

Lakes and impoundments: Lake Dianchi remedial dredging, Kunming, China



Lake Dianchi, located in Yunnan Province in the Southwest, is the sixth largest freshwater lake in China. It covers an area of approximately 300 km² (running 39 km North to South) with an average depth of 4.4 m. The provincial capital of Kunming is located on the Northern shore of the lake. There are more than twenty rivers that drain into Lake Dianchi from the surrounding region, with only one exit river which forms an upper tributary of the Yangtze River. Historically, Lake Dianchi was known as the “Pearl of the Plateau” because of its clear, bright water.

Rapid population growth over the last 50 years coupled with large scale industrial development has led to major pollution problems in Lake Dianchi. This development has also resulted in significant sediment accretion in Lake Dianchi due to extensive deforestation of the lake catchment area. Further, up until the 1990’s all wastewater and other runoff from Kunming and surrounding areas was pumped directly into the lake untreated. There are also large volumes of contaminated sediments in the lake bed. Consequently, the lake water is now undrinkable and is also rated unfit for agricultural and industrial use.

During the mid 1990’s a barrage was constructed across the Northern part of Lake Dianchi to isolate the more-polluted Inner Lake area from the

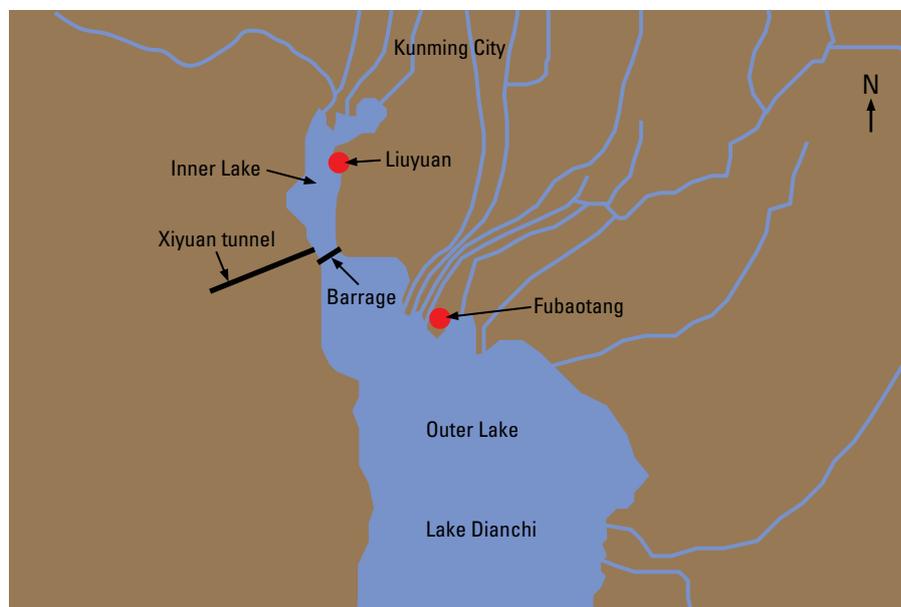
less-polluted Outer Lake area. While the Inner Lake accounts for less than 3% of the surface area of Lake Dianchi it is the source of much of the pollution. The table below shows a comparison of the typical concentrations of heavy metals in the contaminated sediments of the Inner and Outer Lakes. It is common for the water in the Inner Lake to resemble a green-pea soup colour with large algal plumes. To prevent the water of the Inner Lake from mixing with the water of the Outer Lake it is diverted via the Xiyuan bypass tunnel to a water treatment plant prior to discharge into a downstream river. This has resulted in

an improvement of the water quality in Lake Dianchi.

