Environmental Impact Assessment (Final)

Project Number: 51274-001
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THA: Bangkok Mass Rapid Transit (Yellow Line) (Part 5 of 6)

Prepared by The Mass Rapid Transit Authority of Thailand.

Chapter 6
Health Impact Assessment

6.1 The guidelines for the assessment of health impacts

Health Impact Assessment follows the guidelines of health impact assessments in the report of The environmental impact assessment of Natural Resources and Environmental Policy and Planning Office in December 2009 (3rd Edition September 2010). By combining the principles of the health impact assessment of the project from the Ministry of Health presented in. "The health impact assessment of the project" referred by the Department of Health, Ministry of Public Health for a guideline of the study and impact assessment as well. The assessment has led the consultants to assess the risks in terms of quality (Qualitative Risk Assessment) with the matrix of health risks (Health Risk Assessment Matrix) as well as the likelihood that review and analyzes the probability of the available evidence or that have been happening in the past, or the level of exposure and frequency of exposure and the severity of the impact (Severity of Consequence), which analyzes the severity of health effects that occur with construction workers or people in the community who may be affected by the project. Then prioritize the health effects by matrix (Health Risk Assessment Matrix), to lead a review of the plan and prioritize measures to prevent and reduce health impacts caused by the project.

Yellow Line Project, Lat Phrao - Samrong section integrated health impact assessment in the detailed on the environmental impact assessment report involves the procedure as follows:

6.2 The screening program

The screening program is a step to screen the project or the activities in the project that will proceed with the issue of the health threaten or the framework of the study and an assessment of the health impact. The report will analyze the environmental impact weather it is a normal project or the violence project according to the type and size of the project or activity report by the Ministry of Natural Resources and Environment which must prepare a report on the environmental impact assessment procedures and regulations. The guidelines for the preparation of the environmental impact assessment announced in the Government Gazette Volume 129 Special Part 97D, dated June 20, 2012, were eligible projects by the Ministry of No. 21 rail transit system.

Additionally, according to the Ministry of Natural Resources and Environment on the type, size, and practices for projects or activities that might cause serious impact on the community both the quality of the environment and natural resources and health. The government, state enterprise, and private sector must report to the environmental impact assessment 2010 as announced in the Government Gazette Volume 127, Special 104, dated

August 31, 2010. However, the project is not related to cause severe impacts on the community, according to the announcement.

6.2.1 The data used to screen the issue

The data used in the screen the issues resulting from the implementation of the project consists of.

(1) The project details, including the project activities both during the preparation and construction phases, such as the expropriation of land for the construction phase, such as equipment transportation, waste management and during the operation phase such air pollution and noise, the likelihood of accidents, etc.

(2) The danger that may happen from the project or the projects activities, such as noise, dust, a chance for wastewater contamination, solid waste in nearby surface water etc.

(3) The basis of the existing environment as shown in Chapter 4

(4) Data from the public participation events comments, concerns and suggestions to the project.

(5) The exposure of humans, including those who may be affected both workers and surrounding residents and those who may be at risk, such as children, seniors, pregnant women, people with chronic diseases, including heart disease, asthma and so on.

6.2.2 Factors used to screen the impact issue

factors to be used in the screening is the guideline by the Office of Natural Resources and Environmental Policy and Planning (ONEP) and the National Health Commission Office (NSO) which is consist of 9 factors as follows

(1) The changes in the condition and the use of natural resources. (focus on change that leads to health impacts, the disease outbreaks, quality of life of the people surrounding the project)

(2) The production, transportation and storage of hazardous materials.

(3) The production of waste and emissions and health hazards from the construction, manufacturing processes and other processes

(4) The exposure to environmental hazards.

(5) The changes that affect the local employment and working conditions.

(6) The change and its impact on the relationship of individuals and communities.

(7) The changes in areas that are sensitive or cultural heritage.

(8) The impact of specific or particularly acute for certain groups of people.

(9) The availability of resources and the health sector.

6.2.3 The review of data screening/project related basic information.

1) Project details

The study of the Office of Transport and Traffic Policy and Planning (OTP) decided the light yellow line mass transit, Ratchada / Lat Phrao - Phatthanakan to be a monorail system with the elevated structures along the route a total distances of 12.6 km, with 10 stations and

the mass rapid transit system dark yellow line during Phatthanakan - Samrong to be a Heavy Rail system with the elevated structures along the route. With 11 stations. Therefore, the trains work for the two systems and passengers have to change bus station at Phatthanakan station. Furthermore, the design for the stations, Depot, and train depot must have two systems since the two systems cannot be shared those facilities. As a result, the investment on the project will be double. Thus, MRTA requires a review and comparison of the MRT project for the Yellow Line. (Lat Phrao - Samrong) Section. The review and comparison the MRT subway system found that changing from the Heavy Rail system to the Monorail system are suitable for both passengers volume and capacity of the electric system that currently offered by MRT. The Performance and the cost of developing and implementing the system in the primary and the environment as a result of the operation. Despite reporting the environmental impact of the project Phatthanakan - Samrong and a new presentation, However, It is expected that the report will not last long because it is changing for the better.

Yellow Line Project, Lat Phrao - Samrong Section is a Straddle Monorail transit system which is an elevated structure along the route. The project aims to connect the travelers passengers between the MRT Blue Line at Ratchada station. (Lat phrao station of the Blue Line) with the three lines of MRT project that are the Orange Line at Lam Sali intersection, the project connects with Suvarnabhumi International Airport (Airport Rail Link) at the Rama 9 intersection and the Green Line Bearing - Samut Prakan station. The route starts at the junction with the MRT. Jubilee line Rachamongkol at the Ratchada - Lat Phrao along the Lat Phrao road the level crossing Chalong Rat Expressway to Bang Kapi intersection. After that, the route will turn right and go south on Srinagarindra Road connected to the MRT Orange Line at the Lam Sali intersection. The project route will raise over the Rama 9 junction and connect with the project connecting Suvarnabhumi Airport (Airport Rail Link) and through Phatthanakan junction, Srinuch, Sri Udom, Si Iam, Sri Udomsuk, through Si Thepha junction. From there, the route will turn right again to the west. along the Theparak road past the junction with the Green Line Bearing – Samut Prakan at Samrong station and end at Poochaosamingprai Road with a distance of about 30 kilometers, consisting of all 23 stations, Depot of the area east of the junction of the Si Iam , a Park and Ride buildings near Si Iam intersection.

2) Communities in the study area

The project area of MRT Yellow Line and adjoining areas within a radius of 500 meters, distances of about 30 kilometers in the east of Bangkok (include Chatuchak, Huay Khwang, Wang Thonglang Bang Kapi, Suan Luang, Prawet and Bang Na) and Samut Prakan (Bang Phli and Muang districts). The communities along the route will be urban district, commercial buildings, shops and the entrance of the village including hospitals and schools, such as the Suphaphong Community, market Lat Phrao-45 and Lat Phrao-46 Community, Seri Community, Romyen villaeg, Park Avenue Village, Theparak villaeg, Siripan Wittaya school, Pibul Uppatum School, Thanormpitvithaya School, Lat Phrao Hospital, and Chulavej Hospital etc.

3) The public health status

The status of public health is the information for the current health status of the people, tendency and changes in the health status of the patient, according to the report of the group causes (21 disease groups) of the Health Center in Bangkok in the year 2010 to 2012 found that diseases of the circulatory system are the disease with most patients with 1,382,346 patients, followed by respiratory diseases with 1,333,308 patients and third ranked are the nervous system diseases and metabolic depression with 916, 561 patients respectively. In the report by the group causes (21 disease groups) of the Samut Prakan in the year 2010 to 2012 showed that respiratory diseases are the disease with most patients with 1,274,204 patients, followed by diseases of the circulatory system with, 1,084,377 patients and the third ranked are the nervous system diseases and metabolic depression with 881, 852 patients respectively.

According to the reports from patients with the disease, epidemiological surveillance in the year 2012 by the Office of Strategy and Evaluation, Bangkok Metropolitan Adminis tration found that the diseases has the most number of patients in Bangkok is Diarrhea, 39,157 cases, followed by influenza patients 16,272 and third is Dengue, 10,081 cases in the report. The patients with the disease epidemiological surveillance in the year 2012 by the Office of Public Health found that that the disease has the most number of patients of Samut Prakan, is Diarrheal, 13, 917 cases, followed by fever or unknown, 2,714 cases and the third ranked are Tuberculosis with a total of 2,635 cases.

6.2.4 The screening of the factors that should be studied.

1) The conditions change and the use of natural resources

The project area is covered a large urban area. (Non-conserved areas - protected by law). The land use of most areas along the sides of the road commercial office buildings, community resources, etc. The traffic island and along the roadside with trees planting. To study and analyze the forest recourses, the survey considers trees/tree species found along the side of the road and the road median. The overall conclusions was that the trees found along the pedestrian paths along the side from the park and ride building and Depot located at East of the Si Iam junction, the most common species of trees, more than 95 percent have been planted by humans. Considering the results of the survey and count the number of trees along the route and adjoining areas have concluded that a total of 60 species (5,325 trees) from the traffic island including the 681 trees (8 species) and from the park and ride building and Depot from 73 trees (8 species). In most cases, a medium-sized tree with a diameter at a breast height (DBH) ranging from 31-94 cm, followed by small trees with a diameter at breast high (DBH) ranging from 10-30 cm, the tree is found. a notable feature more than 100 trees such as Indian Devil tree, Indian Laburnum, Burmese Ebony, and Queen's crape myrtle. Therefore, the project will contribute to the existing condition change and natural resource use is low.

The condition of the animals, due to the wildlife survey found small animals that well adapt to the changing environment. In addition, the birds, which moves faster and no large

animals thus no impact from hunting or destruction of animals in any way. The community did not take advantages of these animals.

2) The production, transportation and storage of hazardous materials.

The project does not use hazardous materials as well as storage transportation and production of hazardous chemicals.

3) The formation and release of waste and Health threaten

The project may have defecated and threats to health in the construction phase. The source discharges and threatens the health during construction and operation as phases shown in **Table 6.2 - 1.**

4) The exposure to pollution and Health threats

The pollution and health threaten will affect the health of workers who work on the project and the people surrounding the project. There are different ways for the exposure to the body, such as breathing polluted air, eating contaminated food with pollutants, the sense of touch (In terms of their impact on mental health). The health effects from exposure to pollution depending on the duration and the amount that received as well as the health of those exposed to the risks that diseases such as pregnant women, children or the elderly.

5) The impact on changes in the profession, employment and working conditions in the local areas

In the construction phase, the project will increase employment. The local trade opportunities to increase the local stall, small food stores. However, there is a potential for negative impact on the risk of accidents to the construction of both the workers and the people in the areas. The operation phase will be in the way of economic growth and expansion of the communities, such as increased residential construction, shops, and other services as well as the local employment.

6) The impact of change on the relationship between individuals and communities.

In the projects construction phase, it expects to employ many workers and migrant workers which has a different cultures to urban communities people both the food and the language. Such differences may be an important factors of misunderstanding that leads to conflict or controversy between them However, These problems can be solved by workers training and seriously disciplines for preventing of conflics among project's workers and local communities.

Table 6.2 - 1 Point sources of pollutants and threatens the health during Construction and Operation phases

Pollutants	Point Sources and Threatens to Health	
	Construction phases	Operation phases
1. Air pollutants	- To transport the equipment during the construction period will cause the dust and can affect the respiratory system	-The MRT project will not emit the pollution into the ambient air. But the impact on air quality due to pollution of vehicles running on the road network
2. Noise level	- Construction activities such as preparation of construction area, boring of foundations, and etc. may cause the noise level that will impact to the workers and communities nearby	- The noise whiles the train operation and vehicles running on the road network may cause the impact of health and well-being to communities that located nearby the route alignment.
3. Vibration	- The vibration from the machine may cause a nuisance to the neighboring community	
4. Garbage and Solid waste	- Solid waste from construction areas especially the camp site of workers which may be a carrier of diseases such as flies, mice and etc.	- The lubricant used and debris from the depot may cause the health impacts to the workers and neighboring communities.
5. Water pollutants	- Without the sanitary management, Wastewater from toilets and camp site of workers may cause the diseases	- Wastewater collected from depot requires the appropriate treatment before discharge into water resources.

7) The changes in areas that are critical and cultural heritage.

According to the review data from the register of Historic Places. Bureau of Archaeological, Fine Art Department found that the nearby project route is consist of two historic sites/historic landmarks that registered by the Fine Arts Department that are the Phlang Fai Fa fortress, located in Talad District next to the Pra Pa Dang Municipal School with the distance of the route in approximately 6.21 kilometers and Klang Worawihan Temple located in Pak Num district Muang Samut Prakan with a distance of approximately 4.75 km.

8) The effect of specific or is particularly acute for certain groups of the population.

The implementation of the project in both the construction and operation phase may severely impact for vulnerable groups such as children, pregnant women, the elderly, those with underlying diseases, etc. Such effects include risks from operating activities program. The risk of the spread of epidemics workers from the residence or building assemblies if no sanitary may adversely affect the health.

9) The availability of resources and the health sector.

According to the information on health professionals who regularly work at the nursing homes and centers, public health under the government and private sector along the route projects and adjoining areas within a radius of 500 meters found that There are two health personnel affiliated with government agencies with a total of 23 personnel classified as

four medical personnel 17 nurses and two social workers and Personnel Public Health / Hospital / Ministry of Health, one of the North Samrong health centers over a total of seven people that are classified as a medical staff and six other health workers.

The health personnel under private entities work in seven private hospitals with a total of 2,136 staff, that can be classified as 311 medical, 43 dentists, 45 pharmacists, 995 nurses, 161 technicians, and other health workers 581 people.

6.3 The Study Scoping

According to the results from the project analyze a summary of the scope of the health impact. The health threats and classification of the affected operators are as follows:

The group is expected to be affected is divided into four main groups that are

1) The communities and people who live in the project area and under of the stations is expected to be affected by the project

2) the children, the elderly, and the pregnant women.

3) Those who work in the project construction areas/program staffs or the service stations.

4) Pedestrians/MRT passengers

For the consequences that could be a health threaten including hazards that may arise from the activities of the project. Consultants have extensive cogitated the activities during the construction and operation phase then summarized the health hazards are as follows:

(1) Construction phase

The issue is also a threat to health.

- The formation and release of waste from the workers communities, including trash and sewage that is expected to be affected the public/community and vulnerable group to the impacts such as children, the elderly, pregnant women.
- The exposure to pollution and health hazards, including noise and dust from construction, the likelihood of accidents from the projects construction and traffic routes. The group is expected to be affected that are public/community and groups such as sensitive to the impact on children of construction workers and predestines
- The changes and their impact on public relations and community due to the concerns of the community from the immigration of foreign workers. There is a potential spread of disease from community workers / sexually transmitted infection, the risk of addiction, security of life and property. The group is expected to be affected include public / community and construction workers.
- The availability of resources and the health sector. The group is expected to be affected include public / community.

(2) Operation phase

The potential issue of health threaten are.

- The pollutions from the project, including noise from the train, air quality around the station. The group is expected to be affected include neighboring communities, especially beneath the station.
- The anxiety, the security of life and property. The group is expected to be affected include neighboring communities, especially near the station.
- The availability of resources and the health sector. The group is expected to be affected include public / community.
- The risk of accidents from in - out and on – off the train station. The group is expected to be affected include those using the train.
- Accidents at work, the impact of dust, noise. The group is expected to be affected include maintenance staff.
- The impact of train noise on the worker on the station

6.4 Impact assessment or evaluation of health risks

Health Impact Assessment is the process of analyzing the severity of the impact, the extent of the impact, the duration, and frequency that will be affected. The health impact assessment process are consists of

- Gathering the basic information
- Assessment and prioritization of impact.

After evaluating the health impact, the results led to the priorities and measures to prevent and reduce the environmental impact further.

In assessing the health impacts of the project. Has classified the four related areas.

(1) The impact on the body: assess the impact of the implementation of the project activities that cause health effects in the physical dimension of the community and those who work in areas such as the impact of the construction activities of the project, causing illness and so on.

(2) The psychological impact: assessing the health effects on the psychological dimension of the nearby activities that cause stress, fear or cause annoyance, etc.

(3) The Social impact: assessing the health effects that may occur in the social dimension of the project, such as the impact on the public health system, the ability to access health services, the combinations of social, the strength of the community, etc.

(4) The impact on intelligence: impact assessment from the projects development in the areas of life and culture, a generous community Including the impact of changes in the development of the community or the enhancement of knowledge to the community.

6.4.1 Methods and tools to assess health impacts

The consultants assess the health impact by incorporating the principles-based approach according to the Office of Natural Resources and Environmental Policy and Planning in January 2010 and the use of Health Risk Matrix to identify the significance of the impact on the health of the community and health officials project.

Criteria to assess the health impact of the guidelines of ONEP, January 2010, is determined by **Table 6.4 - 1**. The assessment of the impact significant will apply Health Risk Matrix based on the probability of occurrence (Likelihood) and the severity of the impact caused by (Severity of Consequence) the activities of the project. However, those who have been affected by the project is divided into two main groups, the general public, and workers in the construction project. This is a different manner of exposure size and susceptibility to being affected. Therefore, the basic level of exposure to the risk or consequences and the severity of the impact of the public and the workers are so different. The nature of the health threat is different in each factor criteria to assess the health risk is categorized as follows.

(1) The assessment of concentrations of exposure to air pollution, noise, vibration and wastewater of the general public will use the criteria and guidelines for the assessment in **Table 6.4 - 2.** For the assessment of the level of pollutant exposure on projects staffs, as shown in **Table 6.4 - 3.**

(2) The frequency of the exposure of the public and workers as shown in **Table 6.4 - 4.**

(3) The basis of preparation of the risk of impact or exposure, as shown in **Table 6.4 - 5,** will use information in accordance with (1) the concentration of exposure, and (2) frequency of exposure.

(4) The risk of the effects of access to public health services as shown in **Table 6.4 - 6.**

(5) The health effects and the level of impacts for the people as shown in **Table 6.4 - 7** to **Table 6.4 - 8** while the health effects and the level of impacts for workers as shown in **Table 6.4 - 9.**

(6) Take the risk of impact or exposure from (3) or (4) and the level of impact from (5) into the matrix of health risks (Health Risk Matrix) pollution. air, water, and vibration as shown in **Table 6.4 - 10** and the reading level of risk. The following table shows the system definition and risk as shown in **Table 6.4 - 11.**

(7) For health threats based on other factors that cannot be measured will use the criteria to assess the risk of adverse effects and the severity of the impact. as shown in **Table 6.4 – 12** to **Table 6.4 - 14** and put on the matrix of health risks table (Health Risk Matrix). For the natural resources, public health, social, economic, traffic, waste and etc. and the reading level of risk as shown in **Table 6.4 - 15** and indicate the level of sound and Definitions as shown in **Table 6.4 - 16.**

Table 6.4 - 1 The criteria of health impact assessment

Impacts	Definition
Magnitude	The potential of negative impact of health may induce the change that depends on the sensitivity of change. This change may beyond the capacity of local authorities to manage or level's impact exceed the standard value.
Boundary	How much the impact will expand (at community, region or world level) or whether it expend to important area (reserve or conserve area etc.)
Period and frequency	Length of time of the impact type of impact such as an interval or continuous occurring
Accumulation impact	Whether the occurring impact causing the original impact to increase all this in order to consider whether the accumulated impact beyond the maximum acceptable level
Risk assessment	Chance of impact occurring
Important on economic and social	The level of impact that may occur will cause to economic of community or social structure
People who get impact	Distribution of impact to various group of people especially that have different type of population and risk group such as original community children old people women pregnant etc.
Sensitive of community	People have rapid sense or how much of the awareness to the occurring of impact there is similar problem ever occur at this area in the past or not there is the establishment of the organization for the movement on this issue or not
Recovering to original condition	Must use time to reduce impact or time to recover to the original condition both human and nature that reduce for long time
Expenditure	For how much to spend to reduce the impact who pay have to use money to reduce impact immediately or not
Potential of organization	Present potential of the organization related to management to reduce impact how is it? Including lay and regulation can support or not local government can manage the impact that will occur or not
Positive impact or benefit	Project cause positive impact or not and how project support life quality or living of community or nor and how

Table 6.4 - 2 Exposure Rating of People for Air Pollution, Wastewater, Noise and Vibration

Exposure Rating	Wastewater	Noise / Vibration
1	Concentration of Air pollutants and BOD are less than 10% of standard	Noise level less than 50% of standard Peak particle velocity not exceed 0.15 mm./sec. (not exceed 0.006 inch/sec.)
2	Air pollutants and BOD are more than 10-50 of standard	Noise level is about 50-79% of standard Peak particle velocity from 0.15 - 2 mm./sec. (from 0.006 – 0.079 inch/sec.)
3	Air pollutants and BOD are more than 50-100% of standard	Noise level is about 80-100% of standard Peak particle velocity more than 2.0 mm./sec. (from 0.079 inch/sec.)
4	Air pollutants and BOD are more than 100-120% of standard	Noise level more than 100-120 % of standard Peak particle velocity about 5 mm./sec. (from 0.197 inch/sec.)
5	Air pollutants and BOD are more than 120% of standard	Noise level more than 120% of standard Peak particle velocity about 10-15 mm./sec. (0.394-0.591 inch/sec.)

Remark : Notification of National Environmental Board No. 10 , B.E 2538 (1995), Ambient air standard
Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), Surface water quality standard
Notification of Environmental Board No. 15 B.E.2540 (1997), ambient noise standard
Standard of vibration modified from Whiffin, A.C., and Leonard, D.R., 1971. A Survey of Traffic Induced Vibration, Eng

Table 6.4 - 3 Exposure Rating of Air Pollutants and Noise for Worker

Exposure Rating	Definition
1. None detect	Concentration of air pollutants / noise level in workplace don't exceed 10% TWA
2. Low	Worker's exposure rating not exceed 50% TWA
3. Moderate	Worker's exposure rating between 50 - 100%
4. High	Worker's exposure rating between 100-120 % TWA
5. Very High	Worker's exposure rating of air pollutants / noise level more than > 120 % TWA

Remark : TWA 8 hr noise level not exceed 90 Db(A)
TWA 8 hr Total dust not exceed 15 mg./m^3

Source : adapted from Air sampling instruments for evaluation of atmospheric contaminants, Beverly S.Cohen, Charles S. McCammon, Jr., Editors, 9th Edition, Kemper woods center, Cincinnati, Ohio. 2001.
Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environmental in Relation to Heat, Light and Noise B.E. 2549 (A.D.2006)

Table 6.4 - 4 Criteria for Frequency of Exposure Rating

Frequency	Exposure Rating
1 – Rarely	1 – 2 times in many years
2 – Not often	2-3 times per every year
3 – Frequent	1 – 2 times per every month
4 – Often	1 – 2 times per every week
5 –Usually	every day (continuous and discontinuous)

Table 6.4 - 5 Risk Assessments / Exposure Rating

Frequency	Concentration					Exposure Rating		
	1	2	3	4	5	Score	Definition	Level
1	1	2	3	4	5	1 - 5	None detect	(1)
2	2	4	6	8	10	6 - 8	Low	(2)
3	3	6	9	12	15	9 - 15	Moderate	(3)
4	4	8	12	16	20	16 - 20	High	(4)
5	5	10	15	20	25	21 - 25	Very High	(5)

Table 6.4 - 6 The risk of the effects of access to public health services

Volume Capacity Ratio	Future traffic condition	Access to public health services	Score
0.89-1.00(E)	very heavy traffic congestion	Very high impact	5
0.68-0.88(D)	heavy traffic congestion	High impact	4
0.53-0.67(C)	reasonable moving of traffic	Moderate impact	3
0.37-0.52(B)	good flowing of traffic	Low impact	2
0.20-0.36(A)	very high flowing of traffic	None impact	1

Source : V/C Ratio and traffic condition from Paupong. 1997

Table 6.4 - 7 Criteria of Health Impact Assessment of Air Pollutants to People

Magnitude of Impact	Definition
1	None of Health Impact
2	Low impact for people who has respiratory disease
3	There is the impact for people who has respiratory disease and group of sensitive people for air pollutants such as child and elderly person
4	There is the impact for people who has respiratory disease and group of sensitive people for air pollutants such as child and elderly person, even breath air into the normal amount as well and If inhaled in large quantities

Table 6.4 - 8 Criteria of Health Impact Assessment for Water Pollutants / Noise Level/Vibration to Community and People

Magnitude of Impact	Definition
1	● No impact to people's health and water resources ● No impact to hearing / Unable to recognize the vibrations
2	● Low impact to people's health and water resources ● Low impact to hearing / able to recognize the vibrations
3	● There is impact to water resources for consumption ● Sometime, noise level has disturbed well-being and the relaxation time / Vibration may cause the annoyed feeling.
4	● There is impact to water resources for consumption and use ● Noise level has disturbed well-being and the relaxation time / causing of the temporary loss of hearing / Vibration may cause the low impact to damaging of structure of building.
5	● There severe impact to water resources causing and may be causing of unusable of water resources ● Noise level has always disturbed well-being and the relaxation time / causing of the permanent loss of hearing / Vibration may cause the damage to the structure of building.

Table 6.4 - 9 Criteria of Health Impact Assessment for Workers

Magnitude of Impact	Definition
1	No health impacts are permanent. There is a need to maintain and the worker do not need for leave.
2	Very low health impacts, but it may have consequently symptom. Do not require medical attention. The worker does not need for leave.
3	There are serious health effects that could be cured to recover. The worker may absent or sick leave.
4	There have permanent health effects that could not be cured. The workers have to get the new treatment.
5	The worker would be death or disability or could not help themselves.

Table 6.4 - 10 Health Risk Matrix for Air Pollutants, Wastewater, Noise and Vibration

Exposure Rating	Health Effect Rating				
	Very Low 1	Low 2	Moderate 3	High 4	Very High 5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Table 6.4 - 11 Level of risks and definition

Scoring by Risk Matrix	Risk Assessment	Definition
1-3	low	Acceptable level causing no harmful to health do not increase rate of sickness no affect to budget production no environment mitigation measure
4-9	medium	Acceptable level but must have mitigation measure may have to monitoring all this consider the necessity and possibility together
10-16	high	Increase sickness rating, having wounded may affect to budget must have strict mitigation measure and monitor that the measure is enough or suitable or not, if necessary it may have to increase or improve the measure to be in consistent with the impact occur
17-25	Very high	Very high not acceptable level accelerate management of risk to acceptable level immediately if cannot avoid may need to change method of project operation.

Source : modified from Guidance to the assessment of impact to health at project level, Department of Health, Ministry of Public Health (2011)

Table 6.4 - 12 Criteria Of The Analysis Of Likelihood For Mental Health, Natural Resources, Socio-Economics, Traffic, Public health and etc.

Likelihood	Definition
Very Low (1)	Very low possibility no evidence of occurring and has measure to reduce impact
Low (2)	Low possibility having the data to show the trend to occur but no report of occurring clearly have mitigation measure
Moderate (3)	Moderate possibility ever has record of occurring 1 time in country or other countries from the same project development has mitigation measure
High (4)	High possibility ever have record of the incident more than 1 time in Thailand or other countries from the same project development have mitigation measure may not cover the incident
Very High (5)	Ever have the incident happening during the same project operation no mitigation measure or existing measure not enough

Remark : modified from Guidance to the assessment of impact to health at project level, Department of Health, Ministry of Public Health (2011)

Table 6.4 - 13 Criteria for the analysis of the severity of consequence

Health Consequence Rating	Definition
1 (Very Low)	No wounded or sickness: - No impact to working or daily task. No sickness in the community the thing causing impact - No harmful to health
2 (Low)	Wounded or little sickness cause little: - Impact to working or daily. Task the occurring impact is in limited area - Thing cause impact to sickness is little (skin irritate food poison from bacteria). Do not have to stop working. No impact to budget of local government.
3 (Moderate)	Medium wounded and sickness: - Impact to work and daily task to risk group around the community for long period. Working should be stop. - The thing causing impact can cause impact to health at strong level (such as disturbing loud noise danger from the manner of work.
4 (High)	Permanent wounded or suddenly that the worker must stop working for long time: - The things causing impact can cause strong impact to loss or death in group of labor or risk group in the community or passengers (such as acid base in the laboratory chemical or evaporative substances that can cause cancer when present in the environment for transportation project that is slope cross road and junction etc.) - Cause impact to production local budget - Cause epidemic spread to wider area
5 (Very High)	It may cause the impact with multiple of strength (group of people getting impact in wide area) that may be death and having more budget to rehabilitation: - The things causing impact is the cause of increasing impact (such as chemical toxic and cause cancer especially contamination in air soil and water such as H_2S heavy metal chemical insecticide evaporative type VOC) - Accumulated the number of risk group

Remark : modified from Guidance to the assessment of impact to health at project level, Department of Health, Ministry of Public Health (2011)

Table 6.4 - 14 Criteria of Severity of Consequence for Natural Resources, Socio-Economics, Traffic, Public Health and Etc.

Magnitude	Natural resources, Accidents, Water, Traffic, Socio-economics and waste
1	- No losses of natural resources, soil, forest, wildlife and aquatic ecology - No impact to water resources for use and consumption, traffic, socio-economics, public health, waste and occupational health and safety - No sickness in the community the thing causing impact - No harmful to mental health
2	- Little losses of natural resources, soil, forest, wildlife and aquatic ecology - Little impact to water resources, traffic, socio-economics, public health, waste and occupational health and safety - For mental health, people able to recognize changing of existing environmental condition but still accept to the impact. It may cause some stress and could disappeared in a short time. People has to adapt automatically with the adaptation will such as noise from cars passing or some activities that has not the loud noise
3	- Moderate losses of natural resources, soil, forest, wildlife and aquatic ecology - Moderate impact to water resources, traffic, socio-economics, public health, waste and occupational health and safety - For mental health, people able to recognize changing of existing environmental condition and still accept to the impact, because of mitigation measures. It would be the moderate impact on mental health/stress. The person would have reacted to such fear , anxiety, and /or feeling frustrated
4	- High losses of natural resources, soil, forest, wildlife and aquatic ecology - High impact to water resources, traffic, socio-economics, public health, waste and occupational health and safety - For mental health, people will get more stress although there are the mitigation measures. It is causes of insomnia, inability to control emotions as working time or other activities, lack of working concentration. The stress is very high levels and cannot adapt to stress in a short time. If people do not get relief, it could lead to chronic stress and various diseases later.
5	- High impact of natural resources, soil, forest, wildlife and aquatic ecology with large area - Very high impact to water resources, traffic, socio-economics, public health, waste and occupational health and safety - For mental health, very high of stress will occur. People who fail to adapt themselves, they may boredom, exhaustion control and discouraged. These symptoms of physical or disease-prone may affected their lifestyle such as nervous excitability and paranoia. The effects of stress could be occur to the people or the entire of community

Source : criteria of mental health has been modified from the criteria of stress as questionnaire by Department of Mental Health, Ministry of Public Health, http://www.dmh.go.th/test/stress/ (2011)

Table 6.4 - 15 Health Risk Matrix for Natural Resources, Socio-Economics, Traffic, Public Health, Waste and Etc.

Severity of consequence		Likelihood				
Consequence Rating	Health Harm	Very Low 1	Low 2	Moderate 3	High 4	Very High 5
1	no wounded no sickness	1	2	3	4	5
2	little wounded and sickness	2	4	6	8	10
3	wounded sickness	3	6	9	12	15
4	loss and death	4	8	12	16	20
5	large number of loss (in wide area)	5	10	15	20	25
		Level of Risk				

Source : modified from Guidance to the assessment of impact to health at project level, Department of Health, Ministry of Public Health (2011)

Table 6.4 - 16 Level of Risks and Definition

Scoring by Risk Matrix	Risk Assessment	Definition
1-3	low	Acceptable level causing no harmful to health do not increase rate of sickness no affect to budget production no environment mitigation measure
4-9	medium	Acceptable level but must have mitigation measure may have to monitoring all this consider the necessity and possibility together
10-16	high	Increase sickness rating, having wounded may affect to budget must have strict mitigation measure and monitor that the measure is enough or suitable or not, if necessary it may have to increase or improve the measure to be in consistent with the impact occur
17-25	Very high	Very high not acceptable level accelerate management of risk to acceptable level immediately if cannot avoid may need to change method of project operation.

6.4.2 The Assessment and prioritization of impact

After collected the information and studied about the project details, the operational activities of the project, including health status Health Information Systems, the current survey data, environmental data, economic - and social concerns has led to the scoping study, which can be assessed and prioritized as the following issues:

1) The negative impact on health (Physical and mental)

(1) Construction phase

- **Impact on the community / children, seniors, and pregnant women.**
  - (a) Dust from construction activity
  - (b) Noise from construction
  - (c) Accidents and illnesses resulting from the construction materials transportation.
  - (d) The spread of the disease from the entry of foreign workers, waste water from accommodation for workers, sexually transmitted infection and drug problems.
  - (e) Adequate access to health services
  - (f) The anxiety of the environmental impact, especially people who live underneath the station.
- **The impact on the project construction workers**
  - (a) Dust from construction
  - (b) Noise from construction
  - (c) The spread of infectious diseases among construction workers, sexually transmitted infection and drugs.
  - (d) The harmed or accidents at work.
- **The impact on users**
  - (a) risk of accidents

(2) Operation phase

- **The impact on the community, children, the elderly and pregnant women**
  - (a) Air pollution from cars running on the road network.
  - (b) Noise
  - (c) Waste from Depot
  - (d) Access to health services
  - (e) Security of life and property
- **The impact on maintenance workers/employees working on the station.**
  - (a) Accident from in - out and on - off the train station.

The assessment of the negative impact on health and the importance is shown in **Table 6.4 - 17**, and **Table 6.4 - 18.**

2) The impact on Health in the social dimension

The impact on health in the social dimension including the effects on the public health system, the ability to access health facilities, the impact on the coexistence of society and the strengthening of communities.

(1) Construction phase

(1.1) The impact on access to health facilities

The site preparation and construction activities, the construction materials piles will result in a trip to the health facilities that have suffered or inconvenience. However, the project construction will take about four years as the time is not very long, so the impact is expected a temporary effect. The project will provide a bypass of the bypass or the back provide easy access to the area need not be the same and may even increase in some time. Thus, it is estimated that the negative impact on access to health facilities in moderate traffic while construction activity did not affect the relationship. The combinations of the community in any way

(1.2) The impact on the community economy

The money circulates in the economy of the local will increase due to labor for the construction of the project and the workers will spend to buy consumer goods from local stores. According to preliminary estimates, it is expected to employ up to 1,000 people for a period of about four years, which is a positive impact on the economy as a whole. Thus, it can be assessed that the positive impact is low.

(2) Operation phase

(2.1) The impact on access to health facilities

The project implementation is positive to the use of health services in the project area. It will enable local people to travel to the hospital easily and quickly be delivered to patients and emergency patients to the hospital quickly and with greater ease. From the people to use mass transit more, but probably not very much. The impact assessment is positive in the medium.

Table 6.4 - 17 Assessment and priority determination of negative health impacts level during construction phase

Project Activities	Health threatening	Vulnerable groups are expected to be affected	Health Impacts	Health Risk Matrix		Impact levels	Health impact mitigation measures
				Risk impacts/ exposures	Impact severity		
A. Community impacts 1. Land levelling activities Soil reclamation, Machinery transportation/ Construction materials	Primary pollutants that threaten health during the construction phase is particulate matter from construction activities and vehicles that transport machinery/ construction materials.	- The people nearby projects area especially those who residented under the station. - People with chronic diseases such as asthma, allergies.	Physical health impacts Eyes irritating, irritating to the respiratory system. The symptoms are a result of dust into the respiratory tract. Range from mild symptoms such as coughing, sneezing, runny nose until the inflammation of the sinus, sore throat, cough with sputum or fever, difficulty breathing, chest pain, which is usually human respiratory system has a mechanism to trap dust. Menthal health impacts Exposure to dust for a long time continuously resulting in feel annoyed and frustrated etc. Menthal health impacts especially those who residented under the station. Exposure to dust for a long time continuously especially those who residented under the station, in addition, to feeling annoyed and frustrated, it can cause diseases such as allergies, chronic colds.	**Moderate (3)**: from the prediction of dust amount from the construction along the route. Found that causing dust about 0.00167 mg / m3 when combined with dust in the atmosphere will have the maximum concentration of 0.217 mg / m3, representing 65.75% of the standard. The construction of the station and the ascent – descent will cause dust and when combined with the existing condition about 0.219 mg / m3, representing 66.36% of the standard, which exposure level 3 (Table 8.4 - 2). The communities are exposed to the construction daily. Accounted for frequency level 5 (Table 8.4 - 4). When taken to the risk matrix (Table 8.4 - 5) showed at 15, accounted for a moderate level of risk.	Physical **Moderate (3)**: the impact happens to be in the restricted area, near the construction site, resulting in illness (irritation, coughing, sneezing), especially in patients with respiratory disease. Menthal **Moderate (3)**: dust occurred may cause a nuisance, some anxiety with the moderate impact severity (as the criteria in Table 8.4 - 14).	Moderate (9) Moderate (9)	- Sprain g water with in the construction site at least 3 times/day especially an open space, stripping area and temporary roads. - Opacity fencing to separate construction territory to reduce the dust impacts. - Speed limit for the vehicles transport construction materials, not exceed 40 km/hr. when passing the communities to reduce dust dispersion. - Cover the pick up of the vehicle loaded with construction materials thoroughly, with the edge of fabric or other materials extended at least 30 cm. to prevent the dust diffusion. - Clean vehicle tires before leave the construction site every time. - Concrete mixing area have to away from the communities at least 100 m. or using ready mixed concrete. - If received complaints from residents in the area or nearby, immediately determine the cause and take corrective action, inform the public of the correction results.
2. Use of various mechanical equipment especially pile foundation work, noise from vehicles running in - out the projects.	Lound noise or disturbance sound from the construction	- residents near the project area especially those living under the station	Physical health impacts Noise exceeding 85 dB (A) is a Noise Induced Hearing Loss (WHO, NIOSH) if continue more than eight hours. In addition, impact on health, such as heart beat, breathing rate change, high blood pressure, insomnia, hearing loss, tinnitus, hearing loss temporary or permanent, affect balance system. Menthal health impacts Nuisance, irritability, distracting, emotional changes, resulting in stressors, working performance decline. Menthal health impacts especially those who residented under the station. Receiveing a loud noise in a continuous period of those living under the Station, besides of causing annoyance, irritability, be distracting, also could change the emotional, causing stress.	**Very high (5)**: Calculated of construction noise level. Found that the 8 hours construction noise level is between 65-5 -91.6 dB (A). When calculating to noise level at 24 hours ranged from 60.8 to 86.6 DB (A) as 86.86% to 124% of standard noise level at 24 hours. Considering the area with noise exceeded the standard found that only 3 receptor sites have the noise level above 120% of the standard, 60 receptor sites are between 100-120% over the standard, the rest of the 48 sits complied with the standard. Considering the level of exposure (Table 8.4 to 2). It is very high (5), when combined with the frequency of daily exposure. It is at very high levels. (5 as the criteria in Table 8.4 - 4) Therefore, the risk score was 25 (based on the criteria in Table 8.4 - 5) accounted for a very high risk (5).	Physical **Moderate (3):** Because the noise is going to be a short period of time, not as continuous as long. This may affect communication need to increase the volume of talk. Menthal **Moderate (3)**: Mental impact, causing stress, frustratation in tasks that require thinking or learning, but the effects have been occasional. The severity of the impact is moderate.	High (15) High (15)	- Schedule working hours for the job that make a lound noise, will operate between 08:00 - 18:00 hrs. - Avoid activities that cause lound noise in the public recess time (after 18:00 hrs.). In case of necessity, have to do public inform at least 2 weeks. - Checking and maintainance the machinery and various engine, always in a good condition to reduce noise. - Use of construction techniques that does not cause noise impact or causing low level. By using Bored piles which are less noise than driven piles in a construction, etc. However, if can not use Bored piles, the contractor is required to determine the exact period of piling each day. And inform community leaders and residents in the area have periodically until finished. - Speed limit for the vehicles transport construction materials, not exceed 40 km/hr. when passing the communities. - If received complaints from residents in the area or nearby, immediately determine the cause and take corrective action, inform the public of the correction results.
3. Construction activities, pile driving, transportation of equipment and construction materials.	Vibrations from pile driving/ transportation on the archeological sites and communities in the construction areas.	- Two Archeological sites near by the project ie. Phang Faifa Fort and Wat Klang Worawihan	Physical and mental health impacts Construction activities may cause a vibration level to the community in the nearby area. Which affect people's feelings and strength of the archaeological sites. Depending on the type of machinery and construction activities during the operation.	**Moderate (3)**: Analysis results of the vibration level from the construction activities of the mass transit system. Found that most of the value are not more than 0.3 mm / sec. And in sensitive areas like the hospital ie. Chularat 2 Hospital, Chulavej Hospital, Lat Phrao Hospital, Fut Hul Bari mosque, Khrusapha Kindergarten, Thanormpitvithaya School, Maria Rosa Mystica Church, Peach of Bangkok Church, the vibrations level in the range of 0.305 to 2.094 mm / sec. And found that Suan Luang church has the highest vibration level of 3.152 mm / sec., So that the exposure level at 3 (Table 8.4 - 2), and people are exposed every day of the pile driving, although not continuously, which the frequency of 5 (Table 8.4 - 4) Therefore, the risk of adverse effects, it is moderate.	Physical and mental **Low (2):** Pile driving activities of the project occurs just a short time, which may recognize some vibration. The vibrations that occur without causing any damage to buildings and archeological sites.	Moderate (6)	- Routing transportation of construction equipment and materials to a minimize the community impact. - Limit the construction only at 08:00 - 18:00 hrs. - Speed limit for the vehicles transport construction materials, not exceed 40 km/hr. in the construction site. - Truck weight control by laws. - Using the construction techniques which causing niose and vibration impacts in the low level.
4. Transportation of construction equipment and materials	Accidents/ Traffic obstruction	- People who use the route and at the roadside, especially those living under the station.	Physical health impacts Harmed, injured, property loss or death from a truck transporting equipment and materials excessed the construction site and main roads.	**High (4):** Construction of the project will take Lat Phrao Road, Srinakarin Road, and Thepharak Road as the main road for supplies transportation. During the construction has to resize of traffic lanes, including Lat Phrao Road and Srinakarin Road. Decling in traffic ability.	Physical **High (4):** When an accident is likely to cause injury, death, and property loss. But in a limited area.	High (16)	- Speed limit for the vehicles transport construction materials, not exceed 40 km/hr.when pass through the communities. - Provide staff to supervise the transportation of construction materials at the entrance of the project.

