“Anaerobic Treatment Implementation at Wastewater Treatment Systems in Natural Rubber Production Lines”

(Implemented by Nihon Suido Consultants Co., Ltd.)

<table>
<thead>
<tr>
<th>Study Partners</th>
<th>o Kurita Water Industries Ltd. / o Tepia Corporation Japan ● PT. Bridgestone Sumatra Rubber Estate (PT.BSRE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project site</td>
<td>Republic of Indonesia</td>
</tr>
<tr>
<td>Category of project</td>
<td>Waste management, biomass utilization</td>
</tr>
<tr>
<td>Description of project</td>
<td>A large volume of water is used at natural rubber production factories in North Sumatra province during its production process. The low concentration organic wastewater generated as a result is treated to meet the wastewater standard by activated sludge process, an aerobic treatment, which requires substantial electricity for aeration. This project aims to reduce GHG emissions by installing anaerobic treatment as a pretreatment to reduce energy consumption at blower in activated sludge process and utilize methane gas collected during anaerobic treatment process to generate electricity and/or heat.</td>
</tr>
<tr>
<td>JCM methodology</td>
<td>Eligibility criteria</td>
</tr>
<tr>
<td></td>
<td>Criterion 1: To install anaerobic treatment before the existing activated sludge process treatment. The project has to recover/utilize methane gas from biomass in wastewater from natural rubber production. Its wastewater quality CODcr shall not exceed 2,000mg/L.</td>
</tr>
<tr>
<td></td>
<td>Criterion 2: Target quality of treated wastewater is planned to be achieved before implementation of anaerobic wastewater treatment system, and the same target shall be applied after implementation of anaerobic wastewater treatment system.</td>
</tr>
<tr>
<td></td>
<td>Criterion 3: Soluble CODcr removal ratio should be more than 80% in the installed anaerobic treatment process and it has to be stated in the catalog or technical data of implementing anaerobic treatment technology.</td>
</tr>
<tr>
<td></td>
<td>Criterion 4: To utilize all methane gas to generate electricity and/or heat and consume within the factory or supply to the grid.</td>
</tr>
<tr>
<td></td>
<td>Criterion 5: Existing activated sludge treatment system can control wastewater treatment energy depending on the change of inflow CODcr load.</td>
</tr>
<tr>
<td>Default values</td>
<td>Emission factor of fossil fuel (diesel oil) and operational safety factor of existing activated sludge treatment system are set as defaults. The former is a default value defined by IPCC; the latter is the result value of BSRE.</td>
</tr>
<tr>
<td>Calculation of</td>
<td>The following two methods are defined. Option-A is for a case where energy consumption data of the last four years are available, and Option-B is for the</td>
</tr>
</tbody>
</table>
### Reference Emissions

Reference emissions, Option-A: Energy consumption of activated sludge treatment system is estimated from CODcr removal load necessary in the wastewater treatment system using the estimation formula created from the result data of the previous year and multiplied by the emission factor.

Option-B: Energy consumption is estimated by subtracting possible energy reduction calculated using the actual treatment conditions (wastewater quantity and quality) and operational safety factor of the wastewater treatment system from the designed energy consumption of activated sludge treatment system to estimate energy consumption and multiplied by the emission factor.

### Monitoring Method

<table>
<thead>
<tr>
<th>Items to be monitored</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater quantity, wastewater quality, energy consumption, and heat recovery from cogeneration system (quantity and temperature of hot water).</td>
<td>Currently, wastewater quantity and quality as well as energy consumption are measured and recorded at least once a day. Water quality is analyzed at a laboratory within BSRE by experts based on Indonesian National Standard (SNI). Items such as heat recovery quantity need to be measured after implementation of anaerobic wastewater treatment system, and measurement methods and precision control need to be identified.</td>
</tr>
</tbody>
</table>

### GHG Emission Reductions

The following shows the GHG emissions and GHG emission reductions calculated based on the result values of wastewater quantity and quality of 2012 using the methodology discussed:

**Reference emissions**

<table>
<thead>
<tr>
<th>Option</th>
<th>GHG Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1,436 t-CO₂/year</td>
</tr>
<tr>
<td>B</td>
<td>1,278 t-CO₂/year</td>
</tr>
</tbody>
</table>

Actual emissions: 11% reduction in case of Option-A and 24% reduction in case of Option-B compare to 1,693 t-CO₂/year. Emissions are evaluated conservatively.

**Project emissions**

| Project emissions | 595 t-CO₂/year |

**GHG reductions**

<table>
<thead>
<tr>
<th>Option</th>
<th>GHG Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>842 t-CO₂/year</td>
</tr>
<tr>
<td>B</td>
<td>683 t-CO₂/year</td>
</tr>
</tbody>
</table>

Energy required for wastewater treatment is expected to be almost the same even after implementation of anaerobic treatment, but by utilizing methane gas to generate electricity/heat, GHG of 700-850 t-CO₂/year are expected to be reduced.

### Environmental Impacts

Any projects that have the potential to affect the environment significantly need to conduct environmental impact assessment. This project, however, is merely to add anaerobic treatment system to the existing wastewater treatment system, and is not considered as the subject of environmental impact assessment. The biogas power generation plant planned to be installed in the facility may be considered as the subject of environmental assessment if the capacity of the plant is more than 10MW. The capacity of power plant in this project is less than 0.1MW, and therefore this project does not need to conduct environmental impact assessment.

In terms of implementation of technology, wastewater treatment technology itself prevents water pollution and no effect is expected on water environment. By installing desulfurizing equipment and preventing leakage of...
methane gas collected during anaerobic treatment process, and by implementing environmental measures such as choosing low noise type equipment to reduce noise from a blower or generator, it is possible to reduce the environmental impact as much as possible.

