Detailed Works Program
and
Site Specific Environmental & Social Management
& Monitoring Plan for Grouting Works at Secondary
Upstream Cofferdam

for
Nam Ngiep 1 Hydropower Project

Document No. : NNP1-MS-CD-004-A3

OBAYASHI Corporation

Submitted By:

Kazuhiro CHABAYASHI
Project Manager
Nam Ngiep Project Office
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PART 1: DETAILED WORKS PROGRAMME
(DWP)
1. GENERAL

The secondary upstream cofferdam grouting work will be carried out to prevent the water seepage from upstream side passing through the soil foundation. The grouting work shall be done to improve the impermeability of the cofferdam foundation where big boulder may exist in the talus and river deposit. This detail works program focuses on the methodology to seal soil foundation beneath the RCC & CVC secondary upstream cofferdam by systematic sleeve grouting method.

The grouting works of the secondary upstream cofferdam consist of 2 locations, left bank and right bank of Nam Ngiep River. Both locations are designed to have primary grout holes, primary check holes, secondary grout holes, secondary check holes and some additional grout holes and check holes.

The work will adopt sleeve grouting method and the grout lengths are varying from 5 – 26 m.

The detail of grouting location is shown in Figure 1 – Figure 4.

Fig.1 Layout of Grouting Work
Fig. 2 Longitudinal Profile of Grouting

Fig. 3 Actual Site Condition of Secondary Upstream Cofferdam
2. REFERENCE

Reference Specification:

- Technical Specification: Section 7 Drilling and Grouting

3. MATERIAL

3.1 Cement

Cement to be used for grouting material is port-land cement type 3 of ASTM C150, in a 50 kg/bag packaging

Compatibility of cement with the admixtures shall undergo required laboratory tests before usage. If the cement contains lumps or foreign material that would clog the grouting
equipment or interfere with grout injection, it shall be screened through a screen mesh. Cement is used for grouting in sandy soil and tightly fractured rock where cracks are fine in order to take advantage of the finer grain size.

3.2 Water
Water will be from Nam Ngiep River that will undergo required quality laboratory tests conforming to the specifications. The water will be pumped through supply lines installed nearby the river. All the water will be stored in storage tanks, allowing the fine particles to settle and be kept cool for the preparation of grout mix. The water shall not contain particles larger in size than the cement particles and the temperature of water shall be maintained below 30°C.

3.3 Bentonite
Bentonite is used to modify the physical property of the grout, delaying the gel time of the grout to suit the project requirement. Bentonite is retarder material which composed of natural clay minerals. This mineral is also used for increasing the workability of the grout to conform the requirement of the project.

Bentonite is supplied as a solid powder, stored in 45 kg/bag. The specified manufacturer’s instructions for storage, proportioning, mixing and safe handling procedures shall be carefully followed.

Material specifications are indicated in our grouting materials submittal thru our letter PCL-01822 dated 24th December 2015.

3.4 Grouting Material
The mix proportion shall be confirmed on site by conducting the trial grout mix. The mix proportions provided by the owner are shown below:

<table>
<thead>
<tr>
<th>Description</th>
<th>C:B</th>
<th>(C+B):W</th>
<th>Cement (kg)</th>
<th>Bentonite (kg)</th>
<th>Water (l)</th>
<th>Mix volume (l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lu &gt; 1×10^-3 cm/s</td>
<td>5:1</td>
<td>1:1</td>
<td>50</td>
<td>10</td>
<td>60</td>
<td>80.04</td>
</tr>
<tr>
<td>Lu &lt; 1×10^-3 cm/s</td>
<td>5:1</td>
<td>1:2</td>
<td>50</td>
<td>10</td>
<td>120</td>
<td>140.04</td>
</tr>
</tbody>
</table>

Table 1: Mix Proportion for Grouting Work

4. EQUIPMENT AND MANPOWER

4.1 Equipment and Tool
Equipment to be deployed shall be suitable with the site condition and conforming to the technical specifications. Spare part with various capacity shall be maintained to replace inefficient ones on-site.

4.1.1 Drilling equipment
The non-core rotary drilling methods will be used. The skid base type shall be utilized for drilling both grout holes and check holes in the range of diameter 45 mm to 76 mm.

4.1.2 Mixer
The mixers shall be mechanically operated and provided with an accurate measuring system for controlling the amount of mixing water used in the grout.

Mixing shall be carried out in high speed mixers, and closed-circuit circulation of the grout milk shall be allowed.
4.1.3 Agitators

The agitator is impeller type where the grout is thoroughly mixed slowly by revolving paddle to keep the grout particles in-suspension and to remove air bubbles, created in the mixing process while awaiting the injection. The agitator capacity ranges from 300 l to 500 l in-conformance with the general specification.

4.1.4 Water Meter

All new water meter will be calibrated by an accredited company prior to use of measuring the amount of water added to the grout mix in the permanent grouting campaign.

4.1.5 Grout Pumps

The grout pumps will be duplex double acting piston type, equipped with air pressure chamber. The pumps will be capable of operation at a maximum discharge pressure of 1.5 – 3.0 Mpa and delivery not less than 50 l/min of liquid grout.

4.1.6 Water Pumps

The water pump for water pressure test shall be triplex plunger type, which will be capable of operating at a maximum discharge pressure of 2.5 Mpa and maximum suction capacity up to 100 l/min.

4.1.7 Pressure Gauges

The calibrated new pressure gauges will be used to monitor the injection pressure of the grout being delivered to the grout hole. A protective medium will be used to separate the grout from the gauge. A master gauge will be used to check calibration of the production gauges both prior to use in grouting and during every specified period.

4.1.8 Packers

Double packers are used to seal off or isolate a portion of sleeve port along grout hole that allows grout to be injected under pressure into a soil foundation. The pneumatic inflatable double packer are proposed to use in secondary upstream cofferdam grouting by tube a machete method.

4.1.9 Data Acquisition & Recording Equipment

The data acquisition and recording equipment consist of measuring unit and recording unit. The measuring unit measures flow rate and pressure. In recording unit the electronic signal of the measuring unit are processed and flow rates and pressures are displayed digitally. The equipment can be used to measure and record data from both grouting operations with cement-based grouts and permeability testing.

The recording units, manufactured by DAEJUNG, will be available that display flow rates in L/min with the accumulated totals displayed in litre and pressures in bars at every 10 seconds or specified interval. The measurement range of recording unit will be (0 – 120 l/min) in flow rate and (0– 60 bar) in pressure.
4.1.10 Delivery and Distribution System

The delivery and distribution system consists of all grout lines, valves, gauges, and fitting between the discharge end of the pump and the hole being grouted. The delivery or supply lines brings the grout from the pump to the header or control manifold. The return line recycles the unused grout back to the agitator tank. The return line also serves as the pressure relief line to help control pressure at the header.

Table 2. Major Equipment List

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment / Tool</th>
<th>Capacity</th>
<th>Nos</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hydraulic rotary drilling machine</td>
<td></td>
<td>2</td>
<td>Drilling of grout hole</td>
</tr>
<tr>
<td>2</td>
<td>Generator</td>
<td>100-220 KVA, 380V</td>
<td>1</td>
<td>Supply electrical power for grouting work</td>
</tr>
<tr>
<td>3</td>
<td>Grout mixer</td>
<td></td>
<td>2</td>
<td>Mixing of grouting material before transfer to agitator tank</td>
</tr>
<tr>
<td>4</td>
<td>Grout agitator</td>
<td></td>
<td>2</td>
<td>Stirring of grout mix, transfer from grout mixer</td>
</tr>
<tr>
<td>5</td>
<td>Grout pump</td>
<td>Max pressure 30 bar</td>
<td>2</td>
<td>Injection of grout mix and accelerator into the grout holes</td>
</tr>
<tr>
<td>6</td>
<td>Pneumatic double inflatable packer, r28</td>
<td></td>
<td>6</td>
<td>Isolated specified depth interval for grouting</td>
</tr>
<tr>
<td>7</td>
<td>Automatic grout flow meter</td>
<td></td>
<td>2</td>
<td>Measuring and recording of grout flow rate, flow volume and pressure</td>
</tr>
<tr>
<td>8</td>
<td>High pressure water pump</td>
<td></td>
<td>2</td>
<td>Water pressure test, water supply</td>
</tr>
<tr>
<td>9</td>
<td>Grout hoses</td>
<td>Max pressure 70 bar</td>
<td></td>
<td>Delivery of grout from pump to grout holes</td>
</tr>
</tbody>
</table>

4.2 Nominated Subcontractor and Manpower Distribution

Nominated Subcontractor: **RIGHT TUNNELLING CO., LTD.**

In general, the subcontractor will be nominated, concerning not only price/rate but also following items, fully described below.

1) Technical competence
2) Financially stable
3) Administrative competence
4) Past project experience and reference
5) Ability to meet schedule
6) Quality and skill of work
7) Capacity(equipment, staff, worker) and organization
8) Ability to meet safety and environment requirements

And then, the evaluation for subcontractor will be done and recorded. Manpower distribution for this work is shown below.

Table 3. Manpower Distribution for Main Dam excavation works

<table>
<thead>
<tr>
<th>No.</th>
<th>Manpower</th>
<th>Planned Number</th>
<th>Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineer</td>
<td>2</td>
<td>Site management</td>
</tr>
<tr>
<td>2</td>
<td>Technical Engineer</td>
<td>1</td>
<td>Engineering</td>
</tr>
<tr>
<td>3</td>
<td>Mechanic</td>
<td>4</td>
<td>Mechanical &amp; electrical work</td>
</tr>
<tr>
<td>4</td>
<td>Foreman</td>
<td>2</td>
<td>Work management</td>
</tr>
<tr>
<td>5</td>
<td>Equipment operator</td>
<td>8</td>
<td>Drilling machine, grouting machine</td>
</tr>
<tr>
<td>6</td>
<td>Skilled Worker</td>
<td>40</td>
<td>Drilling work, grouting work</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. CONSTRUCTION PROCEDURE

The working procedure is described by the flow chart below:
5.1 Survey Work

5.1.1 Benchmark Coordination
The Main Dam coordinates are based from public/local agency survey references.

- **NNG1-2**  N 2062622.962  E 344440.726, EL351.111
- **MDL-1**  N 2062498.474  E 344655.722, EL324.215
- **MDL-5**  N 2061979.291  E 344363.534, EL353.177
- **MDL-6A** N 2062005.745  E 344202.327, EL375.011
Existing point of local references shall be confirmed to carry out the survey work. Contractor shall submit the transferred new reference coordinates/bench mark to the Client

![Location of the Bench Mark for Grouting Works](image)

5.1.2 Survey Work
Firstly, transferred benchmarks for elevations and coordinates are established around the working area. Setting drilling holes locations and existing elevations by total station, the distance among holes shall be 0.75 m along the cofferdam axis. The tolerance of actual holes location shall not exceed 10 cm compared with the design location. All holes shall be numbered for the convenience during construction work.

5.2 Preparation Work
Preparatory works prior to grouting campaign in power waterway will be as follow:
   a) Setting of water supply system and water storage tanks
   b) Setting of electric generators
   c) Waste disposal system
   d) Fabrication of Grouting Scaffolding (if required)
   e) Transportation of Manpower and Drills & Grouting Equipment
   f) Storage facility of Cement & other grouting materials
   g) Lighting system and Safety equipment

5.3 Drilling Hole
5.3.1 Drilling at Grout Hole
The drilling for grout holes shall be rotary non-coring method. The drilling shall not be carried out earlier than 3 days after pouring of concrete cap in that section. The grout holes will be drilled vertically with 0.75 m spacing. The grouting shall be started from lower elevation then move to the upper elevation from left bank, and from the downstream row to upstream row.

5.3.2 Drilling at Check Hole
After each area of grouting has been completed, the primary check hole shall be conducted following the drawing for evaluate the grouting efficiency. The permeability of foundation shall be tested by Lugeon method or water constant head method at every 5 m. if the Lugeon value is high, additional grout holes shall be carried out.

In the area of uncertainly, the secondary check holes shall be conducted with permeability test to ensure soil foundation conform to technical specification.

5.4 Sleeve tube installation
The 1.5 inches PVC pipe with rubber sleeve covered 4 injection ports at every 0.33 m along the pipe shall be installed immediately after the drilling has reached the specified depth. The sleeve PVC pipe shall installing through entire depth with the bottom cap to protect muddy soil from drilling process intrude into the pipe. The weak cement bentonite grout shall pumping through the ¾ inch tremie pipe to cast around the PVC pipe. The weak cement bentonite use for protecting the leakage upward along the PVC pipe during injection at the bottom part. After filling annular space by weak cement bentonite, the steel casing shall be removed from the hole leaving the PVC pipe in place. The PVC pipe will have a cap on the top and bottom to prevent debris from entering the grout hole.

5.5 Grouting
The grouting is consisting of 3 rows, downstream row, upstream row and the middle row of check holes. The injection shall be conducted after install the perforated PVC pipe. The primary grout hole at D/S side shall be completed first and then following by secondary grout holes in the same row. The upstream side of primary and secondary grout hole shall following after downstream side has completed with same sequence. The primary and secondary check holes shall be located at the middle between the downstream and upstream rows.
5.5.1 Cement Bentonite Injection

This type of grouting shall use for soil foundation improvement on both abutments of secondary upstream cofferdam by Sleeve grouting method. The purpose of grouting is to fill the voids between the rock boulder/rock boulder and rock boulder/soil foundation.

The sequence of soil foundation improvement shall be started by drilling the grout hole until reached the specified depth and install the sleeved PVC pipe with weak cement bentonite casted around the pipe. Leaving for 1-2 days let weak cement bentonite setting.

In primary grout hole, setting double packer between the bottommost of injection port and then injecting the proposed grout mix with high pressure to breaking out the rubber sleeve and weak cement bentonite around the pipe. The acceptance grout mix ratio shall continuous injecting through this port and cracks from first opening to filling voids in soil foundation until reached the acceptance refusal. After the bottommost of injection ports have completed, the upper injection ports shall be continue injected by using the same procedure. The injection shall start from bottommost ports to uppermost ports in every grout holes. The stop valve at the hole collar shall be closed for some minute after complete the injection.

The secondary grout holes shall start after both sides of primary grout holes have completed. The injection procedures shall be same as primary grout holes.