Table 6.4 - 17 Assessment and priority determination of negative health impacts level during construction phase (Cont'd)

Project Activities	Health threatening	Vulnerable groups are expected to be affected	Health Impacts	Health Risk Matrix		Impact levels	Health impact mitigation measures
				Risk impacts/ exposures	Impact severity		
			Mental health impacts Construction activity on the road with severe traffic jams currently and when loses some traffic surface in the construction. This will cause more traffic jams. Resulting in stressors of travelers in increasing of travelling time.	Moderate impact because it does not reduce traffic lane. But for Thepharak Road have to reduce the number of traffic lanes. Down from three lanes / direction to two lanes / direction. Traffic impact is high (level 4) and the travelers and people along sidewalks get daily exposure (level 5 based on criteria in Table 8.4 - 4), so the risk score is 20, which high risk of impact (Table 8.4 - 5).	Mental **Moderate (3):** Traffic jams can cause stress, anxiety from increasing of traffic jams during the construction phase. But the results of the entrepreneurs and group of households, near the project area. Most thought that the project will help solve the traffic jam problem in the long term. And is a good alternative for travel, cost and time saving. So during the construction phase, the community can accept the consequences since it is a temporary impact. But there is a suggestion that should have a good and effective mitigation measures. Therefore, assessing mental health is moderate.	High (12)	- Check traffic conditions in the project area and nearby regulary. Prohibited to park a truck in front of the project area and the entrance to avoid obstructing of traffic from the transporting equipment and materials as well as the vehicle. - Coordination with authorities in the areas like the highway patrol, local police, in the case of transportation of large equipment and materials. - Installing signs and lights that meet the standard at the construction area, which can see markedly in both day and night. - Training drivers who transport the construction materials and equipment to follow traffic regulations strictly.
5. Construction workers camp sites - Garbage / wastewater - Sexually transmitted infection and drug problems.	Spreading diseases from migrant workers.	- People nearby the project	Physical health impact Deficiencies in sanitation management in construction workers' housing. May result in the breeding place of the carriers of various diseases, including rodents, flies, mosquitoes, resulting in the outbreak of diseases such as diarrhea, Dengue fever, Chikungunya fever, Flu 2009, etc. Or even an outbreak of exotic disease from workers community, such as tuberculosis, sexually transmitted infection. Including drug problems and so on. Mental health impacts Anxiety, uncomfortable, the nuisance of having a labor communities.	**Moderate (3):** Construction workers camp sites are isolated from the community areas. And has established measures to prevent and reduce the impact, however, the risk of sexually transmitted infection, caused by visiting at a nightclub. Thus, the risk of adverse effects is moderate.	Physical Moderate (3): The disease, spread by workers will affect the performance or against routine of risk group which may need to stop working, such as diarrhea, fever, however, the project already has prevention and mitigation measures. Thus causing health effects in low level and treatable. Mental Moderate (3): The workers camp sites close to communities may cause anxiety in the area. Especially in the early stages of construction. The project will provide a workers control measure and good sanitation facilities in the camp site. The impact on the community's anxiety is moderate.	Moderate (9) Moderate (9)	- The toilet adequate for construction workers with the distance not less than 50 meters away from water sources. - Supply garbage bins and place adequately and contact local authorities for waste disposal. - Monitoring and maintain dumpsters to be in good condition, not damaged or leaking and has closed lid to protect not to be a breeding ground for disease vectors. - Strict on workers sanitation to prevent the formation/spreading of germs or contagious. - Provide knowledge and advise the workers on preventing the disease. By asking for cooperation from hospitals or Health Centers in the project area within months of construction begin. - Contractors must provide sanitation welfare such as drinking water, clean water supply and adequate waste containers. - Instructed the construction workers to carry out the environmenta sanitation in the camp sites hygienically. Cooking area must be keptclean and no food waste, water logging and waste residues remainin - If received complaints from residents in the area or nearby, immediately determine the cause and take corrective action, inform the public of the correction results. - Contractors must recruit construction workers who do not have circumstances of the drug offense, not including drug users/addicts who receive treatment and rehabilitation. And the emotional of the drug users/ addicts return to normal. - Contractor must control, monitor and take care the construction workers not to execution or assemble on drug offense. - Contractors must train the construction workers to understand the prevention of drug use regularly. - Contractor shall provide a sign or warning about the dangers or penalty under the law on drugs by signs or notices which clearly - Contractor has to facilitate the authorities to investigate. Or tested for drugs in the body of a construction workers. - If the construction worker hooked, contractor must cooperate with the Narcotics Control Board official, administrative official or police to identify the drug perpetrators or provide information or circumstance of the suspect person or to believe that the drug offense in the area of the owner construction sites. - Provide knowledge to raise awareness of construction workers on safe sex. - Campaign to use condoms every time they have sex. - Contractor must provide condoms at the first aid unit. And provide media advice on how to use condoms properly, such as posters or leaflets.

Table 6.4 - 17 Assessment and priority determination of negative health impacts level during construction phase (Cont'd)

Project Activities	Health threatening	Vulnerable groups are expected to be affected	Health Impacts	Health Risk Matrix		Impact levels	Health impact mitigation measures
				Risk impacts/ exposures	Impact severity		
6. Safety of life and property	Thievery, robbed and the crimes from the migrant workers	- Residents nearby the project area	Physical health impact The harmed, injury or loss of property from the crimes. Mental health impacts Anxiety, uncomfortable, the nuisance of having a labor communities.	Moderate (3) : The construction of the project expects to employ many workers and most is migrant workers, which differences in culture with people in the communities and may be a factor of a misunderstanding that leads to conflict or controversy between the workers and local communities. There may also be problems of substance abuse, drinking and gambling which would induce or lead to other crimes committed by them, but the project has set up the camp site separated from the community areas. Including has determined strict penalties for non-compliance with labor regulations on the safety of life and property of nearby communities. Thus, the risk of adverse effects is moderate.	Physical **Moderate (3)** : When the impact on the safety of life and property happened, the severity of the event may entail harmed or injury. But the project has provided restrictive measures against the offending workers. So expect the impact will be moderate. Mental **Moderate (3):** When has the workers' camp site near by the communities, houses, causing anxiety among communities in the area, causing annoyance, anxiety, and uneasiness, mistrust towards migrant workers coming into the community. Therefore, the expected impact on the anxiety of the community is moderate.	Moderate (9) Moderate (9)	- **Contractor must control, monitor and take care the construction workers not to execution or assemble on drug offense including thievery and crime.** - Contractor shall provide signage or warnings about the danger or penalty according to the law on drugs. Including thievery and the crimes by signs or notices must be clearly visible. - Contractor has to facilitate the authorities to investigate. Or tested for drugs in the body of a construction workers. - If the construction worker hooked, contractor must cooperate with the Narcotics Control Board official, administrative official or police to identify the drug perpetrators or provide information or circumstance of the suspect person or to believe that the drug offense in the area of the owner construction sites. the area of the owner construction sites.
7. Health care providers of health centers in the area.	Adequate health care providers of ocal health centers	- Residents nearby the project area	Physical health impact In the case of migrant workers use the health services from the health centers in the project area may affect the health centers, in terms of the adequacy of health manpower, medical equipment and services. Causing overcrowding in the service using, this affects the treatment of patients. Mental health impacts Causing anxiety, nuisance, uneasiness and potential strain on the health services users, due to the number of users is increased; the waiting time will be longer.	Moderate (3) : In the construction of the project, expected to recuit a lot of workers which will impact to the health centers and hosiptals in terms of the adequacy of health manpower, medical equipment and services. Causing overcrowding in the service using, this affects the treatment of patients. The risk of impact is moderate.	**Low (2)**: The construction of the project is expected to employ many workers. This could possibly result in a delay in service providing. But it will not affect the effectiveness of treatment. Because Hospitals or health centers near the project area are standardized. Medical personnel have completed in all fields. Therefore, it is expected that the impact will be low. **Low (2)**: For the old service users could feel the increase in the number of services users than usual. The queues are longer. May feel irritated but it will not strongly affect the emotional. Therefore, the estimation of the impact is low.	Moderate (6) Moderate (6)	- Set up First Aid unit in the construction office or workers campsite. - Coordinating with hospitals along the project route, by informing the number of workers, construction period, in order to know the situation and prepare the plans or specific measures to provide services to foreign workers, such as the procedure for providing medical convenient and faster.
8. Construction activity in the overall project.	Anxiety from the environmental impacts.	- Residents nearby the project area	Physical health impact Achieve harmed, injuries, property loss from the project construction project, the potential impact on public health in the long term from the pollution caused by the construction activities of the project. Mental health impacts Have stress, insomnia caused by anxiety and annoyance.	**Moderate (3)**: Construction activities will take approximately 36 months, which will be open the construction area, leveling the area, and pile driving periodically. And has provided mitigation measures in various fields, thus the expected concern about the construction is	Physical **High (4)**: when an accident is likely to result in injury, death and property loss, but in a limited scope. Mental **Moderate (3)**: People in the study area are concerned about the impact of dust, noise and vibration, traffic problem during the construction, pollution from exhaust pipe and insecurity of life and property. This may cause a psychological impact, frustrated. But also can accept with the prevention and mitigation measures and the benefits to be derived from the project.	High (12) Moderate (9)	- Supervises contractors to comply strictly prevention and mitigation measures by appending with the contract. - Organized public relations team to meet and visit neighboring communities for monitoring damages complaints and the disturbance occurred. - Inform the people about the construction plans in advance.
B. The impact on children, the elderly and pregnant women. 1. Activities on land leveling, filling and machineries/ equipment transportation.	**The main pollutants that are threatening health in the construction period is dust from construction activities and vehicles used in transportation of construction machineries/equipment.**	Sentivity people as - children, the elderly and pregant woment	Physical health impact Eyes and respiratory system irritated from inhaling the dust. The symptoms range from mild such as coughing, sneezing, runny nose until the inflammation of the sinus, sore throat, cough with sputum or fever, difficulty breathing, chest pain etc. Usually the respiratory system of the human has a mechanism to trap the dust. Mental health impacts Exposure to dust for a long time continuously causing annoyed and frustrated.	**Moderate (3)**: The predicted amount of dust from construction along the route. Found causing the dust of 0.00167 mg/m3 when combined with dust in the atmosphere will have the highest concentration of 0.217 mg/m3, representing 65.75% of the standard. The construction of the station and ascent - descent causing dust and when combined with the atmosphere is of 0.219 mg/m3, representing 66.36% of the standard. Accounted for level three of exposure (Table 8.4 - 2), community have daily exposure during the construction, a frequency levels of 5 (Table 8.4 - 4) when put on the risk matrix (Table 8.4 - 5) showed that at level 15, representing a risk level of Moderate. representing a risk level of Moderate.	Physical **Moderate (3)**: The impact occurred in a limited area near the construction site, resulting illness (irritation, coughing, sneezing), especially in patients with respiratory disease. Mental **Moderate (3)**: Dust potentially causing a nuisance, some anxiety, the severity of the impact is expected to be Moderate.	Moderate (9) Moderate (9)	Spraying water within the construction area at least three times a day, especially in open, excavated area and temporary road. - Opacity fence to separate the construction territory to reduce the impact of dust. - - Speed limit for the vehicles transport construction materials, not exceed 40 km/hr. when passing the communities to reduce dust dispersion. - Cover the pick up of the vehicle loaded with construction materials thoroughly, with the edge of fabric or other materials extended at least 30 cm. to prevent the dust diffusion. - Clean vehicle tires before leave the construction site every time. - Concrete mixing area have to away from the communities at least 100 m. or using ready mixed concrete. - If received complaints from residents in the area or nearby, immediately determine the cause and take corrective action, inform the public of the correction results.

Table 6.4 - 17 Assessment and priority determination of negative health impacts level during construction phase (Cont'd)

Project Activities	Health threatening	Vulnerable groups are expected to be affected	Health Impacts	Health Risk Matrix		Impact levels	Health impact mitigation measures
				Risk impacts/ exposures	Impact severity		
2. The use of various mechanical equipments especially pile driving, foundations and noise from vehicles running in - out of the projects area.	Lound or annoying noise from the construction.	- Sentivity people as children, the elderly and pregant woment	Physical health impact Noise exceeding 85 dB (A) is a Noise Induced Hearing Loss (WHO, NIOSH) If heard more than eight hours. In addition, the impact on health, such as heart beat, high blood pressure, respiratory rate change, insomnia, hearing degeneration, tinnitus, hearing loss temporary or permanent, affect stability system. Mental health impacts Nuisance, irritability, distracting, emotional changes as a result of stress, working performance decline.	**Very high (5)**; calculation of the volume of construction found that the volume of the construction of 8 hours was between 65.5 -91.6 dB (A) when calculating the Leq24 ranged from 60.8 - 86.6 dB (A) as a percentage from 86.86 to 124 of Leq24 standards. Considering that the noise exceeded the standard found only three receptor sources of the noise level is higher than 120% of the standard, 60 receptor sources is between 100 - 120% above the standard, the rest of the 48 receptor sources is meet the standard. Considering the level of exposure (Table 8.4 - 2) is very high (5), when combined with the frequency of daily exposure (based on the 5 criteria in Table 8.4 - 4). The risk score is 25 (according to the criteria in Table 8.4 - 5) a potential risk is very high	Physical **Moderate (3)**: The noise is going to be a short period of time, not continuously long. This may affect the rest of children, elderly, and need to increase the volume of talk. Mental Moderate (3); Psychological impact, causing stress, frustrated in tasks that require thinking or learning, but the effects have been occasionally. The severity of the impact is Moderate.	High (15) High (15)	- Schedule working hours for the job that make a lound noise, will operate between 08:00 - 18:00 hrs. - Avoid activities that cause lound noise in the public recess time (after 18:00 hrs.). In case of necessity, have to do public inform at least 2 weeks. - Checking and maintainance the machinery and various engine, always in a good condition to reduce noise. - Use of construction techniques that does not cause noise impact or causing low level. By using Bored piles which are less noise than driven piles in a construction, etc. However, if can not use Bored piles, the contactor is required to determine the exact period of piling each day. And inform community leaders and residents in the area have periodically until finished. - Speed limit for the vehicles transport construction materials, not exceed 40 km/hr. when passing the communities. - If received complaints from residents in the area or nearby, immediately determine the cause and take corrective action, inform the public of the correction results.
3. Construction workes camp sites - Garbage / wastewater - Sexually transmitted infection and drug problems.	Spreading diseases from migrant workers.	- Sentivity people as children, the elderly and pregant woment	Physical health impact Deficiencies in sanitation management in construction workers' housing construction. May result in the breeding place of the carriers of various diseases, including rodents, flies, mosquitoes, resulting in the outbreak of diseases such as diarrhea, Dengue fever, Chikungunya fever, Flu 2009 etc. Or even an outbreak of exotic disease from workers community, such as tuberculosis, sexually transmitted infection. Including drug problems and so on. Mental halth impacts Anxiety, uncomfortable, the nuisance of having a labor communities.	**Moderate (3):** Construction workers camp sites are isolated from the community areas. And has established measures to prevent and reduce the impact, however, the risk of sexually transmitted infection, caused by visiting at a nightclub. Thus, the risk of adverse effects is moderate.	Physical **Moderate (3):** The disease, spread by workers will affect the performance or against routine of risk group which may need to stop working, learning such as diarrhea, fever, however, the project already has prevention and mitigation measures. Thus causing health effects in low level and treatable. Mental **Moderate (3)**: The workers camp sites close to communities may cause anxiety in the area. Especially in the early stages of construction. The project will provide a workers control measure and good sanitation facilities in the camp site. The impact on the community's anxiety is moderate.	Moderate (9) Moderate (9)	- The toilet adequate for construction workers with the distance not less than 50 meters away from water sources. - Supply garbage bins and place adequately and contact local authorities for waste disposal. - Monitoring and maintain dumpsters to be in good condition, not damaged or leaking and has closed lid to protect not to be a breeding ground for disease vectors. - Strict on workers sanitation to prevent the formation/spreading of germs or contagious. - Provide knowledge and advise the workers on preventing the disease. By asking for cooperation from hospitals or Health Centers in the project area within months of construction begin. - Contractors must provide sanitation welfare such as drinking water, clean water supply and adequate waste containers. - Instructed the construction workers to carry out the environmental sanitation in the camp sites hygienically. Cooking area must be kept clean and no food waste, water logging and waste residues remaining. - If received complaints from residents in the area or nearby, immediately determine the cause and take corrective action, inform the public of the correction results. - Contractors must recruit construction workers who do not have circumstances of the drug offense, not including drug users/addicts who receive treatment and rehabilitation. And the emotional of the drug users/ addicts return to normal. - Contractor must control, monitor and take care the construction workers not to execution or assemble on drug offense. - Contractors must train the construction workers to understand the prevention of drug use regularly. - Contractor shall provide a sign or warning about the dangers or penalty under the law on drugs by signs or notices which clearly visible. - Contractor has to facilitate the authorities to investigate. Or tested for drugs in the body of a construction workers. - If the construction worker hooked, contractor must cooperate with the Narcotics Control Board official, administrative official or police to identify the drug perpetrators or provide information or circumstance of the suspect person or to believe that the drug offense in the area of the owner construction sites. - Provide knowledge to raise awareness of construction workers on safe sex. - Campaign to use condoms every time they have sex. - Contractor must provide condoms at the first aid unit. And provide media advice on how to use condoms properly, such as posters or leaflets.

Table 6.4 - 17 Assessment and priority determination of negative health impacts level during construction phase (Cont'd)

Project Activities	Health threatening	Vulnerable groups are expected to be affected	Health Impacts	Health Risk Matrix		Impact levels	Health impact mitigation measures
				Risk impacts/ exposures	Impact severity		
C. Impact on construction workers 1. Activities on land leveling, filling and machineries/ equipment transportation.	Dust from the construction	- Construction workers - People with chronic diseases such as asthma, allergies.	Physical health impact Eyes and respiratory system irritating, including respiratory illness such as allergies and colds. Mental health impacts Exposure to dust for a long time continuously resulting in feel annoyed and frustrated etc.	**Moderate (3)**: from the prediction of dust amount from the construction along the route. Found that causing dust about 0.00167 mg / m3 when combined with dust in the atmosphere will have the maximum concentration of 0.217 mg / m3, representing 65.75% of the standard. The construction of the station and the ascent – descent will cause dust and when combined with the existing condition about 0.219 mg / m3, representing 66.36% of the standard, which exposure level 3 (Table 8.4 - 2). The communities are exposed to the construction daily. Accounted for frequency level 5 (Table 8.4 - 4). When taken to the risk matrix (Table 8.4 - 5) showed at 15, accounted for a moderate level of risk.	Physical **Moderate (3)**: the impact happens to be in the restricted area, near the construction site, resulting in illness (irritation, coughing, sneezing), especially in patients with respiratory disease. Menthal **Moderate (3)**: dust occurred may cause a nuisance, some anxiety with the moderate impact severity	Moderate (9) Moderate (9)	- Spraying water within the construction area at least three times a day, especially in open, excavated area and temporary road. - Provide personal protective equipment (PPE) such as dust masks and safety helmet every working time.
2. Using of various mechanical equipments.	Lound or annoying noise from the construction.	- Construction workers working with noisy equipment.	Physical health impact Noise exceeding 85 dB (A) is a Noise Induced Hearing Loss (WHO, NIOSH) if heard more than eight hours. In addition, the impact on health, such as heart beat, high blood pressure, respiratory rate change, insomnia, hearing degeneration, tinnitus, hearing loss temporary or permanent. Mental health impacts Nuisance, irritability, distracting, emotional changes as a result of stress.	**High (4)**: The forecast of construction noise level showed a pile driving activity of projects are causing the nosiest level. The construction noise level of 8 hours was in the range of 65.5 - 91.6 dB (A) a percentage from 72.89 - 101.78 of the standard that allow employees to hear through the working day (8 hours). The exposure level is high (4) (criteria in table 8.4 - 3), but the frequency of pile driving was only 1-2 times a week, which not continuing through the day (4) (criteria in Table 8.4 - 4). Therefore, the potential exposure is High (Table 8.4 - 5).	Physical Moderate (3): In worst case scenario the worker was not wearing PPE, the impact on workers' health include, likely to cause temporary hearing loss, tinnitus, but the noise level was at an average of 88 dB (A), which is the standard set at 90 dB (A) at working 8 hours a day, so the noise level was also in the standard of noise in working places, assessing the impact on Moderate. Mental **Low (2)**: Workers exposed to noise levels are also within the standard of noise level in work places and it is a familiar noise for the construction workers. So workers will be exposed to noise at work. But acceptable, it does not cause anxiety and also have PPE, so the effect is Low.	High (12) Moderate (8)	- Requiring workers to wear hearing protectors, such as ear plug all the time working in a noisy area. - Switched workers working in the areas where noise levels exceed 90 dB (A) not exceed 8 hours per day by law. - Regularly maintainance the various equipments in a good condition to reduce noise.
3. Sanitation in construction workers camp site.	- Spreading of infectious diseases among construction workers - Sexually transmitted infection and drug problems	- Construction workers	Physical health impact Lack of sanitation in the workers camp site and non hygienic habit, may cause the spread of diseases such as cholera, diarrhea, dysentery and food poisoning. It also includes a sexually transmitted infection and drug problems as well.	**Moderate (3): S**anitation within workers camp site is the measures taken by the contractor by supplying drinking water, clean water, adequate and hygienic toilets, proper waste management. Not to be a breeding sources for animals. For the risk of sexually transmitted infection and drug problems, caused by visiting at a nightclub. But with the strict measures of the project, thus, the risk of adverse effects, is Moderate.	Physical Moderate (3) : Lack of sanitation in the workers camp site and non hygienic habit, may cause the spread of diseases such as cholera, diarrhea, dysentery and food poisoning, etc. But it is treatable.	Moderate (9)	- The toilet adequate for construction workers with the distance not less than 50 meters away from water sources. - Supply garbage bins and place adequately and contact local authorities for waste disposal. - Monitoring and maintain dumpsters to be in good condition, not damaged or leaking and has closed lid to protect not to be a breeding ground for disease vectors. - Strict on workers sanitation to prevent the formation/spreading of germs or contagious. - Provide knowledge and advise the workers on preventing the disease. By asking for cooperation from hospitals or Health Centers in the project area within months of construction begin. - Contractors must provide sanitation welfare such as drinking water, clean water supply and adequate waste containers. - Instructed the construction workers to carry out the environmental sanitation in the camp sites hygienically. Cooking area must be kept clean and no food waste, water logging and waste residues remaining. - If received complaints from residents in the area or nearby, immediately determine the cause and take corrective action, inform the public of the correction results.

Table 6.4 - 17 Assessment and priority determination of negative health impacts level during construction phase (Cont'd)

Project Activities	Health threatening	Vulnerable groups are expected to be affected	Health Impacts	Health Risk Matrix		Impact levels	Health impact mitigation measures
				Risk impacts/ exposures	Impact severity		
							- Contractors must recruit construction workers who do not have circumstances of the drug offense, not including drug users/addicts who receive treatment and rehabilitation. And the emotional of the drug users/ addicts return to normal. - Contractor must control, monitor and take care the construction workers not to execution or assemble on drug offense. - Contractors must train the construction workers to understand the prevention of drug use regularly. - Contractor shall provide a sign or warning about the dangers or penalty under the law on drugs by signs or notices which clearly visible. - Contractor has to facilitate the authorities to investigate. Or tested for drugs in the body of a construction workers. - If the construction worker hooked, contractor must cooperate with the Narcotics Control Board official, administrative official or police to identify the drug perpetrators or provide information or circumstance of the suspect person or to believe that the drug offense in the area of the owner construction sites. - Provide knowledge to raise awareness of construction workers on safe sex. - Campaign to use condoms every time they have sex. - Contractor must provide condoms at the first aid unit. And provide media advice on how to use condoms properly, such as posters or leaflets.
4. Construction activity in the overall project.	Harmed or accidents on work	- Construction workers	<u>Physical health impact</u> The harmed, injuries from heavy lifting, illness from work or loss of organs from accidents <u>Mental health impact</u> The work is likely to cause nuisance, annoyance, distracting, emotional changes, resulting in stress, working performance decline.	**High (4)**: Workers must work routines, both continuous and discontinuous. When considered in case of no prevention and mitigation measures, so it is potentially in the High Risk (Table 8.4 - 12).	<u>**Physical**</u> Moderate (3): When got the accident or occupational diseases, the workers have to stop working. It may impacts on the project construction (Table 8.4 to 9). <u>**Mental**</u> **Low (2)**: Workers exposed to noise levels are also within the standard of noise level in work places and it is a familiar noise for the construction workers. So workers will be exposed to noise at work. But acceptable, it does not cause anxiety and also have PPE, besides the environmental in work places such as vibration, construction area management and have the the prevention and mitigation measures. It is acceptable does not cause anxiety or frustration or annoyance, thus the mental impacts is in the low level.	High (12) Moderate (8)	- Provide PPE such as safety helmets, safety glasses, safety gloves, ear plug, etc. with a sufficient number of workers and proper to - Contractors must comply with the law or regulations related to construction strictly, especially, the Ministerial Regulations No. 4 (2526) and Notification of the Ministry of Interior on Safety in Construction. - Contractors must abide by regulations that on the standards in the administration and management of safety, occupational health and environment in the construction work B.E. 2551 - Provide First Aid Kits in the project area. And coordinate with the hospital in case of emergency. - Preparation adequately and ready to use fire protection equipment and accidents and monitoring in regular basis. - Contractor shall provide a basic fire extinguisher within the construction office and workers camp site (By the standards of the Building Control Division), as well as train on using of the basic Fire extinguishers.

Table 6.4 - 17 Assessment and priority determination of negative health impacts level during construction phase (Cont'd)

Project Activities	Health threatening	Vulnerable groups are expected to be affected	Health Impacts	Health Risk Matrix		Impact levels	Health impact mitigation measures
				Risk impacts/ exposures	Impact severity		
							- Have the permission system to access the construction area. Including installation of banners making the general public aware that construction area is a danger zone. And do not enter without permission. - Keep the construction area clean regularly to reduce the number and chance of accidents. - Training the construction workers on proper using and maintainance of machinery equipment. - Officers and construction workers who work in noisy area with exceed 90 dB (A) for 8 consecutive hours or more must wear noise protection gear. And rotating workers who work in noisy areas every 30 days - Issue the prohibit regulations for construction workers and drivers using drugs / stimulants or alcohol while on duty as well as the penalties for violators. - Contractor shall provide life jackets to workers who work in the bridges construction across the river.
D. Impact on raod users Transportation of construction equipment and materials	Accidents/Traffic obstruction	- Road users	<u>Physical health impact</u> Harmed, injured, property loss or death from a truck transporting equipment and materials running on the main road and the elevated construction on the heavy traffic road such as Lat Phrao and Srinakarin Road. <u>Mental health impact</u> Construction activity on the road with severe traffic jams currently and when loses some traffic surface in the construction. This will cause more traffic jams. Resulting in stressors of travelers in increasing of travelling time.	**High (4):** Construction of the project will take Lat Phrao Road, Srinakarin Road, and Thepharak Road as the main road for supplies transportation. During the construction has to resize of traffic lanes, including Lat Phrao Road and Srinakarin Road. Decling in traffic ability. Moderate impact because it does not reduce traffic lane. But for Thepharak Road have to reduce the number of traffic lanes. Down from three lanes / direction to two lanes / direction. Traffic impact is high (level 4) and the travelers and people along sidewalks get daily exposure (level 5 based on criteria in Table 8.4 - 4), so the risk score is 20, which high risk of impact (Table 8.4 - 5).	<u>Physical</u> **High (4):** When an accident is likely to cause injury, death, and property loss. But in a limited area. <u>Mental</u> **Moderate (3):** Traffic jams can cause stress, anxiety from increasing of traffic jams during the construction phase. But the results of surveying public opinions most thought that the project will help solve the traffic jam problem in the long term. And it is a good alternative for travel, cost and time saving. So during the construction phase, the community can accept the consequences since it is a temporary impact. But there is a suggestin that should have a good and effective mitigation measures. Therefore, assessing mental health is moderate.	High (16) High (12)	- Speed limit for the vehicles transport construction materials, not exceed 40 km/hr.when pass through the communities. - Control the materials and equipment construction truck weight to comply with the law. So that not damages the road. - Training the truck driver to follow the traffic regulation strictly to provent the occuring of accidents. If road damages must take immediately repair the good condition. - - When laying the large structure above the traffic road, choose a light traffic time and deviate the path from the activities site. - Installing of clear visible brinking light before the construction site at least 200 meters and in the construction area. - When the construction incidents occuring to the road users. The project must expedite the appropriate compensation. And set up the prevention measures to prevent accidents in the future.

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase.

Project Activities	Health threats	Risk groups expected to be impacted	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure.	The severity of the impact		
<u>A. impact on the community</u> 1. The Route 1.1 The exhaust pollutants from vehicles. The run on the road network.	From Air Pollution - CO - NO_2 - TSP	-People who live in the neighborhood and that the pollution to reach. Especially those who live below the station diseases such as allergic asthma.	<u>The impact on physical health</u> - Carbon monoxide gas is to reduce the ability to transport oxygen in the blood. The body oxygen deficit I was able to reunite. Of hemoglobin in the blood has flown more than 200 times by oxygen breathing as the lungs are organs of oxygen from the atmosphere and then absorbed into the bloodstream. Heart blood with oxygen throughout the body, so this gas, thus causing harm to vital organs such as the heart and brain, causing dizziness, nausea, vomiting, loss of balance caused angina stroke symptoms and loss of consciousness. - Nitrogen dioxide: both people and animals exposed to NO2 short term (average 1 hour), more than 200 ug / m3 is toxic to both humans and animals. In addition to the short-term Also affect long-term health (According to WHO) and nitrogen dioxide when faced with hydrocarbons and sunlight. It becomes ozone at ground level. And nitrate particles This is the most important of dust particles smaller than 2.5 microns (PM 2.5) affect the respiratory system, especially those with asthma and allergies WHO Air Quality Guideline 2005, thus the nitrogen dioxide, the term one year on. 40 ug / m3 and the short one hour at 200 ug / m3 (or 0.11 ppm).	**Medium (3):** The results of the assessment of air quality. The monorail (Monorail), no air pollution emission. But the impact is likely to occur due to pollution from the exhaust of vehicles passing by on the road (Lat Phrao Road, Srinakarin Road, Theparak Road), but the elevation of the project. To raise the height of the road, about 14-25 meters, depending on the project. And the structure of the elevated structure is clear. The construction on the island with a 6-8 lane lane structure will not block the exhaust emissions of those vehicles. So it is not the accumulation of air pollution in the event of a traffic jam on the Lat Phrao Road, Srinakarin Road, Thaparak Road highest concentration of air pollutants in the current measurement with the TSP-24 hour = 0.215 mg / cubic meter, PM-10 24 hour = 0.107 mg / cubic meter, PM-2.5 24 hour = 0.033 mg / cubic meter, CO-1 hour. = 4.1 ppm and NO2- 1 hr. = 0.1001 ppm with the highest concentration of air pollution measurement at Chularat Hospital 65.15 per cent, 89.16, 66.00, 13.67, 58.88 of the standard respectively by which the project will not pollute the air up over the top of these. The risk of a negative impact on public health. The risk of the current traffic conditions. The level of exposure to pollution at three	<u>Physical</u> **Medium (3)** the impact of air pollution on public health, it is caused by the accumulation of pollution from vehicles, but the current structure of the monorail. The light structure should not result in the accumulation of pollutants than the current station in the area, especially on stations in the commercial stations such as Pawana stations, Chokchai 4, Ladprao 101 station and Samrong stations which is likely to accumulate pollutants from traffic congestion. Because a commercial building 3-4 either stand next to the station However, when the project opens Expected volume of use of personal vehicles will be reduced. The streamlined than the current traffic conditions. The pollution from car exhaust will be reduced, but may have negative health effects for patients with respiratory diseases. And susceptible to pollution, such as children, the elderly, if breathing air contaminated through a lot. The health effects it is moderate. However, a measure of health surveillance in the area under the monorail station. <u>Mental</u> **Low (2)** public / community road projects recognize the changing environment of a Monorail train, but the project does not cause air	Medium (9) Medium (6)	- Provide public health surveillance measures in the subways. The density residential areas, commercial buildings, including Pawana Station, Chock Chai-4 Station Ladprao-101 station, Sumrong Station by the air quality monitoring stations in the south. - TSP 24 hours. - PM - 10 24 hours. - PM - 2.5 24 hours. - NO2 - 1 hour - CO - 1 hour Measuring five consecutive days on weekdays and weekends.2 times a year for five years, then reduced to one year each time. If the measurements exceed the standard. -Ambient Air Quality Requires urgent action to improve. -Hastily It may be to plant more trees in. -Design vertical landscaping to absorb pollution. -Provide proper ventilation system. -Measures to detect and prohibit the use of black smoke and white smoke and noisy than standard PCD.

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase (Cont'd).

Project Activities	Health threats	Risk groups expected to be impacted	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure.	The severity of the impact		
			- TSP cause irritation to the eyes. Irritating to the respiratory system. The impact on mental health Exposure to dust for a long time continuously. To feel annoyed and frustrated as a result. The impact on mental health, especially people underneath the station. Dust exposure is continued for a long time under the station. In addition to feeling annoyed and then strung can cause diseases such as allergies, chronic colds.	levels (Table 8.4 -2), the public has been exposed to every day (Table 8.4 -4 and 5), it is likely to be affected in the medium (Table 8.4. -5).	pollution therefore it is acceptable in the change of community without anxiety or nuisance. The Monorail system is a public demand. In particular, the Lat Phroa road therefore the impact of mental health is at a low level.		
1.2 Noise level	Noise	Neighboring communities along the route, particularly those living below the station, students in schools.	The impact on physical health Noise exceeding 85 dB (A) is a volume that is harmful to the hearing system (Noise Induced Hearing Loss) (WHO, NIOSH) also affect health, heartbeat, respiration rate change. High blood pressure, insomnia. Hearing loss, tinnitus, hearing loss is temporary or permanent. The impact on mental health Irritability with nuisance distracting emotional changes, and stress The impact on mental health, especially people under the station. To get such a long period as for those on the station. In addition to causing nuisance distracting Irritability with emotional changes. Resulting in stress reduction and work efficiency, can also cause hearing loss. This may be temporary or permanent.	**High (4)** Calculated on the volume, turn the volume of the project found that the train is equal to 67.70 dB (A) at a distance of 15 meters when combined with measurements of current conditions. The volume resulting from the current vehicle. Found that noise levels average 24-hour values are in the range of 56.2 to 73.9 dB (A) lower than the standard and a higher standard than that. Because the volume is higher than the current standard. However, in assessing the health impact assessment will cover the current conditions. Thus, when compared with the standard volume. It is in the range of 80.28 to 105.57 as the exposure level 4 (the criteria in Table 8.4 - 2), when combined with the frequency of daily exposure (based on the five criteria in Table 8.4 - 4) to score. the risk is equal to 20 (according to the criteria in table 8.4 - 5) for a chance to experience a high level (4)	**Physical** Low (2) Because the noise is going to be a short period of time. Not as continuous as long. And volume caused by the project. The arrival of those affected. Volume was lower than the standard. But may impact psychological stressors. Effect concentration Thinking and learning. Especially in the early stages of the operation, however. Such effects are low. The bus project As a result, the volume does not increase significantly from current engagements. **Mental** Low (2): the sound of the running of the railway project. Is equal to 67.7 dB (A) at a distance of 15 meters, which is the volume of the sound, not unlike the sound of the current conditions. The sound monorail trains that run through briefly. Not cause anxiety or irritation, so the impact on mental health. Therefore, at the low level	Medium (8) Medium (8)	- Provide for inspection of the train regularly. - Provide a channel for complaints. Identify or nuisance arising from the implementation of the project.

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase (Cont'd).

