

Nam Ngiep 1 Hydropower Project

Environmental Management Monthly Monitoring Report

January 2019

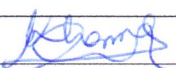
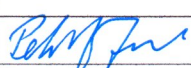
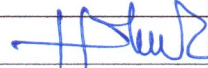
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BBREVIATIONS / ACRONYMS

| | |
|---------|---|
| AIP | Annual Implementation Plan |
| ADB | Asian Development Bank |
| BBS | Biodiversity Baseline Survey |
| BAC | Biodiversity Advisory Committee |
| BOF | Biodiversity Offset Framework |
| BOMC | Biodiversity Offset Management Committee |
| BOMP | Biodiversity Offset Management Plan |
| CA | Concession Agreement between the NNP1PC and GOL, |
| CAP | Corrective Action Plan |
| COD | Commercial Operation Date |
| CVC | Conventional Vibrated Concrete |
| CWC | Civil Works Contract |
| CTA | Common Terms Agreement |
| DEB | Department of Energy Business, MEM |
| DEPP | Department of Energy Policy and Planning, MEM |
| DEQP | Department of Environment and Quality Promotion, MONRE |
| DESIA | Department of Environmental and Social Impact Assessment, MONRE |
| DFRM | Department of Forest Resources Management, MONRE |
| DLA | Department of Land Administration, MONRE |
| DSRP | Dam Safety Review Panel |
| EC | Electrolytic Conductivity |
| EC OCD | EGAT Construction Obligation Commencement Date |
| EDL | Electricite du Laos |
| EDL PPA | Power Purchase Agreement between NNP1PC and EDL |
| EGAT | Electricity Generating Authority of Thailand |
| EGATi | EGAT International Company Limited |
| EIA | Environmental Impact Assessment |
| EMMR | Environmental Management and Monitoring Reports |
| EMO | Environmental Management Office of ESD within NNP1PC |
| EMU | Environmental Monitoring Unit |
| EMWC | Electrical-Mechanical Works Contract |
| EPF | Environmental Protection Fund |
| ERIC | Environmental Research Institute Chulalongkhorn University |

| | |
|--------|---|
| ERM | Environmental Resource Management |
| ESD | Environmental and Social Division of NNP1PC |
| ESMMP | Environmental and Social Monitoring and Management Plan |
| FY | Fiscal Year |
| GOL | Government of Lao PDR |
| GIS | Geographic Information Systems |
| HH | Household |
| HMWC | Hydraulic Metal Works Contract |
| HR | Human Resources |
| IEE | Initial Environmental Examination |
| IMA | Independent Monitoring Agency |
| INRMP | Integrated Natural Resources Management Plan |
| ISP | Intergraded Spatial Planning |
| km | kilometre |
| kV | kilo-Volt |
| LEPTS | Lao Electric Power Technical Standard |
| LHSE | Lao Holding State Enterprise |
| LTA | Lender's Technical Advisor |
| M | million |
| m | metre |
| MAF | Ministry of Agriculture and Forestry |
| MEM | Ministry of Energy and Mines, Lao PDR |
| MOF | Ministry of Finance, Lao PDR |
| MOM | Minutes of Meeting |
| MONRE | Ministry of Natural Resource and Environment, Lao PDR |
| MOU | Memorandum of Understanding |
| NBCA | National Biodiversity Conservation Area |
| NCI | Non-Compliance Issue |
| NCR | Non-Compliance Report |
| NN2 | Nam Ngum 2 Power Company Limited |
| NNP1PC | Nam Ngiep 1 Power Company Limited |
| NPF | National Protection Forest |
| NTFP | Non-Timber Forest Products |
| NT2 | Nam Theun 2 Hydropower Project |
| OC | Obayashi Corporation |
| ONC | Observation of Non-Compliance |
| PAFO | Provincial Department of Agriculture and Forestry |

| | |
|----------|---|
| PAP | Project Affected People |
| PD | Property Damage |
| PONRE | Provincial Department of Natural Resource and Environment, MONRE |
| PvPA | Provincial Protection Area |
| RCC | Roller Compacted Concrete |
| SIR | Site Inspection Report |
| SLBMP | Salvage Logging Biomass Management Plan |
| SOP | Standard Operating Procedure |
| SMO | Social Management Office of ESD within NNP1PC |
| SS-ESMMP | Site Specific Environmental and Social Monitoring and Management Plan |
| TD | Technical Division of NNP1PC |
| TOR | Terms of Reference |
| TSS | Total Suspended Solids |
| UAE | United Analysis and Engineering Consultant Company Ltd. |
| UXO | Unexploded Ordinance |
| WMF | Watershed Management Fund |
| WMP | Watershed Management Plan |
| WRPC | Watershed and Reservoir Protection Committee |
| WRPO | Watershed and Reservoir Protection Office |
| WWTS | Waste Water Treatment System |

EXECUTIVE SUMMARY

In January 2019, the Environmental Management Office (EMO) of Nam Ngiep 1 Power Company (NNP1PC) received one DWP and one SS-ESMMP for Houay Soup landfill operation and one Site Decommissioning and Rehabilitation Plan for review and approval.

The monthly site inspection by the Environmental Management Unit (EMU) of Bolikhamxay Province was carried out on 11 January 2019. The inspection focused on the site decommissioning activities at the RCC plant and Kenber camp. The EMU of Xaysomboun Province conducted a quarterly site inspection during 15 - 18 January 2019.

The effluent monitoring results for the camps in January 2019 indicate that the measurements of Bio-oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), faecal coliform and total coliform comply with the National Effluent Standards. However, non-compliance on the effluent discharge for Owner's Site Office and Village and IHI's subcontractor camp (276 Camp) were still observed. The Owner has undertaken a major repair of the waste water treatment ponds by replacing filtering materials, PVC pipes and growing new reeds. The results of the effluent discharge monitoring will be reported in February 2019 Monthly Progress Report.

In January 2019, the dissolved oxygen (DO) concentrations at the surface of Main Reservoir in R2, R3, R4 and R5 (upstream of the main dam some 35 km, 21 km, 13 km and 0.5 km respectively) were below the Standard of 6 mg/L on 3-4 January and on 28-29 January 2019, and at R5 and R2 on 21-22 January 2019. The DO measurements in R6 and R7 (re-regulation reservoir) were generally above 6.96 mg/L, and the DO at Nam Ngiep downstream the re-regulation dam (NNG05) has remained above 8 mg/L.

A total of 92.7 m³ of solid waste was disposed of at the NNP1 Project landfill, an increase of 5.7 m³ compared to December 2018. During January 2019, EMO conducted three waste spot checks at the NNP1 Project landfill, construction sites and the camps. A total of 12,830 kg of recyclable waste was sold to Khounmixay Processing Factory. A total of 113 m³ of solid waste from Phouhomxay, Thahuea and Hat Gniun Villages was disposed of at the Houay Soup Landfill.

The revised version of the Watershed Management Plan (WMP) was submitted to ADB, IAP, and BAC twice in response to their comments on 4 and 14 January 2019. A further revised version of the WMP was submitted to ADB, IAP, and BAC on 22 January 2019. ADB finally confirmed the WMP approval on 23 January 2019 with the condition that both the IAP and BAC had no objection with the WMP. IAP and BAC provided comments on 24 and 27 January 2019 and the plan was further revised and re-submitted on 31 January 2019. IAP and BAC finally confirmed on 31 January 2019 that they had no objection to approve of the plan and strongly recommended to focus on the implementation including the readiness of the Service Provider (for Technical Assistance on Biodiversity) to be hired by ADB.

Xaysomboun Provincial WRPO (Provincial Agriculture and Forestry Office) has further improved the draft watershed management regulation after the Xaysomboun WRPC coordination meeting on 20 December 2018. Xaysomboun WRPO will present the improved regulation at an internal WRPC-WRPO coordination meeting on 05 February 2019 prior to submitting to the Xaysomboun Provincial Assembly for endorsement and to the Provincial Governor for approval.

NNP1PC provided an official response to the draft AIP 2019 prepared by the Bolikhamxay Provincial WRPO on 31 January 2019. The formulation of the AIP 2019 by the Xaysomboun Provincial WRPO will continue after the internal WRPC and WRPO coordination meeting that is scheduled on 05 February 2019.

The remaining field verification surveys for the Total Protection Zone 1 (TPZ Phou Samsao) at Anouvong District and TPZ2 (TPZ Phou Khata) at Hom District will be continued after internal WRPC and WRPO coordination meeting that is scheduled on 05 February 2019.

The improved Biodiversity Offset Management Plan (BOMP) was submitted to ADB, IAP, and BAC on 25 January 2019. The IAP Biodiversity Specialist provided comments on 27 January 2019 and the Biodiversity Advisory Committee (BAC) provided comments on 29 January 2019, whilst there have been no further comments yet from ADB until 31 January 2019. Thus, further delay is expected for the finalization of the BOMP and approval by ADB. The approval by the Government will be undertaken once the BOMP is approved by ADB.

The fish catch monitoring for December 2018 in Nam Ngiep watershed was dominated by two groups of species which are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species, except *Hemibagrus filamentus* which is classified as Data Deficient.

The recorded catch of Threatened and Near Threatened species (IUCN Red List Classification) in December 2018 included one species that is classified as Endangered (EN), four Vulnerable (VU) species, and eight Near Threatened (NT) species.

1. INTRODUCTION

The Nam Ngiep originates in the mountains of Xieng Khouang Province, flowing through Khoun District into Thathom District of Xaysomboun Province, through Hom District and into Bolikhan District of Bolikhamxay Province. The Nam Ngiep meets the Mekong River just upstream from Pakxan in Bolikhamxay Province (Fig. 1-1).

Figure 1-1: Location Map

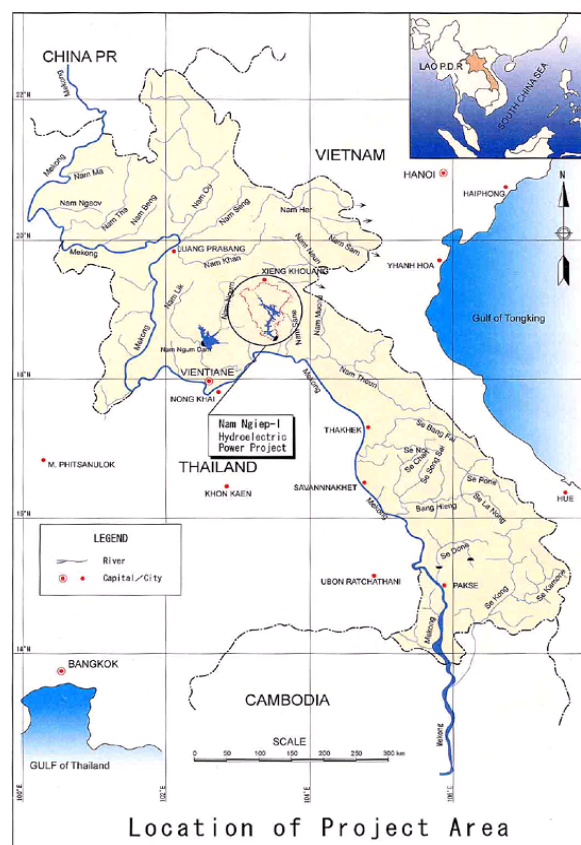
The project will consist of two dams. The main dam which is located 9.0 km upstream of Hat Gnuin Village in Bolikhan District, will create a 70-km-long, narrow reservoir that extends up the Ngiep Valley as far as Thathom District. At almost 150 m high, the main dam will be the second largest in Lao PDR. The Power Station at this dam will generate up to 272 MW of electricity for export to Thailand. With a combined capacity of 290 MW, Nam Ngiep 1 will generate around 1,620 GWh of electricity annually. Two transmission lines will be required to transport the electricity generated by the project. From the main power station, a 230-kV line will run for 125 km to the Nabong outside Vientiane Capital. A 115-kV transmission line will be constructed by EDL from the Re-regulation Power Station to Pakxan substation over a distance of 40 km.

This Environmental Monthly Monitoring Report (EMMR) provides a summary of environmental monitoring activities and mitigation actions in January 2017. The EMMR was prepared by the Project's Environmental Management Office (EMO). It has been internally reviewed and cleared by EMO senior technical staff and management prior to submitting the report to the Government of Lao PDR (GoL) related agencies.

The EMMR and other related reports including related construction Site Specific Environmental and Social Monitoring and Management Plans (SS-ESMMPs) are publicly disclosed on the Project website in line with the ADB and GoL Public Disclosure Policies. Hard copies of the final reports will also be available upon requests at the Project's main office in Vientiane Capital and field office in Pakxan, Bolikhamxay Province.

2. WORK PROGRESS OF PRINCIPAL CONTRACTORS

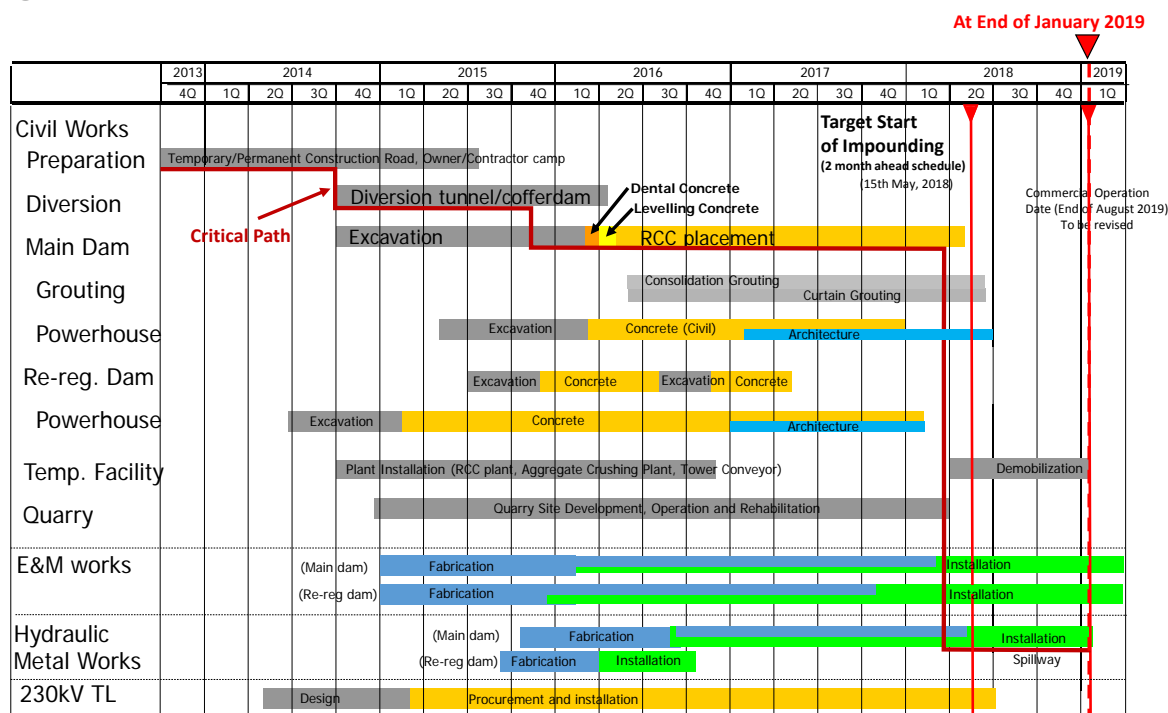
Construction Works for the Project are being carried out through four separate main construction contracts under the supervision of the Technical Division of NNP1PC. The four contracts are the Civil Works, the Electrical and Mechanical Works, the Hydraulic Metal or Hydro-mechanical Works and the 230 kV Transmission Line Works. Actual overall



cumulative work progress until the end of December 2018 was 97.9 %¹ (compared to planned progress of 98.3 %), based on achieved Interim Milestone Payments for all Contracts excluding the value of Advance Payments, varied works and other adjustments allowed under each Contract. In terms of the value of actual work done the percentage is understated since work completed, but not paid, is not included.

The overall construction schedule and progress curve (by achieved Milestone Payments) are shown in **Figure 2-1**.

Figure 2-1: Overall Construction Schedule



2.1 Civil Work

The Civil Works Contract was executed between Obayashi Corporation and the Nam Ngiep 1 Power Company on 30 September 2013 and the NTP was issued on 03 October 2014. Excavation works of the main dam, the diversion tunnel and the re-regulation dam

¹ The progress to-date is calculated as (Cumulative Amount of Achieved Interim Milestone Payments) / (Total Agreed Original Price of Construction Contracts) and expressed as a percentage. These totals exclude varied works and other adjustments allowed under each Contract.

² The progress to-date is calculated as (Cumulative Value Achieved for Completed Work by Variation Order or Other Adjustment) / (Total Budget Contingency Amount)

were commenced in October 2014 and completed in February 2016, following which the concreting works were commenced.

The cumulative actual work progress of the Civil Works until the end of December 2018 was 99.2 % (compared to planned progress of 99.7 %) calculated in the same manner as described above for the value of achieved Interim Milestone Payments excluding advance payment.

2.1.1 Main dam and power house

After starting the main dam excavation works in October 2014 on the left bank, the works were about one month advanced when diversion of the Nam Ngiep River was achieved at the end of October 2015. However, excavated volumes were 20% greater than expected and part of this additional work is necessary to construct a 'shear key' structure due to the weak layers of rock encountered in the dam foundation. Following the efforts on Site, the additional excavation work was completed at the end of February 2016.

