Mekong River Commission

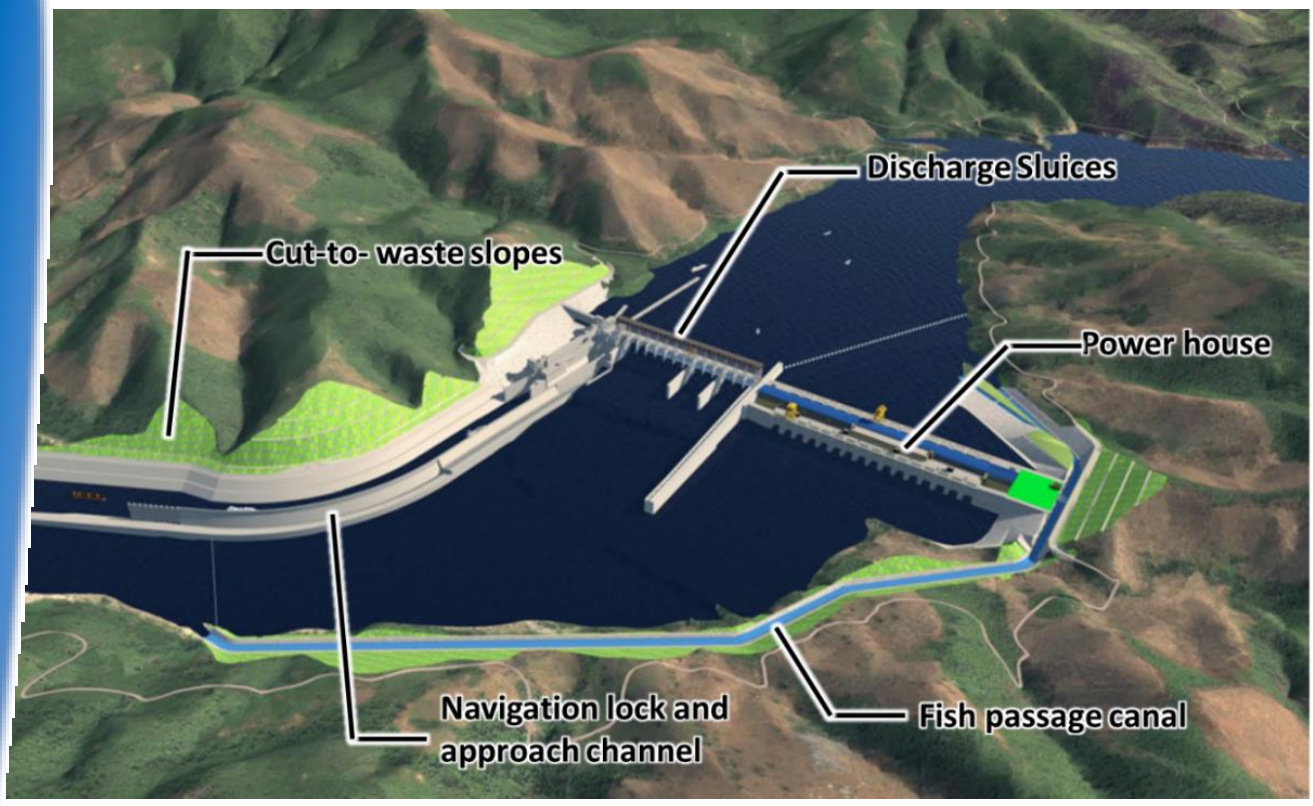
PRIOR CONSULTATION PROCESS FOR THE PAK BENG HYDROPOWER PROJECT

SUMMARY OF THE 2nd DRAFT TECHNICAL REVIEW REPORT

to support

STAKEHOLDER ENGAGEMENT

21 April 2017



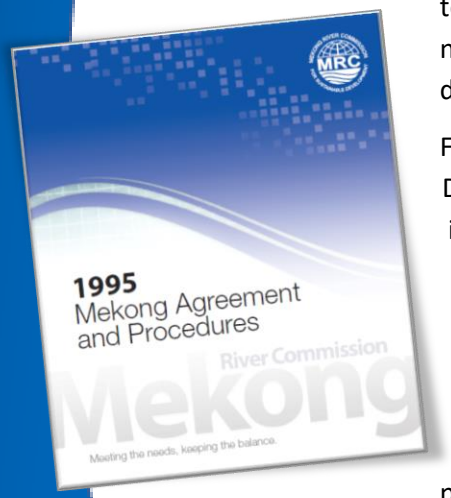
ACRONYMS AND GLOSSARY

Acronyms

HPP	*Hydropower project*
JC	*Joint Committee*
JCWG	*Joint Committee Working Group – established to guide the technical review process*
LBHPP	*Luang Prabang Hydropower Project*
LNMC	*Lao National Mekong Committee*
MC	*Member Country, one of the four parties to the 1995 Mekong Agreement; viz Cambodia, Lao PDR, Thailand, and Viet Nam*
MRC	*Mekong River Commission – established by the MC to support their efforts towards collaboration*
MRCS	*Mekong River Commission Secretariat*
PBHPP	*Pak Beg Hydropower Project*
PC	*Prior Consultation*
PDG	*Preliminary Design Guidance*
PNPCA	*Procedures for Notification Prior Consultation and Agreement*
PPA	*Power Purchase Agreement*
TRR	*Technical Review Report*
XHPP	*Xayaburi Hydropower Project*

INTRODUCTION

Background



On 4 November 2016, the MRC Secretariat received notice of the Lao PDR's intention to submit the Pak Beng Hydropower Project (PBHPP) for prior consultation (PC). The notice submitted included a letter, the necessary completed forms, and supporting documentation outlining the proposed project.

From the outset, it was clear that the expectation from the Member Countries, Development Partners and stakeholders is that the PC process for the PBHPP should improve the PC process by learning from the Xayaburi and Don Sahong processes. Two key issues have been identified in this respect; to enhance external stakeholders' understanding and engagement of the process; and to improve the transparency of the process.

This summary of the draft Technical Review Report (TRR) responds to these needs both by presenting the basis for PC in the 1995 Mekong Agreement, and by presenting the preliminary results of the technical review for the public. After consulting with stakeholders, and considering their view, the full TRR will be revised and made available on the MRC website, once the final report is endorsed by the Joint Committee.

The 1995 Mekong Agreement

To better understand the PC process, it is first necessary to understand how PC is underpinned by the provisions of the 1995 Mekong Agreement,

On 5 April 1995, the Governments of Cambodia, Lao PDR, Thailand, and Viet Nam signed an Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin; the 1995 Mekong Agreement. This re-affirmed the Member Countries' desire to develop, *inter alia*, hydro-power in the Mekong River Basin in a sustainable and cooperative manner. The Agreement promotes cooperation in a constructive and mutually beneficial manner. However, recognising that development could result in adverse impacts, the Member Countries have agreed to a framework of principles and objectives to guide the Member Country's use of the Mekong River System.

Through this framework, the Member Countries have agreed to, (*inter alia)*;

- Protect the ecological balance of the Mekong River Basin;
- The reasonable and equitable use of the waters of the Mekong River System, pursuant to all relevant factors and circumstances, and the Rules of Water Utilisation and Inter-Basin Diversion;
- Discuss and aim to agree (in the Joint Committee) on significant water uses on the mainstream in the dry season (Prior Consultation);
- Maintain flows in the Mekong mainstream;
- Make every effort to avoid, minimise and mitigate harmful effects on the river system;

> The Prior Consultation process is governed by the 1995 Mekong Agreement, and the MRC Procedures.

- Take responsibility where harmful effects result in substantial damage to the other Member Countries;
- Maintain the freedom of navigation on the mainstream; and
- Warn other Member Countries of water quality and quantity emergencies.

The Agreement provides for the achievement of these objectives and principles through the unique spirit of cooperation that has inspired cooperation between the Countries since 1957, and which has been reaffirmed on many subsequent occasions, including at the outset of this current PC process. Importantly, these principles and objectives reflect the commitments made by the Member Countries.

