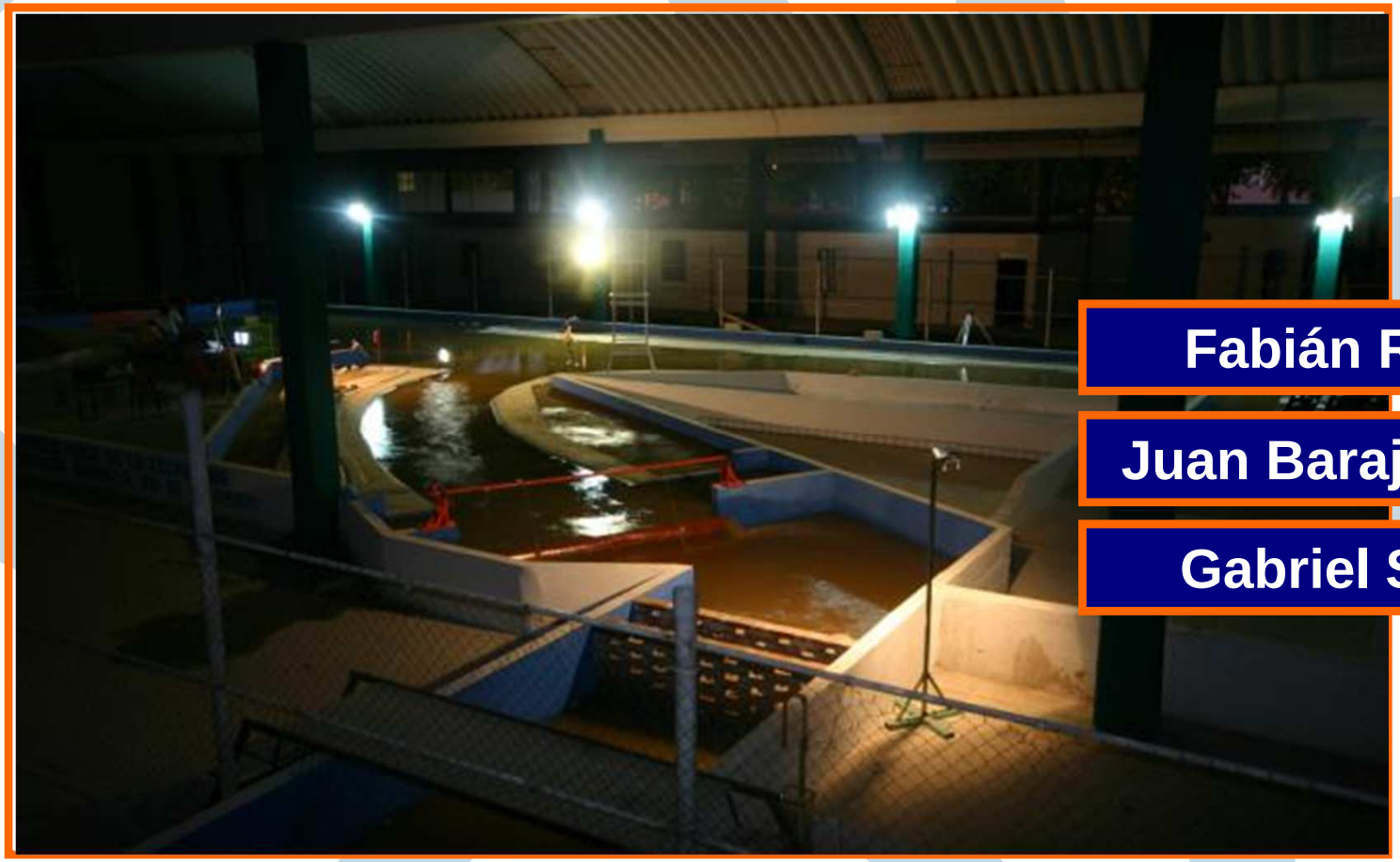
HYDRAULIC OPERATION OF A DIVERSION STRUCTURE: PHYSICAL MODELING

Casa abierta al tiempo



Fabián Rivera-Trejo[1]

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Gabriel Soto-Cortés[2]

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WHERE IS TABASCO?

Casa abierta al tiempo

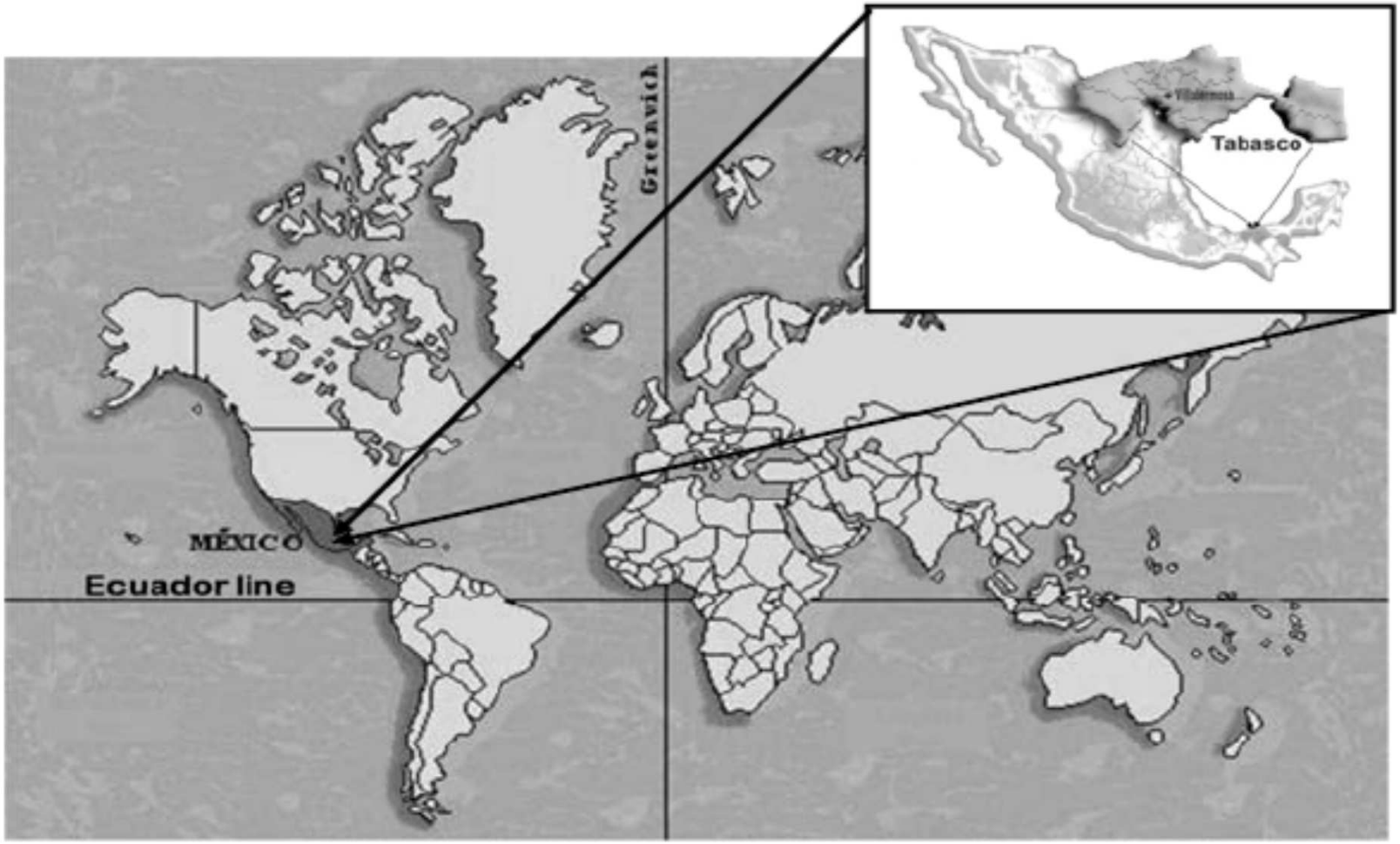

Fig. 1. Tabasco, México.

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FLOOD PROBLEMS IN TABASCO

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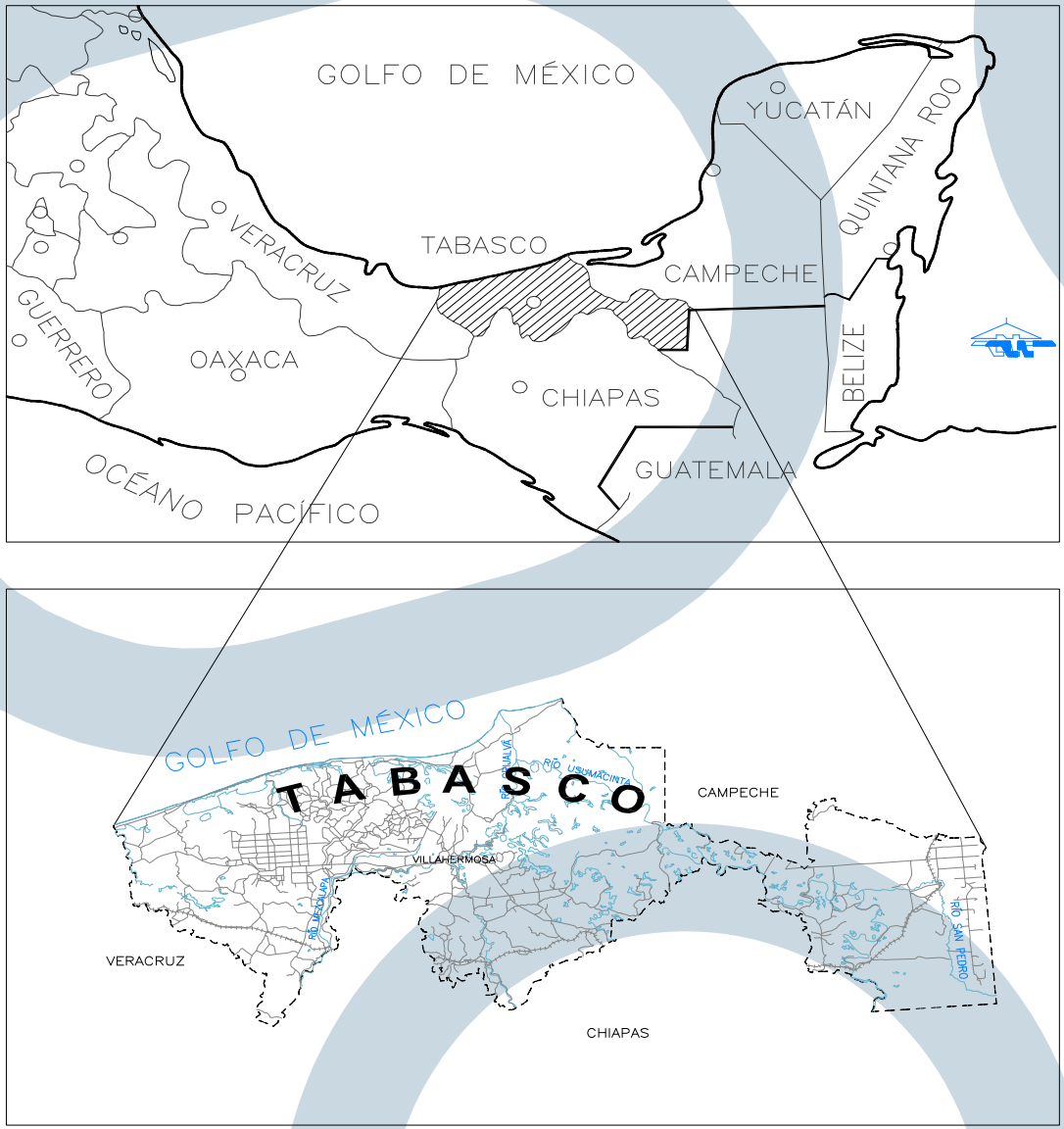
THE CAUSE



