

# Environmental and Social Monitoring Report

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January–June 2021  
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## Lao PDR: GMS Nam Theun 2 Hydroelectric Project

Prepared by Nam Theun 2 Power Company Limited for the Asian Development Bank.

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# NAM THEUN 2 POWER COMPANY LTD

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### Related Documents

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### Subsidiary Documents

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## ACRONYMS

ADB	Asian Development Bank
AE Lab	Aquatic Environment Laboratory
AIP	Annual Implementation Plan
AMLs	Artificial Mineral Licks
ASPT	Average Score per Taxon
BH	Borehole
BMWP	Thai Biological Monitoring Working Party (Mustow, 2002)
CA	Concession Agreement
CEMMP	Company's Environmental Monitoring and Management Plan
Chl a	Chlorophyll a
CIH	Hydro- Engineering Center of EDF
COD	Commercial Operations Date
CRM	Certified Reference Material
CSR	Corporate Social Responsibility
DAFO	District Agriculture and Forestry Office
DEB	Department of Energy Business (Ministry of Energy & Mines)
DOI	Lao Department of Irrigation Analytical Chemistry Laboratory
DONRE	District Of Natural Resources and Environment
E&S	Environmental and Social
EAMP	Environmental Assessment and Management Plan
EDF	Electricité de France
EDFI	Electricité de France International
EGAT	Electricity Generating Authority of Thailand
EGCO	Electricity Generating Public Company Limited
ESMP	Environmental and Social Management Plan
GHG	Greenhouse Gas
GoL	Government of Lao PDR
GPS	Global Positioning System
HH	Household
HEC	Human Elephant Conflict
HSE	Health Safety and Environment
IUCN	International Union for Conservation of Nature
J value	Equitability Indices which dependence on the Species Count
LTA	Lenders Technical Advisor
MONRE	Ministry Of Natural Resources and Environment
NBCA	National Biodiversity Conservation Area
NGO	Non-Government Organisation
NNT-NP	Nakai Nam Theun National Park
NPA	National Protected Area
NPLAF	Nakai Plateau Livestock, Agriculture and Fishery
NRO	Nakai Resettlement Office (formerly known as Resettlement Monitoring Office)
NT2	Nam Theun 2 Project
NTPC	Nam Theun 2 Power Company Limited
PAFO	Provincial Agriculture and Forestry Office
POE	Panel of Experts
PONRE	Province Of Natural Resources and Environment
RC	Resettlement Committee
SERF	Social and Environment Remediation Fund
RFA	Reservoir Fisheries Association
RIP	Resettlement Implementation Period
RMU	Resettlement Management Unit
RNT	Residence Nam Theun
SGS	Société Générale de Surveillance
UAE	United Analyst and Engineering Consultant Co., Ltd.

UXO Unexploded Ordnance  
VFG Village Fisheries Group  
VTE NTPC - Vientiane Office  
WB World Bank  
WCS Wildlife Conservation Society  
WGH Wooden guesthouse  
WMPA Watershed Management & Protection Authority  
WMPP Wildlife Management and Protection Program  
WQB Water Quality and Biodiversity Department  
WQMAP Water Quality Monitoring and Assessment Program  
XBF Xe Bangfai.

## GENERAL INTRODUCTION

NTPC is subject to environment monitoring obligations under the CA until the end of the CA Period.

The Environmental and Social bi - annual progress report follows the AIP 2021 Ver.1 NTPC-S-B1002-0017.

Since the obligation on reporting on social activities has ended with the closing of the Resettlement Implementation Period last July 2018, the current report only focuses on environment activities.



## ENVIRONMENTAL ACTIVITIES

### 1. INTRODUCTION-KEY MILESTONES

There are key milestones of Environment Program during January to June 2021, referring to the key tasks of AIP 2021, as follow:

- **Water quality monitoring**

- (i) Monitor and understand the evolution of the whole NT2 hydro system in relation to Project operations, as required by the Concession Agreement;
- (ii) Provide data for predictive models of the reservoir's water quality and GHG emissions. This model developed by EDF-CIH will help in assessing scenarios of water quality evolution in the medium-term period (30 years). Greenhouse Gases are also taken into consideration in this model in order to refine the estimation of the carbon footprint of the hydropower plant within its entire concession period.

- **Hydrobiology monitoring**

- (i) As part of the concession agreement and the 4<sup>th</sup> Service Agreement of NTPC-EDF (May 2017 to April 2023), the hydrobiology monitoring includes the routine monitoring of main aquatic groups e.g. Chlorophyll a (as production indicator in the Reservoir), aquatic invertebrates in the rivers upstream and downstream of the reservoir.
- (ii) To continue of Fish Population Monitoring in the rivers and reservoir with a total of 15 sampling stations in order to monitor the fish biomass in the project area.

Additional activities will lead to support the end of research programs by providing assistance of data analysis and interpretation.

- **Biodiversity Program**

- (i) Follow up the Nakai Elephant Program with Nakai DAFO.
- (ii) Education and outreach on HEC: provide the necessary support and follow up the effectiveness of HEC mitigation and awareness activities by the HEC outreach team from Nakai DAFO.
- (iii) Chinese Swamp Cypress germination program: (i) Environment team plan to continue the joining with the experts from IUCN Conifer Redlist Authority to collect Swamp Cypress seed; (ii) organise germination, (iii) plant seedlings in the NPA.
- (iv) Continue invasive species monitoring and control; and
- (v) Mineral lick replenishment: as advised by an Elephant Specialist (WCS), one replenishment has been organised in 2020 before the wet season.

- **Environment Compliance Program**

- (i) To undertake periodic inspection of all activities by NTPC or its contractors to ensure the compliance with CEMMP.

- (ii) Organize and manage the waste disposal in appropriate methodologies for the wastes stored in NTPC Landfill (hazardous wastes, laboratory wastes, recyclable wastes, used fluorescents, electronic wastes).
- (iii) Regularly organize the landfill observation borewells water quality monitoring for NTPC landfill by using the appropriate methodologies and suitable frequency to ensure that potential of contamination leached from waste cells and/or its leachate ponds are captured and corrective action to avoid further contamination into the local groundwater system will be taken properly.
- (iv) Continue to follow up with NTPC-Site management on taking a proper action for wastewater treatment modification and its maintenance to ensure that the effluent water discharged from NTPC facilities are under the GoL effluent standard guidelines and no environmental impact to the local discharged areas.
- (v) Progress work of the Nakai Landfill construction project and its associated activities; and
- (vi) Continue to support and promote the environmental awareness program in both districts (Gnommalath and Nakai).

## **2. ORGANIZATION AND RESPONSIBILITIES**

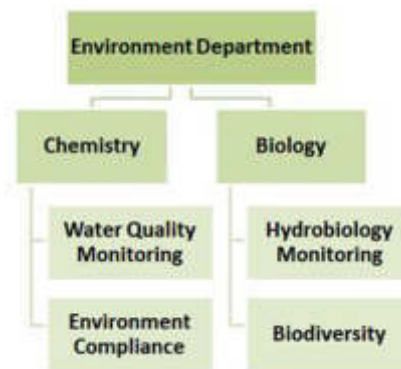
### **2.1 Historical background**

The Environment Management Office was divided into two separate departments in 2010. The role of ensuring compliance with NTPC's environmental commitments was transferred to the Health, Safety and Environment Department and is under NTPC's Integrated Management System Division. In June 2015 this unit has been renamed Risk & Strategy Unit, along with this organisational change, all tasks related to biodiversity monitoring and management; water quality monitoring and analysis (chemistry, hydrobiology); and erosion monitoring have been maintained within E&S Division's Water Quality and Biodiversity Department. Since January 2016, the Environment Compliance team under the Risk & Strategy Unit was transferred to Water Quality and Biodiversity Department and the name of department has been changed to Environment Department since August 2016. Since October 2018, as the social activities were completed, the E&S unit was split into 2 parts: Environment Department is integrated in Technical Branch and Social team is re-named to CSR Department which is merged with CSR, GoL affairs and Communication Unit.

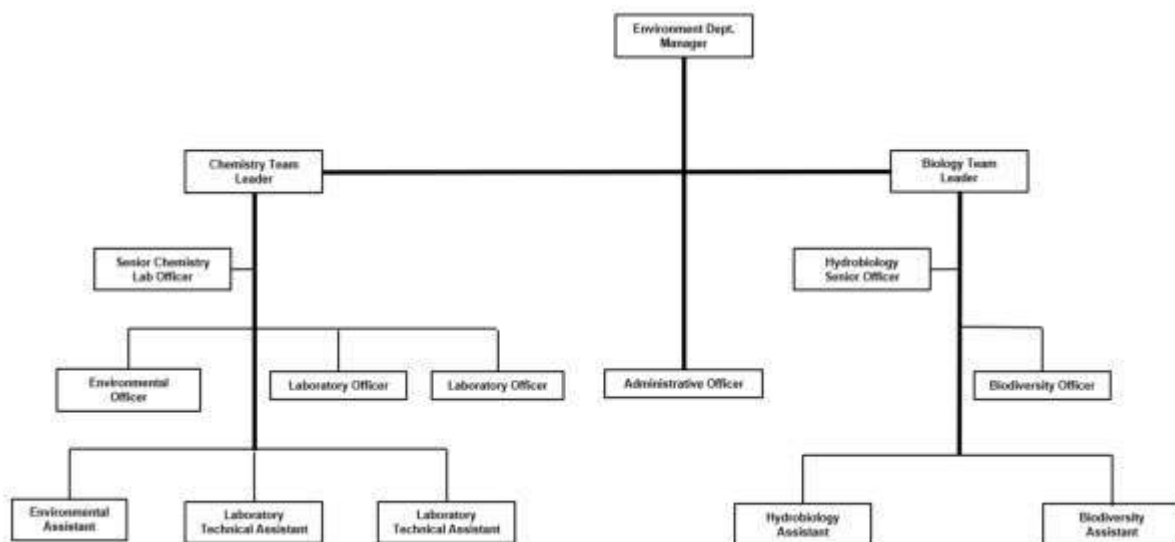
The Forth Service Agreement between EDF and NTPC to support the Laboratory started in May 2017 and will last till April 2023.

### **2.2 Current organization and responsibilities**

The department is organized as below:



**Figure 1 – Environment Department Organization**



**Figure 2 – Detailed Organization Chart of the Environment Department**

The Environment Department is in charge of design, implementation and monitoring of activities and achievement of objectives of Environmental (including all water quality and biodiversity) contractual obligations of NTPC during the Operational Phase.

The Aquatic Environment Laboratory (AE Lab), within the Environment Department to monitors water quality, hydrobiology and greenhouse gas emissions in the reservoir, upstream and downstream areas under funding agreement between NTPC and EDF starting from April 2011 for 3 years period and is extended to April 2017. Another 6 years (May 2017 to April 2023) of funding agreement with a lightened scope of monitoring is accepted by EDF. The team also conducts the riverbank erosion monitoring along the Xe Bangfai. Furthermore, a fish catch monitoring in the Nakai Reservoir will end when the RIP will be closed (end of CA obligations). However, a handing over to the Nakai district was realized to ensure their capacity to perform the monitoring upon the needs and important information and document were shared with the NPLAF team.

The environment compliance team monitors, inspects and manages all environmental internal issues and supports the solid waste management in the 2 local districts (Gnommalath and Nakai). The mission ensures that there is no negative impact by the

project to the local environment in a short term and on a long run. The corrective and preventive actions are taken for any environment incident and follow up by the team.

The elephant program, the invasive species program and swamp cypress program are under the biodiversity section of the Environment Department.

### 3. ENVIRONMENT PROGRAMS STATUS AS PER JUNE 2021

#### 3.1 The Aquatic Environment Laboratory (AE Lab)

After twelve years of operation of NT2 Aquatic Environment Laboratory (AE Lab), the *Service Agreement* between NTPC and EDF for water quality will end as of April 30, 2023. Since 2008 four contracts were signed with EDF-CIH.

**The AE Lab was set up in order to develop two kinds of in-house capacities:**

- Perform the analysis of most water quality parameters to be monitored by NTPC to fulfil its obligations under the **Concession Agreement** (only analysis such as oil and grease are still being sent for analysis to UAE, a Thai laboratory based in Bangkok).
- Support various **research programs**: Greenhouse Gas (GHG) emissions measurements and related studies, Dynamic of Mercury content in fish flesh, Fish stock assessment in the reservoir, and Effects of a reservoir on fish composition using a tropic approach.

**The main outputs for the AEL are the following:**

- Maintained the quality of Laboratory and staff performance by continuing to conduct the internal QA/QC for laboratory by performing the tests of method blank analysis, blind samples analysis and Quality Control Standards by CRM.
- The proficiency testing (PT) program for the external QA/QC could not be applied to participate with the accredited provider in USA due to the new Import regulation of Lao PDR by Air Freight against the amount of Chemical product.
- Support of the Scientific research:
  - Greenhouse gas (GHG) emission monitoring: the monitoring continues in routinely basis but the sampling sites, as well as frequencies are decreased according to the 4<sup>th</sup> Service Agreement of NTPC and EDF-CIH. The monitoring result is on progress of review by the researchers (Toulouse University, IRD etc.).

As of June 2021, **28 scientific articles** relating to Nam Theun 2 Project have been published in peer reviewed journals and are accessible online (**Annex 1**).

#### 3.2 Water quality monitoring

##### 3.2.1 Obligations

References related to CA Obligations - Volume 2A, Schedule 4, Part 2, Subject 9: 1 to 4.

The Concession Agreement (Volume 2A, Schedule 4, Part 2) details the obligations of NTPC in regard to water quality monitoring during the whole Concession Period. In the CA, it is specified that NTPC has to provide a detailed program to cover the three different phases to check that the Project meets environmental standards (i) prior to inundation, (ii) during the reservoir impounding throughout the construction period and (iii) during operation. A Water Quality monitoring program has to ensure an accurate assessment of water quality and

biological parameters relating to the Project (rivers, domestic water supply, groundwater in the Project Land, effluent discharge, livestock drinking and irrigation water). Monitoring of variations and trends exceeding specified trigger levels are as well clearly specified. The water quality monitoring program has to be regularly reviewed and evaluated to assess its effectiveness.

