THE KINGDOM OF CAMBODIA
PHNOM PENH CAPITAL CITY
DEPARTMENT OF PUBLIC WORKS AND TRANSPORT

THE PREPARATORY SURVEY FOR PROJECT OF DEVELOPMENT OF TRAFFIC MANAGEMENT SYSTEM IN PHNOM PENH

PREPARATORY SURVEY REPORT

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JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Mets Research & Planning Inc., (consist of Mets Research & Planning Inc., and CTI Engineering International Co., LTD).

The survey team held a series of discussions with the officials concerned of the Government of The Kingdom of Cambodia, and conducted a field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of The Kingdom of Cambodia for their close cooperation extended to the survey team.

January, 2015

Akira Nakamura

Director General,

Infrastructure and Peace Building Department

Japan International Cooperation Agency

SUMMARY

1. Outline of the Country

The capital city of the Kingdom of Cambodia (hereafter refer to as Cambodia), Phnom Penh, with an urban population of 1.85 million person in 2012, is the center of politics and economy of Cambodia. Rapid economic development in recent years (GDP growth rate of 6.5% since 2010) has witnessed a very rapid increase of registered vehicles from 61,000 vehicles in 2000 to 268,000 vehicles in 2012 – an increase of 4.36 times. As a result, the average vehicle travel speed in the city has declined from about 20 kph in 2001 to 15 kph in 2012, reflecting the seriousness of traffic congestion in the city.

In the coming years, the continued infrastructure development will further enhanced the growth of manufacturing and tourism industries in Cambodia. Its GDP is expected to expand at an average annual rate of 7.0%. Its capital city of Phnom Penh shall continue to see a concentration in the movement of people and goods.

2. Background and Outline of the Project

In 2001, in response to request for technical assistance from Cambodia, the Japanese Government through JICA, has conducted the "Phnom Penh City Urban Transport Planning Study" for assisting the Cambodian Government in drafting an Urban Transport Master Plan for Year 2015 (2001 MP). Under this 2001 MP, Phnom Penh city (from 2010, it is renamed as Phnom Penh Capital City (PPCC)) was able to accomplish a series of infrastructure development projects through the second JICA technical assistance project namely "The Improvement Project of The Urban Transport in the Phnom Penh Metropolitan Area". This achievement includes the construction of road and bridges and intersection improvements that also includes the installation of traffic control signals. In particular, road development for districts with a high potential for urban land development was able to be accomplished well before the target year stated in the 2001 MP.

On the other hand, public transport development was seriously lagging behind the growth of private transport. With the daily increase in vehicles converging from an enlarged metropolitan area towards the city center, traffic congestion and traffic accidents have escalated in tandem in recent years.

The government of Cambodia hence requested the further assistance from JICA to review and reformulate the 2001 M/P as well as for the drafting of an Action Plan to tackle the worsening urban transport problems. In response to this, JICA conducted the 'Phnom Penh City Comprehensive Urban Transport Planning Project' in 2012 with the drafting of a revised Phnom Penh City Urban Transport Master Plan (PPUTMP). The PPUTMP has set a target year of 2035 for its Long-Term Development Plan while 2016 and 2020 are set as target years for its Short-Term and Mid-Term Development Plans, respectively.

Various strategic plans such as urban road network development and expansion, introduction

of a public transport system, introduction of ITS including that of traffic signal control, traffic surveillance center and others are expected to be completed by 2014. One of the projects among the group of most high priority projects for the Short-Term Plan (2016) in PPUTMP, is the introduction of a traffic control system in an effort to mitigate the worsening traffic congestion problems in Phnom Penh.

The reason for proposing the Traffic Control System as the most priority project was chiefly due to the present conditions of the existing traffic signals in the city. Although Phnom Penh City has a total of 69 signalized intersections (64 of which are within the city center), most of them are isolated signal control, and each of them is individually operated using an independent display pattern. They are not functioning as a collective and consistent group of signal controls and thus are not able to effectively response to the changing traffic pattern especially during the morning and evening peak hours.

With the above background and situations, the Government of Cambodia requested a Grant Aid Project from the Japanese Government in July 2013, for the implementation of the most priority project in the Short Term Plan, namely the introduction of a traffic control and surveillance system covering a total of 100 intersections (inclusive of the existing 64 signals in the city center) and its traffic control center facilities.

This Grant Aid Project is aimed at installing 100 new traffic signals at selected intersections (inclusive of the 64 inner city signalized junctions out of the total of 69 existing signalized junctions in Phnom Penh) and a centralized traffic control center which together form a computerized signal control and surveillance system capable of on-line and real time systematic control functions, thus contributes to mitigating the existing traffic congestion and aids in the improvement of traffic operation and urban living environment in Phnom Penh.

3. Result of Preparatory Survey and Outline of the Project

Considering the request from the Cambodian government, the Government of Japan decided to conduct the “Preparatory Survey for Project of Development of Traffic Management System in Phnom Penh” and through JICA dispatched the Preparatory Survey Team to Cambodia from 1st June to 26th July 2014. Activities during the survey in Cambodia by the Team are 1) discussion related to the Project among relevant agencies such as PPCH, DPWT, Phnom Penh Traffic Police and MPTC, 2) conduct of site survey, 3) evaluation of the location of target intersections and the traffic control center and 4) confirmation of project implementation organization. After coming back to Japan, the Preparatory Survey Team completed the Preparatory Survey Report (draft). Then again, JICA dispatched the second Preparatory Survey Team from 7th to 16th December 2014 to explain and discuss the project plan to the Cambodian side and agree on the contents of the project.

The project’s objective is to ensure the smooth operation of the traffic control system at target intersections based on the site survey and discussion with Cambodian counterparts.

Traffic control system consists of the equipment at the control center and signal equipment installed at intersection. These equipment is listed in Table 2 and Table 3, respectively. The equipment used for data communication between the control center and intersection equipment is included in one of the lists.

Table 1: List of Equipment at Control Center

	Equipment	Functions
1	Network management server	System management
2	Signal control server	Signal control at higher level
3	Signal control workstation	Signal monitoring and control operation by operator
4	Network attached storage	Data storage
5	Front-end processor	Signal control Vehicle detector data processing
6	Network printer	System printer
7	Video wall	Display of traffic condition, system monitoring, etc.
8	Video wall controller	Control of video wall
9	Traffic monitoring workstation with console	Monitoring of traffic conditions
10	Vehicle detector data processing software	Row vehicle detector data are processed into traffic flow data
11	Signal control software	Monitoring and control of signal
12	Equipment operation monitoring software	Monitoring of system equipment
13	Human-machine interface	Display to operator and processing of input by operator
14	Statistics software	Statistical processing of traffic data and system operation data
15	Database software	Database management software
16	Parameter setting for vehicle detector	Vehicle detector ID, location, adjustment factor, etc.
17	Signal control parameter setting	Controller ID, phase, step setting, etc.
18	Uninterruptible power supply	Supply of interruptible power
19	Controller for traffic monitoring video camera	Control and monitoring of traffic monitoring video camera
20	Layer 3 switch	Network switch
21	Layer 2 switch	Network switch
22	Media converter	Electronic – optical conversion

Table 2: Equipment at Intersection

	Equipment	Function
1	Local controller (standard and large)	Signal control in remote or isolated mode
2	Layer 2 switch	Network switch
3	Media converter	Electronic – optical conversion
4	Signal lantern (vehicle and pedestrian)	For vehicle and pedestrian
5	Vehicle detector	Detection and counting of vehicles
6	Traffic monitoring video camera	Traffic monitoring camera and controller.

4. Project Implementation Schedule

The project schedule is 8 months for detailed design and 16 months for procurement/installation or a total 24 months.

5. Project Evaluation

5-1 Relevance

(1) Beneficiaries of this Project

Direct beneficiaries of this Project are the vehicles and their users within the project coverage area. All the citizens of Phnom Penh City (1.85 million people) will also indirectly benefit from this Project.

(2) Project Target

The primary objective of the project is to alleviate traffic congestion and contribute to the urban economy vitalization of Phnom Penh. Especially, the project aims to introduce traffic signals at 100 intersections (including replacement of 64 existing signalized intersections out of 69) and establish a traffic control center in Phnom Penh where the traffic situation continue to worsen.

(3) Consistency with National Development Plan of Cambodia

A major priority policy has been accorded to the planning of urban transport infrastructure by the Cambodian Government in supporting the growth of an efficient and competitive Cambodian economy. This has been stipulated in the infrastructure development sector contained in the Cambodian National Strategic and Development Plan (2014 – 2018). This particular grant aid project is one of the Priority Projects proposed in the Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City (PPUTMP). It was subsequently shortlisted for implementation under its Short-Term Action Plan. This Project is therefore consistent with aspirations of the Cambodian national level development strategy and plan.

(4) Consistency with the Policy and Direction of Japanese official assistance

The proposed traffic control system procured for this Project is a system developed based on the advanced technology in Japan. Japan has long being recognized for its strength in infrastructure development and this project is thus an example of such development package that is being extended by Japan to all the Asian countries. Such efficient use of Japanese technical knowhow and experience may become the engine of sustainable growth in Asia. This Project is thus consistent with the Japanese Government policies regarding the promotion of economic growth in the Asia Region.

5-2 Effectiveness

(1) Quantifiable Effects

The Project is expected to produce the following positive quantifiable effects such as improved travel speed, savings in travel costs and reduction in traffic police personnel needed to direct

traffic at intersections.

Table 3: Quantifiable Effects of this Project

Indicator	**Base Values (Actual Values in 2014)**	**Target Values (Year 2020) [3 years after project completion]**
Average travel speed (km/hr) (average values of speed on major radial roads)	12.5*[1]	14.2*[2]
Travel time cost (in million JPY/year) *[3] X 3 years X 7 routes	14,742*[4]	12,978
Average ratios of traffic demand/traffic capacity (vehicles) at 10 major locations	Morning Peak 1.18 Evening Peak 1.37	Morning Peak 1.13 Evening Peak 1.33
Traffic police needed in traffic control (person)	About 400 *[5]	About 320

*1: Results of Travel Speed Survey conducted in this Study

*2: A 14% in speed improvement result is assumed, based on results on travel speed improvements achieved by actual implementation of similar traffic control system and intersection improvement projects in other countries.

*3: Travel time cost means a monetary value a person in the project area attach to a unit of his travel time.

*4: Using average travel speed, the actual travel time cost on Monivong Blvd. in 2014 as well as 3 years after the project completion are estimated. (taken as the average cost for one major road). This average cost per route is then applied to the 7 major routes in the city center area of Phnom Penh (Monivong Blvd., Norodom Blvd., Charles de Gaulle Blvd., Russian Blvd., Sihanouk Blvd., Mou Tse Tong Blvd. and Inner Ring Road).

*5: At present, about 2 to 4 traffic police are assigned to each of the 64 high traffic demand locations (inclusive of non signalized intersections). Assuming 2 shifts of assignment, about 400 traffic police are required. With the Project, signalization will be carried out at all these locations and traffic flow at high demand locations will be smoother than before using the central control system. It is estimated that a reduction of about 20% of traffic police personnel can be achieved in future (based on discussions with Phnom Penh Deputy Traffic Police Chief).

(2) Qualitative Effects

The Project is also expected to produce various direct and immediate positive qualitative effects, namely an improvement to the traffic environment which would be noticeable within a short time period after the introduction of the traffic signal control system. In addition, the Project would also produce long term and indirect benefits as a result of such improvement to the traffic environment. One such important benefit is the contributions to the regional and socio economic development in Cambodia. In the long term, the Project would also produce an overall improvement to the environment quality via a reduction in gas emission which causes global warming. Other expected long term benefits from this Project are vitalization of region-wide commercial activities, increases in tourist arrival and hence tourism revenue, increases in tax revenue, improvement in goods transportation and hence promoting the establishment of business enterprises, improvement in service levels of medical care and emergency which can enhance the well being of residents and others.

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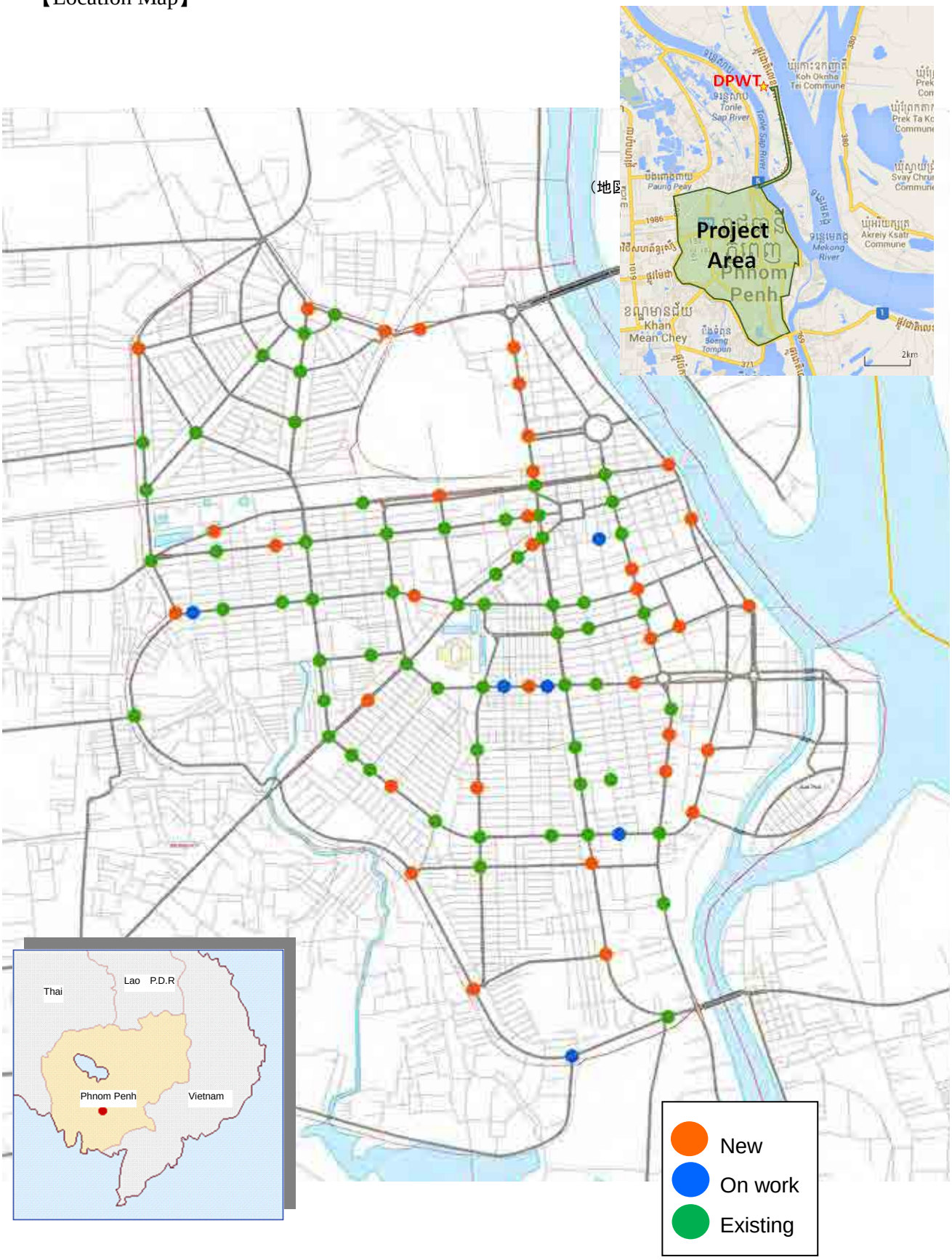
【Location Map】



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Abbreviations

2001M/P	The Urban Transport Master Plan in the Phnom Penh Metropolitan Area
A/P	Authorization to Pay
B/A	Banking Arrangements
CDC	Council for the Development of Cambodia
DPWT	Department of Public Works and Transport of Phnom Penh
EDC	Electricite du Cambodia
GDP	Gross Domestic Product
HMI	Humam-Machine Interface
IP	Internet Protocol
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MEF	Ministry of Economy and Finance
MOI	Ministry of Interior
MPTC	Ministry of Posts and Telecommunications
MPWT	Ministry of Public Works and Transport
PPCH	Phnom Penh City Hall
PPUTMP (2014M/P)	Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City
PVC	Polyvinyl Chloride
SVV	S=Signal V=PVC
TCC	Traffic Control Centre
TOD	Time of Day
USD	US Doller
V-C Ratio	Volume to Capacity Ratio
VPN	Virtual Private Network
WS	Workstation

1. Background of the Project

1-1 General outline and background of the Grant Aid Project

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On the other hand, public transport development was seriously lagging behind the growth of private transport. With the daily increase in vehicles converging from an enlarged metropolitan area towards the city center, traffic congestion and traffic accidents have escalated in tandem in recent years.

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The reason for proposing the Traffic Control System as the most priority project was chiefly due to the present conditions of the existing traffic signals in the city. Although Phnom Penh City has a total of 69 signalized intersections (64 of which are within the city center), most of them are isolated signal control, and each of them is individually operated using an independent display pattern. They are not functioning as a collective and consistent group of signal controls and thus are not able to effectively response to the changing traffic pattern especially during the morning and evening peak hours.

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1-2 Natural Conditions

The implementation of this Project shall be carried out basically within the right-of-way of the existing road in the city; hence, there is no serious adverse impact on the natural or social environment (e.g. Relocation of residents, etc.).

1-3 Environment and Social Considerations

In terms of impact on the environment, this Project falls under the Category ‘C’ in accordance to the “JICA’s Environment and Social Consideration Guidelines” (published in April 2010). Under this category, the Project is judged to have no impact on the natural environment

2. Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Background and Purpose

Phnom Penh, Cambodia's capital city, is the centre of politics and economy with a population of about 1.85 million (2012) and a land area of 678 km2. Traffic conditions and traffic accidents in Phnom Penh have been worsening in recent years due to the rapid increase of vehicles (number of registered 4-wheel vehicles in Cambodia: 62,000 in 2000 and 235,000 in 2011, or an increase rate of 379%) and the travel speed in the city centre decreased from 20 km/h (2001) to 15 km/h (2012) as a result of the country's vital economic growth. Phnom Penh Capital City (PPCC) tried to cope with these conditions by implementing some measures such as installation of traffic signals, improvement of intersections, construction of flyovers and widening of secondary roads to create better urban transport circumstances. However, their effort did not result in any substantial improvement; it has now become necessary to implement more drastic traffic improvement measures considering the expected increase of registered vehicles owing to the continuous population and income increase.

Japan International Cooperation Agency (JICA) conducted "The Urban Transport Master Plan in the Phnom Penh Metropolitan Area (2001 MP)" with the target year of 2015. And through "The Improvement Project of The Urban Transport in the Phnom Penh Metropolitan Area" (March 2007-2010), JICA promoted the transfer of technologies for intersection improvement, installation of traffic signals in the city, and traffic safety to Phnom Penh. Road construction completed earlier than planned in the 2001 MP in the urban and suburban area, but especially in the suburban area.

However, traffic congestions and traffic accidents have increased because public transport system is yet to be introduced. A request was therefore made by Cambodian Government to reformulate the 2001 MP and to develop a comprehensive urban transport plan (PPUTMP) including the action plans for solving transport problems in 2012. PPUTMP will formulate a comprehensive urban transportation plan that includes the development of the road network, and introduction of public transport and traffic management including traffic signal system upgrading. The target year of PPUTMP is 2035 (long term) including 2016 (short-term) and 2020 (medium-term). The introduction of traffic control system is proposed for one of the short-term priority projects to minimize the traffic congestion.

The reason why traffic control system is selected as one of the short-term priority projects is that although there are 69 signalized intersections in the city, the traffic signal system in Phnom Penh City is outdated as they are isolated signals operating with a single fixed timing plan regardless of traffic condition especially during morning and evening peak hours.

Considering the above circumstances, the Cambodian Government requested a Grant Aid from Japanese Government in July 2013, for the introduction of new traffic signals at 100 intersections (including existing 64 signalized intersections out of total 69 intersections), a traffic control center, including intersection improvement (the Project).

The purpose of the preparatory survey is to evaluate the adequacy of the above request and to work

out the preliminary design to examine the optimum planning contents and size of the Project.

2-1-2 Effectiveness of the Project

The effectiveness of the Project, introduction of new traffic signals at 100 intersections together with a traffic control center, is estimated quantitatively as follows:

(1) 14% improvement of the average travel speed in the city center (from 12.5km/h to 14.2km/h);

(2) USD2.5 million reduction in travel time cost for vehicle users along Monivong Blvd.;

(3) 3% improvement of volume-capacity ratio at major intersections (V-C ratio: from 1.37 to 1.33 during evening peak hour);

(4) 20% reduction of traffic police personnel assigned at intersections (from 400 traffic police officers to 320); and

(5) Reduction of the traffic accidents.

The Project is also expected to bring about the following qualitative benefits:

(1) Long-term vitality of Phnom Penh's regional economy;

(2) Reduction of global warming; and

(3) Improvement of the urban environment and increase of number of tourists to Phnom Penh.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

(1) Basic Approach

1) System configuration

This project will introduce a Traffic Control System to Phnom Penh and a total of 100 signalized intersections in the city will be controlled from the Traffic Control Center (TCC). Area traffic control system is a computer system and all components comprising the system must work in a coordinated manner to exhibit its intended functions. Thus the total system will be the subject of cooperation.

On the other hand, TCC can be placed at any location suitable for computer system and there is no special conditions for the building and room that accommodates the system. For this reason, the room for TCC will be prepared by the Cambodian side.

In a traffic control system, the server at the center needs to be connected with the signals at intersection through data communication line. There is two ways to realize the connection; construction of own communication network using dedicated newly installed cable, or subscription to the existing data communication network provided by data communication company. The former option is not feasible as the amount of data communicated in the traffic control system is not large enough to justify self-owned network. Moreover, engineer and technician are required for the maintenance of communication line. In Phnom Penh, data communication companies exist and data communication service is available at cost. Separately, Ministry of Posts and Telecommunications (MPTC) owns nationwide data communication network for government agencies. It was agreed with MPTC that the network will be made available for the traffic control system so that no network will be newly constructed.

The basic policy for the design of the traffic control system is enumerated below.

- The system will be designed to have high reliability as it controls traffic. Not only the reliability of individual component but also that of total system will be ensured.
- The concept of fail-safe will be applied to the system and the system will be provided with multiple levels of signal control method so that signal control only degrades in the event of communication error, processor error of local controller, lack of detector data, and so on.
- General purpose servers will be used at TCC and no purpose made sever will be used so as to cut the cost of equipment.
- Multiple narrow bezel LCD monitors will be used to form a video wall for low cost but highly clear display of images.
- Signal control method will be the one that takes traffic characteristics in Phnom Penh into consideration and can be managed by the staff of TCC.
- Local controller with the reliable operation record will be adopted.

