The Kingdom of Cambodia

Ex-Post Evaluation of Japanese ODA Grant Aid Project

The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (Phase II)

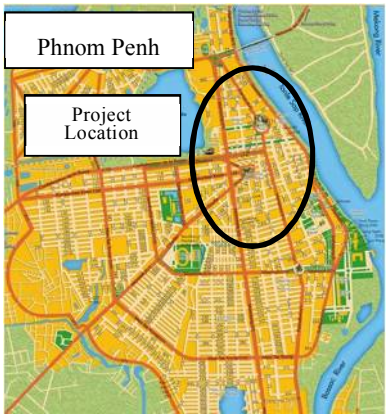
External Evaluator: Jun Totsukawa, Earth and Human Corporation

0. Summary

This project is to improve the flood control safety of Phnom Penh city, with the aim of reducing the damage caused by flood disasters through revetment work on flood protection facilities and the development of drainage facilities. This project was relevant with Cambodia's development plan and needs at the time of planning and is still relevant at the time of ex-post evaluation, therefore the relevance of the project is high. Further, from the information collected in this survey, it can be said that the project achieved the target values of numerical indicators set during the planning in regards to both "duration of flooding" and "inundation depth". Also, due to the fact that traffic congestion has been reduced and there has been a positive economic impact to the region brought about by the mitigation of inundation, the effectiveness and impact of this project is high. The target revetment work and construction of drainage facilities has completed as planned within originally planned budget and project period, thus, efficiency is evaluated high as well. On the other hand, in regards to sustainability, the Drainage and Sewerage Division (DSD) of the Department of Public Works and Transportation which is responsible for the maintenance of drainage facilities, has faced with a limited number of cleaning staff of drainage pipes and other facilities. Also, the budget has been one of challenging issues for ensuring the fully implementation of drainage cleaning until now. However, despite of challenging concerns as such, positive pictures are also observed at present such as improvement of cleaning infrastructure e.g. vacuum trucks have been brought up with other countries' assistance including Japan. Therefore, sustainability can be evaluated to be fair.

In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description



Project Location

Revetment work

1.1 Background

The drainage and flood control facilities in Phnom Penh City had been developed and maintained during the period of French colonial rule up until the 1960s. However, during the civil war that spanned almost 20 years, starting from the 1970s, they were neglected and maintenance almost completely ceased, and the majority of facilities had deteriorated so that their functionality had significantly decreased. Therefore, during the rainy season, dikes in places such as the Tonle Sap River were annually exposed to a risk of overflow due to rising water levels and inundation brought about by inadequate drainage facilities would occur frequently across the city. As a result, while there was the obvious impact on economic activity and the living environment of citizens, there was also a growing concern over the increase in water-related disasters coinciding with the rapid population growth in Phnom Penh City. Therefore there was an urgent need for improvement measures.

With this background, following an assistance request from the Cambodian government, the Japanese government produced a comprehensive Master Plan for the flood protection and urban drainage in Phnom Penh City and suburbs through JICA between 1998 and 1999. A basic design study for the emergency projects proposed in this Master Plan was implemented in 2001 by JICA and, following a detailed design created in 2002, the "The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh" corresponding to Phase I of the project was implemented during the period of December 2002 to September 2004. It has been requested that Phase II of the project be carried out in the same manner as Phase I of the above Master Plan. Whereas in Phase I the target area of drainage improvement was the western and southern regions of Phnom Penh City, in Phase II of the project the target areas for drainage improvement were the North, Eastern and Southern parts of the City. After a survey was carried out in the requested target areas of the project and after the target areas were narrowed down, a plan and detailed design was produced and construction was started in 2007.

1.2 Project Outline

The project aims to reduce the damage caused by flooding disasters by putting in place drainage and flood control facilities in Phnom Penh City and improving the degree of flood control safety.

Grant Limit / Actual Grant Amount	2,644 million yen (Detailed Design: 49 million yen, Main: 2,595 million yen) / 2,354 million yen (Detailed Design: 49 million yen, Main: 2,305 million yen)
Exchange of Notes Date	Detailed Design: January 2007, Main: June 2007
Implementing Organizations	Phnom Penh City Department of Public Works and Transport (DPWT)
Project Completion Date	February 2010
Main Contractor	Kubota Construction Co.,Ltd
Main Consultants	CTI Engineering International Co., Ltd, Nippon Koei Co., Ltd.
Basic Design	The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (Phase II), December 2005 – November 2006
Related Projects (if any)	• The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (2002 exchange of notes signed) • The Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (Phase III) (grant agreement in 2011)

2. Outline of the Evaluation Study

2.1 External Evaluator

Jun Totsukawa, Earth and Human Corporation

2.2 Duration of Evaluation Study

The External Evaluator performed an evaluation study as follows in the course of this ex-post evaluation:

Duration of the Study: November 2012 - August 2013

Duration of the Field Study: December 16 - 25, 2012 and May 5 - 10, 2013

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Relevance with the Development Plan of Cambodia

(At the time of planning)

In Cambodia between 2001 and 2005 in the Social-Economic Development Plan II (SEDP II), the three national goals shown below in (1) to (3) were raised.

