TENCATE Mirafi®

CASE STUDY

Reinforced sludge capping layer, Harbin City

TENCATE GEOSYNTHETICS

Reinforced soft site closures: Reinforced sludge capping layer, Harbin City, Heilongjiang Province, China

Wenchang Wastewater Treatment Plant in Harbin City generates sludge as a waste product of the wastewater treatment process. Over the years, the plant operator has been storing the waste sludge in an on-site sludge containment pond.

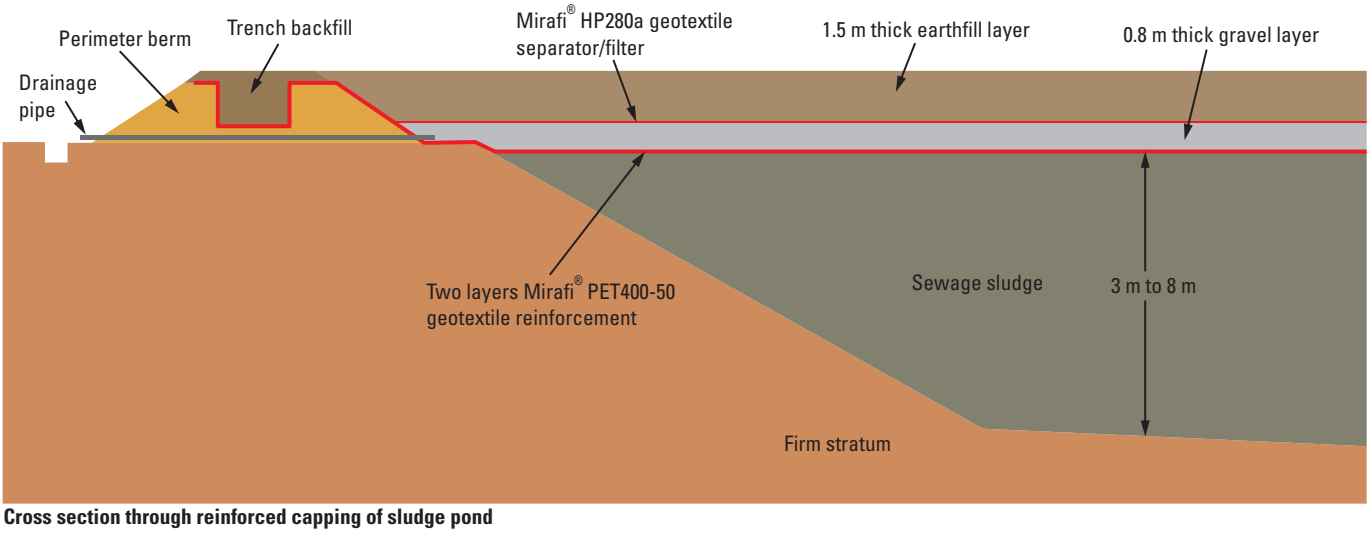
The sludge pond is located within the Wastewater Treatment Plant boundary. The sludge containment pond is trapezoidal shaped in cross section with a surface area of 70,000 m^2 and varies in depth from 3 to 8 m. The base of the sludge containment pond consists of firm ground. The wastewater treatment sludge consists of largely biosolids. The specific gravity of the solids ranges from 1.2 to 1.5, depending on which part of the wastewater treatment process it comes from. Therefore, the sludge in the containment pond is a mixture of very low density material of extremely low undrained shear strength. The sludge is generally thicker towards the bottom as the solids in suspension and colloids have settled out gradually over an extended period of time and have been subject to relatively higher overburden. However, even the bottom solids generally have only 25 to 30 percent solids concentration as a maximum. The undrained shear strength is estimated to be about 2 to 3 kPa at best.

One option investigated was to desludge the pond to extend its containment lifespan. However, this option was not deemed practical for the Wenchang Wastewater Treatment Plant as the city landfills would only accept dewatered wastewater sludge material that has attained a specific dryness. Also, over the years the land on and adjacent to the Plant premises had been fully developed, ruling out any dewatering of the sludge that would be necessary before the material could be sent to the landfills. Therefore, capping the sludge containment pond was the only practical option available. Safety and environmental requirements required the provision of an engineered soil capping layer over the sludge containment pond.

The soil capping layer consisted of a lower layer of gravel of thickness 0.8 m and an upper layer of earth backfill of thickness 1.5 m. A separation/filtration geotextile (Mirafi® HP280a) was used between the gravel and earth backfill layers. The gravel layer served as a drainage layer for the dissipating water from the sludge during the consolidation period. The earth backfill layer acts as both a surcharge and a load spreading layer. Because of the extremely soft nature of the sludge, the soil capping layer required geotextile basal reinforcement to provide both short term and long term reinforcement. The layer of reinforcement provided short term stability and prevention of loss of fill and prevented local shear and bearing capacity failures of the sludge.

Two layers of Mirafi® PET400-50 geotextile reinforcement, placed orthogonally over the sludge surface, was used for the basal reinforcement. Mirafi® PET400-50 is a uniaxial reinforcement with initial tensile strength of 400 kN/m in longitudinal direction and 50 kN/m in cross direction. By using a double layer, placed orthogonally, this would effectively result in a combined reinforcement layer of 400 kN/m in both directions.

Unrolling Mirafi® PET400-50 geotextile reinforcement across sludge pond



Cross section through reinforced capping of sludge pond

A raised earth berm 2 m in height was provided at the edge surrounding the sludge pond. An anchor trench was dug into the top of the earth berm to anchor the extremities of the Mirafi® PET400-50 geotextile reinforcement.

The construction of a capping layer over very soft material is always a challenge. This was particularly so for the wastewater treatment sludge pond because of the extremely low strength of the waste sludge. Movement directly on top of the sludge surface was impossible, both for construction workers and for earthworks equipment. The geotextile reinforcement had to be laid as a continuous panel in its longitudinal direction with the panel edges seamed together into a complete cover fabric. However, to prefabricate and lay the complete cover fabric can be very difficult by normal means; the prefabricated complete cover fabric would be too massive to handle, and besides there was no workspace at site to do on-site fabrication.

The contractor came up with a novel method of construction. This involved the fabrication of the cover geotextile reinforcement as the rolls of geotextile was being laid over the top of the sludge pond. To support workmen and sewing equipment over the sludge pond floating boards were used made from a combination of polystyrene and timber. These floating boards could be pulled across the sludge surface like snow sledge boards from the opposite bank.

Polystyrene board working platform beneath the Mirafi® PET400-50 geotextile reinforcement

Once the double layer of Mirafi® PET400-50 geotextile reinforcement had been installed and anchored in the surrounding anchor trench the granular drainage material was pushed out over the geotextile reinforcement by first constructing "fingers" of fill at predefined distances apart. These "fingers" were used to prestress the geotextile reinforcement preventing large differential deformations (mud waves) during filling. Once the fingers had been constructed subsequent infilling was carried out using light dumpers.

Once the granular drainage layer had been installed the separation/filtration geotextile was laid out over the site with the earth fill placed on top.

Client: Longjiang Environmental Protection Group Co., Ltd, Heilongjiang Province, China.

Consultant: China Nerin Engineering Technology Co., Ltd, Jiangxi Province, China.

Contractor: Shanghai Tongji Construction Technology Co., Ltd, Shanghai, China.

Anchor trench around edge of sludge pond

Creating a gravel "finger" across top of Mirafi® PET400-50 geotextile reinforcement

Using light dumpers to spread aggregate between fill fingers

Bringing fill onto edge of platform

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