2) Selection of target intersections

Master Plan Study identified the candidate intersections for the signal control system. These intersections were reviewed from the viewpoints listed below. Finally the list of target intersections was prepared with few intersections replaced from the original list.

The following criteria will be applied to determine whether a signal is needed as an intersection:

- Traffic volume during peak hours
- Saturation ratio (ratio of traffic volume against capacity) during peak hours
- Conflict factor (volume of traffic flows that conflict each other)
- Number of crossing pedestrians
- Number of traffic accidents, if data is available
- Public facility such as school, hospital, shopping center, etc. in the neighborhood
- The distance from the adjacent signal
- Planned flyovers

(2) Policy on natural and social environmental conditions

The project will be carried out within the existing right of way and underground conduit line crossing carriageway will be constructed without cutting pavement so that there is no serious natural or social environment issue such as relocation of residents and closure of road.

(3) Socio-economic condition

Target of traffic control system is the road users of various modes such as vehicles, tuk-tuk, bicycles and pedestrians and they are also recipient of the benefit of the Project. For this reason, the system must consider the local traffic characteristics that vary among the countries. The features of the traffic in Phnom Penh and measures to be taken are summarized below.

There are many 2-wheel vehicles and tuk-tuks that cannot be precisely detected and counted by the vehicle detector. Signal control method needs to consider the estimated ratio of these modes when calculating the optimum signal control parameters

Due to the characteristics mentioned above and lack of pavement markings, lane discipline is not well observed.

The existing signals lack pedestrian lantern. Or if there are pedestrian lanterns, most of them are not functioning. As a result, pedestrians do not pay attention to the pedestrian signal. Therefore, road user education is required.

(4) Policy on the conditions of construction and procurement

The local contractors can provide construction machinery on lease in Cambodia. The basic materials for the construction can be procured from the local suppliers and contractors. The materials such as cement and/or reinforcement bars are procured from neighboring third countries such as Thailand, Vietnam.

(5) Policy of the utilization of the local contractors and consultants

The local contractors in Cambodia, except for state of the art product that requires the special

technology such as log-span bridges, have enough abilities of ordinary construction. In the field of electrical works, the electrical construction companies in Cambodia have the enough abilities for the common electrical works required for traffic control system.

(6) Policy of operation and maintenance

Efficient operation by the competent personnel after completion of the system is required for traffic control system to exhibit its intended functions. Signal phasing and signal control parameters must be adjusted periodically to cater for increase or change in traffic volume, change of road network, modification of traffic regulation, etc. The breakdown of a component that constitutes the system will lead not only inefficient operation but also possible traffic accident. For these reasons, adequate maintenance of the system is crucial.

All the existing signals in Phnom Penh are a single pattern signal that operates with the fixed timing regardless of the time of day and traffic condition. Operation and maintenance of this kind of signal do not require technical skill as there is little things to adjust.

Currently, Public Lighting Section of the Department of Public Works and Transport (DPWT) is in charge of operation and maintenance of the signal. There is no expert of signal in the section and the signals are attended only when a malfunction occurs. No review is made for signal phasing and signal timing. A section of Traffic Control Center (TCC) needs to be established to carry out the operation and maintenance of the system.

It is envisaged that maintenance during defect liability period will be included in the system construction contract so as to ensure the maintenance by the signal system experts.

(7) Policy for selection of facility and equipment

The servers placed at the control center and local controller at the intersection will carry out the basic functions of traffic control system. Malfunction of these devices and that of software result in the serious impact on the system operation and traffic flow. Thus, high functionality and reliability are required for them. In particular, local controller and signal control software are the key components of the system that define functionality and performance of the system. For these reasons, Japanese products must be selected for control software and local controller for their reliability and functionality.

There is still quality difference between the signal lanterns made in the developed countries and developing countries. High efficiency LEDs, which consumes less power, are used in good quality lantern manufactured in developed countries. Thus, lanterns must be from the developed countries.

Restriction on the country of origin is not necessary for servers and network devices as long as a product is made by reputable manufacturers and maintenance service is available in Phnom Penh.

Signal pole and signal cable can be procured in Cambodia or in third countries as long as they comply with the specifications required.

(8) Policy for construction method

1) Intersection geometric improvement work

The following policy will be adopted with regard to intersection geometric improvement works:

- Works will be limited to carriageway.

- The works mentioned above are within 100 meters for main roads and within 50 meters for local roads from the stop line.
- Center lines and center dividers will be relocated where the relocation is found effective in improving traffic flow.
- The pavement marking material must be thermoplastic that conforms to international standards.
- Type of traffic regulation sign is reflective sheet type that is currently used in Phnom Penh.
- Damaged areas of pavement surfaces that were identified during the site survey by the JICA Preparatory Survey Team and were found to affect smooth traffic flow will be repaired.

2) Signal installation work

The signal cable that connects local controller with lanterns at intersection will be through the underground conduit to be constructed.

Conduit line will be constructed by horizontal augering method and no open cut method will be allowed. Thus traffic flow will not be affected and pavement will not be damaged.

As the construction work needs a certain period, the work must start as earlier as possible, so as to ensure earlier completion than signal installation work to avoid long construction time.

2-2-2 Basic Plan (Construction Plan / Equipment Plan)

(1) System Design

Configuration of the proposed traffic control system is shown in Figure 1. Traffic control system consists of the roadside equipment installed at the target intersection, server system installed at TCC and the data communication network that connects roadside equipment with the central equipment.

1) Roadside equipment

Roadside equipment of the system is local controller, signal lanterns and accessories, vehicle detector, and traffic monitoring video camera. The target intersection where new signal is installed are shown in Figure 4. Traffic monitoring video cameras will be installed only at key intersections that has large traffic volume and high volume-capacity ration (see Figure 7).

2) Equipment at Traffic Control Center

TCC carries out the signal control based on the data gathered by vehicle detector. In addition, traffic conditions at key intersections are monitored through traffic monitoring video camera system. Traffic condition as well as the status of the system is displayed on the video wall and workstation for operator.

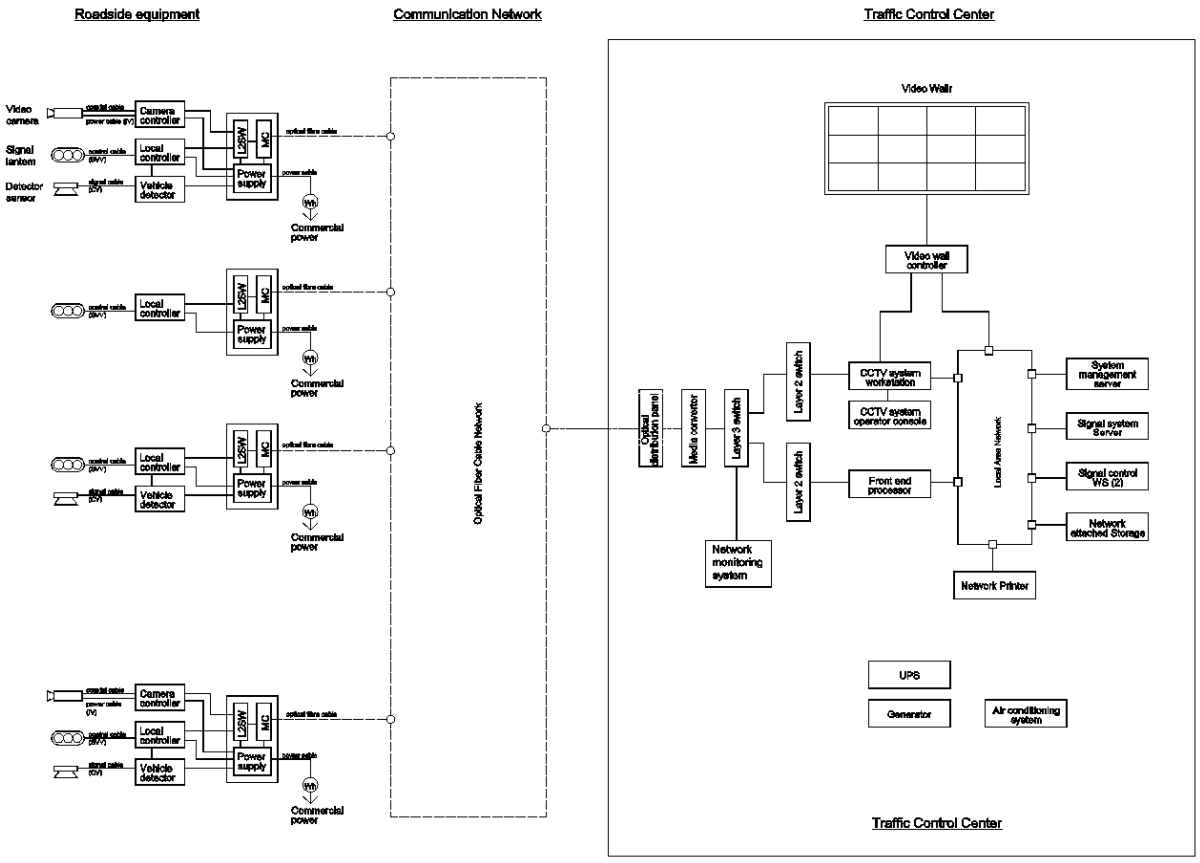


Figure 1: Configuration of Proposed Area Traffic Control System

Source; JICA Study Team

3) Data communication

The existing optical fiber network owned by the Ministry of Posts and Telecommunication (MPTC) will be used for data communication. It is not recommended to establish a new optical fiber network as it incurs additional construction, operation and maintenance costs. Data communication engineer is also required if self-owned network is constructed. There is an existing optical fiber network in Phnom Penh that connects government agencies and use of it for traffic control system has been agreed by MPTC. Using this network is more feasible as there is a scale merit.

Internet protocol will be used for signal system. As the protocol is widely used in many data communication applications, the cost of equipment is relatively lower than special purpose device so that the system can be constructed more economically. They are also easily available.

Although the system adopts Internet protocol, the network must be completely separated from other networks as virtual private network (VPN) to protect it against attacks.

4) Signal control method

1. Hierarchical signal control level

Traffic control system is a system that controls traffic signals and several control levels

are set as shown below. The levels are divided into two groups; central control by the control center and isolated control at intersection, in which each signal operates independently. The system will have multiple level of signal control. Normally central control, which is more efficient than isolated control, is applied. But in case of communication interruption, isolated control is applied automatically. The central control is automatically resumed when the communication link is re-established.

Central control is further classified into adaptive control, which modifies control parameter dynamically in real-time, pattern selection, in which most suitable set of control parameters is selected based on the traffic condition, and time-of-day (TOD) control that selects control parameter according to time-of-day and day-of-the week.

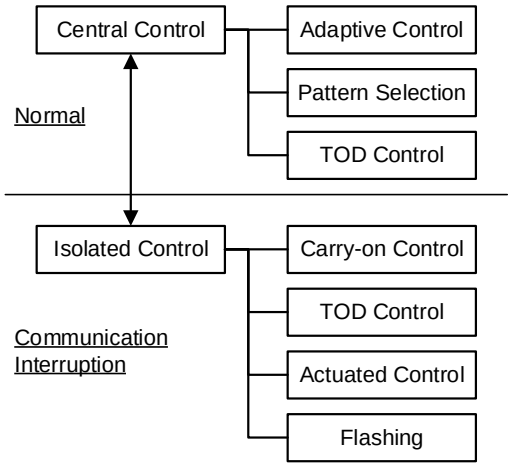


Figure 2: Signal Control Level

Source; JICA Study Team

2. Sub-area

Traffic condition within the control area varies by location and time so that same control cannot be applied to the entire area. The entire area will be divided into sub-areas for signal control purpose. A sub-area is a minimum unit for signal control and consists of one or more signals. Traffic condition within a sub-area is assumed to be always same. All signals that belong to a sub-area operate in principle with the same cycle length so that offset between signals can be defined. Key intersection may be defined as sub-area with single intersection so that it can operate freely and independently with surrounding signals.

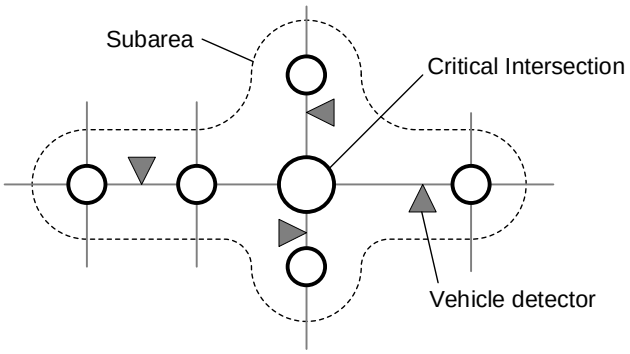


Figure 3: Concept of Sub-area

Source; JICA Study Team

Sub-areas are connected together if the traffic condition inside two sub-areas is found similar. Sub-areas once connected operate with the same cycle length so that the offset between two sub-areas can be defined. Connection or separation of sub-area is reviewed and decided at every signal timing parameter calculation interval, which is normally 5 – 15 minutes.

As explained above, signal control is carried out with sub-area as minimum unit for control. It is necessary, therefore, to understand the traffic condition of each sub-area. Vehicle detector will be installed for each sub-area for this reason. The tentative plan for target intersections, sub-area formation and detector deployment plan is shown below.

Figure 4: Signal, Sub-area and Vehicle Detector Deployment Plan

Source; JICA Study Team

3. Vehicle detector

Vehicle detector must be installed at various locations shown in Figure 4 to gather traffic condition data for signal control system. There are various types of vehicle detectors

available. Most common type is inductive loop type vehicle detector. In recent years, image sensor type vehicle detector is becoming more common due to the development of image processing software. Advantage of image sensor vehicle detector is that one unit can cover multiple lanes and high detection accuracy is achieved even for the traffic flow that does not follow lane. Another advantage is that the detection area can be defined freely by parameter. Considering the heterogeneous traffic and lack of lane discipline in Phnom Penh, image sensor type vehicle detector will be used for the system.

In order to detect and count traffic arriving at intersection, vehicle detector will be placed on the pole for signal lantern at higher position than lantern for better accuracy. Video camera part of vehicle detector will be placed at the height of 8 meters above the ground level. Each vehicle arriving at intersection will be more easily identified with this height. The example of video camera installation is shown in Figure 5.

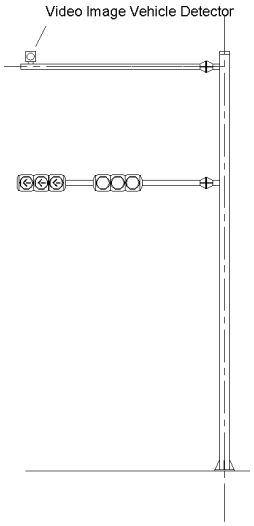


Figure 5: Installation of Image Sensor Vehicle Detector

Source; JICA Study Team

4. Traffic Control Center (TCC)

TCC has been already decided to be constructed inside the DPWT compound. TCC will consists of control room where operators stations to monitor traffic condition and system operation, server room where servers and other equipment will be placed, power supply room, workshop and office. They are summarized in Table 1. It is confirmed during preparatory survey that the proposed location can accommodate these facilities.

Video wall will consists of matrix of LCD monitors arranged four units horizontally and three rows vertically. These monitors will show images as one large screen, or independently and separately in each monitor by the control of video wall controller. The contents to be shown is the screen image of the central server monitor and the video image taken by the traffic monitoring video camera.

Table 1: Rooms for Traffic Control Center

Room	Equipment/facility	Function	Remarks
Control Room	Video wall Control desk	Traffic monitoring Signal operation monitoring	Area: Approx. 100m2
Server room	Main server Signal control WS HMI WS Front end processor Central controller for traffic monitoring video camera Network attached storage Data communication devices	Signal control and monitoring Detector data processing Traffic monitoring camera control Operation and maintenance log	Area: 50-100 m2 depending on configuration and future expansion plan
Power supply room	Generator Uninterruptible power	Supply of uninterruptible and stable power	Area: Approx. 50 m2
Workshop	Testing equipment, tools and spare parts	Maintenance work Spare part inventory	Area: Approx. 50 m2
Office	System monitoring	Desk works	

Notes: HMI: Human-machine Interface WS: Workstation

Source; JICA Study Team

5. Signal design standards

All signals at the target intersection will be newly designed. Signal design will adopt the design standards stated in the paragraphs below.

Signal Lantern

All lanterns will be LED type. Size of vehicle lantern will be 300 mm diameter if mounted on mast arm, and nominal 200 mm for straight pole. If vehicle movements are controlled by movement direction, arrow lantern will be used. Arrow lantern will have only one arrow and no lantern with two arrows as used now will be used.

Lantern will be attached to arm horizontally and lantern will be vertically attached to straight pole.

Pedestrian lantern will have two aspects; one showing standing pedestrian in red and another showing walking pedestrian in green. Animation type pedestrian lantern will not be used as the animation control circuit is susceptible to failure. One aspect pedestrian lantern that shows both standing pedestrian and walking pedestrian in one aspect will not be used as it confuses color blind pedestrian.

Clearance

Lanterns attached to mast arm will have a clearance of minimum 5.5 meter above the ground level, while lanterns attached to straight pole will have a clearance of minimum

2.8 meter above the sidewalk.

Angle adjustment mechanism

Lanterns must be firmly attached to either arm or pole. Angle adjustment mechanism must be provided so as to adjust lantern direction to face approaching traffic squarely.

Lantern Layout

In order to secure the visibility of lantern, two sets of lantern will be installed for each movement. One set will be placed before intersection (near side lantern) and another set after the intersection (far side lantern). Typical lantern layout is shown below. Pedestrian lantern will be installed across the road having width of 8 meter or more.

Standard Layout **Reverse Layout**

Figure 6: Typical Lantern Layout

Source; JICA Study Team

Countdown timer

Countdown timer is the device that displays the remaining time of current signal indication based on previous signal cycle. If signal cycle changes dynamically every cycle, it is impossible to show the remaining time correctly. For this reason, countdown timer will not be used.

Display sequence

For vehicle lantern, signal display will follow the sequence of green, yellow and red, and pedestrian lantern sequence will be green, flashing green and red. No flashing green at the end of vehicle green and simultaneous display of red and yellow just before vehicle green will not be used.

Left turn phase

If exclusive left turn phase (protected left turn) is used, no permissible left turn will be added before or after protected left turn.

All red interval

All red interval will be inserted between two conflicting movements.

Conduit

Connection from the local controller to the lantern will be made by the cable laid underground. Cable will be inserted inside conduit to be installed by horizontal augering method. No connection of cable is allowed inside conduit, at hand-hole or any other underground location. Conduit must be placed at least 1.0 meter below the ground level. However at intersection where the drainage, top of which is about 1.0 meter below pavement, exists, steel conduit will be used and placed shallower than 1.0 meter. Open cut method is not allowed as it requires road closure and damages pavement.

Conduit will be PVC or high density polyethylene, or steel when sufficient depth cannot be secured. Number of conduits will be either one line with 100 mm diameter conduit, or two lines with 50 mm diameter conduit.

Hand-hole

Except when hand-hole is available nearby, hand-hole must be constructed near mast arm and straight pole. All underground conduits will terminates at hand-hole.

Existing signal pole

Existing mast arm and straight pole will be replaced with new must arm or pole as the existing mast arm and poles will be used at other locations together with the controller removed.

Signal cable

For the signal cable connecting local controller with lantern, SVV type vinyl insulated vinyl sheathed cable having 4, 8, 12, 19 or 30 conductors of nominal 1.2 mm2 will be used.

5) Traffic monitoring video camera system

Traffic monitoring video camera will be installed at key intersections to observe traffic. As the video data transmission requires wide bandwidth, the usage fee of the video data transmission is much higher than the line for controller. Considering the high cost of video data transmission, traffic monitoring video camera will be installed only at key intersections with frequent congestion.

Pan, tilt, zoom functions will be provided to the traffic traffic monitoring video camera and they are controlled from the TCC. At the Control Center, video image will be recorded and kept for some time so that it is possible to watch on the video wall not only live video image from the camera but also video image taken and recorded previously.

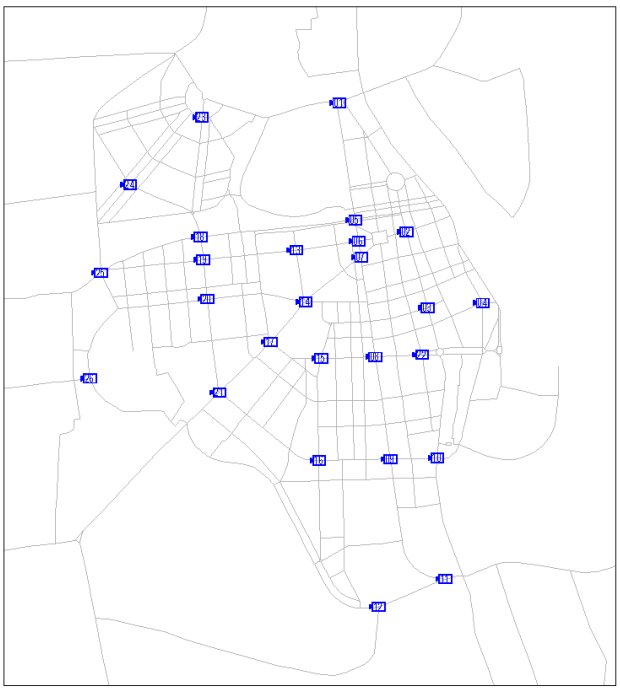


Figure 7: Deployment Plan of Video Camera

Source; JICA Study Team

6) Equipment List

Traffic control system consists of the equipment at the control center and signal equipment installed at intersection. These equipment is listed in Table 2 and Table 3, respectively. The equipment used for data communication between the control center and intersection equipment is included in one of the lists.

Table 2: List of Equipment at Control Center

	Equipment	Functions
1	Network management server	System management
2	Signal control server	Signal control at higher level
3	Signal control workstation	Signal monitoring and control operation by operator
4	Network attached storage	Data storage
5	Front-end processor	Signal control Vehicle detector data processing
6	Network printer	System printer
7	Video wall	Display of traffic condition, system monitoring, etc.
8	Video wall controller	Control of video wall
9	Traffic monitoring workstation with	Monitoring of traffic conditions

	console	
10	Vehicle detector data processing software	Row vehicle detector data are processed into traffic flow data
11	Signal control software	Monitoring and control of signal
12	Equipment operation monitoring software	Monitoring of system equipment
13	Human-machine interface	Display to operator and processing of input by operator
14	Statistics software	Statistical processing of traffic data and system operation data
15	Database software	Database management software
16	Parameter setting for vehicle detector	Vehicle detector ID, location, adjustment factor, etc.
17	Signal control parameter setting	Controller ID, phase, step setting, etc.
18	Uninterruptible power supply	Supply of interruptible power
19	Controller for traffic monitoring video camera	Control and monitoring of traffic monitoring video camera
20	Layer 3 switch	Network switch
21	Layer 2 switch	Network switch
22	Media converter	Electronic – optical conversion

Source; JICA Study Team

Table 3: Equipment at Intersection

	Equipment	Function
1	Local controller (standard and large)	Signal control in remote or isolated mode
2	Layer 2 switch	Network switch
3	Media converter	Electronic – optical conversion
4	Signal lantern (vehicle and pedestrian)	For vehicle and pedestrian
5	Vehicle detector	Detection and counting of vehicles
6	Traffic monitoring video camera	Traffic monitoring camera and controller.

