



**Conceptual Design to Recycle Water  
in Post-Panamax Locks  
Hydraulic Part**

**Diseño Conceptual para el Reciclaje  
de Agua en las Esclusas  
Pospanamax  
Sección Hidráulica**

**CONSORCIO POST PANAMAX**

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**Resumen Ejecutivo**

## 0. EXECUTIVE SUMMARY

This report deals with the conceptual design to recycle water in Post Panamax locks (3<sup>rd</sup> lane), by a pumping system. The study is only conducted for the Pacific side.

The pumping system, added to a multiple lift locks system with water saving basins, allows to save almost 100 % of the water required for the lockages.

The study has been carried out for the 3 pumping scenarios described hereafter :

- **Direct pumping system** : the water is pumped from Pacific Ocean to Gatun Lake. It is the more simple system, yet it is also the worst concerning the salt intrusion into the Gatun Lake since the pumped water is salty.
- **Semi direct pumping system** : the water is pumped from a lower reservoir to the Gatun Lake. The reservoir is located on the west bank of the locks. Its maximum water level is set under ocean level in order to be able to recover all the water spilled from the lower lock. This system also injects brackish water in Gatun Lake.
- **Pond to pond pumping system** : the water is pumped from a lower reservoir to an upper reservoir. The reservoirs are connected to the longitudinal culverts of the locks filling and emptying system. The lower reservoir is located on the west bank of the locks. Its maximum water level is set under ocean level in order to be able to recover all the water spilled from the lower lock. The upper reservoir is actually made by damming the Cocoli River. This system is the best for preventing salt intrusion into the Gatun Lake.

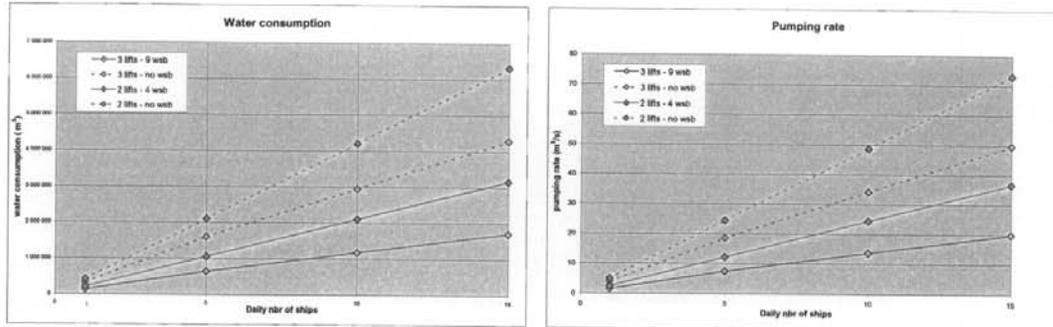
Every scenario has been tested for the 2-lift and 3-lift locks system with and without water saving basin. Moreover, study assumes daily traffic levels for Post-Panamax vessel of 1, 5, 10 and 15 lockage per day.

Calculations assumes a Gatun Lake level of + 26.00 m PLD and the Mean Low Water Spring ocean tide range, i.e. [ -2.32 ; + 2.40 ] m PLD.

The first stage consists in :

- Calculating the volumes of water taken from the Gatun Lake (respectively from the upper reservoir) and spilled to the Pacific Ocean (respectively to the lower reservoir),
- Determining the pumping flow rate for different daily traffic levels (1, 5, 10 and 15 ships per day),
- Determining the water level variations in the upper and lower reservoirs.

These calculations have been carried out with the Consultant Software already used in former studies. The graphics hereafter give an overview of water consumption and pumping flow rate evolution with the daily traffic level for the 2-lift and 3-lift lock system.



Then the pumping system (pump, culvert, valve, grid) has been designed by means of the Flowmaster software. For each configuration, the pumping system is composed of three identical pumping networks designed for flow rates ranging from 0 to  $\frac{Q_{max}}{3}$  where  $Q_{max}$  is the pumping flow rate associated with a daily traffic of 15 ships/day.

Flowmaster has been used in order to :

- define the components of the pumping circuit between lower and upper ponds (valve, bends, length and size of culverts and grid),
- calculate regular and singular head losses in every component for the range of flow rates given by the consultant software calculations. These data are required to elaborate the network curve,  $\Delta H=f(Q)$  for each configuration.

Culvert arrangements have been studied to minimize excavation works.

Tests have also been carried out to evaluate the time to fill the upper lock chamber from the upper reservoir and the time to empty the lower lock chamber to the lower reservoir. The conclusion is that the pumping system will not reduce the daily number of passing ships since filling and emptying times are shorter than times without the pumping system.

The problem of water hammer in the conduits has also been investigated. It is compulsory to install a valve upstream the pumps to avoid reversing flow if it runs out of order.