# State-of-the-art Bauxite Tailings Disposal Facilities and Techniques

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**Abstract**

The tailings from the bauxite beneficiation process and the caustic residue, generated by the alumina refining process, have always been a major issue for the bauxite & alumina industry. Hydro, as a major player in the industry, is proactively addressing this unavoidable challenge. By adopting the best available technologies, Hydro has built newer and safer tailings storage facilities in its operations in the state of Pará, Brazil - such as the Paragominas bauxite mine Plateau Dam and Alunorte's enhanced residue dry stacking process, the DRS2 area. The Paragominas recently commissioned Plateau tailings disposal site represents a technological advance when compared to other dams. The Plateau dam is designed for continuous rotation between disposal quadrants, each quadrant receiving a 50 cm layer of tailings at each cycle, allowing for solar drying of the layers deposited at the other adjacent quadrants. Prior to disposal, the tailings go through a gravity settler that promotes solid-liquid separation. Alunorte's DRS2 is a state-of-the-art dry stacking disposal area that uses press filtration, pipe conveyors and in-situ mechanical compaction. The filter presses produce a dry cake, quite different from the residue produced by previous technologies. The press-filtered residue is transported to the DRS2 disposal site by using a pipe conveyor. At the deposit, the dry cake is spread out in layers and then compacted using machinery. This paper presents results obtained and key aspects of these two facilities – such as increased solids content, better drainage conditions and increased geotechnical safety – and how they compare to previously used technologies.

**Keywords:** tailings, bauxite residue, dams, filter press.

## 1. Introduction

Hydro currently owns two major operations in Brazil: the Paragominas bauxite mine and the Alunorte alumina refinery. Paragominas is located in the municipality of Paragominas, state of Pará, Northern Brazil. The mine production capacity is approximately 11 Mtpy and it has started operations in 2006 [1]. Alunorte, the largest alumina refinery outside China, is located in the municipality of Barcarena, near Pará state capital city of Belém. The plant started operations in 1995 and has undergone three expansions since. The current alumina nameplate production capacity is close to 6.3 Mtpy [2]. Hydro acquired both operations in 2012.

This paper will use the term "bauxite tailings" to describe the byproduct generated in the bauxite ore mining and beneficiation processes at Paragominas through the continuous stages of comminution associated with the process of desliming, and "bauxite residue" for the solid byproduct of the Bayer process at Alunorte, resulting of the filtration and washing after extraction and liquor desilication [3, 4].

Bauxite tailings and residue and their appropriate management is of increasing concern to the environment and to the industry. With more than 130 years since the invention of the Bayer

process, the bauxite residue inventory is estimated to be over 5.0 billion tonnes [5]. In Brazil, this concern is especially reinforced due to the recent dam failures from the iron ore industry.

After acquiring Paragominas and Alunorte, Hydro also became responsible for all of their existing tailings dams and bauxite residue deposits. Since then, Hydro has taken a number of measures in order to guarantee the long-term structural stability and safety of the legacy storage facilities, such as Valley Tailings Disposal System, at Paragominas and Solid Reside Deposit 1 (DRS1), at Alunorte.

This paper has the objective of presenting the main facts and the best practices that were performed for tailings and residue management in both Mineração Paragominas and Alunorte. Furthermore, this paper will present the newer, recently commissioned, state-of-the-art facilities at these two sites.

## 2. Tailings Management

According to the International Commission on Large Dams, water has played a fundamental role in either cause or consequence of most dam failures recorded [6]. Hydro, as a major player in the industry, has been proactively addressing the unavoidable challenge of managing the tailings generated by the bauxite mining and alumina refining processes, namely by:

I. Adopting the best available practices and techniques to manage legacy facilities, such as the Valley TSF (Tailings Storage Facilities) and Alunorte DRS1;

II. Adopting the best available technology to thicken and filter bauxite tailings and residue and thus build newer and safer tailings disposal facilities, such as the Paragominas Plateau Dam (RP1) and Alunorte Solid Residue Deposit 2 (DSR2);

Hydro is positioning itself as a technology leader in the industry through the early adoption of state-of-the-art sustainable solutions to manage bauxite mining and alumina refining tailings [7], coupled with robust investment in R&D to develop utilization alternatives for the tailings and modifications in the alumina refining process to reduce the amount of caustic associated with the bauxite residue.