Source; JICA Study Team

Table 4: Spare Parts

	Category	Spare Parts
1	Server and workstation	Power supply unit for server
2		Power supply unit for workstation

3	Video wall	Power supply unit for video wall controller
4	Local controller	Local controller main board (Standard)
5		Local controller main board (Large)
6		SSR unit
7		Power supply unit
8		Surge arrestor
9		PROM writer
10		Local controller for testing
11		Signal lantern simulator
12		Notebook computer
13		Diagnosis and setup software
14	Signal lantern	Power supply unit for vehicle lantern
15		Power supply unit for pedestrian lantern
16	Vehicle detector	Power supply unit for camera unit
17		Control board of camera unit
18		Controller unit power supply unit
19		Controller main board
20	Video camera	Control board
21		Power supply unit
22	Network equipment	Layer 3 switch
23		Layer 2 switch
24		Media converter

Source; JICA Study Team

(2) Traffic Control Center (TCC) and Its Interior Layout

1) Rooms Required and Their Scale

The rooms required for the setup of a TCC as well as the scales of these rooms and their contents have been previously presented in Section 2.2.1 (4). Based on these requirements, and by matching them with the existing conditions of the candidate rooms proposed by the Department of Public Works and Transport (DPWT), the Team designed the recommended layout plan for the proposed TCC.

The followings are the exterior views of the building where the candidate rooms are located and the existing conditions and layouts of the candidate rooms suggested by DPWT.

Figure 8: Exterior view of the Building, Existing Interior

Source; JICA Study Team

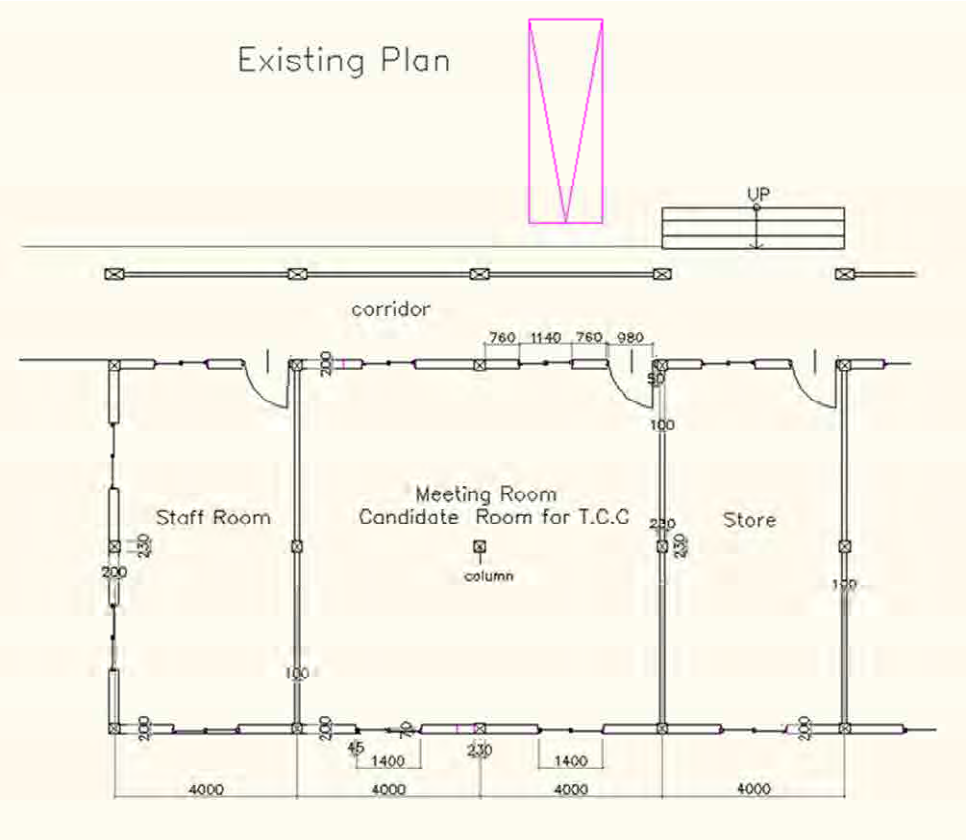


Figure 9: Existing Layout of Candidate Room

Source; JICA Study Team

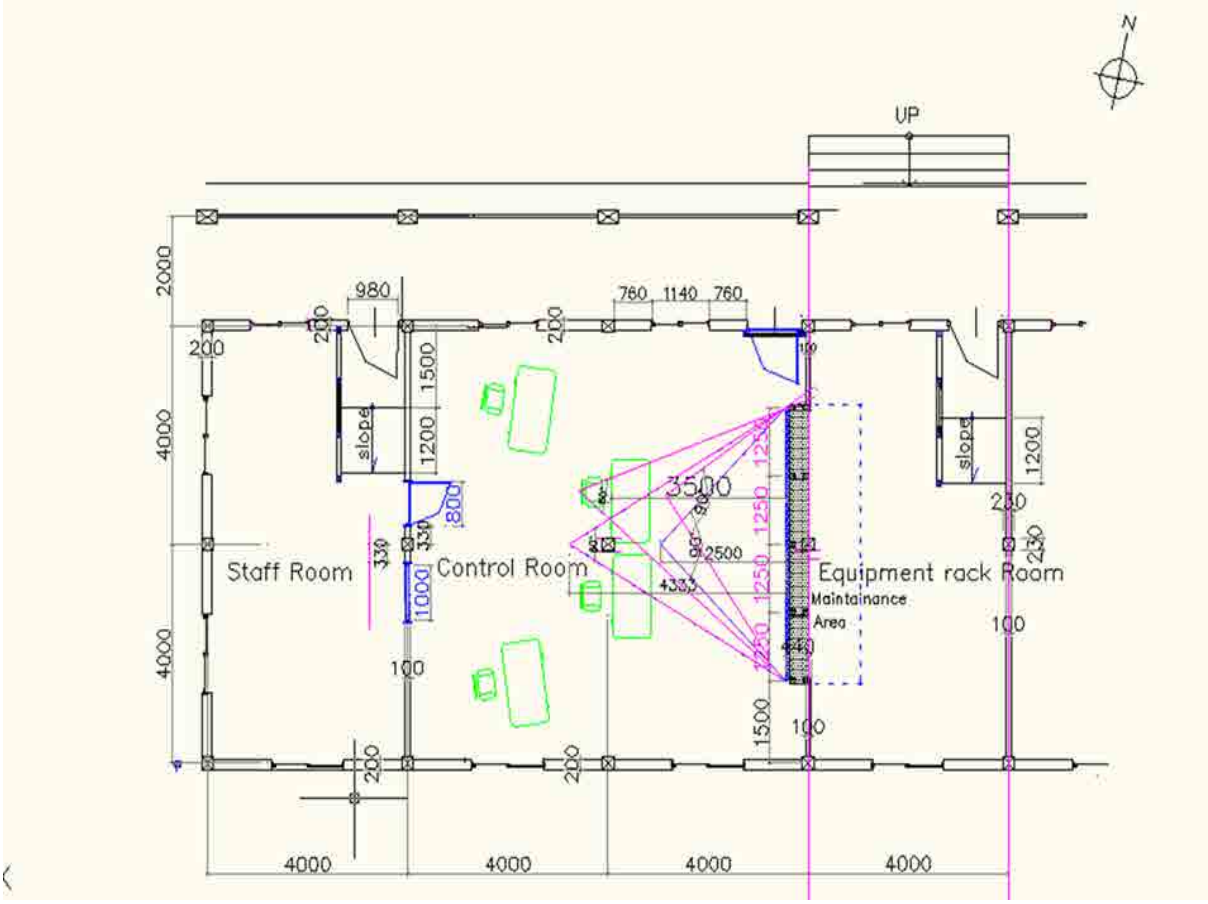


Figure 10: Recommended Interior Layout Plan of Proposed TCC

Source; JICA Study Team

After a series of consultation and discussions with the DPWT, the Team proposed the layout plan for the TCC as shown in the Figure above.

The name and floor areas of rooms for the proposed TCC are summarized below:

Table 5: Name and Floor Areas for the Proposed TCC

Within the Existing Building		**Additional New Construction (60m southwest of existing building)**	
Name of Room	**Floor Area**	**Name of Room**	**Floor Area**
Control Room	61.8 m^2	Power Generator Room	32.0 m^2
Equipment/Server Room	34.2 m^2	Store/Workshop	32.0 m^2
Staff Room/Office	32.0 m^2		
Total	**128.0 m^2**	**Total**	**64.0 m^2**

Source; JICA Study Team

2) Criteria for Designing and Planning of TCC

- Large size liquid crystal display (LCD) monitors are to be used as video wall. Size and weight of LCD screen recommended are to be W=125 cm, H=72cm, D=6.5 cm and W=25.3kg.
- The video wall comprises 12 LCD screens described above, arranged with four LCD monitors across and three monitors high.
- At the back of the video wall, a space with a width of at least 1 m must be reserved as maintenance space.
- The distance from the operators to the video wall must be within a specific distance and angle whereby the visibility of the operators can be secured and focused very quickly on the images of the video wall. (Stable focusing distance)
- The location for achieving stable and focus visibility must be kept within angles of 600 - 900 horizontally and 450 - 750 vertically. Using these guidelines, the placement of the operator control desks in the control room is determined.
- There will be potentially many crisscrossing cables linking the operator desks and equipment in the control room. Without proper treatment of such cables on the floor, they can become hazardous to human movements within the room. Therefore, a raised floor will be constructed above the existing floor, in part for the objective of creating a safe and sufficient storage space to accommodate all the cables and put them out of sight.
- This new raised floor must be about 15 cm - 20 cm above the existing floor.
- It is very essential that traffic monitoring and control at the TCC continues to function uninterrupted even during a power blackout in the city. Therefore, a power generation facility must be planned and setup to be equipped with a diesel fuel power generator.
- For normal operation of the TCC, a maximum power of 15,000 w is required. For this reason, the power generator to be procured must have a 15 KVA specifications.
- The power generator is to be placed in a newly constructed building that houses both the power generator room as well as a store cum workshop. The layout plan and location for this proposed new building are shown in the figure below.

Figure 11: Site for Generator House

Source; JICA Study Team

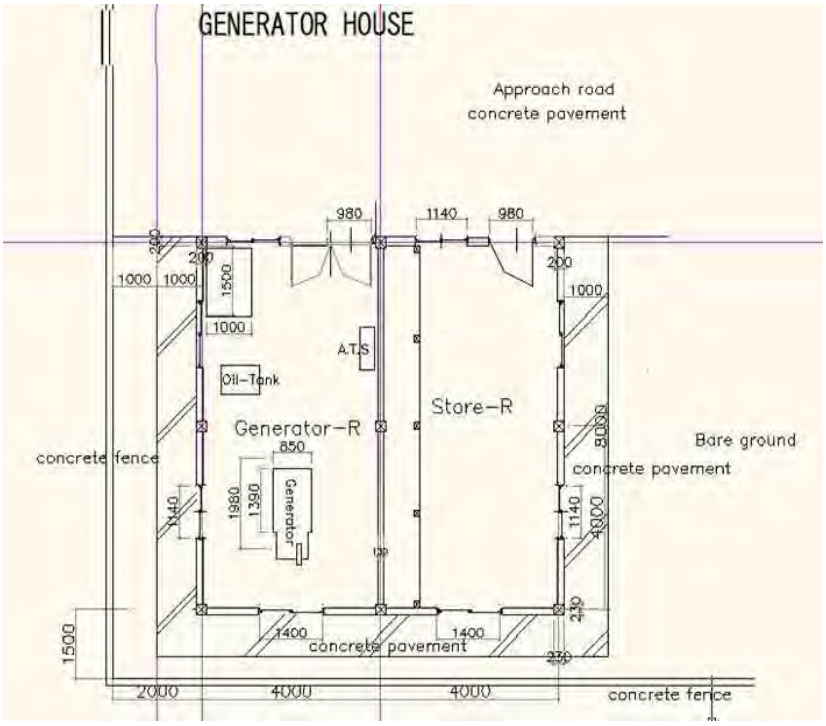


Figure 12: Layout Plan of Generator House

Source; JICA Study Team

3) Existing Condition of Candidate Room and Planning of its Interior Furnishing

- The candidate room identified by DPWT for TCC is currently a meeting room. Two extra rooms to the left and right of this candidate room will further serve as an equipment/server room and a staff room/office.
- Going to control-room in and out is assumed by way of the office.
- The isolated column in the center of the candidate room is a potential obstacle to good visibility of the monitor screen on the video wall by the traffic operators. Its removal however is difficult due to the present building structure.
- The interior layout plan thus has to take into account the presence of this column. In order to secure good view of the video wall without obstruction by column and to keep the entire video

wall within the stable and focus visibility angles required for the operators, the video wall is forced to retreat as far back as possible towards the back wall in the room.

- However, the video wall requires a specific space at the back of it for maintenance of the monitor. Fortunately, the back wall of the room is not a structure wall but just a dividing wall to the adjoining room. Therefore its removal with proper reinforcement is possible.
- If this dividing wall is to be entirely removed, it also involves the removal of the ceiling and all the lighting fixtures. This may incur a substantial cost for the remodeling. Therefore, it is proposed that the portion of the wall directly behind the proposed video wall be removed while the remaining wall is to be reinforced so that it does not collapse.
- The method of reinforcing the remaining part of the wall while removing the specific area is as follows. First remove a small portion of it at the top fringe and then insert reinforcement support. The adjoining portion of this area will be given the same treatment, and the process repeated until the required portion of the wall for constructing a horizontal support beam is removed.
- Next, reinforcement bars for the beam are put in place. Concrete mix is injected into the beam formworks. After proper curing of the concrete beam over a period of 3 to 4 weeks, the portion of the wall below the beam can then be removed without the danger of the remaining upper wall falling.
- For the construction of doorways on the wall, similar reinforcement method is used to remove those portions of the wall for the doors.
- The columns are found to have fairly small horizontal cross sections, indicating that these columns are only able to support small loads. Therefore, to strengthen the columns, they are first knock off for a specific length and additional bars are added to the existing reinforcement and then new concrete mixes are injected to form new columns.
- The support structure for mounting the LCD monitors must be constructed of wood. The reason for this is that a wooden structure provides much freedom in adjusting and fixing the frames for the monitors at the back of the video wall. Thus works at site becomes easier.
- To achieve the overall consistency and color on all the interior walls, the final finishing works are applied to all the internal walls, irrespective of whether they are newly replaced wall or existing wall. This is because the color tones on the existing wall often differ from those that are given new finishes.

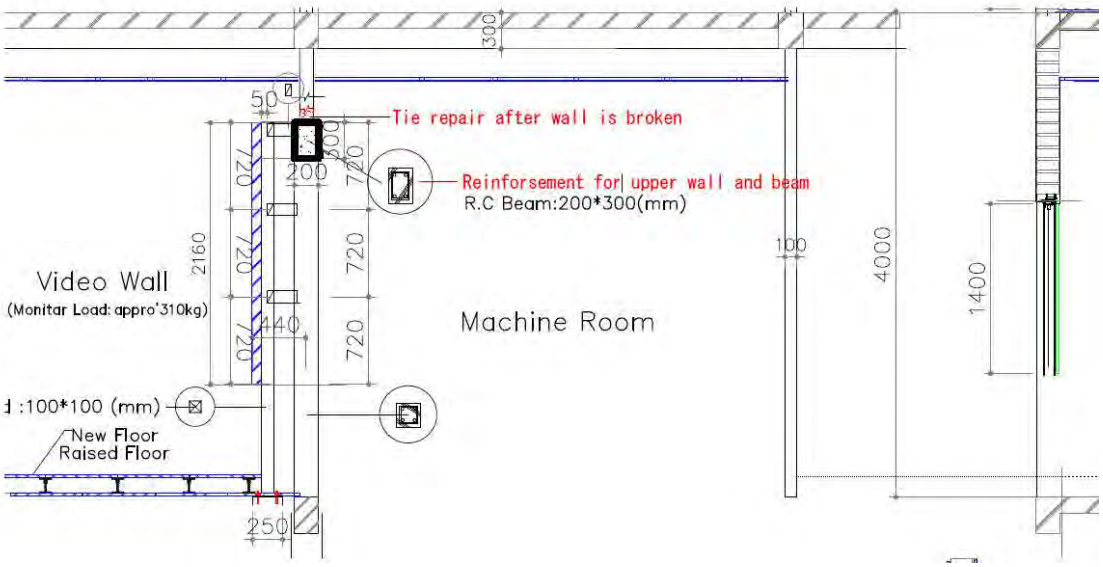


Figure 13: Proposed Construction Reinforcement Method

Source; JICA Study Team

(3) System Security

The following measures must be incorporated in the system design as well as system operation to protect the system against the possible attack from outside and inside:

- Data communication network completely isolated from other networks and access limited to the authorized terminal only,
- Access control system at Traffic Control Center using ID card and access log with video recording, and
- Log-on process required for system operation and recording of all manual operations through work station.

(4) Intersection Improvement

1) Planning Concept of Intersection Improvement

The formulation of the intersection improvement plan is required following the implementation of road marking in accordance with the signal installation. The basic planning policy related to intersection improvement is as follows.

- The area of intersection improvement covers the carriageway only to avoid relocation of facilities such as poles and drainage.
- The planning area is 100m from the stop line for the road having four or more lanes, and 50m is from stop line for 2-lane road.
- The road cross section such as roadway width, outer and inner shoulder width is determined based on the Cambodian Road design standard (2003), and current

situation.

- The planning for the road-related facilities such as center dividers and traffic signs also follows Cambodian design standards. The harmonious with existing structures facilities are considered in new facilities planning.
- The planning of road markings is based on Cambodian road marking standard (2004) and international design standards. The road marking that is not covered in the standards is approved by Cambodian side in advance.
- Potholes and damaged pavement that cause slow moving of traffic and prevent application of road markings will be repaired.

2) Facilities Planning

1. Standard Road Cross Section

The standard Road Cross Section is shown in Figure 14, based on the Cambodian Design Standards.

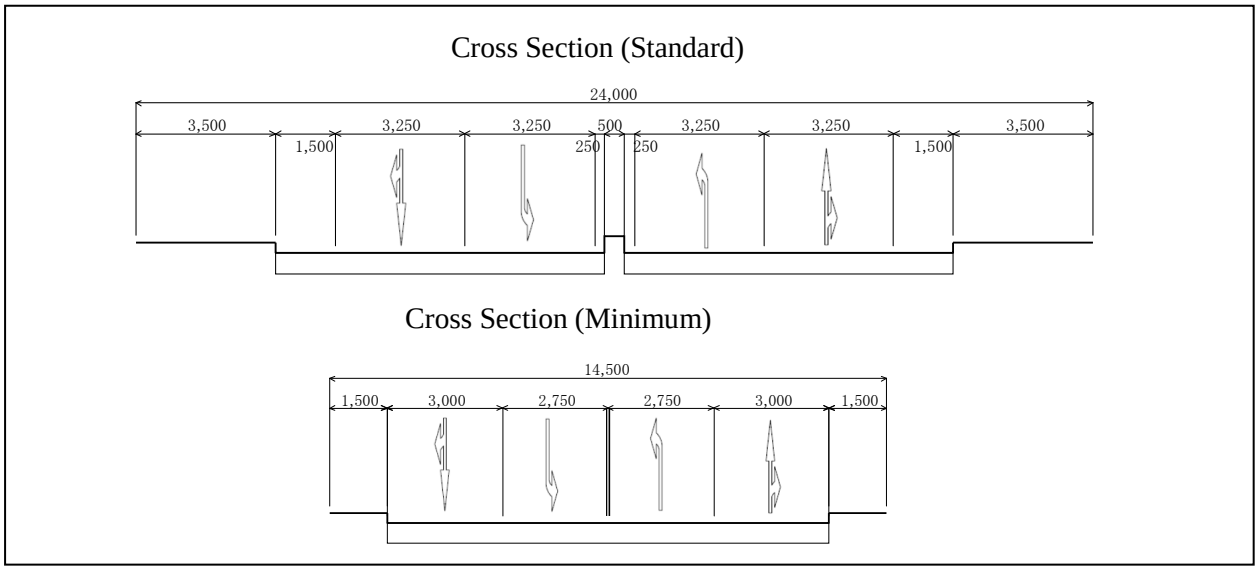


Figure 14: Road Cross Section

Source; JICA Study Team

2. Driving Lane Divider

The center divider will be installed along the road having four or more lanes. The types of center divider to be installed are following three types.

- Concrete block of low height（H=400mm）
- Concrete block of medium height（H=750mm）
- Steal fence（H=900mm）

		
Concrete block of low height （H＝400mm）	Concrete block of medium middle height （H＝750mm）	Steal fence （H＝900mm）

Figure 15: Center divider

Source; JICA Study Team

3) Road Marking Design

Road marking will be newly applied or renewed at the intersections where traffic signal is installed. Road marking will follow the standards stated hereunder.

1. Type of pavement marking

The following types of road marking will be applied to the intersections and road sections.

- Stop line
- Pedestrian crossing
- Centre line
- Lane line
- Directional arrow (through, right-turn, left-turn and their combination)

2. Specification for marking material

Marking material must be thermoplastic type complying with BS 3262 or equivalent and the supplier of the marking material is requested to submit a certificate certifying that the product meets the standard.

3. Standard layout

Standard layout of road marking is shown below. Centreline, lane line and edge line will be drawn 100 meters from the stop line except minor road (width is less than 8.0 meter) where the limit will be 50 meters from stop line.