<table>
<thead>
<tr>
<th>Project plan</th>
<th>The payback periods of the two cases are 6.2 and 4.9 years respectively. Use of cogeneration system is determined by taking into account that the review of drying process is in progress. Details of the facility scale are determined based on the result of the methane gas continuous test which is performed in parallel with this study. The detailed design and construction will take about one year after the contract of subsidized project is made, and the project will start in August 2015 and completed at the end of 2020, depending on the result of the gas generation test to be performed later on.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion of Japanese technologies</td>
<td>This project will adopt Biosaver TK, anaerobic treatment system applicable to low concentration organic wastewater developed by a Japanese company. During the indoor batch experiment, more than 80% of soluble organic matters are decomposed, a proof that it has sufficient performance. When compared with possible competitive technologies such as sedimentation treatment and anaerobic lagoon in terms of GHG emission reductions and costs, Biosaver TK shows larger GHG emission reductions than other two, and by applying JCM subsidy, Biosaver TK’s treatment cost per year is less than that of sedimentation treatment and about equal to that of anaerobic lagoon. Therefore, Biosaver TK is proved to be superior in terms of GHG emission reductions and treatment cost.</td>
</tr>
<tr>
<td>Sustainable development in host country</td>
<td>The natural rubber industry is one of 22 major industries with expectations of future economic expansion. Projects such as this which provide support in the field of energy saving and environmental measures are expected to contribute to the economic development of the country. In the Master Plan for the Acceleration and Expansion of Indonesia’s Economic Development, 6 economic corridors are defined as the focus of growth. While increase in inflation rate in Indonesia is a major concern, implementing a project such as this, which expects short payback period, will help support local companies. Moreover, introduction of energy saving technology also promote stable provision of electricity in regions that lack electricity. This project is to promote treatment of organic wastewater from factories and to provide Japan’s technological support against biological treatment which is difficult to maintain and manage. This project is in line with the Indonesian government’s policies to promote implementation of wastewater treatment technology to improve water pollution in public water area and will contribute significantly to the environmental measures of Indonesia.</td>
</tr>
</tbody>
</table>
JCM Feasibility Study (FS) 2013
“Anaerobic Treatment Implementation at Wastewater Treatment Systems in Natural Rubber Production Lines”
(Host country: Republic of Indonesia)

Study Entity: Nihon Suido Consultants Co., Ltd.

1. Study Implementation Scheme

<table>
<thead>
<tr>
<th>Country</th>
<th>Name of study partners</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Kurita Water Industries Ltd.</td>
<td>Manufacturer of anaerobic treatment systems to be implemented in this project. Responsible for evaluation of wastewater treatment method, calculation of construction cost, and evaluation of maintenance and management method.</td>
</tr>
<tr>
<td></td>
<td>Tepia Corporation Japan</td>
<td>Support for methodology development (for example, creating a reference scenario by investigating factories that conduct same type of business in Indonesia)</td>
</tr>
<tr>
<td>Host country</td>
<td>PT. Bridgestone Sumatra Rubber Estate (BSRE)</td>
<td>Local subsidiary of Bridgestone (rubber production) Provide data and evaluate profitability of the project as a project owner.</td>
</tr>
</tbody>
</table>

2. Overview of Proposed JCM Project:

(1) Description of project contents:
The natural rubber production process produces a large volume of wastewater to wash latex collected from rubber tree. To satisfy the wastewater standard, aerobic treatment is adopted in the wastewater treatment process, which consumes energy for aeration and emits GHG. This project implements anaerobic treatment (methane collection) before the existing wastewater treatment to reduce energy consumption at the blower in the down-flow activated sludge process, and aims to reduce GHG emissions by utilizing collected methane gas to generate power and using the remaining heat after power generation as heat source (cogeneration usage).

PT.BSRE (PT.Bridgestone Sumatra Rubber Estate), owner of this project, manufactures natural rubber products in North Sumatra province. The power used within the factory is generated mainly by diesel oil and in-house power generation system. They have considered adopting UASB to reduce diesel oil in wastewater treatment process, but have given up since the concentration level of wastewater was not applicable for UASB. In this project, use of Biosaver TK (technology of Kurita Water Industries Ltd.) is proposed which is applicable to low concentration organic water and enables methane gas collection.

(2) Situations of host country
Indonesia signed the United Nations Framework Convention on Climate Change in June 1992 and ratified in August 1994. In June 1998, Indonesia signed Kyoto Protocol and ratified it in December 2004. In August 2013, Indonesia signed the bilateral agreement on the Joint Crediting Mechanism between Japan and Indonesia and the framework of JCM project was formally launched. The first Japan-Indonesia Joint Committee was held in October 2013 to discuss details of JCM.

GHG emissions of Indonesia were 2,055MtCO$_2$e in 2005 and are expected to reach 3,260MtCO$_2$e in 2030 according to the BAU scenario. Indonesia’s NAMAs basically consist of existing emission reduction
programs and activities in all fields of national development including forestry, agriculture, industrial, mining, energy and public works. As reduction targets, 26% reduction measures include use of national budget or implementation of domestic specific measures, 15% reduction measures include use of ODA or implementation of measures with financial support from other countries.

This project is targeted for natural rubber industry, given that production of natural rubber of Indonesia accounts for about 30% of production in the world and 6-7% of the total export amount, and is promoted as one of 22 major products in the Indonesia’s long term economic development master plan (2005-25). As for the GHG emission reduction of natural rubber industry, energy reduction measure in the industrial field is described as the essential measure in the action plan. This project is deemed to be consistent with the energy saving measure to suppress the increase in demand for electricity.