Reference related to the 4<sup>th</sup> Service Agreement between NTPC and EDF (period of May 2017 to April 2023). The maps of the monitoring stations for the 4<sup>th</sup> Service Agreement are presented in **Annex 2, Annex 3, Annex 4 and Annex 5**.

### 3.2.2 Main outputs until June 2021

#### ***Reservoir and Downstream Water Quality***

##### ***Reservoir***

- NT2 reservoir still showed clear thermal stratification cycles following natural seasons (December to January: mixing stage, March to July: stable stratification, and August to October: weak stratification due to the disturbance of water current from the rainy runoff). Influence of stratification sequences remains the key driving factor for reservoir chemistry: (i) maximum of nutrients/gas release was recorded at the end of the stratified period, (ii) nutrients/dissolved gas decrease from annual flooded and reached minimum consecutive to the mixing event.
- High value of Dissolved oxygen (>5mg/L) at the surface water were always observed in all stations except at RES03, RES04 and RES09 in June where the DO was slightly low (4.4 mg/L, 4.9 mg/L and 4.6 mg/L respectively).
- DO at the bottom level tends to increase during mixing period around 7mg/L at Thalang (RES04) and around 8mg/L at Intake (RES09). When the stratification appeared, the anoxic condition was observed at RES04 at various layers (5 to 16 m) from March to June. The summary of Water Quality in the Reservoir January to June 2021 are respectively presented in **Annex 6**.

##### ***Rivers***

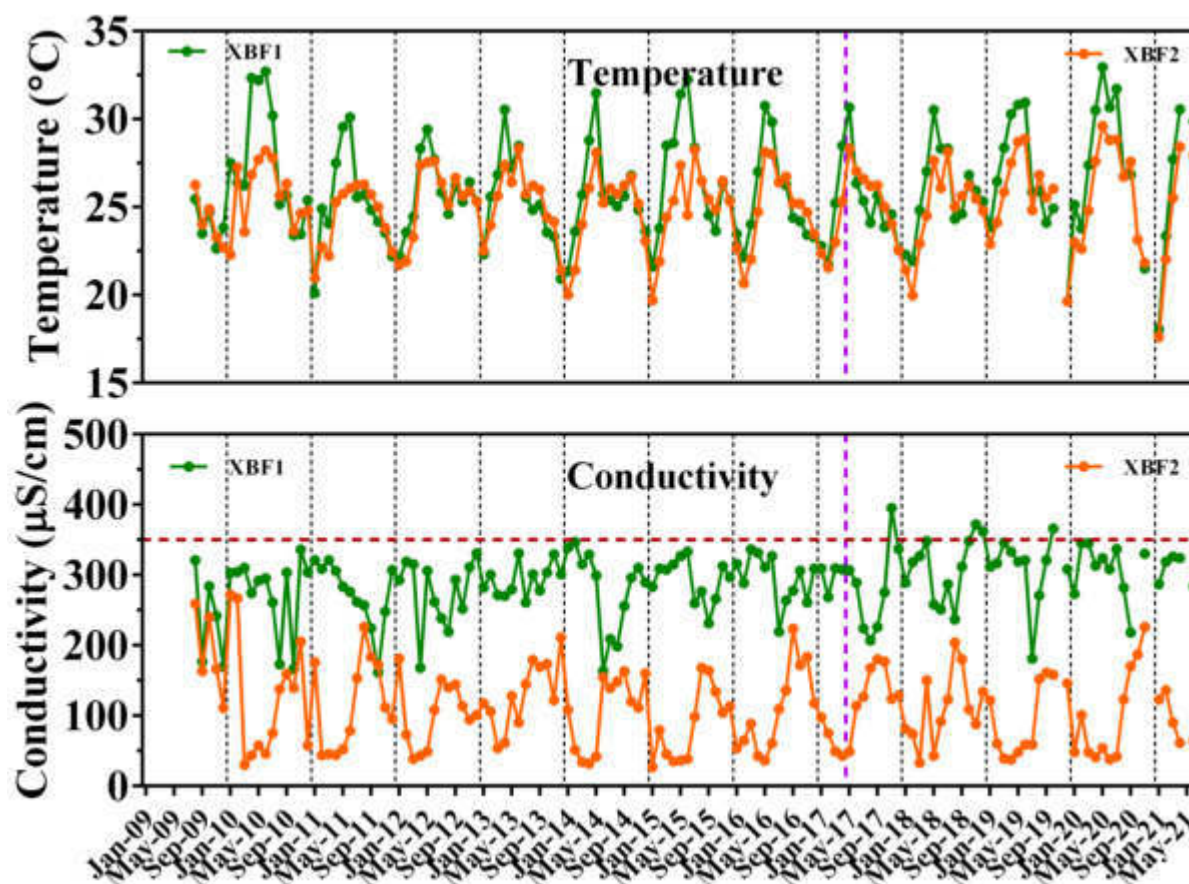
Key WQ results related to Project releases during the January to June 2021:

- **Dissolved Oxygen (DO)** remained above the surface water guideline for Nam Theun, and Xe Bangfai Rivers throughout the 6 months. The DO in Nam Kathang downstream of Regulating Dam was slightly lower than the guideline in June (4.38 mg/L).
- **Biological Oxygen Demand (BOD)** slightly exceeded the guideline in June in Nam Kathang Downstream of Regulation Dam.
- **Chemical Oxygen Demand (COD)** slightly exceeded the guideline for few months in Xe Bangfai downstream of the Downstream Channel (DSC) confluence, in Nam Kathang downstream of the Regulating Dam and in Nam Theun downstream of Nakai Dam (If the uncertainty of measurement is considered on the reported results, values may remain under the guideline or slightly exceed the guideline\*).

\*Water quality standard guideline of surface water, Decision on National Environmental Quality Standard, Prime Minister's Office, No.81/PMO. 2 Feb 2017, MoNRE, Vientiane Capital.



The water discharged to Xe Bangfai still show seasonal effects on temperature and conductivity parameters due to the cooler water and low conductivity of water from the reservoir.



**Figure 3 – Measurement of Temperature and Conductivity in Xe Bangfai river**

#### **Greenhouse Gas (GHG) Monitoring**

GHG emission monitoring continue in routinely basis in reservoir, tributaries, downstream rivers and civil work area, the monitoring frequency is set as same as Reservoir and Downstream Water Quality Monitoring. As per the research on lifecycle net GHG emission from reservoir by Barros et al. (2011), it is considered that emission stabilize after 20 years (GHG emission rate decreased by 9% per year).

The recent information on the emission for 11 years (2009 to 2019), has been assessed by EDF-CIH (used 3 scenarios):

- (i) Same decrease as that observed between 2009 and 2019 (power law), Model 2009-2019.
- (ii) 9 % decrease every year and stable after 20 years (like in Petit Saut reservoir), the scenario provided by Toulouse University in 2014 for their first long-term assessment; and
- (iii) 7% decrease every year and stable after 15 years.

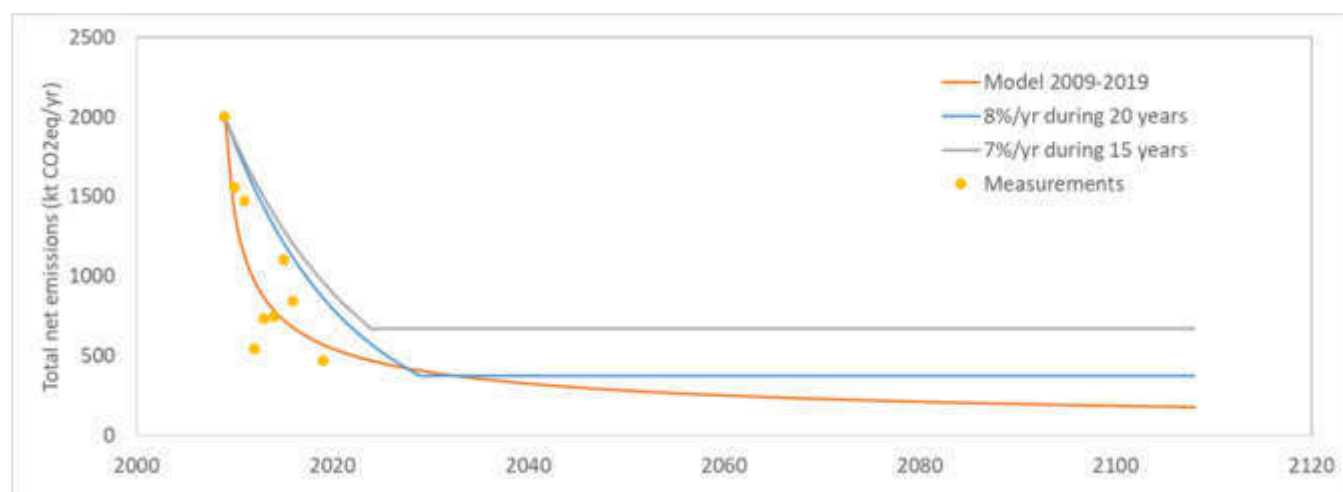


Figure 4– Extrapolation to estimate the GHG emission over 100 years

Scenarios		Gas considered	Details	Emissions 100 yr (MtCO2eq)	gCO2eq/kWh
1	Model 2009-2019	CH4, CO2, N2O	Net emission: post-pre impoundment	35	58
2	9% decrease / 20 yr	CH4, CO2, N2O	Net emission: post-pre impoundment	50	83
3	7% decrease / 20 yr	CH4, CO2, N2O	Net emission: post-pre impoundment	76	127

The result shows that emission trend is “between” scenarios 1 and 2. So, based only on measurements, it would imply that long-term emissions are between **60 and 80 gCO2eq/kWh**. However, to confirm the emission trend, the data between 2020 and 2022 are needed to improve the assessment.

#### ***Village Water Supply and Water Quality***

New round of borehole(BH) monitoring started in 2018, up to June 2021, 489 of 827 BH ( or 59%) of total in-use BH installed by NTPC are monitored. Monitoring results of groundwater for Village Water Supply in first semester of 2021 are:

- i) Q1\_2021: 85 BH (including 16 fixed BH, see **Annex 7**) were monitored, 30 BH in Nakai Resettlement area and 55 BH in Downstream Program area.
- ii) Q2\_2021: due to COVID-19 outbreak in April and May, most of BH samplings were cancelled , so only 49 BH (including 9 fixed BH, see **Annex 7**) were monitored by end of June and early July, included 26 BH in Nakai Resettlement area and 23 BH in Downstream Programme.

Monitoring period	Exceedances
Q1_2021	<ul style="list-style-type: none"> <li>- <b>Total Hardness</b> exceedance at 3 BH at Xe Bangfai district</li> <li>- <b>pH, conductivity and turbidity</b>: 20 BH showed results exceeding guidelines at least one of these parameters</li> <li>- <b>Faecal Coliform Bacteria</b>: exceedance at 45 BH (19 BH in Nakai district, 11 BH in Mahaxay district, 13 in Gnommalath district, 1 BH in Nongbok district and 1 BH in Xaybouly district)</li> </ul>
Q2_2021	<ul style="list-style-type: none"> <li>- <b>pH, conductivity and turbidity</b>: 7 BH showed results exceeding guidelines at least one of these parameters</li> <li>- <b>Faecal Coliform Bacteria</b>: exceedance at 36 BH (20 BH in Nakai district, 3 BH in Mahaxay district, 13 in Gnommalath district).</li> </ul>

### **Laboratory QA/QC for Water Quality Testing**

The AE Lab continued to conduct the QA/QC plan for both internal and external. From January to June 2021, AE Lab staff participated to the blind samples' analysis for Total Suspended Solid (TSS) parameter. All testing results were in the acceptance range.

## **3.3 Hydrobiology monitoring**

### **3.3.1 Obligations**

As per CA obligations and the 4<sup>th</sup> Service Agreement between NTPC and EDF, the monitoring is conducting for biological production parameters in reservoir ([Chl a] and fish) and rivers (aquatic invertebrate and fish).

### **3.3.2 Main outputs until June 2021**

Routine monitoring conducted according to the CA and in the framework of the 4<sup>th</sup> Service, hydrobiology programme realized in first semester of 2021 as following:

- (i) Routine monitoring for main Aquatic Group ([Chl a] in reservoir);
- (ii) Field sampling for Aquatic Invertebrate monitoring for 2021 in March and April; and
- (iii) Fish Population Monitoring was conducted for end of Warm-Dry (WD) season.

### **Fish Population Monitoring**

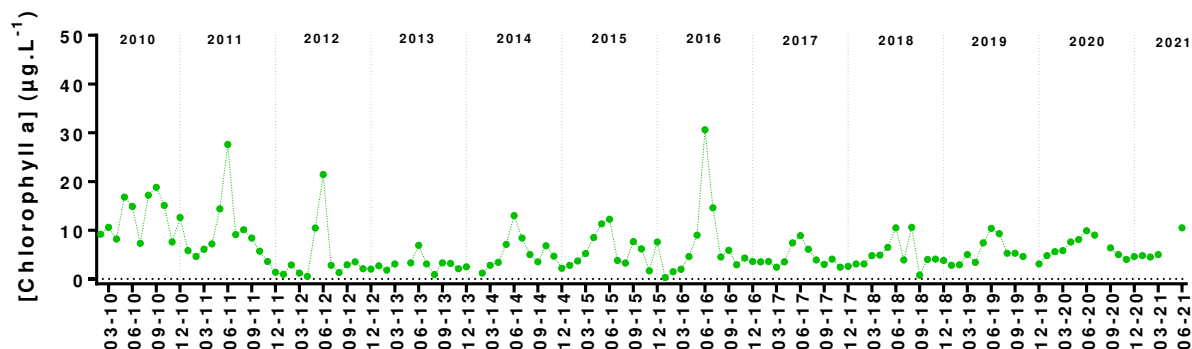
The monitoring schedule was delayed until June 2022, all samples are under the analysis and the result will be summarized in annual progress report.