The maximum grouting pressure shall applied for injecting the grout into the soil foundation with the limited flow rate less than 30 L/minute. The grouting will seem to be completed when the volume of the injecting grout is reach 471 L/m or 157 L/sleeve port. In case of low intake, the volume of the grout may not reach the target, refusal shall specified by injection rate less than 5 L/min at maximum pressure or surface leakage has detected during injection operation. The refusal criteria is shown in Table below:

Table 4: Grouting refusal criteria in secondary upstream cofferdam

<table>
<thead>
<tr>
<th>Type of Grouting</th>
<th>Refusal Criteria</th>
<th>Maintained Pressure (minutes)</th>
</tr>
</thead>
</table>
| Cement-bentonite grouting at both abutments | 1) Cement-bentonite grout volume = 471 l/min or 157 l/sleeve  
2) The injection rate less than 5 l/min at design pressure  
3) Surface leakage has detected | 5-10                           |

5.5.2 Grout Mixing and Injection Procedure

From the evaluation of extensive trial mixes, performed with actual production volume and laboratory equipment and on site testing for their grout mix properties, the detailed sequence of mixing and the function of grouting has been standardized as follows:

a) The correct quantity of bentonite mud for the batch is pumped through the calibrated dosing tank and filled into the mixer.
b) Operate the mixer up to max speed.
c) Added the required water through the calibrated water meter to the mixer.
d) Operate the mixer up to max speed to mix bentonite mud and add water.
e) Gradually pour the required quantity of cement (from whole bags of cement) in the mixer and mix for 1-2 minute.
f) After all ingredients have been added, mix for 1 minute more.
The colloidal grout mixture is then transferred to agitator which keeps it stirred up until it is needed by the pump. The pumps draw the grout from agitators and pump it around the circulation line and passes the mixture through the pressure & flow sensor unit to go down the hole. Adjusting the injection pressure to 7-10 bars for opening the sleeve and weak cement bentonite. After opening, the pressure shall be dropped automatically and should be controlled below the maximum grouting pressure. Start injecting cement bentonite grout by slowly increasing the injection pressure and flow rate at the return valve installed in the line of grout pipe, immediately before the sensor unit. Impulses transmitted from a combined unit of inductive flow meter and electronic pressure transducer are simultaneously received in parallel by the recorder in which the injected grout volume (l/min) and accumulated grout volume (l) and injection pressure are displaying every 10 seconds. The grout returned through the circulation line is received by the agitator to remove air bubbles and air pockets and keep the mix in suspension. Grout injection will continue and deem to be completed when the mixed grout has reached limited volume of 157 l/sleeve port. The packer is loosened and installed between two sleeve ports to be grout. The injection work shall be repeated for the next injection port. At the end of grouting, each hole shall be filled with cement mortar until reached the concrete cap level.

The grout mixing plant for sleeve grouting is shown in Figure below.

Fig 8 Grout Plant layout

5.6 Water Pressure Test
The water pressure test is carried out in grout holes before injection and also in check holes after injection completed. There are several method to measure the permeability of the foundation. For soil foundation, the falling head test shall be used. In rock foundation, Lugeon test shall be carried out.
5.6.1 **Lugeon Test**

Lugeon test shall be carried out with clean water under continuous pressure at every stage of drilling. Different pressure will be required of different stages of the grout holes. Sufficient water shall be provided to develop the design pressure, and pressure gauges and water meter shall be provided to measure the amount of water injection and the pressure during the test.

Water shall be pumped into holes to maintain the testing pressure, this pressure should be maintained during the test by injection water continuously. During testing period, monitor volume of leakage water and maintain the set pressure. If the injection water volume becomes constant or testing work achieve the required time, the test will be completed and continue to the next pressure.

- **Lugeon test at 1st drilling stage (5 m depth)**

  **Step 1:** Firstly, water test shall be pumped into hole gradually to achieve the pressure of 0.2 Mpa. This pressure must be maintained during testing time of 5 minutes, and the injection volume shall be monitored accordingly. After 5 minutes the injection of water volume shall be recorded for calculation of Lugeon value.

  **Step 2:** Continue injection of water until reaches the pressure 0.4 Mpa. The procedure is repeated from first step, then injection of water volume shall be recorded after 5 minutes maintaining the pressure of 0.4 Mpa.

  **Step 3:** After testing under 2nd step, the pressure in hole shall be released to the pressure of 0.2 Mpa and continue going back to step 1.

![Fig.9 Lugeon test at 1st drilling stage](image-url)
The Lugeon test procedure is described in the chart below.

- **Lugeon test at 2nd drilling stage (10 m depth)**

  **Step 1:** Firstly, water test shall be pumped into hole gradually to achieve the pressure of 0.2 Mpa, this pressure must be maintained during testing time 5 minutes, and the injection volume shall be monitored accordingly. After 5 minutes the injection of water volume shall be recorded for calculation of Lugeon value.

  **Step 2:** Continue increasing the pressure in hole to 0.3 Mpa, and measure the injection of water volume after 5 minutes.

  **Step 3:** Continue increasing the pressure up to 0.5 Mpa and repeat as of previous Steps.

  **Step 4:** After testing at the pressure of 0.5 Mpa, decrease the pressure until 0.3 Mpa and measure the injected water volume after 5 minutes.

  **Step 5:** Continue decreasing the pressure to 0.2 Mpa and measure the injection of water volume after 5 minutes.
The Lugeon test procedure is described in the chart below.

- **Lugeon test at 3rd drilling stage (15 m depth) & next drilling stage:**
  The drilling work is continued until reaching the specified depth and then the permeability test shall be carried out repeating the procedures.
Based on the result of injection of water volume in accordance with pressure reading, the Lugeon value (qu) of hole shall be defined by the graph below.

\[ \text{Lugeon} = \frac{(10 \times q)}{(P \times L)} \]

Whereas: q = water loss, l/min

\[ P = \text{water pressure, bar} \]
\[ L = \text{test interval, m} \]

5.7 Closure of hole

After grouting, the hole shall be filled up tightly by cement milk until top surface and the surface shall be levelled and clean up. All the scaffoldings and the machineries shall be dismantled and mobilized to the next location.

6. SAFETY CONTROL

Safety control for site works shall follow the latest Safety and Security Program (Document No. NNP1-PRG-SSP-A3) enclosed with Contractor’s letter NNP1- PCL- 00044, dated 10th December 2013.

Before commencement of work, safety training shall be carried out to relevant staffs and workers. The emergency action plan is attached in Appendix 9.3.

6.1 Safety indoctrination
Tool box meeting (TBM) shall be conducted by Safety Officer to remind the individual work crew on health and safety issues related to the work in progress throughout the construction period.

Work and safety instruction shall be issued by Chief Engineer/Construction Manager to subcontractors’ representative or workers during daily meeting, then it will be signed by the person receiving the instruction.

6.2 Health control for occupational health program
Safety officer shall check and ensure that appropriate Personal Protective Equipment (PPE) are provided to the workers and that training is given to use and maintain their PPE effectively and appropriately for the jobs on the site.

In-house Rules and Regulations shall be posted at prominent locations, e.g. bulletin boards, at project sites. All new workers, subcontractors and staff shall be briefed on the rules and regulations and it shall be abide by them.

6.3 Accident countermeasures

Countermeasures for prevention of occurrence of accident, especially during grouting work, the following shall be concerned.

6.3.1 Safety measure for rainy season and against flood
- Equipment should always park at the parking area after the work
- Engineer or safety officer should always check water level when raining.
- Clear warning sign shall be arranged around the boundary between river and land and to inform all worker “Mind Your Step” and “Slippery Rock Surface”.
- When thunderstorm will come, all work shall evacuate.
- The discontinuance criteria for the climate condition is as follows,
  - (i) over 30mm per day of expected rainfall amount.
  - (ii) over 10mm per hour of rainfall amount
  - (iii) the gap of wildfire and thunder is short
  Re-starting of work will be after checking of site condition.
- In case of heavy rain, engineer or safety officer shall monitor the river water level carefully when it reaches at EL.188.50m, all equipment and workers shall be evacuated to a higher ground level or shall be parked at Camp Yard.

6.3.2 Safety measures to prevent from slope sliding
- Visual check of slope condition before commencement of construction work.
- Training of a sign of land sliding for labor.
- No vehicle, equipment, and machinery park at the edge of embankment or on unstable ground.

6.4 Safety control plan against flood and evacuation procedure
6.4.1 General
Monitoring for safety control plan against flood shall be based on the following measures described below.
- Weather and tide forecast from the Local Bureau of meteorology
- Analysis of water level based on survey monitoring data.
• Visual monitoring of water level gage by engineer or safety officer in the Main Dam area daily.
• Actual river discharge and rainfall intensity.

6.4.2 Procedure
• The procedure shall be complied with Management System for the Flood in Rainy Season (Document No. NNP1-OTH-MSF-A3) enclosed with Contractor’s letter NNP1-PCL-01337, dated 18th July 2015.

• UC area shall use monitoring point at inlet of River Diversion Tunnel. Please refer to clause 4.1 Monitoring Point at Inlet for River Diversion Tunnel of Document No. NNP1-OTH-MSF-A3 for details.

7. QUALITY ASSURANCE
Quality Assurance shall be followed to the Quality Assurance Program (Document No. NNP1-PRG-DrQAP-A3) enclosed with Contractor’s letter NNP1-PCL-00086, dated 16th January 2014. Quality control works shall be conducted by the Contractor whereby effective implementation and inspection of this work shall be made to ensure that the quality is maintained.
PART 2
SITE SPECIFIC ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (SS-ESMMP)
8. ENVIRONMENTAL & SOCIAL MANAGEMENT & MONITORING PLAN

8.1. Introduction

This Site Specific Plan has been prepared to highlight environmental and social conditions prior to the beginning of each construction activity and will be used as a tool to ensure the particular activity follows the correct management and mitigation procedures. Sub-Plans will be used to detail mitigation methods for each of the activities associated with the construction or embankment works.

This detail works program focus on the method to seal foundation beneath the RCC & CVC secondary upstream cofferdam by systematically sleeve grouting method. The grouting of secondary upstream cofferdam located at left bank and right bank of Nam Ngiep river.

Table 8.1 below shows the referential linkages of documents regarding environmental matters in the NNP1 Project. The Owners (NNP1) documents use references and information from the Concession Agreement. This SS ESMMP (Contractor) uses references and information from Owners EIA/ESMMP and Owners ESMMP-CP.

<table>
<thead>
<tr>
<th>Item</th>
<th>Hierarchy of Documents</th>
<th>Approving Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Concession Agreement</td>
<td>GOL</td>
</tr>
<tr>
<td>2</td>
<td>NNP1 EIA/ESMMP</td>
<td>GOL</td>
</tr>
<tr>
<td>3</td>
<td>ESMMP-CP</td>
<td>GOL</td>
</tr>
<tr>
<td>4</td>
<td>Contractors EMP</td>
<td>NNP1</td>
</tr>
<tr>
<td>5</td>
<td>SS ESMMP</td>
<td>NNP1</td>
</tr>
</tbody>
</table>

The Contractor documents are; Contractors EMP (Item 4) and SS ESMMP (Item 5) which have used applicable information extracted from the Owners documents which are Concession Agreement (Item 1), NNP1 EIA/ESMMP (Item 2) and ESMMP-CP (Item 3).

All obligations of the contractor are stated in the Civil Works Contract (CWC) which includes Schedule 9 (Concession Agreement Pass Through Obligations) and is the only governing document for the Contractor.

8.2. Environmental and Social Pre-Construction Description

8.2.1. Land use in the area

There is no land use directly in the Upstream and Downstream Coffer Dams areas as structures are located in Nam Ngiep River.

Previous land use consisted mainly of shifting cultivation in the upper valley of the construction area. Vegetation types in the Main Dam construction area and its steep valleys are mainly mixed deciduous forest. Surrounding forest is mixed species of dry evergreen and bamboo forests. Canopy cover is approximately 60-70%. Top canopy height is 20-40 m.
8.2.2. Proximity to villages, cultural sites

The closest village to Upstream and Downstream Cofferdams construction area is Ban Hatsaykham, over 3 km downstream of the site. There will be no impacts to cultural sites.

Table 8.2 below is a pre-construction checklist to identify any major environmental impacts that may occur during construction works. After completion of the checklist the Sub-Plans can be selected accordingly.

Table 8.2 – Environmental Assessment Checklist – For Pre Construction

<table>
<thead>
<tr>
<th>Site Location</th>
<th>Consolidation Grouting area located at Main Dam Right bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS Coordination</td>
<td>Refer to item 5.1.1 of this DWP</td>
</tr>
<tr>
<td>Photo</td>
<td>See attached photos below</td>
</tr>
<tr>
<td>Date</td>
<td>November 23, 2015</td>
</tr>
<tr>
<td>Estimated Area</td>
<td>Area of grouting work is 220 m²</td>
</tr>
<tr>
<td>Prepared By</td>
<td>Santi Sayakoummane</td>
</tr>
<tr>
<td>Checked By</td>
<td>Mr Keisuke Machida</td>
</tr>
<tr>
<td>Site Description</td>
<td>This grouting work is carried out to improve the impermeability of secondary cofferdam</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Setting</th>
<th>Yes</th>
<th>No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will the site require UXO clearance?</td>
<td>✓</td>
<td></td>
<td>UXO clearance for this area has been completed for the Main Dam Earthwork</td>
</tr>
<tr>
<td>Is there surface water located in close proximity to the site?</td>
<td>✓</td>
<td></td>
<td>This work is carried out at the Main Dam area, above the Nam Ngiep river water level</td>
</tr>
<tr>
<td>Is there a village or community located in close proximity to the site?</td>
<td>✓</td>
<td></td>
<td>Closest Village is Ban Hatsaykham, approx. 4 km downstream</td>
</tr>
<tr>
<td>Is the site located in a vegetated area?</td>
<td>✓</td>
<td></td>
<td>The work is carried out within the Nam Ngiep riverbed</td>
</tr>
<tr>
<td>Is the site located in agricultural land?</td>
<td>✓</td>
<td></td>
<td>No agricultural land at riverbed</td>
</tr>
<tr>
<td>Are there any PCR in the area?</td>
<td>✓</td>
<td></td>
<td>No confirmed PCR on site</td>
</tr>
<tr>
<td>Is there an existing access road to the site?</td>
<td>✓</td>
<td></td>
<td>Road T4B on the left bank of Nam Ngiep river</td>
</tr>
<tr>
<td>Can the site be viewed from public viewpoints?</td>
<td>✓</td>
<td></td>
<td>Area is closed off to the public</td>
</tr>
<tr>
<td>Is the site located within an existing Construction Area?</td>
<td>✓</td>
<td></td>
<td>Located within Secondary Cofferdam area</td>
</tr>
</tbody>
</table>
Will the site development require the construction of a sub-camp, office and storage? (if yes, provide a list) | ✓ | Worker Camp No.2 will be used for the Sub-Contractors worker camp.