Project Activities	Health threats	Risk groups expected to be impacted.	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure	The severity of the impact		
1.3 sewage, waste, and garbage from Depot and Park & Ride buildings	The sewage/ waste/garbage	- Neighboring communities along the route and nearby communities, Depot and park and ride buildings.	<u>The impact on physical health</u> Waste from Depot can be harmful to those exposed. May cause allergic reactions or toxic to the body if not managed Good. <u>The impact on mental health</u> The stench of chemicals may cause irritation, dizziness, irritability, emotional changes, stress	**Low(2):** Depot is separate from community living.In terms of waste / hazardous waste resulting from Depot, including waste oil from maintenance. Wash Depot grease tank of used oil. Rags contaminated by the oil, and the project will be compiled into a container with the lid closed. Stored in a storage building waste before sending it to the operators licensed by the department to the treatment of hazardous waste disposal next. Thus, the risk of a negative impact on the people at the lowvel.	<u>**Physical**</u> Medium (3): When leaks of hazardous waste. Will affect your work or daily activities on vulnerable groups. May need to stop allergic reactions such as fever, despite the preventive measures. And reduce the impact already Thus causing The health effects are mild and treatable. <u>**Mental**</u> **Very low(1)** maintenance activities. The building is closed and a living area. Thus, community / public You cannot be touched by such activities. It does not cause any anxiety.	Medium (6) Low (2)	Provide staff sorting station / depot. The agency responsible for garbage collection operation. Waste collection disposal In the hazardous waste to be collected. To provide entrepreneurs with the permission of the department. As the treatment of hazardous waste disposal next. Monitoring and treatment of the garbage depot area. Station buildings in good condition are not damaged. If found to be renovated or provide new bin soon Public relations and campaign staff in Depot. Station parking garage operated sorting waste. The separate wet waste and dry waste. Before leaving the tank support The solid waste such as glass and plastic bottles. The paper should be sold separately to get old. To reduce the amount of waste that must be taken to eliminate this waste. Hazards such as batteries, batteries And rags contaminated. Etc. to gather input from the oil containers. Cover tightly kept in storage buildings waste before sending. The operator is licensed by the department. The treatment of hazardous waste disposal next. Provide wastewater treatment system for the Park & Ride building. To monitor and maintain Depot and the Park & Ride Buildings the system. Wastewater treatment plant for the And a depot Efficiency in wastewater treatment The quality of effluent After the treatment, according to the designs regularly.

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase (Cont'd).

Project Activities	Health threats	Risk groups expected to be impacted	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure	The severity of the impact		
2.Access to health services	Route and time that takes to travel to receive health services	- People in the area	Obtaining health services in a timely manner. The ability to access additional services. The benefits or positive impacts from the project.	**No impact (1):** the implementation of the project. To keep the traffic on the Lat Phrao Road, Srinakarin Road Theparak Road more streamlined than current conditions The current conditions in severe congestion. Development projects Is an important choice to make people to use public transport due to the increase in travel time savings as well as more trips to the hospital. To act quickly Can be admitted immediately. There is no risk to health facilities.	No impact (1): After opening the route to help users get the facility and more Impact on travel to receive health of people in the project area.	No negative impacts	-
3. Security of life and property	Burglary and robbery, and organized crime.	- People nearby the projects	The health effects of physical injury or damage to the property from crimes affecting mental health, anxiety, annoyance uneasy suspicion.	**Low (2)** to carry out projects. There may be a group of muggers rob passengers traveling by train, but that such an opportunity will happens less The train station is a high security. By providing security. In each of the stations including CCTV station and outside the station This will not deter the thieves.	**Physical** Medium (3) in the event of a side impact Security of life and property The severity of the event may be. the harmed or injury But the project has provided Restrictive measures against those who breach the law. So expect The impact will be more moderate. **Mental** Medium (3) in the event of a side impact. Security of life and property The severity of the event may be. This anxiety, annoyance uneasy suspicion of tickets including public area. So expect. The impact will be more moderate.	Medium (6) Medium (6)	- The train must comply with the regulations. Establish rules governing the safety of life. Body and property To maintain order Cleanliness and tidiness within the Metro system by 2004.

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase (Cont'd).

Project Activities	Health threats	Risk groups expected to be impacted	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure	The severity of the impact		
4. Operating activities in the whole project.	The anxiety of the environmental impact.	- People nearby projects	<u>The impact on physical health</u> The affected people's health in the long term. The monorail will be no air pollution emission but the impact will occur from obtaining air pollution from the exhaust of vehicles on the road. The noise level caused by a train and a vehicle on a road underneath the project area has an impact on mental health, stress, insomnia, anxiety caused by anxiety.	**Medium (3):** People often get to experience the rush of vehicles on a regular basis, although not continuous (5 according to Table 8.4 - 4), the concentration level of the effect in action there. the forecast does not exceed the standards set. As a result, the exposure or potential impact is moderate (3) (15 points according to Table 8.4 - 5).	<u>Physical</u> **Medium (3)** the impact of air pollution on health. People are caused by the accumulation of pollution from vehicles, but the current structure of the monorail. The airy structure should not result in the accumulation of pollutants than the present. <u>Mental</u> **Low (2)** Because the noise is going to be a short period of time. Not as continuous as long. Public / community can recognize. The trains run through the monorail, but not cause anxiety or annoyance.	Medium (9) Medium (6)	- Arrange an inspection of the train regularly. - Monitoring and treatment of the garbage depot and station areas. In good condition If it is not broken, damaged or leaks must be repaired. Or supply trash immediately
<u>B. The impact on children, the elderly, pregnant women.</u> 1. The exhaust pollutants from vehicles which run on the existing road network.	From Air Pollution - CO - NO_2 - TSP	- Risk groups that are less resistant to air pollution than other groups, including the elderly, children and pregnant women.	<u>The impact on physical health</u> - Carbon monoxide gas is to reduce the ability to transport oxygen in the blood. The body oxygen deficit I was able to reunite. Of hemoglobin in the blood has flown more than 200 times by oxygen breathing as the lungs are organs of oxygen from the atmosphere and then absorbed into the bloodstream. Heart blood with oxygen throughout the body, so this gas, thus causing harm to vital organs such as the heart and brain, causing dizziness, nausea, vomiting, loss of balance caused angina stroke symptoms and loss of consciousness. - Nitrogen dioxide: both people and animals exposed to NO2 short term (average 1 hour), more than 200 ug / m3 is toxic to both humans and	**Medium (3):** The results of the assessment of air quality. The monorail (Monorail), no air pollution emission. But the impact is likely to occur due to pollution from the exhaust of vehicles passing by on the road (Lat Phrao Road, Srinakarin Road, Theparak Road), but the elevation of the project. To raise the height of the road, about 14-25 meters, depending on the project. And the structure of the elevated structure is clear. The construction on the island with a 6-8 lane lane structure will not block the exhaust emissions of those vehicles. So it is not the accumulation of air pollution in the event of a traffic jam on the Lat Phrao Road, Srinakarin Road, Thaparak Road highest concentration of air pollutants in the current measurement with the TSP-24 hour = 0.215 mg / cubic meter,	<u>Physical</u> **Medium (3)** the impact of air pollution on public health, it is caused by the accumulation of pollution from vehicles, but the current structure of the monorail. The light structure should not result in the accumulation of pollutants than the current station in the area, especially on stations in the commercial stations such as Pawana stations, Chokchai 4, Ladprao 101 station and Samrong stations which is likely to accumulate pollutants from traffic congestion. Because a commercial building 3-4 either stand next to the station However, when the project opens Expected volume of use of personal vehicles will be reduced. The streamlined than the current traffic conditions. The	Medium (9)	- Provide public health surveillance measures in the subways. The density residential areas, commercial buildings, including Pawana Station, Chock Chai-4 Station Ladprao-101 station, Sumrong Station by the air quality monitoring stations in the south. - TSP 24 hours. - PM - 10 24 hours. - PM - 2.5 24 hours. - NO2 - 1 hour - CO - 1 hour Measuring five consecutive days on weekdays and weekends.2 times a year for five years, then reduced to one year each time. If the measurements exceed the standard. -Ambient Air Quality Requires urgent action to improve. -Hastily It may be to plant more trees in. -Design vertical landscaping to absorb

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase (Cont'd).

Project Activities	Health threats	Risk groups expected to be impacted	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure	The severity of the impact		
		-	animals. In addition to the short-term Also affect long-term health (According to WHO) and nitrogen dioxide when faced with hydrocarbons and sunlight. It becomes ozone at ground level. And nitrate particles This is the most important of dust particles smaller than 2.5 microns (PM 2.5) affect the respiratory system, especially those with asthma and allergies WHO Air Quality Guideline 2005, thus the nitrogen dioxide, the term one year on. 40 ug / m3 and the short one hour at 200 ug / m3 (or 0.11 ppm). - TSP cause irritation to the eyes. Irritating to the respiratory system. <u>The impact on mental health</u> Exposure to dust for a long time continuously. To feel annoyed and frustrated as a result.	PM-10 24 hour = 0.107 mg / cubic meter, PM-2.5 24 hour = 0.033 mg / cubic meter, CO-1 hour. = 4.1 ppm and NO2- 1 hr. = 0.1001 ppm with the highest concentration of air pollution measurement at Chularat Hospital 65.15 per cent, 89.16, 66.00, 13.67, 58.88 of the standard respectively by which the project will not pollute the air up over the top of these. The risk of a negative impact on public health. The risk of the current traffic conditions. The level of exposure to pollution at three levels (Table 8.4 -2), the public has been exposed to every day (Table 8.4 -4 and 5), it is likely to be affected in the medium (Table 8.4. -5)	pollution from car exhaust will be reduced, but may have negative health effects for patients with respiratory diseases. And susceptible to pollution, such as children, the elderly, if breathing air contaminated through a lot. The health effects it is moderate. However, a measure of health surveillance in the area under the monorail station. <u>Mental</u> **Low (2)** public / community road projects recognize the changing environment of a Monorail train, but the project does not cause air pollution therefore it is acceptable in the change of community without anxiety or nuisance. The Monorail system is a public demand. In particular, the Lat Phroa road therefore the impact of mental health is at a low level	Medium (6)	pollution. -Provide proper ventilation system. -Measures to detect and prohibit the use of black smoke and white smoke and noisy than standard PCD
<u>**C. The impact on project employees.**</u> 1. Operations and maintenance activities in the Metro	Accidents at work	- Employees who work on projects	<u>The impact on physical health</u> The wounded from work due to either negligence or unsafe as well, not working properly Not skilled in using such machines. <u>The impact on mental health</u> The work is likely to cause nuisance, annoyance distracting to change the mood that can cause stress	**Medium (3):** Performance of maintenance activities that must be performed regularly. It is possible to cause a risk to the health and safety at work. But measures to prevent and minimize the impact to support. So therefore, the risk is moderate (Table 8.4 - 12)	<u>**Physical**</u> **Medium (3)** : The violence will occur if there is an accident at work. The illness may cause the work to cease. <u>**Mental**</u> **Low (2)** : Maintenance work A routine maintenance staff. The project must be exposed Psychological threats include noise from the work, which caused some devices. And occasionally The maintenance activities Will not cause any anxiety. The impact is at a low level.	Medium (9) Medium (6)	- Provide personal protective equipment to employees. - Use training tool for employees who work in Depot. And operating under strict terms.

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase (Cont'd).

Project Activities	Health threats	Risk groups expected to be impacted.	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure	The severity of the impact		
2. Operation of service staff within the station.	Noise	- The staff at the service station.	<u>The impact on physical health</u> Noise exceeding 85 dB (A) is a volume that is harmful to the hearing system (Noise Induced Hearing Loss) (WHO, NIOSH) also affect health, heartbeat, respiration rate change. High blood pressure, insomnia. Hearing loss, tinnitus, hearing loss is temporary or permanent. <u>The impact on mental health</u> Irritability with nuisance distracting emotional changes, and stress	**High (4)** Calculated on the volume, turn the volume of the project found that the train is equal to 67.70 dB (A) at a distance of 15 meters when combined with measurements of current conditions. The volume resulting from the current vehicle. Found that noise levels average 24-hour values are in the range of 56.2 to 73.9 dB (A) lower than the standard and a higher standard than that. Because the volume is higher than the current standard. However, in assessing the health impact assessment will cover the current conditions. Thus, when compared with the standard volume. It is in the range of 80.28 to 105.57 as the exposure level 4 (the criteria in Table 8.4 - 2), when combined with the frequency of daily exposure (based on the five criteria in Table 8.4 - 4) to score. the risk is equal to 20 (according to the criteria in table 8.4 - 5) for a chance to experience a high level (4)	<u>Physical</u> **Low (2)**: The noise is going to be a short period of time. Not as continuous as long. And volume caused by the project. The arrival of those affected. Volume was lower than the standard. But may impact psychological stressors. Effect concentration Thinking and learning. Especially in the early stages of the operation, however. Such effects are low. The bus project As a result, the volume does not increase significantly from current engagements. <u>Mental</u> **Low (2):** the sound of the running of the railway project. Is equal to 67.7 dB (A) at a distance of 15 meters, which is the volume of the sound, not unlike the sound of the current conditions. The sound monorail trains that run through briefly. Not cause anxiety or irritation, so the impact on mental health therefore, at the low level	Medium (8) Medium (8)	- Provide for inspection of the train regularly. - Provide a channel for complaints identify or nuisance arising from the implementation of the project.
<u>D. The impact on the street users.</u> <u>1. The operation route</u>	Traffic congestion	- People who take the path along the railway route.	The project will help in saving time and expense to travel a lot. Currently, the problem of traffic congestion. The time spent on the road is long. Causing stress situation is very serious, so when opening the project will reduce the stress of urban travel.	**No impact (1):** the implementation of the project. To keep the traffic on the Lat Phrao Road, Srinakarin Road Road and Theparak Road more streamlined than current conditions The current conditions in severe congestion. Development projects Is an important choice to make people to use public transport more. Due to save more time to travel.	**No impact (1):** After opening the route, the route will facilitate the users in the use of facilities and more positive impact on the quality of urban life.	No negative impacts	

Table 6.4 - 18 Assessment and prioritize the negative health impacts during operation phase (Cont'd).

Project Activities	Health threats	Risk groups expected to be impacted.	Health Impact	The Risk of Health Impact (Health Risk Matrix).		The level of impact	Measures to minimize the impact on health
				The risk to impact / level of exposure.	The severity of the impact		
E. The impact on the train. 1. The operation route	accidents from ascent-descent or in and out the train stationsThe	- The users	The impact on physical health The injury or accidents from ascent-descent or in and out the train stations.	Low (2) : in the park to pick up - drop off the passengers, the elevated tracks between the platforms have platform screen doors. It is a glass wall along the length of the platform. At the train station docking doors will open automatically. This is the safety of passengers falling from the platform. In the escalator users must be careful when using. the escalator. In case the passengers do not want to use the escalator, they can be used in conventional stairways. Each platform will include control room stations which will be equipped with operational control stations. The well control and monitoring system. Check disorders and stations will be staffed on a 24-hour security monitoring. Assistance provide information and data to use the service. Thus, the risk is at a low level.	Physical Medium (3): The violence will occur if there is an accident caused to service users, that, can cause illness to stop work.	Medium (6)	-Posted warnings in the train station for the safety of those who use such services. - Be extra careful on the escalator railing and caught it. - Facing in the direction of the escalator. - Give special care to children, the elderly and people with disabilities. - If you do not open the escalator. Take the stairs down to the plain. - Do not let children use the escalators alone. - Do not stand in the way - out of the escalator. - Do not put the cart or baggage up - down escalator. - Set up a facility to passengers aged children. And those with disabilities to use the service. - Clean and inspect the cleanliness inside the train. Regularly - The space station as a bridge for the public. In order to cross the road without traffic through the area payment. Each station - The train must comply with the regulations. Establish rules governing the safety of life. Body and property To maintain order Cleanliness and tidiness within the Metro system by 2004.

(2.2) The impact on the well-being of the community.

The project engages the easier travel between communities including the travel between the residents with a work place, attend school or engage occasioned by various communities are expected to benefit the communities along the route of the entire project.

In summary, the benefits of support the quality of life regarding the travel and access to medical facilities in the moderate level.

6.5 The summary of Project Health Impact Assessment

The health impact assessment, to be carried out, according to the procedures and principles above, a summary of health impacts that may occur as follows.

6.5.1 Construction phase

1) The Impact on physical health

Impact on the Community

The construction activities may affect health in a physical dimension to the communities neighboring the project, which is a major risk, and directly affected. The pollutants include dust, which can cause irritation to the respiratory, noise, the risk of harming from the equipment and material transportation and the construction of the elevated structure from which the assessment found that the impact is moderate to high then need for mitigation measures.

The impact on children, the elderly, pregnant women.

The construction activity will impact particularly on those who sensitive to the effects include the elderly, children and pregnant women. This is likely to be affected by pollution and construction activities as possible. The assessment found that the impact is moderate to high. Thus, the mitigation measures are necessary. The contractor must comply with the requirements / legislation concerning the level of impact is acceptable.

Impact on construction workers

The construction workers will be affected by pollution and construction activities, as well as the community, children, the elderly and pregnant women. The evaluation found that the impact is moderate to high. Thus, the mitigation measures are needed. The contractor must comply with the requirements / legislation concerning the level of impact is acceptable.

The impact on users

The construction activity will affect the user directly. The construction project will cause the risk of an accident resulting in injury, death, property damage or death. The evaluation found that the impact of the high and need for measures to reduce the impact.

2) The Impact on physical health

In construction phase the psychological impact on all vulnerable groups including children, the elderly, pregnant women, the construction workers, the users that are feeling frustrated, bother with construction activity, emotional changes resulted in the stress of the people in communities near the project. The stress of travel from the traffic congestion is high,

however, the project has taken measures to ease the anxiety as well as promoting the participation of people, such as overseeing contractors to strictly comply with the measure, promote the project to enhance knowledge and understanding about the project, provide for measures to prevent and reduce the impact and channel complaints of nuisance. So it is expected that the measures to reduce the impact will make it possible to reduce the impact of mental health to a level acceptable.

3) The Health Impact on intelligence

construction phase, the impacts from the project development to increase the knowledge of the community found that there is no significant impact of the project directly. However, it may have a positive indirect impact. The construction, which requires workers to perform, these workers will have the opportunity to develop skills and techniques in the profession and the opportunity to learn new technology. However, the development of the skilled workers that are the minority group besides, most workers are not in the area. Thus, the development project It is related to the enhancement of knowledge in society is low.

4) The Health Impact on Community

The health impact on society will benefit in the trading in the project area. As a result, revenue and cash flow in that area. For the impact on health services in the area, it is expected that the construction site that will result in a trip to the health facilities that have suffered or inconvenience from the increased traffic. However, the project will provide a bypass to access the areas even it not be the same. It is, therefore, a negative impact in the medium while construction activity did not affect the relationship and coexistence of the community in any way due to the current state of the urban community. A group of very little social capital.

6.5.2 Operation phase

1) The Impact on physical health

The project is likely to cause negative health impact in the physical dimension of the community and vulnerable groups, including those who are elderly, pregnant women, children, those who live underneath the station, the project staff including the user, that are the air pollution, noise level, solid waste which the project has provided mitigation measures to serve strictly so, in operation, it could be assumed that the health impact on the body is less than that in the construction phase. Thus, the impact is moderate on the acceptable level.

2) The impact on mental health

The project will make a change from the original condition. However, for vulnerable groups including children, the elderly, pregnant women, employees, communities, the project may be affected by stress or a lack of concentration from the noise of the train especially those who live underneath the station. However, the impact on mental health is expected to be at acceptable levels due to the provision of appropriate measures to minimize the impact of development projects and to assist in saving the time and expense of traveling. The current traffic congestion, the time spent on the road are causing a lot of stress. So to reduce the stress of urban travel significantly, the impact on users would be a positive impact. Since the implementation of the project will make the traffic on the Lat Phrao Road, Srinagarindra Road,

and Theparak Road will more streamlined than current conditions. As the current conditions is in server congestion. Development projects Is an important choice to make for the people to use public transportation due to the saving on travel time even more.

3) The Health Impact on the intelligence

The health impact on intelligence indicates that the health impact, including the impact of changes in the development of the community or the enhancement of knowledge to the community. The generosity of the community in the implementation of such projects will not affect the hospitality of the community. For the impact on intelligence found that a school near the project route in the 500 meters radius are about 75 schools, that are Yam Sa-ad kindergartens, Rungwittaya Kindergarten, Thanormpitvithaya school, Bangkok Suksa School, Klong Kelantan School, Darul Amin School, Siri Witthaya School, Klong Katum Ratuthit School, which are located from 64-500 meters from the project. According to the calculated noise levels found that the noise level is below a certain value (up to 10 dB). Due to the noise caused by the train system is relatively low, the predicted noise level is no different from the current level. Therefore, there will be no impact on the concentration and teaching in any of the schools. Also, the travel to school will be more convenient that are beneficial to the learning of local students.

4) The Health Impact on Community

The project will promote travel between Bangkok and Samut Prakan in the convenience and the faster aspect. This project allows passengers can reach to the inner city easily and quickly and reduce traffic congestion on the Lat Phrao Road. Srinagarindra Road and Theparak Road. So that the project will enhance the quality of life in the economy - social and community infrastructure.

6.6 Measures to reduce health impacts

6.6.1 Construction phase

1) Air Quality

- Spraying within the construction area at least three times a day especially in the open areas, the excavated areas, and the temporary roads.
- Bordering the construction area with the solid fence to separate the construction area and to reduce the impact of dust.
- Require the employees to drive vehicles carrying construction materials at a speed not exceeding 40 km/h, to reduce the spread of dust.
- Required materials covered of the trucks cover entirely of materials with the seam extended by at least 30 cm to prevent the spread of dust.
- Clean the wheels and the vehicle before leaving the construction site at all times.
- The concrete mixing area must be at least 100 meters away from the community or use ready mixed concrete.

- In the case of getting complaints from residents in the area or nearby, immediately determine the cause and take immediate corrective action then amend the result to the public's knowledge.

2) Noise

- Limit the construction time to the period 08:00 to 18:00 hrs.
- Avoid the activities that cause noise in the rest time of the people (after 18:00 pm). In the event that it is necessary to let the community know at least two weeks in advance.
- Always monitoring and maintaining the condition of the machinery, the engine in a good condition, to reduce the noise.
- Use of construction techniques that not cause the side effects of the sound or causing only low noise level by using drill pillars which are less noise than a needle in a pile of construction, etc. However, in the case of drill pillars cannot be used, the contractor is required to determine the exact time for the piling each day and inform community leaders and residents in the area have been informed in time of piling activities completed.
- Require the employees to drive vehicles carrying construction materials through the community at a speed not exceeding 40 km/h.
- In the case of getting complaints from residents in the area or nearby, immediately determine the cause and take immediate corrective action then amend the result to the public's knowledge.

3) Vibration

- Determine the route for equipment and materials transportation to minimized the impact to the community.
- Limit the construction time during 8:00 to 18:00 hrs. only.
- Limit a speed of vehicles that used in materials transport, not to exceed 40 km/h in the construction area.
- Control the trucks weight to comply with the law.
- Use of construction techniques that cause the effects of noise and vibration levels low.

4) Transportation

- Limit a speed of vehicles that used in materials transport, not to exceed 40 km/h while driving through the community
- Control the construction material truck weight according to the law to prevent the damage of the road.
- Provide the staff to supervise the transportation of construction materials at the construction site entrance in - out of the project.
- Check the traffic conditions in both the project area and the adjacent area including prohibited to park the trucks in the project area and in front the entrance area, to ensure the materials are transported as well as the vehicle itself, obstructing the traffic.
- Coordinate with authorities in areas like highway patrol police in the event of an over-sized material transport.

- Installing the signs and lights in the construction area that are standard and prominently in both day and night.
- Training the staff to carrying construction material follow traffic rules strictly to prevent accidents.
- In the case of the road, damage must take corrective action to repair in the good condition.
- In the case of lying the large structure over the road with the oncoming traffic, it is necessary to choose a time when traffic is light and the deviation from the route of the event.
- Provide flashing lights clearly visible before the construction of at least 200 meters and in the construction area
- In the case of the incident from the construction on the road, the project must accelerate the implementation of appropriate compensation and measures to prevent accidents in the future.

5) Occupational Health and Safety

- The contractors must comply with the law or regulations related to construction especially The Ministerial Regulations No. 4 (1983) and the Ministry of Interior for Safety in Construction
- The contractors must abide by regulations that set standards for the administration and management of safety, health and environment in the work on the construction of 2008 strictly.
- Provide personal protective equipment (PPE) such as dust masks. and helmet for every worker.
- Requiring workers to wear hearing protectors, such as ear plug all the working time in a noisy area.
- The shuffle workers working areas where noise levels exceed 90 dB (A) shall not exceed eight hours per working day by law.
- Maintenance equipments always in a good condition to reduce noise levels
- Provide sufficient toilets for construction workers with distance from water supplies of at least 50 meters.
- Supply sufficient trash cans and provide enough places for trash cans and contact local authorities for waste disposal.
- Monitoring and treatment of trash to be in a good condition, no damaged or leaking and the lid must be closed not to be a breeding ground for disease vectors.
- Strict sanitation workers to prevent the formation/spreading of germs or contagious
- Educate and advise the workers on preventing the disease by encouraging community hospitals or health facilities in the project area within the months of starting construction.
- Contractors must provide welfare services such as water, sanitation, drinking water, clean and adequate waste receptacles

- Instruct the construction worker to implement the environmental sanitation and hygienic in the accommodation for the workers. The need to maintain cleanliness in the cooking area hygienic food no water and waste residues remaining.
- In the case of getting complaints from residents in the area or nearby, immediately determine the cause and take immediate corrective action then amend the result to the public's knowledge.
- The contractors must screen the construction workers who do not have to consider the circumstances of the offender on the drugs. Does not include substance abuse/drug abuse, which has been acting treatment and rehabilitation of drug addicts. The body and mind of the addict/drug addicts to return to normal.
- The contractor must take care, monitor, and control the construction workers not to commit an offense or gathering information about the drug.
- The contractors must train workers to understand the prevention of drug use regularly.
- The contractor shall provide a sign or warn about danger or penalty under the law of drugs by signs or notices must be clearly visible.
- The contractor must facilitate the authorities examined or tested for drugs in the body of a construction worker.
- In the case of the construction worker addicted, the contractor must cooperate with the Narcotics Control Board administrative or police officer. In the report, found fault with the drug. Or provide information or conduct of a person who has reason to suspect or believe the offender is about drugs in the area of its construction sites.
- Educate the construction workers to aware of safe sex.
- Promoting condom uses every time that has sex
- The contractor must provide condoms at first aid and provide media advice on how to use condoms correctly, such as posters or leaflets.
- Provide the first aid equipment in the project area and coordinate with the hospital in case of emergency.
- Preparing and monitoring equipment, fire safety and accident adequate and always available
- The contractor should provide a fire extinguisher, primarily within the construction office and hotel workers. (By the standards of the Building Control Division), as well as providing a training tool primarily with fire.
- Provide a system to allow the construction and installation of signs to make the public aware that the area is a construction zone which is a dangerous zone and not permitted to entrance without written permission.
- Provide the cleanliness of the construction site regularly and to reduce the likelihood of accidents.
- Educate the construction worker on the cleanliness of the construction site regularly and to reduce the likelihood of accidents.

- Provide the regulations prohibit the construction workers and drivers using drugs/stimulants or alcohol while on duty as well as the penalties for violators.
- The contractor must provide life jackets to workers who work in the construction of bridges over the river.

6.6.2 Operation phase

1) Air Quality

- Provide public health surveillance measures for those who live underneath in the stations. especially the density residential areas, commercial buildings, including Phawana Station, Chok Chai 4 Station, Lat Phrao 101 Station, Samrong Station by the air quality monitoring stations in the south as follows:

  - TSP 24 hrs.
  - PM-10 24 hrs.
  - PM-2.5 24 hrs.
  - NO2- 1 hr.
  - CO - 1 hr.

Measuring five consecutive days on weekdays and weekends 2 times a year for five years thereafter reduced to one year at a time. In case, the measurements exceed the standard air quality, the urgent requirement to accelerate improvement by.

1) Install the ventilation fan right away.
2) Planting trees in the vertical garden to absorb the pollution
3) Strict measures to detect vehicles with black smoke and white smoke, including the noisy than PCD standard.

2) Noise

- Always maintenance the train in good conditions.
- Provide the channel for complaints or inform nuisance from the implementation of the project.

3) Garbage and sewage

- Provide staff sorting the garbage for the station/depot then collect for the responsible agency for waste disposal. In the hazardous waste to be collected to send to the operators licensed by the department to the treatment of hazardous waste disposal.
- Monitoring and treatment of the garbage depot near the station, parking building in good condition if defective need to be repaired or supply trash immediately
- Public relations and campaign for the staff in the Depot and parking garage operated by sorting solid waste into wet and dry waste. Before dumping to the tank for waste The solid waste such as paper, glass and plastic bottles should be sold separately to get old people to reduce the amount of waste requiring disposal. In addition, hazardous waste such as batteries, batteries. And rags contaminated by oil, grease, etc. to put a container with the lid closed. Stored in a storage building waste before sending it to the operators licensed by the department to the treatment of hazardous waste disposal next.

- Provide the staff for the sewage treatment system for park and ride buildings, Depot to monitor and maintain the sewage system to be effective in the treatment of wastewater. The quality of effluent after treatment, according to the designs regularly.
- Monitoring and treatment of the garbage depot and station areas to be in good conditions If it is not or broken, damaged or leaks must be repaired or supply trash immediately

4) Occupational Health and Safety

- Provide personal protective equipment to employees.
- Use the training tool for employees who work in Depot and to work according to strict specifications.

Chapter 7
Environmental Mitigation Measures

During the implementation of MRT Yellow Line Project, Lat Phrao - Samrong Section, the project formulates the measures to prevent and mitigate the potential impacts during the construction and operation phase. Below are the authorized agencies to ensure that the Project complies with the impact prevention and mitigation measures:

1) During Construction phase, the contractor is responsible for the cost of environmental impact monitoring throughout the contract term (about 48 months). It must hire the authorized third party environmental compliance audit from the Office of Natural Resources and Environmental Policy and Planning (ONEP) to prepare EIA report. This person supervises and prepares the report on the compliance with impact prevention and mitigation measures before presenting it to ONEP once every six months (in January and July of each year). Mass Rapid Transit Authority of Thailand (MRTA) supervises the contractor's implementation and make sure that they strictly follow the impact monitoring plans in this report.

2) During Operation phase, the operator under the supervision of MRTA is suggested to continuously implement the environmental impact monitoring plan in this report. They can then monitor how severe the impacts are throughout the operation. This will not only maximize the project's benefits and efficiency and make it worth the investment, but also minimize the environmental impact and effect on the people who live along the route. Therefore, the authorized third party environmental compliance audit from Office of Natural Resources and Environmental Policy and Planning (ONEP) must be employed to supervise and prepare EIA report and environmental impact monitoring report and present the reports to ONEP once every six months (in January and July of each year).

7.1 Physical Environmental Resources

7.1.1 Topography

1) Construction and Operation Phase

The construction and operation of depot and park & ride buildings may not impact any topographic change. Therefore, the project does not need to formulate any prevention and mitigation measure.

7.1.2 Soil Resources

1) Construction phase

1.1) The construction area of elevated structures, MRT stations, depot and park & ride buildings must clearly specified. The solid fencing, at least 2 meters higher from the original ground, is temporarily built around the construction area to prevent the sediment from flowing into the public drainage channel, lowlands or surface water.

1.2) Major construction activities, such as excavating/filling the land, relocating the public utility system (such as plumbing, piping and utility pole), and excavating the land to

construct the foundation of elevated structures, MRT stations, depot and park & ride buildings, should be implemented during the dry season to avoid the soil erosion problem during the rainy season.

1.3) The construction materials should be arranged (as necessary) in the suitable setting and it should avoid the location that is prone to erosion, especially the places near the water surface. The trucks should carry the soil excavated from the construction area where the foundation of elevated guide way and MRT stations is built to fill the areas indicated by MRTA. The soil should never be piled or left in the construction area.

1.4) Once the land excavation and land filling is done in the construction area of elevated structures and MRT stations, the land must be firmly compacted until the surface is even. Then, the soil with proper nutrients for groundcover, shrubs and middle-sized trees is used to replace the previous soil and to prevent the soil erosion, especially in the rainy season.

1.5) The construction area of depot and park & ride buildings or the bare and open area used for material storage must be covered with gravels, crushed stones, canvas or groundcover.

1.6) In the south of depot construction area, the temporary sedimentation tank, with over 5,100-cubic meter capacity, and the temporary gutter are made to prevent the sediments that come with the water or rain from flowing into the surface water, public drainage channel or lowlands.

2) Operation phase

Once completed, the construction of elevated guide way, MRT stations, depot and park & ride buildings will not pose any impact, especially soil erosion. That is because most space beneath the elevated guide way, MRT stations, depot and park & ride buildings grows groundcover, shrubs and trees, builds the concrete floor or fencing, or plants a row of trees as a fence. Therefore, there is no recommendation on prevention and mitigation measures.

7.1.3 Geology and Earthquake

Construction and operation of depot and park & ride buildings, especially during the construction activities, may affect the geology/geological foundation at medium level. This requires the following prevention and mitigation measures:

1) Construction phase

1.1) The steel sheet pile must be installed around the construction area and deep in the medium soft clay layer (about 18 meters deep from the original ground). Then, a trench must be dug outside the line of steel sheet pile in the soft ground to reduce the earth pressure. In the construction area near the surface water, double steel sheet pile must be installed to prevent the soil erosion or movement of soft ground. Below are the implementation details and process:

Soil protection system, which must be stable, uses the steel sheet pile to prevent the water pressure, earth pressure and other pressure, which causes the building movement. This structure helps protect the soil during the construction by installing the steel sheet pile along the baseline, with a buffer of 1 to 1.5 meters away from the baseline as

appropriate. The structure of steel sheet pile is shown in **Figure 7.1.3 - 1**. Below are the structural components:

(a) Steel sheet pile is the wedge-shaped steel sheet driven vertically into the ground to prevent the water pressure or earth pressure based on the depth of excavation.

(b) Wale is a structural component that resists the side action from steel sheet pile, which transfers the uniform horizontal force to the wale.

(c) Strut is a structural component that absorbs the axial force from the wale and vertical force from the platform on the strut. Generally, there are two types of struts, horizontal and vertical struts and the layers are divided by the level of depth.

(d) Kingpost absorbs the vertical force from the strut and transfers it to the ground. It serves as the pole in large buildings and as the base of tower crane in transferring materials and items.

The steel sheet pile must be installed in the area to be excavated for the foundation building. If the location is near canals or water, double steel sheet pile should be installed.

The example of steel sheet pile is displayed in **Photo 7.1.3 - 1**, the construction area of bored pile for MRT stations and guide way.

1.2) The methods are set up to prevent soil erosion and stabilize the hole, such as using polymer slurry to increase the side force friction between the bored pile and sand layer. Unlike polymer slurry, the bored pile under bentonite slurry affects the friction on pile surface.

The study on the design and construction of wet process bored piles in Thailand revealed that bentonite slurry is replaced with polymer slurry to increase the side force friction between the bored piles and sand layer. Unlike polymer Slurry, bentonite Slurry affects the friction on bored piles. The test results from the wet process bored piles that use Polymer Slurry to stabilize the hole revealed that the settlement at the maximum test load is lower than the bored piles that use bentonite slurry in the wet process, as displayed in **Figure 7.1.3 - 2**. The graph that compares the test result between the load of bored piles using bentonite slurry and polymer slurry is shown in **Figure 7.1.3 - 3**.

1.3) If the pier foundation of elevated guide way and MRT stations is located near the traffic surface, the surface may settle. The structures is therefore designed to adjust the differential settlement between the foundations of pier and MRT stations and the roads to prevent the road surface damage caused by this factor, as shown in **Figure 7.1.3 - 4**. A structure is built to cover the pier foundation of elevated guide way and MRT stations that overlaps with the road surface. To avoid the damage to road surface, it leaves some space in case of differential settlement when the road and pier foundation moves vertically.

2) Operation phase

-

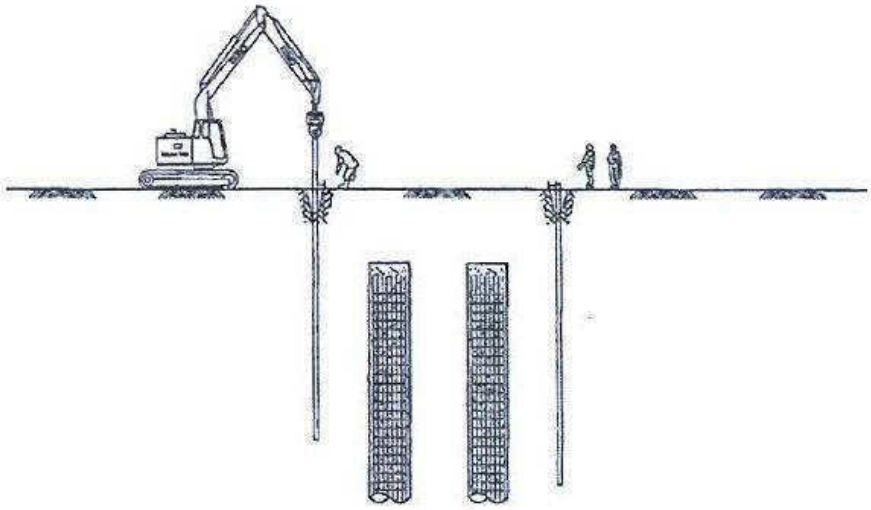


Figure 7.1.3 - 1 Structure of steel sheet pile

Photo 7.1.3 - 1 Steel sheet pile

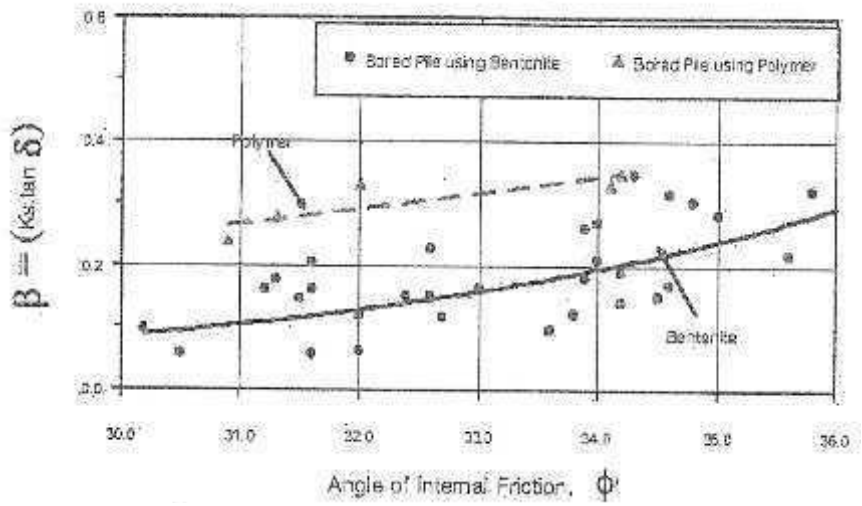


Figure 7.1.3 - 2 Friction Coefficient of Bangkok Sand (β)

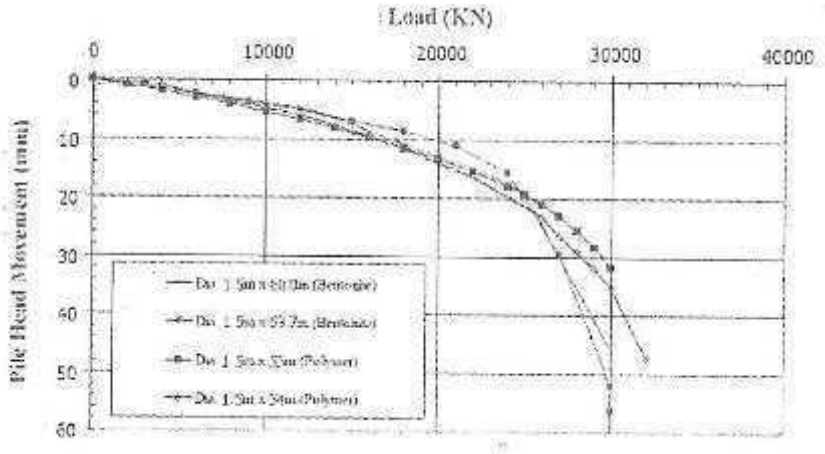
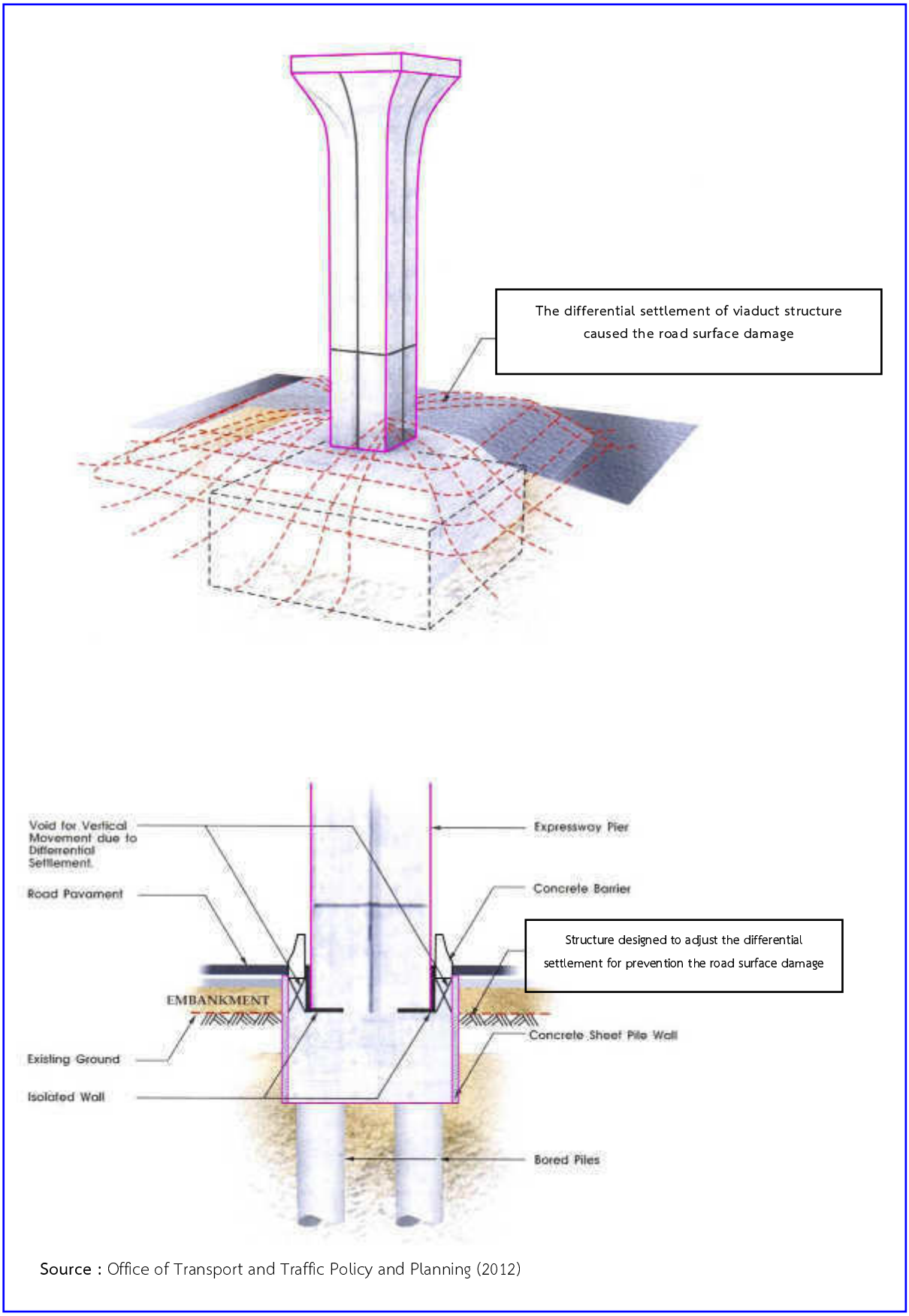


Figure 7.1.3 - 3 The graph that compares the test result between the load of bored piles using bentonite slurry and polymer slurry



Source : Office of Transport and Traffic Policy and Planning (2012)

Figure 7.1.3 - 4 Example of structure designed to adjust the differential settlement for prevention the road surface damage

7.1.4 Surface Water Quality

The construction and operation of project and depot, especially during the construction activities, may affect and disturb the quality of surface water. The impact is expected to be at low to medium level and the following prevention and mitigation measures need to be implemented:

1) Construction phase

1.1) The contractor must establish only "Project Office" in the location near the construction area. The workers' camp must be separate from the office and the camp establishment must be at least five kilometers from the project. It must not only be proposed to and approved by MRTA, but also strictly comply with the laws and regulations of local administrative offices on the residence construction, Building Control Act, B.E. 2522 or the regulation of the Ministry of Interior No. 55 B.E. 2543.

