DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

JAPAN INTERNATIONAL COOPERATION AGENCY

THE DETAILED DESIGN
OF
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III)

FINAL REPORT

VOLUME-II

MAIN REPORT

FEBRUARY 2013

CTI Engineering International Co., Ltd.
Consulting Engineers

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COMPOSITION OF FINAL REPORT

VOLUME-I	:	SUMMARY
VOLUME-II	**:**	**MAIN REPORT**
VOLUME-III-1	:	STRUCTURAL CALCULATION OF PASIG RIVER
VOLUME-III-2	:	STRUCTURAL CALCULATION OF LOWER MARIKINA RIVER
VOLUME-IV-1	:	QUANTITY CALCULATION OF PASIG RIVER
VOLUME-IV-2	:	QUANTITY CALCULATION OF LOWER MARIKINA RIVER
VOLUME-V	:	COST ESTIMATE

EXCHANGE RATES USED IN THE REPORT:
PHP 1.00 = JPY 1.968
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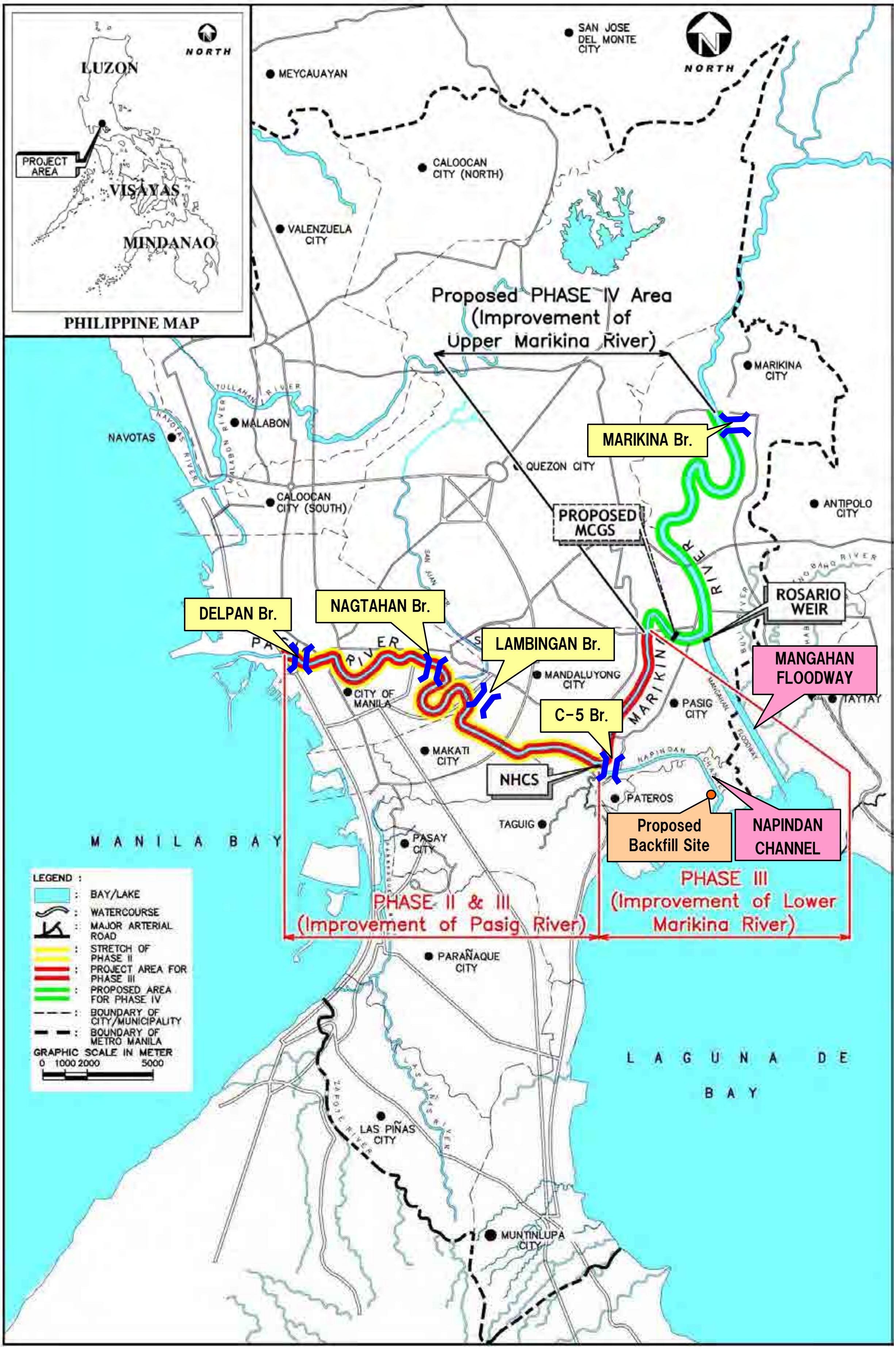
(Monthly Average in November 2012 of Central Bank of the Philippines)



PROJECT LOCATION MAP

THE DETAILED DESIGN
OF
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IMPROVEMENT PROJECT (PHASE III)

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ABBREVIATIONS AND ACRONYMS

Government Institutions and Organizations

AASHTO	:	American Association of the State Highway and Transportation Office
ACEL	:	Association on Carriers and Equipment, Inc.
ACI	:	American Concrete Institute
ASTM	:	American Society for Testing Materials
BOC	:	Bureau of Construction, DPWH
BOD	:	Bureau of Design, DPWH
DENR	:	Department of Environmental and Natural Resources
DOLE	:	Department of Labor and Employment
DPWH	:	Department of Public Works and Highways
EMB	:	Environmental Management Bureau, DENR
FMC	:	Flood Mitigation Committee
GOJ	:	Government of Japan
GOP	:	Government of the Philippines
ICC-CC	:	Investment Coordinate Committee - Cabinet Committee
JBIC	:	Japan Bank for International Cooperation (formerly OECF)
JGS	:	Japan Geological Society
JICA	:	Japan International Cooperation Agency
LGU(s)	:	Local Government Unit(s)
LLDA	:	Laguna Lake Development Authority
LWUA	:	Local Water Utility Administration
MCGS	:	Marikina Control Gate Structure
MERALCO	:	Manila Electric Company
MWCI	:	Manila Water Company, Inc.
MWSI	:	Maynilad Water Services, Inc.
MWSS	:	Metropolitan Water Supply and Sewerage System
NAMRIA	:	National Mapping and Resources Information Authority
NCR	:	National Capital Region
NEDA	:	National Economic and Development Authority
NHCS	:	Napindan Hydraulic Control Structure
NHRC	:	National Hydraulic Research Center
NIA	:	National Irrigation Administration
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PMC	:	Price Monitoring Committee
PMO	:	Project Management Office, DPWH
PMO-MFCP	:	Project Management Office for Major Flood Control Projects, DPWH
PMRCIP	:	Pasig-Marikina River Channel Improvement Project
PRRC	:	Pasig River Rehabilitation Committee
SSS	:	Social Security System
STEP	:	Special Term Economic Partnership
UP	:	University of the Philippines
USEPA	:	United States Environmental Protection Agency

Others

ASD	:	Allowable Stress Design
BAC	:	Bids and Awards Committee
BOQ	:	Bill of Quantities
CAD	:	Computer Assisted Design
CARI	:	Contractor's All Risk Insurance
DAO	:	DENR Administrative Order

D/D : Detailed Design
DHWL : Design High Water Level
D.O. : Department Order
EAM : Average End Method
ECC : Environmental Compliance Certificate
EIA : Environmental Impact Assessment
EIS : Environmental Impact Statement
EMP : Environmental Management Plan
EMoP : Environmental Monitoring Plan
F/S : Feasibility Study
GDOP : Geometric Dilution of Precision
GPS : Global Positioning System
ICB : International Competitive Bidding
ICP : Information Campaign Policy
IEE : Initial Environmental Examination
IRR : Implementing Rules and Regulation
JIS : Japanese Industrial Standards
JV : Joint Venture
L/A : Loan Agreement
MHHW : Mean Higher High Water
MLLW : Mean Lower Low Water
MP : Master Plan
MSHHW : Mean Spring Higher Water Level
MSL : Mean Sea Level
MVFS : Marikina Valley Fault System
NBCP : National Building Code of the Philippines
NESC : National Electrical Safety Code
NSCP : National Structure Code of the Philippines
O&M : Operation and Maintenance
ODA : Official Development Assistance
PMRCIP : Pasig-Marikina River Channel Improvement Project
PNS : Philippine National Standards
P/Q : Prequalification
RA : Republic Act
RAP : Resettlement Action Plan
R/D : Record of Discussion
ROW : Right of Way
SAPROF : Special Assistance for Project Formulation
SBD : Sample Bidding Document
SPD : Sample Prequalification Document
TAC : Technical Advisory Committee
TCLP : Toxicity Characteristic Leading Procedure
TTS : Telegraphic Transfer Selling
TWG : Technical Working Group
VAT : Value Added Tax

Units of Measurement

mm : millimeter
cm : centimeter
m : meter
km : kilometer
g, gr : gram
kg : kilogram
t, ton : metric ton

m^2 : square meter
ha, has : hectare, hectares
km^2 : square kilometer
l,lt.,ltr : liter
m^3 : cubic meter
s, sec : second
m, min. : minute
h, hr : hour
y, yr : year
MW : megawatt
mm/hr : millimeter per hour
m/s : meter per second
km/hr : kilometer per hour
mg/l : milligram per liter
m^3/s : cubic meter per second
$m^3/s/km^2$: cubic meter per second per square kilometer
% : percent
ppm : parts per million
x x : symbol of multiplication (times)
≤ , ≥ : Inequality sign (e.g. $A \leq B$ means that value A is less than or equal to value B.)
< , > : Inequality sign (e.g. $A < B$ means that value A is less than value B.)
Y, Y, JPY : Japanese Yen
P, P, PHP : Philippine Peso
$: US Dollar

CHAPTER 1 PROJECT DESCRIPTION

1.1 Background of the Project

The Pasig-Marikina-San Juan River System, with a total catchment area of 621km2, runs through the center of Metro Manila and empties into Manila Bay. It drains 16 cities and one (1) municipality with a total population of over 11 million as of 2010. Bank overflow from these three (3) major waterways contribute largely to the flood disasters experienced in Metro Manila over the last 25 years from 1986 to 2010. In particular, one of the most devastating floods was brought about by Tropical Storm Ondoy on 26 September 2009. Dumping a record rainfall of 453mm/day according to PAGASA, Ondoy brought a huge volume of flood discharge along the Pasig-Marikina River that resulted to massive loss and damage to life and property.

A Master Plan (MP) of flood control for the Pasig-Marikina River that included drainage in Metro Manila was prepared in 1952. Implementation of the structural works started in 1970, consisting mainly of river walls and revetments along Pasig River. Later, the Mangahan Floodway was completed in 1988, which diverted flood waters from Marikina River to Laguna Lake at the design flow capacity of 2,400m^3/s.

However, even with the completion of Mangahan Floodway, flooding continued to be a perennial problem in Metro Manila. This prompted the Department of Public Works and Highways (DPWH) to update the master plan for flood control and drainage improvement. The “Study on Flood Control and Drainage Project in Metro Manila”, including a Feasibility Study (F/S) on the channel improvement of the Pasig-Marikina River, was carried out from January 1988 to March 1990, with technical assistance from the Japan International Cooperation Agency (JICA).

1.1.1 Master Plan of Flood Control for Pasig-Marikina River

The updated Master Plan of flood control of Pasig-Marikina River is premised on a 100-year return period. It proposed the construction of the Marikina Control Gate Structure (MCGS) at the existing Mangahan Floodway and the Marikina Multipurpose Dam. The design flood discharges are as shown in **Figure R 1.1.1**.

