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From Aggregate Pits to Water Storage

Sustainability – More Than a New Age ‘Buzz’ Word
Before the excavator takes its first bite of earth, the aggregate mining operator applies to the Colorado Division of Reclamation Mining & Safety for a permit. A major requirement to receive a permit is a bonded reclamation plan for post-mining use. Past reclamation of pit quarries have produced wetlands, wildlife refuges, state and city parks, and lakes. For example, Barber Ponds in Loveland and Littleton’s city park originated as aggregate pits. Today, more and more of these aggregate pits along Colorado’s rivers will serve a second life in water storage as municipalities and water districts eagerly acquire them.

“This development trend is one of the unintended consequences of the dedicated Two Forks Dam proposal,” says Mike Applegate, president of Applegate Group Inc. of Denver, an engineering firm specializing in land, minerals, and water. “Water utilities are looking at smaller buckets where they can store water without going through long permitting processes.”

Colorado water law allows a municipality to exchange water. Ed Pokorney, Director of Planning for Denver Water, explains the process. “We have a right to reuse the water that comes through your faucet and goes down the drain, but we logistically cannot put it back into Dillon Reservoir. We need to find another way to use it. The gravel pits will give us the advantage of catching our water downstream from Metro and Bi-City wastewater treatment plants and storing it. Then when someone, for example in Fort Morgan downstream who has a right to South Platte water, calls for that water, we can release the water out of the gravel pit and take a like amount of water upstream above Chatfield.”

From Aggregate Pits to Water Storage

By Carol Carder
By storing water for exchange, the riverside storage pits will complement Denver Water’s high mountain storage as the district grows from its current 1.2 million water customers in Denver and in its 69 suburban districts to an estimated 1.9 million customers 50 or 60 years from now. Denver Water has potentially 30,000 acre-feet of water storage in six pit complexes acquired and in various stages of development, some in partnership with other municipalities. An acre-foot is one acre of water 12 inches deep, enough for two families of four for a year.

“These pits are not needed yet because we have an 80,000 acre-foot surplus in our system,” Pokorney explains. “They are assets we are developing for the future.” To date, excluding the recent Lupton Lakes acquisition, Denver Water and South Adams County have jointly expended approximately $50 million on gravel pit site acquisition, design, lining costs, delivery facilities and other infrastructure costs.

The city of Fort Collins is considering pit water storage to regulate its return flows. Dennis Bode, water resource manager for Fort Collins, explains that “The Colorado water law system is designed to protect the river and deliver water to those with water rights. When we take water from the river into our system, we need to return it in a timely manner so it matches the historic return flows. Having a pit for storage of releases from our wastewater treatment plant will give us the flexibility to meet our return flow obligations.”

Also, Loveland is currently looking at water storage options including possible pit storage in a two-year study.
Converting Pit Quarries into Water Storage

Personnel now part of the Longmont-area engineering firm Deere and Ault Consultants Inc. (D&A) have performed geotechnical investigations and designed clay or slurry wall liners, inlet and outlet works, and associated work for approximately 15 aggregate pit reservoirs that will be coming on line in 2007 and subsequent years.

When a mining operator is planning to convert the pit to water storage, he may have a contractor install a slurry wall around the perimeter of the area to be mined, according to Dan Ault, D&A. The contractor digs a trench down to bedrock. As the excavator digs, the hole is filled with a bentonite slurry about the consistency of pancake batter that keeps the soil from caving in. To complete the waterproofing wall, the slurry in the trench is replaced with a soil bentonite backfill.

“The slurry wall enables the mining operator to pump out the groundwater once, then work in a dry pit with minimal dewatering efforts,” says Colby Hayden, D&A. “Over a mining life of 10 years, a slurry wall can save significant dewatering costs.”

When mining is completed, the pit area sealed by the slurry wall is ready for conversion into a reservoir. Instead of building a slurry wall, other mining operators may stockpile clay overburden material on site for building a clay liner for the pit after mining to prepare it for water storage. Generally, the mining operator funds the construction of a slurry wall or clay liner and the initial grading of the pit to slope the sides at a cost ranging from $700 to $1,000 an acre-foot of storage, according to Dan Ault of D&A. The water utility acquiring the pit funds the inlet/outlet structures, pumping stations, and diversion pipelines to bring the pit on line. The market price of completed storage may range from $3,000 to $3,500 an acre-foot.

Gravel pit below-grade storage capacities often range from 500 to 2,000 acre-feet. If the topography is sloped so water can gravity feed the pit, an embankment or jurisdictional dam can double the storage capacity.

Gravel Pit Reservoirs in Use and in Development

Thornton pioneered the development of aggregate pit storage in the mid-70s. Mark Koleber, water engineer for Thornton, tallies 12,976 acre-feet of water storage in the five complexes the city has developed. At East Gravel Lakes the city is increasing the storage capacity by digging three of the four lakes deeper and building up zoned earth fill dikes. The older complexes such as West Gravel Lakes south of 88th along the South Platte have compacted clay liners installed by the city. Thornton’s pits where the mining and reclamation are completed and inlet/outlet facilities are under construction will store 4,175 acre-feet. Pits with mining underway and anticipated completion in approximately 10 years will yield 6,500 to 8,000 acre-feet of storage. Pits with mining underway or soon to start may come on line within 20 years and add another 4,500 to 6,000 acre-feet of storage.