(1) Sustainable economic development in a wide range of fields that provides a break from poverty.
(2) Socio-cultural Development through the equal distribution of health care, education, etc.
(3) Sound environmental management and sustainable use of natural resources

Of these, "prevention and control of disaster" was specified as part of the strategy to achieve number (3) "sound environmental management and sustainable use of natural resources", and the aim to establish a safe town structure with no inundation and flooding was raised.

In addition, the third mandate of the Royal Government of Cambodia formed in 2004 set a "rectangular strategy" at the heart of the nation's development strategy and with a focus on "good governance" it positioned "further construction and reconstruction of infrastructure" as one aspect of this important development strategy.

Also, in Phnom Penh City the City Development Strategy (CDS), was developed in 2005 setting 2015 as a target and as part of this one of the items in the strategy section on "social infrastructure", "rehabilitation and improvement of dilapidated drainage pipes", was raised as a target issue.

It can be said from the above that the project's aim to contribute to disaster prevention, drainage improvement and flood protection in Phnom Penh City, is an approach that is consistent with the development plan of Cambodia.

(At the time of ex-post evaluation)

At the time of this ex-post evaluation the above "rectangular strategy" is moving into Phase II and while the four aspects that make up the strategy are all basically being implemented, construction of infrastructure is still regarded as one essential aspect. Currently, the National Strategic Development Plan Update 2009-2013 based on the rectangular strategy has been presented as a development plan, in which it raised the item of "irrigation management and water resources", and touted the necessity of "meeting the needs of locals in flood-prone areas and striving for infrastructure development for reducing inundation damage and flooding."

Therefore, this project was relevant with Cambodia's development plan at the time of planning

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[2] 3: High, 2: Fair, 1: Low

and is still regarded as key issues even at the time of ex-post evaluation.

3.1.2 Relevance with the Development Needs of Cambodia

(Development needs at the time of planning)

Having originally been developed in the back marshes and natural levees on the right bank of the Mekong River, Phnom Penh City has expanded to the floodplain while establishing a ring levee in conjunction with development of the city. Therefore, although it is basically flat terrain, it also has lowlands with qualities that make it difficult to drain water that accumulates there. Therefore inundation during the rainy season occurs at various locations throughout the city due to poor drainage which leads to a deterioration of the living environment and sanitary conditions of residents. In addition, urban areas facing the Tonle Sap River and Mekong River are in a constant state of discord because of the risk of flooding due to the rising water of these two rivers, and there is the serious problem of preserving the functionality of the capital during times of flood.

The drainage and flood control facilities in Phnom Penh City had been developed and maintained during the period of French colonial rule up until the 1960s. However, during the civil war that spanned almost 20 years, from the 1970s up until 1991, they were neglected and maintenance almost completely ceased, and the majority of facilities had deteriorated so that their functionality had significantly decreased.

From the above, improvement of drainage and flood control facilities in the city is, from the view of preserving the functionality of the capital and conserving the living and hygiene environment of citizens, recognized as an important issue to be addressed as soon as possible.

From the above, the project can be evaluated as being relevant with the development needs of the target areas.

(Development needs at the time of ex-post evaluation)

Phnom Penh has until now been working to improve its drainage and flood protection including this project. However, there are still many facilities in the city that require rehabilitation and improvement.

The Phnom Penh City Department of Public Works and Transport (hereinafter referred to as the DPWT), as well as other relevant local authorities have laid an annual average of about 20 km of new drainage pipe in Phnom Penh City since 2007. However, although such efforts have been made, there still remain markedly decrepit drainage pipes in the city. The efforts to reduce or mitigate damages of inundation are still in the developing stage.

Table 1: Length of Newly Laid Drainage Pipe in Phnom Penh City

(m)

Pipe/Year	2008	2009	2010	2011	2012
Newly laid	29,586	33,956	8,479	3,343	3,429
Total extension	420,638	454,594	463,073	466,416	469,845

Source: Material from Phnom Penh City Department of Public Works and Transport (DPWT)

Note: These figures include 4,400 meters laid by this project

In addition, the drainage plan of Phnom Penh City has been promoted on the basis of the Master Plan by JICA created in 1999.