Table 2-1: Main Powerhouse Sub-Structure Concrete Works Progress at 31 January 2019.

| Location | Total Anticipated Volume (m ³) | Completed (m ³) | Progress (%) |
|--------------------|--|-----------------------------|--------------|
| Main Powerhouse | 34,800 | 34,800 | 100 |
| Penstock Embedment | 11,885 | 11,885 | 100 |
| Spillway | 35,500 | 35,500 | 100 |

2.1.2 Re-regulation dam and powerhouse

The re-regulation powerhouse excavation and cofferdam works for river diversion were commenced in early October 2014. The excavation works for the powerhouse on the left bank were fully completed down to El. 146.7 m at the end of February 2015.

Structural concrete works were commenced in March 2015, in coordination with installation of the grounding system. The progress of structural concrete works is shown in **Figure 2-2** below:



Figure 2-2: Completed Re-regulation Dam and Powerhouse at the End of June 2018

2.1.3 Temporary work facility

2.1.3.1 DIVERSION TUNNEL INLET AND OUTLET

The diversion tunnel works which is over 600 m in length and 10 m in diameter were commenced in October 2014 by drill and blast techniques and completed in late September 2015. The river diversion took place on 31 October 2015 together with construction of earth-fill cofferdams upstream and downstream.

The second diversion to divert the river from the diversion tunnel through the bottom outlet or conduit in the dam was implemented on 13 January 2018.

2.1.3.2 SECONDARY UPSTREAM COFFERDAM

The concrete placement works in both conventional and roller compacted concrete (CVC and RCC respectively) for the secondary upstream cofferdam were started in November 2015 and completed ahead of construction schedule in the middle of February 2016. The grout curtain works were completed on 02 April 2016.

2.1.3.3 PLANT YARDS

These comprise the Aggregate Crushing Plant, the CVC Batching Plant and the RCC Batching Plant.

Foundation work and installation of equipment were completed at all the plant yards and the belt conveyor system from the RCC plant to the main dam was completed in early April 2016. Decommissioning and rehabilitation is underway on both plants and almost completed for the Aggregate Crushing Plant.

2.1.3.4 QUARRY

After removal of overburden the excavation of raw materials for aggregate crushing were started in July 2015. The nature and type of the rock being exploited is acceptable though unsuitable soil layers are removed to spoil disposal areas, and good quarry management continues.

2.1.3.5 DISPOSAL AREAS

The disposal area on the right bank has been available for operation since January 2015, as was the adjacent waste disposal area. The Disposal Area No.9 along Road P1 near the entrance of Road T5 started operation in April 2015. Unsuitable material from the quarry continues to be hauled to Disposal Area No.6 and Disposal Area No.9 is being developed by the E&M Contractor as stated above.

2.2 Electrical and Mechanical Works

The EMW Contract was executed between Hitachi-Mitsubishi Hydro Corporation and NNP1PC on 13 June 2014 and the NTP was issued in 03 October 2014. The cumulative work progress of the Electrical and Mechanical Works by value at the end of January 2019 was 98.8 % (compared to planned progress of 100.0 %).



Figure 4.2-1: Upper shaft levelling measurement for Unit 1



Figure 4.2-2: Lower shaft inclination measurement for Unit 1



Figure 4.2-3: Turbine shaft inclination measurement for Unit 1



Figure 4.2-4: Turbine bottom cover levelness measurement for Unit 1



Figure 4.2-5: Lowering of rotor for Unit 2 (Reassembly work)



Figure 4.2-6: Shaft inclination check inside turbine pit for Unit 2

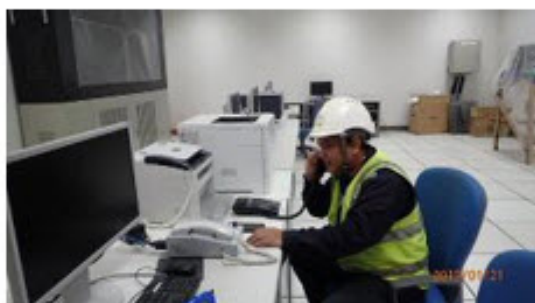


Figure 4.2-7: Sound test of speaker PAGA paging system for main powerhouse



Figure 4.2-8: SCADA Operation test of spillway gate No.2



Figure 4.2-9: Final inspection of balance of plant



Figure 4.2-10: Installation of grounding system was completed



Figure 4.2-11: Operation test of drainage pump system



Figure 4.2-12: Operation test of fire extinguishing system for main transformer



Figure 4.2-13: Operation test for cooling water supply system for turbine and generator



Figure 4.2-14: Alarm operation test of governor panel



Figure 4.2-15: SCADA loop check and interface with intake dam and main power station



Figure 4.2-16: Wet test of intake gate by local panel control and SCADA operation



Figure 4.2-17: Operation test of line protection for 115 kV transmission line



Figure 4.2-18: Changeover switching test of MCC panels by energy power supply from diesel generator



Figure 4.2-19: Loop jumper connection from 115 kV transmission line to CVT in switchyard



Figure 4.2-20: Punch list inspection on control room

2.3 Hydro-Mechanical Works

The HMWC was executed between IHI Infrastructure Systems (IIS) and NNP1PC on 18 April 2014 and the NTP was issued to the Contractor on 03 October 2014. The actual cumulative work progress of the Hydro-Mechanical Works until **the end of December 2018 was 97 % (compared to planned progress of 97 %)**. The main activities carried out during this month are described below:

Table 2-2 : Progress of Spillway Gate Erection at the Main Dam at the End of January 2019.

| Progress of MD Spillway Gate | 2018 | | | | | | | | | | | | 2019 | | | | | |
|----------------------------------|-----------|---|---|---|-----------|-----------|---|---|---|----|----|----|---------|--------|----------------|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
| Trunnion Girder and Tension Beam | Completed | | | | | | | | | | | | | | | | | |
| Radial/Stop-long Guide Frame | | | | | Completed | | | | | | | | | | | | | |
| Radial Gate Leaf | | | | | | Completed | | | | | | | | | | | | |
| Dry tests | | | | | | | | | | | | | Planned | Actual | 98 % Completed | | | |
| Wet tests | | | | | | | | | | | | | Planned | | | | | |



Figure 2-3: Progress of Spillway Gate Erection at the Main Dam in January 2019



Figure 2-4: Functional test (Dry test) of the gate leaf for the spillway gate No.2 at the Main Dam in January 2019.



Figure 2-5 : Spillway Gate in Operation from the Spillway Gate No. 4 at the Main Dam in January 2019.

2.4 230kV Transmission Line Works

The TLW Contract was executed between Loxley-Sri Consortium and NNP1PC on 11 July 2014 and the NTP was issued to the 230 kV TL Contractor on 03 October 2014. The cumulative work progress of the Transmission Line Works until the end of June 2018 was 100 % (compared to planned progress of 100 %).



Figure 2-6: Tower No. 3



Figure 2-7: Preparation for Megger Test Section PWH-T3 & Visual Check along the Line Route before the Energization Test

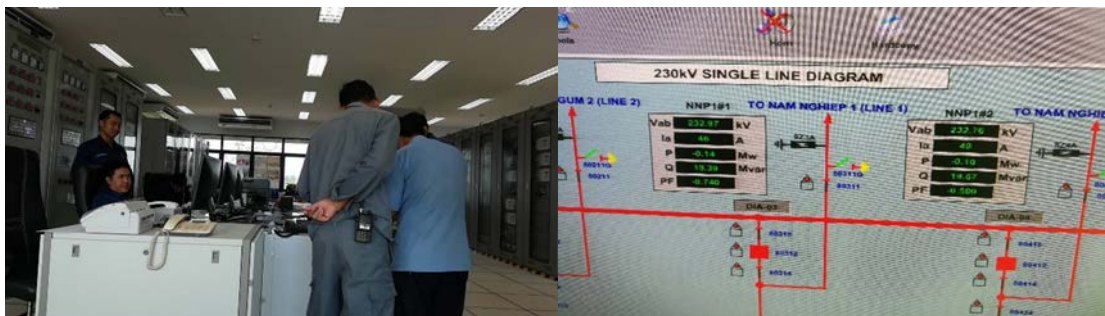


Figure 2-8: The energization work for the 230 kV Transmission Line from Nabong Substation to Main Power House NNP1

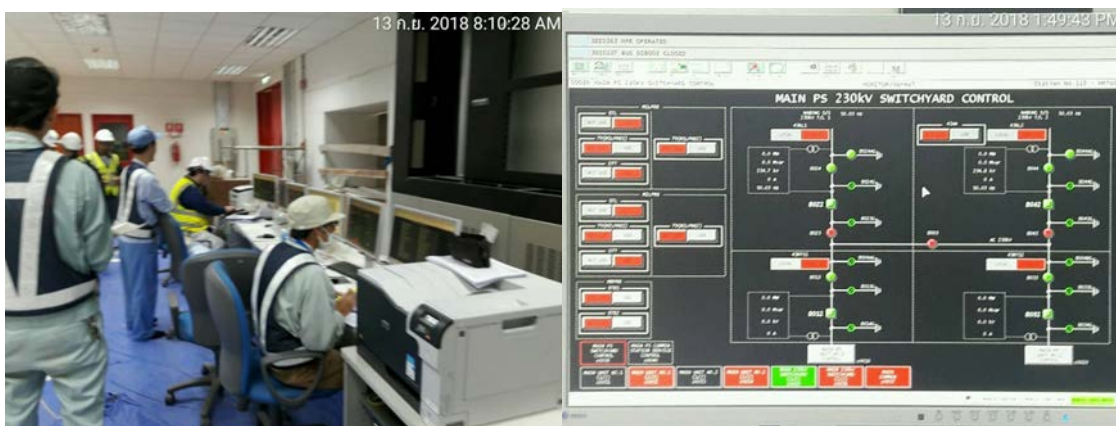


Figure 2-9: The Energization Work for the 230 kV Transmission Line from Nabong Substation to Main Power House NNP1.

3. ENVIRONMENTAL MANAGEMENT MONITORING

3.1 Compliance Management

In January 2019, the Environmental Management Office (EMO) of Nam Ngiep 1 Power Company (NNP1PC) received one DWP and one SS-ESMMP for Houay Soup Landfill Operation and one Site Decommissioning and Rehabilitation Plan for review and approval.

Table 3-1: *Summary of ONC and NCR*

| Items | ONC | NCR-1 | NCR-2 | NCR-3 |
|-------------------------------|----------|----------|----------|----------|
| Carried over from 2018 | 0 | 1 | 1 | 0 |
| Newly Opened in January 2019 | 5 | 0 | 0 | 0 |
| Total in January 2019 | 5 | 1 | 1 | 0 |
| Resolved in January 2019 | 0 | 0 | 0 | 0 |
| Carried over to February 2019 | 5 | 1 | 1 | 0 |
| Unsolved Exceeding Deadlines | 0 | 1 | 1 | 0 |

3.1.1 Inspection by Environment Monitoring Unit

The monthly site inspection by the Environmental Management Unit (EMU) of Bolikhamxay Province was carried out on 11 January 2019. The inspection focused on the site decommissioning activities at the RCC Plant and Kenber Camp. There was no significant environmental issue identified during this inspection.

3.2 Environmental Quality Monitoring

The analyses of Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD₅), faecal coliform, E. Coli bacteria and total coliform have been carried out by NNP1PC Environmental Laboratory since August 2017.

All data are reported to the Ministry of Natural Resources and Environment (MONRE) and the Project Lenders on a monthly and quarterly basis and published on the Company website <https://namngiep1.com/resources/monitoring-reports/>.

3.2.1 Effluent Discharge from Camps and Construction Sites

Detailed monitoring results are provided in **Annex B** of this Report. The effluent monitoring results for the camps in January 2019 indicate that the measurements of BOD₅, COD, faecal coliform and total coliform comply with the relevant effluent standards for a few camps whereas the results of a few parameters for Owner's Site Office and Village, Song Da 5 Camp No.2, Zhefu Camp, HM Main Camp, IHI Main Camp and IHI Field Shop 276 Camp did not comply with the Standards.

Following the completion of the RCC placement work at the Main Dam by the end of April 2018, the production at the aggregate crushing plant and the RCC plant has stopped and the associated sediment retention ponds are therefore no longer in operation.

EMO discontinued the water sampling at the RCC Plant, Aggregate Crushing Plant, Sino Hydro Camp and Kenber Camp because these sites were decommissioned in November 2018.

The status of implementation of the corrective actions addressing non-compliances at the camps and key construction sites that continue to have non-compliances is summarized in **Table 3-2**.

Table 3-2: Status of Corrective Actions at Camps and Construction Sites

| Site | Sampling ID | Status | Corrective Actions |
|---|-------------|---|---|
| Owner's Site Office and Village (OSOV) | EF01 | Non-compliance for total coliform, faecal coliform, total nitrogen, ammonia-nitrogen and BOD ₅ . | Wetland ponds improvement was completed in January 2019 including the replacement of the filtration material, weeds clearing and reeds planting. The results will be monitored and reported next month. |
| Obayashi Corporation Camp | EF02 | Non-compliance for total nitrogen and ammonia-nitrogen. | The Contractor has been advised to improve the operation of the waste water treatment system. The results will be monitored and reported in February 2019 Report. |
| Song Da 5 Camp No. 1 | EF07 | Non-compliance for ammonia nitrogen and total nitrogen. | See above |
| Song Da 5 Camp No. 2 | EF08 | Non-compliance for ammonia nitrogen and total nitrogen. | See above |
| Zhefu Camp (Subcontractor of Hitachi-Mitsubishi Hydro) | EF09 | Non-compliance for COD, ammonia nitrogen and total nitrogen. | See above |
| V&K Camp | EF10 | Non-compliance for total nitrogen in first fortnightly sampling. | No action is required as the second fortnightly sampling was fully complied. |

| Site | Sampling ID | Status | Corrective Actions |
|--------------------------------|-------------|--|--|
| HMH Main Camp (WWTS) | EF13 | Non-compliance for COD, ammonia nitrogen and total nitrogen. | The Contractor was requested to readjust the auto pump to aid more residence time for waste water in the wetland ponds. |
| IHI Main Camp | EF14 | Non-compliance for COD and total nitrogen. | EMO will follow up on this issue and report in the next monitoring period. |
| IHI Field Shop 276 Camp | EF18 | Non-compliance for TSS, BOD ₅ , COD, NH ₃ -N and total nitrogen, and total coliform and faecal coliform. | The Site inspection report (Ref. no.: EMO-SIR-IHI-0010) was issued to the Contractor in January 2019 to fix and maintain the chlorination dosage rate as per NNP1PC-EMO's recommendation (30 ml/minute) and assign key responsible staff to operate and maintain the Wastewater Treatment System properly |

3.2.2 Ambient Surface Water Quality Monitoring

The ambient surface water quality monitoring programme comprises 5 monitoring stations in the main reservoir (R1-R5), 2 stations in the re-regulation reservoir (R6 and R7), 5 stations in the mainstream Nam Ngiep (NNG01 and NNG05 to NNG08) and 4 stations in the main tributaries to Nam Ngiep (Nam Chiane [NCH01], Nam Phouan [NPH01], Nam Xao [NXA01] and Nam Houay Soup [NHS01]).

In addition, weekly depth profile monitoring (pH, DO, Conductivity, TDS and Temperature) was started on 18 September 2018 for stations located in the re-regulation and main reservoirs.

Table 3-3: Monitoring Frequency for Surface Water Quality Parameters

| Frequency of Monitoring | Parameters (Unit) | Monitoring Sites |
|-------------------------|---|--|
| Saturday | pH, DO (%), DO (mg/l), Conductivity ($\mu\text{S}/\text{cm}$), TDS (mg/l), Temperature ($^{\circ}\text{C}$) and Turbidity (NTU) | <ul style="list-style-type: none"> - R5, main reservoir immediately upstream the main dam; - NNG05, Nam Ngiep downstream the re-regulation dam at Hat Gniun Village |
| Weekly | pH, DO (%), DO (mg/l), Conductivity ($\mu\text{S}/\text{cm}$), TDS (mg/l), Temperature ($^{\circ}\text{C}$), Turbidity (NTU), TSS (mg/l), BOD ₅ (mg/l), Faecal coliform (MPN/100 ml), Total coliform (MPN/100 ml) and Hydrogen sulphide (mg/l) | <ul style="list-style-type: none"> - Main Reservoir: R1, R2, R3, R4, R5 - Re-regulation Reservoir: R6, R7 - Nam Ngiep downstream: NNG05 - Tributaries: NPH01, Nam Phouan |
| Fortnightly | pH, DO (%), DO (mg/l), Conductivity ($\mu\text{S}/\text{cm}$), TDS (mg/l), Temperature ($^{\circ}\text{C}$), Turbidity (NTU) | All stations |
| Monthly | TSS (mg/l), BOD ₅ (mg/l), COD (mg/l), NH ₃ -N (mg/l), NO ₃ -N (mg/l), total coliform (MPN/100 ml), faecal coliform (MPN/100 ml) | All stations |

The monitoring results for key parameters (DO, TSS and BOD₅) during January 2019 are presented in

Table 3-4, Table 3-5, and Table 3-6. The full set of data for January 2019 is attached in Annex A. In addition, the results for DO are presented as line graphs in **At R5**, the DO level in the upper 5.0 m fluctuated from about 6.7 mg/L to 11.3 mg/L, and the entire water column below 9.0 m had DO levels less than 2.79 mg/L on 07 and 14 January 2019. The DO concentration in entire water column at R5 were between 0.03 - 4.74 mg/L on 3, 21 and 28 January 2019.

At R4, the DO level in the upper 4.5 m fluctuated from about 3.83 mg/L to 8.63 mg/L and the entire water column below 11.0 m had DO levels below 1.7 mg/L on 7, 14, 21 and 28 January 2019. The DO concentration in entire water column at R4 were between 0.03 - 2.90 mg/L on 3 January 2019.

