Tensioning Institute (PTI) provides numerous specifications and guides on the design, fabrication, handling, storage, placement and inspection of post-tensioning systems. Post-tensioning is proven technology with decades of successful applications on thousands of structures worldwide including bridges, high-rise buildings, foundation systems, parking structures, silos for granular material storage and liquid storage tanks.

TANK FEATURES:

- Durable
- Low maintenance
- Joint-free floor and roof
- Reduced mild reinforcement
- Efficient construction schedule
- Reduced material and labor costs
- Seismic resistance
- Multiple layers of corrosion protection
- Built in all weather conditions
- Walls may be finished to meet architectural requirements
- Suitable for all types of liquids and granular materials
- Variety of shapes and sizes from 250,000 gallons to over 30 million gallons

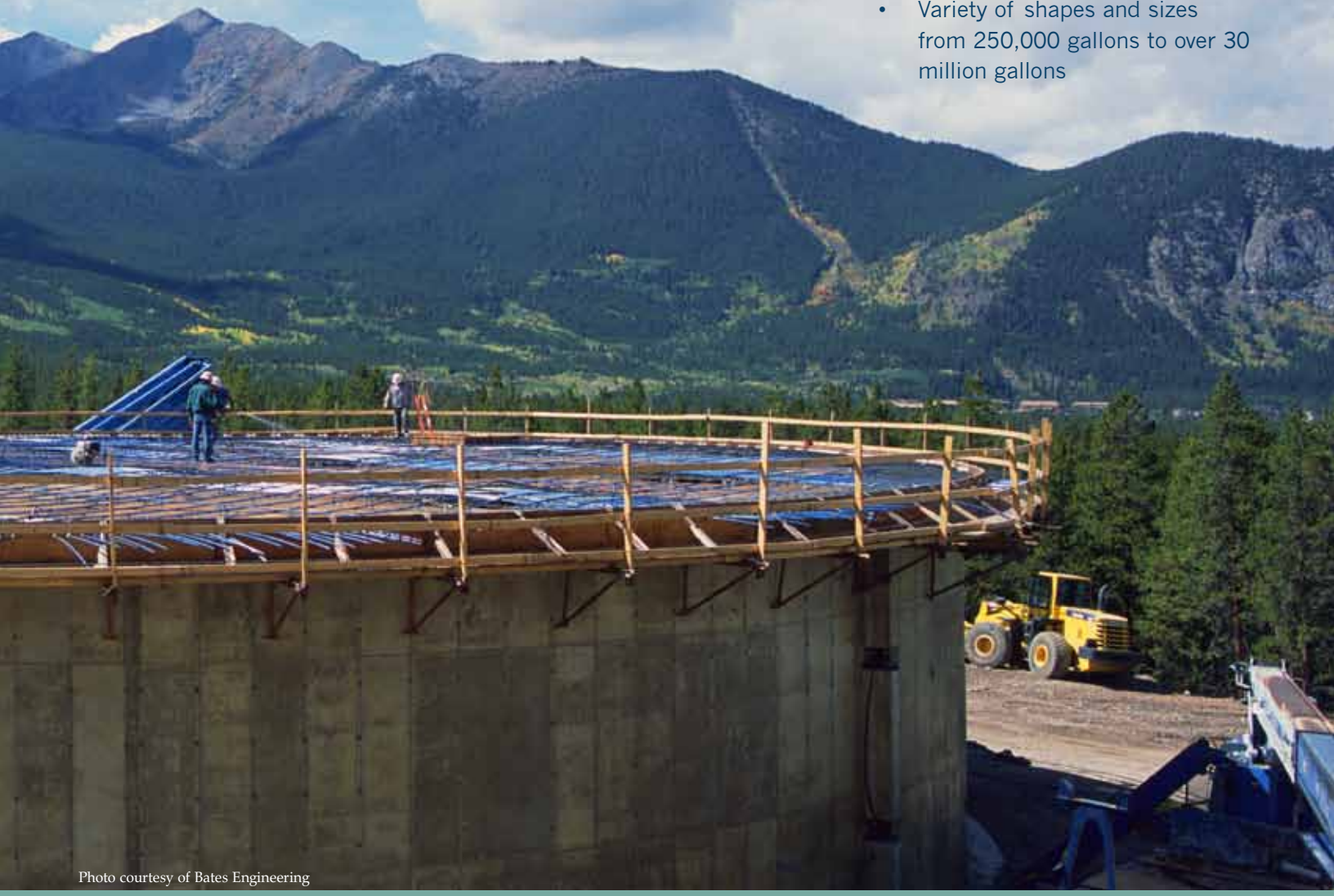

Photo courtesy of Bates Engineering

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▲ Floor post-tensioning and formwork prior to concrete placement[1]

▲ Uniquely shaped post-tensioned tanks under construction[2]

Durable. Watertight. Economical. Versatile.

