Initial Environmental Examination for Nam Seng Representative Subproject

Project Number: 50236-002
April 2019

Lao PDR: Sustainable Rural Infrastructure and Watershed Management Sector Project

CURRENCY EQUIVALENTS

(as of 5 April 2019)

Currency Unit	–	Kip (KN)
KN1.00	=	$ 0.000116
$1.00	=	KN8,600

ABBREVIATIONS

ADB	:	Asian Development Bank
AF	:	Additional Financing
CCA	:	climate change adaptation
CIFOR	:	Center for International Forestry Research
COL	:	Concessional OCR lending
DAFO	:	District Agriculture and Forestry Office
DALAM	:	Department of Agricultural Land Management
DDMCC	:	Department of Disaster Management and Climate Change
DMF	:	Design and Monitoring Framework
DRR	:	disaster risk reduction
EIA	:	Environment Impact Assessment
EMP		Environmental Management Plan
ERP	:	Emissions Reduction Program
FAO	:	Food and Agriculture Organization (of the United Nations)
GCF	:	Green Climate Fund
GDP	-	Gross Domestic Product
GIZ	:	Deutsche Gesellschaft für Internationale Zusammenarbeit (German International Cooperation Agency)
GMS	:	Greater Mekong Subregion
IEE	:	Initial Environment Examination
IMT	:	irrigation management transfer
IPM	:	Integrated pest management
ISF	:	irrigation service fee
IUCN	:	International Union for the Conservation of Nature
IWMI	:	International Water Management Institute
LDC	:	least developed country
LIC	:	Loan implementation consultant
MAF	:	Ministry of Agriculture and Forestry
MONRE	:	Ministry of Natural Resources and Environment
NGO	:	Non-governmental Organisation
NRI	:	Northern Rural Infrastructure Development Project
NSEDP	:	National Socio-Economic Development Plan
NTFP	:	non-timber forest product
O&M	:	Operations & Maintenance
OCR	:	Ordinary Capital Resources
ODA	:	Overseas Development Assistance
PAFO	:	Provincial Agriculture and Forestry Office
PAM	:	Project Administration Manual
PDR	:	People's Democratic Republic (of Lao)
PGT	:	Program Governance Team
PLUP	:	participatory land use planning
PPIT	:	Provincial Project Implementation Team

PONRE	:	Provincial Office of Natural Resources and Environment
PRAP	:	Provincial REDD+ Action Plans
PRC	:	People's Republic of China
PRI	:	productive rural infrastructure
PRT	:	Pesticide reduction training
RRP	:	Report & Recommendations to the President
RSP	:	representative subproject
SME	:	Small-Medium Enterprises
SRIWSM	:	Sustainable Rural Infrastructure and Watershed Management
TRTA	:	Transaction Technical Assistance
VDF	:	village development fund
WUA	:	water user association
WUG	:	water user group

GLOSSARY

Catchment	In its totality a catchment is equivalent to a watershed, however a watershed may comprise of micro-catchments and sub-catchments. In this document a catchment refers to a subset of the larger watershed.
Watershed	A topographically delineated area from which rainwater drains as surface run-off via a river or stream to a common outlet point (e.g. a large river, lake or the sea).
Watershed management	Securing watershed functions in a sustainable manner. Broadly these functions include: ➢ Ecological function: availability of sufficient good quality water over time, space; erosion control, soil fertility, biodiversity, clean air, carbon sequestration; ➢ Economic function: sufficient natural resource products like food, fuel wood, timber, water, fish, energy required for basic needs of the local population; income generating opportunities; ➢ Social function: maintenance of social structures; protection and development of knowledge and lifestyle arrangements; maintenance and revitalisation of cultural identity and values, recreational facilities.

NOTE(S)

(i) In this report, "$" refers to US dollars unless otherwise stated.

CONTENTS

I. INTRODUCTION

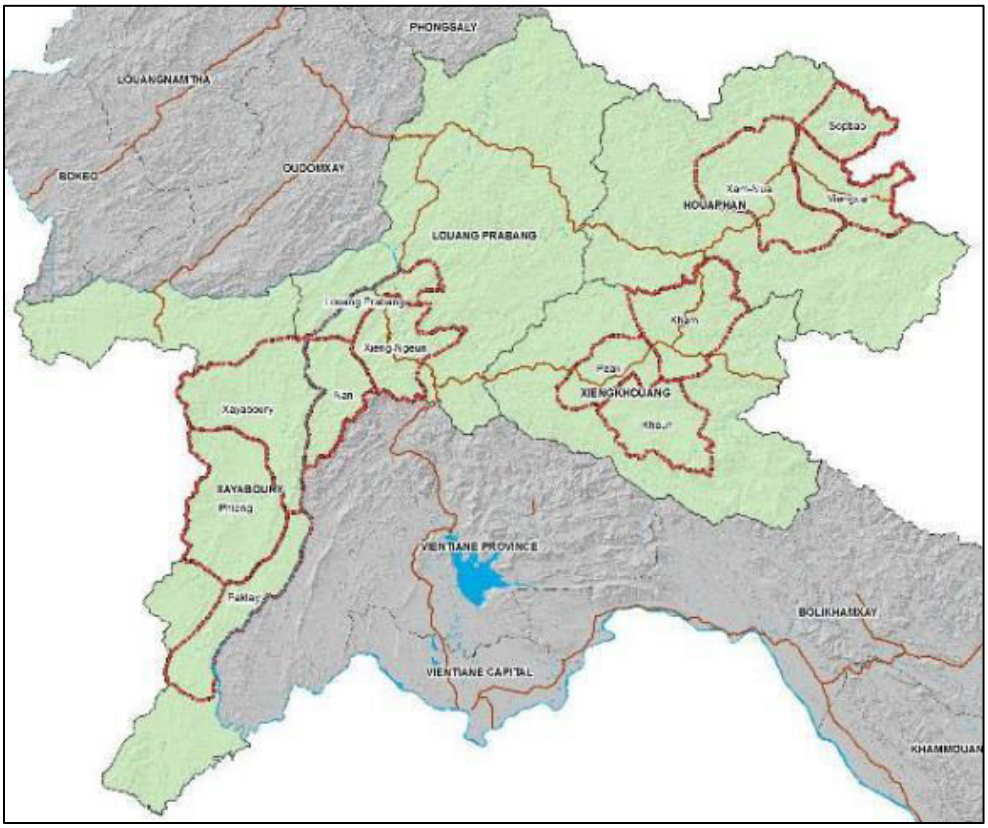
A. Overall Project Area and Scope

1. The geographic scope of the overall project extends to the four provinces of Houaphan, Xieng Khouang, Luang Prabang and Xayaboury. The Sustainable Rural Infrastructure and Watershed Management - Sector Project (SRIWSM) will finance subprojects in three agreed districts in each province, see Table 1 and Figure 1.

Table1: Project Area

Province	District
Houaphan	1. Nam Xeua 2. Vengxiay 3. Sop Bao
Xieng Khouang	1. Peak 2. Khoan 3. Kham
Luang Prabang	1. Nan 2. Nguen 3. Luang Prabang
Xayaboury	1. Xayaboury 2. Phieng 3. Paklai

Figure 1: Project Provinces and Districts



2. The ADB SRIWSM project is part of a wider investment by Government into more sustainable intensification and diversification of the agriculture sector. The investment is being supported by parallel cofinancing from IFAD (for output 1 and output 3 - WUG support) and GIZ for output 2 (with the exception of Xieng Khuoang province). ADB will invest in the establishment of irrigation headworks, conveyance systems to the command areas, and water control structures within the command areas along with the provision of improved access. IFAD will support WUGs to intensify and diversify land use during the dry season. GIZ will invest in more sustainable land uses in the upper catchments with the SRIWSM catchments prioritised. For safeguards IFAD have committed to apply ADB safeguard policy whilst GIZ is applying the required WB safeguards from the emission reduction program into which GIZ is investing.

3. The SRIWSM is expected to have a net positive impact on subproject catchments as it will reduce the risk from dry season cropping of the irrigation command areas. It will also support a potential increase in income from higher crop values. This will reduce the pressure on land conversion for upland cropping. Such land conversion is identified as a major driver of forest loss as crops are grown on steep, bare ground subject to high rates of soil erosion in the wet season.

4. The risks associated with intensification relate to (i) increased use of agrichemicals and fertilizer, and (ii) increased demand for irrigation water during the dry season. The IEE incorporates the requirements to mitigate inappropriate pesticide and herbicide use through the Government Pesticide management training and integrated pesticide management (IPM) training within the IFAD support program. Nutrient management will be incorporated into the IFAD WUG training, farm to farm extension and on-farm demonstrations. For this IEE the risks linked to the "associated facilities" are the risk of intensification of agricultural inputs for the production of high value crops. The subproject will introduce Lao Good Agricultural Practice (GAP) certification and branding for all agricultural production systems in the upgraded command areas.

5. The borrower/client will not use products that fall in World Health Organization Recommended Classification of Pesticides by Hazard Classes 1a (extremely hazardous) and 1b (highly hazardous) or Class II (moderately hazardous), if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply and dispose of these products properly. The good practice requirement will include training in the handling, storage, application and disposal of pesticides in accordance with international good practice such as the Food and Agricultural Organization's International Code of Conduct on the Distribution and Use of Pesticides.

6. Risks to environmental flows are considered within the context of ADB supported facilities and are addressed through the requirements for water source gauging stations and information, flow modelling and estimation, the use of crop water demand planning using CROPWAT software upon which crop planning i.e. sowing dates, crop choice are scheduled within the available water resources. For most cropping options in Nam Seng the irrigation demand occurs prior to the timing of minimum flow with the final irrigation for green soya bean being in mid to late February.

B. Location of the Nam Seng Subproject

7. The Nam Seng Irrigation Subproject supports a command area within the adjacent Nan District in the south-western province of Luang Prabang. The supply of irrigation water is already established coming from the Nam Seng via a conveyance tunnel built in 2004. The proposed subproject invests in the next stage of development of the Nam Seng Irrigation program that is currently irrigating 350ha of the designed 1000 ha command area. Both Districts are close to the

Mekong, and both drain into it. A provincial scale overview of the subproject location is shown in Figure 2. A larger scale map in Figure 3 shows the drainage layout.

Figure 2: Location of Nam Seng

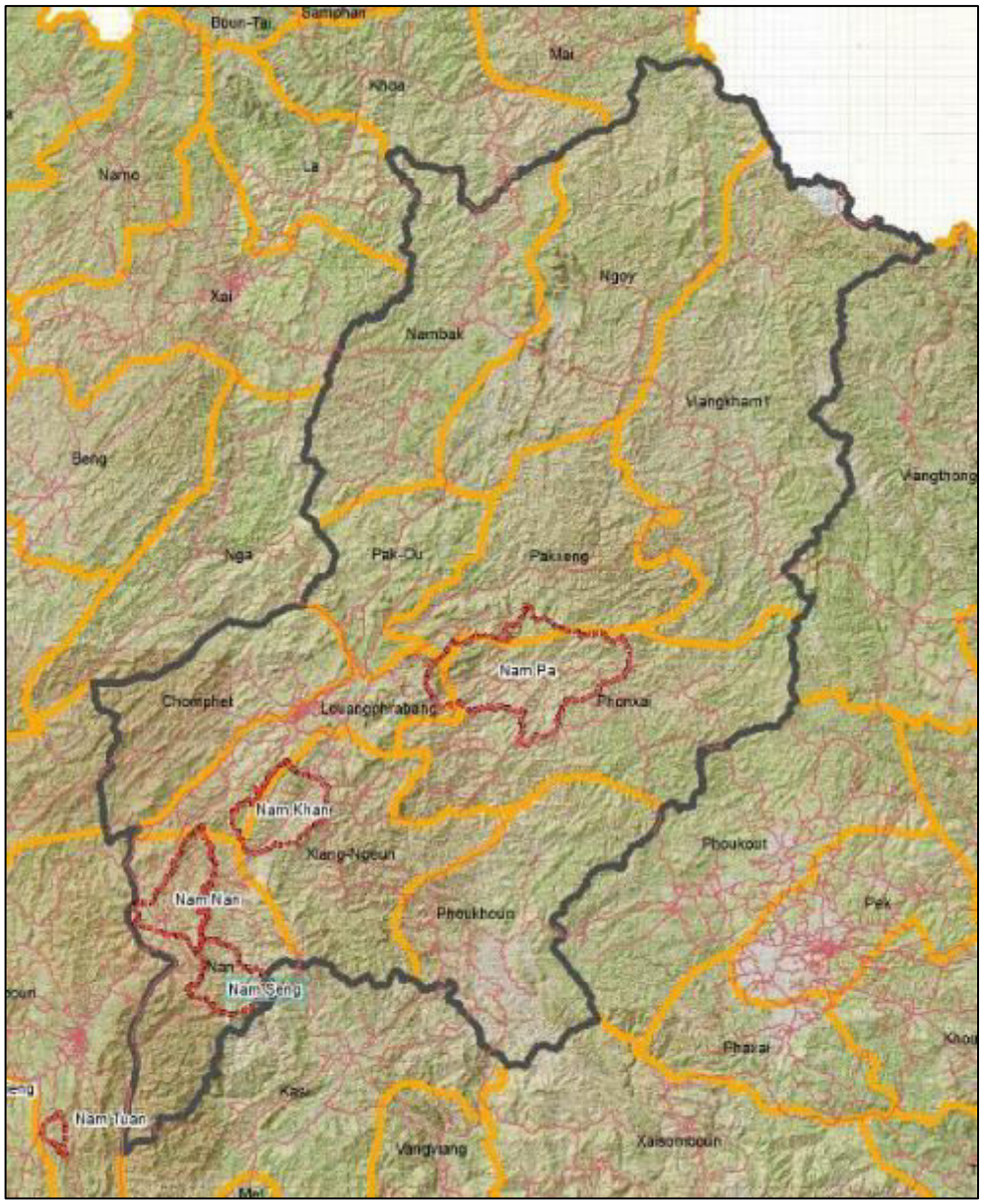
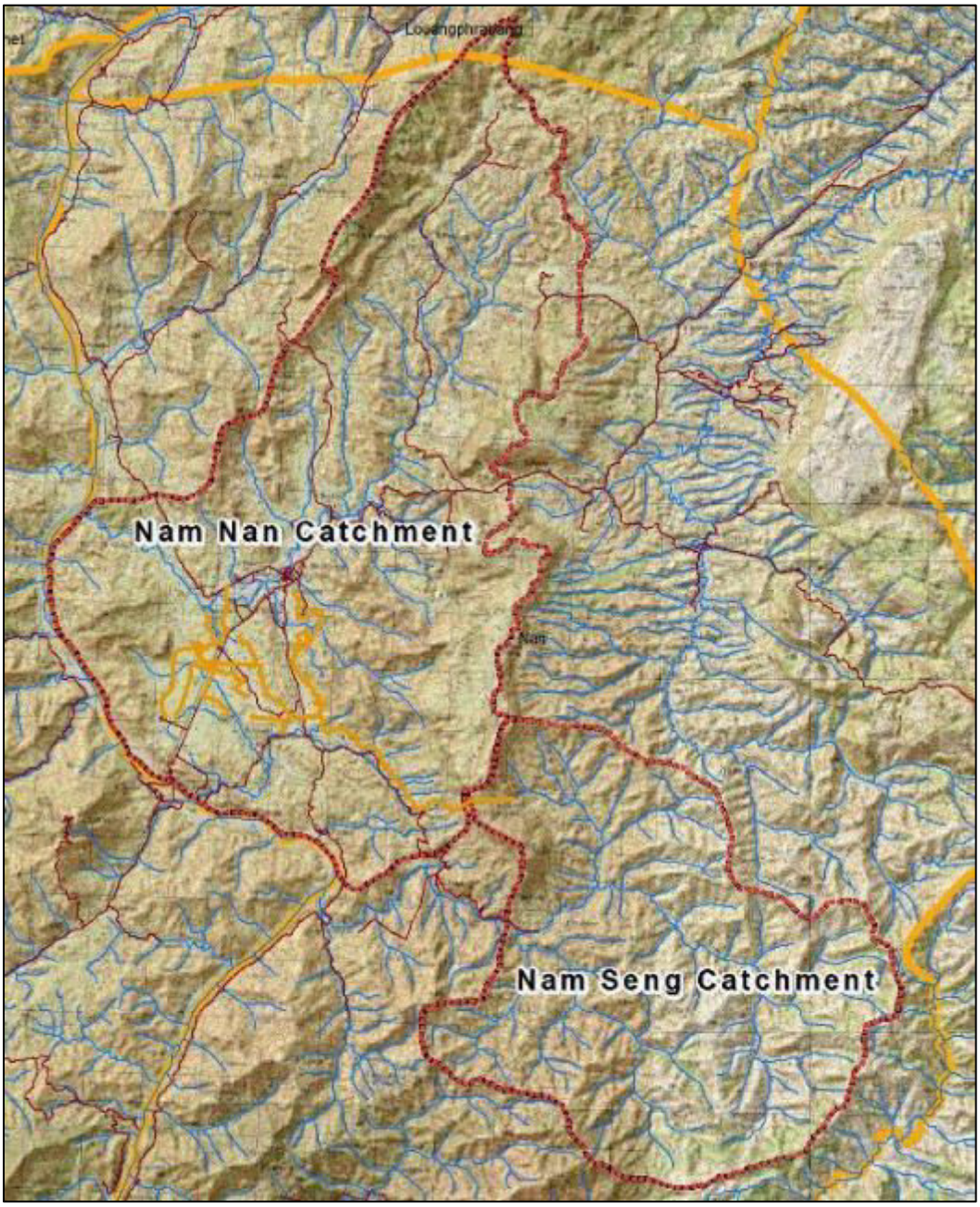


Figure 3: Drainage within the Nam Seng Catchments.



C. Rationale for the Overall Project

8. The SRIWSM will increase the profitability of the agriculture, natural resources and rural development sector by enhancing sustainable, market oriented agricultural production together with natural resources management. The project outputs will: (i) increase market oriented production, (ii) protect watershed ecological services, (iii) improve the reliability of command area irrigation and, (iv) nutrition awareness and facilities improved. For Luang Prabang only output (i) and (iii) will be implemented as output 2 is being financed by GIZ and output 4 is limited to Houaphan and Xiengkhuoang Provinces.

9. The project rationale is economic growth through the sustainable use of natural resources by maximising the value of irrigation water to smallholder irrigators and the wider rural communities of which they are part. Historically, investment in wet season irrigation improvements involved replacing traditional weirs and structures with engineered concrete structures to provide supplemental wet season irrigation. The headworks and distribution canals generally fed water to the highest point of the command area, from where field to field flow was used for distribution. This improved household food security and often provided surplus rice which is sold. As food security based on rice productivity has been achieved the surplus of rice has resulted in declining world and local prices limiting the sustainability of these irrigation systems. Food security investment overlooked dry season cultivation and crop diversification which requires a substantially higher level of investment in the command areas.

10. The government operates a policy of transferring to the users the management of irrigation systems that have been supported by donor investment. However, low returns from rice do not currently provide sufficient margin to finance more efficient water management and maintenance of assets through the irrigation service fees that users contribute. As a result, most schemes do not maintain assets or use operational systems that support their command areas, leading to a decline in size and efficiency over time.

11. Dry season crop and livestock systems have vastly higher income opportunities than are feasible from irrigated rice. These opportunities require dry season irrigation, when water is less abundant and requires active management in the command area. But without effective control, farmers face insecure or uncertain irrigation outcomes and will not invest in new opportunities. Ensuring control requires more in-command area investment for delivering the right amount of water, at the right time and in sufficient quantity through more active regulation and management of irrigation water. There is a need to move away from systems of field to field flow with abundant wet season water, to approaches which increase the precision of use of potentially scarce water.

12. Equally important is the recognition that labour is increasingly scarce and valuable, with most irrigators earning less than 50 percent of their income from agriculture. The relative return to irrigated crops per day of labor input determines the household allocation of labor. Once a household is food secure, labor is allocated to the highest return which for the dry season, and increasingly for the wet season, is often casual or contract labor markets in the construction sector, tourism sector and or upland cropping. High value dry season crops are shown to increase income returns substantially. Within the Nam Nan district this is reflected in the movement of labor out of the district during the dry season to seek higher returns to labor in Thailand and Luang Prabang whilst labor from more remote communities often migrates into the District for agricultural inputs and as such both the land owners and the in-migrants are obtaining increased returns to their labor.

13. The efficient and precise use of water is critical because of the impact of climate change and resultant instability within both ecosystems and production cycles. Hence water management is no longer a choice, but has become a necessity. New technologies that increase efficiencies in both water use and labour must be the priority to maximise the value of irrigation water. The control of water requires capacity in the Water User Groups to plan and operate their schemes. These operational inputs require financing, which wet season rice is unable to provide – resulting in rice-only irrigation schemes being unsustainable.

14. Dry season irrigation is exposed to upper catchment degradation and loss of watershed environmental services that reduce in-catchment storage and lead to longer periods of low flows during the extended dry season. Managing catchment-based risks to the watershed is a critical

success factor for the sustainability of dry season irrigation. Uncertainty of water access or unreliable water quantities make smallholder investment far too risky, so that during the wet season farming households move their labour into off-farm opportunities.

15. To date, Participatory Land Use Planning has too often been seen as an output to address these risks, when in fact it is an input. The output requires a stronger focus on changing land use behaviours. Planning systems need to identify far more clearly what behaviours need to change, who in these communities are responsible for these behaviours and how can they be supported for change.

16. The efficient allocation of labour and farmer investment into dry season agriculture requires high value cropping and livestock to generate higher incomes. The increased incomes make the operation of schemes more affordable while providing sufficient incentive to retain labour on the farm. These options however carry substantially more market and business risk than irrigated rice. To manage these risks requires strong and reliable market linkages. Smallholders, and the sector as a whole, need to move from selling outputs to producing for markets through better market connections and strengthened value chains. Agribusiness skills that support Provincial Agriculture and Forestry Office (PAFO) staff and build connections from markets to producers are non-existent, and need to receive additional capacity building.

17. Business risks are a significant hurdle for most smallholders, as they arise from the need for new technologies, different management skills and more complex sets of inputs and outputs. Extension services in Laos have proven difficult to establish, access, and even more difficult to sustain outside of a project. Options for linking farmers to other farmers, and to access the pool of knowledge and experience that exists in recent past or ongoing development or private sector projects is considered a high priority.

II. DESCRIPTION OF NAM SENG SUBPROJECT

A. Purpose of the Initial Environmental Evaluation

18. This Initial Environmental Evaluation (IEE) has been undertaken in compliance with the specified safeguard requirements of the borrower, the Government of Lao PDR (the government), and the Asian Development Bank (ADB).

B. Scope of Subproject IEE

19. The following IEE is limited to the ADB financed infrastructure under output 1 of the SRIWSM project and the associated impacts arising from the construction and use of the infrastructure. The IEE will also be applied by the International Fund for Agricultural Development (IFAD) in its financing of the agricultural capacity and management support program within the SRIWSM subproject sites. IFAD will operate under a separate loan and financing agreement with supporting documentation as required by IFAD.

20. Within the ADB financing the subproject is limited to infrastructure development with investment in watershed management being provided by the proposed GIZ – GCF funded project under the World Bank Emissions Reduction Program.

C. Subproject Rationale

21. Nam Seng is an existing irrigation scheme that is currently being developed using government funds. The scheme was built in 2008 using a Chinese contractor as part of the Xayaboury Hydropower station on the Mekong River. To date, the headworks and main canals (MC1 and MC 2) have been constructed and are delivering wet and dry season irrigation to a 385 hectares of command area in the neighbouring Nan District. The design command area approaches 1000 hectares. The overall scheme is spread over nine villages with approximately 550 households. The design standard of the headworks based on the DoI feasibility study that used one-year flow data concluded that diversion of 80% of the March low flow was sufficient to support wet season rice of up to 1000 hectares and an additional 500 hectares of unregulated flow for dry season paddy production.

22. The existing 350 ha command area is used by 442HHs residing in 9 villages. The command areas involve steep valley sides that use plot to plot unregulated water flow from the main canal elevations down to the valley floor. The land use within the existing MC 1 and 2 command areas is based on two seasons of paddy rice as the unregulated plot to plot flow restricts high value dry season cropping (HVC) to plots where water can be regulated. In total there is limited dry season HVC cropping involving mostly the production of onion, garlic and rice. Within the existing system the SRIWSM subproject will undertake remedial works to upgrade weak sections in the canal system that transfers water from the Nam Seng into the Houy La River (a tributary of the Nam Nan).

23. The existing scheme has water user groups formed in each village but no water user association. The water user groups are relatively weak as water is never scarce and the need for water management is limited. The Water Users Group of Nam Seng Irrigation System was formed in 2009 under the technical and managerial support of the Luang Prabang PAFO (Irrigation Section) and Nan DAFO (Irrigation Unit). The existing WUG membership of 442 HH reside in 9 villages with land in the 381 ha area designated for irrigation at that time. The WUG are collecting irrigation service fees which in 2018 equalled approximately LAK 60 million per annum (the equivalent of 100 kg rice per ha of wet season rice production). No irrigation service fee is applied to dry season cropping despite the high value of water in the dry season.

24. The SRIWSM Nam Seng Irrigation Subproject seeks to use the existing headworks and distribution system by extending the irrigation distribution canals by 4.8 km and developing the associated command area referred to as SC1. The topography of the SC1 command area differs from the existing command areas that are steep with terraced plot to plot paddy rice systems running from the main canal elevation to the valley floor. The command area for SC1 is located on a broad valley floor and, as such, has a very little difference in elevation ranging from 1m to 2m. The new command area therefore requires more intensive distribution and water regulation infrastructure.

25. The subproject supports the next stage of command area development within the Nam Nan District known as SC1 and will add 265 ha into the Nam Seng irrigated command area. Current land use involves 238 households from 7 villages that grew 272 hectares of wet season rainfed rice and 25 ha of banana. The planting of Banana within irrigation command areas is illegal. The 25ha planted was undertaken with knowledge that the command area development was imminent, and the concession agreement includes clauses for the cancellation of the land use agreement within the command area and surrounding land. These clauses have been enacted during 2018 in preparation for the SRIWSM.

26. In summary the subproject will provide the infrastructure and water management infrastructure and supporting operational inputs to ensure reliable water supply and management throughout the dry season. This will involve upgrading short sections of the two existing main canals, installation of a new secondary canal (4.8km) and a total of four tertiary and two sub-tertiary distribution canals with improved water control structures. The investment will enable dry season water to be delivered for 12 hour per day on an agreed schedule using a 5 or 7 day return period. In summary the subproject is expected to:

(i) Reduce the yield losses of wet season rice by providing supplementary irrigation to 265 ha
(ii) Increase dry season command area by 265 ha
(iii) Manage dry season irrigation water more effectively through efficient water distribution and scheduling
(iv) Improve overall scheme management, O&M through improved water control
(v) Establish routine and periodic maintenance programs within the capacity of the WUA to implement
(vi) Establish appropriate ISFs that reflect the actual costs for O&M

27. The subproject seeks to increase farmer returns through enabling dry season high value crop production while strengthening producer-based water user groups to operate and maintain the irrigation scheme. Operations and maintenance costs will be funded through significantly increased irrigation service fees that are affordable due to significantly higher profitability from dry season crops.

28. The subproject will cover remedial work to (i) the existing intake headworks on the Nam Seng, (ii) the distribution canal that transfers the water into the two main canals in the Nam Nan catchment that irrigate the existing command area, and (iii) extend the distribution canals for the development of 265 ha in SC1. The project sources water from Seng District and delivers this to command areas within Nan District. The two districts are shown in Figures 4 and 5.

29. The subproject proposal has two parts. Part one is the upgrade of the main canal from the headworks to the offtake structure from the Houy La River. The investment required is mostly canal repair or preventative measures to stop soil and vegetation movement into the canal, protection of the integrity of the main canal embankment. The project will also secure the headworks access road that has sections at risk to downside erosion and slippage of the embankment, inadequate stream and river crossings, and a lack of flood water bypasses.

30. Part two is the development of block 1 command area based on an extension of the existing distribution network.

31. The rationale for the subproject is economic impact. Given the availability of water and the sunk cost of headworks and will enable the operations and maintenance cost of the existing headwork and canal system to be spread over a larger command area. The subproject will also include: (i) soil and water conservation planting to protect infrastructure including buffer planting, cropping and cultivation bans on the topside of the main canals, and provide structures to enable side stream flood flows to pass over the canal without entering it; and (ii) dry season cropping systems for market-led high value cropping choices.

32. The subproject fulfils the eligibility criteria listed in Table 2, which provides further information on the scale and context within which it is to be implemented.

D. Subproject Design

33. The Nam Seng Subproject involves the following main engineering works.

(i) Installation of a sediment gate in the Nam Seng headworks weir crest to permit flushing in the wet season.
(ii) Repair of the concrete on the downstream apron and resolution of the localised scour.
(iii) Securing of the main canal from damage during large floods. This involves ensuring the canal front and side walls at the first control gate are above design flood level.
(iv) Repairing of the main canal road for 8 km from downstream of the tunnel to the outlet to the Houy La catchment.
(v) Repairing and installing additional masonry linings in 15 sections in canals (total of 2,340 m) to reduce leakage losses.
(vi) Covering the canal in unstable bank sections to prevent landslide debris blockages (total of 865 m).
(vii) Installing improved canal crossings or super-passages for watercourses to secure canals and prevent water ingression at 12 places.
(viii) Construction of a new secondary canal (4.8km) to serve the 265 ha extended command area.
(ix) Construction of four tertiary canals and two sub-tertiary canals for water distribution and use efficiency in the new command area.
(x) Improvements to field access in the extended command area by incorporating roads along the secondary and tertiary canals to facilitate agricultural production, and irrigation operation and maintenance.
(xi) Installation of staff flow gauges to facilitate water management in all canals and distribution points.

Figure 4: Nam Seng Subproject. Top, Water Supply Catchment. Bottom, Distribution Canal and Command Areas.

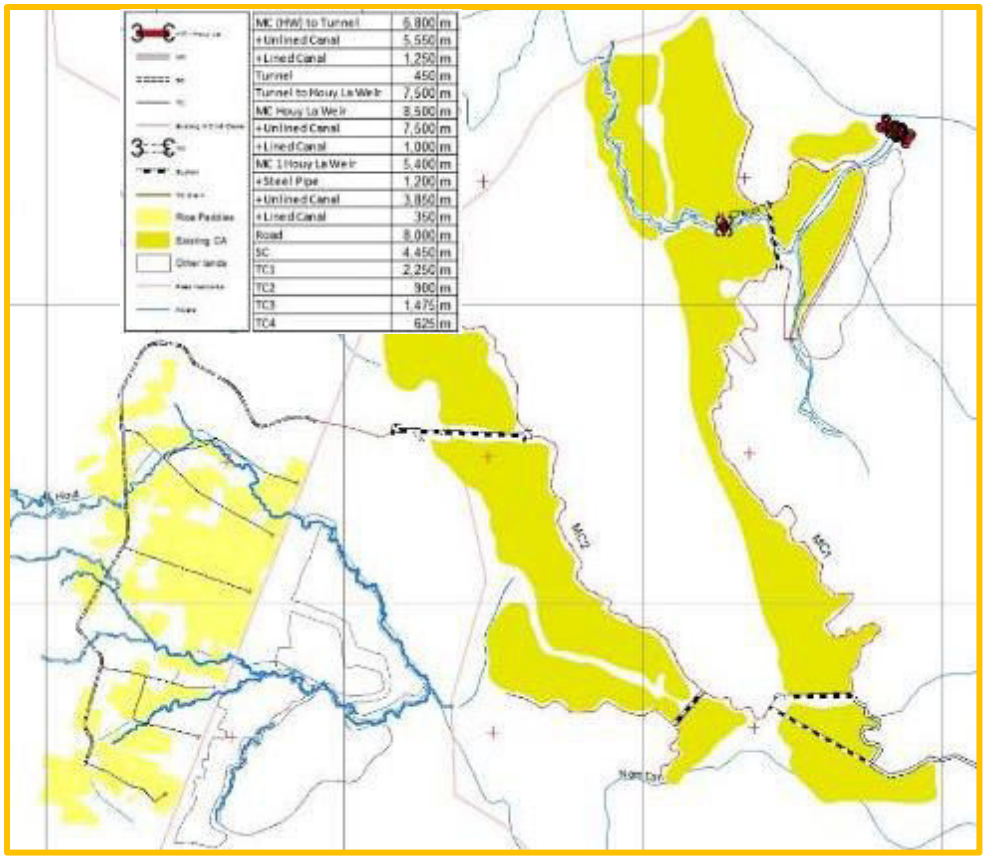

MC (HW) to Tunnel 6,800 m
+Unlined Canal 5,550 m
+Lined Canal 1,250 m
Tunnel 450 m
Tunnel to Houy La Weir 7,500 m
MC Houy La Weir 8,500 m
+Unlined Canal 7,500 m
+Lined Canal 1,000 m
MC 1 Houy La Weir 5,400 m
+Steel Pipe 1,200 m
+Unlined Canal 3,850 m
+Lined Canal 350 m
Road 8,000 m
SC 4,450 m
TC1 2,250 m
TC2 900 m
TC3 1,475 m
TC4 625 m
Rice Paddies
Existing CA
Other lands
MC2
MC1
Nam Dat

Figure 5: Nam Seng and Nam Nan Watersheds and Subproject: Locational Overview.

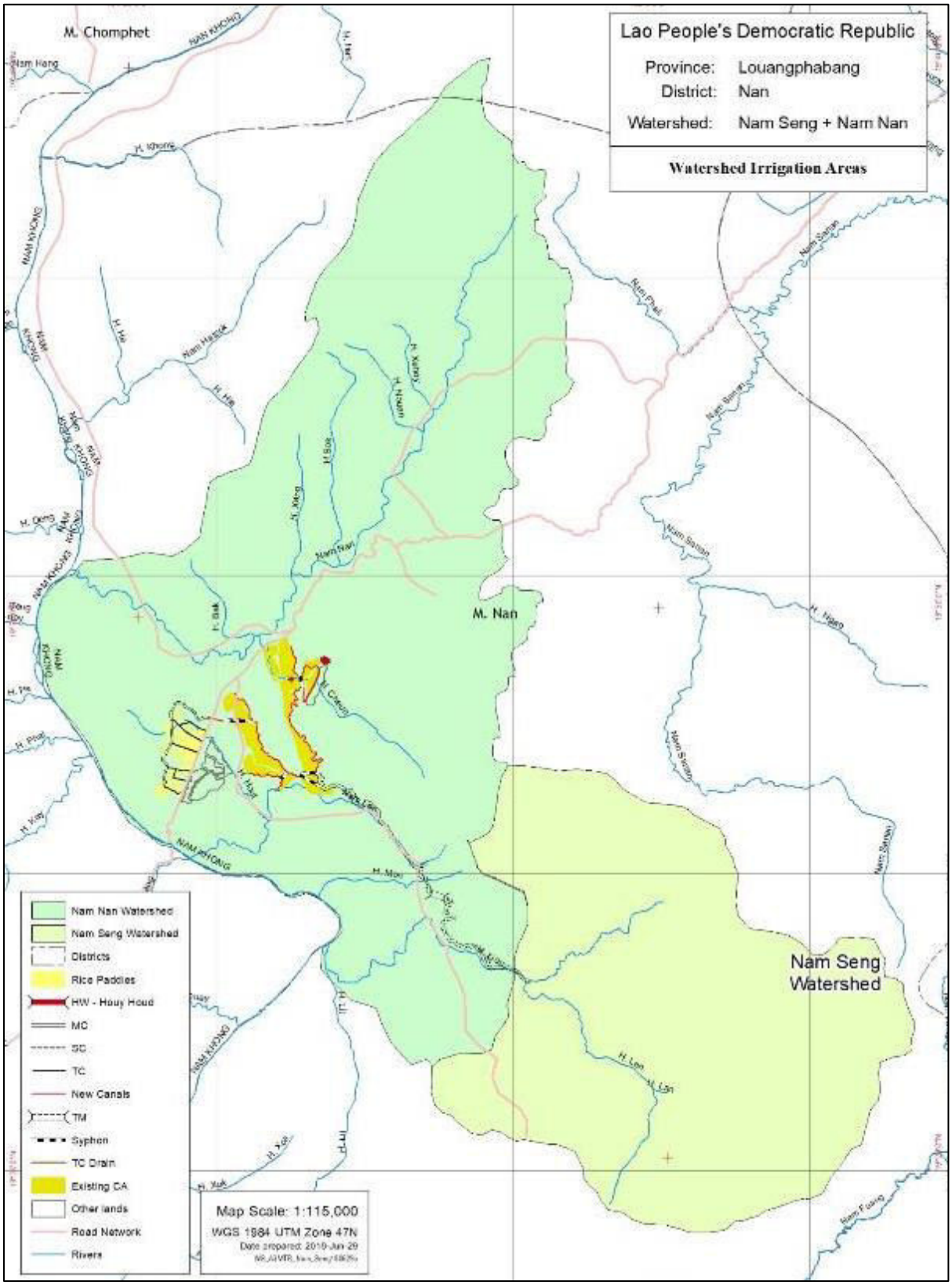


Table 2: Eligibility Check for Nam Seng Subproject

No.	Eligibility Criteria	Nam Seng Subproject
1	**National Strategy.** Be consistent with government strategies and policies.	The subproject supports government agriculture policy.
2	**Socio-economic Relevance.** Be consistent with medium and long-term socio-economic development plans at the provincial and district levels.	The subproject aims to help improve the livelihoods opportunities for the catchment beneficiaries.
3	**Effectiveness.** Have relatively simple and logical designs within one contiguous command area.	It is based on a single distribution system to a command area along one valley.
4	**Safeguards Compliance.** Comply with government and ADB safeguard guidelines and involve a minimum of negative environmental and resettlement impacts, i.e. only MONRE category 1 and ADB safeguard category B or C will be considered. Preference where works are maintained within existing footprint or right of way to minimise land acquisition costs to government.	This IEE confirms that it complies with MONRE category 1 and ADB safeguard category B, and that the anticipated environmental impacts can be satisfactorily mitigated.
5	**Location 1.** Subprojects must be located in rural areas where the majority of beneficiaries are likely to be dependent upon agriculture for their livelihoods.	The villages of the Nam Seng catchment fit into this category.
6	**Location 2.** Subprojects must not be located in any area where a major development, such as a new hydropower scheme, a mine, major land concession, or a Special Economic Zone, is planned.	No such scheme is known, despite exhaustive enquiries among the government agencies and development partners.
7	**Commitment.** There must be demonstrated local commitment to the subproject with confirmation by beneficiaries (inclusive of women and ethnic groups), participating kumbans, and district authorities to that effect, including a confirmed willingness of beneficiaries to contribute land voluntarily for tertiary canals.	This has been expressed verbally and minuted at a number of stakeholder meetings. It will be formalised in signed agreements before the subproject is implemented.
8	**Financial Scale.** The estimated cost of the subprojects must be in the range of $0.7 to $2.0 million (with any exceptions specifically justified).	Detailed costing is not yet available, but the subproject cost is expected to be around the middle of this range.
9	**Productivity.** All proposed subprojects will include more than one type of PRI infrastructure.	Canal improvements and piped distribution are key elements.
10	**Social Conflict.** No significant social conflict in the watershed that will delay investment.	This has not been identified as a constraint during investigations.
10	**No Pumped Schemes.**	No pumping will be involved.