1.2) If the construction of elevated guide way and MRT stations is less than 50 meters from the surface water, the net or canvas must cover the area underneath to prevent the construction materials (such as soil, sand and cement) from falling down to the surface water and causing turbidity.

1.3) In the construction area of three MRT stations located less than 50 meters from the surface water, namely Lat Phrao 101, Kalantan and Suan Luang Ro 9, major construction activities must be implemented during dry season. This includes excavating/filling the land, relocating the public utility system (such as plumbing, drainage pipe and utility pole), or excavating the land for the construction of train station foundation. The objective is to avoid the turbidity caused by soil erosion or water contamination caused by leftover oil/lubricant from the machine used in the construction.

1.4) Below are two cases caused by the activities in the office and the workers' camp:

a) Temporary

- The project must prepare enough restrooms that meet the sanitary standard (10 people/rooms) and install 5 tanks with size 2-cubic meter septic tank, totaling 10 cubic meters, to treat the wastewater caused by the activities in the Office.
- The project must prepare 8 bins with size 0.24 cubic meter waste bin, totaling 1.92 cubic meters. They are distributed as a group of four in different locations in the Office until the District Office under Bangkok Metropolitan Administration (BMA) or local administrative offices in Samut Prakan province come to collect and dispose of the waste in compliance with the sanitary principle.

b) Office and workers' camp

- The project must prepare enough restrooms that meet the sanitary standard (10 people/rooms) and install 20 septic tanks (12-cubic meter/tanks), totaling 240 cubic meters, to treat the wastewater caused by the activities in the Office and workers' camp.
- The project must prepare 50 bins (0.24-cubic meter/bins), totaling 12 cubic meters. They are distributed as a group of 10 in different locations in the Office and workers'

camp until the District Office under BMA come to collect and dispose of the waste in compliance with the sanitary principle.

1.5) To avoid causing the wastewater, the construction activities of elevated guide way and MRT stations, such as fuel change and washing and cleaning the construction equipments or vehicles, must be done in the prepared area in the Office and must be at least 100 meters from the surface water. Furthermore, 2 septic tanks (6-cubic meter/septic tanks), totaling 12 cubic meters, must be installed to treat the wastewater caused by these activities.

1.6) In the south of depot construction area, the temporary sedimentation tank, with over 5,100-cubic meter capacity, and the temporary gutter are made to prevent the sediments that come with the water or rain from flowing into the surface water, public drainage channel or lowlands.

2) Operation phase

2.1) The Project must prepare waste bins with lids (trash/garbage/hazardous waste) to contain the waste in every train station. The Project also coordinates with the District Office under BMA or local administrative offices in Samut Prakan province so that they can collect and dispose of the waste in compliance with the sanitary principle.

2.2) The Project must check the septic tanks in every train station.

2.3) Depot and park & ride buildings

a) To treat the wastewater in the depot, three set of 50-cubic meter onsite treatment plants (Septic - Anaerobic Filter and Contact Aeration Process), totaling 150 cubic meters, must be installed, along with the retention pond. The wastewater caused by activities in the office, control center and employee dormitory will be gathered in the onsite treatment plant. The wastewater caused by canteen, maintenance and train washing will flow through the oil separator, which separates the grease and oil, before running into the onsite treatment plant and finally into Khlong Khlet.

b) The waste in depot and park & ride buildings, such as the waste caused by the cleaning of compartment interior, scraps in the Office, dust from roads and foot path, material fragments from the workshop, waste from septic tank and garbage waste, must be managed as below:

- Prepare 22 groups of 10 set of 240 liter waste bins with lids (trash/garbage/hazardous waste) in the depot and the location must be easy to use and collect.
- Prepare a few staff members to collect the waste and keep it in garbage storage building so that the agencies in charge can take and get rid of the waste in the disposal area outside the depot.
- Make sure that the garbage storage building is large enough to keep the waste at least 3 days (with capacity of 151.59 cubic meters).

c) For the waste management, the hazardous waste, such as oil, grease and chemicals, must be kept in the dangerous goods building so that the agencies in charge can take and get rid of the waste in the appropriate location, such as Samae Dam Industrial Waste Disposal Center in Bang Khun Thian, Bangkok. It is designed with pallet racking system and the roof so that the cranes and trucks can easily and safely transport pass.

7.1.5 Air Quality

The construction and project operation, depot and park & ride buildings may affect the air quality, especially during the land excavation and filling, relocation of public utility or building, material transportation and concrete mixing. The impact in the operation phase is probably caused by the passing vehicles on the road network beneath the elevated Structure or MRT stations. However, the MRT Yellow Line is electricity driven. As a result, it will not emit pollution and its effect is expected to remain at low to medium level. Below prevention and mitigation measures are therefore required:

1) Construction phase

1.1) The contractor must follow the regulations on construction dust control issued by the Air Pollution Committee in Bangkok and Communities in Thailand.

1.2) Install the solid fencing , at least or equivalent to 2 meters high, to indicate the construction boundary. Moreover, install the revolving warning lights every 30 meters along the construction area and the installation must be completed before the construction begins. Once the construction in each area is done, these materials must be immediately removed.

1.3) Use the precast concrete that is produced and mixed outside the construction site to prevent and mitigate the potential impact on the surrounding communities, which are in commercial, business and highly populated residential areas.

1.4) Spray the water on the existing road surfaces at least three or four times a day along the construction area that may cause the spread of dust, such as a pile of soil and sand or the area of land excavation/foundation excavation. Moreover, remove the scraps of construction materials or the piles of soil from the construction area as fast as possible or within 24 hours.

1.5) In each construction site, prepare at least three or four staff members to collect the waste and clean the area after the construction activities are done at the end of day. This includes arranging the pile of construction materials and equipments throughout the construction phase to prevent the dust from spreading.

1.6) Establish the unit to control, maintain, or check the condition of engines and machines used for the construction at least once a week to prevent the emission of dust (TSP and PM-10) and toxic smoke, such as CO, NO_x, SO_2. If something goes wrong, the team must immediately take action.

1.7) If the elevated guide way and MRT stations is constructed on the road median of existing road network, there will not be enough space to construct the wheel cleaning place. Therefore, three or four staff members must be assigned in each area to wipe, clean, or remove the dirt or mud on the tires every time before the vehicles leave the construction area. For the construction of depot and park & ride buildings, the project must provide the area for washing the mud, cement or sand off the tires and vehicles to prevent these residues from falling on the road surface outside the construction area.

1.8) The staff members must carefully drive the trucks that carry the construction materials under the speed limit of 30 km/hr. when passing the sensitive communities or residential

or commercial area, such as healthcare facilities, schools/educational institutes or religious places, such as temples, mosques and churches.

1.9) The measure must be enacted to request the trucks carrying the construction materials and equipments to cover the beds. This will prevent the materials or leftover from falling on the surface of existing road network or into the water resources along the route where these vehicles pass.

1.10) Request and supervise the staff and workers to wear the equipments that protects them from dust or pollutant, such as CO, NO_x and SO_2, if they work in the construction areas where the machines spread the dust or pollutant, especially land excavation, foundation excavation, relocation or removal of construction scrap or concrete mixing.

1.11) Provide the sign of bypass/shortcut for the passers on the existing road network so that they can use alternative routes. Coordinate with police stations, such as Huay Kwang/Hua Mak/Suan Luang/Prawet police station, to facilitate the passers, smooth the traffic flow, and reduce the air pollution caused by traffic jam.

1.12) Provide the small-mesh net or canvas underneath the elevated guide way , MRT stations, depot or park & ride buildings to catch the construction equipments and materials that may fall from the construction taking place 10 meters above the ground or to prevent the dust from spreading.

1.13) Must provide the small-mesh net or canvas to cover or separate the the station entrances or exits construction areas and to prevent the dust impact caused by the construction.

1.14) Prepare at least three or four staffs to clean the existing road network where the elevated guide way or MRT stations are constructed. The cleaning should be implemented during the night time at least four days a week, starting from midnight to 3 am. of the following day.

2) Operation phase

2.1) Contact the Department of Land Transport, Pollution Control Department and police stations in charge of each section of the route underneath the stations (such as Huay Kwang, Hua Mak and Suan Luang station) so that all parties concerned can collaborate in controlling and forbidding the medium and large sized trucks from running on the existing road network under the elevated guide way and MRT stations during the morning rush hours (7 - 9 am.) and evening rush hours (4 - 7 pm.). Clearly set up the prohibition signs and ask them to use alternative routes to reduce the pollution caused by the exhaust, especially CO and NO_2.

2.2) MRTA should coordinate with the following agencies:

a) Coordinate with the police stations, such as Huay Kwang, Chok Chai 4, Hua Mak, Wang Thonglang and Udom Suk, to plan and organize the traffic system on the existing road network under the elevated guide way and MRT stations. This can ensure the flexibility and reduce the traffic congestion. Moreover, the traffic signals should be set up to tell the direction and speed limit under the train station.

b) Coordinate with the Department of Land Transport, Pollution Control Department and police stations (such as Huay Khwang, Chok Chai 4, Hua Mak,Wang Thonglang and Udom Suk station) to control and forbid the medium and large sized trucks from running on the

existing road network under the elevated guide way and train station during the morning rush hours (7 - 9 am.) and evening rush hours (4 - 7 pm.). Clearly set up the prohibition signs and ask them to use alternative routes to reduce the pollution caused by the exhaust, especially CO and NO_2.

2.3) In operation phase, if the result of dust analysis underneath any train station yields higher value than the standard of atmospheric air quality for five consecutive days based on the announcement of National Environment Board No. 24 (B.E. 2547), high-pressure spray nozzle must be immediately installed under the MRT stations and turned on during the morning rush hours (7 – 9 am.) and evening rush hours (4 – 7 pm.) to reduce the amount of dust. **Figure 7.1.5 - 1** shows the example of spray nozzle installed under the MRT stations, especially in the highly populated commercial areas, such as the Phawana, Chok Chai 4, Lat Phrao 101 and Samrong Stations.

2.4) If the result of air pollution analysis, such as CO or NO_2, yields higher value than the standard of atmospheric air quality, the fans must be installed to ventilate the area beneath the MRT stations and reduce the accumulative air pollution under the MRT stations. Coordinate with Bangkok Metropolitan Administration (BMA) and Samut Prakan Municipality to monthly clean and vacuum the dust off the road surface.

2.5) Set up no parking signs for all types of vehicles (except buses) under the MRT stations.

Figure 7.1.5 - 1 The example of spray nozzles installed under the MRT stations

7.1.6 Noise

The construction and operation of project, depot and park and ride buildings may increase the noise level, especially during the land excavation and filling, relocation of public utility or building, and material transportation. The impact in the operation phase is probably caused the passing vehicles on the road network beneath the elevated guide wayor MRT stations. This includes the electricity system that drives the train movement and causes loud noise when the wheels touch the guide way. However, its effect is expected to remain at low level and below prevention and mitigation measures are required to ensure the minimum impact:

1) Construction phase

1.1) Install 2 meters high concrete walls and metal sheet in the construction site.

1.2) Use tools, equipments and machines that do not produce loud noise or use the noise control equipments (such as sound isolation or cover) if the noise level at the source exceeds 90 dB (A) for one hour.

1.3) The contractor should prepare at least three to four staff members to control, maintain, or check the machines, equipments and vehicles used for the construction. This aims to ensure that they remain in good condition throughout the construction phase and to keep the noise level in the standard limit.

1.4) The speed of vehicles transporting materials and equipment should not exceed 30 km/hr. when passing the communities, residential areas or commercials areas, such hospitals, religious places or temples, and schools or educational institutes. This aims to avoid the noise problem, especially during the school period or religious practice, such as morning and evening prager (Buddhism) or the Muslim prayer (Islam) or resting time.

1.5) Mostly elevated guide way and MRT stations are constructed on the road median of existing road network, which has limited space. Therefore, the construction period must start from 8 am. to 6 pm. The major structure (e.g. elevated guide way and MRT stations), such as foundation excavation of elevated guide way and MRT stations and cementing to mold the piers of elevated guide way and the floor of MRT stations, must not be constructed between 9 pm. and 5 am. of the following day to avoid disturbing the sleep of communities on the existing road network. This excludes removing the pillars/concrete beam/concrete slab/guide way, which must be done at night to reduce the traffic jam in the area.

1.6) The depot and park & ride buildings are constructed on the empty land, with fencing to clearly indicate the boundary, from 8 am. to 6 pm. After this period, the construction is not allowed. This excludes the removal of concrete mold, concrete beam and concrete slab or the removal of unused construction scraps from the construction site, which can be done from 7 to 9 pm.

1.7) The staffs or workers, who work in the construction areas for eight to ten consecutive hours, must wear the protective equipments to reduce the noise level, such as ear muffs and ear plugs. The staffs or workers who work in the construction areas or the noisy area for at least 15 consecutive days must be rotated.

1.8) The contractors must install the absorptive materials under four MRT stations, namely Phawana, Chok Chai 4, Lat Phrao 101 and Samrong stations, to reduce the noise impact. These stations are semi-closed area (semi-tunnel), which may somehow cause echo. The absorptive materials used include Glass Fiber Reinforced Plastics (FRP) and others, such as aluminum, metal sheets and cellocrete, which are lightweight and long-lasting. The absorptive materials installed can reduce 23 – 47 decibel, as shown in **Table 7.1.6 - 1**, and the example of FRP and Cellocrete installed under MRT stations is also shown in **Figure 7.1.6 - 1**.

1.9) Install two meters high solid steel fences at the depot and park & ride buildings.

1.10) The depot and park & ride buildings are constructed on the empty land, with fences to clearly indicate the boundary, from 8 am. to 6 pm. After this period, the construction is not allowed. This excludes the removal of concrete mold, concrete beam and concrete slab or the removal of unused construction scraps from the construction site, which can be done from 7 to 9 pm.

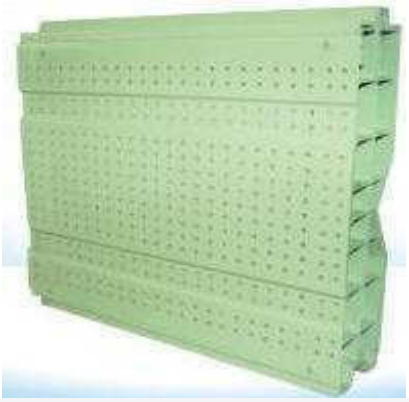
Table 7.1.6 - 1 Transmission Loss by difference Absorptive Materials

Material	Thickness (mm)	Surface Density (Kg/m^2)	Transmission Loss* (dB)
- Polycarbonate	8-12	10-14	30-33
- Acrylic (Poly-Methyl-Meta-Acrylate (PMMA)	15	18	32
- Concrete block 200x200x400 light weight	200	151	34
- Dense concrete	100	244	40
- Light concrete	150	244	39
- Light concrete	100	161	36
- Brick	150	288	40
- Steel, 18 ga	1.27	9.8	25
- Steel, 20 ga	0.95	7.3	22
- Steel, 22 ga	0.79	6.1	20
- Steel, 24 ga	0.64	4.9	18
- Aluminum Sheet	1.59	4.4	23
- Aluminum Sheet	3.18	8.8	25
- Aluminum Sheet	6.35	17.1	27
- Wood	25	18	21
- Plywood	13	8.3	20
- Plywood	25	16.1	23
- Absorptive panels with Polyester film backed by metal sheet	50-125	20-30	30-47
- Glass Fiber Reinforced Plastic sound absorption board**	80-100	<16	>28

Remark : * Values assuming no openings or gaps in the barriers

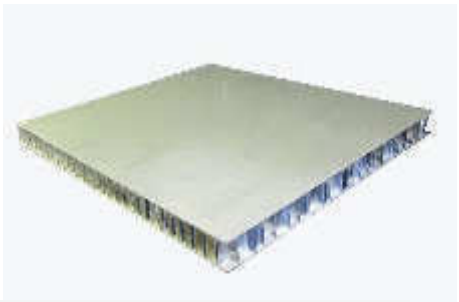
** Data from www.clima.net.cn/ and www.xrhr.com

Source : Environmental Protection Department and Highways Department, Government of the Hong Kong SAR., 2003



Glass Fiber Reinforced Plastic Sound Absorption Board

Source: www.clima.net.cn/



FRP Honeycomb panel

Source: www.aluminum-honeycomb-panel.com/

Ordinary Cellocrete

Foam Cellocrete

Dome

Shell

Octagon

Special Cellocrete

Source: www.cellocretethai.com/

Figure 7.1.6 - 1 The example of FRP and Cellocrete installed under MRT stations

2) Operation phase

2.1) The absorptive material was already installed in the construction phase. Therefore, the project will not pose the noise impact in the operation phase. It is necessary to check the conditions and effectiveness of the materials installed along the route or under the MRT stations at least once a month. Once finding any damage or that its effectiveness decreases more than 40%, the Project should consider replacing it immediately.

2.2) If analysis of noise level in the operation phase under any train stations yields higher than the noise standard indicated in the announcement No. 15 of the National Environment Board B.E. 2540 (louder than 70 dB (A) for five consecutive days, the absorptive material must be installed under the MRT stations to reduce the noise level.

2.3) Set up the traffic signs, such as direction, speed limit and no honking, in the area before and after each train station.

2.4) Regularly check and maintain the train system, especially the wheels and guide way (or follow the manufacturers' terms) to keep them in good condition and avoid the noise problem.

2.5) Design the guide way to ensure the even top and side surface.

2.6) Monorail train is designed to operate with rubber tires only, as shown in Figure **7.1.6 - 2** and **Figure 7.1.6 - 3**. All rubber tires of the monorail trains must be strictly checked and replaced as scheduled. Normally, the tires are replaced every 200,000 km (based on an operator of electric train[1]). The preventive maintenance (based on an operator of electric train[2]) consists of three parts as below:

- **Routine Maintenance or Daily Inspection**

For the routine maintenance or daily inspection, every monorail must be inspected every three days at the workshop, which takes six hours per train. This inspection checks the general condition and make sure that the trains are ready to serve the passengers.

- **Monthly Maintenance**

For the monthly maintenance, every monorail train must be inspected every three months at the workshop, which has 3 levels of platforms. The lowest level is for changing the fuel and tire, the middle level is for maintaining the interior of wheel coaches, and the top level is for maintaining air conditioning units. Each compartment takes 3 days.

- **Yearly Maintenance**

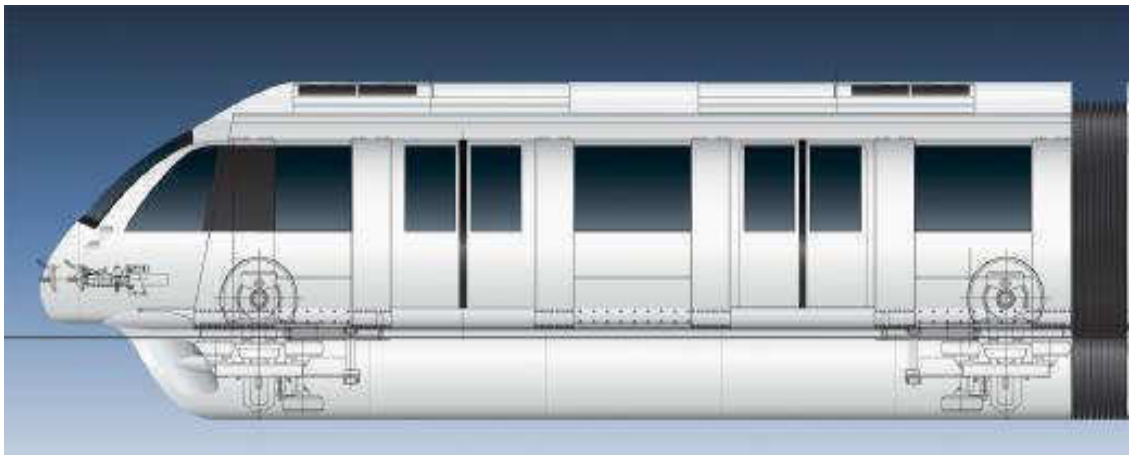
For the yearly maintenance, every monorail train must be inspected every 3 to 6 years at the workshop to repair the bogies or engines. The repair is done by lifting the car bodies on the platform and the duration depends on the severity of damage.

2.7) The monorail train must have the nave plates designed to cover the whole wheel to reduce the noise caused by the running train throughout the operation. The picture is shown in **Figure 7.1.6 - 4**.

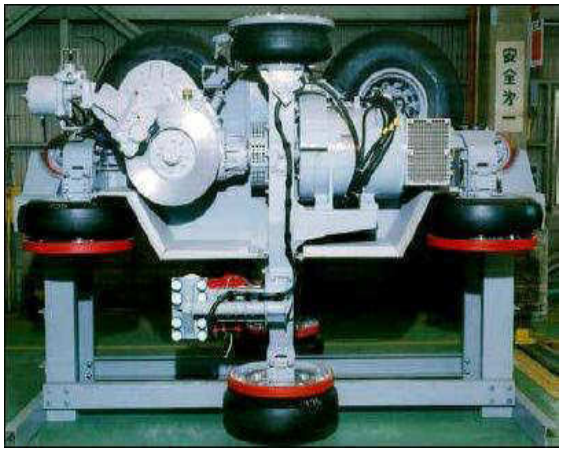
2.8) Plant tall trees with thick leaves at least two zigzag rows, such as Mast Tree, Devil Tree or Mahogany, around the area as the buffer zone. Furthermore, they help lower the noise from running vehicles/electric train or train maintenance, around the depot and park & ride buildings.

[1] Source of information: Hitachi

[2] Source of information: Chongqing Monorail

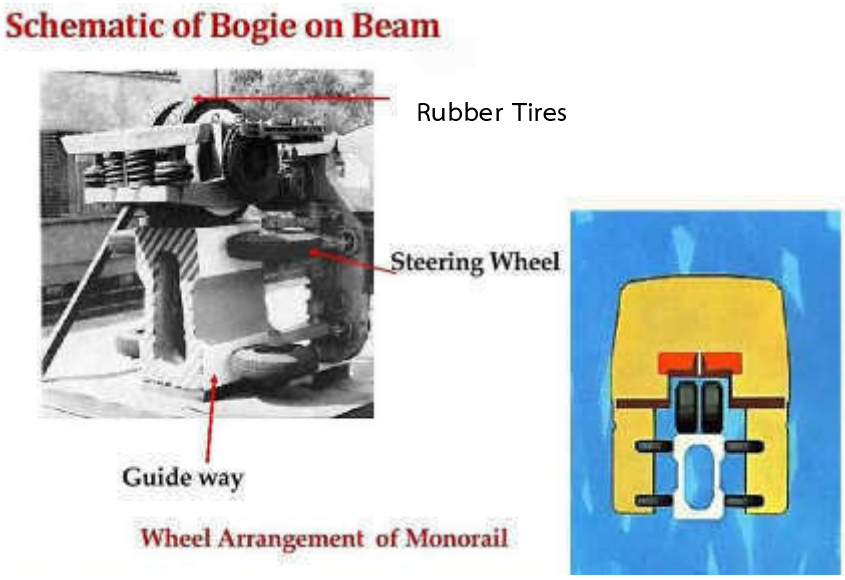


Source: Bombardier

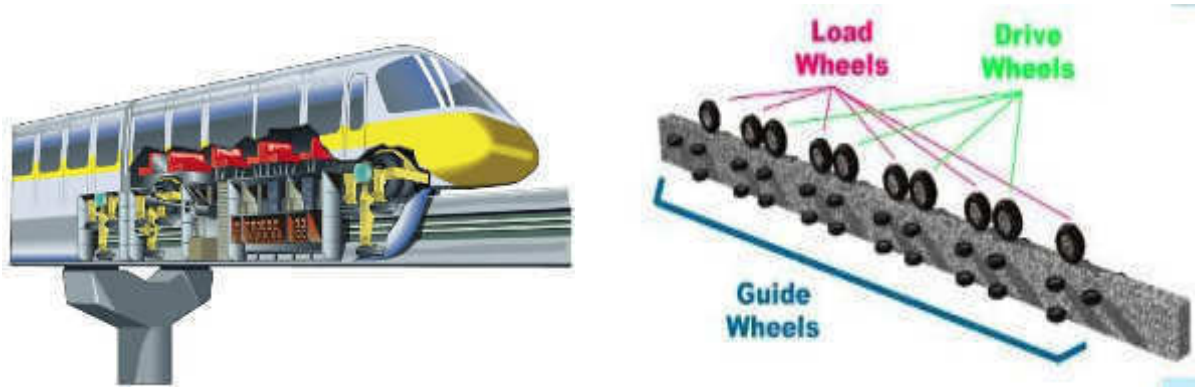


Source: Hitachi

Figure 7.1.6 - 2 Monorail with Rubber Tires and Noise Reduction System by some company



(1) Rubber Tires and Noise reduction system



(2) Load Wheels & Drive Wheels and Guide wheels

(3) Bottom view of Guide Wheels

(4) Side view of Guide Wheels

Figure 7.1.6 - 3 Monorail with Rubber Tires and Noise Reduction System.

Sao Paolo Monorail, Brazil
(Source: Bombardier)

Mumbai Monorail, India
(Source: Scomi)

Chongqing Monorail, China

Daegu Monorail, South Korea

Las Vegas Monorail, United State of America
(Source: www.gohowknowhow.com)

Sydney Monorail, Australia
(Source: www.abc.net.au)

Figure 7.1.6 - 4 Existing Monorail with nave plates designed to cover the whole wheel.

7.1.7 Vibration

The construction of project route, MRT stations, depot and park & ride buildings may increase the vibration level, especially during the land excavation and filling, foundation excavation, relocation or transportation of materials and equipments. The impact in the operation phase is probably caused by the passing vehicles on the road network beneath the elevated guide way or MRT stations. Since the electricity system used for driving the trains does not exceed 80 km/hr., the vibration transferred from the railway to the elevated guide way and ground is expected to have low to medium effect. As a result, prevention and mitigation measures are required to minimize the effect:

1) Construction phase

1.1) In the detail design and the construction of elevated guide way , MRT stations, depot and park & ride buildings, the structure must be able to safely absorb the vibration of earthquake or geological disaster in compliance with the regulation of the Ministry of Interior B.E. 2554 on weight bearing, the durability of building and the ground supporting the building that resists the earthquake vibration. This regulation is issued in compliance with the context of Building Control Act, B.E. 2522.

1.2) During the foundation construction to support the elevated guide way and MRT stations, the steel sheet pile must be installed 18 meters deep in the soft to medium soft clay layer. This will help reduce the vibration and prevent it from disturbing the existing road network, especially three sensitive areas located less than 30 meters away, namely Suan Luang Church, Chularat 2 Hospital and Chulavej Hospital.

1.3) The construction that will cause the vibration, such as foundation excavation to support the elevated road, MRT stations, depot and park & ride buildings, can start at 8 am. and finish no later than 6 pm. This aims to avoid disturbing the communities' daily activities or the sensitive areas, such as Dharma teaching and learning, religious practice, morning - evening prayer (Buddhism), Muslim prayer (Islam) or resting time.

1.4) If the construction activities continue to cause the vibration, especially foundation excavation, it is necessary to reduce the energy used for the pier excavation and increase the frequency of excavation to reduce the vibration.

1.5) Ensure that the vehicles transporting materials and equipments strictly follow the traffic law and speed limit of no faster than 30 km/hr. and contain the load under 25 tons when passing the residential or commercial zones or sensitive areas, such as healthcare facilities, schools/education institutes or religious places, namely temples, mosques and churches.

1.6) In case of complaints made by the landlords of buildings or commercial buildings near the construction areas of elevated guide way and MRT stations, the civil engineers must be sent to inspect and analyze the damage and urgently find the solution.

1.7) Promote the construction plan at least three months in advance among the people and focus the promotion among the people at least 15 days.

2) Operation phase

Inspect the route condition. this includes the flexibility of the trains' rubber tire, which must be strictly replaced as scheduled by the manufacturers.

7.2 Biological Environmental Resources

7.2.1 Aquatic Ecology

1) Construction and Operation Phase

The construction and operation of depot, especially during the land excavation, foundation excavation and the oil contamination from the machines or equipments used for the construction, may have low impact on aquatic ecology. However, the prevention and mitigation measures are required. In the construction phase, the measures must be formulated in line with the quality of surface water.

7.2.2 Terrestrial Ecology

Forests

1) Construction phase

1.1) Coordinate with the agencies concerned in Bangkok, such as District Office of Lat Phrao, Wang Thonglang, Bang Kapi, Suang Luang, Prawet and Bang Na, and in Samut Prakan province, namely Samrong Nuea Municipality and Thepharak Administrative Organization, to discuss about the construction guideline and setting the construction areas to limit the expected effect on trees.

1.2) Survey and estimate the number of trees to be cut down during the project operation and to be removed (dig around) from the project area and planted in the prepared areas.

1.3) Use labors or machines to remove (dig around) the large and important trees (with the chest-wide diameters; DBH > 10 cm.) from the project area before the construction phase. Then, plant them in the prepared areas, such as empty space along the project route or inside the depot. The types and number of each tree must be recorded. The workers are allowed to cut down the degenerating trees but they need to clear the scraps out of the areas.

1.4) After the area opening to construct the project, the land must be cleared and graded to facilitate the tree planting process.

1.5) Fill the land with the soil from or outside the project area before planting trees so that the roots can attach the soil in the first period.

1.6) The medium or large trucks must carefully remove the soil gained from the foundation excavation or materials and equipments to avoid damaging the nearby trees.

1.7) Grow the plant succession to save the eco-system. The Project may ask for the advice or saplings from BMA, Samut Prakan province, Royal Forest Department and National Park, Wildlife and Plant Conservation and Department. The selected types of plants should be suitable for the urban ecology, can grow in the project environment, and does not obstruct the view when the train runs. For example, grow the climbing plants, such as medium or heavy vines, to soften the look of the pier of elevated guide way or MRT stations, increase green areas, and arrange the small garden in the area under the MRT stations (if available) or along the route to enhance the balance of eco-system.

1.8) Take care of the trees, such as loosen the soil, add fertilizer, get rid of weeds and pests, and plant replacement trees.

1.9) Check the trees planted and environment of remaining forest around the project.

1.10) After the construction is completed, the workers' camps must be immediately taken apart and taken out of the site. Then, the land must be cleared to resume its previous condition. If the eco-system of any area needs to be revived by tree planting, the action should be taken at once.

2) Operation phase

2.1) Control and prevent the woodcutting in the project area by coordinating with the agencies concerned in Bangkok Metropolitan, such as District Office of Lat Phrao, Wang Thonglang, Bang Kapi, Suan Luang, Prawet and Bang Na, and in Samut Prakan province, namely Samrong Nuea Municipality and Thepharak Administrative Organization.

2.2) Take care of trees that the Project grows and plant the replacement if the trees are dead.

7.3 Human Use Values

7.3.1 Land Use

The construction and operation of depot and park & ride buildings is expected to have low or high effect depending on the area condition along the project route. As a result, below prevention and mitigation measures are required:

1) Construction phase

1.1) The construction activities must be implemented in the construction site, depot and park & ride buildings only.

1.2) Provide the specific area to store the construction materials so that they are well organized and will not be piled up outside the construction area. Do not place the construction equipments or tools in the location that obstructs the water flow.

2) Operation phase

-

7.3.2 Transportation

The construction and operation of depot and park & ride buildings, especially land excavation, land filling and foundation excavation of the elevated guide way and MRT stations, need to use some parts of median on the existing road network, namely Lat Phrao, Srinagarindra and Thepharak Roads. This decreases the road surface and capacity, which is expected to have medium impact level. Therefore, below prevention and mitigation measures are required:

1) Construction phase

1.1) Because the construction of MRT project, especially the elevated guide way and MRT stations, needs to use the median of existing road network, whose traffic is quite heavy. Two lanes next to the median must be closed (one incoming and one outgoing lane) in some periods. This will decrease the surface and capacity of the existing road network. As a result, the project must

offer the alternative routes to the road users to reduce the number of vehicles on the existing road network during the construction. Below are the bypasses on the existing road network:

(a) Lat Phrao Road (Ratchada/Lat Phrao Intersection-Chaloemrat Expressway or Ram Indra/At Narong Expressway)

- Pass Ratchadaphisek Road and enter Suthisan Winitchai Road, which merges with Lat Phrao 66 Road on the opposite side of the Printing House of the Teachers' Council.

- Pass Ratchadaphisek Road, enter Soi Ratchada 8, and Pass Wat Samakkee Dharma before merging with Lat Phrao Road at Soi Lat Phrao 80 (Soi Chanthima).

- Pass Soi Phawana (Lat Phrao 41) and Wat Lat Phrao, enter Chok Chai 4 Road, Pass Soi Sangkhom Songkhro Nuea 1, which merges with Lat Phrao 71 Road and Pradit Manoontham Road .

(b) Lat Phrao Road (Intersection of the Chaloemrat Expressway or Ram Indra/At Narong Expressway-Bang Kapi Intersection).

- Pass Soi Lat Phrao 94 and Soi Indraphon, which merges with Soi Lat Phrao 112, and enter Ramkamhaeng Road.

- Pass Soi Lat Phrao 112 (Mahat Thai) and Jaturapat Village before entering Ramkhamhaeng Road

- Pass Soi Lat Phrao 130, enter Soi Ramkhamhaeng 81, pass Ramkhamhaeng Road, enter Soi Ramkhamhaeng 50, pass Soi Sukhonthi, and enter Srinagarindra Road at Krungthep Kritha Intersection.

- Pass Soi Ramkhamhaeng 60 (Mooban Suan Son) and Soi Kan Sul Sor Lee Han Foundation, merge with Krungthep Kritha Road, and enter Srinagarindra Road.

(c) Srinagarindra Road (Phatthanakan-Thepharak Intersection)

- Pass Phatthanakan Road, enter Soi Phonlathep, and pass Soi Prachit, which merges with Srinagarindra Road at Esso gas station.

- Pass Srinagarindra Road (Soi Kia Koi Kit), which merges with Sukhumvit 77 Road (On Nut) before Public Health Center 22.

- Pass Sukhumvit 77 Road and enter Soi On Nut 46, which merges with Srinagarindra Road at Food Lion.

- Pass Soi Sukhumvit 103, enter Soi U-Dom Suk 60, pass Soi Suan Sawan, which merges with Bang Na-Trat at Central Bang Na Department Store.

(d) Thepharak Road (Srinagarindra Intersection-Sukhumvit Intersection)

- Pass Soi Mooban Tippawal and merge with Sukhumvit Road at Burarak School

- Pass Soi Thepharak 12 and Papawarin Apartment and enter Soi Sukhumvit 117

1.2) The topics of travelling on the alternative routes to avoid the existing road network during the construction was presented as follows: (1) It is necessary to improve the physical condition of alternative routes so that they have more capacity and can facilitate the traffic flow without congestion. Therefore, the road surface of alternative routes, namely Soi Ratchada 18, Suthisan Winitchai Road, Soi Lat Phrao 66, Soi Chanthima, Indraphon, Soi Sukhonthi, Soi Phonlathep, Prachit Road, Soi Bunlom, Soi Dara Chai, Soi Suan Sawan and Thipphawan village Road, must be improved to ensure a good condition at all time. The physical management must

also consider the size of lanes and the standard radius for different vehicles to make a safe turn in compliance with AASHTO regulations and Japanese standard as below:

Vehicle	Turing radius (m)	
	AASHTO	Japanese Standard
1. car	7.32	6.00
2. Truck	12.80	12.00
3. Trailer	13.72	12.00

1.3) At least 1 km from the project, the project must set up the traffic signs and symbolic signs, such as warning signs, direction signs, traffic lane signs, rotating warning lights and blinking light, including the barricades, to indicate the construction areas, paint the traffic lines, and place the traffic cones based on traffic safety standard. This is done to ensure the safety, avoid the confusion, and reduce the travelling time around the construction areas. The marks and signs used during the construction are shown in **Figure 7.3.2 - 1**.

