4. Procurement Plan

a. Items to be procured from Foreign Countries - Tunnel

Works	Items		Remarks
Tunnel Works (Shield Tunneling Methods)	Material	Backfilling Material	
		Additive (Mud Additive)	
	Equipment	Shield Machine	Japan, Western Countries (Germany, America, etc.)
		Plant	Japan, Western Countries, Singapore, Taiwan, China, etc.
		Segment Lifter	Unloading of Segments into Shafts
	Labor	Technical Staff	Overall Tunneling Works
		Maintenance Staff	Repair and Maintenance of the above Machineries
Tunnel Works (NATM)	Material	Support Materials (Rock Bolt, Steel Support)	
	Temporary Material	Movable Formwork for Lining Concrete	
	Equipment	Drill Jumbo	Hydraulic Drifter (Making Narrow Holes by Rock Bolt)
		Shotcrete Machine	
		Brower	
		Measurement Apparatus	
	Labor	Technical Staff	Overall Tunneling Works
		Maintenance Staff	Repair and Maintenance on the above Machineries

【Remarks】 Segments for Shield：Local Fabrication to be considered subject to the guidance from foreign supplier

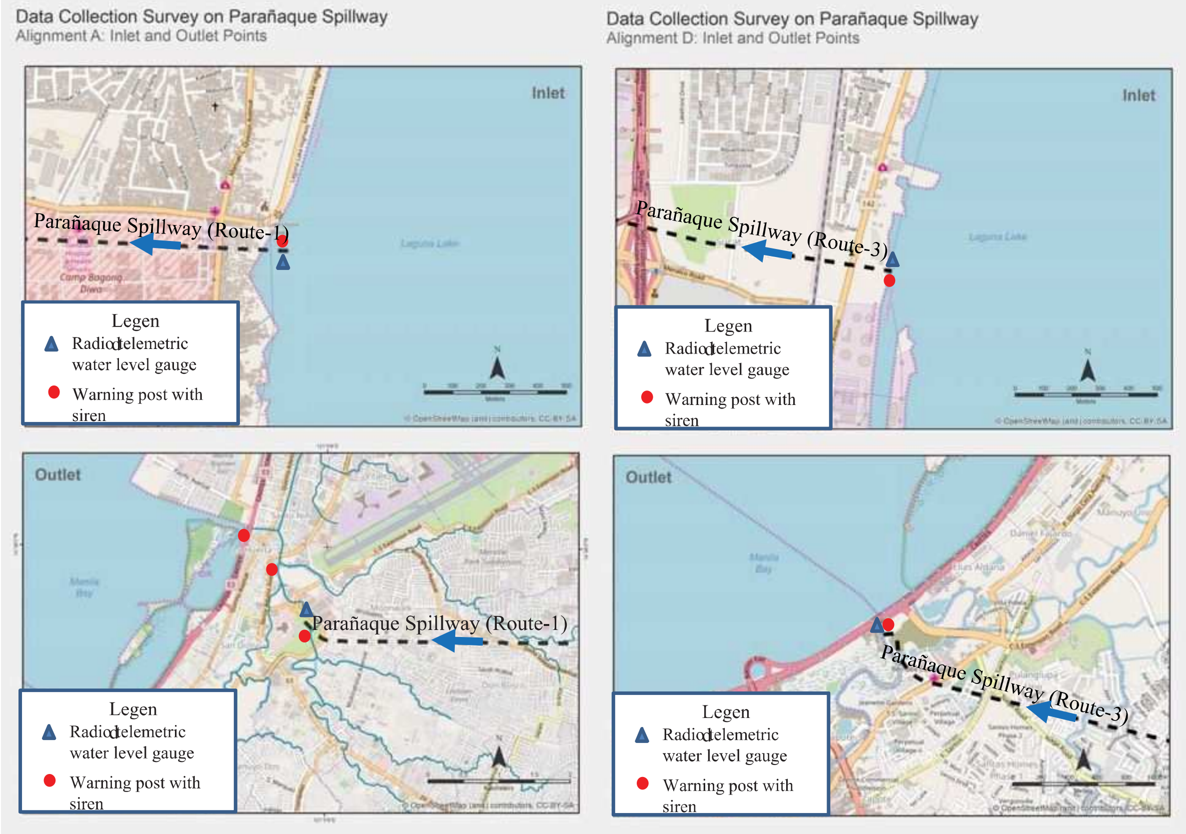
4. Procurement Plan

b. Items to be procured from Foreign Countries – Shafts, M&E

Works	Items		Remarks
Construction of Shafts (Open Caisson Method)	Equipment	Jacking Apparatus ･Boring Machine ･Anchor for Reaction Force ･Press-in Jacks ･Press-in Beams ･Reinforcing Steel Plate of Cutting Edge	Procurement from Japan (the team for the construction of shafts)
	Labor	Technical Advisor	
Construction of Shafts (Diaphragm Wall)	Equipment	Trencher	Japan, Western Countries, Singapore, etc.
		Muddy Water Treatment Plant	Ditto
	Labor	Technical Advisor	Ditto
M&E	Equipment	Pump, Ventilation Fan, Screening Equipment, Gate, Control Panel, etc.	Ditto

5. Non-structural Measures

Radio Telemetric Water Level Gauges and Warning Posts with Siren for Operation of the PSW