Extension
24, 664 km^2

Proportion of national territory
1.3%

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THE CAUSE

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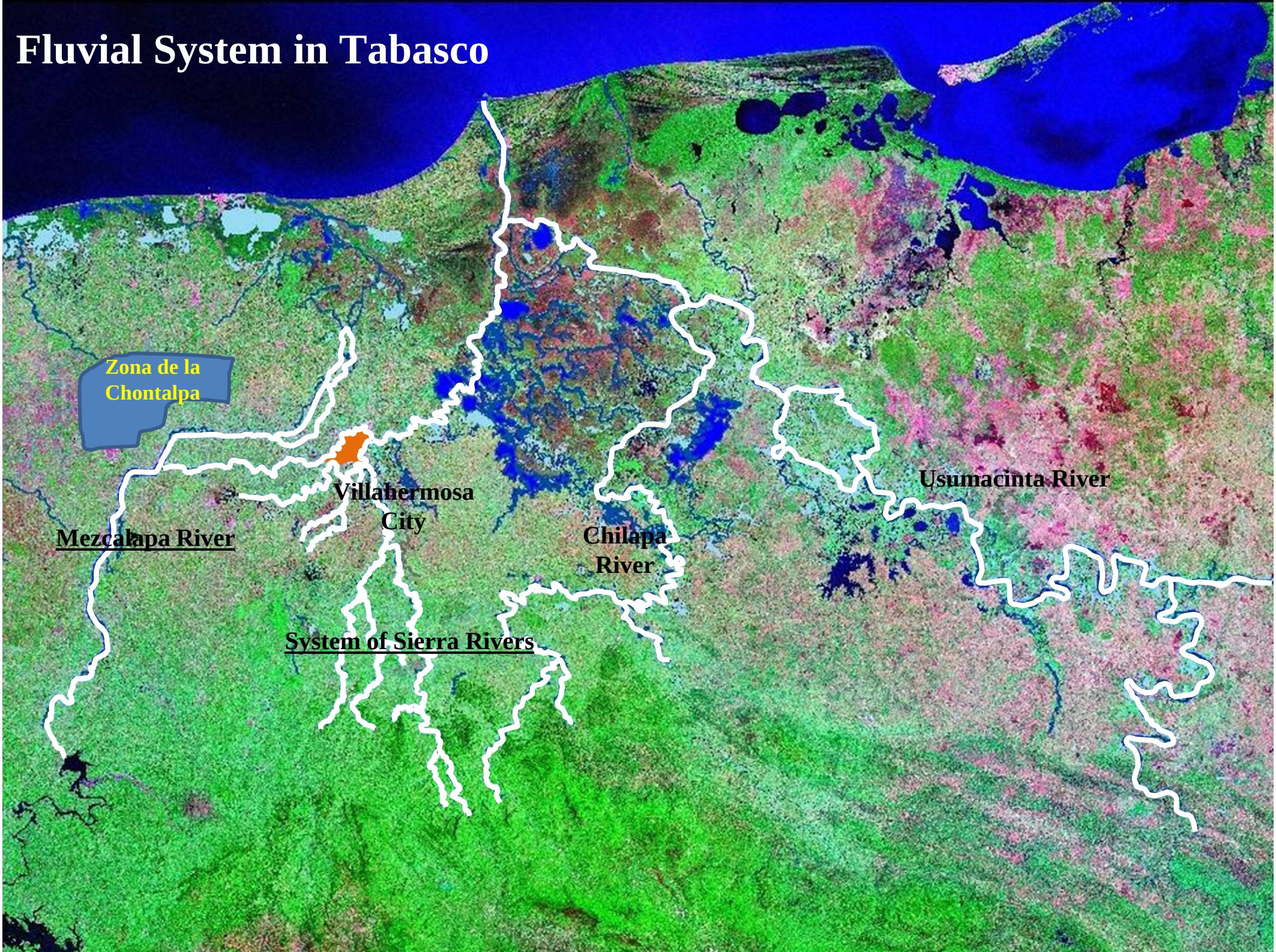
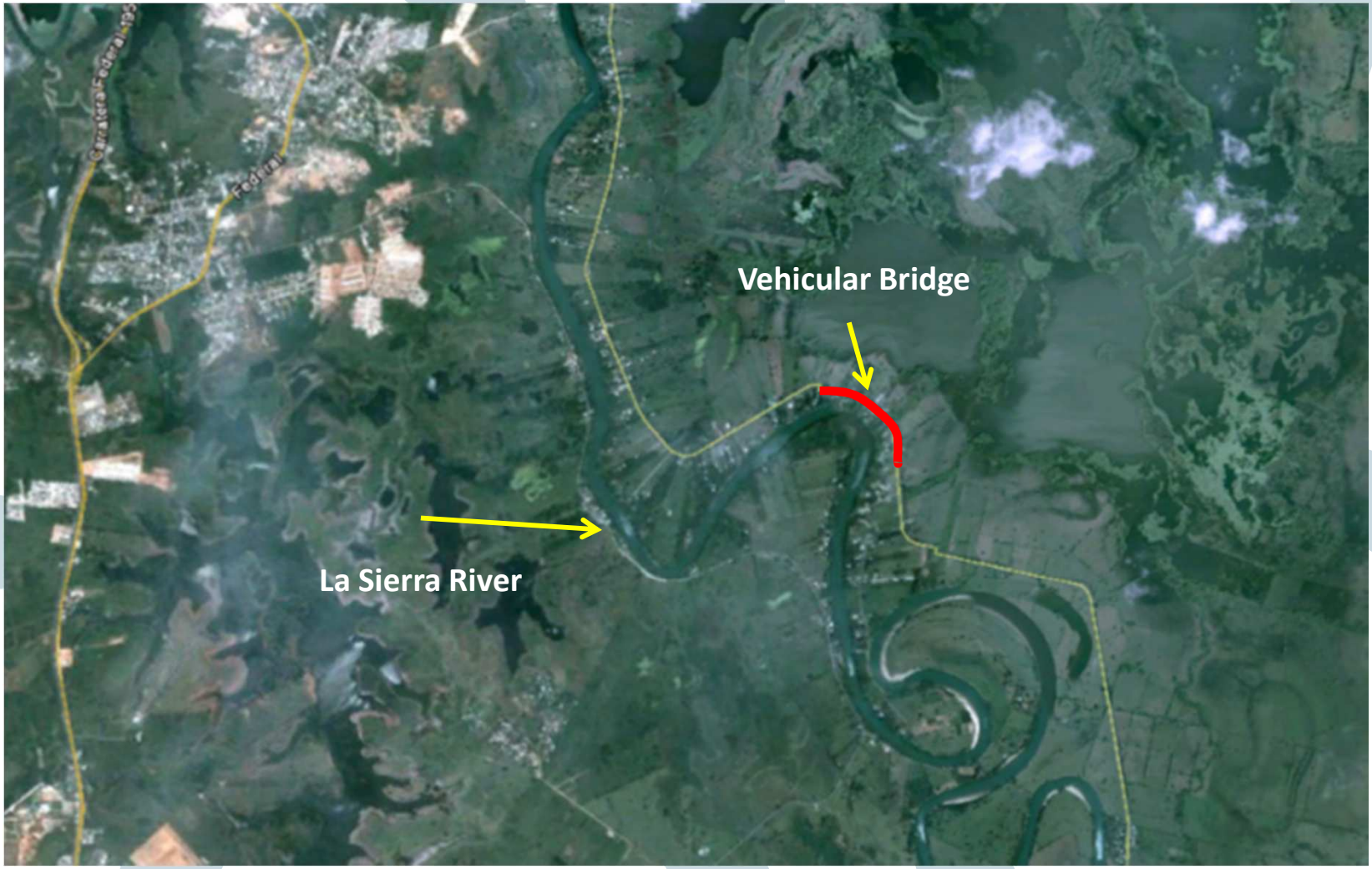

Fluvial System in Tabasco
Zona de la Chontalpa
Villahermosa City
Mezcalapa River
Chilapa River
Usumacinta River
System of Sierra Rivers