### **Chlorophyll a [Chl a]**

*Chlorophyll a* concentration showed the same pattern since 2011 (**Figure 4**). After a higher production in 2010 (trophic upsurge), concentration decreased to reach a stable level in 2011. Concentration showed an annual production peak observed at the end of Warm-Dry (June) and second weaker peak in end of the Warm-Wet (October). In general, the low concentration of [Chl a] underlined the oligo-mesotrophic level of NT2 reservoir. In 2018, a high peak observed in August and this was observed at RES08 (**Annex 8**) and this could be linked to the higher amount of total Phosphorus ( $0.041\text{mgL}^{-1}$ ) which was the main factor to increase of [Chl a] concentration (**Annex 9**). There are no data for April and May 2021 due to the lockdown (second time of COVID-19 outbreak in Laos), all activities were cancelled. Furthermore, the water level in reservoir was very low in June, no [Chl a] sampling in



RES08, and the water collection at RES06 was done instead. The peak of [Chl a] concentration in June 2021 reached the same level observed in the previous year and this can confirm the annual cycle of [Chl a] in NT2 ( increase from January to reach the peak in June).



**Figure 5 – Monthly average (of all stations) of [Chlo a] ( $\mu\text{g.L}^{-1}$ ) in NT2 reservoir from 2010 to mid of 2021**

### **Aquatic Macroinvertebrate Monitoring**

Pictures and maps of the monitoring stations in **Annex 10**.

#### ***Nam Theun Area***

The main substrate of NTH1 (the station in the upstream of reservoir) is composed by sand and pebbles while the substrate of NTH6 (downstream of Nakai Dam) is composed by bed rock and big rocks. Both areas have the similar range of water velocity (5 – 150 cm/s).

#### ***Nam Kathang/Gnom Area***

To strengthen data to support the Nam Kathang release, NKT4 the station located just below the Regulating Dam was added to the monitoring. The sampling sites in this area were composed by various substrate. The substrates were mainly composed by mineral sediment of medium to large size. Bed rock, big rocks, sand, and silt were found for some area. Generally, water velocity for the area was ranged between 0 – 150 cm/s.

#### ***Xe Bangfai Area***

It is large area of the river and composed by various habitat. The substrate of sampling sites was mainly composed by sand, silts, and mineral sediments of medium to large size of 2.5 – 25 mm. The station in the upstream of the Xe Bangfai and NT2 downstream channel confluence is surrounded by bushes. The water velocity of sampling area was mainly ranged between 5 – 150 cm/s and at the river body, the water velocity can be higher 150 cm/s.

## **3.4 Biodiversity Program**

### **3.4.1 Obligations**

References related to CA Obligations - Volume 2A, Schedule 4, Part 2, Subject 9: 4, 9, 12, 14, 15, 16, 18, 19, 20.

### **3.4.2 Main outputs until June 2021**

#### **Elephant Program**

##### ***Human Elephant Conflict (HEC) Monitoring and Mitigation***

89 HEC incidents occurred during the first semester of 2021. 10 incidents were related to Thalang Group and 79 incidents were related to the Group of Three. 27 incidents were crop damages; 25 incidents were property damages, and 36 incidents occurred with crop and

property damages. A lethal incident occurred on 12<sup>th</sup> April 2021, a 59-year-old man from Ban Sob Bor, Bualapha District was found dead in the forest approximately 1 km on the West of the village. The investigation by concerning authorities figured out that he was attacked by elephants which related to the Group of Three elephants.

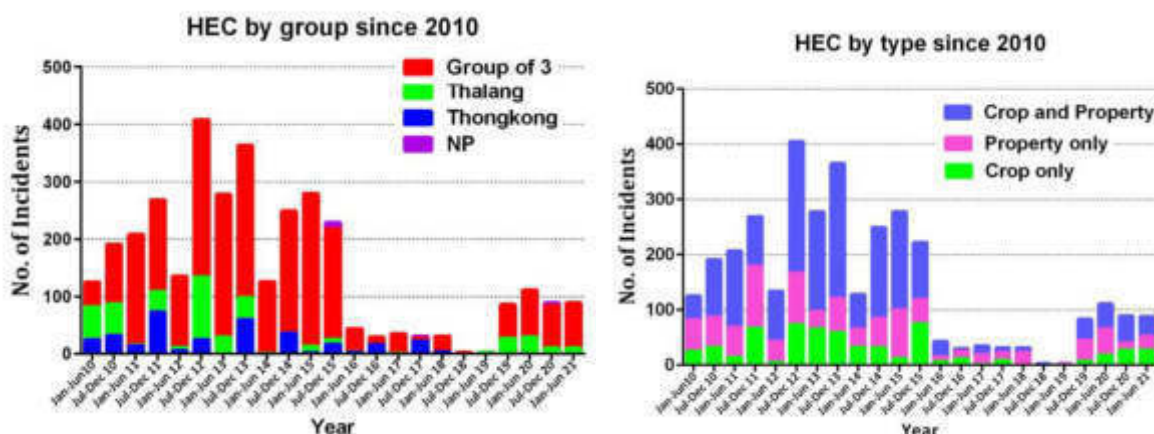


Figure 6 – HEC incidents by group and type since 2010 to June 2021

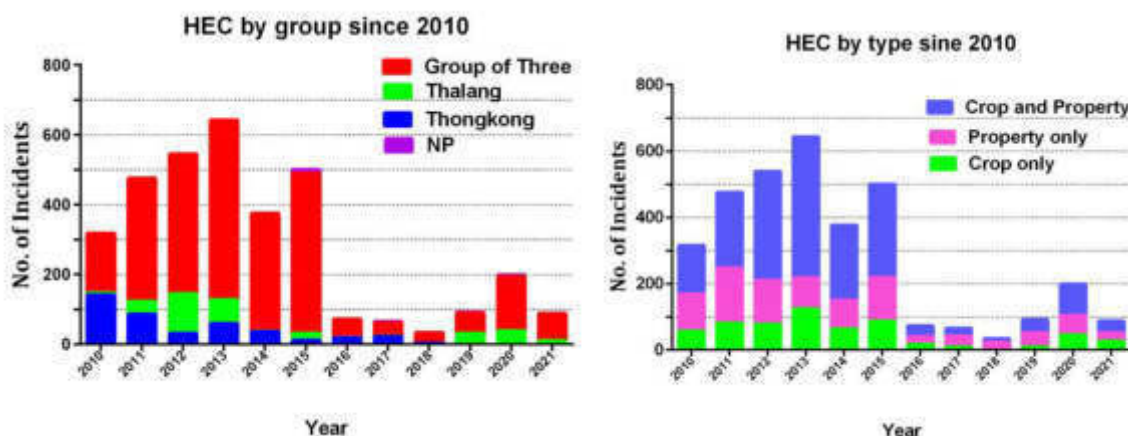


Figure 7 – yearly accumulate of HEC incidents

### Artificial Mineral Lick Replenishment (AMLs) and its monitoring

Artificial Mineral Licks replenishment for Dry season 2021 was conducted in February. The total mineral refilled was 2,045 kg included: 1,100 kg of Sodium chloride; 625 kg of Monosodium phosphate; 220 kg of Calcium carbonate and 100 kg of Potassium chloride. Detail of mineral refilled in each AML sites (**Annex 11**).

The monitoring of wildlife visitation at the AMLs has been conducted as schedule for both methods (observation and camera trap monitoring). The evidence showed elephants and

wild ungulate using all AML sites in 3 zones. Cattle found using AML sites in zone II and III. Human acts evidence found in all AML sites (**Annex 12**).

### **Invasive species survey and destruction**

*Mimosa pigra* spreads in everywhere in Nakai resettlement area especially along the shore of the reservoir. The survey and destruction were conducted for 2 rounds in the first bi-annual (March and June) 2021 and the activities were focused in Nakai resettlement area and NTPC's industrial area only. There were approximately 150,000 mature trees and countless seedlings were found and destroyed.

### **Chinese Swamp Cypress (*Glyptostrobus pensilis*) conservation program**

The monitoring for saplings planted in 2019, there is only 1 sapling is survived. Six saplings planted in May 2020; all the trees are death. Through the seed's germination was conducted in late November 2020, there were 794 seeds germinated from the approximately to 37,000 of collected seeds. 702 seedlings were transplanted to tree pots. In May 2021, 120 seedlings were planted in the reserved area in Oudomsouk village (Nakai).

## **3.5 Environment Compliance Program**

### **3.5.1 Obligations**

References related to CA Obligations - Volume 2A, Schedule 4, Part 2, Subject 9: 35, 39 and Volume 2A, Schedule 4, Part 1, 15.1(b): (i), 2.2.

### **3.5.2 Main outputs until June 2021**

#### ***NTPC Waste management facility***

A sub-contractor (PKC Co., Ltd) is performed the management of the NTPC landfill since 2018, the wastes coming from all NTPC premises to the site are well separated as per classification (general waste, composite waste, recyclable waste and hazardous waste). The recyclable wastes are sold to the local traders. The food wastes are used for producing of fertilizer (Effective Micro-organism (EM)). The hazardous wastes are well stored in the close building where the access is restricted, and the general wastes go into the waste cell. As of June 2021, about 50% of in-use waste cell was filled (waste cell No. 7). The evaporation process has been selected to reduce the quantity of the liquid waste (Acid/Base waste), the disposal process has started in February 2020 and as of June 2021, about 80L of Base and 700L of Acid wastes were disposed. The solid particulates after the evaporation were collected and stored in the Hazardous waste storage.

#### ***Landfill observation borewell***

Groundwater quality monitoring in the 9 monitoring wells around the NTPC landfill is performed on monthly basis (5 of the existing ones and 4 of the new installation). Guideline exceedances in some parameters (pH, BOD, COD and Lead) can be observed sometime. In 2021, due to COVID-19 outbreak, the samples of January to June could not be sent to UAE Thailand for analysis because the border has closed. The **Annex 14** shows monitoring results during the 1<sup>st</sup> semester of 2021.

### ***NTPC Wastewater Treatment Management (Black and Grey Wastewater)***

Up to date, effluent from all 5 wastewater treatment plants (3 Black wastewater treatments at RNT and Powerhouse and 2 Grey wastewater treatments at Wooden Guesthouse and Nongboua) are routinely monitored in monthly basis. The effluent guideline exceedances have been observed sometime in some parameters (BOD, COD, TSS, Ammonia-Nitrogen, and Faecal Coliform Bacteria) (**Annex 15** and **Annex 16**).

- ***Environment site inspections and monitoring***

As part of Environment Department, the Environmental Compliance team continues to fulfil its role of undertaking the audits, inspections, and monitoring of all facilities to ensure compliance with NTPC environmental guidelines and Lao PDR law.

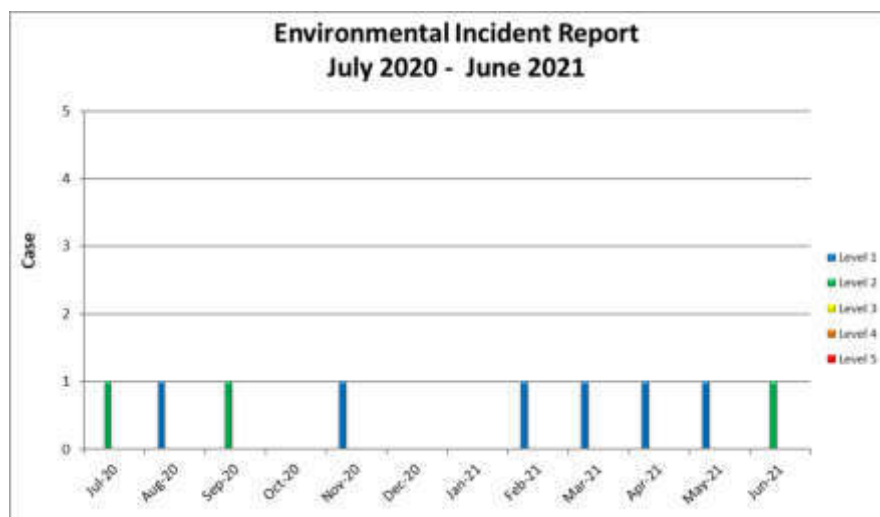
Total of 64 environmental inspections at all NTPC sites were conducted from January to June 2021. The numbers of environmental inspections for special missions from January to June 2021 were 15 missions (**Annex 17**).

- ***Environment incident management***

There are 2 Environmental incidents were reported during January to June 2021 as shown in

**Figure 6** by level classifying:

- Level 1 – Minor Environmental Pollution
- Level 2 – Significant Environmental Pollution
- Level 3 – Serious Environmental Pollution
- Level 4 – Major Environmental Pollution
- Level 5 – Catastrophic Environmental Pollution



**Figure 8 - Environment Incident Reports during July 2020 to June 2021**

Corrective and preventive actions for the reported environment incidents are clarified in **Annex 18**.

- ***Environment awareness programs***

**Awareness training**

The environmental training was conducted for both NTPC staff and contractor from January - June 2021 (**Annex 19**).