1.4) Since the road users come from out of town, from the East to the West, and large volume of vehicles need to get into town via the existing road network, especially during morning rush hours. Therefore, the reversible lanes must be provided to facilitate the flow for incoming vehicles, with equal capacity to the pre-construction phase. However, it will cause the bottleneck issue at the merging lane, which reduces the number of lanes at the end of special lanes. As a result, enough distance to narrow down the lane (40-150 m.) is required, depending on the speed of vehicles. This will facilitate the safe and smooth traffic flow around the construction area and helps the vehicles safely merge into the flow without causing any accident. Moreover, the Project should coordinate with traffic police officers to facilitate the traffic in the construction areas to ensure the safety and traffic flow.

1.5) Inform the people who use the route via several media, such as billboards, brochures, newspapers, traffic radio stations (Jor Sor 100, Sor Wor Por 91, Ruam Duay Chuay Kan), websites and TV stations. Moreover, disseminate the news and information and ask for comments and recommendations of the agencies concerned. Below are key communication points:

(a) Avoid travelling in the existing road network: Recommend the people to use the alternative routes, ask for their cooperation, or encourage them to follow the traffic plan.

(b) Avoid travelling in rush hours in the existing road network unless necessary so that the secondary roads can sufficiently support the traffic volume shifted from the existing road network.

(c) Encourage the road users to mainly use the public transport and avoid single occupancy vehicle. Moreover, promote the use of public ferries in the service area to serve the people coming into or going out of Bangkok. For example, the people working or living on Lat Phrao Road or Srinagarindra Road (Lam Sali Intersection) are encouraged to use express boats in Khlong Saen Saep instead.

(e) Encourage the road users to have discipline and comply with the traffic laws, enforce the laws, arrest or fine the people who violate the law, especially at no turning or no U-turn area to facilitate the traffic flow.

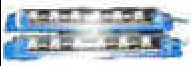
Signage	Name of Signs	Details of Signs	Description
	Beware of construction site	Plate size 60x60 cm. with black signage on the yellow background and black border	To inform the driver beware of construction area is ahead at a distance of 1 km and 500 meters, 150 meters.
	Beware of reducing the right lane	Plate size 60x60 cm. with black signage on the yellow background and black border.	A warning to the driver that the traffic lane has been reduced from 3 lanes to 2 lanes
 	Beware of reducing speed Beware of worker	Plate size 80x120 cm. with black signage on the yellow background and black border Plate size 60x60 cm. with black signage on the yellow background and black border	speed limit 30 km./hr. To inform the driver to beware of worker working
	Beware of engine	Plate size 60x60 cm. with black signage on the yellow background and black border	To inform the driver beware of engine working
	Keep left	Plate diameter ∅ 60 cm. with white arrow signage on the blue background and white border	Keep drive on the left side
	Traffic sign	It could be visible over a distance of 1,000 meters with an arrow type halogen lamps, and flashing parallel	To use with guide post sign
	End of Construction area	Plate size 80x120 cm. with black signage on the yellow background and black border	To inform the driver beware of the end of construction areas
	Concrete barrier	Concrete barrier	To separate the traffic lane and construction areas
	Light bulb	Light bulb	To enlighten the light along the construction areas
	Blinker	This light and reflector mirror attached to the lamp	A warning to driver by installation of blinker between 3 meters
	Funnel	Orange funnel	Take place the funnel between 1-2 meters over to the lane along the construction areas

Figure 7.3.2 - 1 The marks and traffic signs used during the construction

1.6) The contractors must prepare the traffic plan that is aligned with the project's construction plan. Then, it must present the plan to MRTA, BMA or police stations responsible for their approval at least 30 days before opening the construction area in each location. Below is the preliminary traffic management in the existing road network during the construction:

(a) Lat Phrao Road (from the Ratchada-Lat Phrao Intersection to the Bang Kapi Junction), with 30-meter right-of-way width. This road is heavily congested, especially during morning and evening rush hours. During the construction of MRT system, the plumbing pipes with 1.5-meter diameter under the median on Lat Phrao Road, from Ratchada-Lat Phrao intersection to the Bang Kapi Junction, must be removed and assembled. The new line of plumbing pipes will be located 5-6 m from the line of pillars. Furthermore, the new construction method does not require the stripping and will be implemented at night or when the traffic is light to reduce the traffic impact on Lat Phrao Road. The construction area requires at least 7 m along Lat Phrao median and it is divided into 500-meter sections throughout the period of pier and foundation construction on Lat Phrao Road, from Ratchada-Lat Phrao intersection to the Bang Kapi Junction. Another traffic lanes must be blocked to transport the soil and materials at night. During the normal period, the Project will manage to have the same amount of traffic lanes as the current state but the lanes will become narrower. The width of the far left lane will be reduced to 3 m for buses. Furthermore, the existing stone curbs and gutters must be improved to increase the road surface by 0.30 m. Both sides of road and the smaller lanes of 2.75 m will reduce the road surface by totally 8.50 m per direction, with 3 lanes per direction like the current state. The traffic management during the construction on 3-lane Lat Phrao Road (2.75-3.00 m/lane) is shown in **Figure 7.3.2-2**. Once the construction of piers and foundation is completed, total road surface of 9.75 m per direction and 4-meter wide median will return to their previous condition. The traffic management after the construction on 3-lane Lat Phrao Road (3.25 m/lane) is shown in **Figure 7.3.2-3**.

(b) Srinagarindra Road (the Bang Kapi Junction to the Rama 9 Interchange) has the right-of-way width of 30 m and the same traffic pattern as today. Like Lat Phrao Road, Srinagarindra Road consists of 6 lanes (incoming-outgoing lanes), each of which is 3.25 m wide. The road has a 4-m wide raised median and footpath on each side. Throughout the period of pier and foundation construction, the project requires at least 7 m of construction areas along Srinagarindra median. It is divided in sections and about 500 m per section. Another traffic lane must be blocked to transport the soil and materials at night. In the normal period, the traffic management on Srinagarindra Road from the Bang Kapi Junction to the Rama 9 Interchange, follows the same plan as Lat Phrao Road.

(c) For Srinagarindra Road (The section from the Rama 9 Interchang to the Si Thepa Intersection), the right-of-way width on Srinagarindra Road from the Rama 9 Interchange to the Si Thepha Intersection, can be divided into 2 sections. First, the right-of-way width from the Rama 9 Interchange to the Phatthanakan Intersection is 30 m. Second, the right-of-way width from the Phatthanakan Intersection to the Si Thepha Intersection is 60 m. As a result, the details of current traffic management and traffic management plan during the construction can be divided as follows:

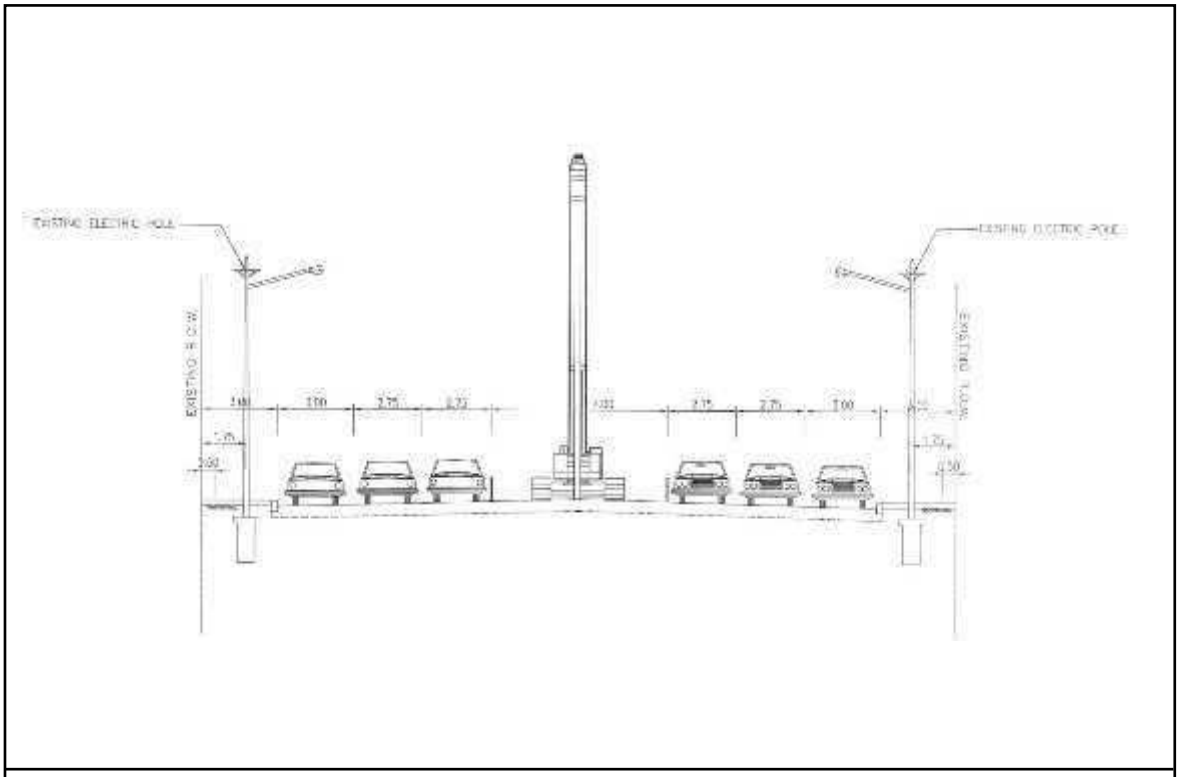


Figure 7.3.2 - 2 The pattern of traffic management during the construction on 3-lane Lat Phrao Road (2.75-3.00 m/lane).

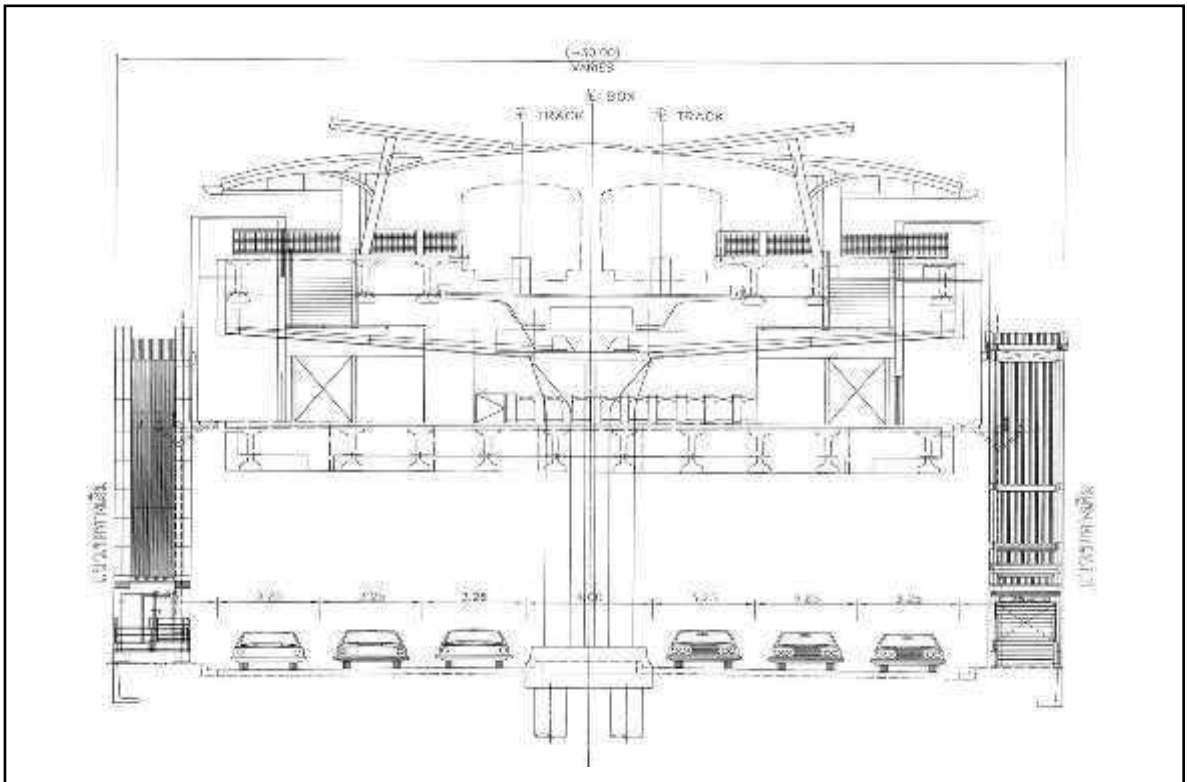


Figure 7.3.2 - 3 The pattern of traffic management after the construction on 3-lane Lat Phrao Road (3.25 m/lane).

- The section from the Rama 9 Interchange to the Phatthanakan Intersection has a 30 m long right-of-way. This section has six lanes (both directions), each being 3.25 m wide, with a 4 m wide raised median.

- The section from the Phatthanakan Intersection to the Si Thepha Intersection has a 60 m long right-of-way. Currently, it is an 8-lane urban road (both directions), with each lane being 3.50 m. It has a 4 m wide raised median and a footpath on each side of the road. It is a 6-lane sub-urban road (both directions), with each lane being 3.50 m. It has a 7 m wide depressed median. The traffic management on Srinagarindra Road from the Phatthanakan Intersection to the Si Thepha Intersection is shown in **Figure 7.3.2-4**. The project construction along Srinagarindra Road from the Rama 9 Interchange to the Si Thepha Intersection is characterized by elevated structure of guideways and stations. Thus, it is necessary to reserve a construction area of at least 7 m along the median of Srinagarindra Road at different sections for approximately 500 m throughout the foundation and pier construction period. It is also necessary to reserve a lane of the construction area for transporting materials and soil during nighttime. During the normal time, the traffic management pattern on Srinagarindra Road is as follows in:

- On the 8-lane urban road (both directions), the alignments of the foundations and piers are mostly within the median alignment. During normal period, the number of lanes provided will be the same as today, but their width will be decreased from 3.5 m to 3.0 m. Therefore, the width of the road surface will be 12 m, and there will be four lanes per direction, as today. The traffic management pattern during the construction on Srinagarindra road from the Phatthanakan Intersection to the Si Thepha Intersection (urban road) is shown in **Figure 7.3.2-5.**

When the construction of the foundation and pier structures is completed, the road surface of 14 m per direction and the 4-m wide median can be returned to the normal condition as today. The pattern of traffic management after the construction on Srinagarindra Road is shown in **Figure 7.3.2-6.**

(d) From the Phatthanakan Intersection to the Si Thepha Intersection (urban road), in the 6-lane suburban road section (both directions), the foundation and pier alignments are mostly within the alignment of water channels in the middle of the road. The area of water channels in the middle of the road and inner road shoulders in this section is large enough to be reserved as a construction area. Thus, during normal time, the number of traffic lanes available will be the same as today. The width of the lanes will be the same as today. The depressed median and inner road shoulders of 1.5 m each side will be adjusted to be an 8-m construction area. A temporary concrete wall will be installed between the construction area and the road surface. The pattern of traffic management during the construction on Srinagarindra Road from the Phatthanakan Intersection to the Si Thepha Intersection (sub-urban road) is shown in **Figure 7.3.2-7**. When the construction of the foundation and pier structures is completed, the road surface of 10.5 m per direction can be returned to the original condition. A lane of the road surface per direction will be added, with a 4-m wide median without a need for acquiring land or widening the road surface into the footpath. The pattern of traffic management after the construction on Srinagarindra road from the Phatthanakan Intersection to the Si Thepha Intersection (sub-urban road) is shown in **Figure 7.3.2-8.**

(e) Thepharak Road (from the Si Thepha Intersection to the Samrong Intersection) has 40-m wide right-of-way. The pattern of traffic management on Thepharak Road involves three lanes per direction, each being 3.50 m width. There are a 4-m wide raised median and a footpath on each side. The pattern of traffic management on Thepharak Road from the Si Thepha Intersection to the Samrong Intersection is shown in **Figure 7.3.2-9.**

The construction of the project along the Thepharak Road from the Si Thepha Intersection to the Samrong Intersection comprises the elevated structures of guideways and stations. Thus, it is necessary to reserve a construction area of at least 7 m along the median of Thepharak Road at different sections, each being 500 m during the foundation and pier construction. In addition, it is necessary to reserve a lane for a construction area for transporting materials and soil during nighttime. During normal time, the number of traffic lanes available will be the same as today, but the width of the lanes will be reduced, from 3.50 m to 3.00 m. Therefore, the width of the road surface will be 9.00 m, and there will be three lanes provided per direction as today. The pattern of traffic management during the construction on Thepharak Road from the Si Thepha Intersection to the Samrong Intersection is shown in **Figure 7.3.2-10.**

When the construction of the foundation and pier structures is completed, the road surface of 10.5 m per direction and the 4-m wide median can be returned to the normal condition as today, without a need for acquiring land or widening the road surface into the footpath. The pattern of traffic management after the construction on Thepharak Road from the Si Thepha Intersection to the Samrong Intersection is shown in **Figure 7.3.2-11**

1.7) Ensure that the drivers for transporting materials and equipments for construction will strictly comply with traffic rules and limit their driving speed when they drive past community areas or susceptible areas, such as temples/religious places, educational institutions, and health facilities to a maximum of 30 km/hour to prevent road accidents for themselves or the road users.

1.8) Improve the road surface on the existing road networks under the structures of elevated guide way and stations and associated areas to ensure its evenness. After construction areas are returned, clearly define the boundary of respective lanes.

1.9) Install lighting in areas under the stations and footpaths along the existing road networks to illuminate the road surface. The illumination should be at least 21.50 lux, which should be similar to natural light as much as possible to prevent accidents.

1.10) Install guide way, mesh to prevent material waste, noise walls, sound barriers, and water traps; keep material waste away from the road surface; and ensure safety of people concerned and local people who travel past the construction areas.

1.11) Install lighting in areas under the structures of elevated guide way , MRT stations, and footpaths along the existing road networks.

1.12) If there are construction activities that will block travel on the footpaths, provide temporary pedestrian ways and install direction signs to ensure the safety of bus users.

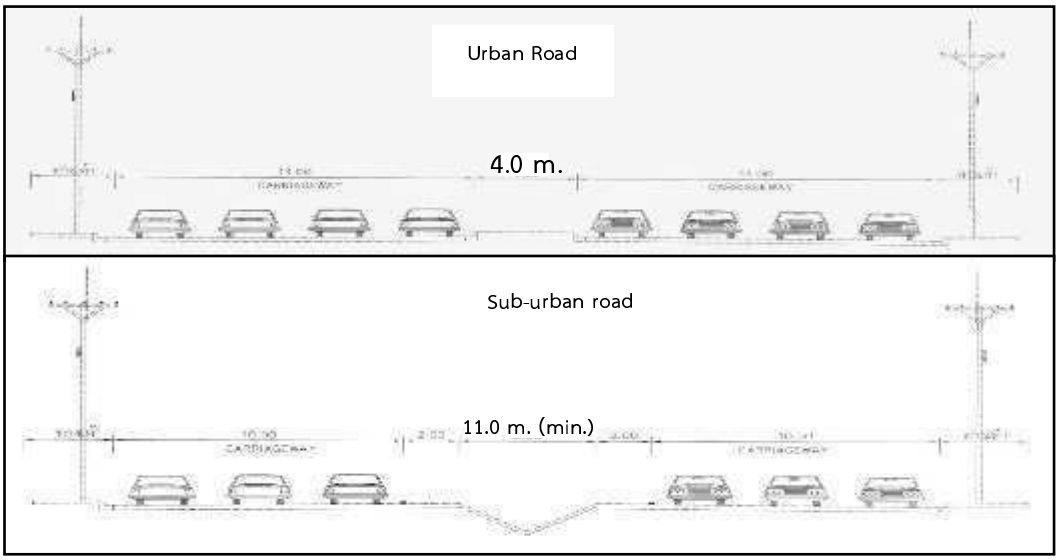


Figure 7.3.2 - 4 The pattern of traffic management on Srinagarindra Road from the Phatthanakan Intersection to the Si Thepha Intersection

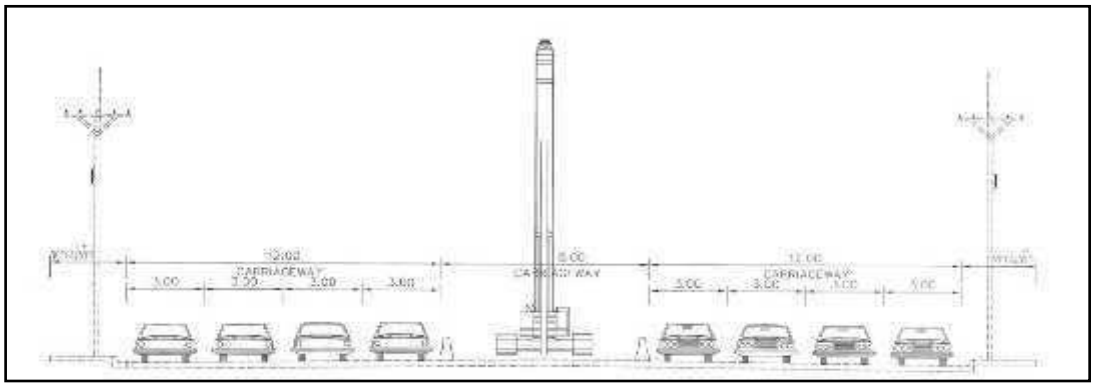


Figure 7.3.2 – 5 The pattern of traffic management pattern during the construction on Srinagarindra road from the Phatthanakan Intersection to the Si Thepha Intersection (urban road)

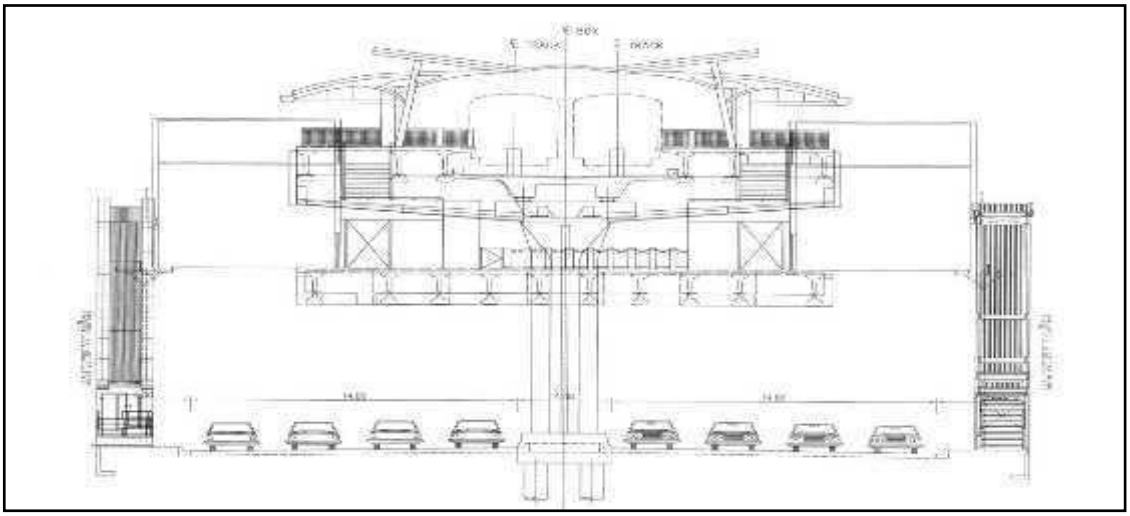


Figure 7.3.2 - 6 The pattern of traffic management after the construction on Srinagarindra Road

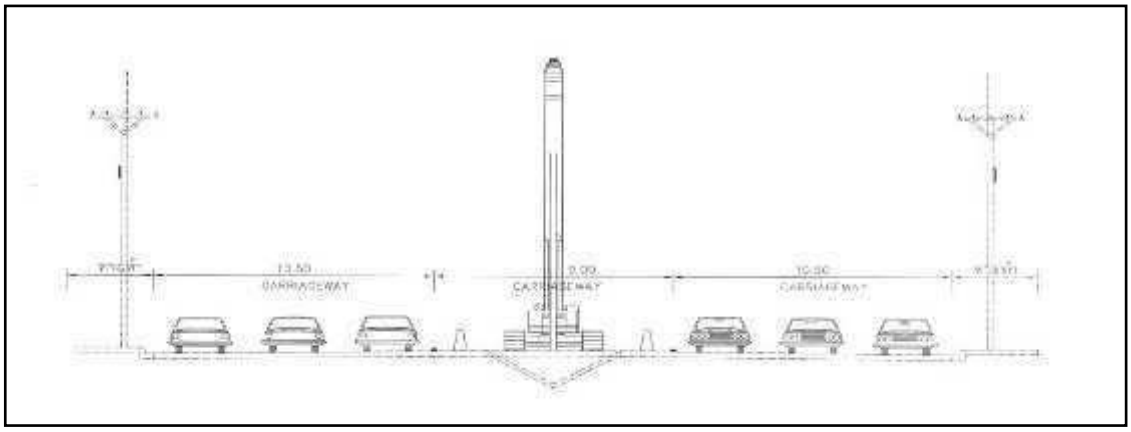


Figure 7.3.2 - 7 The pattern of traffic management during the construction on Srinagarindra Road from the Phatthanakan Intersection to the Si Thepha Intersection (sub-urban road)

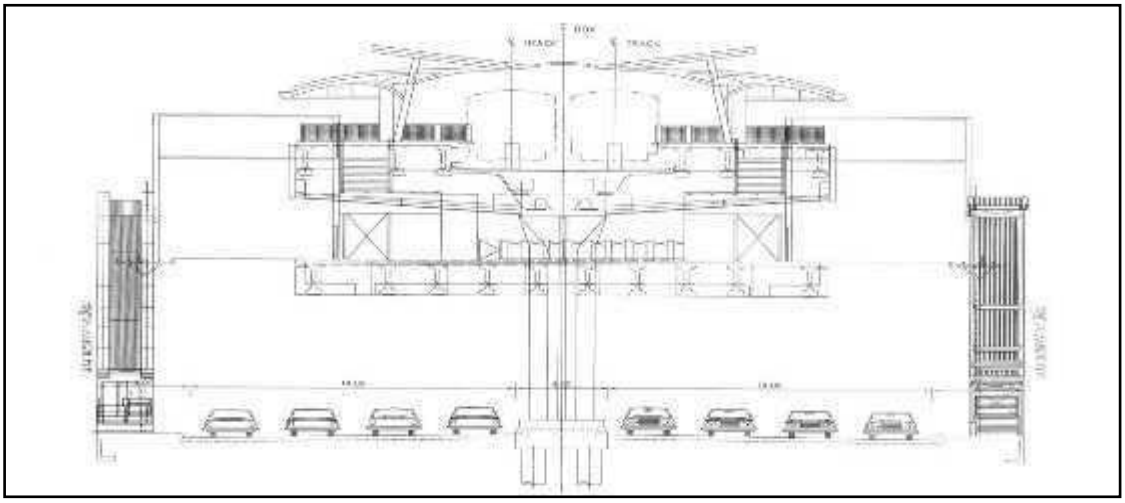


Figure 7.3.2 - 8 The pattern of traffic management after the construction on Srinagarindra road from the Phatthanakan Intersection to the Si Thepha Intersection (sub-urban road)

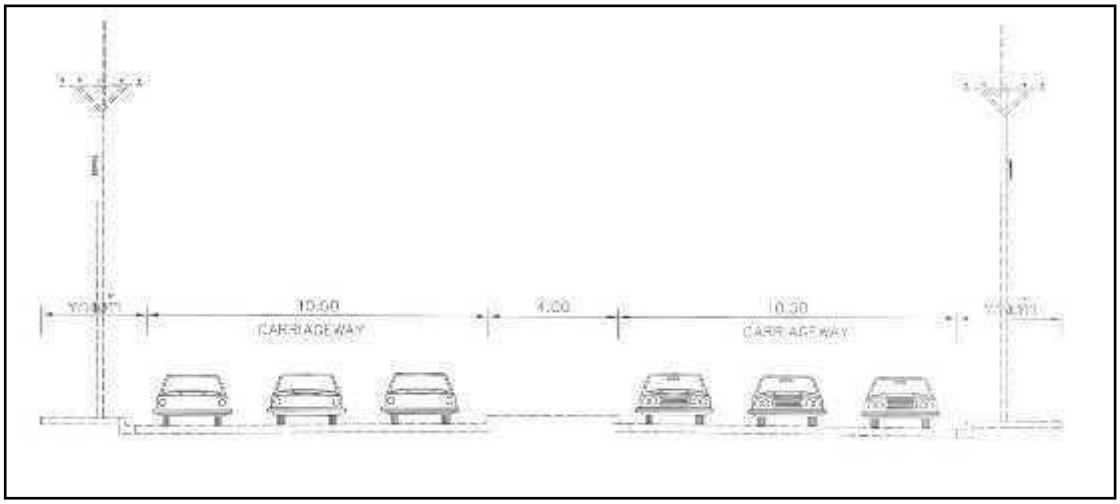


Figure 7.3.2 - 9 The pattern of traffic management on Thepharak Road from the Si Thepha Intersection to the Samrong Intersection

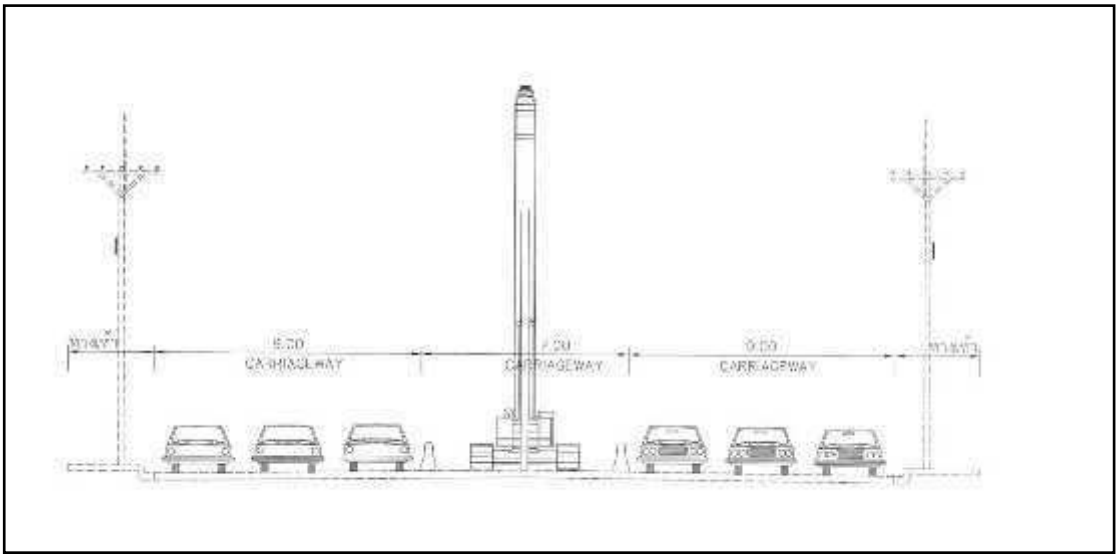


Figure 7.3.2 - 10 The pattern of traffic management during the construction on Thepharak Road from the Si Thepha Intersection to the Samrong Intersection

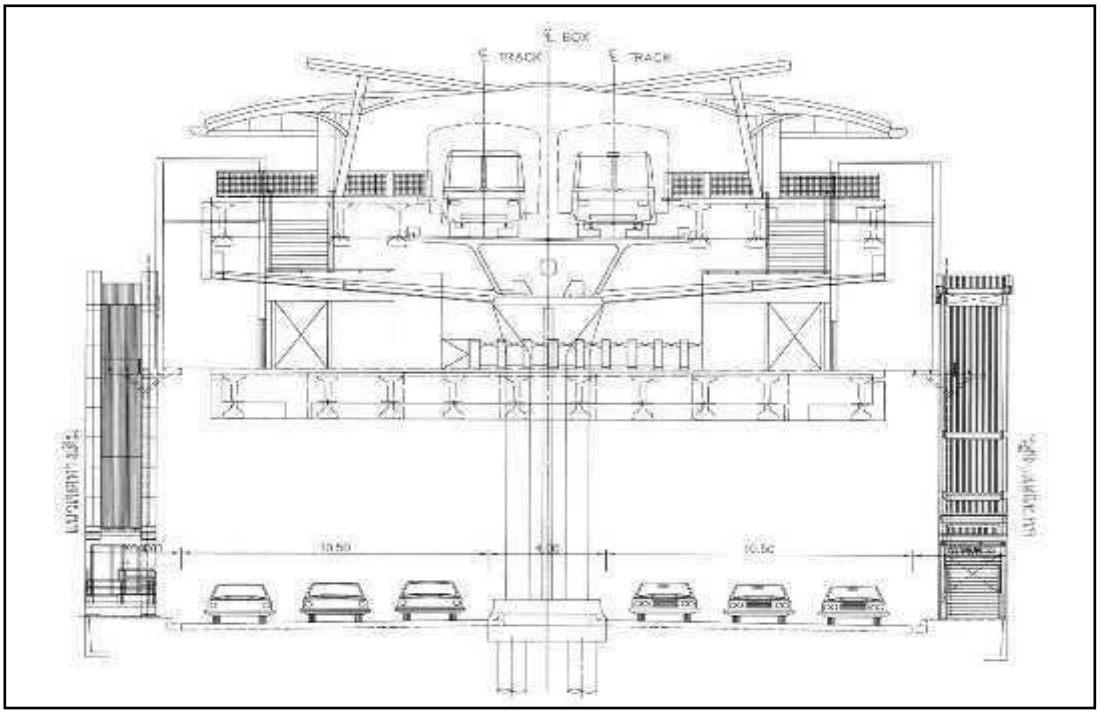


Figure 7.3.2 - 11 The pattern of traffic management after the construction on Thepharak Road from the Si Thepha Intersection to the Samrong Intersection

2) Operational phase

The project development is part of the government policy to address the issue of traffic in Bangkok and peripheral provinces, especially on the existing road networks and connected areas. The MRT system can move a large number of passengers with a short travel time. This is an important choice of users of the existing road networks and connected areas. Thus, the project has a positive impact on the overall traffic conditions on the exiting road networks and connected areas, which is better traffic flows. The structures of the elevated guide way and the MRT stations will not

result in a decrease in the road surface because of the use of medians of the existing road networks and footpaths. Thus, no impact prevention and mitigation measures were proposed. Proposed measures were the measures to enhance the benefits for the transport network on the existing road networks and connected areas.

2.1) Carry our public relations activities and campaigns for encouraging those with personal vehicles to shift to the mass transit system to resolve the problems of traffic jam and air and sound pollution. Incentive measures can be implemented on a periodic basis, such as offering discounted fares during festivals, offering a monthly ticket with a discount of at least 20 percent, and waiving the fares for people aged 60 or above.

2.2) Install non-parking signs for all types of vehicles on the existing road networks throughout the length of the stations for approximately 250 m: approximately 50 m ahead and behind the stations.

2.3) Coordinate with related agencies, such as the Bangkok Metropolitan Administration (responsible for the Bangkok Mass Transit system) or the Marine Department (responsible for boats) to connect to other public transport systems to transport passengers with the maximum efficiency.

2.4) Request cooperation from relevant authorities, particularly police stations with areas of responsibility along the project alignments, in order to ensure that the management of traffic on the existing road networks and connected areas will be in line with project time.

7.3.3 Public Utilities

During the construction and operation phase for depot and park & ride buildings, especially excavating and stripping areas for the excavation of foundations to support the structure of elevated guide way and stations, it is necessary to use medians of some roads, e.g. Lat Phrao, Srinagarindra, and Theparak Roads or areas along the footpath. This will affect public utilities of the following agencies:

Agencies	Details
The Metropolitan Waterworks Authority (MWA)	Plumbing pipes with a length of 20,620 m
The Metropolitan Electricity Authority (MEA)	440 high-voltage electric poles/electric cables/electrical equipment
The Department of Highways (DOH)	1) 3,300-m long drainage pipes 2) 820 lighting poles 3) The Bang Kapi Intersection Flyover (4 lanes) with a length of 1,820 m
TOT Public Company Limited (Thailand) (TOT)	1) A 2,700-m long telephone cable system 2) 11,700-m long communication system/fiber optic cables/media cables
CAT Telecom Public Company Limited (CAT)	11,700-m long communication system/fiber optic cables/media cables
Fuel Pipeline Transportation Limited (FPT)	30-m long oil pipes
PTT Public Company Limited	30-m long natural gas pipes

It is expected that the impact on public utilities will be at moderate-high levels; therefore, it is necessary to provide impact prevention and mitigation measures, which are described below:

1) Pre-construction phase

1.1) Request approval for the construction schedule and breakdown construction schedule.

1.2) Inform the starting date of the project and coordinate with relevant public and private agencies in Bangkok Metropolitan and Samut Prakan areas. This must comply with conditions specified by the agencies.

1.3) Appoint the Employment Screening and Supervision Committee of the MRTA and provide the contractor with the list of committee members. After that, the contractor shall submit the list of personnel to the MRTA for approval before the construction. These personnel consist of project engineers, representatives of employees, as the representatives with the full authority to implement the project, field managers, foremen, pipe technicians, welders, etc.

1.4) Conduct PR activities before the construction – The contractor must install different signs, which consist of information signs, construction signs, and traffic signs in order to ensure orderliness and safety of the general people and to publicize the construction (**Figure 7.3.3-1**). The contractor shall submit details about the type, number, and location of the signs for approval before the installation. The type and forms of installation must conform to conditions specified in the contracts. The contractor must be urged to post the signs 15 days before implementation on the first route.

Figure 7.3.3 - 1 Example of information board, construction signs, and traffic signs during the construction phase

1.5) Install at least 2 m high or equivalent solid fences, as shown in **Figure 7.3.3-2,** to mark the boundary of the areas where public utilities must be relocated.

1.6) Request approval for traffic management plans - Culvert construction and jacking are usually carried out on the main roads. Although making long grooves using the traditional methods is not allowed, activities in the work process, including relocating machinery and transporting pipes, usually disturb traffics in the local areas. The contractor is required to submit a traffic management plan to the Royal Thai Police or local police to ensure a proper traffic management system and minimal trouble during construction.

1.7) Relocation of plumbing pipes must be strictly based on methods of the MWA and other authorities.

2) Construction phase

2.1) Vehicles used for transporting public utilities must be covered in mesh or canvas to prevent them from falling onto the road surface and the speed of driving to the locations where materials are kept must not exceed 30 km/hour.

2.2) Provide temporary footpaths and direction signs in the case when the relocation of public authorities disturbs traffic on the footpath to ensure safety to the pedestrians.

2.3) If there is a complaint from the general public or road users that 'the relocation of public utilities' has caused trouble and nuisance or caused damage to existing public utilities, corrective actions must be urgently taken.

2.4) Repair of road surface, footpaths and road side

(a) Maintain road surface, footpaths, road side, trees, and grass that are damaged by the relocation of public utilities based on standard requirements identified in drawings or standard requirements from the area owners so that they return to the original conditions. In practice, photos that show the original conditions should be taken for comparison.

(b) Check which agencies are responsible for areas in which maintenance will be carried out and what maintenance requirements are : Use of materials, material compaction, and the thickness of the subbase shall meet the requirements of road owner agencies. Traffic signs and other signs must be installed to prevent accidents and to provide facilitation at necessary locations, e.g. merged lanes, intersections, and access roads to houses in order to avoid unnecessary suffering.