The DO concentrations at R3 were recorded between 2.64 mg/L to 6.66 mg/L in the upper 6.0 m on 03 and 29 January 2019 and were between 6.04 mg/L to 8.15 mg/L in the upper 2.5 m on 08, 15 and 22 January 2019, and the concentration of DO in the entire water column below 6.5 m was less than 2.55 mg/L.

The DO concentrations at R2 were between 1.3 mg/L to 6.76 mg/L in the upper 2.0 m on 08, 22 and 29 January 2019 and DO level was greater than 7.9 mg/L in upper 2.5 m on 15

January 2018. the DO concentration at R2 in entire water column between 4.5 – 19.0 m were 0.02 mg/L to 0.88 mg/L and DO level increased from 0.07 mg/L to 5.28 mg/L at 20.0 m till the bottom during January 2019. The increment of DO near bottom reservoir at R2 may influence from high DO concentration in R1.

The DO concentrations in the entire water column at R1 were from 6.29 mg/L to 9.40 mg/L (15, 22 and 29 January 2019) and from 4.61 mg/L to 6.73 mg/L (08 January 2019).

The temperature measurements indicate the start of formation of a thermocline in R2-R5.

As expected, the TSS concentrations in the main reservoir have been consistently very low since the start of impounding with a mean in R4 and R5 of 5 mg/L compared to high flow season means of about 100 mg/L – 250 mg/L and low flow season means of 20 mg/L - 50 mg/L.

The BOD5 measurements show – as expected – increasing levels in R1 and R5 in the main reservoir since about one month into impounding.

Figure 3-1.

Re-regulation Reservoir

The level of DO in both R6 and R7 has remained well above 6.84 mg/L in the whole water column and with water temperatures unchanged from the surface to the bottom of the reservoir. There are no indications of a thermocline.

Main Reservoir

At R5, the DO level in the upper 5.0 m fluctuated from about 6.7 mg/L to 11.3 mg/L, and the entire water column below 9.0 m had DO levels less than 2.79 mg/L on 07 and 14 January 2019. The DO concentration in entire water column at R5 were between 0.03 - 4.74 mg/L on 3, 21 and 28 January 2019.

At R4, the DO level in the upper 4.5 m fluctuated from about 3.83 mg/L to 8.63 mg/L and the entire water column below 11.0 m had DO levels below 1.7 mg/L on 7, 14, 21 and 28 January 2019. The DO concentration in entire water column at R4 were between 0.03 - 2.90 mg/L on 3 January 2019.

The DO concentrations at R3 were recorded between 2.64 mg/L to 6.66 mg/L in the upper 6.0 m on 03 and 29 January 2019 and were between 6.04 mg/L to 8.15 mg/L in the upper 2.5 m on 08, 15 and 22 January 2019, and the concentration of DO in the entire water column below 6.5 m was less than 2.55 mg/L.

The DO concentrations at R2 were between 1.3 mg/L to 6.76 mg/L in the upper 2.0 m on 08, 22 and 29 January 2019 and DO level was greater than 7.9 mg/L in upper 2.5 m on 15 January 2018. the DO concentration at R2 in entire water column between 4.5 – 19.0 m were 0.02 mg/L to 0.88 mg/L and DO level increased from 0.07 mg/L to 5.28 mg/L at 20.0 m till the bottom during January 2019. The increment of DO near bottom reservoir at R2 may influence from high DO concentration in R1.

The DO concentrations in the entire water column at R1 were from 6.29 mg/L to 9.40 mg/L (15, 22 and 29 January 2019) and from 4.61 mg/L to 6.73 mg/L (08 January 2019).

The temperature measurements indicate the start of formation of a thermocline in R2-R5.

As expected, the TSS concentrations in the main reservoir have been consistently very low since the start of impounding with a mean in R4 and R5 of 5 mg/L compared to high flow

season means of about 100 mg/L – 250 mg/L and low flow season means of 20 mg/L - 50 mg/L.

The BOD₅ measurements show – as expected – increasing levels in R1 and R5 in the main reservoir since about one month into impounding.

Figure 3-1: Surface Water and Re-Regulation Reservoir Water Quality Monitoring Stations

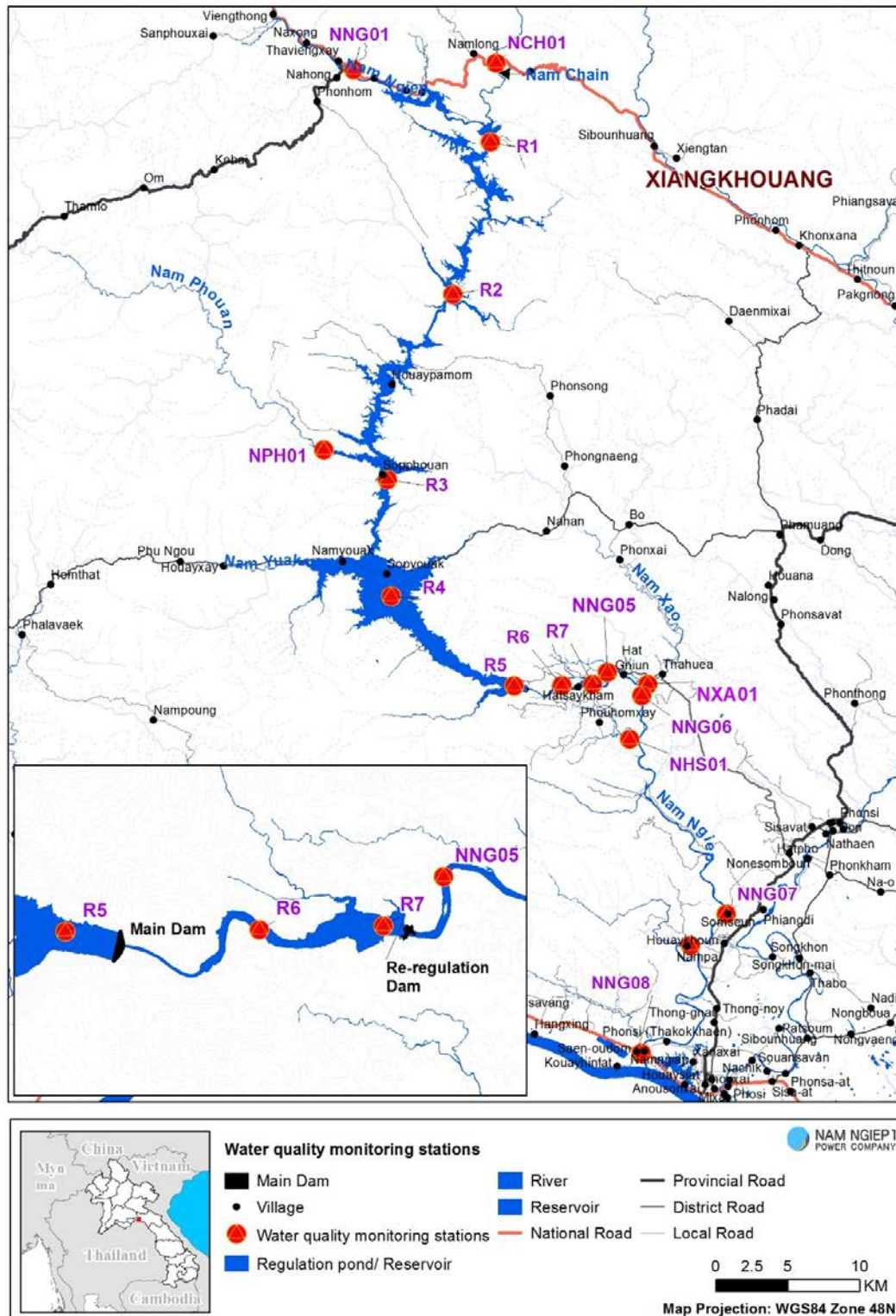
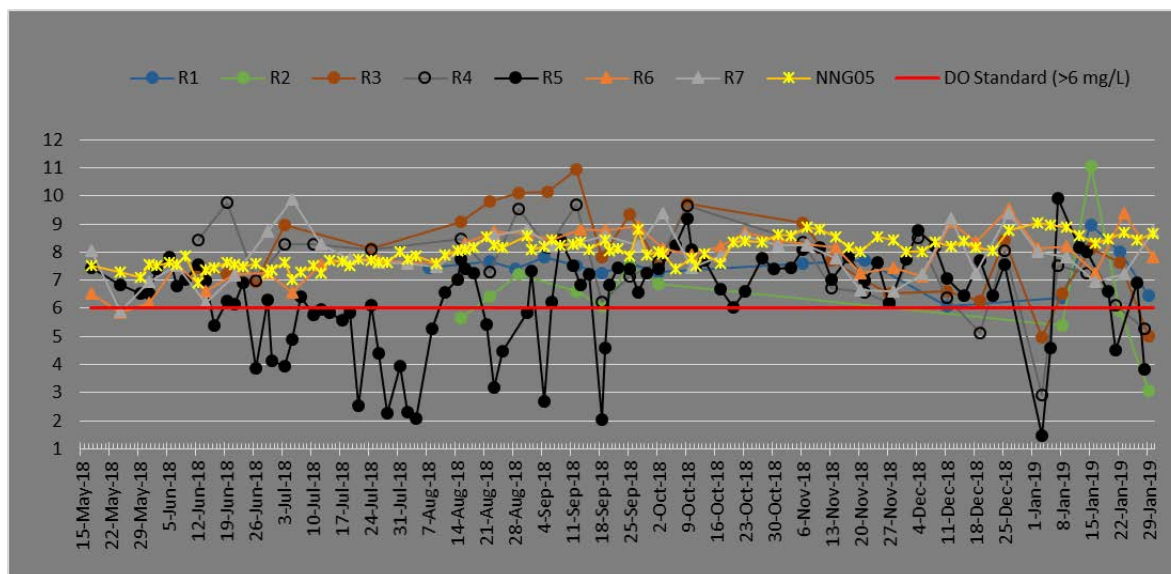


Figure 3-2: Concentration of Dissolved Oxygen in the upper 0.5 m since the Start of Impounding**Table 3-4:** Results of Surface Water Quality Monitoring for Dissolved Oxygen (mg/L) in the upper 0.5 m - Water Quality Standard: > 6.0 mg/L

| Dissolved Oxygen (mg/L) | NNG01 | R1 | R2 | R3 (NNG02) | R4 (NNG03) | R5 (NNG09) | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|-------------------------|-------|------|-------|------------|------------|------------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| 2-Jan-19 | | | | | | | 8.13 | 8.0 | 9.04 | 9.06 | 8.39 | 7.92 | | | 8.45 | 7.07 |
| 3-Jan-19 | | | | 4.96 | 2.9 | 1.46 | | | | | | | | 8.52 | | |
| 5-Jan-19 | | | | | | 4.58 | | | 8.98 | | | | | | | |
| 7-Jan-19 | | | | | 7.5 | 9.92 | | | | | | | | | | |
| 8-Jan-19 | | 6.39 | 5.38 | 6.51 | | | | | | | | | | 7.94 | | |
| 9-Jan-19 | | | | | | | 8.22 | 7.84 | 8.89 | 8.9 | 8.6 | 8.19 | | | 8.59 | 8.53 |
| 12-Jan-19 | | | | | | 8.18 | | | 8.57 | | | | | | | |
| 14-Jan-19 | | | | | 7.26 | 8.02 | | | | | | | | | | |
| 15-Jan-19 | 8.55 | 8.97 | 11.06 | 8.12 | | | | | | | | | 8.37 | 9.25 | | |
| 16-Jan-19 | | | | | | | 7.24 | 6.96 | 8.32 | 8.21 | 7.82 | 7.37 | | | 7.31 | 6.84 |
| 19-Jan-19 | | | | | | 6.6 | | | 8.46 | | | | | | | |
| 21-Jan-19 | | | | | 6.1 | 4.53 | | | | | | | | | | |
| 22-Jan-19 | | 8.01 | 5.91 | 7.62 | | | | | | | | | | 9.95 | | |
| 23-Jan-19 | | | | | | | 9.37 | 7.23 | 8.71 | 8.54 | 8.02 | 7.76 | | | 7.55 | 8.54 |
| 26-Jan-19 | | | | | | 6.9 | | | 8.42 | | | | | | | |
| 28-Jan-19 | | | | | 5.26 | 3.83 | | | | | | | | | | |
| 29-Jan-19 | | 6.47 | 3.05 | 5.02 | | | | | | | | | | 8.56 | | |
| 30-Jan-19 | | | | | | | 7.82 | 8.74 | 8.65 | 8.51 | 7.55 | 7.61 | | | 7.77 | 8.13 |

Table 3-5: Results of Surface Water Quality Monitoring for Total Suspended Solids (mg/L) - Water Quality Standard: No Standard

| Total Suspended Solids (mg/L) | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|-------------------------------|-------|----|----|----|----|----|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|
| 2-Jan-19 | | | | | | | 21.72 | 15.88 | 30.1 | | | | | | | |
| 3-Jan-19 | | | | | | <5 | | | | | | | | | | |
| 7-Jan-19 | | | | | | <5 | | | | | | | | | | |
| 9-Jan-19 | | | | | | | 11.23 | 7.34 | 8.12 | | | | | | | |
| 14-Jan-19 | | | | | <5 | <5 | | | | | | | | | | |
| 15-Jan-19 | 10.57 | <5 | <5 | <5 | | | | | | | | | 141.61 | 6.68 | | |
| 16-Jan-19 | | | | | | | <5 | <5 | <5 | <5 | 6.07 | 6.25 | | | <5 | <5 |
| 21-Jan-19 | | | | | | <5 | | | | | | | | | | |
| 23-Jan-19 | | | | | | | 6.99 | 6.76 | 13.33 | | | | | | | |
| 28-Jan-19 | | | | | | <5 | | | | | | | | | | |
| 30-Jan-19 | | | | | | | 55.1 | 28.16 | 31.55 | | | | | | | |

Table 3-6 Results of Surface Water Quality Monitoring for BOD5 (mg/L) - Water Quality Standard: < 1.5 mg/L

| BOD5 (mg/L) | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|-------------|-------|------|-----|----|----|------|----|----|-------|-------|-------|-------|-------|-------|-------|-------|
| 2-Jan-19 | | | | | | | <1 | <1 | <1 | | | | | | | |
| 3-Jan-19 | | | | | | 1.4 | | | | | | | | | | |
| 7-Jan-19 | | | | | | 1.1 | | | | | | | | | | |
| 9-Jan-19 | | | | | | | <1 | <1 | 1.06 | | | | | | | |
| 14-Jan-19 | | | | | <1 | 1.37 | | | | | | | | | | |
| 15-Jan-19 | <1 | 1.56 | 1.1 | <1 | | | | | | | | | <1 | <1 | | |
| 16-Jan-19 | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 | | | <1 | <1 |
| 21-Jan-19 | | | | | | <1 | | | | | | | | | | |
| 23-Jan-19 | | | | | | | <1 | <1 | <1 | | | | | | | |

3.2.3 Groundwater Quality Monitoring

During January 2019, community groundwater quality analyses were carried out for four water-wells located in Somseun Village, Nam Pa Village, Thong Noi Village and Pou Village.

All results of community groundwater complied with the groundwater quality standards for water supply purposes, except for faecal coliform and E.Coli bacteria in Nam Pa and Thong Noi Villages).

Table 3-7: Groundwater Quality Monitoring Results, Somsuen, Nam Pa, Thongnoi and Pou Villages

| | Site Name | Somseun Village | NamPa Village | ThongNoy Village | Pou Village |
|-------------------------------|-----------|-----------------|---------------|------------------|-------------|
| | Station | GSXN01 | GNPA01 | GTHN01 | GPOU01 |
| Parameter (Unit) | Guideline | | | | |
| pH | 6.5 - 9.2 | 7.79 | 7.35 | 7.21 | 6.7 |
| Sat. DO (%) | | 80.7 | 81.7 | 79.7 | 92.2 |
| DO (mg/l) | | 6.58 | 6.6 | 6.37 | 7.31 |
| Conductivity (µS/cm) | | 274 | 313 | 301 | 18.75 |
| TDS (mg/l) | | 137 | 156.5 | 150.5 | 9.3 |
| Temperature (°C) | | 24.8 | 25.2 | 25.6 | 24.9 |
| Turbidity (NTU) | <20 | 0.96 | 1.16 | 1.46 | 2.42 |
| Faecal coliform (MPN/100 ml) | 0 | 0 | 13 | 240 | 0 |
| E. Coli Bacteria (MPN/100 ml) | 0 | 0 | 13 | 240 | 0 |

3.2.4 Gravity Fed Water Supply (GFWS) Quality Monitoring

During January 2019, water samples from water taps at Thahuea Village, Hat Gniun Village and Phouhomxay Village were analysed. The WPHX01 represents raw water in the head tank before filtration.

The results of the water quality analyses are presented in **Table 3-8**. All parameters complied with the National Drinking Water Standards except for faecal coliforms and E.Coli at WTHH02, WHGN02, WPHX01, WPHX02 (tap water at the primary school in Phouhomxay Village) and WPHX03 (tap water at a house in Phouhomxay Village). The villagers were informed about the results and encouraged to boil the water before drinking.