No.	Eligibility Criteria	Nam Seng Subproject
11	**Improved Resource Utilisation.** Prioritise the sustainability of assets through WUG or provincial Government to commit to support periodic maintenance through written assurance. Where an existing WUG is operating, the PAFO/DAFO is to obtain written agreement of each stakeholder prior to the field visits.	Options for a sustainable management system have been discussed at a number of stakeholder meetings. The agreed mechanism will be formalised in a signed agreement before the subproject is implemented.

E. Analysis of Alternatives

34. The engineering options were effectively prescribed during the original design of the Nam Seng Irrigation Scheme. During the TRTA design options for dry season water management and water schedules were added to the original design allowing for increased water use efficiency and far greater value per unit volume of water delivered.

35. During the technical assistance inception period, a large number of possible subprojects were assessed for suitability. In Luang Prabang Province, as elsewhere, subprojects were proposed by the PAFO for consideration. The consultants used an agreed screening process, which was defined in the technical assistance Inception Report. This led to seven subprojects being selected for a short list: these are shown in Table 3. Although these may be funded later as SRIWSM subprojects, at this stage they remain alternatives compared with the subproject that is the subject of this IEE.

Table 3: Subproject Short List – Luang Prabang Province.

District	Subproject	Command Area (ha)		Catchment Area	Villages	House-holds
		Wet Season	Dry Season	(km^2)	(no.)	(no.)
Nan	Nam Seng Existing	350	350	154	9	421
Nan	Nam Seng CA expansion block 256ha	256	180		3	380
Nan	Nam Seng CA Expansion Block 2 and 3 344ha	344	130		8	520
Nan	Nam Nan (1-5)	354	258	212	16	545
Xieng Ngeun	Nam Khan (1-4)	131	73	238	9	114
Luang Prabang	Nam Pa	40	40	639	2	42
Luang Prabang	Houy Xi (2-3)	338	135	12.5	7	286

36. From the short list, one representative subproject was selected for each province. This secondary selection process focused on several parameters. Overall the types of subproject

selected were considered in terms of ADBS sector modality requirements for the representative subprojects to adequately reflect the likely scope of investment under the SRIWSM. This requirement enables the feasibility to identify the viability of the proposed scope of investment.

37. Given Government policy seeks to increase the value of past irrigation capital investment through agriculture diversification and intensification within existing built irrigation scheme command areas the sites were also considered from the perspective of building a demonstration of modern irrigation, efficient irrigation management, and overall development impact. Nam Seng subproject was selected due to the potential to develop a highly accessible command area, linked to two regional markets in Thailand via Xayaboury and to People's Republic of China via the railway network expected in 2021.

38. The demonstration value will be built around a structured monitoring programme, implementation of Lao Good Agricultural Practice (GAP) systems, farmer-first research, and technology demonstrations that respond to market-led agriculture as part of the IFA financed investment. The SC1 on the western side of the Luang Prabang – Xayaboury road is considered to offer the greatest opportunity for demonstrating project effectiveness with substantial improvement in both wet and dry season productivity by extending the use of the existing infrastructure at an acceptable cost and benefiting the greatest number of additional households.

III. LEGAL AND POLICY FRAMEWORK OF THE IEE

A. Lao PDR Environmental Law and Policy

39. Government policy on environmental protection is expressed in the eighth National Socio-economic Development Plan (SEDP), for the period 2016 to 2020. This builds on the achievements in previous planning periods, including the regularisation of environmental assessment procedures through the widespread use of IEE and environmental and social impact assessment (EIA), greater use of environmental monitoring and the establishment of five environmental laboratories, including a national laboratory certified to ISO standards. In the eighth SEDP, environmental protection, climate risk and disaster preparedness are effectively mainstreamed by placing them as the third of three major outcomes, albeit behind overall economic growth and the development of human capital. This raising of the profile of environmental issues means that all forms of natural resources development should be sustainable during the plan period, with greater emphasis given to management plans and monitoring, and reinforcing of the "polluter pays" principle through increased taxes of largescale resource users and fines against abusers.

40. Specific policy for environmental management of investment projects is provided in the objectives for the Decree on Environmental Impact Assessment, dated April 2010 (EIA Decree), which states that all investment projects may create adverse environmental and social impacts, are to be designed with the correct and appropriate environmental and social impact prevention and mitigation measures or environmental management and monitoring plans (EMMP)[1] and social management and monitoring plans (SMMP).

41. The law governing the protection of the environment, including the assessment and management of projects, is the Environmental Protection Law (EPL) 1999, which is further

[1] The Government requirement for an Environmental Mitigation and Management Plan (EMMP) is referred to as Environmental Management Plan (EMP), hereinafter.

elaborated on by the Decree on the Implementation of the EPL of 2002. Responsibilities and procedures for environmental assessment, together with requirements for environmental monitoring of projects, were revised and are set out in the new EIA Decree.

42. The EIA Decree sets out the principal institutional arrangements, assigning primary responsibility for undertaking environmental assessment of projects to the project developer, which may be an individual or private sector entity as well as a government department. In the case of development projects, the relevant line ministry is responsible to review and assess draft environmental assessments and issue its own approval before submission to the Ministry of Natural Resources and Environment (MONRE), formerly the Water Resource and Environment Administration (WREA) – and local administrations, as appropriate.

43. The MONRE is responsible for the review and approval of category 2, EIA-level environmental assessment reports, coordination of monitoring and evaluation, and issuance of compliance certificates, acting through the head office in Vientiane or through its provincial departments. Public participation and discussion with local administrations is required throughout the environmental assessment process. The approval of category 1, IEE-level environmental evaluations and award of permits is devolved to the respective provincial department (PONRE).

44. The MONRE was created in 2011 by merging the WREA with departments of the National Land Management Authority (NLMA) and portfolios of other ministries including the Geology Department, and the Forest Conservation and Divisions within the Ministry of Agriculture and Forestry (MAF). The MONRE houses the Department of Environment, which hosts the Climate Change Office that acts as the Designated National Authority or national focal point for the United Nations Framework Convention on Climate Change. The Department of Forest Resource Management (DFRM) was formed within the MONRE in 2012. Under MONRE's technical directive, a PONRE has been established in each province.

45. Investment projects are categorised according to a schedule in the EIA Decree into one of the following, unless they are very small.

(i) Category 1: Small scale investment projects with minor environmental and social impacts, for which initial environmental examination is required.
(ii) Category 2: Large scale investment projects which are complicated or create significant environmental and social impacts, for which environmental impact assessment is required.

46. For irrigation projects, those with a command area of between 100 and 2,000 hectares (ha) are in category 1, and those with a command area greater than 2,000 ha are in category 2. In the EIA Decree, where a project is of a type that is not in either category, an investment application is submitted to MONRE for screening. This subproject has a command area of 265 ha with negligible impacts so does not fall into Category 1 or 2.

47. Lao PDR is signatory to the following international environmental agreements, the provisions of which apply:

(i) ASEAN Agreement on the Conservation of Nature and Natural Resources
(ii) Convention for the Protection of the World Cultural and Natural Heritage
(iii) Agreement on the Cooperation for Sustainable Development of Mekong River Basin
(iv) United Nations Convention to Combat Desertification

(v) United Nations Framework Convention for Climate Change
(vi) Convention on Biological Diversity
(vii) Montreal Protocol on Substances that Deplete the Ozone Layer
(viii) Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer
(ix) Millennium Declaration
(x) Convention on International Trade in Endangered Species of Wild Fauna and Flora
(xi) Stockholm Convention on Persistent Organic Pollutants
(xii) Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention)
(xiii) Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

48. Several laws and regulatory decrees and directives underpin the national adherence to these international conventions. Examples of these include the following, although this is not an exhaustive list.

(i) Law on Water and Water Resources (2017) 23.
(ii) Decree on Compensation and Resettlement Management in Development Projects, No. 84, dated 5 April 2016
(iii) Directive on the Prohibition of Hunting and Trading Wildlife and Aquatic Animals, Nationally and Internationally, and of Providing Passage to Third Countries, No. 76/MAF, dated 2 June 2002
(iv) Law on Chemical Management No. 07/NA, dated 10 November 2016
(v) Decree on Pesticide Management, No. 258 /GOV, dated 24 August 2017
(vi) Regulation on Control of Pesticides in Lao PDR, No. 2860/MAF, dated 11 June 2010

49. The EIA Decree sets out in detail the procedures, rights and responsibilities for the preparation and approval of IEE, and the preparation, approval, implementation and verification of EMP.

50. **Environmental Standards.** The government published its National Environmental Standards in 2017, that supersede the previous 2010 standards. These cover air quality, water quality, water quality, noise and vibration in considerable detail. The project shall use these standards as part of its safeguarding programme, and they are to be incorporated into each subproject IEE. While standards have been developed, the implementation of these standards has yet to be defined within the legal or regulatory framework. In some instances, such as for the purpose of preparing EIA for major development projects, the government provides guidance such as the requirement for a specified minimum proportion of instream flow to be retained as an environmental flow.

51. Operational implementation of the standards has yet to be fully defined by the government. Where no guidance or procedural protocols are detailed, the EARF will apply international best practices, as required by ADB SPS. For example, the borrower will apply pollution prevention and control technologies and practices (for parameters that would affect human health, eg. air pollutant and noise emissions) as reflected in internationally recognised standards, such as IFC General Environmental Health and Safety Guidelines (World Bank Group, 2007).. When host country regulations differ from these levels and measures, the borrower will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project

circumstances, the borrower will provide full and detailed justification for any proposed alternatives.

52. For surface water quality the national standards are adopted, as presented in Appendix 5. National standards for agricultural water use are intended to protect food safety as well as the aquatic biota in downstream water ways. The broad range of parameters defined under the standards would result in significant requirements for water quality testing. The Project adopts a risk-based assessment approach as applied by the USDA for irrigation surface water quality. Based on the risk based assessment, certain parameters defined under national standards will be tested to establish crop season data sets within the practical constraints that are outlined below. The Project includes a strong focus on integrated pest management to minimize the risk of increased use of agrichemical inputs and potential associated pollution impacts on groundwater and other drinking water sources.

B. ADB Environmental Policy

53. ADB's environmental policy is described in Safeguard Policy Statement (SPS, 2009). The Operational Manual Bank Policies (OM Section F1/BP, Issued 1 October 2013) sets out procedures and guidance on the implementation of SPS. The Environment Safeguards: a Good Practice Sourcebook – Draft Working Document, dated December 2012 provides additional good practice guidance.

- **Category A:** A proposed subproject is classified as Category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works.

- **Category B:** A proposed subproject is classified as Category B if its potential adverse environmental impacts are less adverse than those of Category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for Category A projects.

- **Category C:** A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. An EIA or IEE is not required, although environmental implications need to be reviewed.

C. Categorization of the Nam Seng Irrigation Subproject

54. The Nam Seng Irrigation Subproject was screened using the criteria summarised in Table 4a, with the results shown in Table 4b, which forms part of the review process described in the EARF. The screening resulted in an allocation of the subproject to MONRE category 1 and ADB category B. The irrigated command area for this project is 265 ha. There will be environmental impacts, but the likely impacts are expected to be reversible and can be mitigated. An IEE and EMP is required for the subproject, the environment classification was confirmed as B during preparation.

Table 4a: Environmental Appraisal Categorization Checklist

Screening issue	Outcome
1. Will the subproject involve an irrigation command area of more than 2000 hectares?	• If "yes", then it qualifies as MONRE category 2 (ADB category A) and cannot be supported. • If no, then address all of the questions below.
2. Will the subproject involve an irrigation command area of more than 100 hectares? 3. Might the siting of the subproject cause the removal of native trees and shrubs? 4. Might the site of the subproject be affected by climate conditions including extreme weather-related events such as floods, droughts, storms or landslides? 5. Will the subproject cause alteration of surface water hydrology that might result in increased sediment in streams? 6. Will there be bare surface at the construction site that might give rise to soil erosion? 7. Might silt and waste runoff from construction lead to a deterioration of surface water quality? 8. Might there be increased air pollution due to subproject construction and operation? 9. Might there be increased noise and vibration due to subproject construction and operation? 10. Might the subproject or its construction generate solid waste or hazardous waste? 11. Might chemicals or fuels be stored and used for the subproject or its construction? 12. Might wastewater be produced during subproject construction or operation? 13. Might there be construction dust and erosion from earthworks? 14. Might there be any loss of habitat or micro-habitat for local biodiversity? 15. Might there be changes to local drainage? 16. Might the subproject involve an excessive use of local water resources? 17. Might the subproject lead to water use conflicts? 18. Might the subproject cause cumulative impacts on limited water resources? 19. Might the construction and use of access roads be close to and affect residences, waterways or other facilities due to dust, noise or runoff? 20. For agricultural components, might there be transport, storage, handling and use of materials, and inputs of seeds, seedlings, fertilisers and pesticides? 21. Might there be increased residues of plastics, including mulch materials, in soil and water? 22. Will soil conservation and management risks be increased or important for the sustainability of the infrastructure 23. Will the subproject increase the use of pesticides?	• If the answer to any one of these questions is "yes" **and** the potential adverse impacts are likely to be significant, irreversible, diverse or unprecedented, then it qualifies as MONRE category 2 and ADB category A and cannot be supported. • If the answer to any one of these questions is "yes", but the likely impacts are reversible and can be mitigated, then it qualifies as MONRE category 1 and ADB category B and requires an IEE (see Environmental Assessment and Review Framework). • If the answer to all of these questions is "no", then it does not fall into a MONRE category and ADB category C, it requires an investment application that must be covered by the Environmental Code of Conduct (see Environmental Assessment and Review Framework).

24. Will fertiliser use increase with the diversification and intensification of irrigated cropping? 25. Will there be a change greenhouse gas emissions? 26. Will there be increased risks to occupational safety and health from physical, chemical hazards including UXO? 27. Will there be changes to the Community Safety and Health risk arising from traffic and vehicle movement, in-migration of labor, and chemical use?	

Table 4b: Environmental Appraisal Categorisation Checklist Completed for Nam Seng.

Screening issue	Finding
1. Will the subproject involve an irrigation command area of more than 2000 hectares?	• No.
2. Will the subproject involve an irrigation command area of more than 100 hectares?	• Yes, it involves a command area of 265 ha.
3. Might the siting of the subproject cause the removal of native trees and shrubs?	• No
4. Might the site of the subproject be affected by climate conditions including extreme weather-related events such as floods, droughts, storms or landslides?	• Yes. Flood events are expected to increase, Drought is in determinant as AWARE assessment predict declining rainfall but this is highly uncertain and the report concludes that rainfall may go up or down
5. Will the subproject cause alteration of surface water hydrology that might result in increased sediment in streams?	• Current baseline is already modified through the transfer of water between catchments. The subproject per se will not alter the baseline
6. Will there be bare surface at the construction site that might give rise to soil erosion?	• Minimal but this will be carefully controlled through the EMP.
7. Might silt and waste runoff from construction lead to a deterioration of surface water quality?	• Yes, but this will be carefully controlled through the EMP.
8. Might there be increased air pollution due to subproject construction and operation?	• Yes, but this will be carefully controlled through the EMP.
9. Might there be increased noise and vibration due to subproject construction and operation?	• Yes, but this will be carefully controlled through the EMP.
10. Might the subproject or its construction generate solid waste or hazardous waste?	• Yes, but this will be carefully controlled through the EMP.
11. Might chemicals or fuels be stored and used for the subproject or its construction?	• Fuel will be stored, but this will be carefully controlled through the EMP.
12. Might wastewater be produced during subproject construction or operation?	• Yes, but this will be carefully controlled through the EMP.
13. Might there be construction dust and erosion from earthworks?	• Yes, but this will be carefully controlled through the EMP.
14. Might there be any loss of habitat or micro-habitat for local biodiversity?	• No biodiversity habitat of significance will be affected. Fish assessment by LARAC identified no impact due to the nature of the Nam Seng River bed.
15. Might there be changes to local drainage?	• No the area to be irrigated is already under paddy wet season rice

16. Might the subproject involve an excessive use of local water resources?	• No if he scheme is fully developed to design parameters an environmental flow of 20% of minimum flow is expected, however SRIWSM will not develop the total remaining areas, and is using HVC that do not require irrigated after February, effectively saving water
17. Might the subproject lead to water use conflicts?	• No
18. Might the subproject cause cumulative impacts on limited water resources?	• No
19. Might the construction and use of access roads be close to and affect residences, waterways or other facilities due to dust, noise or runoff?	• Possibly. The proposed access roads that will be improved are mostly away from habitation, but limited impacts are possible.
20. For agricultural components, might there be transport, storage, handling and use of materials, and inputs of seeds, seedlings, fertilisers and pesticides?	• Yes, but the command area has a main road access through the center with commercial and residential areas along the road including storage facilities. Additional agrichemical use is seen to be minimal and in the case of dry season cropping may reduce agrichemical use relative to dry season rice • Nutrient use will increase over the baseline of rainfed wet season rice to reflect the two crops, proposed DS HVC options will involve less nitrogen (UREA) but higher application of NPK 15-15-15 but at rate of 150 to 200kg/ha
21. Might there be increased residues of plastics, including mulch materials, in soil and water?	• No
22. Will Soil Conservation and Management risks be increased	• No – to the contrary substantial gains are likely
23. Will the subproject increase the use of pesticides	• Command area pesticide use is unlikely to increase although the crop type and chemical used may change
24. Will fertiliser use increase	• Based on expected soya bean cropping the fertiliser use will change from nitrogenous fertiliser to phosphate and Potash, with multiple cropping in the dry season fertiliser use may increase
25. Will there be a change in greenhouse gases	• Yes but minimal declines, from the reduction in dry season paddy production and the movement away from nitrogenous fertilisers
26. Will there be increased risk to occupational	• Occupation risks will increase for

safety and health from physical and chemical hazards including UXO	areas not previously dry season cropped with additional canal structures, UXO exposure is however low but will require certified clearances
27. Will there be changes to the Community Safety and Health Risks from Traffic and vehicle movement, in-migration and chemical use	• Construction vehicle risks will increase however post construction community access will not require the use of the main road reducing risks from traffic, local construction is expected and the labor risks to community will be low but need to be managed, chemical use will increase as cropping during the dry season is adopted

D. Environmental Standards

55. in addition to national environmental standards, to ensure that each subproject maintains best environmental practices, a number of additional guidelines have been defined. These are listed in the accompanying EMP. They cover a wide range of construction site management issues to help ensure compliance by contractors, and are to be used throughout the subproject to underpin the environmental mitigation measures adopted in the EMP.

56. The World Bank Group Environment, Health and Safety General Guidelines (2007) also provide indicative standards designed for use in an international setting where national standards are not fully developed. Elements of these and the subsequent elaboration of these have been adopted in the project-specific guidelines listed in the EMP. National Surface Water Quality standards are also included in the EMP appendices. There are no comparable international standards for water used for agriculture.

IV. DESCRIPTION OF THE SUBPROJECT ENVIRONMENT

A. Topography and Geology

57. The underlying geology of Luang Prabang Province is mainly a mixture of ancient igneous and metamorphic rocks. Considerable areas are of Carboniferous origin. It is a complex structure, with a great deal of faulting that trends north-east to south-west. Tectonically it is stable. Geotechnically, slopes formed in the older igneous and Carboniferous metamorphic rocks should be strong, but there may be weaknesses – and a potential to landsliding – in the limited areas of weaker sedimentary rocks. Major slopes, even in the stronger rock types, might have superficial layers of colluvium that could give rise to shallow slope failures.

58. The topography of the Nam Seng catchment is shown in Figure 6. An area of high hills, rising to about 1800 metres, runs around the eastern and southern sides of the catchment, with a series of streams running off them. The streams form three main rivers that coalesce low in the catchment to form the Nam Seng, which flows generally westwards. At the point where it leaves the subproject area, the river is about 400 metres above sea level. The subproject area of the catchment extends about 20 km north-south and 20 km east-west.

59. The topography of the Nam Nan catchment has far less steep hill country. Elevations increase to the north east and the western and eastern boundaries. The drainage river is the Nam Nan to flows into the Mekong river. In total the Nam Nan Catchment area is 300sq km and while the 2010 land use data indicates that the 2015 satellite images clearly show extensive areas of cultivated upland crops indicating the large-scale land conversion since 2010.

B. Soils, Vegetation Cover and Land Utilisation

60. Soils in the subproject area are mostly Acrisols. These are heavily weathered, clay-rich tropical soils that are usually moderately acidic and can have high contents of iron and aluminium, and relatively low fertility. In the lower-lying locations, where soil drainage is limited, soils are subject to waterlogging and therefore have the characteristics of Gleysols (i.e. soils subject to seasonal changes in saturation, and consequently the aeration and oxidising or reducing conditions that strongly dictate the growing conditions for plants. Luvisols also occur in some parts of the landscape, showing heavy leaching and the displacement of clay.

61. Vegetative cover in the water source catchment of Nam Seng from 2010 and 2018 satellite imagery assess the trends over the last eight years. Extensive cloud coverage and shadow in the 2010 satellite image make it difficult to be precise about the trends. Based on this interpretation, the areas of different land cover were calculated as shown in Table 5, as mapped in Figure 7. Based on this the increase in upland cropping amounted to less than 0.05% of the total catchment during this period or an increase of 10 ha per year.

Figure 6: Outline Topographic Map of the Nam Seng Catchment.

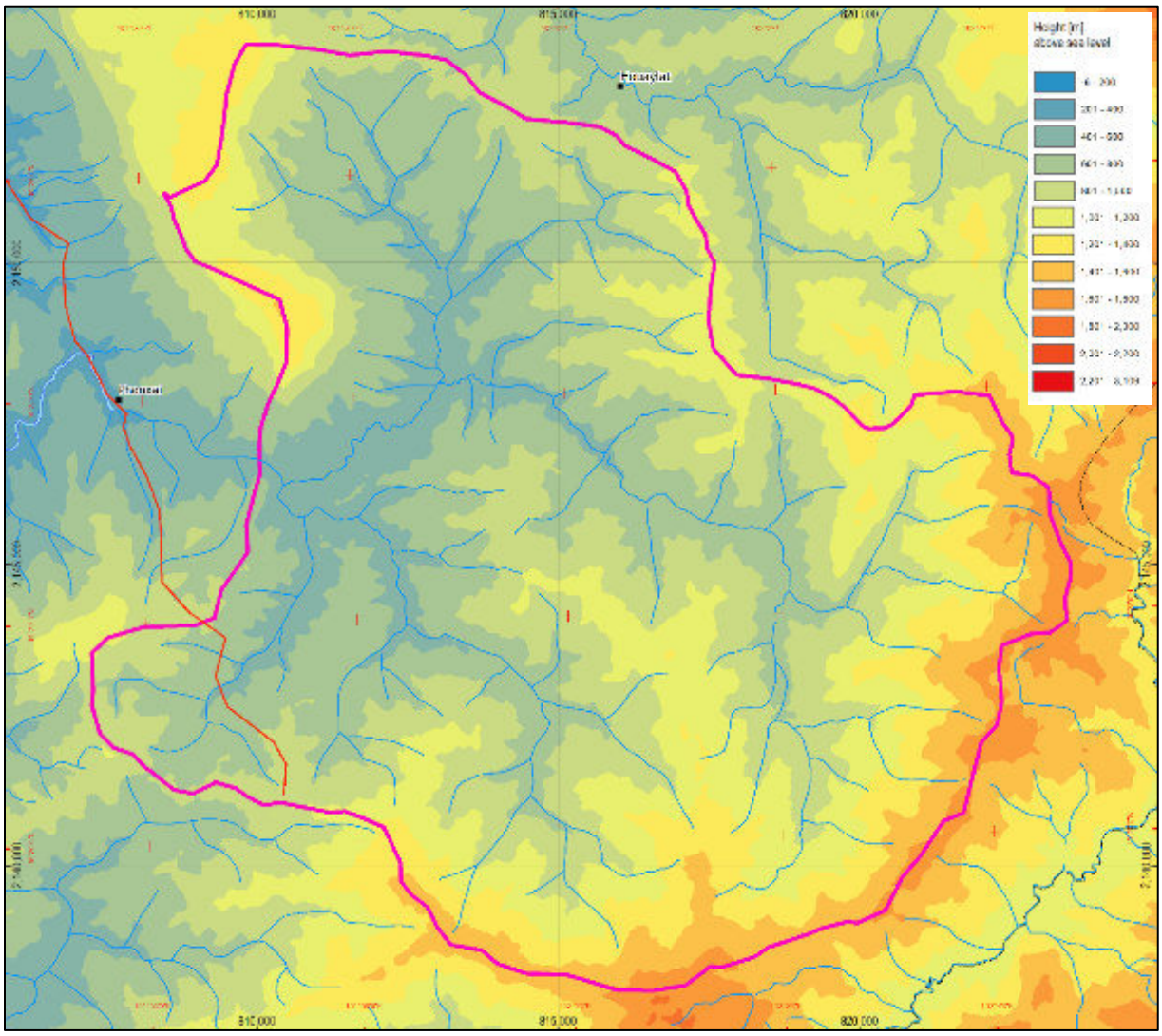


Table 5: Defined Land Use Areas based on Satellite Imagery Interpretation

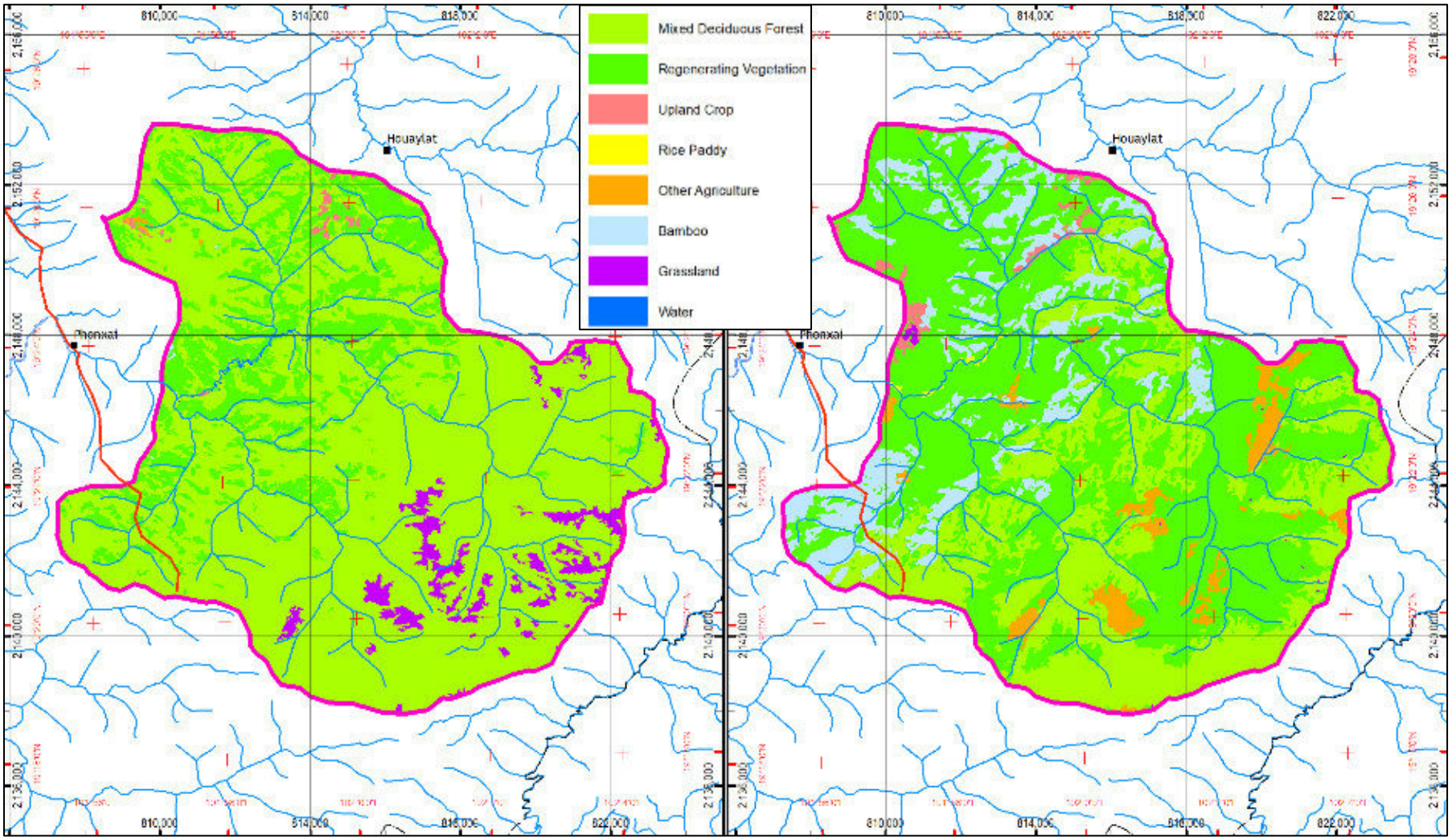
Land Use	Area 2010 (ha)	Area 2018 (ha)	Variation (ha)
Mixed deciduous forest	11,925	4,256	-7,669
Bamboo	6	1,845	1,840
Regenerating vegetation	2,834	8,597	5,763
Grassland	582	17	-565
Upland agricultural cropping	54	138	84
Rice paddy	0	23	23

Other agriculture	13	557	544
Other land	1	0	-1
Water	17	0	-17
Total catchment area	15,433		

62. Based on interpretation of Table 5 and Figure 7, the following changes appear to have occurred in the Nam Seng catchment between 2010 and 2018.

- Mixed deciduous forest, which covered 77 percent of the catchment, has declined by two thirds. The catchment appears to have been relatively pristine in 2010, but to have undergone major changes since then.
- Around 67 percent of the catchment is now covered by bamboo and regenerating forest, suggesting that it has been used for shifting cultivation in recent years.
- Areas currently under upland agricultural cropping have increased and now appear to occupy 4.5 percent of the catchment (i.e. 695 hectares). This is ten times more than in 2010, when it was a very small proportion of catchment land use. Most of this appears to be maize and job's tear at present.
- The change from forest to degraded vegetation cover (i.e. grassland, bamboo and regeneration, presumably different stages of fallow and regenerating forest) has averaged 880 hectares per year over this period.
- If most areas are only cropped for one year, then it suggests that there is currently less land under upland cropping than has been the case in previous years.
- The small area of paddy (only 23 hectares) remains unchanged.

Figure 7: Interpretation of Land Utilisation in the Nam Seng Catchment: left, 2010; right, 2018.



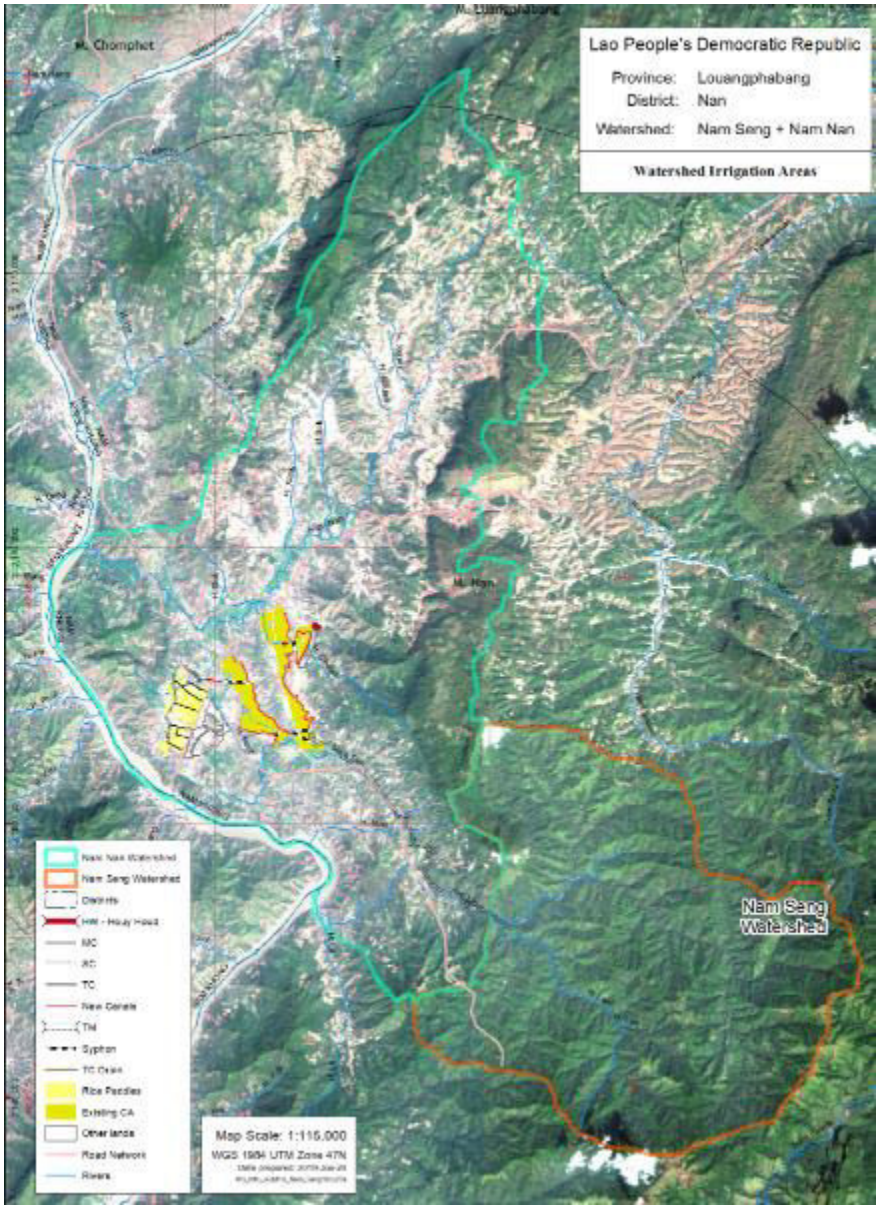


Figure 8: Nam Nan Catchment

63. Nam Nan catchment (see Figure 2) is highly modified with extensive upland cropping based on rotations of maize and jobs tears. The majority of this conversion has used mechanisation up to the limits of vehicular safety and with the use of herbicide for land preparation. There is significant and growing risk of soil erosion within the catchment. Residual forest cover is highly fragmented and face ongoing conversion along the upland cropping margin.

64. Cultivated land has land use rights that, in some instances, have been transferred and aggregated through informal contracts that often involve the legal owner transferring their tax book. The direct impact on the subproject SC1 command area is minimal as water is derived from the Nam Seng catchment system.

65. Potential agri-chemical contamination from upland cropping areas through surface water is highly unlikely apart from the area that directly drains into the SC command area. Also the

predominant use of glyphosate as the herbicide of choice that has short active life in both soil and water reduces the risk

C. SC1 Command Area Land Use

66. The command area is essentially a flat valley floor plain that drains into the Houay Lay river and thereafter into the Mekong river above the Xayaboury dam. Within the command area land is highly modified with paddy plots and bunds that have been established over a long period of time. Surrounding the valley floor are low sloping hills that are being used to grow banana under a concession held consortia of four companies. The banana plantation was irrigated by spray and drip through a pumped scheme where water is sourced from the Nam Nan river. There are reports but little evidence of soil erosion in some parts of the plantation. Agrichemical use is high both in terms of application to the plantation during the growing season and through the dipping of ripe bunches. Soil contamination is unknown but likely to be in localised places associated with open pits being used for waste chemicals at or near the dipping stations.

67. Occupational risk and community risks to local households that work or live adjacent to these sites is high, with reported instances of chemical burns and deaths when bunch dipping and washing facilities fail discharging chemicals onto workers and their families. The operation is due to be closed down following the harvest.

68. Other land use adjacent to the command areas include Maize, groundnut and teak woodlot plantations. The following figures provide an overview of the SC1 command area.

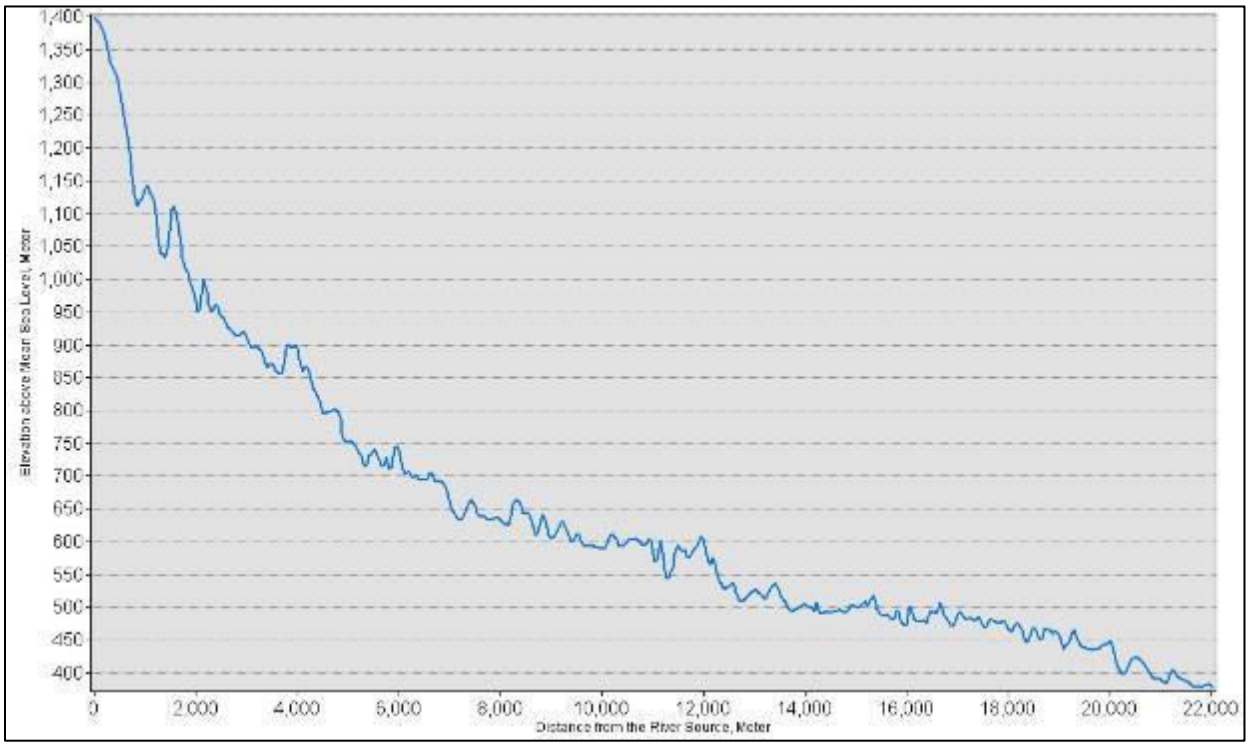



69. Within the command area the main canal was realigned to avoid residential houses, graves, and a historical Korea religious site – see Figure 3 below. The subproject command area layout and operation ensure that these sensitive receptors are not impacted by the subproject.