Versatile

VSL's DuraStor™ Tanks can be constructed in many shapes to suit project needs. Shapes include circular, rectangular, rectangular with rounded corners, egg-shaped digesters, irregular-shaped polygons, and oval – there are no practical limitations with this method of construction. Tanks have been constructed with capacities ranging from 250,000 gallons to above 30,000,000 gallons.

DuraStor™ Tanks are appropriate for all types of liquid containment including chilled and potable water, storm water retention, sludge, wastewater, digesters, ethanol, petroleum products, and liquefied natural gas. They also are used in the storage of granular materials such as coal, grains, ash, cement, clinker, and nuclear containment.

Site conditions may require that the tank be constructed fully-buried, partially-backfilled, above-grade, in sloped backfill or in conditions where ground water is above the tank floor. VSL's DuraStor™ Tank is adaptable to any of these conditions. Additionally, if required, walls can have any architectural finish to meet project requirements.

Durable

Because of its durability, cast-in-place post-tensioned concrete is recognized as the preferred method of construction for many types of structures exposed to the environment and other corrosive elements. Post-tensioning tendons have multiple layers of corrosion protection including the highly pre-compressed concrete cover, thick polyethylene ducts filled with high-performance grout or a corrosion-inhibiting coating, encapsulated anchorages and watertight duct connections. With the highly developed design methodology, structural detailing, and applications in high seismic zones - prestressed concrete tanks have the proven ability to withstand severe earthquakes.

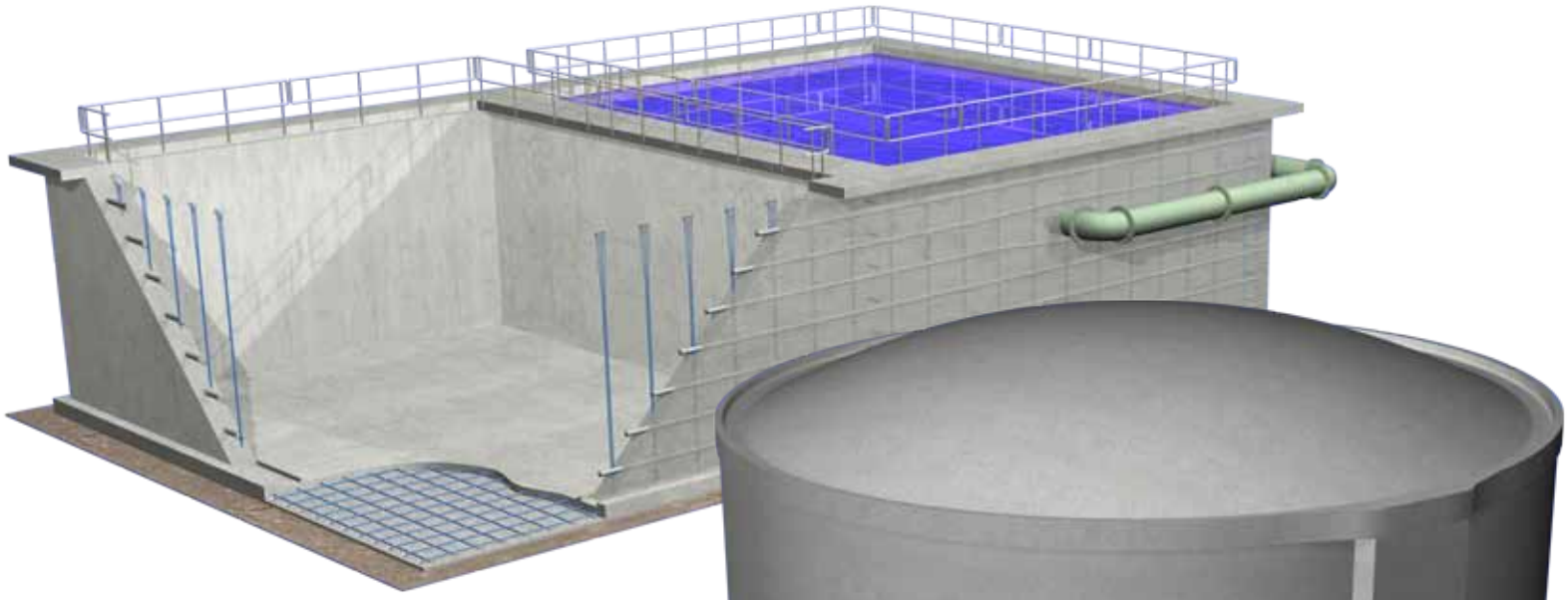
Constructable

VSL DuraStor™ Tanks require no proprietary construction methods or construction equipment - the potential for project delays due to unavailable proprietary equipment or materials is not an issue. The post-tensioning allows for thinner members resulting in reduced materials, placement labor, construction schedules and costs compared with other types of concrete tanks. Additionally, the construction sequencing of a post-tensioned concrete tank allows for multiple tasks to be accomplished simultaneously - resulting in a highly efficient use of manpower and short construction duration. Work can progress under freezing conditions with proper protection and curing of concrete members.