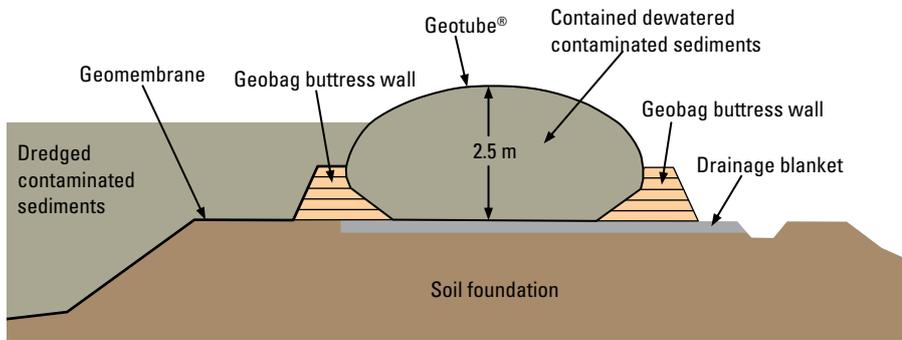
Contaminant	Inner Lake	Outer Lake
Copper	360-714 ppm	34-446 ppm
Lead	661-1000 ppm	28-66 ppm
Cadmium	42-80 ppm	0.4-3.36 ppm
Mercury	1.0-1.4 ppm	0.1-0.35 ppm
Arsenic	267-332 ppm	13-43 ppm

ppm – parts per million (by weight)

It was decided to implement a comprehensive environmental dredging program to remove the contaminated



Lake Dianchi layout showing contaminated sediment storage locations



Section through the Geotube® containment dyke

sediments from Lake Dianchi. This sustained program began with those areas most severely contaminated. In 2009 a contract was awarded to dredge 1.5 million m³ of contaminated sediments from the Inner Lake and 1.9 million m³ from the more-polluted area of the Outer Lake near the river mouths in the North. To contain the dredged sediments two containment lagoons were constructed – one at Liuyuan to contain the Inner Lake dredged sediments and one at Fubaotang to contain the Outer Lake dredged sediments.

To maximize the volume of dredged sediments in the containment lagoons it was decided to construct the containment dyke walls using Geotube® dewatering containers filled with dewatered contaminated sediments. First, the soil foundation was graded to the required level. Next, a granular drainage blanket was constructed across the base of the containment dyke wall in order to facilitate the efficient dewatering of the contaminated sediments that would be later pumped into the Geotube® dewatering units. Two geobag buttress walls were constructed along the alignment of the containment dyke. These walls fulfilled two roles. First, to provide additional lateral stability for the Geotube® containment units, and second, to confine the Geotube® units during filling to ensure the filled height could be maximized.

The Geotube® dewatering units were installed and were then filled with dredged contaminated sediments to form the structural containment dykes for both sludge lagoons. The Geotube® dewatering containers used had a circumference of 15.4 m and were filled to a control height of 2.5 m. The Geotube® containers were then allowed to dewater for a week before the next filling and dewatering cycle was repeated. This was repeated for about 10 cycles in order to achieve the

final dyke design height of 2.5 m and the desired stability for the contained sediment. Finally, a geomembrane liner was installed across the base of the lagoons to prevent contaminant loss into the ground stratum.

Once the dyke walls were completed and the geomembrane liner installed the contaminated sediments were dredged from locations in the Inner and Outer Lakes and pumped into the two sludge containment lagoons. On completion of the dredging operation the sludge lagoons were allowed to consolidate and dry out sufficiently before the contaminated sediment was removed to a landfill site for permanent disposal. Once the sludge lagoons had been cleaned out the Geotube® dyke wall was demolished with the dewatered contaminated sediment fill also taken to the landfill for permanent disposal.

Client: Kunming City Lake Dianchi Authority, Kunming, China.

Consultant: CCCC Tianjin Port and Survey & Design Institute Co., Ltd, Tianjin, China.

Contractor: Beijing Hengchuan Helitong Science & Technology Development Co., Ltd, Beijing, China.



Algal plume in the Inner Lake



Installing Geotube® containers inside the geobag buttress walls



Filling Geotube® containers with contaminated sediments



Dredging of contaminated sediments in Lake Dianchi



Contaminated sediment containment lagoon