Other Comments:

<table>
<thead>
<tr>
<th>Environmental Impacts</th>
<th>Likelihood (Yes/No)</th>
<th>Mitigation measure to be Implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will the site development result in increased dust generation at near-by villages?</td>
<td>No</td>
<td>No Village within vicinity of site</td>
</tr>
<tr>
<td>Will the site development result in increased noise generation at near-by villages?</td>
<td>No</td>
<td>No Village within vicinity of site</td>
</tr>
<tr>
<td>Will the site development result in surface water turbidity?</td>
<td>Yes</td>
<td>Construction work shall be carried out within dry season of 2015 - 2016</td>
</tr>
<tr>
<td>Will site development result in changes to drainage patterns?</td>
<td>Yes</td>
<td>Grouting work shall be carried out within dry season of 2015 – 2016</td>
</tr>
<tr>
<td>Will the site result in erosion?</td>
<td>No</td>
<td>Grouting work will be carried out within RCC and CVC structure</td>
</tr>
<tr>
<td>Will vegetation clearing be required?</td>
<td>No</td>
<td>Clearing work has been carried out for the Construction of secondary cofferdam</td>
</tr>
<tr>
<td>Will the site be setting up hazardous components? (storage, workshop)</td>
<td>No</td>
<td>Workshop and storage shall be at worker camp</td>
</tr>
<tr>
<td>Will the site generate waste?</td>
<td>Yes</td>
<td>Rubbish, garbage will be gathered and transported to the approved disposal area. All hazardous materials such used oils and containers will be transported back to workshop.</td>
</tr>
</tbody>
</table>
Picture 1 – Downstream view of grouting work at Secondary Cofferdam

Picture 2 – Upstream view of grouting work at Secondary Cofferdam
Table 8.3 identifies the relevant list of Sub Plans required for Grouting works. The Sub Plans were selected after a review of the following:

- Detailed Works Program (DWP)
- Pre-Construction assessment (as per attached Environmental Checklist)
- NNP1 EIA and ESMMPs

### Table 8.3 Sub Plans for Consolidation Grouting works

<table>
<thead>
<tr>
<th>Sub-Plan</th>
<th>Item</th>
<th>Environmental</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP01</td>
<td>Erosion and Sediment Control</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP02</td>
<td>Water Availability and Pollution Control</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP03</td>
<td>Emission and Dust Control</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP04</td>
<td>Noise and Vibration</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP05</td>
<td>Waste Management</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP06</td>
<td>Hazardous Material Management</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP07</td>
<td>Vegetation Clearing</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>SP08</td>
<td>Landscaping and Re-vegetation</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SP09</td>
<td>Biodiversity Management</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SP10</td>
<td>Spoil Disposal</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>SP11</td>
<td>Quarry and Construction Layout</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SP12</td>
<td>Unexploded Ordinance (UXO) Survey and Disposal</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP13</td>
<td>Construction of Work Camps</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SP14</td>
<td>Traffic and Access</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP15</td>
<td>Training Awareness</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP16</td>
<td>Project Personal Health Program</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP17</td>
<td>Emergency Preparedness</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SP18</td>
<td>Cultural Resource</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Detailed descriptions are found in the relevant sections relating to Environmental or Social Management and Monitoring Plans. See Contractors EMMP-CP Appendix 2.1 “Sub-Plan for Civil Works”

A detailed Environmental Management Activity Schedule for Consolidation Grouting works can be referred to in Appendix 9.6 of this report.
8.3. Sub-Plan Detail for Grouting Works at Secondary Upstream Cofferdam – Environment

SP01 Erosion and Sediment Control
- Grouting work will be carried out in the dry season 2016
- Drainage berm has been constructed for the Main Dam Excavation work
- The grouting work shall be carried out on the secondary cofferdam which is constructed by RCC and CVC materials.
- Effluent treatment system shall be provided at site and will be met by regular manual cleaning of sedimentation and final ponds as required by the site condition before disposal of clearer waste water to Nam Ngiep river by pump.

SP02 Water Availability and Pollution Control
- No grouting material will be disposed on site, any leftover material must be transported to the disposal areas No. 2 or No. 6.
- No concrete waste is to be left behind or disposed into any water course.
- Sludge and spoiled concrete will be segregated to a controlled area at site to let them dry and become solid before an authorized collector will collect and dispose the waste material outside the Nam Ngiep1 Hydropower project.
- Toilet shall be supply at the working area. All worker must use these facilities
- In case of oil leakages incidents, the emergency countermeasure shall be carried out by absorbent sheet
- Generators must have oil trays or bund to reduce the spread of any oil leaks or spill

SP03 Emission and Dust Control
- All workers must wear the appropriate PPE when on site.
- Water spraying will be conducted daily on existing access road
- All vehicles, while parking at construction site shall be requested to turn the engines off

SP04 Noise and Vibration
- The distance from the construction areas to the nearest village, Ban Hatsaykham, is more than 3 km downstream from the site. There is no influence of noise and vibration.
- All workers must wear the appropriate PPE at all times, including hard hat, ear plugs when working with loud cutting equipment/ vibratory roller. And worker must wear gloves for working with welding machines and safety harnesses when working at heights.

SP05 Waste Management
- General waste or recycled waste from workers must be collected and transported back to worker camps or main construction site for correct disposal
- At least two waste bin shall be supplied on construction site to collect recycled and general waste.
- Construction waste, such a steel reinforcements, steel plate, H – beam will be stockpiled on site and then transferred to main construction site.
- Dumping any type waste into watercourses is prohibited.
SP06 Hazardous Material Management

- All fuels for heavy machinery are stored at worker camp sites in specially designed areas, with mobile fuel trucks used for refueling of machinery.
- Any used containers will be stored appropriately on site in a designated area.
- Hazardous materials such as oils, paints and gas tanks will be kept securely to prevent from spilled and gas tanks will be kept in a storage cage which is installed higher than any potential flood level.
- Any hazardous containers will be labeled accordingly and kept in appropriate storage facilities, with all Material Safety Data Sheets (MSDS) when required.
- Storage should have adequate roofing and concrete flooring to reduce the risk of any spillage.
- Any hazardous waste materials will be maintained within these storage facilities and disposed of by approved companies.
- Spill response kits will be provided where any such hazardous materials are stored.
- Correct PPE must be used at all times.
- Discharge of any hazardous materials into watercourses is prohibited.

8.4. Sub-Plan Detail for Grouting Works at Secondary Upstream Cofferdam – Social

SP12 Unexploded Ordinance (UXO) Survey and Disposal

- UXO clearance was carried out along the riverbed of Nam Ngiep by NNP1 before the commencement of any construction activities.
- If any UXO’s or suspicious objects are found, work must be stopped immediately and inform to NNP1.

SP14 Traffic and Access

- Traffic speed regulation devices as signage will be installed at sensitive locations in the vicinity and approaching construction site.
- Barriers will be installed around high risk areas.
- Only project workers and staffs are allowed to access into site. No unauthorized entry will be permitted.
- Security gate along road P1 (STA. 3+945km) will require an ID card for both persons and vehicles, and when access to site, ID card must be presented to security staff. Anyone without an ID card will not be allowed to access into the construction site.

SP15 Training and Awareness

- All new employees will be required to complete Induction Training from OC/NNP1 prior to commencement of any work on site.
- In this training, the Contractor will highlight site regulation/rule, and safety & environmental issue.
- A register of induction training will be maintained and can be provided to NNP1 upon request.
- Monthly safety meetings and joint inspections will be conducted with all top management and safety staff, and it will cover all relevant health and safety issues on site.
- Weekly meetings are also conducted to bring further awareness to environmental health and safety issues.
- Only project workers and staffs are allowed to access into site. No authorized entry will be permitted.
- Security gate along road P1 will require an ID card for both persons and vehicles, and when access to site, ID card must be presented to security staff. Anyone without an ID card will not be allowed to access into the construction site.
- All construction vehicles will be restricted to 30 km/h within the construction site.
- Regularly monitoring of traffic conditions will be conducted as part of the weekly Environmental, health and Safety inspection, and main focus is driving speeds around the Project site.
- Weekly and monthly environmental monitoring will also be carried out, items include visual monitoring of air quality, soil erosion, effluent discharge and waste disposal.
- Toolbox meetings are also conducted to raise worker awareness regarding safety and environment issues such as regular check and maintenance machinery, not disturb natural resource like watercourse, flora and fauna. All worker shall be training not hunting and fishing around construction site.

**SP16 Project Personnel Health Program**

- Referring to Section 6 in Part 1 of the DWP, a tool box meeting will also be carried out weekly and before commencement of any new works.
- Health Awareness Training will be carried out for all personnel in the monthly mass meeting.
- All new employees will be required to complete induction training from OC/NNP1 prior to commencement of any work on site.
- In this training, the Contractor will highlight site regulation/rule, and safety & environmental issue.
- A register of induction training will be maintained and can be provided to NNP1 upon request. Monthly safety of induction training will be maintained and can be provided to NNP1 upon request.
- The register for each item above can be provided to NNP1 upon request.
- First aid kits will be prepared on site accordingly, these include; Individually wrapped sterile adhesive dressing, Crepe bandage (5.0 cm), Crepe bandage (7.5 cm), Absorbent Gauze (packet of 10 pcs), Adhesive plaster roll (1.25 cm width), Triangular bandages, Scissors, Safety Pins, Disposable gloves (pairs) One-way valve transparent mask or 2-way mouthpiece, Sterile water or saline in 100 ml disposable container (only where tap water is not available).
- First aid kits will be stocked in subcontractor vehicles.

**SP17 Emergency Preparedness**

- Referring to the emergency action plan in Appendix 9.3, the emergency response procedures, emergency contact numbers and communication and reporting procedures will be clearly displayed and each staff shall always carry it.
- First aid kits will be prepared at each site accordingly.
- Hazardous materials will be stored in the permitted area or the area instructed by the authorities.
• The safety control plan against flood and evacuation procedure is as follows. Please refer to Management System for the Flood in Rainy Season (Document No. NNP1-OTH-MSF-A3) enclosed with Contractor’s letter NNP1-PCL-01337, dated 18th July 2015 for details.

1) Monitoring for safety control plan against flood shall be based on the following measures described below:
   - Weather forecast from the Local Bureau of meteorology
   - Analysis of water discharge based on survey monitoring data.
   - Visual monitoring of water level gauge by watchman along main dam site.

2) When there is a forecast of heavy rain, watchman shall monitor elevation of water level carefully.

3) Warning shall be given when the water level rises rapidly, (Re-Regulation Dam describes an increase of 1.5 m per hour)

4) Watchman shall follow the reporting procedure of the Emergency Action Plan in Appendix 9.3. Evacuation procedure for safety control plan is described as follows:
   (i) After confirmation alert, the safety officer shall provide signal voice (whistle and/or siren) as commencement for immediate evacuation of all construction, equipment and tools, and workers to higher ground.
   (ii) After the removal of equipment and tools, attendance of workers shall be checked and confirmed after the evacuation.
   (iii) The Safety officer will do a final check of whole area to ensure the evacuation process is completed.

SP18 Cultural Resource

According to the EIA document, a preliminary survey of the Project Area was conducted by the Lao PDR Department of Museums and Archaeology (DMA) in October of 2007. In September 2013 local villagers informed NNP1 of Buddha images located in caves near the NNP1 Temporary Bridge site (adjacent to T7 area). On the 30th November 2013 the images were successfully relocated to the local Temple at Ban Hat Gniun. The relocation was complemented by traditional Buddhist ceremonies, which involved Lao department and authorities including; Head of Hat Gniun Village, Representative from NNP1, Representative from Bolikhamxay Province, Representative from Bolikh District and RMU.

If the Contractor is to find any new physical or cultural resources during construction, the Contractor shall stop the works and inform the Owner immediately and follow the Chance Find Procedures outlined below.

8.5. Chance Find Procedures

Objectives of Chance Find Procedures are to; (a) minimize impacts to resources from all NNP1 related activities and (b) to ensure that any artifacts uncovered are appropriately recorded, documented and reported to the appropriate line agencies.

If any fossil or cultural item of significance is found, the Contractor will promptly give notice to the Owner. This follows the guidelines stated in the Civil Works Contract “CWC” Clause 4.25 regarding Fossil and Artifacts.

If the Contractor is to find any new physical or cultural resources during construction, the Contractor shall stop the works and inform the owner immediately and follow the Chance Find Procedures outlined below.
Chance find procedures as described in Contractors EMMP-CP Sub-plan Appendix 2.1 Sub-Plan for Civil Works, “21: Cultural Resources” The following steps will be implemented in the event that previously unidentified artifacts are identified:

i. The Contractor shall immediately cease operations in areas where artifacts/archaeological finds are unearthed and immediately inform NNP1 Site Manager.

ii. The Owner will consult the Head of Village and Culture and Tourism Administration Office to obtain advice regarding the next steps.

iii. The Contractor to recommence work only after the Culture and Tourism Office has provided official notification accordingly.
9. **APPENDIX**

9.1 Working Drawings

9.2 Organization Chart

9.3 Emergency Action Plan

9.4 Construction Schedule

9.5 Risk Register

9.6 Environmental Management Active Table

9.7 Inspection and Test Plan

9.8 List of Equipment

9.9 General Arrangement of Temporary Facilities

9.10 Trial Grouting Test Result
Appendix 9.1

Working Drawing

(Submitted thru letter PCL-01855 dated 8th Jan. 2016)
Appendix 9.2

Organization Chart
Appendix 9.3

Emergency Action Plan
Emergency Plan for Nam Ngiep 1 Hydropower Project

OBAYASHI Corporation

VTE Office
021-265-185
Mr. Yamabayashi
020-59-565-888
Mr. Tsutsui
020-55-566-959

Obayashi Corporation
Pakxan Office 054-280-168

Mr. Chabayashi
020-59-888-201
Mr. Harada
020-59-888-208
Mr. Ishii
020-59-888-213
Mr. Machida
020-55-524-578
Mr. Tsuchihashi
020-59-888-206
Mr. Kimura
020-59-888-204
Mr. Ishiguro
020-59-888-217
Mr. Dodo
020-22-422-582
Emergency Assistance Japan
+81-3-3811-8153

Hospital / Immigration / Embassy / Others

Bolikhamxay Provincial Hospital
054-212-154 (8:00 - 16:00)
054-212-149 (8:00 - 16:00)
Emergency 24hrs.
Tel : 054-212-099
054-212-099
054-212-099

Bueng Kan Hospital
066-42-491-161 (24hrs)

Mr. Sunan Nokthong
Chief Nurse
Mobile: +66-86-857-8279

Bangkok Hospital
066-42-343-111
Mr. Prayoon Thavon (John)
(International Marketing Executive)
Mobile: +66-85-030-6383

Udon Thani

Mr. Sykhamsay
Mobile: 020-2343-4666

Immigration (Lao)

Mr. Dodo
Mobile: 021-414-400

Embassy of Japan

Ambulance

Bolikhamxay Provincial Hospital
+66-42-343-111

Emergency 24hrs.
Mr. Prayoon Thavon (John)
(International Marketing Executive)
Mobile: +66-85-030-6383

Pakxan POLICE
054-280-308

Pakxan Police
054-280-190
054-212-256

Dept. of Environment
054-790-836

Mr. Khamsing Sayphouvong
Deputy Director
020-2233-5546

Resettlement Management Unit

Mr. Chabayashi
020-59-888-201
Mr. Harada
020-59-888-208
Mr. Ishii
020-59-888-213
Mr. Machida
020-55-524-578
Mr. Tsuchihashi
020-59-888-206
Mr. Kimura
020-59-888-204
Mr. Ishiguro
020-59-888-217
Mr. Dodo
020-22-422-582
Emergency Assistance Japan
+81-3-3811-8153

Head of Villagers of Relevant Villages

<table>
<thead>
<tr>
<th>Name of Village</th>
<th>Name of Head</th>
<th>Contact No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonsomboun</td>
<td>Mr. Touy Inthavong</td>
<td>020-5614-9468</td>
</tr>
<tr>
<td>Thaheua</td>
<td>Mr. Boonhieng</td>
<td>020-5549-1810</td>
</tr>
<tr>
<td>Hat Gniun</td>
<td>Mr. Phouvieng</td>
<td>020-5977-4434</td>
</tr>
<tr>
<td>Hatsaykham</td>
<td>Mr. Phonsysong</td>
<td>030-5738-860</td>
</tr>
</tbody>
</table>

Not Only Accident, Also Environmental Incident/Hazard

TAKE ACTION
- Send injured person to hospital
- Urgent countermeasure
- Inform and explain to authorities
- Record etc.