The Member Countries have also, through the 1995 Mekong Agreement, established the Mekong River Commission (MRC), and its sub-structures as a *separate* international body. They also confer certain powers and functions on the MRC's structures. With respect to the PC process;

> The MRC Member Countries established the Commission and its organs, and conferred powers and functions to these bodies in the 1995 Mekong Agreement.
>
> The MRC can ***only*** function within these given mandates.

- ***The Council*** is empowered to establish the 'Rules for Water Utilization and Inter-Basin Diversions' (now the five Procedures). The Council agreed the Procedures for Notification, Prior Consultation and Agreement (PNPCA) in 2003.
- ***The Joint Committee (JC)*** is empowered by the Procedures for Notification, Prior Consultation and Agreement to undertake the PC process, and has established Technical Guidelines to support this process.
- ***The Secretariat (MRCS)*** provides technical and administrative support to the PC process.

The MRC can only work within the framework and powers conferred by the 1995 Mekong Agreement and Procedures. The Agreement also indicates that PC is neither a veto right, nor a unilateral right to proceed without taking the other Member Countries concerns into account. The Procedures are not a regulatory mechanism, but rather establish a basis for cooperation for information sharing, discussion and negotiation, and to work together in avoiding, minimising and mitigating potential risks and transboundary impacts.

The PNPCA and PC process

The PNPCA derive from Article 5 of the 1995 Mekong Agreement where the Parties agree to the reasonable and equitable use of the Mekong River system. The PNPCA specify three distinct forms of inter-State communication; i) Prior Notification, ii) Prior Consultation and iii) specific Agreement. Notification is applicable to water use on the tributaries of the Mekong mainstream, and for 'wet season' use on the mainstream. PC is required for water use on the mainstream in the 'dry season', and for inter-basin diversions in the 'wet season'. Specific agreement is required for inter-basin diversions in the dry season. The PBHPP represents a year-round use of the Mekong mainstream, and is therefore subject to PC.

These increasing levels of interaction reflect a balance between the likelihood of adverse transboundary impacts, and the principle of sovereignty. Specifically, the PNPCA is based on the following principles;

a. Sovereign equality and territorial integrity;
b. Equitable and reasonable utilisation;
c. Respect for rights and legitimate interests; and
d. Good faith and transparency.

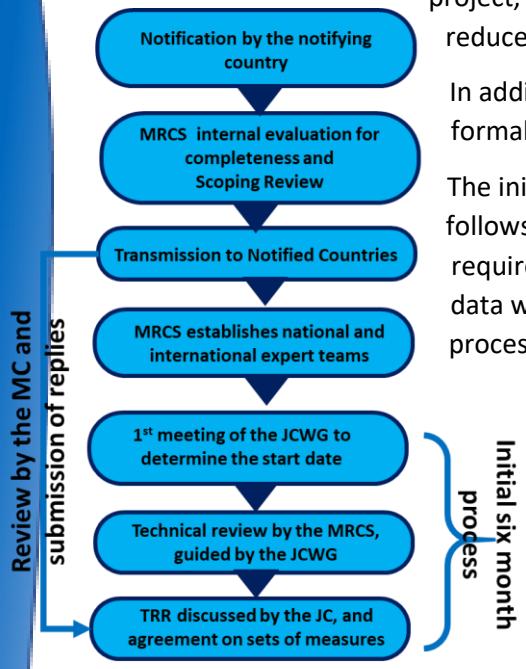
> The outcome of the PC process is advice, unanimously agreed by the JC, on a set of measures to guide the ongoing development and operation of the proposed use.

The experiences in the first two PC processes have highlighted that while the process must consider the whole of the 1995 Mekong Agreement, its primary focus is on Article 7, and what additional efforts can be made to avoid minimise and mitigate any potential impacts, particularly where they may be transboundary in nature.

More information on the PNPCA is available in the MRC's Brochure on Procedural Rules for Water Diplomacy[1].

Because PC is neither a veto right, nor a right to unilaterally proceed without taking the concerns of the notified Countries into account, it need not end with a 'yes' or 'no' decision. Rather a statement calling on the notifying Country to consider a set of measures in the ongoing development of the proposed project can be unanimously agreed by the JC. While this statement did not emerge from the previous two PC processes, it is hoped that the PC process for the PBHPP will end in such a statement from the JC, as well as a Joint Action Plan that provides for ongoing engagement of the MRC and stakeholders in the development of the PBHPP.

Importantly, agreement on a set of measures does not imply tacit approval of the project, but rather agreement that additional steps could be taken to further reduce the risk of transboundary impacts.



In addition to this MRC driven process, the notified Countries will submit formal replies to the proposed use, which are also placed on record.

The initial PC process and technical review takes place over six months, and follows the steps as outlined here. This is a very tight timeframe, which requires the submission of documents that provide all relevant and available data with the initial notification. The details and timing of the PBHPP PC process are presented in the following section.

[1] Available at: http://www.mrcmekong.org/assets/Publications/PNPCA-brochure-11th-design-final.pdf

Certain key principles are important to engaging the PC process

Key principles to keep in mind

Stakeholders need to bear the following in mind regarding the PC process;

- In the Mekong Agreement, the Member Countries have committed to the *reasonable and equitable* use of the Mekong River System. However, the determination of whether any proposed use is *reasonable and equitable* is nuanced, and is beyond the scope of a technical review process.
- The MC have committed to making *every effort to avoid, minimise and mitigate possible harmful effects* on the Mekong River System, even if they are not transboundary in nature.
- The Joint Committee's deliberations are primarily focused on potential transboundary impacts, and the development of a set of measures to avoid, minimise or mitigate these impacts.
- In the PBHPP case, documentation at a feasibility level has been put forward to support the prior consultation process. Any measures the JC may wish to propose for the ongoing development of the project can refer to either the Final Design, Construction or Operational phases should the project proceed.

The main purpose of the TRR and the PC process is, therefore, to highlight what *additional and reasonable* efforts can be made to avoid, minimise and mitigate any harmful effects. It also attempts to evaluate the extent of any residual harmful effects, particularly those of a transboundary nature.

THE PBHPP PC PROCESS

Start and end of the PC process

> The PC process takes place over an initial 6-month period. This may be extended by agreement in the JC.

The MRCS received the notification of the PBHPP from Lao PDR on 4 November 2016. This included the cover letter, the completed forms for PC, and 23 technical documents prepared by the Datang (Lao) Pak Beng Hydropower Co. Ltd. (the developer) outlining the studies they had conducted during the feasibility stage of the PBHPP. The Secretariat checked these documents for completeness, and prepared a Scoping Assessment Report outlining an initial rapid review of the documents provided. The documents provided by the LNMC were sent to the Governments of Cambodia, Thailand and Viet Nam on 6 December 2016, and the Scoping Assessment Report followed on 16 December 2016.

It was decided that the official start date of the six-month PC process would be 20 December 2016. The special session of the JC to discuss the findings of the technical review will therefore be on 19 June 2017.

The PBHPP was notified at the feasibility stage

Large infrastructure projects go through several phases;

This allows the developer to incrementally assess the viability of the proposed project before committing additional resources into it, and allows them to identify specific design requirements before finalising the design. The PBHPP has completed the feasibility stage, and the final design processes have started. Discussions with the developer and the Government of Lao PDR have indicated that the design progress is ongoing. This means that the technical review process aims at a moving target.