DIVERSION CHANNEL



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PHYSICAL MODEL

- Model design
- Instrumentation
- Calibration
- Test
- Results

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MODEL DESIGN

Size of the laboratory

- Geometric scale

Pump capacity

- Not to geometric scale

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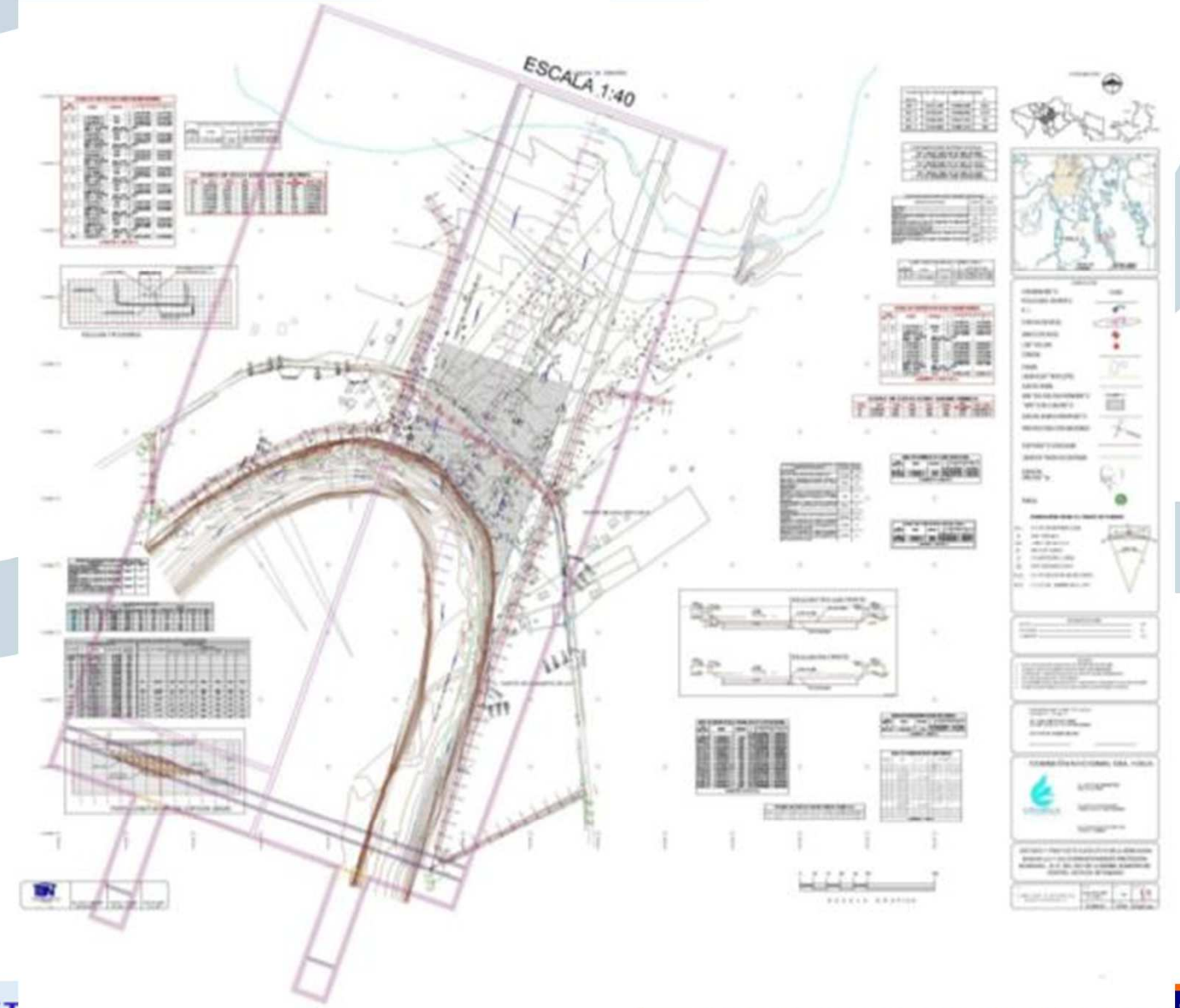
Geometry



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Pump capacity

$$Q_m = \frac{Q_p}{Q_e} = \frac{Q_p}{L_e^{5/2}}$$

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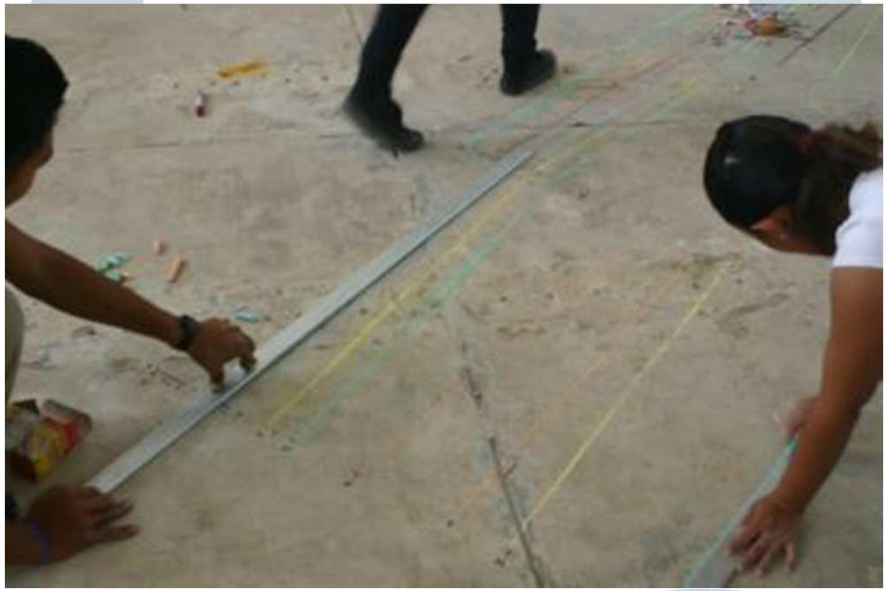
Trace and model configuration

Casa abierta al tiempo



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Trace and model configuration

Casa abierta al tiempo

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Trace and model configuration

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INSTRUMENTATION

- Level measurement
- Discharge measurement
- Velocity measurement
- Bed profiler measurement

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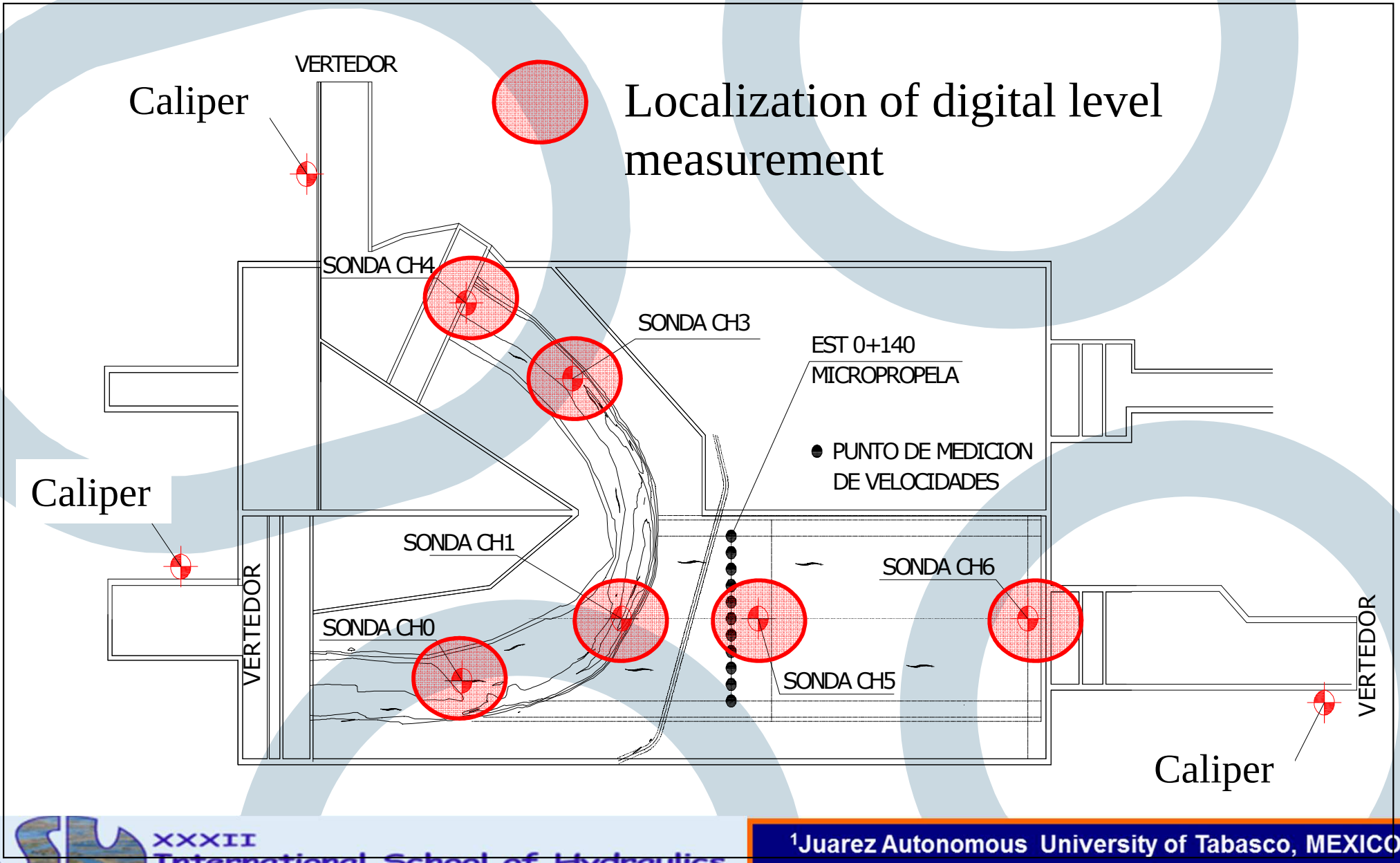
Level measurement

Casa abierta al tiempo



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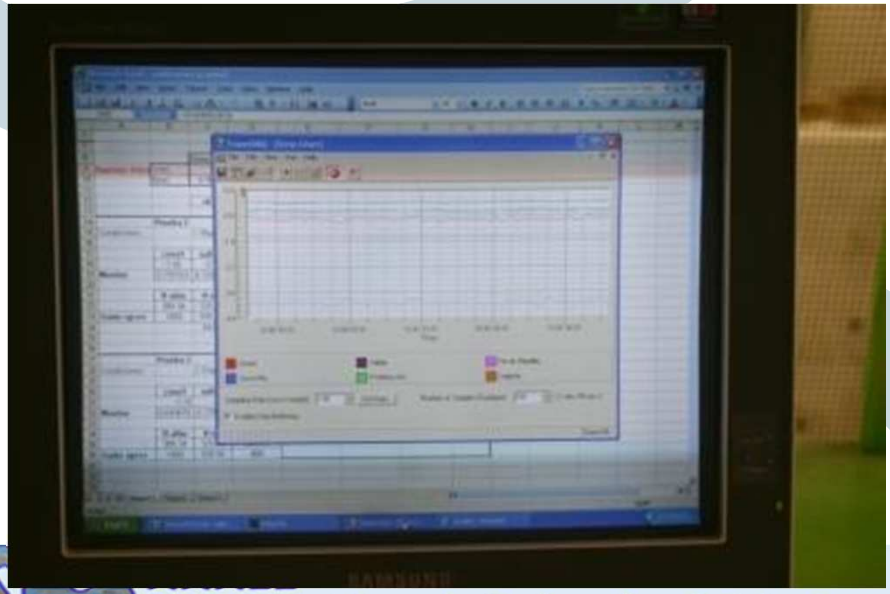
Level measurement