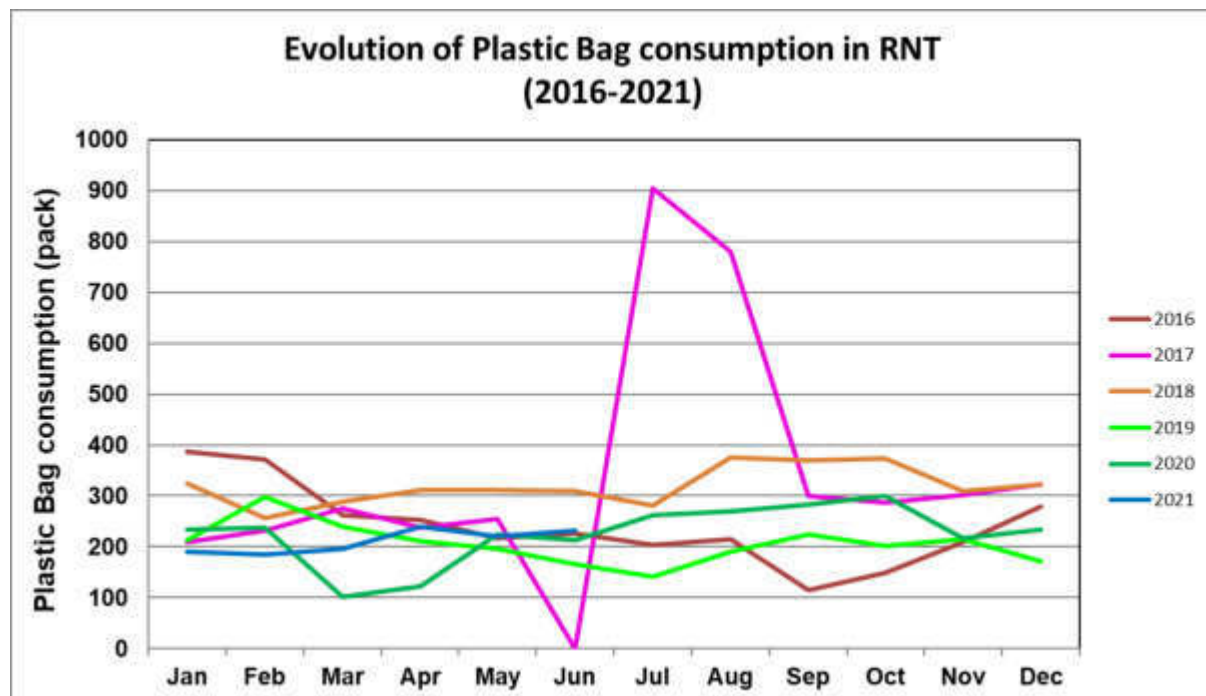
- NTPC Staff, Consultant and Fresh Graduates: 74 persons for induction training.
- NTPC's Contractor: 518 persons for induction training.

The training assessment was performed via quiz, question, game, and real practice on waste management with good participation from participants.

### Environment awareness program - Plastic bag usage reduction

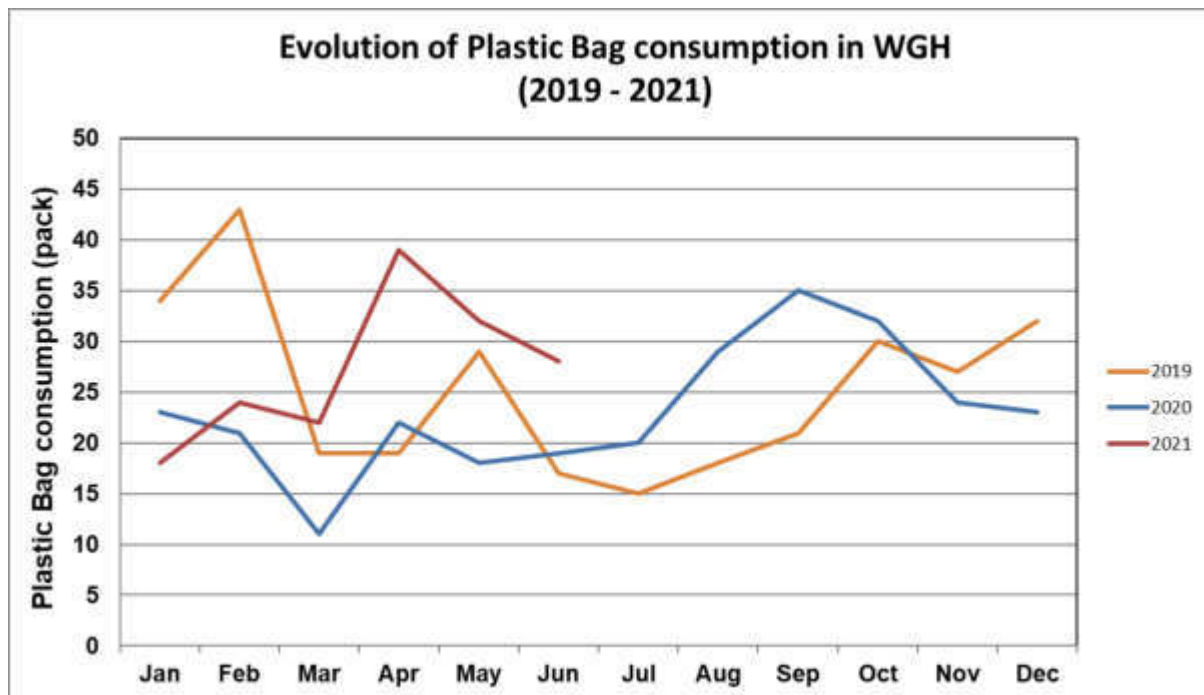
Since 2013, the program has included into a yearly implementation of Health, Safety and Environmental Improvement Programs(HSEIP). In 2021, the yearly reduction percentage of was set at 5% (this number is based on the limitation of reduction, the plastic bag are needed in some case such as waste collection and waste delivery). From January to June 2021, the consumption increased by 14.5% compared to January – June 2020, the increase trend is associated to the food delivery for staff perform of self-isolated (quarantine) at RNT and WGH during the pandemic of COVID-19. Below are the current situation of the program:

- **RNT:** The total consumption is increased compared to the previous year (1,262 packs in January to June 2021 and 1,130 packs in January to June 2020). The trend of changes are shown in **Figure 7**.



**Figure 9 – Monthly Plastic Bag consumption in RNT (2016-2021)**

- **WGH:** the total consumption in Wooden guesthouse was increased as well (163 packs in January to June 2021 and 114 packs in January to June 2020, **Figure 8**)



**Figure 10 - Monthly Plastic Bag consumption in WGH (2019-2021)**

The increasing trend at both residences was observed since April where there was a food delivery service by NEWREST to provide meals for staff under self-quarantine as per the COVID-19 prevention rule.

#### **Environment awareness program - Paper usage reduction**

This program was launched since 2017 to record the paper consumption from all offices. In 2021, the target of paper usage reduction is set at 5% compared to year 2020. Based on the data collected, the paper usage depends on the needs of users and only the A4 type was used regularly and easy make comparison each period. The graph below showed the evolution of A4 consumption, the most common paper type regularly used. A Total of 33.4% of A4 paper reduction was achieved during the 1<sup>st</sup> semester 2021 (the trends for each offices -VTE, RNT and Powerhouse) illustrated in **Figure 9**).



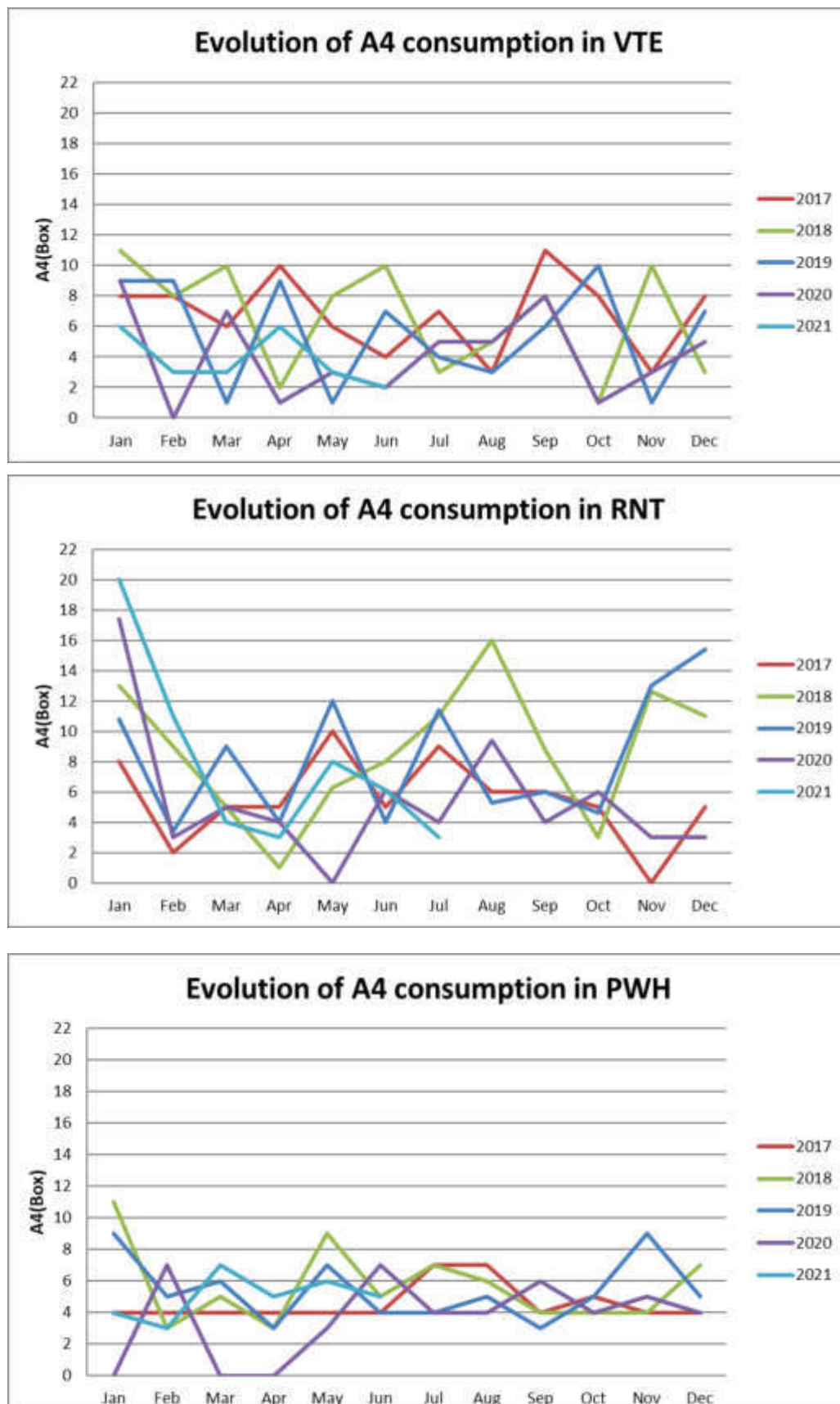


Figure 11 – The evolution of A4 paper usage at 3 offices

- **Supporting of Gnommalath District Solid Waste Management**

To increase the efficiency of the waste segregation and secure the area, a guard was hired by Gnommalath DoNRE to work at the landfill with financial support of NTPC until December 2021. He has also segregated the waste and to guide other people who come to dump their waste at landfill. Furthermore, NTPC financially supported GML DoNRE to organize the 2021 World Environment Day celebration in June by conducting the waste collection with villagers and tree plantation.

Regarding the implementation of district waste management study by GRET, due to COVID – 19 outbreaks, the work was delayed and expected to be started as soon as the situation is back to normal state. This project will also undertake the same study in Nakai district.

- **Supporting of Nakai District Solid Waste Management**

Referred to Company ambitions “For our Communities and Environment”, NTPC has decided to participate in regular education programs regarding waste management plans and service in Nakai Resettlement villages to development initiative with the district.

In 2021, NTPC provided equipment and PPEs to Nakai DoNRE, using in the waste collection service by the contractor.

### **3.6 Erosion Monitoring Program**

#### **3.6.1 Obligations**

References related NTPC Obligations - Volume 2A, Schedule 4, Part 2, clause 9, Item 11 (e)).

#### **3.6.2 Main outputs until June 2021**

Photograph survey is still being conducted, as part of on-going erosion monitoring in the Xe Bangfai (including Total Suspended Solids measurements and Cross Section Survey). This survey also gathers data on erosions in sensitive areas (i.e. temples, school).

**The latest Xe Bangfai riverbank survey** (the 28<sup>th</sup> mission) was conducted by the Environment team on 8<sup>th</sup> – 9<sup>th</sup> June 2020 (Detail of observation are in the previous Annual report *NTPC-S-J0160103-0027 Ver.1*). In 2021, the mission before wet season was cancelled due to the COVID-19 pandemic.

### **3.7 Implementation of the Environmental Management System**

#### **3.7.1 Obligations**

Referred to the HSE Legal and Other - Requirements Register (Ref: NTPC M B150302) in the Company’s Environmental Management and Monitoring Plan (CEMMP – **Annex 21**).



### 3.7.2 Main outputs until June 2021

In 28 March 2014, NTPC has been certified on Environmental Management System (ISO 14001) by SGS (Thailand) as Certifying Body under UKAS. To maintain and continue improvement of Environment Management System, the internal audit was performed in March 2021 by Risk Management Unit (RMU). There are 3 Observation For Improvements (OFI) were noticed during the audit, the evidences are related to the documentations and records.