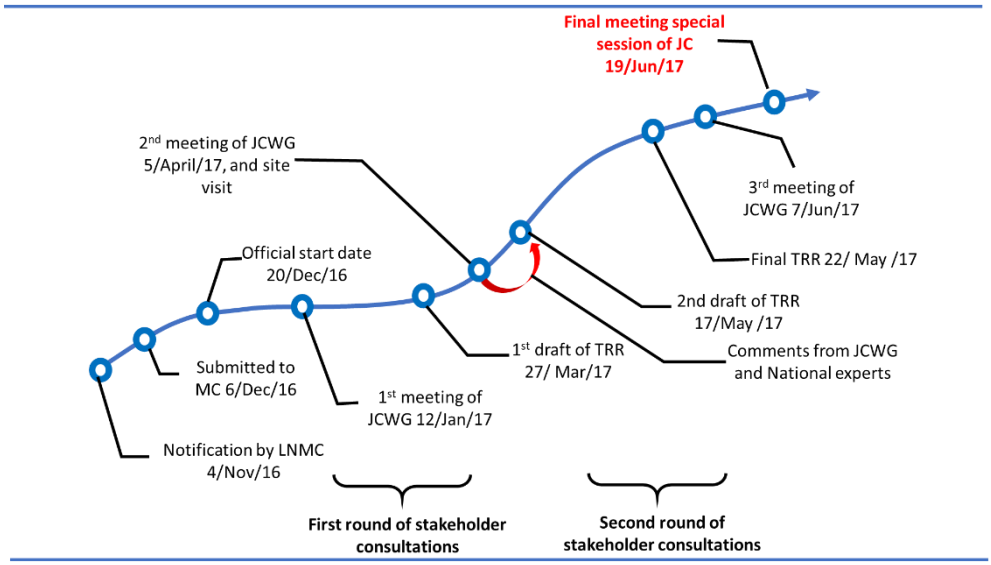
There are both advantages and disadvantages to this. Because PC takes place before the final design is completed it can directly influence the final design and operational plan. In addition, the Lao PDR and the developer can make an earlier decision on the viability of the project based on the inputs from the MRC. However, there may be insufficient information available to undertake a full and final technical review, and an unnecessarily negative impression of the proposed project may arise by identifying issues that are already being addressed.

This is the case with the PBHPP. During the development of the TRR, the MRCS has been informed of several ongoing processes that are already addressing many of the issues raised. However, the due process of the PC process requires that the technical review must be based on the materials formally provided, and it is on this basis that this review is being conducted. Nonetheless, to provide a balanced picture, where the MRCS has been made aware of further work, this has been noted in the review. However, because the details of this additional work have not been provided yet, it has not been technically reviewed in the TRR.

The PBHPP PC process

The PC process for the PBHPP is illustrated in the timeline below. The official start date of the PC process was determined to be on 20 December 2017 at the first meeting of the JCWG on 12 January 2017. At this meeting, the JCWG highlighted the key issues they wanted the technical review to address. They also endorsed the composition of the various expert teams.

This initial meeting was followed by the first regional stakeholder engagement forum on 22 February 2017 in Luang Prabang, where the PC process was described, early views sought and the expected end-point was outlined. The forum attracted more than 180 participants representing the MRC member countries, development partners, regional NGOs and civil society, as well as research institutions, academics,



private developers and media.

The outcomes of this regional consultation are not discussed in depth here, as a full report is available at: http://www.mrcmekong.org/assets/Publications/Forum-report-for-website.pdf. However, responses from stakeholders at the meeting on the engagement process waswere positive, and the increased transparency of the process was lauded. Feedback from this meeting was built into the first draft of the TRR, ensuring that the concerns raised by stakeholders were considered in the review process. Some questions regarding the PNPCA process and information about the project itself were responded to at the Forum. mandates, and end-points of PC. The regional stakeholder session ran in parallel with national stakeholder sessions in the notified Countries, which focused on national stakeholders.

Work on the first draft of the TRR started in February, and the 1st draft was submitted to the JCWG on 27 March 2017. This 1st draft was discussed at the 2nd meeting of the JCWG, and feedback from this meeting together with comments received from national experts was used to prepare a 2nd draft of the TRR. That draft formed the basis for this Summary of the TRR.

The 2nd draft TRR will form the basis for the second round of stakeholder workshops, and the outcomes of those workshops, and comments from the JCWG will be used to prepare the final draft of the TRR. That final draft, after endorsement by the JCWG will, together with the reply forms from the MC, form the basis for discussions in the special session of the JC on 19 June 2017.

The commitment to stakeholders

Part of the MRC and MC's commitment to continually improving the PC process is to improve the transparency of the process, and to enhance stakeholders' understanding of PC process and the mandates provided by the 1995 Mekong Agreement and PNPCA and to engage them in a constructive manner. This was identified as a key lesson learnt from the first two PC processes, and was flagged by questions posed by stakeholders in the first regional consultation process. Broader stakeholder engagement is also seen as one of the priorities in the MRC Strategic Plan for 2016-2020.

Two main groups of stakeholders are recognised;

- **Internal stakeholders:** This includes the structures of the MRC, the Council, the Joint Committee and the Secretariat, as well as other government agencies in the Member Countries;
- **External stakeholders:** This includes non-MRC member countries such as development partners, dialogue partners (China and Myanmar), and non-state actors such as NGOs, civil society organizations, research institutions, academics, individuals and other interested groups.

> More frequent and transparent engagement with stakeholders was identified as key to improving the outcomes of the PC process.

Stakeholder engagement takes place at national and regional levels. National level engagements are conducted by the National Mekong Committees in each notified Member Country, and are used to inform that Member Country's position in the Joint Committee discussions. The regional consultations are managed by the MRC Secretariat.

In addition to this summary, other documents available on the MRC website also increase the transparency of the process;

- A PBHPP Fact sheet, and an overview of the documents submitted by the LNMC are available at;

http://www.mrcmekong.org/assets/Consultations/PakBengBengHydropowerProject/Overview-of-Key-Features-of-Submitted-Documents-26-Jan-2016.pdf

- Stakeholders can submit their comments at;

http://www.mrcmekong.org/stakeholder-consultations

- The results of the first regional stakeholder forum are available at;

http://www.mrcmekong.org/assets/Publications/Forum-report-for-website.pdf

This commitment to greater transparency will continue with the upcoming national and regional stakeholder workshops. Feedback from these workshops will be made available on the MRC website, and will be considered in the final TRR.

THE PBHPP AT A GLANCE

> The PBHPP will be the uppermost of the cascade of dams on the mainstream in the LMB. This has proven to be important to this review process.

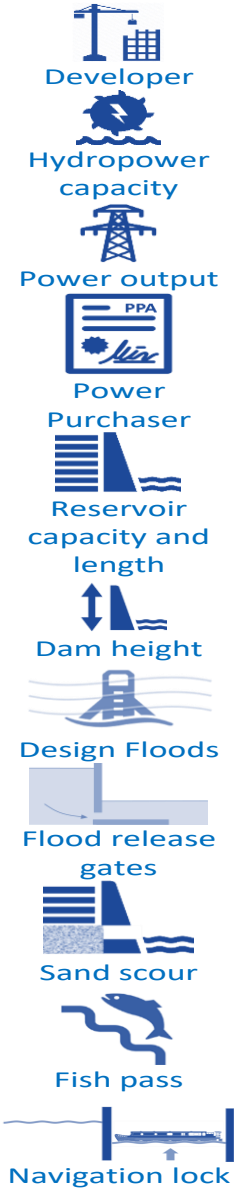
Location

The PBHPP dam site is in the Pak Beng District, Oudomxay Province, northern Lao PDR, about 530km downstream from Jinghong Hydropower dam, in China. It lies 180km downstream of Chiang Saen (the first hydrological station on the Lower Mekong River). Pak Beng will be the upper most dam in a planned cascade of hydropower projects on the mainstream of the Lower Mekong River.

It is located at 298m above the mean sea level (masl) and is 2,188 km from the sea, 174 km upstream of Luang Prabang, and 258 km upstream of the Xayaburi Hydropower Project. A possible future Luang Prabang HPP will lie between Xayaburi and Pak Beng. This placement of the 3 HPPs is important to the potential impacts of the PBHPP.

The PBHPP at a glance

The following diagram presents the key features of the proposed PBHPP.