D. Water Resources

70. The Nam Seng forms a steeply falling hill catchment with a classic profile, shown in Figure 8, that gradually flattens down the valley. The catchment area above the existing headworks that will be upgraded by the GIZ / GCF project covers approximately covers 210 km^2.

Figure 9: Longitudinal Profile of the Nam Seng above the Headworks.



E. Climatic Conditions

71. There was no available weather data specifically for the Nam Seng or Nam Nan District, so climate must be considered at the provincial scale. Luang Prabang as a whole has a humid tropical climate, being situated between 19.0 and 21.5 degrees north of the equator. Average temperatures are generally in the range of 15 to 30 degrees centigrade throughout the year in the valleys. Temperature declines with elevation, to the extent that the high land at the heads of the mountain catchments have temperature regimes about five to eight degrees cooler than the valley bottoms. To this extent the higher areas might be considered to have subtropical climates, while the valley bottoms are tropical.

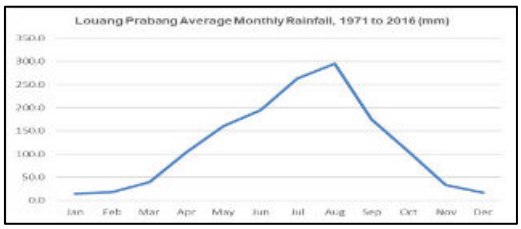
72. Moisture is dominated by seasonal air movements, with most rainfall coming with the south-west monsoon during the northern hemisphere summer. Simply put, the northward migration of the sun draws warm, moist maritime air from the Indian Ocean across the land masses of south and south-east Asia. Rainfall varies across Lao PDR, but Luang Prabang is in a relatively low rainfall belt. The only weather station in the Province, at Luang Prabang City, has recorded an average annual rainfall of 1,420 mm over 45 years. The range of annual totals recorded over this period has variations between about 1000 and 2200 mm. This is a significant variation – 30 percent below the mean and 55 percent above it – and so much variability over this

period suggests that over a longer timeframe there is likely to be even wider extremes. Monthly and annual rainfall figures are given in Figure 9.

73. The pattern is for increasing rain as pre-monsoon warming gives rise to convective cells that produce thundery downpours through March, April and May. The monsoon arrives in June, with rainfall highest – typically around 250 to 300 mm per month – in July and August. The monsoon weakens and dissipates in September, with the last substantial rain clearing usually in the first half of October. This leads into the pronounced dry season from November to February. However, this pattern can be altered in any year by the passage of tropical cyclones, usually affecting Lao PDR from the South China Sea: these are discussed below.

Figure 10: Monthly Rainfall (mm) at Luang Prabang.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1971	4.1	9.3	5.2	-	149.0	212.1	482.7	312.6	47.3	12.9	-	5.9	1,241.1
1972	13.0	52.1	27.0	149.9	65.7	33.7	141.8	210.4	144.6	138.7	63.5	1.8	1,042.2
1973	-	1.9	61.9	69.0	106.0	51.6	324.2	407.7	346.3	66.2	2.8	-	1,437.6
1974	8.7	-	44.9	164.9	102.0	90.6	184.2	304.6	144.3	86.1	4.7	4.0	1,139.0
1975	54.9	17.0	37.6	19.4	190.8	52.9	302.7	273.2	196.7	93.1	14.9	9.1	1,262.3
1976	2.3	69.2	4.7	112.4	170.4	191.9	200.7	267.4	269.0	120.4	55.5	-	1,463.9
1977	26.0	-	17.6	99.1	140.6	57.0	359.7	219.1	158.1	235.5	94.0	57.2	1,463.9
1978	20.2	37.4	11.4	121.9	174.2	246.0	294.9	293.4	191.7	245.5	-	-	1,636.6
1979	43.8	50.2	-	109.3	271.5	237.4	183.5	319.0	49.5	97.4	-	-	1,361.6
1980	0.2	37.2	-	63.8	130.5	330.9	255.2	254.1	258.8	115.9	22.0	16.6	1,485.2
1981	-	-	11.8	208.4	277.5	210.9	282.6	279.2	174.8	355.1	31.3	-	1,831.6
1982	12.2	1.0	23.5	127.4	225.4	193.4	156.4	232.5	174.6	28.9	35.8	-	1,211.1
1983	50.2	34.4	44.5	28.2	169.0	199.1	223.8	359.2	56.9	95.7	44.3	24.5	1,329.8
1984	-	4.9	34.8	43.9	124.9	171.8	137.4	290.7	103.2	169.6	1.1	-	1,082.3
1985	4.9	31.7	17.7	132.3	128.8	116.1	141.8	292.6	103.7	22.4	101.5	-	1,093.5
1986	-	-	10.4	267.3	214.9	373.4	352.0	210.4	62.0	267.2	-	27.5	1,785.1
1987	2.2	29.0	-	145.5	57.4	122.5	180.2	193.5	130.9	28.1	98.9	-	988.2
1988	0.8	31.7	1.5	155.8	173.8	141.1	240.4	181.4	39.2	174.7	15.3	-	1,155.7
1989	13.7	-	69.1	-	156.3	154.2	287.4	288.9	160.8	130.5	-	-	1,260.9
1990	9.7	50.6	77.8	127.9	114.0	193.2	329.3	208.3	262.4	61.1	199.4	-	1,633.7
1991	9.9	-	47.5	32.6	169.8	103.0	179.7	267.2	206.4	21.8	19.4	6.3	1,063.6
1992	19.3	91.1	-	49.7	65.7	124.6	297.1	283.7	92.9	58.4	9.5	137.2	1,229.2
1993	-	-	76.8	80.7	146.1	212.5	263.5	189.5	100.6	118.6	-	1.0	1,189.3
1994	-	5.4	110.7	19.2	170.2	243.6	202.5	366.1	151.6	31.6	18.5	81.6	1,401.0
1995	7.5	4.8	8.7	49.0	201.5	239.4	331.4	541.5	118.8	167.0	71.3	7.0	1,747.9
1996	-	22.0	38.9	147.2	151.6	219.9	291.8	302.4	176.6	185.0	61.2	-	1,596.6
1997	1.5	0.4	56.9	105.7	144.3	147.7	311.6	258.5	128.4	40.1	2.4	-	1,197.5
1998	27.0	2.2	33.0	178.1	160.9	138.2	179.4	265.4	99.4	47.1	25.5	7.5	1,163.7
1999	9.0	-	44.1	60.3	203.5	281.1	73.9	285.0	197.5	97.9	54.9	24.5	1,331.7
2000	-	35.3	11.5	68.0	243.5	269.1	274.4	233.9	228.4	115.6	-	7.0	1,486.7
2001	8.1	-	155.9	53.0	191.9	156.8	393.1	395.7	246.2	192.3	2.0	-	1,795.0
2002	48.5	1.1	24.0	55.5	268.8	155.6	384.4	258.9	161.4	71.0	75.7	96.9	1,601.8
2003	14.6	19.5	76.6	140.0	68.2	315.4	195.5	313.6	222.6	35.0	-	-	1,401.0
2004	15.3	-	-	143.1	240.5	208.4	286.9	233.0	152.2	165.5	27.8	-	1,472.7
2005	-	10.0	82.2	55.8	134.9	307.0	296.8	269.6	200.9	23.1	31.3	23.4	1,435.0
2006	-	17.5	73.9	82.9	93.7	78.1	306.9	266.3	164.1	122.5	-	-	1,205.9
2007	1.0	12.2	30.4	118.7	125.0	138.2	146.9	242.7	256.0	117.2	37.0	-	1,225.3
2008	50.4	60.6	136.6	166.5	154.7	230.6	357.9	272.9	171.3	73.8	13.4	20.0	1,708.7
2009	0.0	0.7	23.6	112.1	127.0	218.2	373.2	169.8	147.2	78.6	9.0	-	1,259.4
2010	23.4	-	24.6	198.4	115.5	146.4	321.1	372.4	90.4	19.2	-	57.2	1,368.6
2011	6.7	-	121.6	127.0	272.3	520.2	291.1	532.5	269.1	83.8	9.2	-	2,233.5
2012	10.8	-	27.7	174.7	226.3	321.5	306.0	337.0	106.8	102.5	118.3	1.4	1,733.0
2013	28.0	1.5	67.5	93.8	141.1	244.6	288.9	394.1	332.9	124.4	28.0	56.9	1,801.7
2014	-	-	15.6	54.7	119.0	205.4	198.3	273.1	470.4	79.7	52.3	-	1,468.5
2015	60.7	72.4	27.4	136.6	87.4	129.1	238.6	428.1	158.2	90.1	28.4	110.1	1,567.1
2016	82.6	2.5	-	123.7	220.9	225.1	232.8	410.6	332.8	8.2	70.9	-	1,710.1
Average	15.0	17.8	39.5	103.8	160.6	194.8	262.7	294.8	175.2	104.7	33.7	17.1	1,419.6
Minimum	0.0	0.0	0.0	0.0	57.4	33.7	73.9	169.8	39.2	8.2	0.0	0.0	988.2
Maximum	82.6	91.1	155.9	267.3	277.5	520.2	482.7	541.5	470.4	355.1	199.4	137.2	2,233.5

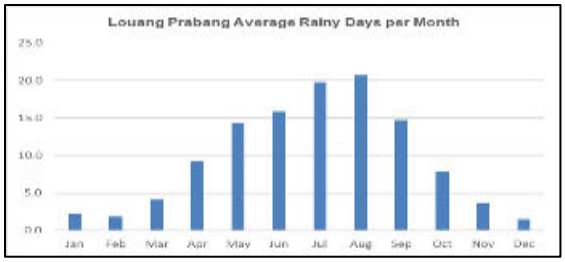


74. The annual spread of rainfall can be seen by the data on the number of rainy days per month, given in Figure 10. Although it is not rare for there to be no rain in a month, longer periods

can also be seen where there is very little: for example, there was a total of 6.4 mm of rain in four days in the period of November 1993 to February 1994, presumably giving a significant drought. By contrast, it is rare for there to be rain on less than half the days in July and August, and sometimes in August there are less than five days with no rain.

Figure 11: Number of Days with Rain by Month at Luang Prabang.

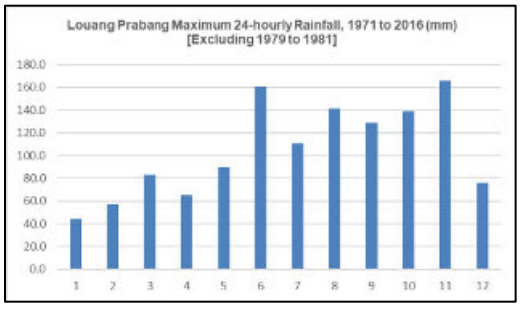
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1971	3	2	2	0	16	18	25	26	11	7	0	1	111
1972	2	2	3	21	8	11	17	23	14	5	6	2	114
1973	0	1	6	4	15	17	24	21	19	6	1	0	114
1974	3	0	10	15	11	15	18	23	17	9	2	1	124
1975	12	1	4	9	16	17	19	24	13	8	4	4	131
1976	1	2	3	10	14	20	16	22	16	9	5	0	118
1977	3	0	3	10	17	7	24	17	19	15	3	3	121
1978	5	6	2	10	19	19	21	26	16	9	0	0	133
1979	2	5	0	7	16	19	10	23	10	4	0	0	96
1980	1	3	4	10	17	27	24	16	13	9	2	4	130
1981	0	0	3	12	18	23	25	24	11	13	7	0	136
1982	2	1	2	17	14	11	19	22	21	7	6	0	122
1983	7	5	6	7	13	15	14	23	14	18	8	2	132
1984	0	3	1	7	17	16	18	23	13	11	1	0	110
1985	1	3	3	12	12	17	22	24	12	6	9	0	121
1986	0	0	2	17	16	18	16	18	9	8	5	5	114
1987	1	4	5	7	6	17	20	18	10	3	6	0	97
1988	1	2	1	9	13	16	19	20	9	8	4	0	102
1989	3	0	6	7	16	14	18	15	14	12	3	0	108
1990	2	4	6	10	19	17	21	15	21	7	5	0	127
1991	1	0	5	6	17	20	21	23	20	6	2	3	124
1992	5	3	0	6	9	10	20	18	15	16	1	2	105
1993	0	0	5	8	19	13	15	20	13	7	0	1	101
1994	0	3	9	4	15	19	21	27	17	5	3	6	129
1995	6	2	1	1	5	15	18	23	26	10	11	3	121
1996	0	5	5	9	15	19	21	17	12	7	5	0	115
1997	1	1	8	9	10	11	22	20	12	8	2	0	104
1998	1	1	3	14	15	16	19	15	8	7	5	1	105
1999	1	0	3	8	18	14	13	21	16	8	6	3	111
2000	0	5	1	6	21	19	21	14	11	8	0	1	107
2001	3	0	11	5	16	14	23	21	12	13	1	0	119
2002	3	1	3	8	19	14	25	20	13	10	7	4	127
2003	2	2	8	7	6	19	12	19	14	2	0	0	91
2004	3	0	0	14	16	13	18	22	16	5	5	0	112
2005	0	1	7	8	13	19	19	23	13	6	2	6	117
2006	0	3	6	11	12	16	22	25	10	7	0	0	112
2007	1	3	3	10	15	12	14	20	16	9	4	0	107
2008	3	5	6	14	11	17	26	21	18	11	4	2	138
2009	0	1	3	11	13	16	20	12	16	7	1	0	100
2010	6	0	6	12	11	13	22	26	12	6	0	4	118
2011	2	0	8	10	19	18	21	21	19	1	2	0	121
2012	2	0	2	12	18	11	21	20	14	5	10	1	116
2013	2	1	2	7	15	16	27	20	18	6	6	2	122
2014	0	0	4	6	8	13	18	20	21	4	5	0	99
2015	4	3	5	9	13	11	20	20	14	9	4	7	119
2016	6	1	1	6	18	17	20	20	18	5	5	0	117
Average	2.2	1.8	4.1	9.2	14.3	15.8	19.8	20.7	14.7	7.9	3.7	1.5	115.6



75. Rainfall intensity data are scarce, but the maximum 24-hour rainfall totals are available: see Figure 11. Some of the source data supplied were faulty. In general, these show the same pattern of greater amounts during the summer monsoon, although high figures after the monsoon are the result of tropical storms. The general pattern is that up to half a month's rain can fall in a single 24-hour period, except where a tropical storm can deliver a much higher proportion in an otherwise quite dry month.

Figure 12: Maximum Daily Rainfall (mm) at Luang Prabang.
Cells Shaded in Grey Contain Faulty Data.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Maximum
1971	1.8	1.3	4.7	0.0	37.0	47.9	94.4	52.2	13.2	5.1	0.0	0.0	94.4
1972	9.0	50.4	12.5	28.3	42.0	9.0	38.0	39.8	38.9	138.7	31.0	1.1	138.7
1973		1.9	24.0	32.6	32.0	10.4	54.9	124.4	95.6	5.5	2.8	0.0	124.4
1974	6.6	0.0	23.3	30.5	43.3	36.8	34.9	60.0	37.0	59.0	4.4	4.0	60.0
1975	20.0	17.0	18.0	4.7	73.5	10.5	60.1	64.0	47.0	34.9	11.1	4.9	73.5
1976	2.3	56.8	2.6	48.4	33.8	28.4	38.3	39.7	57.8	54.6	26.3	0.0	57.8
1977	44.4	0.0	3.6	28.9	35.0	9.7	108.8	54.2	32.2	100.0	56.0	25.7	108.8
1978	10.0	8.8	8.6	36.8	32.2	109.2	100.0	34.1	96.2	68.4	0.0	0.0	109.2
1979													0.0
1980													0.0
1981													0.0
1982	0.0	1.0	18.9	24.3	37.4	48.5	26.0	32.1	38.1	16.3	2.6	0.0	48.5
1983	10.2	4.0	13.6	13.1	23.0	10.7	30.6	38.8	3.9	14.3	18.1	22.8	38.8
1984	0.0	3.8	34.8	7.5	15.2	43.4	16.6	50.7	4.9	32.6	0.0	0.0	50.7
1985	0.0	12.9	17.0	8.0	27.1	11.0	9.3	32.9	30.6	5.0	23.3	0.0	32.9
1986	0.0	0.0	0.0	26.7	17.9	33.9	50.0	43.7	6.7	93.0	17.0	0.6	93.0
1987	2.2	15.7	19.5	46.6	1.3	18.9	43.8	66.2	37.5	28.1	50.3	0.0	66.2
1988	0.8	0.5	1.5	38.3	35.3	19.7	48.6	38.9	16.0	123.8	11.2	0.0	123.8
1989	1.9	0.0	29.1	50.1	59.6	69.1	58.8	96.0	46.7	54.6	14.9	0.0	96.0
1990	7.6	36.4	24.6	50.5	29.6	47.1	59.7	71.0	60.2	17.9	166.0	0.0	166.0
1991	9.9	0.0	18.1	12.2	50.0	14.6	42.2	81.6	37.4	13.5	11.2	4.5	81.6
1992	6.4	57.5	0.0	20.0	15.4	43.0	47.1	97.3	31.2	14.0	19.5	55.0	97.3
1993	0.0	0.0	23.4	35.5	26.5	73.8	46.1	44.1	21.3	50.3	0.0	1.0	73.8
1994	0.0	2.0	30.0	14.0	34.6	59.7	36.5	67.9	27.7	17.0	15.0	39.0	67.9
1995	0.7	0.0	8.7	12.5	57.0	39.0	64.1	96.7	31.6	85.5	42.0	7.0	96.7
1996	0.0	9.4	28.5	47.0	38.0	37.5	48.0	72.0	51.0	96.0	28.0	0.0	96.0
1997	1.5	0.4	17.2	31.0	49.0	50.0	58.9	41.1	33.0	10.6	0.0	0.0	58.9
1998	27.0	1.5	18.0	47.0	39.0	37.0	36.5	75.0	32.0	20.0	20.0	7.5	75.0
1999	9.0	0.0	32.4	17.0	90.0	54.0	18.0	40.0	54.0	35.0	20.5	36.0	90.0
2000	0.0	10.0	11.5	39.5	33.2	85.0	55.5	40.3	47.0	35.0	0.0	7.0	85.0
2001	4.6	0.0	75.0	17.1	28.5	39.0	83.1	79.5	77.5	78.3	2.0	0.0	83.1
2002	40.5	1.1	12.0	28.0	75.0	60.0	96.5	65.6	52.0	17.0	39.0	62.9	96.5
2003	9.1	14.0	43.5	61.0	43.0	73.0	58.5	43.6	52.5	25.5	0.0	0.0	73.0
2004	7.7	0.0	0.0	30.0	47.5	51.5	48.0	55.5	43.0	70.0	8.5	0.0	70.0
2005	0.0	10.0	30.0	31.1	24.0	120.0	81.6	38.5	54.0	5.5	31.0	11.0	120.0
2006	0.0	8.0	50.0	21.3	21.0	20.0	111.0	32.6	68.0	89.0	0.0	0.0	111.0
2007	0.0	0.0	3.4	25.5	29.0	60.0	29.5	63.5	54.3	70.8	28.0	0.0	70.8
2008	25.0	42.5	83.5	42.0	69.0	92.2	57.5	37.7	33.3	25.9	6.7	0.0	92.2
2009	0.0	0.7	13.8	60.7	45.5	58.5	107.3	42.0	28.0	27.4	9.0	0.0	107.3
2010	9.5	0.0	7.6	60.0	0.4	32.9	77.5	43.4	29.0	6.0	0.0	0.0	77.5
2011	5.0	0.0	39.3	24.8	58.5	160.7	72.0	107.5	37.0	83.6	4.5	0.0	160.7
2012	6.0	0.0	26.5	39.0	37.4	145.4	87.1	81.8	44.2	70.5	33.1	1.4	145.4
2013	24.0	1.5	34.5	38.3	22.2	86.0	51.7	141.2	87.1	65.2	9.0	55.9	141.2
2014	0.0	0.0	13.0	16.0	34.0	73.0	41.5	60.4	129.0	53.5	20.0	0.0	129.0
2015	42.2	50.5	13.5	33.5	31.0	36.4	30.1	100.4	53.5	28.0	10.7	75.9	100.4
2016	42.0	2.5	4.0	65.0	37.0	28.0	40.2	78.6	95.3	2.5	36.5	2.6	95.3
Maximum	44.4	57.5	83.5	65.0	90.0	160.7	111.0	141.2	129.0	138.7	166.0	75.9	166.0



76. The Climate Risk and Vulnerability Assessment gives a more thorough analysis of the risk and impacts of tropical cyclones, but it is important to consider the key factors in an IEE. The tracks and effects of typhoons across south-east Asia have been well documented over recent decades. There is variability between years, and in some years cyclones can develop into typhoons in every month of the year. However, the most common time for this to happen is in the spring or autumn. For Luang Prabang, the high monthly rainfall in October 1981 is presumed to have been from Typhoon Lorna (Figure 8). The exceptionally high daily rainfall figure of 166 mm in November 1990 is presumed to have been from Typhoon Mike, and that of 160 mm in June 2011 from Typhoon Haima (Figure 10). Although both of these had been downgraded before they had penetrated as far inland as Lao PDR, they could still have contained very large amounts of moisture.

77. Very intense rainfall is not only due to typhoons, however. Daily totals of around 140 mm are possible in the monsoon. This is also only for rainfall collection periods, and obscures possibly greater amounts of rain within 24 hours but split between two recording periods. Data are also not sufficient to ascertain cumulative heavy rainfall prolonged over a 48- or 72-hour period, and the effects of this on flood or landslide events. There are no parallel river level data to link with rainfall.

F. Hydrology

78. The flows in the Nam Seng River and Houy La River follow the rainfall pattern with the mean highest flows being in July and August and lowest flows in late March. There is no flow recording station installed on either river.

79. Estimates were made of the flows being diverted from the Nam Seng and Houy La headworks along their canals, on 3 February 2018. For Nam Seng, the flow observed at the outlet to the tunnel in the main canal (MC) was estimated to be 1.85 m^3/s about 80% of the total Nam Seng flow. At the Houay La headworks, 1.2 m^3/s was being diverted into canal MC1. There was residual flow observed passing over the Houy La weir and flowing on downstream. At the time of the visit, PIS staff reported that not all water was being diverted from the Nam Seng or Houy La headworks as the dry season demand was only for about 320 ha of rice. The headworks of both sites were again visited on 15 April 2018 and about 1.2 to 1.3 m^3/s observed in the MC, with a similar amount in the MC1. All water was being diverted from the river at both headworks sites. The PIS reported that observed flows were typical of the low flows at those times of the year.

80. The PIS reported that the potential irrigation scheme design is based on the minimum flows with the MC canal capacity being 3.2 m^3/s for supplementary wet season rice production (800 ha) and 1.8 m^3/s for irrigation of 500 ha of dry season rice production. Based on the observed flows and the reports from the PIS, there is sufficient flow to meet the wet season peak irrigation demand and still leave sufficient water in the Nam Seng for environmental purposes. For the dry season irrigation demand, with good management sufficient water is available throughout the cropping season to supply the existing 320 ha of dry season rice and also the 265 ha extended command area in a mix of field crops as proposed.

81. Climate change predictions suggest a potential for increased drought frequency and longer duration which will affect the recession flows in the rivers, and consequently scheme management. The peak irrigation daily water demand is likely to remain largely unchanged, but the duration for peak irrigation demand may be extended depending on crop choices. For the green soyabean market the irrigation season needs to be completed prior to the end of February if the market closing and supply contract deadline of March 15th is to be met.

82. Decreased minimum flows may be expected however current irrigation efficiency assumptions of 40% are low and offer opportunity for increased efficiency gains with increasing knowledge of water management during implementation. This will avoid the need of having to reduce the cropped areas in the longer term as water availability is reduced. The proposed use of green soyabean that is required to be harvested prior to March 20th each year means that the last irrigation will be in February before the low flow period in March-April

83. The highest rainfall recorded in Luang Prabang in the period of rainfall records from 1971 to 2016 was 181 mm in October 1981. Based on simple probability analysis, the probably of exceedance (return period) is about 40 years. From extrapolating the maximum 24-hour rainfall data, the P2% (1-in-50-year) and P1% (1-in-100-year) maximum 24-hour rainfalls are determined to be 203 mm and 228 mm respectively. Based on these figures, the corresponding flows estimated using the SOKOLOV, ASIA and BYVE empirical methods applied in Laos, for Nam Seng (catchment area of 151.6 km^2) are 230 m^3/s and 318 m^3/s; for Houy La (catchment area 18.7 km^2) they are 71 m^3/s and 94 m^3/s respectively.

84. The ongoing ADB funded Northern Rural Infrastructure Sector (NRI-AF1) project has adopted the historical P2% flood flow as the design standard for all weirs irrespective of catchment area. To allow for project impacts from climate change, NRI includes a 20% “capacity safety factor” in the key hydraulic capacities of their designs (as stated in the Aide Memoire of the Inception Mission, 20 to 31 October 2017, paragraphs 35 to 37). A preliminary assessment of the impacts from increased rainfall intensities and durations by the TRTA used a comparison with adjustment factors for maximum daily rainfall totals under RCP8.5 Climate Change Scenario Projections for the period 2016 to 2035 relative to the baseline period from 1986 to 2016 for neighbouring provinces in Vietnam (source: ADB PPTA 8957). This suggests that a flow adjustment in the range of 35 to 55 percent above the P2 value could in fact be expected, which in effect increases the standard design flow from the P2 values to near the historic P1 values. Therefore, it is recommended that the historic P1 flood should be adopted as the new standard for all weirs.

85. The standard flood flow consideration currently adopted for the hydraulic design of head works by the Department of Irrigation are: the 100-year flood flow for dam spillways; the 50-year flood for weirs with catchment areas greater than 100 km^2; the 25-year flood for catchment areas between 50 and 100 km^2; and the 10-year flood for catchment areas smaller than 50 km^2. These return periods represent flood flows of P1, P2, P4 and P10 respectively.

86. For the design of spillways for small dams (i.e. those less than 15 metres high) as typically used for small to medium scale irrigation, the TRTA recommends that the standard remains at the P1 capacity but that sufficient freeboard above the reservoir full supply level is included to allow for double (i.e. twice) the P1 flow to pass over the spillway without the main dam embankment being overtopped. This is based on a review of the probable maximum flows (PMF) expected in the watersheds in the northern provinces of Lao PDR which found them to be approximately 75% greater than the P1 flows. This recommendation is in line with findings in other countries where this rule of thumb is applied.

87. In line with the TRTA recommendation SRIWSM will apply the P1 flood flow as the new standard for design of headworks, the capacities of the headworks structures have been reviewed and at both sites it was confirmed that the design floods are able to be safely passed. However, for Nam Seng, confirmation that flows can be prevented from entering the main canal at the PMF levels has still yet to be checked during finalisation of the design.

G. Habitat, Ecology and Wildlife

88. There are no protected areas in Luang Prabang Province, even though it covers large tracts of central-northern Laos. However, the subproject site is close to the defined Key Biodiversity Area along the Mekong River from Luang Prabang to Vientiane which supports a number of Critically Endangered, Endangered or Vulnerable species, significant migratory bird habitat, significant species congregations, and other important biodiversity features. Since both catchments drain into the Mekong within a few kilometres, there is limited significance for any impact from the subproject, given the big dilution factor.

89. Aquatic ecology was not studied scientifically, but local communities were asked for information about fish and other fauna known to be present in the Nam Seng (Appendix 1). This generated the list given in Table 6. All of these species are caught for domestic consumption and were considered to be quite common, but no trading of fish was reported.

Table 6: List of fishes and other fauna known in the Nam Seng.

Scientific name	Lao name	English name
Poropuntius laocnsis	ปาจาด	
Nemacheilidae	Pa Phanh	
Puntius aurotaeniatus	ปาขาอ	
Cyprinidae, *Osteochilus lini*	Pa Morm	
Dasyatidae	Pa Fa	
Not known	Pa Hoapoum	
Channidae	Pa Kung	
Mastacembelidae	Pa Lad	
Not known	Pa Khing ปาຂิง	
Claias batrachus	PaDouk ปาดุก	
Not known	Kouing	Small river shrimp
Not known	Kob	Frog

90. A biodiversity proximity report was generated for the Nam Seng catchment by ADB using the Integrated Biodiversity Assessment Tool (IBAT). The IBAT report lists over a thousand species on the IUCN Red List that could be found in the Nam Seng catchment given adequate habitat, of which about half are birds, species under threat are listed in Table 7. The Nam Seng includes an area of protected forest 8 to 10 km above the headworks and is not within the subproject area or subproject area of influence.

91. In the subproject area, the local consultations included discussions on the biodiversity found in the forest. Certain tree species are used for small timber in house construction and other local uses. A significant proportion of households appear to be involved in the gathering of non-timber forest products, and there is also a certain amount of hunting in the forests. The majority of this activity occurs in the Nam Seng Catchment whereas the available habitat in the Nam Nan District is increasingly inaccessible, dispersed and highly modified. The response tables in Appendix 1 give details of the species involved. Identifications are difficult to verify, but as far as possible the species have been checked against the IBAT listing.

92. The Critically Endangered Mammals are *Manis javanicus* (Sunda pangolin), *Manis pentadactyla* (Chinese Pangolin) and *Nomascus leucogenys* (northern white-cheeked gibbon). None of these are reported as seen by hunters in the forest, as recorded during the IEE

consultation (see Appendix 1). The Critically Endangered birds comprise a pochard (a type of wild duck), a bunting, a myna and three vultures. None of these are (listed in Appendix 1) reported to have been seen by hunters or other local people consulted during project preparation. One of the Endangered species listed by IBAT is a species of junglefowl, which could be the one listed by hunters as occasionally seen but not hunted. The three Critically Endangered fish include a carp and a catfish, which are both endemic to the Mekong, and the giant pangasius, a shark catfish that is also endemic to Indochina.

Table 7: Threatened Species in the Proximity of the Nam Seng Catchment.

Order	Critically Endangered	Endangered	Vulnerable
Amphibians	0	0	0
Birds	6	4	5
Fishes	3	3	5
Invertebrates	0	0	2
Mammals	3	3	10
Plants	0	0	1
Reptiles	0	2	4

93. The subproject area is all valley floor or within the existing Nam Seng Irrigation system, there is no natural habitat in the command areas or the immediate project area of influence. Downstream the command area drains to the Mekong, this corridor is highly modified agricultural land and the receiving body of the Mekong is further modified by the recently completed Xayaboury dam, although residual populations of migratory fish may still be resident in the reservoir that is now filling. There are no records of protected species or habitats for the subproject area or project area of influence.

94. The disturbed and fragmented, 4,000 hectares of forest in the Nam Seng catchment could harbour a wide range of species, and other species may re-colonise the area if the forest and habitat qualities improve. In addition, over 7,500 hectares of land classified as regenerating forest with about one third dominated by bamboo suggests that there is more habitat diversity in Nam Seng than Nam Nan district.

H. Air Quality

95. There are no records of air quality measurements in the Nam Seng and Nam Nan catchments, and being a rural area with no significant industries other than agriculture, the air quality is generally good. There are the usual short-duration impacts from road traffic in the vicinity of the existing roads, in the form of dust and vehicle emissions, but traffic levels are usually very low. The subproject area has the major highway from Luang Prabang to Xayaboury on its eastern boundary which with the increasing traffic density and composition (ie increased truck and bus movement) will contribute to local air pollution.

96. Within the command area the burning of crop residues is not usually practiced on a large scale for the rainfed crops unless a dry season crop is to be sown. For SC1 a lot of crop residue is simply grazed and reincorporated. For the MC1 and MC2 command areas crop residue burning is still practiced in order to plant the dry season paddy crop.

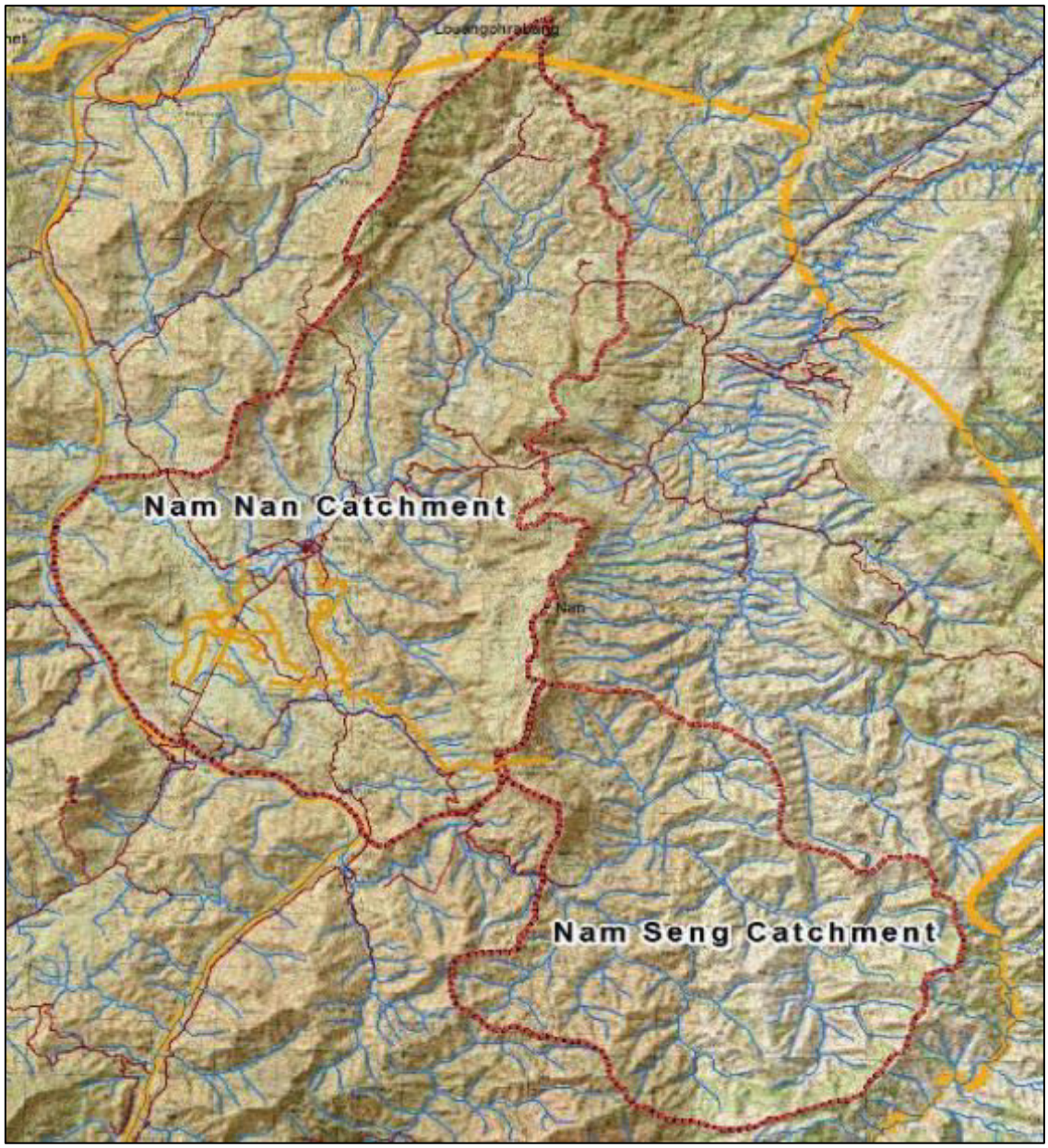
I. Ambient Noise

97. As with air quality, there are no records of ambient noise measurements in the two catchments, and, again, being a rural area with no significant industries other than agriculture, ambient noise levels are generally very low. Again, there is the usual short-duration impact from vehicle noise in the vicinity of the existing roads, but traffic levels are usually very low.

J. Infrastructure

98. An infrastructure map of the catchment is given in Figure 12. Most of the catchment is served by existing roads, excluding the higher ground on the western side. There are ten small irrigation headworks in the subproject area, though these all need some degree of maintenance or rehabilitation.

Figure 13: Infrastructure Map of the Nam Seng Subproject Area.
This shows: roads (thick amber lines and thin dark red lines); and the subproject catchments boundaries (thick red and black line).



99. An irrigation scheme was installed in 2008 under government funds. Until that time there was no irrigation in either catchment, apart from wet season lowland rice paddies. The headworks has the design capacity to support 1000 hectares during the wet season. Dry season cropping, including rice, will be limited to 500ha of dry season rice or an expanded area of lower water demand crops including soya bean, garlic and SRI (wet –dry) rice which is currently being practiced. To date, 350 hectares of the potential 1000-hectare command area has been developed. In total, some 550 households are benefiting within the existing command area. The existing irrigation system is almost entirely based on paddy rice with plot to plot flow, and there is limited dry season cropping linked to onion, garlic and rice.

K. Pollution Prevention, Resource Use Efficiency

100. Pollution impacts in the subproject project site are limited to the construction period with the impacts being limited to potential pollution risks of fuel spills, construction equipment emissions and local construction site solid waste management. The nature of the construction involves minor works and as such the potential impact is relatively low and localised.

101. The impacts relate to the command area use of the water delivered through the canals. Here issues of resource use efficiency relate to water use efficiency. Water use efficiency is currently low due to the reliance on rainfed irrigation during the wet season, and the lack of water control and regulation. No information on water use efficiency is available within the overall scheme including the SC1 command area. In the 'with project scenario' water use efficiency gains will be available based on the effectiveness of (i) water management operators, and (ii) crop management. The provision of within command area distribution – at the tertiary and sub-tertiary level, water control and regulation infrastructure such that water is provide during the day time on a regulated schedule water use efficiency should increase by at least 30% of and above the current scenario. The design water use efficiency is 41% which is conservative reflecting the need for development of WUG capacity under the IFAD project. These efficiency gains provide scope for future increases in command areas.

102. The move from reliance upon paddy rice to high value crops such as soybean offers substantial water use savings through the lower water use demand of soybean relative to paddy rice.

103. Pollution risk within the command area are currently assessed to be extremely low with most rainfed paddy receiving limited fertiliser inputs ranging from nil to 100kg/ha) of NPK 15-15-15 for wet season rice production. However once irrigation is provided and the reliability of wet season production increases farmers will invest more into inputs in search of productivity gains.

104. In the neighbouring MC 1 and MC2 command areas the rice varieties grown are improved rice varieties, such as TDK 5, Kor Kho 15 and Thin Keo 17. These rice varieties are lowland, glutinous, and medium short-maturing rice varieties (less than 120 days), which suited for the lowland and upper fields. Two rice production techniques are found in MC1 & 2: Conventional paddy rice (76% of cropped area) and System of Rice Intensification (SRI) that is being practiced on 24% of MC 1 & 2.

105. Fertiliser use for traditional production during the wet season involves NPK 15-15-15 being applied at 50 to 150 kg /ha. SRI farmers apply chemical fertilizers (NPK16-20-0 and NPK15-15-15) at rates from 150 to 300 kg per ha. The SRI farmers also apply intensive fertilizer for their dry season rice usually with the addition of urea at levels similar or above the wet season crop.

