The 6th Regional Stakeholder Forum

Second Regional Information Sharing on Pak Lay Prior Consultation Process

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Luang Prabang, Lao PDR

Second Draft Technical Review on Hydrology & Hydraulics

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Outline

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- Tailwater and floods
- Reservoir operating rule
- Risk and concerns / tools
- Impacts related to structure
- Monitoring
- Transboundary impacts
- Alignment with PDG

I. Background

- Hydrology and hydraulics determines how infrastructure is designed and operated for hydropower production, navigation, sediment routing and environmental and social considerations. Hence it is relevant for all topics, and addressed up front.
- The PDG (2009) does not provide specific guidance (only consequences to other topics)
- The new (draft) DG (2018) includes a section on hydrology and hydraulics

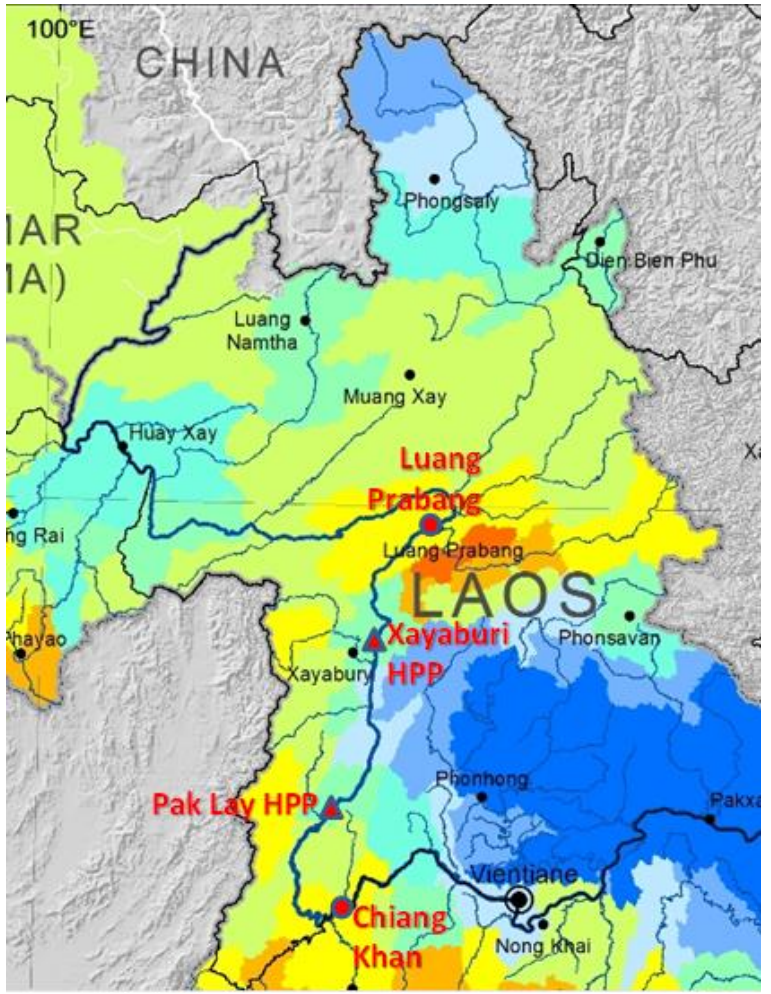
I. Background

Concerns/risks:

- How does the operation of Pak Lay HPP contribute to changes in seasonal flows and daily fluctuations downstream?
- Is the project viable considering mitigating the possible negative impacts and changes in the river?
- Did the developer use proper methods to quantify the physical behavior of the river, and its variability (wet/dry years, upstream dams, detailed flows near the infrastructure, etc.)
- How about the role of Pak Lay in the Lao dam cascade, and its contribution to the impacts?
- Are the hydraulic conditions well optimized for the different components of the dam?