Datang (Lao) Pak Beng Hydropower Co., Ltd

16 bulb turbines of 57 megawatts (MW) each, totalling an installe capacity of 912 MW. This makes it one of the larger HPP planned the Lower Mekong River. Design discharge of 5,771 m^3/s.

Annual average energy production = 4,765 GWh; 2,947 GWh in th wet season and 1,818 GWh in the dry season.

- 90% exported to Thailand
- 10% used in Lao PDR

559 million m^3 at a maximum water level of 340 masl, and 97km long

Maximum height of about 64m, and a crest length of 896.70m

Designed for a 500-year return period flood (26,800 m^3/s, and to safely pass a 2,000-year return period (i.e. 30,200 m^3/s) flood.

14 undershot sluices of 15 m wide × 23 m high.

8 sand outlets between the turbines - 2.5 m wide × 5 m high, and through the flood release gates

A 1.6 km long channel, with a bottom width of 10 m. and a 17.2 m top width, and a longitudinal slope of about 1.85%.

A one-way, one-step ship lock capable of conveying 500-ton ships 120 m long × 12 m wide × 4 m deep. Space has been reserved for second ship lock.

A Run-of-River project

> The PBHPP will be operated as a run-of-river project with inflows close to outflows for most of the time.

The PBHPP will be operated, as a run-of-river hydropower project, with inflows roughly equivalent to outflows. There are no plans to provide peaking power, which results in rapid and damaging changes in water levels in and downstream of the reservoir. However, the water level in the reservoir will be varied between 335 masl, and 340 masl, to prevent flooding into Thailand in the upper reaches of the reservoir, and to keep the inundation at the Keng Pha Dai reefs at the Thai border close to what would have occurred without the PBHPP. The change in water level between these operating limits will be limited to less than 1m / day.

Operating rules

The operating rules for the PBHPP have been designed to optimise hydropower output and navigation. The dam will be operated as follows;

- At the start of the wet season, when inflows first exceed 2,200 m^3/s, the reservoir level will be gradually raised (over 5 days) from 335 masl to 340 masl. This means that some water will be stored from the first floods of the year, to raise the level of the reservoir;
- When inflows exceed 5,771 m^3/s, all the turbines will be operational, and excess water will be spilled through the flood gates and through the sand sluicing gates.
- When inflows exceed 10,000 m^3/s, the reservoir level will be gradually lowered from 340 masl to 334 masl (dead water level), until inflows are at 12,900 m^3/s. This aims to prevent additional flooding upstream in Thailand. This is achieved by controlling the main flood gates.
- The hydropower units are switched off when power head becomes less than 7.5 m. The level 334 masl is the minimum level for operation of the navigation structures.
- Above 12,900 m^3/s navigation is stopped, and the sediment flushing sluice to the approach channel is opened.
- If the discharge exceeds 14,600 m^3/s, the spillway gates are fully opened and flows are as close as possible to the natural situation. All power units remain offline.
- During the dry season the reservoir water level will be maintained at 335 masl.
- For discharges below 5,771 m^3/s all the inflow passes through the turbines. At low flow, only a limited number of turbines are operated, and spillways and sand outlets are closed.

Operational rules can also play a role in minimising any potential impacts of the PBHPP.

TECHNICAL REVIEW

Background

The MRCS undertook the technical review of the proposed dam, with the support of international experts. Six teams were established to deal with the detailed assessments required for the review. These teams have produced detailed assessments, which are attached as Annexes to the main TRR, while the main body of the TRR summarises the main findings, particularly with respect to the requirements of the PC process. The key reference document for the review is the MRC Preliminary Design Guidance (PDG). This section further summarises the main findings for the public.

The primary focus of PC is to identify measures that can avoid, minimise and mitigate potential impacts. For the purposes of the TRR;

- *Avoid* means the measure, if implemented, would ensure that any harmful effects will be negligible;
- *Minimise* means the measure, if implemented, would reduce harmful effects, or the risk of harmful effects, considerably; and
- *Mitigate* means the measure, if implemented, would reduce the impact of any residual harmful effects on other users of the Mekong River System.

The following sections summarise the outcomes of the expert teams' reviews. Stakeholders wishing to gain further insights and details may refer to the final TRR.

Hydrology and Hydraulics

The use of good hydrological data is critical to the way the PBHPP is designed and operated, and may allow the developer to consider the recommendations made by the review teams to improve fish passage and sediment flushing without compromising the agreed power supply.

The main concern related to the hydrology is the increased water levels due to backwater effects of the reservoir into Thailand. The PBHPP operational rules are designed to reduce the impact of the PBHPP on the Keng Pha Dai reefs at the Thai border, but other studies being carried out by the MRC have indicated that impacts may not be mitigated, and additional modelling is recommended.

The developer has used the MRC hydrological data from the Chiang Saen and Luang Prabang stations for the period 1960 – 2007, and has used a basin-scaling method to determine flows at the dam site. For the period 2008-2014, the developer used data from direct measurements at the dam site. However, the reviewers noted that the methodologies used could be improved. Importantly, the historical record may not adequately reflect the future hydrology due to influence of dams in China. In particular, the higher flows required for flushing sediment may occur less frequently, while base flows in the dry season may be higher. Similarly, the dams in China are likely to affect the flood peak determinations for dam design.

The water levels immediately downstream of the PBHPP are largely dependent on whether the Luang Prabang HPP will be developed. The development of the LPHPP may reduce the hydropower potential at Pak Beng. This could limit the operational flexibility. It is not clear whether the developer has considered this in the planning.

The PBHPP will be operated as a run-of-the-river scheme with minimal active storage. However, some of the early wet season floods will be used to refill the reservoir, and water levels will range from 340 m to 335 m at different inflows to address inundation of the Keng Pha Dai reef, and to draw down the reservoir level for sediment flushing. These operations are expected to have temporary impacts on the hydrology of the river both immediately up- and downstream of the dam. However, the developer proposes a maximum water level change in the reservoir of 1 m/day, which will limit these immediate impacts. Nonetheless, a public information network should be installed to advise river users of expected fluctuations in water levels.

The storage in the PBHPP is not large enough to make a substantial impact on the seasonal hydrology of the LMB, or to provide possible drought relief further downstream.

The review team has also raised concerns regarding the hydraulics, noting the potential for reduced hydropower output due to the sequential operation of the turbines, and possible eddies forming at the entrance to the navigation lock.

The developer has not undertaken an environmental flow assessment. However, minimum flow requirements are unlikely to be compromised due to the operation of the dams in China.

Sediment transport and river morphology

Sediment transport and geomorphic processes influence the distribution and quality of aquatic habitats, and is necessary for maintaining bank stability. The coarse sediment transported by rivers is extracted for construction and development activities, whilst the fine sediment is necessary for the transport of nutrients onto the flood plain and delta areas and the maintenance of estuarine and coastal ecosystems.

The developer has included several options to minimise sediment deposition near the power house infrastructure. However, these measures are primarily aimed at protection of the infrastructure rather than passing fine and coarse sediment through the impoundment. However, as the project is at a feasibility level, the design and operating rules may change. The review focussed on providing advice in this regard.

The sediment management infrastructure and strategies at Pak Beng are based on modelling using the annual sediment budget, the seasonal patterns of sediment delivery and the sediment characteristics at the site. However, as with the hydrology, much of the data stems from before the operation of the dams in China, and the assessment relies on limited monitoring and rudimentary methodologies.

The model results suggest that ~20% of the sediment will be captured in the reservoir over the first decade of operations, reducing to ~8% after 100 years of operation. Similarly, the results suggest that there will be limited deposition of sediment on the Keng Pha Dai reef. However, the grain sizes used for modelling do not align with the data available at the MRC. This may result in an underestimation of deposition in the reservoir.

> The feasibility level design of the PBHPP is unlikely to be able to transport much sediment downstream. However, this could be improved in the final design.