## 4. VISITS AND CONSULTANCIES

During the 1<sup>st</sup> semester of 2021, there were main activities of visits, audits and consultancies as follows:

- **Lab visit by:**
  - (i) Students from French International School of Vientiane (Hoffet) conducted a study tour in February. All activities related to Environment department are presented.
  - (ii) Environment team from Nam Theun 1 Power Company (NT1PC) to observe and learn NTPC's experience on environmental monitoring and management such as: water quality, greenhouse gas monitoring, fishery, biodiversity, and erosion monitoring.
- **Adaptive Management Committee (AMC)** – the 2020 annual AMC meeting was organized on 18<sup>th</sup> February 2021 at RNT. All monitoring results of Environmental Monitoring and NT2 water release management were presented to the meeting.
- NTPC representative attended to the meeting with MoNRE and French research institution for development (IRD) about Xe Bangfai riverbank erosion in March, the discussion is agreed to be focused:
  - (i) For short term plan: to find a root cause of riverbank erosion by using the existing IRD modelling (input data of different parameters which are already in the database of NTPC and MoNRE) and combine with specific information (Satellite picture from previous years etc.). **IRD to provide the ToR including a budget estimation and share to all parties, and NTPC would support for the budget.**
  - (ii) For Long term plan: what will be a benefit/advantage for all members (Lao-MRC, NTPC and IRD in term of management of Mekong River and its tributaries). **For this propose, IRD will draft another ToR including the budget proposal which may be supported from various private sectors** (WB, ADB, MRC or participation from NTPC). NTPC will internally discuss for considering on the possibility of budget allowance.
  - (iii) MoNRE is requested to share and provide as much as possible of data set which will be input into the modelling for both short- and long-term plan.
- NTPC, IRD-Laos, National University of Laos and Nakai-Nam Theun National Park (NNT NP) conducted Botanical Survey at Artificial Mineral Licks between 6<sup>th</sup> – 8<sup>th</sup> April 2021. The survey is to document the botanical regimen of wild elephants inside the park.
- **Nam Kathang release project** – during the Downstream Channel (DSC) repairing work in April – June 2021, Environment department supported to monitor water quality, to conduct the erosion survey, to cooperate with Gnommalath DoNRE for waste collection along the river and to follow up the installation of water tank for villagers.

- Special mission request by TB-ED and EDF consultants – (i) elaborate the water quality testing mission in DSC (upper part of confluence with Xe Bangfai river) in order to have a data set relevant to the characteristics of natural rivers coming to the DSC in May. Furthermore, some recommendations to improve the Aggressive CO<sub>2</sub> testing campaign were discussed in order to get the more comprehensive data for interpreting the cause of concrete structure degradation and; (ii) water sampling in PWH tunnel and Access adit in June to identify the characteristic of water droplets inside these structures (support data for the study of Concrete structure inspection by EDF experts).

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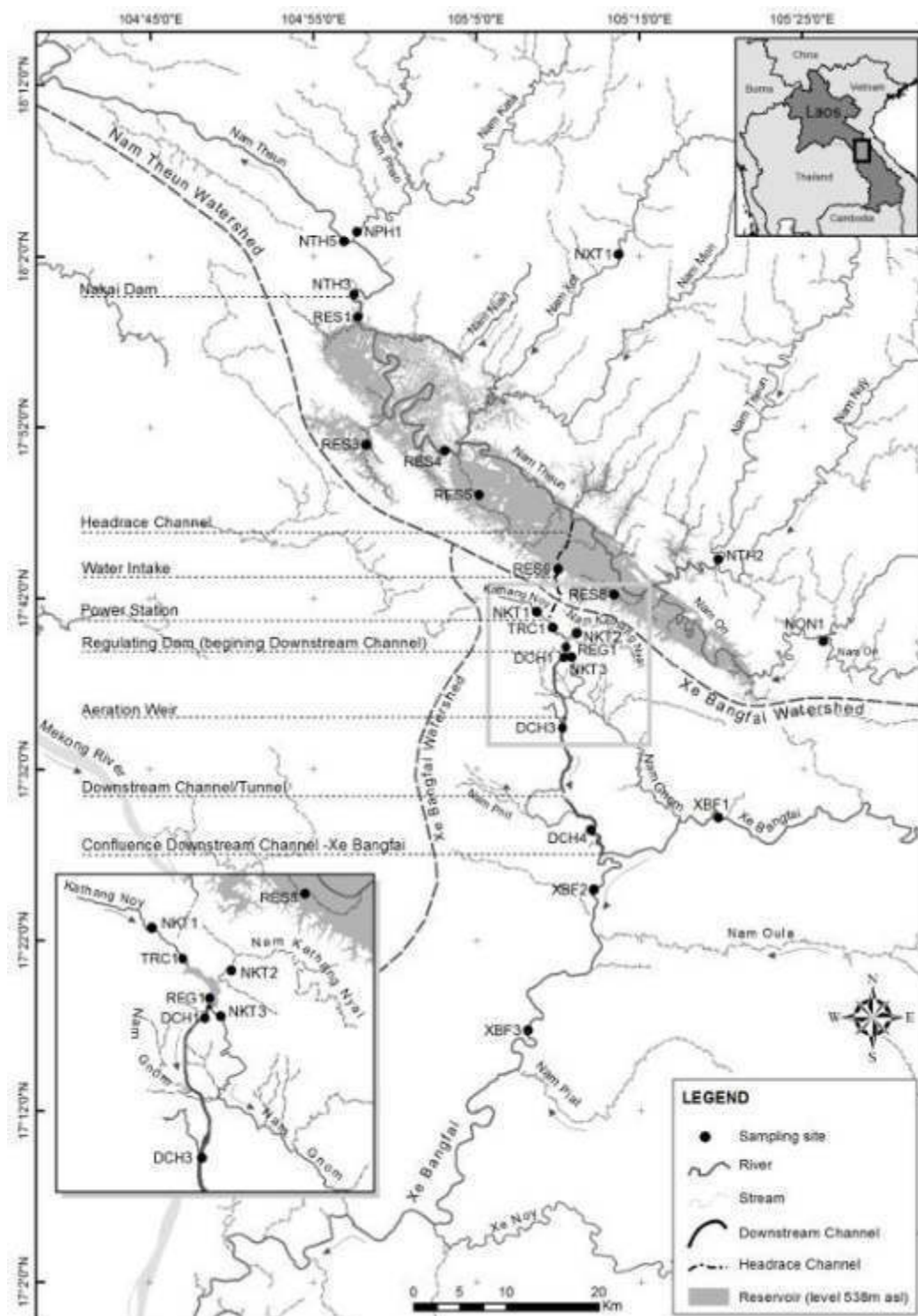
### Annex 1 - List of scientific articles relating to Nam Theun 2 Project

Articles	Under review	Approved	Published and online
<b>HYDROECOLOGIE APPLIQUEE – NAM THEUN 2 SPECIAL ISSUE</b>			
Descoux et al. Main features of the Nam Theun 2 hydroelectric project (Lao PDR) and the associated environmental monitoring programme. Hydroeco. appl., 2014			√
Chanudet et al. Evolution of the physico-chemical water quality in the Nam Theun 2 Reservoir for the first 5 years after impoundment. Hydroeco. appl., 2014			√
Chanudet et al. Hydrodynamic and water quality 3D modelling of the Nam Theun 2 Reservoir (Lao PDR): results of simulations of some scenarios. Hydroeco. appl., 2014			√
Martinet et al. Phytoplankton community and trophic status assessment of a newly impounded sub-tropical reservoir: case study of the Nam Theun 2 Reservoir (Lao PDR, Southeast Asia). Hydroeco. appl., 2014			√
Descoux et al. Efficiency of the Nam Theun 2 hydraulic structures on water aeration and degassing. Hydroeco. appl., 2014			√
Cottet et al. Fish Population dynamic in the newly impounded Nam Theun 2 Reservoir (Lao PDR). Hydroeco. appl., 2015			√
Pécastaings et al. Biofilm colonizing the Nam Theun 2 Power Plant Penstock (Lao PDR) - mechanism and potential evolution. Hydroeco. appl., 2014			√
Visser et al. Developing approaches for establishing a fisheries baseline: case-study for Xe Bangfai basin (Lao PDR). Hydroeco. appl., 2014			√
Attwood & Cottet. Malacological and parasitological surveys along the Xe Bangfai and its tributaries in Khammouane Province, Lao PDR. Hydroeco. appl., 2015			√
Streicher U. The Wildlife Rescue Programme of the Nam Theun			√

Articles	Under review	Approved	Published and online
2 Hydropower Project (Lao PDR). Hydroeco. appl., 2014			
Som & Cottet. Turtle and tortoise rescue and monitoring programme in the Nam Theun 2 Reservoir (Laos). Hydroeco. appl., 2015			√
Kottelat. The fishes of the Nam Theun and Xe Bangfai drainage, Laos. Hydroeco. appl., 2015			√
Clavier et al. Spatial and temporal variation of benthic macroinvertebrates in the Nam Gnom Basin receiving discharged waters from the Nam Theun 2 Reservoir (Laos). Hydroeco. appl., 2015			√
Descoux & Cottet. 5 years of monitoring of zooplankton community dynamics in a newly impounded sub-tropical reservoir in Southeast Asia (Nam Theun 2, Lao PDR). Hydroeco. appl., 2015			√
D. Serça et al. Nam Theun 2 Reservoir four years after commissioning: significance of drawdown methane emissions and other pathways, Hydroécol. Appl., 19, 119-146, 2016.			√
<b>GREENHOUSE GAS</b>			
Deshmukh et al. Physical controls on CH <sub>4</sub> emissions from a newly flooded subtropical freshwater hydroelectric reservoir: Nam Theun 2 Biogeosciences Discuss., 11, 3271-3317, doi:10.5194/bgd-11-3271-2014, 2014.			√
Deshmukh, C., Guérin, F., Labat, D., Pighini, S., Vongkhamsoo, A., Guédant, P., Rode, W., Godon, A., Chanudet, V., Descoux, S., and Serça, D.: Low methane (CH <sub>4</sub> ) emissions downstream of a monomictic subtropical hydroelectric reservoir (Nam Theun 2, Lao PDR), Biogeosciences, 13, 1919-1932, 2016.			√
F. Guérin et al., Effect of sporadic destratification, seasonal overturn and artificial mixing on CH <sub>4</sub> emissions at the surface of a subtropical hydroelectric reservoir (Nam Theun 2 Reservoir, Lao PDR). Biogeosciences. 22 June 2016			√
M. Adon, C. Galy-Lacaux, D. Serça, P. Guedant, A. Vongkhamsoo, W. Rode, Y. Meyerfeld, F. Guérin: First assessment of nitrogen deposition budget following the impoundment of a subtropical hydroelectric reservoir (Nam Theun 2, Lao PDR). Atmospheric Chemistry and Physics			√
C. Deshmukh et al., Carbon Dioxide emissions from the bottom and shallow Nam Theun 2 Reservoir: drawdown area as a neglected pathway to the atmosphere. Biogeosciences			√
<b>LIMNOLOGY</b>			

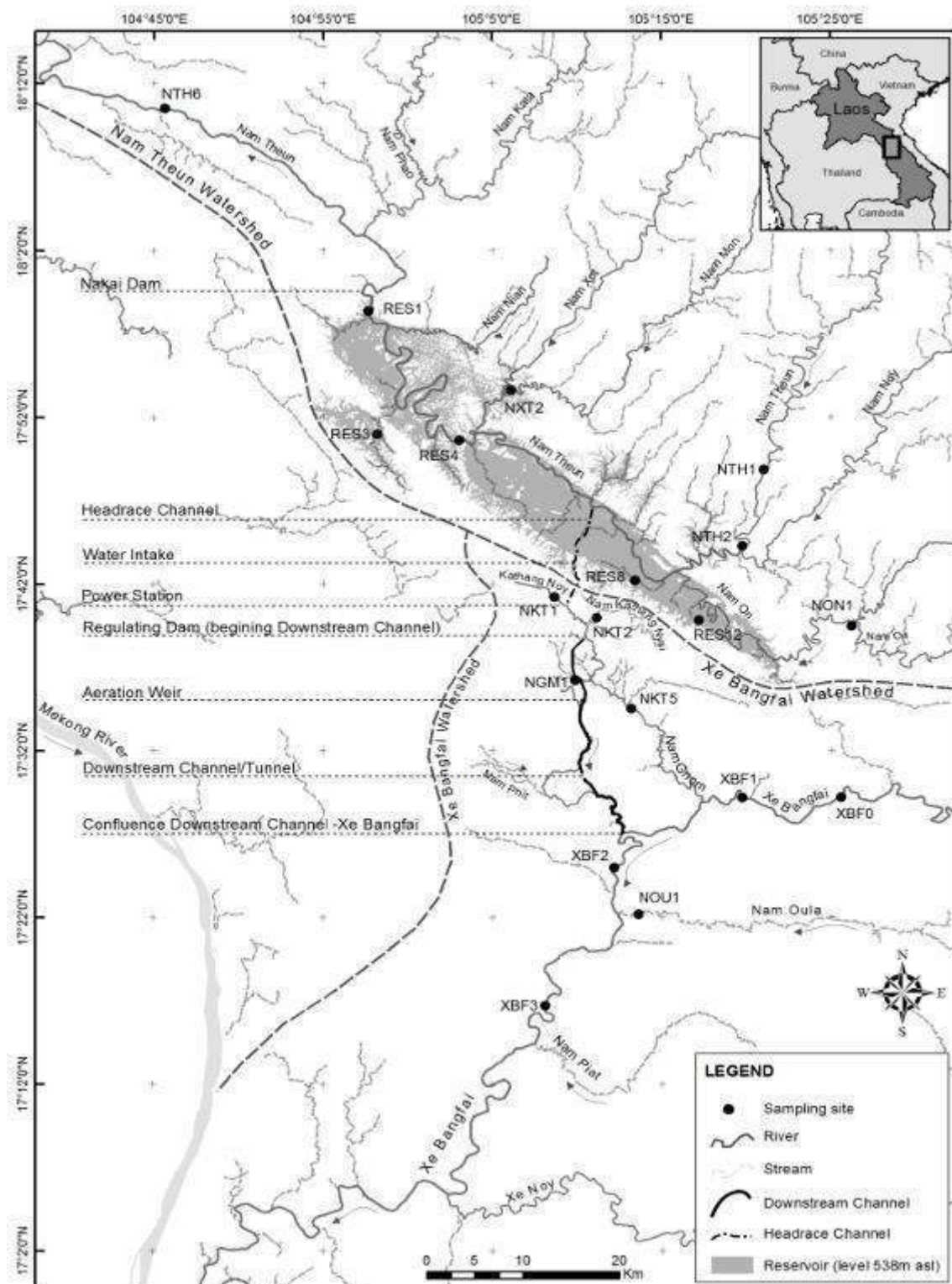
Articles	Under review	Approved	Published and online
Martinet et al. Phytoplankton functional groups for ecological assessment in young sub-tropical reservoirs: case study of the Nam-Theun 2 Reservoir, Laos, South-East Asia. Journal of Limnology, doi:10.4081/jlimnol.2014.958, 2014.			√
Pedrono et al. Seasonal algal community succession in epixylic biofilms in a tropical meso-oligotrophic shallow reservoir, Nam Theun 2 (Lao PDR). Journal of Limnological		√	
<b>FISH and FISHERIES</b>			
Cottet et al. Total iron concentrations in waters and fish tissues in the Nam Theun 2 Reservoir area (Lao PDR). Environmental and Monitoring Assessment.			√
Tessier et al. Fish assemblages in large tropical reservoirs: overview of fish population monitoring methods. Journal of Fisheries Sciences and Aquaculture.			√
A. Tessier, J. Guillard, V. Chanudet & M. Cottet: Length-weight relationships of 8 Asian freshwater fish species from Nam Theun 2 Reservoir (Lao PDR)			√
M Cottet & T. Visser: Fish catch and fishing practices in the Nam Theun 2 Reservoir and watershed (Lao PDR)			√
Hughes et al. Combination of direct fishing and indirect e DNA metabarcoding monitoring during a 3 years survey significantly improves the fish biodiversity report around a South East Asian reservoir.			√
A.Tessier et al., Low input of the pelagic zone of a large tropical neo-reservoir to fisheries		√	
Tessier, et al. Life history traits of the exploited Nile Tilapia ( <i>Oreochromis niloticus</i> ) in a subtropical reservoir (Lao PDR)			√
A.Tessier, et al. Life history and exploitation of <i>Hampala macrolepidota</i> in the Nam Theun 2 reservoir, Lao PDR	√		
D. Beaune, et al. Population dynamics of the Nile Tilapia in a large Asian reservoir: Length-at-age versus length frequency distribution growth analyses	√		
E. Baran et al. Developing a fishery in a subtropical reservoir- experience from Nam Theun 2 Dam in Lao PDR	√		
<b>GENERAL ENVIRONMENT</b>			
Descoux at al., 2011: Co-assessment of biomass and soil organic carbon stocks in a future reservoir area located in Southeast Asia. Environmental Monitoring and Assessment			√