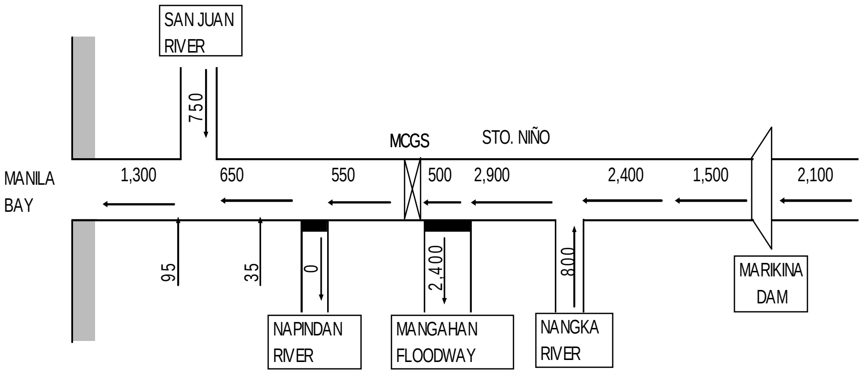


Figure R 1.1.1 Plan of the Pasig-Marikina River Renovation Works (100-Year Return Period Probable Discharge)

1.1.2 The Overall Project (PMRCIP)

Though a Special Assistance for Project Formation (SAPROF) Study commissioned by JICA in 1998, the “Pasig-Marikina River Channel Improvement Project (PMRCIP)” was proposed to be implemented with financial assistance from the Japanese Official Development Assistance (ODA), according to the following phases:

Phase I:	Detailed Design for the Overall Project from Delpan Bridge to Marikina Bridge (29.7km)
Phase II:	Construction Stage I: Channel Improvement Works for Pasig River from Delpan Bridge to Napindan River (16.4km)
Phase III:	Construction Stage II: Channel Improvement Works for Lower Marikina River including Construction of Marikina Control Gate Structure (MCGS) from the Junction with Napindan River to Mangahan Floodway (7.2km)
Phase IV:	Construction Stage III: Channel Improvement Works for Upper Marikina River from Mangahan Floodway to Marikina Bridge (6.1km).

1.1.3 PMRCIP Phase I

The Detailed Design (D/D) of the overall project was carried out from October 2000 to March 2002. Assuming a 30-year flood, the design flood discharge distribution of the PMRCIP is as shown in **Figure R 1.1.2**.

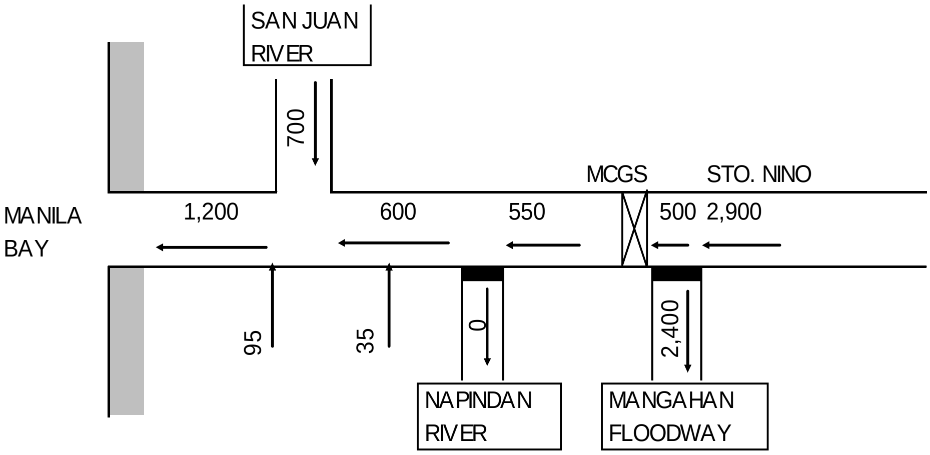


Figure R 1.1.2 Design Flood Distribution for Pasig-Marikina River Channel Improvement Works (30-Year Return Period Probable Discharge)

1.1.4 PMRCIP Phase II

The implementation of the Phase II Project was financed under the 26th JICA Yen Loan Package - Special Term Economic Partnership (STEP) Loan. The construction works under the two (2) contract packages (1-A and 1-B) were commenced in July 2009. The original target completion is by June 2012. However, this may be extended to May 2013 due to additional works in the Malacañang area.

Before the completion of the Phase I, locally funded flood control projects such as revetment rehabilitation, linear parks and drainage improvement works were introduced by the Pasig River Rehabilitation Commission (PRRC), Local Government Units (LGUs) and other concerned agencies. These developments necessitated the review and revision of the proposed works prior to the commencement of the Phase II project. Additional survey works were carried out from January to July 2008 in order to resolve the following technical issues:

- Revision of proposed revetment and drainage works in line with Linear Park Development and present structural conditions
- Revision/Modification of proposed works to meet the loan condition (STEP) from the general untied loan condition
- Study on alignment of Upper Marikina River
- Necessity and implementation schedule of Phases III and IV

1.2 PMRCIP Phase III

1.2.1 Background of PMRCIP-III

The tremendous damage brought about by Tropical Storm Ondoy in September 2009 provided the push to complete the whole scheme of the Pasig-Marikina River Channel Improvement Project (PMRCIP). JICA funded the Preparatory Study carried out from September 2010 to October 2011 to formulate Phase III of PMRCIP. The existing river improvement Plan was reviewed to reflect current river basin development, recent flood conditions and probable impacts of climate change. As a result, the scope and phasing of PMRCIP was proposed to be revised as shown in **Table R 1.2.1**.

Table R 1.2.1 Modified Project Components based on the Preparatory Study

Implementing Phase	Items of Work	Length to be Improved (Design Discharge)
II (Construction Stage I)	Pasig River Channel Improvement (1) (from Del Pan Bridge to Napindan Channel)	13.1km on both banks (1,200/600m^3/s)
III (Construction Stage II)	Lower Marikina River Channel Improvement (from Napindan Channel to downstream of MCGS)	5.4km channel length (550m^3/s)
	Pasig River Improvement (2) (Sections not covered by Phase II)	9.9km on both banks (1,200/600m^3/s)
IV (Construction Stage III)	Upper Marikina River Channel Improvement & Marikina Control Gate Structure (MCGS) (from MCGS to Marikina Bridge)	7.9km (2,900m^3/s)

Phase III (Construction Stage II) was proposed to be implemented immediately after Phase II. It will involve riverbank improvement works covering 9.9km sections of Pasig River not covered by Phase II as well as the 5.4 stretch of the Lower Marikina River Channel from the immediate vicinity of the Napindan Hydraulic Control Structure (NHCS) to the section just before Mangahan Floodway. Dredging works in Lower Marikina River were also proposed to improve flood conveyance.

JICA dispatched a contact mission on December 5-8, 2011 to pave the way for the preparation of the Detailed Design Study for Phase III through a grant from JICA. The Record of Discussions (R/D) was executed on 07 December 2011. The Loan Agreement to implement PMRCIP Phase III was subsequently signed on 30 March 2012 between JICA and the Government of the Philippines (GOP).

1.2.2 Policy Considerations of the Basic Design

The following policy considerations lay the ground work for the formulation of the Detailed Design of PMRCIP Phase III:

	Item		Particulars
(1)	JICA Loan (dated 30th March 2012)	:	Loan Amount: JPY 11,836 million, Special Terms for Economic Partnership (STEP)
(2)	ICC-CC Approved Project Cost	:	PHP 7,948.41 million
(3)	Construction Period	:	Three (3) years
(4)	Contract Package for Civil Works	:	Two (2) separate Contract Packages (Pasig River and Lower Marikina River)
(5)	Procurement of Civil Works Contractors	:	International Competitive Bidding with Prequalification (ICB with P/Q) (Single-stage: Two envelop bidding)
(6)	Involuntary Resettlement	:	58 informal households (204 people) and 60 structures along the Pasig River (Based on the Preparatory Study in 2011, to be updated in this Report)
(7)	Environmental Considerations	:	Environmental consideration for noise, vibration, dust, pollution and traffic hindrance.
(8)	Adequacy/Accuracy of Output of Detailed Design Study	:	Liability of the JICA Consultant

1.2.3 Objective of the Detailed Design Study

The objective of the Detailed Design Study for the PMRCIP Phase III is to prepare the basic design, detailed design, cost estimate of the Project and tender documents for the construction of civil works.

1.2.4 Scope of the Detailed Design Study

The Detailed Design Study encompasses the two (2) river stretches identified below:

(1) Pasig River from Del Pan Bridge to Napindan Hydraulic Control Structure (NHCS); and

(2) Lower Marikina River between NHCS and 5.4km before the Rosario Weir of Mangahan Floodway.

Specifically, the Detailed Design Study covers the following items:

(1) Review and confirmation of the existing flood control plan
(2) Review of the Detailed Design (2002) and the Design Review of Phase I (2008)
(3) Additional surveys on the present natural conditions
(4) Formulation of the basic design (Definitive Plan)
(5) Preparation of the detailed design of the proposed facilities
(6) Preparation of construction plan and cost estimate
(7) Preparation of prequalification documents and tender documents

In addition, the following services are part of the Detailed Design Study and will be submitted under separate cover along with the Detailed Design Report (except (1), O&M plan.

(1) Preparation of Operation and Maintenance (O&M) Plan
(2) Conduct of Environmental Impact Assessment (EIA) Study on the Proposed Disposal Site for Dredged/Excavated Materials
(3) Assistance to DPWH in the organization and identification of tasks and responsibilities of the proposed Flood Mitigation Committee (FMC)
(4) Conduct of Information Campaign and Publicity (ICP) activities

1.2.5 Scope of Construction Works in the Preparatory Study

The scope of construction works in Phase III in Preparatory Study is shown in **Table R 1.2.2** below.

Table R 1.2.2 Scope of Phase III Construction Work in Preparatory Study

Construction Work	Length to be Improved (Design Discharge)
Construction Area I: Pasig River Channel Improvement (Remaining sections which require rehabilitation between Del Pan Bridge and Napindan Hydraulic Control Structure) *The sections were damaged due to Typhoon 'Ondoy' and others after the commencement of Phase II construction work. Excluded from Phase II section	9.9km on both banks (1,200/600m^3/s)
Construction Area II: Lower Marikina River Channel Improvement (From Napindan Hydraulic Control Structure to downstream of MCGS) 1) Dredging of Riverbed: 612,000m^3 2) Dike: 1,814m (Three (3) locations) 3) River Wall: 337m (One (1) location) 4) Boundary Bank: 7,063m 5) Bridge Pier Protection: four (4) existing bridges	5.4 km channel length (550m^3/s)

* Above works will be re-evaluated in detailed design study

CHAPTER 2 NATURAL CONDITIONS

2.1 Topographic Survey

2.1.1 Objectives and Scope of the Topographic Survey

(1) Objectives

The main purpose of the topographic survey is to produce the topographic and hydrographic maps for the design, cost estimation, and establishment of concrete control points for reference during the construction stage.

(2) Scope of Work

The scope of work includes as follows:

(a) Marikina River (about 5.4km):

- Establishment of control points for both banks
- Control traverse and control leveling for control points
- Cross section survey for planned dredging
- Hydrographic survey of the river
- Topographic survey for both banks
- Correction for existing topographic map
- Position, elevation and dimension survey for outlet of drainage

(b) Pasig River (about 9.9km):

- Establishment of control points for planned construction area
- Control traverse and control leveling for control points
- Hydrographic survey for the planned construction area
- Topographic survey for the planned construction area
- Correction for existing topographic map
- Position, elevation and dimension survey for outlet of drainage

(c) Backfill Site Survey:

- Control point survey
- Spot height survey

2.1.2 Methodology of the Topographic Survey

(1) Coordinate System and Datum Level

The survey coordinates system and datum level used for the survey and mapping were the same as those used for the Pasig-Marikina River Channel Improvement Project (Phase II), as shown in **Table R 2.1.1.**

Table R 2.1.1 Coordinates System and Datum Level for the Survey

Coordinate System	Philippine Transverse Mercator Zone III
Spheroid	Clarke1866 Semi major Axis : 6378206.4m Inverse Flatting : 294.9786982
Origin	Central Meridian : just 121 degree East Latitude : just 0 degree (on the equator) False Northing : 0.000 m False Easting : 500,000.000 m Scale factor : 0.99995
Datum Level	DPWH MLLW: DPWH MLLW = NAMRIA MLLW + 10.000 m NAMRIA MLLW = NAMRIA MSL – 0.475 m DPWH : Department of Public Works and Highways MLLW : Mean Lower Low Water Level NAMRIA: National Mapping and Resource Information Authority MSL : Mean Sea Level

(2) Work Procedures

(a) Establishment of Control Points

At first, the control points were strategically established in visible locations adjacent to the other control points where these would be easy to find as reference for control survey, topographic survey and hydrographic survey works. These control points will remain until construction stage. The control points are shown in **Table R 2.1.2**.