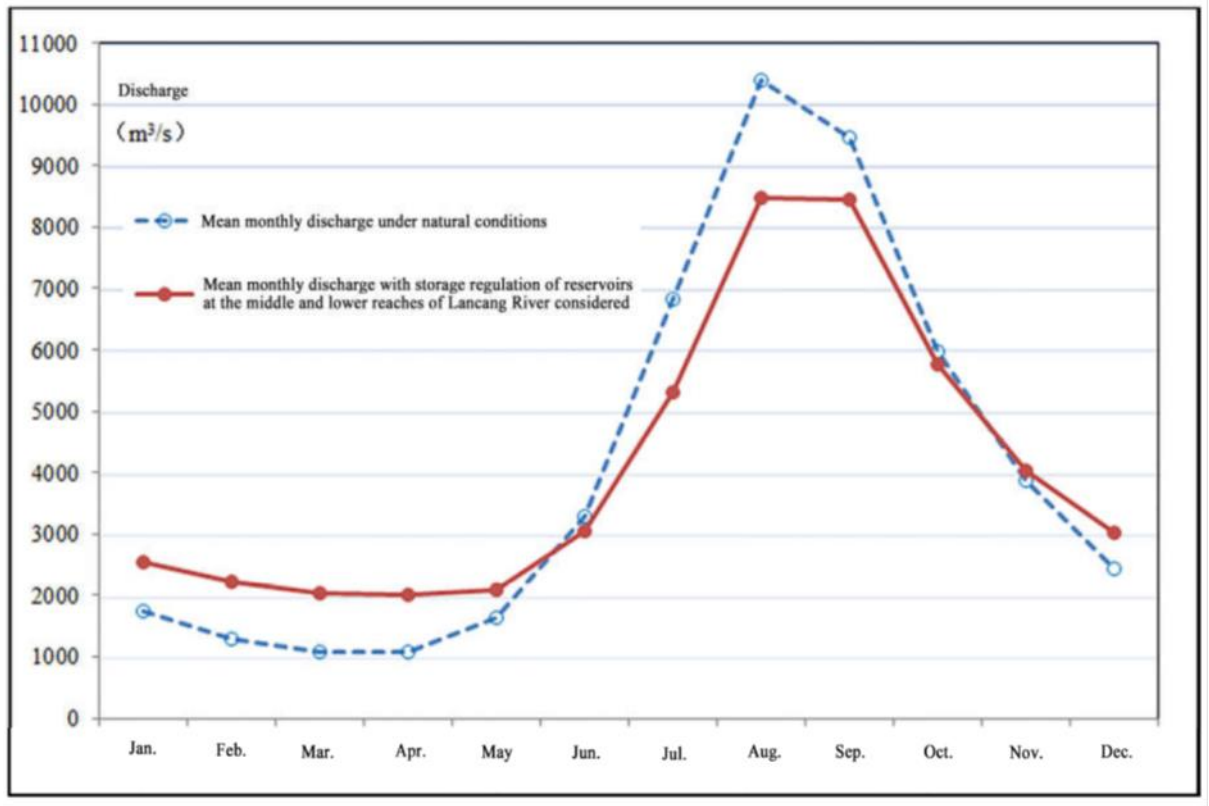
II. Main Review Findings: data used

- Quality of data and analyses should be given high priority because of their relevance to the design, operation
- Hydrological data, discharges and water levels used:
  - Historic flows and water levels of Luang Prabang (1960-2015) and Chiang Khan (196-2015) stations;
  - Pak Lay dam site monthly discharges obtained from these data by scaling on basin area ratio
  - Observed water levels and discharges at the dam site in 2008-2009 and from 2016;
  - Approximations of the impacts on discharge for the future dam development in the upstream reaches, only considering Lancang cascade;
- Further review and harmonization with MRC data needed. Report the quality issues and inconsistencies.



II. Main Review Findings: data used

- The linear scaling approach (scaling Luang Prabang and Chiang Khan data) used to correlate the discharges is acceptable for monthly flows, but not for daily flows. These synthesized discharge data have not yet been checked with the observations at the dam site.



