**Zeitschrift:** IABSE structures = Constructions AIPC = IVBH Bauwerke
**Band:** 13 (1989)
**Heft:** C-49: Structures in sanitary engineering

**Artikel:** Ryaverket purification plant, Gothenburg (Sweden)
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**DOI:** https://doi.org/10.5169/seals-21562

## 2. Ryaverket Purification Plant, Gothenburg (Sweden)

*Owner:* *The Gothenburg Region Ryaverk Company*

*Engineer:* *Birger Ludvigson Ingenjörsbyrå, AB, Gothenburg*

*Contractors:* *NCC AB and Skanska AB*

*Construction time:* *Stage 1 1969 – 1971*
*Stage 2 1980 – 1981*
*Stage 3 1989*

### Introduction

The Gothenburg Region Ryaverk Company (GRYAAB) is a company formed by several local authorities to supervise the maintenance and operation of the Ryaverket purification plant, which accepts sewage and waste water from the surrounding municipalities to an amount of 120 000 000 $m^3$/year (corresponding to 4 $m^3$/s on average).

When the Ryaverket plant began operation in 1971/1972, sewage water from 220 000 people was being treated. After continuous development of the tunnel system the figure for 1988 was 540 000 people. Industrial waste water equivalent to an additional 240 000 persons is also treated.

The various municipalities involved are connected to Ryaverket through an extensive system of tunnels having a total length of 92 kilometres and cross-sectional areas varying from 6 to 18 $m^2$.

### The plant

The waste water arrives at Ryaverket at a depth of 20 metres, from where it is pumped into a channel at ground level. Suspended matter, which easily sinks to the bottom or rises to the surface, is first separated in presedimentation basins (mechanical or physical treatment).

Iron salts are then added and large amounts of air passed through the sewage in special aeration basins. This converts the dissolved waste to solid form by the action of microorganisms and chemical precipitation.

The sludge thus formed is separated in final clarification basins. Aeration, precipitation and secondary sedimentation form the bio-chemical treatment stage.

Main basin data:

| | Number of basins | Total area $m^2$ | Total volume $m^3$ | Water depth m |
|---|---|---|---|---|
| Presedimentation | 12 | 5 800 | 22 800 | 4 |
| Aeration | 31 | 8 300 | 39 100 | 3-6 |
| Final clarification | 24 | 11 300 | 31 200 | 3 |

The treated sewage water is finally piped into the sea through a tunnel with a length of 825 m.

In addition to the presedimentation, aeration and clarification (sedimentation) basins, the main parts of the plant are: channels and culverts, a sludge treatment building, and a central building accomodating the pumpstation and space for operation, control and administration.

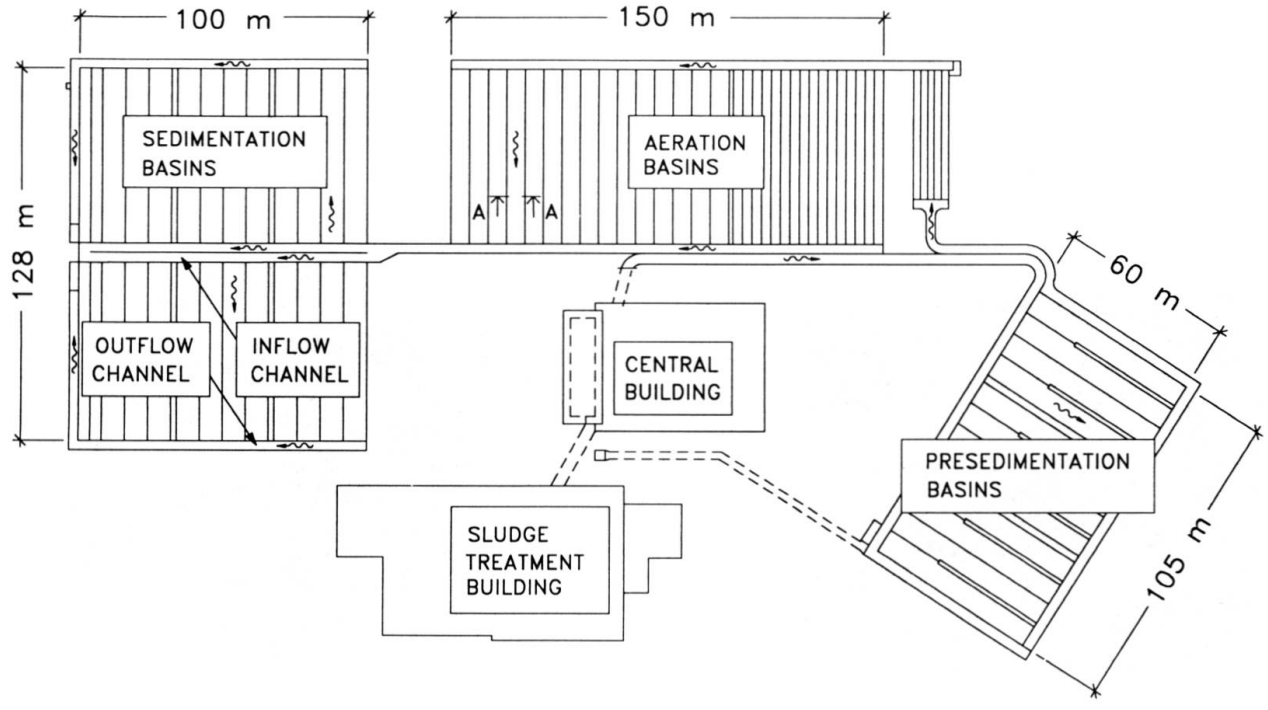


*Fig. 1 Site plan*

**Basins and channels**

The main structures of the purification plant have their foundation on solid rock. Only some parts of the final clarification basins are supported on plinths or on piles with a maximum length of 10-12 metres.