106. The expectation is that SC1 wet season rice would adopt similar levels of fertiliser use as the MC 1 – traditional system i.e., 50 to 150kg/ha. Dry season production in SC1 is expected to be predominantly high value crops including garlic, ground nut and soya bean. The soya bean production will not require nitrogenous fertiliser i.e., urea and will use around 150kg/ha to 250kg/ha of NPK 15-15-15[2]. Given the site topography, the ability to control dry season water to

[2] There has been reports that the higher yield of green pod soybean ((t/ha) will require excessive fertiliser applications compared to the traditional yields of 3 to 4 t/ha for soybean seed. The TRTA discounts this as the green soybean for China yield per hectare includes the whole pod and is a green weight not a dry weight and as such the yield is relatively similar to the dry seed weight already being achieved with very low fertiliser application rates. Further Officials

deliver water over a 12hour watering period and within a 7 day return period using water scheduling will mean a very low risk of nutrient movement outside the command area. The use of contract soybean production will use significantly lower amounts of nitrogenous fertilizers, whilst at the same time providing substantial soil health and nitrogen input through mycorrhizal bacterium. Existing producers of soybean report significant improvement in soil structure and a resultant yield increase in the following wet season rice crop.

107. Pesticide use for soybean is limited usually for stem borer at an applicate rate of around 1.5l/ha and is likely to be less than dry season rice producers especially for years where there are significant rice leaf hopper infestations. Within the command area pesticide pollution is most likely to occur in mixing sites and due to poor container waste disposal. The likelihood of either product or soil residue is very low, given the output is fresh produce for human consumption. Occupational safety risks are high due to (i) poor application technologies, (ii) limited access to safety equipment for operators, and (iii) application management is poorly supervised and controlled.

108. Further afield upland cropping of maize and Jobs Tears in the Nan District is extensive and there is a practice of using herbicide prior to mechanical cultivation. The predominant herbicide used is currently Glyphosate that has low residual effect once in contact with soils. The alternative 24 D is used less but has more residual effects.

109. There are no records of significant pollutants of the soil, water or air currently in the Nam Nan District, despite the Banana concession and upland cropping. Water turbidity can be high during the wet season (see Figure 13). The cause of this sediment load were not established but is common across most rivers in the northern provinces of Lao PDR during the wet season. While sediment is a symptom of wider catchment issues turbid water being passed through flood irrigation systems effectively removes a large part of the sediment from the river systems as irrigation drainage water re-enters the river system.

110. No evidence of pollution was observed or reported during field visits, although there is public concern about possible risk of agrichemical exposure linked to land concessions and upland cropping by “others”. The risk to public health from these sources is low with 100% of the command area beneficiaries surveyed connected to urban water supply schemes.

111. Establishment of a water quality baseline if required, faces issues relating to the ability to establish a baseline that is reliable and robust[3]. This is challenging due to (i) extensive variability of rainfall, (ii) seasonality of agrichemical use over a range of different upper catchment crops, and (iii) the need for sampling protocol that can identify provide a reliable time series able to identify changes in the parameters.

112. The site based water testing protocols of MRC will apply and need to be implemented by DOI, PONRE and PAFO staff with knowledge of these protocols. The testing program would involve some local site based testing for temperature, pH, and turbidity. A minimum of three sets

reporting high fertiliser only have information about the request for tax exemption on fertiliser. IN 2018 the area of soya bean that the contractor sought was 1200ha however due to lateness only 200ha was contracted, whilst the planned fertiliser demand was based on 1200ha resulting in the perception of higher use. No one from the fact finding mission actually spoke with the contractor who controls the crop production model and the specification of inputs.

[3] Other ADB irrigation projects are adopting a single water test for a limited set of parameters one a year from one site. While providing data it does not provide data that can be reliably applied in a time series monitoring framework. Despite being introduced to respond to future water quality standards the data collected cannot be interpreted for the purposes of assuring standards are appropriate or otherwise.

of samples will be required from each site to enable (i) chemical testing that would then need to be split into inorganic and organic testing, (ii) biological testing, and (iii) physical parameters. The samples will need to be assured of meeting required but as yet unspecified protocols for each of the receiving laboratories contracted to conduct the testing. Currently these would include the DoI laboratory for site based tests, inorganic chemical tests and biological testing. Inorganic samples will need to use either a private laboratory service in Laos or be transported to Thailand. All laboratories need to be certified for the testing of the specified parameters.

113. The movement of samples to any of these laboratory services is challenging, for example the DoI Laboratory samples will need to be delivered to the laboratory within 48 hours, and all samples need to be kept within a controlled temperature range less than 25 degree celsius to avoid loss of integrity for testing BoD, COD, and E Coli readings. The agrichemical and nutrient testing require different protocol and sample management.

114. The sampling of one or two samples from one site per water source provides unreliable data that can be highly distorted by (i) rainfall events, (ii) sampling intensity at each site, (ii) farm management practices, (iii) river flow rates, (iv) period since potential pollutants were applied, and (v) time of day. The intensity of sampling on river sources plus the number of samples per site by time of day needs to be rigorous to remove spurious data points distorting the baseline.

115. To establish robust baseline data requires an intensity of sampling over a minimum of at least one year and perhaps more given the variability of climate in relation to the agricultural use of the catchments. Sampling will need to involve testing in the Nam Seng and Houay Lay rivers at least three sites along the river above the headworks to ensure site impacts are reduced. For each sampling day a minimum requirement will be to sample at three times during the day with a least 3 samples per sample site at each time of sampling. Sampling that cannot support a rigorous and defendable baseline should not be implemented. A risk-based approach to water quality monitoring is proposed.

116. The project includes a support program for irrigated agriculture including pesticide reduction and management training and integrated pest management to be financed and implemented under the IFAD PICASA program. Where necessary, water quality testing will respond to anticipated threats based on likely chemical use and will require customized sampling and testing programs to be developed as part of the irrigated agriculture support program. Obtaining reliable water tests requires a programme of sampling over a considerable period of time. If there are significant changes to the use of agricultural inputs then monitoring should be undertaken during project implementation to ensure that the quality of water remains satisfactory.

Figure 14: The Nam Seng Headworks in May 2018.
A High Level of Turbidity is Visible in the River.

L. Unexploded Ordnance

118. The western part of Luang Prabang Province as a whole has a relatively very small amount of unexploded ordnance, there are no records for the Nam Seng and Nam Nan catchments. The Government will be required to certify to ADB that all Project areas are clear of UXO, with any UXO clearance activities being the responsibility of the Government of Lao PDR. No Contract may be awarded without this certification.

M. Occupation and Community Health and Safety

1. Population and Ethnicity

119. The proposed Nam Seng Subproject will benefit approximately 238 new households, residing in seven villages and owning rainfed paddy areas within the Thongphieng Vilay area. The six subproject villages comprise Thongphieng Vilay, Sivilay, Nakheun, Thad, Phon Hine and Pak Khone. These were all selected for the socio-economic survey. The demographic characteristics of all subproject villages are presented in Table 8.

Figure 15: SC1 Command Area and Village Locations

120. There are 841 households (855 families) with a total population of 4,514 (2,254 females), and composed of five main ethnic groups.

- 622 households (74 percent) are ethnic Lao, speaking the Lao language, following Buddhism and belonging to the Lao-Tai ethno-linguistic group.
- 95 households (11 percent) are ethnic Hmong, speaking the Hmong and Lao languages.
- 11 households (1 percent) are ethnic Iu Mien, speaking the Iu Mien and Lao languages.
- Both the Hmong and the Iu Mien belong to the Hmong-Mien ethno-linguistic group and follow Animism.
- 90 households (11 percent) are ethnic Pray, speaking the Pray and Lao languages.
- 23 households (3 percent) are ethnic Khmu, speaking the Khmu and Lao languages.
- The Pray and Khmu follow Animism and belong to the Mon-Khmer ethno-linguistic group.

121. Most households are outside of the command area however some residential plots are affected by the SC 1 canal and these have been identified in the LARP along with mitigation and compensation. For some areas this involved realignment of the canal whilst in other instance the canal is being piped and buried. The level of community risk from open canals has been discussed with local residents, who have indicated a preference to be able to access canal water for garden, laundry and livestock uses.

122. Households generally comprise one family, with only 1.7 percent (14 households) having two families. The size of household averages 5.4 persons (at 6.1 for Thongphien Vilay, 6.0 for Sivilay, 4.8 for Nakheun, 5.0 for Thad, 5.3 for Phon Hine and 5.1 persons per household for Pak Khone village). There are 49 female-headed households (6 percent of the total households in all six subproject villages). Of these, 25 reside in Thongphieng Vilay, 6 in Silvilay, 5 in Nakheun, 4 in Thad, 8 in Phon Hine and 1 in Pak Khone village. The number of poor households amounts to 1.6 percent. These comprise three households in each of Thongphieng Vilay, Sivilay and Nakheun villages. The rate is slightly lower at 1.4 percent (just one household) in Phon Hine village. [4]

123. In four of the subproject villages, there is a total of nine vulnerable households, amounting to 1 percent of all households in the six villages. Of these, three are in Thongphieng Vilay, one in Sivilay, one in Nakheun and four in Pak Khone village. There are 30 landless households (4 percent of the total households of all six villages). These are mainly young couples working as officers in government offices.

[4] Village leader reporting of poor is based on (I) type of households, (ii) size of land holding and landlessness, (iii) the number of available labor in the household. The government policy line is US 1.50 per day in PPP terms.

Table 8: Demographic Characteristics of the Subproject Villages.

Subproject Village	Population					Religion/ Belief		Ethnic Group															Average HH size	Average family size	No. of female headed	No. Poor HHs	No. of vulnerable HHs	No. of landless HHs
								Lao			Hmong			Iu Mien			Pray			Khmu								
	No. of household	No. of Family	Total population	No. of female		Buddhism	Animism	No. of HH	No. of Population	No. of female	No. of HH	No. of Population	No. of female	No. of HH	No. of Population	No. of female	No. of HH	No. of Population	No. of female	No. of HH	No. of Population	No. of female						
	(HH)	(Fam)	(pers.)	(pers.)	(%)	(HH)	(HH)	(HH)	(pers.)	(pers.)	(HH)	(pers.)	(pers.)	(HH)	(pers.)	(pers.)	(HH)	(pers.)	(pers.)	(HH)	(pers.)	(pers.)	(pers./HH)	(pers./Fam.)	(HH)	(HH)	(HH)	(HH)
1. Thongphieng Vilay	191	191	1,173	527	45%	49	142	49	286	146	35	234	109	6	37	19	90	549	280	11	67	33	6.1	6.1	25	3	3	2
2. Sivilay	107	107	646	308	48%	51	56	51	279	142	56	367	166										6.0	6.0	6	3	1	13
3. Nakheurn	262	276	1,270	637	50%	256	6	256	1,233	620										6	37	17	4.8	4.6	5	3	1	15
4. Thad	145	145	725	410	57%	140	5	140	696	394				5	29	16							5.0	5.0	4			
5. Phon Hine	69	69	361	200	55%	59	10	59	303	167	4	23	13							6	35	19	5.2	5.2	8	1		
6. Pak Khone	67	67	339	172	51%	67		67	339	172													5.1	5.1	1		4	
Total	**841**	**855**	**4,514**	**2,254**	**50%**	**622**	**219**	**622**	**3,136**	**1,641**	**95**	**624**	**288**	**11**	**66**	**35**	**90**	**549**	**280**	**23**	**139**	**69**	**5.4**	**5.3**	**49**	**10**	**9**	**30**
% of female population (%)			100%	50%					100%	52%		100%	46%		100%	53%		100%	51%		100%	50%						
% of Population by Ethnic Group (%)	100%							74%			11%			1%			11%			3%								
% of HHs by religion/ Belief (%)	100%					74%	26%																					
% of FHH (%)	100%																								6%			
% of poor HHs	100%																									1%		
% of Vulnerable (%)	100%																										1%	
% of LLHHs (%)	100%																											4%

2. Social Resources

124. The six subproject villages are scattered within Nan District, with some lying along National Road No. 4 (upgraded by an ADB project). All villages have connections to the power grid, and are covered by the mobile cell phone network and piped water supplies. Villages are mostly located outside of the command area with the exception of one section – see figure 3 where the SC1 canal was realigned to the west of the original design alignment. Other sections of the canal impact residential land plots (mostly without houses) and these have bene identified and mitigation and compensation options discussed and agreed as presented in the Nam Seng Subproject LARP.

125. It was confirmed by the village authorities that all school aged children have access to the schools. There is one primary school in each of the villages. A lower secondary school is located in Thongphieng Vilay, providing a service for the children from Pak Khone, Thongphieng Vilay and Nakheun villages. A higher secondary school is located in Paphai village (in the centre of Nan District Urban), providing this level of teaching for all villages in the district, but up to 7 km distant from the subproject villages. For higher education facilities; the closest technical and vocational colleges are in Xayaboury City (25 to 30 km distant). Other technical and vocational colleges, and the Souphanouvong University, are located in Luang Prabang City (about 70 km) and Vientiane Capital (about 500 km).

126. Villagers stated that for health care services they go to the Nan District Hospital in Nalao Village (in the urban area of Nan District). For more serious cases, they go to Xayaboury Provincial Hospital (about 30 km) or Luang Prabang Provincial Hospital (about 70 km), as necessary.

127. The primary means of getting to health and other public facilities is by motorbike, and sometimes by pickup. The condition of the roads is very good and they are trafficable in all seasons. This is mainly because National Road No. 4 was upgraded in 2008 to 2012 by ADB-supported Project. The distances to the public facilities are shown in Table 9.

128. It was reported that villagers drink bottled water produced by and delivered from factories located in Nan Urban. Some is also produced in Vientiane and in Thailand, and sold by local shops. Some people drink boiled water and use water from the piped system for boiling. In terms of domestic water, all inhabitants obtain water from the district water supply system. The village authorities reported that all households in Sivilay, Phon Hine and Pak Khone villages have their own toilets; but in Nakheun and Thad Villages, the rate is around 90 percent, and in Thongphieng Vilay village only around 80 percent of the total households have toilets.

Table 9: Access to Public Facilities in District and Provincial Centres

Subproject Village	Distance to primary school (km)	Distance to high school (km)	% School aged at school	Distance to health post (km)	Distance to nearest regular market (km)	All year road access (Y/N)
Thongphieng Vilay	0.5	7.0	100	9.0	7.0	Yes
Sivilay	0.3	2.5	100	4.0	4.0	Yes
Nakheun	0.7	1.3	100	4.5	4.0	Yes
Thad	0.7	2.0	100	3.0	2.5	Yes
Phon Hine	0.5	1.0	100	2.0	0.5	Yes
Pak Khone	2.0	7.0	100	25.0	7.0	Yes

3. Livelihoods, Agriculture, Development and Economic Conditions

129. The total lowland (including upper terracing lands) areas are around 506 hectares, of which 251 hectares are used for wet season rice planting and 27 hectares are used for the cultivation of different consumable crops (sweet corn, groundnut, garlic and vegetables). Thinkeo 17 is an improved variety of sticky rice that is grown in both the wet and dry seasons in Nan District, mainly for local consumption but with surplus quantities sometimes sold in the local market or to buyers from Luang Prabang, Xayaboury and elsewhere.

130. Garlic, sweet corn, water melon, groundnut, cucumber and vegetables are planted as cash crops in the dry season. This is done in upper irrigated areas using small pumping engines, electric pumps, watering cans and other methods. The total area planted to cash crops is around 27 hectares by 107 households.

131. Since the Land Use Planning and Land Allocation campaign was applied in these villages, slash and burn practices have been almost stopped. Only permanently allocated uplands are now used for upland crops, including rice, maize, job's tear and groundnut, by households in Thongphieng Vilay, Nakheun, Thad and Pak Khone villages.

132. Fruit trees planted in the area are mostly not in formal plots. There are found only traditional fruit trees planted around houses. These include mango, pomelo, coconut, longan, banana and others. The village authorities reported that there are around 25 hectares of Chinese banana planted, with one hectare in Nakeun, one hectare in Phon Hine and the rest in Thad village, all in the form of land concessions. No pollution was directly linked to the banana plantation however there have been "events causing serious health issues" at the site of the bunch washing and dipping station. Teak has been an important industrial tree planted in many villages for a long time. There are 244 hectares of teak plantations in five of the six subproject villages with one plot being slightly affected by the alignment of the SC1 canal.

133. Based on the proposed works program in SC 1 125 land parcels will be affected however the vast majority of these are not adversely impacted as they receive irrigation water and will be able to increase incomes levels four to five fold. A total of 11 of the 125 plots owners are assessed to be adversely impacted resulting in a loss of assets and income, with the majority being aligned to the SC1 main canal outside of the command area. The only structures to be impacted are 3 toilets as the canal alignment was adjusted to avoid residential areas as much as possible.

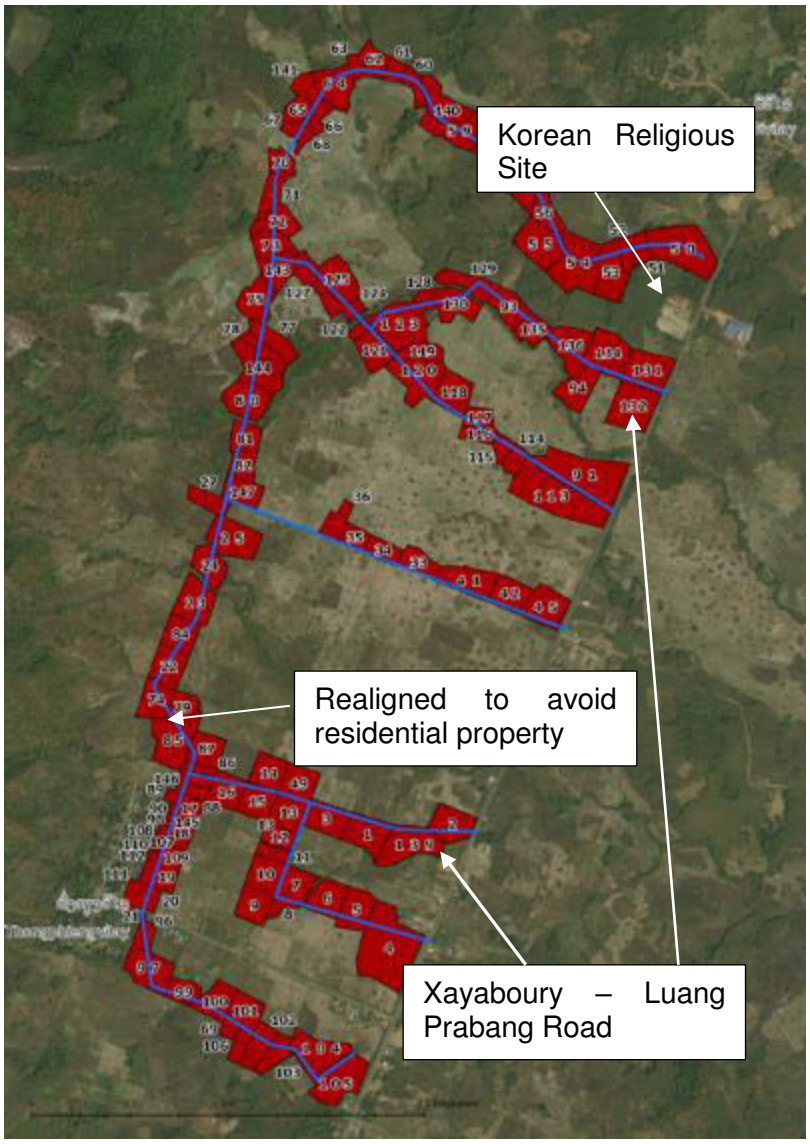
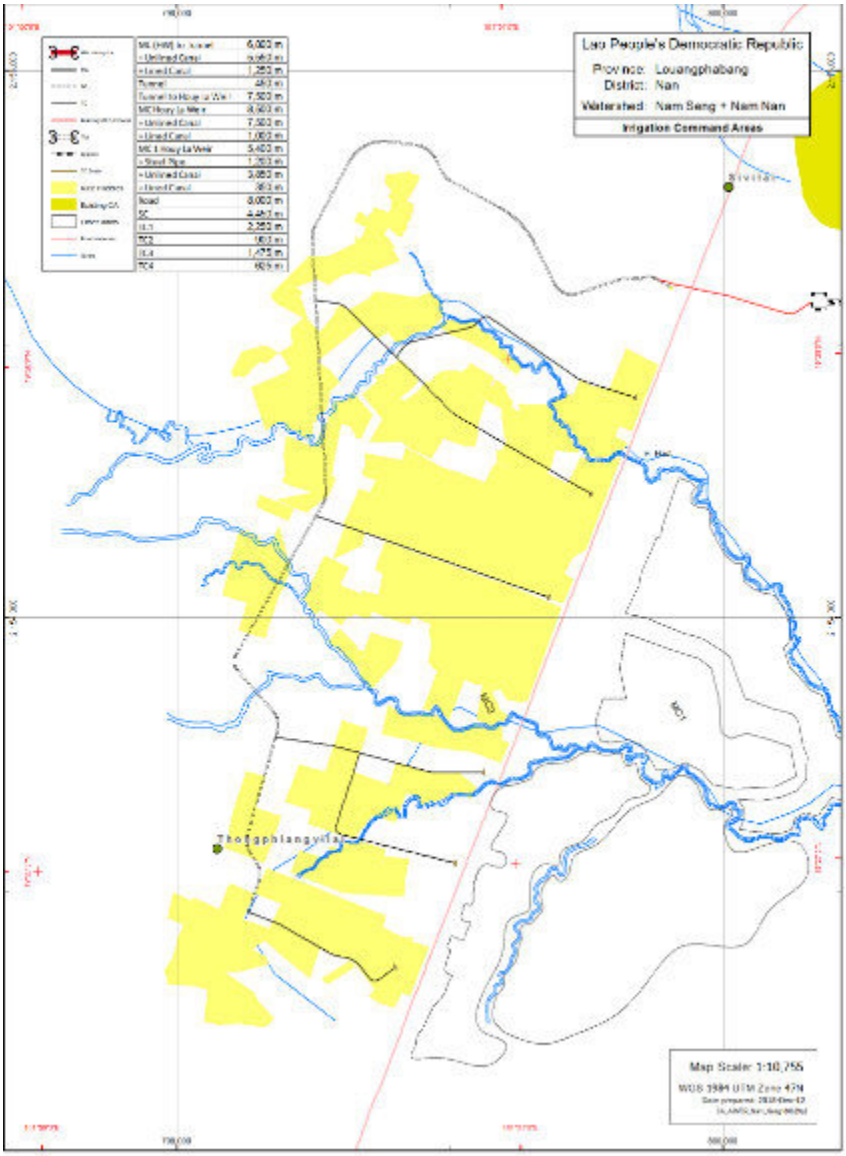


Figure 16: Land parcels affected by construction



N. Physical and Cultural Resources

134. None of the communities or authorities consulted reported any areas of cultural value that would be affected by the proposed subproject, even though there are 34 temples in Nan District as a whole. No temples or pagodas are impacted by the proposed works or within the command area. There is a historical Korean religious site – see Figure 3.

135. The Cultural World Heritage Site of Luang Prabang City, which covers 12,500 hectares, is approximately 150 km distant from the subproject and will not be affected.

136. In Nan District, there are a few tourist sites, such as Waterfall Hieng at Ban Fai, the Rat Cave, the Buffalo Cave, and the Top View Deck and Plant View Deck of the Mekong hydropower scheme. These are all well away from the subproject location and will not be affected in any way.

137. Within and adjacent to the command area there are two locations of cultural value. On the north-eastern boundary of the command area and adjacent to the Luang Prabang – Xayaboury

road is a Korean religious site. The subproject design has excluded the site from the command area and with access being from the main road there is no impact. Second, there is a gravesite at approx. km 27 along the SC1 canal on the western boundary of the command area - near to plot 147 in Figure 4. During the design process, the SC1 alignment passed through these and was subsequently based on community consultation realigned further west of the site of the graves. The command area and the irrigation will not affect the site whilst the canal service road will provide additional access.

138. As a result of the changes to the alignments the subproject is not expected to have any direct influence on physical or culture resources.

O. Data Gaps

139. With respect to rainfall and hydrology data, the complete absence of detailed information for the subproject catchment is the single biggest concern regarding the evaluation of the environment within which the proposed works and development will be undertaken. Even for the province as a whole, there is one weather station with a data set covering 45 years. This is a reasonable period but not really long enough to judge the degree of variability and any trends accurately.

140. For biodiversity, the obvious data gap is the absence of catchment-specific biological studies. For the general area, the Integrated Biodiversity Assessment Tool highlights the large proportion of fishes which are listed as Data Deficient by the IUCN. A considerable number of invertebrates are also listed as Data Deficient.

V. CLIMATE CHANGE CONSIDERATIONS

A. Current Understanding of Climate in Luang Prabang

141. The current understanding of climate in Luang Prabang is limited by the restricted data for the province, and the consequent need to extrapolate from other areas. Figures 8 to 10 give the available precipitation data from the meteorological station at Luang Prabang City, some 20 km from the subproject site and deep in the Mekong valley. The analysis given in the baseline statement on climatic conditions earlier in this IEE also discusses the evidence for extreme rainfall events, which are mostly linked either to tropical storms, particularly when developed into cyclones or full typhoons. Figure 17 shows the tracks of a two severe tropical storms (typhoons at the point of landfall in Viet Nam and Hainan respectively) which both led to unusually heavy rainfall in the province. Lorna in 1972 appears to have given rise to 139 mm in one day, and Haima in 2011 to 161 mm of rain in one day.

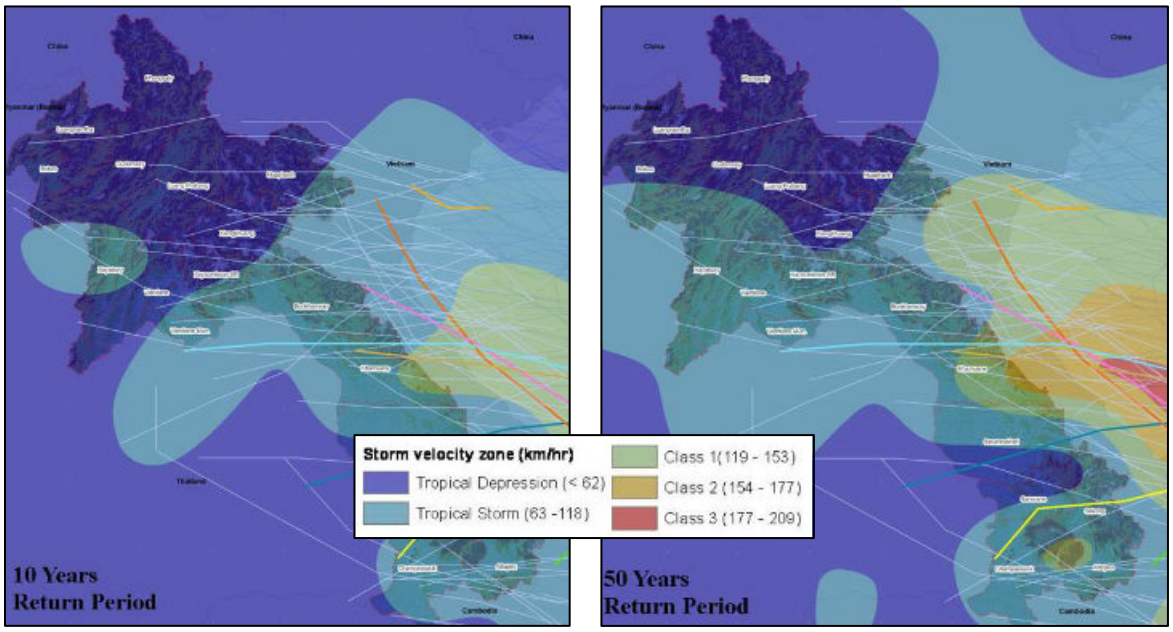
Figure 17: Tracks of two Tropical Storms affecting Northern Lao PDR: Left, Lorna in September-October 1972; Right, Haima in June 2011.

Sources: NASA.

142. While Figure 17 shows the effects of two storms many years apart, a wider range of data have been analysed to determine the overall storm risk: these are shown in Figure 18 for two possible return periods. Even so, these data so far cover only a 30-year period, and so also give only what can best be described as an approximation. While these show that the whole of Laos is susceptible to the impacts of tropical depressions, even on a projected 50-year return period, storms of tropical storm force barely appear to touch the southern side of Luang Prabang Province: the risk is much less than in Khammouane Province, far towards the south. Sometimes the proximity of storms does not actually translate into extreme rainfall; but conversely, although the winds may have eased as they pass across the land, there is frequently a lot of remaining moisture to be shed rapidly.

143. At the other end of the climate moisture scale, droughts can also be a feature in Luang Prabang. These can occur as relative effects at any time of year, since in meteorological terms they are defined as a drier deviation from “normal” rainfall. Drought hazard maps and frequency charts for a range of depths of drought are shown in Figure 19. These demonstrate that droughts can occur at any time of year in the western part of Luang Prabang Province, where the subproject is situated. The risk seems to be relatively high, with 10 to 15 droughts in each of the dry season and the wet season, in 30 years of data: in other words, there is a drought at some point in most years.

Figure 18: Storm Risk Maps of Lao PDR. Left, 10 Years Return Period; Right, 50 Years return Period. Based on Data from 1979 to 2009.



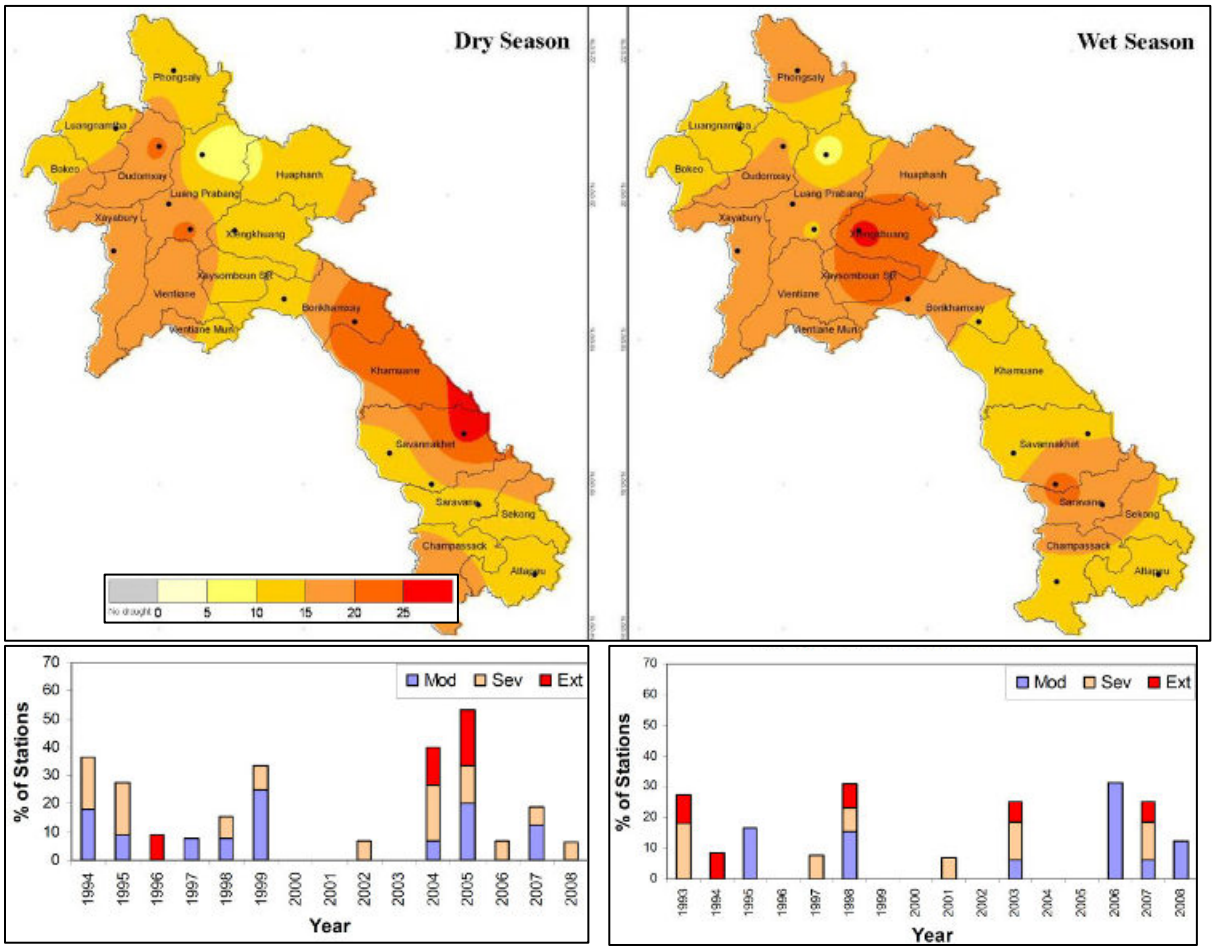
Source: United Nations Development Programme. 2010. Developing a National Risk Profile of Lao PDR. Part 1: Hazard Assessment.

B. Initial Climate Change Risk Assessment

144. The Nam Seng subproject has been screened using the regional-level AWARE™ climate risk assessment tool. The overall climate risk level determined is "medium risk". In this case, out of 11 categories of relevance in the risk assessment, two are considered to be high risk: these are flood and landslides, both of which are directly caused by heavy rainfall. Medium-level risks were identified in temperature increase, solar radiation change, and changes in precipitation (either increase or decrease). A radar chart presenting these risks is given in Figure 20. Any project falling into the overall medium or high risk rating requires further analysis, and this is provided in the overall project's Climate Risk and Vulnerability Assessment (CRVA). The analysis given above shows the occurrences of severe monsoon downpours and extremely heavy rainfall from depleting tropical storms from the Pacific.

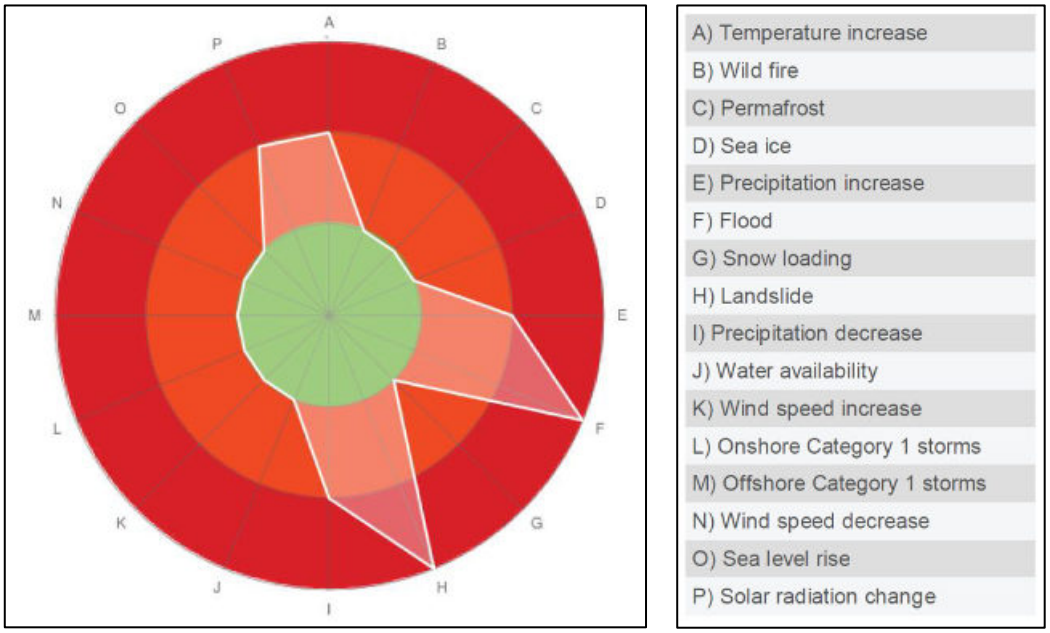
145. Drought risk is not considered by the AWARE™ tool, although the decrease in precipitation and increase in temperature are drought risk factors. However, as this could be a potentially serious issue in relation to irrigation, it is considered in the project CRVA.

Figure 19: Moderate to Extreme Drought Susceptibility Maps: Numbers of Droughts between 1980 and 2009, based on Standardised Precipitation Indices.
Below: Drought Occurrence by Year, Severity and Proportion of Recording Stations: Left, Dry Season; Right, Wet Season.



Source: United Nations Development Programme. 2010. Developing a National Risk Profile of Lao PDR. Part 1: Hazard Assessment.

Figure 20: Climate Risk Radar Depiction from the AWARE™ Tool.
The Red Outer Band Denotes High Risk Parameters.



VI. ENVIRONMENTAL IMPACTS AND THEIR MITIGATION

A. Environmental Justification

146. The main justification for the Nam Seng Irrigation Subproject is that it will provide both improved irrigation facilities for 550 households in a number of villages, plus new irrigation to a further 238 households in the new command area. The upgraded irrigation systems will allow for better dry season cropping options through larger and more reliable water supplies outside the rainy season. This will allow each participating household to increase its incomes from the more intensively used irrigated land, thereby improving livelihoods. Hence there should be significant benefits to socio-economic environmental conditions.

147. Improved lowland irrigation generally results in reduced pressures on the less productive uplands. This in turn helps to move the farming system away from its dependence on the remaining upland forests, because they are no longer reliant on the traditional systems of shifting cultivation and the growing of the less productive dryland rice and other crops. Hence there is expected to be a greater degree of forest rehabilitation in the upland catchment areas, which will improve soil protection and reduce threats to biodiversity. Therefore the subproject is also expected to have longer-term benefits for the bio-physical environment.

B. Potential Adverse Environmental Impacts – Overview

148. The largest environmental impacts from the subproject are likely to relate to the volumes of water taken off the Nam Seng, and the effects of downstream users and ecology. At the design stage it is difficult to know exactly how much water is available due to the lack of year-round data on the flows of small rivers in northern Laos, and the large amount of study that would be required to understand the exact requirements of other water uses. To overcome these potential impacts, the following pragmatic process must be followed to address potential negative impacts.

(i) All available rainfall and flow data for the river catchment will be collected and assessed to provide a working model of average monthly flows throughout the year. Limitations in the data must be acknowledged to make clear both the requirements for further knowledge and the extent to which the design is based on approximations.

(ii) A river gauging station must be placed on the river as early in the design process as possible, close upstream from the main headworks. Ideally a raingauge will be placed nearby, however as the purpose is to measure low flow the need for correlated rainfall data is low to non-existent. The future development of a catchment water release flow model requires a rainfall record which would require over 15 years to be meaningful and as such is not warranted.

(iii) The proximity and flows of tributary streams close downstream from the proposed headworks must also be assessed. These might help to resolve downstream requirements while allowing a greater offtake.

(iv) A pragmatic calculation must then be made as to the offtake that can be allowed. The rationale and assumptions used must be recorded as part of the scheme design, since these will need to be revisited when more information is available.

(v) If it becomes apparent that there is unlikely to be adequate water for the proposed irrigation scheme, then water-saving irrigation systems must be considered (e.g. pipe and spray or drip systems rather than flood irrigation).