Table R 2.1.2 Control Points

Location	Station	Northing (m)	Easting (m)	Elevation (m)
Pasig River	JP1	1614305.61	497916.36	12.110
Pasig River	JP2	1614190.59	497997.54	12.005
Pasig River	JP3	1614171.35	497895.61	12.251
Pasig River	JP4	1613731.83	498543.88	12.240
Pasig River	JP5	1613735.77	498654.43	12.148
Pasig River	JP6	1613717.09	498808.11	12.013
Pasig River	JP7	1614473.80	500364.47	13.221
Pasig River	JP8	1614370.03	500849.79	13.533
Pasig River	JP9	1614215.97	500102.50	12.808
Pasig River	JP11	1613754.24	501491.90	13.512
Pasig River	JP12	1614090.19	501078.84	12.708
Pasig River	JP13	1613350.07	501038.76	13.093
Pasig River	JP14	1612730.82	501084.63	13.404
Pasig River	JP15	1613244.66	501509.09	13.333
Pasig River	JP16	1613171.22	501639.77	13.591
Pasig River	JP17	1613220.09	501827.68	14.493
Pasig River	JP18	1612388.68	501740.87	13.590
Pasig River	JP19	1612282.94	501916.03	13.563
Pasig River	JP20	1612064.62	502446.85	12.808

Location	Station	Northing (m)	Easting (m)	Elevation (m)
Pasig River	JP21	1611795.54	502817.80	13.741
Pasig River	JP22	1611137.42	504151.52	15.004
Pasig River	JP23	1611294.87	504462.14	14.240
Pasig River	JP24	1611187.03	505122.35	14.432
Pasig River	JP25	1611022.29	505548.62	16.046
Pasig River	JP26	1610828.61	506271.15	14.676
Pasig River	JP27	1610551.54	506575.62	14.329
Pasig River	JP28	1610372.02	506730.24	14.609
Pasig River	JP29	1610351.44	506969.38	24.436
Pasig River	JP30	1610244.00	506896.47	23.070
Marikina River	JM1	1610062.76	507218.87	15.675
Marikina River	JM2	1610195.83	507489.51	14.505
Marikina River	JM3	1610303.01	507617.21	20.368
Marikina River	JM4	1610984.22	507797.42	21.152
Marikina River	JM6	1612110.62	508382.57	14.311
Marikina River	JM7	1612662.68	508728.87	20.481
Marikina River	JM8	1613099.88	508870.25	12.195
Marikina River	JM9	1613627.99	508813.73	21.336
Marikina River	JM10	1610337.65	507579.64	18.338
Marikina River	JM11	1610988.75	507723.92	21.113
Marikina River	JM12	1612682.38	508680.62	19.608
Marikina River	JM13	1613616.70	508756.76	20.875
Marikina River	JM14	1614974.59	508695.32	13.510
Marikina River	JM15	1615121.41	508887.44	15.552
Backfill Site	JD1	1607189.75	510607.51	14.086
Backfill Site	JD2	1607005.52	510316.78	13.792
Backfill Site	JD3	1607332.66	510800.32	15.609
Backfill Site	JD4	1607222.99	510559.40	12.488
Backfill Site	JD5	1607148.39	510228.70	13.583
Backfill Site	JD6	1607257.94	510266.52	13.010
Backfill Site	JD7	1607379.91	510114.55	13.018
Backfill Site	JD8	1607520.14	509925.99	13.514
Backfill Site	JD9	1607385.44	509832.84	13.238
Backfill Site	JD10	1607627.51	510099.31	13.604
Backfill Site	JD11	1607668.17	510362.99	12.748
Backfill Site	JD12	1607545.13	510611.10	13.503

(b) Control Traverse

Closed or closed-loop traverse method were used to confirm the accuracies of control points. Total station and data logger were used and raw field data were submitted the same day after observation. The control points were surveyed using Global Positioning System (GPS) with at least five (5) tracking satellites per site. The traverse survey accuracies are shown on **Table R 2.1.3**.

Table R 2.1.3 Traverse Survey Accuracies

LOCATION	TRAVERSE	CONTROLS	LENGTH	N. ERROR	E. ERROR	LEC	RELATIVE ERROR
Pasig River	1	JP1-JP2-JT1-JT2-JT3-JT4-JT5-JT6-JT7-A2_1-A2-A1	869.207	0.036	0.029	0.0463	1/18,773
Pasig River	2	A2-A1-JT100-JP4-JP5-JP6-JT16-JT17-B1-B2-B3-B4-B5-A2-A1	1171.433	-0.076	-0.015	0.078	1/15,018
Pasig River	3	JP2-JP1-JP3-JT8-JT9-JT10-JT11-JT12-JT13-JT14-JT15-JT15A-A2-A1	1194.299	0.069	0.074	0.1012	1/11,801
Pasig River	4	N1-N2-JP9-JP7-JP7A-N1-N2	1174.893	-0.013	-0.005	0.0138	1/85,137
Pasig River	5	PR8-PR7-JP8-JP12-JP10	1117.395	0.002	-0.012	0.0119	1/93,899
Pasig River	6	PR7-PR8-JT101-JT102-JT103-JP11-JT18-JT19-JP13-JT20-JT21-JT22-JT23-JT24-JT25-JT26-JT27-JT28-JT29-JP14-JT30-JP15-JP16-JP17	3607.91	-0.075	-0.061	0.0966	1/37,349
Pasig River	7	JP18-JP19-JT31-JT31A-JP20-JP21	1389.071	-0.049	0.007	0.0498	1/27,893
Pasig River	8	JP18-JP19-JP20-JT32-JP21-JP19	2261.992	-0.112	0.037	0.1179	1/19,186
Pasig River	9	JP22-JP23-JT33-JT34-JT35-JT36-JP24-GP1-GP2-GP2A-JP25-JT37-JT38-JT39-JP26-JT41-JP27-JP28	2920.155	0.223	0.088	0.24	1/12,167
Pasig River	10	JP27-JP28-JP29-JP30	606.814	0.009	-0.06	0.0603	1/10,063
Marikina River	11	JM3-JM2-JT50-JT501-JM3-JM10	531.75	-0.012	-0.003	0.0128	1/41,543
Marikina River	12	JM10-JM3-JM2-JM1	519.322	0.014	0.004	0.0146	1/35,570
Marikina River	13	JM3-JM10-JT606-JT604-JT603-JT602-JT601-JT520-JT521-JM4-JM11	1565.67	-0.007	0.044	0.0448	1/34,948
Marikina River	14	JM11-JM4-JT522-JT523-JT701-JT525-JT526-JT527-JT528-JT529-JT530-JT531-JT532-JT533-JM7-JM12	2302.43	0.033	-0.004	0.0336	1/68,525
Marikina River	15	JM12-JM7-JT533-JT534-JT536-JT537-JT538-JT703-JT704-JM9-JM13	1682.17	-0.078	-0.017	0.0794	1/21,186
Marikina River	16	JM9-JM13-JT704-JT550-JT551-JT552-JT553-JT554-JT555-JT556-JT557-JT558-JT559-JT560-JT561-JT562-JM14-JM15	2054.653	-0.053	0.039	0.0663	1/30,990
Marikina River	17	JM13-JM9-JT538-JT700-JT513-JT512-JT511-JT705-JT514-JT515-JT516-JT517-JT518-JT519-JT555-JM9-JM13	1724.744	-0.059	0.009	0.0599	1/28,794
Pasig River	18	PR11-PR12-JT54-JT53-JT52-JT51-JT50-JT49-JP18-JP19	1372.934	-0.05	-0.068	0.0844	1/16,267

(c) Leveling

Leveling was done by forward and backward round method starting from a known control point and connected to another known point. The traverse survey accuracies are shown on **Table R 2.1.4**.

Table R 2.1.4 Leveling Survey Accuracies

LOCATION	LEVEL RUN	CONTROLS	DIFFERENCE OF 2 RUNS
Pasig River	1	GM21-JP1-JP2-JT1-JT2-JT3-JT4-JT5-JT6-JT7-B8	0.007
Pasig River	2	GM19-JP3-JT8-JT9-JT10-JT11-JT12-JT13-JT14-JT15-A1-JT100-A2-JP4-JP5-JP6-JT17-B15	-0.002
Pasig River	3	BM CIMA 18A-JP7-25J	-0.006
Pasig River	4	BM CIMA 18A-N2-N1-JP9-25O8	-0.002
Pasig River	5	PR7-JP10	0.005
Pasig River	6	PR7-JP12-JP11-JT19-PR75D	0.003
Pasig River	7	PR7-PR8-JP8-25-25A	0
Pasig River	8	PR11-PR12-JP15-JT19-JP13-JT20-JT21-JT22-JT23-JT24-JT25-JT26-JT27-JT30	-0.015
Pasig River	9	PR11-JP17-JP16-JP14-JT29-JT28-JT27	0.004
Pasig River	10	GMQ1-JP19-JP18-TP12	-0.006
Pasig River	11	JP18-JT49-JT50-JT51-JT52-JT53-JT54	0.028
Pasig River	12	BM GM Q1-JP21-JT32-JP20-JT31-MMA3056-ADD05	-0.008
Pasig River	13	BM GM Q1-JP22-JT34-G1-JT35-JP24-JT1001-JT1002-JP25-JP28-JP30-C1	0.017
Pasig River	14	BM GM Q1-JP23-JT33-G2-JT37-JT38-JT39-JT40-JP26-JT41-JP27-JP29-C1	0.011
Marikina River	15	NP2-JM1-GM48M	0.003
Marikina River	16	GM48M-JT501-JT500-JM2-JM3-JM10-C1	-0.012
Marikina River	17	JM10-JT606-JT604	0.001
Marikina River	18	BM GM 49M-JM4-JM11-BM GM 49M	-0.001
Marikina River	19	BM GM 49M-JT520-JT602-JT604-JT603-JT601-ADD06	0
Marikina River	20	MA1-JT520-JT522-JT521-MA13	0.002
Marikina River	21	MA13-JT523-JT701-JT525-JT526-JT527-JT528-JT529-JM6-JT530-JT531-JT532-JT533-JM12-JM7-MA2	0.014
Marikina River	22	MA2-JT534-JT535-JT536-JM8-JT537-JT702-JT538-JT703-JT04-JT705-MA3	-0.004
Marikina River	23	JT538-JT700-JT513-JT512-JT511-MA3	0.005
Marikina River	24	MA3-JM9-JM13-JT550-JT551-JT514-JT515-JT516-JT517-JT518-JT519-JT554-JT553-JT552-JT555-JT556-JT557-JT558-JT559-JT560-JT561-JT562-JM14-JM15-MA10-MA4	-0.003
Backfill Site	25	PUMPING STATION 15.5-JD2-JD1-JD3-ABUTMENT	-0.005
Backfill Site	26	JD1-JD4-JD5-JD6-JD7-JD8-JD9	0.002
Backfill Site	27	JD8-JD10-JD11-JD12-JD3	0.001

(d) Cross-Section Survey and Hydrographic Survey

River cross-sections were surveyed using supersonic echo sounder at less than 20m intervals. Cross-checking of survey lines was done for the hydrographic survey. Calibration for the supersonic speed in the water was done at the beginning and the end of each day at the deepest location and in the different river environs and results were recorded as sounding data. Shallow areas of the river were surveyed using total stations or GPS.

(e) Topographic Survey

The following objects, land marks and topographic features were surveyed and recorded using total stations and GPS on a day to day basis:

- walls, fences, abutments, piers, culverts and other structures
- pavement edge, road shoulder, embankment, ditches, drainage
- electricity lines, water pipe and optic fiber lines
- trees, electricity poles, telephone poles, streetlights
- soil investigation points such as bore holes

(f) Correction of Existing Plan Map

The existing digital plan map was corrected by direct field measurements. The location of buildings, house structures, roads, etc., was verified one by one through actual physical checking and double-checking against the printed digital map. The dimension and location were measured relative to other surrounding objects.

(g) Backfill Site Survey

The Backfill Site was surveyed through spot height survey method using total station and data logger or GPS. The raw field data were submitted as electronic data based on day to day observations.

(h) Survey for Outlet of Drainage

All the outlets of drainages were marked and numbered on both sides of Marikina River and the planned construction area along Pasig River. The position and elevation of outlet pipe bottoms were surveyed using total station and dimensions were measured with measuring tape then recorded. Total station and data logger were used to electronically store and submit raw field data and observation on a day to day basis.