Site Engineer
Site Engineer

Discoverer
Managing Director
Mr. Yamabayashi

Deputy Managing Director
Mr. Tsutsui

Project Manager
Mr. Chabayashi

Administration Manager
Mr. Harada

Safety Chief Engineer
Mr. Vanhxyay

OBAYASHI Corporation Overseas Division (Tokyo)
+81-3-5769-1254

Deputy Construction Manager
Mr. Machida

Deputy Managing Director
Mr. Chabayashi

Notice

Report
- Report (if necessary)
- Instruction
- Person to Take Action

Instruction

Head of Villagers of Relevant Villages

<table>
<thead>
<tr>
<th>Name of Village</th>
<th>Name of Head</th>
<th>Contact No.</th>
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<tr>
<td>Hatsaykham</td>
<td>Mr. Phonsysong</td>
<td>030-5738-860</td>
</tr>
</tbody>
</table>

Site Engineer
Site Engineer

Discoverer
Managing Director
Mr. Yamabayashi

Deputy Managing Director
Mr. Tsutsui

Project Manager
Mr. Chabayashi

Deputy Construction Manager
Mr. Machida

Administration Manager
Mr. Harada

Safety Chief Engineer
Mr. Vanhxyay

OBAYASHI Corporation Overseas Division (Tokyo)
+81-3-5769-1254

Deputy Construction Manager
Mr. Machida

Deputy Managing Director
Mr. Chabayashi

Managing Director
Mr. Yamabayashi

Report
- Report (if necessary)
- Instruction
- Person to Take Action

Emergency Plan for Nam Ngiep 1 Hydropower Project
Appendix 9.4

Construction Schedule
### SCHEDULE FOR GROUTING WORKS AT SECONDARY UPSTREAM COFFERDAM

<table>
<thead>
<tr>
<th>No.</th>
<th>Work Description</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>W1 W2 W3 W4</td>
<td>W1 W2 W3 W4</td>
<td>W1 W2 W3 W4</td>
<td>W1 W2 W3 W4</td>
<td>W1 W2 W3 W4</td>
</tr>
<tr>
<td>1</td>
<td>Mobilization of equipment to site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Trial/Test grouting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Survey the grout hole location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Trial grout test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Grout hole Drilling &amp; installation of perforated PVC pipe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary Grout hole for abutment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary Grout hole for abutment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Grout Injection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cement Bentonite for Primary Grout hole</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cement Bentonite for Secondary Grout hole</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check hole Drilling &amp; installation of perforated PVC pipe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary Check hole for abutment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary Check hole for abutment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Permeability Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary Check hole for abutment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 9.5

Risk Register
# Grouting Works at Secondary Upstream Cofferdam - Register of Aspects and Hazards

<table>
<thead>
<tr>
<th>Activity</th>
<th>Sub Activity</th>
<th>Hazards</th>
<th>Risks/ Impacts</th>
<th>Risk Rating</th>
<th>Control Measure</th>
<th>Risk Rating After Control Measure</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Occupational Health and Safety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery Mobilization and Operation</td>
<td>Equipment and material transport</td>
<td>Potential of traffic accident with third party</td>
<td>Injury to third party</td>
<td>Low</td>
<td>Training to sub-contractors and supplier prior to first delivery</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Erection and dismantling of machinery</td>
<td>Potential of falling from heights</td>
<td>Injury/ Fatality</td>
<td>Medium</td>
<td>Training for wearing of safety harness when at heights prior to work</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Installing and wiring electricity</td>
<td>Potential of electrical faults</td>
<td>Injury/ Fatality from electrocution</td>
<td>High</td>
<td>Only use trained technicians</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Hand and power tools</td>
<td>Potential of electrical faults</td>
<td>Injury/ loss of limb/ fatality from miss-use of tool</td>
<td>High</td>
<td>Adequate training and use of experienced workers</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Common Works</td>
<td>Lack of awareness for health and safety</td>
<td>Unsafe action, inadequate health control</td>
<td>Injury/ disease</td>
<td>Low</td>
<td>Carry out induction training and toolbox meetings</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Using hand/ power tools</td>
<td>Potential of electrical faults</td>
<td>Injury/ loss of limb/ fatality from miss-use of tool</td>
<td>High</td>
<td>Adequate training and use of experienced workers</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Loading and unloading of equipment off/ on trailer</td>
<td>Equipment or workers falling from trailer</td>
<td>Injury/ fatality</td>
<td>Medium</td>
<td>Conduct training and toolbox meetings</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Installing and dismantling of equipment and/ or facilities</td>
<td>Getting caught in equipment</td>
<td>Injury/ fatality</td>
<td>Medium</td>
<td>Conduct toolbox meeting and periodical training</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Operating, maintenance, falling from equipment</td>
<td>Contact with or falling from equipment</td>
<td>Injury/ loss of limbs/ fatality</td>
<td>High</td>
<td>Conduct training and toolbox</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>
# Grouting Works at Secondary Upstream Cofferdam - Register of Aspects and Hazards

<table>
<thead>
<tr>
<th>Activity</th>
<th>Sub Activity</th>
<th>Hazards</th>
<th>Risks/ Impacts</th>
<th>Risk Rating</th>
<th>Control Measure</th>
<th>Risk Rating After Control Measure</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Works</td>
<td>Working at heights</td>
<td>Falling from height or equipment</td>
<td>Injury/ fatality</td>
<td>High</td>
<td>Conduct training and toolbox meetings. Provide safety belts.</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Working in confined spaces</td>
<td>Potential of hit with equipment</td>
<td>Injury/ fatality</td>
<td>High</td>
<td>Conduct training and toolbox, provide warning signboard/ watchman</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Slope Protection</td>
<td>Preparing slope surface</td>
<td>Potential of falling from heights</td>
<td>Injury/ fatality</td>
<td>High</td>
<td>Provide safe working areas and daily monitoring of work site and slope</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Erection/ Assembly</td>
<td>H-beam/ steel plate assembly</td>
<td>Potential of falling from heights</td>
<td>Injury/ fatality</td>
<td>Medium</td>
<td>Provide safety harness if working at heights</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Welding of re-bar/ H-beam/ steel plate</td>
<td>Falling from heights, unsafe manner when use welding machine</td>
<td>Injury/ fatality/ respiratory problems</td>
<td>High</td>
<td>Provide cage/ platform when work on height, training for welder prior to work, provide welding mask and glove</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Environmental</td>
<td>Machine and material transportation</td>
<td>Dust caused by transportation vehicles</td>
<td>Air pollution</td>
<td>Medium</td>
<td>Conduct frequent water spraying of roads, especially along village locations.</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Installing and dismantling of temporary structure</td>
<td>Consumption of fuel and electricity</td>
<td>Air pollution from equipment</td>
<td>Low</td>
<td>Maintain vehicle condition</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

Prepared by Name/Signature: ____________________________ Date: ______________________

Approval by Name/Signature: ____________________________ Date: ______________________

Obayashi Corporation
## Grouting Works at Secondary Upstream Cofferdam - Register of Aspects and Hazards

<table>
<thead>
<tr>
<th>Activity</th>
<th>Sub Activity</th>
<th>Hazards</th>
<th>Risks/ Impacts</th>
<th>Risk Rating</th>
<th>Control Measure</th>
<th>Risk Rating After Control Measure</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common Works</strong></td>
<td>Daily transportation</td>
<td>Consumption of fuel</td>
<td>Air pollution</td>
<td>Low</td>
<td>Regular maintenance of vehicles</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Lack of awareness for health and safety</td>
<td>Environmental Awareness</td>
<td>Workers disposing of chemicals and other waste into waterways and local vegetation</td>
<td>Medium</td>
<td>Provide correct training to all workers before starting work</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Loading and unloading of equipment off/on trailer</td>
<td>Consumption of fuel</td>
<td>Air pollution</td>
<td>Low</td>
<td>Regular maintenance of vehicles</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Installing and dismantling of temporary structure</td>
<td>Consumption of fuel, gas or electricity</td>
<td>Disposing of waste materials into the environment</td>
<td>Low</td>
<td>Training on how to treat waste materials after site closure</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>Common Works</strong></td>
<td>Operating, maintaining and repairing of equipment</td>
<td>Consumption of fuel or electricity</td>
<td>Air pollution, oil leaks, cleaning of vehicles</td>
<td>Low</td>
<td>Regular maintenance of vehicles. Clean and wash vehicles in correct location eg, wash bays.</td>
<td>Low</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>Slope Protection</strong></td>
<td>Preparing slope surface</td>
<td>Landslides, rock fall</td>
<td>Potential erosion and land slides</td>
<td>High</td>
<td>Implement adequate erosion control measures. Daily monitoring of work site and slope</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Concreting</td>
<td>Improper disposal of remained concrete</td>
<td>Potential pollution of watercourses</td>
<td>Medium</td>
<td>Instruct to mixer truck driver to dispose concrete correctly</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>Welding of steel</td>
<td>Litter of steel rubbish, welding rod</td>
<td>Potential pollution of underground water, land</td>
<td>Low</td>
<td>Training for welder/ worker. Transfer the rubbish to designated area</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Natural Disasters</td>
<td>Flooding, Storms, Heavy Winds</td>
<td>Increased chance of injury or fatality, damage to vehicles, buildings and machinery</td>
<td>High</td>
<td>Emergency Procedures to be followed in the case of any natural disaster</td>
<td>Medium</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>
Appendix 9.6

Environmental Management Active Table
### Environmental Management Activity Table – Grouting Work at Secondary Cofferdam