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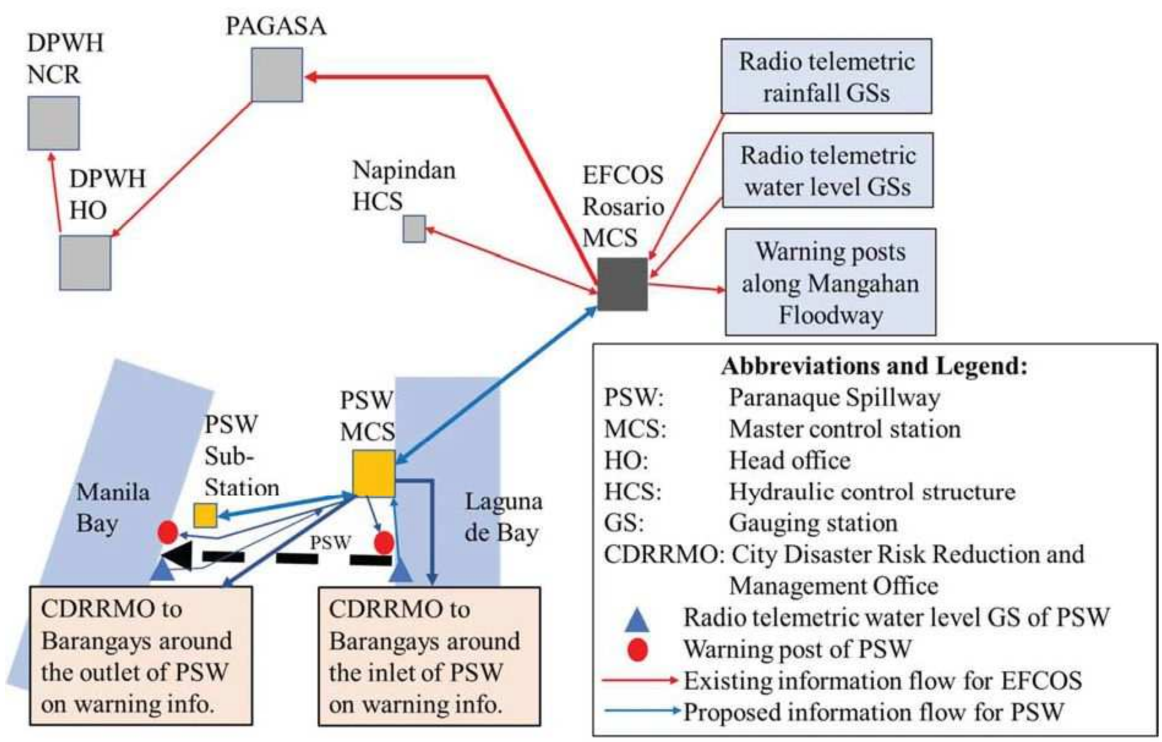
5. Non-structural Measures

Radio Telemetric Water Level Gauges and Warning Posts with Siren for Operation of the PSW



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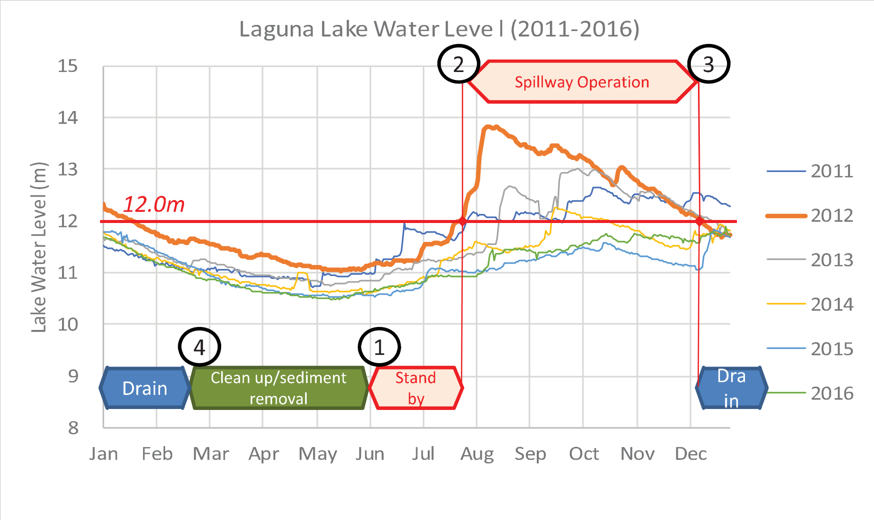
6. Operation and Maintenance

Example of General Schedule of O&M for Parañaque Spillway (Case Study for CY2012)



① Stand-by
② Start spillway operation (when Lake WL >12.0m)
③ Finish spillway operation (when Lake WL <12.0m), and start drain from tunnel
④ Start clean up of underground tunnel after completion of drainage
⑤ Stand by

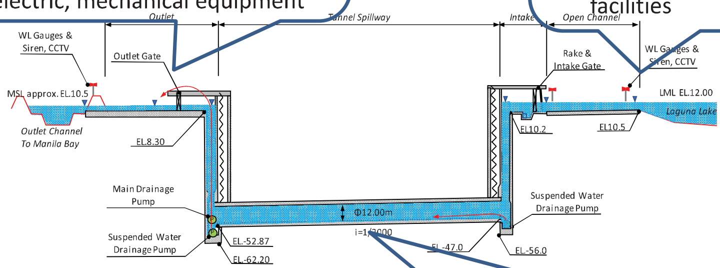
Items of Works for O&M on the Parañaque Spillway

Pump House

- ✓ Outlet Gate/Pump Operation
- ✓ Removal of garbage/sediment at outlet
- ✓ Maintenance & repair of hydro-electric, mechanical equipment

Intake/Inlet

- ✓ Intake Gate Operation
- ✓ Removal of garbage/sediment at inlet
- ✓ Maintenance & repair of intake facilities



Underground Tunnel

- ✓ Gate/Pump Operation for drainage from tunnel
- ✓ Cleaning and ventilating of tunnel
- ✓ Removal of sediments
- ✓ Inspection/Rehabilitation of tunnel

Ex. Annual O&M Cost
Kan-nana Underground Storage in JAPAN in 2016 [L=4.5km, D=12.5m]

Clean up of tunnel	P45 Mil./y	43.6%
Maintenance of Mechanical Works	P30 Mil./y	28.0%
Fuel/Electricity	P30 Mil./y	28.4%
Total	P105 Mil./y	100%
	(0.22% of Project cost)	