3. Study Contents and Results
(1) JCM methodology development
a. Eligibility criteria

The activated sludge process is usually adopted as the treatment technology of organic wastewater discharged from natural rubber production lines. Since activated sludge process uses microorganisms active in aerobic environment and requires substantial electricity for aeration to provide oxygen, increase in CO₂ emissions originated from fossil fuel as well as in treatment cost is considered as an issue.

As a countermeasure to the above issue, implementation of anaerobic wastewater treatment system is promoted which uses anaerobic microorganism to decompose organic matters without any oxygen, reduces energy required for aeration to zero, and utilizes methane gas collected to generate energy, thus saving treatment energy and cost.

However, microorganism (methanogenic bacteria) that decomposes organic matter in anaerobic treatment has slow growth rate compared to aerobic microorganism, and USAB and similar methods which can hold the bacterial cells in the reaction tank at high concentration are mainly adopted to save the overall treatment cost. In order to keep the bacterial cells at high concentration, organic water to be treated must have medium to high concentration (CODcr: 2,000 - 10,000mg/L).


Methodology discussed in this project is for low concentration organic wastewater (CODcr: 500 - 2,000mg/L) on which UASB is not applicable, and proposes implementation of advanced method (Biosaver TK) which is able to hold bacterial cells in the reaction tank at high concentration by using carriers with microorganism attached for low concentration wastewater. The low concentration organic wastewater which this technology applies is assumed to be generated in large volume mainly in natural rubber production and food production lines in Indonesia, and JCM project through implementation of this technology can promote the wastewater treatment technology developed in Japan and contribute to the sustainable development of the host country. The eligible criteria defined by this methodology are shown in Table 3.1 Eligible criteria
### Table 3.1 Eligible criteria

<table>
<thead>
<tr>
<th>Item</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion 1</td>
<td>To install anaerobic treatment before the existing activated sludge process treatment. The project has to recover/utilize methane gas from biomass in wastewater from natural rubber production. Its wastewater quality (CODcr)* does not exceed 2,000mg/L.</td>
</tr>
<tr>
<td>Criterion 2</td>
<td>Target quality of treated wastewater is planned to be achieved before implementation of anaerobic wastewater treatment system, and the same target shall be applied after implementation of anaerobic wastewater treatment system.</td>
</tr>
<tr>
<td>Criterion 3</td>
<td>Soluble COD$_{cr}$ removal ratio should be more than 80% in the installed anaerobic treatment process and it has to be stated in the catalog or technical data of implementing anaerobic treatment technology.</td>
</tr>
<tr>
<td>Criterion 4</td>
<td>To utilize all methane gas to generate electricity and/or heat, and consumed within the factory or supplied to the grid in case of electricity.</td>
</tr>
<tr>
<td>Criterion 5</td>
<td>Existing activated sludge treatment system can control wastewater treatment energy depending on the change of inflow COD$_{cr}$ load.</td>
</tr>
</tbody>
</table>

*: Wastewater quality planned during the designing of the existing activated sludge process system.

Reasons for setting each criterion are as follows:

1) Reasons for setting Criterion 1
To identify a project scheme to improve the existing activated sludge treatment systems by introducing anaerobic treatment (for energy saving, GHG emission reduction), and to limit the anaerobic treatment technology to be implemented in the methodology to “Biosaver TK” by specifying the project to recover/utilize methane gas from low concentration organic wastewater with CODcr planned wastewater quality of no more than 2,000mg/L.

2) Reasons for setting Criterion 2
To limit the implementation to those factories that have the capability to perform MRV after implementation of the project based on JCM system, the criterion is set to target the factories that have blue rank or above in PROPER system. In addition, this criterion is for factories that voluntarily set the target quality lower than the wastewater standard so that their GHG reductions achieved through implementation of anaerobic treatment are evaluated appropriately.

3) Reasons for setting Criterion 3
To eliminate poor anaerobic treatment technologies, only those that have in their catalog or technical data stated that soluble COD$_{cr}$ removal ratio is more than 80% are targeted as anaerobic treatment technologies.

4) Reasons for setting Criterion 4
To define a project scheme to utilize all methane gas collected during anaerobic treatment process to generate electricity and/or heat, and to prevent it from released to the air or flaring of residual methane gas.

5) Reason for setting Criterion 5
Some activated sludge treatment systems are unable to control wastewater treatment energy even if
anaerobic treatment is implemented, and there is a risk of increase in emissions (energy consumption) with implementation of the project. This criterion is set to eliminate such factories in advance.

b. Data and parameters fixed *ex ante*

1) Default value setting
In this methodology, emission factor of diesel oil and operational safety factor* of the existing activated sludge treatment facilities are set as default values. As for the emission factor of diesel oil, the default value of 74.1t-CO₂/TJ defined by IPCC is used. For operational safety factor, operational results of BSRE which perform relatively efficient wastewater treatment compared to other factories are organized and the value at the lowest safety factor (1.39) is set.

*: The actual value of energy consumption divided by the energy consumption at ideal condition (condition where energy is used effectively in accordance with wastewater quantity and quality)

2) Preset values
a) Energy consumption estimation formula of activated sludge treatment system (Option-A)

An estimation formula is created to conservatively evaluate energy consumption of activated sludge treatment systems using the results of water quantity, quality and energy consumption. Specifically, by setting CODcr removal load on the horizontal axis and energy consumption on the vertical axis, data from the previous year is plotted so that the energy consumption becomes the lower limit (refer Figure 3.1).