<table>
<thead>
<tr>
<th>Sub-Plan Item</th>
<th>Monitoring Method</th>
<th>Monitoring Frequency</th>
<th>On-Site Implementation</th>
</tr>
</thead>
</table>
| SP01 Erosion and sediment control | Visual            | Weekly or Heavy rain | - Grouting work will be carried out in the dry season 2016  
- Drainage berm has been constructed for the Main Dam Excavation work  
- The grouting work shall be carried out on the secondary cofferdam which is constructed by RCC and CVC material  
- Effluent treatment system shall be provided at site and will be met by regular manual cleaning of sedimentation and final ponds as required by the site condition before disposal of clearer waste water to Nam Ngiep river by pump. |
| SP02 Water Availability and Pollution Control | Visual            | Routine            | - No grouting material will be disposed on site, any leftover material must be transported to the disposal areas No. 2 or No. 6.  
- No concrete waste is to be left behind or disposed into any water course.  
- Sludge and spoiled concrete will be segregated to a controlled area at site to let them dry and become solid before an authorized collector will collect and dispose the waste material outside the Nam Ngiep1 Hydropower project.  
- Toilet shall be supply at the working area. All worker must use these facilities  
- In case of oil leakages incidents, the emergency countermeasure shall be carried out by absorbent sheet  
- Generators must have oil trays or bunding to reduce the spread of any oil leaks or spill |
| SP03 Emission and Dust Control | Visual            | Daily               | - All workers must wear the appropriate PPE when on site.  
- Water spraying will be conducted daily on existing access road  
- All vehicles, while parking at construction site shall be requested to turn the engines off |
| SP04 Noise and Vibration      | Visual            | Each time          | - The distance from the construction areas to the nearest village, Ban Hatsaykham, is more than 3 km downstream from the site. There is no influence of noise and vibration.  
- All workers must wear the appropriate PPE at all times, including hard hat, ear plugs when working with loud cutting equipment/ vibratory roller. And worker must wear gloves for working with welding machines and safety harnesses when working at heights. |
| SP05 Waste Management        | Visual            | Each time          | - General waste or recycled waste from workers must be collected and transported back to worker camps or main construction site for correct disposal  
- At least two waste bin shall be supplied on construction site to collect recycled and general waste.  
- Construction waste, such a steel reinforcements, steel plate, H – beam will be stockpiled on site and then transferred to main construction site.  
- Dumping any type waste into watercourses is prohibited. |
<table>
<thead>
<tr>
<th>Sub-Plan Item</th>
<th>Monitoring Method</th>
<th>Monitoring Frequency</th>
<th>On-Site Implementation</th>
</tr>
</thead>
</table>
| SP06 Hazardous Material Management | Visual | Weekly | • All fuels for heavy machinery are stored at worker camp sites in specially designed areas, with mobile fuel trucks used for refueling of machinery.  
• Any used containers will be stored appropriately on site in a designated area.  
• Hazardous materials such as oils, paints and gas tanks will be kept securely to prevent from spilled and gas tanks will be kept in a storage cage which is installed higher than any potential flood level.  
• Any hazardous containers will be labeled accordingly and kept in appropriate storage facilities, with all Material Safety Data Sheets (MSDS) when required.  
• Storage should have adequate roofing and concrete flooring to reduce the risk of any spillage.  
• Any hazardous waste materials will be maintained within these storage facilities and disposed of by approved companies.  
• Spill response kits will be provided where any such hazardous materials are stored.  
• Correct PPE must be used at all times.  
• **Discharge of any hazardous materials into watercourses is prohibited.** |
| SP12 Unexploded Ordinance (UXO) Survey and Disposal | Visual | Each time | • UXO clearance was carried out along the riverbed of Nam Ngiep by NNP1 before the commencement of any construction activities.  
• If any UXO’s or suspicious objects are found, work must be stopped immediately and inform to NNP1. |
| SP14 Traffic and Access | Visual | Routine | • Traffic speed regulation devices as signage will be installed at sensitive locations in the vicinity and approaching construction site.  
• Barriers will be installed around high risk areas.  
• Only project workers and staffs are allowed to access into site. No unauthorized entry will be permitted.  
• Security gate along road P1 (STA. 3+945km) will require an ID card for both persons and vehicles, and when access to site, ID card must be presented to security staff. Anyone without an ID card will not be allowed to access into the construction site. |
<table>
<thead>
<tr>
<th>Sub-Plan Item</th>
<th>Monitoring Method</th>
<th>Monitoring Frequency</th>
<th>On-Site Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP15</td>
<td>Training and Awareness</td>
<td>Visual / Verbal</td>
<td>Routine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• All new employees will be required to complete Induction Training from OC/NNP1 prior to commencement of any work on site</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• In this training, the Contractor will highlight site regulation/rule, and safety &amp; environmental issue</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• A register of induction training will be maintained and can be provided to NNP1 upon request</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Monthly safety meetings and joint inspections will be conducted with all top management and safety staff, and it will cover all relevant health and safety issues on site.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Weekly meetings are also conducted to bring further awareness to environmental health and safety issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Only project workers and staffs are allowed to access into site. No authorized entry will be permitted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Security gate along road P1 will require an ID card for both persons and vehicles, and when access to site, ID card must be presented to security staff. Anyone without an ID card will not be allowed to access into the construction site</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• All construction vehicles will be restricted to 30km/h within the construction site</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Regularly monitoring of traffic conditions will be conducted as part of the weekly Environmental, health and Safety inspection, and main focus is driving speeds around the Project site</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Weekly and monthly environmental monitoring will also be carried out, items include visual monitoring of air quality, soil erosion, effluent discharge and waste disposal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Toolbox meetings are also conducted to raise worker awareness regarding safety and environment issues such as regular check and maintenance of machineries, not to disturb natural resources like watercourse, flora and fauna. All workers shall be working, not hunting and fishing around construction site</td>
</tr>
<tr>
<td>Sub-Plan Item</td>
<td>Monitoring Method</td>
<td>Monitoring Frequency</td>
<td>On-Site Implementation</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------</td>
<td>----------------------</td>
<td>------------------------</td>
</tr>
</tbody>
</table>
| SP16 Project Personnel Health Program | Visual / Verbal | Routine | • Referring to Section 6 in Part 1 of the DWP, a tool box meeting will also be carried out weekly and before commencement of any new works.  
• Health Awareness Training will be carried out for all personnel in the monthly mass meeting.  
• All new employees will be required to complete induction training from OC/NNP1 prior to commencement of any work on site  
• In this training, the Contractor will highlight site regulation/rule, and safety & environmental issue.  
• A register of induction training will be maintained and can be provided to NNP1 upon request. Monthly safety of induction training will be maintained and can be provided to NNP1 upon request  
• The register for each item above can be provided to NNP1 upon request.  
• First aid kits will be prepared on site accordingly, these include; Individually wrapped sterile adhesive dressing, Crepe bandage (5.0 cm), Crepe bandage (7.5 cm), Absorbent Gauze (packet of 10 pcs), Adhesive plaster roll (1.25 cm width), Triangular bandages, Scissors, Safety Pins, Disposable gloves (pairs) One-way valve transparent mask or 2-way mouthpiece, Sterile water or saline in 100 ml disposable container (only where tap water is not available).  
• First aid kits will be stocked in subcontractor vehicles. |
| SP17 Emergency Preparedness | Visual | Weekly | • Referring to the emergency action plan in Appendix 9.3, the emergency response procedures, emergency contact numbers and communication and reporting procedures will be clearly displayed and each staff shall always carry it.  
• First aid kits will be prepared at each site accordingly.  
• Hazardous materials will be stored in the permitted area or the area instructed by the authorities.  
• The safety control plan against flood and evacuation procedure is as follows. Please refer to Management System for the Flood in Rainy Season (Document No. NNP1-OTH-MSF-A3) enclosed with Contractor’s letter NNP1-PCL-01337, dated 18th July 2015 for details.  
• Monitoring for safety control plan against flood shall be based on the following measures described below:  
• Weather forecast from the Local Bureau of meteorology  
• Analysis of water discharge based on survey monitoring data.  
• Visual monitoring of water level gauge by watchman along main dam site.  
• When there is a forecast of heavy rain, watchman shall monitor elevation of water level carefully.  
• Warning shall be given when the water level rises rapidly, (Re-Regulation Dam describes an increase of 1.5m per hour)  
• Watchman shall follow the reporting procedure of the Emergency Action Plan in Appendix 9.3. Evacuation procedure for safety control plan is described as follows:  
• After confirmation alert, the safety officer shall provide signal voice (whistle and/or siren) as commencement for immediate evacuation of all construction, equipment and tools, and workers to
<table>
<thead>
<tr>
<th>Sub-Plan Item</th>
<th>Monitoring Method</th>
<th>Monitoring Frequency</th>
<th>On-Site Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>higher ground.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• After the removal of equipment and tools, attendance of workers shall be checked and confirmed after the evacuation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The Safety officer will do a final check of whole area to ensure the evacuation process is completed.</td>
</tr>
<tr>
<td>SP18</td>
<td>Cultural Resource</td>
<td>Visual</td>
<td>Each time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• If the Contractor is to find any new physical or cultural resources during construction, the Contractor shall stop the works and inform the Owner immediately and follow the Chance Find Procedures outlined below.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The Environmental mitigation plan will be changed, revised and added in accordance with the occurrence of adverse impact to the surrounding environment and social environment and the Owner’s comments.</td>
</tr>
</tbody>
</table>

The above table is the key environmental management activities that are to be implemented at the site.
Appendix 9.7

Inspection and Test Plan
<table>
<thead>
<tr>
<th>Description</th>
<th>Spec Clause</th>
<th>Standard</th>
<th>Inspection and Testing Item</th>
<th>Test Method</th>
<th>Conformity</th>
<th>Frequency of inspection</th>
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<tbody>
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<td>Section 6 Material</td>
<td>Portland Cement Cl 6.18.1(2)</td>
<td>ASTM C150</td>
<td>Chemical Physical</td>
<td>ASTM C114, ASTM C185, ASTM C150 Table 1&amp;2</td>
<td>By mill certificate &amp; per 1 source, By mill certificate &amp; per 1 source</td>
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</table>
# DRILLING REPORT

**Location:**

**Rig No.:**

**Station:**

**Hole No.:**

**Elevation (msl.):**

**Dia. of Hole:** ___ mm.

**Water level (m.):**

**Azimuth of Hole:** ___ Degree

**Inclination of Hole:** ___ Degree from vertical

**Coordinate:**

**Depth of Casing (m.):**

**Type of Drilling:**
- [ ] Day Shift
- [ ] Night Shift
- [ ] Percussion drilling
- [ ] Rotary drilling

**Type of drilling Bit No.:**
- [ ] Button bit
- [ ] Diamond core bit

**Driller:**

### Time Log

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<tr>
<th>Time</th>
<th>Lap</th>
<th>Depth</th>
<th>Core Recovery</th>
<th>Core Loss</th>
<th>Soil / Rock type</th>
<th>Water / Cutting Color</th>
<th>Remark</th>
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<td>From (hr.)</td>
<td>To (hr.)</td>
<td>From (m.)</td>
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<td>Length (m.)</td>
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</table>
## GROUTING REPORT

**Location:**

**Hole No.:**

**Date:**

**Shift:**

**Elevation (m):**

**Dia. of Hole (mm):**

**Cement used (kg):**

**Results of water pressure tests (EU):**

**Packer Depth (m):**

**Degree from vertical:**

**Cement take (kg.m):**

**Mix ratio:**

**Azimuth of Hole:**

**Groove Operator:**

---

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of Grouting (m)</th>
<th>From Time (hr)</th>
<th>To Time (hr)</th>
<th>Lap Time (min)</th>
<th>W/C</th>
<th>Unusual Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>Mix Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remained Volume (litre)</th>
<th>Cement (kg)</th>
<th>Water (litre)</th>
<th>Bitumen (kg)</th>
<th>Denka ES (kg)</th>
<th>ES Seta (kg)</th>
<th>Remarks</th>
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**Total**

---

**Inspected by:** Right Tunnelling Geologist

**Checked by:** NNPI Site Engineer / Geologist

**Verified by:** NNPI Engineer / OE

---

**Signature:**

**Name:**

**Date:**

---

**Signature:**

**Name:**

**Date:**

---

**Signature:**

**Name:**

**Date:**

---

**Signature:**

**Name:**

**Date:**

---
### Water Pressure Test Sheet (Lugeon Test)

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<thead>
<tr>
<th>Hole Number</th>
<th>Coordinates</th>
<th>Date</th>
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<td>Test Section</td>
<td>Hole Diameter</td>
<td>Vertical G.W.L.</td>
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<td>m.</td>
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<td>Swivel Height</td>
<td>Type of Packer</td>
<td>Inclination of hole (degrees)</td>
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<td>m.</td>
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<td>Length of Testing</td>
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<td>Test by</td>
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#### Injection Time and Lag Time

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<th>Injection Rate</th>
<th>Unit Take, Q/L</th>
<th>Lugeon Value</th>
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#### Pressure vs. Flow Curve

- **P - Q Curve**
- **Pattern of Lugeon**
  - **Value of Lugeon**

#### Lugeon Calculation

\[
Lugeon = \frac{100}{LH}
\]

- \( Q \): Injection Rate (l/min)
- \( L \): Length of Testing (m.)
- \( H \): Gauge Pressure, Kg/cm²
- \( H_1 \): Swivel or Pressure gauge height from GL (m.)
- \( H_2 \): Depth from GL to half of testing interval (m.)
- \( H_3 \): Length of G.W.L. to half of testing interval (m.)

1. When the ground water level reveals above the upper packer the sign of \( H_3 \) is minus (-)
2. When the ground water level reveals below the lower packer the sign of \( H_3 \) is zero (0)

#### Report by:
- Right Tunneling Geologist

#### Check by:
- NNPI Site Engineer / Geologist

#### Verified by:
- NNPI Engineer / OE
## Record of Grout Mix Properties

### BLEEDING TEST

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</table>

### DENSITY TEST

<table>
<thead>
<tr>
<th>Time</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>12</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from Starting</td>
<td>minutes</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Theoretical Specific Gravity</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tested Density (gm/cc)</td>
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</tr>
</tbody>
</table>

**REMARKS:**

**HOLE NO.** | **MIX NO.** | **STAGE NO.** | **DEPTH OF GROUTING (METERS)** | **GROUTING STATUS**

---

**Prepared by:** RT Site Engineer / Geologist

**Checked by:** NNPI Site Engineer / Geologist

**Checked by:** NNPI Engineer / QC Inspector

**Name:**

**Name:**

**Signature:**

**Signature:**

**Date:**

**Date:**

**Note:**

---
# Normal Consistency & Setting Time of Cements

(ASTM C187 & ASTM C191)

<table>
<thead>
<tr>
<th>Sample No.:</th>
<th>Mix Ratios: W/C/A</th>
<th>Admixture</th>
<th>% of C. Bentonite</th>
<th>% of C. Sand</th>
<th>% of C</th>
<th>Sample Description:</th>
<th>Hole no.</th>
<th>Mix no.</th>
<th>Stage no.</th>
<th>Depth of grouting (m.)</th>
<th>Grouting status</th>
</tr>
</thead>
<tbody>
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<table>
<thead>
<tr>
<th>Sampling Location:</th>
<th>Ambient Temperature (°C)</th>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Initial Setting Time Determination</th>
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<tr>
<td>Date of Reading</td>
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<td>-----------------</td>
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<table>
<thead>
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<th>Penetration (mm)</th>
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<tbody>
<tr>
<td>55.0</td>
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</table>

<table>
<thead>
<tr>
<th>Acc Elapsed Time (min)</th>
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<td>0.0</td>
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</table>

Initial Setting Time (Minutes) = In Hour : Minutes
Final Setting Time (Minutes) = In Hour : Minutes

(Final Setting Time (Minutes) = Time where needle does not sink visibly to paste - Time after mixing)

Remarks:

<table>
<thead>
<tr>
<th>Tested By Right Tunnelling</th>
<th>Checked by : NNPI Site Engineer / Geologist</th>
<th>Verified by : NNPI Engineer / OE</th>
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</thead>
<tbody>
<tr>
<td>Signature:</td>
<td>Signature:</td>
<td>Signature:</td>
</tr>
<tr>
<td>Name:</td>
<td>Name:</td>
<td>Name:</td>
</tr>
<tr>
<td>Date:</td>
<td>Date:</td>
<td>Date:</td>
</tr>
</tbody>
</table>
Appendix 9.8

List of Equipment
Light Weight Rotary Drilling Machine
Featuring the acker ACE
Versatile, Shallow Exploration Drill

The ACE is a rugged, lightweight, and portable skid rig with a range of job-tested features for versatility and dependable performance.

Features:
- Lightweight (under 3,000 lbs.) transported easily into difficult terrain.
- 4 Speed Transmission - up to 1,300 RPM.
- Drill head swivels 360 degrees.
- Shallow exploration (910 ft. 'N' wireline).
- Wireline winch available.

P.O. Box 830, Scranton, PA 18501 USA
Toll Free: 800.752.2537 Fax: 570.586.2659
E-Mail: sales@ackerdrill.com Website: www.ackerdrill.com
ACE STANDARD FEATURES:

A. Power Unit - 28 H.P. diesel engine with 12-volt electric start. Other power options available on request.

B. Drill Head - AW6-5 hydraulic drill head with 24" stroke, AW rod hand chuck, spiral bevel gears and manual spindle lockout when hoisting or sampling. Drill head swivels 360 degrees.

   Thrust - 8,424 lbs.  Pull - 12,568 lbs.  Spindle I.D. - 1-27/32"

   Drill Head Speeds:
   1st gear (204 RPM)  2nd gear (422 RPM)
   3rd gear (772 RPM)  4th gear (1,302 RPM)

   Optional speeds available on request.