DATE,0 ZONA1,1CURVA,3SALIDA,4FRONTERA AA,5FIN DE PLANTILLA,6LAGUNA

12/06/2011 10:38:12.59 A.M.,-1.21,-0.83,-0.61,-0.87,-4.04,-4.08

12/06/2011 10:38:13.59 A.M.,-1.19,-0.89,-0.61,-0.85,-3.98,-4.07

12/06/2011 10:38:14.57 A.M.,-1.12,-0.84,-0.63,-0.85,-4.01,-4.07

12/06/2011 10:38:15.59 A.M.,-1.12,-0.87,-0.63,-0.84,-4.05,-4.06

12/06/2011 10:38:16.59 A.M.,-1.17,-0.85,-0.65,-0.84,-4.11,-4.04

12/06/2011 10:38:17.59 A.M.,-1.04,-0.85,-0.64,-0.83,-4.09,-4.06

12/06/2011 10:38:21.57 A.M.,-1.09,-0.89,-0.65,-0.83,-4.06,-4.05

12/06/2011 10:38:22.59 A.M.,-1.19,-0.86,-0.66,-0.83,-4.02,-4.06

12/06/2011 10:38:23.59 a.m.,-1.07,-0.85,-0.65,-0.83,-4.05,-4.08

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Level measurement






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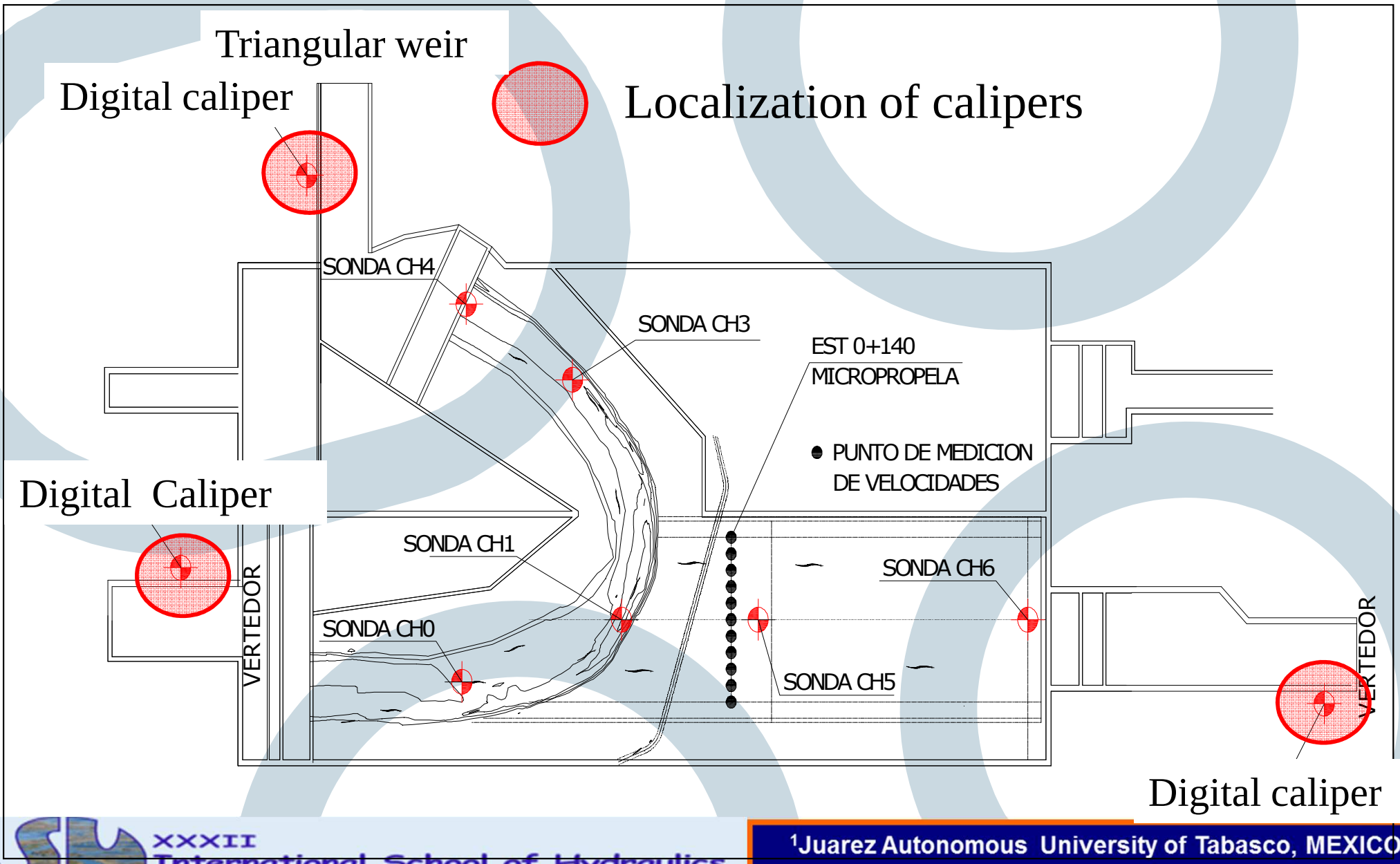
Discharge measurements

Casa abierta al tiempo



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Discharge measurements






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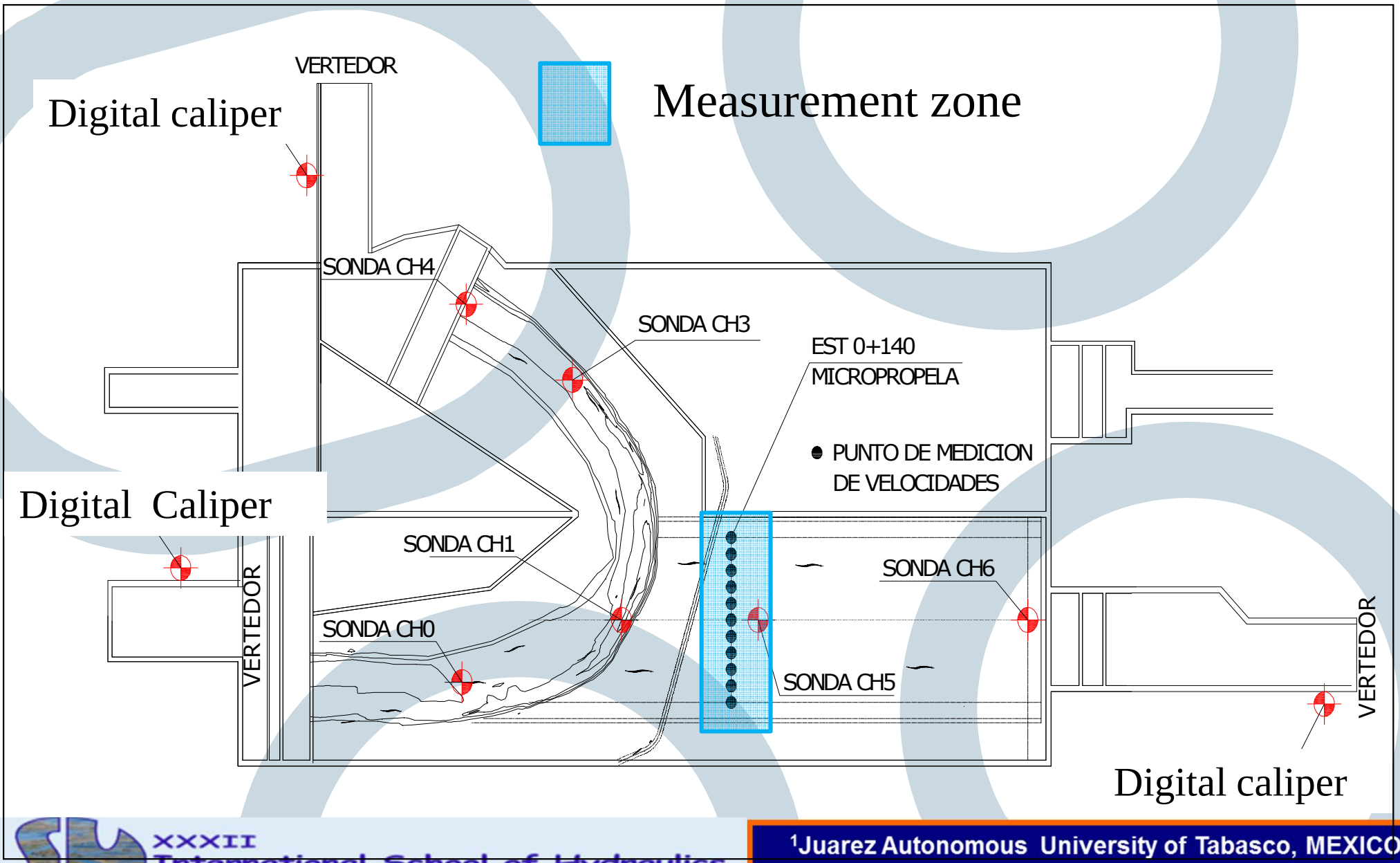
Velocities measurements



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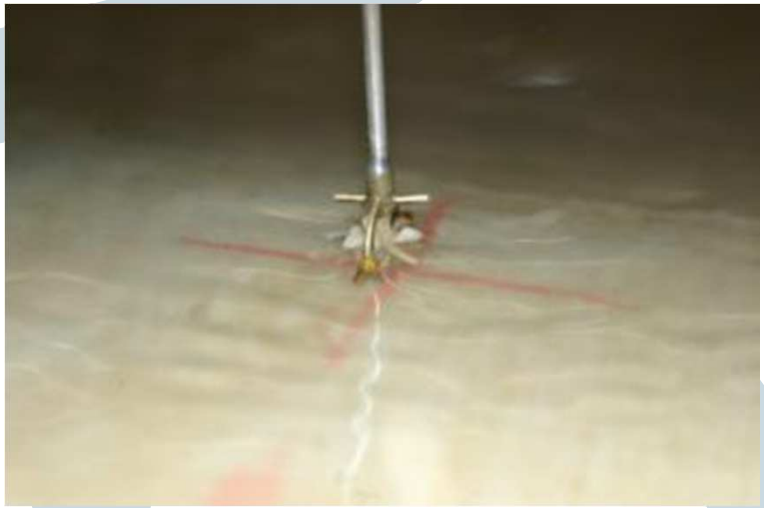
Velocities measurements