Table 2: Relationship of this project to the Master Plan

Master Plan contents	Phase	Scope of the Project
Sap River section revetment	Phase 2	Only repair of damaged places
Reinforcement of Tumpun and Kop Srov ring levee	Phase 1	Only Tumpun embankment
Tumpun basin drainage improvement	Phase 1	Only downstream of major drainage facilities
Trabek basin drainage improvement	Phase 2	Only the Northeast
Drainage improvement to northern part of city	Phase 2	Only Wat Phnom Area
Eastern Pochentong basin drainage improvement	Out of the scope of the project	-
Northeast, northwest basin drainage improvement	Phase 1	Only Svay Pak Drainage Sluiceway

Source: Preparatory Survey Report on the Project for Flood Protection and Drainage Improvement in the Municipality of Phnom Penh (Phase III) in Cambodia

Note: Drainage improvement projects carried out through the grant aid of Japan have not been referred to as phases 1, 2, and 3 formally, however the term “phase” was used amongst the related parties to distinguish each work. Therefore they are referred to as “phases” in the above table as well as below.

As shown in the table above, the contents of Phase 2, which is this project, corresponds to the three items represented in the shaded regions and components of the Master Plan. However, project target areas shown in the inner right column of the Table merely cover a part of the Master Plan and are not intended to be covering the entire Master Plan region (It should be noted, Phase 3, currently being conducted, is also intended for some areas in the table).

Since the Master Plan was created in 1999, there are significant aspects that can be seen that do not meet the reality of the rapid development of Phnom Penh City. In particular, due to the expansion in urban areas great changes have occurred in land use and residential areas have been developed in areas not studied in the Master Plan. These include places that served as a buffer against flooding such as reclaimed lakes, ponds or wetlands. Therefore, a new drainage Master Plan is currently being planned to make for Phnom Penh City.

In this way Phnom Penh City is faced with the need to improve drainage not only for the previous city center but also in accordance with the expansion of the new city, therefore, it can be said that development needs are higher than ever before.

In addition, flood protection in the form of revetment measures are also still an important issue, and its necessity is still high. The Cambodia side itself has implemented revetment work on the opposite side of the project area since 2011,, apparently showing that the need is recognized as high.

Thus, it can be confirmed that the project is aligned with the development needs of the government and the target areas at that time of planning and this ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

Japan's Country Assistance Plan for Cambodia (2002), fixing poverty reduction and sustainable economic growth as the biggest theme, sought to develop human resources for addressing the serious shortage of skilled workers, restructure battered institutions and develop the essential infrastructure left destroyed by the country's protracted civil war. In other words it focused on realizing support balanced on both hardware and software perspectives.

The plan has set four challenges for emphasis, one of which is; "strengthening of social and economic infrastructure and environmental improvement for economic growth". In this regard, the plan clearly shows "because massive flooding occurs in the Mekong River Basin, there is a necessity for attention to be focused on disaster-resistant infrastructure development".

From these, the project's goal to maintain the drainage and flood control facilities of Phnom Penh City can be evaluated as being relevant with Japan's ODA policy.

In light of the above, this project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Effectiveness[3] (Rating: ③)

3.2.1 Quantitative Effects

Quantitative effects of the project were composed of three major fields, and each was

[3] Sub-rating for Effectiveness is to be put with consideration of Impact.

implemented as follows.

(Flood protection)

The quantitative effect of the project has been determined as "highest water level of the Mekong and Tonle Sap rivers, which corresponds to about 30-year probability of planning scale, does not overtop the dike without any damages". At the time of this ex-post evaluation, there is no conspicuous damage to revetment facilities. In addition, since the completion of revetment work, overtopping and dike breaks have not occurred which means floods have been prevented suggesting that the target effects have been secured.

(Inundation reduction)

Regular monitoring of the duration and depth of inundation has not been implemented. Therefore, in this ex-post evaluation the extent of damage mitigation was determined through responses of residents to a beneficiary survey[4]. The results are shown in the table below and it can be evaluated that there have been reductions in both the duration and depth of inundation and that the target values have been achieved[5].

Table 3: Achievement State of Quantitative Effects (Inundation Reduction)

At time of planning (2005)		Target value after completion		At the time of ex-post evaluation *Average value of the beneficiary survey answers to flooding during the rainy season during 2012	
Inundation depth: Maximum 60cm	Duration: longest 12 hours	Inundation depth: 20cm or below	Duration: 1-2 hours or less	Inundation depth: 18cm	Duration: 0.91 hours

Source: Results of surveys of beneficiaries

Note: Made up from three areas of Wat Phnom Area, Central Market Area, and Royal Palace & National Museum Area (a total of 100 people). The three target areas of these are important areas that are located in the commercial center.

[4] The beneficiary survey was implemented in January 2013 targeting 80 store owners in Wat Phnom Area, Central Market Area, and Royal Palace & National Museum Area, as well as 20 company employees in the areas, totaling 100 people. The store owners are local residents since basically they live in the premises of the target stores.