### 2.1. Legacy Facilities

The Valley Tailings Disposal System was built when mining operations began in Paragominas. The system is comprised of 6 dams, named B1 to B6. B1 to B4 dams were used for bauxite tailings disposal, B5 dam was built to allow the environmental preservation of the springs at the upstream edge of the valley and B6 dam, the downstream-most dam, was used to contain run-off water and to allow its reuse in the mining process.

Ever since takings over operations, Hydro has taken safety measures to adequately increase the safety of the Paragominas Valley Tailings Disposal System, including (i) the construction of reinforcement downstream berms, (ii) adopting operational procedures that minimize the volume of surface water and (iii) installing enhanced instrumentation and monitoring programs. These safety measures combined guarantee the long-term structural stability and safety of the Valley dams. Figure 1 shows the Valley Tailings Disposal System.

minimum compaction of 90 % Normal Proctor was set as operational standard. DRS2 also has surface drainage and pumping systems that ensure that reservoirs are kept free of water. Figure 6 shows the designed cross-section for DRS2.

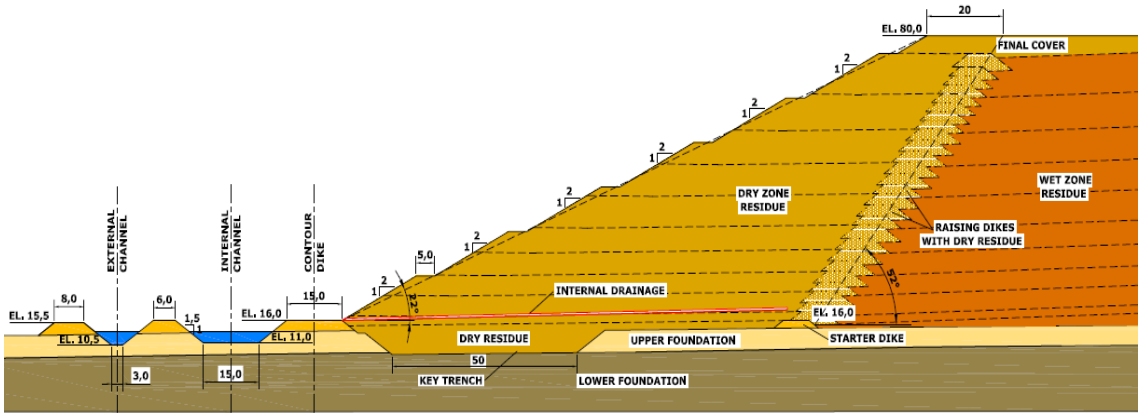


**Figure 6. Design cross section for DRS2.**

The design of DRS2 associated to the use of press-filtered residue allowed a fourfold increase in the tailings to area ratio, when compared to DRS1. The better use of land reduces environmental footprint and is of paramount interest for Hydro in its operations in Brazil.

Hydro's two state-of-the-art facilities, RP1 Dam and DRS2, follow the same basic principle: that by reducing and appropriately managing water, the resulting facility is safer in geotechnical terms. Furthermore, both RP1 dam and DRS2 underwent periodic independent third-party review both during design and operations – a best practice adopted by Hydro in tailings and residue management.

## 3. Conclusion

Hydro will continue to pursue and further consolidate the position of technological leadership regarding the safe management of mining tailings and alumina refining residue, adopting state-of-the-art technologies and practices to design and operate its geotechnical structures, such as:

- Thickening and subsequent solar drying of bauxite tailings;
- Adopting robust dam heightening methods, namely downstream and centerline;
- Using compacted soils, instead of tailings, as constructive material;
- Pioneering the full-scale press-filtration and in-situ compaction of bauxite residue;
- Periodic independent third-party reviews of projects;

The aggregate result of these systematic efforts is a high standard of operational safety in the management of mining tailings and alumina refining residue.

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