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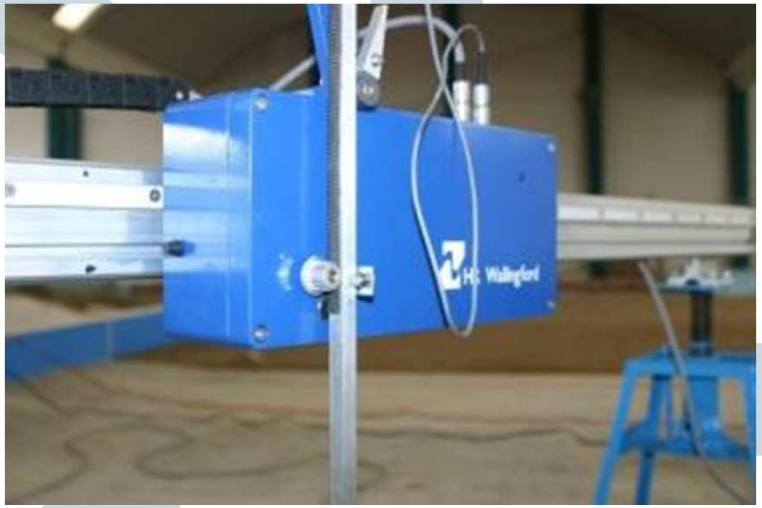
Bed profiler measurement



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CALIBRATION

- Bathimetry
- Triangular weirs
- Digital level measurement
- Experimental discharge curve

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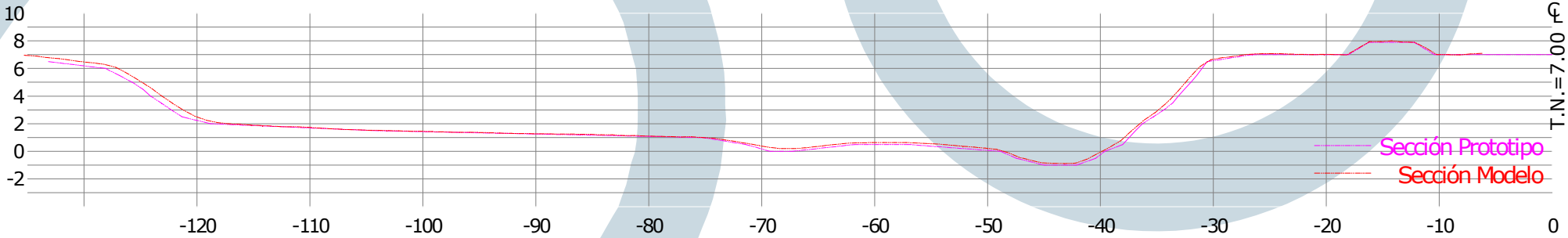
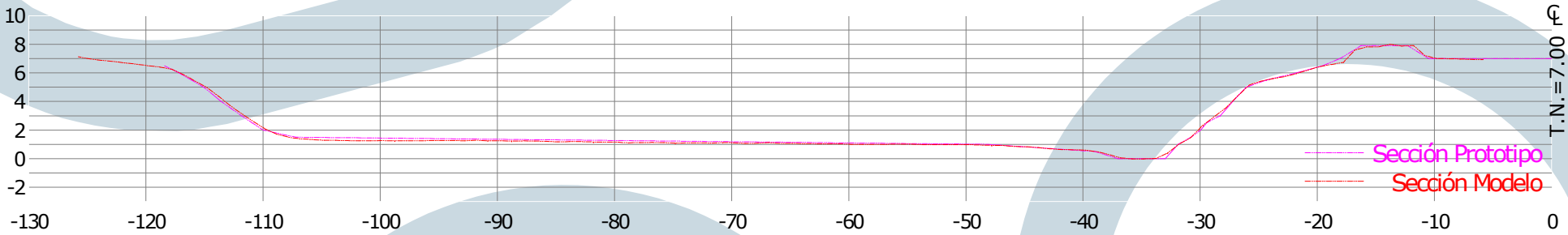
Bathimetry



ESTACION 0+280.00

ESCALA HORIZONTAL 1 : 40
ESCALA VERTICAL 1 : 40



ESTACION 0+240.00

ESCALA HORIZONTAL 1 : 40
ESCALA VERTICAL 1 : 40

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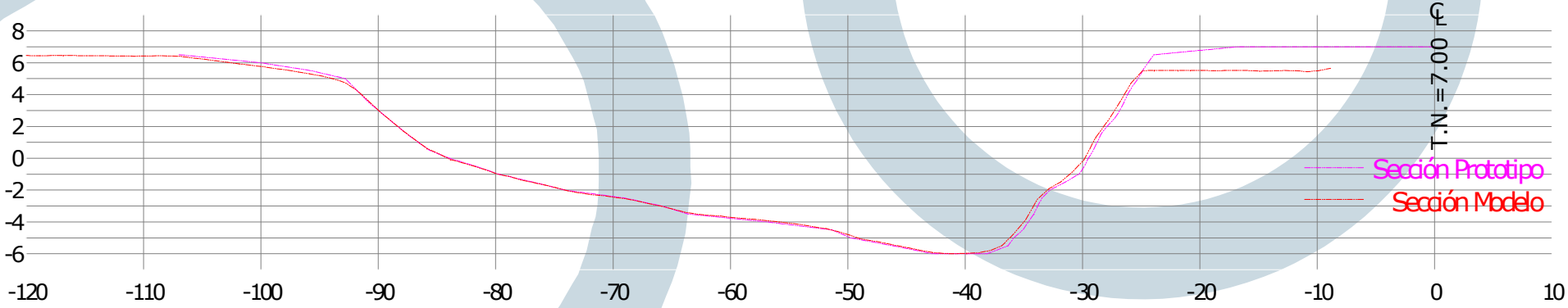
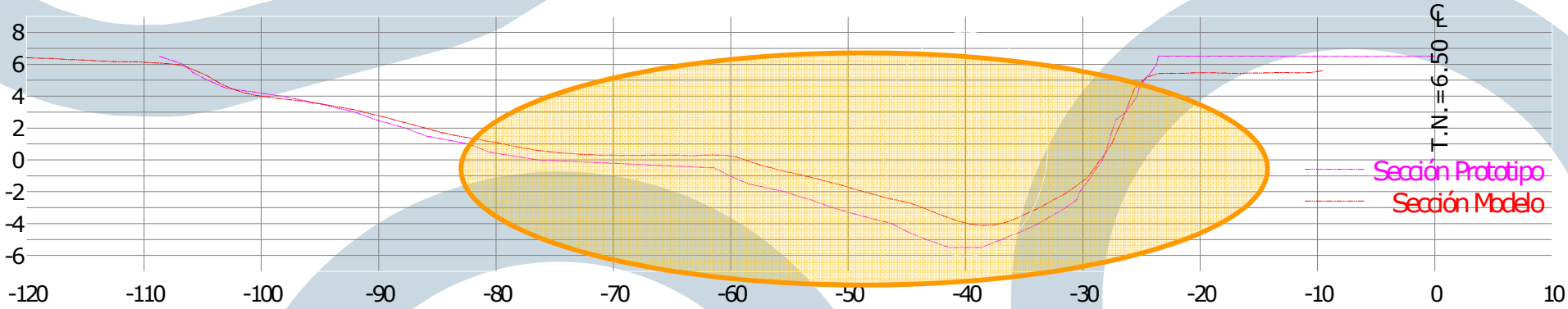
Bathimetry



ESTACION 0+600.00

ESCALA HORIZONTAL 1 : 40
ESCALA VERTICAL 1 : 40



ESTACION 0+560.00

ESCALA HORIZONTAL 1 : 40
ESCALA VERTICAL 1 : 40

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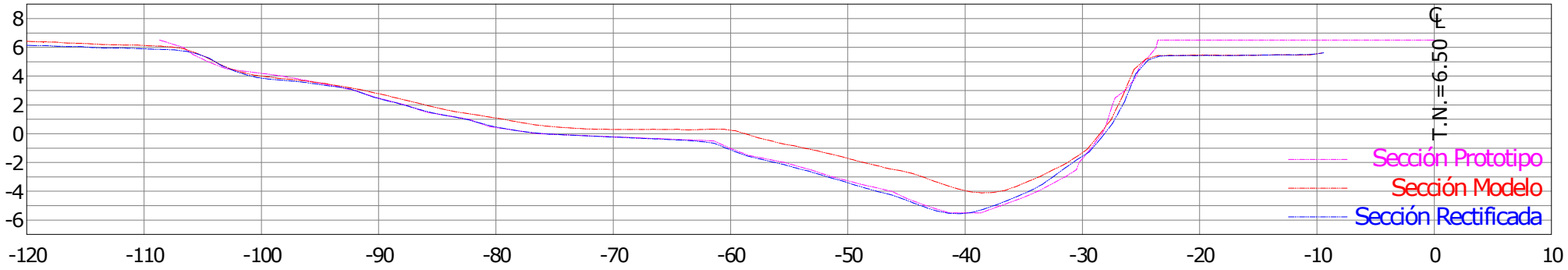
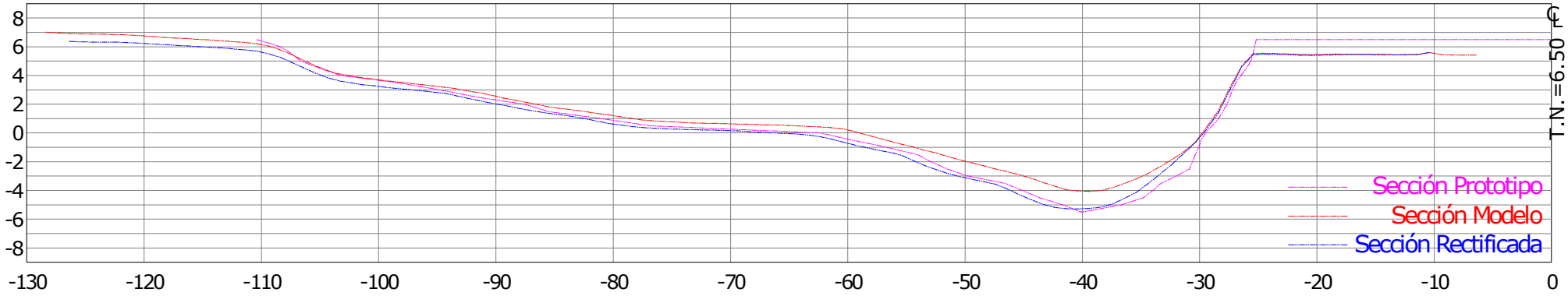
Bathimetry