The concrete in the basins and channels is designed to be watertight, the reinforcement being calculated for a maximum crack width of 0.2 mm. The requirement of limited crack width in combination with tension forces has resulted in a higher than usual percentage of reinforcement.

The basins are all of rectangular shape, composed of a number of 6-8 m wide parallel minor basins. The walls separating the minor basins have been designed for one-sided water pressure. Typical thicknesses for outside and inside walls are 400 mm for 6 m water depth and 300 mm for 4 m depth.

The distance between construction joints in the watertight structures has been carefully determined with respect to stresses and cracks caused by shrinkage. Basin bottoms were constructed in sections of 10 m × 18 m and walls in lengths of 10 m, with concrete placement separated by intervals of at least one week. Expansion joints with water bars were located at distances of about 40 m.

Construction joints in the watertight structures were classified according to requirements for tightness, considering, for example, the frequency of one-sided water pressure. Thus several joints could be constructed with shear keys only, without the use of special water stops.

**Sludge treatment**

Residual products in the form of surplus sludge are taken to the sludge treatment section of the plant where the material is thickened, treated with lime and centrifuged. The yearly production of dewatered sludge is about 120 000 tons. A part of this is composted with bark and used for landscaping projects.

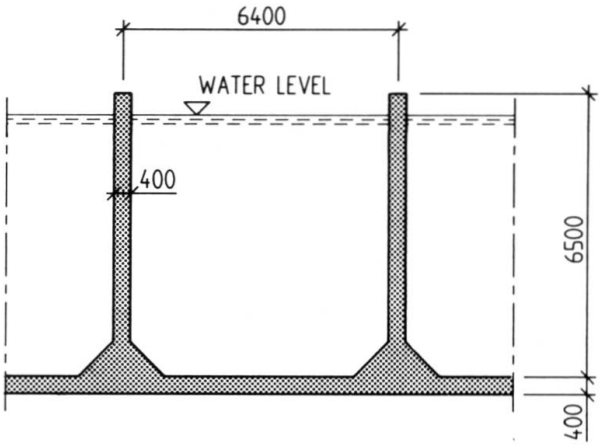


*Fig. 2 Aeration basin, section A-A*

The decreasing demand for sludge (due to the debate regarding health and environmental considerations) has necessitated a new treatment installation, to be constructed in 1989. In this biogas plant the sludge will be decomposed in sedimentation tanks. These tanks are intended to be 23.5 m in diameter with a height of about 30 m. They will be designed in prestressed concrete with a wall thickness of approximately 350 mm.

***(Björn Löfgren)***

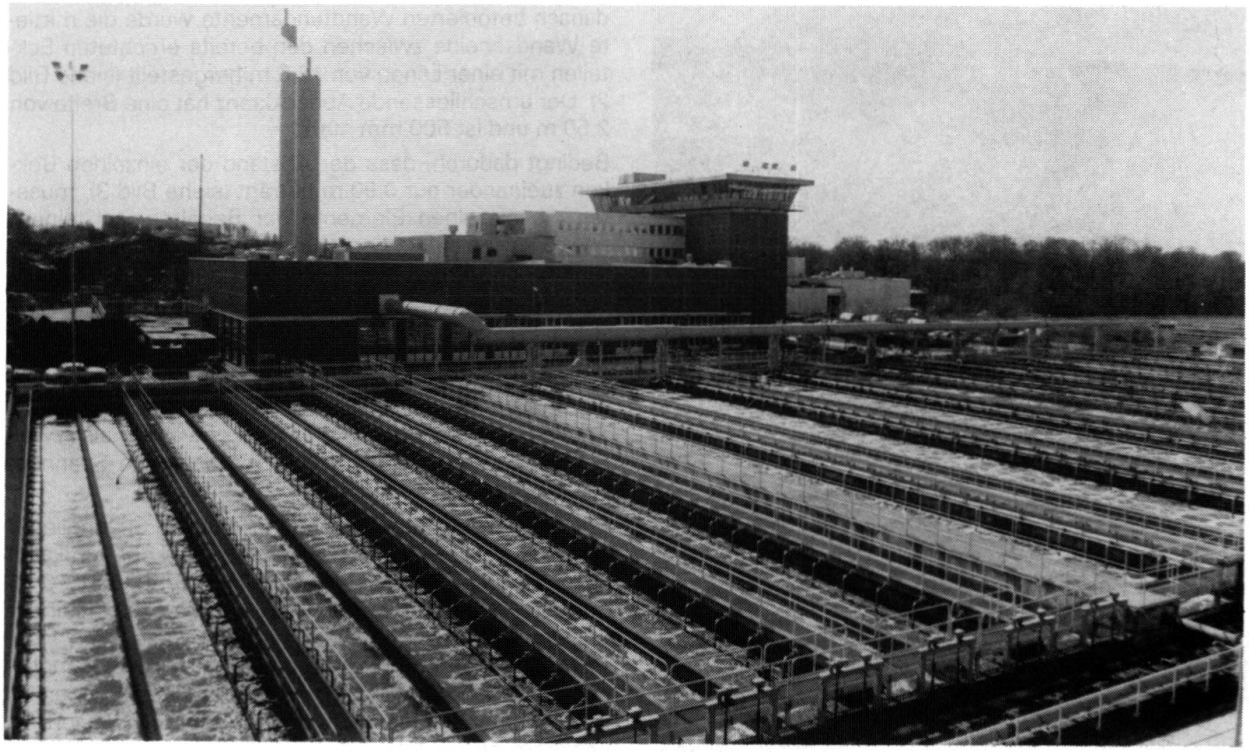

*Fig. 3 View over aeration basins toward central building*