6. Operation and Maintenance

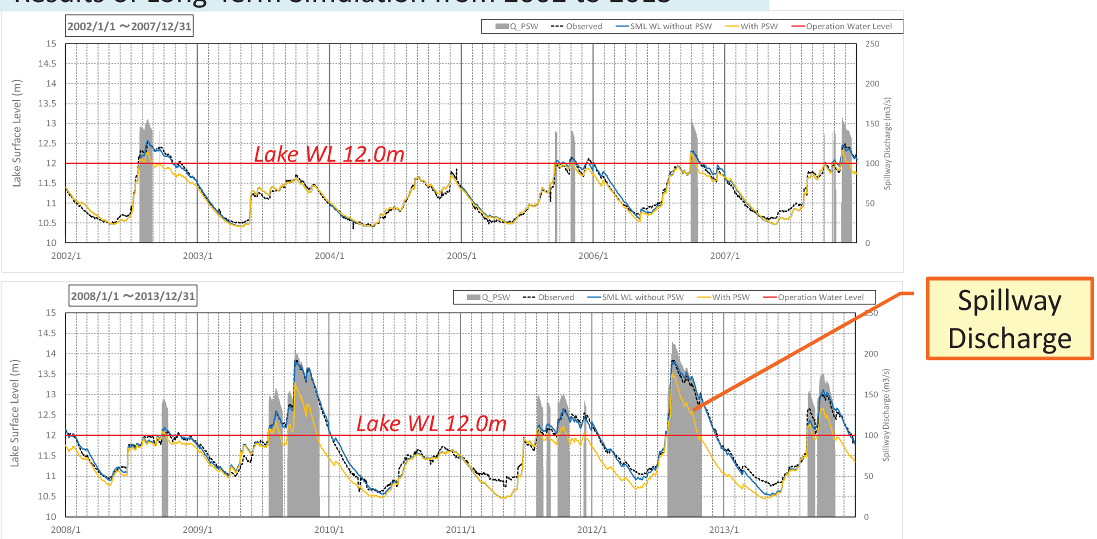
Proposal for Organization
for Comprehensive Flood Control Works in Laguna de Bay

Flood Control Works	Outline	Implementation	Operation and Maintenance
Spillway	Underground tunnel spillway (L7.8-9.8km, drainage pump facilities)	DPWH-UPMO	• DPWH-UPMO/MMDA
Lake Dike	Crest EL.14.0m, total length 83km	DPWH-UPMO	• MMDA-FCSMO (in Metro Manila) • DPWH-RO/DEOs or LGUs (other areas) • Land management for relating structures by LLDA/LGUs
Pump Station	28 pump stations in the low lying area of lake dike	DPWH-UPMO	
River Improvements	Major tributaries in the construction area of lake dike	DPWH-UPMO	

- ✓ The responsibility of O&M is going to be shared among several organizations in the regular case, however it is not effective.
- ✓ Since the measures to be proposed are the large-scale structures, it is appropriate to establish the project implementation/operation and maintenance system by positioning DPWH in center.

6. Operation and Maintenance

Results of Long-Term Simulation from 2002 to 2013



Basic Information of the Parañaque Spillway Operation

year	Operation Period	The Number of Operation Date (days)	Operation Frequency (times)	Total Spillway Discharge (million m^3)
Min.	July-December	0	0	0
Max.		129	4	1,785
Average		42.3	1.7	556

6. Operation and Maintenance

Operation and Maintenance Cost for The Priority Project (Parañaque Spillway)

Item	Items	O&M Cost (million PHP)	
		Route-1	Route-3
Parañaque Spillway	Operation cost of drainage pump	1.3	1.6
	Maintenance cost of hydromechanical facilities,	17.9	17.9
	Maintenance cost of underground tunnels	142.9	201.8
	Sediment removal and cleaning of spillway tunnel	13.6	16.6
	Sub-Total	**175.7**	**237.9**
Expansion of EFCOS	O&M of Electrical and Mechanical Equipment	1.1	1.1

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6. Operation and Maintenance

Issues and Considerations on Operation, Maintenance and Management

< Operational Issues and Considerations >

① Establishment of organization system of operation, maintenance and management
② Securing budgetary allocation
③ Securing human resources
④ Coordination and Cooperation with LLDA and LGUs

<Technical Issues and Considerations>

① Establishment of methodology and procedure and operation and maintenance
② Countermeasures for garbage and sedimentations
③ Establishment of monitoring and measurements system
④ Social and environmental consideration on operation, maintenance and management
⑤ Study for cost reduction of operation, maintenance and management

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7. Environmental Issues

Current Status around Proposed Location of Intake Facility and Open Channel of Parañaque Spillway

Land Use and Existing Facilities:

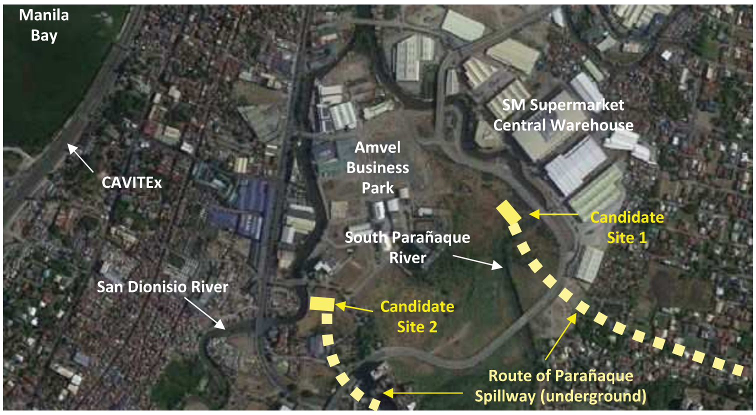
- Residential area along Laguna Lake (ISFs are included)
- Police Facilities (Camp Bagong Diwa)
- University (Polytechnic University)

Land Use and Existing Facilities:

- Residential area along Laguna Lake (ISFs are included)
- PNR (Philippine National Railways)
- Open space (property of a developer: Vista Land and Lifescapes Inc.)

7. Environmental Issues

Current Status around Proposed Location of Drainage Facility (Outlet) of Parañaque Spillway



Land Use and Existing Facilities:

- Located along South Parañaque River (Site 1) and San Dionisio River (Site 2)
- Candidate sites are currently open space (covered by bush and grasses)
- There are ISFs along downstream stretches of the South Parañaque River and San Dionisio River

Land Use and Existing Facilities:

- Located along Zapote River (Site 3), in the property of Las Piñas City (motor pool),
- Left bank side of Zapote River is occupied by ISFs (area of municipality of Bacoor, Cavite)

7. Environmental Issues

Major Potential Impacts of Construction of Parañaque Spillway

Construction of Parañaque Spillway

Pre-Construction Stage

- Land acquisition for (1) Intake facility – Open channel, and (2) Drainage facility and Resettlement of FS and IFS
- Land acquisition:
  Route-1: approx. 10.4 ha.
  Route-3: approx. 5.5 ha.
- Number of affected buildings:
  Route-1: approx. 280.
  Route-3: approx. 290.
- Compensation cost (preliminary calculation):
  Route-1: PhP. 1.20 billion.
  Route-3: PhP. 1.17 billion.