## Annex 2 – Water quality monitoring stations from May 2017 to April 2023





### Annex 3 – Hydrobiology monitoring stations from May 2017 to April 2023



**Annex 4 – Parameters to be monitored from May 2017 to April 2023**

<b>Number</b>	<b>Group</b>	<b>Parameters</b>
<b>1</b>	<b>In situ</b>	Total Depth, Temperature, pH, Dissolved Oxygen, Turbidity, Conductivity, Transparency
<b>2</b>	<b>Carbon budget</b>	Dissolved CH <sub>4</sub> , Dissolved CO <sub>2</sub> , Total Organic Carbon, Total Carbon, Total Inorganic Carbon (Calculation), Total Alkalinity
<b>3a</b>	<b>Other major parameters</b>	BOD, TSS, Total N, Total P, Fe II, Fe III, Total Dissolved Iron, Dissolved Silica
<b>3b</b>	<b>COD</b>	COD
<b>4</b>	<b>Anions and Cations</b>	Potassium, Sodium, Calcium, Magnesium, Ammonium, Phosphate, Sulfate, Chloride, Nitrite, Nitrate, Fluoride
<b>5</b>	<b>N<sub>2</sub>O</b>	Dissolved N <sub>2</sub> O
<b>6</b>	<b>Gas fluxes (bubbling)</b>	Bubbling CH <sub>4</sub> , CO <sub>2</sub>
<b>7</b>	<b>Chlorophyll <i>a</i></b>	Chlorophyll <i>a</i>
<b>8</b>	<b>Benthic macroinvertebrates</b>	Number and identification of specimen per family (per genus or species whenever possible)
<b>9</b>	<b>Fish</b>	Number, identification, size, weight, sex and maturity of specimens per net, species and stomach content
<b>10</b>	<b>Fish flesh for Hg</b>	Mercury (Hg) measurement



**Annex 5 – Frequencies and stations of the measurements in May 2017 to April 2023**

Group of Stations		Frequencies			
		Monthly	By 3 seasons	Biannual	Annual
Nam Theun River and Tributaries	NTH3	1, 2, 3a, 3b, 4, 5	-	-	-
	NTH5	1, 3a, 4	-	-	-
	NTH6	-	9	10	8
	NPH1	1, 3a, 4	-	-	-
	NXT1	1, 2, 3a, 4, 5	-	-	-
	NXT2	-	9	-	-
	NTH2	1, 2, 3a, 4, 5	9	10	-
	NON1	1, 2, 3a, 4, 5	9	10	-
	NTH1	-	9	10	8
Reservoir	RES1 (1)	1, 2, 3a, 3b, 4, 5, 7	9	10	-
	RES3 (1)	1, 2, 3a, 4, 5, 7	9	10	-
	RES4 (6)	1, 2, 3a, 4, 5, 7,	9	10	-
	RES5 (1)	1, 2, 3a, 4, 5	-	-	-
	RES8 (1)	1, 2, 3a, 4, 5, 7,	9	10	-
	RES9 (3)	1, 2, 3a, 3b (3), 4, 5	-	-	-
	RES12	-	9	10	-
	3 bubbling stations	6(6 missions /year)			
Civil Works	TRC1	1, 2, 3a, 4, 5	-	-	-
	REG1 (3)	1, 2, 3a, 3b (1), 4, 5	-	-	-

Group of Stations		Frequencies			
		Monthly	By 3 seasons	Biannual	Annual
	DCH1	1, 2, 3a, 3b, 4, 5	-	-	-
	DCH3	1, 2, 3a, 4, 5	-	-	-
	DCH4	1, 2, 3a, 3b, 4, 5	-	-	-
Nam Kathang	NKT1	1, 2, 3a, 4, 5	-	-	8
	NKT2	1, 2, 3a, 3b, 4, 5	-	-	8
	NKT3	1, 2, 3a, 3b, 4, 5	-	-	-
	NKT5	-	-	-	8
	NGM1	-	-	-	8
Xe Bang Fai	XBF0	-	9	-	8
	XBF1	1, 2, 3a, 3b, 4, 5	9	10	8
	XBF2	1, 2, 3a, 3b, 4, 5	9	10	8
	XBF3	1, 2, 3a, 4, 5	9	-	-
	NOU1	-	9	-	-

## Annex 6 – Water Quality in the Reservoir January to June 2021

**Nakai Dam – NT Thalweg (RE S01):**

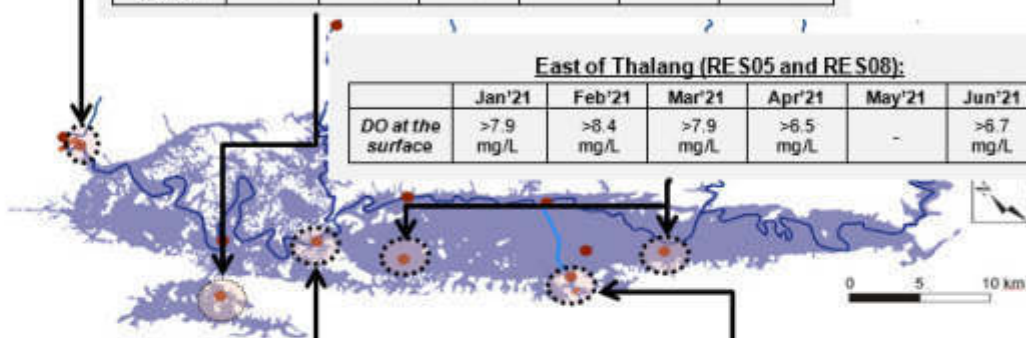
	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
<i>DO at the surface</i>	7.6 mg/L	7.5 mg/L	7.7 mg/L	-	-	6.9 mg/L

**West of Thalang (RE S03)**

	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
<i>DO at the surface</i>	6.9 mg/L	8.3 mg/L	7.1 mg/L	7.5 mg/L	-	4.4 mg/L

**East of Thalang (RE S05 and RE S08):**

	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
<i>DO at the surface</i>	>7.9 mg/L	>8.4 mg/L	>7.9 mg/L	>6.5 mg/L	-	>6.7 mg/L

**West of Thalang (RE S04):**

	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
<i>Thermocline</i>	None	None	4 m	3 m	-	6 m
<i>DO at the surface</i>	7.1 mg/L	8.3 mg/L	7.3 mg/L	6.7 mg/L	-	4.9 mg/L
<i>Oxicline</i>	None	None	At a depth of 8 m	At a depth of 5 m	-	At a depth of 16 m
<i>Anoxic condition</i>	None	None	At a depth of 8 m to 11 m	At a depth of 5 m	-	At a depth of 16 m

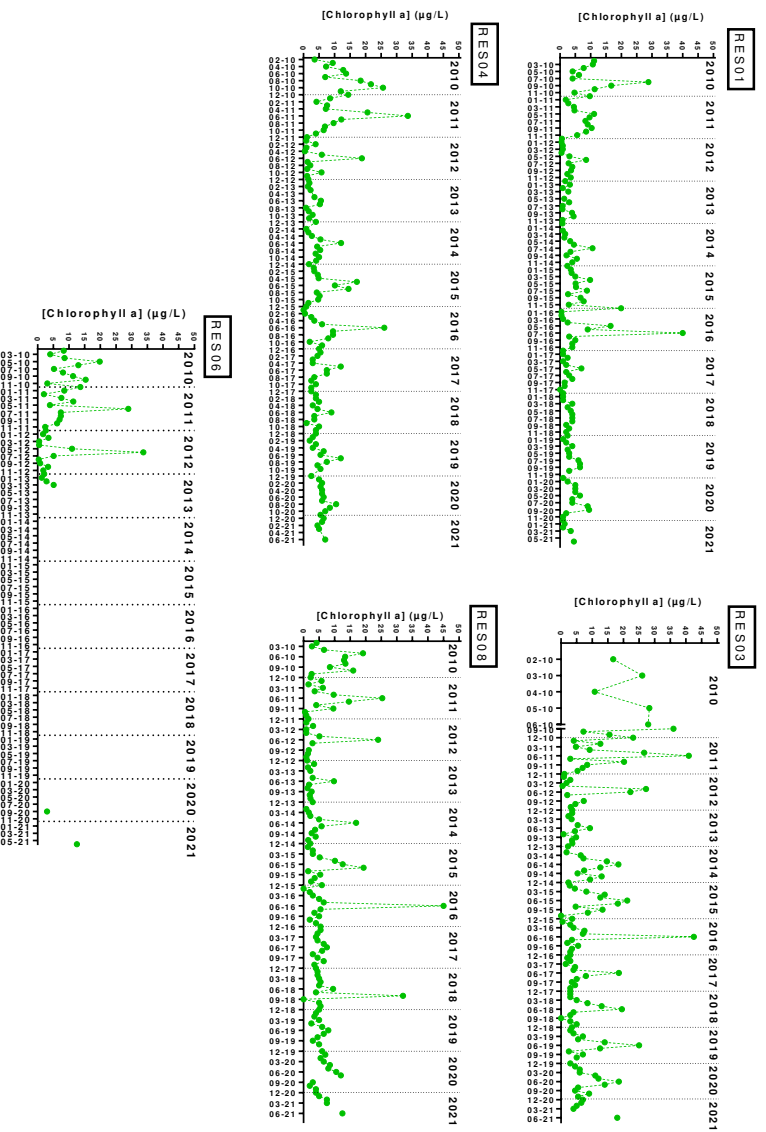
**Intake (RE S09):**

	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
<i>Thermocline</i>	None	None	None	None	-	None
<i>DO at the surface</i>	8.9 mg/L	7.9 mg/L	6.7 mg/L	6.2 mg/L	-	4.6 mg/L
<i>Oxicline</i>	None	None	None	None	-	None
<i>Anoxic condition</i>	None	None	None	None	-	None

**Annex 7 – The 16 fixed boreholes are the most frequently used by villagers in 6 districts**

District	Village	Site Code	Village & Borehole No
Gnommalath	Ban Nongping	GML01003	Nongping BH3
	Ban Khoksavang	GML13105	Khoksavang BH5
	Ban Nakai Neua	NAK0113	Nakai Neua BH13
Nakai	Ban Nong Boua Kham	NAK0911	Nong Boua Kham BH11
	Ban Thalang	NAK1310	Thalang BH10
	Ban Nong Boua	NAK1606	Nongboua BH6
Mahaxai	Ban Sop On	NAK1915	Sop On BH15
	Ban Mahaxai	MHX02410	Mahaxaitai BH10
	Ban Pova	MHX02609	Povatai BH9
Xebarangfai	Ban Kuase	XBFO3708	Kuase BH8
	Ban Dangtha	XBFO4204	Dangtha BH4
Xaiboulée	Ban Khamsavang	XBLO3901	Khamsavang BH1
	Ban Thaphoxai	XBLO7802	Thaphoxai BH2
	Ban Thakharm	XBLO7902	Thakharm BH2
Nongbok	Ban Sorkbor	NBK05307	Sorkbor BH7
	Ban Hatxiengdee	NBK05902	Hatxiengdee BH2