Table 3-8: Result Gravity Fed Water Supply (GFWS) Quality Monitoring

| | | Site Name | Thaheau Village | Hat Gnuin Village | Phouhomsay Village | | |
|-----------|------------------------------|-----------|-----------------|-------------------|--------------------|--------|--------|
| | | Station | WTHH02 | WHGN02 | WPHX01 | WPHX02 | WPHX03 |
| Date | Parameter (Unit) | Guideline | | | | | |
| 24-Jan-19 | pH | 6.5 - 8.6 | 8.23 | 8.45 | 8.73 | 8.87 | 7.84 |
| 24-Jan-19 | Sat. DO (%) | | 97.6 | 96.5 | 97.5 | 93.3 | 90.3 |
| 24-Jan-19 | DO (mg/l) | | 8.02 | 8.12 | 8.27 | 7.81 | 7.58 |
| 24-Jan-19 | Conductivity (µS/cm) | <1,000 | 49.6 | 60 | 12.73 | 13.53 | 13.02 |
| 24-Jan-19 | TDS (mg/l) | <600 | 24.8 | 30 | 6.3 | 6.8 | 6.5 |
| 24-Jan-19 | Temperature (°C) | <35 | 24.2 | 23.1 | 22.6 | 23.4 | 23.1 |
| 24-Jan-19 | Turbidity (NTU) | <10 | 1.47 | 3.83 | 1.33 | 1.87 | 1.94 |
| 24-Jan-19 | Faecal Coliform (MPN/100 ml) | 0 | 22 | 79 | 130 | 130 | 79 |
| 24-Jan-19 | E.coli Bacteria (MPN/100 ml) | 0 | 22 | 79 | 130 | 79 | 49 |

3.2.5 Landfill Leachate Monitoring

During January 2019, the landfill leachate monitoring was not conducted at NNP1 Project Landfill and at Houay Soup Solid Waste Landfill because there was no leachate collected in the treatment ponds (evaporated).

3.2.6 Dust Monitoring

The results indicate that the dust levels at all monitoring stations complied with the National Standard. The results were shared internally with other relevant NNP1PC Departments as a reference for inspection to ensure proper establishment of health and safety procedures.

3.2.7 Noise Monitoring

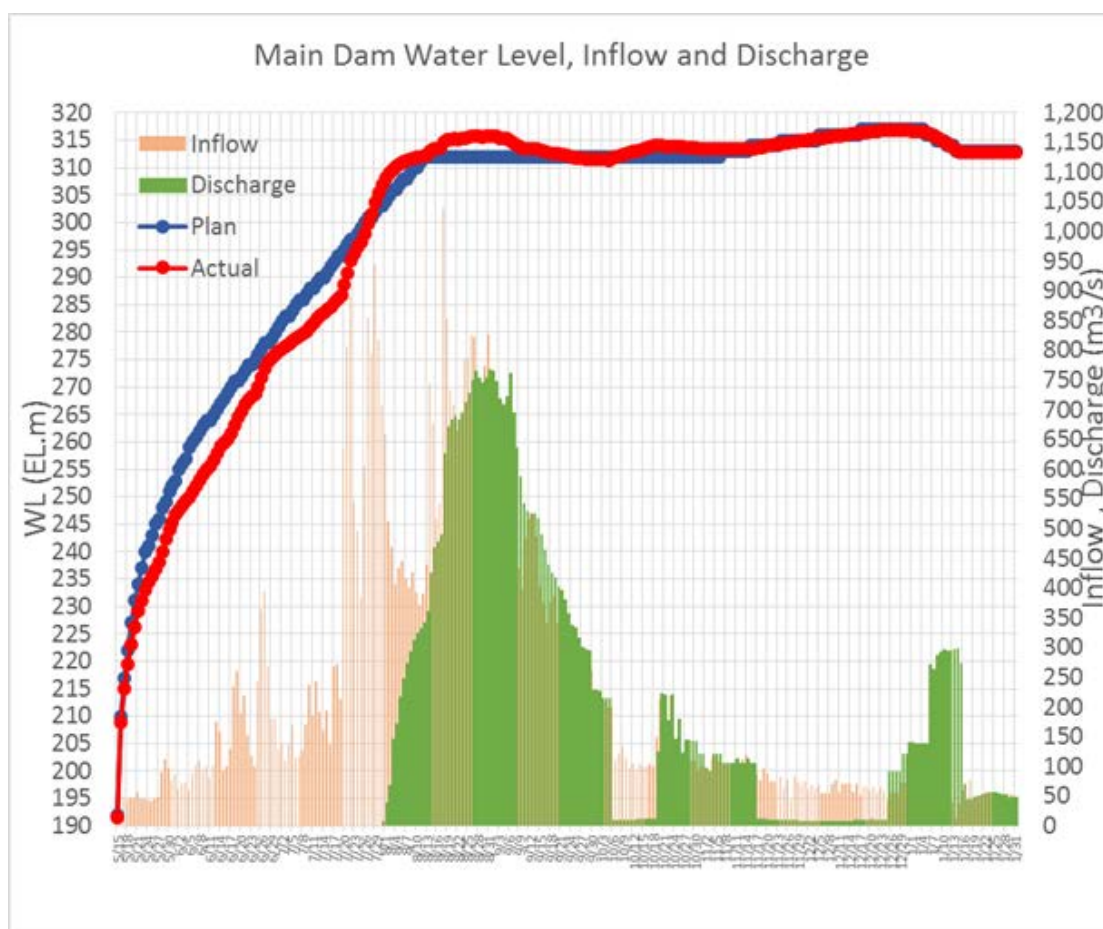
During January 2019, noise monitoring was conducted for 72 consecutive hours at Hat Gniun Village and Phouhomxay Village, and for 24 consecutive hours at the Main Dam, Song Da 5 Camp No.2, Lilama 10 Camp, and the Main Powerhouse.

The results indicate that the recorded maximum noise levels and averaged noise levels complied with the Standard for all stations.

3.2.8 Discharge Monitoring

The progress of impounding from 15 May 2018 to 31 January 2019 is presented on the graph in

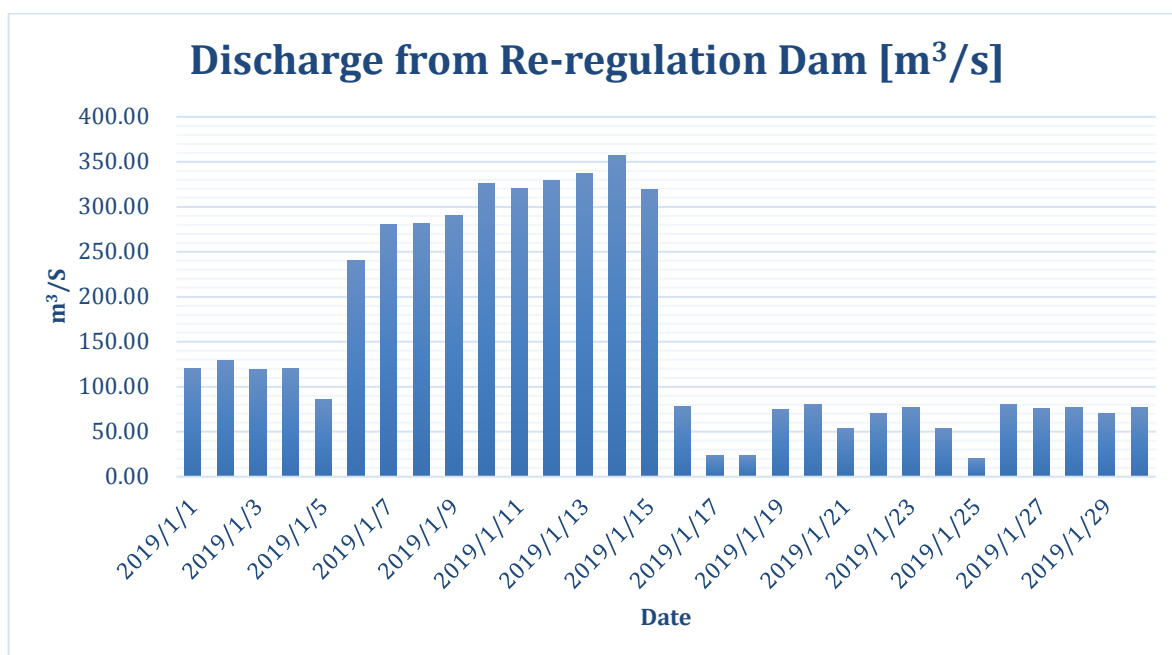
Figure 3-3 indicating the water level in the main reservoir, the inflow to the main reservoir and the discharge from the main reservoir into the re-regulation reservoir. The inflow data shows the gradual reduction in flows from the end of the wet season into the dry season with inflows from about 100 m³/s at the beginning of November 2018 to an average of about 40 m³/s during January 2019.

Figure 3-3: Progress of Impounding the Main Reservoir

On 17 November 2018 the impounding of the main reservoir was restarted and continued until 25 December 2018. The water level in the reservoir rose with 3.2 m from El. 313.6 masl on 17 November 2018 to El. 316.8 masl on 25 December 2018. In the same period, the discharges from the main dam and the re-regulation dam were reduced (see *Figure 3-4*) and maintained close to 10 m³/s, which is well above the minimum flow requirement of 5.5 m³/s. On 25 December 2018 the discharge from the main dam and the re-regulation dam was increased to equal the inflow to the main reservoir and this was maintained during the remaining part of December 2018. As presented in

Figure 3-4, in the first 2 weeks of January 2019, the discharge from the re-regulation dam was increased to about 300 m³/s or about 250 m³/s above the inflow to the main reservoir thereby lowering the water level in the main reservoir with about 4 m to El. 312.8 masl. During the remaining part of January 2019, the discharge from the re-regulation dam was generally kept about 10-20 m³/s above the inflow to the main reservoir.

The changes in the discharge from the re-regulation dam were informed in advance to the RMU and to the heads of the downstream villages, who then announced the changes to the communities over the village speaker systems.

Figure 3-4: Discharge Monitoring at the Re-regulation Dam.

During the restarted impounding, the water level in the re-regulation reservoir was lowered to about El. 173.0 masl (Normal Water Level is El. 179 masl) and this combined with the reduced spillway discharge has enabled various construction works and plunge pool excavations near the main dam to be undertaken.

3.2.9 Nam Ngiep Downstream Water Depth Monitoring

In January 2019, EMO carried out five boat missions to monitor the water depth in Nam Ngiep downstream of the re-regulation dam. EMO has currently identified 19 sites with potential shallow water depths. The monitoring showed that all these sites had water depths from 0.87 – 3.7 m with no difficulties navigating on the river due to the increased discharge from the re-regulation dam as mentioned in Section 1.3 above.

3.3 PROJECT WASTE MANAGEMENT

3.3.1 Solid Waste Management

In January 2019, a total of 92.7 m³ of solid waste was disposed of at the NNP1 Project landfill, an increase of 5.7 m³ compared to December 2018. During January 2019, EMO conducted three waste spot checks at the NNP1 Project Landfill, construction sites and the camps. It was found that waste management of the construction sites and camps was generally improved. However, improper waste storage at the temporary waste storage facilities of Song Da 5 Camp No.2, HM Hydro camp and Zhefu camp was observed. The waste management improvement will be followed up and reported in the monthly report. The NNP1 Project landfill maintenance work is carried out by Administration Department with EMO support which includes waste cleaning-up, grass cutting and repairing perimeter fences.

A total of 12,830 kg of recyclable waste was sold to Khounmixay Processing Factory by the Contractors. The remaining scrap metal will be sold or transported off site by the Contractor later on.

Table 3-9: Amounts of Recyclable Waste Sold

| Source and Type of Recycled Waste | | Unit | Sold | Cumulative Total by 31 January 2019 |
|-----------------------------------|-----------------|-----------|---------------|-------------------------------------|
| Construction Activity | | | | |
| 1 | Scrap metal | kg | 12,805 | 48,439 |
| Sub-Total 1 | | kg | 12,805 | 48,439 |
| Camp Operations | | | | |
| 2 | Glass bottles | kg | 0 | 600 |
| 3 | Plastic bottles | kg | 3 | 217 |
| 4 | Paper/Cardboard | kg | 8 | 154 |
| 5 | Aluminium cans | kg | 14 | 82 |
| Sub-Total 2 | | kg | 25 | 1,053 |
| Grand Total 1+2 | | kg | 12,830 | 49,492 |

The villagers of Phouhomsay Village collected a total of 3,915 kg of food waste from selected camps for animal feed in January 2019, a decrease of 853 kg compared to December 2018 as a result of Kenber Camp decommissioning and withdrawals of some construction workers from Song Da5 Camps.

Table 3-10 Amounts of Food Waste Collected by Villagers

| No. | Site Name | Unit | Total |
|--------------|--|-----------|--------------|
| 1 | Song Da5 Camp No. 2 | kg | 146 |
| 2 | Song Da5 Camp No. 1 | kg | 510 |
| 3 | Obayashi Corporation Camp | kg | 1,066 |
| 4 | Owner's Village and Site Office (OSOV) | kg | 1,082 |
| 5 | LILAMA10 Camp | kg | 1,111 |
| Total | | kg | 3,915 |

3.3.2 Hazardous Materials and Waste Management

The types and amounts of hazardous waste collected and transported for off-site treatment and final disposal at Khounmixay Processing Factory in January 2019.

Table 3-11: Results of Hazardous Material Inventory

| No. | Hazardous Waste Type | Unit | Total in January 2019 (A) | Disposed (B) | Remainder (A - B) |
|-----|---|--------------|---------------------------|--------------|-------------------|
| 1 | Used hydraulic and engine oil | Litre | 5,670 | 980 | 4,690 |
| 2 | Contaminated soil, sawdust and concrete | bag | 515 | 0 | 515 |
| 3 | Used oil filters | Piece | 205 | 0 | 205 |
| 4 | Used tyre | Piece | 232 | 0 | 232 |
| 5 | Used oil mixed with water | Litre | 200 | 0 | 200 |
| 6 | Ink cartridge | unit | 192 | 63 | 129 |
| 7 | Halogen/fluorescent bulbs | unit | 161 | 33 | 128 |
| 8 | Empty paint and spray cans | can | 126 | 0 | 126 |
| 9 | Empty contaminated bitumen drum/container | Drum (200L) | 99 | 6 | 93 |
| 10 | Empty used oil drum/container | Drum (20 L) | 44 | 0 | 44 |
| 11 | Empty used chemical drum/container | Drum (200L) | 52 | 18 | 34 |
| 12 | Contaminated textile and material | kg | 27 | 0 | 27 |
| 13 | Lead acid batteries | unit | 22 | 0 | 22 |
| 14 | Clinic Waste | Kg | 10 | 1.0 | 9.4 |
| 15 | Lithium-ion batteries | unit | 7 | 0 | 7 |
| 16 | Empty used oil drum/container | Drum (200 L) | 6 | 4 | 2 |

3.4 Community Waste Management

3.4.1 Community Recycling Programme

In January 2019, a total of 2,029 kg of recyclable waste was recorded at the Community Waste Bank, an increase of 213 kg compared to December 2018.

Table 3-12: Types and Amounts of Recyclable Waste Traded at the Community Waste Bank

| Types of Waste | Unit | Remaining in Nov 2018 | Additions in Dec 2018 | Sold | Remaining in Dec 2018 |
|-----------------|-----------|-----------------------|-----------------------|------------|-----------------------|
| Scrap metal | kg | 0 | 9 | 0 | 9 |
| Glass bottles | kg | 1,483.5 | 197 | 290 | 1,390.5 |
| Paper/cardboard | kg | 314.5 | 206.5 | 0 | 521 |
| Aluminium cans | kg | 1 | 11 | 0 | 12 |
| Plastic bottles | kg | 8.5 | 88 | 0 | 96.5 |
| Total | kg | 1,807.5 | 511.5 | 290 | 2,029 |

3.4.2 Community Solid Waste Management

In January 2019, approximately 113 m³ of solid waste was collected from Phouhomxay, Thahuea and Hat Gniun Villages. The solid waste was transported to Houay Soup Landfill where recyclable materials were segregated before being disposed of at the landfill.

3.5 Watershed and Biodiversity Management

3.5.1 Watershed Management

3.5.1.1 Watershed Management Plan

The revised version of the Watershed Management Plan (WMP) was submitted to ADB, IAP, and BAC on 04 January 2019. ADB provided specific comments on 14 January 2019 about the watershed organisation structure requiring only one Watershed Management Committee and one secretariat office in Xaysomboun Province. NNP1PC-ESD Management had internal discussion and revised the proposed structure by ADB to include both Committees for the Xaysomboun and Bolikhamxay Provinces under the overall guidance of the MAF. This was discussed with the Department of Forestry (DOF), Ministry of Agriculture and Forestry (MAF), on 22 January 2019. DOF clarified that in case that the arrangement with two committees and two secretariats (WRPOs) turns out not to be suitable then this can be changed in due course with the Prime Minister's Agreement.

A further revised version of the WMP was submitted to ADB, IAP, and BAC on 22 January 2019 with revised organisation structure. This was later agreed by the ADB but the Committee of the WMP and Biodiversity Offset Management Programs were suggested to present in the same structure. ADB confirmed the plan approval on 23 January 2019 with the condition that IAP and BAC also had no objection on the approval.

The IAP Biodiversity Specialist provided comments on 27 January 2019. The IAP comments are related to:

- 1) The confusion over the proposed organogram with the combined committees of watershed and biodiversity programs as suggested by ADB;
- 2) The need for further details in reservoir and fishery management activities that could be elaborated into the Annual Implementation Plan (AIP); and
- 3) The need to prepare an executive summary of max 20 pages for the easy reference by the GOL.

A BAC member provided his comments on 24 and 27 January 2019. His main comments are related to:

- a) The clarity of Service Provider's role;
- b) The correction of information in the sections of baseline information particularly on the citation on the Biodiversity Baseline Survey in 2015;
- c) The clarity on the proposed checkpoint operation;
- d) The engagement of law enforcement officers in the patrolling program, and
- e) The clarity of livelihood development program.

Another revised version was submitted to ADB, IAP and BAC on 31 January 2019. Both IAP and BAC confirmed on the same date that they had no objections to the WMP approval by

ADB and strongly recommended to focus on implementation including the readiness of the service provider.

NNP1PC continued with further improvement of the Lao version of the plan and will further discuss with GOL on the schedule of a final consultation workshop at the central level to be chaired by Minister of MAF in February 2019.

