

# Soil-Cement FOR THE ENVIRONMENT

STRONG, ECONOMICAL, DURABLE, IMPERMEABLE



## Sludge-Drying Lagoons

91st Ave. Wastewater Treatment Plant, Phoenix, Ariz.



Soil-cement is mixed in continuous-flow central plant.



Soil-cement is placed along the slope using special spreader box.

The City of Phoenix is increasing the capacity of its 91st Avenue Wastewater Treatment Plant from 90 million gallons per day (mgd) to 120 mgd. Included in this expansion will be 100 acres of soil-cement-lined sludge-drying lagoons. Phoenix's sunny days and low humidity provide ideal conditions for large-scale use of drying lagoons.

At this facility, primary sludge is pumped directly to an anaerobic digester, where it is mixed with thickened waste-activated sludge from gravity and flotation thickeners. After completion of plant expansion, the sludge will be digested in approximately 20 days, achieving 50% to 60% volatile solids reduction and 200 to 300 ppm volatile acid content. The digested sludge, containing between 1.5% and 2.0% solids with a 7.0 to 7.3 pH, is then pumped to the sludge-drying lagoons. Here free-water is decanted back to the head of the plant leaving an 8% to 10% sludge, which dries via evaporation to 25% to 30%. After drying, the dewatered sludge is removed from the lagoons using rubber-tire front-end loaders and dump trucks, then burned in an onsite commercial plant for metals reclaiming.

Prior to plant expansion, existing 100x600-ft sludge-drying lagoons were unlined and constructed of native soil compacted to 95% of maximum density. During nor-

mal mixing and hauling operations, the saturated native soil became soft and unstable. Front-end loaders, which turned the sludge over in order to accelerate the drying process, and trucks, which hauled the dry sludge out, experienced considerable difficulty in maneuvering along the bottom of the lagoons. Frequently, this heavy equipment would get buried up to its axles.

John Carollo Engineers, Phoenix, Ariz., consulting firm for the planned expansion, and the City of Phoenix believed it essential that the existing and newly proposed sludge lagoons provide a suitable working surface for operating equipment. The consultants, working with the City of Phoenix Water / Sewer and Engineering divisions, considered three alternate designs: (1) native soil compacted to 100% of maximum density; (2) 5-in. asphalt liner over a gravel base; and (3) 6-in. soil-cement liner with no special base material. A 200x600-ft test lagoon was constructed for each alternate. The lagoons were exposed to actual operating conditions for a period of several months.

Analysis of the test program concluded that the unlined lagoon, although compacted to a higher density, provided little improvement over existing conditions. Turning the sludge over in the lagoon with no bottom liner took between 2 to 3 hours, whereas sludge in the

lined lagoons could be turned in about 30 minutes. Although both the asphalt- and soil-cement-lined lagoons performed satisfactorily, soil-cement was chosen because its cost was estimated to be less than one-half that of the asphalt alternative.

The lagoon reconstruction was divided into two phases. Each phase involved approximately 50 acres of lagoons to be lined with soil-cement. Phase I involved 22 lagoons; approximately one-third measured 100x600 ft and the others measured 200x600 ft.

Bentson Contracting Company, Phoenix, Ariz., began construction for Phase I on April 26, 1981, using soil-cement with 10% cement by weight. Original specifications required a minimum unconfined compressive strength of 500 psi in seven days. During field testing, the contractor was unable to achieve 500 psi consistently with the 10% cement content. After anticipated working loads for the soil-cement were reviewed and a reasonable safety factor was applied, the seven-day strength requirement was reduced to 250 psi. This revised requirement was met easily, with actual seven-day strength averaging 467 psi. For Phase II construction, however, cement content for the soil-cement was increased to 12% by weight.

Construction of the lagoons necessitated the use of both central-plant-mixed and mixed-in-placed procedures. For the rather steep 2:1 slopes, a 6-in. layer of central-plant-mixed soil-cement was placed using a special spreader box, which ensured uniform lift thickness. The soil-cement was initially compacted by a self-propelled vibratory sheepfoot roller. Prior to final compaction with a pneumatic-tire roller, the surface was scratched to avoid the possible development of compaction planes. Central-plant-mixed soil-cement also was used for the ramp leading into each lagoon.

After the side slopes were completed, soil-cement for the bottom of each lagoon was constructed using mixed-in-place procedures. Because the bottom would be subjected to wheel loads and traffic from operating equipment, an 8-in. layer of soil-cement was used.

Following compaction, the finished surfaces were cured with 0.3 gal per square yard of an MC250 cutback asphalt. In addition, the soil-cement lagoon bottoms received 8 to 12 in. of sludge immediately after curing to relieve the bottom of some of the sun's heat intensity and to help minimize shrinkage cracking.

Phase I was completed on November 18, 1981, and is now in use. Construction on Phase II was begun on October 26, 1981, with Bentson Contracting Company again the prime contractor. Phase II was completed and put into operation on March 15, 1982.



**Soil-cement is constructed by mixed-in-place method along the bottom of the lagoon.**



**Mechanical mixer turns sludge over in newly constructed lagoon to accelerate drying.**

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