[5] The beneficiary survey result in the table is based on the responses subject to the rainy season during 2012. According to the responses to the same question for 2011, the year when a heavy rain of 10-year probability occurs, the average value was 29.2cm.

(River environmental improvement)

In this project, setting up a new intercepting sewer so that sewage is no longer discharged to the Tonle Sap River during fine weather thereby improving the river's environment was listed as a goal. Published reference values from the time and numerical targets are shown in the table below.

Table 4: Achievement State of Quantitative Effects (River Environmental Improvement)

Item	Standard Value	Target Value (After implementation: 2010)	At the time of ex-post evaluation (2013)
Sewage discharge amount (m3/day)	9,000	0	0 (Judged to be basically 0)
Discharge BOD5 amount (kg/day)	900	0	0 (same as above)

Source: Material provided by JICA (Reference and target values)

Note: The reference value is the BOD5 amount and the amount of sewage discharge based on population estimates of 2010.

In the time of the ex-post evaluation, it can be evaluated by the construction of a new interceptor, sewage discharged into the Tonle Sap is basically no longer occurring in southern Wat Phnom during fine weather and the environment of the river was improved compared to the previous recorded levels. However, in the interpretation of this indicator, it is necessary to pay attention to the following points.

The mechanisms of the intended river environment improvement of this indicator are outlined below.

Before implementation of this project, all drainage in the target area had been discharged into the Tonle Sap River regardless of whether it was rainy or fine weather. After implementation of this project, through the laying of an interceptor, in fine weather, it will not be discharged into the place it has been released so far, but transported through the Trabek main canal to Trabek Pumping Station in the city south and be pumped out into wetlands (by the way, it has been released into the Tonle Sap river during rainy season as usual, but this is as the project intended).

Currently, there is no sewage treatment plant in Phnom Penh City. This way of leaving treatment to the purification effect of water plants in wetlands has become the best way to reduce the load on the river environment at present.

The Trabek pump drainage location is not in the Tonle Sap River but falls on the Bassac River, therefore the goal of "ending discharge to the Tonle Sap River, and improving the river environment" can be said to have essentially been achieved.

The reason we have used the term "essentially" here is that there are scattered cases of waste water overflowing the height of the interceptor in the No. 4 underground reservoir and then being discharged into the Tonle Sap River even in fine weather (eyewitness reports of December 2012 by the evaluator). The amount of wastewater is not a particularly large amount (just during peak flow time), but strictly speaking it means that there is an amount flowing into the Tonle Sap River, and therefore the expression "essentially" has been used. Incidentally, the cause of the overflow is believed to be related to the silt accumulated in existing pipes and out of a view to maintaining the future effects of the project this fact has been described in the sustainability section.

3.2.2 Qualitative Effects

In this ex-post evaluation, the effect qualitative characteristics can be confirmed and these impacts are outlined below (no assumed qualitative effects at the time of planning).

3.3 Impact

3.3.1 Intended Impacts

Implementation of this project has caused the following impacts.

(Economic effects)

The beneficiary survey shows recognition of effects related to economy as follow:

The major answers indicated that economic opportunities have been increased by longer business hours. It seems that effects such as "reduced damage to goods by inundation" and "elimination of interruption of economic activities such as purchase work" are confirmed.

Table 5: Economic Effects Confirmed

Item	% of respondents
Extended possible business hours (Days) for shops.	68.7 %
Amount of products wasted due to inundation has decreased (reduction in products unable to be sold due to submersion or spoilage)	41.8 %
Decrease in damages to furniture, shelves etc. in stores due to inundation which can render them unusable, cause lingering odors and so on.	9.0 %
Cease of interruptions to activities such as stocking operations (cease obstructions to those going to purchase goods or intermediate wholesalers bringing in goods)	32.8 %
Decreases in foul odors seeping from leakages in underground drainage	55.2 %
Increased visitors (Because there are no visitors at times of flood)	28.4 %

Source: Results of surveys of beneficiaries

Note: From multiple responses of 67 (out of 80) shop people who answered "flood damage has been reduced".

(Sanitation improvement)

In regards to sanitation improvements due to reductions in flood damage, the recognized effects are shown in the table below.

Table 6: Comparison to number of infections in homes that occurred after flooding

	Extremely reduced	Reduced	No real change	Slight increase	Increased	Don't know	Total
No of response	19	50	8	0	3	0	80
%	24%	62%	10%	0%	4%	0%	100%

Source: Results of surveys of beneficiaries

Note: 80 shop people residing in the target areas were questioned.

Of the people questioned, among the 69 who answered, "extremely reduced" or "reduced", most pointed out decreases in common colds (45 people), skin diseases (37 people) and diarrhea (29 people).