More analysis needed:

- Impacts of upstream developments only consider the Lancang cascade, but not the Laos tributary schemes and the Pak Beng and Xayaburi schemes
- Impacts of climate change are not included in the used forecasted series

"The impacts of these changes in hydrology on the economics of the PLHPP should be investigated, with a view to adjusting the operating rules to minimise environmental impacts without substantially risking the payback period."

II. Main Review Findings: tailwater and floods

- Tailwater rating curve considers impact of Sanakham HPP
- Flood frequency and design flood based on log-Pearson Type III method, but more methods should be considered (like $G_{eneralised}E_{xtreme}V_{alue}$ as used by MRC)
- Xayaburi design values are much higher: all dams in cascade should be consistent (as addressed in the dam-safety section)

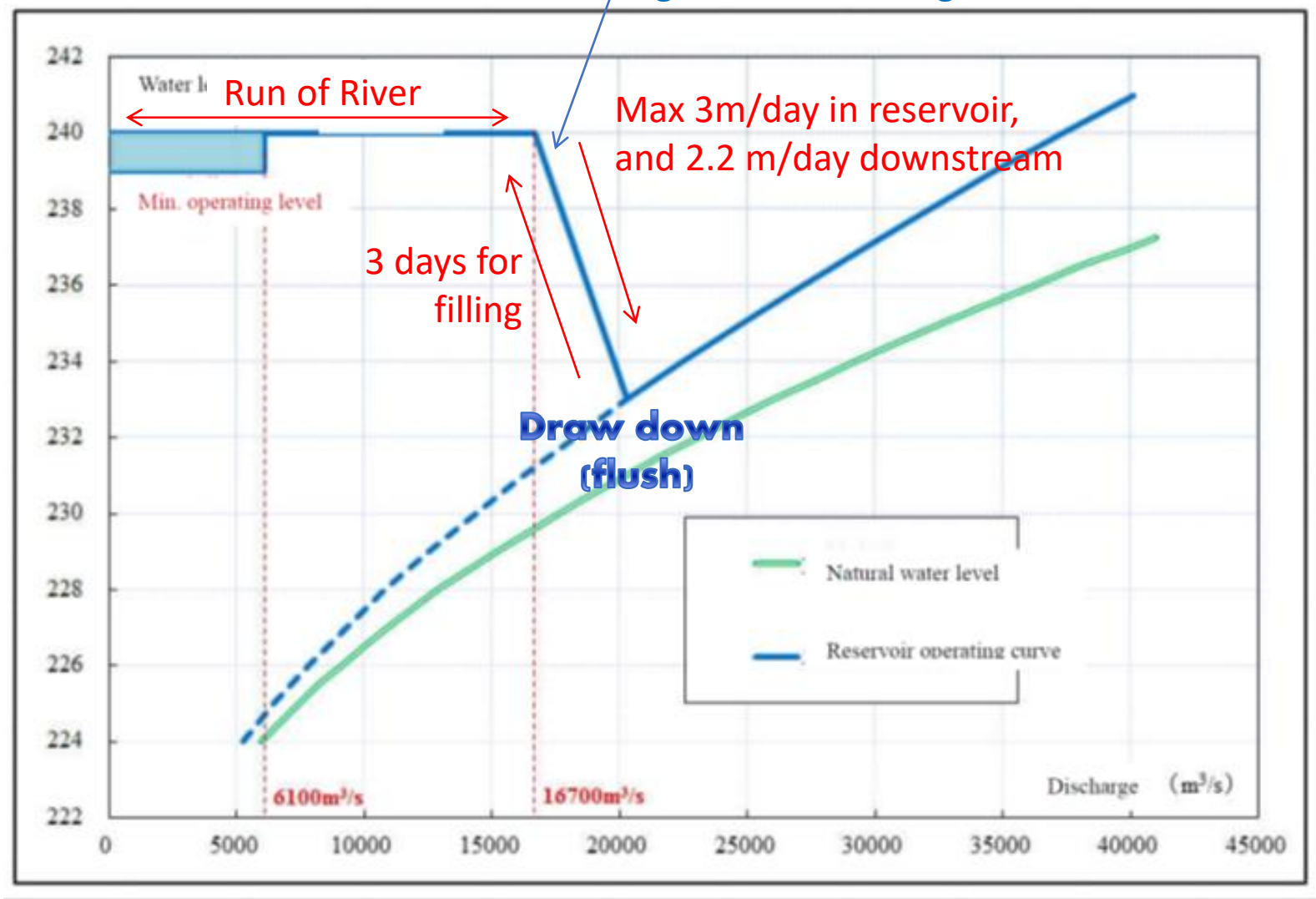
Return (yr)	10000	5000	2000	1000	500	200	100	50	20	10	5
P(%)	0.01	0.02	0.05	0.1	0.2	0.5	1	2	5	10	20
DEVELOPER'S ESTIMATES FOR PAK LAY											
Q_FS	38100	36600	34500	32900	31300	29100	27300	25600	23100	21000	18800
Q_Final	38800	37000	34700	33000	31200	29000	27200	25500	23000	21100	19000
ESTIMATES FOR THE XAYABURI HPP											
Xayab (CNR)	38500	36700	34200	32800		28300	26500	24500	21800	19800	17700
Xayab (AIT)	45007	46621		37083	34697		29146	26744	24076	22033	18480