A coordination meeting between Xaysomboun Provincial Watershed and Reservoir Protection Committee (WRPC) and NNP1PC was held on 29 January 2019 to discuss the overall progress of WMP finalization, the latest structure and activities and other related pending issues for the implementation. The key conclusions of the meeting area are summarised below:

- The WRPC and WRPO agreed on the merging of the Reservoir Management Plan and the Watershed Management Plan into one document and structure it into six components with detailed activities. They also agreed with the list of prioritised activities for the AIP 2019.
- Xaysomboun Provincial WRPO would coordinate with District and Village authorities for the gathering of information and plan the removal of forest encroachment within the proposed TPZ1 at Phou Ngou and Houayxay Villages.
- The WRPO will survey the potential locations for establishing a WRPO field office at Houayxay Village close to the reservoir, three ranger stations in TPZs and two reservoir checkpoints. The WRPC will request support from Provincial Department of Public Work to design the WRPO field office in consultation with NNP1PC.
- The WRPC will have further discussion with NNP1PC on the administrative budget support to the WRPO with the proposed schedule later on.
- The WRPO to prepare the detailed activities in the AIP 2019 and present to the WRPC at the coordination meeting on 05 February 2019.
- The WRPO to submit an improved Provincial Regulation for NNP1 Watershed and Reservoir Management to Xaysomboun Provincial Assembly for final review and certification prior to submitting to the Provincial Governor's approval and signature.

NNP1PC has provided an official response to the draft AIP 2019 prepared by the Bolikhamxay Provincial WRPO on 31 January 2019. The formulation of the AIP 2019 by the Xaysomboun Provincial WRPO will be continued after the internal WRPC-WRPO coordination meeting that is scheduled on 05 February 2019.

The remaining field verification surveys for the Total Protection Zone 1 (TPZ Phou Samsao) at Anouvong District and TPZ2 (TPZ Phou Khata) in Hom District will be included in the AIP 2019 of Xaysomboun Province.

The operation of checkpoints in both Provinces continued in January 2019. The checkpoints made 471 records of people accessing the main reservoir. Out of these, a total of 305 records of people from Houayxay Village (Hom District, Xaysomboun Province) and 166 records of people from Nahanh Village (Bolikham District, Bolikhamxay Province). The main reasons why people access the reservoir include fishing and hunting (64 recorded), agriculture (132 recorded), livestock raising (116 recorded) and other purpose (149 recorded). In addition, the checkpoint in Pou Village recorded 382 boats entering the reservoir and 291 boats leaving the reservoir. Military staff appointed at the checkpoints are not law enforcement officers for Forestry Law and Wildlife and Aquatic Animal Law. Thus, they are only responsible for security checks and report the incidents to the WRPO

for further actions. An approval of the WMP will be needed to provide the basis for the preparation and implementation of the AIP 2019 that will include full patrolling activities in the TPZs and the reservoir.

3.5.1.2 PREPARATION OF PROVINCIAL REGULATION FOR THE WATERSHED MANAGEMENT

Xaysomboun Provincial WRPO (Provincial Agriculture and Forestry Office) further improved the draft watershed management regulation after the Xaysomboun WRPC Coordination Meeting on 20 December 2018. The WRPO will submit the improved regulation to Xaysomboun Provincial Assembly for further review and certification prior to submitting to the Provincial Governor's review and signature.

3.5.2 Biodiversity Offset Management

3.5.2.1 PREPARATION OF BIODIVERSITY OFFSET MANAGEMENT PLAN

The improved Biodiversity Offset Management Plan (BOMP) was submitted to ADB, IAP, and BAC on 25 January 2019 after the discussions and agreements made during the joint IAP and ADB missions.

The IAP Biodiversity Specialist provided comments on 27 January 2019. The main comments are related to:

- 1) The confusion over the proposed organogram with the combined committees of watershed and biodiversity as suggested by the ADB;
- 2) The clarity of the ambitious conservation targets;
- 3) The negative opinion about the threats in the area as well as the capacity gap of GOL, and
- 4) Further improvement on the content of risk assessment of social displacement.

The BAC provided comments on 29 January 2019. Key comments are related to:

- a) The clarity of Service Provider's role;
- b) The clarity on the conservation targets;
- c) The clarification on the proposed management activities;
- d) The negative opinion about the threats in the area as well as the capacity gap of GOL;
- e) The clarity of funding sources for social development program, and
- f) The clarity on the overall funding for the BOMP.

There were no further comments from ADB as of 31 January 2019. Therefore, further delay is expected for the finalization of the Plan and approval by ADB.

3.5.2.2 IMPLEMENTATION OF PRE-BIODIVERSITY OFFSET MANAGEMENT PLAN (BOMP)

The Pre-BOMP-2B proposal was approved by ADB and agreed by BOMC at the end of September 2018. A total of USD 88,578 was disbursed in September 2018 for the

continuation of the checkpoint operation and patrolling from September 2018 – March 2019.

Two patrols with a total of 18 people conducted forest patrolling for 16 days in both Viengthong and Xaychamphone Districts. The patrolling covered 8 biodiversity areas within the NC-NX Offset Site in these Districts. The main threats found in the area are wildlife hunting, unregulated fishing by local villagers, and unregulated Non-Timber Forest Products (NTFP) collection by local villagers. Six temporary hunting camps and 370 small wire snares were recorded by the Viengthong District patrol. The highest record of small wire snares is located in the new patrolling route around Nam Sone area which is inside the proposed highest priority area of Totally Protected Zone (TPZ) in the northwestern part of the NC-NX area. A total of three temporary hunting camps and two small wire snares were recorded by Xaychamphone District's patrol.

3.6 FLOATING DEBRIS REMOVAL

The floating debris removal work contract is being prepared and negotiated. The work will be resumed in March 2019 after the contract is signed.

4. FISHERY MONITORING

Three species groups and two species dominated the fish catch by weight in December 2018 as listed in **Table 4-1**. These species are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species, except *Hemibagrus filamentus* which is classified as Data Deficient.

Table 4-1: Fish Species dominating the Fish Catch in December 2018

| <i>Species</i> | Lao Name | Fish Catch (kg) | IUCN Red List Classification |
|--|-----------------|------------------------|-------------------------------------|
| <i>Poropuntius normani</i> , <i>Poropuntius laoensis</i> | ປາຈາດ | 447.9 | LC |
| <i>Channa striata</i> | ປາຄໍ້ | 250.5 | LC |
| <i>Hemibagrus nemurus</i> , <i>Hemibagrus filamentus</i> | ປາກົດ | 179 | LC, DD |
| <i>Clarias batrachus</i> | ປາດູກ | 156.3 | LC |
| <i>Systomus orphoides</i> | ປາປິກ | 140.1 | LC |

The recorded catch of Threatened and Near Threatened species (IUCN Red List Classification) in December 2018 is presented in **Table 4-2**. The list includes one species that is classified as Endangered (EN), four Vulnerable (VU) species, and eight Near Threatened (NT) species.

Table 4-2: *Threatened Species of December 2018 Fish Catch*

| Species | Lao Name | Fish Catch (kg) | IUCN Red List Classification |
|------------------------------------|----------------|-----------------|------------------------------|
| <i>Bagarius bagarius</i> | ປາແຂ້ | 6 | NT |
| <i>Bangana behri</i> | ປາມ້ອມ | 13.6 | VU |
| <i>Chitala blanci</i> | ປາຕອງກາຍ | 0.3 | NT |
| <i>Cirrhinus cirrhosus</i> | ປານວນຈັນ/ປາແກງ | 59.5 | VU |
| <i>Cirrhinus molitorella</i> | ປາແກງ | 18.3 | NT |
| <i>Cyprinus carpio</i> | ປາໄນ | 0.2 | VU |
| <i>Hypophthalmichthys molitrix</i> | ປາເກັດແລບ | 1 | NT |
| <i>Neolissochilus stracheyi</i> | ປາສອງ | 9.4 | NT |
| <i>Ompok bimaculatus</i> | ປາເຊືອມ | 8.4 | NT |
| <i>Onychostoma gerlachi</i> | ປາຄົງ | 34.5 | NT |
| <i>Probarbus jullieni</i> | ປາເອີນ | 4.8 | EN |
| <i>Scaphognathops bandanensis</i> | ປາວຽນໄຟ | 33.5 | VU |
| <i>Syncrossus beauforti</i> | ປາແຂ້ວໄກ້/ປາໝູ | 0.6 | NT |

The total recorded monthly fish catch for the downstream and upstream fishing households and the Mekong control group involved in the monitoring programme from July 2015 to December 2018 is presented in

Figure 4-1. Note that the upstream fish catch excludes the fish catch from the fishing households in Zone 2LR because these households were resettled during Q4-2017.

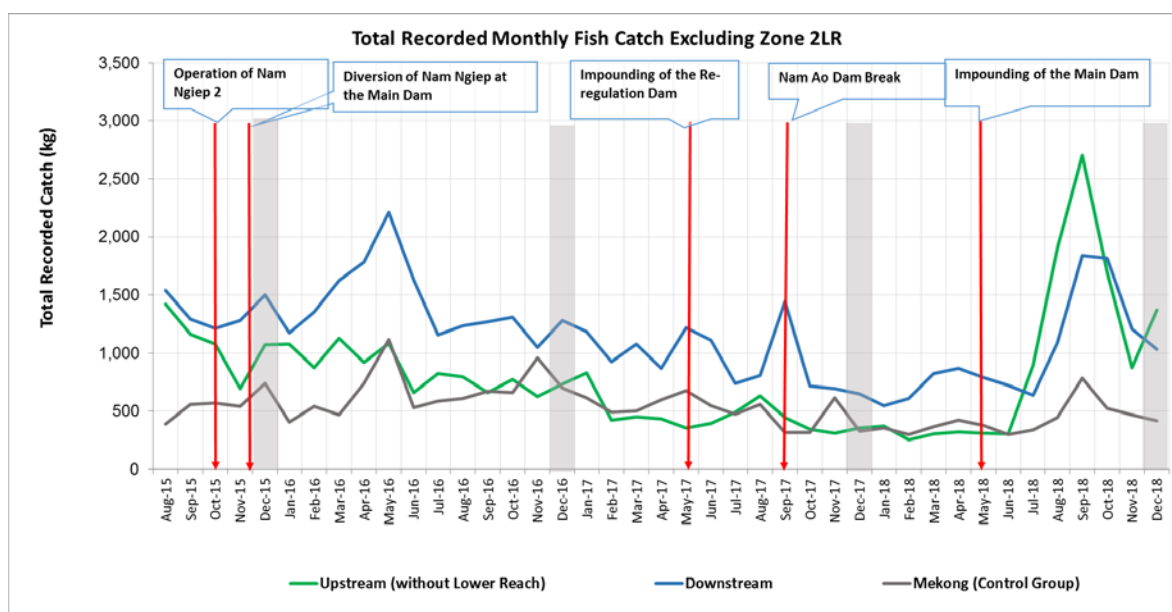
Figure 4-1: Total Recorded Monthly Fish Catch July 2015-December 2018

Table 4-3 and **Figure 4-2** show the total recorded fish catch for December 2015, December 2016, December 2017 and December 2018 in the upstream (excluding Zone 2LR) and downstream communities and the Mekong control group. The total fish catch data represents the total fish supply provided by the involved fishing households.

¹ The IUCN Red List of Threatened Species is the world's most comprehensive inventory and classification of threatened species. The Red List classifies species into nine groups: Extinct (EX), Extinct in the wild (EW), Critically endangered (CR), Endangered (EN), Vulnerable (VU), Near threatened (NT), Least concern (LC), Data deficient (DD), and Not evaluated (NE). The term "Threatened" includes Critically Endangered, Endangered, and Vulnerable.

Table 4-3: Total Recorded Fish Catch by Upstream (Excluding Zone 2LR), Downstream and Mekong Control Group Fishing Households in December 2015, December 2016, December 2017 and December 2018

| Fishing Zone | December 2015 (kg) | December 2016 (kg) | December 2017 (kg) | December 2018 (kg) |
|----------------------|--------------------|--------------------|--------------------|--------------------|
| Upstream | 1,073 | 731 | 357 | 1,374 |
| Downstream | 1,503 | 1,283 | 650 | 1,035 |
| Mekong Control Group | 742 | 698 | 326 | 417 |

Figure 4-2: Total Recorded Fish Catch in November by Upstream (Excluding Zone 2LR), Downstream and Mekong Control Group Fishing Households

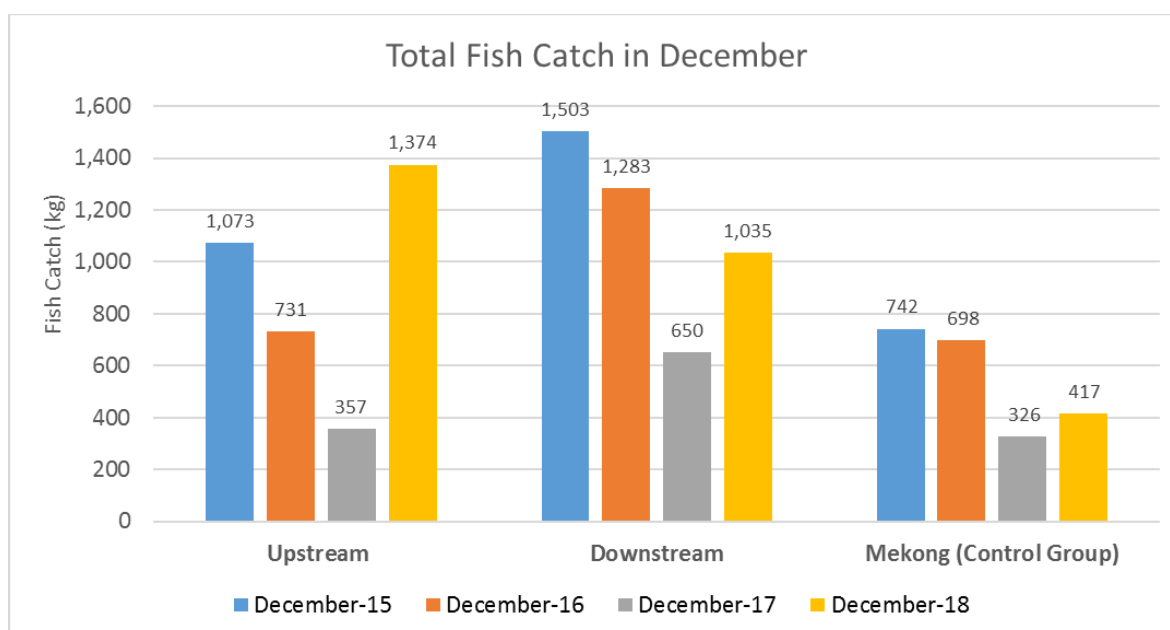


Figure 4-3: Number of Fishing Households Involved in the Fish Catch Monitoring Programme

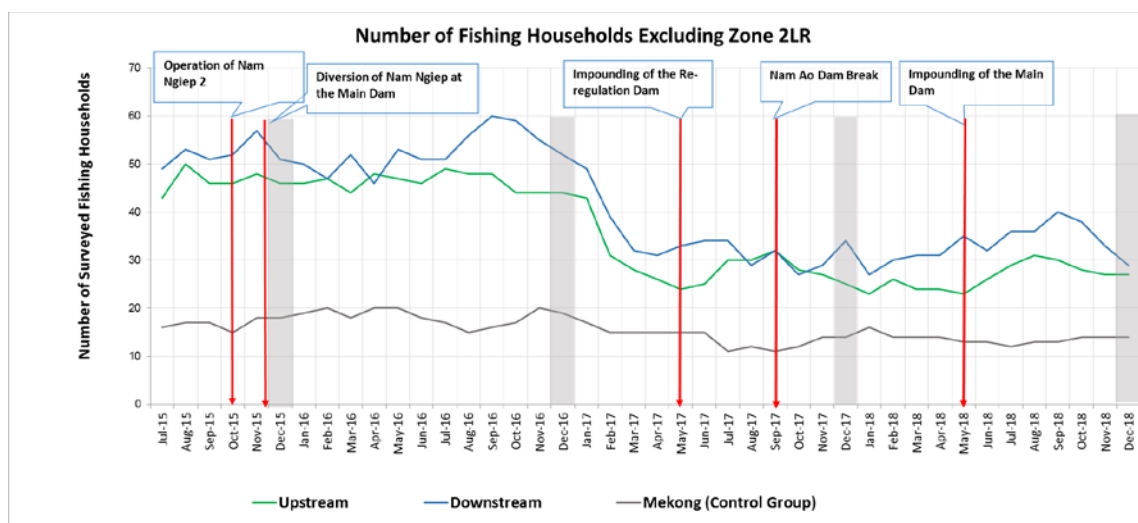


Figure 4-4: Mean Monthly Household Fish Catch without Zone 2LR

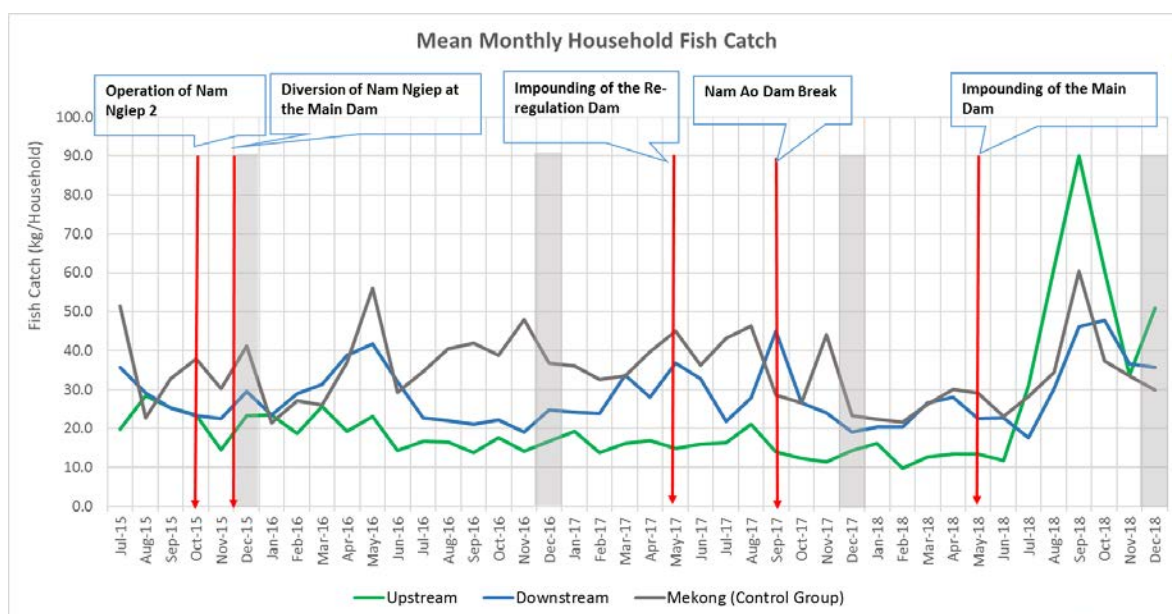


Table 4-4: Mean Monthly Household Fish Catch in the Upstream and Downstream Communities Excluding Zone 2LR

| Fishing Zone | November 2015 (kg) | November 2016 (kg) | November 2017 (kg) | November 2018 (kg) |
|----------------------|--------------------|--------------------|--------------------|--------------------|
| Upstream | 23.3 | 16.6 | 14.3 | 50.9 |
| Downstream | 29.5 | 24.7 | 19.1 | 35.7 |
| Mekong Control Group | 41.2 | 36.7 | 23.3 | 29.8 |