※ No need of compensation for underground channel because of its depth (deeper than 50m from ground surface).

Construction Stage

- Traffic disturbance due to transportation of construction equipment (segment for tunnel lining) and excavated materials: 700 no./day of trailers/dump trucks.
- Disposal of excavated materials from tunneling (1.9 to 2.0 million m3) and development of backfill site.
- Potential impact on groundwater use at deepwells due to tunneling works.

Operation Stage

- Impact on economic activities in Laguna Lake (fishery, etc.) due to construction of intake facility.
- Potential impact on downstream areas of outlet river (effluent stream) including LPPCHEA (Ramsar site)

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7. Environmental Issues

Considerations necessary for Major Potential Impacts

Potential Impacts	Measures for Mitigation and Compensation
Land acquisition and resettlement	• Just compensation for affected lands and structures based on RA No. 10752 and other relevant laws and regulations. • IEC (information, education and communication) with PAPs and coordination with relevant GAs (such as NHA and concerned LGUs) for proper resettlement.
Traffic disturbance by project-related traffic	• Development of Traffic Management Plan based on the detailed traffic survey. • The Plan should include: - Consideration in the transportation route and time of construction materials, - Deployment of traffic control person, - Public relation by means of mass media on schedule of construction works, etc.
Generation of excavated materials and disposal	• Development of disposal/reclamation site and/or utilization of existing disposal/reclamation site through coordination with relevant GA (including PRA, LLDA) and LGUs.
Impact on groundwater use	• IEC (information, education and communication) with users of groundwater (owners of deepwells) and compensation when necessary (in case of actual impact generation) through coordination with relevant GAs (such as NWRB: national water resources board and concerned LGUs) for proper compensation.
Impacts on economic activities in Laguna Lake	• Conduct of detailed investigation on existing economic activities in Laguna Lake, • Formulation of impact mitigation measures including: - coordination with local fisher folks for proper compensation for the impacts, - establishment of alternative and/or temporary facilities for existing water transportation, navigation route, mooring facilities, etc., when necessary.

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7. Environmental Issues

Necessary Survey in the Stage of Feasibility Study

◆ Implementation of EIA (Environmental Impact Assessment) based on PEISS and JICA Guidelines:

Considering the impact magnitude of the Project, for example, spatial extent and significance of potential impacts (physical modification of land, economic activity, etc.), the Project is to be required to conduct EIA in accordance with both Philippine Environmental Impact Statement System and JICA Guidelines for Environmental and Social Considerations.

◆ Preparation of RAP (Resettlement Action Plan)

Since the Project requires land acquisition and resettlement of FS and IFS (PAPs), RAP shall be prepared in accordance with both Philippine legislation and JICA Guidelines for Environmental and Social Considerations.

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8. Water Quality

Water Quality Comparison

- The observed water quality of Laguna de Bay is better than that of Manila Bay.
- pH and Phosphate of Manila Bay failed Class SC standard.

Water quality comparison between Laguna de Bay vs Manila Bay (offshore)

Item	Manila Bay Offshore Evaluation	Laguna de Bay Evaluation	Comparison
DO	SA 7.19 mg/L	AA 8.54 mg/L	Both Manila Bay and Laguna de Bay are rich in oxygen. It is appropriate for fishes.
pH	SD 8.84	AA 8.13	pH is higher in Manila Bay. It is attributed to photosynthesis by phytoplankton and photosynthetic micro organs. Laguna de Bay is better in terms of pH.
Phosphate	SD 1.3 mg/L	A 0.123 mg/L	Laguna de Bay satisfies Class A. Manila Bay (offshore) failed Class SC.
Salinity	– 2.31%	AA 0.02%	The salinity of Laguna de Bay is normally almost zero. When salt water intrusion occurs it increases up to about 0.18%. The salinity of Manila Bay is lower than the average salinity of open sea of 3.5 – 4 %. The reason is expected that the Manila Bay is an inner bay and the tidal current speed is relatively slow.

The values are annual average of 2014.

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8. Water Quality
Water Quality Comparison

- The observed water quality of Laguna de Bay is better than that of Manila Bay near LPPCHEA.

Water quality comparison between Laguna de Bay vs Manila Bay near LPPCHEA

Item	Manila Bay Coast Evaluation	Laguna de Bay Evaluation	Comparison
BOD	N/A 16.9 mg/L	A 3.61 mg/L	BOD of salt water cannot be evaluated because the standard is not defined. However, compared with the standard for fresh water, the BOD of Manila Bay fails Class D, while that of Laguna de bay passes Class A.
DO	Fails D 1.71 mg/L	A 8.01 mg/L	The dissolved oxygen of Laguna de Bay is enough for fishes, while that the coast of Manila bay is too small for fishes to survive.
Fecal coliform	Fails SD 180 Million MPN/100mL	–	Fecal coliform is not monitored in Laguna de Bay. The fecal coliform of the coast of Manila Bay is 100 thousand to 1 million times larger than the standard. It has been getting worse.
Total coliform	–	OK 262 MPN/100mL	This item is not monitored in the coast of Manila Bay. The total coliform of Laguna de Bay passes Class A (<1000 MPN/100mL). The evaluation was done with DAO No.34, because the DAO2016-08 doesn't include the standard for total coliform.
pH	SD 6.3	AA 8.42	The pH of the coast of Manila Bay is lower than Class C range. The pH of Laguna de Bay is within Class AA range.
Nitrogen	SA 0.55 mg/L	AA 0.17 mg/L	Both the coast of Manila Bay and Laguna de Bay are top rating.
Phosphorus	SD 0.8 mg/L	A 0.105 mg/L	Phosphorus of Laguna de Bay passes Class A. Phosphorus of the coast of Manila Bay is Class SD, but now it is on the improvement.
Ammonia	–	D 0.07 mg/L	Ammonia is not monitored in the coast of Manila Bay, but it is assumed to be high, because a lot of fecal coliform implies the inflow of human waste. Ammonia of Laguna de Bay fails Class C of 0.05 mg/L.
TSS	SA 13.1 mg/L	–	TSS of the coast of Manila Bay passes top rating of SA. TSS is not measured in Laguna de Bay since 2015 and in 2015 monitoring was carried out in October to December only. The data of the objective period is only available in 2013, and it is about 24 mg/L.