In the range of low CODcr removal load, energy consumption increases linearly corresponding to removal load, but when removal load is rather high, treatment efficiency goes up, causing energy consumption to show diminishing tendency until it reaches the upper limit defined by the designed electricity consumption. Monod curve is adopted as an approximation to the tendency similar to above, and the result of approximation equation created using the extracted lower limit data is shown in the same figure.

b) Design conditions of activated sludge treatment system (Option-B)

From the design documents of the existing activated sludge treatment system, designed energy consumption, design conditions of blower (details of necessary oxygen, oxygen dissolution efficiency of diffuser), designed water quantity and quality (BOD, NH₃-N) are extracted.

c) Emission factor for electricity (common to Option-A, Option-B)

This project’s target, BSRE, generates all electricity consumed by the wastewater treatment system using in-house power generation system and the fuel is diesel oil. The emission factor as shown in Table 3.2 is set.
as 0.848kg-CO₂/kWh.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Value</th>
<th>Grounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In-house power generation’s diesel oil consumption rate</td>
<td>L/kWh</td>
<td>0.317</td>
<td>Average of monthly data from 2008 to 2012</td>
</tr>
<tr>
<td>2. Calorific value of diesel oil</td>
<td>GJ/kL</td>
<td>36.1</td>
<td>IPCC default values</td>
</tr>
<tr>
<td>3. Emission factor for diesel oil</td>
<td>t-CO₂/TJ</td>
<td>74.1</td>
<td>IPCC default values</td>
</tr>
<tr>
<td>Emission factor for electricity at BSRE</td>
<td>kg-CO₂/kWh</td>
<td>0.848</td>
<td>③×②×①÷1,000</td>
</tr>
</tbody>
</table>

(d) Efficiency of existing hot water generating system
Heat exchange efficiency of existing hot water generation system is extracted from a catalog.

e) Target quality of treated wastewater (common to Option-A and Option-B)
Target quality of treated water before implementation of the project continues to be applied after implementation of the project regardless of Option. At BSRE, CODcr: 50mg/L is set as target quality.

c. Calculation of GHG emissions (including reference and project emissions)
1) Establishment of reference scenario
Based on the survey conducted on natural rubber production factories in Indonesia that actually treat wastewater to meet the wastewater standard, reference scenario is set as the general wastewater treatment condition at a natural rubber production factory, whose details are defined as follows:
- Wastewater is treated to the target quality of treated wastewater (lower than wastewater standard) only by activated sludge treatment system.
- Electricity used by wastewater treatment system is supplied by in-house power generation system and the fuel is diesel oil.

2) Method of calculating reference emissions
a) Setting of options
Creating the energy consumption estimation formula is important to calculate reference emissions. The estimation formula cannot be created without operational data saved before implementation of the project. Therefore, to offer choices in calculation methods of reference emissions, two types of reference emission calculation methods (Option-A and Option-B) are discussed which can be chosen depending on the availability of energy consumption estimation formula.

b) Method of calculating reference emissions
- Option-A: Using the estimation formula shown in Figure 3.1, energy consumption of activated sludge treatment system is estimated from CODcr removal load necessary in the wastewater treatment system, which is then multiplied by the emission factor.
- Option-B: Energy reduction corresponding to the actual wastewater flow status (treated water quantity, CODcr dissolved or nitrified amount necessary) is subtracted from the designed energy consumption to estimate energy consumption, which is then multiplied by emission factor.
The following shows the outline of Option-A, which results in larger emission reductions.

### Option-A reference emission calculation formula

\[
RE_y = RE_{treatment,y} = \Sigma\{ (\frac{L_{COD,r}}{K_{COD,r}}) \times CF_{electricity} \}
\]

\[
L_{COD,r} = Q_m \times (C_{COD,m,in} - C_{COD,m,st}) \div 1,000,000
\]

- \( RE_y \): Reference emissions in year \( y \) (tCO\(_2\)e)
- \( RE_{treatment,y} \): GHG emissions from activated sludge facility in year \( y \)
- \( \mu, K \): Energy consumption estimation factor (\( \mu=227, K=42 \))
- \( L_{COD,r} \): Actual COD\(_{cr}\) removal load (t-COD\(_{cr}\)/year)
- \( CF_{electricity} \): Emission factor for electricity (0.848kg-CO\(_2\)/kWh)
- \( Q_m \): Actual value of treated wastewater (m\(^3\)/moth)
- \( C_{COD,m,in} \): Actual value of wastewater’s COD\(_{cr}\) (mg/L)
- \( C_{COD,m,st} \): Target quality of treated wastewater-COD\(_{cr}\) (50mg/L)

### Method of calculating project emissions

2) **Method of calculating project emissions**

The project scenario is the case where anaerobic treatment is implemented as pretreatment in the activated sludge treatment system and methane gas is collected and used as energy (electricity and heat). The project emissions are GHG released when the wastewater is treated to the target quality by both anaerobic treatment system and activated sludge treatment system.

Project emissions are calculated by multiplying the actual fossil fuel originated energy consumption and emission factor. The actual fossil fuel originated energy consumption is calculated by subtracting fossil fuel originated energy consumption that is to be replaced by electricity and thermal energy generated from methane gas which is supplied to outside wastewater treatment system from fossil fuel originated energy consumed at wastewater treatment systems (anaerobic treatment, activated sludge process).