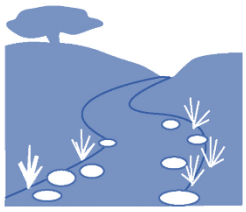
Sediment deposition near the dam was assessed with both numerical and physical models. These suggest that 80% of the suspended sediment would pass through the turbines and sand gates, or will be trapped behind the sill of the flood section of the project.

Sediment flushing is likely to have a limited effect due to the high sill level at the sluice gates, and the low-level sand outlets between the turbines will only remove sediment that accumulates in front of the power house inlets. The developer has indicated that sediment flushing will not be conducted during the peak fish spawning periods, the gates shall be gradually opened to minimise impacts, and a maximum sediment concentration limit will be identified prior to operations.

Downstream transboundary impacts were modelled and the results suggest that the PBHPP will decrease suspended sediment in the river by 22% at Luang Prabang, with impacts decreasing with distance downstream. The developer, therefore, concludes that the dam would likely result in transboundary sediment, morphology and nutrient impacts, and the consequent environmental impacts. The developer has not provided a geomorphic baseline for the project area, to assess any changes due to the operation of the PBHPP.

Of the 21 general criteria in the MRC's PDG, the PBHPP partially or fully aligns with 17. However, the criteria that relate to the larger catchment or cascade setting, such as downstream geomorphic changes, are inadequately considered. Guidelines for the construction and operation of large low level sluicing gates, and for the formal engineering review of the project are not adequately addressed.

Water Quality and Aquatic Ecology



The water quality risks associated with hydropower development include changes to physical and chemical water quality parameters in the impounded section and changes to habitats in the reservoir and downstream ecosystems. While some water quality changes may occur in the PBHPP, these will not be as substantial as in HPPs with large and deep reservoirs, due to the short water residence times in the impounded section of the river. These impacts will also be minimised due to the removal of some of the vegetation in the impounded area. However, habitats in and downstream of the reservoir will be affected.

> While some water quality changes may occur due to the PBHPP, these will not be as substantial as in HPP with large deep reservoirs.

The developer has not reviewed the extensive data and reports available from the MRC, and the data used are outdated. Very little baseline data on aquatic habitats, biota and water quality are provided. The assessment of the impact of PBHPP on water quality and aquatic ecology, once operational, will therefore be difficult. Similarly, the developer has not assessed the likely impacts on aquatic habitats, and aquatic biota.

> The developer has undertaken a very limited sampling programme, and the proposed ongoing monitoring programmes need to be expanded in scope.

The water quality and biota monitoring programmes need to be expanded in scope, including more sites, samples taken monthly over the wet and dry seasons, and additional relevant parameters need to be included. While a budget for this monitoring has been provided, the details of how the budget was derived are not provided. Similarly, no details are provided on whether the monitoring programmes will be tailored to address potential problems.

There is a potential for pollution during construction, and increased pollution from a higher population in Pak Beng village during operations. The developer has outlined a range of measures to address these potential water quality problems. These measures appear to be acceptable.

The developer has undertaken a very limited sampling programme for phyto- and zooplankton, and bottom living invertebrates. This is not consistent with international best practices or the methodologies employed by the MRC. The reported results showing a poor diversity of zooplankton and benthic macroinvertebrates and therefore questionable.

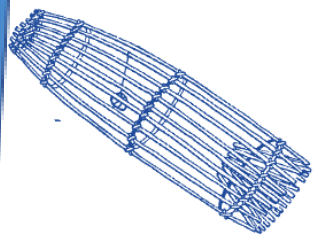
> The change from a flowing river, to a lake environment in the reservoir will result in the loss of important habitats.

Aquatic habitats will change from a lentic (flowing water) to a lotic (impounded water) in the impounded section upstream of the dam. Some of the important flowing water habitat in the upper reaches of the LMB will therefore be lost. Similarly, the habitats immediately downstream of the dam site will be affected by 'sediment hungry' outflows, which will scour sediments. Releases of water to flush the accumulated sediments may also deposit new sediments immediately downstream of the dam, smothering habitats and causing the loss of aquatic invertebrate fauna which acts as food for fishes. In addition, fish are vulnerable to the smothering of eggs and spawning habitat. This together with the loss of the flowing water habitat may impact on the local fisheries.

Notably, the entire upper Mekong Basin would be considered as a 'critical habitat' under the World Bank's - IFC Performance Standard 6. There should be no measurable adverse impacts on the biodiversity values, nor a net reduction in the populations of 'Critically Endangered' or 'Endangered' species for projects financed by the World Bank in these areas.

The documents provided show only partial alignment with the PDG with respect to water quality and aquatic ecological aspects.

Fisheries



Dams disrupt the life cycle of migratory fishes, and this impacts on fisheries production upstream, downstream, and in the inundated area or the reservoir. It is possible to minimise these impacts, but the extent to which they are effective depends on integrating the ecological characteristics with hydro-geomorphological characteristics in the design and operation of fish passage facilities. The review team concentrated on the extent to which the PDG has been taken up, and provided advice on improvements to the fishpass design.

Fish and biota monitoring by the developer, while done in both the dry (January 2011) and rainy seasons (July 2011), has been limited to two occasions, and only at six locations in the project area. The sampling methods were limited. As a result, the number of species recorded are much lower than has been found by the MRC.

The EIA and fish migration studies concluded that the impact of the PBHPP would be *"medium to high magnitude, and potential impacts will be negative and moderate level during construction period"*. However, these conclusions are likely to underestimate the potential impact and more detailed studies are required to underpin the EIA. Similarly, the fish monitoring proposals by the developer need to be considerably expanded, so that adequate data can be fed into any optimisation of operational rules.

> There is likely to be a reduction in the total fishery catch in the upper migration zone. This may extend to the wider LMB.

Of concern are those fish species which require flowing water habitats, and long and short distance migrating whitefish species, which make up most of the fisheries catch in the Pak Beng region. It is estimated that some 40,000-60,000 tons/year are caught in the upper migration zone, and it is highly likely this catch will be compromised. A range of amphibians, snails and Crustacea also make up the total catch, but have not been considered as an important source of food for livelihoods. Moreover, the upper reaches of the LMB provide a spawning habitat for several important species, including the Mekong giant catfish which migrates beyond the PBHPP to spawn in Chiang Rai Province – Thailand.

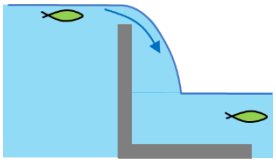
Fish larval drift studies at Xayaburi by MRC Secretariat have shown that large numbers of larvae of several species drift downstream through this reach, and the numbers caught in the dry season suggest that downstream drift in the dry season could be equally as important as the wet season. These larval drift studies have not been investigated or reported by the developer.

Fish passage

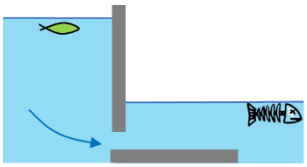
Any fish passage considerations for Pak Beng must be compatible with those at the Xayaburi Hydropower Project (XHPP), as a less effective fish passage at Pak Beng would negate the expected benefits of the additional investments already made at Xayaburi. The feasibility level design available for the review, presents broad fishpass options, but does not rigorously compare the design with functional criteria. The result is that the proposed fishpass design will not function effectively. The review team has, however, been made aware of initiatives to improve the fishpass facilities. The following recommendations are made to support this process;

- Fish will be attracted to the powerhouse and not the downstream entrance of the fishpass. The electric barrier proposed is not effective in large river systems, and should be removed. The entrance of the fish pass needs to be moved to the powerhouse, and a collection gallery included, as was done at Xayaburi.
- The flows through the fish pass should be increased to the international standard of some 10% of river flow (at present less than 1% of the flow will pass through). The fishpass should be lengthened to reduce the gradient to make it easier for the fish to swim upstream.
- Multiple exits for the fishpass should be provided to accommodate the full range of reservoir operating levels.