The values are average of Jul to Dec 2016, but BOD and pH are those of 2015 due to data availability.

8. Water Quality
Impact on Water Quality of Manila Bay

Based on the survey, it looks like that the environmental impact of Parañaque Spillway on Manila Bay is small. There are three reasons.

1. <u>Amount of fresh water</u>
   Pampanga River contributes approximately 50% of all fresh water that enters Manila Bay. Compared to the water from Pampanga River, the increase in flow rate by the Parañaque Spillway is smaller, and the total amount of fresh water doesn't change. Therefore, it is not likely to decrease the density of chloride of Manila Bay.
2. <u>Water Quality</u>
   Owning to the control by LLDA, the water quality of Laguna de Bay is better than that of Manila Bay.
3. <u>Sediment</u>
   Sediment concentration of the water discharged through the spillway is expected to be small because Laguna de Bay works as a settling basin. In addition, the tributaries which are main sediment source enter the central and eastern part of the lake and the intake of the spillway will be constructed in western part of the lake. Considering the low current velocity in the lake, sediment is not likely to transported to the intake.

8. Water Quality

Impact on Water Quality around LPPCHEA

Based on the survey , it looks like that the environmental impact of Parañaque Spillway on Manila Bay near LPPCHEA is small. There are three reasons.

1. Water Quality
   According to the water quality data provided by LLDA and DENR, the water quality of Laguna de Bay is better than that around LPPCHEA. Although the TSS of Laguna de Bay is a little bit higher than that of the coast of Manila Bay, it will be washed away with the momentum of drainage and not likely to dwell in that area, because it is expected to consist of relatively fine sediments.
2. Fresh Water
   If the Parañaque Spillway increases the amount of fresh water enter the area near LPPCHEA, it will not devastate mangroves, because they don't need salt water to survive. If mangroves survive, the ecosystem fishes, birds etc. will be preserved.
3. Temporary Event
   The drainage through is a temporary event that lasts 1 to 3 months. After drainage finishes, the environment restores to its normal state. The salinity also rises to its normal level and it maintains the environment that is suitable for mangroves.

8. Water Quality

Water Quality Simulation

It looks like that the environmental impact of Parañaque Spillway on water quality of Manila Bay and the area around LPPCHEA is small. However it is necessary to confirm it quantitatively by conducting water quality simulation of Manila Bay.

Proposition of Analysis Method and Study Items

1. Modeling Area	• **Whole Manila Bay (to set boundary conditions at the mouth of the bay)** • **Major 15 rivers that enter Manila Bay (water quality and flow regime)** • **Sewage plant that discharge to Manila Bay(amount of effluent)**
2. Simulation period and Computation time steps	• Computation period is before draining to the period when the salinity of the coast of Manila Bay becomes normal level (JULY to January or February seem to be enough). • Computation time step is a minute to consider tide. • Input data hydrological data, weather data are hourly
3. Mesh size	• Mesh sizes are 100 m near the outfall. • Mesh sizes become larger with the distance from the outfall.
4. Water quality item to be modeled	• Select items which pose big impact from the existing data. (ex. water temperature, salinity, DO, coliform, phosphate, nitrate, zooplankton, phytoplankton, TSS etc.)
5. Input data	• Seabed topography • The water quality of Manila Bay (offshore) • Th water quality and discharge of the major 15 rivers that enter Manila Bay • Water quality of Laguna de Bay. • Tide level at mouth of the bay and near LPPCHEA • Bottom sediment data (sediment diameter distribution and amount of organic materials) • Effluent from large sewage plants and factories and their water quality.
6. Flora and Fauna	• Only include planktons and exclude and exclude other animals. • The impact on the other animals will be considered based on the simulation result
7. Flushing by Drainage	• Modeling the movement of bottom sediment is costly and takes long time. Therefore, it will be considered based on the simulation result current velocity, tractive force and diameter of sediment. • The impact on the roots of mangroves will be considered in the same manner above. • Raising up of heavy metals in the bottom sediment will also be considered with the simulation result.

9. Implementation Plan
a. Planning Condition

【F/S,E/N,L/A】 2018 to Dec.2019

【D/D, Tender】 Jan.2020 to Dec.2021

【Construction of Parañaque Spillway】

（Route-1: Tunnel 6.0km, Open Channel 1.2km, Route-3: Tunnel 8.8km, Open Channel 0.6km)

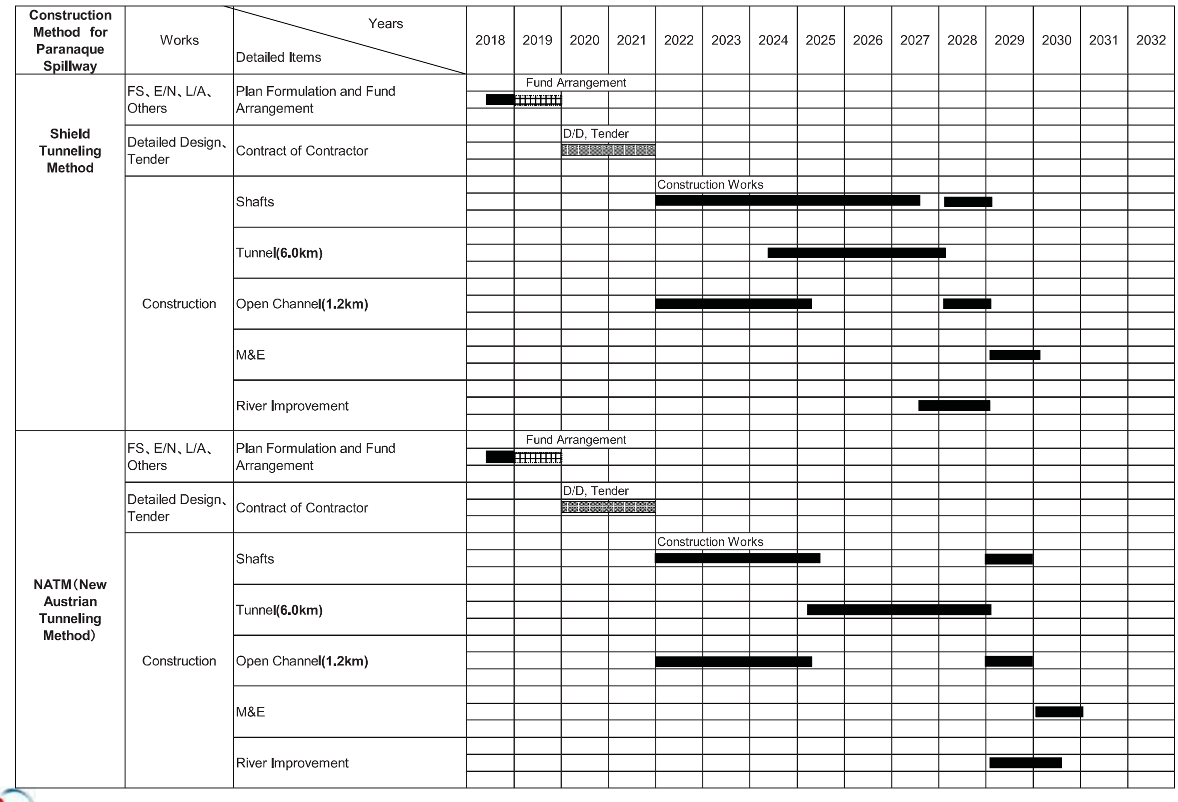
Option1: Route-1, Shield Tunneling Method : **Jan. 2022 to Feb. 2030**