(i) Quality Assurance

Accuracy of data was checked by connecting with GPS survey and total station traverse survey for horizontal controls, and by comparing with multiple leveling observations for vertical controls. Mutual accuracy was confirmed by connecting the given points of this survey with those of the previous Pasig-Marikina River Channel Improvement Project (Phase II). Reference back target check for topographic survey and drainage outlet survey were carried out at appropriate intervals to confirm the stability of total station and accuracy of the observation. Leveling observations in this survey were also checked against data acquired from the tidal observatory.

2.2 Geology

2.2.1 Objective of the Geotechnical Study

The objective of the geotechnical study is to investigate the sub-surface conditions, the engineering properties of the soil for design and the quality of riverbed materials for embankment. The results were used as inputs in preparing the detailed design of civil works structures PMRCIP Phase III. Specifically, the results were used to: (i) confirm the sub-surface layers and estimate the soil modulus required for the design of river improvement works and (ii) identify the appropriate stabilization method to improve the quality and usability of riverbed sediments from Lower Marikina River as embankment materials after dredging.

2.2.2 Scope and Methodology of the Geotechnical Study

The scope of the geotechnical investigation includes review of secondary data, in situ tests, core sampling and laboratory analysis. The methods are shown on the flow chart in **Figure R 2.2.1** and described below:

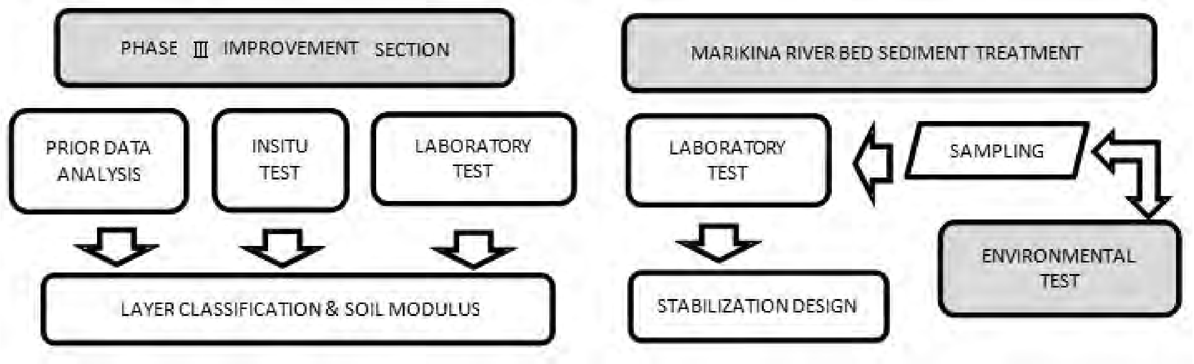


Figure R 2.2.1 Flow of the Geological Survey

(1) Geological features and Soil Modulus for River Improvement Works

(a) Review of Existing Data

Previous survey data and laboratory results were analyzed along with new borehole logs from 28 boreholes in Pasig River area and 29 boreholes in Lower Marikina River area. From these, the subsurface condition was confirmed, the longitudinal geological sections of Pasig-Marikina River basin were reconstructed, the stratification and distribution of soil layers were updated and the soil modulus was calculated.

(b) In situ Test

The following in situ tests were carried out:

a. Standard Penetration Test (SPT) was carried out for each borehole up to 1m depth of soil in accordance with ASTM D1586.
b. Groundwater Level Survey, taken daily at every working hole.
c. Thin-walled (Shelby) tube sampling for silt and clay layer in accordance with ASTM D1587.

(c) Laboratory Tests

The following laboratory tests were carried out for every borehole.

a. Japanese Unified Soil Classification for Engineering Purposes
b. Classification System, ASTM D2487
c. Specific gravity of soil solids, ASTM D854
d. Moisture Content of Soils, ASTM D2216
e. Particle Size Analysis of Soils, ASTM D422
f. Liquid Limit of Soils, ASTM D4318
g. Plastic Limit and Plasticity of Soils, ASTM D4318
h. Unconfined Compression Test, ASTM D2166
i. Unconfined Compressive Strength of Rock Cores, ASTM D2938
j. Unit Weight Analysis, ASTM C29
k. Consolidation Test, ASTM D2435

(2) Evaluation of Marikina River Bed Sediment

(a) Sampling

Sampling of riverbed was carried out at various depths at 1 km intervals along Lower Marikina River. Sediment samples were analyzed in the laboratory for both engineering properties and toxicity levels.

(b) Laboratory Test

Six typical samples of riverbed sediments were mixed with cement and lime in varying proportions. Cone penetration test was then performed on the samples to evaluate the best stabilization method that will enable transport and use of dredged soils as embankment materials during construction. **Table R 2.2.1** shows the soil stabilization methods used while **Table R 2.2.2** shows the proportion of stabilizing agent used with each sample.

The design strength for the target backfill site is over 200kN/m^2. This is in accordance with the Japan Road Association Guideline (refer to **Table R 2.2.3**).

Table R 2.2.1 Summary of Soil Stabilization Methods

Procedure		Method	Remarks
1	Mixing	ASTM D558	Use Test Method A (Section 7: 4.75mm sieve)
			Mixing percentage is as shown in Table-a
			Use Portland Cement and Quick Lime
			Compaction method is D698
			Mix in natural water content condition without drying or moistening
2	Compaction	ASTM D698	Use Method-A (101.6mm diameter mold, 3 layers, blows per layer: 25)
			Do not reuse soils
3	Curing	JGS 0811	Curing 24 hours and 7days wrapping with polythene
4	Strength Test	JIS A1228	Calculate the Cone Index by the result of Cone Penetration Test
5	Report		Report Cone Index of each stabilizing materials and each mixing ratio

Table R 2.2.2 Stabilizer Percentage per Soil (1m^3)

Sample No.	Case 1	Case 2	Case 3
Percentage Wt. (kg)	50	100	150
Weight Ratio	1:30	1:15	1:10
*(Assuming soil unit weight is 1.50t/m^3)			

Table R 2.2.3 Required Cone Penetration Strength for Construction Machine (Guideline of Earth Works, Japan Road Association, 2009)

Construction Machine	Ground Pressure (kN/m^2)	Minimum qc (kN/m^2)
Super swamp bulldozer	15-23	200
Swamp bulldozer	22-43	300
Normal bulldozer (15t Class)	50-60	500
Normal bulldozer (21t Class)	60-100	700
Scrape dozer (super swamp type)	41-56 (27)	600 (400)
Dragged scraper (small size)	130-140	700
Self-propelled scraper (small size)	400-450	1,000
Dump truck	350-550	1,200

2.3 Results of the Survey

2.3.1 Topography and Geology of the Survey Area

The Pasig-Marikina River Basin is located in the southern part of Luzon Island. Marikina River flows due south to its confluence with the Napindan Channel. It runs parallel with the west side fault of the Marikina Valley Fault System. Pasig River flows due west starting from this confluence and empties into Manila Bay.

(1) Topography

Pasig River has a very mild slope of 1/17,000; in contrast, Marikina River has a relatively steep slope of 1/9,000. The lowland elevation is less than 10m above sea level with slightly higher intermediate areas of about 10-30m elevations (**Figure 2.3.1**).

From the mouth of Pasig River going upstream, Pasig-Marikina River Basin is topographically divided into: Swamp, Delta, Sandbar/Spit, Floodplain, Natural levee, Central Hill/Plateau, and Marikina lowland （**Figure 2.3.2**).

(2) Geology

The geologic map of Pasig-Marikina River basin is shown in **Figure 2.3.3.** The new borehole logs confirmed the lithology of the study area, which consists of Guadalupe Formation in the higher portion and unconsolidated alluvial sediments in the lowlands. The distribution of subsurface rock formations is shown in **Figure 2.3.4.**

The detailed borehole log data and the general geology of the area are presented in detail in Volume III of the Detailed Design Report.

The new borehole log results also confirmed and updated the soil layer classification (**Table R 2.3.1)** and distribution as shown in the dredging material distribution map of Marikina River (also shown in **Figure 2.3.5**). Moreover, the borehole log results yielded updated information on the condition of water table as described in **Table 2.3.1.**

Table R 2.3.1 Layer Classification

Age		Soil Classification		
		Formation	Lithic	
QUATERNARY	HOLOCENE	F	Embankment	unconsolidated
		As1	Sand, Gravel	
		Ac1	Clay, Silt	
		As2	Sand, Gravel	
		Ac2	Clay, Silt	
	PLISTOCENE	D	Silt, Sand	
		GF	Guadalupe Formation tuff,sandstone,mudstone	consolidated

2.3.2 Engineering Properties of Soils

(1) Engineering Properties of Clayey Soils

Soils from the target design sections of the Study area are typically soft, unconsolidated and poorly compacted. This was confirmed by the laboratory results, which describe soil engineering properties that are characteristic of clay or clayey materials as listed below. The soil engineering properties are discussed in detail in Volume III of the Detailed Design Report.

- Unit weight = 1.3-2.0g/cm^3 in the Pasig River; 1.6-1.9g/cm^3, concentrated near 1.7gf/cm^3 in the Marikina River
- Unconfined compression strength: q_u < 0.1kg/cm^2 to 1.0kg/cm^2 in Pasig River; < 0.1kg/cm^2 near the surface and 0.1-0.5kg/cm^2 elsewhere in Marikina River
- OCR < 1.0 to 2.0 in Pasig River; around 1.5 in Lower Marikina River.

- OCR generally increases with depth in Pasig River, which indicates a delayed consolidation process (**Figure 2.3.6**).
- OCR in diluvium layer in Lower Marikina River indicates that vertical load has not been imposed in a long term.
- Initial void ratio = 1.0 to 2.0, which is slightly bigger than expected of generally soft clayey soils. This indicates that subsidence by imposed vertical load would be small.
- Cv = 10^{-3} to 10^{-4}cm^2/sec

(2) Soil Modulus

The Soil Modulus was derived statistically from the laboratory results and is summarized below.

Strength Modulus: (**Figure R 2.3.1**)

Right Bank: C = 5.9N
Left Bank: C = 6.6N
Mean (Both Banks): C = 6.0N
Upper limit of N (representative value) = 50

Unit Weight:

Sandy soil, clay, gravel (F) = 17.0 kN/m^3
Clay, silt (AC1 and AC2) = average of measured values
Sand, Gravel (AS1 and AS2) = 18.0kN/m^3

Modulus of Consolidation:

Consolidation data shows typical e-log curve and P-mv curve of AC1 and DC.

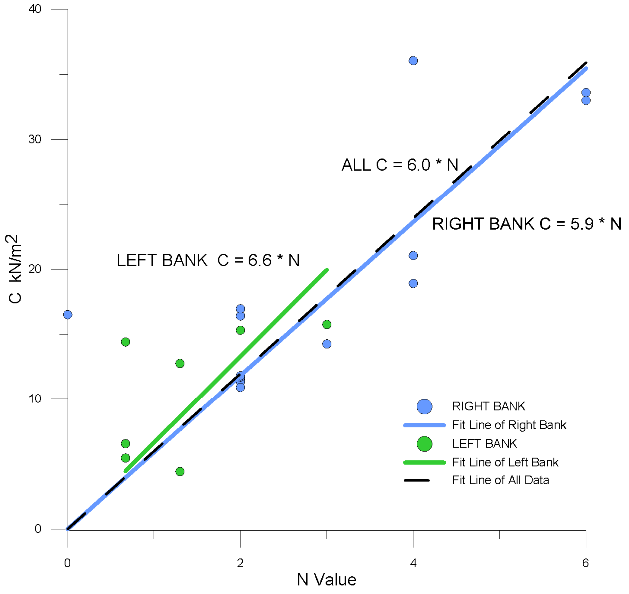


Figure R 2.3.1 Relationship of N value and C(qu/2) in Pasig River

(3) Hardness of Guadalupe Formation

The results of the core compression test of Guadalupe Formation along Pasig River area are shown in **Figure 2.3.7**. The results in terms of strength, qu, are presened in **Table R 2.3.2**

Table R 2.3.2 q_u of Guadalupe Formation

Mean	44.3
Median	35.0
Mode	45.5
Standard Deviation	32.2
Maxima	3.8
Minima	147.0
Sample Number	21

(4) C14 Dating Result

Carbon C14 dating results confirmed that the exact geological age of the unconsolidated sand, silt and clay layers (AC2 and DC) is Holocene, while the consolidated mudstone layer of the Guadalupe Formation (GF) is Upper Pleistocene (**Table R 2.3.3**).