- Consideration should be given to using the navigation lock as a fishpass, as is done in Xayaburi. This can be important to support fish migration during construction.
- Consideration should be given to operating the reservoir to maintain higher flow velocities at critical times, to reduce the loss of drifting larvae.
- A fish screen should be installed to divert larger fish into the fishpass, and away from the turbines.
- Either overshot sluice gates, or the operation of the undershot gates in a more open state, should be considered. (It is understood that the developer intends following the latter proposal.)



Overshot flood gates



Undershot flood gates

Overall, the feasibility level design and operational rules for the PBHPP falls short of expectation of compliance with the PDG, although there is inadequate information to make a final assessment. However, the review team has been informed that the feasibility level design was primarily intended to demonstrate that a fish passage facility is being considered in the design, and that new designs are being prepared.

> The fish pass design outlined in the feasibility level documents is unlikely to function well. It is understood that that is being addressed as part of the final design.

The mitigation measures proposed to deal with reduced fisheries potential focus on fisheries production in the reservoir by stocking and aquaculture, rather than other compensation mechanisms. These are unlikely to compensate fully for the loss of fishery production, and will not necessarily be equitable, benefiting only those with entrepreneurial skills and access to capital.

Unfortunately, there is no definitive solution to mitigate the lost natural fish production and non-fisheries solutions must be found. Stocking of exotic or invasive fish species in the impoundment would have significant negative impacts on natural fish stocks and aquatic ecosystems at the PBHHP site as well as downstream in the LMB. Moreover, there is an increased risk of losing the rare Mekong Giant Catfish species.

Socio-Economic Impacts

The socio-economic impacts of hydropower development stem not only from the knock-on impacts on the environmental goods and services on which people (even those far from the dam site) depend, but also from the direct impacts of the impounded area and construction activities. The social and economic review therefore focused on the site-specific and transboundary impacts of the PBHPP. Specifically, the review team assessed whether the social, environmental and transboundary information provided by the developer would reliably support the JC in their deliberations, and whether measures to further mitigate any potential impacts on the shared river system can be taken. The review process combined an existing framework for the review of hydropower development, with the outputs from a workshop that identified a comprehensive list of possible primary, secondary and tertiary impacts of hydropower in the Mekong. The review approach was presented to a stakeholder forum, and feedback recorded to further refine the process.

> The socio-economic study was not as rigorous as would be expected from a project of this size.

Generally the information provided by the developer was old, and informally or partially referenced. The potential impacts of upstream inundation and reduced fisheries in Thailand were not adequately covered, and the MRC data was not used to supplement the findings. Importantly, the developers have not undertaken an assessment of a future without the PBHPP, addressing both its positive and negative impacts. However, the developer does postulate that livelihoods and the environment will continue to deteriorate under the No Build scenario, but without providing an evidence base.

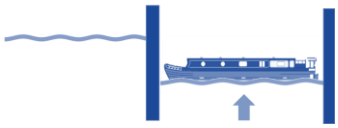
The surveying rationale and sampling regimes to assess impact were not detailed and data and analysis for the villages is informally described and would not meet international standards for a project of this size. There appear to be inconsistencies in the data, with socio-economic variables reported differently in various reports.

The developer draws several conclusions with respect to the socio-economic impacts. However;

- The significance of impacts and how these conclusions have been derived, and the evidence base is not clearly explained.
- The transboundary assessment is preliminary, and is not founded on the potential transboundary physical and environmental impacts associated with a final design and operation.
- The assessment treats transboundary impacts inconsistently. All residual impacts after minimisation are classed as no significant impact.
- Upstream transboundary impacts focus on navigation (tourist, passenger and cargo vessels), and a partial fish survey at Chiang Saen. No Thai villages were surveyed to assess the current and future livelihood consequences of for example reduced fish catch[2].
- The qualitative methods, underlying assumptions and input data are only partially described.
- Impacts are classed according to type, severity and duration. The classification rationale and the process of ranking are not supported or explained with reported evidence.
- No worst-case scenarios have been reported, for example with a potential dam failure.
- The assessment provides a quantitative assessment of sediment losses and erosion. Fish loss is discussed and qualitatively assessed.

Generally, the downstream transboundary impacts of the PBHPP have been poorly described, despite the assertion that a transboundary social and economic assessment was done. Nonetheless, the review team notes that due to the feasibility stage of development, the potential transboundary hydrological, sediment and fisheries impacts of the PBHPP have not yet been fully described.

[2] It is noted that the developer does not have a mandate to engage villages in Thailand. However, the MRC data could be used.



Navigation

> The navigation lock, as presented in the documentation, will likely result in problems if vessels are lifted over 30 m. This will be the case if the LBHPP is not completed, or is operated at a lower level.

Article 9 of the 1995 Mekong Agreement provides for the freedom of navigation, noting that navigation is not assured a priority over other uses, but should be integrated into any mainstream project. The harmful effects to navigation, therefore, mainly pertain to the unnecessary slowing down of shipping due to excessive down time of the lock system for repairs. There may also be dangers posed to shipping due to the design of lock, and crew may also suffer some inconvenience while waiting to use the lock, especially if they need to moor overnight.

However, there may be positive effects related to easier and safer navigation on the reservoir behind the dam, and the navigation lock design could make for safer mooring for crew to go ashore for provisioning purposes.

The main concern with respect to the design of the navigation lock, is the proposed single lift system. This system will, in the dry season, need to lift or lower shipping over more than 30 m (assuming that the Luang Prabang HPP is not completed[3]). The PDG, and other international standards, note that in these cases a double lift locking system should be provided. While there are a few single lift lock systems lifting over 30m elsewhere in the world, most of them encounter problems. The proposed lock system for the PBHPP appears to have been copied from the Yinpan lock on the Wujiang River in China, which lifts over 36 m, and which is experiencing problems.

Recommendations that may be considered to *minimise* the risk of down time for repairs, or to improve safety are;

1. The single-lift lock should be redesigned as a double lift tandem-lock to accommodate situations where the lift required will be greater than 30m.
2. High pressure water jets are recommended to clear the miter gate chamber during opening and the sill during closing, to clear debris.
3. Grouting curtains at the downstream and upstream ends must be doubled and extended to the banks or under the barrage, and down into the impermeable soil layer.
4. The vehicle access to the navigation lock system must be able to accommodate a heavy-duty crane.
5. The guiding pontoons should be fixed in the X – Y direction, while being vertically guided for the water fluctuations that can occur.
6. International guidelines are recommended for approach walls and guiding walls, including the accommodation for waiting barges and overnight moored barges, in particular the following should be considered;
    a. A lay-by area where ships prepare to enter the ship lock chamber.
    b. A waiting area where arriving shipping can moor.
    c. An overnight mooring area where the ships may moor without expecting to be ship-locked. These berths may also be equipped with santation facilities and external power supply and should have access to the shore for provisioning purposes.

[3] Lao PDR has indicated that the navigation lock was designed on the assumption that the LBHPP will be built.

7. The upstream entrance to the lock is close to the discharge sluices. If these are operational there is a risk that vessels will be sucked towards the sluice gates. The upstream approach channel should therefore be extended.
8. Visibility around the bend at the downstream end should be improved by removing more of the embankment.
9. Upstream and downstream approach channels should be redesigned, especially the downstream approach with the embankment to be excavated with considering the second lock-design.

Dam Safety

There are likely to be many regular users of the river and its banks at and immediately downstream of the dam site, and failure of the dam will place these users at severe risk. Dam break and impact assessment modelling is standard in large projects, and the review team understands that this analysis has been done, but the results have not been made available for the review.

Operation of the PBHPP can also create a safety hazard as the large natural flows that pass through the turbines and spillway can create dangerous river conditions, if not managed safely. These flows can create a greater risk than dam break flood waves, as they are more frequent. However, at this stage, no information has been made available upon which to assess the safety impacts of the scheme operation. Failure of the dam will also cause hydropower generation to cease and could risk power security in Thailand.

> There are not expected to be large transboundary risks associated with possible dam failure. However, this should be established by dam break modelling.
>
> It is understood that this has been done, but not yet shared.