Option2: Route-1, NATM : **Jan. 2022 to Jan. 2031**

Option3: Route-3, Shield Tunneling Method : **Jan. 2022 to Sep. 2030**

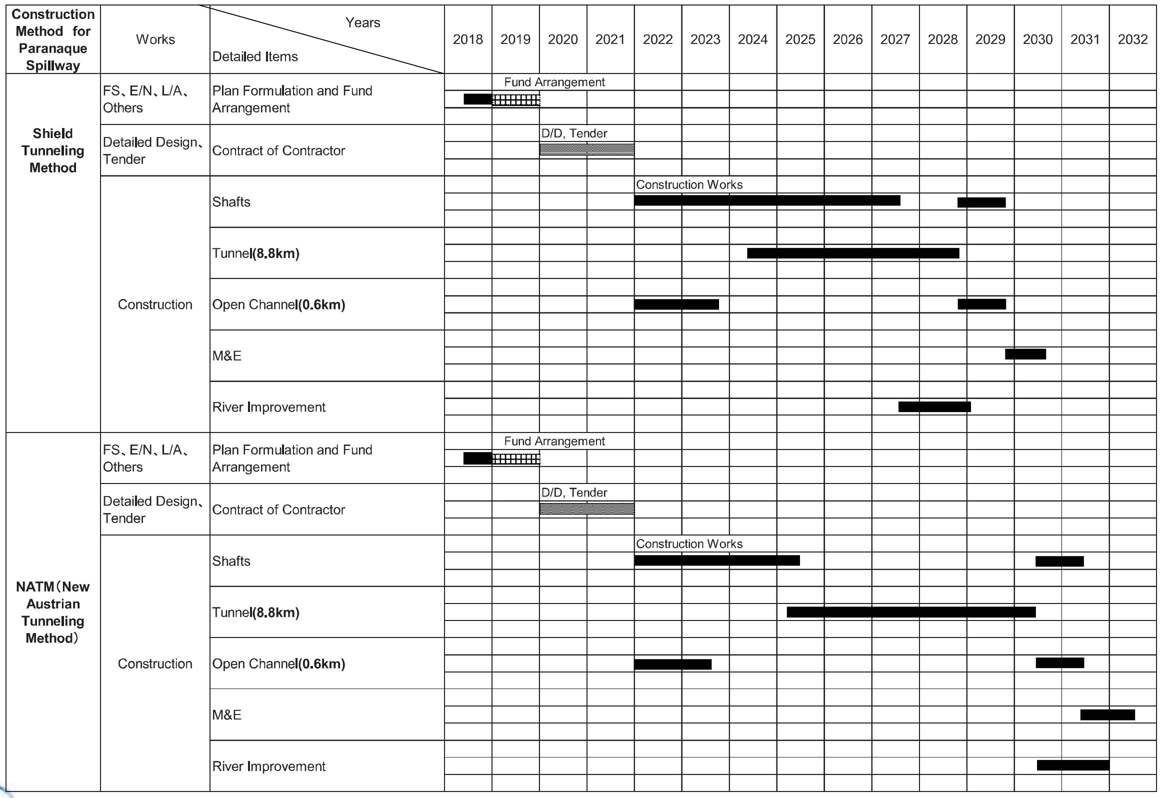
Option4: Route-3, NATM : **Jan. 2022 to Jun. 2032**

9. Implementation Plan
b-1. Implementation Schedule (Parañaque Spillway : Route-1)



9. Implementation Plan

b-2. Implementation Schedule (Parañaque Spillway : Route-3)



10. Preliminary Cost Estimate

a. Items on Project Cost

a. Construction Cost

b. Engineering Cost (the cost for consulting service) ; 10% of Construction Cost

c. Price Escalation; FC 0.8% , LC 1.8%

d. Contingency; 10% of total amount for Construction Cost , Engineering Cost and Price Escalation

e. Land Acquisition and Compensation

f. Project Administration Cost; 2% of total amount for Construction Cost, Engineering Cost and the cost for Land Acquisition and Compensation

g. VAT; 12%

Base Year of Cost Estimate : September 2017, PHP 1 = JPY 2.183

10. Preliminary Cost Estimate

b. Project Cost

Cost Item	Work Item	Project Cost (million PHP)			
		Option 1 (1-S)	Option 2 (1-N)	Option 3 (3-S)	Option 4 (3-N)
Construction Cost	Tunnel	17,879	11,707	24,258	16,839
	Vertical Shafts	11,940	9,899	11,940	9,899
	Open Channel	4,544	4,544	3,412	3,412
	River Improvement	2,382	2,382	596	596
	Surplus Soil Disposal	1,828	1,828	1,937	1,937
	Sub-total	38,573	30,360	42,143	32,683
Engineering Cost		3,857	3,036	4,214	3,268
Price Escalation		4,022	3,645	4,359	4,218
Contingency		4,645	3,704	5,090	4,017
Land Acquisition, Compensation		1,352	1,352	1,316	1,316
Project Administration Cost		1,049	842	1,146	910
VAT		6,294	5,052	6,876	5,460
Total (million PHP)		**59,792**	**47,991**	**65,324**	**51,873**

11. Economic Evaluation and Verification of the Project

Outline of Economic Analysis

Quantified Economic Cost and Economic Benefits

Project Cost	Economic Benefits
(1) Initial Construction Cost (2) O&M Cost	<u>(1) Reduced Economic Damage caused by Inundation (Case1)</u> (household assets, commercial/industrial assets, infrastructure, agricultural crops, suspension of economic activities) (2) Increase of Land Price (Case2)

Annual average value of "(1)Reduced economic damage caused by inundation" is calculated by multiplying the "avoided damage of assets under different return period cases (2, 3, 5, 10, 20, 30, 50, 100, 200 years)" and "occurrence rate of each cases per year".