Figure 4-5: Mean Household Fish Catch per Fishing Day

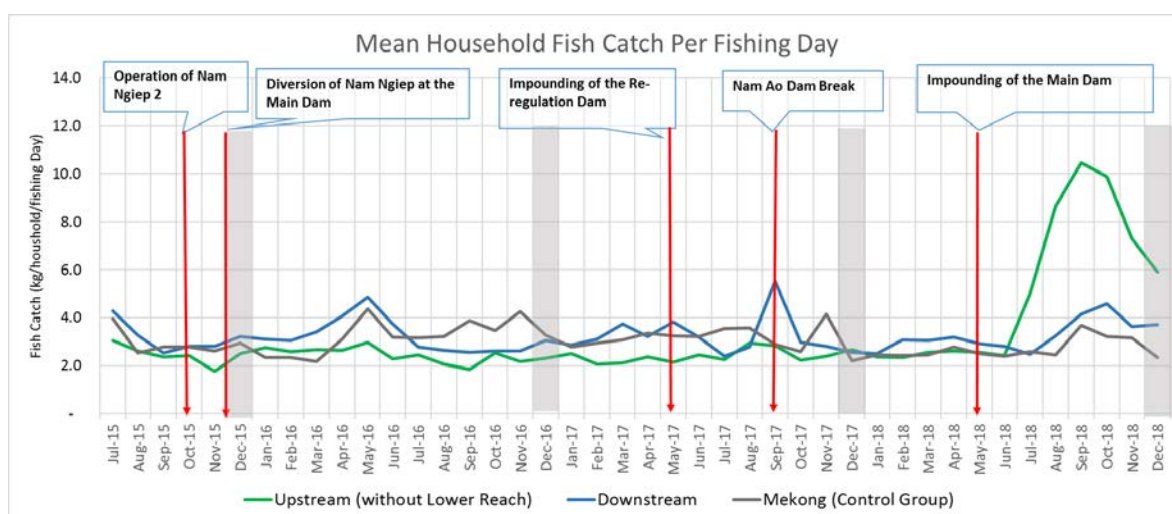


Table 4-5: Mean Household Fish Catch per Fishing Day in Decemberr

| Fishing Zone | November 2015 (kg) | November 2016 (kg) | November 2017 (kg) | November 2018 (kg) |
|------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| Upstream | 2.5 | 2.31 | 2.67 | 5.90 |
| Downstream | 3.2 | 3.05 | 2.56 | 3.72 |
| Mekong (Control Group) | 3.0 | 3.28 | 2.22 | 2.35 |

ANNEXES

ANNEX A: Results of Surface Water Quality Analyses

Table A- 1: Results of Main Reservoir, Re-regulation Reservoir and Surface Water (Nam Ngiep River) Quality Monitoring

| | | Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 |
|-----------|-------------------|--------------|--------|------|------|------|------|-------|------|------|--------|--------|--------|--------|
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 2-Jan-19 | pH | 5.0 - 9.0 | | | | | | | 7.89 | 8.09 | 7.19 | 7.15 | 7.62 | 7.16 |
| 3-Jan-19 | pH | 5.0 - 9.0 | | | | 7.39 | 7.35 | 7.21 | | | | | | |
| 5-Jan-19 | pH | 5.0 - 9.0 | | | | | | 7.22 | | | 7.1 | | | |
| 7-Jan-19 | pH | 5.0 - 9.0 | | | | | 7.89 | 7.89 | | | | | | |
| 8-Jan-19 | pH | 5.0 - 9.0 | | 7.38 | 7.21 | 7.74 | | | | | | | | |
| 9-Jan-19 | pH | 5.0 - 9.0 | | | | | | | 7.72 | 7.68 | 7.54 | 7.37 | 6.89 | 7.02 |
| 12-Jan-19 | pH | 5.0 - 9.0 | | | | | | 7.57 | | | 7.49 | | | |
| 14-Jan-19 | pH | 5.0 - 9.0 | | | | | 7.93 | 7.69 | | | | | | |
| 15-Jan-19 | pH | 5.0 - 9.0 | 7.47 | 7.83 | 8.58 | 7.85 | | | | | | | | |
| 16-Jan-19 | pH | 5.0 - 9.0 | | | | | | | 7.84 | 7.53 | 7.77 | 7.01 | 7.97 | 7.98 |
| 19-Jan-19 | pH | 5.0 - 9.0 | | | | | | 7.84 | | | 7.8 | | | |
| 21-Jan-19 | pH | 5.0 - 9.0 | | | | | 7.76 | 7.58 | | | | | | |
| 22-Jan-19 | pH | 5.0 - 9.0 | | 7.74 | 7.6 | 7.99 | | | | | | | | |
| 23-Jan-19 | pH | 5.0 - 9.0 | | | | | | | 7.53 | 7.83 | 8.41 | 8.26 | 8.42 | 8.75 |
| 26-Jan-19 | pH | 5.0 - 9.0 | | | | | | 8.44 | | | 8.64 | | | |
| 28-Jan-19 | pH | 5.0 - 9.0 | | | | | 7.51 | 7.56 | | | | | | |
| 29-Jan-19 | pH | 5.0 - 9.0 | | 7.78 | 7.24 | 7.36 | | | | | | | | |
| 30-Jan-19 | pH | 5.0 - 9.0 | | | | | | | 7.71 | 7.8 | 7.98 | 7.61 | 7.55 | 8.24 |
| 2-Jan-19 | Sat. DO (%) | | | | | | | | 96.6 | 95.4 | 107.7 | 106.5 | 101.4 | 97.8 |
| 3-Jan-19 | Sat. DO (%) | | | | | 61 | 34.4 | 17.3 | | | | | | |
| 5-Jan-19 | Sat. DO (%) | | | | | | | 57.2 | | | 111.2 | | | |
| 7-Jan-19 | Sat. DO (%) | | | | | | 93.6 | 112.8 | | | | | | |
| 8-Jan-19 | Sat. DO (%) | | | 77.4 | 65.1 | 80.1 | | | | | | | | |
| 9-Jan-19 | Sat. DO (%) | | | | | | | | 98.2 | 93.8 | 107.8 | 108 | 104.5 | 100.7 |
| 12-Jan-19 | Sat. DO (%) | | | | | | | 103.1 | | | 106 | | | |

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| | | Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 |
|-----------|-------------------|--------------|--------|------|-------|------|------|------|------|------|--------|--------|--------|--------|
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 14-Jan-19 | Sat. DO (%) | | | | | | 91.1 | 99.9 | | | | | | |
| 15-Jan-19 | Sat. DO (%) | | 104.5 | 86.8 | 106.4 | 96.2 | | | | | | | | |
| 16-Jan-19 | Sat. DO (%) | | | | | | | | 86.5 | 83.2 | 102.7 | 100.3 | 96.1 | 93 |
| 19-Jan-19 | Sat. DO (%) | | | | | | | 79.6 | | | 101.7 | | | |
| 21-Jan-19 | Sat. DO (%) | | | | | | 75.1 | 54.8 | | | | | | |
| 22-Jan-19 | Sat. DO (%) | | | 97.8 | 71.7 | 92.2 | | | | | | | | |
| 23-Jan-19 | Sat. DO (%) | | | | | | | | 101 | 85.6 | 102.9 | 101.8 | 97.3 | 8.75 |
| 26-Jan-19 | Sat. DO (%) | | | | | | | 85.8 | | | 104.2 | | | |
| 28-Jan-19 | Sat. DO (%) | | | | | | 65.2 | 46.8 | | | | | | |
| 29-Jan-19 | Sat. DO (%) | | | 78.9 | 36.8 | 58.7 | | | | | | | | |
| 30-Jan-19 | Sat. DO (%) | | | | | | | | 92.7 | 98.2 | 103.7 | 102.1 | 94.8 | 95.3 |
| 2-Jan-19 | DO (mg/l) | <6.0 | | | | | | | 8.13 | 8 | 9.04 | 9.06 | 8.39 | 7.92 |
| 3-Jan-19 | DO (mg/l) | <6.0 | | | | 4.96 | 2.9 | 1.46 | | | | | | |
| 5-Jan-19 | DO (mg/l) | <6.0 | | | | | | 4.58 | | | 8.98 | | | |
| 7-Jan-19 | DO (mg/l) | <6.0 | | | | | 7.5 | 9.92 | | | | | | |
| 8-Jan-19 | DO (mg/l) | <6.0 | | 6.39 | 5.38 | 6.51 | | | | | | | | |
| 9-Jan-19 | DO (mg/l) | <6.0 | | | | | | | 8.22 | 7.84 | 8.89 | 8.9 | 8.6 | 8.19 |
| 12-Jan-19 | DO (mg/l) | <6.0 | | | | | | 8.18 | | | 8.57 | | | |
| 14-Jan-19 | DO (mg/l) | <6.0 | | | | | 7.26 | 8.02 | | | | | | |
| 15-Jan-19 | DO (mg/l) | <6.0 | 8.55 | 8.97 | 11.06 | 8.12 | | | | | | | | |
| 16-Jan-19 | DO (mg/l) | <6.0 | | | | | | | 7.24 | 6.96 | 8.32 | 8.21 | 7.82 | 7.37 |
| 19-Jan-19 | DO (mg/l) | <6.0 | | | | | | 6.6 | | | 8.46 | | | |
| 21-Jan-19 | DO (mg/l) | <6.0 | | | | | 6.1 | 4.53 | | | | | | |
| 22-Jan-19 | DO (mg/l) | <6.0 | | 8.01 | 5.91 | 7.62 | | | | | | | | |
| 23-Jan-19 | DO (mg/l) | <6.0 | | | | | | | 9.37 | 7.23 | 8.71 | 8.54 | 8.02 | 7.76 |
| 26-Jan-19 | DO (mg/l) | <6.0 | | | | | | 6.9 | | | 8.42 | | | |
| 28-Jan-19 | DO (mg/l) | <6.0 | | | | | 5.26 | 3.83 | | | | | | |
| 29-Jan-19 | DO (mg/l) | <6.0 | | 6.47 | 3.05 | 5.02 | | | | | | | | |
| 30-Jan-19 | DO (mg/l) | <6.0 | | | | | | | 7.82 | 8.74 | 8.65 | 8.51 | 7.55 | 7.61 |

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| | | Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 |
|-----------|----------------------|--------------|--------|------|-----|------|------|-------|------|----|--------|--------|--------|--------|
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 2-Jan-19 | Conductivity (µs/cm) | | | | | | | | 69 | 68 | 52.9 | 57.1 | 52.7 | 51.7 |
| 3-Jan-19 | Conductivity (µs/cm) | | | | | 74 | 68 | 67 | | | | | | |
| 5-Jan-19 | Conductivity (µs/cm) | | | | | | | 52.6 | | | 52 | | | |
| 7-Jan-19 | Conductivity (µs/cm) | | | | | | 69 | 76 | | | | | | |
| 8-Jan-19 | Conductivity (µs/cm) | | | 89 | 84 | 76 | | | | | | | | |
| 9-Jan-19 | Conductivity (µs/cm) | | | | | | | | 70 | 70 | 55.1 | 54.2 | 53.7 | 53.1 |
| 12-Jan-19 | Conductivity (µs/cm) | | | | | | | 50.7 | | | 68.9 | | | |
| 14-Jan-19 | Conductivity (µs/cm) | | | | | | 69 | 69 | | | | | | |
| 15-Jan-19 | Conductivity (µs/cm) | | 73.1 | 125 | 110 | 81 | | | | | | | | |
| 16-Jan-19 | Conductivity (µs/cm) | | | | | | | | 69 | 70 | 51.9 | 57.5 | 52.2 | 49.5 |
| 19-Jan-19 | Conductivity (µs/cm) | | | | | | | 50.6 | | | 51.4 | | | |
| 21-Jan-19 | Conductivity (µs/cm) | | | | | | 70 | 69 | | | | | | |
| 22-Jan-19 | Conductivity (µs/cm) | | | 90 | 82 | 77 | | | | | | | | |
| 23-Jan-19 | Conductivity (µs/cm) | | | | | | | | 79 | 70 | 52.6 | 52.9 | 51.5 | 55.2 |
| 26-Jan-19 | Conductivity (µs/cm) | | | | | | | 51.3 | | | 58.7 | | | |
| 28-Jan-19 | Conductivity (µs/cm) | | | | | | 70 | 69 | | | | | | |
| 29-Jan-19 | Conductivity (µs/cm) | | | 90 | 85 | 76 | | | | | | | | |
| 30-Jan-19 | Conductivity (µs/cm) | | | | | | | | 71 | 74 | 51.6 | 51.9 | 54.8 | 54.8 |
| 2-Jan-19 | TDS (mg/l) | | | | | | | | 34.5 | 34 | 26.4 | 54 | 26.3 | 25.5 |
| 3-Jan-19 | TDS (mg/l) | | | | | 37 | 34 | 33.5 | | | | | | |
| 5-Jan-19 | TDS (mg/l) | | | | | | | 26.3 | | | 26 | | | |
| 7-Jan-19 | TDS (mg/l) | | | | | | 34.5 | 38 | | | | | | |
| 8-Jan-19 | TDS (mg/l) | | | 44.5 | 42 | 38 | | | | | | | | |
| 9-Jan-19 | TDS (mg/l) | | | | | | | | 35 | 35 | 27.5 | 27.1 | 26.8 | 26.5 |
| 12-Jan-19 | TDS (mg/l) | | | | | | | 25.35 | | | 34.5 | | | |
| 14-Jan-19 | TDS (mg/l) | | | | | | 34.5 | 34.5 | | | | | | |
| 15-Jan-19 | TDS (mg/l) | | 36.55 | 62.3 | 55 | 40.5 | | | | | | | | |
| 16-Jan-19 | TDS (mg/l) | | | | | | | | 34.5 | 35 | 25.5 | 27.5 | 26.1 | 24.8 |
| 19-Jan-19 | TDS (mg/l) | | | | | | | 25.3 | | | 25.7 | | | |

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| | | Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 |
|-----------|-------------------|--------------|--------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 21-Jan-19 | TDS (mg/l) | | | | | | 35 | 34.5 | | | | | | |
| 22-Jan-19 | TDS (mg/l) | | | 45 | 41 | 38.5 | | | | | | | | |
| 23-Jan-19 | TDS (mg/l) | | | | | | | | 39.5 | 35 | 26.3 | 26.45 | 25.75 | 27.6 |
| 26-Jan-19 | TDS (mg/l) | | | | | | | 25.65 | | | 29.35 | | | |
| 28-Jan-19 | TDS (mg/l) | | | | | | 35 | 34.5 | | | | | | |
| 29-Jan-19 | TDS (mg/l) | | | 45 | 42.5 | 38 | | | | | | | | |
| 30-Jan-19 | TDS (mg/l) | | | | | | | | 35.5 | 37 | 25.8 | 26 | 27.4 | 27.4 |
| 2-Jan-19 | Temperature (°C) | | | | | | | | 23.93 | 24.26 | 23.6 | 22.8 | 24.6 | 25.3 |
| 3-Jan-19 | Temperature (°C) | | | | | 25.93 | 24.39 | 24.02 | | | | | | |
| 5-Jan-19 | Temperature (°C) | | | | | | | 24.7 | | | 25.3 | | | |
| 7-Jan-19 | Temperature (°C) | | | | | | 26.24 | 21.76 | | | | | | |
| 8-Jan-19 | Temperature (°C) | | | 25.13 | 25.38 | 25.63 | | | | | | | | |
| 9-Jan-19 | Temperature (°C) | | | | | | | | 24.3 | 24.31 | 24.1 | 24.2 | 24.4 | 24.8 |
| 12-Jan-19 | Temperature (°C) | | | | | | | 25.3 | | | 25.2 | | | |
| 14-Jan-19 | Temperature (°C) | | | | | | 26.98 | 26.39 | | | | | | |
| 15-Jan-19 | Temperature (°C) | | 23.4 | 23.98 | 23.91 | 23.81 | | | | | | | | |
| 16-Jan-19 | Temperature (°C) | | | | | | | | 24.41 | 24.96 | 25.1 | 24.5 | 25.4 | 26.2 |
| 19-Jan-19 | Temperature (°C) | | | | | | | 24 | | | 23.7 | | | |
| 21-Jan-19 | Temperature (°C) | | | | | | 26.16 | 25.5 | | | | | | |
| 22-Jan-19 | Temperature (°C) | | | 25.45 | 25.14 | 25 | | | | | | | | |
| 23-Jan-19 | Temperature (°C) | | | | | | | | 19.24 | 23.9 | 22.9 | 23.3 | 24.4 | 25.2 |
| 26-Jan-19 | Temperature (°C) | | | | | | | 24.9 | | | 25.4 | | | |
| 28-Jan-19 | Temperature (°C) | | | | | | 26.51 | 25.4 | | | | | | |
| 29-Jan-19 | Temperature (°C) | | | 25.6 | 25.3 | 24.34 | | | | | | | | |
| 30-Jan-19 | Temperature (°C) | | | | | | | | 23.9 | 21.02 | 23.6 | 23.7 | 26.2 | 26 |
| 2-Jan-19 | Turbidity (NTU) | | | | | | | | 13.47 | 13.23 | 13.98 | 12.26 | 14.58 | 19.25 |
| 3-Jan-19 | Turbidity (NTU) | | | | | 2 | 2.16 | 2.06 | | | | | | |
| 5-Jan-19 | Turbidity (NTU) | | | | | | | 1.31 | | | 4.82 | | | |
| 7-Jan-19 | Turbidity (NTU) | | | | | | 1.29 | 1.04 | | | | | | |