Table R 2.3.3 Result of C14 dating of Borehole Sample

Sample No	Layer	14C Date
BHLP-04 out 21.5m	AC2	8025±30
BHLP-04 in 21.5m	AC2	8000±30
BHLM-08 45.0m	GF	44600±540
BHLM-08 20.0m	DC	8235±30

2.3.3 Test Results on Dredging Materials

(1) Natural Condition of Riverbed Sediments

Figure R 2.3.2 shows the average thickness of the sludge layer in Lower Marikina River. This shows that the sludge gets thicker going downstream, as follows: 0 to 1km, 85cm; 1 to 2km, 46cm; 2 to 3km, 54cm; 3 to 4km, 31cm; 4 to 5km, 7cm and 5 to 5.5km, 15cm.

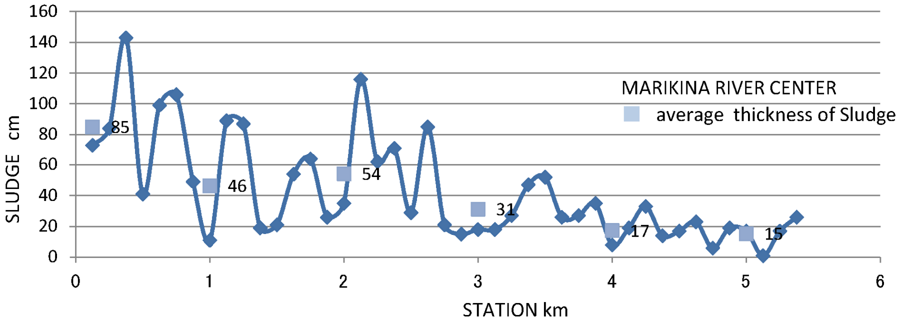


Figure R 2.3.2 Distribution of Sludge Thickness in Marikina River (13 June 2012)

Samples were classified into four soil types, namely: Sludge, Clay, Sandy clay and Sand according to their properties **(Table R 2.3.4)**. The soil distribution in the dredging area is shown in **Figure 2.3.8.**

Table R 2.3.4 Samples of Dredging Soil Stabilizing Test

Sample No.		**S-5**	**S-15**	**S-25**	**S-34**	**S-45**	**S-55**
Station		0+400	1+300	2+200	3+000	4+000	5+000
Soil Type		clay	sandy clay	sandy clay	sludge	sand	sand
Unit Weight	g/cm^3	1.380	1.540	1.310	1.570	1.870	1.800
Moisture Content	%	69	54	37	54	26	33
Fine Particle Content	%	67	24	23	94	16	18

(2) Result of Dredging Soil Stabilization Test

(a) Strength of Material

For stabilization test, Quick Lime (CaO : 87.3%) and Portland Cement(Type 1P) were applied as stabilizers because these materials are common in Philippines. The results of the stabilization test are fully discussed in the Geological Report. The response of the samples to the cone penetration test strength in relation to varying stabilizer proportion and curing period is summarized in **Table 2.3.2** and **Figure 2.3.9.**

In summary:

- Sludge and Clay; The lime volume need to gain the strength of qc = $400kN/m^2$ is 150 to $200kg/m^3$, while the cement volume needed is $67kg/m^3$ after one day curing
- Sandy clay; The strength after one day of curing increases from $66kg/m^3$ to $126kg/m^3$ in lime, but is limited to $35kg/m^3$ to $47kg/m^3$ in cement.
- Sand; Both in the quicklime and cement, one day curing strength indicates over qc>3,000 kN/m^2 by the minimum ratio of $50kg/m^3$. In the dry state without stabilizers qc shows more than 1,500 kN/m^2 .
- The increase in strength of material in proportion to curing period is obvious in cement but not in lime. Lime, however, seems to be more effective than sludge and clay samples.

Riverbed sediments in Lower Marikina River can be classified into 3 types. The stabilizing character of these soils is shown in **Table R 2.3.5**..

Table R 2.3.5 Dredging Soil Classification by Stabilizing Character

Stabilizing Pattern		**Soil Type**				**Amount of Dredging Soil m^3**
		Soil type combination	**Sample No.**	**MC(Moisture Content) %**	**FC（Fine Particle Content）%**	
A	cement 75kg or quick lime 200kg	sludge sludge +clay	5,34	54-69	67-94	262,249
B	cement 50kg(minimum) or quick lime 120kg	sludge+clay+sand sludge+sandy clay sandy clay	15,24	48-54	24-25	303,189
C	no stabilize	sludge+sand sand	45,55	26-33	16-18	306,114

(b) pH of Stabilized Soils

The pH of soils stabilized for both quick lime and cement is over 11.0 and peaks near 12.0 (**Table R 2.3.6)**. The pH increases proportionately with the stabilizer volume and reaches the peak near 12.0. The minimum pH is 10.5, for S-45 sample, which does not need stabilizing. These shows that stabilized soils are highly alkaline.

Table R 2.3.6 pH of Stabilized Soils

sample (station No.)		S-5 (0+400)								S-15 (1+300)							S-25 (2+200)						
stabilizer		Origin	Lime				Cement			Origin	Lime			Cement			Origin	Lime			Cement		
	weight kg/m^3	0	50	100	150	300	50	100	150	0	50	100	150	50	100	150	0	50	100	150	50	100	150
soil type		clay								sandy clay							sandy clay						
natural condition	unit weight g/cm^3	1.380								1.540							1.310						
	moisture content %	69								54							37						
	fine particle content %	67								24							23						
pH		7.10	11.25	11.93	11.98	11.87	10.90	10.91	11.67	7.26	11.68	11.85	11.83	10.47	10.95	11.35	7.34	11.45	11.75	11.87	10.82	10.95	11.13
		–	11.85	11.87	11.79	11.88	10.89	11.55	11.24	–	11.45	11.76	11.77	10.83	10.95	11.56	–	11.40	11.77	11.89	10.87	11.12	11.39
	average	7.10	11.55	11.90	11.89	11.88	10.90	11.23	11.46	7.26	11.57	11.81	11.80	10.65	10.95	11.46	7.34	11.43	11.76	11.88	10.85	11.04	11.26

sample (station No.)		S-34 (3+000)								S-45 (4+000)							S-55 (5+000)						
stabilizer		Origin	Lime				Cement			Origin	Lime			Cement			Origin	Lime			Cement		
	weight kg/m^3	0	50	100	150	300	50	100	150	0	50	100	150	50	100	150	0	50	100	150	50	100	150
soil type		sludge								sand							sand						
natural condition	unit weight g/cm^3	1.570								1.870							1.800						
	moisture content %	54								26							33						
	fine particle content %	94								16							18						
pH		7.53	11.88	11.85	11.87	11.89	10.86	10.80	11.34	7.56	11.37	11.92	11.73	10.90	11.41	11.42	7.59	11.81	11.95	11.95	11.20	11.32	11.34
		–	11.80	11.87	11.90	11.91	10.89	11.14	11.21	–	11.57	11.92	11.90	11.00	11.02	11.51	–	11.80	11.91	11.94	10.91	11.29	11.40
	average	7.53	11.84	11.86	11.89	11.90	10.88	10.97	11.28	7.56	11.47	11.92	11.82	10.95	11.22	11.47	7.59	11.81	11.93	11.95	11.06	11.31	11.37

(c) Permeability of the Compacted Sandy Soils

Compacted sandy soils showed very good permeability of $4.76*10^{-6}$ ~$5.50*10^{-6}$m/s, as shown in **Table R 2.3.7.**

Table R 2.3.7 Result of Compacted Sandy Sediment Permeability Test

No.	**Hydraulic Conductivity (m/s)**
1	5.50×10^{-6}
2	4.76×10^{-6}
3	5.00×10^{-6}
Average	5.09×10^{-6}

(d) Mixing Test of Clayey Soils and Sand Soils

Table R 2.3.8 shows that mixing with clay and sand would be effective at the ratio of 25:75(IV), where both FC and MC are the same as the sample with the desired strength (400kN/m^2) without stabilization.

Table R 2.3.8 Mixing Test Result

Test No.	Unit	I	II	III	IV	V
Ratio (S-5:S-45)	%	100:0	75:25	50:50	25:75	0:100
Moisture Content	%	67.6	60.4	52.6	39.5	27.8
Fine Particle Content	%	78	58	47	24	7

2.3.4 Recommendation for Construction

The followings are proposed to be observed during construction:

- FC and MC tests should be carried out for cost saving and safety measures. The testing frequency should be done more than once, preferably once in the morning and once in the afternoon for every 1000 m^3 or whenever change in the soil type is observed. (This is considered for the cost estimation.)
- To shorten the testing time, it is suggested to use the microwave oven method for MC (ASTM 4643) and the fine fraction content method (JIS A 1223) for FC.
- To reduce the stabilizing cost, if possible, it is suggested to keep the FC and MC low by mixing sand with sludge or clay.
- When necessary to mix several stabilizers or soils, the mixing plants should be used to ensure mixing quality. (This is considered for the cost estimation.)

CHAPTER 3 BASIC DESIGN OF RIVER AND DRAINAGE IMPROVEMENT

3.1 Summary of Basic Design of Pasig River Improvement Works

3.1.1 Review of Improved Areas

3.1.1.1 Classification of the Pasig River Improvement Plan in Phase III

The areas for improvement under Phase III were identified in the Preparatory Study for Phase III based on agreement with the DPWH and on existing site conditions as shown in **Table R 3.1.1**.

Table R 3.1.1 Potential Areas of Phase III (Pasig River)

No.	Bank (Right or Left)	Station		Length of Bank (m)	Location
		Sta.	Sta.		
1	R	2+283	2+540	350	Manila City
2	L	2+406	2+651	258	Manila City
3	R	2+550	2+950	400	Manila City
4	L	2+850	3+076	238	Manila City
5	R	3+160	3+280	108	Manila City
6	R	3+300	3+400	91	Manila City
7	L	3+480	3+560	82	Manila City
8	R	3+645	3+753	105	Manila City
9	R	5+030	5+217	171	Manila City
10	R	5+270	5+410	164	Manila City
11	R	5+543	5+630	102	Manila City
12	L	6+119	6+219	101	Manila City
13	L	6+248	6+269	27	Manila City
14	R	6+350	6+510	150	Manila City
15	L	6+360	6+515	166	Manila City
16	L	7+344	7+439	96	Manila City
17	R	7+518	8+220	632	Manila City
18	R	8+220	8+500	280	Manila City
19	R	8+510	9+341	827	Manila City
20	R	9+430	9+722	301	Manila City
21	R	9+750	9+790	41	Manila City
22	R	9+810	9+950	202	Manila City
23	R	10+957	11+263	320	Mandaluyong City
24	L	11+500	11+628	128	Makati City
25	R	11+602	11+653	52	Mandaluyong City
26	R	11+787	11+802	15	Mandaluyong City
27	L	12+024	12+173	149	Makati City
28	R	13+534	14+397	863	Mandaluyong City
29	L	13+806	14+442	636	Makati City
30	R	14+450	14+730	280	Mandaluyong City
31	R	14+837	14+944	107	Mandaluyong City
32	R	14+985	15+072	87	Mandaluyong City
33	R	15+196	15+246	50	Pasig City
34	L	15+236	15+424	188	Makati City
35	R	15+410	15+439	29	Pasig City
36	L	15+443	15+547	104	Makati City
37	R	15+477	15+505	28	Pasig City
38	R	15+505	16+469	970	Pasig City
39	L	15+747	15+870	123	Makati City
40	L	15+965	16+562	597	Makati City
41	R	16+469	16+722	253	Pasig City
042	R	16+776	16+828	52	Pasig City
Total				**9,923**	

The areas identified under the preparatory study in Phase III were then classified into 3 priority groups to identify which areas need urgent repair works (refer to **Table R 3.1.2)**.