**Annex 8 – Chlorophyll a concentration by station**



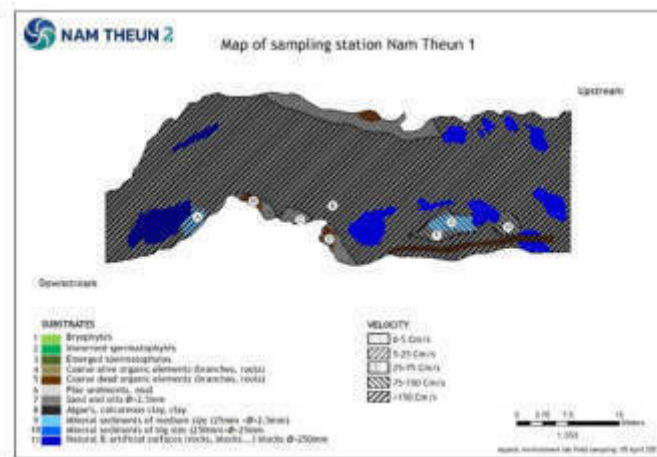
## Annex 9 – Reference of Chl a result at RES08

- (i) Normally in August (high water level in NT2 reservoir) the concentration of Phosphorus is ranged between 0.01-0.036 mg.L<sup>-1</sup> since 2012, but in August 2018 Phosphorus' concentration could reached 0.041 mg.L<sup>-1</sup>
- (ii) BZ. Pan *et al.* Factors Influencing Chlorophyll a Centration in the Yangtze-Connected Lake Fresenius Environmental Bulletin, PSP Volume 18 – No 10.2009

## Annex 10 – Maps and pictures of Aquatic Invertebrate monitoring stations

### Nam Theun Area

#### Nam Theun (NTH1)

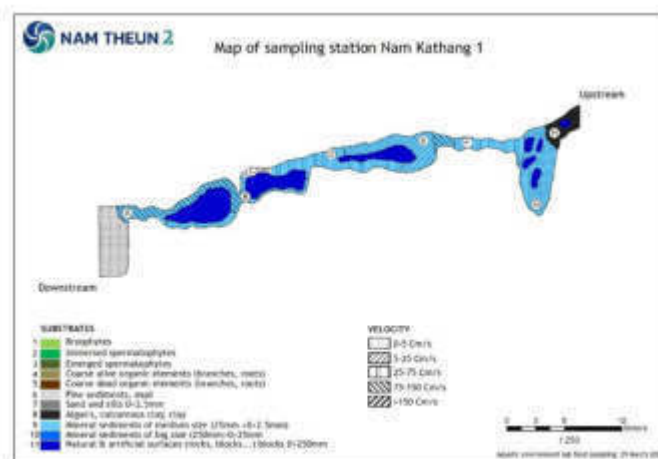


## Nam Theun (NTH6)



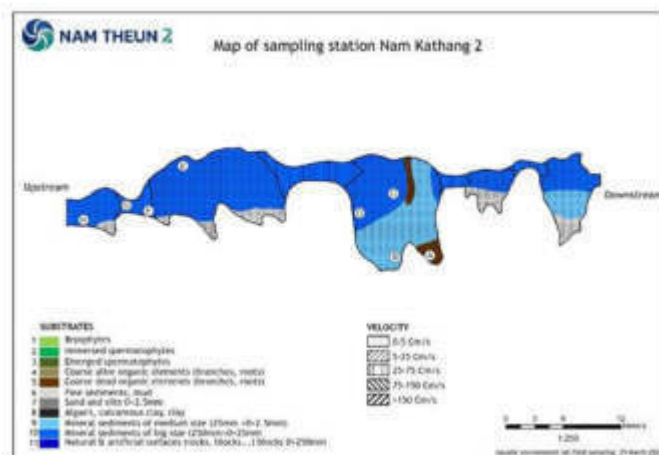
## Nam Kathang/Gnom Area

### Nam Kathang (NKT1)

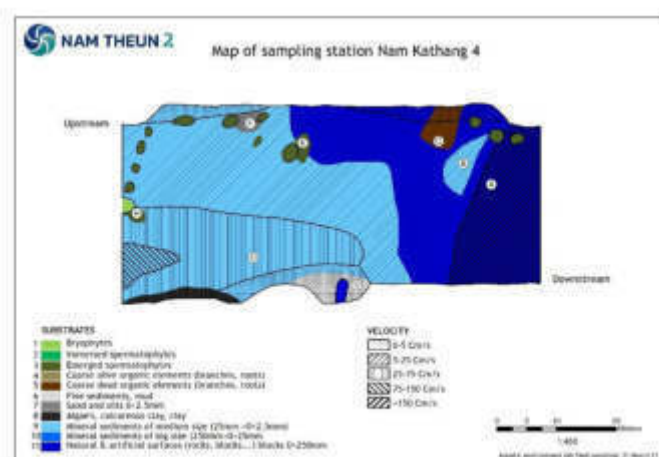




## Nam Kathang (NKT2)

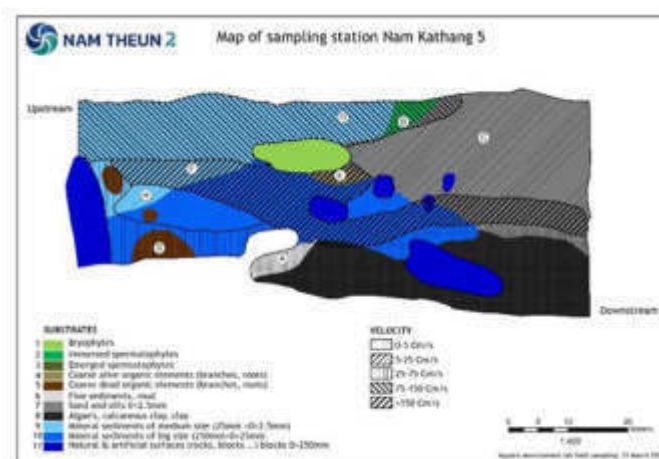


## Nam Kathang (NKT4)



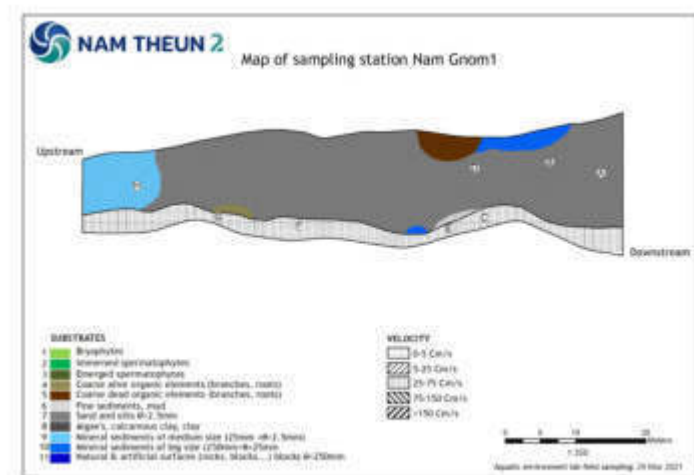


### Nam Kathang (NKT5)





## Nam Gnom (NGM1)



## Xe Bangfai Area

### Xe Bangfai (XBF0)



**Xe Bangfai (XBF1)****Xe Bangfai (XBF2)****Annex 11 – Mineral used for replenishment in each AML sites for Dry Season 2021**

<b>AML sites</b>	<b>Sodium Chloride (NaCl) (Kg)</b>	<b>Monosodium Phosphate (NaH<sub>2</sub>PO<sub>4</sub>) (Kg)</b>	<b>Calcium Carbonate (CaCO<sub>3</sub>) (Kg)</b>	<b>Potassium Chloride (KCl) (Kg)</b>	<b>Total</b>
PML1/5	140	65	25	10	<b>240</b>
PML1/9	160	40	25	25	<b>250</b>
PML1/19	120	65	25	10	<b>220</b>
PML2/7	180	110	35	10	<b>335</b>

PML2/16	240	180	60	30	<b>510</b>
PML3/18	90	50	20	5	<b>165</b>
PML3/19	80	60	20	5	<b>165</b>
PML3/23	90	55	10	5	<b>160</b>
<b>Total</b>	<b>1,100</b>	<b>625</b>	<b>220</b>	<b>100</b>	<b>2,045</b>

### Annex 12 – Picture of AMLs monitoring result by camera trap during first semester of 2021





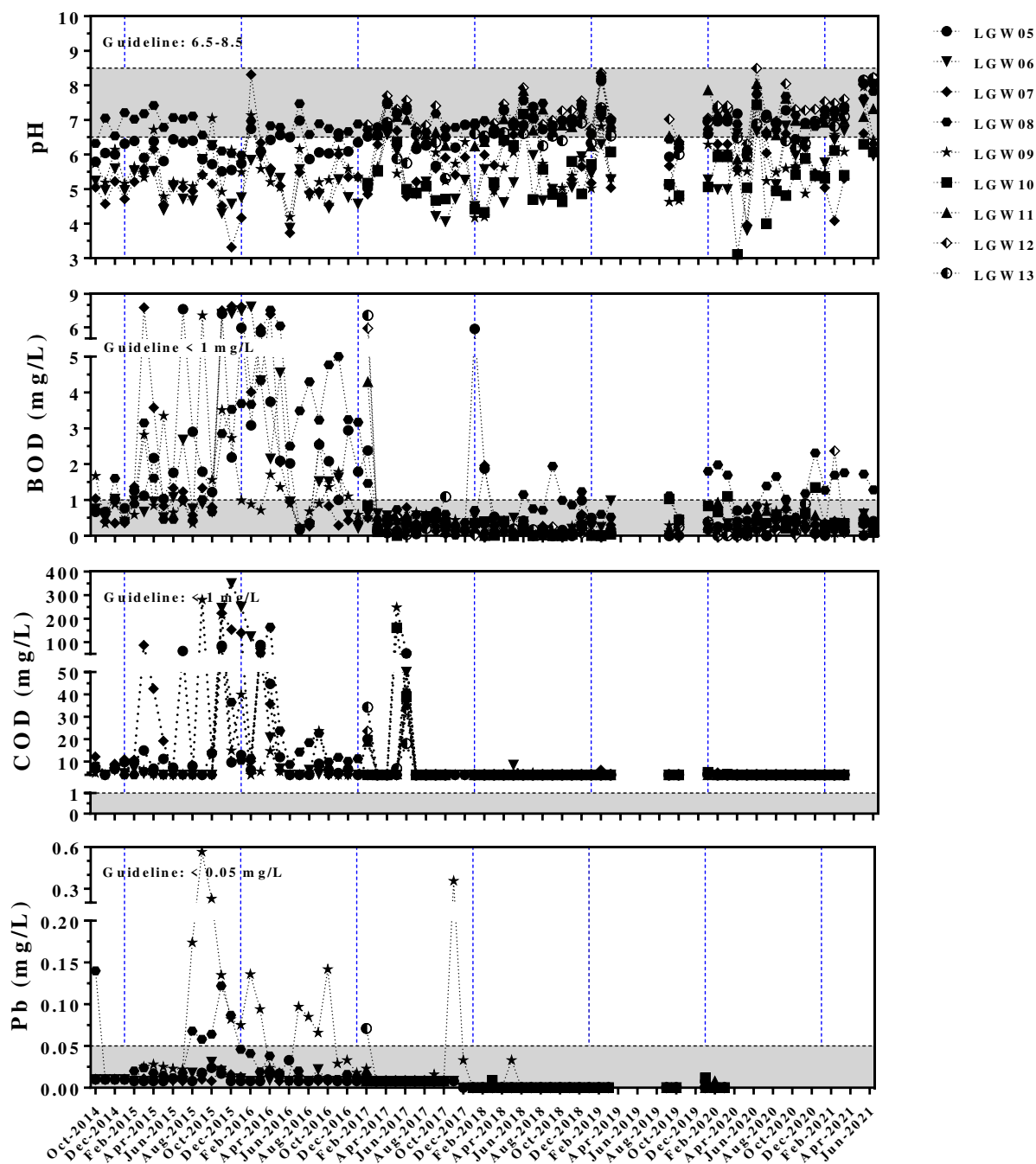
**Annex 13 – Saplings of *Glyptostrobus pensilis* planted in May 2021**



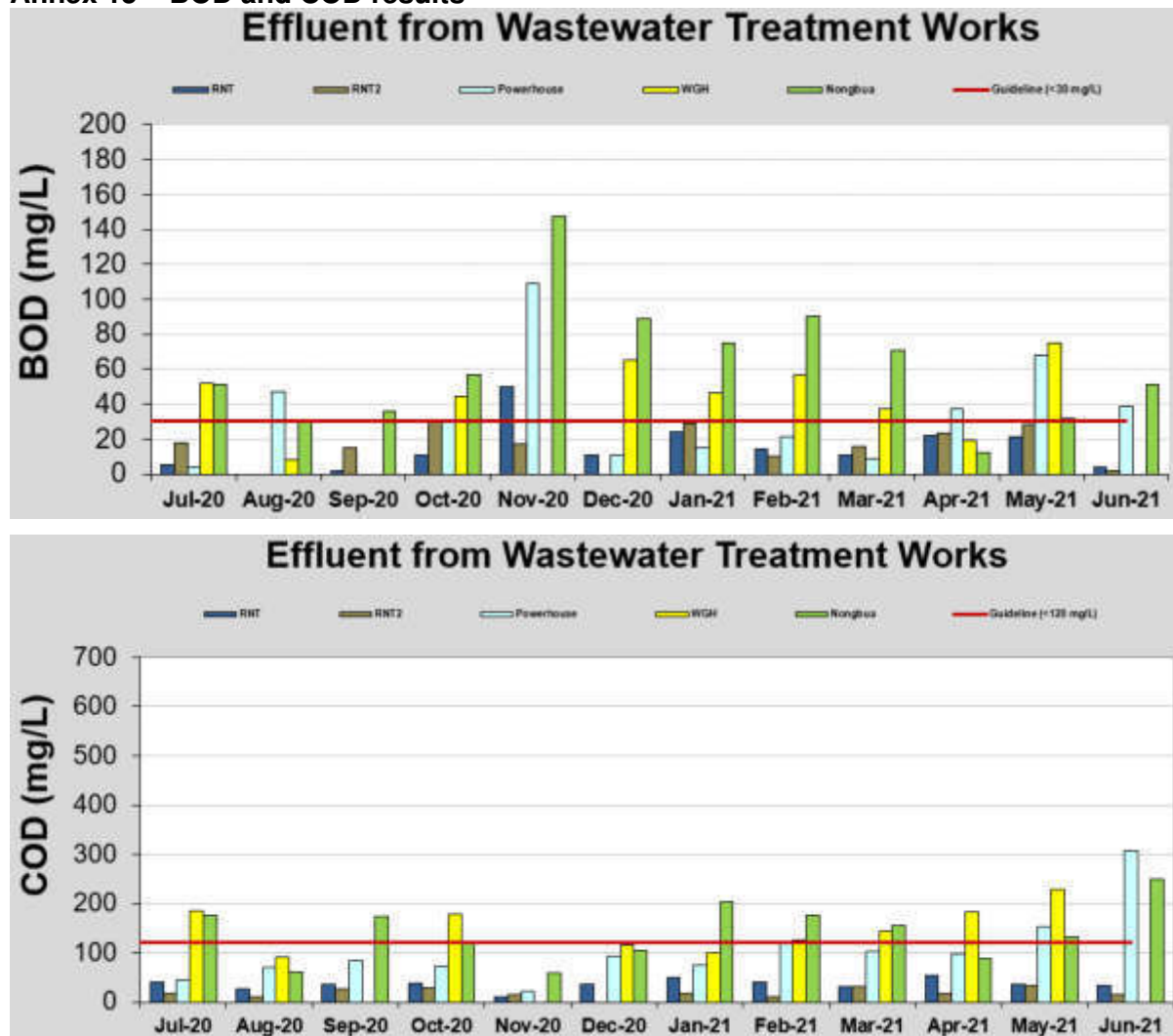
## Annex 14 - Landfill observation borewells testing results January to June 2021