ESTACION 0+560.00

ESCALA HORIZONTAL 1 : 40
ESCALA VERTICAL 1 : 40



ESTACION 0+550.00

ESCALA HORIZONTAL 1 : 40
ESCALA VERTICAL 1 : 40

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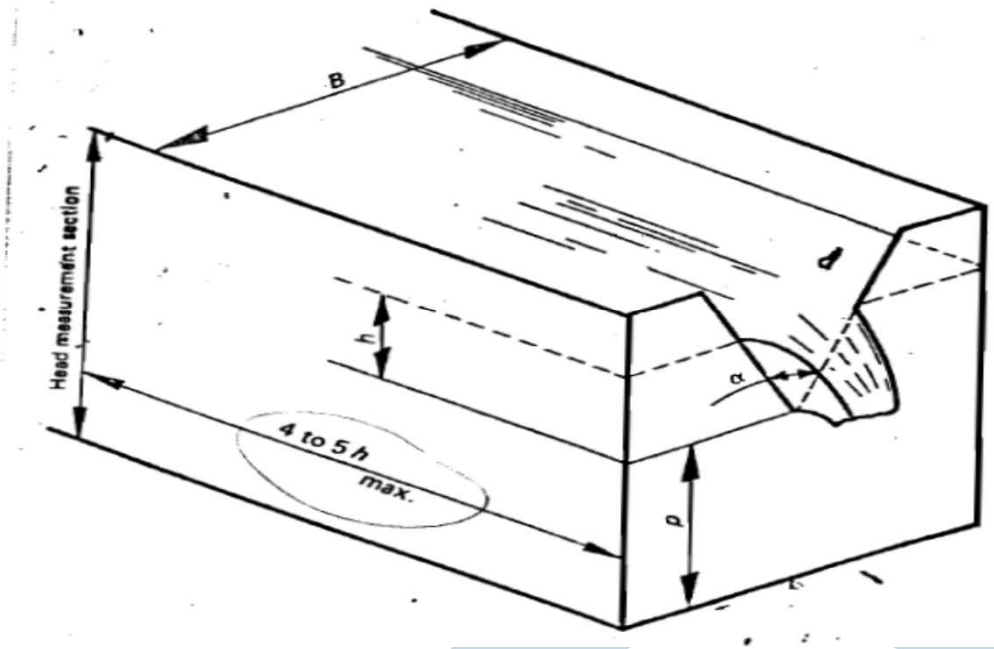
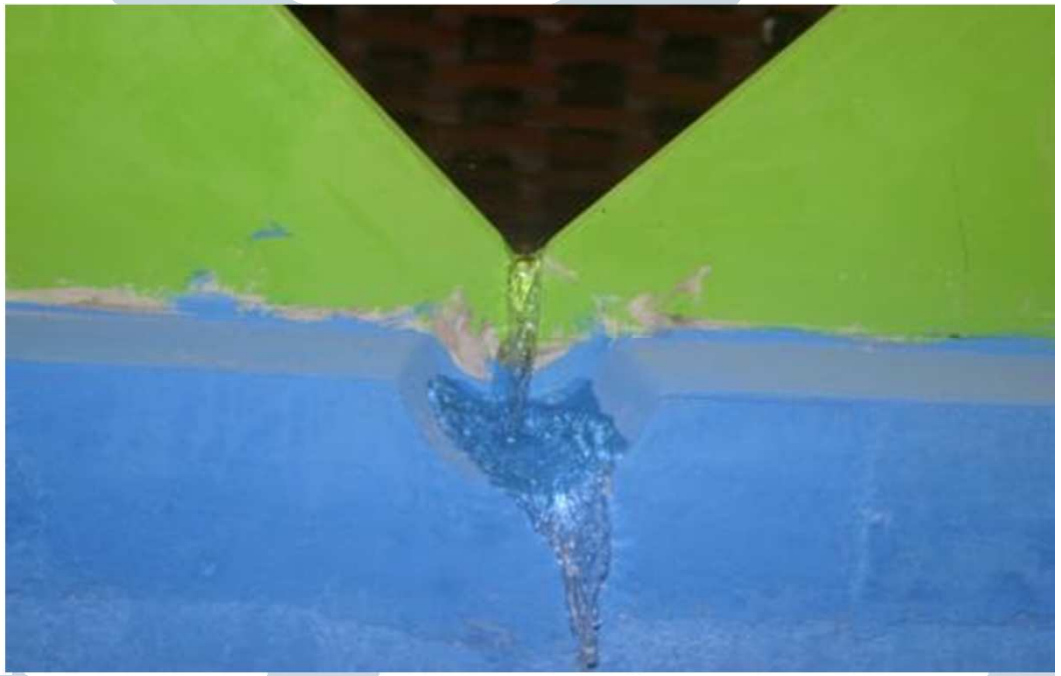
Triangular weirs





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Digital Level Measurements

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TESTS

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Experimental design

Test	Conditions	Feature to study
I	Naturals, Q_D=1800 m³/s	Verify design discharge, bankfull discharge (Q_{bf}) and experimental curve Q - H
II	Q= Q_{bf}, without/groynes, H_{lag}=6.00 masl	Operation of the derived structure to bankfull discharge
III	Q= Q_{bf}, without/groynes, H_{lag}= free	Operation of the diversion structure to bankfull discharge and lagoon empty
IV	Q= Q_{bf}, without/groynes, H_{lag}=6.00 masl	Operation of the diversion structure from bankfull discharge to stop deriving
V	Q= Q_{bf}, without/groynes, H_{lag}= free	Operation of the diversion structure from bankfull discharge to stop deriving
VI	Q= Q_{bf}, one groyne, H_{lag}=6.00 masl	Operation of the derived structure to bankfull discharge with one groyne
VII	Q= Q_{bf}, one groyne, H_{lag}= free	Operation of the derived structure to bankfull discharge with one groyne and lagoon empty
VIII	Q= Q_{bf}, seven groynes, H_{lag}=6.00 masl	Operation of the derived structure to bankfull discharge with seven groynes
IX	Q= Q_{bf}, seven groynes, H_{lag}= free	Operation of the derived structure to bankfull discharge with seven groynes and lagoon empty

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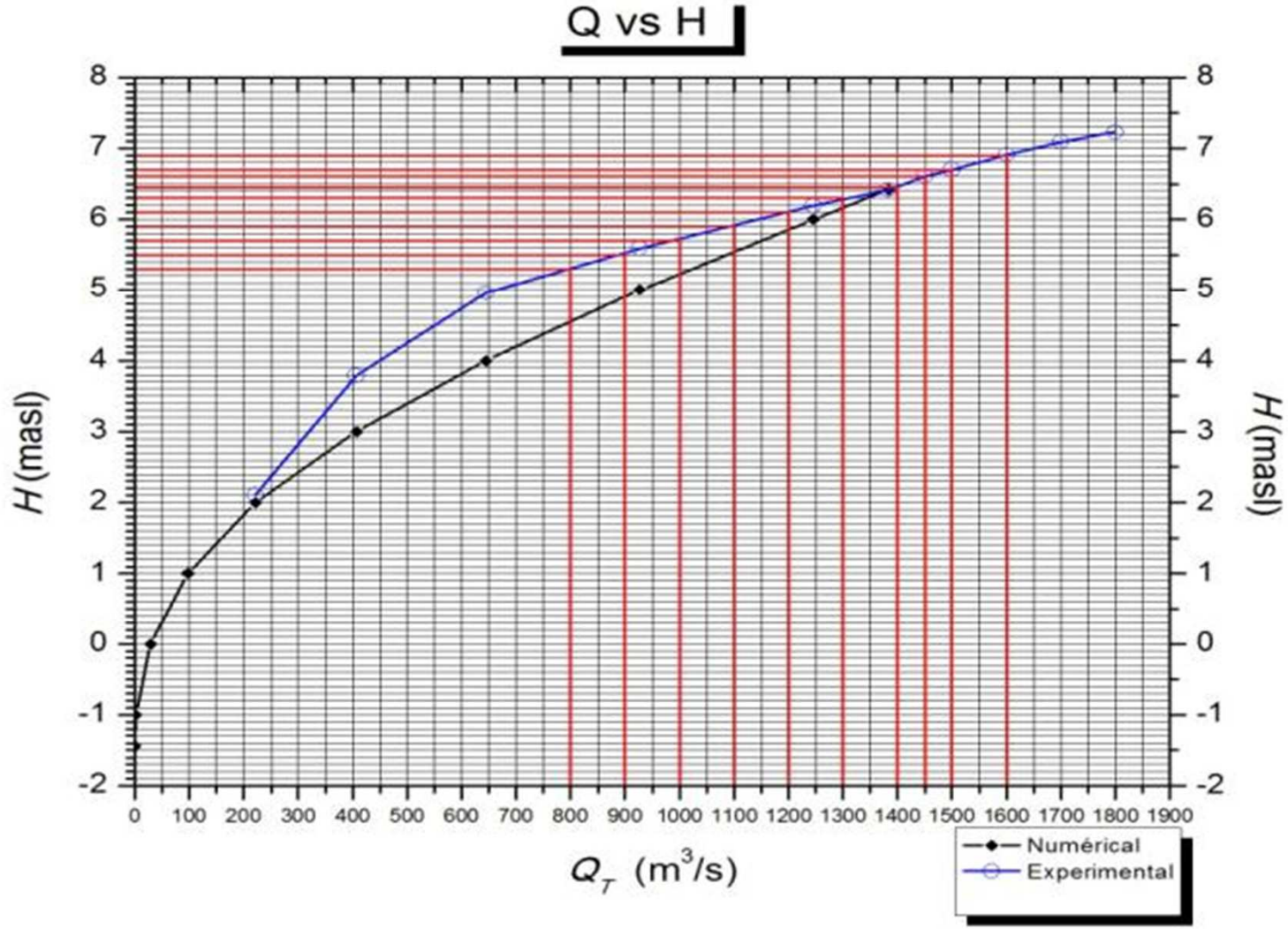
Experimental discharge curve Q vs H