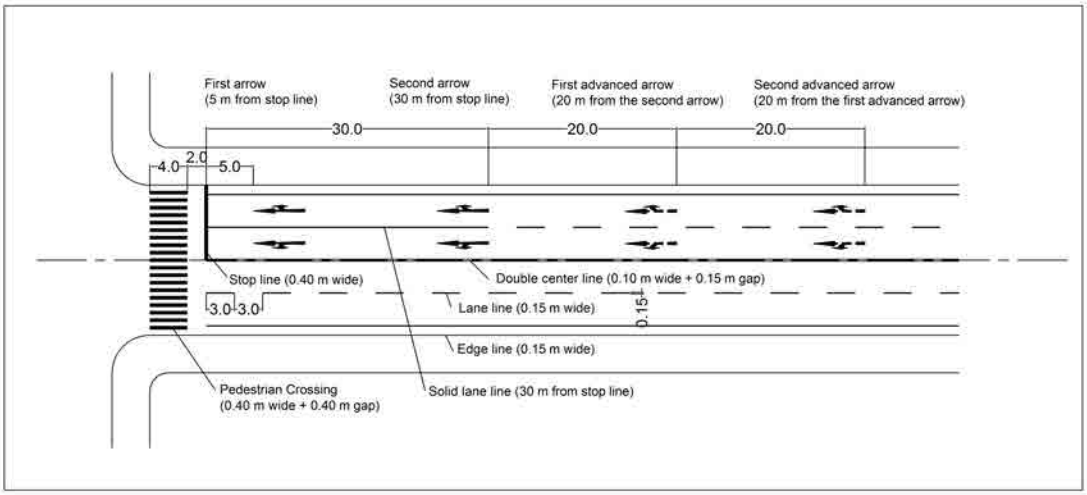


Figure 16: Standard Road Marking Design Layout

Source; JICA Study Team

2-2-3 Outline Design Drawing

List of outline design drawings is shown in Table 4 and the drawings are in the Appendix 3.

Table 6: List of Outline Design Drawings

No.	Items	Name of Drawing		No. of Drawing	Drawing No.
1	OVERALL	Location Map		1	
2	TRAFFIC CONTROL SYSTEM	System Hardware Configuration		1	
		Software Configuration		1	
		Data Communication Network		1	
3	INTERSECTION PLAN	Intersection Improvement Plan (Intersection. No1)		1	
		Pavement Marking Standard Traffic Arrows		1	
		Design Standard of Lane Divider		1	
		Design Standard of Traffic Sign		1	
		Design Standard of Layer of Pavement Repair		1	

Source; JICA Study Team

2-2-4 Implementation Plan

(1) Implementation Policy

Both civil and electrical works are expected to be implemented adopting the local companies under the supervision of the Japanese Contractor.

The test and adjustment are expected to be implemented by Japanese Engineers and/or experts for securing quality of the work.

The consultant is required to keep contact constantly with DPWT counterpart. The optical cable network lines connecting to the existing data network are constructed by MPTC. The consultant is also to keep contact and coordinate with MPTC.

(2) Implementation Conditions

The labors in Cambodia have the enough man power and skills for both civil work and electric work under the guidance of the contractor's engineer. The existing construction machines have the enough capacities for the Project, no machine is required to be obtained and/or transported from third countries.

The construction materials for both of civil work and electric work are available in Cambodia on both basis of the local production and the import from third countries. When imported, they will be mainly imported from Thailand and Vietnam on land.

(3) Scope of Works

Cambodia shall ensure to provide the enough and stable electricity supply through the electric supplying line to the target intersections, and Cambodia also shall ensure the adequate maintenance of the transmission lines of optical fiber and the electricity supply to TCC in collaboration with PPCH, MPTC and EDC.

The existing traffic signals are removed and transported to the stock yard of the DPWT after the commencement of new traffic signal, which are constructed at almost same location of the existing traffic signal poles.

The disposal area which locates approximately 5km away from the city center is secured and maintained by DPWT.

(4) Consultant Supervision

The contractor should be a Japanese companies or Joint-ventures headed by Japanese companies who have the experiences on both the road improve work and the electric communication work. The works of both traffic signals and communication lines are constructed as a part of the civil work because they are classified as road improvement. The equipment of the traffic signal system and the traffic control system in TCC are Japanese products procured in Japan, considering the long term quality, durability and the constancy to the software developed in Japan. The products for the traffic control center are procured as a system so that the products have the sensitive relations each other.

The civil work such as installation of road marking and the signal installation works are constructed under the supervision of the contractor's engineer and the local engineers hired for the Project. The supervision of the procurement of the products are supervised by the procurement engineer of the consultant and specialist from the contractor.

The number of the intersections must be finished the construction in one month will be about ten and four intersections are simultaneously constructed. Therefore, optimum numbers of the engineers are designated to the check, test and adjustment in order to maintain the quality of the project. The products assembled at TCC are also tested, checked and adjusted, and the instruction of the initial operation and maintenance are provided by the contractor.

(5) Quality Control Plan

The quality control will be executed in the following manner.

- Requirements for quality must be clearly stated in the technical specifications.
- Factory test must be conducted at manufacture's factory to examine the function and the quality of the product.
- Test on completion for a signal must be conducted when a signal has been installed at an intersection.
- Test of completion for system must be conducted when the system is completed

(6) Procurement Plan

The traffic control system consists of traffic control devices (including software) in the center, traffic signals and devices at intersections and the connection/communication lines which connect the center and target intersections. The devices in TCC are general computing system except the software. Considering the software being developed in Japan, the procurement of the computer is not necessary to restrict on the country of the origin as long as a product is made by reputable manufacturers and maintenance service is available in Phnom Penh.

The traffic signal devices at the intersections are all sophisticated state of art productions. From the point of view of the functions, quality and reliability the products are limited in Japanese signal products.

The communication system used in this project are not special, but the ordinary optical fiber communication network and its devices. Therefore, the special consideration on the country of procurement or origin is not required on this communication system.

The same consideration can be applied on the spare parts. The traffic signal devices are not general purpose ones, but the special electronic devices. These devices are order-made, which requires the time to obtain and the supplier is also limited to the producer of the device. Additionally there is a problem of the electric power supply. Japanese traffic signal is so highly reliable as Mean Time Between Failure exceeds Three hundred thousand Hours 300,000, equal to 30 years or more. But this is the case used under the good conditions in Japan. Considering bad quality of the electricity supply in developing countries, the occurrence of the failure of the devices is much more frequent. These factors require the need of the considerable spare parts relate to electricity.

(7) Initial Operation Training

Initial operation training will be provided by the supplier of the system. It covers both the center system and equipment, and roadside equipment and mostly conducted at the Control Center or at site as hand-on trading. The objectives of the training are to make the operators familiar with the operation procedure of the equipment and make them able to operate them. The basic knowledge of traffic engineering and signal control will be left to the training provided by the supervision consultant as soft component.

The training must cover as minimum the following subjects:

- Startup and shutdown procedure
- Screen menus and their functions for server and workstation
- Meaning and interpretation of the displays and indicators
- Operation of keys and switches of the equipment
- Measurement, testing and diagnosis
- Alarm and actions to be taken

A set of operation manuals must be prepared by the supplier in advance of the training. The manual must be concise but detailed enough for the operator to handle the system and equipment.

All operators and maintenance technicians must be available and receive the training.

(8) Soft Component (Technical Assistance) Plan

The system operator is required to have knowledge necessary for the operation in order to efficiently manage the traffic control system. The staff of DPWT currently does not have sufficient knowledge of signal control. Training sessions by the system supplier are planed during the project as to the operation of the equipment. But, it is not sufficient to operate the system.

During the construction of traffic control system, various parameters must be input and adjusted for both equipment at the center and the equipment at intersection. The efficiency of signal control largely depends on the quality of these works. During this period, technology transfer will be made as soft component through lecture and on-the-job training for system administrator and operator. The subjects to be covered are:

- Preparation of operation and maintenance manual,
- On-the job training for DPWT staff regarding operation of the traffic control system,
- Educational session for the traffic police about basic knowledge of the traffic signal system, and
- System operation procedure
- Campaign of traffic signal for road users.

(9) Tentative Implementation Schedule

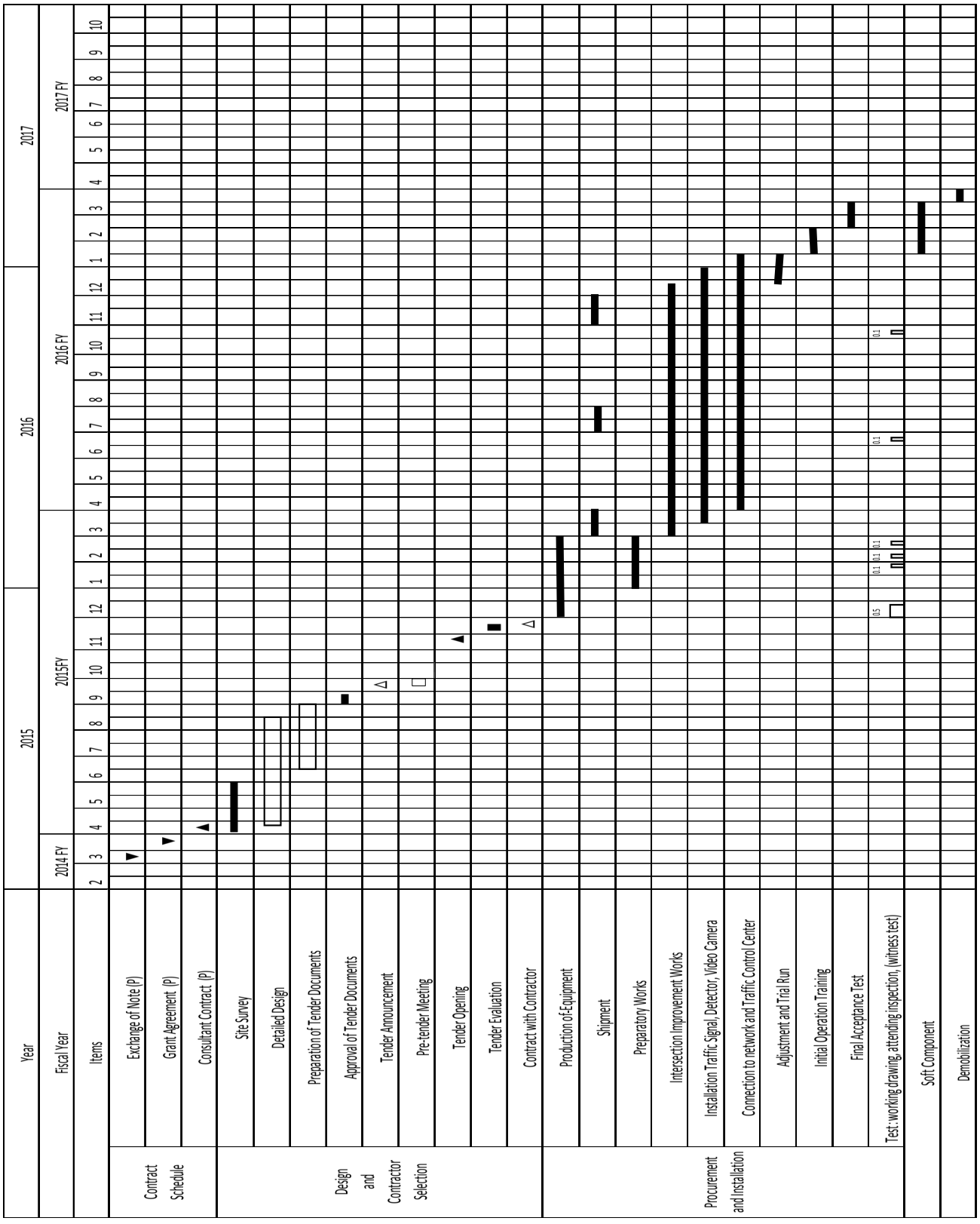


Table 7: Implementation Schedule

2-3 Obligation of the Recipient Country

The responsibility of both sides is summarized in the table below.

Table 8: Obligation of Each Government

No.	Input	Japanese side	Cambodia side
1	Facilitate process in opening of bank account (B/A), Issuance of Power of Attorney (A/P) and their fees and duties		✓
2	Tax exemption approval, custom excise and duties		✓
3	Work inspection		✓
4	Building for housing the Traffic Control Center		✓
5	Provision of storage for all equipment		✓
6	System main frame cost	✓	
7	Packaging, shipping and inland transportation costs	✓	
8	Delivery to site, installation, tuning, and testing costs	✓	
9	Work permit for all works on existing roads		✓
10	Application for the supply of power for the Project		✓
11	Application for connection to existing optic fiber cable network		✓
12	Guidance/instructions for initial operation of system	✓	
13	Storage space for dismantled equipment		✓
14	Obtain global IP address		✓
15	System operation cost (electricity cost and others)		✓
16	System maintenance and repair costs		✓
17	Assigning of necessary staff		✓

Source; JICA Study Team

2-4 Operation and Maintenance Plan

2-4-1 Operating Organization

(1) Skills required for system operation

In order for a traffic control system to exhibit its functions properly, operation by the operator who has the required skills is indispensable. Thus capacity strengthening of the staff as well as the agency is required.

The two key staffs should be assigned on the project during detail design stage. Additionally

the all operating staffs should receive the technical transfer when installation works, the adjustment works and trial run by the contractor.

The specialties required for the operation of traffic control system is listed below.

- Knowledge of traffic engineering
- Traffic survey, analysis and application to signal design
- Geometric design of intersection
- Signal design
- Computer and data communication
- Operation of traffic control system
- Database of traffic control system
- Maintenance of traffic control system
- Administration of document and drawings

(2) Operation of system

Tasks to be performed by the system operator to operate the traffic control system are listed below. Actual maintenance work is undertaken by maintenance contractor but supervision of their work is required as part of system operation.

- Monitoring of signal operation
- Monitoring of traffic in the system control area
- Reception of event information from traffic enforcer, road user or other sources
- Preparation of countermeasure and its implementation in case of event
- Periodic communication with other sections or organizations
- Review of signal operation and preparation and input of new parameters
- Reception of the fault report about equipment comprising the system
- Supervision of maintenance work undertaken by maintenance contractor
- Review and storage of system operation log
- Spare part inventory management

(3) System operation hours

The system operates 24 hours a day and 7 days a week without stoppage. But the operator will station from 6 o’clock in the morning until 9 o’clock in the evening for 15 hours in two shifts. The system operates unmanned from 9 o’clock in the evening until 6 o’clock in the morning next day.

(4) Fault reporting system

Fault reporting system, in which malfunction of the system and equipment will be reported to a dedicated mobile phone, need to be established. The mobile phone must be available for 24 hours and fault report must be accepted any time. Depending on the type of malfunction, action is taken immediately or next working hours.

(5) Operator

The staff necessary for the operation of the traffic control system is summarized below. Administrative staff is excluded in the list.

Table 9: Staff at Traffic Control Center (tentative)

Position	Number of person	Tasks	Qualification
Traffic control system chief engineer	1	Responsible for the operation of the system	Bachelor of Science Engineering background with experience of system administration
Deputy chief (operation)	1	Responsible for operation of the system	Bachelor of Science Background of traffic engineering or similar subjects
Deputy chief (maintenance)	1	Responsible for maintenance of the system	Bachelor of Science IT engineer
Operator	6	System operator	Engineering background
Maintenance technician	2	Maintenance staff	IT/Electrical engineering background

Source; JICA Study Team

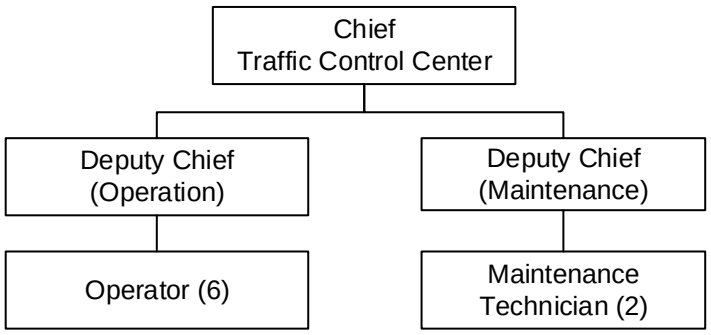


Figure 17: Organization of Traffic Control Centre (tentative)

The traffic control system to be introduced by the project is entirely new to DPWT. To build the capacity of the agency as well as staff, training by the expert who has experience of managing traffic control system is required as soft component in addition to the initial training to be provided by system supplier.

(6) System security

As the traffic control system manages and operates traffic signals, the system must be protected against possible attacks from both inside and outside. The data communication network must be designed in such a way that it is completely isolated from other network sharing the same optical fiber cable. No Internet access from the outside is allowed except by the authorized terminal to the global IP address assigned to the system.

Access to the control center is limited to the authorized personnel with the access controlled door. All access record through the door are recorded and kept in access log file. Security video camera will be installed to monitor and record the access by the staff.

The system requires log-in procedure for operator to operate the system. All manual operations of the workstation will be logged with user's name and time stamp. If any irregularity is found in the system behavior, operation log will be retrieved and reviewed to identify the cause of such event.

2-4-2 System maintenance

Maintenance work can be broadly divided into four categories shown below.

- Preventive maintenance
- Repair of fault and recovery
- System modification
- Spare part inventory
- Actual maintenance work will be carried out by maintenance contractor under a contract with DPWT. The staff at TCC will receive a fault report and inform the maintenance contractor of the fault. The maintenance contract will undertake maintenance work and report the completion of the work to the DPWT. The procedure is depicted in the figure below.

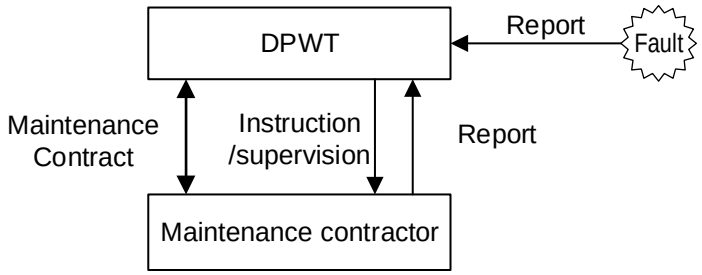


Figure 18: Maitenance Procedure

Source; JICA Study Team

Maintenance specifications that stipulate the contents of these activities must be prepared as part of tender document for the system. The maintenance specifications will have the contents shown in table below.

Table 10: Table of Contents of Maintenance Specifications

1.	General provisions	3.4	Maintenance office
1.1	General requirements	4.	Preventive maintenance
1.2	Scope of work	4.1	Check items and schedule
1.3	Type of maintenance work	4.2	Check list
2.	Maintenance personnel	4.3	Software preventive maintenance
2.1	Maintenance organization	5.	Fault repair and recovery
2.2	Chief maintenance engineer	5.1	Time to recovery
2.3	Maintenance staff	5.2	Defective part
3.	Maintenance facilities	5.3	Fault reporting and instruction
3.1	Test equipment and tools	6.	System modification
3.2	Maintenance vehicle	7.	Spare parts and consumables
3.3	Maintenance equipment provided by		

the Employer

Maintenance organization will be set up in Phnom Penh. In addition, the system will be equipped with remote maintenance function, with which the servers at the Traffic Control Center can be accessed directly from Japan for maintenance. With this function, it is not necessary to deploy experienced engineer all the time at site.

2-5 Project Cost Estimation

2-5-1 Cost Borne by the Government of Japan

This section is closed due to the confidentiality.

2-5-2 Cost Borne by the Cambodian Side

(1) Implementation Stage

1) Implementation Stage

1. Operation Cost

Operation cost is the electricity cost for additional 36 intersections.

2. Maintenance Cost

There is no maintenance cost during the implementation stage.

Table 11: Project Cost Borne by the Cambodian Side

Items	Necessary budget(thousand USD)
1. Operation Cost	32
2. Maintenance Cost	0
Total	32

Source; JICA Study Team

(2) Operation Stage

1) Operation Cost

The Traffic Control Center (TCC) unit, which has been newly established in DPWT, is to take charge of the operation work. The operation cost includes 1) electricity cost including fuel for generator and 2) vehicle cost for site inspection.

2) Maintenance Cost

Since, actual maintenance work is expected to be contracted to a private maintenance companies with TCC division, DPWT overseeing its work, a large portion of maintenance cost goes to pay the services of the private maintenance company. This covers cost of the maintenance workers, vehicle cost and office expenses, etc. In addition, the operation/maintenance cost of the connecting optic cable borne by the PPCH.

Table 12: Operation and Maintenance Cost

Items	Necessary budget(thousand USD)
1. Operation Cost	65
2. Maintenance Cost	54
Total	119

Source; JICA Study Team

3. Project Evaluation

3-1 Pre-requisite Condition on Project Implementation

The prerequisite conditions on the implementation of the Project are several requirements (acquisition of land, relocation of utility lines, permits for the logistical transhipment of equipment in Cambodia and others) which must be fully facilitated by the Cambodian Government to ensure a smooth and successful implementation.

Besides the need in granting all the applicable tax exemption on this Project, other local costs that should be borne by the Cambodian Government are clearly noted in official minutes between the two sides. On tax exemption, for instance, the need for close coordination between the MEF and CDC was acknowledged and agreed upon by the Cambodian Government and this was also carefully noted in the minutes. Such costs that have to be borne by the Cambodian Government were explained and presented to the MEF. The study team also presented the findings that there will be no foreseeable major problems for PPCH to manage and operate the Project within its current capacity. In view of the importance of this Project, the study team explained to the MEF that in the event that a contingent issue would arise, special consideration in the allocation of its expenditure budget to solve such problem should be given.

3-2 Input or Facilitations by Recipient Country for Achieving the Overall Planning of the Project

As the grant aid donor, the Japanese Government shall only bear the costs of procuring all the system components and the necessary computer software, shipping and packaging costs, transportation cost within Cambodia, delivery cost of equipment to project site, installation cost, tuning and test costs, as well as the provision of initial training on the system operation to the local counterpart personnel.

On the other hand, other inputs by the Cambodian Government are facilitating all the necessary processes and applications, provision of a suitable building for the temporary safe keeping of the system components or equipment and to act as the system control center. The Cambodian Government shall also bear the costs related to all the electrical power supply and telecommunications needs during the implementation of the Project. In addition, it is necessary for the Cambodian side to acquire a global IP address to enable the online linkage of the proposed system to the Japanese Central Servers. This is to allow for the system operator to expeditiously seek help remotely from Japan if necessary.

The respective inputs or facilitations by both the Japanese and Cambodian Governments for

implementing this Project are listed below:

Table 13: Respective Inputs or Contributions by Both Governments

No.	Input	Japanese side	Cambodia side
1	Facilitate process in opening of bank account (B/A), Issuance of Power of Attorney (A/P) and their fees and duties		✓
2	Tax exemption approval, custom excise and duties		✓
3	Work inspection		✓
4	Building for housing the Traffic Control Center		✓
5	Provision of storage for all equipment		✓
6	System main frame cost	✓	
7	Packaging, shipping and inland transportation costs	✓	
8	Delivery to site, installation, tuning, and testing costs	✓	
9	Work permit for all works on existing roads		✓
10	Application for the supply of power for the Project		✓
11	Application for connection to existing optic fiber cable network		✓
12	Guidance/instructions for initial operation of system	✓	
13	Storage space for dismantled equipment		✓
14	Obtain global IP address		✓
15	System operation cost (electricity cost and others)		✓
16	System maintenance and repair costs		✓
17	Assigning of necessary staff		✓

Source; JICA Study Team

3-3 Important Assumptions

The project precondition is for the Cambodian side to securely implement its inputs or contribution; namely, work inspection, provision of storage for equipment, assigning of necessary staff, etc.

