Design and Construction of the Pacific Access Channel to the Third Set of Locks at the Panama Canal

by

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EXTENDED ABSTRACT

The Panama Canal Authority (ACP) officially began the works related to the Panama Canal Expansion in September 2007, with the excavation of the Pacific Access Channel (PAC), which is a 6.1 km long channel that provides navigation access from the Third Set of Locks on the Pacific side (Cocoli Locks) to the Gaillard Cut, also known as the Culebra Cut. With an investment of nearly $374 million US Dollars, the works included the dry excavation of about 50 million cubic meters and the dredging of 4 million cubic meters. On the east bank of the channel the Borinquen Dams 1E and 2E, retain the water in the channel about 9.4 meters above the Miraflores Lake and on the west bank the Borinquen Dams 1W and 2W were required in the low laying area on the southern end of the PAC, just north of the Cocoli Locks. In addition to the excavation of material and construction of dams, other activities were carried out such as: disposal of excavation material not used for dam construction; construction of cofferdams; diversion of the Cocoli River and relocation of Borinquen road and power lines.

The geologic investigations for the PAC were completed by ACP, between the years 1938 and 2008. Different geologic investigation campaigns were undertaken in the area, in relation to the original Third Set of Locks Project and different other smaller projects in the vicinity. All these investigations were used as the base of the specific investigation campaign for the Pacific Access Channel that started in the year 2001 and ended in the year 2008. These investigation campaigns included drill holes, test pits, geophysical investigations, in situ tests, laboratory testing, geologic mapping, elaboration of geologic sections, and reports.

The design works of all the dry excavations and dredging were performed by ACP engineers and validated by the Geotechnical Advisory Board (GAB), so the designs complied with the best design practices. The GAB is comprised by 5 notable experts in the field of geotechnical engineering and has been supporting the ACP in all related programs and relevant projects, through 19 technical meetings and workshops, since 1987 to the present. The Borinquen Dams were designed by external consultants: Borinquen Dam 1E was designed by URS Holding, Inc. and Borinquen Dams 2E, 1W and 2W were designed by GUPC (Grupo Unidos por el Canal), following the industries best practices and ACP specifications.

The works for the PAC were divided in 5 phases, known as PAC-1, PAC-2, PAC-3, PAC-4 and PAC-0; while the Borinquen Dams were constructed simultaneously to PAC-4 and PAC-0. The first phase of the project or PAC-1 started in 2007 and ended in 2009 and covered the excavation of 7.3 million cubic meters of material, mostly from Paraiso Hill, on the west bank of the Canal, in front of Pedro Miguel Locks. The Paraiso Hill was leveled down from elevation 136 to 46 meters PLD; 3.5 kilometers of the Borinquen Road were relocated and 146 hectares located in the west bank of the Canal were cleared of unexploded ordinance UXO

The second phase of the project or PAC-2, started in 2007. The works included the removal of 7.4 million cubic meters from a 2.4 kilometer segment. PAC-2 involved the relocation of 1.3 kilometers of the Borinquen Road and the construction of 3.5 kilometer long Cocoli River Diversion, on the west bank of the Canal. The excavation of about 650,000 cubic meters of material was required to divert the Cocoli River. Protection and erosion control structures were installed along the new 3.5 kilometer long

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diversion channel. The second excavation phase of the Pacific Access Channel was completed in December 2009.

In 2008 the excavation of the third phase of the Pacific Access Channel or PAC-3, began the excavation of 8.0 million cubic meters of material and cleared an additional 190 hectares of unexploded ordinance UXO. Under this contract, the Paraiso Hill was leveled down from elevation 46 to 27.5 meters just above the Gatun Lake.

The fourth phase (PAC-4) and fifth phase (PAC-0) of the Pacific Access Channel, began in 2009 and 2010 respectively and were accomplished simultaneously. The PAC-4 involved the removal of 26 million cubic meters of material, clearing of 80 hectares of UXO contaminated area and the construction of a cellular cofferdam on the east side of the access channel that allowed the building of a 2.1 kilometer long dam, named Borinquen Dam 1E; while the PAC-0 included the dry excavation of 3.8 million cubic meters of material that originally was conceived as a dredging task. However, nearly 75% of the task was established as dry excavation to optimize the work. The 1.6 km long, PAC north entrance, was widened to 218 meters and deepened to reach the design elevation of 9.14 meters Precise Level Datum (PLD).The dredging of the northern entrance to the Pacific Access Channel was performed in one of the Canal´s most restricted areas, due to the proximity to the vessels transiting the waterway daily and the closeness to key structures such as the Centennial Bridge and the Cartagena Tie-Up Station.

The Borinquen Dams began construction in the year 2011. They consist of four main embankments, designated as Dams 1E, 2E, 1W and 2W. The largest of the Borinquen Dams, Dam 1E, extends from the existing west monolith wall of the Pedro Miguel Locks, near the northern gates to the northern slope of Fabiana Hill, over a length of about 2.1 km. Dam 2E, has a length of about 1.4 km extending from the southern slope of Fabiana Hill, to the east wing wall of the Pacific Locks Complex (Cocoli Locks). Dams 1W and 2W are separated by a small hill named Dam Hill; the two dams have a combined length of about 1.2 km and form the west bank of the PAC in the flood-plain area of the Cocoli River. Dam 2W´s southern abutment is the west wing wall of the Pacific Locks Complex (Cocoli Locks).

Presently, the embankment performance of Borinquen Dams is monitored by instrumentation, including vibrating wire piezometers in the foundation, settlement sensors in the core zone, inclinometers, survey monuments installed in the embankment and accelerographs. Likewise, along the excavated slope of the PAC, survey monuments were installed, as well as multipoint piezometers, traveler pipes and Casagrande piezometers.

From the conceptual design to the geologic characterization of the project area and thorough analysis of the quality of materials, the challenge of constructing the Pacific Access Channel and Borinquen Dams, encouraged the Canal workers and Contractors to become involved in a series of activities that combined the experience of international companies and the unique knowledge of the Canal employees about the waterway operation to successfully complete the project.

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