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Test (Without Groynes)

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Test (With 7 Groynes)

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RESULTS

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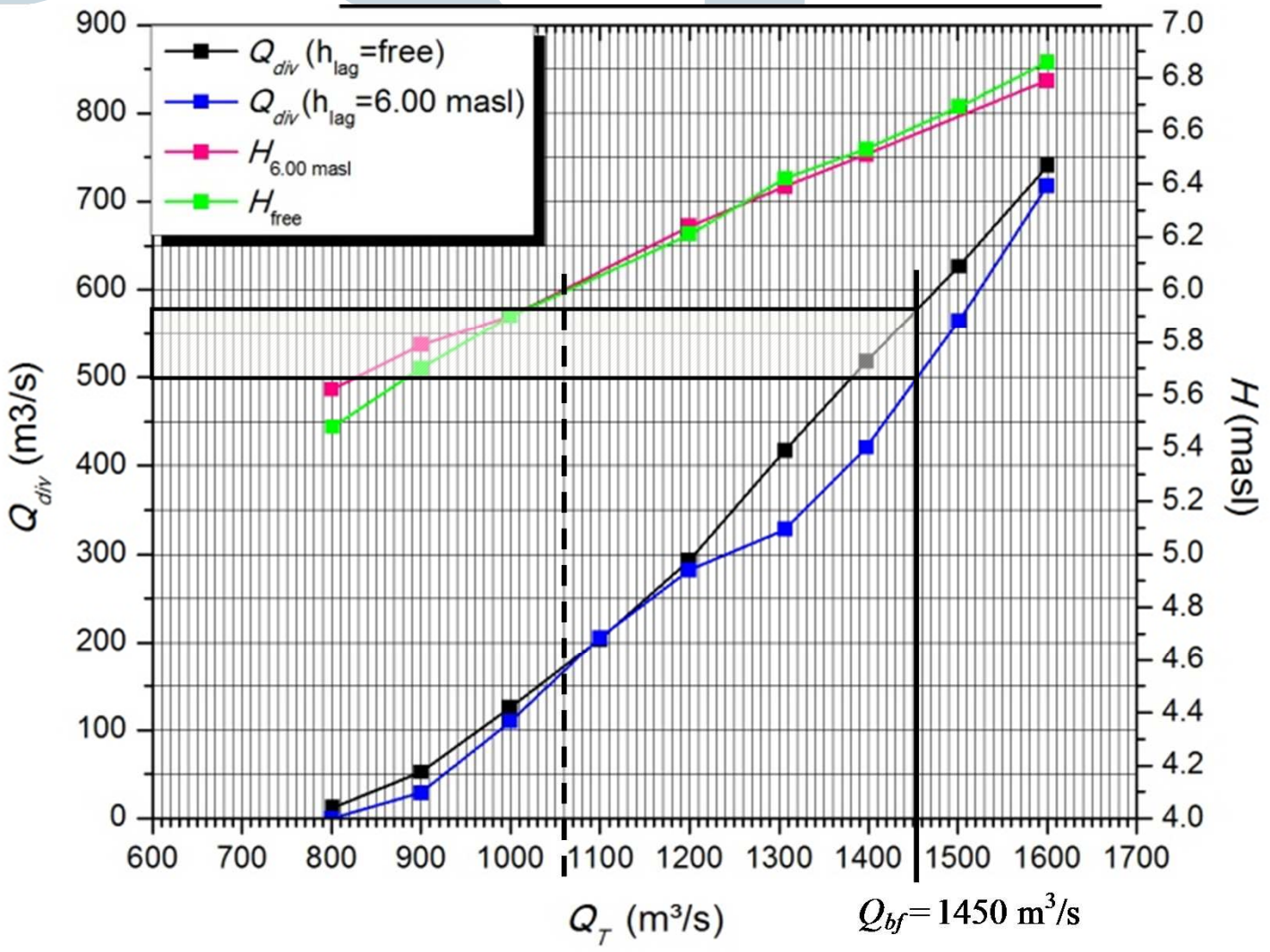
Operation of the derivation structure without groynes



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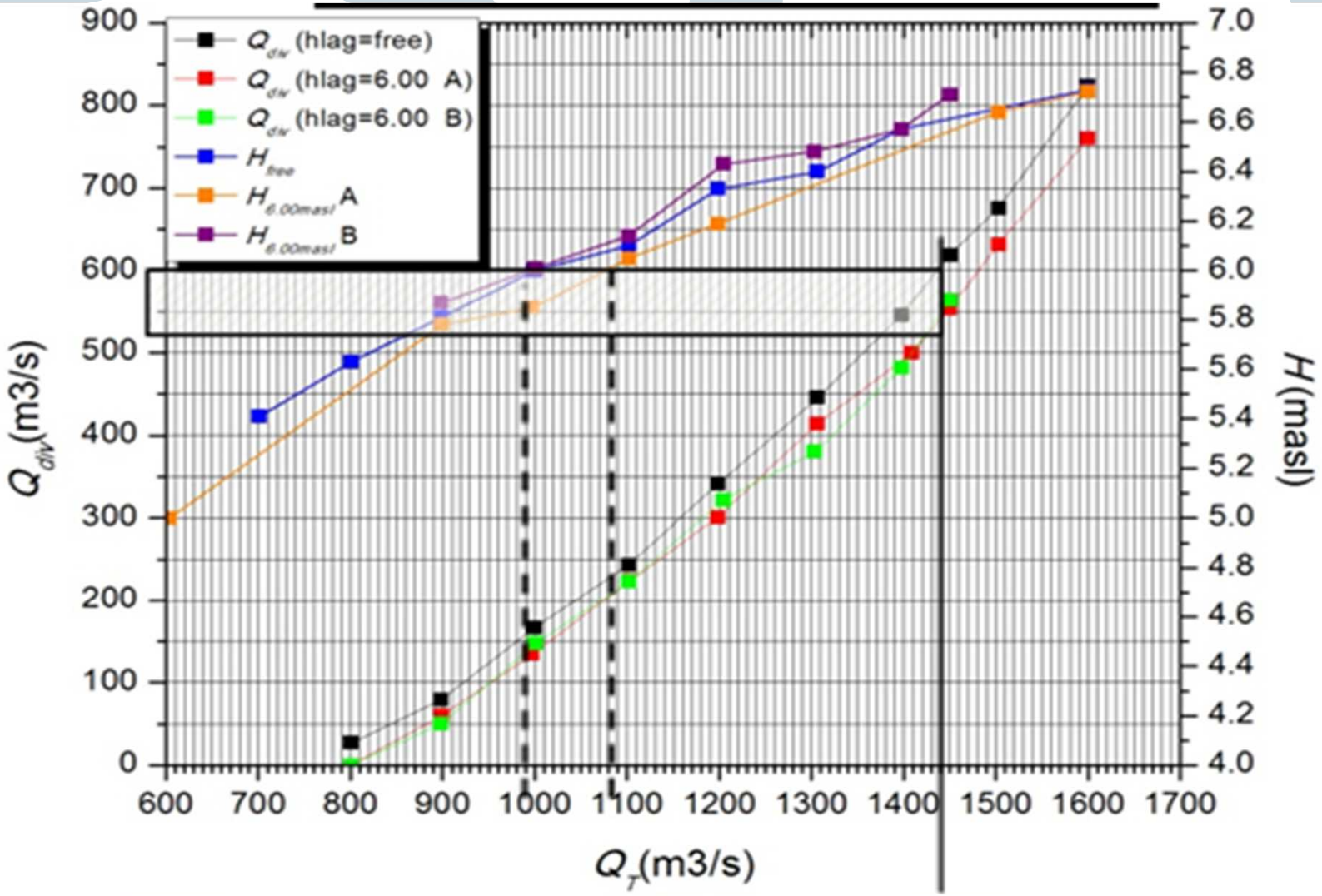
Operation of the derivation structure with one groyne



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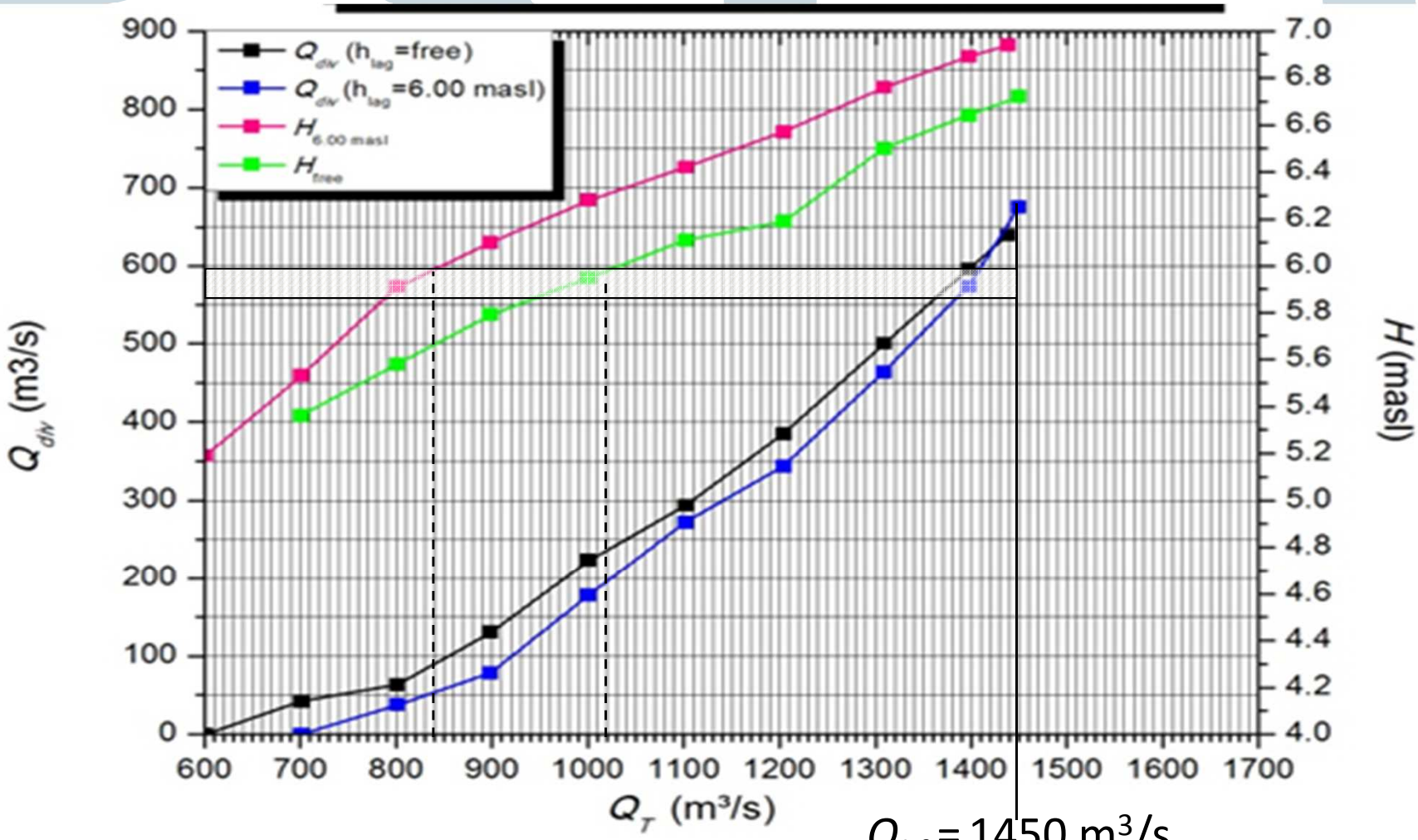
Operation of the derivation structure with seven groynes