The external factor for securely completing the project is that there is no serious security situation in Cambodia.

3-4 Project Evaluation

3-4-1 Relevance

(1) Beneficiaries of this Project

Direct beneficiaries of this Project are the vehicles and their users within the project coverage

area. All the citizens of Phnom Penh City (1.85 million people) will also indirectly benefit from this Project.

(2) Objective of the Project

The primary objective of the project is to alleviate traffic congestion and contribute to the urban economy vitalization of Phnom Penh. Especially, the project aims to introduce traffic signals at 100 intersections (including replacement of 64 existing signalized intersections out of 69) and establish a traffic control center in Phnom Penh where the traffic situation continue to worsen.

(3) Consistency with National Development Plan of Cambodia

A major priority policy has been accorded to the planning of urban transport infrastructure by the Cambodian Government in supporting the growth of an efficient and competitive Cambodian economy. This has been stipulated in the infrastructure development sector contained in the Cambodian National Strategic and Development Plan (2014 – 2018). This particular grant aid project is one of the Priority Projects proposed in the Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City (PPUTMP). It was subsequently shortlisted for implementation under its Short-Term Action Plan. This Project is therefore consistent with aspirations of the Cambodian national level development strategy and plan.

(4) Consistency with the Policy and Direction of Japanese official assistance

The proposed traffic control system procured for this Project is a system developed based on the advanced technology in Japan. Japan has long being recognized for its strength in infrastructure development and this project is thus an example of such development package that is being extended by Japan to all the Asian countries. Such efficient use of Japanese technical knowhow and experience may become the engine of sustainable growth in Asia. This Project is thus consistent with the Japanese Government policies regarding the promotion of economic growth in the Asia Region.

3-4-2 Effectiveness

(1) Quantifiable Effects

The Project is expected to produce the following positive quantifiable effects such as improved travel speed, savings in travel costs and reduction in traffic police personnel needed to direct traffic at intersections.

Table 14: Quantifiable Effects of this Project

Indicator	**Base Values (Actual Values in 2014)**	**Target Values (Year 2020) [3 years after project completion]**
Average travel speed (km/hr) (average values of speed on major radial roads)	12.5*[1]	14.2*[2]
Travel time cost (in million JPY/year) *[3] X 3 years X 7 routes	14,742*[4]	12,978
Average ratios of traffic demand/traffic capacity (vehicles) at 10 major locations	Morning Peak 1.18 Evening Peak 1.37	Morning Peak 1.13 Evening Peak 1.33
Traffic police needed in traffic control (person)	About 400 *[5]	About 320

*1: Results of Travel Speed Survey conducted in this Study

*2: A 14% in speed improvement result is assumed, based on results on travel speed improvements achieved by actual implementation of similar traffic control system and intersection improvement projects in other countries.

*3: Travel time cost means a monetary value a person in the project area attach to a unit of his travel time.

*4: Using average travel speed, the actual travel time cost on Monivong Blvd. in 2014 as well as 3 years after the project completion are estimated. (taken as the average cost for one major road). This average cost per route is then applied to the 7 major routes in the city center area of Phnom Penh (Monivong Blvd., Norodom Blvd., Charles de Gaulle Blvd., Russian Blvd., Sihanouk Blvd., Mou Tse Tong Blvd. and Inner Ring Road).

*5: At present, about 2 to 4 traffic police are assigned to each of the 64 high traffic demand locations (inclusive of non signalized intersections). Assuming 2 shifts of assignment, about 400 traffic police are required. With the Project, signalization will be carried out at all these locations and traffic flow at high demand locations will be smoother than before using the central control system. It is estimated that a reduction of about 20% of traffic police personnel can be achieved in future (based on discussions with Phnom Penh Deputy Traffic Police Chief).

(2) Qualitative Effects

The Project is also expected to produce various direct and immediate positive qualitative effects, namely an improvement to the traffic environment which would be noticeable within a short time period after the introduction of the traffic signal control system. In addition, the Project would also produce long term and indirect benefits as a result of such improvement to the traffic environment. One such important benefit is the contributions to the regional and socio economic development in Cambodia. In the long term, the Project would also produce an overall improvement to the environment quality via a reduction in gas emission which

causes global warming. Other expected long term benefits from this Project are vitalization of region-wide commercial activities, increases in tourist arrival and hence tourism revenue, increases in tax revenue, improvement in goods transportation and hence promoting the establishment of business enterprises, improvement in service levels of medical care and emergency which can enhance the well being of residents and others.

Appendix 1: Member List of the Study Team

Member List of the Study Team

1)：Field survey (1/June/2014-26/July/2014)

Name	Processing section	Affiliation
Shigeki MIAKE	Leader	JICA Economic Infrastructure Department Transportation and ICT Group
Yosuke KAZAMA	Planning Coordinator	JICA Economic Infrastructure Department Transportation and ICT Group
Masato KOTO	Team Leader/Transport Planner	METS Research & Planning, Inc.
Seiya MATSUOKA	Signal equipment and traffic control system planner	METS Research & Planning, Inc. (Reinforcement)
Chikahiko MACHIDA	Intersection improvement planner	METS Research & Planning, Inc.
Iwao NAKAJIMA	Control center facility planner	METS Research & Planning, Inc. (Reinforcement)
Masazumi ONO	Traffic analysis planner	CTI Engineering International Co., Ltd.
Shinsuke MORI	Procurement situation/Procurement Planner	CTI Engineering International Co., Ltd.

2)：Draft Report Description (7/December/2014-16/December/2014)

Name	Processing section	Affiliation
Takema SAKAMOTO	Leader	JICA Infrastructure and Peace Building Department Transportation and ICT Group
Yosuke KAZAMA	Planning Coordinator	JICA Infrastructure and Peace Building Department Transportation and ICT Group
Masato KOTO	Team Leader/Transport Planner	METS Research & Planning, Inc.
Seiya MATSUOKA	Signal equipment and traffic control system planner	METS Research & Planning, Inc. (Reinforcement)

Appendix 2: Study Schedule

Study Schedule

1) Field survey

			JICA		Consultants					
			三宅 繁輝 Shigeki MIYAKE 総括 Leader	風間 遥介 Yosuke KAZAMA 計画管理 Planning Coordinator	古藤 政人 Masato KOTO 業務主任/交通計画 Chief Consultant/ Transport Planner	松岡 誠也 Seiya MATSUOKA 信号機材・交通管制システム計画 Signal equipment and traffic control system planner	町田 親彦 Chikahiko MACHIDA 交差点形状改良計画 Intersection improvement planner	中嶌 巌 Iwao NAKAJIMA 管制センター設備計画 Control center facility planner	小野 正純 Masazumi ONO 交通解析 Traffic analysis planner	森 信介 Shinsuke MORI 調達事情/積算 Procurement situation / Procurement Planner
1	1-Jun	Sun			TOKYO(11:30)→PHNOM PENH(19:25)	TOKYO(11:30)→PHNOM PENH(19:25)				
2	2-Jun	Mon			Site Visit/Survey preparation	Site Visit/Survey preparation	TOKYO(11:30)→PHNOM PENH(19:25)			
3	3-Jun	Tue			Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation			
4	4-Jun	Wed			Site Visit/Survey preparation	Meeting with DPWT on question	Site Visit/Survey preparation			
5	5-Jun	Thu			Site Visit/Survey preparation	Meeting with DPWT on question	Site Visit/Survey preparation		TOKYO(11:30)→PHNOM PENH(19:25)	
6	6-Jun	Fri			Site Visit/Survey preparation	Meeting with NiDA	Site Visit/Survey preparation		Site Visit/Survey preparation	
7	7-Jun	Sat			Internal meeting	Internal meeting	Internal meeting		Internal meeting	
8	8-Jun	Sun	TOKYO(12:00)→PHNOM PENH(19:25)	TOKYO(10:35)→PHNOM PENH(19:25)	Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation	TOKYO(11:30)→PHNOM PENH(19:25)	Site Visit/Survey preparation	
9	9-Jun	Mon	0800 Team meating, Meeting with JICA Cambodia office / 0930 Meeting with Phnom Penh Government Office, DPWT, Police and NiDA							
10	10-Jun	Tue	M/M discussion with DPWT				Site Visit/Survey preparation	Site Visit	Site Visit/Survey preparation	
11	11-Jun	Wed	1500 M/M signing with PPCH/1630 Report to JICA Cambodia office/1830 Dinner with H.E. Tauch Chankosal and excellences				Site Visit/Survey preparation	Site Visit	Site Visit/Survey preparation	TOKYO(10:50)→PHNOM PENH(18:20)
12	12-Jun	Thu	0830 Site visit 1(Chroy Changwar Bridge) with RID/ MPWT 0930 Site visit 2(intersections) by the mission 1400 Discussion with DG of RID/MPWT about Technical Cooperation Project for road and bridge inspection and maintenance 1500 C/C on MPWT minister 1600(TBC) Discussion with DG of RID/MPWT about TCP (continue)		0930 Site visit 2(intersections) by the mission		Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation
13	13-Jun	Fri	0830-930 Report to EOJ 1000 Discussion with DG of RID/MPWT about TCP 1430(TBC) Discussion with DG of GDT/MPWT about TCP		0830-930 Report to EOJ Meeting with DPWT		Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation
14	14-Jun	Sat	PHNOM PENH→TOKYO(08:10)	PHNOM PENH→TOKYO(06:55)	Internal meeting	Internal meeting	Internal meeting	Internal meeting	Internal meeting	Internal meeting
15	15-Jun	Sun			Site Visit	Site Visit	Site Visit	Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation
16	16-Jun	Mon			preparation of documents	Site Visit	Site Visit	Site Visit/Survey preparation	Site Visit/Survey preparation	Site Visit/Survey preparation
17	17-Jun	Tue			preparation of documents	Site Visit	Site Visit	Preliminally Design Control room	Site Visit	Site Visit/Survey preparation
18	18-Jun	Wed			preparation of documents	Site Visit	Site Visit	Preliminally Design Control room	Site Visit	Site Visit/Survey preparation
19	19-Jun	Thu			preparation of documents	preparation of documents	Site Visit	Preliminally Design Control room	Site Visit	Site Visit/Survey preparation
20	20-Jun	Fri			preparation of documents	preparation of documents	Site Visit	Preliminally Design Control room	Site Visit	Site Visit/Survey preparation
21	21-Jun	Sat			Internal meeting	Internal meeting	Internal meeting	Internal meeting	Internal meeting	Internal meeting
22	22-Jun	Sun			Site Visit	Site Visit	Site Visit	Site Visit	Site Visit	Survey Phnom Pehn
23	23-Jun	Mon			Preperration of the technical note	Meeting with contractors	preparation of documents	Existing conditions survey Build'	Site Visit	Survey Phnom Pehn
24	24-Jun	Tue			Preperration of the technical note	Meeting with contractors	preparation of documents	Existing conditions survey Build'	Site Visit	Survey Phnom Pehn
25	25-Jun	Wed			Preperration of the technical note	Summarring the survey data	preparation of documents	Existing conditions survey Build'	Site Visit	Survey Phnom Pehn
26	26-Jun	Thu			Preperration of the technical note	Summarring the survey data	preparation of documents	Summarring the survey data	Site Visit	Survey Phnom Pehn
27	27-Jun	Fri			Explaination of the technical note toDPWT	Explaination of the technical note toDPWT	preparation of documents	Summarring the survey data	Site Visit	Survey Phnom Pehn
28	28-Jun	Sat				Internal meeting	Internal meeting	Internal meeting	Internal meeting	Internal meeting
29	29-Jun	Sun				PHNOM PENH→TOKYO	Site Visit	Site Visit	Site Visit	Site Visit
30	30-Jun	Mon				PHNOM PENH→TOKYO	Site Visit	preparation of documents	Site Visit	preparation of documents
31	1-Jul	Tue					Site Visit	preparation of documents	Site Visit	preparation of documents
32	2-Jul	Wed					Site Visit	preparation of documents	Site Visit	preparation of documents
33	3-Jul	Thu			TOKYO→PHNOM PENH		Site Visit	preparation of documents	Site Visit	preparation of documents
34	4-Jul	Fri			preparation of documents		Site Visit	preparation of documents	Site Visit	preparation of documents
35	5-Jul	Sat			Internal meeting		Internal meeting	Internal meeting	Internal meeting	Internal meeting
36	6-Jul	Sun			Site Visit		Summarring the survey data	PHNOM PENH→TOKYO	Summarring the survey data	Site Visit
37	7-Jul	Mon			preparation of documents		Summarring the survey data	PHNOM PENH→TOKYO	Summarring the survey data	preparation of documents
38	8-Jul	Tue			preparation of documents		Summarring the survey data		Summarring the survey data	preparation of documents
39	9-Jul	Wed			preparation of documents		Summarring the survey data		Summarring the survey data	PHNOM PENH→TOKYO
40	10-Jul	Thu			preparation of documents		Summarring the survey data		Summarring the survey data	PHNOM PENH→TOKYO
41	11-Jul	Fri			preparation of documents		Summarring the survey data		Summarring the survey data	
42	12-Jul	Sat			Internal meeting		Internal meeting		Internal meeting	
43	13-Jul	Sun			preparation of documents		preparation of documents		preparation of documents	
44	14-Jul	Mon			preparation of documents		Summarring the survey data		preparation of documents	
45	15-Jul	Tue			preparation of documents		preparation of documents		preparation of documents	
46	16-Jul	Wed			preparation of documents		preparation of documents		preparation of documents	
47	17-Jul	Thu			preparation of documents		preparation of documents		preparation of documents	
48	18-Jul	Fri			preparation of documents		preparation of documents		PHNOM PENH→TOKYO	
49	19-Jul	Sat			PHNOM PENH→TOKYO		preparation of documents		PHNOM PENH→TOKYO	
50	20-Jul	Sun			PHNOM PENH→TOKYO		preparation of documents			
51	21-Jul	Mon					preparation of documents			
52	22-Jul	Tue					preparation of documents			
53	23-Jul	Wed					preparation of documents			
54	24-Jul	Thu					preparation of documents			
55	25-Jul	Fri					PHNOM PENH→TOKYO			

2）Draft Report Description

Date			Leader 総括 Takema Sakamoto 坂本　威午	Planning Coordinator 計画管理 Yosuke Kazama 風間　遥介	 業務主任 Masato Koto 古藤　政人	 信号機材 Seiya Matsuoka 松岡　誠也
1	12/7	Sun	TG683　Haneda(10:45)→Bangkok(15:45) TG584　Bangkok(18:20)→Phnom Penh(19:35) Stay at Phnom Penh		TG683　Haneda(10:45)→Bangkok(15:45) TG584　Bangkok(18:20)→Phnom Penh(19:35) Stay at Phnom Penh	
2	12/8	Mon	AM　Team meeting, Meeting with JICA Cambodia office PM　Meeting with Phnom Penh Government Office and DPWT Stay at Phnom Penh			
3	12/9	Tue	M/M discussion with DPWT Meeting with MEF and Ministry of Planning Stay at Phnom Penh			
4	12/10	Wed	All day　Site visit (intersections, Chroy Changwer Bridge, Neak Loeung Bridge) Stay at Phnom Penh		All day　Site visit (intersections, Chroy Changwer Bridge, Neak Loeung Bridge) Stay at Phnom Penh	
5	12/11	Thu	AM　M/M discussion and signing with DPWT PM　Report to JICA Cambodia office and Embassy of Japan Stay at Phnom Penh			
6	12/12	Fri	TG585　Phnom Penh(20:35)→Bangkok(21:40) TG682　Bangkok(23:15)→		Meeting with DPWT and MPTC Stay at Phnom Penh	
7	12/13	Sat	→Haneda(06:55)		All day Site visit (Intersections in the city center) Stay at Phnom Penh	
8	12/14	Sun			All day Site visit (Intersections in the suburban area) Stay at Phnom Penh	
9	12/15	Mon			TG585　Phnom Penh(20:35)→Bangkok(21:40) TG682　Bangkok(23:15)→	
10	12/16	Tue			→Haneda(06:55)	

Appendix 3: List of Parties Concerned in the Recipient Country

List of Parties Concerned in the Recipient Country

Phnom Penh City Hall (PPCH)	
H.E. PA Socheatavong	Governor
H.E. TRAK Thaisieng	Vice Governor
H.E. CHREANG Sophan	Vice Governor
H.E. IENG Aunny	Vice Governor
Mr. SIN Boramey	Director of Urban Planning
Mr. LONG Dimanche	Director of Administration Division
Ms. PHAN Sopheaknita	Director of International Relation Office
Department of Public Works and Transport of Phnom Penh (DPWT)	
Mr. SAM Piseth	Director
Mr. CHOUR Kimtry	Deputy Director
Mr. MOEUNG Sophan	Advisor to DPWT
Mr. PROM Kampoul	Deputy Director of Transport Office
Mr. OU THONSAL	Deputy Director of Transport Office
Mr. PHUONG Chamroeung	Chief of Public Lighting Division
Phnom Penh Traffic Police	
Mr. CHEV Hak	Director of Traffic Department
Ministry of Posts and Telecommunications (MPTC)	
Mr. SEM Virak	Officer
Mr. MOK Khemera	Director
Mr. OUK Vandy	Director of Infrastructure Department
Ministry of Economy and Finance	
Mr. DARY Chetana	Deputy Director, Department of Investment
Mr. KEM Channdoeun	Deputy Chief, Department of Investment
Department of Economy and Finance, PPCH	
Mr. VA Sothea	Director
Mr. LON Sor	Deputy Director
Mr. KIM Seth	Deputy Director
JICA Cambodia	
Mr. RZAKI Hiroshi	Chief Representative
Mr. ITO Takashi	Deputy Chief Representative
Mr. EGAMI Masahiko	Representative
Ms. MIURA Aya	Representative

Appendix 4: Minutes of Discussions

Minutes of Discussions
on the Preparatory Survey for the Project for
Development of Traffic Management System in Phnom Penh

In response to the request from the Government of Kingdom of Cambodia (hereinafter referred to as "Cambodia"), the Government of Japan decided to conduct a Preparatory Survey for the Project for Development of Traffic Management System in Phnom Penh (hereinafter referred to as "the Project"), and entrusted the Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to Cambodia. The Team is headed by Mr. Shigeki MIYAKE, Director, Transport and ICT Division 2, Economic Infrastructure Department, JICA, and is scheduled to stay in the country from June 1st to July 26th, 2014.

The Team held a series of discussions with the officials concerned of the Government of Cambodia and conducted a field survey in the Project area. In the course of the discussions, both sides have confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Preparatory Survey Report.

Phnom Penh, June 11th, 2014

三宅繁輝

Shigeki MIYAKE
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

PA Socheatevong
Governor
Phnom Penh Capital City
Kingdom of Cambodia

ATTACHMENT

1. Objective of the Project

The objective of the Project is to attain smooth and safe traffic condition by introducing efficient traffic control system in Phnom Penh.

2. Project Site

The project site locates in Phnom Penh, which is shown in Annex-1.

3. Responsible and Implementing Organizations

The responsible organization for the Project is Phnom Penh Capital Hall and the implementing organization for the Project is the Department of Public Works and Transport (hereinafter referred to as "DPWT").

The organization chart of DPWT is shown in Annex 2.

4. Items requested by the Government of Cambodia

4-1. By reconfirming application form submitted by Cambodia in July 2013, the Cambodian side finally requested improvement of the traffic control facilities and introducing traffic control system in Phnom Penh (Traffic control center equipment, Signal control software/database, Intersection equipment, and CCTV system, etc.). JICA will assess the appropriateness of the request through the Preparatory Survey and will report the findings to the Government of Japan. The Cambodian side understands the general rule of Japan's Grant Aid Scheme that implementation and components of the Project will be decided by the Government of Japan.

4-2. Both sides confirmed that there was no duplication for the Project to be conducted by the other donors or private enterprises.

5. Japan's Grant Aid Scheme

5-1. The Cambodian side understands the Japan's Grant Aid Scheme and necessary measures to be taken by the Government of Cambodia. The Team explained the procedures for the Project described in Annexes-3 and 4.

5-2. The Cambodian side will take the necessary measures, as described in Annex-5 for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Environmental and Social Considerations

The Team explained environmental and social considerations for the Project is categorized as "Category C" according to the JICA Environmental and Social Consideration Guideline, since the Project is improving traffic signals, and its impact on the environmental may be limited.

7. Schedule of the Study

7-1. The Outline Design Study in Cambodia starts on June 1st, 2014 and is scheduled to be carried out on July 26th, 2014.

7-2. JICA will prepare a draft final report and dispatch a mission to Cambodia in order to explain its contents in early December 2014.

8. Other Relevant Issues

8-1. Provision of Conveniences to the Team by the Cambodian side

Cambodian side shall, at its own expense, provide the Team with the following items for the convenience of the Preparatory Survey.

(1) Security-related information as well as measures to ensure the safety of the survey team.
(2) Information as well as support in obtaining medical service.
(3) Data and information necessary for the Survey.
(4) Counterpart personnel.
(5) Credentials or identification cards if necessary.
(6) Entry permits necessary for the survey team members to conduct field surveys.
(7) Support in obtaining other privileges and benefits if necessary.

8-2. Provision of Conveniences to the Project by the Cambodian side

The Cambodian side accepted that the following undertakings should be taken by the Cambodian side at the Cambodia's expenses under the Project if implementation of the Project is approved by the Government of Japan.

(1) To provide tax exemption for construction materials and equipment for the Project.
   1) Cambodian side agreed that customs duties, internal taxes and other fiscal levies which may be imposed in Cambodia are exempted under mutual agreement of Exchange of Note (E/N).
   2) Whenever it will be needed to pay any expense once on the assumption to get reimbursement, Cambodian side will pay for it. Cambodian side will inform JICA about the results or progress of internal discussions with relevant agencies.

such as Ministry of Economy and Finance about this matter accordingly.

(2) To secure sites for material storing yard, temporary construction yard and waste disposal, if necessary.

(3) To relocate existing utilities within the Project site to designated area or Project affected area, if necessary.

(4) To arrange issuance of license, permission and other necessary procedures for the Project.

(5) The Cambodian side shall secure enough budget and personnel necessary for the operation and maintenance of the facilities implemented by the Project, including the periodical maintenance work after the completion of the Project.