PMF 47,500 m^3/s

II. Main Review Findings: reservoir operating rule

- Start emptying and filling at 16700 m^3/s
- During high floods, draw down for sluicing and 'open channel'
- Most of time operation is "Run of River", and includes hydropeaking operation at low flows
- However, joint operation, transboundary impact of operations during flood, and environmental flow are not elaborated

Return period (=2 years) (may change due to future developments)
Draw down should be aligned with flushing in the cascade



II. Main Review Findings: risks and concerns / tools

➢ Main risks and concerns are:

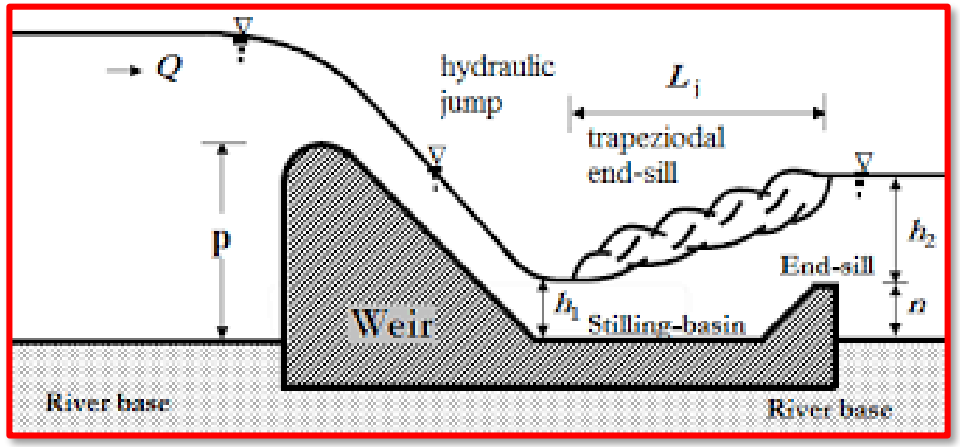
- the downstream impacts of the peaking operations, causing daily fluctuations of flows and water levels: impacts and mitigation need to be addressed in more detail
- The reduction of flow velocities in the impoundment during low flows: impacts to ecology and sediment load need to be considered properly

➢ Modelling tools used to calculate the risks are:

- 1D model (SUSBED-2) between Xayaburi and Pak Lay HPPs. Hydraulic calibration and verification need further attention.
- 2D model for flows close to the dam (about 4 km long). Hydraulic calibration of model and validation of the software need further attention.
- Laboratory physical model 1:100 scale for flows close to the infrastructure. Details on scaling and comparison to computational models should be presented

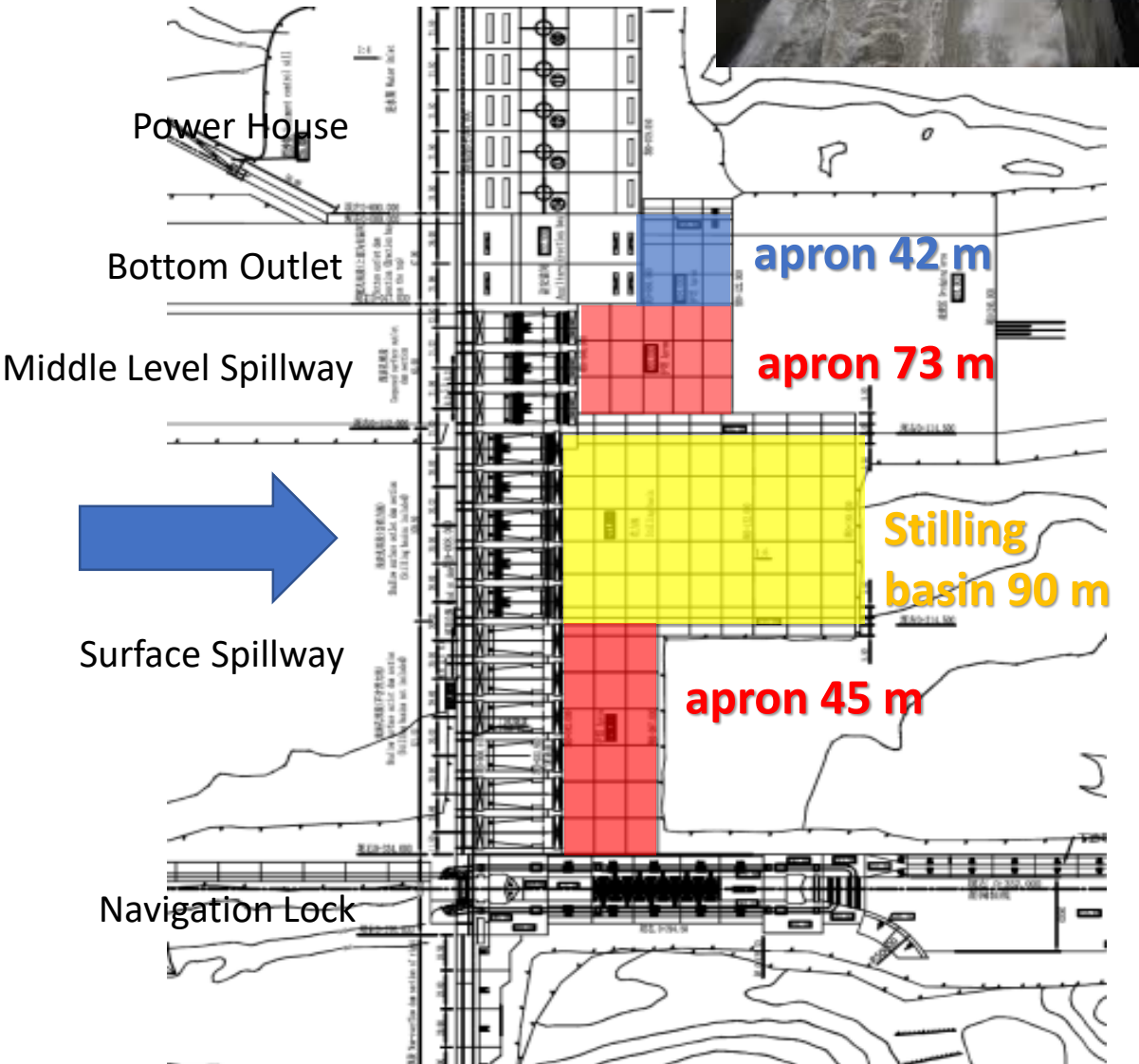
II. Main Review Findings: impacts related to structure

- The stilling basin and aprons downstream of the spillways are needed to protect the toe of the structure against erosion and damage by the turbulent outflows.
- More details of calculations and model tests must be presented to comprehend the chosen lengths.