### Project emission calculation formula

\[
PE_y = \left( E_{treatment,y} - E_{generator,y} \right) \times CF_{electricity} \div 1,000 - E_{thermal,y} \div (\eta_{thermal} / 100) \times CF_{Diesel}
\]

- \( PE_y \): Emissions from the project activity in year \( y \). (tCO\(_2\)e)
- \( E_{treatment,y} \): Energy consumption at anaerobic treatment and activated sludge process systems in year \( y \). (kWh/year)
- \( E_{generator,y} \): Fossil fuel originated energy consumption that is to be replaced by electricity generated from methane gas which is supplied to outside wastewater treatment systems in year \( y \). (kWh/year)
- \( E_{thermal,y} \): Thermal energy supplied by cogeneration system in year \( y \). (TJ/year)
- \( \eta_{thermal} \): Efficiency of existing hot water generating system
- \( CF_{electricity} \): Emission factor for electricity (0.848kg-CO\(_2\)/kWh)
- \( CF_{Diesel} \): Emission factor for diesel oil (74.1t-CO\(_2\)/TJ)

### Calculation of GHG emissions (reference emissions, project emissions)

a) **Reference emissions**

As shown in the attached document, reference emission is 1,436t-CO\(_2\)/year. Overall electricity consumption
in 2012 was 1,996,160 kWh/year. Since this methodology uses energy consumption estimation formula which evaluates reference emissions conservatively, the calculation result is estimated to be about 15% lower than the actual electricity consumption.

b) Project emissions
Project emissions are 595t-CO$_2$/year. With implementation of anaerobic treatment, electricity consumption required for wastewater treatment will be 1,632,114 kWh/year, only 5% reduction compared to the reference scenario. By generating power from methane gas, fossil fuel originated power consumption becomes 1,076,635 kWh/year, 36% reduction from the reference emissions.

c) GHG emissions
Based on the calculation results of GHG emissions, the GHG reduction of this project is calculated to be 842t-CO$_2$/year.

(2) Development of JCM Project Design Document (PDD)

a. Necessity of environmental impact assessment
Any projects that have potential to affect the environment significantly are required to conduct environmental impact assessment as defined in Article 16 of the former Environment Management Act. Types and scale of project to be subjected are defined in the “Decree of the State Ministry for the Environment on Types of Businesses and/or Activity Plants that are required to be completed with the Environmental Impact Assessment (No. 17 of 2001)”.

This project, however, is to add anaerobic treatment system to the existing wastewater treatment system in the factory, and is not considered to be the subject of environmental impact assessment. Therefore, the necessity of conducting environmental impact assessment is low.

The biogas power generation plant planned to be installed in the facility may be considered as the subject of environmental assessment if the capacity of the plant is more than 10MW. The capacity of power plant of this project is less than 0.1MW, and therefore this project does not need to conduct environmental impact assessment. It is necessary, however, to carry out the project considering environmental integrity.

b. Comments from stakeholders
The stakeholders for this project are residents in the neighboring areas and governmental agencies concerned. Since the factory is located in the premises of BSRE and employees also live in the premises, residents in the neighboring areas are employees of the factory and their families.

Residents were asked to provide their comments about the project through questionnaire. The result showed some concern about safety, but the majority was in favor of the project and had high expectation for Japan’s technology.

In addition, interview meeting was held with the local government. The head of the region asked about the contribution and safety of the project, to which we explained about the effect of diesel oil reduction and that there should be no problem with safety in local community. After hearing the explanation, the head of the region said that she would welcome this project and contact other government agencies concerned, and cooperate in effective usage of sludge.
c. Monitoring plan
As for monitoring, currently, production, emissions, energy consumptions and so on are measured and recorded at BSRE at high frequency. Water quality is analyzed at a laboratory within BSRE by experts. As for equipment, they are calibrated according to the Measurement Act of Indonesia. Therefore, in terms of monitoring system, current staff members at BSRE are capable of performing monitoring accurately. Once the project is implemented, temperature and flow of hot water need to be measured (figure 3.2), and measurement methods as well as precision control need to be determined.

As for calculating and reporting GHG emission reductions based on the methodology by using various measurement results, staff members of BSRE, a consortium member, are capable of doing so. If necessary, company in charge of this study and developer of the methodology will support the creation of the report.

As for verification, it will be entrusted to a third party institution which will be determined after discussing with GEC. For operation, management and maintenance of anaerobic treatment systems, Kurita Water Industries, Ltd., a study partner, will carry out in accordance with operational management/maintenance contract.

Figure 3.2 Monitoring points and items relevant to the project

(3) Project development and implementation
a. Project planning
1) Securing profitability and financing plan
The improvement plan of equipment in this project is shown in the figure below (facilities indicated in red in Figure 3.3).
Figure 3.3  Outline of facilities to be improved in this project

A settling tank and anaerobic reactor will be installed before the existing activated sludge treatment system. A gas folder and biogas co-generation system will also be installed to treat/utilize methane gas generated.

The results of estimated construction cost of facilities and equipment are shown below. The construction cost includes the cost of carriers and pumps used in anaerobic treatment, as well as the cost of procurement and transportation of machinery such as mixer from overseas. Detailed design, engineering works and overhead costs that are expected in the future are also added to obtain the construction cost.

The amount of reduction in maintenance and management cost is calculated by taking into account the annual reduction of diesel oil cost as a result of lower energy usage of the project and the chemical cost of anaerobic treatment to be implemented. In this study, two cases are considered: waste heat generated is utilized in one case, and waste heat is not utilized in another case. The results show that payback periods calculated from estimated construction cost and annual maintenance and management reduction amount are expected to be 6.2 years for the case where waste heat is not utilized, and about 4.9 years for the other case where waste heat is utilized (on the premise that 50% of equipment subsidy is provided as JCM project).

Although the project partners who constitute the consortium will raise funds, basically it is being judged that procurement from personal funds is possible.