(vi) Once scheme operation commences, the gauged river flows and water offtake volumes must be reassessed. These, along with a follow-up ecological survey and ongoing review of other water uses and consultations with downstream users, must be used to recalculate the allowable offtake. The scheme must then be revised accordingly.

149. It may not be possible to establish a fully quantified calculation of the minimum downstream flows, particularly because of the difficulty of determining ecological needs without long term studies. In this case, the rule of thumb to be used is that a compensatory flow must always be released that is at least 30 percent of the average monthly flow in each calendar month below which requires a PONRE review. Ecological requirements normally vary through the year, with most species adapted to higher wet season flows or requiring them as part of their life cycle. Other users may also have seasonal variations in their requirements. Flow variations are also required in most rivers to prevent a build-up of sediment.

150. Reduced flows in rivers and streams can have consequences on both biodiversity and downstream water uses, however in the Nam Seng water diversion has occurred for over a decade. Aquatic biodiversity is directly affected for the following main reasons: (i) water flow levels are a major determinant of physical habitat in streams, which in turn is a major determinant of biotic composition; (ii) aquatic species have evolved life history strategies primarily in direct response to their natural flow regimes; (iii) maintenance of natural patterns of longitudinal and lateral connectivity is essential to the viability of populations of many riverine species; and (iv) the invasion and success of exotic and introduced species in rivers is facilitated by the alteration of flow regimes (Bunn and Arthington, 2002). Mitigation is by setting minimum environmental or compensatory flows, which must be maintained throughout the year. These might typically be based on a proportion of dry season flow; but as flow regimes are not well understood in most small catchments, they may need to be based on approximations. There are various methods for doing this (e.g. Tennant, 1976; Acreman and Dunbar, 2004), but there are still too few data available for the subproject catchment to use any of the recognised quantitative methods.

151. Excessive water flows are also damaging, but mainly to infrastructure. Floods can damage irrigation headworks but more often cause damage along canals. Flood overflow structures are needed, either to reduce flood water entry into canals, or to divert the water back into the river from an overflow weir on the side of the canal. For Nam Seng this is not an issue due to the structure of the use of a transfer tunnel and the run of river canal offtake.

152. The uses of agrichemicals, both fertilisers and pesticides, will likely be increased as a result of the subprojects especially as the high value dry season cropping is developed with IFAD support. Without adequate training and extension support, farmers are apt to misuse these substances unintentionally, but often with very damaging consequences. Excessive phosphates and nitrates can alter the biochemistry of waterways significantly, particularly affecting algal growth and its use of dissolved oxygen. Many pesticides are very damaging to aquatic biota, and some can persist in the soil or at different levels in the food chain. Two legal provisions are in place to control pesticides: Regulation on the Control of Pesticides in Lao PDR (Regulation No 2860/MAF, 11 June 2010); and Decree on Pesticide Management: (Decree No. 258/GOV, 24 August 2017). Nevertheless, there is evidence that enforcement of these provisions is limited, especially in remote areas where banned substances are easily brought across national borders and sold with labels only in Thai and Chinese scripts. The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, to which Lao PDR acceded on 9 October 2010 and entered into force on 20 December 2010, gives an international dimension to potential control measures. The limited land use change into cropping suggests a very limited risk of their being chemical contamination of water in the catchment.

153. ADB investment into SRIWSM is not intended to support investment in agricultural productivity which is planned to be financed by IFAD. In the case of delay, ADB has budgeted support for quality assurance and Lao GAP systems that include pesticide reduction training (PRT) and IPM training of farmers by the DOA Plant Protection Centers. Based on discussions with water users in 2018 the expected cropping pattern will move towards contract production of Soya bean (similar to the Nam Phieng arrangements) with small areas of ground nut, peanuts, garlic and onion. A limited area of dry season rice will be grown and is likely to have the highest risk of agrichemical use. Based on other dry season irrigation areas nutrient management systems are unlikely to be required, whilst pesticide awareness and occupation health issues will be mostly required in dry season rice. The ability of SRIWSM to apply IPM to the contract farming operator is highly limited and would be unlikely to be adopted. The co-financed GIZ program for catchment management will address land conversion and use of agrichemicals.

C. Evaluation of Potential Adverse Environmental Impacts

154. The identified environmental impacts have been listed according to the various subproject periods: (i) planning and design phase; (ii) construction phase; and (iii) the subsequent operation period. The potential adverse environmental impacts, anticipated significance of impacts and rationale is given in Table 10.

Table 10: Anticipated Environmental Impacts and their Level of Significance.

No.	Environmental Impact	Anticipated Significance
Subproject Planning Phase		
1.01	Loss of land or other property to infrastructure.	Low. Little land affected and land values will increase.
1.02	Loss of land of importance for biodiversity.	Low. Infrastructure is in areas of very low biodiversity value.
1.03	(a) Incomplete hydrological data and as yet poorly developed climate change models lead to inaccurate designs for infrastructure. (b) Infrastructure is damaged by high flood levels, reducing the scheme's lifespan or effectiveness and causing damage to the nearby environment.	Medium. Mitigation measures required to resolve data gaps.
1.04	Disruption of hydrological flows by increased offtake from rivers.	Low. Existing water supply in place for 10 years
1.05	Water supplies polluted by upstream land management practices do not comply with national standards for surface water.	Very low land conversion within the Nam Seng catchment (conversion rate into crop is less than 0.05% per annum or about 10 ha per year mostly in no input production of Jobs Tears) as such there is a low risk of agrichemical pollution of the water source. GIZ program for catchment management will address land conversion and use of agrichemicals
1.06	Upstream land uses cause a decline in the quality and quantity of water available for the irrigation scheme.	Medium. Pro-soil conservation watershed management schemes through MAF – GIZ proposed project.

No.	Environmental Impact	Anticipated Significance
1.07	Farmers in Nakheum village that use water, but do not pay any irrigation service fees to maintain the irrigation systems, currently irrigate an area of 21ha. using drainage water may not have access to water after the subproject has been implemented.	Low The subproject impact from the SC1 development will in future provide water to SC2 (165 ha) from end of the distribution point where the 21 ha in Nakheun Village is currently taking water. With a surplus of drainage water, Nakheum village will still have access to the drainage water. Future development of SC2 may impact the water available for the 21 ha. The wider issues are: (1) the "rights" of Nakheun villagers to use water "outside" the designated scheme command area over the rights of villagers "inside" the command areas of SC1 and SC2, and (2) are Nakheun villagers willing to contribute funds for the scheme O&M. These aspects will be addressed through the WUG at the time of preparing the O&M regulations / schedules for the overall scheme.
Subproject Construction Phase		
2.01	(a) Release of silt into water courses from excavations and earthworks during construction. (b) Release of silt into water courses from poorly finished earthworks following construction.	Medium. This is a common problem on many projects, but it can be managed by the contractor and monitored by the project implementing agency. Appropriate bio-engineering measures are recommended.
2.02	Environmental damage results from the poor understanding of subproject requirements by the contractor and subcontractors.	Medium. This is a common problem, but the PPIT must manage the contractor to ensure that it does not happen here. Clear mitigation measures are to be included in all works contracts

No.	Environmental Impact	Anticipated Significance
2.03	Clearance of vegetation leads to the unnecessary removal of teak trees.	Low. This can be managed by the contractor and monitored under the EMP Provisions The only loss of tree is within the SC1 command area where plantation teak trees will be affected however the owner of these has indicated their preference to harvest the tree and move the land into irrigation (See Nam Seng LARP)
2.04	Temporary closure of irrigation systems during construction.	Low. This can be agreed between the water users and contractor.
2.05	Disposal of soil from excavations such as irrigation canals.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.06	Release of dust into the atmosphere from excavations and other construction activities.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.07	Release of noxious gases into the atmosphere.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.08	Noise nuisance from construction activities.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.09	Temporary use of land for construction affects livelihoods or leaves it damaged. This may include borrow pits.	Low. This must be agreed between landowners and the contractor, and monitored by the project implementing agency.
2.10	Influx of temporary labour disrupts local communities.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.11	Operation of construction machines disrupts local residents through noise, limited access points, and the presence of excavation equipment creating safety risks around residential land	Low. This can be managed by the contractor, through appropriate controls, maintenance, signage, training, and monitored by the PAFO, PONRE and LIC.

No.	Environmental Impact	Anticipated Significance
2.12	Pollution by hydrocarbons from construction plant.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.13	Pollution from construction site wastewater, from camps and other work sites.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.14	Pollution from solid waste materials.	Low. This can be managed by the contractor and monitored by the project implementing agency.
2.15	Injuries to workers and members of the community	Low. This can be managed by the contractor EHS Officer through site based safety programs and monitored by PAFO and construction supervisor and checked during site audits and review missions.
2.16	Disruption of cultural sites.	Low. This can be managed by the contractor and monitored by the project implementing agency. All chance finds of such assets or sites will trigger a stop work and a reporting to the PPIT. The PPIT shall assess the need for mitigation or additional management requirement for the contractor
Subproject Operation Period		
3.01	Disruption of downstream hydrological flows due to offtake from river.	Low. Water offtake is to be fine-tuned and managed on the basis of environmentally allowable volumes.
3.02	Upstream land uses cause a decline in the quality and quantity of water available for the irrigation scheme.	Low Pro-soil conservation watershed management schemes are required as part of the subproject.

No.	Environmental Impact	Anticipated Significance
3.03	(a) Extraction of water from river causes a decline or loss of aquatic biodiversity. (b) Extraction of water from river leaves downstream users short. (c) Subproject irrigation scheme requires more water than is available.	Low. The river is already a highly altered environment, the changes to the flow regime are expected to be modest and have been the subject of detailed assessment. In addition, long term monitoring and refinement is a required mitigation measure.
3.04	(a) Flood damage to headworks. (b) Erosion of canal banks, either from flood surges or normal flows.	Low. The subproject design specifically aims to make these resilient.
3.05	Subsequent users may not fully understand how to manage the subproject works.	Low. The project is supporting WUG capability development
3.06	Increased Pesticide and Fertilizer Use	Low to moderate as the co-financed investments by IFAD and GIZ will support PRT and IPM training as part of the LAO GAP program Higher risk to farmer workers and handlers of agrichemicals relates to the ESH risks of agrichemical handling, mixing and application in the short term. Produce and environmental risk from agrichemical over use is unlikely in the medium term however LAO GAP certification requires safe production principles including IPM and PRT

D. Environmental Mitigation Measures – General

155. This section identifies mitigation measures to avoid and minimise identified impacts of designing and implementing the Nam Seng Subproject. The detailed mitigation measures depend on individual site conditions. However, in most cases there are only a limited number of options for the mitigation of certain issues. The proposed mitigation measures are therefore listed in the EMP, covering all of the main impacts that are likely to occur. Most of them represent simple, practical, common sense measures to ensure that disruption is limited to the minimum as a result of all subproject activities.

156. In some cases, mitigation measures cannot be defined precisely because there is inadequate information on which to base precise actions. Water flows are particularly little understood because to date there have been very few gauging stations maintained in smaller catchments. Defining compensatory flows throughout the year is therefore difficult, and initially must be based on estimates. The mitigation strategy in this case is to use as much information as possible to ensure that the initial estimates are as accurate as they can be, while starting to collect continuous series monitoring data. Because of natural variations from year to year, this

process needs to be continued every year for at least ten years, and ideally throughout the life of the infrastructure, so that the compensatory flows can be updated as the running averages, minima and maxima for flow in each month become more statistically robust.

157. Both to realise the environmental benefits of the project and to safeguard the infrastructure investments, catchment land use needs to be improved in the Nam Seng watershed. This in turn requires the communities within the catchment to adopt improved land use planning, which will focus on intensified agriculture in the irrigated land and leave a greater proportion of the watershed under a longer-term cycle of forest use. Better land use management is therefore critical to the subproject achieving its purpose and to the mitigation of the impacts of increased infrastructure and it is recommended that the EA (MAF) ensures that the proposed GIZ GCF project supports catchment management in the Nam Seng catchment.

158. In a steep hilly catchment and with the intense rainfall that occurs in the Nam Seng watershed, the protection of soil surfaces is essential around all of the infrastructure that will be installed. This includes irrigation headworks, canals and access roads. There are two main purposes for this. The first is to avoid erosion from rainfall, with bare surfaces highly prone to the entrainment of soil particles as a result of raindrop impact and runoff, leading to the loss of topsoil and increased amounts of sediment in water courses. The second is to protect earthworks from flood scour, when river or canal flows overtop the structures during high floods. Simple bio-engineering measures are the only effective way of protecting large surface areas from rainfall-induced erosion, and so this is a straightforward but critical mitigation measure in targeted areas.

E. Potential Adverse Environmental Impacts – Design Phase

159. Design phase environmental impacts are expected to be minimal, but should still be recorded and plans made for their mitigation. Potential impacts might come particularly from geotechnical site investigations for structure foundations, or as a result of vegetation clearance for surveying. Climate change risks are predicted but highly uncertain in the design and operational life of the infrastructure. Current projections for P1 and P2 exceedance frequencies for maximum flow rates indicate the historical record of P1 will approximate the P2 exceedance levels under the highest climate change projections and as such all engineering designs will adopt the P1 exceedance frequency for estimating the maximum flow rates.

160. LArrec and ACIAR fish passage team undertook a survey of the Nam Seng to review if there was a need to integrate a fish passage into the head works they recommended that it was not required as there were no migratory species due to the number and size of waterfalls limiting any potential migration.

161. Identified impacts and the proposed mitigation measures for the subproject design phase are listed in Table 11: these are an extract from the impact, mitigation, responsibility and monitoring tables provided in the EMP.

162. A key part of the design period is to set the scene and conditions for the successful implementation of the project and the subsequent operation of the infrastructure it will provide. To ensure that this happens effectively, there are non-negotiable key environmental elements that must be incorporated into all subproject agreements and which, like all environmental compliance, are a condition of financing.

(i) A continuous series river gauging station in the Nam Seng river be established above where water is extracted. Arrangements must be made for data collection

and transmission to the PPIT and PONRE for collation. Records of the data (both primary and interpreted) and reviews must be lodged with the Department of Irrigation (MAF) and the Department of Water Resources (MONRE) in Vientiane, to help build up the national databases.

(ii) As part of the associated cofinancing program of GIZ a catchment land use plan will be developed for the subproject to ensure that the subproject irrigation scheme is safeguarded in terms of water supply and limited sediment supply.

(iii) Protection measures must be designed and implemented as part of all elements of infrastructure. Engineering designs must not be approved without adequate provision of protection against high flood conditions. Construction must not be approved as complete before all protection works have been finished as per the design. The purpose of the protection measures is to ensure that the subproject infrastructure and surrounding land can sustain climate-induced events – mostly high flood levels – both under current climate conditions and potentially more extreme over the period between 2020 and 2050. These measures would typically be a combination of bio-engineering and hard engineering works.

(iv) Water used for irrigation and fish ponds as part of the PRI must be tested to ensure that it complies with the National Environmental Standards (2017). This is to ensure that it does not cause downstream pollution as a result of contaminants entering the rivers from land uses in the catchment above the headworks. Contaminants can be transported either in direct solution in water that has leached through the soil, or in soil colloids carried in suspension. The sampling and testing will be based on the national standards and will be implemented **if there is evidence of probable contamination**. If required, the international environmental specialist will work with DOI (PGT) and MONRE to define a scientifically reliable sampling and testing protocol to be implemented by PONRE.

Table 11: Anticipated Environmental Impacts and Mitigation Measures during the Subproject Planning Phase

No.	Anticipated Impact	Proposed Mitigation Measures
1.01	Loss of land or other property to infrastructure.	1. Full consent to the subproject must be sought through standard consultative processes. Full and fair compensation according to the Land Acquisition and Resettlement Framework to apply
1.02	Loss of land of importance for biodiversity.	1. Subproject landtake is to be minimised. 2. Landtake is to use land that is already degraded, to the greatest extent possible. 3. Disturbance of forest and other natural habitats and removal of mature trees should be avoided. Where works will be carried out adjacent to an area of natural habitat, the area of should be clearly demarcated to avoid encroachment and damage. 4. Subprojects in forest or protected areas, would not be eligible for SRIWSM financing.

No.	Anticipated Impact	Proposed Mitigation Measures
1.03	(a) Incomplete hydrological data and as yet poorly developed climate change models lead to inaccurate designs for infrastructure. (b) Infrastructure is damaged by high flood levels, reducing the scheme's lifespan or effectiveness and causing damage to the nearby environment.	1. Care is to be used to interpret as well as possible the best available data for the subproject catchment. 2. A significant margin is to be allowed to ensure that infrastructure is likely to be resilient under current climatic conditions. 3. An additional margin is to be allowed to ensure that infrastructure remains resilient under possible future more intense or prolonged rainfall events. 4. Specially designed protection measures such as bio-engineering must be incorporated into designs as a matter of course. 5. Engineering designs must not be approved without adequate provision of protection against high flood conditions. 6. In very dry periods, released flows from the intake must be monitored to ensure that the minimum agreed environmental base flow is always provided downstream of the intake.
1.04	Disruption of hydrological flows by offtake from rivers.	1. All available rainfall and flow data for the river catchment must be collected and assessed to provide a working model of average monthly flows throughout the year. 2. A hydrological gauging station must be established on the subproject catchment, upstream of the headworks, to help define acceptable dry season minimum flows. The proximity and flows of tributary streams close downstream from the proposed headworks must also be assessed. 3. A survey must be undertaken which establishes the cumulative minimum water needs of other existing users, plus ecological requirements. 4. A calculation must then be made as to the offtake that can be allowed. 5. Where no flow data exist, initial minimum flows of at least 30 percent below which PONRE must review the proposal no subproject extraction is allowed where the residual flow falls below 10%.of the estimated monthly average flow. 6. Offtake regimes must be refined as more data become available. 7. Use of CROPWAT for water use scheduling, the adoption of alternative cropping sowing dates and crop patterns to change the nature of water demand

No.	Anticipated Impact	Proposed Mitigation Measures
1.05	Water supplies polluted by upstream land management practices do not comply with national standards for surface water.	1. If risks are identified that warranted a water testing regime an assessment must be made of the quality of water at the headworks and its likely suitability for use in irrigation. 2. If there is doubt about water quality, then the subproject should be abandoned as a candidate for SRIWSM funding.
1.06	Upstream land uses cause a decline in the quality and quantity of water available for the irrigation scheme.	1. Under the GIZ cofiancing discussions on creating a catchment land use plan should be initiated before construction starts on physical works. The plan should be both socio-economically beneficial and environmentally sound, in that its primary objective would be upstream catchment protection to ensure that the subproject irrigation scheme is safeguarded in terms of water supply and limited sediment supply.

F. Potential Adverse Environmental Impacts – Construction Phase

163. Although the subproject construction phase will be relatively short, the impacts from can be significant if not effectively managed. Access routes can be particularly destructive, and should be planned alongside the main infrastructure works, with appropriate mitigation measures. Contractors' construction sites can be very damaging to the environment if not appropriately sited and managed. Physical construction may be only in limited areas, fuel transport and storage, and temporary site camps for materials, plant, offices and labour. Poor scheduling during construction can result in activities taking place at inappropriate times, for example with earthworks being kept open through the wet season.

164. Impacts during construction may be short-lived, but they can be intense. Dust and noise pollution can be highly disturbing to local residents. A single season of sediment flows into rivers can devastate the aquatic biota, requiring perhaps years or even decades for the river to recover. One large spillage of fuel can take many years to clean up. Mitigation is therefore through the provision of preventative measures, such as through using noise abatement measures, dust suppression, sediment control and sound fuel management measures.

165. The intensification of agriculture may require increased inputs during the operational period of the infrastructure. The co-financed IFAD and GIZ programs will support the use of pesticide reduction training and IPM as part of the Lao GAP program.

166. Identified impacts and the proposed mitigation measures for the construction phase are listed in Table 12: these are an extract from the impact, mitigation, responsibility and monitoring tables provided in the EMP. A project specific Grievance Redress Mechanism (GRM) will be established and contact details provided at work sites, camps and affected villages to ensure issues arising can be resolved quickly working directly with the Contractor and PPIT. Details of construction activities and schedule will be made available to affected villages in advance.

Table 12: Anticipated Environmental Impacts and Mitigation Measures during the Subproject Construction Phase

No.	Anticipated Impact	Proposed Mitigation Measures
2.01	(a) Release of silt into water courses from excavations and earthworks during construction. (b) Release of silt into water courses from poorly finished earthworks following construction.	1. The removal of vegetation and creation of bare surfaces must be minimised to essential areas only. 2. Vegetation clearance and earthworks may only be undertaken during the months of October to April. 3. Temporary sediment settling ponds built using strong stone or timber check dams (not bamboo or fabric silt fences) must be constructed to trap sediment from all earthworks that have unprotected surfaces at any time during the months of April to October inclusive. 4. Borrow areas, camp sites, temporary access tracks etc. must be fully rehabilitated back to a condition that is fully protected against soil erosion. 5. Bio-engineering surface protection must be planted on all bare earthworks during the months of May to July. Design guidelines and bill of quantities include specifications and costs for planting,
2.02	Environmental damage of any form results from the poor understanding of subproject requirements by the contractor and subcontractors.	1. At a pre-mobilisation site meeting, the contractor must demonstrate a full understanding of the requirements of the EMP. 2. Each contractor will prepare a site-specific CEMP that is fully responsive to requirements of EMP and GRM. 3. Each contractor will appoint a qualified Environmental health and safety officer to supervise implementation of CEMP and GRM, provide training to workers and prepare monthly reports on implementation. 4. The contractor must demonstrate full responsibility for all subcontractors' adherence to the provisions of the EMP.

No.	Anticipated Impact	Proposed Mitigation Measures
2.03	Clearance of vegetation leads to the unnecessary removal of trees and other plants.	1. No tree over 200 mm diameter at breast height (1.5 metres above the ground) may be cleared unless the design drawings specifically require it. Mature trees close to working area should be demarcated and protected from encroachment. 2. The contractor's site clearance plan must be limited to the agreed work site boundaries and must be approved by the PPIT's environmental representative before any clearance may be commenced. 3. Any damage to areas outside the agreed corridor of impact will be compensated/restored to pre-project condition at cost of contractors.
2.04	Temporary closure of irrigation systems during construction.	1. Contractors must provide a plan in advance to provide irrigation water into existing supply channels, which must be approved by the project implementing agency and the Water User Group. 2. If it is not possible to avoid temporary closure, then full and fair compensation is to be paid for loss of crops as a consequence.
2.05	Disposal of soil from excavations such as irrigation canals.	1. Soil from excavations should be re-used in designs wherever possible. 2. Where soil is excess to engineering requirements and is treated as spoil, it must be disposed of in the nearest available approved location, and stabilised and protected from rainfall using bio-engineering measures.
2.06	Release of dust into the atmosphere from excavations and other construction activities.	1. Earthworks must be halted during periods of strong winds. 2. Heavily used access tracks must be sprayed with water during dry periods. 3. On all unmetalled surfaces, construction traffic must be limited to 30 kmh within 250 metres of habitation and 80 kmh elsewhere. 4. Loads of dust-making materials must be covered. 5. Crushers must be fitted with water sprays to prevent dust emissions.
2.07	Release of noxious gases into the atmosphere.	1. Vehicles and machines must be in a good condition and serviced regularly, to ensure minimal emissions. 2. All vehicles and machines must comply with the Lao PDR emissions standards.

No.	Anticipated Impact	Proposed Mitigation Measures
2.08	Noise nuisance from construction activities.	1. Contractors must not exceed statutory noise levels at any time. 2. Work sites within 500 metres of habitation: (a) must not operate during the hours of darkness or on holidays; and (b) must have noise-abatement measures installed for other periods.
2.09	Temporary use of land for construction affects livelihoods or leaves it damaged.	1. Land for use by any contractor or subcontractor must be agreed by both the PPIT and the local community authority before the contractor may have access. 2. Full and fair compensation is to be paid for loss of crops or other assets before the contractor may have access to the land. 3. The contractor must have a land restoration plan, which must have been implemented to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid.
2.10	Influx of temporary labour disrupts local communities.	1. Contractors and subcontractors are required to use the maximum local labour possible. 2. If a significant number of staff and workers (i.e. more than 20) are to be brought into the subproject site, then the contractor must provide a management plan and code of conduct for the staff and workers, that is approved by the local community authority.
2.11	Operation of construction machines affects both workers and local society.	1. The noise and dust reduction measures listed above must be adhered to. 2. Safety measures for machine operation must be defined and approved by the project implementing agency. 3. Machine operators and workers must be trained and certificated in the safe use of machines.

No.	Anticipated Impact	Proposed Mitigation Measures
2.12	Pollution by hydrocarbons from construction plant.	1. The contractor must prepare a plan for the management of hydrocarbons, which must be approved by the PPIT before the contractor is permitted to mobilise to site. 2. Fuel and oil must be transported in properly designed vehicles meeting national standards. 3. Fuel and oil must be stored at least 50 metres from a water body, in covered and bunded locations, and dispensed under strict controls. 4. Vehicle and machine parking and service areas must have impermeable surfaces and the outlet drains must be fitted with oil traps. 5. Contractors must have spill clean-up equipment on site, and persons always present who know when and how to use it. 6. The contractor must have a land restoration plan that includes hydrocarbon facilities, which must have been implemented to the satisfaction of both the project implementing agency and the landowner before the contractor's final bill may be paid. 7. Any subcontractor must comply with the same rules, at the contractor's liability.
2.13	Pollution from construction site wastewater, from camps and other work sites.	1. The contractor must prepare a plan for the management of wastewater, which must be approved by the PPIT before the contractor is permitted to mobilise to site. 2. "Black" wastewater from sanitation facilities must be led to a properly constructed septic tank and soakaway. 3. "Grey" wastewater from washing and cooking facilities must be led to a septic tank or to a specially built reed bed filtration system. 4. Oil-contaminated water from workshops and fuel stores must be collected and taken to an approved municipal waste management facility. 5. The contractor must have a land restoration plan that includes wastewater facilities, which must have been implemented to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid. 6. Any subcontractor must comply with the same rules, at the contractor's liability.

No.	Anticipated Impact	Proposed Mitigation Measures
2.14	Pollution from solid waste materials.	1. Solid waste must be recycled wherever possible. 2. Non-recyclable solid waste must be sent to an official landfill site. 3. Any open burning of solid waste is prohibited 4. The contractor must have a land restoration plan that includes solid waste, which must have been completed to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid.
2.15	Injuries to workers and others.	1. Work sites must be clearly demarcated using barrier tape and all non-project personnel excluded. 2. All staff, workers and visitors to construction sites must be issued with appropriate personal protective equipment. 3. All staff, workers and visitors to construction sites must be briefed on safe working procedures for that site. 5. Every construction site must have a first aid kit and at least two persons always present who are trained and competent to use it.
2.16	Disruption of cultural sites.	1. All small cultural sites (such as small shrines and graves) must be protected by the contractor during works periods. 2. A plan for the protection of cultural sites must be approved by the PPIT. 3. All chance finds of such assets or sites will trigger works to stop. The PPIT shall assess the need for mitigation or additional management in co-ordinating with the relevant authority. 4. Once construction is complete the surrounding of such sites must be restored to their pre-construction condition.
2.17	Subsequent users may not fully understand how to manage the subproject works.	1. Instructions on maintaining and operating the infrastructure must be provided to the end users and Water User Group before handover. 2. Before handover, the operating instructions must be finalised and the EMP requirements included.

G. Potential Adverse Environmental Impacts – Operation Period

167. Identified impacts and the proposed mitigation measures for the operation period are listed in Table 13: these are an extract from the impact, mitigation, responsibility and monitoring tables provided in the EMP.

Table 13: Anticipated Environmental Impacts and Mitigation Measures during the Subproject Operation Period

No.	Anticipated Impact	Proposed Mitigation Measures
3.01	Disruption of downstream hydrological flows due to offtake from river.	1. Once scheme operation commences, the gauged river flows and water offtake volumes must be reassessed. 2. These, plus any complaints from downstream users, must be used to recalculate the allowable offtake. Downstream use from the Nam Seng irrigation scheme are very few due to the proximity of drainage into the Mekong and will not be affected 3. Future development of new command areas after SC1 may require water sharing or water use efficiency measures at which point the scheme must then be revised accordingly.
3.02	Upstream land uses cause a decline in the quality and quantity of water available for the irrigation scheme.	1. The GIZ cofinanced catchment land use plan, preparations) should be implemented to ensure that the scheme is safeguarded throughout its operational life. The plan's primary objective is upstream catchment protection to ensure that the subproject irrigation scheme is safeguarded in terms of water supply and limited sediment supply. 2. Arrangements for implementation of the plan must be maintained.
3.03	(a) Extraction of water from a river causes a decline or loss of aquatic biodiversity. (b) Extraction of water from a river leaves downstream users short. (c) Subproject irrigation scheme requires more water than is available.	1. If these impacts occur, then it shows that the assumptions of water flow made during subproject design were wrong. This is likely to be due to a lack of flow data at design stage. 2. The minimum flow release must be recalculated, based on user needs and the latest data on river flow. 3. Water use by the subproject scheme must be reviewed against what is actually available. 4. A revised scheme management plan must be introduced, implemented, monitored and adjusted until it resolves the problem.

No.	Anticipated Impact	Proposed Mitigation Measures
3.04	(a) Flood damage to headworks. (b) Erosion of canal banks, either from flood surges or normal flows.	1. All flood protection works must be maintained as per the design of the subproject, or any subsequent engineering works. 2. Any flood damage must be reviewed and appropriate measures designed for resolution. 3. Occasional minor flood damage should normally be resolved by using appropriate measures. 4. The use of civil engineering structures (i.e. concrete or gabion works) may be required in the event of serious damage from exceptional floods.

H. Cumulative and Transboundary Impacts

168. The most likely cumulative impact will arise from the continued development of the total planned command area of 960 to 1000ha. At this scale there is likely to be seasonal water shortages and as such dry season cropping may not be possible for the entire command area including the existing and the SRIWSM SC1 command areas.

169. Cumulative environmental impacts would occur if other significant developments were to be proposed in the subproject area or close to it. At the time of planning, no such major proposals were known about. This was one of the subjects of enquiry at both provincial and district levels during the preparation of this IEE.

170. A proposed project is under investigation to install a small electrical power generator (1.5 megawatts) in the Nam Seng channel, but there are no detailed plans available or any approval in place. The government investment board has cancelled this proposal as small hydropower schemes are no longer legal. The MAF has advised both ADB and the PPTA that this proposal is no longer valid, as all such small schemes have been excluded from the investment program due to the high cost of electricity produced.

171. There are two potential mineral exploitation projects, in Ban Pak Nern and Ban Pak Bor, Nan District. One is Phoubia Lanna Mining, for copper, gold and manganese (GPS location 805295 / 2133452). The other is Phoubia Trade Import-Export (GPS location 796300 / 2131294). Both of these mines are far from the subproject, are unlikely to have an impact. Nevertheless, the PAFO should remain in contact with the PONRE and the Provincial Energy and Mining Office in connection with these possible projects

172. Transboundary impacts are theoretically possible because the subproject catchment flows into the Mekong, which later forms a border with Thailand, and ultimately flows through Cambodia and Viet Nam. However, the likely impacts were judged to be negligible on account of the nature of the subproject proposals, and the very large dilution by the Mekong mainstream of the waters from both the Nam Seng and Nam Nan watersheds.

VII. CONSULTATION

A. Consultation Process

173. During planning, construction and operation, the subproject developer – in this case the PAFO supported by the SRIWSM – is obliged under the EIA Decree and ADB SPS requirements to inform project-affected people and other stakeholders of project activities which are likely to create environmental and social impacts, and to provide access to general information about the subproject.

174. The process for public consultation and information disclosure is described in the EIA Decree and ADB SPS. The project developer is required to make people in the affected area aware of the project and what it will involve, and to collect their views, early in the IEE process. These initial disclosure and consultation meetings must then be followed up later on, to release a draft of the IEE for comment over a period of at least 30 days. Potentially damaging impacts must be made clear to all stakeholders. Associated with this consultation process is a grievance redress mechanism (GRM) that allows complaints to be heard by the authorities responsible for the project, and recorded at the district administration. The mechanism must allow concerns to be raised from village to district level and if still not resolved, to national level. In addition to the country system, ADB requires establishment of a project-specific GRM.

175. During IEE preparation, a series of meetings was held in the provincial, district and village centres, at which the following activities were undertaken: (i) a summary of the works proposed under the subproject was presented; (ii) discussion was held on the subproject objectives, and likely positive and negative environmental impacts, covering the construction phase and longer term operational period; and feedback was gathered in the form of any comments that the various stakeholders made, along with their suggestions on mitigation. Table 14 provides a list of the groups consulted and the dates of the meetings. Full information on the dates, attendees, topics covered and conclusions of consultations are recorded and included in Appendix 1. In some cases, comments, corrections or further information have been provided alongside the records.

Table 14: Consultative Meetings Held Regarding the Nam Seng Subproject.

Group consulted	Date of meeting
Meeting with the Head of Division of Forestry and Agriculture at the Provincial Agriculture and Forest Office. Meeting at the Provincial Information, Culture and Tour Office. Meeting with the Provincial Environmental Office.	23 March 2018
Meeting with the related offices within the Provincial Agriculture and Forest Office, including Irrigation, Forestry, Livestock and Plantation.	24 March 2018
Meeting with the Provincial Public Works and Transport Office. Meeting with the Provincial Energy and Mine Office.	26 March 2018
Meetings with the related officers of the District Agriculture and Forest Office, the District Irrigation Office, the District Energy and Mine Office, the District Environment Office, the District Information, Culture and Tour Office, the District Public Works and Transport Office, the District Planning Office, and water users, at Nan District.	26 March 2018
Meetings with the local authorities at the village level, including the related officers from the Provincial and District levels.	27 March 2018
Consultation with Nakheun villagers that use drainage water outside the command 16th November 2018 at Nan District meeting hall,	16 November 2018

consultation was conducted for both project committee and AHH with Mr Sanya (PAFO- Irrigation Section) explaining the design and the availability of water to the group	

176. Following completion of the IEE it should be summarised and made available to the public for a period of at least 30 days. For this purpose, the IEE must be prepared in both English and Lao, and distributed to district administrations, where they will be made available for public review.

177. During construction and operation, the project developer is obliged to undertake ongoing consultation to inform project-affected people and other stakeholders of project activities which are likely to create environmental and social impacts, and to provide regular access to general information about the subproject and opportunities for feedback. The PAM sets out a detailed consultation and communication plan for ongoing consultation with beneficiaries, affected persons and key stakeholders during subproject preparation and implementation. Consultation on environmental issues will be integrated into planned consultation activities and carried out *ad hoc* during monitoring visits and review missions.

B. Information Disseminated

178. The preliminary engineering designs, along with estimates of potential impacts on land, the acquisition needed and compensation and resettlement for the subproject implementation, were used as the basis for discussions in meetings with the community. Additional specific meetings were then conducted with households whose land would be affected by the proposed rehabilitation or construction. Safeguard specialists assisted project engineers to disseminate and discuss the preliminary engineering designs with the community, and particularly with the affected households.

179. The meetings provided the information required to clarify: (i) the justification of the proposed subproject rehabilitation or construction works considering the anticipated resettlement impacts; (ii) mitigation measures to restore the affected households' livelihoods and standard of living; and (iii) assistance from the community or the district administration to plan, agree and implement the mitigation and support measures for the affected households. The consultations also covered the villagers' views on measures to mitigate the anticipated impacts including compensation and design alternatives to reduce impacts.

180. More details on information dissemination and consultation are provided in the SRIWSM's Resettlement Land Acquisition and Ethnic Group Development Framework, which forms a parallel safeguard document to this IEE.

C. Results from Consultation

181. Few environmental concerns were raised during the consultations in the subproject area. Those that emerged are listed in Table 15. While most of the discussions focused on accounts of development and environmental conditions in the general area, some participants at the consultative meetings were concerned that sand pumping and quarrying had increased the sediment load in the river, affecting agricultural activities, reducing the amount of water available for village use, disturbing fish movements, causing fish deaths and decreasing the river weed grown. Clearly these other uses of the Nam Seng will need to be reconciled with the changes proposed by the subproject as part of the implementation of the subproject.

Table 15: Matrix of Concerns Raised by Participants during Consultations.

Consulted groups	Concerns raised	
Provincial Agriculture and Forest Office	PAFO staff raised the following main concerns regarding rural development and land management in the subproject area. Poorly controlled pesticide use in some agricultural and shifting cultivation areas, and the current lack of specific solutions. Illegal logging around the Nam Seng catchment area despite it being protected forest managed by village development and water user groups. Community planting of fruit trees in degraded forest areas. Ongoing measures to decrease shifting cultivation through land use management, consultation on the regulation of illegal logging and forest burning, and the regulation and fining of perpetrators of the hunting and sale of wildlife.	Under the IFAD program Lao GAP, PRT and IPM will be applied GIZ catchment plan will address this issue Outside scope of ADB investment an option for inclusion in GIZ program
District Agriculture and Forest Office	The poor condition and insufficient capacity of the existing irrigation channel to deliver enough water for the villages. Leakage water from breaks in the irrigation canals affect the road surface and cause soil erosion and landslide along the roadsides, and create sediment flows to the village plantations, fields and natural streams. These reduce local people's livelihoods and decrease village funds because of the requirement for maintenance of blocked irrigation canals and roads.	Design was modified to address these issues

Consulted groups	Concerns raised	
Provincial Natural Resources and Environment Office	The PONRE staff raised the following main concerns.	
	Potential residue of eight types of chemical pollutants resulting from uncontrolled agriculture activities such as rubber and banana plantations, and the lack of official documentation of this.	The inclusion of LAO GAP PRT and IPM however banana plantation is closing
	The lack of high value and economically important trees in the provincial forests due to shifting cultivation.	Outside scope of ADB
	The need to improve waste management, control sources of pollutants, protect and increase forest areas, promote agricultural programmes, and provide land use management.	IFAD Agriculture program may consider but these activities are not linked to ADB investment
	The potential control of agriculture and industrial tree plantations by limiting land clearance, encouraging clean technologies, identifying native seeds, supporting organic products and controlling the importation of dangerous chemicals.	The inclusion of LAO GAP PRT and IPM
	The potential control of the livestock industry through improved land use allocations, grass planting, disease checks and vaccinations, use of native seeds, better quality control, building union groups, training and technical supervision, and the reuse of compost fertilisers.	Outside the scope of Project, not relevant to ADB investment
	The potential control of NTFP collection by increasing market understanding, increasing product prices, building union groups, management systems and analysis centres, and surveying protected areas for NTFP.	Not relevant to irrigation command area

Consulted groups	Concerns raised	
Village consultation groups	Mostly the villagers were in favour of the project because they would be the main beneficiaries. They have decreased the land leased for banana plantations because it is causing soil erosion from agricultural land. Key interests stated were as follows. To make permanent improvements to this irrigation channel, and to provide enough water to every village. For the irrigation project to pay more attention to improving the operation system in order to release sufficient water to each village and each plantation area.	 Included in design Strong emphasis for dry season criopping design of irrigation system and the follow on IFAD WUG training to operate schemes

182. The results of all the consultations regarding environmental issues are given in Appendix 1. In general, the stakeholders were all in favour of the subproject, since it involves rehabilitating and improving an existing irrigation scheme, and it will lead to better cropping options and improved incomes. At both district and provincial levels it is supported as a positive intervention that fits with their strategies for environmentally sound agricultural development.