Economic Analysis is further elaborated for the project of Parañaque Spillway under 4 Options.

11. Economic Evaluation and Verification of the Project

Economic Initial Construction Cost under 4 Options (PHP million)

Year	Financial Cost (inc. Price Escalation and TAX)				Economic Cost			
	1: 1-Shield	2: 1-NATM	3: 3-Shield	4: 3-NATM	1: 1-Shield	2: 1-NATM	3: 3-Shield	4: 3-NATM
2020	1,246	1,112	1,242	1,076	965	856	931	828
2021	1,266	1,130	1,261	1,093	976	867	945	838
2022	4,397	4,330	4,576	4,642	3,421	3,345	3,337	3,570
2023	4,458	4,392	4,068	4,136	3,426	3,350	2,991	3,171
2024	7,242	4,456	7,350	3,025	5,410	3,355	5,446	2,365
2025	10,099	5,195	10,633	4,823	7,664	3,869	7,846	3,617
2026	9,740	5,008	10,780	5,172	7,342	3,660	7,950	3,771
2027	9,870	5,081	10,268	5,249	7,236	3,667	7,529	3,778
2028	7,603	5,156	8,504	5,326	5,328	3,673	6,173	3,784
2029	3,384	7,347	4,539	5,405	2,519	5,048	3,323	3,791
2030	488	4,536	2,102	5,654	368	3,186	1,603	3,899
2031	0	247	0	4,759	0	181	0	3,292
2032	0	0	0	1,513	0	0	0	1,098
Total	59,792	47,991	65,324	51,873	44,653	35,057	48,074	37,802

Economic O&M Cost (PHP million)

Facility	Items	Financial Cost		Economic Cost	
		Route-1	Route-3	Route-1	Route-3
O&M Cost of Parañaque Spillway	O&M cost	162.1	221.3	136.0	185.7
	Cleaning of Tunnel	13.6	16.6	11.4	13.9
	Total	175.7	237.9	147.4	199.6
O&M of EFCOS	O&M of Machines	1.1	1.1	0.9	0.9

11. Economic Evaluation and Verification of the Project

Methodology of Calculation of Economic Damage caused by Inundation

Economic Damage	Formula	Economic Benefit (PHP million /year)
Damage of House and House Assets	"Number of Affected Household" x "Value of House and House Assets" x "Damage Rate" x 1.2 (including indirect damage) (Value of House Assets = 30% of House Value)	859 (23%)
Damage of Commercial and Industrial Assets	"Number of Affected Enterprises" x "Value of Commercial Assets" x "Damage Rate" x 1.2 (including indirect damage)	1,127 (30%)
Damage of Infrastructure	"Direct Damage of Household and Commercial/Industrial Assets" x 65%	1,076 (29%)
Damage of Agricultural Crops (Paddy, Maize, commercial crops)	"Affected Area of Crops" x "Economic Value of Agricultural Crops per m2" x "Damage Rate"	28 (1%)
Avoided Economic Cost of Suspended Business Activities	"Number of Affected Enterprises" x "Reduced Period of Suspension" x "Average Daily Added Value per Enterprise"	665 (18%)
Total	-	**3,755**

Methodology of Calculation of Other Economic Benefits

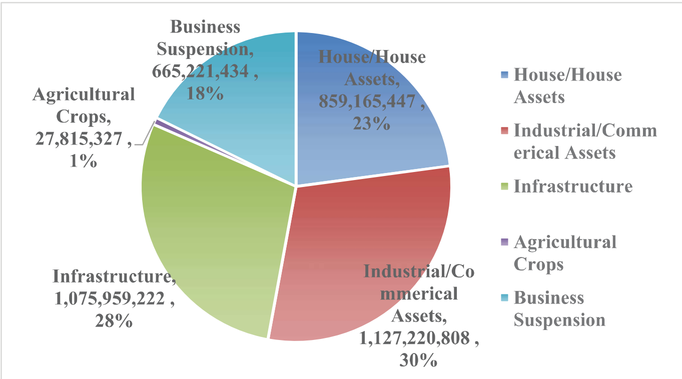
Economic Benefit	Formula	Economic Benefit (PHP million)
Increase of Land Price (Case2)	"Influenced Area" x "Current Market Value of Land" x "Increase Rate of Land Value"	1,520 X 10 years

11. Economic Evaluation and Verification of the Project

Calculation of Annual Average Benefit (31 LGUs)

Return Period	Water Level (m)			Damage Value			Suspention of Business (b)	Total Economic Loss (c)=(a)+(b)	Probability (d)	Probability between two cases (e)	Average Damage of two cases(f)	Annual Economic Loss (e) x (f)
	Without	With	Difference	Without	With	Difference (a)						
200	14.7	14.3	0.4	171,900,856,031	109,151,662,797	62,749,193,234	11,139,603,814	73,888,797,048	0.005	0.00500	63,782,454,775	318,912,274
100	14.3	13.9	0.4	118,748,667,980	73,389,780,852	45,358,887,128	8,317,225,375	53,676,112,502	0.010	0.01000	49,105,402,872	491,054,029
50	14.0	13.7	0.3	84,024,543,627	46,380,838,792	37,643,704,835	6,890,988,407	44,534,693,242	0.020	0.01333	36,333,566,423	484,447,552
30	13.7	13.4	0.3	52,754,246,724	29,281,697,620	23,472,549,104	4,659,890,500	28,132,439,604	0.033	0.01667	25,111,316,517	418,521,942
20	13.6	13.4	0.2	42,533,334,981	24,731,047,902	17,802,287,079	4,287,906,351	22,090,193,430	0.050	0.05000	16,573,312,168	828,665,608
10	13.2	13.0	0.2	18,139,247,230	9,166,508,290	8,972,738,939	2,083,691,967	11,056,430,906	0.100	0.10000	7,585,214,628	758,521,463
5	12.9	12.8	0.1	6,721,906,318	3,683,561,418	3,038,344,900	1,075,653,450	4,113,998,350	0.200	0.13333	2,660,308,555	354,707,807
3	12.6	12.5	0.1	1,206,618,760	0	1,206,618,760	0	1,206,618,760	0.333	0.16667	603,309,380	100,551,563
2	12.3	12.3	0.0	0	0	0	0	0	0.500	0.50000	0	0
												3,755,382,239