8-3. Improvement of Intersections/ Installation of Traffic Signals

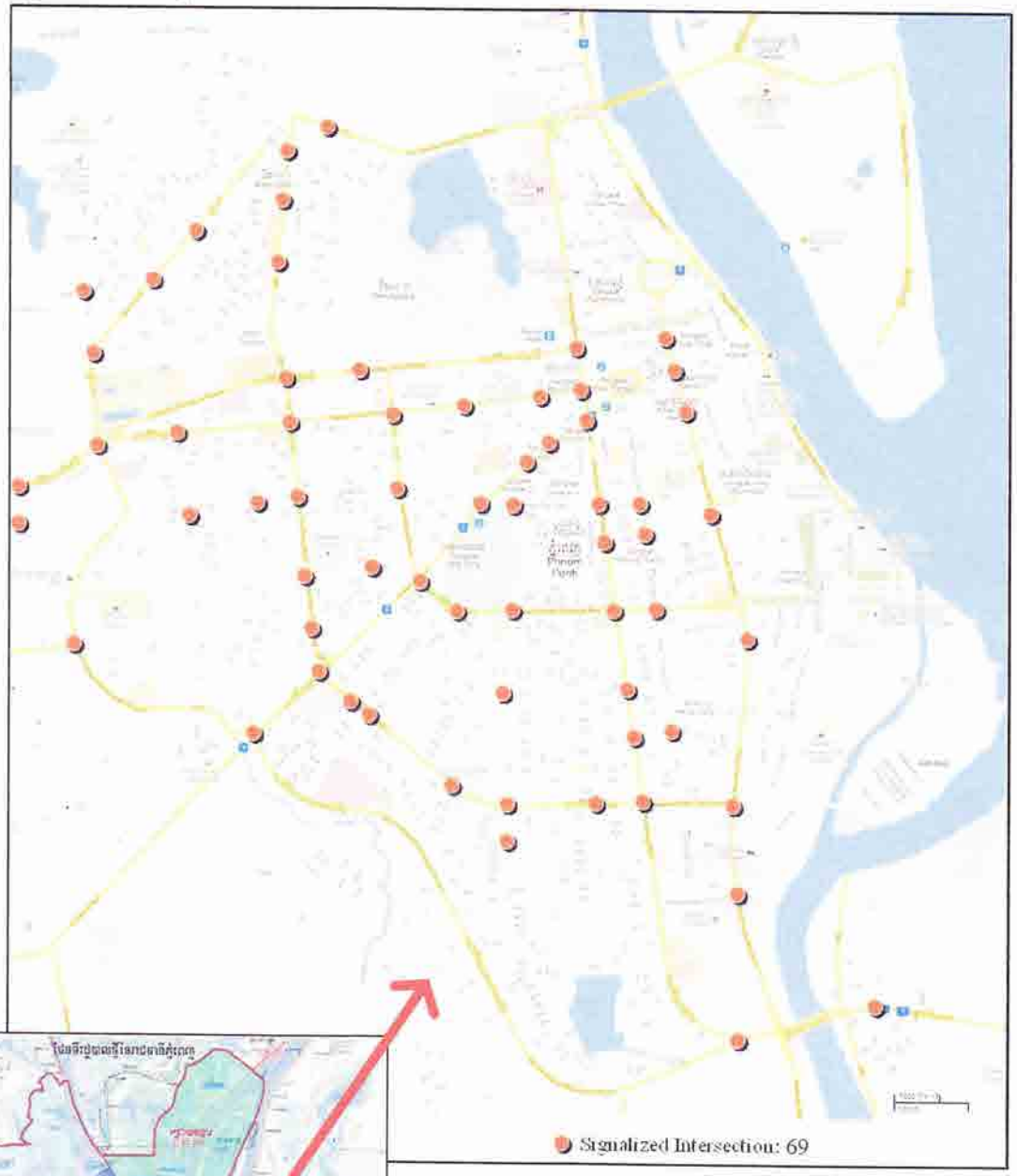
The Team explained that the intersections that become objects to install the traffic signal should be decided based on results of the Preparatory Survey and refer to ongoing another project, the Project for Traffic Improvement in Phnom Penh City. And if the improvement of the shape of intersections (e.g. increase a lane exclusive to right/left turns) is desirable and the land acquisition and resettlement of the Project affected facilities are not necessary, JICA will consider to include the improvement of shape of intersections in the Project components. The Cambodian side will supply stable and uninterruptable electricity for all traffic signals.

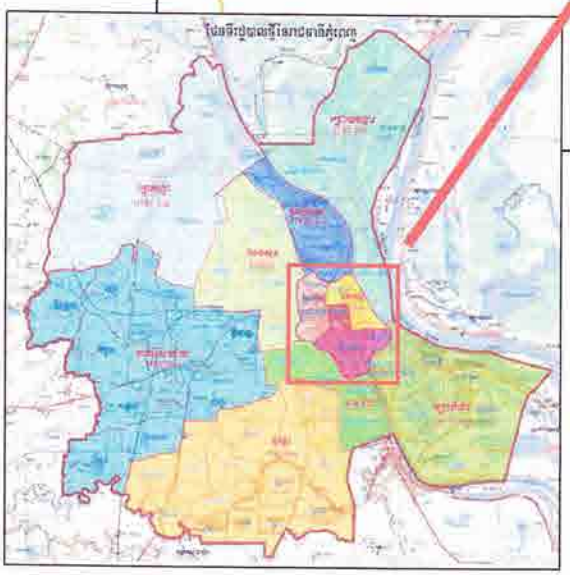
8-4. Traffic Control Center

The Cambodian side suggested that the Traffic Control Center (New Site) will be located at a suitable place and all necessary facilities and equipment for the Project will be prepared by the end of March 2015. The location of the New Site will be informed to the Team by June 20th, 2014 and the issues that should be obeyed by the Cambodian side will be informed by the Team as a Technical Note by June 30th, 2014. The Team will investigate environmental and social considerations for the New Site and Cambodian side will prepare an EIA report for the New Site by December 2014, if necessary.

Annex-1 Project Site
Annex-2 Organization Chart
Annex-3 Japan's Grant Aid
Annex-4 Flow Chart of Japan's Grant Aid Procedures
Annex-5 Major Undertakings to be taken by Each Government

Project Site (Phnom Penh)

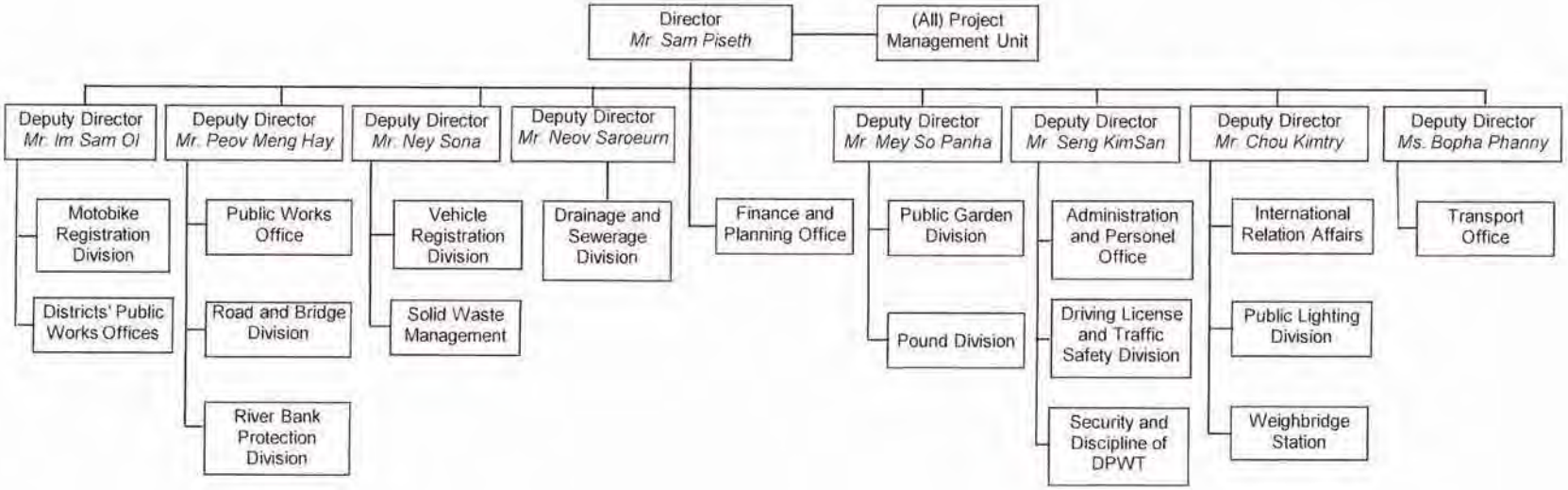




Administrative Area of Phnom Penh Capital City

Annex-2

DEPARTMENT OF PUBLIC WORKS AND TRANSPORT OF PHNOM PENH MUNICIPALITY
ORGANIZATION CHART



JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

・Preparatory Survey
- The Survey conducted by JICA

・Appraisal &Approval
-Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet

・Authority for Determining Implementation
-The Notes exchanged between the GOJ and a recipient country

・Grant Agreement (hereinafter referred to as "the G/A")
-Agreement concluded between JICA and a recipient country

・Implementation
-Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.

- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of a outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

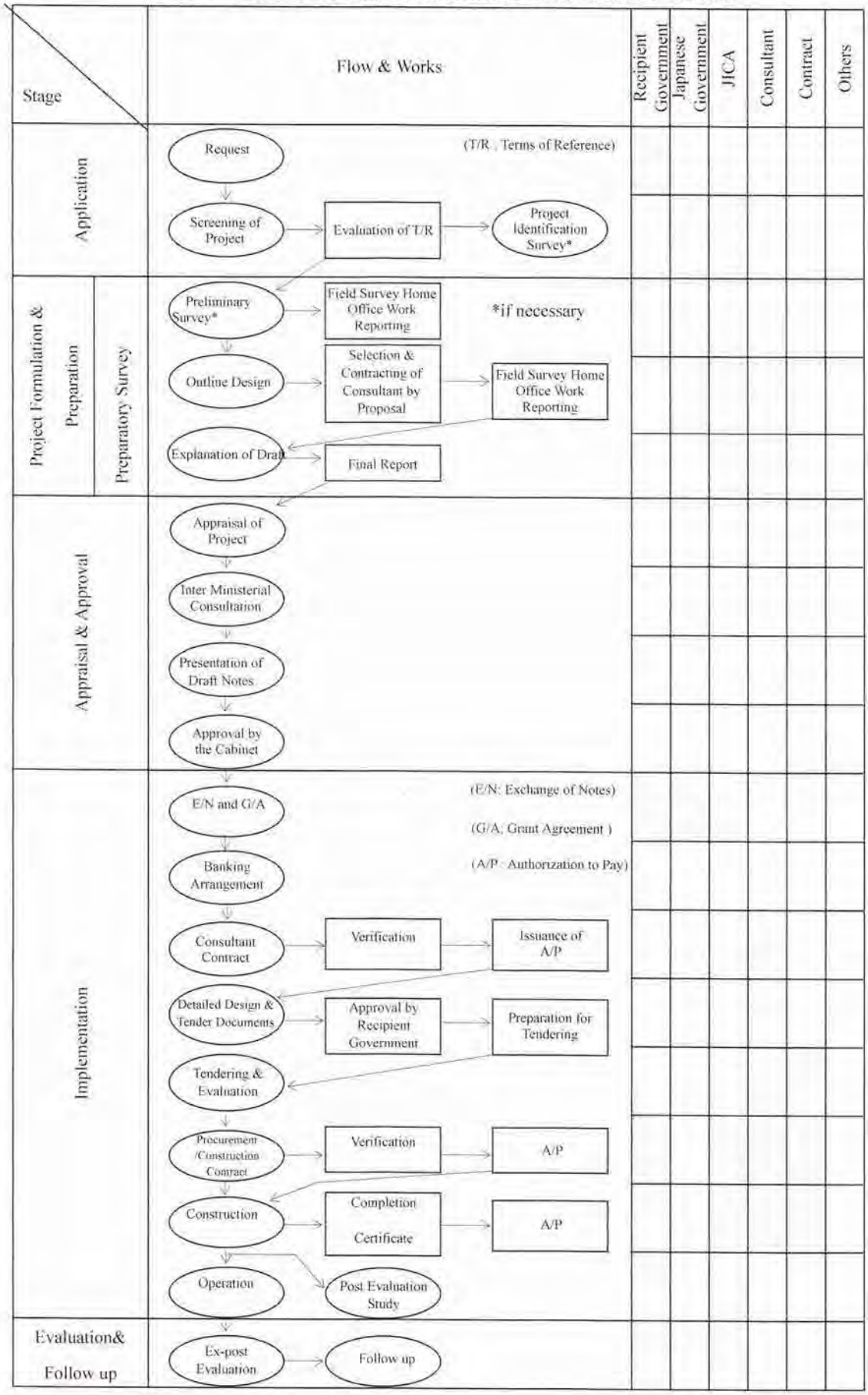
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment

commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Internal transportation from the port of disembarkation to the project site	(●)	(●)
2	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be exempted/be borne by the Authority without using the Grant		●
3	To accord Japanese physical persons and / or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
4	To ensure that [the Facilities and the products]/[the Facilities]/ [the products] be maintained and used properly and effectively for the implementation of the Project		●
5	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
6	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
7	To give due environmental and social consideration in the implementation of the Project.		●

(B/A : Banking Arrangement, A/P : Authorization to pay)

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
FOR
THE PROJECT FOR DEVELOPMENT OF TRAFFIC MANAGEMENT SYSTEM IN PHNOM PENH

(Explanation of the Draft Final Report)

On the basis of the previous preparatory surveys in the Kingdom of Cambodia (hereinafter referred to as "Cambodia") from June to July, 2014 and following technical examination in Japan, Japan International Cooperation Agency (hereinafter referred to as "JICA") prepared a Draft Final Report on the Project for Development of Traffic Management System in Phnom Penh (hereinafter referred to as "the Project").

The Preparatory Survey Team visiting Cambodia from Dec. 7th, 2014 to Dec. 12th, 2014 (hereinafter referred to as "the Team"), headed by Mr. Takema Sakamoto, Deputy Director General, Infrastructure and Peacebuilding Department, JICA, explained to and consulted with the Phnom Penh Capital Hall (hereinafter referred to as "PPCH"), the Department Public Works and Transport in Phnom Penh (hereinafter referred to as "DPWT") and concerned officials of the Royal Government of Cambodia (hereinafter referred to as "the RGOC") on the contents of the Draft Final Report.

As a result of discussions, the both sides confirmed the main items described in the attachment.

Phnom Penh, December 11th, 2014

Takema Sakamoto
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan (JICA)

PA Socheatevong
Governor
Phnom Penh Capital City
Kingdom of Cambodia

ATTACHMENT

1. Components of the Draft Final Report

The Team explained the components of the Draft Final Report (hereinafter referred to as "the Report") to the Cambodian side December 8th, 2014. The main requires raised in response to the presentation are 1) possibility of additional traffic monitoring video (*), 2) selection criteria of spare parts, 3) availability of operation and maintenance manual, 4) road user education, 5) capacity building program for traffic control center staffs, 6) lane width standard, 7) adjustment of installation of lane dividers and signals, and 8) traffic condition information sharing with public.
The Team replied to all questions and explained the design policy adopted in the basic design of the system. No further question or request for modification of the report contents was raised from the Cambodian side. The list of equipment to be procured is indicated in Annex-1.
(*) Any future expansion plan including adjustment, increase of numbers, etc. can be secured in the technical manner after the Project completion under the discretion of the Cambodian side, while appropriate prior consultation with JICA is required, in case that the future plan would cover any removal/relocation or change of original equipment/facilities to be developed under the Project.

2. Project Cost Estimation

2.1. The Team explained to the Cambodian side the Project Cost Estimation described in Annex-2; while the final Project Cost to be described in the Exchange of Notes (hereinafter referred to as "E/N") would be appraised by the Government of Japan (hereinafter referred to as "GOJ") and might be fluctuated.

2.2. The both sides further confirmed that the Project Cost Estimation in Annex-2, and details of the construction works in the Report should never be duplicated and/or disclosed to any third parties until all the contracts for the Project are concluded.

2.3. There may be a possibility that, during installation work, currently unexpected underground facilities will be found. In order to avoid such case and possible increase of the project cost, both sides recognized that the consultant to be employed for the Project in the implementing stage could and should take appropriate measures in the detailed design fully utilizing existing data and other relevant information, e.g. underground utility maps, and also recognized that the consultant should be responsible for the possible additional construction cost caused by underground facilities not found during the detailed design, if any, in principle. PPCH promised to coordinate with relevant organizations, such as the Phnom Penh Water Supply Authority、the Electricity of Cambodia and the Ministry of Posts and Telecommunications (hereinafter referred to as "MPTC") to support the consultant to collect necessary data and information from them. Furthermore, both sides agreed to consult each other appropriately, in case that

any event, for which it should not be fair to impose the additional cost payment on the consultant, happens.

3. Undertakings by the Cambodian Side

3.1. The Cambodian side promised to undertake the following major undertakings to be taken by RGOC for the Project at full responsibility and its own expenses based on the components of the Report.

(1) Commission for Banking Arrangement (B/A) and Authorization to Pay (A/P)

(2) Tax exemption and custom clearance

(3) Supervision of the construction

(4) Rooms for traffic control center

(5) Work permit on public road

(6) Application/approval for power supply

(7) Application/approval for optical cable connection

(8) Warehouse for removed equipment

(9) Obtaining global IP address

(10) Operation cost (including electricity and vehicle) of the equipment/facilities

(11) Maintenance cost (including connecting optic cable and vehicle) of the equipment/facilities

(12) Personnel allocation

3.2. The Cambodian side re-confirmed to provide tax exemption for installation materials and equipment for the Project by E/N stipulations, which are conformity to Cambodian law.

1) The Cambodian side agreed that customs duties, internal taxes and other fiscal levies which may be imposed in Cambodia are exempted under mutual agreement of E/N.

2) Whenever it will be needed to pay any customs duties, internal taxes and other fiscal levies once on the assumption to get reimbursement, the Cambodian side will pay for it.

For the sake of this smooth tax exemption procedures, the Team strongly recommended that PPCH will cause DPWT (1) to begin necessary preparations of the application of tax exemption mentioned above and necessary consultation with Ministry of Economy and Finance (hereinafter referred to as "MEF"), Council for the Development of Cambodia (hereinafter referred to as "CDC") and relevant organizations, if any, based on the past E/N contents, (2) to consult with MEF and CDC to acquire comprehensive approval about the tax exemption from MEF, based on expected all equipment to be imported, just after the completion of detailed design, and (3) to consult with MEF and

CDC again to ask them to apply "automatically" tax exemption procedures for each shipment time in response to DPWT's request based on the comprehensive approval mentioned in above (2).

4. Operation and Maintenance of the Equipment/Facilities after the Completion of the Project

4.1. The Cambodian side agreed to secure enough staff necessary for appropriate operation and maintenance of the equipment/facilities for the Project. The annual operation and maintenance costs are estimated and shown in the table 1) below. And also, the Cambodian side agreed to assign two trainees (future Traffic Control System Chief Engineer and Deputy Chief of Maintenance in table 2) below) by the detailed design stage, so that they will be able to supervise and re-train other nine staff for the stage after the commencement of the system operation in a cascade manner. Thus, nine staff should be assigned as soon as possible, at least by the soft component stage.

1) Annual Operation and Maintenance Cost after the completion

Items	Necessary budget(thousand USD)
1. Operation Cost	65
2. Maintenance Cost	54
Total	119

2) Staff at Traffic Control Center

Items	Number of personnel
1. Traffic Control System Chief Engineer	1
2. Deputy Chief (operation)	1
3. Deputy Chief (maintenance)	1
4. Operator	6
5. Maintenance Technician	2
Total	11

5. Japan's Grant Aid Scheme

The Cambodian side fully understood and reconfirmed the scheme of the Japan's Grant Aid and the necessary measures to be undertaken by the Cambodian side, which was explained by the Team and agreed as the Minutes of Discussion signed on 11th June, 2014.

6. Schedule of the Study

6.1. The Team explained that JICA will complete the Final Report of the Preparatory Survey both in Japanese and English reflecting the discussions during this mission appropriately, in accordance with the confirmed items, and send the English version to the Cambodian side around February, 2015.

6.2. The above schedule is tentative and subject to change.

7. Disclosure of Information

Both sides confirmed that the study results excluding the Project cost estimation and details of the construction works will be disclosed to the public after completion of the Preparatory Survey. All the study results including the Project cost and details of the construction works will be disclosed to the public AFTER all the contracts for the Project are concluded.

8. Collaboration among Relevant Organizations

PPCH promised to work closely with relevant organizations, such as DPWT, the Ministry of Public Works and Transport (hereinafter referred to as "MPWT"), the Traffic Police in Phnom Penh, the Ministry of Interior (hereinafter referred to as "MOI"), MEF, CDC, MPTC, and the Electricity of Cambodia with mutual common understanding and cooperation for the Project. Roles, responsibilities/jurisdiction and relationships among these organizations are described below and Annex-4.

(1) PPCH: The responsible organization of the Project. (For specific information, see Item 9. below.) PPCH has power and responsibility to supervise, coordinate and direct DPWT and the Traffic Police in Phnom Penh, representing ministries and institutions of the RGOC, such as MPWT and MOI, based on Cambodia laws and regulations, such as stipulations of Law on Administrative Management of the Capital, Provinces, Municipalities, Districts and Khans.

(2) DPWT: The executing agency of the Project. DPWT has power and responsibility of planning and implementing the Project under the guidance of PPCH.

(3) MPWT: The ministry in charge of transport sector. Generally each DPWT is counted as one of MPWT's departments, i.e. subordinate entity; however, actually, departments of ministries in Phnom Penh Capital City are legitimately under PPCH's jurisdiction, so MPWT is not institutionally involved to DPWT for the Project.

(4) The Traffic Police in Phnom Penh: The organization in charge of management the traffic for main roads in Phnom Penh Capital City under the guidance of PPCH.

(5) MOI: The ministry in charge of issues of security, social and public order, law, and human rights. Generally each Traffic Police is counted as one of MOI's departments, i.e. subordinate entity. However, like DPWT's case mentioned above (3), MOI is not directly institutionally involved to the Traffic Police.

(6) MEF and CDC: Organizations related to the procedures to tax exemption such as treatment of tax exemption applications for the Project.

(7) MPTC: The ministry which manages all optical cable networks in Cambodia including the network for traffic signals to be installed in this Project, while the

operation/maintenance cost for the network for traffic signals for the Project will be borne by PPCH. (For specific information see Item 12.2. below.)

(8) The Electricity of Cambodia: The state owned organization in charge of power distribution for traffic signals and the Traffic Control Center (hereinafter referred to as "TCC").

9. Authority of PPCH

PPCH explained that, based on stipulations of Law on Administrative Management of the Capital, Provinces, Municipalities, Districts and Khans, especially article 154, the governor of Phnom Penh Capital City, same as other governors of provinces, shall represent ministries and institutions of the RGOC in supervising, coordinating and directing all line departments and units of the government ministries and institutions that operate within the jurisdiction of the council. PPCH also explained that, therefore, the Governor of Phnom Penh Capital City shall represent DPWT and the Traffic Police in Phnom Penh in supervising, coordinating and directing all, and that the responsible organization for the Project is PPCH while the executing agency for the Project is DPWT. Under this understanding, PPCH added that whole Cambodian side's consent including DPWT and the Traffic Police in Phnom Penh for this minutes of discussions can be fully confirmed by the signature of the Governor of Phnom Penh Capital City.