(c) For the affected footpaths, road shoulders, trees and grass, grooves to maintain must be made in a straight alignment and existing steel needs to be maintained. The new steel must be in accordance with details in drawings. Laying floor tiles or concrete must be properly done. The surface must be even and slopes in line with curbs. Furrows or basins must be prevented. If existing footpaths have decorative grooves, they shall be furnished in line with the original conditions as much as possible. The materials used to repair the footpaths or road shoulders must comply with details in drawings or standards of agencies that are their owners. The top surface must be repaired to return to its original or better conditions. Trees and grasses that have been damaged or temporarily relocated because of piping must be maintained (**Figure 7.3.3-3**).

3) Operational phase

During the operational phase is expected that there will be no loss or relocation of additional public utilities. Instead, areas along the alignment will be positively impacted by additional public utilities, e.g. the power system, water supply system, and telecommunications system.

For electromagnetic emissions and power supply in the MRT driving system, design and installation of electrical systems must be in accordance with the requirements of the Electromagnetic Compatibility (EMC) Standard (IEC 6100).

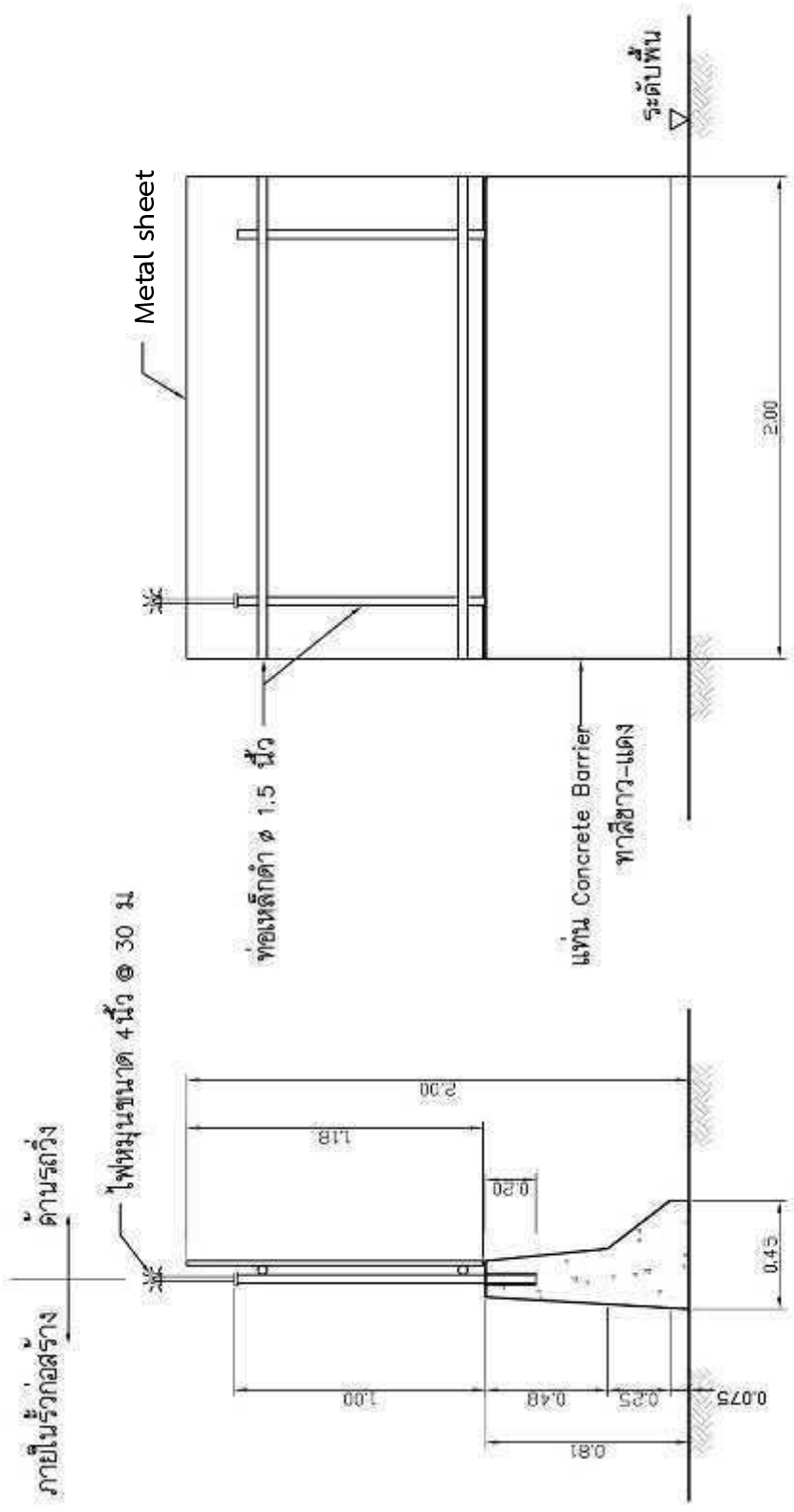


Figure 7.3.3 - 2 Installation of Solid fences at least 2 meters in height or equivalent for marking the boundary of construction area.


Figure 7.3.3 - 3 The maintenance of sidewalks at the end of construction phase

7.3.4 Flood Control and Drainage

The construction and operation of depot and park & ride buildings, especially during construction, can obstruct the flows of water into the public drainage system or lowland areas or surface water. It is expected that the impact will be at a moderate level, so impact prevention and mitigation measures are required, which are as follows:

1) Construction phase

1.1) The contractors shall provide 2-3 construction workers regularly stationed at the construction site to conduct monitoring and collect construction material wastes, such as dirt, stone, sand, and cement falling in the construction areas or the road surface on the existing road networks on a daily basis. If there are leftover materials from the construction, they must be moved out from the construction areas as soon as possible or within 24 hours to prevent obstruction to natural water flow, especially during the rainy season.

1.2) Request the contractors to place necessary construction materials in proper locations and not to place them in areas that can obstruct water flowing into the public drainage channel during the rainy season or lowland areas or surface water, e.g. Khlong Nam Kaeo, Khlong Bang Sue, Khlong Lat Phrao, branch canals of Khlong Yai Phuean, Khlong Saen Saeb, Khlong Hua Mak, Khlong Ban Ma, Khlong Prawet Burirom, and Khlong Khlet.

1.3) The design of the structures of elevated guide way on Srinagarindra Road in the areas where there are water channels in the middle of the road should include a drainage system that have similar efficiency to the original one.

1.4) In the construction areas for depot, temporary sediment traps in the southern part will be excavated, with a capacity of at least 5,100 cu.m. for rainwater during the construction phase before it is released into Khlet Canal and Sarai Canal.

2) Operational phase

1.1) The depot manager shall monitor and maintain the drainage system and areas around the automated drainage system of retention ponds at least once per month, especially before the rainy season or the time when it is expected that out-season heavy raining will occur.

1.2) Pump rainwater from rainwater retention ponds of the project to release to Khlet Canal after rain stops.

1.3) Check the levels of water in Khlet Canal before releasing it from the project areas. In the case when the level of water in the canal is over 0.50 m below the bank, pump it out. If the water level in the canal reaches 0.10 m from the bank level, wait until the water level decreases before pumping, so this will not affect drainage or flooding outside the project areas.

7.4 Quality of Life value

7.4.1 Socio-Economic

The development of the project and depot will have socio-economic impacts on local communities along the project alignment and areas surrounding depot during the construction and operation periods. Particularly, during the construction period, the impacts will consist of expropriation of property and impacts on business and travel between communities. It is expected that the impacts will be at low-high levels. Impact prevention and mitigation measures are as follows.

1) Construction phase

1.1) Although the likelihood of conflict between pedestrians on the existing road networks and local people and project employees/construction workers will be very low, it is necessary to provide measures for preventing and mitigating the impacts.

(a) For working in the project or depot construction areas, the project outline must be publicized through the Bangkok Metropolitan Administration local agencies (District offices) or municipalities that are area owners at least 30 days in advance. The local agencies will further publicize this through community leaders, who will inform this to their people members.

(b) The contractors must ensure that project staffs and construction workers will not behave in a way that creates nuisance, trouble, or dispute with local people or users of the existing road networks along the construction areas.

1.2) To address the issues of nuisance, trouble, discomfort, or worry about safety in life and property of local residents or users of the existing road networks, the impact prevention and mitigation measures have been proposed.

(a) Establish an information and complaint center at the project office, which will receive information or complaints from affected people. It has to post a sign which contains a phone number, e-mail address, provide staff stationed 24 hours a day, as well as collect and process data on complaints, suggestions, and results of corrective actions to the MRTA at least once a month to assist affected people.

(b) The contractor has to carry out construction with caution to avoid damage to life and property of local citizens in the construction areas, such as damage to the road surface and travel within the local communities. If this cannot be avoided, minimize the impact within three days.

(c) Make an announcement to the general public or users of the existing road networks during the construction at least seven days before traffic is blocked to carry out construction or large construction materials equipments transportation, via several media, such as billboards, brochures, newspapers, traffic radio stations (Jor Sor 100, Sor Wor Por 91, Ruam Duay Chuay Kan), websites and TV stations.

(d) Provide at least two security staff per construction area to monitor the construction areas and facilitate traffic during construction activities.

1.3) To create benefits for, or gain acceptance from, local communities, a condition that shall be stated in the employment contract is the contractor has to recruit skilled workers or construction workers from individuals whose hometown is in Bangkok Metropolitan or Samut Prakan province or individuals who can show evidence that they are domiciled in Bangkok Metropolitan or Samut Prakan province.

1.4) If there are complaints from existing business operators along the construction areas, affected persons have to be allowed to express their opinions about resolving or alleviating the problem under the principle "public participation" based on rights specified in the Constitution of the Kingdom of Thailand, B.E. 2550 (2017). It is necessary to attach great importance to solving or mitigating the problem seriously and urgently through, for example, e.g. mental healing. The contactor has to immediately rectify situations caused by construction.

1.5) A mobile mass relations unit has to be established to carry out public relations activities on a periodic basis and to create a positive understanding between the contractor and people in local communities near the construction areas. This unit has to publicize information about the characteristics and steps of construction, the disaster prevention system, and the monitoring system to avoid impacts; and acknowledge information and opinions of the general public at least once a month. The information will be studied to make improvements or mitigate impacts during construction or to make the construction schedule clear and be in line with local people's needs.

1.6) The MRTA must provide a mass relations unit, which will participate in activities within local communities along the construction areas to create familiarity and acceptance by local people.

2) Operational phase

If small establishments located near the stations are entirely or inevitably affected, they have to receive special mental healing. Mental healing measures consist of, for example, granting them the privilege to work or do business on the stations or entitling them to receive fair compensation/mental healing cost and business opportunity cost.

7.4.2 Property Compensation

It is expected that the project and depot development, especially land acquisition and compensation for structures/trees of the government and private sectors along the project alignment in the sections that veer off the median of the existing roads or depot construction areas will have moderate-high impacts. Thus, it is necessary to formulate impact prevention and mitigation measures, as follows:

1) Construction phase

1.1) Public consultations have to be organized to inform affected persons about information, e.g. project details, expected benefits, procedure/methods of expropriation, as well as rights and duties of affected persons at least 18 months before the construction starts.

1.2) The royal decree on land demarcation for acquisition will identify the starting-ending points and width of the area boundaries under the royal decree.

1.3) The royal decree will be posted at different places, e.g. offices of officers, the Bangkok City Hall and the Samut Prakan City Hall, the Land Office of the BMA and its branches, the Samut Prakan Provincial Land Office and its branches, the Chatuchak/Huay Kwang/Wang Thonglang/Bang Kapi/Suan Luang/Prawet/Bang Na District Offices, and the Samut Prakan District Office.

1.4) Survey of property to expropriate (such as land, structures, and crops) – Acquisition officers must inform the property owners of the date of survey in writing at least 15 days before the survey. They have to conduct detailed survey on the number of directly affected persons to identify their need for assistance from the government sector, as well as methods/approaches/duration for paying compensation, or suggestions for relocation to serve as the guidelines that are in line with the affected persons' needs the most.

1.5) The Committee for Appraisal of Land, Property, and Trees Compensation Costs. Basically, the Committee must consist of representatives of affected persons and local community leaders in affected areas, who will participate in considering and establishing criteria for paying property replacement cost.

1.6) Preliminarily, property replacement cost will be paid to the following persons.

(a) The owner or occupant with title to land that will be acquired.

(b) The owner of buildings and other non-removable structures on land that will be acquired on the day of enforcement of the royal decree or a building and another non-removable structure that is built later under authorities' permission.

(c) The lessee of buildings or other structures on land that will be acquired – The lease must come with a written lease document made prior to the day of enforcement of the royal decree or a written lease document made later under authorities' permission. The lease must not be terminated on the day when the officer or authorized person occupies the land, buildings or structures. However, the compensation cost for the lease will be paid to the lessee who suffers from loss as a result of leaving the land, buildings, or structures before the lease agreement is terminated.

(d) The owner of a trees growing on land on the day of enforcement of the royal decree.

(e) The owner of a building or other removable structures on land that will be acquired on the date of enforcement of the royal decree, who shall not be the person who has to remove the building or structure after being notified by the land owner. The compensation will be only for removal, relocation, and rebuilding (in the original condition).

(f) The person who loses right to the use of ways and installation of water pipes, drainage pipes, electrical cables, or other similar things crossing the land that will be acquired under Section 1349 or Section 1352 of the Civil and Commercial Code (in the case when the person pays compensation for the right to the owner of land that will be acquired).

1.7) The property compensation cost should be fair, reasonable, and acceptable to affected persons. Fairness, mental healing cost (opportunity cost), and mental loss must be taken into account. The period for paying compensation must be in line with the project construction schedule, and the payment must be completed before the construction starts. The valuation of

compensation cost for affected persons needs to take into account costs during loss of income that they used to receive, as well as other special compensations to restore their status until they return to normal conditions.

1.8) The issuance of the Immovable Property Expropriation Act to transfer the ownership of the property to the government.

1.9) Implementation of the Immovable Property Expropriation Act, Eviction Act, and Ministerial Regulations on Eviction if necessary, to minimize impacts on the general public. The issuance of the Eviction Act and the Ministerial Regulations on Eviction of the MRTA is described in **Appendix 9L**

2) Operational phase

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7.4.3 Public health and health

The construction and operation of depot and park & ride buildings will have both positive and negative impacts on the health of employees/construction workers, local people, and users of the existing road networks along the project alignment or areas surrounding the depot and park & ride buildings. It is expected that the impacts will be at low-moderate levels, so it is necessary to define impact prevention and mitigation measures, as follows:

1) Construction phase

1.1) Reduce risks of respiratory illness for residents living near the construction areas or staff/construction workers who have to stay in construction areas with air pollution continuously - The contractor must strictly comply with measures for preventing and mitigating impacts on air quality during the construction period.

1.2) Reduce the risks of impaired hearing, such as, deafness and ruptured eardrums of residents living near the construction areas or staff/construction workers within the construction areas exposed to loud noise due to machinery and equipments for eight consecutive hours. Thus, the contractor must strictly comply with sound impact mitigation prevention and mitigation measures during construction.

1.3) In the construction areas or project offices, environmental health should be managed properly based on the recommendation by the Engineering Institute of Thailand under H.M. The King's Patronage and the Ministry of Public Health's requirements.

(a) Provide sufficient clean drinking water (5 liters/worker/day) and water for washing (50 liters/worker/day) for staffs and construction workers working within the construction areas or project offices.

(b) Provide sufficient bathrooms-toilets (1 bathroom/toilet/10 people) which are equipped with a septic tank system within the project office.

(c) Provide sanitary waste containers in the construction areas and project offices: containers for wet waste (green), containers for dry waste (yellow), and containers for hazardous waste (red or orange).

(d) Provide sufficient waste containers for the amount of waste generated: waste from workers' housing, construction material waste, hazardous waste, etc., at various points around the construction areas; and request waste collection trucks of agencies responsible to collect the waste for disposal on a daily basis. The contractor must gather the waste in areas which are convenient for waste collection trucks to collect.

(e) Recyclable waste, e.g. wood, galvanized iron, and steel scrap should be separated for recycling or selling to reduce the amount of waste for disposal.

(f) Hazardous waste generated from maintenance and machine operation has to be separated from general waste for disposal collection.

(g) Monitor and maintain waste containers and ensure that they are covered with lids.

(h) The construction workers must put solid waste in containers provided.

(j) The contractor must comply with laws on pollution control, solid waste, infectious waste, and hazardous substances and must manage and dispose of contaminated waste with appropriate and safe methods.

1.4) Provide workers with temporary shelters in the construction areas for daytime rest located in the vicinity of the construction areas, as shown in **Figure 7.4.3 - 1**. The temporary housing consists of:

(a) Provide shelters with an appropriate size, where workers can have lunch and relax but are not allowed to cook.

(b) Two temporary toilets, with built-in tanks connected to septic tanks. These toilets will facilitate construction workers, and there must be staff responsible for cleaning the toilets and removing waste from the toilets every 1-2 weeks.

(c) Provide construction workers with sufficient clean water for drinking and washing face and hands only.

(d) Provide containers for wet and dry waste, e.g. food waste and plastic bags, and relocate it every 5-10 days.

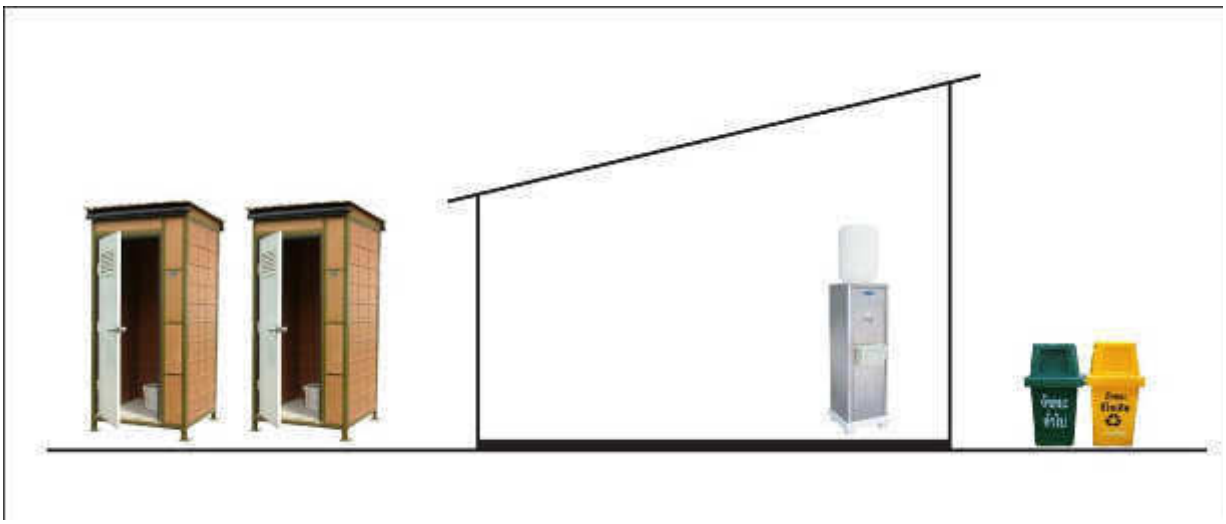

Figure 7.4.3 - 1 Temporary shelters for construction workers

1.5) It is estimated that there will be 200 workers involved in the project construction. The estimated amount of water usage, wastewater, and waste is as follows:

Amount of water usage

Number of workers	=	200	person
Amount of water usage	=	200	liters/worker/day (Kriangsak, 1996)
Total	=	40	cum/day

Amount of wastewater

The amount of wastewater from the temporary shelters is based on the amount of water usage in the shelters at the rate: 200 liters/worker/day (Kriangsak, 1996). The wastewater comes from bathrooms, toilets, and other water usage activities. The amount of generated wastewater represents 80 percent of the total amount of water demand (Kriangsak, 1996).

Amount of wastewater = 32 cu.m./day

Management of wastewater and waste generated by the Project during the construction and operation phase involves the design of the septic tank system. Treated wastewater will be drained into project retention ponds, which connect to public retention ponds.

The project construction planning will take approximately four years. Thus, to make construction workers' housing plans, as shown in **Figure 7.4.3 - 2**, it has been proposed to apply the standards and the plans for construction workers' temporary shelters of the Engineering Institute of Thailand under H.M. The King's Patronage (E.I.T. Standard 1010 - 30). This aims to ensure the orderliness of construction workers' housing, without impacts on nearby local communities. Each construction workers' camp, which consists of approximately 1 rai will serve approximately 200 workers. The standard of the construction workers' camp is:

- Five 1-story construction workers' camp, each consisting of 20 rooms (10 rooms on each side of front and back). Each room is designed for two 2 workers, so each camp can serve 40 workers.
- 20 toilets, which are based on standard (sanitary toilets for workers: at least 1 toilet per 10 workers).
- Two bathing-washing areas with four 4.8-m^3 ponds.
- Temporary channels for the water system around the areas and waste or sediment traps.
- Waste containers for workers' housing that are sufficient for construction workers and waste rest areas, from which relevant agencies will relocate waste.
- Eight 15-lb dry chemical fire extinguishers per each construction workers' house (four upstairs and the other four downstairs).
- Guard box at the construction workers' camp.
- Provide sufficient necessary public utilities, e.g. electricity and water.

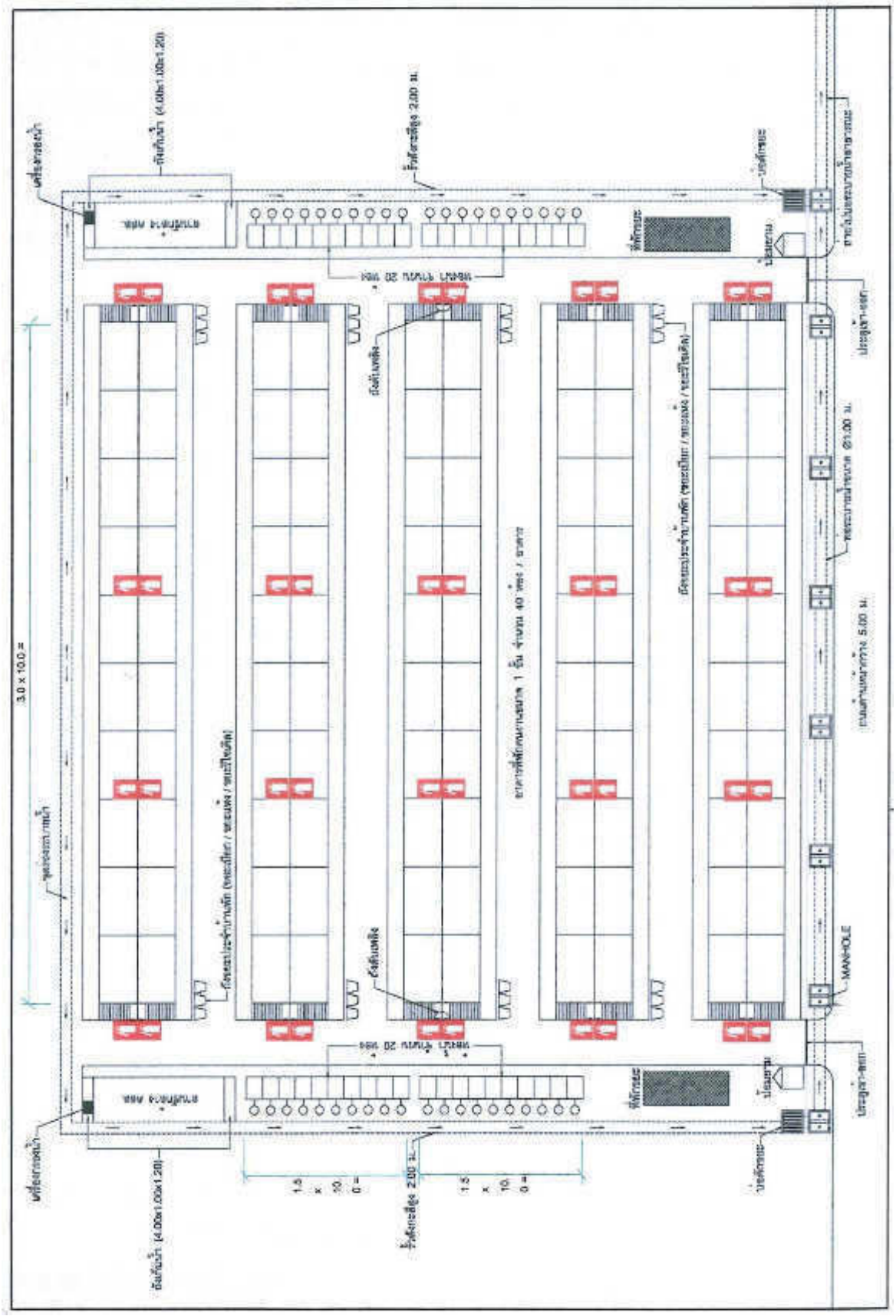

Figure 7.4.3 - 2 Layout of temporary shelters for worker

Amount of solid waste

Solid waste generated within the project consists of two types: general waste and construction material waste.

General waste consists of food waste, paper waste, and plastic waste, which arises from construction workers' consumption activities. The solid waste generation rate is 0.5 kg/worker/day. The details of amount of solid waste are as follows:

Number of workers	=	200	persons
Solid waste generation rate	=	0.5	kg/worker/day
Thus, total	=	100	kg/day

Construction material wastes consist of brick waste, cement waste, wood waste, concrete sacks, wire or other metal scraps. Their amount is not certain. Some types of waste materials can be recycled in construction, such as wood forms, and some can be sold for recycling.

Solid waste arising in the project will be collected and put in containers provided by the BMA, or project staff can coordinate with the BMA to collect the waste for disposal. Municipal waste in Bangkok will be collected and transported to three waste stations, namely the Sai Mai Waste Transfer Station, the Nong Khaem Waste Transfer Station, and the On Nut Waste Transfer Station, as shown in **Figure 7.4.3-3.** General solid waste will be transferred to the landfill in Kamphaeng Saen District. Nakhon Pathom Province and the landfill in Phanom Sarakham District, Chachoengsao Province. Some organic waste will be used to make compost at the On Nut Fertilizer Plant. As for infectious waste and other hazardous waste, the BMA hires a private company to transport and dispose of with a particular method.

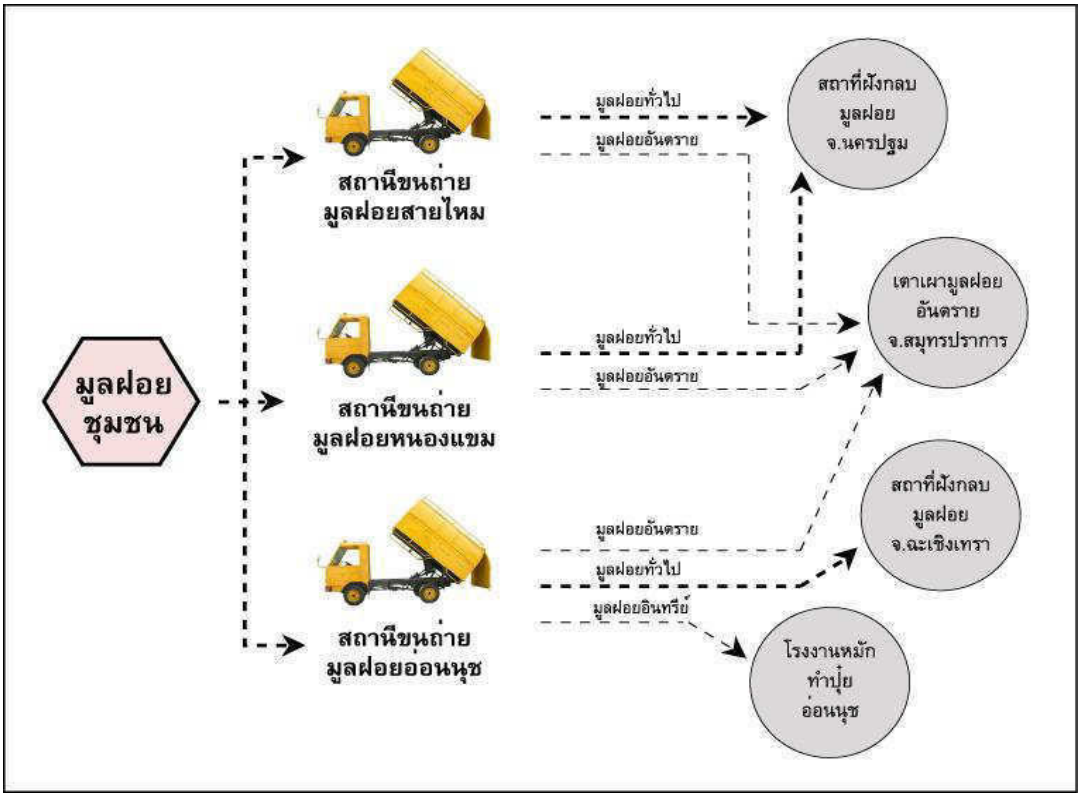

Figure 7.4.3 - 3 Transfer of General solid wastes by Bangkok Metropolitan Administration

2) Operational phase

Because the development of the project, depot and park & ride buildings has positive and negative low-moderate impacts on public health and safety, the impact prevention and mitigation measures and supplementary measures for health monitoring have been proposed, for local people and users of the existing road networks.

2.1) Air quality and Noise impact prevention and mitigation measures during the operation phase must be strictly implemented.

2.2) There must be campaigns for encouraging the general public and personal vehicle users to use the electric train to reduce air pollution and noise levels, which will reduce health problems, especially for the respiratory and hearing systems.

2.3) Drivers of personal vehicles or public transport must strictly comply with traffic rules to reduce accidents, especially in areas under the MRT stations.

2.4) Carry out a public relations program through via several media, such as billboards, brochures, newspapers, traffic radio stations (Jor Sor 100, Sor Wor Por 91, Ruam Duay Chuay Kan), websites and TV stations; and educate the general public about the significance and potential impacts of air pollution from vehicles. They have to avoid direct exposure to air pollution and need to strictly take care of their health.

2.5) Implement the impact prevention and mitigation measures for surface water quality during the operational phase.

2.6) Solid waste management:

- Provide waste containers at the entrance and exit of the stations.
- Investigate the conditions of solid waste management on a regular basis.
- Carry out a public relations program and campaign for encouraging staff in depot and park & ride building to sort solid waste into wet and dry waste before putting it in waste containers. Glass and paper waste have to be sorted out for selling to reduce the amount of solid waste. Hazardous waste, such as batteries must be put in provided waste containers.

7.4.4 Occupational Health and Safety

1) Construction phase

1.1) During the construction, there is a possibility of accidents if workers are reckless and careless. To prevent serious accidents, the contractor must take the actions:

- Establish a safety committee to formulate policies towards safety at work within the construction areas, by developing the construction schedule and safety measures, supervising staff and construction workers to ensure their compliance with safety rules or laws, investigating the causes of accidents, as well as providing advice to training staff and construction workers and train them in prudent work practices.
- Training staffs and construction workers in how to properly use and maintain tools, machinery and devices and assign at least three staff per construction to check and maintain them to ensure that they are always usable. If any of them is damaged, prompt repair is needed to prevent accidents.

- Staffs and construction workers are required to use personal protective equipments at all times while operating within the construction areas to prevent hazard and accidents at work, such as helmets, gloves, dust mask, ear muffs, or earplugs.

- Ensure that construction workers and drivers who transport construction materials and equipments will not use stimulant drugs or substances or drink alcohol during work; and impose severe penalties on the violators, such as work suspension, cutting 50% salary, or dismissal.

- Ensure that drivers who transport construction materials and equipments will strictly comply with traffic rules and the speed limit to 30 km/h, especially when they drive past community areas or susceptible areas, such as education institutions, health facilities, and religious places.

- Provide signs that indicate the boundary of the construction areas and conduct a public relations program through via several media, such as billboards, brochures, newspapers, traffic radio stations (Jor Sor 100, Sor Wor Por 91, Ruam Duay Chuay Kan), websites and TV stations in the case when sections on Lat Phrao, Srinagarindra and Theparak Roads have to be blocked for the relocation of public utilities or large construction materials and equipments, concrete beam laying, etc.

- Define measures to supervise all construction areas; and provide security staff to conduct monitoring and prevent unauthorized and unconcerned persons to stay near or pass the construction areas.

- Build protective equipments or cover the construction areas for the structures of elevated guide way , stations, and other components with mesh or canvas to prevent accidents from the fall of construction materials or equipments, especially stone, steel, concrete, cement or metal residue caused by fire from electrical welding. If any complaints are sent to the information and complaint center, the contractor has to assign relevant staff to investigate the damage and has to be responsible for the damage cost on a fair and reasonable basis or on the actual basis.

- Provide lighting inside the construction areas to ensure road users' safety and provide warning or flashing light signals to indicate the construction areas, especially at night.

- Install lighting in areas under the elevated structures, the stations, and the footpaths along the existing road networks.

- Provide temporary footpaths and direction signs in the case when the relocation of public utilities disturbs traffic on the footpath to ensure footpath users' safe service.

2) Operational phase

2.1) Prepare a safety and occupational health management plan based on an international standard - There must be at least two drills a year for the emergency action plan for safety during critical situations, such as a fire incident on the station, street level, ticketing floor, and platform; evacuation of passengers out of the station/train; stopping train operation; and providing assistance to passengers during evacuation/train derailment.

2.2) Provide red boundary lines, which identify areas which passengers cannot cross over when the train is coming and stopping on the platform, and prepare rough surface for the platform floor.

2.3) Provide public insurance on the lives and property of passengers and the third party.

2.4) Coordinate with, and request cooperation from, agencies involved in safety along the project alignment and areas surrounding depot and park & ride building, such as police stations, hospitals, or disaster mitigation centers; and install a modern coordination system and communication modern that can give notifications when there are emergencies and relocation of equipments for assistance to the scenes within 10 minutes.

2.5) Provide clear warning signs in dangerous working areas.

2.6) Provide an annual health checkup program.

2.7) Provide personal protective equipments for employees who are exposed to dangers, and ensure that they wear the equipments every time they work, such as ear plugs, ear muffs, a dust mask, helmet, safety shoes, and safety glasses.

2.8) Provide emergency drills at least once a year. The Fire Prevention and Suppression Plan is shown in **Appendix 7A**

2.9) Strictly comply with air quality impact mitigation measures.

2.10) Safety measures on the stations are as follows:

- Provide alarm buttons at the stations or platforms and signs that are clearly visible if an emergency or a fire incident happens at the station or platform; and provide security staff that can reach the scene immediately.

- Provide an automatic fire alarm system and automatic fire sprinkler system at the platform and station areas.

- Provide fire extinguishers with instructions at the doors between staff rooms, cabins, and stations.

- Provide emergency stop buttons on the platform floor, which are pressed when an emergency occurs to stop the train from coming to the station when, for example, a passenger or thing falls onto the rail.

- Provide CCTV cameras at the platform and station areas, which are always monitored by staff at the control center.

- Provide evacuation routes, which connect the platform to the monorail in an emergency only.

- Provide first-aid rooms, with necessary equipments and drugs for emergency use, which must be looked after by a doctor at all times.

- Set up a center for coordination with other agencies located near the stations, such as hospitals, police stations, and fire stations.

- Provide training and drills for staff working on emergency prevention and security on trains and stations on a regular basis to ensure preparedness at all times.

7.4.5 Historical Site and Archaeology

The construction and operation of depot and park & ride buildings does not result in loss or relocation of historic or archaeological sites. Instead, it has indirect impacts on historic or archaeological sites or major places of local communities that are located within a radius of 50 m from the construction areas. The impacts consist of dust dispersion, noise from equipments or

vibration, especially during area excavation/filling, relocation of public utilities or structures, transport or relocation of materials and equipments, concrete mixing and so on. It is expected that the impacts will be at low-moderate levels. The measures for preventing and mitigating air quality, sound, and vibration impacts shall be implemented, as outlined below.

1) Construction phase

1.1) Dust dispersion from construction will cause damage, dirt, disturbance, and nuisance to visitors to two places situated within a radius of 50 m from the source of dust, which consist of Lat Phrao Church and Fatthullbalee Mosque. The impact prevention and mitigation measures are as follows:

- Comply with rules and practices on control of dust from different types of construction of the Committee on Air Pollution in Bangkok and Communities in Thailand.

- Spray water at the surface of the existing road networks at least 3-4 times a day along the construction areas and areas where dust dispersion may occur, e.g. earth and sand piles or areas where top soil stripping and excavation/foundation excavation occur. Construction material waste or piles of earth excavated should be removed out of the construction areas as soon as possible or within 24 hours.

- Provide at least 3-4 staffs to clean construction areas after completed construction activities are each day; and regulate the placement of construction materials and equipments to dust dispersion throughout the construction phase.

1.2) The noise caused by heavy and large machineres may disturb visitors to two places located within a radius of 50 meters from the source of dust, which consist of Lat Phrao Church and Fatthullbalee Mosque. The impact prevention and mitigation measures are as follows:

- Utilize tools, equipments and machinery that do not cause loud noise and utilize noise reduction or control devices (such as soundproofing pipes or casing) in the case when the noise level exceeds 90 dB (A) at the source for one consecutive hour.

- Provide at least 3-4 staffs to control, maintain and check machines, equipments and vehicles for construction purposes throughout the construction phase to prevent excessive sound levels defined by relevant authorities, such as the Department of Land Transport, the Office of Natural Resources and Environmental Policy and Planning (ONEP), and the Pollution Control Department.

- Limit the speed for driving for transporting materials and equipments to 30 km/hr in the case of passing through residential and commercial areas, hospitals, religious places/temples, and educational institutions to prevent loud noise, especially during students' study, dhamma practice (morning-evening paying respect to senior monks, chanting, and prayer), as well as rest or sleep.

1.3) Vibration from pile drilling and boring for the construction of foundation for the structures of elevated guide way and stations may have an impact on two major places of local communities located within a radius of 30 meters from the source of vibration, which consist of Lat Phrao Church and Fatthullbalee Mosque. The impact prevention and mitigation measures are as follows:

- Construction of the foundation of the structures of elevated guide way and stations shall involve the circular bored piles or barrette piles to reduce vibration levels.

- Driving steel sheet piles during the construction of foundations of the structures of elevated guide way and stations must be conducted beyond the soft-moderately soft clay layers with a depth of approximately 18 m, which helps block and reduce vibration that affects surrounding areas.

- If construction activities continually result in vibration, especially the excavation for foundation construction, it is necessary to decrease energy for pile drilling each time, by increasing the number of drilling to reduce vibration levels.

- Ensure that vehicles for relocating construction materials and equipments will use a speed limit to 30 km/hr and have a load that does not exceed 25 tons to reduce vibration levels in the case when they pass major places of local communities (Lat Phrao Church and Fatthullbalee Mosque).

1.4) Construction activities, such as area excavation and filling, pile drilling for foundation construction, the relocation of public utilities or structures, as well as the transport of materials and equipments may cause inconvenience of accessing six places, which consist of religious places, historical sites, and major places of local communities located within a radius of 500 m from the construction areas. They consist of Lat Phrao Church, Wat Mae Phra Kularb Tip (Maria Rose Mystica church), Fatthullbalee Mosque, Darissalam Mosque, the Ko Klang Health Center, and Ulidhard Mosque. The impact prevention and mitigation measures are as follows:

- Avoid traveling through the existing road networks and use other alternative routes or request cooperation from road users to comply with the traffic management plan.

- Avoid traveling during peak hours on the existing road networks if it is not necessary, in order to allow minor roads to adequately accommodate the volume of traffic redirected from the existing road networks.

- Public relations or announcement via media (such as billboards, brochures, traffic radio stations) to inform the general public or road users about construction and traffic blockage in particular areas must be carried out at least 15 days in advance. There should be campaigns for traffic discipline and traffic rules, traffic rule enforcement, detection and arrest of traffic rule violators, especially in areas where turning or u-turning is not allowed to ensure good traffic flows.