D. Grievance Redress Mechanism

183. A project specific GRM is established to receive and facilitate resolution of affected peoples' concerns and grievances about the borrower's social and environmental performance at project level using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. In most cases complaints and issues are directed to the contractor or via local administration or farmer groups. Key GRM focal points should be identified within Contractor, PPIT, PGT teams and other appropriate local entry points. The LIC will train GRM focal points on GRM implementation, including recording, monitoring and reporting requirements. GRM focal point contacts should be displayed on notice boards in affected villages and on contractor sign boards at active construction sites and camps. To ensure that complaints are dealt with in a timely manner, time limits should be set for referral and resolution of complaints.

184. All complaints and resolutions must be properly documented by the receiving entry point, whether through the project GRM entry points or through the country system. The Contractors will report on issues and complaints raised and resolved in monthly reports. PPIT and PGT GRM focals will ensure that the quarterly project progress reports and semi-annual integrated safeguards monitoring report submitted to ADB include a report on GRM, taking into account issues raised through the project specific GRM and the country system. The country system

provides recourse to village, district, provincial and national level authorities as may become necessary.

VIII. INSTITUTIONAL ARRANGEMENTS AND RESPONSIBILITIES

A. Project Organisation and Government Staff Capacities

185. The executing agency of the SRIWSM is MAF, with support from the IA - Department of Irrigation (DOI). Implementation is decentralised to the Provincial Agriculture and Forestry Offices (PAFO) where implementation activities will be assigned to the respective sections of PAFO, co-ordinated by a Provincial Project Implementation Team (PPIT) for the management of the SRIWSM Project.

186. The executing agency (i.e. MAF) and IA (i.e. DOI) will establish a Program Governance Team (PGT) that would be responsible for: (i) establishing the operational procedures to be used by the PPIT, including planning, budgeting, financial management, procurement, disbursement, contract management, safeguard monitoring and compliance monitoring; (ii) ensuring both government and donor audit requirements are met; (iii) providing capacity building at the provincial level for both PPIT staff and potential contractors; and (iv) providing technical support for advanced engineering designs and project management teams, including the provision of skill mentoring and technical assistance input to procurement and contract management.

187. Government staff are involved in environmental management and monitoring at a number of levels and in two main ministries: MAF for both management and monitoring; and MONRE as delegated to PONRE for monitoring. Reforms of government to separate the environmental portfolio from agriculture and forestry started in 2017 and is not yet complete. Capacity in this respect is therefore still being developed, particularly at the provincial and district levels.

188. The capabilities required of staff varies depends on the phase of the subproject, and their level and remit, a sound understanding of the environment and society in the rural hill catchments of the northern provinces, and a particular understanding of current issues in both upland and irrigated agriculture is needed. PONRE staff have the underlying environmental knowledge but often lack the technical expertise to address specific issues. DONRE staff are far less experienced and qualified. The LIC will be expected to help improve capacity and assist the government to improve its staff skills and knowledge in this respect. This should include support to PONRE and DONRE staff in their capabilities for environmental monitoring. The LIC – both international and National will provide (i) Project awareness training, (ii) technical training with respect to environmental monitoring systems and techniques that will apply to their specific subproject, (iii) PONRE staff receive budgetary support for their additional costs on an output basis ie PAFO will pay for monitoring reports received. In addition, PONRE and DONRE monitoring staff will be supported for regular site visits by the construction supervision staff of PAFO.

189. During the project implementation period, which effectively involves subproject design and construction phases, safeguards are the responsibility of the Vice Governor Office represented by PAFO with support from the PGT within the Department of Irrigation. Environmental safeguard monitoring responsibility will be assigned to PONRE through a Memorandum of Understanding (MoU) between the Vice Governor Office, Director of PAFO and Director of PONRE. The environmental safeguard consultants in the Loan Implementation Consultant (LIC) team will undertake screening, classification and assessment of future subprojects and will train and support PONRE and DONRE staff with monitoring visits and preparation of monthly and quarterly safeguard reports that will be submitted to the Vice Governor, and the EA via the PGT in DOI.

The LIC will support the PGT to prepare a summary of safeguards and GRM implementation to be included in the quarterly project progress reports to be submitted to ADB.

190. At the provincial level, a PAFO will assign overall project management to an existing PAFO Deputy Director General to implement subprojects. Within each PAFO, the technical staff will be assigned to the PPIT must be able to monitor the implementation of works programs with the supervision role also maintaining both social and environmental checklists for site visits. The LIC will support PGT to prepare semi-annual integrated safeguard reports to be submitted to ADB. These reports will include details of issues raised and resolved through the GRM during the reporting period. The semi-annual integrated safeguards monitoring report will be disclosed on ADB website once approved.

191. Following construction and commissioning, the subproject infrastructure will be handed over to and operated by the Water User Groups. The relevant PONRE will be responsible for environmental monitoring during operation. More detailed information is provided in the EMP and the PAM.

1. Training and Capacity Building

192. The LIC ES will provide training and capacity building on environmental safeguards and GRM as set out in Table 1. At provincial, district and subproject levels, it will use formal seminars and training courses focused on the needs of the individuals working with each of the stakeholder organisations, as well as guided on-the-ground action learning-through-doing.

Table 16: Environmental Safeguard Capacity Strengthening Plan

Topic	**Trainee**	**When**	**Training Responsibility**
Project Awareness	WUG Official DONRE PONRE assigned staff and Section Head PAFO Safeguard Focal Point PAFO Construction Supervision	Q1-2 Project year 1	PGT Project Management Advisor
ADB and Govt Environment Safeguard Requirements	DONRE PONRE assigned staff and Section Head PAFO Safeguard Focal Point	Q2 Py 1	LIC National Environemtnal Consultant and National Project Management Advisor

Topic	Trainee	When	Training Responsibility
	PAFO Construction Supervision PPIT DIrector		
Environmental Documentation – Additional Subproject Processing	WUG, Assigned staff PONRE and DONRE PAFO – construction supervision	Q2-3 PY 1	LIC Project Management Advisor –PGT LIC International and National Consultant
Environmental Monitoring – RSP	WUG Assigned staff PONRE and DONRE PAFO – construction supervision	Q3 PY 1	LIC International and National Environmental Consultant Lt National Construction Supervision Consultant
Environmental Reporting	Assigned staff PONRE and DONRE PAFO – construction supervision PPIT Project Management Advisor	Q4 PY1 and Q1 Py2	LIC International and National Consultant
Environmental Sampling and water Flow data analysis	Assigned staff PONRE and DONRE PAFO – construction supervision PPIT Project Management Advisor	Q1 Py 2Q2 PY 2	LIC International and National Consultant

IX. ENVIRONMENTAL MONITORING AND REPORTING

A. Environmental Management Plan

193. The EMP is the key document underpinning each IEE and ensuring that the required environmental safeguards are adequately implemented. The EMP will be translated into Lao language. Written acceptance of the EMP from the WUGs is obligatory before a subproject may be funded. Acceptance of and a commitment to implement the EMP must also form part of the contractual conditions for any civil works under a subproject.

X. EMP BUDGET

194. The budget[5] for the implementation of the IEE and EMP include the items in the following table – however training of PONRE and DONRE staff is included in the LIC terms of reference and are not included in the table below as they are not budgeted inputs by individual subproject.

Item	Amount (USD)
Monitoring Equipment	600
Sample Testing	5,800
Allowances	11,000
Lao GAP IPM implementation	17,800
Subtotal	35,200

XI. CONCLUSIONS

A. Justification of the Proposed Subproject

195. This IEE provides an overview of the proposed subproject and its purposes. It provides a brief description of existing environmental conditions. It makes an evaluation of the likely impacts that will occur to the environment as a result of the proposed subproject activities. It outlines the mitigation measures that will be required to avoid and minimise damage to the environment.

196. The assessment to date confirms that, as previously determined, the subproject is classified as MONRE category 1 and ADB category B, which are satisfied by the preparation, review and approval of an IEE and accompanying EMP. Overall, it is considered that the enhancement of rural livelihoods in the subproject catchment through increased access to reliable year-round irrigation and better access will have direct socio-economic benefits which may indirectly reduce threats to upland forest habitats. Adverse environmental impacts may occur during the implementation and operation of the subproject, but these impacts can be readily mitigated within acceptable limits through the effective implementation of the EMP and proposed

[5] Costs for implementing the water testing, if required due to the changed cropping intensity will be included in the irrigated agriculture support financed by IFAD PICSA project.

capacity building and training in respect of integrated pest management and sustainable water resource management.

B. Environmental Management and Monitoring

197. The EMP has been prepared on the basis of the design for the subproject, and its likely effects on the environment, that has been evaluated in this IEE. It defines the anticipated environmental impacts, the measures required to mitigate and monitor them, the responsible parties and budget for doing so and the timing. Following the approval of this IEE, the EMP forms the guiding document to ensure that all necessary environmental safeguards are put in place.

198. The next steps are: (i) ADB approval of the IEE, (ii) Public consultation of the Lao language IEE,[6] (iii) PONRE approval of the LAO IEE.

[6] The subproject engineering design is currently updated to DED status and once approved by the PAFDO, and Vice Governor the IEE can be finalised for Lao translation.

Reference Documents

Acreman, M. and Dunbar, M.J. 2004. Defining environmental river flow requirements – a review. *Hydrology and Earth System Sciences*, 8(5): 861-876.

Asian Development Bank. 2018. Integrated Biodiversity Assessment Tool. 2018. Proximity report generated by the Integrated Biodiversity Assessment Tool – Lao Nam Seng Luang Prabang (May 2018).

Aware for Projects. 2018. Climate and Geological Risk Screening – Luang Prabang Nam Seng. Asian Development Bank, May 2018.

Bunn, S. and Arthington, A. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. *Environmental Management*: doi.org/10.1007/s00267-002-2737-0. Available from: http://hdl.handle.net/10072/6758

Emission Reductions Program Document (ER-PD): Promoting REDD+ through Governance, Forest landscapes & Livelihoods in Northern Lao PDR. 2018. (Revision: 30 January 2018). Forest Carbon Partnership Facility Carbon Fund.

Government of Lao PDR. 1996a. The Forestry Law.

Government of Lao PDR. 1996b. Law on Water and Water Resources. (Law No. 02-96, 11 October 1996).

Government of Lao PDR. 1997.The Land Law. (Law No. 01/97/NA, 12 April 1997).

Government of Lao PDR. 1999. Environmental Protection Law.

Government of Lao PDR. 2002. Directive on the Prohibition of Hunting and Trading Wildlife and Aquatic Animals, Nationally and Internationally, and of Providing Passage to 3rd Countries. (Directive No. 76/MAF, 2 June 2002).

Government of Lao PDR. 2007. Wildlife and Aquatic Law. (Law No 07/NA, 24 December 2007).

Government of Lao PDR. 2010a. Decree on Environmental Impact Assessment. 2010. (Decree No. 112/PM, 16 February 2010).

Government of Lao PDR. 2010b. Regulation on the Control of Pesticides in Lao PDR. 2010. (Regulation No 2860/MAF, 11 June 2010).

Government of Lao PDR. 2010c. Strategy on Climate Change of the Lao PDR.

Government of Lao PDR. 2011. The Lao PDR Joint Damage, Losses and Needs Assessment (August 2011).

Government of Lao PDR. 2016. Decree on Compensation and Resettlement Management in Development Projects. (Decree No. 84, 5 April 2016).

Government of Lao PDR. 2017a. National Environmental Standards. (Decree No. 81/ENV, 21 February 2017).

Government of Lao PDR. 2017b. Water Law Update. (Update of 9 June 2017 following National Assembly Meeting on 11 May 2017).

Government of Lao PDR. 2017c. Decree on Pesticide Management. (Decree No. 258/GOV, 24 August 2017).

International Water Management Institute. 2018. IWMI Environmental Flow Calculators. http://www.iwmi.cgiar.org/resources/models-and-software/environmental-flow-calculators/

Ministry of Planning and Investment. 2016. 8th Five-Year National Socioeconomic Development Plan (2016–2020). (VIIIth National Assembly's Inaugural Session, 20–23 April 2016).

Tennant, D.L. 1976. Instream flow regimens for fish, wildlife, recreation and related environmental resources. *Fisheries*, 1:6-10.

World Bank (including International Finance Corporation). 2007. Environment, Health and Safety General Guidelines. World Bank Group.

World Bank (including International Finance Corporation). 2016. Environment, Health and Safety General Guidelines: Annual Crop Production. World Bank Group.

Appendix 1. Records of Consultations

Provincial Agriculture and Forest Office

The project is located in Ban Phaunxay, Nan District, Luang Prabang Province. The project is far from the urban area about 25km, GPS(E17796-E17804 /N2152-N2162).

The existing irrigation use is 350 ha in the 10 villages. The proposed project shall increase the beneficiary villages in 14 village within the 1400 ha.

The provincial and district development plan had focused on the agriculture development under the land use management and permission, the agriculture development is the main income for the local people and the basis of local occupation for earning the income.

The current condition of the existing irrigation was required to maintenance yearly and sometime 3 times per years, therefore the use of the village's group fund had been decreased of the village income.

The existing access road along the irrigation channel had been directly reflect and soil erosion naturally caused by the rainfall and landslide during the rainy season and natural disaster (typhoon, flooding, thunderstorm and other). The district authority has conducted the monitoring for any maintenance request and investigate the cause issue before proposing the maintenance plan.

There is no specific land management and arrangement in Nam Seng catchment area; no official land title for agricultural land use in the provincial level, while only the village and district authority permission for use of land for plantation such as job's tear plant, corn in the dry season.

There has been no soil quality analysis and the potential land arrangement is only in the district level, which there is the district land management plan.

The job's tear and corn plantation are mostly agreed and contracted among the village and investors via the district authorities documentation. The contract shall be made among the related partners, village, investor on the amount of product requirement, type of product, time to be collected and transport, price and worker employment and local authorities free, which of those items would be agreed and conducted by the village and investor afterward.

The pesticide use in some agricultural area and shifting cultivation have appeared in the plantation area and forest area. Specific solutions are still required to the district level through provincial level, but the usual measure and possible solution is to stop using the pesticide and leave the plantation natural treatment. The penalty may be the reminding and take in the awareness program to the village.

The watershed area and protected forest at the upstream of irrigation head, was managed and protected by the village development groups and water user groups, which in a few year cycle reforestation activities would be implemented but there still happen the illegal logging around Nam Seng catchment area.

The community base and participation for the young plant nursery and planting the trees and fruit trees in the degraded forest.

The current mitigation measure for decreasing the shifting cultivation from the provincial through the district and village level are: (1) land use arrangement and methodology (2) public share and consultation on the regulation and law on the prohibition for illegal logging, forest burning for other activity, penalty role and fine price; and (3) to disseminate the wildlife hunting regulation and the fine role of the buy and sale the wildlife.

District Agriculture and Forest Office

The most agriculture activities are the upland rice, job's tear and corn plantation, livestock which of those reflect to increase the shifting cultivation on the forest area.

The existing irrigation channel condition is insufficient capacity and quality to delivery enough water volume for the village. The leak water at the broke irrigation channel reflects to the road surface which cause of the soil erosion and landslide along the road side, and create of the sediment flows to the village plantation and natural canal/stream and plantation field.

Those result could reflect to the local people living condition and decrease the village fund and income because the requirement for maintenance the block irrigation channel and road blocked.

This year, district office had used 79 million kip for maintenance of the irrigation channel by using the budget from the water use fee and some of the village development fund and villagers as the worker for access road maintenance.

The Nam Seng catchment area is protected forest which mostly there is the mixed deciduous forest and fallow forest.

The shifting cultivation outside the permitted area still occurs inside and outside catchment area, the penalty measure has been undertaken and to referring the official penalty regulation (Ref.No.48/DFRM.MAF).

Some of the beneficiary area 1000ha from the Nam Seng irrigation was replaced by the building area because of the village extension and infrastructure development.

The agriculture development plan is focus to improve the land use measurement by apply the official land book (registration book) for agriculture land, and to prevent the changing for being the building land.

To continuous implement the reforestation activities in the catchment area, to conduct the forest land mapping and issue the forest management regulation.

The overall support the local people and investor to increasing the number of agriculture program such as rice planting, fruit tree planting, vegetation planting, economic and industrial trees plantation by preventing the use of chemical fertilizer. And increasing dry season plantation as much as possible.

District land use area as below table, data source: ISP Nan District, Luang Prabang (2012-2013) and based on the DAFO, Nan District.

Most of the villagers live along the main road #4 and Mekong river.

The living condition bases on the agriculture and livestock such as rice planting.

Industries vegetation and livestock.

Total forest area is 61,291 ha, steep mountain and hill.

No	Land type	Area (km2)	%
1	Residence	363.52	0.23
2	Forest	100,456.99	66.26
3	Agriculture	48,412.42	31.93
4	River and stream	2,006.09	1.36
5	Infrastructure	155.40	0.10
6	Industry	4.65	0.003
7	Culture	118.77	0.07
8	Army land	26.83	0.01

No	Forest type		2012 data
1	National protected forest Nam Feuang		37,600 ha
2	National Protected forest and Nam Seng reforestation		33,800 ha
3	Provincial protected forest Phousakean		1,240 ha
4	District protected forest at Phakhone Horng and Pha Kouy		2,450 ha
5	Reforestation Phou Jong		1,890 ha
	Total		76,980 ha

Nan district has 16,616 ha of agriculture land, including paddy rice (2,101 ha), upland rice (78.2 ha), corn (360.5 ha), job's tear (6,380 ha), orange (35.5ha), mango (1,762ha), coconut plant (2,032ha), garlic (28,28ha), and other crops such as cucumber.

The dry season vegetation production area has decreased from the year 2012 up to present.

The livestock products are important income for the villages and the district office has conducted the livestock vaccine awareness and use training. Some farms are operated in Nan district as specialist enterprises for cattle, buffalo and chicken farms.

The Nan district has plantation forest are 2,727.8 ha which includes teak (1,011 ha), oil palm (3.5 ha), rubber plantation (2,893 ha).

In total there are 137 irrigation channels, of which 17 are permanent with 120 being natural that support the field to feld flow for paddy production in 1,781 ha and 800 ha of dry rice fields.

The conserved area had been identified such as catchment protected forest, protection forest, historic place, rice field, the residence area, proposed urban extension area, industrial area, water supply conservation, prohibited stream and area, wildlife conserved area, reservior area and landfill. The Nam Seng is one of the catchment protected forest which it was required to be conserved for catchment management however it does not have formal protection status..

Trend of the potential development for Nan district

For agriculture: paddy field and upland rice – District officials

Strong point	Weak point	Chance	Challenge	Environmental impact	Environmental Mitigation measure
Production area	No production technology	Market	Product prices for rice	Soil quality decreasing due to the chemical use and land use	Support and proposed the natural compost and fertilizer us
	Good seed	Organic product	Rice price	Waste water issue increasing due to the chemical use	Awareness on the use of pesticide and prevention
	Labour	Upgrade of production system	Degraded soil	Lost well seed and traditional seed	Upgrade the product price by adding the natural value
Irrigation	Capital	Extending the irrigation system and channel	Seed	Conflict of land use management	Increase the modern technique and method
	Product price		Bio-agriculture	Decrease the forest area for extending the agriculture and other developed investment.	Control the use and sale the prohibited chemical product.
	Soil quality		Disease		Support and use of the organic product
	Agriculture development group		Decrease rice field for resident area and other service		Awareness on the potential impact of the chemical use in the product.
	Technical supervisor				Increasing the irrigation for sustainable agriculture

Major trends include:

1. Land conversion supporting increased livestock, industrial cropping and agriculture plantation and NTFP (Mai Pao, tiger grass, orchid, and paper trees).
2. Increased tourism – to nearby historical and cultural sites
3. Move to reservoir fisheries in the Mekong and its tributaries
4. Increased industrial production and processing including furniture, brick making factories, bottled water, brick and concrete making facilities

The main request to achieve to the social economic and environmental development plan are:

1. Public outreach to the local authorities on the development policy.
2. Political training together with the actual implementation.
3. Clarity for the sectors' mandate and organization.
4. Clear understanding of the framework and target plan before any actual implementation.
5. More focus on local authorities work with clear technical supervision and support.
6. Providing sufficient budget and plan.
7. Improved clarity of land use development plan and investment plan for increasing the investment unit and firms.

Provincial Office of Natural Resources and Environment

1. Seasonal diseases are diarrhoea, dengue, lung infection, fever.
2. Seasonal traditional ceremonies are: Lao New Year, Buddha Lent, Rice festival, Khamu new year, Mong new year.
3. There are 34 temples in the Nan and Seng Districts.
4. Current proposed project is Nam Seng small electrical power generator(1.5MW) in Nam Seng channel.
5. There are 2 potential projects for mineral exploitation in Ban Pak Nern and Ban Pak Bor, Nan district (1) Phoubia Lanna mining for Cu, Au and Mn exploitation GPS(805295/2133452) and (2) Phoubia Trade import-export, exploitation GPS(796300/2131294). which of these mines are far from subproject which it may no impact to the irrigation project. The actual monitoring of these shall be take action by the related sector for more information and cooperation.
6. The provincial ISP had been completed and the further action is to be conducted into the local level.
7. The potential for 8 residue chemical pollutants apparently due to the uncontrolled agriculture activities such as the plantation of rubber and banana plant. However there is no specific official documentation which presented the 8 types of the polluted chemical.
8. Presently, the provincial forest lands have no trees of conservation or economic value left in Nan District Shifting cultivation should be a high priority for control by PAFO
9. There is no issue of the Environmental Compliance Certificate (ECC) for the small scale power generator project yet.
10. There is no issue of the Environmental Compliance Certificate (ECC) for the proposed mine project at the Nam Seng catchment area.
11. There is no specific water flow data of Nam Seng channel. In total there are 75 rivers and 185 streams flow through the Luang Prabang province. Nan district has Nampapa in 15 villages, 36 Nam Lin, 14 rivers and 17 streams. Refer to ISP, 2015.
12. Water use as a Percent of total use by sector is dominated by household use - 87%, followed by agriculture 11%, and office 2%.
13. Luang Prabang has forest cover area of 1,303,267 ha, 65% of the total area. The conservation forest is 248,084 ha (national conservation forest 166,740 ha, provincial conservation forest 1,370 ha, and district conservation forest is 79,971 ha, national protected forest 703.746 ha, provincial protected forest is 6.090 ha, district protected forest is 69.164 ha, productive forest 147,943.152 ha.
14. Nan District has rehabilitation forest of 11,500 ha, and the industrial trees plantation is 5,625.95 ha.
15. Luang Prabang province has 636,445.71 ha of agricultural land, including included rice 36,823 ha, paddy fields 13,594 ha, dry season field 1,605 ha, upland rice 21,624 ha. Other crops include corn 9,711 ha, seasonal crops 4,818 ha, job's tear 11,272 ha, and tobacco 1,089 ha. The green vegetation area is 2,380 ha, pineapple 133 ha, orange 507 ha and banana 863 ha.

16. There are 10 pig farms, 9 chicken farms and 5 fish farms.
17. Nan District has 21 permanent irrigation dams, covering 1,093ha. 227 temporary irrigation dams cover 1,113 ha.
18. The potential mineral sources in Nan District are gold, zinc and copper.
19. There is regular flooding during the rainy season from August to October.
20. The watershed conservation areas in Nan District are Houy Oud, Houy Jern, Nam Seng, Nam Nan, Houy Khorng, Nam Houyhip, Nam SaNan, Nam Houyxok.
21. The protected forest area located in Nan District where covered the area of Nam Feuang, Phouchotng, Phahiem, Phanouan, Nam Phuk, Nam Seng, Khonelog-Phousakean. The historic places are Phakhoum, Phajia.
22. The potential mineral exploitation and fishery program are not located in Nan District, but for other districts.
23. The conserved wildlife area in Nan District has been one of the district where has Houy Oud, Nam Feuang, Nam Nern.
24. The catchment area for irrigation channel in Nan District are Nam Seng, Nam Nan, Nam Sanan, Nam Houy Sok, Nam Phuk.
25. The development priorities in Nan District are (1) Agriculture, (2) Livestock (3) Industrial vegetation (4) agricultural plantation (5) NTFP (6) Tour service (7) Fishery (8) Trading (9) Industrial factory and family business.
26. The environmental management plan reflects the socio-economic development sustainable including waste management, reduce the source of waste produce, manage and control the pollutant source, promote to reduce using the car instead of use bicycle and battery car, awareness for knowing about the air pollution into the villages, and monitoring on the pollutant emissions from the invested projects, protect and increase the forest area, promote the agriculture program, support the organic product, control the dangerous chemical import, provide the land use management and increase the green area.
27. The potential environmental mitigation on the agriculture by (1) limit the use of land conversion, (2) support the organic vegetation, (3) limit use of dangerous chemicals, (4) provide the clean technology, (5) provide awareness programs, (6) identify endemic and native seed.
28. The potential environmental mitigation on the industrial tree plantation by (1) control the chemical use and limited the waste produce (2) scope the land use clearly (3) create the land use management (4) having the participation from all related stakeholders, (5) provide the technical supervision (6) increase awareness on the negative impact from chemical use.
29. The potential environmental mitigation on the livestock program by (1) scope the land use (2) identify the grass planting (3) disease check (4) inject vaccine (5) use of native and natural seed (6) monitoring QA/QC (7) build the union group (8) training on the technical supervision, and (10) to reuse of the compost fertilizer.
30. The potential environmental mitigation on the NTFP collection by (1) confirming on the market (2) increase the product price (3) build the union group for supporting the product (4) build the management system (5) build up the analysis centre (6) scope the protected area for NTFP.

Nan District Natural Resources and Environment Office

Total forest area is 61,291 ha, steep mountain and hill.

There are 5 rivers in Nan District, including Nam Nan, Nam Phuk, Nam Sanan, Nam Seng, Nam Nern, and 25 brenchs.

Water supply use in Nan District has 15 villages (use tap water), 32 villages (use of natural gravity water) and 4 villages (use of stream water). The percentage of water use is: agriculture purpose is 30%, industry purpose is 5% and for general household use 65%.

The ISP is the guide for the district development plan, the catchment and environmental management plan are included in the ISP. The main focus is to mitigate the use of chemical fertilizer from the agriculture program.

The district land use management and ISP mentioned that the potential land use of the Nam Seng catchment area is for reforestation in order to protect the protected forest and watershed area.

Provincial Information, Culture and Tourism Office

Kouangsy national waterfall is the main natural tour place, the focus of this waterfall to development and maintenance program. Some of the nearby village had been resettled off the upstream watershed area.

District Information, Culture and Tourism Office

There are a few tourism places in the Nan district such as Waterfall Hieng at Ban Fai, Rat cave, buffalo cave, top view deck, and Mekong hydropower plant view deck.

The cultural historical place and artefact subject at Thong Pha Khoum and ThongPhaJiey.

There is no proposed tourism plan inside the Nam Seng catchment area.

Village Consultations in Thongphieng Vilay, Sivilay, Nakheun, Thad, Phon Hine and Pak Khone.

The forest area is the mixed deciduous forest and old fellow forest, the illegal approach had been occurred occasionally, a few villages had been resettled to the downstream while only one village (Ban Phaunxai) decided to settle near the rice field where it is far from the main road.

The villages were informed and official announce not to extending the shifting cultivation area, and to use only the village forest and fellow forest for NTFP collecting. And not allow to use of the provincial protected forest for any agriculture activities.

Ban Phaunxay could collect and use the forest in the village forest only because there is the forest boundary among other village and among the provincial protected forest.

Villagers would like to permanently improve this irrigation channel, and to provide enough water to every village.

Villagers decided to decrease the lease land for banana plantation because it caused the soil erosion in the agricultural land.

Villagers would like the irrigation project to pay more attention for improving the operation system in order to release the water to each village and each plantation area sufficiently.

Village reports of Biodiversity presence

Wildlife

No	Name	Always see	Rarely seen	Hunting number (-Unit)	Hunting time (-Time/Month)	Remark
1	Wild boar, Mupa	√		6 /year	1/month	In case of the tracked occassionly
2	Common palm civet, Ngen		√	No	No	
3	Rat, Nou na	√		2 /week	8/month	To hunt during the dry season
4	Mole, Toun	√		1	8/month	
5	Muntiacus feai, Fan		√	No	No	
6	Porcupine, Men		√	No	No	
7	Bengal monitor, Lan		√	No	No	
8	Monkey	√		No	No	
9	Sciuridae. Kahok	√		30/year	18 time a year	To hunt during the dry season
10	Tupaiidae, Katea	√		20/year	18 time a year	
11	Rat snake, Zamenis sp.	√		No	No	
12	Boa, NgooLeaun	√		No	No	
13	Enhydris, Ngoo pa	√		No	No	
14	จ้อบ		√	No	No	

Birds

No.	Bird name	Always see	Rarely see	Hunted bird per time (bird number)	Hunting freqency(time per season)	Remark
1	Riparia paludicola, Nok Aen	√		10ฺ๓/year	6 time per dry season	
2	Barbet , Nok Tung lor	√		Occasion	Occasion	
3	Rumped Munia, Nok Ka Pid	√		No hunt	6 time per dry season	
4	Greater coucal, Nok Kot	√		No hunt	No	
5	Black and grey Drongo, Nok Seow	√		10ฺ๓/year	6 time per dry season	
6	Cuckoo drove, Nok Khao	√		10ฺ๓/year	6 time per dry season	rarely seen and no hunt, in case of tracked for once occasion which it is for family only
7	Changeable Hawk Engle, Leow		√	No hunt	No	
8	Crested Finchbill, Nok Khoak	√		No hunt	Occasion	
9	Nok Khee Hut		√	No hunt	No	
10	Junglefowl, Nok Kaina	√		No hunt	Occasion	
11	Red Legged Crake,Nok Kai na		√	No hunt	No	
12	Wagtail, Nok kadekdao		√	No hunt	No	
13	Golden-Throated Barbet, Nok khon dok		√	No hunt	No	
14	Green Pigeon, Nok Pao		√	No hunt	No	

Fish

No	Fish name	which stream had seen (name of stream)	distance from village (ກມ)	How many kg per time fishing(average per week)	Domestic Consumption	Sale, how many kg	Where to sale (village or market)
1	Poropuntius laocnsis ปาจาด	All stream	100m - 2km	0.5	Yes	No	Only to share with the neigbourhood
2	Puntiusaurotaeniatus ปาขาอ	All stream	100m - 2km	0.5	Yes	No	
3	ปาคี้ง, Pa Khiing	Nam Seng	100m - 2km	0.5	Yes	No	
4	Nemacheilidae, Pa Phanh	Houy Thung, Houy Lung	100m - 2km	0.5	Yes	No	
6	Cyprinidae, Osteochilus lini, Pa morm	All stream	100m - 2km	0.5	Yes	No	
7	Dasyatidae, Pafa	Nam Seng	100m - 2km	0.5	Yes	No	
8	Pa Hoapoumปาฮื้อปุม	Houy Ngoou	2km	20kg/year	Yes	Yes	
9	Channidae, Pa Kung	All stream	100m - 2km	0.5	Yes	No	
10	Mastacembelidae, Pa Lad	All stream	100m - 2km	0.5	Yes	No	
11	Claias batrachus, PaDouk	Houy sy	5km	320kg/year	Yes	Yes	
12	Small river shrimp, Kouing	All stream	100m - 2km	0.5	Yes	No	
13	Frog, Kob	All stream	100m - 2km	0.5	Yes	No	

Forest Products Using Trees

No	Timber type	Last seen	Use or not	Use for what	Still have in the project area (many, not so many)
1	Bamboo tubes, Mai Pong	current	use	Community purpose, regular used for household activity and some of the agriculture work such as being the fence, chacol, build the small hut, shall house, rice storage, field hut, and other temporary structure in the village.	Many
2	Mai Bong	current	use		
3	*Peltophorum dasyrachis, Mai Safang*	current	use		
4	Mai SomFak	current	use		
	Cratoxylum formosum, Mai Tiew	current	use		
5	Mai Yom	current	No	No	Not many
6	*Mai Saphong*	current	No		
7	*Mai Taen*	current			

Non-timber Forest Products

No	NTFP type	Collect month	Whom collect(male or female)	Domestic consumption (Eat or sale)	How many Kg per year	Price per kg (kip)	Where to sale
					Kg		(village or market)
1	Mushroom	Dry season(Nov-April)	Female	Eat	No	No	No
	Bamboo shot	All year	Female	Eat	No	No	No
2	Wild Vegetable	All year	Female	Eat	No	No	No
3	Wild Fruit	Dry season(Nov-April)	Female	Eat	No	No	No
4	Tiger grass ccaw	October - April	Female	Use	No	No	No
5	Orchidaceae, Dok Pheaung	Occasion	Female	Sale	Based on the request	150,000kip/ kg	Trader collects at village
6	Arenga westerhoutii, Mak Tao	Dry season(Nov-April)	Female	Eat	No	No	No
7	Sa kha	Dry season(Nov-March)	Female	Eat	NA	No	No
8	Rattan, Waii	Dry season(Nov-March)	Female	Eat	NA	No	No
9	Moraceae, Por Sa	October - Feb	Female	Sale	48 T/ yr	3000kip/kg	Trader collects at village
	ตีอccงด้น	Nov-March	Female	Sale	2 T/yr	1000kip/kg	Trader collects at village
	Ginger, Khing kheng	Nov- June	Female	Eat	NA	No	
	Green algae, Thao	Nov- June	Female	Eat	NA	No	
	ปีอกเมือก	March - April	Female	Sale	500 kg/ yr	5000kip/kg	Trader collects at village
	Banana flower	All year	Female	Sale	50kg/yr	100,000 kip	Trader collects at village

Participant Registration Lists at the Consultation Meetings

LPB

ວັນທີ 23/03/2018 ([illegible])

ຊື່ ແລະ ນາມສະກຸນ (Name and surname)	ຕຳແໜ່ງ (Position)	ມາຈາກພາກສ່ວນ (Organizational)	ເບີໂທ (Phone No.)	ທີ່ຢູ່ອີເມວ (Email address)	ລາຍເຊັນ (Signature)
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24. /03/2018 : [illegible]

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ໃບລົງທະບຽນ

ກອງປະຊຸມ: ...
ສະຖານທີ່: ...
ວັນທີ: 26/03/2018

ລ/ດ No.	ຊື່ ແລະ ນາມສະກຸນ (Name and surname)	ຕຳແໜ່ງ (Position)	ມາຈາກພາກສ່ວນ (Organizational)	ເບີໂທ (Phone No.)	ທີ່ຢູ່ອີເມວ (Email address)	ລາຍເຊັນ (Signature)
1	...	...	...	54541789	...	
2	...	...	...	58406243	...	
3	...	...	...	55599353		
4	...	...	...	55671555	...	
5	...	...	...	22351023		
6	...	...	...	5866720	...	
7	...	...	...	95811177	...	
8						
9						
10						
11						
12						

ໃບລົງທະບຽນ

ກອງປະຊຸມ: [illegible]
ສະຖານທີ່: [illegible]
ວັນທີ: 26. 10/2018

ລ/ດ No.	ຊື່ ແລະ ນາມສະກຸນ (Name and surname)	ຕາແໜ່ງ (Position)	ມາຈາກພາກສ່ວນ (Organizational)	ເບີໂທ (Phone No.)	ທີ່ຢູ່ອີເມວ (Email address)	ລາຍເຊັນ (Signature)
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Appendix 2. Photographs from Consultation and Field Visits

Environmental Management Plan

Project Number: 50236-002
April 2019

Lao PDR: Sustainable Rural Infrastructure and Watershed Management Sector Project

Nam Seng Irrigation Scheme

Luang Prabang Province

Prepared by the Ministry of Agriculture and Forestry for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 5 April 209)

Currency Unit	–	Kip (KN)
KN1.00	=	$0.000116
$1.00	=	KN 8,600

ABBREVIATIONS

ADB	:	Asian Development Bank
AF	:	Additional Financing
CCA	:	climate change adaptation
CIFOR	:	Center for International Forestry Research
COL	:	Concessional OCR lending
DAFO	:	District Agriculture and Forestry Office
DALAM	:	Department of Agricultural Land Management
DDMCC	:	Department of Disaster Management and Climate Change
DMF	:	Design and Monitoring Framework
DRR	:	disaster risk reduction
EIA	:	Environment Impact Assessment
EMP		Environmental Management Plan
ERP	:	Emissions Reduction Program
FAO	:	Food and Agriculture Organization (of the United Nations)
GCF	:	Green Climate Fund
GDP	-	Gross Domestic Product
GIZ	:	Deutsche Gesellschaft für Internationale Zusammenarbeit (German International Cooperation Agency)
GMS	:	Greater Mekong Subregion
IEE	:	Initial Environment Examination
IMT	:	irrigation management transfer
ISF	:	irrigation service fee
IUCN	:	International Union for the Conservation of Nature
IWMI	:	International Water Management Institute
LDC	:	least developed country
LIC	:	Loan Implementation Consultant
MAF	:	Ministry of Agriculture and Forestry
MONRE	:	Ministry of Natural Resources and Environment
NGO	:	Non-governmental Organisation
NRI	:	Northern Rural Infrastructure Development Project
NSEDP	:	National Socio-economic Development Plan
NTFP	:	non-timber forest product
O&M	:	Operations & Maintenance
OCR	:	Ordinary Capital Resources
ODA	:	Overseas Development Assistance
PAFO	:	Provincial Agriculture and Forestry Office
PAM	:	Project Administration Manual
PDR	:	People's Democratic Republic (of Laos)
PGT	:	Program Governance Team
PIS	:	Provincial Irrigation Section

PLUP	:	participatory land use planning
PONRE	:	Provincial Office of Natural Resources and Environment
PPIT	:	Provincial Project Implementation Team
PRAP	:	Provincial REDD+ Action Plans
PRI	:	productive rural infrastructure
PRT	:	Pesticide reduction training
REDD	:	Reduction of Emissions through Deforestation and forest Degradation
RRP	:	Report & Recommendations to the President
RSP	:	representative subproject
SME	:	Small-Medium Enterprises
SRIWSM	:	Sustainable Rural Infrastructure and Watershed Management
TRTA	:	Transaction Technical Assistance
VDF	:	village development fund
WUA	:	water users association
WUG	:	water user group

GLOSSARY

Catchment	In its totality a catchment is equivalent to a watershed, however a watershed may comprise of micro-catchments and sub-catchments. In this document a catchment refers to a subset of the larger watershed.
Watershed	A topographically delineated area from which rainwater drains as surface run-off via a river or stream to a common outlet point (e.g. a large river, lake or the sea).
Watershed management	Securing watershed functions in a sustainable manner. Broadly these functions include: ➢ Ecological function: availability of sufficient good quality water over time, space; erosion control, soil fertility, biodiversity, clean air, carbon sequestration; ➢ Economic function: sufficient natural resource products like food, fuel wood, timber, water, fish, energy required for basic needs of the local population; income generating opportunities; ➢ Social function: maintenance of social structures; protection and development of knowledge and lifestyle arrangements; maintenance and revitalisation of cultural identity and values, recreational facilities.