Table R 3.1.2 Potential Classification of Areas for Improvement in Phase III

Priority I:	Flood prone area spreads widely from 2 km downstream of the end of Pasig River, which is around the Makati-Mandaluyong Bridge. This group of Potential Areas is located in the wide flood prone area. (Area Nos. 1, 3, 8, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27)
Priority II:	Potential Areas located in the narrow flood prone area on both banks between Makati-Mandaluyong Bridge and the end of Pasig River where congested houses and roads exist, or, Potential Areas are located at the channel curves more damaged by attack of flood of Typhoon Ondoy. (Area Nos. 2, 4, 5, 6, 7, 9, 10, 11, 28, 32, 38, 40, 42)
Priority III:	At present, urgent rehabilitation works are not necessary because there is no critical floodwater attack at these Potential Areas and relatively high inland. On the other hand, from the PRRC environmental aspect, improvement works are necessary. (Area Nos. 29, 30, 31, 33, 34, 35, 36, 37, 39, 41) Note: PRRC has no schedule for improvement as of June 2011.

Both Priority I and II areas should be improved based on the previous study. On the other hand, Priority III should be examined by additional field surveys using the Schmidt Hammer Test to classify whether the area is to be improved or not.

3.1.1.2 Correlation between Result of Schmidt Hammer Test and Damage

The Schmidt Hammer Test results conducted by the Study Team on Priority III areas are shown in **Table R 3.1.3**. The damaged conditions in Priority 3 revetment are also described in **Figure 3.1.2**.

Test date: June 20th to 21st and July 11th, 2012

Table R 3.1.3 Schmidt Hammer Test Results

Wall	Bank	Test Point	f'c (MN/m^2)	Cracked Width (mm)	Wall	Bank	Test Point	f'c (MN/m^2)	Cracked Width (mm)
A	Left	1	10.50	Broken	E	Right	26	6.90	3.0
		2	32.20	Broken			27	27.60	19.0
		3	28.60	2.5			28	19.80	4.0
		4	17.40	Broken			29	22.80	Broken
		5	23.00	3.0			30	14.60	2.5
		6	28.20	Broken			31	19.80	None
		7	32.80	Broken			32	40.60	4.0
		8	17.20	5.0	F	Right	33	20.30	4.0
		9	28.40	1.0			34	23.60	Broken
		10	21.60	6.0			35	22.20	Broken
		11	22.40	4.0	G	Right	36	11.10	Broken
		12	16.60	5.0			37	28.40	Broken
		13	14.20	2.0	H1	Right	38	28.30	2.5
		14	23.50	4.0	H2	Right	39	25.30	Broken
		15	38.00	6.0	I	Right	40	19.50	7.0
B	Left	16	24.10	Broken			41	13.80	None
		17	22.90	None			42	18.80	None
		18	29.30	Broken			43	23.70	None
		19	37.80	None			44	18.30	16.0
C	Left	20	22.60	None			45	24.90	4.0
		21	27.00	Broken			46	18.00	None
		22	30.00	6.0			47	32.20	Broken
D	Left	23	20.90	Broken	Maximum			40.60	19.00
		24	19.80	Broken	Minimum			6.90	1.00
		25	15.70	Broken	Average			23.09	5.26

The minimum compressive strength of plain concrete Class-C is f'c=16.5MN/m^2. Test points 1, 13, 25, 26, 30, 36 and 41 from the above table indicate an f'c value under 16.5MN/m^2. In some of these test points, the wall have been apparently broken (test points 1, 25, 36).

In some test points (13, 26, 30 and 41), the damage is superficial and allowable at this moment. But future calamities may cause to develop the damage of the existing structures and to eventually collapse; hence, repair works are necessary.

Moreover, the results of the investigation show that the problem is mainly caused not only by low compressive strength of concrete but also by foundation.

3.1.1.3 Possible Causes of Deterioration of Revetment

The possible causes of the deterioration of the revetment include sliding, weak traction, overturning and horizontal displacement caused by hydrodynamic forces, earth pressure and water pressure. These are analyzed and described in "The Dynamic Design of the Revetment".

The progressive deterioration of the revetment is evidenced by cracks and settling of the revetment surface caused by the caving in of the backfill; deformation of the revetment caused by the scouring of foundation; cave-in and collapse caused by the scouring of the backfill sand during flooding; sliding failure caused by the decrease in strength of the backfill during floods; cracks caused by the erosion and weathering of the concrete wall; and settling of the backfill on top of the revetment. In addition, other factors may be contributing to the deterioration of the revetment, including growth of vegetation, water pressure from the river flow, rainfall, ship-generated waves, earth quake, weathering, normal wear and tear.

With the considerations mentioned above and on the basis of recent field investigation, the following observations and assumptions are summarized below:

- It is expected that revetment having low compressive strength showing initial signs of damage will eventually collapse after a series floods.
- Even revetments with high compressive strength show signs of damage and most of them have already collapsed.
- Most parts of the revetment walls at the riparian part have already been broken.
- Numerous cracks over one millimeter wide are noted on the revetment walls that were constructed with no reinforcement.
- Most of the revetments where the lower portion is broken have their upper portions also broken.
- Heavy damages mostly occur at the upstream and downstream of convex river alignments.
- The impact of waves generated by the frequent passage of navigating vessels is a serious factor that contributed to the deterioration of the revetments as indicted in below.

The photos in **Photo R 3.1.1** were taken during field investigation and shows waves generated by high-speed boats cruising through the Pasig River.

Photo R 3.1.1 Waves Generated by Navigating Water Crafts

Destruction of the revetment progresses in the following sequence.

Step 1;	Initial Condition - Cracks develop on the concrete surface of the revetment.
Step 2-1;	Wave Damage - The impact of waves by watercraft destroys the river edge.
Step 2-2;	Invasion by Plants - Growth of vegetation opens the cracks of the walls wider.
Step 3-1;	Collapse by Floods - With the initial damages caused by the 3 factors mentioned above, the wall will eventually collapse when the next flood occurs.
Step 3-2;	Collapse by Rain - Rainwater seepage into the cracks and gaps will lead to its eventual collapse.

As field evidence shows, any scale of flood and heavy rainfall causes total collapse of the revetments due to the present condition of these structures, which poses damage to life and property.

Therefore, the sections, where revetments are already in the Step 2-1 state of deterioration, need urgent repair to prevent disaster. Repair is also needed to prevent additional damage from waves generated by navigating vessels. Furthermore, where the revetments are already broken need repair to eliminate potential danger to life and property.

To this end, the following countermeasures are considered:

- Coutermesure-1: The revetment around should be constructed of strong materials, such as reinforced concrete or steel.
- Coutermesure-2: To prevent the initial cracks, the concrete should be reinforced with at least temperature reinforcement.

3.1.1.4 Improvement Areas for Phase III

Table R 3.1.4 summarizes the results of field investigation and the corresponding recommendations on the necessary repair works along Pasig River.

Table R 3.1.4 Priority-III Results of Assessment of Necessary Repair Works

Area No.	Extent of Damage	Concrete Strength	Present Use	Urgency	Assessment Point	Necessity
A No.29	Large(5)	13%(1)	Residential(5)	Very Urgent(5)	16 points	1
B No.34	Large(5)	0%(0)	Park(3)	Very Urgent(5)	13 points	1
C No.36	Large(5)	0%(0)	Park(3)	Very Urgent(5)	13 points	1
D No.39	Large(5)	33%(2)	Park(3)	Very Urgent(5)	15 points	1
E No.30	Small(1)	29%(2)	Others(1)	Not Urgent(1)	5 points	3
F No.31	Medium(3)	0%(0)	Park(3)	Urgent(3)	9 points	2
G No.33	Medium(3)	50%(3)	Factory(1)	Urgent(3)	10 points	2
H No.35 &37	No-Wall(5)	0%(0)	Others(1)	Urgent(3)	9 points	2
I-1 No.41A	Small(1)	13%(1)	Factory(1)	Not Urgent(1)	4 points	3
I-2 No.41B	Large(5)	13%(1)	Factory(1)	Urgent(3)	10 points	2

(Assessment Point)

Extent of Damage: Large; No wall = 5points, Medium =3points, Small =1point

Concrete Strength: +Roundup (%×5points/100, 0), % = under 16.5MN/m^2 observation places/ measurement places

Present Use: Residential =5points, Park =3points, Factory& Others =1point

Urgency: Very Urgent =5points, Urgent =3points, Not Urgent =1point

Necessity: 1=over 12points, 2=over8points, 3=under/equal 8points

Note: Shaded areas in the above table are excluded from the improved areas in accordance with discussions with the DPWH. The reasons are the damages of both the Area E and the Area I-1 are small and the urgencies of those are not urgent. In addition, the Area G is excluded because the existing revetment is a private revetment.

Considering budgetary constraints, it is highly recommended to repair the walls, as categorized, according to the level of necessity.

- Necessity-1: The area is highly recommended for repair= A to D
- Necessity-2: The area is also recommended repair= F,G, H, I-2
- Necessity-3: The area is recommended for repair only if there is available budget= E, I-1

(1) Additional Improvement Areas for Phase III

The field survey was conducted jointly by the Study Team and DPWH on July 19th, 2012. After a series of discussions, the DPWH recommended to include additional areas, herein referred to as “New Areas Proposed by DPWH” (**Table R 3.1.5**). These areas need further investigation to identify the urgency of improvement and find the appropriate way to improve where necessary.

Table R 3.1.5 Areas Proposed by DPWH

No.	Bank	Station		Location/Owner	DPWH Recommendation	Basic Design Decision
		Start	End			
1	Right Bank	2+550	2+575	Estero de Quiapo, Manila	(New) Extend RCF	(New) Extend Reinforced Concrete Floodwall (RCF)
2	Left Bank	2+651	2+695	Arroceros Pumping Station, Manila	(New) SSP : Re-investigation at Low Tide	(New) RCF: Re-investigation of Foundation at Low Tide
3	Left Bank	7+494	7+580	Chevron Gas Station, Manila	(New) SSP (New) RCF	(New) RCF Check the Foundation (New) RCF Check Ground High
4	Right Bank	8+500	8+510	Marcelo Steel, Manila	Continue SSP (Demolish the Existing Pier)	(New) Continue SSP (Demolish the Existing Pier)
5	Right Bank	9+722	9+750	Pascual Shipyard, Manila	Continue (Might be RCF, Reinvestigation)	(New) RCF Confirm to the Owner
6	Right Bank	10+140	10+178	Mabini Jetty, Manila	(New) RCF	(New) RCF Confirm to the Owner
7	Left Bank	10+230	10+340	Flying V/ Antonio Loo/ Chan, Manila	(New) SSP	(New) RCF Confirm to the Owner
8	Left Bank	10+405	10+470	Ocampo, Manila	(New) RCF Check the Ground High (New) Repair	(New) RCF (New) Repair the Revetment

Experience during the implementation of Phase II indicated that it was difficult to get an agreement with the stakeholders. But the owners have changed their minds afterword.

(2) Over-all Total Improvement Areas for Phase III

The improvement areas are shown in **Table R 3.1.6** based on the results of the discussions with the DPWH; the As-Built and As-Staked drawings under Phase II; and the above-mentioned study results. The specific locations are shown in **Figure 3.1.3**.

In the detailed design stage, some areas may be excluded because of the budget constraint. The fundamental plans of the reconsideration are following;

- Priority-1 and -2 Groups: Improvement Areas and
- Priority-3 Group and Additional Areas: After the consideration of the priority order of each area, some of these areas might be excluded if the total project cost exceeded the limit.