It is therefore important that the dam is designed to ensure that the risk of failure is negligible, and that procedures are also put into place to ensure that operation of the flood gates does not increase the safety risk for people downstream. However, given the small size of the PBHPP storage, it is not expected that any dam break flood wave would affect safety at Xayaburi (and potentially a future Luang Prabang) HPP. The other Member Countries are also unlikely to be affected by a dam break. As such, there is no basis for the MRC to justify a deviation from the Lao PDR's dam safety regulations. This must nonetheless be confirmed through the dam break analysis

However, the review team has outlined the following which the developer may wish to consider;

- The developer has indicated that they will prepare dam safety monitoring plans in accordance with the World Bank Operational Policy. However, at this stage only a basic outline has been provided. The final plan should be made available for review.
- The design criteria for floods and seismic safety do not align with either national or international guidelines and increases in the flood and seismic loading should be considered. Similarly, the reported ground movement data is half that reported in other studies.
- The developer has not yet presented detailed failure modes nor a dam break assessment to identify the impacts of a hypothetical failure of the dam. This is needed to assess the dam risk category, and will support safe design and assist in the preparation of emergency plans.

- An independent Panel of Experts should be appointed to review the dam design which is considered to be an important requirement of the PDG. The developer has indicated that a panel will be appointed but has not indicated when this panel will be set up.
- The hydrological data used to calculate flood peaks should be updated, particularly taking flood frequencies after the completion of the dams in China into account.
- A summary of the geological investigation data is included in the Engineering Status Report and the drawing provided. However, this does not provide sufficient detail on which to provide a useful review.
- No structural design criteria were provided, and the adequacy of the structural load cases cannot be commented on.

Conclusions

The review of the PBHPP for PC has been hampered by the feasibility level of the design process. In most cases, insufficient information has been made available, and the design process is ongoing. As such, many of the recommendations made may already be being addressed. A final review with a higher level of confidence will only be possible once the final design is complete, and is made available. It is recommended that provision is made for reviewing the ongoing design and development of operating rules as part of the Joint Action Plan.

The following chapter draws out the expected transboundary impacts of the PBHPP.

TRANSBOUNDARY IMPACTS

Background

In Article 7 of the 1995 Mekong Agreement the Member Countries commit to avoiding, minimising and mitigating harmful effects on the Mekong River System. However, the Member Countries are primarily concerned about any potential transboundary impacts of the PBHPP. These are associated with;

- Increased inundation upstream in Thailand due to backwater effects;
- Changes to flow regimes and hence ecological functioning downstream;
- Reduced fish passage and hence reduced fisheries potential upstream and downstream with consequent impacts on local livelihoods;
- Loss of rare species;
- Reduced sediment flows downstream and the associated loss of nutrients for floodplain areas, and loss of habitat;
- Impaired freedom of navigation due to excessive down time of the navigation locks for repairs, and;
- Dangers posed by dam failure.

This section draws out the expected transboundary impacts due to the PBHPP in isolation, and comments on its contribution to the impacts of development in the Mekong basin as a whole.

Transboundary impacts of the PBHPP in isolation

The developer has not fully assessed the potential transboundary impacts of the PBHPP in isolation. However, the technical review has drawn out the following;

Changes in hydrology

The potential for increased flooding in Thailand, upstream of the dam needs to be more comprehensively addressed. The developer has proposed operating rules to minimise these impacts, and Lao PDR has indicated that separate discussions are being held with Thailand over this issue. It is recommended that further 2-dimensional modelling of flooded areas in the mainstream and Thai tributaries is undertaken to support these discussions. This should be done over the full range of reservoir operating levels and inflows, as well as floods in the tributaries.

It is not expected that the PBHPP will have substantial impacts on the seasonal flow regime in the LMB over and above those caused by the operation of the dams in China. However, there will be some storage of water over 5 days at the start of the wet season, although the limits imposed on maximum daily water level changes will minimise the impacts on downstream flood peaks.

Changes in sediment, nutrient transport and geomorphology

Potential transboundary changes in the sediment dynamics of the LMB directly linked to Pak Beng include: (i) disruption to the transport of sand and coarser grained material (ii) an increase in sedimentation at the headwater of the impoundment that may increase sediment deposition at the Keng Pha Dai reef, and (iii) increased water level fluctuations in the reservoir that may affect Thailand, including tributaries.

With or without the development of Pak Beng, the sand supply in the Mekong will decrease over the long term. However, the PBHPP will speed up this process by storing some of the sediment remobilised due to sediment hungry releases from the dams in China. The increased capture of sediment at Pak Beng will reduce the quantity entering and potentially exiting the Xayaburi HPP. However, the long-term sediment equilibrium in the Mekong River will likely be similar with or without the PBHPP, although shorter-term impacts will occur sooner with the dam in place.

Deposition of sediment at the head of the Pak Beng reservoir may increase water levels relative to pre-dam conditions. Water levels associated with flood events could be higher if this occurs, increasing the risk of upstream flooding.

Water level fluctuations in the Pak Beng reservoir have the potential to increase bank erosion through scour and seepage erosion processes and could increase erosion at the mouths of Thai tributaries entering the backwater of the impoundment during floods.

Changes in water quality, aquatic ecology and fisheries potential

The impacts of the PBHPP on fish migration could be reduced through the measures recommended by the review team. However, the dam is still likely to reduce fish migration, and will modify the flowing water river to a slow flowing lake environment. This will affect spawning and nursery habitats of fish, change aquatic communities and food webs, and alter the food web and ecosystem functioning. Because ecosystems are interlinked, this may result in changes in ecosystem functioning far upstream and downstream of the dam site. The fish community structure will inevitably change and productivity will most likely decline, changing from large valuable riverine species to small still water species or a proliferation of alien invasive species such as carps or tilapia.

These losses cannot be compensated by stocking with other species, especially when the impacts are transboundary in nature. There could be loss of productivity and potential loss of long distance migratory species such as the Mekong giant catfish.

Risks of dam failure

As the storage in the reservoir is limited, the review team does not expect dam failure to result in a flood wave that could affect the other Member Countries, or to cause failure of the downstream dams. However, this must be confirmed by the dam break analysis, which should be shared with the MRC.

Failure of the dam would prevent the power being exported to Thailand and therefore the safety of the dam is considered to have a transboundary impact. However, these risks may have been built into the Power Purchase Agreement.

Cumulative transboundary impacts

The technical review, and the prior consultation process, may focus on the PBHPP. However, due diligence requires that the developer considers the likely impacts of future and existing developments, both upstream and downstream, on the design, operations and measures to minimise impacts. Similarly, while the PBHPP may in isolation pose relatively small transboundary impact, it may amplify the impacts of future and existing developments. Similarly, the position of the PBHPP as the uppermost HPP in the cascade of dams in the LMB creates opportunities for synchronising its operations with other dams, optimising hydropower and minimising potential impacts.

> The developer has not yet undertaken a rigorous assessment the PBHPP's contribution to the cumulative impacts, and has not considered the potential for optimising the hydropower output, and minimising the impacts of the full cascade.

The developer has not undertaken a rigorous analysis of these aspects. However, the MRC has undertaken several studies highlighting these cumulative impacts. These studies show a very large decrease in sediment supply associated with the already completed Lancang cascade. Sediment trapping in tributary dams was projected to remove approximately an additional 10 million tonnes, resulting in a sediment load of approximately 21 million tonnes per year into Cambodia in the *absence* of a cascade of dams in the Lao PDR.

The northern Lao PDR cascade of five HPPs was projected to trap about 70% of that 21 million tonnes, and with full implementation of all the proposed dams the sediment loads could be reduced to less than 10% of the natural condition. There would also be a change in the composition of suspended sediments, with fine silt and clay readily passing through the impoundments, but fine sand and coarser material trapped. The results also showed increased channel erosion downstream.

However, coordinated sediment flushing and routing increased sediment discharge by about 30%, with the volume of sediment mobilised by flushing expected to increase over time as more material enters the cascade.