Data comparing to the GoL standard\* of groundwater for drinking purpose (in grey shade)

(\*Water quality standard guideline of groundwater for drinking purpose, Decision on National Environmental Quality Standard, Prime Minister's Office, No.81/PMO. 21 Feb 2017, MoNRE, Vientiane Capital).



# Annex 15 – BOD and COD results



**Annex 16 – NTPC wastewater treatment facilities monitoring results**

Month	Parameter	Guideline	Guideline Exceedance				
			RNT1	RNT2	Powerhouse	WGH	Nongbua
Jan-21	Biological oxygen demand (BOD)	<30mg/L				X (46)	X (75)
	Chemical oxygen demand (COD)	<120 mg/L					X (204)
	Ammonia-nitrogen (NH <sub>3</sub> -N)	<4mg/L	X (7.68)		X (67.56)	X (4.94)	
	Thermotolerant (Faecal) Coliform	<1000 CFU/100mL	X (1000)	X (1000)			
Feb-21	Biological oxygen demand (BOD)	<30mg/L				X (57)	X (90)
	Chemical oxygen demand (COD)	<120 mg/L			X (124)	X (126)	X (176)
	Ammonia-nitrogen (NH <sub>3</sub> -N)	<4mg/L	X (6.67)	X (7.57)	X (67.54)		
	Thermotolerant (Faecal) Coliform	<1000 CFU/100mL	X (1000)	X (1000)			
	Total suspended solids	<40mg/L					X (40)
Mar-21	Biological oxygen demand (BOD)	<30mg/L				X (37)	X (71)
	Chemical oxygen demand (COD)	<120 mg/L				X (143)	X (155)
	Ammonia-nitrogen (NH <sub>3</sub> -N)	<4mg/L	X (7.81)	X (14.79)	X (95.71)		
	Thermotolerant (Faecal) Coliform	<1000 CFU/100mL	X (1000)	X (1000)			
	Total suspended solids	<40mg/L			X (52)		
Apr-21	Biological oxygen demand (BOD)	<30mg/L			X (37)		
	Chemical oxygen demand (COD)	<120 mg/L				X (182)	
	Ammonia-nitrogen (NH <sub>3</sub> -N)	<4mg/L	X (12.54)	X (6.68)	X (29.79)		
	Thermotolerant (Faecal) Coliform	<1000 CFU/100mL		X (1000)	X (1000)		
	Total suspended solids	<40mg/L			X (64)		
May-21	Biological oxygen demand (BOD)	<30mg/L				X (75)	X (32)
	Chemical oxygen demand (COD)	<120 mg/L			X (153)	X (228)	X (133)
	Ammonia-nitrogen (NH <sub>3</sub> -N)	<4mg/L	X (28.59)	X (8.72)	X (163.48)	X (12.81)	X (7.56)
	Total suspended solids	<40mg/L			X (106)	X (42)	
Jun-21	Biological oxygen demand (BOD)	<30mg/L			X (39)		X (51)
	Chemical oxygen demand (COD)	<120 mg/L			X (307)		X (250)
	Ammonia-nitrogen (NH <sub>3</sub> -N)	<4mg/L	X (12.07)	X (11.62)	X (31.22)		
	Thermotolerant (Faecal) Coliform	<1000 CFU/100mL		X (1000)	X (1000)		



**Annex 17 - Environment inspection and monitoring**

NTPC sites	Number of Inspection
	January to June
Nakai Dam Site	3
Wooden Guesthouse	9
PWH & Switchyard	3
RNT Complex	10
Gnommalath Landfill	17
Surge Shaft/Access Adit	4
Intake and Headrace Channel and Tunnel	4
Nong Boua Boat area	10
Regulating Dam	4
<b>Total</b>	<b>64</b>

**Note:** Due to the workload during the Major overhaul and Nam Kathang releaser project, the monthly inspections at industrial sites were cancelled in February to May. Only the routine inspections at non-industrial sites and Landfill were organized.

There are 31 environmental issues raised from the industrial site inspection and workplace inspection (non-industrial site) during January to June 2021, the current status is reported in table below:

Period	Inspection area	Number of issues	Status		Remark
			Closed	Pending	
January to June 2021	Industries site	16	7	9	Action follow up is going on
	Non-Industries Site	15	6	9	

The issues raised from these inspections were informed, via the joint inspection checklist or email, to concerned parties such as AB-site management, AB-security, TB-QHSE, KGS contractor or the area owner for improvement.

The Environment team participated in 15 special missions of environmental inspection in January - June 2021 as follows:

- 1 mission of Daily managerial patrol during the 2021 Major Overhaul and the Downstream Channel repairing (May to June)
- 1 mission of Workplace inspection at Vientiane office (January)
- 8 mission of General managerial patrol at : (i) Nakai Dam, Water Intake, Regulating Dam in February; (ii) Surge shaft and Adit in March; (iii) RNT and Sub Station in April and (iv) Wooden guesthouse in May.
- 4 missions of joining final inspection of : (i) the new storage and improvement the drainage at landfill in January; (ii) the replacement Eave roof in RNT camp 103 building in February; (iii) the upgrading the energy resource for back up at RNT,

WGH and Boat camp in February and; (iv) Welding and repairing HDPE Liner on treatment pond at NTPC Landfill in May.

- 1 mission of construction site: Construction of new houses at RNT, January to June.

The issues observed during each inspection/patrol were mainly related to waste segregation and waste disposal. All issues were immediately informed to concerned parties such as a site engineer, contractor, AB-site management or TB-QHSE for improvement.

#### Annex 18 - Corrective and preventive action for incident reports January to June 2021

No	Incident Date	Level	Description of Incident	Corrective Action Plan	Status	ID Ref.
01	19-02-2021	1	Found the wastewater leaked from wastewater pipe affected the bad odor surrounding.	AB-Site Management repaired the wastewater pipe and linked the wastewater to treatment system	Closed	2,920
02	02-03-2021	1	found a death body buffalo at the bank of emergency spill way (Regulating Dam).	AB-Security informed to PWH main control room and report to chief of Sangkeo village.	Closed	2,946
03	07-04-2021	1	Found the untreated wastewater leaked from wastewater pipe at Lao Canteen which affected the bad odour around the area.	AB-Site should repair the wastewater pipe and linked the wastewater to treatment system	CAP Follow Up	3,009
04	20-05-2021	1	Found the oil leaked from old generator at WGH.	AB-Site Management should check and repair to prevent the leakage	CAP Required	3,154
05	11-06-2021	2	On 09 June 2021, there was a hole from land erosion around the plastic septic tank of wastewater treatment system of Powerhouse. the hole has Length:3.8m, Width:2.5m and Height:1.8m.	AB-Site Management should organize a Root cause Failure Analysis (RCFA) meeting with concerned department and finalize the corrective actions	CAP Follow Up	3,212

#### Annex 19 - Environment awareness training January to June 2021

- **For NTPC staff and family**

No.	Description of group	#Trained Persons	Remarks
1	NTPC new staff	1	
2	NTPC new fresh graduates and short-term Intern	10	
3	NTPC consultants	5	
4	Volunteers	58	

• **For Contractors**

No.	Company name of contractors/providers	#Trained Persons	Remarks
1	Advice Khammouan	3	
2	Bounpheng Construction Road-Bridge & Irrigation Co, Ltd (BPC)	43	
3	Newrest Lao Sole Co.,Ltd	8	
4	Xaysana Group Sole Co., Ltd (XSN)	241	
5	PMC Lao Sole Co., Ltd	8	
6	BK Construction Road-Bridge & Irrigation Co., Ltd (BK)	42	
7	DIHEC	14	
8	Katalyst Partners	1	
9	L&B UXO Company Limited	4	
10	Khammouane Security Services Company (KSSC)	23	
11	General supply maintenance and Service (GM)	16	
12	SSV Education Group	1	
13	Phonxay Driving School	4	
14	Chaijaroen Electrical Service (CES)	10	
15	Electricite Du Laos (EDL)	4	
16	Song Pha Lung music band	5	
17	Electricity Generating Authority of Thailand (EGAT)	85	
18	Soulignet Choummanivong Construction (SCC)	6	

**Annex 20 – 2021 Health, Safety and Environment Improvement Program (HSEIP)**

Objective & Target Reference	Objectives	Targets
HSE 06/2021	Saving Energy and Water Program	(i) Follow up the installation the meters to record water and electricity consumption (ii) Sharing information and promoting the campaign during parties, at least 2 events in 2021 (iii) Implement "Earth Hour" event (turn off the light and other electrical appliance together about 1 hour, doing outdoor activity together) once a month (iv) Yearly refresh training for staff and families, about "tips to reduce Energy and Water consumption"
HSE 07/2021	Environmental - To prevent major environment accident - To comply with the local law and other requirements (LTA, IMA and POE), Project: Waste	Zero major environment accident

Objective & Target Reference	Objectives	Targets
	cell, Waste water treatment.	
HSE 08/2021	Hazardous chemical waste disposal	(i) 80% of acid and base waste are disposed by evaporation process. (ii) 100% of sediments from waste evaporation process are disposed by incineration. (iii) Finding disposal choices for other chemical waste such as Formalin, Mercury chloride.
HSE 09/2021	Recycling waste compaction	(i) 100% of compactable waste (cans, cardboards, plastic bottles) were compacted (ii) Finding recycling factory in lao who accept the compacted recycle waste (paper, plastic bottle, can)
HSE 10/2021	Ban Single-use campaign	(i) Zero plastic use event, implement in all events at NTPC (ii) Encourage staff use their own box to get the takeaway food from restaurants (iii) Encourage NEWREST to stop providing single-use chopsticks and tissues at all canteens (iv) Encourage NEWREST to stop providing plastic bags in Green and Yellow waste bins (v) Encourage NEWREST to stop providing plastic bags to collect garden waste and waste in offices. (vi) Replacement of drinking water bottle from 0.6 and 1.5 liters by 20 liters

#### Annex 21 – List of Documents in CEMMP

- Quality Health Safety and Environment Policy (POLQSE)
- Job Hazard and Environmental aspect Assessment Instruction (PR B15 01)
- Legal and Other Requirements Procedure (PR B15 02)
- HSE Objectives Targets and Programs (PR B15 03)

- NTPC Health, Safety and Environmental Objectives and Targets (NTPC M B 15 0303 17)
- Health, Safety and Environmental Improvement Programs (NTPC M B 15 03 03 0018)
- Waste Management Plan (NTPC M B 15 03 04 0016)
- Hazardous Materials and Contamination Control Management Plan (NTPC M B 15 03 04 0012)
- Water Management Plan (NTPC M B 15 03 04 0015)
- Water Quality Monitoring Plan (NTPC M B 15 05 01 0001)
- Biodiversity Management Plan (NTPC M B 15 03 04 0017)
- Health, Safety and Environmental Training Procedure (PR B15 04)
- Training Procedure (PR 1410)
- NTPC Health, Safety and Environmental Training Needs Matrix
- HSE Communication Participation and Consultation Procedure (PR B15-05)
- Documents and Records Control Procedure (PR B15 06)
- Chemical Management Procedure (PR B14 04)
- Waste Segregation Work Instruction (WI B14 04)
- Waste Management at Gnommalath Landfill Work Instruction (WI B14 07)
- Clinical Waste Management Work Instruction (WI B14 07)
- HSE Specifications for Contracts and Bidding Documents (NTPC M B 15 04 06 0004)
- Crisis and Emergency Management Plan (NTPC M B0501 0001)
- Hydrocarbon and Chemical spill Response Procedure (NTPC O P0602 13 0002)
- OMD-Natural Disaster Management Procedure (NTPC O P1004 17 0001)
- OMD-Emergency Contingency Plan for Powerhouse (NTPC O P10 04 13 0001)
- Emergency and Preparedness and Response Procedure (PR B14 05)
- HSE Performance Monitoring and Measurement Procedure (PR B15-07)
- Reporting and Incident Management Procedure (PR B15 10)
- Nonconformity Corrective and Preventive Action Procedure (PR B15-08)
- Internal Audit Procedure (PRB15 09)
- NTPC Senior Management Review (NTPC M B 15 06 01 0001)