Table R 3.1.6 Improvement Areas for Phase III

No.	Channel Bank (Left or Right)	Station		Length of Bank (m)	Administration
		Start	End		
I. Priority – I & -II Groups					
1	R	2+283	2+540	350	Manila City
2	L	2+406	2+651	258	Manila City
3	R	2+550	2+950	400	Manila City
4	L	*2+855	*3+071	**228	Manila City
5	R	3+160	3+280	108	Manila City
6	R	3+300	3+400	91	Manila City
7	L	3+480	3+560	82	Manila City
8	R	*3+648	3+753	**104	Manila City
9	R	5+030	5+217	171	Manila City
10	R	5+270	5+411	165	Manila City
11	R	*5+547	5+630	**98	Manila City
12	L	6+119	6+219	101	Manila City
13	L	6+248	6+269	27	Manila City
14	R	6+350	*6+508	**148	Manila City
15	L	*6+376	*6+482	**106	Manila City
16	L	7+344	*7+443	**100	Manila City
17	R	*7+516	8+220	**634	Manila City
18	R	8+220	8+500	280	Manila City
19	R	8+510	9+341	827	Manila City
20	R	9+430	9+722	301	Manila City
21	R	9+750	9+790	41	Manila City
22	R	9+810	9+950	202	Manila City
23	R	10+957	11+263	320	Mandaluyong City
24	L	11+500	11+628	128	Makati City
25	R	*11+610	*11+655	**46	Mandaluyong City
26	R	11+787	11+802	15	Mandaluyong City
27	L	12+024	12+173	149	Makati City
28	R	*13+578	14+397	**819	Mandaluyong City
32	R	14+985	15+072	87	Mandaluyong City
38	R	15+505	16+469	970	Pasig City
40	L	15+965	16+562	597	Makati City
42	R	16+776	16+828	52	Pasig City
Sub-Total				***8,005***	
II. Priority – III Groups *1					
29	L	13+806	14+442	636	Makati City
31	R	14+837	14+944	107	Mandaluyong City
34	L	15+236	15+424	188	Makati City
35	R	15+410	15+439	29	Pasig City
36	L	15+443	15+547	104	Makati City
37	R	15+477	15+505	28	Pasig City
39	L	15+747	15+870	123	Makati City
41B	R	16+667	16+722	55	Pasig City
Sub-Total				***1270***	
III. Additional Areas *2					
1A	R	2+550	2+575	88	Manila City
2A	L	2+651	2+695	45	Manila City
3A	L	7+494	7+580	79	Manila City
4A	R	8+500	8+510	10	Manila City
5A	R	9+722	9+750	29	Manila City
6A	R	10+140	10+178	40	Manila City
7A	L	10+230	10+340	106	Manila City
8A	L	10+405	10+470	92	Manila City
Sub-Total				***489***	
TOTAL REPAIR AREA				**9,764**	
IV. Excluded Area *3					
30	R	14+450	14+730	280	Mandaluyong City
33	R	15+196	15+246	50	Pasig City
41A	R	16+469	16+667	198	Pasig City
Sub-Total				***528***	

Notes:* Corrected station of the Phase-III As-Staked Plan based on the As-Built Plan from Phase II.
**Adjusted length of bank based on the corrected station of Phase-III As-Staked Plan.
*1: The areas are classified as the improved areas of the Priority-III.
*2: The areas are added by the filed survey jointly conducted by the Study Team and DPWH on July 19th, 2012.
*3: The areas are excluded as the improved areas of the Priority-III (No.30=Area-E, No.33=Area-G, No.41A=Area-I-1). (Refer to **Table R 3.1.4**)

3.1.2 Basic Design of Steel Sheet Pile Revetment in Pasig River

(1) Block Segmentation and Design Condition of Repair Area

Field investigation was conducted on the design area of the revetments indicated in **Table R 3.1.6**. Repair methods, which will be applied to the areas considering the construction case of Phase II, are shown in **Figure R 3.1.7**.

Table R 3.1.7 Applied Repair Methods

No.	Condition of Existing Revetment of Repair Area	Applied Repair Methods
1	The existing revetment is in good condition but the top elevation is lower than the required (Design Flood Level + 1.0 m free board). Construction of additional upper structure is necessary.	Reinforced Concrete Floodwall (Parapet Wall) is constructed on top of the existing revetment. 
2	The existing revetment has required elevation but the surface concrete is already broken and the back-filling material is corroded.	Revetment is restored by putting back-fill materials and repairing the broken surface of concrete. 
3	No existing revetment, the existing revetment has been deteriorated, or the existing revetment has been broken substantially.	Steel sheet pile revetment is constructed and additional upper structure is also installed on the top to satisfy the required design elevation (Design Flood Level + 1.0m free board). 

Steel sheet pile revetments are suitable for Pasig River for the following reasons:

- Reduction of river cross sectional area is minimal due to installation of vertical revetment
- Required construction period is shorter since provision of temporary coffer dam, drainage and drying around construction area are not necessary.
- Required elevation of revetment is achieved easily with the installation of upper structure
- Various adverse field conditions such as restrictive geological features, underlying hard rock formation, and water depth for the dock, are addressed by adjusting the scale and length of the steel sheet piles.

The type and length of steel sheet pile are designed appropriately in consideration of design conditions. It is also necessary to set block segmentation because the design condition is different for each location.

For the block segmentation of the repair areas, the following condition should be considered:

- Geotechnical condition (result of drilling survey),
- Topographic condition (ground height of rear side, existing revetment, etc.),
- Existing harbors (enough water depth for the docking of ships), and
- For long repair sections, division into suitable lengths is applied.

Based on the above, the result of block segmentation of repair areas is listed in **Table R 3.1.8** and **Table R 3.1.9.** Furthermore, these segmentations will be reviewed in the detailed design stage in consideration of the results of topographic survey of river cross section and drilling test conducted at riverbank.

Table R 3.1.8 Block Segmentation of Steel Sheet Pile Revetment Area (Right Bank)

STA,		Length of Bank (m)	Design Condition		Consideration Points for Segmentation
from	to		rear ground level (EL.)	representative N-value	
2+283	2+341	65	12.600	2	
3+160	3+280	108	12.030	8	
3+648	3+753	104	12.600	18	
5+030	5+217	171	13.880	2	
5+270	5+411	165	13.580	2	
5+547	5+630	98	13.730	2	
6+350	6+508	148	13.840	2	
8+220	8+250	30	13.860	5	
8+250	8+510	260	14.800	6	destroyed wide revetment on the alignment of SSP
8+510	8+800	286	14.740	4	transformation of backside terrain
8+800	9+150	350	13.310	6	transformation of backside terrain
9+150	9+200	50	13.200	2	water depth for dock in front of factory
9+200	9+341	141	13.310	6	
9+430	9+722	301	13.450	4	(no segmentation) same geological, topographic & landuse features
9+750	9+770	20	13.000	4	
9+770	9+790	21	13.000	8	water depth for dock at ferry station
9+810	9+830	29	13.000	8	water depth for dock at ferry station
9+830	9+950	173	13.400	5	
10+957	11+263	320	13.930	17	(no segmentation) in front of factories
11+610	11+655	46	13.330	8	
11+787	11+802	15	13.510	5	
13+578	13+700	122	14.110	11	
13+700	13+800	100	14.110	18	transformation of backside terrain
13+800	14+000	200	14.210	16	segmentation in appropriate span length
14+000	14+100	100	14.230	20	
14+100	14+250	150	14.330	12	
14+250	14+397	147	15.120	20	
14+837	14+944	107	14.730	4	
14+985	15+072	87	15.290	20	
15+410	15+439	29	16.604	30	
15+477	15+505	28	14.590	4	
16+776	16+828	52	12.800	10	

Table R 3.1.9 Block Segmentation of Steel Sheet Pile Revetment Area (Left Bank)

STA.		Length of Bank (m)	Design Condition		Consideration Points for Segmentation
from	to		rear ground level (EL.)	representative N-value	
2+406	2+651	258	12.470	2	
2+855	3+071	228	12.470	2	
6+119	6+219	101	14.200	30	
6+248	6+269	27	13.510	30	
6+376	6+482	106	13.100	10	
7+344	7+443	100	13.420	8	
11+500	11+628	128	14.090	10	
12+024	12+173	149	13.490	20	
13+806	14+250	444	14.640	15	transformation of backside terrain
14+250	14+442	192	15.950	15	
15+236	15+424	188	15.020	20	
15+443	15+547	104	14.670	20	
15+747	15+870	123	14.520	10	
15+965	16+562	597	14.850	10	

(2) Design Condition of Steel of Steel Sheet Pile Revetment

Design calculations of the steel sheet pile revetment are implemented according to the flowchart shown in **Figure R 3.1.1.**

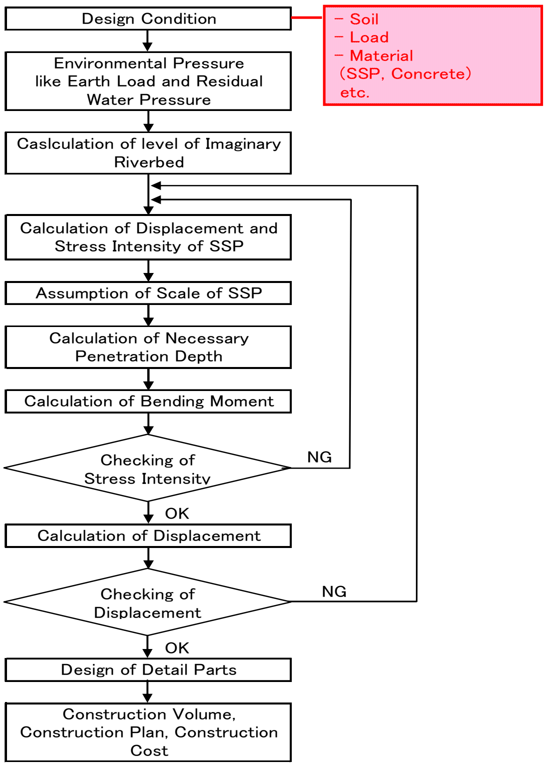


Figure R 3.1.1 Flow Chart of Design of Steel Sheet Pile Revetment

Table R 3.1.10 shows the design condition of the steel sheet pile revetment.

Table R 3.1.10 Design Condition of Steel Sheet Pile Revetment

Item			Design Condition		
Material Unit Weight	Concrete: Reinforced/Prestressed		$24.0 kN/m^3$		
	Concrete: Plain		$23.5 kN/m^3$		
	Mortar		$21.0 kN/m^3$		
	Structural Steel		$77.0 kN/m^3$		
	Cast Iron		$71.0 kN/m^3$		
	Water		$9.8 kN/m^3$		
Soil Condition	Quality of soil		Loose sandy soil		
	Unit Weight	Damp or wet condition	$18 kN/m^3$		
		Saturated condition	$20 kN/m^3$		
		Submerged condition	$10 kN/m^3$		
	N-value		Measurement value with standard penetration test		
	Angle of Internal Friction		$\phi = 15+\sqrt{15N} \leq 45°$: for $N \geq 5$		
	Cohesion		C=0		
Steel Sheet Pile	Steel Type		SYW295		
	Allowable Bending Stress		Normal Condition : $180 N/mm^2$ Seismic Condition : $270 N/mm^2$		
	Allowable Displacement		Normal Condition : 50mm Seismic Condition : 75mm		
	Section Efficiency		Hat-shape	Moment of Inertia	100%
				Section Modulus	100%
			U-shape	Moment of Inertia	100%
				Section Modulus	80%
	Young's Modulus of Elasticity		$2.0\times10^5 N/mm^2$		
	Corrosion Allowance		2mm （1mm for each side）		
	Level of Coping concrete		Refer to **Figure R 3.1.2** (design condition in Phase II is applied)		
Water Level Condition			[Water Level in Rear Side] Rear Side Ground Level ≥ Top of Coping concrete Water Level in Rear Side: Top of Coping concrete Rear Side Ground Level < Top of Coping concrete Water Level in Rear Side: Rear Side Ground Level		
			[Water Level in Front Side] Normal Condition : Mean Low Water (MLW) EL.10.10m Seismic Condition : Mean Water level (MWL) EL. 10.60m		
Horizontal Seismic Coefficient			$k_h=0.20$		
Surcharge			Normal Condition : $10 kN/m^2$ Seismic Condition : $5 kN/m^2$		

Cross sectional shape of riprap is designed such that necessary active earth load is secured (refer to **Figure R 3.1.2 and Figure R 3.1.3**).