(Effects of reduced travel time)

The majority of people answered that reduction in the lengths of inundation had improved traffic congestion compared to in the past. However, because the number of bikes and vehicles is rapidly increasing in Phnom Penh City, it is also a fact that recognition of the mitigating effect is difficult to determine due to an increase in absolute traffic volume. That said, if we take into account the fact that until now flooding would reach up to the knees, last up to a few hours, and stop road traffic completely, it can be said that improvements in traffic congestion and shortening of transit times have been clearly realized.

Table 7: Recognition of improved traffic congestion at times of flooding

	Extremely improved	Improved	No real change	Slightly worsened	Worsened	Don't know	Total
Stores	11	49	7	4	9	0	80
Companies	4	6	8	1	0	1	20
Total	15	55	15	5	9	1	100
%	15%	55%	15%	5%	9%	1%	100%

Source: Results of surveys of beneficiaries

3.3.2 Other Impacts

(Impact on the natural environment)

The environmental monitoring plan and environmental impact mitigation plan were implemented as scheduled.

At the time of revetment work and construction of the underground reservoir for the Tonle Sap river, in order to prevent third party injury on the river side of the road parallel to the river bank and to reduce the noise and dust generated by construction, installation of construction fences was implemented. In addition, in the implementation of the monitoring plan, a system was arranged of weekly meetings where the three parties of Cambodian side, contractors and consultants met and the results of work observations reported. In addition, meeting minutes were shared among the participants as a record. Furthermore, in addition to these meetings, safety patrols were performed weekly and confirmations of construction location safety and environmental impacts were made. Information sharing on patrol checkpoints as well as improvements was carried out through the meetings and minutes. Overall, it was confirmed that there were no negative impacts to the natural environment caused by the construction of this project.

(Land acquisition and resettlement)

No occurrence of land acquisition nor resettlement.

(Other indirect effects)

1) Tourist attraction effect

In the perceptions of more than half of regional shops and residents, it was recognized that flood damage mitigation contributed to a certain extent to the increase in domestic and foreign tourists.

Table 8: Recognition of the role flood damage mitigation played in the increase in tourists

	Very large	Somewhat Large	Not really related	Had a negative effect	Don't know	Total
Stores	33	28	1	0	18	80
Companies	9	9	2	0	0	20
Total	42	37	3	0	18	100
%	42%	37%	3%	0%	18%	100%

Source: Results of surveys of beneficiaries

2) Aesthetic effect

Survey respondents expressed the opinion that the landscape around Tonle Sap River has been

improved considerably by green belt development of the river carried out alongside the laying of drainage facilities and revetment work.

Table 9: Recognition of the landscape change to Tonle Sap River

	Extremely improved	Improved	Not really change	Slightly Worsened	Worsened	Don't know	Total
Stores	38	32	5	0	1	4	80
Companies	10	4	4	1	1	0	20
Total	48	36	9	1	2	4	100
%	48%	36%	9%	1%	2%	4%	100%

Source: Results of surveys of beneficiaries

In light of the above, this project has largely achieved its objectives, therefore its effectiveness and impact is high.

3.4 Efficiency (Rating: ③)

3.4.1 Project Outputs

In this project, because there was a route change during the laying of the interceptor pipe and part of the drainage pipe, a small difference occurred in the total length, but construction of the facility itself was carried out as planned. Also, revetment work for flood protection was done as planned. Planned and actual values are compared as the table below.

Table 10: Comparison of planned and actual flood defenses

Area name	Facility	Plan	Actual
ChaktoMukh Theater Revetment	Revetment work	70 m	Same
Old Market East Revetment	Revetment work	260 m	Same

Source: Provided materials by JICA

Table 11: Interceptor pipe laying and drainage improvement

Area name	Facility	Plan	Actual
Wat Phnom Area	Drainage pipe	1,115 m	1,104 m
	Side Ditch	320 m	Same
Central Market Area	Drainage pipe	2,216 m	2,218 m
	Pumping Station	2 stations	Same
	Reservoir	2 stations	Same
Royal Palace & National Museum Area	Drainage Pipe	726 m	767 m
	Pumping Station	2 stations	Same
	Reservoir	2 stations	Same
Along the Tonle Sap River	Interceptor Pipe	1,818 m	1,518 m

Source: Provided materials by JICA

Changes in the drainage pipe were a result of making changes to the pipe line shape due to a need to avoid buried structures. In addition, the total length of the interceptor pipe was 1,518 m. This was also due to changes in the pipe line shape but proved to have a positive effect as it enabled a reduction in the bent portion of the pipeline and, as a result, the flow of the interceptor pipe became even smoother.

In addition, drainage pipe laid in this project are large scale tubes with tube diameters ranging from between 1,000 mm to 1,800 mm and thus the flow rate is very large compared to pipes with average tube diameters. Thus, the large effect of drainage improvement has been noted (including the new drain pipe shown in Table 1, the scale of most are 600mm or less).