$Q_{bf} = 1450\ m^3/s$

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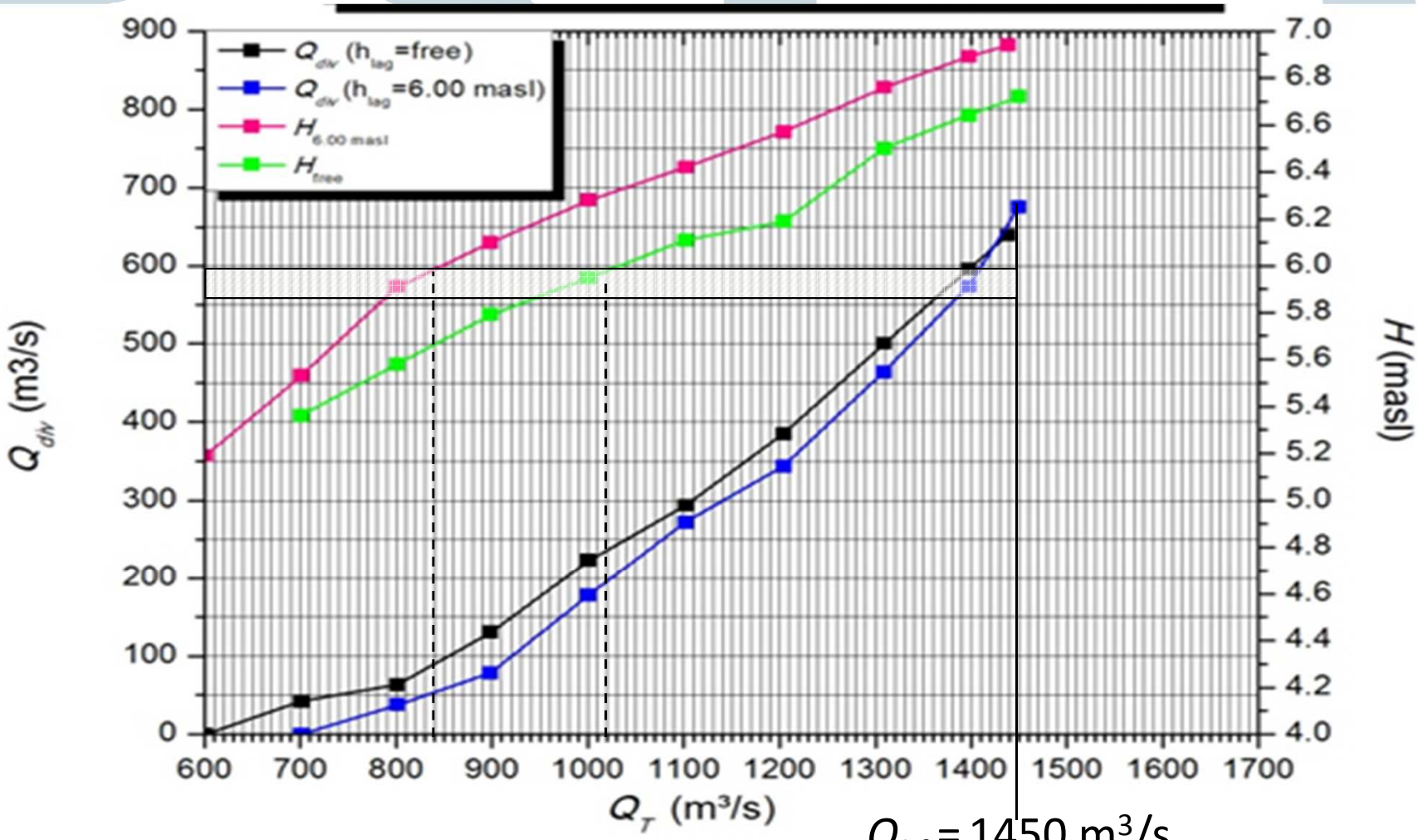
Operation of the derivation structure with seven groynes



$Q_{bf} = 1450\ m^3/s$

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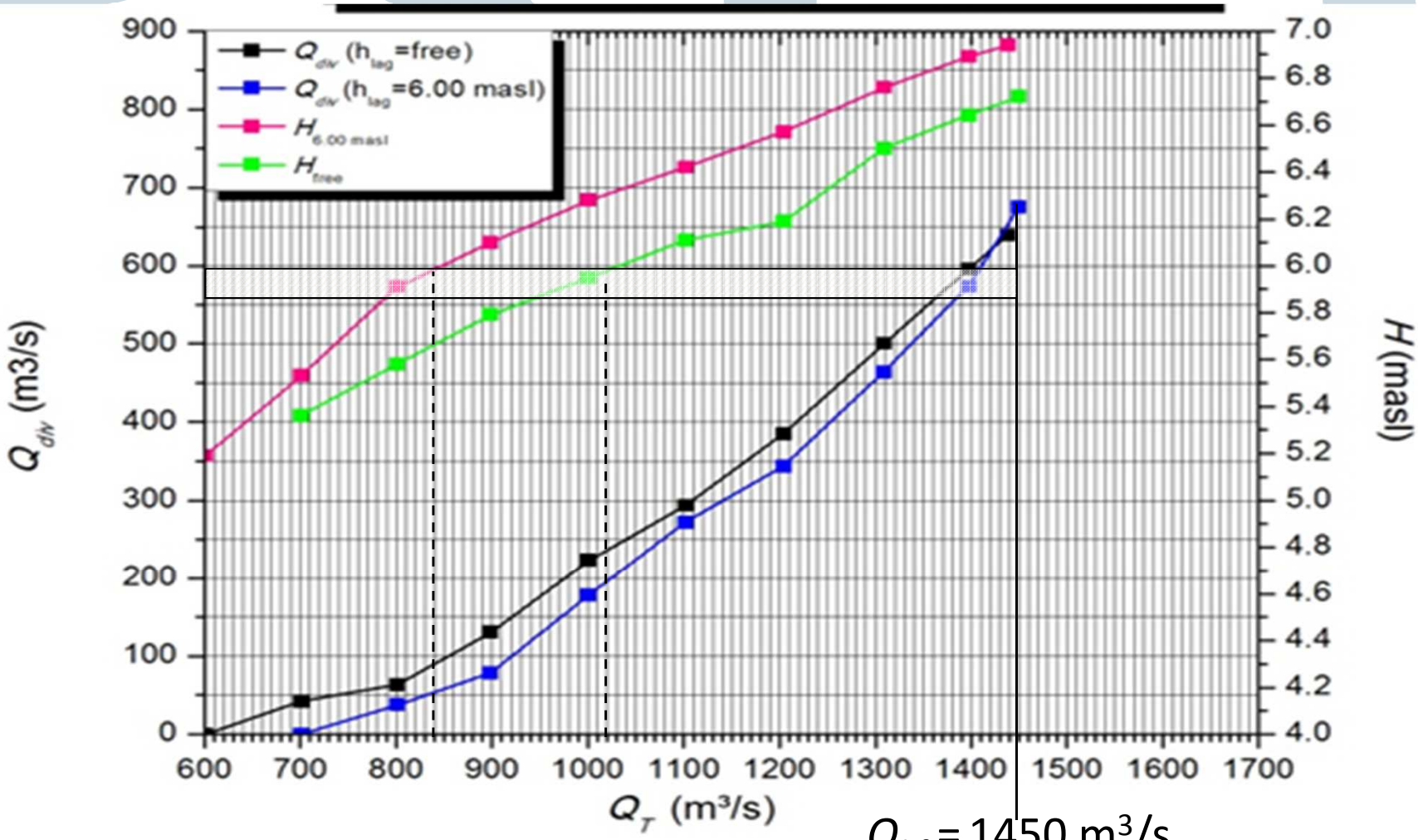
Operation of the derivation structure with seven groynes



$Q_{bf} = 1450\ m^3/s$

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CONCLUSIONS

The design of the diversion structure proposal considered to control the discharge a 515 m3 /s by using a lateral weir, for a river design discharge of 1800 m³/s and a level of 6.00 masl in the downstream lagoon. However, the experimental study found that the maximum discharge to bankfull (Qbf) that can run without overflowing over the river is 1450 m³ / s, so it does not reach the 1800 m³/s, however, the derived discharge are around of 50% 30% of the total discharge through the river. Moreover, in case of flow rates less than 1000 m³/s in the river and with the lagoon filled (6.00 masl), we have the possibility of water comeback from the lake to the river due the level difference, because at this condition the river level has a lower than the lagoon level.

In this paper we showed the goodness of the application of physical models to test the operation of hydraulic works, and were found to be a useful tool for solving engineering problems where numerical models are not sufficiently reliable.

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THANK YOU

¡WIZYTA TABASCO!

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