Graph: length *L* ranges from 88 to 132 m

The hydraulic jump determines the length of the stilling basin



II. Main Review Findings: monitoring

➢Proposed monitoring by the developer:

- Environmental monitoring at dam site
- Independent distributed automatic monitoring system at dam site (most structure related)
- Hydrological telemetry and forecast system: scheme 1 with 12 telemetry stations is preferred by the developer

➢Recommended (by MRCS):

- Follow MRC and WMO guidelines (HYCOS system) for technical details of the stations and system, for easy integration into the country (expertise) and connection with existing systems
- More attention for QA/QC process in monitoring program
- Include additional monitoring station about 10 to 20 km downstream of the dam site

II. Main Review Findings: transboundary impacts

- Thailand border is 100 km downstream (which is close)
- In the submitted documents the long-term Pak Lay impacts are not separated from the impacts of all the other developments (such as seasonal patterns due to Lancang operation)
- In section 4.2.1 of the TBESIA the figures on transboundary hydrological impacts refer to Pak Beng
- TBESIA should quantify propagation and damping of water-level fluctuations related to operations of Pak Lay (such as hydropeaking and flood operations)
- Consider maintaining minimal flows during filling operations (e.g. during filling period of hydropeaking cycle)

OSM

II. Main Review Findings: alignment with the PDG

- The PDG 2009 indicates the need for a comprehensive environmental flow assessment (EFA) to consider the water releases for maintaining freshwater ecosystems and wetlands and their benefits. This has not been carried out yet.
- The TRR Hydrology provides an overview of all clauses in the PDG 2009 (for all topics) that have a link to hydrology:
  - Several clauses require more detailed clarification and analysis
  - Special care should be taken to mitigate the flow fluctuations due to operations/peaking
- Compliance to the draft DG 2018: some remaining issues have been reported in the TRR

OSM

III. Recommendations

- Data and information should be improved and shared.
- Methods for assessment of the hydrology and hydraulics should be revisited and updated. Details of the approaches should be shared.
- Downstream impacts on flows should be properly addressed. Clarity on the water level fluctuations in the impoundment and downstream is needed.
- Operational rules have been largely based on the pre-Lancang Dams flow scenarios and with a rudimentary examination of the Lao tributary inflows and without considering operation of upstream dams (including Xayaburi HPP).
- Design flow discharge at Pak Lay needs further verification, and should be consistent with the design conditions used for Xayaburi HPP and should include future hydrology.
- Further attention required with respect to joint cascade operations.
- Economics of operations that further reduce the environmental impacts by drawing down the impoundment more often could be investigated.

Comments from Public on Hydrology & Hydraulics and our consideration

COMMENTS/SUGGESTIONS	Consideration in the draft TRR
Consider methodologies on hydraulic, hydrology and sediments assessments (tools, hydra	• TRR shows where information is insufficient to evaluate the used methods, and recommends alternatives motivated by international practice or Mekong-experience. • TRR recommends a clear description and evaluation of the methods, and reporting of the final results. • The developer notes that the most practical approaches were used at the feasibility level, and that new data are being collated.
Lao Government ppt indicates 240 m asl as operating water level; what is the backwater effect under normal flow conditions?	The TRR confirms that the results of backwater simulations have been documented. However, the TRR also notices some issues regarding the used 1D modelling approach. The TRR does not consider the backwater impacts to be transboundary.

Thank you