3.4.2 Project Inputs

3.4.2.1 Project Cost

Given below are the planned and actual project costs of this project. The project cost was lower than planned.

Table 12: Planned and Actual Project Costs

	Japan side:			Cambodia side:	Total project cost To Japan and Cambodia
Plan	Detailed design	Main	Subtotal		
	49 million yen	2,595 million yen	2,644 million yen	3.8 million yen	2,647 million yen
Actual	49 million yen	2,305 million yen	2,354 million yen (89.0% compared to the planned value)	3.9 million yen (102.6% compared to the planned value)	2,357 million yen (89.0% compared to the planned value)

Source: Provided materials by JICA and the Phnom Penh Department of Public Works and Transport (DPWT)

Primarily as a result of the fact that the main construction bid amount was lower than initially estimated, the project cost of the Japan side was within the estimated amount. On the other hand, while the burden on the Cambodian side was almost as expected, the distance of electricity cable extension was slightly longer than planned, and therefore the estimated amount was exceeded slightly.

3.4.2.2 Project Period

The Project period including detail design and construction was mostly as planned.

Table 12: Planned and Actual Project Period

Materials	Planned Period	Actual Period
Entire project	37.5 months in total	37.2 months in total :99% compared to the planned value

Source: Provided materials by JICA

Both project cost and project period were within the plan, therefore efficiency of the project is high.

3.5 Sustainability (Rating: ②)

In order to take advantage of the facilities established in this project and sustain their desired effects in the future there is a need for the following points to be improved. To put it another way, because they are important requirements to ensure the sustainability of the project's facilities, by first clarifying these points, it is assumed that the sustainability of the project will be addressed.

1. The need for cleaning and periodic inspection of existing pipes

Currently, refuse has accumulated in the existing pipes that are connected to the new drainage

pipes of this project which results in silt and garbage flowing from the existing pipes into the new pipes of this project. So far, even if refuse flows into the new pipe it doesn't cause a serious hindrance to the flow rate due to its large capacity. However, if this situation continues, the flow rate of the new pipe will be limited and it will have a negative impact on drainage function.

In fact, in regards to the mentioned impact on effectiveness, silt accumulation has continued in the No. 4 underground reservoir, and incidents of overflow from the interceptor pipe have already occurred[6].

In future, it will be necessary for the DPWT, particularly those responsible for actual cleaning within the Drainage and Sewage Division (referred to below as DSD), to carry out cleaning of existing pipes which adheres to a cleaning plan created through careful consideration of the results of regular inspections of drainage pipes.

2. Further reduction of refuse inflow flowing into the underground reservoir screen pit ~ Need for enlightenment of residents

In order to prevent refuse from entering the underground reservoir a screen pit (grating) has been installed. However, during heavy rain, incidents of considerable amounts of waste accumulating on the trash screen are expected to occur. If the trash screen is blocked by refuse the pump in the underground reservoir may not run in full capacity and drainage may become less effective.

To prevent this situation, in addition to performing regular inspections and cleaning of drainage pipe networks, to stop the dumping of waste into roadside gutters and so on it is necessary to promote resident awareness. At the same time it is also necessary to carry out services improvements on private companies doing garbage collection in the city. In order to prevent trash from flowing into gutters etc., it is important to implement shorter holiday periods in the festival week and ensure regular garbage collection work as well as strengthen the garbage collection services.

Along with the simultaneous improvement of the above situation, it can be considered that effective utilization of the project facilities is persisting.

In addition to the points described above, below are the outlines of the sustainability of the project's facilities in operational and maintenance aspects.

3.5.1 Institutional Aspects of Operation and Maintenance

(Drainage facilities)

Staffing for the project facility is as shown in the table below. It can be said that, as the number of assigned staff has quite generously exceeded the number proposed during planning, that the situation is adequate for carrying out operation and maintenance of the project facilities.

[6] From eye-witness accounts in December 2012. Following this, in March and February 2013, cleaning of the underground reservoir and drainage pipes laid out in this project was carried out by the DPWT. Thus it can be assumed that the subsequent circumstances have improved.

Table 13: Placement number of personnel in the project drainage facilities

(people)

	Proposed Number	Actual Number
Pumping Station No 1	3	4
Pumping Station No 2 (concurrently acting as No 3)	3	6
Pumping Station No 4	3	4
Pumping Station No 5	3	4
Underground Reservoir	10	10

Source: Material from Phnom Penh Department of Public Works and Transport (DPWT)

On the one hand, for cleaning the existing drainage pipe there are 24 personnel belonging to the DSD "drainage pipes cleaning section". However, in order to clean the existing pipes throughout the city, including the target area, the present 24 people will be insufficient and the DSD estimates that about 90 or so people will be required.