10. Traffic Control Center

The both sides agreed that TCC will be located at DPWT Compound along NR6 in Churoy Changvar. In accordance to the possible future requirement of further development, PPCH may reconsider the relocation of TCC by making prior report to JICA.

11. The Intersection Improvement Work

The both sides agreed that the scope the intersection improvement work is as follows.

(1) Works will be limited to carriageway.
(Other works such as traffic signal installation will be limited to right-of-way.)

(2) Center line and center divider may be relocated where the relocation is clearly effective in improving traffic flow.

(3) Some damaged pavement within 100 meters from stop-lines for main roads and within 50 meters for minor roads that was already identified during the site survey will be repaired.

(4) Pavement markings within 100 meters from the stop line for main roads and within 50 meters from the stop line for minor roads.

12. Optical Cable Network

風間

12.1. The connecting work from new traffic signals, which will be constructed by the Project, to the existing optical cable network, which is owned by General Department of ICT of MPTC, will be borne by the Japanese side.

12.2. PPCH explained that, after the completion of the Project, General Department of ICT of MPTC will take over the optical cable network for traffic signals in Phnom Penh, while the operation/maintenance cost for the connecting section will be borne by PPCH.

12.3. PPCH promised that PPCH will do every effort to assure stable power distribution for traffic signals and TCC through the coordination with the Electricity of Cambodia , and that PPCH will do every effort to assure stable ICT network environment for traffic signals through the coordination with MPTC.

13. Providing Information

The Team recommended PPCH to provide Phnom Penh citizen with traffic conditions information through media such as radio broadcasting.

14. Soft Component Plan

Both sides agreed that the technology transfer will be made as soft component under the Project through lecture and on-the-job training for management and staff level personnel before the commencement of the system operation. The subjects expected to be covered are:

(1)Enrichment of operation and maintenance manuals

(2) On-the-job training for the DPWT/PPCH staffs regarding operation of the traffic control system

(3)Educational session for the Traffic Police about basic knowledge of traffic signal system.

(4)Campaign of traffic signal system for road users.

As explained above (1), operation and maintenance manuals will be prepared for Cambodian side by a contractor and will be enriched in soft component stage. However, it should be noted that it is de facto impossible to prepare manuals in Khmer technically exactly and properly with full responsibility by Japanese side. The Team strongly recommended that the Cambodian side will take necessary measures to utilize these manuals efficiently and sustainably such as translating important points from English to Khmer, awareness improving activities like internal workshops. PPCH agreed to do so.

15. Information System Security

The Team explained that necessary information security measures (examples are referring below) will be implemented to protect the system stability against the possible attack from both inside and

outside. In this connection, the Team strongly recommended the security measures and procedures to be established and strictly adhered to by the Cambodian side.

(1) Data communication network completely isolated from other networks and access limited to terminals authorized by PPCH only.
(2) Access control system at TCC using ID card and access log with video recording.
(3) Log-on process required for system operation and keep records of all manual operations through work station.

16. Safety Measures

16.1. To avoid accidents on site during the implementation stage, the Cambodian side agreed to take and cause the consultant and the contractor take safety measures such as setting safety assurance to the site, providing information for security control to public, and deploying adequate security personnel, based on "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" which has been published on JICA's URL below.

http://www.jica.go.jp/activities/schemes/oda_safety/ku57pq00001nz4eu-att/guidance_en.pdf

16.2. The Team recommended PPCH to make the Traffic Police in Phnom Penh manage the traffic at the target intersections appropriately, such as parking restriction and lane change guidance during the implementation stage.

16.3. The Team recommended PPCH to explain Phnom Penh citizen about the Project (necessity and significance, construction period, sites, impact etc.), so that wide support of them can be obtained for the smooth operation of the Project.

Annex-1: List of Equipment
Annex-2: Project Cost Estimation
Annex-3: Tentative Project Implementation Schedule
Annex-4: Roles and Responsibilities among Relevant Organizations

LIST OF EQUIPMENT TO BE PROCURED Annex 1

Equiomen/ Material Number	Name of Equipment	Quantity	unit
1	Network management server	1	set
2	Signal control server	1	set
3	Signal control workstation	2	set
4	Netwrok attached storage	1	set
5	Front-end processor	1	set
6	Network printer	1	set
7	Video wall	1	set
8	Video wall controller	1	set
9	Traffic monitoring workstation with console	1	set
10	Vehicle detector data processing software	1	set
11	Signal control software	1	set
12	Equipment operation monitoring software	1	set
13	Human-machine interface software	1	set
14	Statistics software	1	set
15	Database software	1	set
16	Parameter setting for vehicle detector	180	set
17	Signal control parameter setting	100	set
18	Uninterruptible power supply	1	set
19	Local controller (Standard)	90	set
20	Local controller (Large)	10	set
21	Vehicle lantern (3-aspect full circle)*	800	set
22	Vehicle lantern (3-aspect, arrow)*	120	set
23	Veihcle lantern (1-aspect arrow)*	80	set
24	Pedestrian lantern*	800	set
25	Vehicle detector	180	set
26	Traffic monitoring video camera	26	set
27	Layer 3 switch	1	set
28	Layer 2 switch	102	set
29	Media converter	101	set

* Quantity may vary by detailed design

LIST OF SPARE PARTS

Equiomen/ Material Number	Name of Spare Parts	Quantity	unit
	Server and Workstation		
1	Server power supply unit	1	set
2	Workstation power supply unit	1	set
	Video Wall		
3	Video wall controller power supply unit	1	set
	Local controller		
4	Local controller main board (standard)	5	set
5	Local contorller main board (large)	1	set
6	SSR unit	30	set
7	Power supply unit	5	set
8	Surge arrester	28	pc.
9	PROM writer	1	unit
10	Local controller for testing	1	unit
11	Signal lantern simulator	1	set
12	Notebook computer	1	pc.
13	Diagnosis and setup software	1	set
	Signal Lantern		
14	Power supply unit for vehicle lantern	50	set
15	Power supply unit for pedestrian lantern	40	set
	Vehicle detector		
16	Power supply unit for camera unit	9	set
17	Control board of camera unit	9	set
18	Controller unit power supply unit	9	set
19	Controller main board	9	set
	Video Camera		
20	Control board	2	set
21	Power supply unit	2	set
	Network equipment		
22	Layer 3 switch	1	set
23	Layer 2 switch	6	set
24	Media converter	6	set

CONFIDENTIAL

Project Cost Estimation

(1)Cost Borne by the Japanese side

This page is closed due to the confidentiality.

(2) Project Cost Borne by the Cambodian Side

1) Implementation Stage

① Operation Cost

Operation cost is the electricity cost for additional 36 intersections.

② Maintenance Cost

There is no maintenance cost during the implementation stage.

Table 2 Project Cost Borne by the Cambodian Side during the implementation stage

Items	Necessary budget(thousand USD/year)
1. Operation Cost	32
2. Maintenance Cost	0
Total	32

※There is a possibility that, at the detailed design stage, unexpected underground facilities will be found or unexpected additional treatment preventing any accident concerning underground facilities. In such cases, the estimated project cost may be changed.

2) Operation Stage

① Operation Cost

TCC unit, which has been newly established in DPWT, is to take charge of the operation work. The

operation cost includes 1) electricity cost including fuel for generator and 2) vehicle cost for site inspection.

② Maintenance Cost

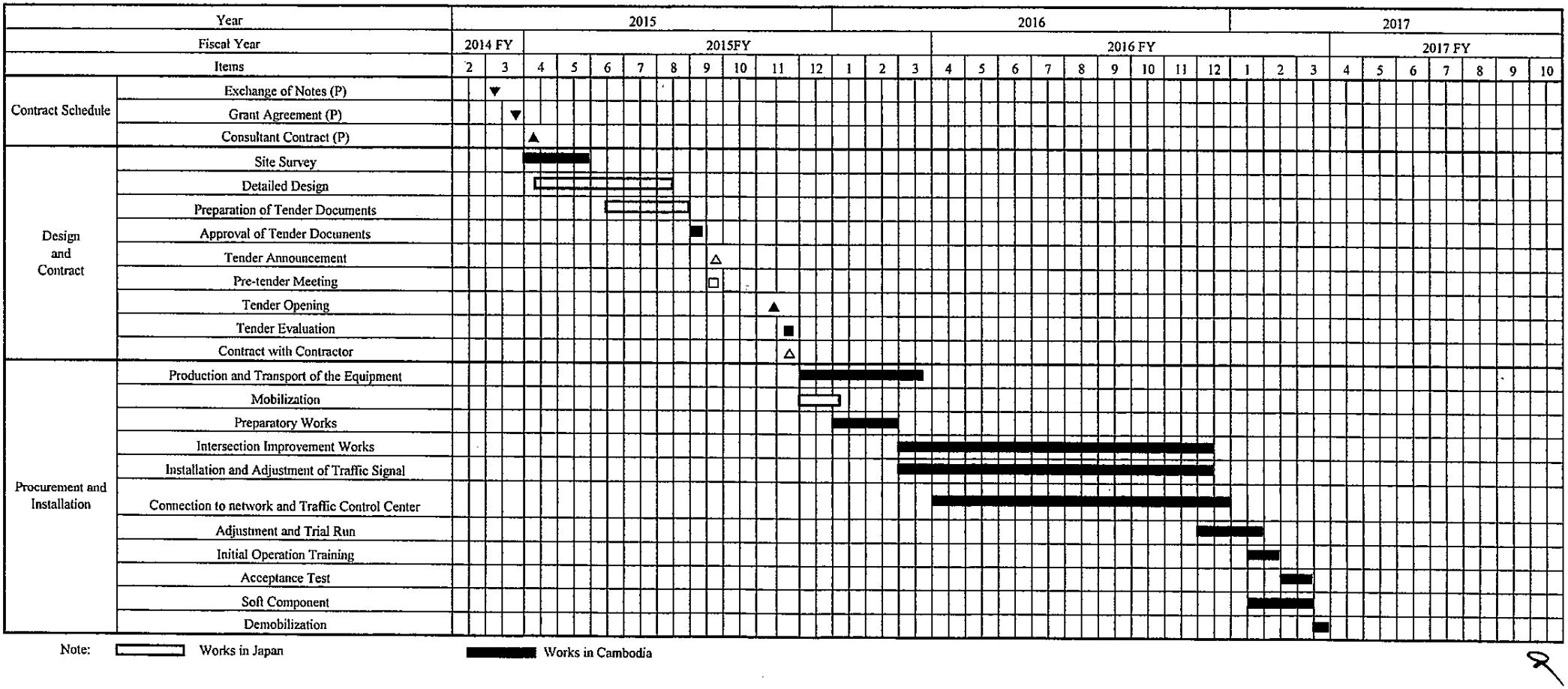
Since, actual maintenance work is expected to be contracted to a private maintenance companies with TCC division, DPWT overseeing its work, a large portion of maintenance cost goes to pay the services of the private maintenance company. This covers cost of the maintenance workers, vehicle cost and office expenses, etc. In addition, the operation/maintenance cost of the connecting optic cable borne by the PPCH.

Table 3 Project Cost Borne by the Cambodian Side during the operation stage

Items	Necessary budget(thousand USD/year)
1. Operation Cost	65
2. Maintenance Cost	54
Total	119

Annex 3

Tentative Schedule



Note: Works in Japan Works in Cambodia

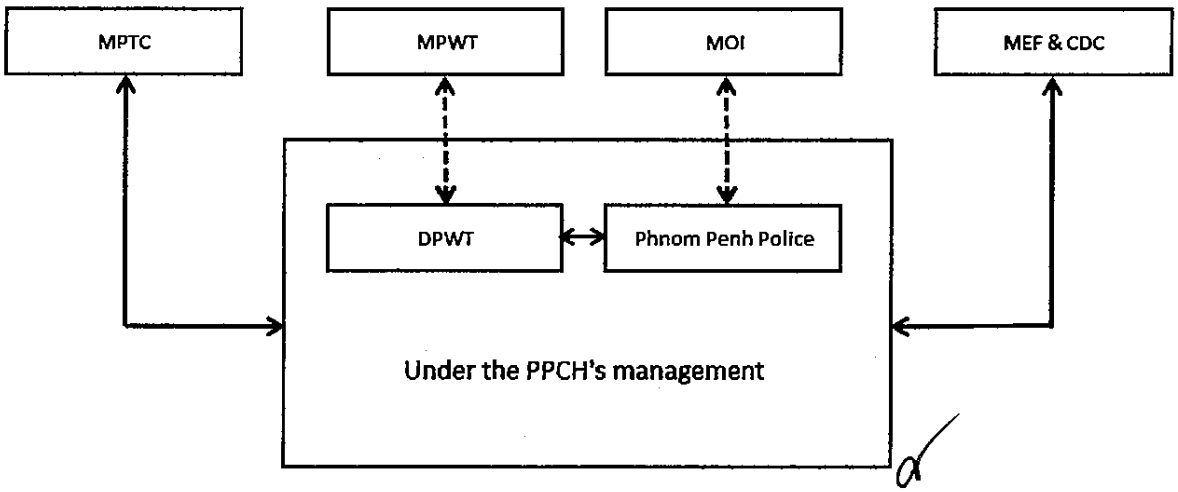
Roles and Responsibilities among Relevant Organizations

Annex 4

Items			MPTC	PPCH	DPWT	PP Traffic Police
During Construction	Administration		✔ Signing of TN	✔ Signing of MD and TN		
	Sipervision of the Engineering Work	TCC			✔	
		Traffic Signal Installation			✔	
		Intersection Improvement			✔	
	Traffic Enforcement	Main Roads				✔
After Completion	TCC and Traffic Signal Operation/ Maintenance	Operation/ Maintenance Work			✔	
		Operation/ Maintenance Cost		✔		
	Operation/ Maintenance of the Optic Cable	Operation/ Maintenance Work	✔			
		Operation/ Maintenance Cost		✔		

※TN: Technical Notes

※MD: Minutes of Disccusions



Appendix 5: Soft Component Plan

Soft Component Program

1. Overview

A traffic control system consists of traffic signals installed at intersection and traffic control center that controls these signals. In order for a traffic control system to function effectively, it is not sufficient for the hardware to operate normally. Signal must operates with proper timing in response to the varying traffic condition. Operation of the system requires the understanding of basic knowledge of traffic engineering, mechanism of traffic control system, operating principle of local controller, functions of vehicle detector, configuration of database and its contents. Soft component program will be held for the system operators of the recipient country to gain the knowledge and technology. Training on the actual operation of the equipment, data setting procedure, identification of defective part will be carried out by the system supplier.

2. Operation Organization

Training will be provided to both the manager of the traffic control system section and operators who operates the system. Outline and basics of the system will be covered for the former, while more detailed and specialized contents will be provided to the latter in addition to the basic knowledge.

The tentative plan for the organization that operates the system is provided in the report of Preparatory Survey for Project of Development of Traffic Management System in Phnom Penh. The qualification shown in Table 1 below may not be suitable for the educational system in Cambodia. If it is the case, the qualification of individual will be considered.

These staff members will be the trainee.

Table 1: Traffic Control System Operation Staff (Tentative)

Position	Number	Work in charge	Qualification
Chief engineer	1	Responsible for overall operation of the system	Bachelor of science with engineering background and experience in managing system
Deputy chief engineer (operation)	1	Responsible for the operation of the system	Bachelor of science in traffic engineering or similar subject
Deputy chief engineer (maintenance)	1	Responsible for the maintenance of the system	Bachelor of science in IT system or similar subject
Operator	6	System operator	Bachelor of science or graduate of technical college
Maintenance staff	2	Maintenance work	Bachelor of science or graduate of technical college in IT

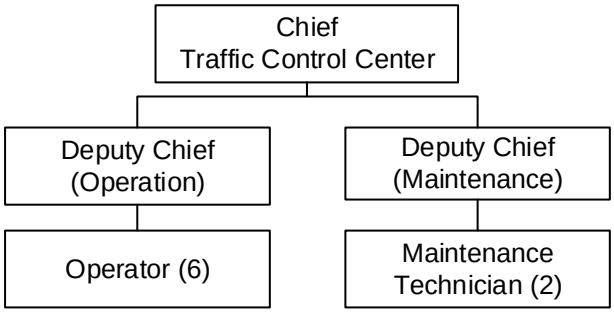


Figure 1: Proposed Organization of Traffic Control Center

3. Training schedule and period

The training will be held two (2) months before system completion. During this period, the installation of the system has been completed and integration and overall test is being held. Some of the signals are already installed and connected to the control center. The training on the installation work, installation procedure, and acceptance procedure is possible based on the actual work.

4. Trainer

The supervision consultant will be the trainer. Two engineers, traffic engineer and traffic control system engineer, will engage in the training for two months respectively totaling four man-months.

5. Venue

All training will be held in Phnom Penh. Training will consist of lecture and workshop at class room and hand-on training at the Traffic Control Center and at intersection where new signal is installed.

6. Syllabus

6.1. Basics of system operation

The training will cover the subjects that are required for the operation of a traffic control system as listed below.

- Knowledge of traffic engineering
- Traffic volume count survey, analysis and application to signal design.
- Intersection geometric design
- Signal design
- Signal installation work
- Test items, procedure and judgment of signal acceptance test
- Test items, procedure and judgment of control center system
- Computer and data communication
- Operation of traffic control system
- Database used in traffic control system
- Maintenance of traffic control system
- Management of documents and drawings

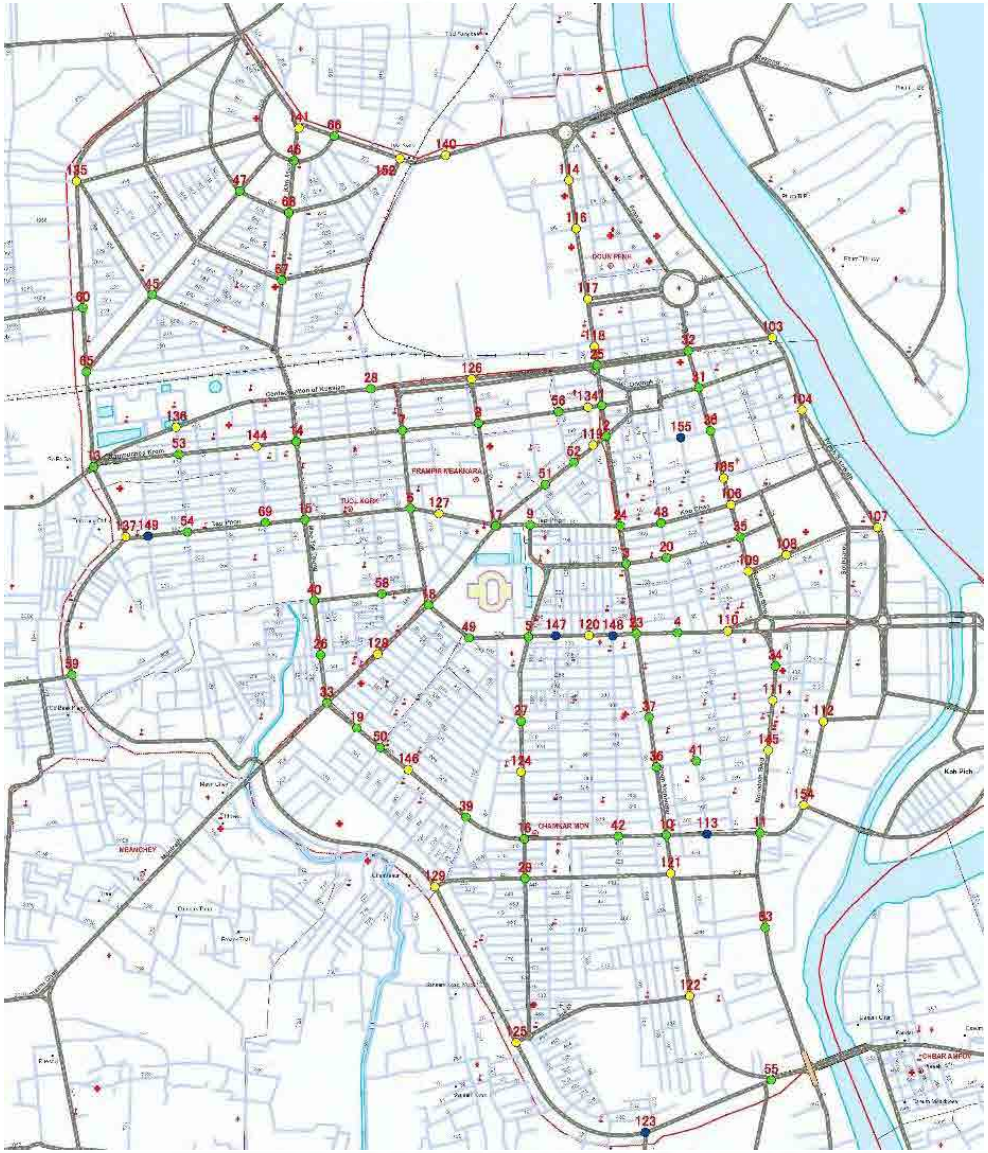
6.2. System operation

Operation of traffic control system includes the works listed below. Actual maintenance work at site is

carried out by the maintenance contractor and staff of traffic control center will supervise the maintenance work.