- Improve the road surface on the existing road networks under the structures of elevated guide way and stations and connected areas so that it is even and smooth; and make the lines for the boundary of the guideway in each lane after construction areas are returned.

2) Operation phase

The impacts during the operation phase can result from vehicles running on the road network below the elevated structures or stations. However, the monorail train operation system of the project is an electric system, so it does not emit pollution. In addition, it produces low levels of sound and vibration, and it provides fast and convenient travel. Thus, it is estimated that this will have a low indirect impact on historical sites, religious places, or major places of local communities. Thus, no additional impact prevention and mitigation measures were provided.

7.4.6 Aesthetics and Tourism

The construction and operation of the Project and depot will result in the blockage and loss of the city scenery at a low level, except for sections where there are historically/culturally important places and unique, valuable, and outstanding structures located within the zone of influence that will have a scenery impact or located within 50 meters from the project alignment. An example is Si Iam Temple (20 km away from the project alignment). Therefore, this is expected to be moderate impact. The impact prevention and mitigation measures are as follows:

1) Pre-construction phase

1.1) The detailed design for the stations should involve urban design, which focuses on thinness, lightless, and harmony with the existing environment. It will involve modern, yet simple engineering and architectural forms in order to reduce impacts and enhance view at the stations. The detailed architectural design and landscape architecture design at respective stations does not need to be the same. It can vary according to their environment to offer a unique and beautiful look.

1.2) The detailed design for the structures of poles and elevated guide way should be in harmony with the environment. The structure should be round, compact, thin, and non-solid. Grooving will be applied to reduce hardness.

1.3) Consider using materials with pale or bright colors to result in the structures of elevated guide way or stations being in harmony with the environment and reduce the level of hardness from the existing view.

2) Construction phase

2.1) Install solid fences that are at least 2 meters high or equivalent to define the boundary of the construction areas; and provide signs that identify the boundary of construction areas and signs that show the scenery of the Project in the future. This aims to reduce the impact on the scenery in the construction areas.

2.2) Avoid creating unsightly view within the construction areas by, for example, leaving garbage being outside the waste containers, disorderly placing construction equipments and material waste, or leaving them without plastic or canvas cover.

3) Operation phase

Grow medium-size shrubs/vines to enhance landscape or reduce the hardness of the structures of elevated guide way within the vacant space along the medians of the existing road networks or along both sides of the footpath, to improve the city view.

Chapter 8
Environmental Monitoring Programs

8.1 Introduction

For the implementation of the Bangkok Mass Transit Yellow Line Project : Lat Phrao – Samrong Section, environmental impact prevention and mitigation measures have been formulated. These environmental impacts include air quality, noise, vibration, surface water quality. In addition, environmental impact monitoring measures have been developed to monitor environmental impacts that are significant issues that may arise from the project development during the construction and operation phases. The environmental impact monitoring plans are necessary as results of the monitoring can be studied to improve the impact prevention and mitigation measures in line with actual situations during the construction and operation phase

To monitor environmental impacts of the project development, these agencies shall be involved:

1) During the construction phase, the contractors shall be responsible for costs incurred during the environmental impact monitoring process throughout the employment agreement phase (approximately 48 months). The third party environmental compliance audit that has been authorized by the Office of Natural Resources and Environmental Policy and Planning (ONEP) to prepare EIA reports shall be engaged to supervise the project implementation and preparing reports on the compliance with the environmental impact prevention and mitigation measures. The schedule for submitting the reports to the ONEP is once per six months (in January and July of every year). The Mass Rapid Transit Authority of Thailand (MRTA) shall ensure the contractor's strict compliance with the impact monitoring plans specified in the report.

2) During the operation phase, the train operator under the supervision of the MRTA shall regularly implement the environmental impact monitoring plans included in the report, in order to monitor the intensity of the impacts throughout the operation phase. This aims to maximize the benefits, efficiency and cost-effectiveness of the project and minimize its impacts on environmental quality and local people. The third party environmental compliance audit that has been authorized by the ONEP to prepare EIA reports shall be employed to prepare environmental impact monitoring reports, which will be submitted to the ONEP once six months (in January and July of every year).

8.2 Environmental Monitoring Programs

There are seven environmental monitoring Programs, as follows:

8.2.1 Surface Water Quality /Wastewater Monitoring Plan

8.2.2 Air quality Monitoring Plan

8.2.3 Noise Monitoring Plan
8.2.4 Vibration Monitoring Plan
8.2.5 Transportation Monitoring Plan
8.2.6 Socio-Economic Monitoring Plan
8.2.7 Public Utility Relocation Monitoring Plan

8.2.1 Surface Water Quality /Wastewater Monitoring Plan

(1) Rationale

Construction activities that involve cutting across water bodies will have impacts on the water bodies. The impacts include the increase in suspended sediments and turbidity and contamination with wastewater from the Construction Supervision Office and the worker's Camp, which may directly impact the surface water quality. Despite environmental impact prevention and mitigation measures, it is necessary to monitor the wastewater quality, which may be affected by project activities. This aims to obtain data from the monitoring to optimize these measures.

(2) Objectives

(1) To monitor impacts on the quality of water in the project areas during the construction and operation phases.

(2) To monitor the impacts of the project development on the quality of water. If any impacts occur, additional measures for impact prevention and mitigation will be provided in a timely manner.

(3) Target Areas

(A) Construction phase

The route alignments will cut across ten rivers or canals. The stations for collecting surface water/wastewater quality samples are shown in **Table 8.2.1 - 1.** The points for collecting samples for monitoring surface water quality during the construction phase are shown in **Figure 8.2.1 - 1.**

Table 8.2.1 - 1 Surface Water Quality Sampling Stations during Construction Phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Nam Kaeo Canal	404 m.	Phawana station (YL - 02)
2	Lat Phrao Canal	500 m.	Phawana station (YL - 02)
3	Chan Canal	132 m.	Lat Phrao 101 station (YL - 07)
4	Saen Saeb Canal	312 m.	Lam Sali station (YL - 09)
5	Hua Mak Canal	446 m.	Phatthanakan station (YL - 11)
6	Prawet Burirom Canal	500 m.	Si Nut station (YL - 13)
7	Tachang Canal	500 m.	Si Udom station (YL - 16)
8	Khlet Canal	205 m.	Si lam station (YL - 17) and Depot
9	Bang Na Canal	500 m.	Si La Salle station (YL - 18)
10	Samrong Canal	500 m.	Si Dan station (YL - 20)

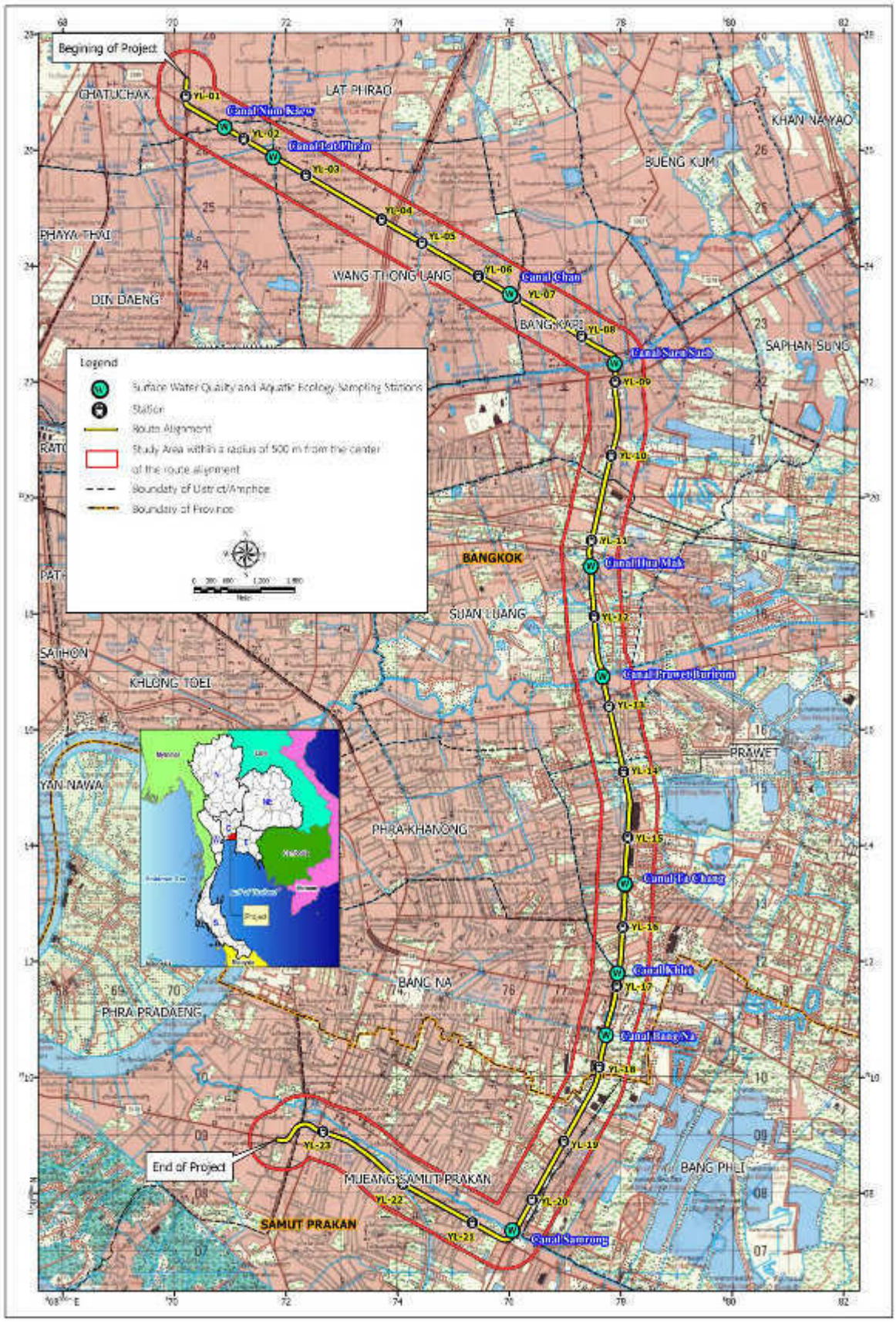

Figure 8.2.1 - 1 Surface water quality sampling stations along the project route during construction phase

(B) Operation phase

The areas consist of five areas where the route alignments will cut across rivers or canals and two areas with retention ponds from the Depot at the Si Iam Interchange (seven stations). The stations for collecting surface water quality samples during the operation phase are shown in **Table 8.2.1 - 2**. The points for collecting samples for monitoring surface water quality during the operation phase are shown in **Figure 8.2.1 - 2**.

Table 8.2.1 - 2 Surface Water Quality Sampling Stations during Operation phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Lat Phrao Canal	500 m.	Phawana station (YL - 02)
2	Saen Saeb Canal	312 m.	Lam Sali station (YL - 09)
3	Phra Khanong Canal	297 m.	Si Nut station (YL - 13)
4	Khlet Canal	205 m.	Si Iam station (YL - 17) and Depot
5	Samrong Canal	500 m.	Si Dan station (YL - 20)
6	Retention pond nearby Srinagarindra road, Pond No.1	20 m.	Khlet Canal
7	Retention pond nearby Srinagarindra road, Pond No. 2	10 m.	Khlet Canal

(4) Methodology

(A) Construction phase

The surface water quality indexes, as well as the Methodology for collecting and analyzing surface water quality samples, shall comply with the 8th Notification of the National Environmental Board, B.E. 2537 (1994). The analysis method is based on APHA-AWWA-WEF (Standard Methodology for the Examination of Water and Wastewater 20th Edition, 1998). The surface water quality indexes and the analysis method are shown in **Table 8.2.1 - 3**.

(B) Operation phase

The surface water quality indexes, as well as the Methodology for collecting and analyzing samples for surface water quality, shall comply with the 8th Notification of the National Environmental Board, B.E. 2537 (1994). The analysis method is based on APHA-AWWA-WEF (Standard Methodology for the Examination of Water and Wastewater 20th Edition, 1998). The surface water quality indexes and the analysis method are shown in **Table 8.2.1 - 4**.

(5) Schedule

(A) Construction phase

- This shall be conducted once and shall be finished one month before the construction starts to serve as the baseline data.
- This shall be conducted once a month until the construction of MRT stations or depot and the Park & Ride Buildings is completed.

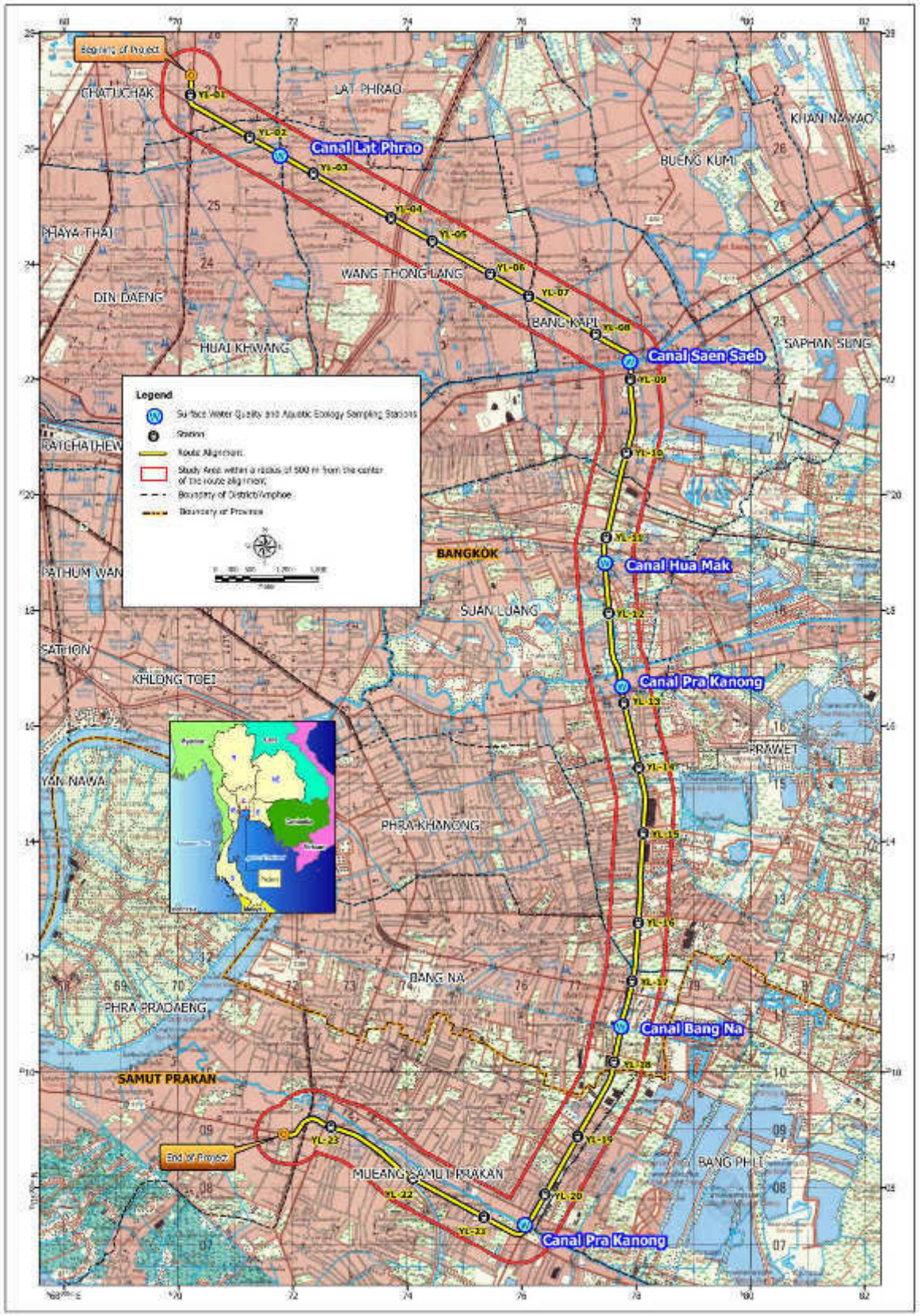

Figure 8.2.1 - 2 Surface water quality sampling stations along the project alignment during operation phase

(B) Operation phase

The analysis of surface water quality /wastewater shall be conducted twice a year, for five consecutive years. If the measurement results are not significantly different, this shall be conducted once a year.

Table 8.2.1 - 3 Surface water quality parameter and analysis method during construction phase

Surface water quality parameter	Analysis method
1. Temperature[1/]	Thermometer
2. Conductivity[1/]	Conductivity Meter
3. pH[1/]	pH Meter
4. Dissolved Oxyen[1/]	Dissolved Oxygen Meter
5. Suspend Solids[1/]	Dried at 103 – 105 °C
6. BOD[1/]	Azide Modification
7. Oil & Grease[2/]	Partition Gravimetric Method
8. Phosphate	Ascorbic Acid
9. Total Coliform Bacteria[3/]	Multiple Tube Fermentation Technique
10. Fecal Coliform Bacteria[3/]	Multiple Tube Fermentation Technique

Remark : 1/ water sampling at middle depth of waterway
2/ water sampling at water surface
3/ water sampling at depth 30 cm. from water surface

Table 8.2.1 - 4 Surface water quality parameter and analysis method during operation phase

Surface water quality parameter	Analysis method
1. Temperature[1/]	Thermometer
2. Conductivity[1/]	Conductivity Meter
3. pH[1/]	pH Meter
4. Dissolved Oxyen[1/]	Dissolved Oxygen Meter
5. Suspend Solids[1/]	Dried at 103 – 105 °C
6. BOD[1/]	Azide Modification
7. Oil & Grease[2/]	Partition Gravimetric Method
8. Phosphate	Ascorbic Acid
9. Sulfide	Titrate
10. TKN - Nitrogen	Kjeldahl
11. Total Coliform Bacteria[3/]	Multiple Tube Fermentation Technique
12. Fecal Coliform Bacteria[3/]	Multiple Tube Fermentation Technique

Remark : 1/ water sampling at middle depth of waterway
2/ water sampling at water surface
3/ water sampling at depth 30 cm. from water surface

(6) Responsible Agencies

(A) Construction phase: The MRTA.

(B) Operation phase: The MRTA.

Management

Construction phase: The MRTA shall ensure the contractor's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures.

Operation phase: The MRTA shall ensure the train operator's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures. The train operator shall be responsible for the costs.

(7) Budget

(A) Construction phase

Analysis cost	4,000	baht/point
Number of sample collection Stations	10	
Frequency of measurement	once a month	
Total	**480,000**	**baht/year**
Total cost for 40-year measurement	**1,920,000**	**baht**

(B) Operation phase

Analysis cost	6,000	baht/point
Number of sample collection Stations	7	
Frequency of measurement	twice a year, for 5 consecutive years and after that once a year.	
Total cost for 40-year measurement	**1,890,000**	**baht**

(8) Evalution

(A) Construction phase

With regard to assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and submit a report to the MRTA on a monthly basis and compile the monthly reports to prepare a 6-month report to submit to the ONEP in January and July throughout the construction phase.

(B) Operation phase

In terms of assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and presents a 6-month report to the MRTA to obtain opinions about the report before submitting it to the ONEP. The report must be submitted within January and July of ever year.

8.2.2 Air Quality Monitoring Plan

(1) Rationale

Due to the fact that project activities carried out during the construction and operation phases may affect local people in terms of dust and other kinds of air pollution, environmental quality monitoring has been assigned to monitor the potential impacts, as outlined in general measures for environmental impact prevention and mitigation. To optimize the measure implementation, the action plan for monitoring air quality impacts was formulated, the results of which will assist in improving environmental impact prevention and mitigation measures.

(2) Objectives

To monitor the quality of air in environmentally-sensitive areas along the project route alignments during the construction and operation phase.

(3) Areas

(A) Construction phase

The quality of air will be monitored in 26 sensitive areas, which are located near the sites for the construction of elevated gvide ways, MRT stations, Depot, and Park & Ride buildings. The stations for collecting samples of the quality of air during the construction phase are shown in **Table 8.2.2 - 1.** The stations for collecting samples of the quality of air during the construction phase are shown in **Figure 8.2.2 - 1.**

Table 8.2.2 - 1 Ambient air quality sampling stations along the project route during Construction phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Judicial Training Institute	402 m.	Ratchada station (YL - 01)
2	Pibool Upphatham School	86 m.	Project route
3	Chok Chai 4 Police Station Flat	95 m.	Chok Chai 4 station (YL - 03)
4	Thanormpitvithaya School	46 m.	Project route
5	Bangkok Suksa School	365 m.	Lat Phrao 101 station (YL - 07)
6	Big C Superstore (Lat Phrao)	225 m.	Lat Phrao 83 station (YL - 05)
7	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church)	459 m.	Mahat Thai station (YL - 06)
8	Vejthani Hospital	47 m.	Project route
9	The Mall Bang Kapi	408 m.	Bang Kapi station (YL - 08)
10	Fatthullbalee Mosque	283 m.	Lam Sali station (YL - 09)
11	Sudnaree Kindergarten	120 m.	Si Kritha station (YL - 10)
12	Huamak Municipality School	255 m.	Phatthanakan station (YL - 11)
13	Jamiul Idhard Mosque (Hua Mak Yai)	361 m.	Project route
14	Huamak School	249 m.	Phatthanakan station (YL - 11)
15	Klongkalantan School	423 m.	Phatthanakan station (YL - 11)
16	Suraomai School	390 m.	Project route
17	Khajonsiri Temple	235 m.	Project route
18	Darul Amin Mosque	95 m.	Project route

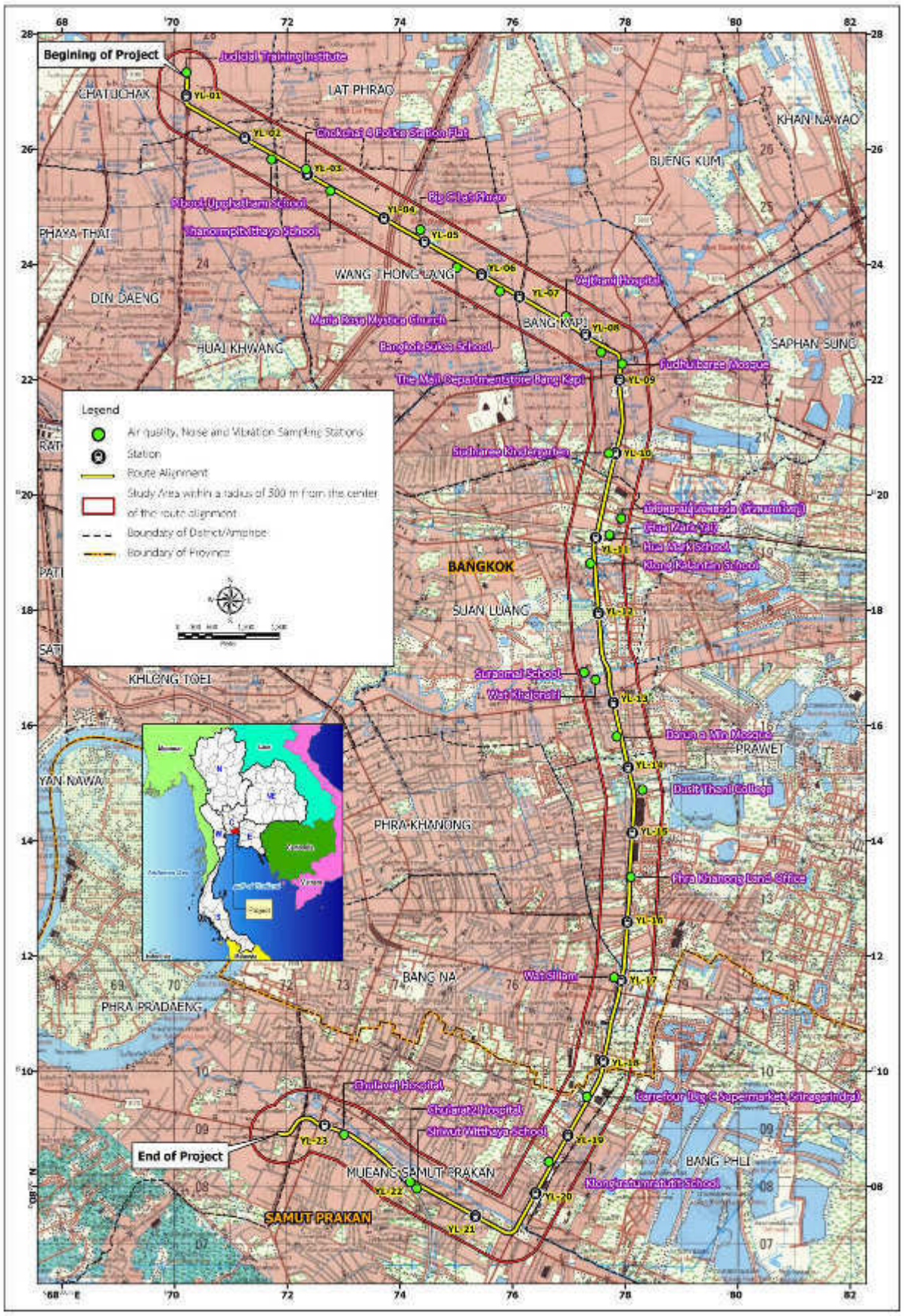

Figure 8.2.2 - 1 Ambient air quality / Noise / Vibration sampling stations along the project route during construction phase

Table 8.2.2 - 1 Ambient air quality sampling stations along the project route during Construction phase (Cont'd.)

No.	Location of Sampling Station	Distance from Station (m.)	
19	Dusit Thani College	460 m.	Srinagarindra 38 station (YL - 14)
20	Bangkok Metropolitan Land Office, Phra Khanong Branch	32 m.	Project route
21	Si Iam Temple	106 m.	Depot
22	Big C Srinagarindra (former Carrefour Srinagarindra)	37 m.	Project route
23	Klongkratumratutit School	66 m.	Project route
24	Siriwutti Wittaya school	273 m.	Thipphawan station (YL - 22)
25	Chularat2 Hospital	115 m.	Thipphawan station (YL - 22)
26	Chulavej Hospital	290 m.	Samrong station (YL - 23)

(B) Operation phase

Monitoring will be conducted on the quality of air in environmentally-sensitive areas along the project route alignments at six stations; five stations for health impact monitoring have been added. The 11 stations are shown in **Table 8.2.2 - 2.** The stations for collecting air quality samples during the operation phase are shown in **Figure 8.2.2 - 2.**

Table 8.2.2 - 2 Ambient air quality sampling stations along the project route during operation phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Pibool Upphatham School	86 m.	Phawana station (YL - 02)
2	Vejthani Hospital	47 m.	Project route
3	Klongkalantan School	423 m.	Phatthanakan station (YL - 11)
4	Darul Amin Mosque	95 m.	Project route
5	Si Iam Temple	106 m.	Depot
6	Chulavej Hospital	290 m.	Samrong station (YL - 23)
7	Under Phawana station (YL - 02)		
8	Under Chok Chai 4 station (YL - 03)		
9	Under Mahat Thai station (YL - 06)		
10	Under Lat Phrao 101 station (YL - 07)		
11	Under Samrong station (YL - 23)		

(4) Methodology

(A) Construction phase

The air quality parameters, as well as the Methodology of collecting and analyzing samples of air quality shall comply with the requirements of the ONEP or US-Environmental Protection Agency or the Methodology of Air Sampling and Analysis: 3rd Edition, AWMA, ACS, AICHE, APWA ASME, AOAC, HPS, and ISA. The air quality indexes and the analysis method during the construction phase are shown in **Table 8.2.2-3.**

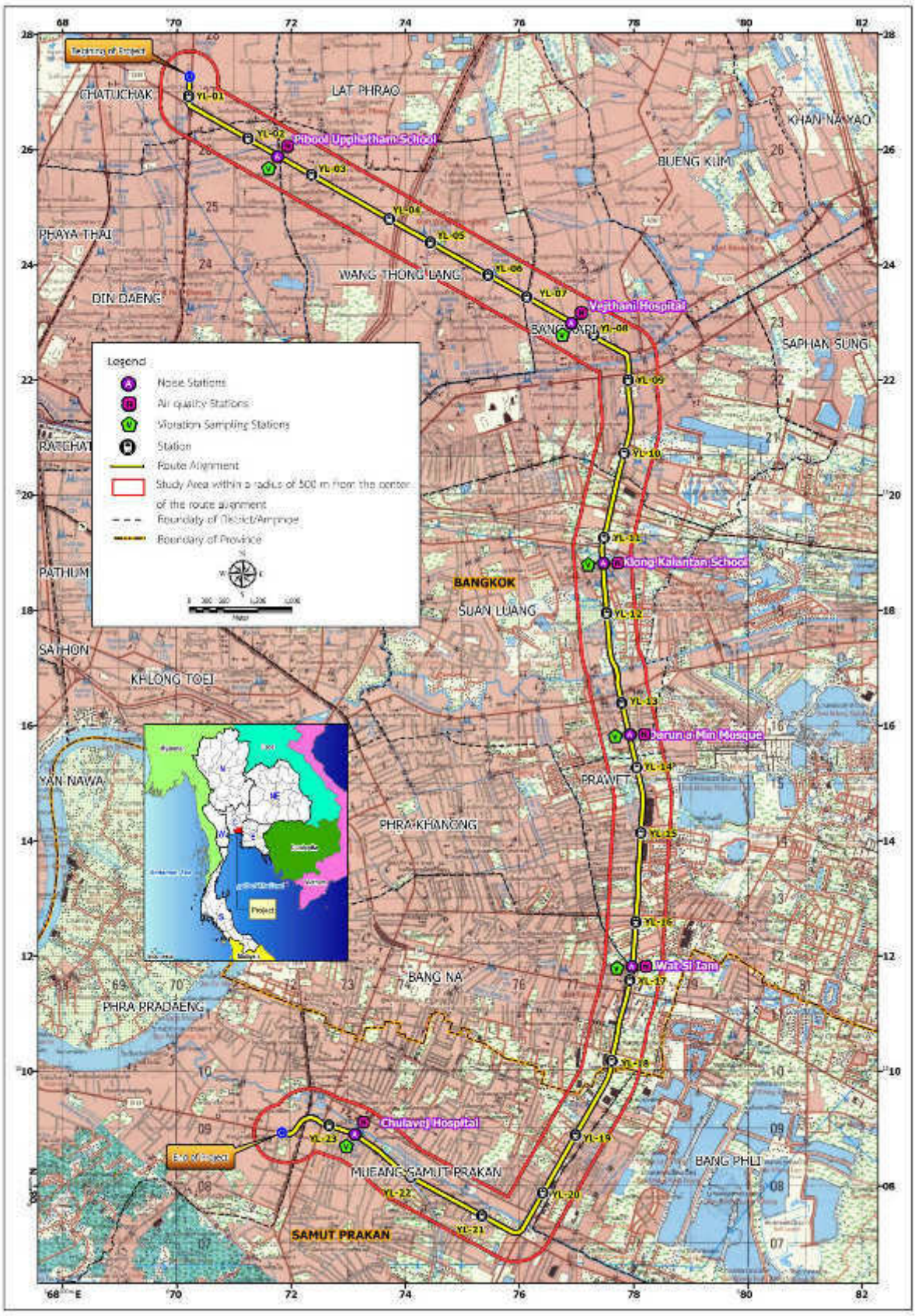

Figure 8.2.2 - 2 Ambient air quality / Noise / Vibration sampling stations along the project route during operation phase

Table 8.2.2 - 3 Air quality parameter and analysis method during construction phase

Air quality parameter	Method	Analysis method*
1. Total Suspended Particulate (TSP)	High-Volume Air Sampler	Gravimetric
2. Particulate Matter less than 10 microns (PM-10)	High-Volume Air Sampler	Gravimetric
3. Particulate Matter less than 2.5 microns (PM-2.5)	High-Volume Air Sampler	Gravimetric
4. Wind speed and direction	Anemometer	Anemometer

Remark : * Use US.EPA. analysis method and ISO analysis method for wind speed and direction

(B) Operation phase

The air quality parameters, as well as the Methodology of collecting and analyzing samples of air quality shall comply with the requirements of the ONEP or US-Environmental Protection Agency or Methodology of Air Sampling and Analysis: 3rd Edition, AWMA, ACS, AICHE, APWA ASME, AOAC, HPS, and ISA. The air quality parameters and the analysis method during the operation phase are described in **Table 8.2.2 - 4.**

Table 8.2.2 - 4 Air Quality Parameter and Analysis Method during operation phase

Air Quality Parameter	Method	Analysis Method*
1. Total Suspended Particulate (TSP)	High-Volume Air Sampler	Gravimetric
2. Particulate Matter less than 10 microns (PM-10)	High-Volume Air Sampler	Gravimetric
3. Particulate Matter less than 2.5 microns (PM-2.5)	High-Volume Air Sampler	Gravimetric
4. Carbon monoxide (CO)	CO Analyzer	Non-dispersive Infrared Detection
5. Nitrogen dioxide (NO_2)	NO_2 Analyzer	Chemiluminescence
6. Wind speed and direction	Anemometer	Anemometer

Remark : * Use US.EPA. analysis method and ISO analysis method for wind speed and direction

(5) Schedule

(A) Construction phase

- This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, to serve as the baseline data.

- This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, during construction within a radius of 1 km and from the monitoring stations throughout the construction phase.

(B) Operation phase

The quality of air shall be monitored twice a year, each covering five consecutive days, which include working days and public holidays. This shall take five consecutive years.

After that, the air quality monitoring will occur once a year, each covering five consecutive days, which include working days and public holidays (during the southwest and northeast monsoons).

(6) Responsible Agencies

(A) Construction phase: The MRTA.

(B) Operation phase: The MRTA.

Management

Construction phase: The MRTA shall ensure the contractor's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures.

Operation phase: The MRTA shall ensure the train operator's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures. The monorail train operator shall be responsible for the costs.

(7) Budget

(A) Construction phase

Analysis cost	35,000	baht/point
Number of sample collection Stations	26	
Frequency of measurement	once a month	
Total	**10,920,000**	**baht/year**
Total cost for 40-year measurement	**43,680,000**	**baht**

(B) Operation phase

Analysis cost	77,000	baht/point
Number of sample collection Stations	11	
Frequency of measurement	twice a year, for five consecutive years and after that once a year.	
Total cost for 40-year measurement	**38,115,000**	**baht**

(8) Evaluation

(A) Construction phase

With regard to assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and submit a report to the MRTA on a monthly basis and compile the monthly reports to prepare a 6-month report to submit to the ONEP in January and July throughout the construction phase.

(B) Operation phase

In terms of assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and presents a 6-month report to the MRTA to obtain opinions about the report before submitting it to the ONEP. The report must be submitted within January and July of ever year.

8.2.3 Noise Monitoring Plan

(1) Rationale

The project construction and operation may have noise impacts, especially during the construction phase. During the construction phase, noise can be derived from machines, pile boring, and pile driving. During the operation phase, the noise impact can arise from monorail train operation. Despite noise control measures, it is necessary to measure the volume of sound in environmentally-sensitive areas along the project route alignments based on the environmental quality monitoring measures. This aims to monitor the efficiency of the environmental impact prevention and mitigation measures and to apply the results to optimize the implementation of the environmental impact prevention and mitigation plans.

(2) Objectives

To monitor the noise level in environmentally-sensitive areas along the project route alignments during the construction and operation phases.

(3) Areas

(A) Construction phase

The noise level in 26 sensitive areas located near the sitess for the construction of elevated guide ways, MRT stations, Depot, and Park & Ride building shall be monitored. The stations for collecting sound level samples during the construction phase are shown in **Table 8.2.3 - 1.** The noise measurement stations during the construction phase are shown in **Figure 8.2.2 - 1.**

Table 8.2.3 - 1 Noise measurement stations along the project route during construction phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Judicial Training Institute	402 m.	Ratchada station (YL - 01)
2	Pibool Upphatham School	86 m.	Project route
3	Chok Chai 4 Police Station Flat	95 m.	Chok Chai 4 station (YL - 03)
4	Thanormpitvithaya School	46 m.	Project route
5	Bangkok Suksa School	365 m.	Lat Phrao 101 station (YL - 07)
6	Big C Superstore (Lat Phrao)	225 m.	Lat Phrao 83 station (YL - 05)
7	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church)	459 m.	Mahat Thai station (YL - 06)
8	Vejthani Hospital	47 m.	Project route
9	The Mall Bang Kapi	408 m.	Bang Kapi station (YL - 08)
10	Fatthullbalee Mosque	283 m.	Lam Sali station (YL - 09)
11	Sudnaree Kindergarten	120 m.	Si Kritha station (YL - 10)
12	Huamak Municipality School	255 m.	Phatthanakan station (YL - 11)
13	Jamiul Idhard Mosque (Hua Mak Yai)	361 m.	Project route
14	Huamak School	249 m.	Phatthanakan station (YL - 11)
15	Klongkalantan School	423 m.	Phatthanakan station (YL - 11)
16	Suraomai School	390 m.	Project route
17	Khajonsiri Temple	235 m.	Project route

Table 8.2.3 - 1 Noise measurement stations along the project route during construction phase (Cont'd)

No.	Location of Sampling Station	Distance from Station (m.)	
18	Darul Amin Mosque	95 m.	Project route
19	Dusit Thani College	460 m.	Srinagarindra 38 station (YL - 14)
20	Bangkok Metropolitan Land Office, Phra Khanong Branch	32 m.	Project route
21	Si Iam Temple	106 m.	Depot
22	Big C Srinagarindra (former Carrefour Srinagarindra)	37 m.	Project route
23	Klongkratumratutit School	66 m.	Project route
24	Siriwutti Wittaya school	273 m.	Thipphawan station (YL - 22)
25	Chularat2 Hospital	115 m.	Thipphawan station (YL - 22)
26	Chulavej Hospital	290 m.	Samrong station (YL - 23)

(B) Operation phase

The noise level in environmentally-sensitive areas along the project route alignments shall be monitored at six stations. The stations for collecting sound level samples are shown in **Table 8.2.3 - 2**, and the noise measurement stations receptors during the operation phase are shown in Figure **8.2.2 - 2.**

Table 8.2.3 - 2 Noise measurement stations along the project route during operation phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Pibool Upphatham School	86 m.	Phawana station (YL - 02)
2	Vejthani Hospital	47 m.	Project route
3	Klongkalantan School	423 m.	Phatthanakan station (YL - 11)
4	Darul Amin Mosque	95 m.	Project route
5	Si Iam Temple	106 m.	Depot
6	Chulavej Hospital	290 m.	Samrong station (YL - 23)

(4) Methodology

The noise indexes, as well as the Methodology for collecting and analyzing the data on sound volume shall comply with the requirements of the ONEP or ISO (International Organization for Standardization (1996/2)). The sound level measurement tool is the Sound Level Meter and Analyzer. The indexes to measure consist of 24-hour equivalent continuous a-weighted sound pressure level (Leq-24 hr), day-night level (Ldn), maximum sound volume (L_{max}), the noise level that is a basic value without a source (L_{90}), as well as the noise level that identifies the exposure of truck sound from traffic (L_{10}).

(5) Schedule

(A) Construction phase

- This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, to serve as the baseline data.

- This shall be conducted once a month, each for five consecutive days, which include working days and public holidays, during construction within a radius of 1 km and from the measurement stations throughout the construction phase.

(B) Operation phase

The sound shall be monitored twice a year, each covering five consecutive days, which include working days and public holidays. This shall take five consecutive years. After that, the noise monitoring will carried out once a year, each covering five consecutive days, which include working days and public holidays (during the southwest and northeast monsoons).

(6) Responsible Agencies

(A) Construction phase: The MRTA.

(B) Operation phase: The MRTA.