<table>
<thead>
<tr>
<th>Description</th>
<th>Without utilization of waste heat generated (US$)</th>
<th>With utilization of waste heat generated (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Tower tanks, mechanical devices, carriers (incl. transportation cost)</td>
<td>1,900,000</td>
<td>2,230,000</td>
</tr>
<tr>
<td>2 Detailed design, engineering works, overhead costs</td>
<td>1,100,000</td>
<td>1,100,000</td>
</tr>
<tr>
<td>Total</td>
<td>3,000,000</td>
<td>3,330,000</td>
</tr>
<tr>
<td>Share of expenses (50% equipment subsidy)</td>
<td>1,500,000</td>
<td>1,665,000</td>
</tr>
<tr>
<td>Annual maintenance and management cost reduction</td>
<td>242,700</td>
<td>342,600</td>
</tr>
<tr>
<td>Payback periods in years</td>
<td>6.2</td>
<td>4.9</td>
</tr>
</tbody>
</table>
2) Project implementation schedule

Details of the facility scale are determined based on the result of the methane gas continuous test (on-site) which is performed in parallel with this study. Facility specifications are organized based on the amount of gas generated which is calculated from the results of the continuous test, and the facility planning is determined to satisfy the conditions of payback periods after calculating the profitability and payback periods of the project.

The methane gas continuous test is to be completed in March. In April, application to subsidized project will be made and upon approval, detailed design of wastewater treatment system and procurement of equipment and material will start. As for the duration of engineering works and so on, the period of detailed design and construction will take about one year after the contract of subsidized project is made and the project will start in August 2015, depending on the results of gas generation experiment and the detailed design.

The project shall be completed by 2020, the deadline to report the results of MRV of this project.

b. MRV structure

The operator of this project is an international consortium in which Bridgestone Corporation and local subsidy of Bridgestone (BSRE) are associates. Kurita Water Industries and Nihon Suido Consultants are study partners and provide support as needed.

The consortium, in accordance with Joint Crediting Mechanism, will submit a proposed methodology and obtain approval from the joint committee. Upon obtaining approval, the consortium shall create PDD, apply for registration of this project, receive verification on validity from a third party entity and obtain approval from the joint committee. As for implementation of facilities, application for subsidy will be made to Japan’s Ministry of Environment to obtain subsidy for facilities.

BSRE will carry out operational management, monitoring and calculation of GHG emission reductions of the wastewater treatment facilities implemented, and a third party institution will carry out MRV verification. The results of MRV verification will be reported from the consortium to the Ministry of Environment and Indonesian government as a MRV implementation report every year.

c. Permission and authorization for the project implementation

The installation work in this project is simply to change (improve) the wastewater treatment system and power generator in the factory. Permit to use other site is unnecessary. As for construction work, since environment-related facilities are not the subject of approval and only required to report after improvements are made, no application for approval is necessary.

In terms of exporting equipment from Japan, machines (pumps and mixer) and carriers of anaerobic treatment are likely to be exported from Japan, while the frame of the facility is likely to be procured in Indonesia. These export items are typical machinery and are shipped to the site after finishing normal customs procedures.

d. Japan’s contribution

This project is aimed at reducing energy consumption at rubber production lines in which activated sludge process is adopted as wastewater treatment by implementing anaerobic treatment before existing activated sludge treatment systems to collect methane gas. As a treatment method implemented before the activated
sludge process other than anaerobic treatment, there is also physiochemical treatment (sedimentation treatment and anaerobic lagoon) which is commonly implemented in Indonesia.

Therefore, GHG emissions and costs of possible competitive technologies, i.e., sedimentation treatment and anaerobic lagoon are compared. The results show that Biosaver TK has larger GHG emission reduction than the other two and has almost the same treatment cost with other two (three technologies have no big difference but by applying JCM subsidy, Biosaver TK’s treatment cost per year is estimated to be about the same as that of anaerobic lagoon), showing that Biosaver TK is superior to the other two.

Biosaver TK, however, requires advanced machineries and facilities such as carrier type anaerobic treatment facility or cogeneration system, which are relatively high in initial cost, and a system such as JCM subsidy to reduce the burden of initial cost is necessary to promote implementation of Biosaver TK.

e. Environmental integrity

The environmental impact expected by the implementation of this technology is summarized below. As for water pollution, since wastewater treatment technology itself serves as a protection for pollution in public water area and target water quality of treated water is the same before and after the implementation of the project, it is considered that environmental integrity is satisfied.

Methane gas collected by anaerobic treatment may contain hydrogen sulfide, and sulfide may be released to the air when methane gas is combusted. By installing desulfurizing equipment and preventing methane gas leakage, environmental integrity can be maintained.

As for a countermeasure to noise from blower for aeration or from a power generator, selecting low noise equipment and installing such equipment inside the building will secure environmental integrity.

<table>
<thead>
<tr>
<th>Environmental items</th>
<th>Expected effects on environment</th>
<th>Measures to secure environmental integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pollution</td>
<td>Water pollution in public water area caused by wastewater</td>
<td>Since the project is to install anaerobic treatment system before the existing activated sludge treatment system and expects to operate the system with the same target water quality of the treated water as before, no problem will arise in terms of water pollution.</td>
</tr>
<tr>
<td>Air pollution</td>
<td>Air pollution caused by combustion of methane gas</td>
<td>Desulfurizing equipment will be installed to remove hydrogen sulfide in methane gas.</td>
</tr>
<tr>
<td>Noise/vibration</td>
<td>Noise from power generator, etc.</td>
<td>Low noise type power generator will be used and it will be installed inside the building.</td>
</tr>
</tbody>
</table>

f. Sustainable development in host country

1) Contributions to economic development

According to the Master Plan for the Acceleration and Expansion of Indonesia’s Economic Development (2011-2025), natural rubber industry is included under the agriculture and industrial programs among 8 primary programs. Natural rubber industry is also one of 22 main economic activities with expectation of
future expansion in economic activities. Since production of natural rubber of Indonesia accounts for about 30% of production in the world and natural rubber is the primary export item of Indonesia, providing support to save energy and proposing environmental countermeasures in natural rubber production lines are expected to contribute to Indonesia’s economic development.