Composition of Annual Average Benefit in 31 LGUs around Laguna Lake



11. Economic Evaluation and Verification of the Project (Lagna de Bay Basin (Paranaque Spillway))

Result of Economic Analysis

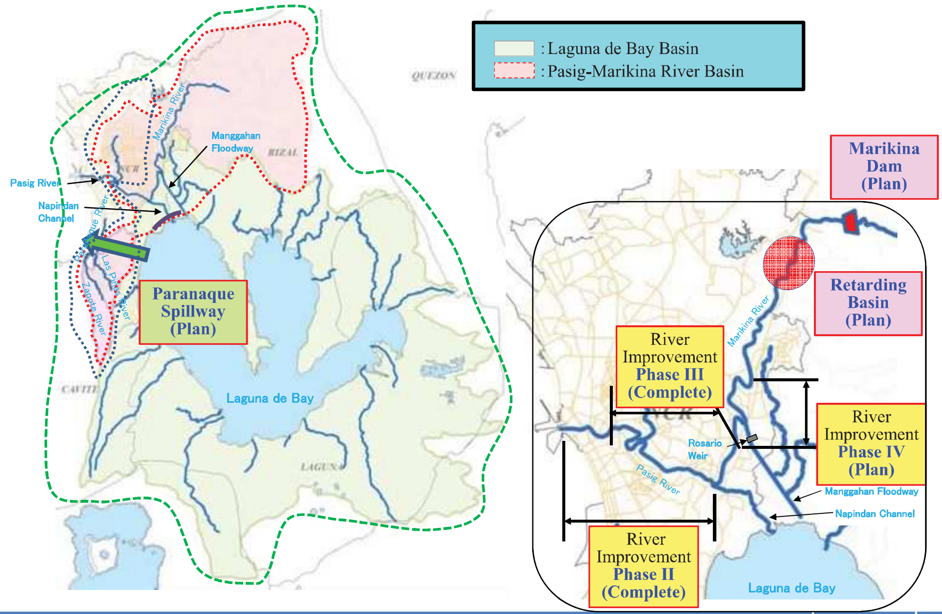
(Case 1, Annual Average Benefit Only)

Option	EIRR	B/C	NPV (PHP million)
Option 1（Route-1, Shield）	9.1%	0.87	-3,199
Option 2（Route-1, NATM）	<u>**10.4%**</u>	<u>**1.06**</u>	<u>**1,094**</u>
Option 3（Route-3, Shield）	8.3%	0.76	-6,297
Option 4（Route-3, NATM）	9.6%	0.95	-1,077

(Case 2, Case 1 + Land Price Increase)　EIRR +1.0%~+1.1%

Option	EIRR	B/C	NPV (PHP million)
Option 1（Route-1, Shield）	<u>**10.1%**</u>	<u>**1.02**</u>	<u>**402**</u>
Option 2（Route-1, NATM）	<u>**11.5%**</u>	<u>**1.23**</u>	<u>**4,368**</u>
Option 3（Route-3, Shield）	9.2%	0.89	-3,024
Option 4（Route-3, NATM）	<u>**10.6%**</u>	<u>**1.10**</u>	<u>**1,899**</u>

11. Economic Evaluation and Verification of the Project (Pasig- Marikina River Basin + Laguna de Bay Basin (Paranaque Spillway))



Projects	EIRR	B/C	NPV (PHP million)
River Improvement	**28.6%**	**4.5**	**27,391**
River Improvement + Paranaque Spillway	**26.9%**	**3.1**	**27,958**
River Improvement + Marikina Dam + Retarding Basin + Paranaque Spillway	**26.1%**	2.8	28,535

12. Study on Downstream River Channel

- Evaluated the downstream river water level due to drainage of Parañaque Spillway on Route 1 (Lower Bicutan - South Parañaque River) and Route 3 (Sucat - Zapote River).

1) Route 1 (Lower Bicutan - South Parañaque River)

- The river water level will raise up 0.3m at 5-year return period and 0.7m up at 2-year return period. The design scale of South Parañaque is 25-year for flood control measures and High Water Level (HWL) of 25-year is 14.3m. The river water level is less than 25-year HWL even if Parañaque Spillway is draining during flooding time at this area.

Figure 7.3.1 Drain Facility Location of Route 1 in South Parañaque River

[Calculation Condition]
Laguna Lake Water Level :14.0m
Tide Level : 11.87m

SP. 1+800

Return Period	without Parañaque Spillway		with Parañaque Spillway				Difference WL ①- WL ②
	WL①	River Q	WL②	River Q	Outlet Q* Max	Outlet Q* Min	
	(m)	(m^3/S)	(m)	(m^3/S)	(m^3/S)	(m^3/S)	(m)
100	15.0	364.8	-	-	-	-	-
50	14.7	315.3	-	-	-	-	-
25	**14.3**	268.5	-	-	-	-	-
15	14.1	235.7	-	-	-	-	-
10	13.9	210.6	14.0	220.8	124.1	7.9	0.1
5	13.5	168.3	13.8	203.9	124.4	33.1	0.3
2	12.9	110.9	13.6	180.8	124.8	66.8	0.7

* Drainage discharge of Parañaque Spillway (Outlet Q) was estimated at the level of water level in the case without Parañaque Spillway (present condition). The calculation method of drainage discharge is calculated based on the calculation of (6) in the crossing (section) plan as shown in 4.3.3.