C. Transmission - Four (4) speed automotive sliding gear type with one (1) speed in reverse. Features flange mounted drive for hydraulic pump.


E. Cathead - Cathead cargo type hoist with manual lockout. Capacity 2,000 lbs.

F. Mounting - Structural steel drag skid base with 16" hydraulic retraction.

G. Derrick - For hoisting 10 ft. sections of rods/casing.

ACE OPTIONAL FEATURES:

1. Drill Head - BWCZ-5 with 2-5/16" spindle bore and 24" travel. Also available with 30" travel.
1a. Drill Head - NXCZ-5 with 3-5/8" spindle bore and 24" travel. Also available with 30" travel.
2. Ackermatic Hydraulic Chuck Assembly - Hydraulic chuck available to suit all drill heads.
3. Water Pumps - Hydraulically driven Moyno Type or Triplex Type (check with factory for details).
5. Derrick - Angle hole type derrick. Up to 25 degrees from vertical for 10 ft. pull.
6. Trailer - Two (2) wheel trailer with bail or pintle hitch with electric brakes and four hand screw or hydraulic jacks.

ACE WEIGHTS AND DIMENSIONS:

(Approx. Standard Build, No Options)

| Length/Overall | 72 inches (1,829 mm) |
| Width/Overall | 40 inches (1,015 mm) |
| Height | 63 inches (1,600 mm) |
| Net Weight | 2,250 lbs. (1,023 kg) |
| Gross Weight Crane | 2,500 lbs. (1,136 kg) |

Note: Weights are approximate and dry measured, + or - 10%

Contact factory for additional details. A complete line of optional accessories are available.
Nam Ngiep 1 Hydropower Project  
DWP and SS-ESMMP for Grouting Works at Secondary Cofferdam

DRS-DS Series
25-120-10 SD
Sensor Separated Type

**Description**
- This model is specially designed for L.W. and has SD memory card slot.

**Features**
- Injection status and injection data are recorded in real time on the recording paper in graph and letter each.
- **Automatic printout data**
  1. Power ON : hour, minute, machine No.
  2. Start : hour, minute, second
  3. Finish : hour, minute, accumulated injection volume, hole No., injection volume per hole, injection time per hole
  4. No need to calculate injection volume as the above data is recorded on the recording paper automatically.
- Injection data to be stored in memory card
  1. Injection data will be stored in memory card automatically.
  2. It is possible to see and print out the data stored in memory card from PC.
  3. Injection data to be printed out from PC
    - (1) 1 hole data
    - (2) 1 day work data
    - (3) Others

**Specifications**
- **Model**
  DRS-DS-25-120-10 SD
- **Applicable methods**
  1. L/W
  2. Cement milk
  3. Other low pressure injection method
- **Measuring range**
  1. Flow : 0 ~ 120 L/min
  2. Pressure : 0 ~ 10.0 MPa (100 bar)
- **Accuracy**
  ±1% of full scale
- **Power**
  AC 220 V ±10 %, 50 Hz, 60 Hz, single phase, 100 VA
- **Inlet and outlet**
  Diameter : 25A (25 mm) / Pipe : SUS 304
- **Dimension**
  Main body : about W 237 × D 345 × H 314 mm
  Sensor : about W 170 × D 330 × H 300 mm
- **Weight**
  Main body : about 27 kg
  Sensor : about 28 kg

Obayashi Corporation
Revision A3
GROUT PUMP "Double Duplex Acting Piston"

- **Model:** TONE - NP 100
- **Max. Pressure:** 48 ksc.
- **Max. Flowrate:** 100 l/min.
- **Cylinder diameter:** 63 mm.
- **Dimension:** 480 mm x 515 mm x 1050 mm (W x L x H)
- **Weight:** 299 kgs.
<table>
<thead>
<tr>
<th>Specification</th>
<th>LS-548</th>
<th>LS-558</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L x W x H (mm)</td>
<td>451x350x520</td>
<td>500x360x590</td>
</tr>
<tr>
<td>Dry Weight (KGS)</td>
<td>31 KGS</td>
<td>44 KGS</td>
</tr>
<tr>
<td>Plunger Dia. (mm)</td>
<td>34</td>
<td>45</td>
</tr>
<tr>
<td>Suction Capacity L/min</td>
<td>31~55</td>
<td>95~133</td>
</tr>
<tr>
<td>R.P.M.</td>
<td>500~900</td>
<td>500~700</td>
</tr>
<tr>
<td>Plunger NO.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Working pressure kgf/cm²</td>
<td>15~45 kgf/cm²</td>
<td>15~45 kgf/cm²</td>
</tr>
<tr>
<td>Power Required HP</td>
<td>3~9</td>
<td>6~17</td>
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<td>Engine PS</td>
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<td>10~27</td>
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<tr>
<td>Ceramic Plunger</td>
<td>Option</td>
<td>Option</td>
</tr>
<tr>
<td>Description</td>
<td>Colloidal Mixer</td>
<td>Agitator</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Operating Revolution:</td>
<td>1,500 rpm</td>
<td>150 rpm</td>
</tr>
<tr>
<td>Capacity:</td>
<td>300 Litres</td>
<td>300 Litres</td>
</tr>
<tr>
<td>Dimension</td>
<td>1.5x0.9x1.1 m.</td>
<td>1.0x0.9x1.1 m.</td>
</tr>
<tr>
<td>Weight:</td>
<td>150 kgs.</td>
<td>100 kgs.</td>
</tr>
<tr>
<td>Motor:</td>
<td>7 Hp.</td>
<td>3 Hp.</td>
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</table>
" Tubes à manchettes" applications

- Use recommendations.

<table>
<thead>
<tr>
<th>Packer</th>
<th>&quot;Tube à manchette&quot; diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>% 1/4</td>
<td>1&quot; 3/4</td>
</tr>
<tr>
<td>% 30 mm Packer</td>
<td>YES</td>
</tr>
<tr>
<td>% 42 mm Packer</td>
<td>NO</td>
</tr>
</tbody>
</table>

The 31 double packers Ø 28, 30 and 42 mm are specially designed for " tubes à manchettes" grouting use; the injection zone length (Lz) remains constant regardless of the diameter of the "tube à manchettes".

The bottom element of the packer is flexible making it easy to introduce into and retrieve from the "tube à manchettes".

The choice of which packer to use depends on the "tube à manchettes" inner diameter. Please refer to the selection chart shown on the left.

**EK Extension Kit (56-170mm)**

For the double packers Ø 56 to Ø 170mm, some applications may require a longer injection zone than the standard one determined by the CE central element length.

In this case, an EK extension kit is available to facilitate extension between the two inflatable elements.

The 3 elements of the EK kit are:
- The IF junction end
- The ER extension pipe
- The FE fixed end

These elements are easily screwed together to form a complete assembly.

Thanks to their modular design, Geopro packers can be adapted in a flexible and economical way to suit the various demands of each job, wherever the worksite.
E037
Marsh funnel viscometer

Utilized for viscosity determination on drilling muds and fluid materials.
Orifice opening 4.7 mm
Half part of the funnel mouth is foreseen of sieving doth 2 mm mesh.
Plastic break-resistant made.
Supplied complete with graduated cup.
Weight: 1 kg.
E037-01
Baroid mud balance

It provides a simple method for the accurate determination of mud density.
The balance consists of a base and graduated arm with cup, lid, knife edge, rider, built-in spirit level and counter-weight, carrying case. The constant volume cup is affixed to one end of the graduate arm and the counter-weight on the opposite end.
Weight: 5 kg
Vicat Consistency Apparatus


Reversible stainless steel plunger with 10mm dia. on one end and threaded, H-3070 1mm dia. stainless steel needle on the other. Weight of plunger assembly with adjustable indicator is 300g. Graduated 0-50mm scale. Includes frame, graduated 0-50mm scale, plunger assembly, H-3080 conical mold and H-3049 glass plate. Shipping wt. 8 lbs (3.6kg) ASTM C91, C141, C187, C191, C308, C451, C472; AASHTO T129, T131, T186
Appendix 9.9

General Arrangement of Temporary Facilities
Appendix 9.10

Trial Grouting Test Result
# INSPECTION REQUEST

**Milestone Item:**
Variation Order No. 38

**Description of Work:**
Waterproofing Works at Secondary Upstream Cofferdam (SUC)

**Date & Time of Inspection:**
- 26-Dec-2015, 9:00 - Drilling work
- 28-Dec-2015, 9:00 - Grouting work

**Location of Inspection:**
Secondary Upstream Cofferdam

**Item of Inspection:**
Trial grouting at SUC - Left bank EL204

**Status of Inspection:**
- First Inspection
- Re-inspection

**Equipment to be Used:**
Drilling machine, Grouting pump, Grout recorder

**Kind of Material:**
Portland cement type III, Bentonite

**Person in-Charge (Obayashi):**
Mr. Jedsada
Tel: 020-9876-7297

---

## INSPECTION RESULT / RECORD

**Inspected by:**
Mr. Khamson

**Date & Time of Inspection:**
Dec 8th, 2015

**Weather Condition:**
FATU

**Equipment for Inspection:**
- Approval
- Rejection

**Reference Document:**
AS ATTACHMENT HEREWITHE

**Inspection Comment:**
- Grouting had been conducted as per criteria requirement.
- Grouting results were met criteria, but finalizing approval must be decided by DMD (Construction Manager / Owner).

**Signature:**
Dec 30, 2015

---

### ACKNOWLEDGEMENT

<table>
<thead>
<tr>
<th>Nam Ngiep 1 Power Company</th>
<th>OBAYASHI</th>
</tr>
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<tbody>
<tr>
<td>Nikhom Koiam</td>
<td>K. Machida</td>
</tr>
<tr>
<td>QA/QC Manager</td>
<td>P.I.C 09/16</td>
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</tbody>
</table>

Important: To be returned to the Contact at the end of the inspection.

---

Obayashi Corporation
Rev. B1, 26th December 2014
**RECORD OF GROUT MIX PROPERTIES**

Materials: 1) Water: 240 L.  
2) Cement: 400 Kg.  
3) Bentonite: 20 Kg.

Mining Location: NAM NGIEP1PP. (Geology Upstream (Thak <$k>$r<a>n</a>)). Ambient Temp (°C): 25  
Water Temp (°C): 24  
Sample No.: 1  
Mix Ratio: W/C = 2.1, Admixture = % of Cement, Bentonite = 20 % of Cement, Sand = % of Cement  
Date of Testing: 28/10/2015  
Time of Mixing: 09:15

### BLEEDING TEST

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<thead>
<tr>
<th>Time from Starting (minutes)</th>
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<th>3</th>
<th>6</th>
<th>12</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from Starting (ml)</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>12</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
</tr>
<tr>
<td>Starting Volume (V1), ml.</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Volume (V2), ml.</td>
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<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
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</tr>
<tr>
<td>Volume (Vg), ml.</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
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</tr>
<tr>
<td>Volume (Vw), ml.</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
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<tr>
<td>Specified Bleeding (%)</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
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<tr>
<td>Tested Bleeding (%)</td>
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<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
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<tr>
<td>Expansion (%)</td>
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<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
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### VISCOSITY TEST

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<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from Starting (ml)</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>12</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
</tr>
<tr>
<td>Temperature °C</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
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<td>Specified Range of Viscosity (sec)</td>
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<td>4.33</td>
<td>4.33</td>
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<tr>
<td>Tested Viscosity (sec)</td>
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### DENSITY TEST

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<th>3</th>
<th>6</th>
<th>12</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
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</thead>
<tbody>
<tr>
<td>Time from Starting (ml)</td>
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<td>3</td>
<td>6</td>
<td>12</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
</tr>
<tr>
<td>Theoretical Specific Gravity</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
</tr>
<tr>
<td>Tested Density (g/ml)</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
<td>2.69</td>
</tr>
</tbody>
</table>

**REMARK:**

HOLE NO. | MIX NO. | STAGE NO. | DEPTH OF GROUTING | GROUTING STATUS
---|---|---|---|---
FTH-1 | 1 | 1 | Part 1 | Completed (depth point 4.33 m.)

**Checked by:** NNPI Site Engineer

**Verified by:** NNPI Engineer

**Name:** 
**Signature:** 
**Date:** 30/11/2015

**Name:** 
**Signature:** 
**Date:** 30/11/2015
# DRILLING REPORT

Location: Non Ngiep 1 HPP (Secondary Upstream)  
Station:  
Elevation (msl): + 204.256  
Water level (m):  
Coordinate: N. 02°6'57.647" E. 54°42'66.239"

Rig No.: RT DN 09 - 006  
Hole No.: Field Trial Test Hole No.1 (FTH-1)  
Dia. of Hole: 76 mm.

Azimuth of Hole:  
Inclination of Hole: 0 Degree from vertical

Type of Drilling:  
Type of drilling Bit No.:  

Driller: Mr. Weeat

<table>
<thead>
<tr>
<th>Time</th>
<th>Lap</th>
<th>Depth</th>
<th>Core Recovery</th>
<th>Core Loss</th>
<th>Soil / Rock type</th>
<th>Water / Cutting Color</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>From (hr.)</td>
<td>To (hr.)</td>
<td>From (m.)</td>
<td>To (m.)</td>
<td>Length (m.)</td>
<td>Meter</td>
<td>%</td>
<td>Meter</td>
</tr>
<tr>
<td>10.50</td>
<td>11.05</td>
<td>15</td>
<td>0.00</td>
<td>3.00</td>
<td>3.00</td>
<td>-</td>
<td>-</td>
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<tr>
<td>11.15</td>
<td>11.40</td>
<td>25</td>
<td>3.00</td>
<td>6.20</td>
<td>8.20</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Total depth: 15.20 m.