NOTE(S)

(i) In this report, "$" refers to US dollars unless otherwise stated.

CONTENTS

Reference Documents

List of Appendixes

I. INTRODUCTION

A. Nam Seng Irrigation Scheme Subproject

1. The Nam Seng Irrigation Scheme Subproject is to support the continuing development of the existing irrigation scheme command areas that are supported by the distribution system constructed during 2004. When designed the scheme was designed for nearly 1000ha of wet season rice irrigation, currently the 350 hectares of command area serving 550 households has been developed. The subproject will support the expansion of the command area by 265 hectares.

2. The subproject covers two distinct areas. The productive rural infrastructure (PRI) element will cover the existing Nam Seng intake headworks, the transfer canal from the Nam Seng to the Houy La River in the Nam Nan catchment, the Houy La headworks, and various distribution canals leading into and around the new command area.

B. Purpose of the Environmental Management Plan

3. This Environmental Management Plan (EMP) has been prepared in compliance with the specified safeguard requirements of the borrower, the Government of Lao PDR (the government), and the Asian Development Bank (ADB). It accompanies an Initial Environmental Examination (IEE) that: (i) provided an overview of the proposed subproject and its purposes; (ii) provided a description of existing environmental conditions; (iii) made an evaluation of the likely impacts that will occur to the environment as a result of the proposed subproject activities; and (iv) outlined the mitigation measures that will be required to ensure that no part of the project causes significant damage to the environment.

4. The EMP has been prepared on the basis of the design for the subproject, and its likely effects on the environment, as evaluated in the IEE. It defines the anticipated environmental impacts, the measures required to mitigate them, the responsibilities for doing so and the responsibility for monitoring that they have been undertaken effectively at the right time. Following the approval of the IEE, this EMP forms the guiding document to ensure that all necessary environmental safeguards are put in place.

5. Adherence to this EMP is a condition of ADB financing for the Nam Seng Subproject. Acceptance of and a commitment to implement the EMP must form part of the contractual conditions for any physical engineering works under the subproject.

C. Use and Review of the EMP

6. Compliance with this EMP is an ADB loan covenant. The subproject works will construct infrastructure that will give rise to changes to the environment. The EMP covers the design, construction and operation periods of the subproject with each period requiring a range of responsibilities. It is recommended that the tables of responsibilities given in the appendices are extracted and used by the appropriate entities as the basis of their working practices on the project. The environmental monitoring team will need to use the monitoring tables relevant to each phase. Once construction has been completed, it is recommended that the EMP be updated to form a simplified document for the operational period following handover of the infrastructure to its users. This should be done by the PAFO, supported by the Loan Implementation Consultant and in consultation with the PONRE.

II. RESPONSIBILITIES AND CAPACITY FOR ENVIRONMENTAL MANAGEMENT AND MONITORING

A. Summary of Institutional Arrangements

7. The executing agency of the SRIWSM is MAF, with support from the IA - Department of Irrigation (DOI). Implementation is decentralised to the Provincial Agriculture and Forestry Offices (PAFO) where implementation activities will be assigned to the respective sections of PAFO, co-ordinated by a Provincial Project Implementation Team (PPIT) for the management of the SRIWSM Project.

8. The executing agency (i.e. MAF) and IA (i.e. DOI) will establish a Program Governance Team (PGT) that would be responsible for: (i) establishing the operational procedures to be used by the PPIT, including planning, budgeting, financial management, procurement, disbursement, contract management, safeguard monitoring and compliance monitoring; (ii) ensuring both government and donor audit requirements are met; (iii) providing capacity building at the provincial level for both PPIT staff and potential contractors; and (iv) providing technical support for advanced engineering designs and project management teams, including the provision of skill mentoring and technical assistance input to procurement and contract management.

9. Government staff are involved in environmental management and monitoring at a number of levels and in two main ministries: MAF for both management and monitoring; and MONRE as delegated to PONRE for monitoring. Reforms of government to separate the environmental portfolio from agriculture and forestry started in 2017 and is not yet complete. Capacity in this respect is therefore still being developed, particularly at the provincial and district levels.

10. The capabilities required of staff varies depends on the phase of the subproject, and their level and remit, a sound understanding of the environment and society in the rural hill catchments of the northern provinces, and a particular understanding of current issues in both upland and irrigated agriculture is needed. PONRE staff have the underlying environmental knowledge but often lack the technical expertise to address specific issues. DONRE staff are far less experienced and qualified. The loan implementation consultant will be expected to help improve capacity and assist the government to improve its staff skills and knowledge in this respect. This should include support to PONRE and DONRE staff in their capabilities for environmental monitoring. The Loan Implementation Consultant (LIC) – both international and National will provide (i) Project awareness training, (ii) technical training with respect to environmental monitoring systems and techniques that will apply to their specific subproject, (iii) PONRE staff receive budgetary support for their additional costs on an output basis ie PAFO will pay for monitoring reports received. In addition, PONRE and DONRE monitoring staff will be supported for regular site visits by the construction supervision staff of PAFO.

11. During the project implementation period, which effectively involves subproject design and construction phases, safeguards are the responsibility of the Vice Governor Office represented by PAFO with support from the PGT within the Department of Irrigation. Environmental safeguard monitoring responsibility will be assigned to PONRE through a Memorandum of Understanding (MoU) between the Vice Governor Office, Director of PAFO and Director of PONRE.

12. At the provincial level, a PAFO will assign overall project management to an existing PAFO Deputy Director General to implement subprojects. Within each PAFO, the technical staff will be assigned to the PPIT must be able to monitor the implementation of works programs.

13. Following construction and commissioning, the subproject infrastructure will be handed over to and operated by the Water User Groups. The relevant PONRE will be responsible for environmental monitoring during operation.

14. The project implementation responsibilities as set out in the PAM are provided in Table 6.

Table 1. Project Implementation Responsibilities

Project organisation	Management Roles and Responsibilities
Ministry of Finance (MOF)	• Establish the Project's Advance Account, • Manage direct payments to contractors, • Provide replenishment reports to ADB, • Provide advances to Implementing Agencies Subaccounts, • Overarching financial control.
Ministry of Agriculture and Forestry (MAF) - Executing Agency (EA)	• The EA will constitute a national steering committee with representatives of MAF, Office of Governor (Implementing Agency – IA) of four northern provinces (FNP), MOF, Ministry of Planning and Investment (MPI) and Ministry of Natural Resources and Environment (MONRE). • Responsible for ensuring loan agreements and covenants and assurances are achieved. • Responsible for internal monitoring of the States' interests.
National Steering Committee (NSC)	• Provide guidance to the IAs and EAs in terms of project scope of work, expected performance standards, remedial action. • Ensure cross sector coordination and integration of work plans • Confirm annual performance. • Membership will include MAF – Minister, Governors of the FNP, Provincial Agriculture and Forestry Offices (PAFO) Director Generals (DG) from each province, and Deputy Director Generals (DDG) of Department of Irrigation (DOI).
DOI - IA	• Support and operate the Program Governance Team and represent the EA in the day to day implementation of the project. • Provide technical support on irrigation and institutional issues. • Consolidate financial and progress reports for the MAF ADB. • Consolidate and quality check all withdrawal applications and replenishment requests to be forwarded to MAF's Department of Planning and Finance (DOPF) for clearance and onward forwarding to MoF.
MAF's DOPF	• Define and validate the project management systems to be applied across the programme to ensure that government and ADB requirements are met. • Verify all subproject draft procurement (including safeguards) documentation prior to be submitted to ADB or publicly advertised. • Undertake a quality control and verification of the quarterly and annual reports that will have document quality control procedures and an endorsement page. • Ensure financial management systems (FMS) are consistent with MAF's requirements. • Ensure that project reporting systems support both Government and ADB requirements. • Provide quality assurance for the replenishment and disbursement documentation to be provided to ADB and MOF.

Project organisation	Management Roles and Responsibilities
Program Governance Team (PGT) within the DOI	• Overall program management and coordination of the project • Prepare a code of conduct including accountability of individuals, authority and levels of delegated authority, jurisdiction and mandate limits. • Produce a project management manual, and the supporting templates, guidelines for planning, budgeting, financial accounts, disbursement, procurement, contract management, reporting, safeguards and audit. • Provide the consolidation and quality assurance function with the project for all work planning, budgeting and financial management records, replenishment requests, withdrawal applications that are then forwarded to DOPF. • Conduct assigned procurement of (i) vehicles, (ii) equipment, (iii) LIC, and (iv) other consultants and service providers. • Facilitate the development of provincial contractor awareness and capability. • Provide technical support for setting up project management systems and templates in the Provincial project implementation team (PPIT) and the required capability to operate these systems • Appoint a Gender focal point from MAF' Women Advancement Unit (WAU) to oversee and support the implementation of the gender action plan (GAP). • Undertake safeguard screening of additional subprojects in line with Resettlement and Ethnic Group Development Framework (REGDF) and Environmental Assessment and Review Framework (EARF) to confirm classifications, and that subprojects that would be classified as Category A to be excluded. • Ensure safeguard frameworks (REGDF and EARF) are applied in the screening, selection and assessment of subprojects and preparation of safeguard plans, Resettlement and Ethnic Group Development Plans (REGDPs) and Initial Environmental Examination / Environment Management Plans (IEEs / EMP) at the subproject level, to be reviewed and commented on within 30 working days by ADB. • Monitor implementation of safeguard requirements as set out in the REGDF/REGDPs and IEEs / EMPs/Environmental Code of Conduct (ECC) during subproject implementation. • Ensure that all subproject design reports (SDR) clearly demonstrate dry season water availability for the reliable irrigation whilst ensuring environmental minimum flow is sustained. • Assign two staff to act as safeguards focal points – one for resettlement and social safeguards and one for environmental safeguards, to provide safeguard oversight and input to semi-annual safeguards reports for submission to ADB.
Provincial Steering Committee (PSC)	• Each of the FNPs will establish a PSC chaired by the Governor, participating District Governors, Directors General of PAFO, Finance, Planning and Investment, Public Works and Transport Office (PWTO), Plant Protection Center, and Provincial office of Natural Resources and Environment (PONRE). • Review annual work plans and provide guidance on project scope and performance standards. • Approve annual work plans and receive regular progress reports

Project organisation	Management Roles and Responsibilities
	• Establish operational memorandums of understanding (MOUs) between PAFO, PONRE, and PWTO.
Provincial Procurement Committee (PPC)	• Each of the FNPs will establish a PSC chaired by the Governor and including Provincial representatives. • Manage evaluation bidding documents, conduct scoring and ranking of bids. • Provide recommended procurement actions to PSC and PAFO.
Provincial Project Implementation Team (within the PAFO)	• Each provincial government will form within PAFO a Project Implementation Team (PPIT), aligned to the Provincial Irrigation Section (PIS). The PAFOs will identify implementation focal points in Department of Agriculture and Land Management (DALAM) and DOF to be seconded into the project management structure of the PPIT to support activities relating to land use planning, catchment management and land registration administration. • PAFO will establish a gender focal point from the WAU that will be responsible for ensuring the GAP is implemented and that all stakeholders are fully aware of the GAP and the associated responsibilities • Each PAFO will appoint a safeguards focal point to supervise implementation of safeguard requirements and to co-ordinate project specific grievance redress mechanism (GRM) and support provincial program safeguards focal point on periodic safeguards monitoring and reporting. • Establish operational systems with staff assigned who have the capacity to maintain the project administration and management systems. • Establish and maintain subproject monitoring and impact assessment using the productive rural infrastructure (PRI) representative subprojects (RSP) as learning sites. • Coordinate the ADB-financed activities and integrate these with the activities of other donor-financed programmes working on watershed management. • Provide quarterly and annual reports and semi-annual safeguards reports according to the templates specified by the PGT. • Ensure subproject REGDPs if any and IEE/EMPs are updated based on detailed engineering design, approved by ADB and disclosed on ADB website prior to contract awards. • Obtain final approval from the PAFO DG in accordance with the Irrigation Law 2014 - (Article 38). • Obtain environmental compliance certificates from the relevant PONREs prior to award of civil works contracts. • With support from the PGT, identify local contractors and conduct awareness and capacity building programmes to increase the inclusiveness of local contracting companies. • Complete land acquisition and compensation as per the REGDF prior to award of civil works contracts. • Contract management during implementation. • Ensure implementation of the mitigation and monitoring measures as set out in the EMPs and any required safeguards corrective actions. • Ensure implementation of the REGDF action plan.

Project organisation	Management Roles and Responsibilities
	• Safeguards monitoring as per the land acquisition and resettlement plans (LARP) and REGDF subproject documents. • On project completion as confirmed by the construction supervision consultant (PG the Project Director (PAFO) conduct a site inspection in accordance with the Public Work and Irrigation Law. On confirmation of contract completion, PAFO will transfer the operation and maintenance (O&M) of the asset to the water user group (WUG). **<u>For WUGs</u>** • Provide awareness and capacity building on project activities, WUG implementation roles and procurement modalities. • Monitor and mentor water WUG contracting of in-command area works.
PONRE Land Registration Department	• Conduct land registration. • Issue land title and demarcation.
PONRE Environmental Management Department	• Conduct regular environmental monitoring of subprojects. • Undertake a general programme of monitoring environmental parameters (e.g. water quality) at strategic sample locations throughout the province. • A budget provision has been made for (i) training, (ii) travel and (iii) field allowances. Training is in the terms of reference (ToR) for the LIC consultants.
MAF _ Plant Protection Centers	• Identify the need for Pesticide Reduction Training (PRT), Crop Surveillance and integrated pest management as part of the LAOGAP quality assurance support
MAF – DALAM	• Agricultural land use planning guidelines and verification.
PAFO – DALAM	• Agricultural land registration survey. • Consultation of land users in command areas. • Land registration proposal for agricultural land. • Participatory land use planning (PLUP) responsibilities
MAF - Department of Forestry	• Provide training and leadership in the issues surrounding ecological service protection for the land use change programs • Forest Land Use Guidelines and quality verification
PAFO - Department of Forestry	• Forest Land use zonation and survey demarcation. • Participate in PLUP when requested. • Supervision of forestry activities funded by ADB.
Provincial Nutrition Committees	• Facilitate multi-sectoral coordination for nutrition, including coordinating joint baseline and end line surveys to be developed by the National Nutrition Committee (NNC) Secretariat; ensuring alignment with any National Nutrition Advocacy and Communication Strategy and Plan of Action, or similar; supporting Joint Government of Lao PDR – Development Partners Monitoring Missions, etc. • Coordinate implementation and monitoring. • Undertake field monitoring activities. • Receive monitoring reports from districts and projects and provide annual and biannual reports to the NNC. • Provide leadership and support for District Nutrition Committees (DNC)
DNC	• Facilitate multi-sectoral coordination for nutrition, including identifying priority villages

Project organisation	Management Roles and Responsibilities
	• Coordinate implementation and monitoring • Undertake field monitoring activities and provides annual and bi-annual reports to Provincial Nutrition Committee (PNC).
District Agriculture and Forestry Office (DAFO)	• Assign a focal point who should be at least a Deputy Head of the DAFO and should be the representative on the DNC. This officer will be responsible for planning and oversight of project Nutrition Support Advisor (NSA) activities in the district, including agreeing monthly and weekly workplans with the assigned technical staff • Assign one staff member to be responsible for the financial management related to project NSA activities • Assign up to 3 full-time equivalent technical staff as members of District Nutrition Teams, with preference for female staff and staff belonging to local ethnic groups • Permit these assigned staff to participate in basic nutrition training and ensure that trained staff remain assigned for the duration of the project • Select priority villages in coordination with the DNC. The primary criterion will be nutrition needs as identified by the DNC, taking account of any other completed, ongoing or anticipated NSA interventions. The secondary criterion will be to give preference to nutrition priority villages in the watersheds and command areas of the PRI subprojects. • Collaborate with the Lao Womens Union (LWU) to form nutrition clubs in the selected villages, and provide them with NSA activities using a farmers' nutrition school approach, resulting in group and / or individual NSA development plans • Provide technical support to facilitate implementation of the development plans

B. Institutional arrangements for implementation of environmental safeguards

15. **PGT.** The PGT will appoint a qualified environmental safeguards officer to supervise and co-ordinate implementation of environmental safeguard requirements with support of the LIC International and National Environment Specialists. The PGT Project Director will be responsible for submitting semi-annual environmental safeguard reports to ADB for clearance and disclosure. They will also carry out regular monitoring during implementation and prepare a summary of progress of EMP and GRM implementation for the quarterly project progress reports. They will participate in ADB loan review missions, ensure that semi-annual environmental safeguards monitoring reports are submitted to ADB on time and follow-up on agreed actions.

16. **PPIT.** Each PPIT will nominate an environmental safeguards focal point to support LIC Environment Specialists and PGT with co-ordination at the province level. The environmental safeguard focal point shall have a background in environmental and social safeguards and will receive training in project environment and social safeguards requirements by the LIC. The PPIT environmental safeguards focal point will undertake joint site visits with subproject Supervision Staff and Contractors to review implementation of EMP and GRM and report issues to PGT and LIC. PPIT will co-ordinate environmental quality monitoring with PONRE and invite PONRE to join site visits and ADB loan review missions. The environmental safeguard focal point shall have a background in environmental and social safeguards and will receive training in project environment and social safeguards requirements by the LIC. The PPIT environmental safeguards

focal point will undertake joint site visits with subproject Supervision Staff and Contractors to review implementation of EMP and GRM and report issues to PGT and LIC. PPIT will co-ordinate environmental quality monitoring with PONRE and invite PONRE to join site visits and ADB loan review missions.

17. **Loan Implementation Consultants.** The LIC will assist the executing agency (i.e. the PGT within DOI), the implementing agency (i.e. PAFO) and the other project stakeholders in the design and construction of the subproject. For this reason, the Program Governance Team will contract a LIC with two environmental specialists (9 months International Environment Specialist and 17 months National Environmental Specialist)- See PAM for detailed ToRs for LIC Environmental Specialists (LIC-ES) to support subproject designs and the preparation of IEE and for the supporting and monitoring of the EMP during subproject implementation.

18. The environmental safeguard consultants in the LIC will undertake screening, classification and assessment of future subprojects and will train and support PONRE and DONRE staff with monitoring visits and preparation of monthly and quarterly safeguard reports that will be submitted to the Vice Governor, and the EA via the PGT in DOI. The LIC will support the PGT to prepare a summary of safeguards and GRM implementation to be included in the quarterly project progress reports to be submitted to ADB. The LIC will support PGT to prepare semi-annual integrated safeguard reports to be submitted to ADB. These reports will include details of issues raised and resolved through the GRM during the reporting period. The semi-annual integrated safeguards monitoring report will be disclosed on ADB website once approved.

19. During the design and preparation phase, the LIC environmental specialists will work with the WUG, PAFO and DAFO and the contractors for the subproject, to ensure the required environmental mitigation measures are incorporated into the final engineering designs documents. During the construction period, they must work with the subproject implementation partners to ensure that all of the environmental management and mitigation measures are fully complied with, as agreed in each IEE and as outlined in every EMP. The LIC Environment Specialists will provide safeguards and GRM capacity development training for PGT, PPIT, LIC, Contractors and GRM focal points on EMP mitigation and monitoring measures, Contractor EMP preparation, templates for environmental monitoring and report.

20. **Contractors and Subcontractors.** The contract documents must include the EMP and an environment section in the terms of reference for bidders, and environmental contract clauses for contractors that include special conditions for the protection of the physical, biological and socio-economic environments. These will underpin the obligations towards the environment that must be upheld by all contractors. There is a need to ensure that contractors, as the stakeholders with the shortest-term involvement in the subproject, do not give rise to long term liabilities for the subproject owners and other stakeholders through reckless practices.

21. While the contractors themselves must fulfil their environmental responsibilities, in most cases success in this respect requires strict management and supervision of the contractor during site works: this is the responsibility of PAFO. Because of the competitive bidding process and the emphasis on engineering works, there is often a tendency for environmental safeguards to be delayed by contractors in the hope that costs can be saved and overlooked by management staff as being of lower importance than the primary functional infrastructure. The Contractor will be required to develop a site-specific Construction Environmental Management Plan (CEMP) in accordance with the IEE/EMP and designate an environmental health and safety (EHS) Officer to supervise and train workers on occupational and community health and safety practices and to monitor and report on implementation of EMP/CEMP and corrective actions. A GRM focal

point/community liaison officer should also be designated to ensure public disclosure of planned construction to affected persons and monitoring and reporting on GRM. Each works Contractor EHS Officer will prepare a monthly report on EMP/CEMP and GRM implementation for submission to PPIT, PGT and LIC.

22. The construction supervision consultants (CSC) will review and approve the CEMP and ensure it covers all the required provisions of the subproject IEE and EMP. The CSC will be responsible for day to day monitoring of implementation of health and safety and EMP requirements and issuing instructions for corrective actions, as needed.

23. ADB will visit project sites and review project performance against the EMPs and legal agreements and as documented in periodic environment monitoring reports submitted by the PGT. If any of the safeguard requirements that are covenanted in the legal agreements are found not to be satisfactorily met, ADB will require the PGT to develop and implement an appropriate corrective action plan (CAP) agreed upon with ADB. If unanticipated environmental impacts become apparent during project implementation, ADB will require the PGT with support of LIC ES to (i) assess the significance of such unanticipated impacts; (ii) evaluate the options available to address them; and (iii) prepare or update the IEE and EMPs.

III. SUMMARY OF THE POTENTIAL ENVIRONMENTAL IMPACTS

A. Potential Impacts on the Environment

24. The IEE identified a number of potential environmental impacts. Some of these are beneficial, mainly directly to the socio-economic environment but also indirectly to the bio-physical environment. Although on balance these are judged to outweigh the negative impacts, as with most projects there are potential adverse impacts. As described below, and given in tables in this plan, mitigating these impacts so that the effects do not cause significant damage is possible.

B. Enhancement Measures

25. Local development is the basis of the subproject. This will be enabled through assistance to the WUGs to establish improved capacity and management systems, so that their members can best gain from the rehabilitated and enhanced infrastructure that the subproject will fund. Improved livelihoods are the intended outcomes for the beneficiaries, giving households dependent on agriculture a wider range of choices and access to more productive farming systems.

26. The infrastructure rehabilitated and upgraded by the subproject is designed to be resilient. This means that it should withstand both current and likely future extreme climatic effects while remaining functional. This is achieved by careful design on the basis of analysis of climate variables and change possibilities, to ensure that the structures are robust but not over-engineered at too high a cost.

C. Mitigation Measures for Adverse Environmental Impacts

27. Under the classification of subprojects into MONRE category 1 and ADB category B, all adverse environmental impacts must be mitigated; if they cannot be mitigated, then the category of the subproject would need to be changed and a full EIA undertaken; this would make it ineligible for SRIWSM funding. Hence ways must be found to avoid, minimise or restore all potential impacts found in the course of designing and implementing an SRIWSM subproject. The detailed

mitigation measures depend on individual site conditions. However, in most cases there are only a limited number of options for the mitigation of certain issues.

28. The mitigation measures are listed in the Environmental Management and Monitoring Matrix, which is given below and forms the main operational core of this EMP. They cover all of the main impacts that are likely to occur. Most of them represent simple, practical, common sense measures to ensure that disturbance to the environment is limited to the minimum as a result of all subproject activities.

D. Specific Key Priority Concerns

29. The quality of water used in irrigation is defined by the government in the National Environmental Standards (2017), where it should meet class 3 quality criteria (see Appendix 5). Water used in fisheries should meet class 2 standards. The reason for this is to protect soil, plants and aquatic organisms from pollutants brought in by river water from polluting activities. In the Nam Seng, there is very little agriculture located upstream of the subproject headworks. The risk of water quality contamination is considered low. For this reason it is not clear that the water quality will meet the national standards, and will be ascertained through sampling and laboratory testing once the national testing protocols for the water standards are agreed and incorporated into the regulatory framework. As considered in detail in the project's Environmental Assessment and Review Framework (EARF), the responsibilities of an entity using polluted water are not specified in the current law which assigns responsibilities to polluters. As also discussed in the EARF, the process of undertaking a reliable and definitive water testing programme is also problematic for a number of technical reasons. The mitigation measures recommended in this EMP therefore address this issue in a pragmatic way.

30. In some cases, mitigation measures cannot be defined precisely because there is inadequate information on the needs for mitigation or the extent of mitigation activities. Water flows are particularly little understood because to date there have been very few gauging stations maintained in smaller catchments, however for Nam Seng the original design for 1000ha has only 35% developed to date indicating that there is a low risk at this stage, given no additional water will be diverted from the source. Instead it simply distributes water to the new command area rather than this water passing through to the end of the discharge back to the Mekong river

31. Defining compensatory flows throughout the year is therefore difficult, and initially must be based on estimates. The mitigation strategy in this case is to use as much information as possible to ensure that the initial estimates are as accurate as they can be, while starting to collect continuous series monitoring data. Because of natural variations from year to year, this process needs to be continued every year for at least ten years, and ideally throughout the life of the infrastructure, so that the compensatory flows can be updated as the running averages, minima and maxima for flow in each month become more statistically robust.

32. Both to realize the environmental benefits of the project and to safeguard the infrastructure investments, catchment land use needs to be improved in the water supply catchment of the subproject. Part of the rationale for the SRIWSM is to assist the rural population to reduce its dependence on upland agriculture, since other land pressures mean that shifting cultivation is used to produce cash crops for export and as a result is giving rise to an unsustainable rate of forest conversion. Loss and fragmentation of the forests has had a major impact on biodiversity. It has almost already occurred in the catchment of the Nam Seng but to a far less extent than in neighboring catchments. These changes typically result in less retention of moisture in the catchment, with increased runoff and shorter duration flood hydrographs with higher peak levels.

Periodic disturbances to vegetation cover have also increased sediment fluxes in the river. In the long term, the sustainability of the subproject irrigation facilities depends on the stabilization of the forest cover in the catchment. This in turn is dependent on the communities within the catchment adopting improved land use planning and changed land use practices to support soil and water conservation, and perennial based vegetation systems. Better land use management is beneficial for the subproject in achieving its purpose.

33. In a steep hilly catchment like that of the Nam Seng, and with the intense rainfall that occurs throughout northern Laos, the protection of soil surfaces is essential around all of the infrastructure that will be installed through the subproject. This includes irrigation headworks, canals and access roads. There are two main purposes for this. The first is to avoid erosion from rainfall, with bare surfaces highly prone to the entrainment of soil particles as a result of raindrop impact and runoff, leading to the loss of topsoil and increased amounts of sediment in water courses. The second is to protect earthworks from flood scour, when river or canal flows overtop the structures during high floods. Simple bio-engineering measures are the only effective way of protecting large surface areas from rainfall-induced erosion, and so this is a straightforward but critical mitigation measure in targeted key locations. For Nam Seng the use of bioengineering for protection of the main canal road in Nam Nan District from the downstream end of the conveyance tunnel is necessary and included within the design.

34. The support for proposed intensification and diversification of irrigated cropping systems will be provided by IFAD. There will be a risk of increased agricultural chemical use. These increases reflect the SC1 command area moving from low intensity rainfed rice systems to high value crops. The modelling for the subproject is based on green soyabean that will have substantial benefits for soil structure and fertility. However, other cropping options will reflect the prevailing market opportunities and this may lead to crops requiring differing fertilizer regimes. Pesticide use is currently relatively low except where dry season rice crops have enabled population build up such that two crops of rice are often associated with increased pesticide use. The current limited dry season high value cropping has limited use of pesticide or other agrichemicals

35. The agricultural support program is market linked and it is proposed to apply the principles and requirement of LaoGap certification systems that include training in PRT and IPM through the PAFO IPM teams.

IV. ENVIRONMENTAL MONITORING

A. Environmental Management Plan

36. The EMP is the key document underpinning each IEE and ensuring that the required environmental safeguards are adequately implemented. This EMP follows the format provided in the EARF for the SRIWSM.

37. Although environmental management and environmental monitoring plans are often issued as separate documents, for SRIWSM they are combined. The purpose of the monitoring plan is to ensure that the management plan is being implemented. Combining the two helps to ensure that this happens, and also clarifies the institutional responsibilities.

B. Institutional Responsibilities for Environmental Monitoring

38. The institutional responsibilities for both the implementation and monitoring of environmental management measures is provided in detail above. Implementation of environmental management actions follows the same responsibilities as the overall construction and implementation of the subproject itself. The PAFO PPIT is responsible for subproject implementation and the participation of the WUG. During the project construction period, the PPIT and PONRE will be supported by LIC for monitoring.

39. The operational responsibilities for the subproject infrastructure will lie with the Water User Groups who will continue to be assisted by IFAD under the PICSA project. The combination of ADB and IFAD support seeks to institutionalize the operational management of irrigation infrastructure based on the increased incentives from dry season irrigated cropping. The application of irrigation service fees are sufficient to finance the operation and maintenance of infrastructure.

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V. ENVIRONMENTAL MANAGEMENT AND MONITORING MATRIX

A. Introduction

41. The matrix below forms the practical management tool of the EMP[1]. It lists the environmental impacts expected to be experienced on this subproject, and the typical mitigation measures that can be used to avoid, minimise or restore the effects of these impacts.

42. The division of responsibilities between different agencies during the planning, construction and subsequent operation phases are given in simplified tables for the various sections of the PAFO (Appendix 2), the contractor (Appendix 3) and the Water User Group (Appendix 4).

43. Additional environmental monitoring by appropriate units of both the Ministry of Agriculture and Forests and the Ministry of Natural Resources and Environment is not always referred to in the matrix but represent further safeguards on the project's activities.

44. The standards against which compliance is to be monitored are: (i) the Lao PDR National Environmental Standards (2017), including the surface water quality standards given in Appendix 5 of this EMP; (ii) the International Finance Corporation's Environment, Health and Safety General Guidelines (2007); and (iii) the SRIWSM environmental guidelines given in Appendix 6.

B. Subproject Planning Phase during Project Implementation

45. Environmental mitigation in the design phase is principally the responsibility of the provincial representative of the project implementing agency (i.e. the Programme Governance Team in the Department of Irrigation), supported by the Provincial Project Implementation Team in the PAFO and the Loan Implementation Consultant company.

[1] Under Government If Lao Environmental Assessments an Environmental Management and Monitoring Plan (EMMP) is required, ADB requires a broader assessment within an Environmental Management Plan (EMP) … EMP is used to cover both of these documents

Table 2: Planning Phase Environmental Management and Monitoring

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
1.01	Loss of land or other property to infrastructure.	1. Full consent to the subproject must be sought through standard consultative processes. Full and fair compensation based on the Land Acquisition and Resettlement Framework is applied.	PIS - PAFO, supported by PAFO representative and project preparation consultant. 1. Before application to the project implementing agency for subproject funding. 2. Before signing a contract for the commencement of physical works.	PPIT - PAFO. 1. Before approval of project funding for the subproject. 2. Before approving any contract for physical works. Safeguard monitoring
1.02	Loss of land of importance for biodiversity.	1. Subproject landtake is to be minimised. 2. Landtake is to use land that is already degraded, to the greatest extent possible. 3. No projects to go ahead in forest or protected areas.	PIS - PAFO and engineering team of the project preparation consultant, supported by environment team of preparation consultant. 1. At the start of subproject design. 2. At each design review.	PPIT and PONRE. Before approval of subproject.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
1.03	(a) Incomplete hydrological data and as yet poorly developed climate change models lead to inaccurate designs for infrastructure. (b) Infrastructure is damaged by high flood levels, reducing the scheme's lifespan	1. Care is to be used to interpret as well as possible the best available data for the subproject catchment. 2. A significant margin is to be allowed to ensure that infrastructure is likely to be resilient under current climatic conditions. 3. An additional margin is to be allowed to ensure that infrastructure remains resilient under possible future more intense or prolonged rainfall events.	PIS - PAFO and engineering team of the project preparation consultant, supported by environment team of preparation consultant. At the start of subproject design.	DG PAFO, DG PONRE. During subproject design.
	or effectiveness and causing damage to the nearby environment. (c) Downstream riverine quality is affected in very dry years due to abstraction of water for irrigation.	4. Specially designed protection measures such as bio-engineering must be incorporated into designs as a matter of course. 5. Engineering designs must not be approved without adequate provision of protection against high flood conditions. 6. In very dry periods, released flows from the intake must be monitored to ensure that the minimum agreed environmental base flow is always provided downstream of the intake.		

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
1.04	Disruption of hydrological flows by offtake from rivers.	1. All available rainfall and flow data for the river catchment must be collected and assessed to provide a working model of average monthly flows throughout the year. 2. A hydrological gauging station must be established on the subproject catchment, upstream of the headworks, to help define acceptable dry season minimum flows. The proximity and flows of tributary streams close downstream from the proposed headworks must also be assessed.	PIS - PAFO and engineering team of the project preparation consultant, supported by environment team of Loan Implementation Consultant.	PONRE Review the emerging data in the light of observations and comments from water users, and discuss with the PIS whether adjustments to water flows are desirable.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
		3. A survey must be undertaken which establishes the cumulative minimum water needs of other existing users, plus ecological requirements. 4. A calculation must then be made as to the offtake that can be allowed. 5. Where no flow data exist, initial minimum flows of at least 30 percent of the estimated monthly average flow below which a PONRE review is required. 6. Offtake regimes must be refined as more data become available.	1. Gauging station to be installed at the start of subproject design. 2. Data to be re-assessed at each design review. 3. Data and offtake regime to be reviewed annually from the date of starting subproject implementation.	
1.05	Water supplies polluted by upstream land management practices do not comply with national standards for surface water.	1. If water quality risk is identified an assessment is required to establish its likely suitability for use in irrigation. 2. Under the PICSA IPM and Pesticide management programs a water quality risk assessment will be undertaken to, if required, customize a water quality testing program of surface water discharged from the command area	Project preparation consultant. During subproject design. PAFO, supported by Loan Implementation Consultant. IFAD implementation team and P0NRE	PONRE. During subproject design. During the planning season for the first dry season crop

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
1.06	Upstream land uses cause a decline in the quality and quantity of water available for the irrigation scheme.	GIZ will prepare and finance implementation of catchment land use plans during the project implementation period	PAFO and MAF will ensure that the catchment management planning are included in the proposed GIZ/GCF project.	MAF on approval of the GIZ/GCF project documentation

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
1.07	Farmers tin Nakheum village that use water, but do not pay any irrigation service fees to maintain the irrigation systems currently irrigate an area of 21ha. using drainage water may not have access to water after the subproject has been implemented	The subproject impact from the SC1 development will also provide water in future to SC2 (165 ha) from the distribution point at the end of the pipeline where the 21 ha in Nakheun Village is currently taking water. Given the surplus of water, drainage water will still be available at this offtake after the subproject is implemented. Further development of SC2 may impact the water available for the 21 ha. The wider issues are: (1) the "rights" of Nakheun villagers to use water "outside" the designated scheme command area over the rights of villagers "inside" the command areas of SC1 and SC2, and (2) are Nakheun villagers willing to contribute funds for the scheme O&M. 1. These aspects will need to be addressed at the time of preparing the O&M regulations / schedules for the overall scheme..	PIS - PAFO and DAFO need to ascertain rights of access to water, provide certainty that if the water is being used legally that it is sustained through the life of the SC1 construction Before subproject approval	Design has been checked by the TRTA engineers and found that there is no loss of water No monitoring required

C. Subproject Construction Phase during Project implementation

46. Environmental mitigation in the construction phase is principally the responsibility of the contractor, supervised by the Provincial Project Implementation Team, supported by PAFO, PONRE and the LIC. The Contractor EHS Officer will monitor implementation of EMP/CEMP and will submit monthly reports on implementation and any required corrective actions throughout construction to PPIT/PGT and LIC. The EHS officer will co-ordinate with the community liaison officer regularly to ensure that any issues/grievances are reflected in the monthly reports.

