

## Reduction of Water Infiltration on the BRDA of the Gardanne Alumina Refinery

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### Abstract

Effective management of runoff water on a tailings storage facility is essential to prevent water infiltration into the ground and avoid any environmental impact. For nearly 130 years, the Gardanne alumina refinery operated a bauxite residue disposal area named Mange Garri, which is now a closed site. Initially designed to accommodate red mud, using the lagooning method, the site was subsequently converted into storage of dehydrated residue from 2006, following the commissioning of press-filter technology. Although a drainage system is present at the base of the storage facility allowing the collection of seepage, the change in the site's operating mode has made it possible to improve water management on the site, by significantly reducing the volume of water infiltrated. Extensive earthworks on the storage areas, combined with the construction of several spillways, enabled all run-off water to be channelled into a single collection pond. An ambitious and innovative project then made it possible to seal this pond, thus preventing water infiltration into the ground.

**Keywords:** Water, Bauxite residue, BRDA.

### 1. Introduction

The Mange Garri site is the historic Bauxite Residue Disposal Area (BRDA) from the Gardanne refinery. Located in the neighbouring municipality of Bouc-Bel-Air, the site received red mud from the early 1900s until 1966. Afterward, it was sent until 2015 to the "Fosse de Cassidaigne", a trench in the Mediterranean Sea, via a 60 km pipeline to a discharge point 7 km offshore and 320 m deep. From 2006, as part of a voluntary initiative to stop discharging red mud into the Mediterranean Sea, filter press technology was gradually deployed, with the successive commissioning of 3 filter presses. The Mange Garri site, which had been partially shut down, was converted into a storage facility for dehydrated bauxite residue.

Beyond the need to redevelop the site to accommodate the production of residue from the refinery, this reconversion was an opportunity to considerably improve water management on the BRDA, and in particular to significantly reduce water infiltration.

Although a drainage system is present at the base of the lagoons to continuously collect percolation water, the use of the lagooning method to operate a tailings storage facility inevitably leads to significant percolation in the stockpile, due to the water content of the tailings.

The storage of bauxite residue from filter presses (with a moisture content of less than 30 %) reduce significantly the amount of percolating water, if it is carried out in accordance with good engineering practice, taking particular care during both the design and operating phases to take measures to prevent water infiltration and encourage run-off.

As part of the redevelopment of the BRDA, and with the aim of improving both the geotechnical behaviour of the storage and the management of water on the site, major works have been undertaken, including the construction of spillways, the reshaping of storage areas and the sealing of the rainwater collection pond.

## 2. History of the BRDA

Cradle of alumina, the Gardanne refinery was the first Bayer process in the world to produce alumina in 1893. The Mange Garri site, located 2 km northwest of the factory, and whose operation has started in 1904 is therefore one of the oldest bauxite residue disposal areas. It comprises a total of seven ponds that have been successively developed and exploited on two valleys with a North-South orientation, named Valon d'Encorse and Valon de Mange Garri. These ponds are bounded by dykes made of limestone, forming dams perpendicular to the axis of the two valleys (Figure 1). Limestone materials were extracted locally through the opening of quarries. Under the bottom of the valleys where the ponds are located, the subsoil is made up of alternating banks of marly limestone, tertiary limestone and marl as well as clay over a thickness of approximately 250 m.

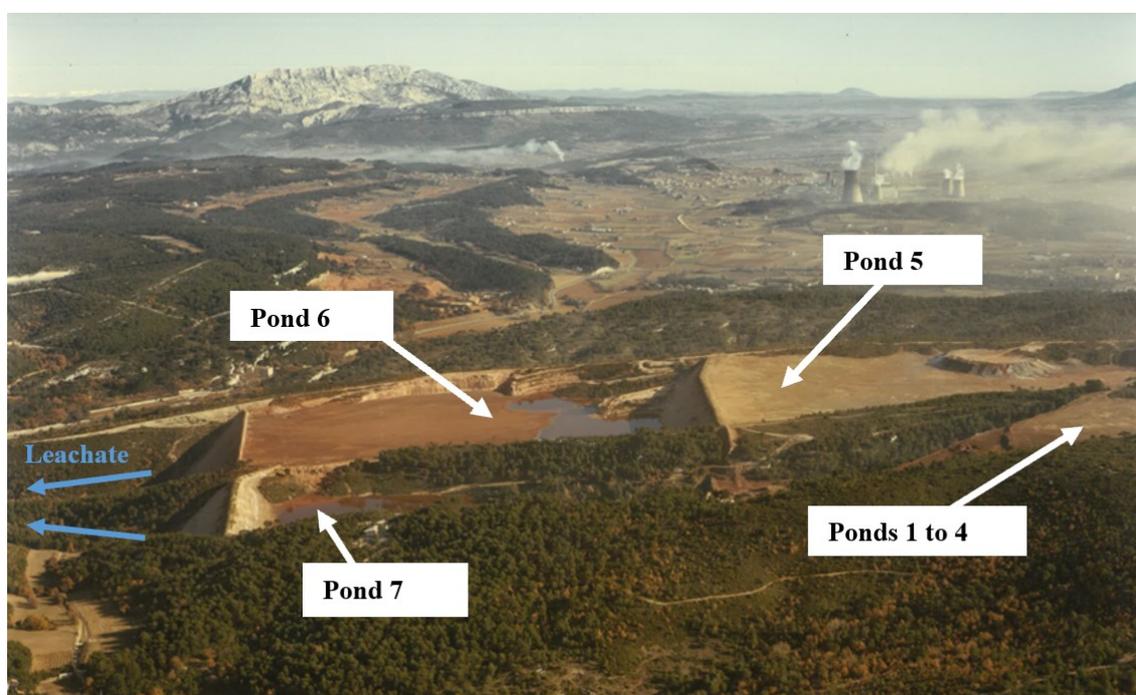


Figure 1. Aerial view of the Mange Garri BRDA around 1970.

The first six ponds were used to store the bauxite residue by lagooning before using the pipeline to the sea. The pond 7 was built to be able to occasionally store the red mud, during maintenance shutdowns on the pipeline.

A drainage and collection system for percolating water has historically been installed at the base of the ponds, allowing leachate to be directed downstream to a pumping station.

This drainage system fulfills 2 objectives:

- continuously collect percolating water from the site
- drain the soils at the foot of the dam, to evacuate rainwater, thus preventing saturation of the foundation soils

On October 8, 2022, operations at the BRDA came to a definitive halt, as part of the transformation of the Gardanne refinery, aimed at replacing bauxite feed with hydrate. Following this, a compost cover was implemented over the entire site. Initially intended to eliminate the risk of dust emissions, it also prevents rainwater from coming into contact with bauxite residue, as demonstrated by the color of the water in pond 7, visible in the foreground of Figure 9.

Even if the BRDA development works was initially intended to support operations at the Mange Garri site, it has nevertheless helped to initiate its rehabilitation.



**Figure 9. Aerial view of the BRDA in June 2023.**