Reported by: Right Tunnelling  
Checked by: NNPI Site Engineer/Geologist O.C.  
Verified by: NNPI 1 Engineer

Signature:  
Name: Mr. Phumviet Lalugjei  
Date: 26/12/2015

Signature:  
Name: Jedsdod Suvarad  
Date: 26 Dec., 2015

Signature:  
Name: Khamsa  
Date: DEC 30, 2015
### GROUTING REPORT

**Location:** Secondary Upstream Cofferdam Nam Ngiep 1 Dam  
**Station (m):** Coordinate N 20 23 49.842 E 14 26 26.270  
**Elevation (msl):** +204.216  
**Results of water pressure tests (MPa):** -  
**Mix ratio:** Water : Cement : Bentonite : 12 : 5 : 1 (W x 120 L/C x 50 Kg / B x 10 Kg)  
**Hole No:** Field Trial Test Hole No. 1 (FTH.1)  
**Dia. of Hole (mm):** 76.0  
**Packer Depth (m):** -  
**Packer type:** Double Packer  
**Inclination of Hole:** 0°  
**Azimuth of Hole:** Degree from vertical  
**Cement used (kg):** -  
**Cement take (kg):** -  
**Cement take (kg/m):** -  
**Grout Operator:** Mr. Suradech T.  
**Date:** 20/12/15  
**Shift:** Day  

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of Grouting</th>
<th>From To</th>
<th>Lap Time</th>
<th>Pressure</th>
<th>Injected Volume (litre)</th>
<th>Injected Materials</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>From (m)</td>
<td>To (m)</td>
<td>From (hr)</td>
<td>To (hr)</td>
<td>Lap Time (min)</td>
<td>Theoretical Pressure (kg/cm²)</td>
</tr>
<tr>
<td>Port 1</td>
<td>Up</td>
<td>-</td>
<td>10.11 10.16</td>
<td>5</td>
<td>12/5</td>
<td>5.5</td>
<td>0-6.0</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10.16 10.17</td>
<td>1</td>
<td></td>
<td></td>
<td>6.0</td>
<td>131</td>
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</tbody>
</table>

**Remarks:** The Grouting is completed. The Max Pressure is maintained at 6.0 bars. The flowrate is less than 5 cfm/minute. (Follow to Refusal Criteria) at design pressure.

: The Grouting Port 1 the depth of injection port at the depth 4.35 m. (Total depth of Hole 5.20 m.)

**Total**

<table>
<thead>
<tr>
<th>W/C</th>
<th>Total Volume (litre)</th>
<th>Total Injected Volume (litre)</th>
<th>Total Remained Volume (litre)</th>
<th>Cement (kg)</th>
<th>Water (litre)</th>
<th>Bentonite (kg)</th>
<th>Admixture (litre)</th>
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<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
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</table>

**Reported by:** RT Geologist  
**Checked by:** NNPI Site Engineer / Geologist  
**Verified by:** NNPI Engineer

**Signature:**  
**Name:** Tanaluk S.  
**Date:** 20/12/15

**Signature:**  
**Name:** Jadsado S  
**Date:** 24 Dec., 2015

**Signature:**  
**Name:** Khamsay  
**Date:** Dec. 30, 2015
FTH. 1 (Port 4)
Date 28/12/15
10:50 START 00.00.00.
12:45 TOTAL 155L
12:45 # 5
12:45 END 00.05.28.

FTH. 1 (Port 3)
Date 28/12/15
10:40 START 00.02.22.
12:30 TOTAL 155L
12:30 # 2
12:38 END 00.17.28.

FTH. 1 (Port 2)
Secondary U/s Cofferdam
Date 28/12/15
10:20 START 00.00.00.
12:17 TOTAL 155L
12:17 # 1
12:17 END 00.27.57.

FTH. 1 (Port 1)
Date 28/12/15
12:10 START 00.00.00.

MPa
# GROUTING REPORT

**Location:** Secondary Upstream Cofferdam, Nam Ngiep 1 Dam  
**Station (m.):** Coordinate N20°623'20.842 E 34°42'66.279  
**Elevation (m.s.l.):** +204.216  
**Results of water pressure tests (LU):**  
**Mix ratio:** Water : Cement : Bentonite  
12 : 5 : 1 (W:120L/c:50kg/b:40kg)

## Stage no.

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Up-Down Stage</th>
<th>Depth of Grousing</th>
<th>From (m)</th>
<th>To (m)</th>
<th>Lap Time (hr)</th>
<th>W/C</th>
<th>Theoretical Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>Mix Volume (litre)</th>
<th>Total Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remained Volume (litre)</th>
<th>Cement (kg.)</th>
<th>Water (litre)</th>
<th>Bentonite (kg.)</th>
<th>Admixture (litre)</th>
<th>Sand (kg.)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port 2</td>
<td>Up</td>
<td>10.20</td>
<td>10.20</td>
<td>5</td>
<td>12/5</td>
<td>5.0</td>
<td>0-5.5</td>
<td>131</td>
<td>40</td>
<td>91</td>
<td></td>
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<td>10.26</td>
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<td>5</td>
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<td>5.5</td>
<td>91</td>
<td>42</td>
<td>49</td>
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<tr>
<td></td>
<td></td>
<td>10.36</td>
<td>10.36</td>
<td>5</td>
<td></td>
<td></td>
<td>5.5</td>
<td>140</td>
<td>50</td>
<td>139</td>
<td></td>
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<td>10.36</td>
<td>10.36</td>
<td>2</td>
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<td>5.5</td>
<td>139</td>
<td>25</td>
<td>114</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:** The Grouting is completed due to the grout mix (Cement : Bentonite Volume) = 4.21L/m. or 1.57 L/m³ Sleeve - (Port) follow to refusal criteria of grouting.

The Grouting Port 2 the depth of injection port of the depth 4.02 m. (Total depth of Hole 5.20 m.)

---

**Signed by:** RT Geologist
**Checked by:** NNPI Site Engineer/Geologist
**Verified by:** NNPI Engineer

- **Signature:**
- **Name:** Tanaweluk S.
- **Date:** 28/12/15

- **Signature:**
- **Name:** Jedsada S.
- **Date:** 28 Dec. 2015

- **Signature:**
- **Name:** Kham Le
- **Date:** Dec 30, 2015
# GROUTING REPORT

**Location:** Secondary Upstream Cofferdam Nam Ngiep 1 Dam  
**Coordinates:** N20°23'39.842 E34°42'6.27"  
**Date:** 28/12/15  
**Shift:** Day

---

**Sheet of 13**

**Hole No.:** Field Trial Test Hole No. 1 (FTH.1)  
**Dia. of Hole (mm):** 76.0  
**Elevation (m.s.l.):** +204.216  
**Mix ratio:** Water : Cement : Bentonite = 12 : 5 : 1 (W=1:20L/C=50kg./B=10kg.)  
**Cement used (kg):**  
**Shift:** Day  
**Cement type:** Double Pack  
**Cement take (kg/m):**  
**Shift:** Day  
**Cement take (kg/m.):**  
**Shift:** Day  
**Mix Operator:** Mr. Suradech T.

---

## Stage No.
<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of</th>
<th></th>
<th>Pressure</th>
<th>Injected Volume (litre)</th>
<th>Injected Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up-Down</td>
<td></td>
<td></td>
<td>W/C</td>
<td>Total Volume (litre)</td>
<td>Cement (kg.)</td>
</tr>
<tr>
<td>Port 3</td>
<td></td>
<td></td>
<td></td>
<td>10.41</td>
<td>5.0 0-5.0</td>
<td>11.4 1 11.3</td>
</tr>
</tbody>
</table>

---

**Remarks:** The Grouting is completed. The Max. Pressure is maintained at 5.0 bars. The injection rate less than 5.0 l/min. minute, at design pressure.

---

**Total**

**Reported by:** RT Geologist  
**Checked by:** NNPI Site Engineer/Geologist  
**Verified by:** NNPI Engineer

---

**Signature:**  
**Name:** Tanawuk S.  
**Date:** 28/12/15  
**Signature:**  
**Name:** Jedsuda S.  
**Date:** 24 Dec, 2015  
**Signature:**  
**Name:** Khamsoy  
**Date:** Dec 30, 2015

---

**Remarks:** Grout Mix Remained From Port 2/114 L.

---

**Surface:** 0.0  
**1.0**  
**2.0**  
**3.0**  
**4.0**  
**5.0**  
**3.69 m.**  
**5.0**
# GROUTING REPORT

**Location:** Secondary Upstream Cofferdam Nam Ngiep 1 Dam  
**Station (m.):** Coordinate N 2062379.842 E 344266.279  
**Elevation (masl):** +204.216  
**Results of water pressure tests (L.U.):** -  
**Mix ratio:** Water : Cement : Bentonite  
\[ 12 : 5 : 1 \]  
\( W = 120 \text{ L} / \text{C} = 50 \text{kg} / \text{B} = 10 \text{kg} \)

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of Grouting (m)</th>
<th>From Time (hr)</th>
<th>To Time (hr)</th>
<th>Lap Time (min)</th>
<th>W/C</th>
<th>Theoretical Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>Mix Volume (litre)</th>
<th>Total Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remained Volume (litre)</th>
<th>Cement (kg)</th>
<th>Water (litre)</th>
<th>Bentonite (kg)</th>
<th>Admixture (litre)</th>
<th>Sand (kg)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port 4</td>
<td>Up</td>
<td>-</td>
<td>10.51</td>
<td>10.56</td>
<td>5</td>
<td>1/2</td>
<td>4.5</td>
<td>0.5</td>
<td>2</td>
<td>113</td>
<td>2</td>
<td>111</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:** The Grouting is Completed. The max. pressure is maintained at 5.0 bars. (Design Pressure 4.5 bars.) The injection rate less than 5.0 L./minute.

**Port 4 is the depth of injection port at the depth 3.36 m. (Total depth of Hole 5.20 m.)

**Total:** 111

**Reported by:** RT Geologist  
**Checked by:** ANN1 Site Engineer/Geologist  
**Verified by:** ANN1 Engineer

**Signature:**  
**Name:** Tawaluk S.  
**Date:** 28/12/15

**Signature:**  
**Name:** Jadelka S.  
**Date:** 28 Dec. 2015

**Signature:**  
**Name:** Khamsay  
**Date:** Dec 30, 2015
**GROUTING REPORT**

Location: Secondary Upstream Cofferdam Nam Ngiep 1 Dam.
Coordinate: N26°23′59.842 E34°42′58.279
Hole No.: Field Trial Test Hole No. 1 (FH. 1)
Dia. of Hole (mm.): 76.0
Packer Depth (m.): -
Inclination of Hole: 0 Degree from vertical
Azimuth of Hole: - Degree
Mix ratio: Water : Cement : Bentonite = 42 : 5 : 1 (W : 120 L / C = 50 kg / B = 10 kg)

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of Grouting</th>
<th>Time</th>
<th>Pressure</th>
<th>Injected Volume (litre)</th>
<th>Injected Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up-Down Stage</td>
<td>From (m) to (m)</td>
<td>From (hr) to (hr)</td>
<td>Lap Time (min)</td>
<td>W/C</td>
<td>Theoretical Pressure (kg/cm²)</td>
</tr>
<tr>
<td>Port 5</td>
<td></td>
<td>10.58 to 11.03</td>
<td>5</td>
<td>12/5</td>
<td>4.0 0.0 - 4.5</td>
<td>111 2 109</td>
</tr>
</tbody>
</table>

Remarks: The Grouting is completed. The max. Pressure is maintained at 4.5 bars. (Design Pressure 4.0 bars).
The Injection rate less than 5 L/minute.

Port 5: The Grouting at the depth of injection port at the depth 3.03 m. (Total depth of Hole 5.20 m).

Grout Mix Remained From Port 4 / 111 L.

Total: QC. (2) 109

Reported by: RT Geologist
Checked by: NNPI Site Engineer/Geologist
Verified by: NNPI Engineer

Signature: [Signature]
Name: Tamoluk S.
Date: 28/12/15

Signature: [Signature]
Name: Jedsoda S.
Date: 28 Dec. 2015

Signature: [Signature]
Name: Khamdai
Date: Dec 30, 2015
## GROUTING REPORT

**Location:** Secondary Upstream Cofferdam Nam Ngiep 1 Dam

**Station (m.):** Coordinate N 1062379.842 E 344266.279

**Elevation (msl):** +204.216

**Results of water pressure tests (L/D):** -

**Mix ratio:** Water : Cement : Bentonite = 12 : 5 : 1 (W : 120L / C : 50kg / B : 10 kg)

### Stage No.

<table>
<thead>
<tr>
<th>Grouting Method</th>
<th>Depth of Greeting</th>
<th>From</th>
<th>To</th>
<th>Lap Time</th>
<th>Time</th>
<th>Pressure</th>
<th>Theoretical Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>W/C</th>
<th>Mix Volume (litre)</th>
<th>Total Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remaining Volume (litre)</th>
<th>Cement (kg)</th>
<th>Water (litre)</th>
<th>Bentonite (kg)</th>
<th>Admixture (litre)</th>
<th>Sand (kg)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port 5 up</td>
<td>-</td>
<td>11.05 11.10 5</td>
<td>12/5</td>
<td>3.5</td>
<td>0-8.0</td>
<td>103</td>
<td>4</td>
<td>105</td>
<td>Grout Mix Completed</td>
<td>Remained From Port 5/108L</td>
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<td></td>
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</tr>
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</table>

**Remarks:** The Grouting is completed. The max. Pressure is maintained at 8.0 bars. Design Pressure 3.5 bars. The injection rate is low volume, the owner engineer introduce increase of surface pressure more than design pressure. For check the injection rate, consider to adjust pressure next time.

The Grouting is Port 6, the depth of injection port at the depth 2.70 m. (Total depth of Hole 5:20 m.)

---

**Total:**

| Signature: | RT Geologist | Checked by: | NNPI Site Engineer/Geologist | Verified by: | NNPI Engineer
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Name:</td>
<td>Tamaluk S.</td>
<td>Name:</td>
<td>Jedada S.</td>
<td>Name:</td>
<td>Khamsay</td>
</tr>
<tr>
<td>Date:</td>
<td>28/12/15</td>
<td>Date:</td>
<td>18 Dec. 2015</td>
<td>Date:</td>
<td>Dec 30, 2015</td>
</tr>
</tbody>
</table>
# GROUTING REPORT

**Location:** Secondary Upstream Cofferdam Nam Ngiep 1 Dam  
**Station (m):** Coordinate N 2062379.842 E 344206.279  
**Elevation (m.s.l.):** +204.216  
**Results of water pressure tests (L.U.):** -  
**Dia. of Hole (mm):** 98.0  
**Packer Depth (m):** -  
**Inclination of Hole:** 0  
**Azimuth of Hole:** -  
**Mix ratio:** Water : Cement : Bentonite 12 : 5 : 1 (W : L / C : 50 kg / B : 10 kg)  
**Cement used (kg):** -  
**Cement take (kg):** -  
**Cement take (kg/m):** -  
**Grout Operator:** Mr. Suradech T.  