In addition, 2 high-pressure washing cars and 2 vacuum trucks have been provided in the third phase of this project and these vehicles are expected to improve the efficiency of cleaning work (which will also have the positive effect to the shortage of workers)[7].

Cleaning of the screen pit can be corresponded with many of the personnel of DSD together, in view of its importance and in its emergency until now. It can be said that the current number of staffs can somehow deal with screen pit cleaning with hand in hand.

(Revetment work)

Currently, the River Bank Division is staffed by four people. Since revetments do not require frequent inspection, the repair work and maintenance management staffing for this project is currently not a concern. As for the revetment cleansing work, it has been delegated to the District to carry out this work.

In general, if the facilities of this project themselves are verified, in general there is no problem in the current system, but it is necessary to enhance the personnel structure related to cleaning in order to continue the project's effects[8].

[7] In addition, in recent years, four vacuum trucks have been granted by France and two by Vietnam and therefore the number of vacuum trucks is becoming quite substantial.

[8] Enlightenment of residents in relation to garbage disposal has been carried out on occasion by the Ministry of Tourism and the Department of Environment of the Phnom Penh government. In addition, with support from the JICA office, the DPWT is also initiating seminars to provide information to the media (an effort stemming from the idea that it is essential to be understood by the media such TV, newspapers, etc. which disseminate information).

3.5.2 Technical Aspects of Operation and Maintenance

(Drainage facilities)

The installation of the facilities and equipment regularly used by the DPWT in this project as well as their primary maintenance work such as inspection and regular cleaning does not demand a particularly high level technical knowledge. For that matter, because it is for tasks such as cleaning, it is not particularly necessary to hold in-house training courses or the like.

However, once again, in view of the above stated need for cleaning work on existing pipes, the formulation of cleaning plans is required for steady implementation and maintenance as well as other related improvements as "techniques". Currently, the DSD has created a yearly cleaning work plan, but this merely indicates the planned figures of cleaning work distance and stops short of outlining plans for inspection work etc. There is also the fact that the monthly plan is insufficient and, despite all the DSD's efforts, delays have been occurring in cleaning work. Therefore, it is expected that the DSD will acquire feasible and effective planning capacities[9].

(Revetment work)

Since repairs and inspection do not occur frequently in revetment, fundamentally, cleaning services are the principle operations and do not require advanced technology. Further, maintenance rules for revetments have been developed and carrying out inspections in emergency situations (such as heavy rainfall) has become possible.

3.5.3 Financial Aspects of Operation and Maintenance

Expenditure items by DSD that are required to maintain the sewage and drainage facilities, included those established in this project, are shown in the table below. Expenditure for these items has continued to decline over the past three years from 2011-2009. Though there was visible improvement in 2012, the situation has still not reached the levels of 2009.

On the one hand Phnom Penh City can finance the maintenance costs of sewage and drainage facilities through assigning 10% of the city's water supply rates revenue, however, this decision is left to the internal departments of the city government and this allocated amount of 10% merely indicates the upper limit. It is estimated that water supply revenue has been increasing every year, though, this survey could not ascertain if its allocation amount has exceeded its 10% assignment or not.

[9] In regards to this point, through incorporating the soft component in the third phase of this project, technical assistance for cleaning planning is currently being undertaken at the time of this ex-post evaluation. It is expected that through the activities of this component DSD officials will improve practical skills for cleaning planning. Over the medium to long term the development of one-year plan and five-year plans will be implemented.

Table 14: Expenditure breakdown of DSD sewage and drainage facility maintenance (million Riel)

	2009	2010	2011	2012
Drainage pipe cleaning	321.48	438.05	732.98	682.02
Drainage pipe repair	265.91	297.73	162.02	179.02
Pump station repair	253.67	0	0	171.00
Regulating reservoir cleaning and maintenance	672.17	0	0	265.74
Total	1,513.23	735.78	895.00	1,297.78

Source: Material from Phnom Penh Department of Public Works and Transport (DPWT)
Note: USD1 = KHR 4,100

However, according to the DSD, which is responsible for the operation of the pumping station, it can be said that there has been no cases in which the pump was unable to be run due to budgetary shortfalls in electricity or diesel costs, and in terms of operation there are no large financial concerns.

In addition, there is no regular expenditure required for revetment work, so from a financial perspective, in the short to medium term revetments are not seen as concerns threatening the sustainability of the project.

[Reference]

The following shows estimates of the degree to which the DSDs actual expenditures can cover the required cleaning tasks (basic design study calculations applied as the basis[10]).

- Necessary amount for drainage pipe cleaning work under DSD jurisdiction:
  About USD 777,400 / year
- Actual amounts assigned to drainage pipe cleaning work under DSD jurisdiction:
  About USD 178,800 (2011 results) > Equivalent to about 22 percent of the amount required
  * In addition, districts administration also conduct cleaning works of drainage pipes.