- Monitoring of signal operation
- Monitoring of traffic condition in the area
- Checking of daily, monthly and annual reports
- Reception of incident information from road user or other organizations
- Preparation of countermeasure against incident and implementation
- Periodic communication with other organizations
- Review of signal timing plan and development of new phase and timing plans
- Calculation of timing parameter and input into database
- Reception of report on defective equipment and abnormal operation of signal
- Supervision of maintenance work by maintenance contractor
- Review and keeping of system operation log
- Spare parts inventory management

Appendix 6: Other Relevant Data



DPWT
Existing
New

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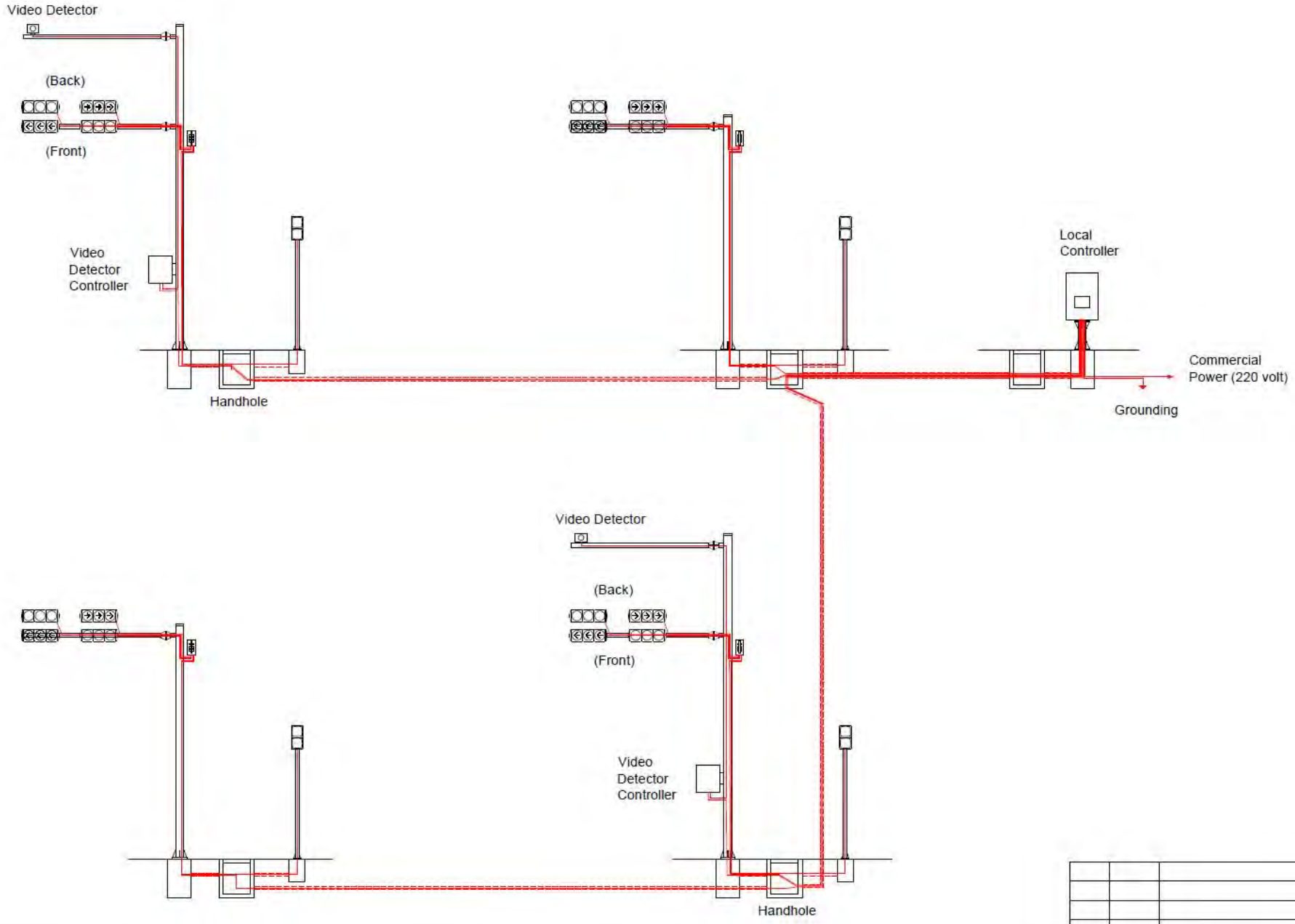

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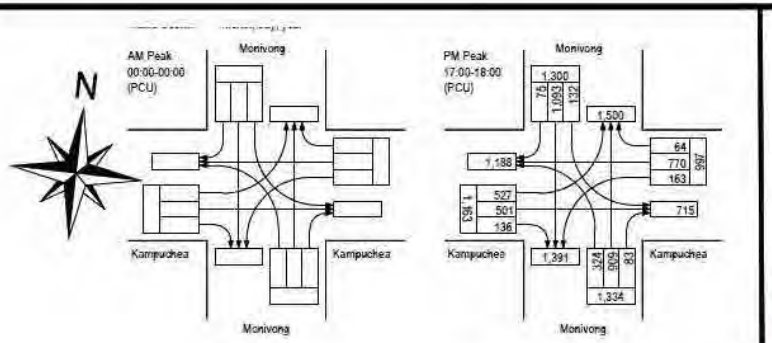

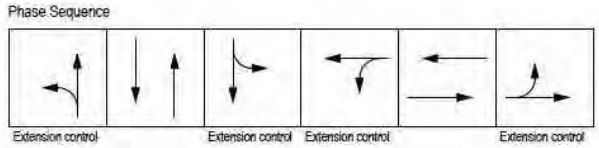

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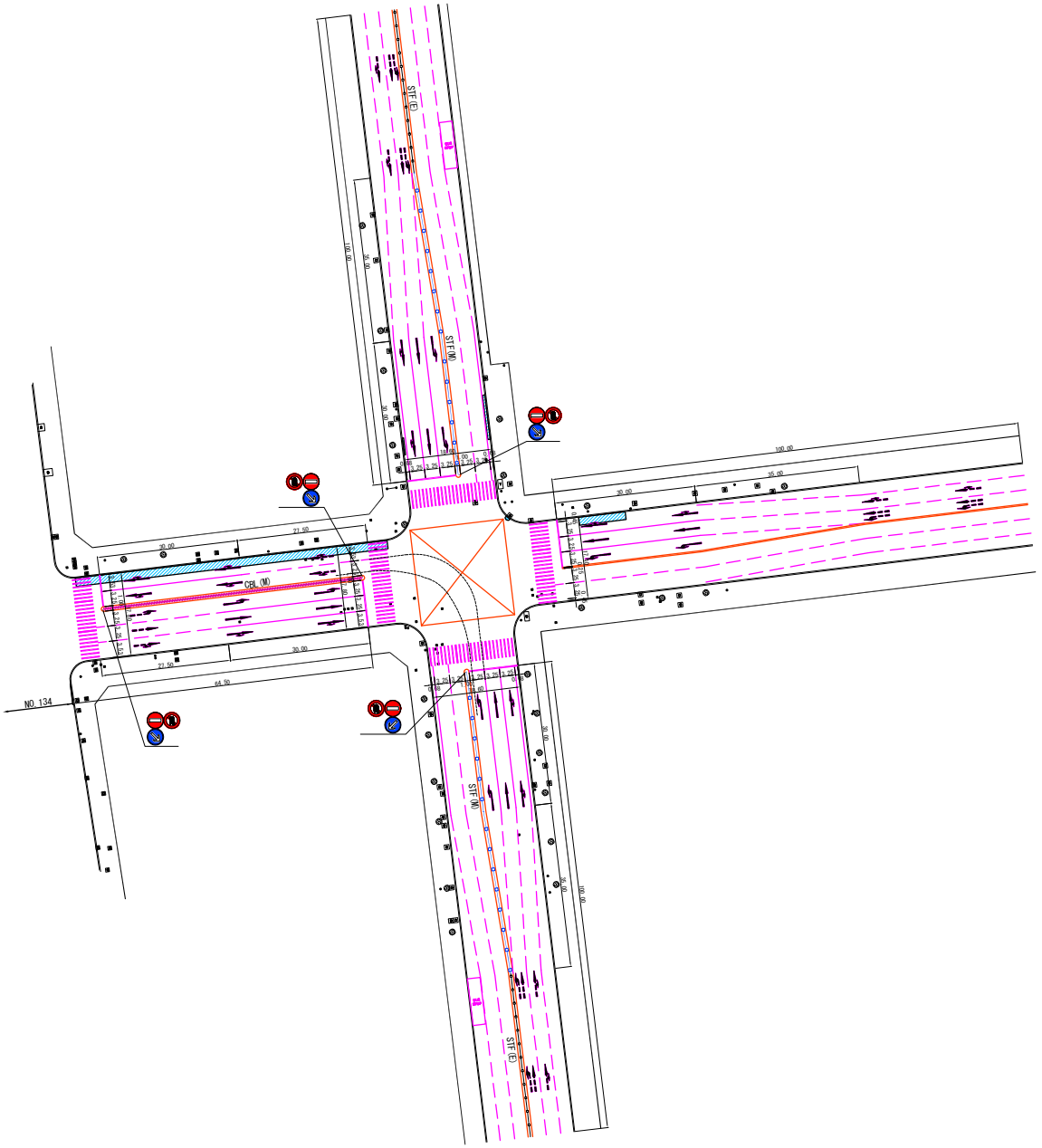

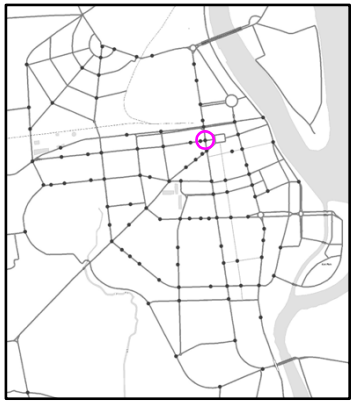

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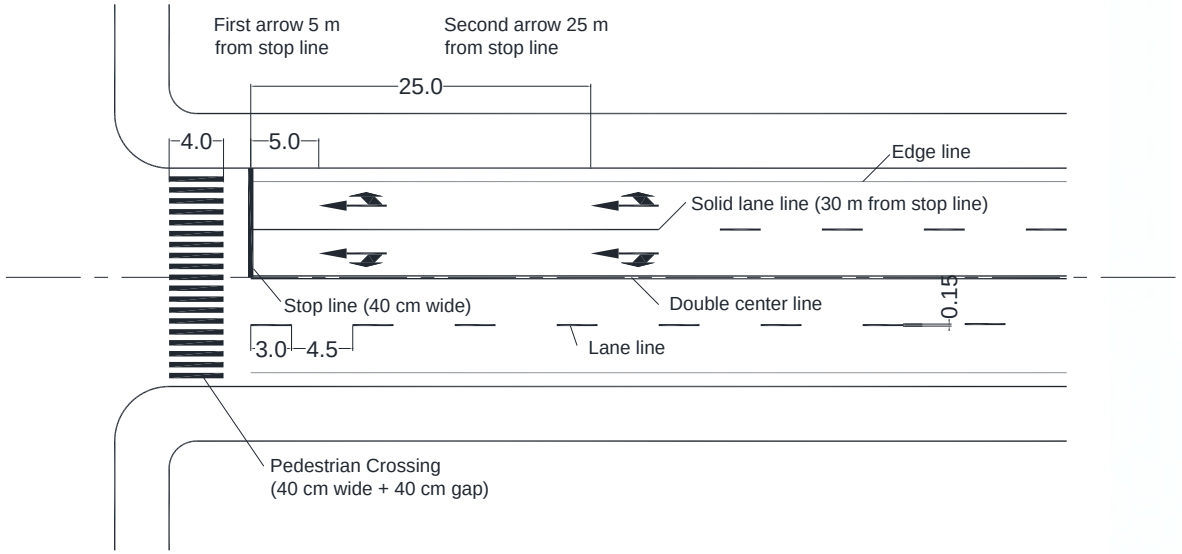

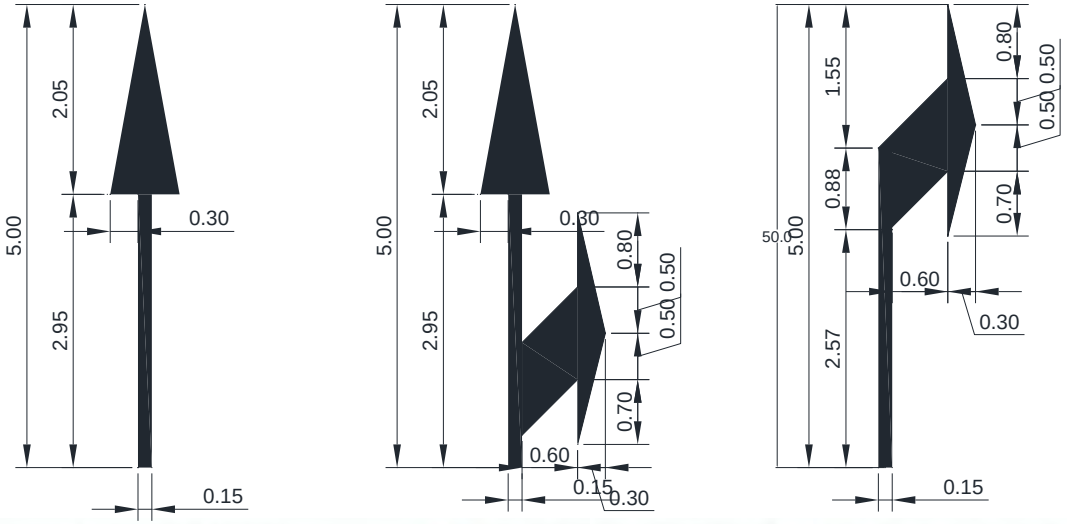

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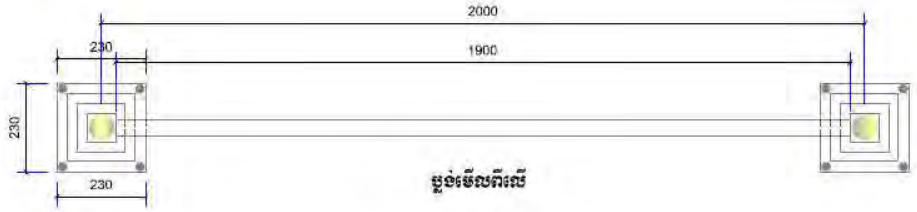

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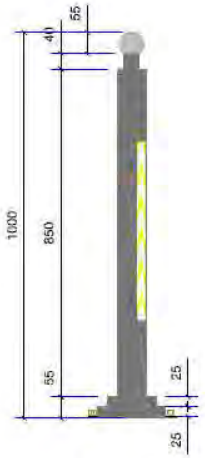

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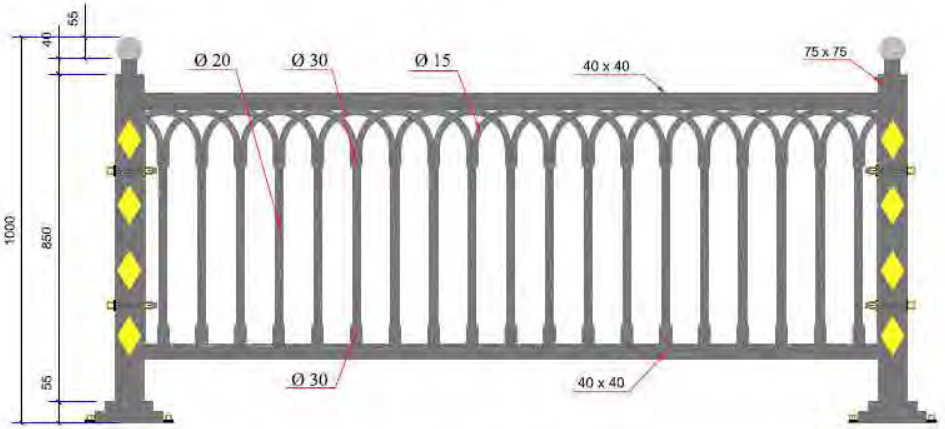

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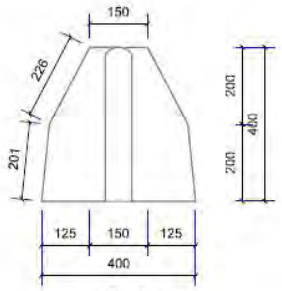

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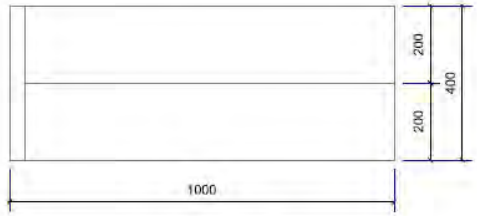

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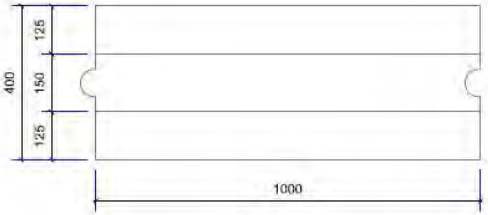

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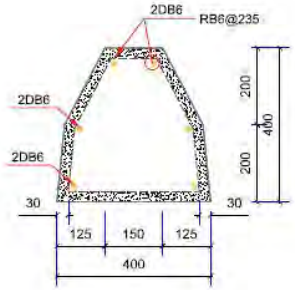

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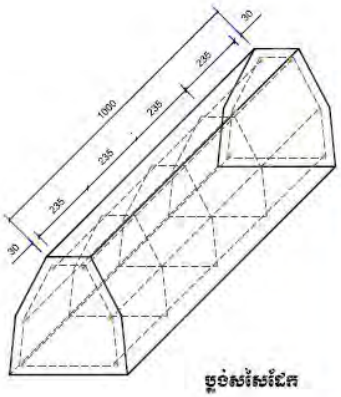

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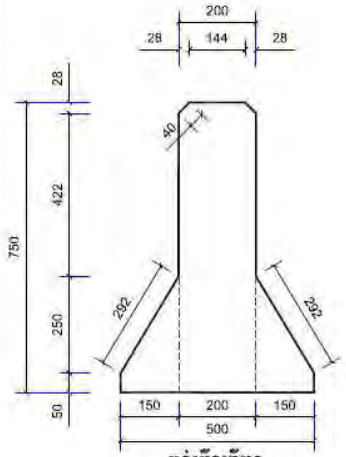

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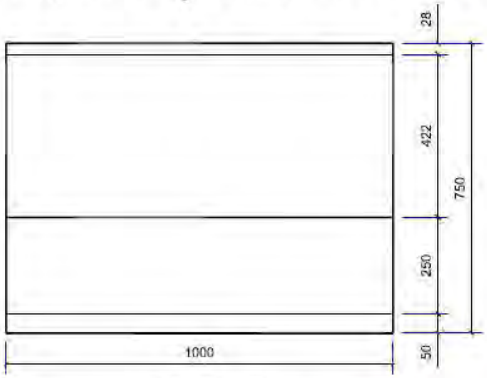

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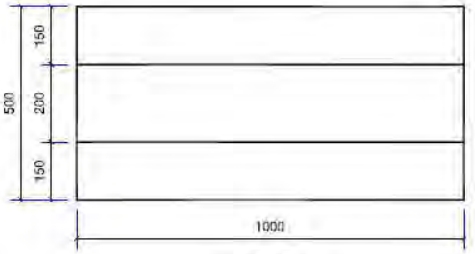

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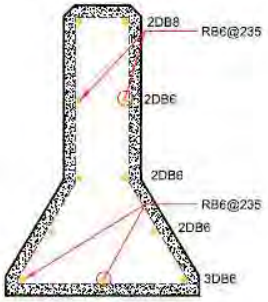

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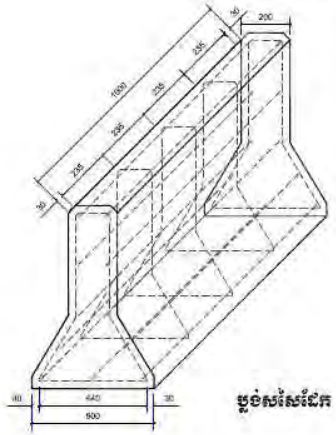


ប្លង់សសៃដែក

រូបភាពឧទ្យានស្បៃ

NO.	DATE	REVISION

CONSUITANT SIDE		CAMBODIAN SIDE	
DESIGNED BY:	DATE:	DESIGNED BY:	DATE:
CHECKED BY:	DATE:	CHECKED BY:	DATE:
APPROVED BY:	DATE:	APPROVED BY:	DATE:

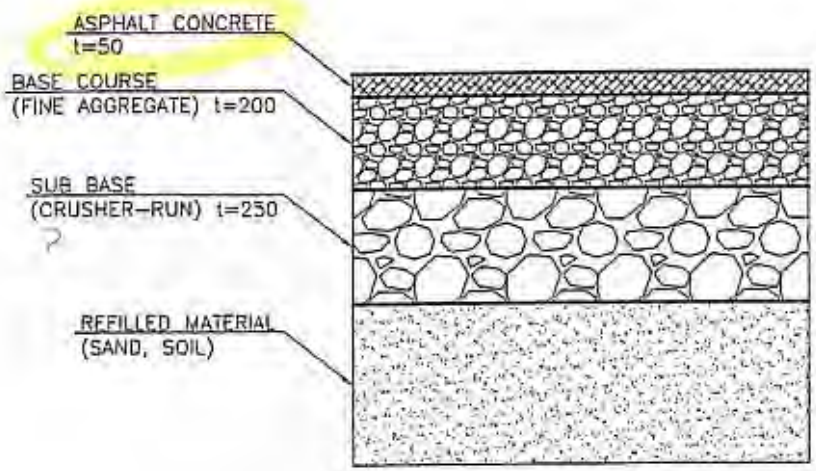
JAPAN INTERNATIONAL COOPERATION AGENCY
METS RESEARCH AND PLANNING, INC.
CTI ENGINEERING INTERNATIONAL CO., LTD.

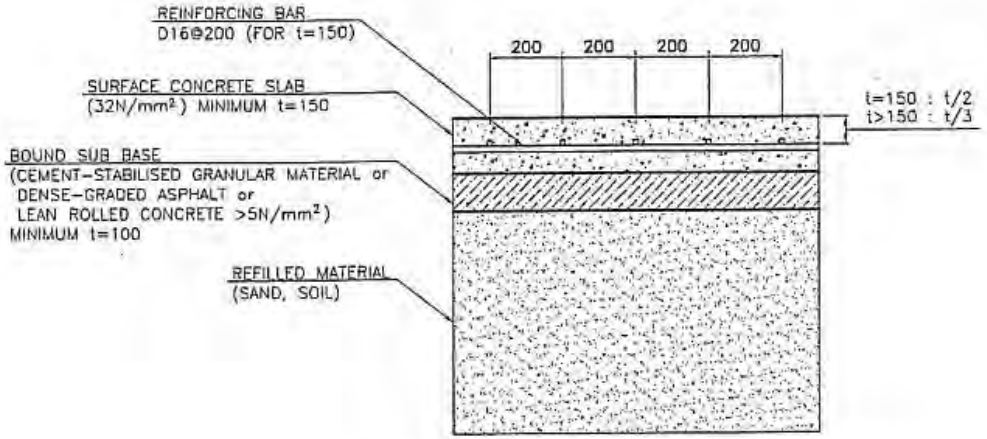
KINGDOM OF CAMBODIA
PHNOM PENH CAPITAL CITY
DEPARTMENT OF PUBLIC WORKS AND TRANSPORT

PROJECT TITLE: PROJECT FOR THE INTRODUCTION OF AREA TRAFFIC CONTROL SYSTEM IN PHNOM PENH CAPITAL CITY IN THE KINGDOM CAMBODIA

CHEET CONTENTS:

SCALE: | DRAWING NO. :





NOTE: THICKNESS, JOINT AND REINFORCEMENT OF RECONSTRUCTED CONCRETE PAVEMENT SHALL BE SET AS EQUIVALENT TO EXISTING PAVEMENT

NO.	DATE	REVISION

CONSUITANT SIDE		CAMBODIAN SIDE	
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CHECKED BY:	DATE:	CHECKED BY:	DATE:
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