Table 3: Construction Phase Environmental Management and Monitoring

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.01	(a) Release of silt into water courses from excavations and earthworks during construction. (b) Release of silt into water courses from poorly finished earthworks following construction.	1. The removal of vegetation and creation of bare surfaces must be minimised to essential areas only. 2. Vegetation clearance and earthworks may only be undertaken during the months of October to April. 3. Temporary sediment settling ponds built using strong stone or timber check dams (not bamboo or fabric silt fences) must be constructed to trap sediment from all earthworks that have unprotected surfaces at any time during the months of April to October inclusive. 4. Borrow areas, camp sites, temporary access tracks etc. must be fully rehabilitated back to a condition that is fully protected against soil erosion. 5. Bio-engineering surface protection must be planted on all bare earthworks during the months of May to July.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Throughout the subproject construction period. 2. Before issuing the contractor's certificate of substantial completion. 3. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.02	Environmental damage of any form results from the poor understanding of subproject requirements by the contractor and subcontractors.	1. The Contractor EHS officer will prepare a CEMP to be approved by supervision consultant prior to starting works. 2. EHS Officer/GRM focal point to ensure details of subproject GRM entry point contacts are disclosed at camp, sites and affected villages. 3. EHS Officer to induct/ train workers on occupational and community health and safety practices 4. GRM focal points/community liaison officers to carry out regular consultation with affected persons.	Contractor, PPIT Before mobilisation and as required eg. whenever the contractor mobilises a new subcontractor.	Programme Governance Unit in DOI. As per the timings given for implementation.
2.03	Clearance of vegetation leads to the unnecessary removal of trees and other plants.	1. No tree over 200 mm diameter at breast height (1.5 metres above the ground) may be cleared unless the design drawings specifically require it. 2. The contractor's site clearance plan must be limited to the agreed work site boundaries and must be approved by the PPIT's environmental representative before any clearance may be commenced.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Throughout the subproject construction period. 2. Before issuing the contractor's certificate of substantial completion. 3. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.04	Temporary closure of irrigation systems during construction.	1. Contractors must provide a plan in advance to provide irrigation water into existing supply channels, which must be approved by the project implementing agency and the Water User Group. 2. If it is not possible to avoid temporary closure, then full and fair compensation is to be paid for loss of crops as a consequence.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Before allowing the contractor to commence work. 2. Throughout the subproject construction period.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.
2.05	Disposal of soil from excavations such as irrigation canals.	1. Soil from excavations should be re-used in designs wherever possible. 2. Where soil is excess to engineering requirements and is treated as spoil, it must be disposed of in the nearest available approved location, and stabilised and protected from rainfall using bio-engineering measures.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Throughout the subproject construction period. 2. Before issuing the contractor's certificate of substantial completion. 3. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.06	Release of dust into the atmosphere from excavations and other construction activities.	1. Earthworks must be halted during periods of strong winds. 2. Heavily used access tracks must be sprayed with water during dry periods. 3. On all unmetalled surfaces, construction traffic must be limited to 30 kmh within 250 metres of habitation and 80 kmh elsewhere. 4. Loads of dust-making materials must be covered. 5. Crushers must be fitted with water sprays to prevent dust emissions.	Contractor, managed by the PPIT and Loan Implementation Consultant. Throughout the subproject construction period.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.
2.07	Release of noxious gases into the atmosphere.	1. Vehicles and machines must be in a good condition and serviced regularly, to ensure minimal emissions. 2. All vehicles and machines must comply with the Lao PDR emissions standards.	Contractor, managed by the PPIT and Loan Implementation Consultant. Throughout the subproject construction period.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.
2.08	Noise nuisance from construction activities.	1. Contractors must not exceed statutory noise levels at any time. Work sites within 500 metres of habitation: (a) must not operate during the hours of darkness or on holidays; and (b) must have noise-abatement measures installed for other periods.	Contractor managed by the PPIT and Loan Implementation Consultant. Throughout the subproject construction period.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.09	Temporary use of land for construction affects livelihoods or leaves it damaged.	1. Land for use by any contractor or subcontractor must be agreed by both the PPIT and the local community authority before the contractor may have access. 2. Full and fair compensation is to be paid for loss of crops or other assets before the contractor may have access to the land. 3. The contractor must have a land restoration plan, which must have been	Contractor managed by the PPIT and Loan Implementation Consultant. 1. Before work is permitted to start. 2. Throughout the subproject construction period. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.
		implemented to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid.		
2.10	Influx of temporary labour disrupts local communities.	1. Contractors and subcontractors are required to use the maximum local labour possible. 2. If a significant number of staff and workers (i.e. more than 20) are to be brought into the subproject site, then the contractor must provide a management plan and code of conduct for the staff and workers, that is approved by the local community authority.	Contractor managed by the PPIT and Loan Implementation Consultant. 1. Before work is permitted to start. 2. Throughout the subproject construction period.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.11	Operation of construction machines affects both workers and local society.	1. The noise and dust reduction measures listed above must be adhered to. 2. Safety measures for machine operation must be defined and approved by the project implementing agency. 3. Machine operators and workers must be trained and certificated in the safe use of machines.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Before work is permitted to start. 2. Throughout the subproject construction period.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

2.12	Pollution by hydrocarbons from construction plant.	1. The contractor must prepare a plan for the management of hydrocarbons, which must be approved by the PPIT before the contractor is permitted to mobilise to site. 2. Fuel and oil must be transported in properly designed vehicles meeting national standards. 3. Fuel and oil must be stored at least 50 metres from a water body, in covered and bunded locations, and dispensed under strict controls. 4. Vehicle and machine parking and service areas must have impermeable surfaces and the outlet drains must be fitted with oil traps. 5. Contractors must have spill clean-up equipment on site, and persons always present who know when and how to use it. 6. The contractor must have a land restoration plan that includes hydrocarbon facilities, which must have been implemented to the satisfaction of both the project implementing agency and the landowner before the contractor's final bill may be paid. 7. Any subcontractor must comply with the same rules, at the contractor's liability.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Before the contractor is permitted to mobilise to site. 2. Throughout the subproject construction period. 3. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.13	Pollution from construction site wastewater, from camps and other work sites.	1. The contractor must prepare a plan for the management of wastewater, which must be approved by the PPIT before the contractor is permitted to mobilise to site. 2. “Black” wastewater from sanitation facilities must be led to a properly constructed septic tank and soakaway. 3. “Grey” wastewater from washing and cooking facilities must be led to a septic tank or to a specially built reed bed filtration system. 4. Oil-contaminated water from workshops and fuel stores must be collected and taken to an approved municipal waste management facility. 5. The contractor must have a land restoration plan that includes wastewater facilities, which must have been implemented to the satisfaction of both the PPIT and the landowner before the contractor’s final bill may be paid. 6. Any subcontractor must comply with the same rules, at the contractor’s liability.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Before the contractor is permitted to mobilise to site. 2. Throughout the subproject construction period. 3. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.14	Pollution from solid waste materials.	1. Solid waste must be recycled wherever possible. 2. Non-recyclable solid waste must be sent to an official landfill site. 3. Open burning of solid waste is prohibited 4. The contractor must have a land restoration plan that includes solid waste, which must have been completed to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Throughout the subproject construction period. 2. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.
2.15	Injuries to workers and others.	1. Work sites must be clearly demarcated using barrier tape and all non-project personnel excluded. 2. All staff, workers and visitors to construction sites must be issued with appropriate personal protective equipment. 3. All staff, workers and visitors to construction sites must be briefed on safe working procedures for that site. 4. Every construction site must have a first aid kit and at least two persons always present who are trained and competent to use it.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Before the contractor is permitted to commence work. 2. Throughout the subproject construction period.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
2.16	Disruption of cultural sites.	1. All small cultural sites (such as small shrines and graves) must be protected by the contractor during works periods. 2. A plan for the protection of cultural sites must be approved by the PPIT. 3. Once construction is complete the surrounding of such sites must be restored to their pre-construction condition.	Contractor, managed by the PPIT and Loan Implementation Consultant. 1. Before the contractor is permitted to commence work. 2. Throughout the subproject construction period. 3. Before returning retention monies.	PPIT environmental section. Quarterly or as required. PONRE. At quarterly inspections throughout subproject construction period.
2.17	Subsequent users may not fully understand how to manage the subproject works.	1. Instructions on managing the infrastructure must be provided to the end users before handover. 2. The operating instructions must be explained to the Water User Group. 3. Before handover, the operating instructions must be finalised and the EMP requirements included.	Contractor, supported by the PPIT and Loan Implementation Consultant. 1. By 6 months before scheduled handover of infrastructure. PPIT and Loan Implementation Consultant. 2. 6 months and 3 months before handover, and at handover. 3. At infrastructure handover.	Director of PAFO and PONRE. 1. 3 months before handover. 2. At infrastructure handover.

D. Subproject Operation Period following Project implementation

47. Environmental mitigation in the operation period is principally the responsibility of the Water User Group and the Provincial Irrigation Section in the PAFO, supported by other sections of the PAFO and the DAFO.

Table 4: Operation Period Environmental Management and Monitoring

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
3.01	Disruption of downstream hydrological flows due to offtake from river.	1. Once scheme operation commences, the gauged river flows and water offtake volumes must be reassessed. These, plus any complaints from downstream users, must be used to recalculate the allowable offtake. 2. The scheme must then be revised accordingly.	PIS - PAFO. Annually.	PONRE. Annually.
3.02	Upstream land uses cause a decline in the quality and quantity of water available for the irrigation scheme.	1. GIZ financing of Catchment land use management plan and the implementation of these plans. The plan's primary objective is upstream catchment protection to ensure that the subproject irrigation scheme is safeguarded in terms of water supply and limited sediment supply. Arrangements for implementation of the plan must be maintained.	GIZ/ PAFO. Annually.	GIZ PAFO- DG (DALAM) PONRE. Annually.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
3.03	(a) Extraction of water from a river causes a decline or loss of aquatic biodiversity. (b) Subproject irrigation scheme requires more water than is available.	1. If these impacts occur, then it shows that the assumptions of water flow made during subproject design were wrong. This is likely to be due to a lack of flow data at design stage. 2. The minimum flow release must be recalculated, based on user needs and the latest data on river flow. 3. Water use by the subproject scheme must be reviewed against what is actually available.	PIS - PAFO. If necessary, specialist expertise should be requested from the central Department of Water Resources and the central Department of Irrigation. Annually.	PONRE. Annually.
		4. A revised scheme management plan must be introduced, implemented, monitored and adjusted until it resolves the problem.		
3.04	(a) Flood damage to headworks. (b) Erosion of canal banks, either from flood surges or normal flows.	1. All flood protection works must be maintained as per the design of the subproject, or any subsequent engineering works. 2. Any flood damage must be reviewed and appropriate measures designed for resolution. 3. Occasional minor flood damage should normally be resolved by using appropriate measures. 4. The use of civil engineering structures (i.e. concrete or gabion works) may be required in the event of serious damage from exceptional floods.	Water User Group, calling on the PIS – PAFO for advice if damage is severe. Annually.	PAFO and PONRE. Annually.

No.	Potential Impact	Safeguards or Mitigation	Responsibility to Implement and Timing	Monitoring, Checking and Timing
3.05	Increased Agrichemical use	1. Identification of crops, cropping and farming systems 2. Support for Lao Gap training and awareness 3. Where warranted PRT 4. Where required IPM training for specific crops that require pesticide use 5. Nutrient management regimes built into farm technology demonstrations	1. PAFO with Input from IFAD financed support services	1. Cropping season monitoring to capture detail of agrichemical use – PPIT, PAFO monitoring program implemented by WUG through mobile phone systems at sowing and harvest of each cropping season

VI. ENVIRONMENTAL MONITORING FORMAT

A. Recommended Format

48. Environmental monitoring in both the subproject construction phase and the subsequent operation period is principally the responsibility of the Environmental Section of the PONRE. During the construction phase, monitoring must be undertaken quarterly, or more frequently if deviations are observed or complaints received. During the subsequent and indefinite operation period, monitoring must be undertaken annually, or more frequently if deviations are observed or complaints received.

49. It is recommended that a simple table and traffic light system is used to indicate the level of seriousness of any lapses. A key and format for this is given below. The intention is to give a quick and clear indication of anything that is going wrong, who needs to take action to resolve it, and what they must do.

Category 3	Serious issue causing widespread pollution or other environmental damage.
Category 2	Significant issue causing localised pollution or other environmental damage.
Category 1	Minor lapses causing short term environmental damage that can be easily rectified.
Category 0	No environmental problems or previous problem resolved.
Category D	Issues requiring action but deferred due to plans for future activities that will affect them, or for other reasons.

Table 5: Monitoring Action Report

No.	Mitigation	Assessment of Condition	Corrective Actions Required	Timing	Cat.

B. Example of the Monitoring Format Used

50. The version of the monitoring table below shows a hypothetical worked example for some of the mitigation measures during the construction phase of the subproject.

Table 6: Monitoring Action Report – Nam Seng Subproject (Hypothetical Example, 1 September 2020)

No.	Mitigation	Assessment of Condition	Corrective Actions Required	Timing	Cat.
2.01(1)	The removal of vegetation and creation of bare surfaces must be minimised to essential areas only.	Contractor is complying well and there are no areas cleared unnecessarily.	DAFO to continue encouraging contractor to go on complying.		0
2.01(2)	Vegetation clearance and earthworks may only be undertaken during the months of October to April.	Contractor commenced vegetation clearance on feeder canal in August to try to improve its schedule. Erosion has started and some neighbouring land has been inundated with sediment.	DAFO engineer must hold a site meeting with the contractor. The contractor must install emergency erosion control measures within one week. The contractor must also rehabilitate the damaged land in consultation with the engineer and the landowner, within one month.		2
2.01(3)	Temporary sediment settling ponds built using strong stone or timber check dams must be constructed to trap sediment from all earthworks that have unprotected surfaces at any time during the months of April to October inclusive.	These were installed successfully in March. However, the heavy rains in early August caused some damage near the headworks construction site, leading to some erosion and soil washing into the irrigation canal.	The contractor must repair the damaged sediment traps within two weeks. The DAFO engineer is to ensure this is done.		1
2.01(4)	Bio-engineering surface protection must be planted on all bare earthworks during the months of May to July.	Bio-engineering works were implemented on schedule in June. The grass has established well and is already providing a good protection from erosion on the main canal embankment.	The contractor is to continue to protect the site and ensure that livestock do not graze it during the forthcoming dry season. The DAFO engineer is to monitor.		0

No.	Mitigation	Assessment of Condition	Corrective Actions Required	Timing	Cat.
2.03(1)	No tree over 200 mm diameter at breast height (1.5 metres above the ground) may be cleared unless the design drawings specifically require it.	No trees had to be cut in the process of these works.	Not applicable.		**0**
2.03(2)	The contractor's site clearance plan must be limited to the agreed work site boundaries and must be approved by the PPIT's environmental representative.	The contractor is keeping to the agreed site boundaries in most cases. However, there are lapses in that the contractor's trucks are frequently parked overnight on the river bank and not taken back to the camp. Engine oil is dripping on to the soil surface and could be leached into the river.	The contractor must ensure that the trucks are parked in the correct location overnight, with immediate effect. The contractor must clean up the oil contamination within two days. The DAFO engineer is to ensure this is done.		**1**

Reference Documents

Environmental Protection Law. 1999. Government of Lao PDR.

Decree on Environmental Impact Assessment. 2010. (Decree No. 112/PM, 16 February 2010). Government of Lao PDR.

National Environmental Standards. 2017. (Decree No. 81/ENV, 21 February 2017). Government of Lao PDR.

Regulation on the Control of Pesticides in Lao PDR. 2010. (Regulation No 2860/MAF, 11 June 2010). Government of Lao PDR.

Decree on Pesticide Management. 2017. (Decree No. 258/GOV, 24 August 2017). Government of Lao PDR.

The Land Law. 1997. (Law No. 01/97/NA, 12 April 1997). Government of Lao PDR.

Decree on Compensation and Resettlement Management in Development Projects. 2016. (Decree No. 84, 5 April 2016). Government of Lao PDR.

The Forestry Law. 1996. Government of Lao PDR.

Directive on the Prohibition of Hunting and Trading Wildlife and Aquatic Animals, Nationally and Internationally, and of Providing Passage to 3rd Countries. 2002. (Directive No. 76/MAF, 2 June 2002. Government of Lao PDR.

Law on Water and Water Resources. 1996. (Law No. 02-96, 11 October 1996). Government of Lao PDR.

Water Law Update. 2017. (Update of 9 June 2017 follow National Assembly Meeting on 11 May 2017). Government of Lao PDR.

Wildlife and Aquatic Law. 2007. (Law No 07/NA, 24 December 2007). Government of Lao PDR.

8th Five-Year National Socioeconomic Development Plan (2016–2020). 2016. (VIIIth National Assembly's Inaugural Session, 20–23 April 2016). Ministry of Planning and Investment.

Strategy on Climate Change of the Lao PDR. 2010. Government of Lao PDR.

International Finance Corporation. 2007. Environment, Health and Safety General Guidelines. World Bank Group.

Emission Reductions Program Document (ER-PD): Promoting REDD+ through Governance, Forest landscapes & Livelihoods in Northern Lao PDR. 2018. (Revision: 30 January 2018). Forest Carbon Partnership Facility Carbon Fund.

Integrated Biodiversity Assessment Tool. 2018. Proximity report generated by the Integrated Biodiversity Assessment Tool – Lao Nam Seng and Nam Nan Luang Prabang. Asian Development Bank, May 2018.

Aware for Projects. 2018. Climate and Geological Risk Screening – Luang Prabang Nam Seng and Nam Nan. Asian Development Bank, May 2018.

International Water Management Institute. 2018. IWMI Environmental Flow Calculators. http://www.iwmi.cgiar.org/resources/models-and-software/environmental-flow-calculators/

Appendix 1. Subproject Terms of Reference for Technical PONRE Staff

Category	Description
A: Position /Title	**Provincial Environmental Officer**
B: Position / Type	Staff member of the PONRE
C: Source	National
D: Qualifications	Degree in an environmental subject (e.g. soil science, botany, zoology, physical geography, ecology, forestry, agronomy or environmental science).
E: Experience	At least five years of field experience in the operation of rural infrastructure development projects (i.e. in project implementation).
F: Posting	Provincial Centre
G: Reporting To	DG-PONRE and National Environmental Safeguards Consultant
H: Role duration	21 person months over project years 2 to 6 inclusive.
I: Starting Date	Q2 of project year 2.
J: Deliverables	1. Provincial Quarterly Environmental Monitoring Reports.
K: Outputs	The officer will contribute as follows to the Project outputs in their province: 1. The EMP for every GOL Category 1 subproject, or Environmental Codes of Conduct for non-qualifying subprojects, in the officer's province is effectively implemented and monitored as per the requirements of the Subproject EMP and as per the provisions of the Project Administration Manual (PAM).
L: Tasks	SRIWSM Outputs 1 and 3: As directed by the PIC National Environmental Safeguards Consultant, undertake the following tasks. 1. Participate in training seminars provided by the Loan Implementation Consultant's team. 2. Support the Loan Implementation Consultant's team in undertaking the field studies and consultations necessary for future subprojects. 3. Co-ordinate the implementation of the EMP or Code of Conduct for every subproject in the province. Work with the relevant subproject stakeholders to support them in fulfilling their obligations under the plans and codes. 4. Undertake active on-site monitoring throughout the construction period of the subproject infrastructure. This should involve at least two site visits per week while the contractor is mobilised to ensure that it is fully compliant with the requirements of this EMP. 5. Prepare quarterly environmental monitoring report. 6. Undertake regular on-site monitoring during the infrastructure operation period until the termination of the project in the province. This should involve one site visit per month to ensure that the WUG's management of the new infrastructure is fully compliant with the requirements of this EMP. 7. Monitor the subproject areas that are the target of activities under these outputs, to determine whether there are any unexpected negative environmental impacts caused by the upgraded rural infrastructure. 8. Report findings to the Provincial Steering Committee and DG-PAFO. 9. Implement practical demonstrations of environmental mitigation actions as necessary to assist the subproject stakeholders in fulfilling the environmental safeguards as needed. 10. Assist project stakeholders in the collection of additional environmental data, particularly relating to meteorology and hydrology. 11. Undertake environmental sampling as necessary to ensure that safeguards are in place or to quantify lapses affecting air, water or soil. 12. Complete the quarterly monitoring of the subprojects using the formats in the EMP to compile Provincial Quarterly Environmental Monitoring Reports from when civil works starts.

Appendix 2. Responsibilities of the Provincial Agriculture and Forest Office

Provincial Irrigation Section of the PAFO – Planning Phase		
No.	**What you Must Do**	**Why You Must Do It**
1.01	1. Full consent to the subproject must be sought through standard consultative processes. 2. Full and fair compensation is to be paid for loss of land, crops or other assets before the subproject commences. 3. Land Acquisition and Resettlement Framework to be followed diligently.	To compensate people for losses of land or other property to infrastructure.
1.02	1. Subproject landtake is to be minimised. 2. Landtake is to use land that is already degraded, to the greatest extent possible. 3. If previously undisturbed forest must be used (not planned as part of the design), the subproject would be changed to a different environmental category and would no longer be eligible for SRIWSM financing.	To compensate for the loss of land of importance for biodiversity.
1.03	1. Care is to be used to interpret as well as possible the best available data for the subproject catchment. 2. A significant margin is to be allowed to ensure that infrastructure is likely to be resilient under current climatic conditions. 3. An additional margin is to be allowed to ensure that infrastructure remains resilient under possible future more intense or prolonged rainfall events. 4. Specially designed protection measures such as bio-engineering must be incorporated into designs as a matter of course. 5. Engineering designs must not be approved without adequate provision of protection against high flood conditions. 6. In very dry periods, released flows from the intake must be monitored to ensure that the minimum agreed environmental base flow is always provided downstream of the intake.	To protect infrastructure from high flood levels in an uncertain climate setting.

Provincial Irrigation Section of the PAFO – Planning Phase		
No.	**What you Must Do**	**Why You Must Do It**
1.04	1. All available rainfall and flow data for the river catchment must be collected and assessed to provide a working model of average monthly flows throughout the year. 2. A hydrological gauging station must be established on the subproject catchment, upstream of the headworks, to help define acceptable dry season minimum flows. The proximity and flows of tributary streams close downstream from the proposed headworks must also be assessed. 3. A survey must be undertaken which establishes the cumulative minimum water needs of other existing users, plus ecological requirements. 4. A calculation must then be made as to the offtake that can be allowed. 5. Where no flow data exist, initial minimum flows of at least 30 percent of the estimated monthly average flow must be used as the abstraction criterion below which a PONRE review is required. 6. Offtake regimes must be refined as more data become available.	To minimise the disruption of hydrological flows by offtake from rivers.
1.07	1. It must be established whether the subproject design will be a significant issue for farmers to the north of the new command area. 2. If it is, then either the new command area must be altered to include those people, or they must be compensated accordingly.	To ensure that farmers to the north of the new command area currently using drainage water from the primary canal will still have access to water after the subproject has been implemented.

PAFO and DAFO Watershed Management, Agriculture and Forestry Teams – Planning Phase		
No.	**What you Must Do**	**Why You Must Do It**
1.05	1. An assessment must be made of the quality of water at the headworks and its likely suitability for use in irrigation. 2. If there is doubt about water quality, then the subproject should be abandoned as a candidate for SRIWSM funding.	In case water supplies polluted by upstream land management practices do not comply with national standards for surface water.
1.06	Discussions on creating a catchment land use plan should be initiated before construction starts on physical works. The plan should be both socio-economically beneficial and environmentally sound, in that its primary objective would be upstream catchment protection to ensure that the subproject irrigation scheme is safeguarded in terms of water supply and limited sediment supply.	So that upstream land uses do not cause a decline in the quality and quantity of water available for the irrigation scheme.

Provincial Project Implementation Team of the PAFO – Construction Period		
No.	**What you Must Do**	**Why You Must Do It**
2.02	1. At a pre-mobilisation site meeting, the contractor must demonstrate a full understanding of the requirements of the EMP. 2. All of the sub-plans listed below must be created, reviewed, improved if necessary and accepted for approval. 3. The contractor must demonstrate that it is fully responsible for all subcontractors' adherence to the provisions of the EMP, and that it has formally ensured this.	To ensure that environmental damage of any form does not result from the poor understanding of subproject requirements by the contractor and subcontractors.
2.17	1. Instructions on managing the infrastructure must be provided to the end users before handover. 2. The operating instructions must be explained to the Water User Group. 3. Before handover, the operating instructions must be finalised and the EMP requirements included.	To ensure that subsequent users fully understand how to manage the subproject works.

Provincial Irrigation Section of the PAFO – Operation Period		
No.	**What you Must Do**	**Why You Must Do It**
3.01	1. Once scheme operation commences, the gauged river flows and water offtake volumes must be reassessed. These, plus any complaints from downstream users, must be used to recalculate the allowable offtake. 2. The scheme must then be revised accordingly.	To ensure that there is no disruption of downstream hydrological flows due to offtake from river.
3.03	1. If water shortages occur, then it shows that the assumptions of water flow made during subproject design were wrong. This is likely to be due to a lack of flow data at design stage. 2. The minimum flow release must be recalculated, based on User needs and the latest data on river flow. 3. Water use by the subproject scheme must be reviewed against what is actually available. 4. A revised scheme management plan must be introduced, implemented, monitored and adjusted until it resolves the problem. 5. A provincial policy needs to be in place as to the priorities of water allocations in water-short years.	So that the extraction of water from a river does not cause a decline or loss of aquatic biodiversity, or leave downstream users short, if the subproject irrigation scheme requires more water than is available.

PAFO and DAFO Watershed Management, Agriculture and Forestry Teams – Operation Period		
No.	**What you Must Do**	**Why You Must Do It**
3.02	1. The catchment land use plan initiated before project implementation (see 1.06) should be continued indefinitely to ensure that the scheme is safeguarded throughout its operational life. The plan's primary objective is upstream catchment protection to ensure that the subproject irrigation scheme is safeguarded in terms of water supply and limited sediment supply. 2. Arrangements for implementation of the plan must be maintained.	So that upstream land uses do not cause a decline in the quality and quantity of water available for the irrigation scheme.

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Appendix 3. Responsibilities of the Contractor

The subproject civil works contractor is responsible for the following actions during the construction phase.

Contractor – Construction Phase		
No.	**What you Must Do**	**Why You Must Do It**
2.00	1. Appoint qualified Environmental, Health and Safety Officer to manage site safety and implementation of EMP and GRM requirements. 2. Prepare subproject specific Construction EMP (CEMP) confirming how EMP requirements will be implemented. 3. EHS Officer to provide induction, training and toolbox talks for all Contractor staff and other site visitors. 4. EHS Officer to liaise with affected persons and local community 5. EHS Officer to implement and monitor any required corrective actions and resolution of issues raised through the GRM. 6. EHS Officer to report monthly to PPIT on implementation of EMP and GRM.	To ensure Contractor fulfils their contractual requirements to: provide and maintain a safe and hygienic working environment; implement, monitor and report on subproject EMP and GRM requirements effectively.
2.01	1. The removal of vegetation and creation of bare surfaces must be minimised to essential areas only. 2. Vegetation clearance and earthworks may only be undertaken during the months of October to April. 3. Temporary sediment settling ponds built using strong stone or timber check dams (not bamboo or fabric silt fences) must be constructed to trap sediment from all earthworks that have unprotected surfaces at any time during the months of April to October inclusive. 4. Borrow areas, camp sites, temporary access tracks etc. must be fully rehabilitated back to a condition that is fully protected against soil erosion. 5. Bio-engineering surface protection must be planted on all bare earthworks during the months of May to July.	To avoid water course pollution from releases of silt from excavations and earthworks during construction, and from poorly finished earthworks following construction.
2.03	1. No tree over 200 mm diameter at breast height (1.5 metres above the ground) may be cleared unless the design drawings specifically require it. 2. The contractor's site clearance plan must be limited to the agreed work site boundaries and must be approved by the PPIT's environmental representative before any clearance may be commenced.	So that the clearance of vegetation does not lead to the unnecessary removal of trees and other plants.

Contractor – Construction Phase		
No.	**What you Must Do**	**Why You Must Do It**
2.04	1. Contractors must provide a plan in advance to provide irrigation water into existing supply channels, which must be approved by the project implementing agency and the Water User Group. 2. If it is not possible to avoid temporary closure, then full and fair compensation is to be paid for loss of crops as a consequence.	To avoid temporary closures of irrigation systems during construction.
2.05	1. Soil from excavations should be re-used in designs wherever possible. 2. Where soil is excess to engineering requirements and is treated as spoil, it must be disposed of in the nearest available approved location, and stabilised and protected from rainfall using bio-engineering measures.	To ensure the safe disposal of soil from excavations such as irrigation canals.
2.06	1. Earthworks must be halted during periods of strong winds. 2. Heavily used access tracks must be sprayed with water during dry periods. 3. On all unmetalled surfaces, construction traffic must be limited to 30 kmh within 250 metres of habitation and 80 kmh elsewhere. 4. Loads of dust-making materials must be covered. 5. Crushers must be fitted with water sprays to prevent dust emissions.	To minimise the release of dust into the atmosphere from excavations and other construction activities.
2.07	1. Vehicles and machines must be in a good condition and serviced regularly, to ensure minimal emissions. 2. All vehicles and machines must comply with the Lao PDR emissions standards.	To minimise the release of noxious gases into the atmosphere.
2.08	1. Contractors must not exceed statutory noise levels at any time. 2. Work sites within 500 metres of habitation: (a) must not operate during the hours of darkness or on holidays; and (b) must have noise-abatement measures installed for other periods.	To minimise noise nuisance from construction activities.
2.09	1. Land for use by any contractor or subcontractor must be agreed by both the PPIT and the local community authority before the contractor may have access. 2. Full and fair compensation is to be paid for loss of crops or other assets before the contractor may have access to the land. 3. The contractor must have a land restoration plan, which must have been implemented to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid.	To ensure that the temporary use of land for construction does not affect livelihoods or leave it damaged.

Contractor – Construction Phase		
No.	**What you Must Do**	**Why You Must Do It**
2.10	1. Contractors and subcontractors are required to use the maximum local labour possible. 2. If a significant number of staff and workers (i.e. more than 20) are to be brought into the subproject site, then the contractor must provide a management plan and code of conduct for the staff and workers, that is approved by the local community authority.	To minimise the disruption to local communities due to an influx of temporary labour.
2.11	1. The noise and dust reduction measures listed above must be adhered to. 2. Safety measures for machine operation must be defined and approved by the project implementing agency. 3. Machine operators and workers must be trained and certificated in the safe use of machines.	To minimise the effects on both workers and local society from the operation of construction machines.
2.12	1. The contractor must prepare a plan for the management of hydrocarbons, which must be approved by the PPIT before the contractor is permitted to mobilise to site. 2. Fuel and oil must be transported in properly designed vehicles meeting national standards. 3. Fuel and oil must be stored at least 50 metres from a water body, in covered and bunded locations, and dispensed under strict controls. 4. Vehicle and machine parking and service areas must have impermeable surfaces and the outlet drains must be fitted with oil traps. 5. Contractors must have spill clean-up equipment on site, and persons always present who know when and how to use it. 6. The contractor must have a land restoration plan that includes hydrocarbon facilities, which must have been implemented to the satisfaction of both the project implementing agency and the landowner before the contractor's final bill may be paid. 7. Any subcontractor must comply with the same rules, at the contractor's liability.	To avoid the pollution by hydrocarbons from construction plant.

Contractor – Construction Phase		
No.	**What you Must Do**	**Why You Must Do It**
2.13	1. The contractor must prepare a plan for the management of wastewater, which must be approved by the PPIT before the contractor is permitted to mobilise to site. 2. "Black" wastewater from sanitation facilities must be led to a properly constructed septic tank and soakaway. 3. "Grey" wastewater from washing and cooking facilities must be led to a septic tank or to a specially built reed bed filtration system. 4. Oil-contaminated water from workshops and fuel stores must be collected and taken to an approved municipal waste management facility. 5. The contractor must have a land restoration plan that includes wastewater facilities, which must have been implemented to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid. 6. Any subcontractor must comply with the same rules, at the contractor's liability.	To avoid the pollution from construction site wastewater, from camps and other work sites.
2.14	1. Solid waste must be recycled wherever possible. 2. Non-recyclable solid waste must be sent to an official landfill site. 3. The contractor must have a land restoration plan that includes solid waste, which must have been completed to the satisfaction of both the PPIT and the landowner before the contractor's final bill may be paid.	To avoid pollution from solid waste materials.
2.15	1. Work sites must be clearly demarcated using barrier tape and all non-project personnel excluded. 2. All staff, workers and visitors to construction sites must be issued with appropriate personal protective equipment. 3. All staff, workers and visitors to construction sites must be briefed on safe working procedures for that site. 4. Every construction site must have a first aid kit and at least two persons always present who are trained and competent to use it.	To avoid injuries to workers and others.
2.16	1. All small cultural sites (such as small shrines and graves) must be protected by the contractor during works periods. 2. A plan for the protection of cultural sites must be approved by the PPIT. 3. Once construction is complete the surrounding of such sites must be restored to their pre-construction condition.	To minimise the disruption of cultural sites.

Contractor – Construction Phase		
No.	**What you Must Do**	**Why You Must Do It**
2.17	1. Instructions on managing the infrastructure must be provided to the end users before handover. 2. The operating instructions must be explained to the Water User Group. 3. Before handover, the operating instructions must be finalised and the EMP requirements included.	So that subsequent users fully understand how to manage the subproject infrastructure.

Appendix 4. Responsibilities of the Water User Group – Operation Period

Water User Group – Operation Period		
No.	**What you Must Do**	**Why You Must Do It**
3.05	1. All flood protection works must be maintained as per the design of the subproject, or any subsequent engineering works. 2. Any flood damage must be reviewed and appropriate measures designed for resolution. 3. Occasional minor flood damage should normally be resolved by using appropriate measures. 4. The use of civil engineering structures (i.e. concrete or gabion works) may be required in the event of serious damage from exceptional floods.	To prevent flood damage to headworks and the erosion of canal banks, either from flood surges or normal flows.

Appendix 5. Surface Water Standards

Government of Lao PDR National Environmental Standards (2017)
10. Surface Water Quality Standards

Class 2: Water quality for aquatic animal conservation, fisheries and water sports.
Class 3: Water quality for agriculture, livestock and other uses.

No.	Substances	Symbol	Unit	Standard Value		Method of Measurement
				Class 2	Class 3	
1	Colour, Odour and Taste	-	-	n'	n'	Description
2	Temperature	t	°C	n'	n'	Thermometer
3	Potential of Hydrogen	pH	-	6-8	5-9	Electronic pH meter
4	Dissolved Oxygen	DO	mg/l	6.0	5.0	Azide Modification
5	Electro-conductivity	EC	µS/cm	≤ 1000	≤ 2000	EC meter
6	COD	COD	ml/l	5-7	7-10	Potassium Dichromate Digestion; Open Reflux or Closed Reflux
7	Total Coliform Bacteria	Coliform Bacteria	MPN/100 ml	5000	20000	Multiple Tube Fermentation
8	Faecal Coliform Bacteria	Faecal Bacteria	MPN/100 ml	1000	4000	
9	Total Suspended Solids	TSS	mg/l	≤ 25	≤ 40	Glass Fibre Filter Disk
10	Phosphate	PO_4	mg/l	0.5	1.0	Ascorbic Acid
11	Ammonium Ion	NH_4^+	mg/l	≤ 1.5	≤ 3.0	Kjeldahl
12	Nitrate-nitrogen	NO_3-N	mg/l	5.0	5.0	Cadmium Reduction
13	Ammonia-nitrogen	NH_3-N	mg/l	0.5	0.5	Distillation Nezzlerization
14	Phenols	C_6H_5OH	mg/l	0.005	0.005	Distillation, 4-Amino antipyrene
15	Copper	Cu	mg/l	1.5	1.5	Atomic Absorption Direct Aspiration
16	Nickel	Ni	mg/l	0.1	0.1	
17	Manganese	Mn	mg/l	1.0	1.0	
18	Zinc	Zn	mg/l	1.0	1.0	
19	Cadmium	Cd	mg/l	0.003	0.003	
20	Chromium, Hexavalent	Cr^{6+}	mg/l	0.05	0.05	
21	Lead	Pb	mg/l	0.01	0.01	
22	Mercury	Hg	mg/l	0.001	0.001	Atomic Absorption Cold Vapour
23	Arsenic	As	mg/l	0.01	0.01	Atomic Absorption Direct Aspiration, ICP
24	Cyanide	CN^-	mg/l	0.07	0.07	Pyridine-Barbituric Acid
25	Alpha Radioactivity	α	Becquerel/l	0.1	0.1	Geiger Counter
26	Beta Radioactivity	β	Becquerel/l	1.0	1.0	
27	Organochlorine Pesticide	-	mg/l	0.05	0.05	Gas Chromatography
28	Dichlorodiphenyl-trichloroethane (DDT)	$C_{14}H_9Cl_5$	µg/l	1.0	1.0	
29	Alpha-Benzene Hexachloride (BHC)	αBHC ($C_6H_6Cl_6$)	µg/l	0.02	0.02	
30	Dieldrin	$C_{12}H_8Cl_6O$	µg/l	0.1	0.1	
31	Aldrin	$C_{12}H_8Cl_6$	µg/l	0.1	0.1	

29	Heptachlor and Heptachlor Epoxide	$C_{10}H_5Cl_7$, $C_{10}H_5Cl_7O$	µg/l	0.2	0.2	
30	Endrin	$C_{12}H_8Cl_6O$	µg/l	None	None	

Appendix 6. Project Environmental Guidelines

The Government of Lao PDR National Environmental Standards (2017) will be used as the reference points for the areas that they cover. The list below gives the additional guideline standards that must be followed on all SRIWSM subprojects. If new standards are gazetted by the government during the project implementation period, then they shall take precedence if they are stricter.

Soil

- All bare surfaces (including roadsides and drains but excluding road running surfaces) shall be protected using bio-engineering measures that shall be implemented during the months of May to July each year. The SRIWSM bio-engineering guidelines will be followed.
- Agrichemicals shall only be used that are not on the Government of Lao PDR lists of prohibited substances under the Regulation on the Control of Pesticides in Lao PDR (Regulation No 2860/MAF, 11 June 2010) and the Decree on Pesticide Management: (Decree No. 258/GOV, 24 August 2017).

Vegetation

- No tree of more than 200 mm diameter at breast height (1.5 metres above the ground) shall be cleared unless the design drawings specifically require it.
- Other vegetation shall be cleared only within agreed site boundaries or in connection with agreed subproject activities.
- Fire shall not be used as a means of clearing vegetation or for the disposal of cleared vegetation.

Water

- The National Environmental Standard (2017) for water quality shall apply in every case.
- A vegetated band of at least 50 metres should be maintained between any areas of disturbance and any water course. Exceptions are made only where irrigation headworks and road crossings must necessarily be closer.
- Irrigation headworks shall utilise the minimum amount of cleared land. During and after construction, the surface drainage from all earthworks shall be directed via sediment traps to ensure that runoff water is clear at the point of discharge into a flowing watercourse.
- Road crossings shall be at 90 degrees to a water course. Properly designed and constructed culverts and bridges shall be used. Road drainage shall be provided and sediment traps shall be installed to ensure that road runoff water is clear at the point of discharge into a flowing water course. Alignments should be at 90 degrees to the water course within a band of 50 metres on each side unless the terrain or an obstruction prevents this.
- The minimum river flow in each calendar month shall not be lower than 60 percent of natural flow below offtakes in locations defined by an IEE as having high value biodiversity, unless site-specific measurements and calculations have been used to justify an alternative level.
- All weirs and other obstructions in rivers, streams and canal channels must have provision for native migratory fish to pass.

Animals

- All subproject staff, workers and beneficiaries shall be issued with a list of rare, threatened and endangered species in the area around the subproject, which shall not be hunted, traded or eaten. Such a list shall be included in each subproject IEE and shall be based on the regional data held by the International Union for the Conservation of Nature (IUCN) Red List.

Air

- The National Environmental Standard (2017) for ambient air quality shall apply in every case.
- On all unmetalled surfaces, construction traffic shall be limited to 30 kmh within 250 metres of habitation and 80 kmh elsewhere.
- Dust emissions shall be minimised by spraying water during dry weather and using other site-specific measures.
- Vehicle and machine engines shall be stopped when stationery.

Storage

- No storage of oil, fuel or chemicals is permitted within 50 metres of a water body.
- All stores shall be covered with full rain protection.
- Oil and fuel stores shall have impermeable bunds capable of retaining 150 percent of the stored volume indefinitely.

Hazardous Materials

- Fuels, oils, cement, fertilisers and pesticides shall be included in the category of hazardous materials.
- All hazardous materials shall be stored in secure compounds, with rain protection and bunds in case of spills and leakages.
- Every site where hazardous materials are stored or used shall have spill clean-up equipment and staff trained in its use.
- Fuel handling areas shall be bunded and all drainage water directed through oil traps. Sediment from oil traps shall be sent for disposal at a waste disposal facility authorised for the handling of hydrocarbon waste.

Solid Waste Management

- All work sites shall be provided with sanitary facilities. These may be pit latrines or water-based toilets with septic tanks and subsurface soakaways.
- Solid waste shall be recycled where facilities exist.
- Where solid waste cannot be recycled, it shall be sent to an approved landfill site.
- Fire shall not be used as a means of disposing of waste.

Agrichemical Use

- Each cropping system shall be integrated within Lao Gap certification Systems
- Where required PRT provided by the crop protection centre staff of PAFO
- Where warranted IPM training programs provided by PAFO

Society

- The National Environmental Standard (2017) for noise and vibrations shall apply in every case.
- There shall be no night-time working (i.e. between sunset and sunrise) within 500 metres

of habitation.

Construction Site Safety

- All construction sites shall be delineated with barrier tape and non-project personnel excluded at all times.
- All staff and workers shall wear appropriate personal protective equipment (PPE) at all times that they are on a work site.
- The minimum for all personnel is: reflective vest; safety helmet; and safety boots.
- Other PPE such as gloves, eye protection, ear protection, etc. shall be used according to the work performed or underway nearby in the site.