Currently, it can be expected that the effect of materials and equipment such as sludge vacuum trucks will reduce the required amount for cleaning tasks calculated above based on labor costs. However, it has to be judged that there is still a gap between the required amount and the actual result at a certain level.

[10] USD5 / m set as pipe cleaning costs.

3.5.4 Current Status of Operation and Maintenance

Currently, a little over two and a half years have passed since completion of the project facilities and there have not been any occurrences of damage or failure. As mentioned in the above system section, the Cambodia side is staffing the project facilities in accordance with the recommendations.

In terms of actual results, the cleaning of underground reservoirs in four locations, in accordance with the recommendations of this project, is being carried out prior to the rainy season every year. In addition, the submersible motor pump is only lowered into the water at times when the water level of the Tonle Sap River has risen, in line with the manual.

In addition, there is no current record of spare parts being purchased so far, but should the need occur, the purchase is possible through an agent in Cambodia.

However, as mentioned repeatedly, in order to continue the effective use of drainage it is necessary to implement even more regular and systematic cleaning work and inspections.

Overall, concerning the sustainability of this project, 1) the number of cleaning staff, 2) capacity for cleaning plan development as well as plan compliance (including inspection work), 3) the budget, including the cleaning work, are essential points. Within this, technical guidance is being performed using phase 3 soft components for 1) and 2), and, in conjunction with introduction of vehicle equipment such as sludge vacuum vehicles, etc., it is expected that increased efficiency of cleaning work. On the other hand, although there are uncertain areas in regards to 3), the outlook for the budget has a larger advantage in terms of the possibility of securing budget allocation from Phnom Penh city water supply rates, comparing with other types of public works where there are no expectations of funds at all.

From the above, some problems have been observed in terms of structural, technical and financial aspects, therefore sustainability is fair. It, however, should be noted that activities to enhance its sustainability are being carried out actively as of ex-post evaluation period and as a result the prospects for improvements in the future are hopeful.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project is to improve the flood control safety of Phnom Penh city, with the aim of reducing the damage caused by flood disasters through revetment work on flood protection facilities and the development of drainage facilities. This project was relevant with Cambodia’s development plan and needs at the time of planning and is still relevant at the time of ex-post evaluation, therefore the relevance of the project is high. Further, from the information collected in this survey, it can be said that the project achieved the target values of numerical indicators set during the planning in regards to both "duration of flooding" and "inundation depth". Also, due to the fact that traffic congestion

has been reduced and there has been a positive economic impact to the region brought about by the mitigation of inundation, the effectiveness and impact of this project is high. The target revetment work and construction of drainage facilities has completed as planned within originally planned budget and project period, thus, efficiency is evaluated high as well. On the other hand, in regards to sustainability, the Drainage and Sewerage Division of the Department of Public Works and Transportation which is responsible for the maintenance of drainage facilities, has faced with a limited number of cleaning staff of drainage pipes and other facilities. Also, the budget has been one of challenging issues for ensuring the fully implementation of drainage cleaning until now. However, despite of challenging concerns as such, positive pictures are also observed at present such as improvement of cleaning infrastructure e.g. vacuum trucks have been brought up with other countries' assistance including Japan. Therefore, sustainability can be evaluated to be fair.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

In order for effective long-term utilization of drainage facilities built in this project, cleaning work on a regular basis with a focus on existing pipes is required. To that end 4 points are required; (1) development of feasible and effective cleaning plans, (2) increasing of the number of cleaning workers based on this plan, (3) effective use of equipment such as high-pressure washing cars and sludge vacuum vehicles, etc., (4) resident awareness about proper waste disposal.

Currently, while receiving cleaning plan capacity building support from the soft component in phase 3, enhancement of cleaning equipment and the effort to carry out complete cleaning of laid target pipes in March and February of 2013 are points that warrant special mention, further efforts from the DPWT are expected for in the future in terms of points (1) to (4) mentioned above.

As for Phnom Penh Capital Hall, allocation of money to cover the maintenance of drainage facilities from water supply charges is an inhibition factor to the implementation of necessary on-site cleaning work and it is recommended that, in view of the current situation, that the current allocation amount be increased.

4.2.2 Recommendations to JICA

For awareness-raising campaigns about residents' garbage disposal, the continuation of indirect support to drive the campaign making effective use of ongoing Phase 3 timing is recommended.

4.3 Lessons Learned

It was recognized from the time of planning, that both the Japanese side and Cambodian side were insufficient for cleaning the existing pipes in this project. However, while the cleaning results still do

not meet the required level, influence has been seen in the effects of this project in terms of achievement level. In light of the above, at the planning stage, it is necessary to confirm if the recipient government actually developed more detailed cleaning plans, structures and cleaning performances. Then, it is crucial to encourage the recipient government for making necessary counteractions and improvement of organizational structure/system.