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| | | Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 |
|-----------|-------------------|--------------|--------|------|------|------|------|------|-------|-------|--------|--------|--------|--------|
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 8-Jan-19 | Turbidity (NTU) | | | 1.1 | 1.22 | 1.21 | | | | | | | | |
| 9-Jan-19 | Turbidity (NTU) | | | | | | | | 5.7 | 3.39 | 5.43 | 6.51 | 8.89 | 15.33 |
| 12-Jan-19 | Turbidity (NTU) | | | | | | | 3.28 | | | 5.21 | | | |
| 14-Jan-19 | Turbidity (NTU) | | | | | | 0.96 | 0.75 | | | | | | |
| 15-Jan-19 | Turbidity (NTU) | | 9.54 | 2.06 | 1.3 | 1.2 | | | | | | | | |
| 16-Jan-19 | Turbidity (NTU) | | | | | | | | 1.73 | 2.23 | 3.37 | 3.6 | 5.93 | 6.49 |
| 19-Jan-19 | Turbidity (NTU) | | | | | | | 2.82 | | | 3.66 | | | |
| 21-Jan-19 | Turbidity (NTU) | | | | | | 0.7 | 0.87 | | | | | | |
| 22-Jan-19 | Turbidity (NTU) | | | 1.58 | 1.15 | 1.07 | | | | | | | | |
| 23-Jan-19 | Turbidity (NTU) | | | | | | | | 7.14 | 5.51 | 10.42 | 12.66 | 16.48 | 16.4 |
| 26-Jan-19 | Turbidity (NTU) | | | | | | | 1.18 | | | 4.09 | | | |
| 28-Jan-19 | Turbidity (NTU) | | | | | | 1.49 | 1.3 | | | | | | |
| 29-Jan-19 | Turbidity (NTU) | | | 1.87 | 3.87 | 2.34 | | | | | | | | |
| 30-Jan-19 | Turbidity (NTU) | | | | | | | | 18.07 | 16.37 | 12.86 | 13.14 | 24.66 | 8.64 |
| 2-Jan-19 | TSS (mg/l) | | | | | | | | 21.72 | 15.88 | 30.1 | | | |
| 3-Jan-19 | TSS (mg/l) | | | | | | | <5 | | | | | | |
| 7-Jan-19 | TSS (mg/l) | | | | | | | <5 | | | | | | |
| 9-Jan-19 | TSS (mg/l) | | | | | | | | 11.23 | 7.34 | 8.12 | | | |
| 14-Jan-19 | TSS (mg/l) | | | | | | <5 | <5 | | | | | | |
| 15-Jan-19 | TSS (mg/l) | | 10.57 | <5 | <5 | <5 | | | | | | | | |
| 16-Jan-19 | TSS (mg/l) | | | | | | | | <5 | <5 | <5 | <5 | 6.07 | 6.25 |
| 21-Jan-19 | TSS (mg/l) | | | | | | | <5 | | | | | | |
| 23-Jan-19 | TSS (mg/l) | | | | | | | | 6.99 | 6.76 | 13.33 | | | |
| 28-Jan-19 | TSS (mg/l) | | | | | | | <5 | | | | | | |
| 30-Jan-19 | TSS (mg/l) | | | | | | | | 55.1 | 28.16 | 31.55 | | | |
| 2-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | | | <1 | <1 | <1 | | | |
| 3-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | | 1.4 | | | | | | |
| 7-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | | 1.1 | | | | | | |
| 9-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | | | <1 | <1 | 1.06 | | | |

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| | | Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 |
|-----------|-----------------------------|--------------|--------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 14-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | <1 | 1.37 | | | | | | |
| 15-Jan-19 | BOD5 (mg/l) | <1.5 | <1 | 1.56 | 1.1 | <1 | | | | | | | | |
| 16-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | | | <1 | <1 | <1 | <1 | <1 | <1 |
| 21-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | | <1 | | | | | | |
| 23-Jan-19 | BOD5 (mg/l) | <1.5 | | | | | | | <1 | <1 | <1 | | | |
| 14-Jan-19 | COD (mg/l) | <5 | 5.4 | | | | <5 | <5 | | | | | | |
| 15-Jan-19 | COD (mg/l) | <5 | 5.4 | <5 | <5 | <5 | | | | | | | | |
| 16-Jan-19 | COD (mg/l) | <5 | | | | | | | 7.2 | <5 | <5 | <5 | <5 | <5 |
| 14-Jan-19 | NH3-N (mg/l) | <0.2 | | | | | <0.2 | <0.2 | | | | | | |
| 15-Jan-19 | NH3-N (mg/l) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | | | | | | | | |
| 16-Jan-19 | NH3-N (mg/l) | <0.2 | | | | | | | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 14-Jan-19 | NO3-N (mg/l) | <5 | | | | | <0.02 | <0.02 | | | | | | |
| 15-Jan-19 | NO3-N (mg/l) | <5 | 0.02 | <0.02 | <0.02 | <0.02 | | | | | | | | |
| 16-Jan-19 | NO3-N (mg/l) | <5 | | | | | | | <0.02 | <0.02 | <0.02 | <0.02 | 0.03 | 0.03 |
| 2-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | | | 23 | 23 | 33 | | | |
| 3-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | | 23 | | | | | | |
| 7-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | | 0 | | | | | | |
| 9-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | | | 12 | 7 | 2 | | | |
| 14-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | 0 | 7 | | | | | | |
| 15-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | 920 | 33 | 79 | 130 | | | | | | | | |
| 16-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | | | 0 | 2 | 0 | 0 | 2 | 2 |
| 21-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | | 1,600 | | | | | | |
| 23-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | | | | | 7 | 5 | 17 | | | |
| 2-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | | | 49 | 23 | 49 | | | |

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| | | Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 |
|-----------|-----------------------------------|--------------|--------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 3-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | | 23 | | | | | | |
| 7-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | | 13 | | | | | | |
| 9-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | | | 130 | 130 | 170 | | | |
| 14-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | 2 | 11 | | | | | | |
| 15-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | 920 | 33 | 79 | 130 | | | | | | | | |
| 16-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | | | 49 | 130 | 79 | 79 | 240 | 540 |
| 21-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | | 1,600 | | | | | | |
| 23-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | | | | | 7 | 5 | 17 | | | |
| 14-Jan-19 | Total Phosphorus (mg/l) | | | | | | <0.01 | <0.01 | | | | | | |
| 15-Jan-19 | Total Phosphorus (mg/l) | | | <0.01 | <0.01 | <0.01 | | | | | | | | |
| 16-Jan-19 | Total Phosphorus (mg/l) | | | | | | | | <0.01 | <0.01 | | | | |
| 14-Jan-19 | Total Dissolved Phosphorus (mg/l) | | | | | | <0.01 | <0.01 | | | | | | |
| 15-Jan-19 | Total Dissolved Phosphorus (mg/l) | | | <0.01 | <0.01 | <0.01 | | | | | | | | |
| 16-Jan-19 | Total Dissolved Phosphorus (mg/l) | | | | | | | | <0.01 | <0.01 | | | | |
| 14-Jan-19 | TOC (mg/l) | | | | | | 1.69 | 1.78 | | | | | | |
| 15-Jan-19 | TOC (mg/l) | | | 2.03 | 2.52 | 1.94 | | | | | | | | |
| 16-Jan-19 | TOC (mg/l) | | | | | | | | 1.84 | 1.78 | | | | |
| 14-Jan-19 | Hydrogen Sulfide (mg/l) | | | | | | | 0.02 | | | | | | |
| 16-Jan-19 | Hydrogen Sulfide (mg/l) | | | | | | | | | 0.02 | <0.02 | | | |
| 14-Jan-19 | Dry Weight Biomass/m3 | | | | | | 1.2 | 1.1 | | | | | | |
| 15-Jan-19 | Dry Weight Biomass/m3 | | | 2.4 | 2.2 | 1.4 | | | | | | | | |
| 16-Jan-19 | Dry Weight Biomass/m3 | | | | | | | | 3.9 | 2.7 | | | | |

Table A- 1: RESULTS OF SURFACE WATER QUALITY MONITORING IN NAM CHIAN, NAM PHOUAN, NAM XAO AND NAM HOUAY SOUP

| | | Station Code | NCH01 | NPH01 | NXA01 | NHS01 |
|-----------|----------------------|--------------|-------|-------|-------|-------|
| Date | Parameters (Unit) | Guideline | | | | |
| 2-Jan-19 | pH | 5.0 - 9.0 | | | 7.22 | 7.7 |
| 3-Jan-19 | pH | 5.0 - 9.0 | | 7.69 | | |
| 8-Jan-19 | pH | 5.0 - 9.0 | | 7.93 | | |
| 9-Jan-19 | pH | 5.0 - 9.0 | | | 7.34 | 7.01 |
| 15-Jan-19 | pH | 5.0 - 9.0 | 8.58 | 7.75 | | |
| 16-Jan-19 | pH | 5.0 - 9.0 | | | 6.69 | 7.88 |
| 22-Jan-19 | pH | 5.0 - 9.0 | | 8.3 | | |
| 23-Jan-19 | pH | 5.0 - 9.0 | | | 8.45 | 7.72 |
| 29-Jan-19 | pH | 5.0 - 9.0 | | 7.85 | | |
| 30-Jan-19 | pH | 5.0 - 9.0 | | | 7.65 | 7.46 |
| 2-Jan-19 | Sat. DO (%) | | | | 99.3 | 96.3 |
| 3-Jan-19 | Sat. DO (%) | | | 90.4 | | |
| 8-Jan-19 | Sat. DO (%) | | | 89.8 | | |
| 9-Jan-19 | Sat. DO (%) | | | | 103.5 | 103.4 |
| 15-Jan-19 | Sat. DO (%) | | 101.7 | 97.9 | | |
| 16-Jan-19 | Sat. DO (%) | | | | 89.4 | 82 |
| 21-Jan-19 | Sat. DO (%) | | | 107.5 | | |
| 23-Jan-19 | Sat. DO (%) | | | | 88.9 | 97.9 |
| 30-Jan-19 | Sat. DO (%) | | | 90.4 | 92.4 | 98.2 |
| 2-Jan-19 | DO (mg/l) | <6.0 | | | 8.45 | 7.07 |
| 3-Jan-19 | DO (mg/l) | <6.0 | | 8.52 | | |
| 8-Jan-19 | DO (mg/l) | <6.0 | | 7.94 | | |
| 9-Jan-19 | DO (mg/l) | <6.0 | | | 8.59 | 8.53 |
| 15-Jan-19 | DO (mg/l) | <6.0 | 8.37 | 9.25 | | |
| 16-Jan-19 | DO (mg/l) | <6.0 | | | 7.31 | 6.84 |
| 22-Jan-19 | DO (mg/l) | <6.0 | | 9.95 | | |
| 23-Jan-19 | DO (mg/l) | <6.0 | | | 7.55 | 8.54 |
| 29-Jan-19 | DO (mg/l) | <6.0 | | 8.56 | | |
| 30-Jan-19 | DO (mg/l) | <6.0 | | | 7.77 | 8.13 |
| 2-Jan-19 | Conductivity (µs/cm) | | | | 108.3 | 41.3 |
| 3-Jan-19 | Conductivity (µs/cm) | | | 66 | | |
| 8-Jan-19 | Conductivity (µs/cm) | | | 68 | | |
| 9-Jan-19 | Conductivity (µs/cm) | | | | 68.6 | 53.9 |
| 15-Jan-19 | Conductivity (µs/cm) | | 28.1 | 72 | | |
| 16-Jan-19 | Conductivity (µs/cm) | | | | 109.6 | 53.2 |
| 22-Jan-19 | Conductivity (µs/cm) | | | 69 | | |
| 23-Jan-19 | Conductivity (µs/cm) | | | | 108.1 | 52.2 |
| 29-Jan-19 | Conductivity (µs/cm) | | | 69 | | |
| 30-Jan-19 | Conductivity (µs/cm) | | | | 97.7 | 52.3 |
| 2-Jan-19 | TDS (mg/l) | | | | 54 | 20.5 |
| 3-Jan-19 | TDS (mg/l) | | | 33 | | |
| 8-Jan-19 | TDS (mg/l) | | | 34 | | |
| 9-Jan-19 | TDS (mg/l) | | | | 34.3 | 26.4 |
| 15-Jan-19 | TDS (mg/l) | | 14.05 | 36 | | |
| 16-Jan-19 | TDS (mg/l) | | | | 54.3 | 27.5 |
| 22-Jan-19 | TDS (mg/l) | | | 34.5 | | |

| | | Station Code | NCH01 | NPH01 | NXA01 | NHS01 |
|-----------|-----------------------------|--------------|--------|-------|-------|-------|
| Date | Parameters (Unit) | Guideline | | | | |
| 23-Jan-19 | TDS (mg/l) | | | | 54.5 | 26.1 |
| 29-Jan-19 | TDS (mg/l) | | | 34.5 | | |
| 30-Jan-19 | TDS (mg/l) | | | | 48.85 | 26.15 |
| 2-Jan-19 | Temperature (°C) | | | | 22.6 | 21.3 |
| 8-Jan-19 | Temperature (°C) | | | 20.96 | | |
| 9-Jan-19 | Temperature (°C) | | | | 23.9 | 24.2 |
| 15-Jan-19 | Temperature (°C) | | 22.9 | 18.04 | | |
| 16-Jan-19 | Temperature (°C) | | | | 24.7 | 23.7 |
| 22-Jan-19 | Temperature (°C) | | | 19.17 | | |
| 23-Jan-19 | Temperature (°C) | | | | 22.9 | 23.2 |
| 29-Jan-19 | Temperature (°C) | | | 18.09 | | |
| 30-Jan-19 | Temperature (°C) | | | | 23.3 | 24.1 |
| 2-Jan-19 | Turbidity (NTU) | | | | 2.36 | 4.4 |
| 3-Jan-19 | Turbidity (NTU) | | | 3.05 | | |
| 8-Jan-19 | Turbidity (NTU) | | | 2.38 | | |
| 9-Jan-19 | Turbidity (NTU) | | | | 6.35 | 5.53 |
| 15-Jan-19 | Turbidity (NTU) | | 81.77 | 2.49 | | |
| 16-Jan-19 | Turbidity (NTU) | | | | 5.75 | 6.55 |
| 22-Jan-19 | Turbidity (NTU) | | | 1.47 | | |
| 23-Jan-19 | Turbidity (NTU) | | | | 3.54 | 10.38 |
| 29-Jan-19 | Turbidity (NTU) | | | 3.44 | | |
| 30-Jan-19 | Turbidity (NTU) | | | | 3.2 | 13.35 |
| 15-Jan-19 | TSS (mg/l) | | 141.61 | 6.68 | | |
| 16-Jan-19 | TSS (mg/l) | | | | <5 | <5 |
| 15-Jan-19 | BOD5 (mg/l) | <1.5 | <1 | <1 | | |
| 16-Jan-19 | BOD5 (mg/l) | <1.5 | | | <1 | <1 |
| 15-Jan-19 | COD (mg/l) | <5 | <5 | <5 | | |
| 16-Jan-19 | COD (mg/l) | <5 | | | <5 | <5 |
| 15-Jan-19 | NH3-N (mg/l) | <0.2 | <0.2 | <0.2 | | |
| 16-Jan-19 | NH3-N (mg/l) | <0.2 | | | <0.2 | <0.2 |
| 15-Jan-19 | NO3-N (mg/l) | <5 | 0.03 | <0.02 | | |
| 16-Jan-19 | NO3-N (mg/l) | <5 | | | <0.02 | 0.03 |
| 15-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | 1,400 | 130 | | |
| 16-Jan-19 | Faecal coliform (MPN/100ml) | <1,000 | | | 40 | 110 |
| 15-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | 1,400 | 130 | | |
| 16-Jan-19 | Total Coliform (MPN/100ml) | <5,000 | | | 700 | 1,600 |