2) Contributions to local industrial activities

In the Master Plan, 6 economic corridors are defined as the focus of growth, among which Sumatra economic corridor will focus on and promote development of natural rubber production as primary industry of the region. BSRE, this project’s target, is located in the center of this economic corridor in Medan, and is a primary company in the region with large number of employees. Introducing Japan’s technology to the company will contribute significantly to the economic activities of the region.

Increase in inflation rate in Indonesia, on the other hand, is a major concern for exporting companies, and implementing a project with short payback period like this one is expected to support the corporate management. Furthermore, implementation of energy-saving technology promotes stable provision of electricity in regions that lack electricity.

3) Contributions to environmental conservation activities

This project is to promote treatment of organic wastewater from factories and to provide Japan’s technological support on biological treatment which is difficult to maintain and manage. This project is in line with the Indonesian government’s policies to promote implementation of wastewater treatment technology to improve water pollution in public water area and will contribute significantly to the environmental measures of Indonesia.

Realizing energy saving by adding anaerobic treatment to aerobic biological treatment process, which is a common wastewater treatment technology for organic wastewater, will contribute not only to stably provide electricity as mentioned above but also to conserve global environment through reduction of GHG.

g. Toward project realization (planned schedule and possible obstacles to be overcome)

BSRE plans to conduct methane fermentation continuous water flow test on site in parallel with this study to promote effective installation of plant equipment. The test is to obtain test results closer to the actual situation, since the sludge used as a substrate in the batch test during the study was that of beer factory. Therefore, capacity of anaerobic treatment tank and so on are to be calculated again using the test results, and review on the economy will be completed by the time the application for subsidy program is made.

In addition, since improvement plan of BSRE’s dryer is in progress, a final conclusion concerning heat utilization of waste heat generated was not obtained. Therefore, as for heat utilization of collected methane, two cases were discussed; one is where methane is used only to generate power and the other is where methane is used to generate power and its waste heat is used as heat source for dryer. The plans need to be reviewed and a use method needs to be finalized.
APPENDIX
1. GHG Calculation policy (Reference Scenario Option-B)

Although it is important to construct estimation equation regarding energy consumption in activated sludge process, it depends on the availability of monitoring data (Amount of wastewater and wastewater quality) which was accumulated past and accuracy of the data.

So, 2 sorts of calculation policies which is named Option-A and Option-B were considered to select base on possibility of the equation construction. However the calculation policy of project emissions is same whether Option-A or Option-B

The option selection flowchart is as below.

![Option selection flowchart](image)

1) Calculation process of reference emissions based on Option-B

\[ RE_y = RE_{treatment,y} = \sum \{ (E_{\text{Design}} - \Delta E) \times CF_{\text{electricity}} \} \]

- \( RE_y \): Reference emissions (tCO₂e)
- \( RE_{treatment} \): GHG emissions from activated sludge process (tCO₂e)
- \( E_{\text{Design}} \): Designed electricity consumption (kWh/month)
- \( \Delta E \): Electricity consumption reduction (kWh/month)

\[ \Delta E = \Delta E_B + \Delta E_P \]

- \( \Delta E_B \): Electricity consumption reduction regarding blowers (kWh/month)
- \( \Delta E_P \): Electricity consumption reduction regarding pumps (kWh/month)

\[ \Delta E_B = E_{B,\text{Design}} \times \frac{\Delta AOR}{AOR_{\text{total,Design}}} \times \frac{\eta_{\text{Design}}}{\eta_{\text{BSRE}}} \]

- \( E_{B,\text{Design}} \): Designed electricity consumption regarding blowers (kWh/month)
- \( AOR_{\text{total,Design}} \): Designed total oxygen demand (t-O₂/month)
ΔAOR : Oxygen demand reduction (t-O₂/month)

η_{Design} : Designed oxygen dissolved ratio (%)

η_{BSRE} : Standard oxygen dissolved ratio (15%)

※ if \( \eta_{Design} > \eta_{BSRE} \), \( \frac{\eta_{Design}}{\eta_{BSRE}} = 1 \)

\[ \Delta AOR = \Delta AOR_{COD} + \Delta AOR_{NH₄-N} \]

\( \Delta AOR_{COD} \) : Oxygen demand reduction regarding BOD degradation (t-O₂/month)

\( \Delta AOR_{NH₄-N} \) : Oxygen demand reduction regarding nitrification (t-O₂/month)

\[ \Delta AOR_{COD} = \{ Q_{Design} \times ( C_{BOD,in,Design} - C_{BOD,out,Design} ) \]
\[ - Q_m \times ( C_{BOD,in,m} - C_{BOD,out,st} ) \} \times A \]

\[ \Delta AOR_{NH₄-N} = \{ Q_{Design} \times ( C_{NH₄,in,Design} - C_{NH₄,out,Design} ) \]
\[ - Q_m \times ( C_{NH₄,in,m} - C_{NH₄,out,st} ) \} \times C \]

\( Q_{Design} \) : Designed amount of wastewater (m³/month)

\( C_{BOD,in,Design} \) : Designed wastewater’s BOD (mg/L)