Thornton has identified at least seven more pits and is in various stages of waiting for mining to conclude or preparing them for storage. Some of the newer pits have slurry wall linings
that are being installed by the mining companies.

Applegate Group designed and oversaw construction of Fairmount Reservoir, the first gravel pit permitted as a jurisdictional dam, for Consolidated Mutual Water Company 15 years ago. Below-grade storage is 500 acre-feet and added above-grade storage is another 500 acre-feet.

The Siebring Reservoir constructed in 1991 along the Cache La Poudre near Greeley was the first gravel pit reservoir in the state of Colorado to be lined with a slurry wall. During gravel mining operations, Hall-Irwin Construction of Milliken, Colorado installed the 10,000 foot-long slurry wall designed by D&A personnel at a cost of $450,000. Central Colorado Water Conservancy District purchased the 1,100 acre-foot storage rights.

According to Applegate, the demand for gravel pit storage is moving northward along the South Platte Basin as Denver metro area water suppliers increase their development efforts. Some municipalities are developing partnerships with neighboring water districts and agricultural ditch companies, enhancing ditch company supplies and potentially adding storage to their systems.

The South Platte Reservoir just across C-470 from Chatfield Reservoir is a pit conversion set to open in the next couple of months. A combination of below-grade storage and an above-grade dam, this clay-lined facility will provide 6,200 acre-feet of storage for the Centennial Water and Sanitation District serving Highlands Ranch. Resident contractor Kiewit Western who has owned and mined the pit since the 50s performed the construction while D&A, in partnership with Tetra-Technology, performed the reservoir engineering and design for the water district.

Denver Water may bring some of its first pits on line in 2008 or 2009, according to Bill Bates, water resource engineer at Denver Water. The first operating pits may be the 900 acre-foot Miller Pit and the 1,300 acre-foot Cat Pit that comprise the South Complex. These pits are on either side of the South Platte between I-76 and I-270. At the Miller pit an embankment may be added or more mining may increase storage capacity a couple hundred acre-feet.

Further north on the South Platte Denver Water has acquired, in cooperation with South Adams County Water and Sanitation District (SACWSD), the Hazelton and Roadrunners Reservoir pits, each approximately 2,000 acre-feet in capacity. These two adjacent pits that form the North Complex have been combined. With modifications when these two pits come on line in 2010, they will add approximately 5,000 acre-feet of storage capacity. Also, in the North Complex, which is located just south of 120th Avenue, is the 6,350 acre-foot Howe Haller site and the Dunca site. Dunca will provide another 5,400 acre-feet of water storage.

Denver Water's newest acquisition, under yet another cooperative arrangement with SACWSD and the Farmers Reservoir Irrigation Company, is Lupton Lakes near Fort Lupton, an approximate 11,000 acre-feet facility that may come on line after 2015. Currently D&A is performing design work for this project.

Greeley developed the Flatiron Pit at 25th Avenue and first stored water in 2005 and stored 1,500 acre-feet in 2006. Water stored is being used for exchange. Additionally, Greeley City Parks is
using the pit as a fishing recreation facility paid for by a “Fishing is Fun” grant. The city is acquiring several pits near Greeley and has partnered in purchasing pits near Fort Collins and the city’s Bellevue Water Treatment Plant. These pits will meet Greeley’s return flow obligations and store excess treatable supplies.

Tri-Districts (a district supplying both rural and urban customers in Larimer and Weld counties) has acquired, in partnership with the city of Greeley, 320 acres of mined out pits on North Taft Hill north of Fort Collins called Overland Ponds. Shawn Hoff, water resource manager for Soldier Canyon Filter Plant which is owned and operated by Tri-Districts, anticipates the first cell now in the clay liner construction phase will be operational in 2008. The 12 other pits at Overland Ponds will be lined with slurry walls where the overburden has been hauled off or with interior clay liners. Berms will separate the cells that will come on line up until 2022. The pit storage will be used for water exchanges, return flow obligations, and possibly for excess water storage for their respective filter plants.

Applegate Group is developing a clay-lined gravel pit for Weld County on the Hoekstra property on the south side of St. Vrain Creek. Westminster has two converted gravel pit reservoirs totaling nearly 2,000 acre-feet and will be bringing a 4,000 acre-foot reservoir on line in Weld County.

Aurora has purchased the Walker pit developed by Hall-irwin in the Brighton area from the Central Colorado Water Conservancy District. Lisa Darling, Aurora Water South Platte Program Manager, expects storage may be 3,300 acre-feet or more depending on future mining activity. She anticipates the first cell at Walker will come on line in 2008 and remaining cells becoming operational in 2010 and 2014. Aurora has also purchased a Fort Lupton site from L.G. Everist that may ultimately provide 6,800 acre-foot storage in six separate cells with deliveries between 2008 and 2018. These pits will increase Aurora’s operational flexibility in water exchanges, return flow obligations, and water augmentation storage.

What does the future hold in the conversion of pit quarries to water storage?

“The demand for storage is not going away,” says Applegate. “These pits located along rivers can react quickly to a call for water and when storm events provide excess water beyond that appropriated to senior water rights they can capture the overflow for a municipality and store it for later use.”

Workers set a temporary flume at pit inlet to measure water for the 90-day test period. Photo by Jennifer Lee, Applegate Group Inc.