The impacts of the cascade on fish is also considerable, although the impact of each dam will depend on the design and operation of the fish pass facilities. The impact of the cascade of dams are multiplicative and include;

- A reduction in the number of fish that can move further upstream. The probability of fish bypassing several dams in series decreases with each successive dam, and the cumulative mortality rates through successive sets of turbines are likely to be considerable.
- Each impoundment will disrupt larval drift to replenish downstream fisheries. The scale of this disruption will depend on the hydraulic regime in the impoundments and downstream passage facilities.
- The cumulative barrier and passage effects of multiple mainstream hydropower dams on migratory fish populations may result in extirpation of populations.
- The increasing loss of flowing water habitat and flooding of spawning and nursery habitats could collapse the traditional river stocks and fisheries. The fish community structure will inevitably change and productivity will most likely decline, changing from large valuable riverine species to small still water species or a proliferation of alien invasive species such as common carps or tilapia.

- Impoundments created upstream of the many dams are not conducive to natural fish production so there is the likelihood that the total yield of fish from the modified river will be heavily compromised and cannot be compensated by stocking or aquaculture.

It is therefore critical that the developer and Lao PDR consider the impacts of multiple dams, and to optimise the operations and sequential development of the full cascade as far as possible.

In this regard, it is understood that the Lao PDR has prioritised the development of hydropower to propose the higher output, lower impact infrastructure first. The position of the PBHPP in this context should be highlighted. Similarly, efforts to optimise the design and operations of all the proposed developments to maximise hydropower production and minimise harmful effects should be included in the documentation provided.

Of concern in the PBHPP case is the extent to which the developer has considered the possible completion of the Luang Prabang HPP, or has considered the lessons learnt from the Xayaburi HPP.

COMMENTS, RECOMMENDATIONS AND WAY FORWARD

Background

This section presents some general comments from the review team, presents preliminary recommendations for JC, and includes suggestions for measures that will minimise transboundary impacts.

It does not include the recommendations made for the developer which are embedded in the overall review, and which may further minimise and mitigate potential harmful effects that may not be transboundary in nature.

Lastly, the way forward is presented.

> The review team accepts that many of the recommendations made may already be being addressed.
>
> However, the PBHPP if designed and operated as outlined in the documents submitted for PC, will have transboundary impacts.
>
> The measures recommended will go some way towards minimising these impacts.

General comments

The developer has made efforts to address the potential impacts of the PBHPP and the provisions of the PDG, and these efforts are ongoing. However, while there are certain advantages to notifying at the feasibility stage, the review has been hampered by the lack of details in the documentation provided. In this respect, the review team accepts that many of the recommendations made may already be being addressed.

Nonetheless, the PBHPP, if designed and operated as outlined in the documents submitted, will impact on fish passage, downstream sediment transport, and aquatic habitats. These may have knock on impacts on the people and economy of the LMB. Populations of the critically endangered Mekong Giant Catfish, already under pressure from past development, will decline, and there is a considerable risk of extinction. Due to the interconnected nature of the shared ecosystem, these impacts are likely to be transboundary in nature. Moreover, the single lock navigation system is likely to experience cavitation problems and hence excessive downtime for repairs if the lifting head remains above 30 m. The current design and operation of the proposed PBHPP only partly aligns with the guidance in the PDG.

However, the measures recommended by the review team will go some way to minimising these impacts, and will further bring it in line with the PDG. Mitigation measures will, however, only partly be able to address any potential residual impacts on the people and economy of the area. Some impacts are unavoidable. Despite this, a functioning ecosystem will remain, albeit heavily modified with the loss of key ecological goods and services. There will be some capture fisheries, albeit at substantially reduced tonnages, and loss of some endangered species.

These impacts need to be seen in the broader development context. The PBHPP, in isolation, will have a smaller impact on the LMB ecology. Fish biomass and diversity is lower in these upper reaches of the Mekong mainstream. Much of the sediment

from the upper basin will in any event be trapped by the already operational Lancang dams, and the PBHPP will not affect sediment loads generated further downstream. Although the PBHPP will speed up the overall decline in downstream sediment loads. Some of the measures proposed to minimise the impacts of the PBHPP may reduce the financial returns of the project. These measures may be both capital and operational in nature. The recommendations to lower the operating level of the reservoir and push more water down the fishpass may reduce the power output beyond the provisions of the Power Purchase Agreement. The impacts of these operational measures on the longer-term power output must therefore be modelled based on the updated hydrology. Some optimisation of the timing of these measures against power output may be possible.

On the other hand, the potential benefits to the Lao PDR's economy through foreign exchange earnings and the associated development opportunities places the Government in a better position to provide improved services for all the people of Lao PDR. While these benefits will be restricted to the Lao PDR, benefits through increased trade opportunities may accrue to the other Member Countries. Thailand benefits from cheaper hydropower, and the avoided environmental costs elsewhere. The key underlying question is, therefore, not whether the PBHPP will result in harmful effects, but whether all reasonable efforts have been made to avoid, minimise and mitigate those impacts, particularly where they are transboundary in nature.

As with the previous two prior consultation processes, the wealth of data and experience available at the MRC were not effectively used.

Recommendations for the Joint Committee

The JC may wish to discuss the following measures[4]:

- The developer should undertake further studies of the upstream impacts into Thailand, including into the tributaries.
- Consideration should be given to incorporating large low-level sediment flushing gates in the flood-sluicing part of the project. This would bring the project more in line with the PDG.
- The sediment management strategy should be reviewed to ensure that sediment is passed downstream on a seasonal or annual basis, and not only when flow levels exceed 5,961 m^3/s. This may require a redesign of the infrastructure to enable sediment routing as well as pressure flushing;
- Greater attention should be paid to how sediment management and operations at Pak Beng could be coordinated with other hydropower projects in the cascade to minimise possible environmental impacts and optimize power supply;
- An external engineering review of the infrastructure should be done;
- Fish passage facilities should be improved based on the recommendations made in the expert review; in particular:
  - The upstream fish pass entrance should be moved to the powerhouse, and a collection gallery added;
  - The slope of the fish pass should be reduced, and the flow capacities increased and design should be in line with international standards;

[4] The PC process is ongoing, and this list of measures may change as the review is finalised.

- The electric fish barrier should be removed;
- Consideration should be given to changing the operating rules to maintain drifting fish larvae in the water column throughout the reservoir;
- The operation of the spillway gates should minimise fish mortality in the undershot gates; and
- A fish screen should be installed to divert larger fish away from the turbines.

- Socio-economic modelling should be undertaken to assess the consequences of the PBHPP on downstream livelihoods, food security, and human migration.
- The single-lift lock should be redesigned as a double lift tandem-lock to accommodate situations where the lift required will be greater than 30m.

> A set of measures would outline what must be done, and how it would be monitored and reported to the MRC.
>
> A Joint Action Plan would detail opportunities to for sharing the details of ongoing design and for continuing engagement of stakeholders

What happens after prior consultation?

The success of PC lies in establishing an enabling environment for the JC to agree a set of measures for the notifying country to support the developer to avoid, minimise and mitigate any potential impacts. The post-prior consultation process rests in the implementation of these measures.

These measures would typically outline what should be done, and how it will be monitored and reported to the MRC. They would call upon the Lao PDR to urge the developer to undertake certain analyses, or to incorporate certain infrastructure in the final design. The measures may also outline procedures to share the results, final design or operating rules with the MRC.

Agreement on these measures in the JC does not necessarily imply approval or disapproval of the project (this is not the role of PNPCA), and notified countries will separately reflect their views in their formal replies. These views would become part of the official record of the special session of the JC.

Agreement on these measures does not prevent the Member Countries from negotiating and agreeing anything outside the prior consultation process.

The rollout of these measures may be detailed in a Joint Action Plan. This Plan will provide opportunities for the developer to share the details of the ongoing design, and how the measures have been taken up, with the MRC and other stakeholders.