Remarks

Construction phase: The MRTA shall ensure the contractor's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures.

Operation phase: The MRTA shall ensure the train operator's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures. The train operator shall be responsible for the costs.

(7) Budget

(A) Construction phase

Analysis cost	6,000	baht/point
Number of sample collection Stations	26	
Frequency of measurement	once a month	
Total	**1,872,000**	**baht/year**
Total cost for 40-year measurement	**7,488,000**	**baht**

(B) Operation phase

Analysis cost	6,000	baht/point
Number of sample collection Stations	6	
Frequency of measurement	twice a year, for five consecutive years and after that once a year.	
Total cost for 40-year measurement	**1,620,000**	**baht**

(8) Evaluation

(A) Construction phase

With regard to assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and submit a report to the MRTA on a monthly basis and compile the monthly reports to prepare a 6-month report to submit to the ONEP in January and July throughout the construction phase.

(B) Operation phase

In terms of assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and presents a 6-month report to the MRTA to obtain opinions about the report before submitting it to the ONEP. The report must be submitted within January and July of ever year.

8.2.4 Vibration Monitoring Plan

(1) Rationale

The project construction and operation may cause vibration in sensitive areas located adjacent to the right-of-way; the structures of buildings may be impacted by vibration. Therefore, the vibration monitoring plan is required. The results of the monitoring will help to enhance the efficiency and effectiveness of the measures for vibration impact prevention and mitigation.

(2) Objectives

To monitor vibration at environmentally-sensitive areas along the project route alignments during the construction and operation phases.

(3) Areas

(A) Construction phase

Vibration in 26 sensitive areas located near the areas for the construction of the structures of elevated guide ways, MRT stations, depot, and Park & Ride Building shall be monitored. The vibration measurement stations during the construction phase are shown in **Table 8.2.4 - 1** and **Figure 8.2.2 - 1.**

Table 8.2.4 - 1 Vibration measurement stations along the project route during construction phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Judicial Training Institute	402 m.	Ratchada station (YL - 01)
2	Pibool Upphatham School	86 m.	Project route
3	Chok Chai 4 Police Station Flat	95 m.	Chok Chai 4 station (YL - 03)
4	Thanormpitvithaya School	46 m.	Project route
5	Bangkok Suksa School	365 m.	Lat Phrao 101 station (YL - 07)
6	Big C Superstore (Lat Phrao)	225 m.	Lat Phrao 83 station (YL - 05)
7	Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church)	459 m.	Mahat Thai station (YL - 06)
8	Vejthani Hospital	47 m.	Project route
9	The Mall Bang Kapi	408 m.	Bang Kapi station (YL - 08)
10	Fatthullbalee Mosque	283 m.	Lam Sali station (YL - 09)
11	Sudnaree Kindergarten	120 m.	Si Kritha station (YL - 10)
12	Huamak Municipality School	255 m.	Phatthanakan station (YL - 11)
13	Jamiul Idhard Mosque (Hua Mak Yai)	361 m.	Project route
14	Huamak School	249 m.	Phatthanakan station (YL - 11)
15	Klongkalantan School	423 m.	Phatthanakan station (YL - 11)
16	Suraomai School	390 m.	Project route

Table 8.2.4 - 1 Vibration measurement stations along the project route during construction phase (Cont'd)

No.	Location of Sampling Station	Distance from Station (m.)	
17	Khajonsiri Temple	235 m.	Project route
18	Darul Amin Mosque	95 m.	Project route
19	Dusit Thani College	460 m.	Srinagarindra 38 station (YL - 14)
20	Bangkok Metropolitan Land Office, Phra Khanong Branch	32 m.	Project route
21	Si Iam Temple	106 m.	Depot
22	Big C Srinagarindra (former Carrefour Srinagarindra)	37 m.	Project route
23	Klongkratumratutit School	66 m.	Project route
24	Siriwutti Wittaya school	273 m.	Thipphawan station (YL - 22)
25	Chularat2 Hospital	115 m.	Thipphawan station (YL - 22)
26	Chulavej Hospital	290 m.	Samrong station (YL - 23)

(B) Operation phase

Vibration in environmentally-sensitive areas along the project route alignments shall be monitored at six stations. The vibration measurement stations during the operation phase are shown in **Table 8.2.4 - 2** and **Figure 8.2.2 - 2**.

Table 8.2.4 - 2 Vibration measurement stations along the project route during operation phase

No.	Location of Sampling Station	Distance from Station (m.)	
1	Pibool Upphatham School	86 m.	Phawana station (YL - 02)
2	Vejthani Hospital	47 m.	Project route
3	Klongkalantan School	423 m.	Phatthanakan station (YL - 11)
4	Darul Amin Mosque	95 m.	Project route
5	Si Iam Temple	106 m.	Depot
6	Chulavej Hospital	290 m.	Samrong station (YL - 23)

(4) Methodology

Vibration indexes, as well as the Methodology for collecting and analyzing vibration data shall be monitored for 24 hours a day for five consecutive days, covering working days and holidays. The vibration measurement tool is the seismometer, which identifies the levels of vibration at measurement points in three directions: transverse, vertical, and longitudinal. The vibration indexes consist of the peak particle velocity (PPV) in mm/sec and frequency in Hz.

(5) Schedule

(A) Construction phase

- This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, to serve as the baseline data.

- This shall be conducted once a month, each for five consecutive days, which include working days and public holidays, during construction within a radius of 1 km and from the measurement stations throughout the construction phase.

(B) Operation phase

The vibration shall be monitored twice a year, each covering five consecutive days, which include working days and public holidays. This shall take five consecutive years. After that, the monitoring will be carried out once a year, each covering five consecutive days: both working days and public holidays.

(6) Responsible Agencies

(A) Construction phase: The MRTA.

(B) Operation phase: The MRTA.

Management

Construction phase:	The MRTA shall ensure the contractor's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures.
Operation phase:	The MRTA shall ensure the train operator's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures. The train operator shall be responsible for the costs.

(7) Budget

(A) Construction phase

Analysis cost	18,000	baht/point
Number of sample collection Stations	26	
Frequency of measurement	once a month	
Total	**5,616,000**	**baht/year**
Total cost for 40-year measurement	**22,464,000**	**baht**

(B) Operation phase

Analysis cost	18,000	baht/point
Number of sample collection Stations	6	
Frequency of measurement	twice a year, for five consecutive years and after that once a year.	
Total cost for 40-year measurement	**4,860,000**	**baht**

(8) Assessment

(A) Construction phase

With regard to assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and submit a report to the MRTA on a monthly basis and compile the monthly reports to prepare a 6-month report to submit to the ONEP in January and July throughout the construction phase.

(B) Operation phase

In terms of assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and presents a 6-month report to the MRTA to obtain opinions about the report before submitting it to the ONEP. The report must be submitted within January and July of ever year.

8.2.5 Transportation Monitoring Plan

(1) Rationale

Because the project development may change mode in the transport system on the existing road networks and associated areas during the construction and operation phases, it is necessary to monitor the transport system. The monitoring results can improve the efficiency and effectiveness of the measures for transport impact prevention and mitigation.

(2) Objectives

To monitor transport impacts during the construction and operation phases.

(3) Areas

(A) Construction phase

The monitoring of transport condition at 14 major intersections on the existing road networks that may be affected by the construction of the structures of elevated guide ways, MRT stations, depot, and Park & Ride buildings shall be conducted. They consist of: the Ratchada-Lat Phrao Intersection, the Phawana Intersection, the Chok Chai 4 Intersection, the Pradit Manuntham Intersection, the Bang Kapi Intersection, the Lam Sali Interchange, the Krung Thep Kritha Intersection, the Rama IV Srinagarind Interchange, the Phatthanakan Intersection, the On Nut Intersection, the Udomsuk Intersection, the Si Iam Interchange, the Thepharak Intersection, and the Samrong Intersection. The locations for measuring and recording data on transport along the route alignments during the construction phase are shown in **Figure 8.2.5 - 1.**

(B) Operation phase

Transport at major six intersections on the existing road networks that may be affected by the construction of the structures of elevated guide ways, MRT stations, depot, and Park & Ride buildings shall be monitored. They comprise: the Phatthanakan Intersection, the On Nut Intersection, the Udom Suk Intersection, the Si Iam Interchange, the Thepharak Intersection, and the Samrong Intersection. The locations for measuring and recording data on transport along the route alignments during the operation phase are shown in **Figure 8.2.5 - 2.**

(4) Methodology

(A) Construction phase

Transport indexes for measuring and data recording consist of:

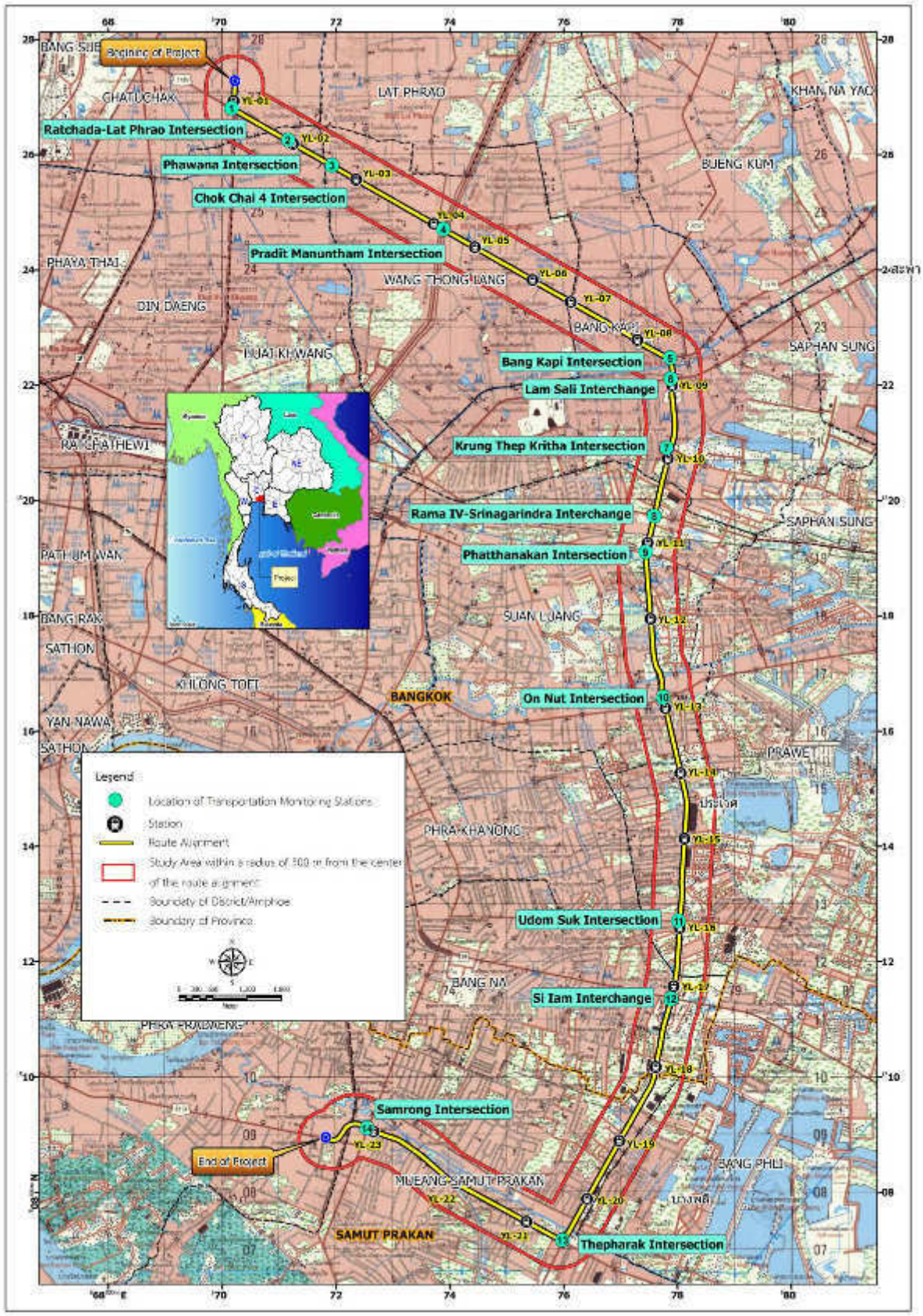

Figure 8.2.5 - 1 Transportation monitoring station along the project route during construction phase

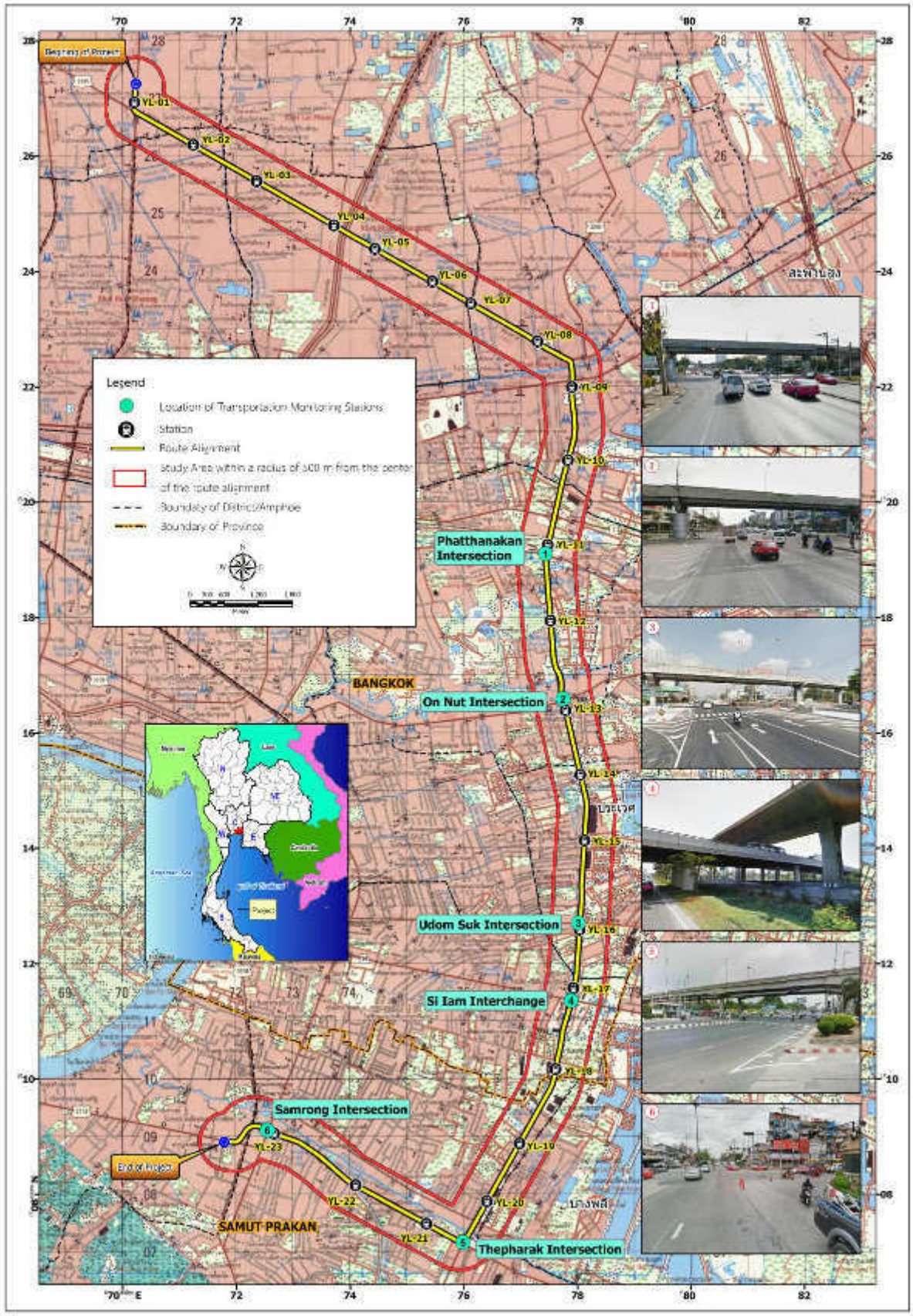

Figure 8.2.5 - 2 Transportation monitoring station along the project route during operation phase

- Number, types and directions of vehicles at the measurement points at different intersections that serve as the routes for transporting construction materials and equipment for the analysis of traffic volume on the highways.
- Statistics of accidents.
- Causes and levels of severity of accidents.

(B) Operation phase

- Number, types and directions of vehicles at the measurement points at different intersections that serve as the routes for transporting construction materials and equipment for the analysis of traffic volume on the highways.
- Statistics of accidents.
- Causes and levels of severity of accidents.

(5) Schedule

(A) Construction phase

- The monitoring shall be conducted one month before the construction starts, once for three consecutive days, which include working days and public holidays during morning peak hours (7 - 9 am.), evening peak hours (4 - 7 pm.), and night peak hours (10 pm. - 12 am.) to serve as the baseline data.
- This shall be conducted once a month, each covering three consecutive days, which include working days and public holidays during morning peak hours (7 - 9 am.), evening peak hours (4 - 7 pm.), and night peak hours (10 pm. -12 am.). The monitoring shall be conducted until the construction of the structures of elevated ways, MRT stations or depots, and the Park & Ride Buildings is completed.

. **(B) Operation phase**

Measurement and data recording shall be carried out twice a year, each covering three consecutive days: working days and holidays during morning peak hours (7 - 9 am.) and evening peak hours (4 - 7 pm.). This shall be done for five consecutive years. The, the frequency of the monitoring will reduce to once a year if the 24-month traffic volume tends to reduce by over 40%

(6) Responsible Agencies

(A) Construction phase: The MRTA.

(B) Operation phase: The MRTA.

Management

Construction phase:	The MRTA shall ensure the contractor's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures.
Operation phase:	The MRTA shall ensure the train operator's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures. The monorail train operator shall be responsible for the costs.

(7) Budget

(A) Construction phase

Analysis cost	10,000	baht/point
Number of sample collection Stations	14	
Frequency of measurement	once a month	
Total	**1,680,000**	**baht/year**
Total cost for 40-year measurement	**6,720,000**	**baht**

(B) Operation phase

Analysis cost	10,000	baht/point
Number of sample collection Stations	6	
Frequency of measurement	twice a year, for five consecutive years and after that once a year.	
Total cost for 40-year measurement	**2,700,000**	**baht**

(8) Evaluation

(A) Construction phase

With regard to assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and submit a report to the MRTA on a monthly basis and compile the monthly reports to prepare a 6-month report to submit to the ONEP in January and July throughout the construction phase.

(B) Operation phase

In terms of assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and presents a 6-month report to the MRTA to obtain opinions about the report before submitting it to the ONEP. The report must be submitted within January and July of ever year.

8.2.6 Socio-Economic Monitoring Plan

(1) Rationale

The project development may have socio-economic impacts on communities at areas with the structures of the elevated guide ways, MRT stations, Depot, and Park & Ride Buildings (at the Si Iam Interchange) and surrounding areas during the construction and operation phases. Thus, it is necessary to monitor socio-economic conditions, and the results of the monitoring will help to improve the efficiency and effectiveness of the measures for impact prevention and mitigation for socio-economic conditions.

(2) Objectives

To monitor socio-economic impacts during the construction and operation phases.

(3) Areas

People living within the right-of-ways who have to relocate, establishments located near right-of-ways, community leaders, as well as the representatives of educational institutions and religious places.

(4) Methodology

(A) Construction phase

Socio-economic indexes and the tool for investigation/recording and data analysis are as follows:

- Field data that will be collected consist of basic data of households, socio-economic data, opinions about the project development, problems, impacts during the construction phase, as well as other suggestions, data on accidents, and complaints.
- The tool for inquiries/interviews is a questionnaire.

(B) Operation phase

Socio-Economic indexes and the tool for investigation/recording and data analysis are as follows:

- Field data that will be collected consist of basic data of households, socio-economic data, opinions about the project development, problems, impacts during the construction phase, as well as other suggestions, data on accidents, and complaints.
- The tool for inquiries/interviews is a questionnaire.
- The sample random sampling technique shall be utilized because the population is not significantly different.
- Data analysis : The codes of answers shall be designed. The data will be recorded on the computer, and the data analysis will be conducted using SPSS PC Plus for Windows or other programs as appropriated. The statistics will be displayed in the formats of percentage, mean, etc.

(5) Phases

(A) Construction phase

Socio-economic survey shall be conducted once a year, each consisting of at least 500 sets of questionnaires, throughout the construction phase.

(B) Operation phase

Socio-economic survey shall be conducted once a year, each at least 500 sets of questionnaires, throughout the 40-year project operation phase.

(6) Responsible Agencies

(A) Construction phase: The MRTA

(B) Operation phase: The MRTA

Management	
Construction phase:	The MRTA shall ensure the contractor's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures.
Operation phase:	The MRTA shall ensure the train operator's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures. The monorail train operator shall be responsible for the costs.

(7) Budget

(A) Construction phase

The monitoring of socio-economic impacts involves the cost of the survey of opinions from 500 samples/time. It will be conducted once a year throughout the 4-year construction phase. The total cost is 1,200,000 baht.

(B) Operation phase

The socio-economic impact monitoring involves the cost of survey of opinions from 500 samples/time. It will be conducted once a year throughout the 40-year operation phase. The total cost is 12,000,000 baht.

(8) Evaluation

(A) Construction phase

With regard to assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and submit a report to the MRTA to submit to the ONEP in January and July throughout the construction phase.

(B) Operation phase

In terms of assessment and reporting, the third party environmental compliance audit shall assess the compliance with the monitoring plans and presents a 6-month report to the MRTA to obtain opinions about the report before submitting it to the ONEP. The report must be submitted within January and July of ever year.

8.2.7 Public Utility Relocation Monitoring Plan

(1) Rationale

The project route alignments will cut across main roads from Lat Phrao to Samrong, where there are many types of public utilities, e.g. the telephone system, electric poles, water pipes, oil pipes, gas pipes, and the Bang Kapi Flyover. Thus, it is necessary to relocate or change the public utilities. This will affect the services of the public utilities and people living along Lat Phrao, Srinagarindra, and Thepharak Roads this is a major impact and people attach great importance to it. Thus, it is necessary to monitor the impacts of the activities. Data from the monitoring will improve the measures for preventing and mitigating impacts of the public utility relocation in line with actual impacts during the project implementation. This shall be strictly complied with by the contractor and agencies concerned.

(2) Objectives

To monitor the impacts of relocation/change of public utilities during the pre-construction and construction phases.

(3) Areas

At the construction areas on Lat Phrao, Srinagarindra, and Thepharak Roads, public utilities will have to be relocated/changed, i.e. the pipe system, the transmission line system, the telephone system, the Bang Kapi Flyover, oil pipes, and gas pipes.

(4) Methodology

(A) Construction phase

- Relevant data shall be collected, i.e. the procedure for coordination and results of working with users of public utilities, activities in the construction areas, problems and obstacles in the fields, impacts during the construction phase, as well as opinions about the project development.
- Inquiries/interviews shall be conducted organizations that use services of the public utilities using questionnaires.

(B) Operation phase

-

(5) Phases

(A) Construction phase

Throughout the relocation/change of public utilities that may be affected. The contractor has to coordinate work and prepare a report to submit to the owner of each public utility on a phaseic basis to prevent damage or impacts on the public utilities. This will reveal the progress, problems, obstacles and people affected by the relocation/change of the public utilities.

(B) Operation phase

-

(6) Responsible Agencies

(A) Construction phase: The MRTA.

(B) Operation phase: -

<u>Management</u>

Construction phase:	The MRTA shall ensure the contractor's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures.
Operation phase:	The MRTA shall ensure the train operator's strict compliance with the environmental impact prevention and mitigation measures and the environmental quality monitoring measures. The monorail train operator shall be responsible for the costs.

(7) Budget

(A) Construction phase

The monitoring of the impacts of the public utility relocation involves the cost of the collection of data on the implementation, problems and obstacles to prepare monthly reports, 6-month reports, and a summary report for a 2-year phase (24 months) or until the areas are returned to the public utilities. The total cost is 500,000 baht.

(B) Operation phase

-

(8) Evaluation

(A) Construction phase

This involves gathering the results of the project implementation and coordination and preparing reports on the implementation by the third party environmental compliance audit to submit to the MRTA, the owners of the public utilities, and the ONEP. The monthly reports, 6-month reports, and annual reports must be submitted throughout the phases of the relocation/change of the public utilities until the areas are returned to the public utility owners. This aims to assess the problems and solutions throughout the phases of the relocation/change of public utilities before the improvement of measures for impact prevention and mitigation in line with current conditions.

(B) Operation phase

-

8.3 Environmental Monitoring Plans

The environmental monitoring measures for the MRT Yellow Line project : Lat Phrao – Samrong Section are outlined in **Table 8.3 - 1.**

8.4 Budget for the Environmental Monitoring programs Implementation

The total cost of the implementation of the environmental monitoring programs equals 145,157,000 baht, as shown in **Table 8.4 - 1.**

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
1. Surface Water/Wastewater Quality 1.1 Construction phase	1. Temperature 2. Suspend Solids 3. Conductivity 4. pH 5. Dissolved Oxyen 6. BOD 7. Phosphate 8. Oil & Grease 9. Total Coliform Bacteria 10. Fecal Coliform Bacteria[3/]	Surface water 1. Nam Kaeo Canal 2. Lat Phrao Canal 3. Chan Canal 4. Saen Saeb Canal 5. Hua Mak Canal 6. Prawet Burirom Canal 7. Tachang Canal 8. Khlet Canal 9. Bang Na Canal 10. Samrong_Canal	- This shall be conducted once and shall be finished one month before the construction starts to serve as the baseline data - This shall be conducted once a month until the construction of MRT stations or Depot and Park and Ride Buildings is completed.	- 4,000 baht/point - Total 40,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)
1.2 Operation phase	1. Temperature 2. Suspend Solids 3. Conductivity 4. pH 5. Dissolved Oxyen 6 BOD 7. Phosphate 8 Oil & Grease 9. Fecal Coliform Bacteria[3/] 10. Sulfide 11. TKN - Nitrogen 12. Total Coliform Bacteria	Surface water 1. Lat Phrao Canal 2. Saen Saeb Canal 3. Phra Khanong Canal 4. Samrong Canal 5. Khlet_Canal Retention pond 6. Retention pond nearby Srinagarindra road, Pond No.1. Retention pond nearby Srinagarindra road, Pond No. 2	The analysis of surface water quality /wastewater shall be conducted twice a year, for five consecutive years. If the measurement results are not significantly different, this shall be conducted once a year	- 6,000 baht/point - Total 42,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
2. Air Quality 2.1 Construction phase	1 Total Suspended Particulate (TSP) 2 Particulate Matter less than 10 microns (PM - 10) 3. Particulate Matter less than 2.5 microns (PM - 2.5) 4. Wind speed and direction	1. Judicial Training Institute 2. Pibool Upphatham School 3. Chok Chai 4 Police Station Flat 4. Thanormpitvithaya School 5. Bangkok Suksa School 6. Big C Superstore (Lat Phrao) 7. Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church) 8. Vejthani Hospital 9. The Mall Bang Kapi 10. Fatthullbalee Mosque 11. Sudnaree Kindergarten 12. Huamak Municipality School 13. Jamiul Idhard Mosque (Hua Mak Yai) 14. Huamak School 15. Klongkalantan School 16. Suraomai School 17. Khajonsiri Temple 18. Darul Amin Mosque 19. Dusit Thani College 20. Bangkok Metropolitan Land Office, Phra Khanong Branch 21. Si Iam Temple 22. Big C Srinagarindra (former Carrefour Srinagarindra) 23. Klongkratumratutit School	- This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, to serve as the baseline data. - This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, during construction within a radius of 1 km and from the monitoring stations throughout the construction phase.	- 35,000 baht/point -Total 910,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
2.1 Construction phase (Cont'd)		24. Siriwutti Wittaya school 25. Chularat2 Hospital 26. Chulavej Hospital			
2.2 Operation phase	1 Total Suspended Particulate (TSP) 2 Particulate Matter less than 10 microns (PM - 10) 3. Particulate Matter less than 2.5 microns (PM - 2.5) 4. Carbon monoxide (CO) 5 Nitrogen dioxide (NO_2) 6. Wind speed and direction	1. Pibool Upphatham School 2. Vejthani Hospital 3. Klongkalantan School 4. Darul Amin Mosque 5. Si Iam Temple 6. Chulavej Hospital 7. Under Phawana station (YL - 02) 8. Under Chok Chai 4 station (YL - 03) 9. Under Mahat Thai station (YL - 06) 10. Under Lat Phrao 101 station (YL - 07) 11. Under Samrong station (YL - 23)	The quality of air shall be monitored twice a year, each covering five consecutive days, which include working days and public holidays. This shall take five consecutive years. After that, the air quality monitoring will occur once a year, each covering five consecutive days, which include working days and public holidays (during the southwest and northeast monsoons).	- 77,000 baht/point - Total 847,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)
3. Noise Level 3.1 Construction phase	1. Leq-24 hr 2. Ldn 3. L_{max} 4. L_{10}, L_{90}	1. Judicial Training Institute 2. Pibool Upphatham School 3. Chok Chai 4 Police Station Flat 4. Thanormpitvithaya School 5. Bangkok Suksa School 6. Big C Superstore (Lat Phrao) 7. Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church) 8. Vejthani Hospital 9. The Mall Bang Kapi 10. Fatthullbalee Mosque	- This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, to serve as the baseline data.	- 6,000 baht/point - Total 156,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
3.1 Construction phase (Cont'd)		11. Sudnaree Kindergarten 12. Huamak Municipality School 13. Jamiul Idhard Mosque (Hua Mak Yai) 14. Huamak School 15. Klongkalantan School 16. Suraomai School 17. Khajonsiri Temple 18. Darul Amin Mosque 19. Dusit Thani College 20. Bangkok Metropolitan Land Office, Phra Khanong Branch 21. Si Iam Temple 22. Big C Srinagarindra (former Carrefour Srinagarindra) 23. Klongkratumratutit School 24. Siriwutti Wittaya school 25. Chularat2 Hospital 26. Chulavej Hospital	- This shall be conducted once a month, each for five consecutive days, which include working days and public holidays, during construction within a radius of 1 km and from the measurement stations throughout the construction phase.		
3.2 Operation phase	1. Leq-24 hr 2. Ldn 3. L_{max} 4. L_{10}, L_{90}	1. Pibool Upphatham School 2. Vejthani Hospital 3. Klongkalantan School 4. Darul Amin Mosque 5. Si Iam Temple 6. Chulavej Hospital	The sound shall be monitored twice a year, each covering five consecutive days, which include working days and public holidays. This shall take five consecutive years. After that, the noise monitoring will carried out once a year, each covering five consecutive days, which include working days and public holidays (during the southwest and northeast monsoons).	- 6,000 baht/point -Total 36,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
4. Vibration 4.1 Construction phase	1. Peak Particle Velocity (PPV) in mm/sec 2. Frequency in Hz	1 Judicial Training Institute 2. Pibool Upphatham School 3. Chok Chai 4 Police Station Flat 4. Thanormpitvithaya School 5. Bangkok Suksa School 6. Big C Superstore (Lat Phrao) 7. Wat Mae Phra Kularb Tip (Maria Rosa Mystica Church) 8. Vejthani Hospital 9. The Mall Bang Kapi 10. Fatthullbalee Mosque 11. Sudnaree Kindergarten 12. Huamak Municipality School 13. Jamiul Idhard Mosque (Hua Mak Yai) 14. Huamak School 15. Klongkalantan School 16. Suraomai School 17. Khajonsiri Temple 18. Darul Amin Mosque 19. Dusit Thani College 20. Bangkok Metropolitan Land Office, Phra Khanong Branch 21. Si Iam Temple 22. Big C Srinagarindra (former Carrefour Srinagarindra) 23. Klongkratumratutit School	- This shall be conducted one month before the construction starts, once for five consecutive days, which include working days and public holidays, to serve as the baseline data. - This shall be conducted once a month, each for five consecutive days, which include working days and public holidays, during construction within a radius of 1 km and from the measurement stations throughout the construction phase.	- 18,000 baht/point -Total 468,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
4.1 Construction phase (Cont'd)		24. Siriwutti Wittaya school 25. Chularat2 Hospital 26. Chulavej Hospital			
4.2 Operation phase	1. Peak Particle Velocity (PPV) in mm/sec 2. Frequency in Hz	1. Pibool Upphatham School 2. Vejthani Hospital 3. Klongkalantan School 4. Darul Amin Mosque 5. Si Iam Temple 6 Chulavej Hospital	The vibration shall be monitored twice a year, each covering five consecutive days, which include working days and public holidays. This shall take five consecutive years. After that, the monitoring will be carried out once a year, each covering five consecutive days: both working days and public holidays	- 18,000 baht/point -Total 108,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)
5. Transportation 5.1 Construction phase	1. Number, types and directions of vehicles at the measurement points at different intersections that serve as the routes for transporting construction materials and equipment for the analysis of traffic volume on the highways. 2. Statistics of accidents. 3. Causes and levels of severity of accidents.	1. Ratchada-Lat Phrao Intersection 2. Phawana Intersection 3. Chok Chai 4 Intersection 4. Pradit Manuntham Intersection 5. Bang Kapi Intersection 6. Lam Sali Interchange 7. Krung Thep Kritha Intersection 8. Rama IV Srinagarind Interchange 9. Phatthanakan Intersection 10. On Nut Intersection	- The monitoring shall be conducted one month before the construction starts, once for three consecutive days, which include working days and public holidays during morning peak hours (07:00-09:00 hrs), evening peak hours (16:00-19:00 hrs), and night peak hours (22:00-24:00 hrs) to serve as the baseline data. - This shall be conducted once a month, each covering three consecutive days, which include working days and public holidays during morning peak hours (07:00-	- 10,000 baht/point -Total 140,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
5.1 Construction phase (Cont'd)		11. Udomsuk Intersection 12. Si Iam Interchange 13. Thepharak Intersection 14. Samrong Intersection	09:00 hrs), evening peak hours (16:00-19:00 hrs), and night peak hours (22:00-24:00 hrs). The monitoring shall be conducted until the construction of the structures of elevated ways, MRT stations or Depot, and Park and Ride Buildings is completed.		
5.2 Operation phase	1. Number, types and directions of vehicles at the measurement points at different intersections. 2. Statistics of accidents. 3. Causes and levels of severity of accidents.	1. Phatthanakan Intersection 2. On Nut Intersection 3. Udom Suk Intersection 4. Si Iam Interchange 5. Thepharak Intersection 6. Samrong Intersection	Measurement and data recording shall be carried out twice a year, each covering three consecutive days: working days and holidays during morning peak hours (07:00-09:00 hrs) and evening peak hours (16:00-19:00 hrs). This shall be done for five consecutive years. The, the frequency of the monitoring will reduce to once a year if the 24-month traffic volume tends to reduce by over 40%	- 10,000 baht/point -Total 60,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
6. Socio-economic 6.1 Construction phase	- Field data that will be collected consist of basic data of households - Socio-economic data, opinions about the project development, problems, impacts during the construction phase, as well as other suggestions, data on accidents and complaints.	People living within the right-of-ways who have to relocate, establishments located near right-of-ways, community leaders, as well as the representatives of educational institutions and religious places.	Socio-economic survey shall be conducted once a year, each consisting of at least 500 sets of questionnaires, throughout the construction phase.	300,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)
6.2 Operation phase	- Field data that will be collected consist of basic data of households - socio-economic data, opinions about the project development, problems, impacts during the construction phase, as well as other suggestions, data on accidents, and complaints.	People living within the right-of-ways who have to relocate, establishments located near right-of-ways, community leaders, as well as the representatives of educational institutions and religious places.	Socio-economic survey shall be conducted once a year, each at least 500 sets of questionnaires, throughout the 40-year project implementation phase.	300,000 baht/time	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.3 - 1 Summary of Environmental Monitoring Program of The MRT Yellow Line project : Lat Phrao - Samrong Section (Cont'd)

Environmental issues	indexes	station	Phase	Budget (baht)	Agency in charge
7. Public Utility Relocation 7.1 Construction phase	1. Relevant data shall be collected, i.e. the procedure for coordination and results of working with users of public utilities, activities in the construction areas, problems and obstacles in the fields, impacts during the construction phase, as well as opinions about the project development. 2. Inquiries/interviews shall be conducted organizations that use services of the public utilities using questionnaires.	At the construction areas on Lat Phrao, Srinagarindra, and Thepharak Roads, public utilities will have to be relocated/changed, i.e. the pipe system, the transmission line system, the telephone system, the Bang Kapi Flyover, oil pipes, and gas pipes.	Throughout the relocation/change of public utilities that may be affected. The contractor has to coordinate work and prepare a report to submit to the owner of each public utility on a phaseic basis to prevent damage or impacts on the public utilities. This will reveal the progress, problems, obstacles and people affected by the relocation/change of the public utilities.	250,000 baht/ year	Mass Rapid Transit Authority of Thailand. (MRTA)

Table 8.4 - 1 Budget for the environmental monitoring programs implementation

Environmental Monitoring Programs	Construction phase				Operation phase																	
	year 1	year 2	year 3	year 4	year 1	year 2	year 3	year 4	year 5	year 6	year 7	year 8	year 9	year 10	year 11	year 12	year 13	year 14	year 15	year 16	year 17	year 18
Environmental Monitoring Programs					B.E.2563	B.E.2564	B.E.2565	B.E.2566	B.E.2567	B.E.2568	B.E.2569	B.E.2570	B.E.2571	B.E.2572	B.E.2573	B.E.2574	B.E.2575	B.E.2576	B.E.2577	B.E.2578	B.E.2579	B.E.2580
1. Surface water quality /wastewater monitoring plan	480,000	480,000	480,000	480,000	84,000	84,000	84,000	84,000	84,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000
2. Air quality monitoring plan	10,920,000	10,920,000	10,920,000	10,920,000	1,694,000	1,694,000	1,694,000	1,694,000	1,694,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000
3. Noise monitoring plan	1,872,000	1,872,000	1,872,000	1,872,000	72,000	72,000	72,000	72,000	72,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
4. Vibration monitoring plan	5,616,000	5,616,000	5,616,000	5,616,000	216,000	216,000	216,000	216,000	216,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000
5. Transportation monitoring plan	1,680,000	1,680,000	1,680,000	1,680,000	120,000	120,000	120,000	120,000	120,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
6. Socio-economic monitoring plan	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
7. Public utility relocation monitoring plan	250,000	250,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total cost	21,118,000	21,118,000	20,868,000	20,868,000	2,486,000	2,486,000	2,486,000	2,486,000	2,486,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000

Table 8.4 - 1 Budget for the environmental monitoring programs implementation (Cont'd)

Environmental Monitoring Programs	Construction phase				Operation phase																		Total
	year 19	year 20	year 21	year 22	year 23	year 24	year 25	year 26	year 27	year 28	year 29	year 30	year 31	year 32	year 33	year 34	year 35	year 36	year 37	year 38	year 39	year 40	
Environmental Monitoring Programs	B.E.2581	B.E.2582	B.E.2583	B.E.2584	B.E.2585	B.E.2586	B.E.2587	B.E.2588	B.E.2589	B.E.2590	B.E.2591	B.E.2592	B.E.2593	B.E.2594	B.E.2595	B.E.2596	B.E.2597	B.E.2598	B.E.2599	B.E.2600	B.E.2601	B.E.2602	
1. Surface water quality /wastewater monitoring plan	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000	**3,810,000**
2. Air quality monitoring plan	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	847,000	**81,795,000**
3. Noise monitoring plan	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	**9,108,000**
4. Vibration monitoring plan	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	**27,324,000**
5. Transportation monitoring plan	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	**9,420,000**
6. Socio-economic monitoring plan	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	**13,200,000**
7. Public utility relocation monitoring plan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**500,000**
Total cost	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	1,393,000	**145,157,000**