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of Grouting</th>
<th>From (m)</th>
<th>To (m)</th>
<th>Time (hr)</th>
<th>Lap Time (min)</th>
<th>W/C</th>
<th>Theoretical Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>Total Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remained Volume (litre)</th>
<th>Cement (kg)</th>
<th>Water (litre)</th>
<th>Bentonite (kg)</th>
<th>Admixture (litre)</th>
<th>Sand (litre)</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Port 2</td>
<td>Up</td>
<td>-</td>
<td>11.14</td>
<td>11.19</td>
<td>11.19</td>
<td>11.24</td>
<td>5</td>
<td>12/5</td>
<td>0-8.0</td>
<td>105</td>
<td>70 35</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Completed</td>
</tr>
</tbody>
</table>

**Remarks:** The Grouting is completed. The max. Pressure is maintained at 3.5 bars. (Design Pressure 3.0 bars.), the owner Engineer introduce increase for check the pressure more than up to 8.0 bars. About 1 minutes, the injection rate is high Volume after that decrease the pressure down to 3.5 bars the injection rate is slow down & maintained in refusal criteria less than 5 litre/minute.

The Grouting is Port 2 at the depth of Injection Port at the depth 2.37 m. (Total depth of Hole 5.20 m.)

**Total**  

06 90 15

**Reported by:** RT Geologist  
**Checked by:** NNPI Site Engineer Geologist  
**Verified by:** NNPI Engineer

**Signature:**  
**Name:** Tamaluk S.  
**Date:** 28/12/15

**Signature:**  
**Name:** Jedsada  
**Date:** Dec 18, 2015

**Signature:**  
**Name:** Chamsay  
**Date:** Dec 30, 2015
# GROUTING REPORT

**Location:** Secondary Upstream Cofferdam Nam Ngiep 1 Dam  
**Coordinate:** N2062378.842 E344266.279  
**Hele No.:** Field Trial Test Hole No. 1 (FTH1)  
**Date:** 28/12/15  
**Shift:** Day  
**Cement used (kg.):** -  
**Cement take (kg.):** -  
**Cement take (kg/m.):** -  
**Grout Operator:** Mr. Suradech T.

**Mix ratio:** Water : Cement : Bentonite 12 : 5 : 1 (W : 100L : C : 50kg. : B : 10kg)

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Up-Down Stage</th>
<th>Depth of Grouting</th>
<th>From (m)</th>
<th>To (m)</th>
<th>Time (hr)</th>
<th>Lap Time (min)</th>
<th>W/C</th>
<th>Theoretical Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>Mix Volume (litre)</th>
<th>Total Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remained Volume (litre)</th>
<th>Cement (kg.)</th>
<th>Water (litre)</th>
<th>Bentonite (kg.)</th>
<th>Admixture (litre)</th>
<th>Sand (kg.)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port B Up</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14.07</td>
<td>14.12</td>
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<td>107</td>
<td>140</td>
<td>140</td>
<td>33</td>
<td>107</td>
<td>140</td>
<td>L.</td>
<td>Completed</td>
</tr>
</tbody>
</table>

Remarks: The Grouting is completed. The max. pressure is maintained at 3.0 bars. (Design Pressure 2.5 bars), the owner engineer introduce increase for check the pressure begin 2 minutes up to 8 bars. & the injection rate volume is high volume. After that decrease the pressure slow down to 3 bars. & continuous stable until the refusal criteria the injection rate less than 5 L/min. (22 L/5 min → 4.4 L/min)

: The Grouting is Port B at the depth of injection Port at the depth 2.04 m. (Total depth of hole 5.20 m.)

Afternoon  
New Mix  
140 L.

Total: 55  
85

Reported by: RT Geologist  
Checked by: NNPI Site Engineer/Geologist  
Verified by: NNPI Engineer

Signature:  
Name: Tanavalde S.  
Date: 28/12/15

Signature:  
Name: Jedsada S.  
Date: 28 Dec., 2015

Signature:  
Name: Khamsay  
Date: Dec 30, 2015
## GROUTING REPORT

**Location:** Secondary Upstream Cofferdam Nam Ngiep1 Dam

**Coordinate:** N2062379.842 E344268.279

**Hole No.:** Field Trial Test Hole No. 1 (FTTH-1)

**Elevation (mSL):** +204.216

**Results of water pressure tests (L/min):**

**Mix Ratio:** 12 : 5 : 1 (Water : 120 L / Cement : 50 kg. Bentonite : 40 kg.)

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of Grouting</th>
<th>Time</th>
<th>Pressure</th>
<th>Injected Volume (litre)</th>
<th>Injected Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Theoretical Pressure (kg/cm²)</td>
<td>Actual Pressure (kg/cm²)</td>
<td>Mix Volume (litre)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.0 - 12.0</td>
<td>2.0</td>
<td>225</td>
</tr>
</tbody>
</table>

**Remarks:**

- The Grouting is completed. The max. Pressure is maintained at 2.0 bars (Design Pressure 2.0 bars). Begin start injection the injection rate is low volume & up pressure to about 12.0 bars. The injection rate yet low volume after that slow down pressure to 2.0 bars, continue until the refusal pressure criteria injection rate < 5 L/min.

- The Grouting is Port 9 the depth of injection Port at 1.74 m. (Total depth of Hole 5.20 m.)

**Total:** 223

**Table:**

<table>
<thead>
<tr>
<th>Signature:</th>
<th>Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Signature]</td>
<td>Tawaluks S.</td>
<td>28/12/15</td>
</tr>
</tbody>
</table>

**Checked by:** NNPI Site Engineer/Geologist

**Verified by:** NNPI Engineer

**Date:** 28 Dec. 2015
## GROUTING REPORT

**Location:** Secondary Upstream Copper Dam Nam Ngiep 1 Dam  
**Station (m.):** Coordinate N 2062379, E 344266.729  
**Elevation (m.):** + 204.216  
**Results of water pressure tests (L.U.):**  
**Mix ratio:** Water : Cement : Bentonite = 12 : 5 : 1 (W:120 L/C : 50 kg./B:10 kg.)

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method</th>
<th>Depth of Grouting</th>
<th>Time</th>
<th>Pressure</th>
<th>Injected Volume (litre)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>From (m)</td>
<td>To (m)</td>
<td>From (hr)</td>
<td>To (hr)</td>
<td>W/C</td>
</tr>
<tr>
<td>Port 10</td>
<td>Up</td>
<td>-</td>
<td>-</td>
<td>14.32</td>
<td>14.34</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.34</td>
<td>14.37</td>
<td>3</td>
</tr>
</tbody>
</table>

**Remarks:** The Grouting is completed. The max. Pressure is maintained at 2.0 bars. (Design Pressure 1.5 bars.) Begin start injection rate is low volume up pressure to about 12.0 bars, the injection rate yet low Volume after that slow down pressure to 2.0 bars, & Continue until the refusal criteria injection rate < 5 L/min.

The Grouting is Port 10 the depth of injection Port at the depth 4.38 m. (Total depth of Hole 5.20 m.)

**Total**

**Reported by:** RT Geologist  
**Checked by:** NNP Site Engineer / Geologist  
**Verified by:** NNP1 Engineer

**Signature:**  
**Name:** Tawaluk S.  
**Date:** 28/12/15

**Signature:**  
**Name:** Jedsada S.  
**Date:** 28 Dec, 2015

**Signature:**  
**Name:** Kramesay  
**Date:** Dec 30, 2015
# GROUTING REPORT

- **Location:** Secondary Upstream Cofferdam Nam Ngiep 1 Dam
- **Station (m.):** Coordinates N24°23'39.842 E 104°26.6279
- **Elevation (m):** +204.216
- **Results of water pressure tests (L.U.):** -
- **Mix ratio:** Water : Cement : Bentonite = 12 : 5 : 1 (W : 120 L / C : 50 kg / B : 40 kg)
- **Hole No.:** Field Trial Test Hole No. 1 (FTH.1)
- **Dia. of Hole (mm):** 96
- **Packer Depth (m):** -
- **Packer type:** Double Packer
- **Inclination Depth of Hole:** 0 Degree from vertical
- **Azimuth of Hole:** - Degree
- **Cement used (kg):** -
- **Cement take (kg/m):** -
- **Operator:** Mr. Suradech T.
- **Date:** 28/12/15, Shift: Day

## Stage Details

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grotting Method</th>
<th>Depth of Grotting</th>
<th>From (m)</th>
<th>To (m)</th>
<th>Time</th>
<th>Lap Time</th>
<th>W/C</th>
<th>Theoretical Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>Mix Volume (litre)</th>
<th>Total Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remained Volume (litre)</th>
<th>Cement (kg)</th>
<th>Water (litre)</th>
<th>Bentonite (kg)</th>
<th>Admixture (litre)</th>
<th>Sand (kg)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port11 Up</td>
<td>-</td>
<td>-</td>
<td>14.39</td>
<td>14.42</td>
<td>3</td>
<td>12/5</td>
<td>1.5</td>
<td>220</td>
<td>215</td>
<td>0</td>
<td>215</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Completed</td>
</tr>
</tbody>
</table>

**Remarks:** The Grotting is completed. The max. Pressure is maintained at 2.0 bars. (Design Pressure 1.5 bars). Begin start injection rate is low volume & up pressure to about 1.0 bars. the injection rate yet low volume after that slow down the pressure to 2.0 bars. *continue until the refusal criteria injection < 5 L/min.

Total: The Grotting is Port 11 the depth of injection port at the depth 1.05 m. (Total depth of Hole 5.20 m).

**Reported by:** RT Geologist
**Checked by:** ANPI Site Engineer/Geologist
**Verified by:** ANPI Engineer

---

**Signature:**
- Tamalkul S.
- 28/12/15

**Date:**
- Dec 30, 2015
# GROUTING REPORT

**Location:** Secondary Upstream Cofferdam, Nam Ngiep I  
**Station (m.):** Coordinate N 0 1 2 3 4 5 6 4 8 9 B 2 4 6 8 4 9  
**Elevation (as):** + 204.216  
**Hole No.:** Field Trial Test Hole No. 1 (FTH 1)  
**Results of water pressure tests (L/L):** -  
**Mix ratio:** Water : Cement : Bentonite 12 : 5 : 1 (W=120L / C=50 kg / B=10 kg)  
**Dia. of Hole (mm):** 96.0  
**Packer Depth (m):** -  
**Packer type:** Double Starter  
**Inclination of Hole:** 0  
**Azimuth of Hole:** -  
**Date:** 28/12/15  
**Shift:** Day  
**Cement used (kg):** -  
**Cement take (kg):** -  
**Cement take (kg/m):** -  
**Grout Operator:** Mr. Suradech T.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Port 12</td>
<td>Up</td>
<td>-</td>
<td>14.46</td>
<td>14.51</td>
<td>5</td>
<td>12/5</td>
<td>0.15</td>
<td>215</td>
<td>Completed</td>
</tr>
</tbody>
</table>

**Remarks:** The Grouting is completed. The max. Pressure is maintained at 1.0 bars. (Design Pressure 1.0 bars). Begin Start injection by low pressure the grout mix take after that past about 2 minutes the grout mix is leakage on top surface & decrease pressure 1.0 bar & continue until full time 5 minutes. & the refusal criteria injection due to 0.92 m. grout mix leakage to surface.

**Total:** 200

**Reported by:** RT Geologist  
**Checked by:** NNPI Site Engineer / Geologist  
**Verified by:** NNPI Engineer

**Signature:**  
**Name:** Tawaluk S.  
**Date:** 28/12/15

**Signature:**  
**Name:** Jedsada S.  
**Date:** 28 Dec. 2015

**Signature:**  
**Name:** Khamalay  
**Date:** Dec 30, 2015
# Grouting Report

**Location:** Secondary Upstream Cofferdam Nam Ngiep 1  
**Station (m.):** N2062379.842 E344266.279  
**Elevation (msl):** +204.216  
**Results of water pressure tests (LU):**  
**Mix ratio:** Water : Cement : Bentonite  
12 : 5 : 1  
**Coordinate:** N2062379.842 E344266.279

<table>
<thead>
<tr>
<th>Stage no.</th>
<th>Grouting Method Up-Down Stage</th>
<th>Depth of Grouting (m)</th>
<th>Time From To (hr)</th>
<th>Lap Time (min)</th>
<th>W/C</th>
<th>Theoretical Pressure (kg/cm²)</th>
<th>Actual Pressure (kg/cm²)</th>
<th>Mix Volume (litre)</th>
<th>Total Volume (litre)</th>
<th>Injected Volume (litre)</th>
<th>Remaining Volume (litre)</th>
<th>Cement (kg)</th>
<th>Water (litre)</th>
<th>Bentonite (kg)</th>
<th>Admixture (litre)</th>
<th>Sand (kg)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.L.</td>
<td></td>
<td>14.53 14.54 1</td>
<td>12/5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>3</td>
<td>197</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**  
Grout Mix Remained From Port 12/02/05.  
(Filling Hole)

**Reported by:** RT Geologist  
**Checked by:** NNP1 Site Engineer/Geologist  
**Verified by:** NNP1 Engineer

**Signature:**  
**Name:** Tawaluk S.  
**Date:** 28/12/15
NORMAL CONSISTENCY & SETTING TIME OF CEMENTS  
(ASTM C187 & ASTM C191)

Sample No.: 1 (Low Permeability)

Mix Ratios: W/C/B = 120 : 50 : 10, Bentonite = 20% of C.

Time of Mixing: 9.45 a.m

Sample Description: Secondary Upstream Cofferdam

Hole no. Mix no. Stage no. Depth of grouting (m.) Grouting status
Sample testing hole 1 Port 1 4.35 Completed

Sampling Location: Nam Ngiep 1 (Secondary Upstream Cofferdam)

Ambient Temperature (°C): 25

Testing Date: 29/12/15

Initial Setting Time Determination

<table>
<thead>
<tr>
<th>Date of Reading</th>
<th>29/12/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Reading</td>
<td>21:00</td>
</tr>
<tr>
<td>Acc Elapsed Time</td>
<td>Minutes</td>
</tr>
<tr>
<td>Penetration (mm) Start Time</td>
<td>39 37 35 33 31 29 27 25 23 21 19 17 15 13 11 9 7 5 3 1 0 0</td>
</tr>
</tbody>
</table>

Initial Setting Time (Minutes) = 22:30 - 9:45 = 765 min

In Hour : Minutes 12 hr 45 min

Final Setting Time (Minutes) = 24:00 - 8:45 = 1035 min

In Hour : Minutes 18 hr 15 min

(Final Setting Time (Minutes) = Time where needle does not sink visibly to paste - Time after mixing)

Remarks:

Tested By Right Tunneling: Signature: [Signature]

Checked by: NNP 1 Engineer O.C. Signature: [Signature]

Verified by: NNP 1 Engineer Signature: [Signature]

Name: Watchara S. Name: Jetsada Srangsrin Name: [Name]

Date: 29/12/15 Date: 28 Dec, 2015 Date: [Date]