\( C_{BOD,out,Design} \) : Designed treated water’s BOD (mg/L)

\( Q_m \) : Actual amount of wastewater (m³/month)

\( C_{BOD,in,m} \) : Actual wastewater’s BOD (mg/L)

\( C_{BOD,out,st} \) : Targeted quality of BOD (50mg/L)

\( C_{NH₄,in,Design} \) : Designed wastewater’s NH₃-N (mg/L)

\( C_{NH₄,out,Design} \) : Designed treated water’s NH₃-N (mg/L)

\( C_{NH₄,in,m} \) : Actual wastewater’s NH₃-N (mg/L)

\( C_{NH₄,out,st} \) : Targeted quality of NH₃-N (3.5mg/L)

\( A \) : Parameter of oxygen demand regarding BOD degradation (0.6-t-O₂/t-BOD)

\( C \) : Parameter of oxygen demand regarding nitrification (4.57-t-O₂/t-N)

\[ \Delta E_P = \sum ( E_{P,Design} \times ( Q_{Design} - Q_m ) / Q_{Design} ) \]

\( E_{P,Design} \) : Designed electricity consumption regarding pumps (kWh/month)

\( Q_{Design} \) : Designed amount of wastewater (m³/month)

\( Q_m \) : Actual amount of wastewater (m³/month)
4) Monitoring plan

Monitoring plan in Option-B is as below.

<table>
<thead>
<tr>
<th>Type of emissions</th>
<th>Category</th>
<th>item</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference (Option-B)</td>
<td>Amount of water</td>
<td>Amount of wastewater</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td>Quality of wastewater</td>
<td>BOD, NH3-N</td>
<td>once or more in a month</td>
</tr>
<tr>
<td>Project</td>
<td>Energy consumption</td>
<td>Electricity consumption depend on fossil fuel in wastewater treatment plant</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electricity supply which is generated from captured methane to outside of wastewater treatment plant</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td>Amount of water</td>
<td>Heated water supply</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td>Temperature before and after heating</td>
<td>Continuous</td>
</tr>
</tbody>
</table>
2. Solicitation of comments from local stakeholders
The result of questionnaire to residents in the neighboring area

(1) Profile of respondent
Interview survey was conducted individually for 19 residents in the neighboring area. 42.1% of them were in their 40’s, and all was female. As for their occupation, 68.4% were housewives, followed by nurse which accounted for 5.3%.

(2) The awareness regarding global warming
The result of the interview regarding global warming prevention is indicated in the following table. The awareness of global warming and its importance was 100%, and they are all willing to take part in the effort to prevent global warming.

<table>
<thead>
<tr>
<th>Questions</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 Have you ever heard of the word, global warming?</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Q2 Do you know the impacts of global warming?</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Q3 Do you think effort to prevent global warming is necessary?</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Q4 Would you like to participate in the effort to prevent global warming?</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

(3) The awareness regarding the impact of wastewater
The result of the interview regarding factory wastewater and environment is indicated in the following table. The awareness of impact of wastewater and the necessity of its treatment was 100% and 78.9% of them knew that BSRE treats wastewater before discharge, while only about half knew about the electricity consumption at the wastewater treatment systems and methane gas recovery technology.

<table>
<thead>
<tr>
<th>Questions</th>
<th>YES</th>
<th>NO</th>
<th>No answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5 Do you think factory wastewater has any impacts on the environment?</td>
<td>100.0%</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Q6 Do you think wastewater needs to be treated before discharge?</td>
<td>100.0%</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Q7 Did you know that BSRE treat wastewater before discharge?</td>
<td>78.9%</td>
<td>15.8%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Q8 Did you know that wastewater treatment systems in the factory need a big amount of electricity?</td>
<td>47.4%</td>
<td>47.4%</td>
<td>5.3%</td>
</tr>
</tbody>
</table>
Did you know that electricity can be produced by methane gas generated from factory’s wastewater? | 52.6% | 42.1% | 5.3%

(4) The awareness regarding this project

The result of the interview regarding this project is indicated in the following table. 73.7% think that this project will contribute to global warming prevention, while 26.3% show their concern about the environmental impact to the surrounding areas.

About 60% are in favor of implementing this project, and about 70% are in favor of using Japanese technologies. Although there were certain percentage of them are against the project or answered “I don’t know”, their reasons are mostly because they do not understand the project or its technologies well.

<table>
<thead>
<tr>
<th>Q9</th>
<th>Did you know that electricity can be produced by methane gas generated from factory’s wastewater?</th>
<th>YES</th>
<th>NO</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q10</td>
<td>Do you think this project will contribute to prevent global warming?</td>
<td>73.7%</td>
<td>10.5%</td>
<td>15.8%</td>
</tr>
<tr>
<td>Q11</td>
<td>Do you think this project will have any environmental impact to the surrounding areas?</td>
<td>26.3%</td>
<td>5.3%</td>
<td>68.4%</td>
</tr>
<tr>
<td>Q12</td>
<td>Why do you think there is environmental impact to the surrounding areas?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q13</td>
<td>Are you in favor of this project that implements power generation system which utilizes methane gas from factory wastewater?</td>
<td>57.9%</td>
<td>10.5%</td>
<td>31.6%</td>
</tr>
<tr>
<td>Q14</td>
<td>What are the reasons of your answer for the previous question? (Q13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15</td>
<td>Are you in favor of promoting acts against global warming countermeasure with Japanese technologies?</td>
<td>68.4%</td>
<td>0.0%</td>
<td>31.6%</td>
</tr>
<tr>
<td>Q16</td>
<td>What are the reasons of your answer for the previous question? (Q15)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>