ANNEX B: Results of Effluent Analyses

Table B- 1: Results of Camp Effluents in January 2019

| | Site Name | Owner's Site Office and Village | | Obayashi Camp | | SongDa5 Camp No.1 | |
|----------------------------------|--------------|---------------------------------|-----------|---------------|-----------|-------------------|-----------|
| | Station Code | EF01 | | EF02 | | EF07 | |
| | Date | 11-Jan-19 | 22-Jan-19 | 11-Jan-19 | 22-Jan-19 | 11-Jan-19 | 22-Jan-19 |
| Parameters (Unit) | Guideline | | | | | | |
| pH | 6.0 - 9.0 | 7.16 | 7.21 | 7.32 | 7.9 | 6.83 | 7.71 |
| Sat. DO (%) | | 33.4 | 39.2 | 82.7 | 78.8 | 63.3 | 55.6 |
| DO (mg/l) | | 2.65 | 3.11 | 6.47 | 6.43 | 5.04 | 4.72 |
| Conductivity (µs/cm) | | 417 | 413 | 458 | 440 | 903 | 1,110 |
| TDS (mg/l) | | 208.5 | 206.5 | 228 | 220 | 451.5 | 555 |
| Temperature (°C) | | 26.6 | 26.2 | 26.8 | 24.8 | 25.3 | 22.8 |
| Turbidity (NTU) | | 6.9 | 4.56 | 9.39 | 7.89 | 30.77 | 17.49 |
| TSS (mg/l) | <50 | 7.37 | 3.9 | 11.03 | 5.21 | 33.75 | 7.14 |
| BOD5 (mg/l) | <30 | 57.52 | 12.72 | <6 | <6 | <6 | <6 |
| COD (mg/l) | <125 | 48.7 | 37 | 40.8 | 34.5 | 55.3 | 53.3 |
| NH3-N (mg/l) | <10.0 | 19 | 20.7 | 15.4 | 15 | 21.6 | 20.7 |
| Total Nitrogen (mg/l) | <10.0 | 19.9 | 25.7 | 15.9 | 16.4 | 22.4 | 21.5 |
| Total Phosphorus (mg/l) | <2 | 0.9 | 1.22 | 0.84 | 1.12 | 0.94 | 1.19 |
| Oil & Grease (mg/l) | <10.0 | <1 | | <1 | | <1 | |
| Total coliform (MPN/100ml) | <400 | 16,000 | 160,000 | 0 | 0 | 0 | 0 |
| Faecal Coliform (MPN/100ml) | <400 | 16,000 | 160,000 | 0 | 0 | 0 | 0 |
| Effluent Discharge Volume (L/mn) | | 12 | 6 | 20 | 0 | 30 | 4 |
| Chlorination Dosing Rate (ml/mn) | | n/a | n/a | 305 | 220 | 228 | 200 |
| Residual Chlorine (mg/l) | <1.0 | n/a | n/a | 0.47 | 0.74 | 0.39 | 0.55 |

| | Site Name | SongDa5 Camp No.2 | | Zhefu Camp | | V&K Camp | |
|----------------------|--------------|-------------------|-------------------------------------|------------|-----------|-----------|-----------|
| | Station Code | EF08 | | EF09 | | EF10 | |
| | Date | 11-Jan-19 | 22-Jan-19 | 11-Jan-19 | 22-Jan-19 | 11-Jan-19 | 22-Jan-19 |
| Parameters (Unit) | Guideline | | | | | | |
| pH | 6.0 - 9.0 | 7.31 | No inflow to the chlorination tank. | 8.48 | 7.62 | 7.22 | 7.68 |
| Sat. DO (%) | | 72.8 | | 37.8 | 26.7 | 57.6 | 28.5 |
| DO (mg/l) | | 5.88 | | 3.08 | 2.24 | 4.76 | 2.39 |
| Conductivity (µs/cm) | | 518 | | 1,146 | 683 | 366 | 346 |
| TDS (mg/l) | | 259 | | 573 | 341 | 183 | 173 |
| Temperature (°C) | | 25.1 | | 24.8 | 23.7 | 24.1 | 23.7 |
| Turbidity (NTU) | | 13.81 | | 16.85 | 39.15 | 6.19 | 3.54 |
| TSS (mg/l) | <50 | <5 | | 27.7 | 26.67 | 8.33 | 2.54 |
| BOD5 (mg/l) | <30 | 13.98 | | <6 | 12.06 | <6 | 7.8 |

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| | | | | | | | |
|----------------------------------|-------|------|--|------|------|------|------|
| COD (mg/l) | <125 | 36.3 | | 65.8 | 140 | 27.2 | <25 |
| NH3-N (mg/l) | <10.0 | 22.2 | | 42.1 | 51.8 | 6 | 6.2 |
| Total Nitrogen (mg/l) | <10.0 | 23.1 | | 45.8 | 53.2 | 19.3 | 8.52 |
| Total Phosphorus (mg/l) | <2 | 0.9 | | 1.04 | 1.93 | 0.67 | 0.71 |
| Oil & Grease (mg/l) | <10.0 | <1 | | <1 | | <1 | |
| Total coliform (MPN/100ml) | <400 | 17 | | 0 | 33 | 0 | 130 |
| Faecal Coliform (MPN/100ml) | <400 | 0 | | 0 | 33 | 0 | 130 |
| Effluent Discharge Volume (L/mn) | | 30 | | 4.2 | 4.2 | 7.5 | 3 |
| Chlorination Dosing Rate (ml/mn) | | 320 | | 3.1 | 3.1 | 32 | 116 |
| Residual Chlorine (mg/l) | <1.0 | 0.17 | | 1.47 | 0.19 | 0.33 | 0.07 |

| | Site Name | HM Main Camp | | IHI Main Camp | | Lilama10 Camp | | IHI Field Shop 276 Camp | |
|----------------------------------|--------------|--------------|-----------|---------------|-----------|---|-----------|-------------------------|-----------|
| | Station Code | EF13 | | EF14 | | EF17 | | EF18 | |
| | Date | 11-Jan-19 | 22-Jan-19 | 11-Jan-19 | 22-Jan-19 | 11-Jan-19 | 22-Jan-19 | 11-Jan-19 | 22-Jan-19 |
| Parameters (Unit) | Guideline | | | | | | | | |
| pH | 6.0 - 9.0 | 7.34 | 7.34 | 6.9 | 6.99 | No any inflow to the chlorination tank. | | 6.96 | 6.23 |
| Sat. DO (%) | | 61.6 | 60.3 | 69.1 | 63.7 | | | 10.4 | 20.5 |
| DO (mg/l) | | 5.05 | 4.87 | 5.53 | 5.08 | | | 0.84 | 1.68 |
| Conductivity (µs/cm) | | 1,076 | 853 | 670 | 627 | | | 435 | 155.2 |
| TDS (mg/l) | | 538 | 426 | 335 | 313.5 | | | 217 | 79 |
| Temperature (°C) | | 24.6 | 25.3 | 25.6 | 26.1 | | | 25.8 | 24.9 |
| Turbidity (NTU) | | 0.15 | 42.98 | 14.89 | 14.92 | | | 90.3 | 43.33 |
| TSS (mg/l) | <50 | 24.83 | 25 | 19.34 | 16.02 | | | 81.93 | 11.73 |
| BOD5 (mg/l) | <30 | <6 | <6 | <6 | <6 | | | 124.27 | 22.08 |
| COD (mg/l) | <125 | 180 | 144 | 156 | 122 | | | 248 | 41.8 |
| NH3-N (mg/l) | <10.0 | 13.5 | 24.9 | 4.3 | 9.1 | | | 12 | 6.4 |
| Total Nitrogen (mg/l) | <10.0 | 14 | 25.6 | 4.74 | 13 | | | 12.6 | 7 |
| Total Phosphorus (mg/l) | <2 | 0.85 | 1.37 | 0.65 | 1.09 | | | 0.58 | 0.29 |
| Oil & Grease (mg/l) | <10.0 | 5 | | 9 | | | | <1 | |
| Total coliform (MPN/100ml) | <400 | 0 | 0 | 0 | 0 | | | 35,000 | 160,000 |
| Faecal Coliform (MPN/100ml) | <400 | 0 | 0 | 0 | 0 | | | 35,000 | 160,000 |
| Effluent Discharge Volume (L/mn) | | 4.2 | 4.2 | 4.2 | 3 | | | 12 | 6 |
| Chlorination Dosing Rate (ml/mn) | | 3.1 | 3.1 | 3.1 | 40 | | | 30 | 41.8 |
| Residual Chlorine (mg/l) | <1.0 | 0.99 | 1.07 | 0.45 | 1.56 | | | 0.03 | 6.4 |

Table B- 2: Results of the Construction Area Discharge in January 2019

| | Site Name | Spoil Disposal No.2 | | | |
|----------------------|--------------|---------------------|-----------|-----------|-----------|
| | Station Code | DS04 | | | |
| | Date | 07-Jan-19 | 16-Jan-19 | 22-Jan-19 | 30-Jan-19 |
| | Guideline | | | | |
| Parameter (Unit) | Guideline | | | | |
| pH | 6.0 - 9.0 | 6.47 | 7.4 | 8.25 | 7.95 |
| Sat. DO (%) | | 95.6 | 71.9 | 95.2 | 87.6 |
| DO (mg/L) | | 7.47 | 5.85 | 7.37 | 7.35 |
| Conductivity (µs/cm) | | 19.34 | 12.24 | 9.6 | 10.78 |
| TDS (mg/l) | | 9.5 | 6.1 | 4.8 | 5.3 |
| Temperature (°C) | | 26.3 | 24.7 | 25.6 | 23.1 |
| Turbidity (NTU) | | 2.02 | 5.02 | 4.39 | 5.38 |
| TSS (mg/L) | <50 | 5.42 | 5.62 | 5.1 | 3.37 |
| Oil & Grease (mg/L) | <10 | | <1 | | |
| Total Iron (mg/L) | | | 12.3 | | |

| | Site Name | Upstream Spoil Disposal No.2 | | | |
|----------------------|--------------|------------------------------|-----------|-----------|-----------|
| | Station Code | DS04-US | | | |
| | Date | 07-Jan-19 | 16-Jan-19 | 22-Jan-19 | 30-Jan-19 |
| | Guideline | | | | |
| Parameter (Unit) | Guideline | | | | |
| pH | 6.0 - 9.0 | 6.06 | 6.24 | 6.45 | 6.9 |
| Sat. DO (%) | | 62.6 | 60.6 | 42.8 | 76.3 |
| DO (mg/L) | | 4.87 | 4.88 | 4.43 | 6.26 |
| Conductivity (µs/cm) | | 49.9 | 51.9 | 53.7 | 54.3 |
| TDS (mg/l) | | 24.9 | 25.2 | 26.9 | 27.1 |
| Temperature (°C) | | 26.6 | 25.9 | 25.3 | 24.3 |
| Turbidity (NTU) | | 6.6 | 8.82 | 6.48 | 6.88 |
| TSS (mg/L) | <50 | 7.71 | 7.77 | 3.63 | 4.44 |
| Oil & Grease (mg/L) | <10 | | <1 | | |
| Total Iron (mg/L) | | | 0.824 | | |

ANNEX C: Ambient Dust Quality

Table C- 1: 24-hour Average Dust Concentrations Measured in Hat Gnuin Village

| Hat Gnuin Village - 24 Hours Average Particulate Matter (PM10) Concentration | | | |
|--|-----------------|-----------------|-----------------|
| Period | 00 to 24 Hours | 24 to 48 Hours | 48 to 72 Hours |
| Start Time | 07-Jan-19 18:00 | 08-Jan-19 18:01 | 09-Jan-19 18:01 |
| End Time | 08-Jan-19 18:00 | 09-Jan-19 18:00 | 10-Jan-19 18:00 |
| Average Data Record in 24h (mg/m3) | 0.016 | 0.019 | 0.023 |
| Guideline Average in 24h (mg/m3) | 0.12 | 0.12 | 0.12 |

Table C- 2 24-hour Average Dust Concentrations Measured in Phouhomxay Village

| Phouhomxay Village - 24 Hours Average Particulate Matter (PM10) Concentration | | | |
|---|-----------------|-----------------|-----------------|
| Period | 00 to 24 Hours | 24 to 48 Hours | 48 to 72 Hours |
| Start Time | 14-Jan-19 18:00 | 15-Jan-19 18:01 | 16-Jan-19 18:02 |
| End Time | 15-Jan-19 18:00 | 16-Jan-19 18:01 | 17-Jan-19 18:00 |
| Average Data Record in 24h (mg/m3) | 0.055 | 0.057 | 0.049 |
| Guideline Average in 24h (mg/m3) | 0.12 | 0.12 | 0.12 |

Table C-3 and Table C-4: Average Results of Dust Monitoring at Song Da5 Camp No. 2 and Lilama10 Camp in January 2019

| Song Da5 Camp No.2 - Dust Emission Average in 24 hours | | Lilama10 Camp - Dust Emission Average in 24 hours | |
|--|-----------------|---|-----------------|
| Period | 24 Hours | Period | 24 Hours |
| Start Time | 02-Jan-19 18:00 | Start Time | 30-Jan-19 18:00 |
| End Time | 03-Jan-19 18:00 | End Time | 31-Jan-19 18:00 |
| Average Data Record -24h | 0.012 | Average Data Record -24h | 0.047 |
| Guideline | 0.12 | Guideline | 0.12 |

Table C-5 and Table C-6: Average Results of Dust Monitoring at Main Dam, and Main Powerhouse in January 2019

| Main Dam - Dust Emission Average in 24 hours | | Main Powerhouse - Dust Emission Average in 24 hours | |
|--|-----------------|---|-----------------|
| Period | 24 Hours | Period | 24 Hours |
| Start Time | 22-Jan-19 18:00 | Start Time | 28-Jan-19 18:00 |
| End Time | 23-Jan-19 18:00 | End Time | 29-Jan-19 18:00 |
| Average Data Record -24h | 0.033 | Average Data Record -24h | 0.056 |
| Guideline Average - 24h | 0.12 | Guideline Average - 24h | 0.12 |

ANNEX D: AMBIENT NOISE DATA

Table D- 1: Average Results of Noise Monitoring at Ban Hat Gniun in January 2019

| Noise Level (dB) | 07-08/January/19 | | | 08-09/January/19 | | | 09-10/January/19 | | |
|---------------------------|------------------|-------------|-------------|------------------|-------------|-------------|------------------|-------------|-------------|
| | 18:30-22:00 | 22:01-06:00 | 06:01-18:00 | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 |
| Maximum Value Recorded | 60.00 | 55.80 | 62.00 | 56.90 | 45.50 | 60.90 | 56.00 | 57.90 | 60.10 |
| Guideline Max | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 115 |
| Average Data Recorded | 38.10 | 32.89 | 39.61 | 37.86 | 34.41 | 40.99 | 37.15 | 36.41 | 38.78 |
| Guideline Averaged | 55 | 45 | 55 | 55 | 45 | 55 | 55 | 45 | 55 |

Table D- 2: Average Results of Noise Monitoring at Phouhomxay Village in January 2019

| Noise Level (dB) | 14-15/January/19 | | | 15-16/January/19 | | | 16-17/January/19 | | |
|---------------------------|------------------|-------------|-------------|------------------|-------------|-------------|------------------|-------------|-------------|
| | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 |
| Maximum Value Recorded | 70.70 | 49.90 | 62.00 | 49.90 | 46.10 | 66.90 | 62.00 | 6.00 | 69.40 |
| Guideline Max | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 115 |
| Average Data Recorded | 43.49 | 36.35 | 38.80 | 38.25 | 36.16 | 36.72 | 40.40 | 37.25 | 37.21 |
| Guideline Averaged | 55 | 45 | 55 | 55 | 45 | 55 | 55 | 45 | 55 |

Table D- 3 and Table D- 4: Average Results of Noise Monitoring at Song Da5 Camp No. 2 and Sino Hydro Camp in January 2019

Song Da5 Camp No.2

| Noise Level (dB) | 02-03/January/19 | | 03/January/19 |
|---------------------------|------------------|-------------|---------------|
| | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 |
| Maximum Value Recorded | 57.3 | 56.9 | 58.3 |
| Guideline Max | 115 | 115 | 115 |
| Average Data Recorded | 38.32 | 35.53 | 33.94 |
| Guideline Averaged | 70 | 50 | 70 |

Lilama10 Camp

| Noise Level (dB) | 30-31/January/2019 | | 31/January/2019 |
|---------------------------|--------------------|-------------|-----------------|
| | 18:30-22:00 | 22:01-06:00 | 06:00-18:00 |
| Maximum Value Recorded | 44.6 | 78.3 | 59.3 |
| Guideline Max | 115 | 115 | 115 |
| Average Data Recorded | 38.10 | 38.56 | 34.33 |
| Guideline Averaged | 70 | 50 | 70 |

Table D- 5 and Table D- 6: Average Results of Noise Monitoring at Main Dam, and Main Powerhouse in January 2019

Main Dam

| Noise Level (dB) | 22-23/January/19 | | 23/January/19 |
|---------------------------|------------------|-------------|---------------|
| | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 |
| Data Record Max | 53 | 52.8 | 60.5 |
| Guideline Max | 115 | 115 | 115 |
| Data Record Average | 50.90 | 50.97 | 48.69 |
| Guideline Averaged | 70 | 70 | 70 |

Main Powerhouse

| Noise Level (dB) | 28-29/January/19 | | 29/January/19 |
|---------------------------|------------------|-------------|---------------|
| | 18:00-22:00 | 22:01-06:00 | 06:01-18:00 |
| Data Record Max | 67.3 | 62.8 | 82 |
| Guideline Max | 115 | 115 | 115 |
| Data Record Average | 56.76 | 59.94 | 57.70 |
| Guideline Averaged | 70 | 70 | 70 |