[1] Photos courtesy of Bates Engineering
[2] Photos courtesy of Jorgensen & Close Associates, Inc.

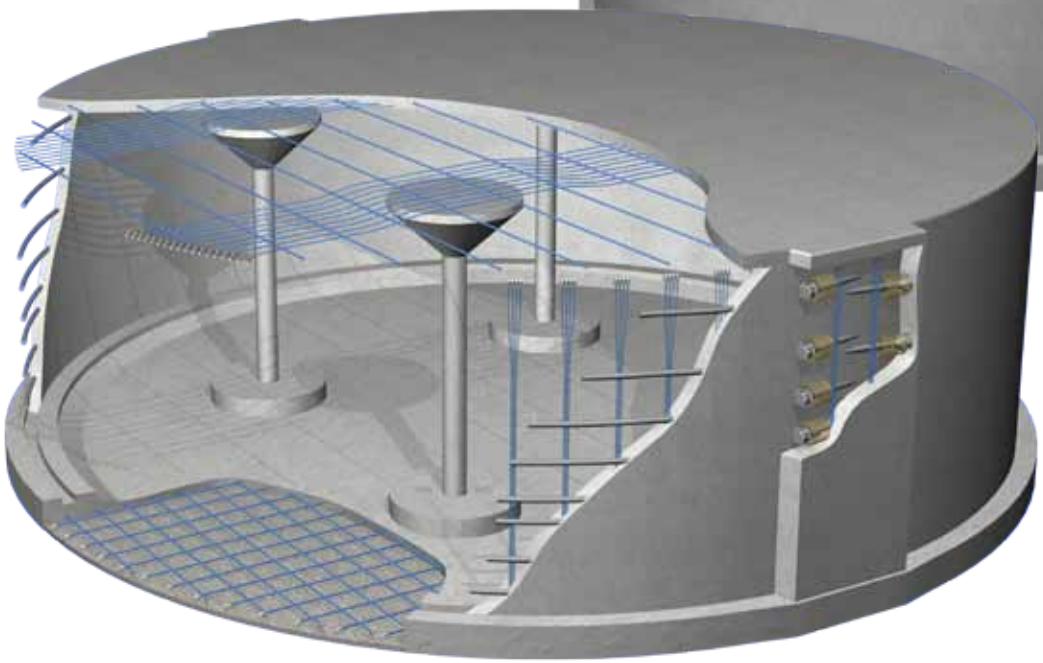
▲ Completed tank structure prior to burial[1]

▲ Placement of roof slab concrete[2]



Rectangular Post-Tensioned Tank

Circular Dome-Roof Post-Tensioned Tank



Circular Flat-Roof Post-Tensioned Tank

▲ Formwork construction prior to concrete placement

▲ Placement of roof slab concrete[1]

Tank Components

The main structural components of the DuraStor™ Tank are the floor slab, walls, and roof slab or concrete dome.

The **floor slab** is a membrane type concrete slab normally five inches in thickness with a thickened perimeter footing. Membrane floors are designed to be highly ductile with the capability of accepting gradual differential movements without affecting watertightness. The concrete is cast in a single placement with no doweling, penetrations, or construction joints which can allow liquids to leak out of a tank – creating the possibility of adversely affecting the environment and/or undermining the structure's foundation. Joints may also allow substances to seep into the tank and potentially contaminate the contents. The post-tensioning tendons are placed orthogonally and are "stage-stressed" within 48 hours of casting the floor slab to eliminate shrinkage cracks by providing immediate precompression to the concrete.

Walls are composed of full-height segments frequently 12-inches thick. They're cast in lengths of approximately 75 feet with no horizontal construction joints. Post-tensioning tendons placed horizontally may be tensioned at pilasters or pilasters may be eliminated depending on the project requirements. Tendons are also placed vertically to provide compression to the concrete and accommodate vertical bending moments and thermal stresses. On large tanks it is possible to place as many as four wall segments per week. Column footings and columns are cast concurrently with the wall to minimize the duration of construction. If required, walls may have any architectural finish, form liner or coating to meet the project's aesthetic requirements.

The **roof slab**, much like the floor, is cast in a single placement with no construction joints. This method results in a watertight slab that eliminates the possibility of substances entering the tank and contaminating the contents. The roof slab is column-supported with typical spans in the 30-foot range each way. Slab thickness is approximately 8 inches. Roof shoring is placed immediately following the column and column footing placement to minimize construction time. Post-tensioning tendons are placed orthogonally as in a typical two-way suspended slab and are "stage stressed" in the same manner as the floor slab tendons. After the tendons are stressed, the shoring is removed through access hatches. Column-supported flat roofs are often chosen for buried tanks or where a less visible tank is desired. A cast-in-place **concrete dome** is an efficient option for circular tanks where a flat roof is not required.

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