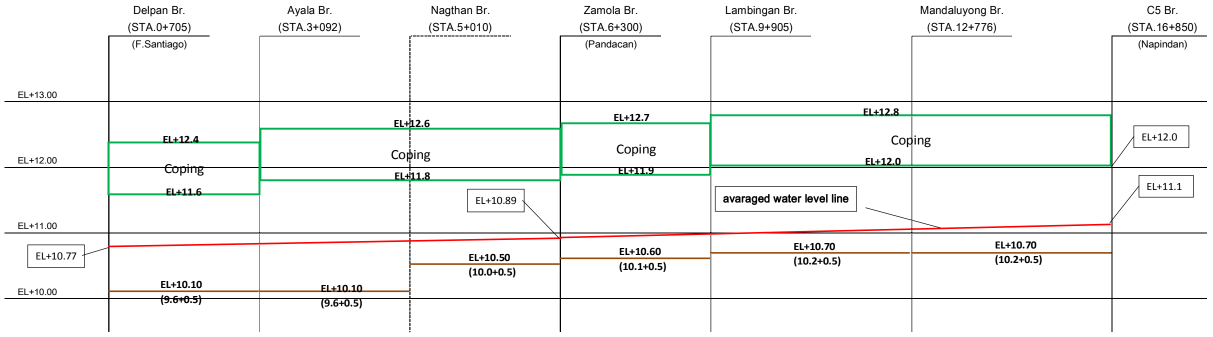


Figure R 3.1.2 Design elevation of Coping Concrete and Riprap

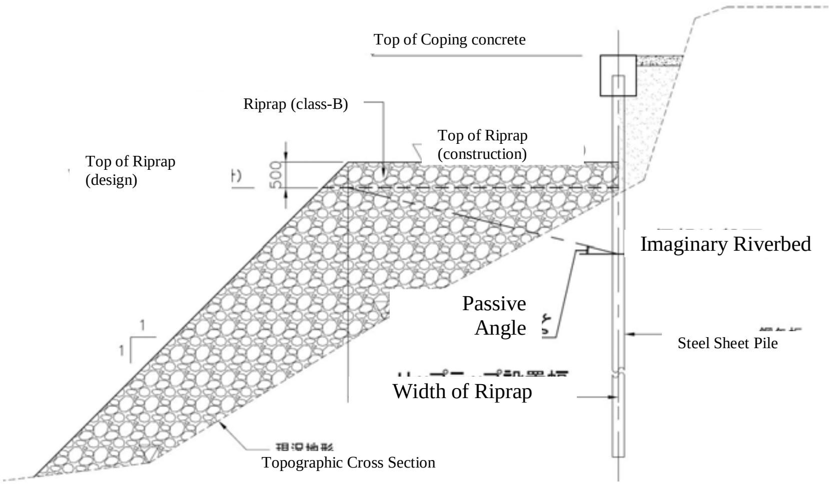
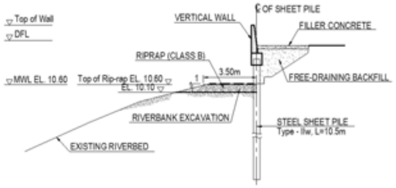
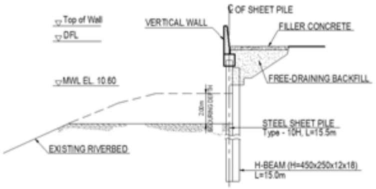
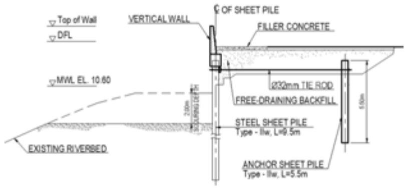
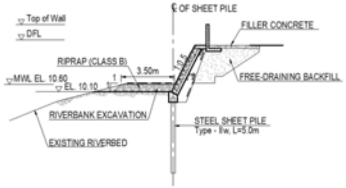


Figure R 3.1.3 Design Method of Necessary Width of Riprap

(3) Design of Steel Sheet Pile Revetment Structure

There are four types of revetment that are applicable for the repair of Pasig River, as shown in **Table R 3.1.11.** Based on the comparison of the four types, "Cantilever Steel Sheet Pile + Foot Protection Works" is recommended. This type is most appropriate and in uniformity with the on-going works under Phase II.

Table R 3.1.11 Comparison of Revetment Structure

Construction Method	**Case-1: Cantilever Steel Sheet Pile + Foot Protection (On going Phase II)**		**Case-2: Cantilever Steel Sheet Pile (Scouring Depth = 2m)**		**Case-3: Tie Rod Steel Sheet Pile (Scouring Depth = 2m)**		**Case-4: Concrete Block Retaining Wall with Steel Sheet Pile Base + Foot Protection**	
General Drawing								
Structural Variables	- Wide shape steel sheet pile, Type-IIw, L=10.5m Riprap V=2m3 Parapet H=1.9m		- Hat shape steel sheet pile, Type-10H, L=15.5m H-450*250*12*18, L=15.0m Parapet H=1.9m		- Wide shape steel sheet pile, Type-IIw, L=9.5m Anchor sheet pile, Type-IIw, L=5.5m Tie rod ϕ32mm @2.4m, L=9.0m Parapet H=1.9m		- Concrete block retaining wall, H=3.1m (1:0.5) Steel sheet pile, Type-IIw, L=5m L-type retaining wall, H=1.7m	
Adaption for Project	- Actually used in on going Phase-II, many in Japan in the case of gabion and concrete block	◎	- Many in Japan, especially for medium and small size rivers (Shallow places of water depth) in large cities	○	- Many in Japan, especially for harbors and low water channel of large river, such as Arakawa river, because of required wide space	○	- Most general revetment foot medium and small size rivers	◎
Durability for Brackish Water	･No problem due to corrosion protection for sheet pile and the other's concrete structures	○	･No problem due to corrosion protection for sheet pile and the other's concrete structures	○	- Even if the corrosion protection for sheet pile, quality of the corrosion treatment about the tie rod parts still remain as the problem due to site treatment.	△	･No problem due to concrete block and corrosion protection of sheet pile	○
Environmental Aspect	- Not so good about the biological system because of no-porous revetment	△	- Not so good about the biological system because of no-porous revetment	△	- Not so good about the biological system because of no-porous revetment	△	- Not so good about the biological system because of no-porous revetment	△
Effect against River Navigation	- Approaching berthing is difficult because of the riprap.	△	- Approaching berthing is easy because of no-riprap.	◎	- Approaching berthing is easy because of no-riprap.	◎	- Approaching berthing is difficult because of the riprap.	◎
Land Required	- The smallest land requirement than the others	◎	- The smallest land requirement than the others	◎	- It is actually impossible that additional land-acquisition is needed due to the anchor sheet pile and the tie rod.	×	- Wider land use due to the inclination of the wall	△
Effect against River Section	- A little obstruct against the river sections	◎	- Wider obstruct against the river sections because of the additional H-beam	△	- A little obstruct against the river sections	◎	- A little obstruct against the river sections	◎
Maintenance and Repair	- No problem	◎	- It is necessary that scouring places should be maintained because of no foot protection. (However, that might be difficult by the present system actually.)	×	- It is necessary that scouring places should be maintained because of no foot protection. (However, that might be difficult by the present system actually.)	×	- It is necessary that frequent maintenances are needed because of the broken points by ship generated waves. In addition, the repair is expensive due to temporary cofferdam.	△
Workability	- Relatively easy due to dumping and leveling the riprap under the water	○	- Easy due to no under-water construction	◎	- Not so easy due to the construction of the tie rod	△	Temporary cofferdam and dewatering are necessary. Especially, control for dewatering is difficult because of basically 24 hours.	△
Cost (Peso/m)	Sheet Pile Costs 163,400 Riprap Costs 4,400 Vertical Wall 5,800 **Total Costs 173,600 Peso/m**	1	Sheet Pile Costs 414,100 Vertical Wall 5,800 **Total Costs 419,900 Peso/m**	4	Sheet Pile Costs 90,700 Anchor Sheet Pile 52,500 Tie Rod 54,000 Vertical Wall 5,800 **Total Costs 203,000 Peso/m**	2	Basement Costs 54,700 Concrete Block Wall 24,300 Cofferdam & Dewatering 153,200 Riprap Costs 4,400 L-Type Parapet Wall 6,500 **Total Costs 243,100 Peso/m**	3
	- Inexpensive because of no temporary cofferdam		- The most expensive because of the heavy weight of the steel caused by the high self support wall		- Expensive because of the anchor pile and tie rod		- Expensive because of the temporary cofferdam and the dewatering	
Evaluation	- The most of the evaluations, especially including the cost, are better than the others and the damages of the barges are not so serious problems.		- The most expensive method. In addition, It is impossible that adequate maintenances for the scouring places by the no foot protection will be conducted.		- The cost is more expensive than Case-1's. Furthermore, it is necessary to acquire the additional lands for the anchor sheep pile and the tie rod. (Even if the foot protection is considered, the cost is more expensive than Case-1 and the additional land-acquisition is still remained.)		- The cost is more expensive than Case-1's. In addition, the durability for the ship generated waves is weak point and the maintenance & repair are still problems.	
	◎: Selection		△		×： Difficulty of Land-Acquisition		△	

Symbol Legend - ◎:Very Good, ○:Good, △:Fare, ×:Poor or Problem

(4) Design Calculation of Steel Sheet Pile Revetment

The type and scale of steel sheet piles of each segment listed in **Table R 3.1.8** and **Table R 3.1.9** are designed based on the aforementioned design condition. Results of design calculation are shown in **Table R 3.1.12** and **Table R 3.1.13**.

Table R 3.1.12 Results of Design Calculation of Steel Sheet Pile Revetment (Right Bank)

Station		Length of Bank (m)	Designed Parapet		
from	to		SSP	H-BEAM	Length of SSP (m)
2+283	2+341	65	SSP-V$_L$	-	12.5
3+160	3+280	108	SSP-IVw	-	12.0
3+648	3+753	104	SSP-IVw	-	10.0
5+030	5+217	171	SSP-10H	400x200x9x22	12.5
5+270	5+411	165	SSP-10H	400x200x9x22	13.5
5+547	5+630	98	SSP-V$_L$	-	12.0
6+350	6+508	148	SSP-VI$_L$	-	12.5
8+220	8+250	30	SSP-10H	400x200x9x22	12.5
8+250	8+510	260	SSP-V$_L$	-	11.0
8+510	8+800	286	SSP-10H	400x200x9x22	12.5
8+800	9+150	350	SSP-IVw	-	10.5
9+150	9+200	50	SSP-10H	650x250x12x28	18.0
9+200	9+341	141	SSP-IVw	-	10.5
9+430	9+722	301	SSP-IVw	-	11.0
9+750	9+770	20	SSP-25H	-	9.5
9+770	9+790	21	SSP-10H	500x250x12x28	15.5
9+810	9+830	29	SSP-10H	500x250x12x28	15.5
9+830	9+950	173	SSP-IVw	-	11.0
10+957	11+263	320	SSP-25H	1000x300x16x32	20.0
11+610	11+655	46	SSP-10H	400x200x9x22	14.0
11+787	11+802	15	SSP-IVw	-	11.0
13+578	13+700	122	SSP-IVw	-	10.5
13+700	13+800	100	SSP-IVw	-	10.0
13+800	14+000	200	SSP-IVw	-	10.5
14+000	14+100	100	SSP-IVw	-	10.0
14+100	14+250	150	SSP-V$_L$	-	10.5
14+250	14+397	147	SSP-10H	400x200x9x22	12.0
14+837	14+944	107	SSP-10H	450x250x12x28	14.5
14+985	15+072	87	SSP-10H	450x250x12x28	13.0
15+410	15+439	29	SSP-10H	800x250x16x28	17.0
15+477	15+505	28	SSP-10H	450x200x12x25	14.0
16+776	16+828	52	SSP-25H	-	9.0

Table R 3.1.13 Results of Design Calculation of Steel Sheet Pile Revetment (Left Bank)

Station		Length of Bank (m)	Designed Parapet		
from	to		SSP	H-BEAM	Length of SSP (m)
2+406	2+651	258	SSP-IVw	-	12.5
2+855	3+071	228	SSP-IVw	-	12.0
6+119	6+219	101	SSP-IVw	-	10.0
6+248	6+269	27	SSP-IVw	-	9.5
6+376	6+482	106	SSP-25H	-	9.0
7+344	7+443	100	SSP-VL	-	11.0
11+500	11+628	128	SSP-10H	400x200x9x22	12.0
12+024	12+173	149	SSP-10H	900x250x16x28	19.0
13+806	14+442	636	SSP-VIL	-	11.0
14+442	14+442	192	SSP-10H	450x200x12x25	12.5
15+236	15+424	188	SSP-IVw	-	9.5
15+443	15+547	104	SSP-VIL	-	11.0
15+747	15+870	123	SSP-VIL	-	11.5
15+965	16+562	597	SSP-10H	400x200x9x22	12.0

(5) Design of Upper Structure

The DFL of Pasig River ranges from EL. 12.10m to EL. 14.05m. Hence, the necessary top elevation of revetment is set between EL. 13.10m and EL. 15.05, which includes 1.0m freeboard.

Upper structures above the concrete coping are constructed considering inland terrain, land use condition and request from residents. Type of upper structure is designed based on the flow chart in **Figure R 3.1.4** considering a vertical wall, inclined wall or combination of them (refer to **Figure R 3.1.5**).

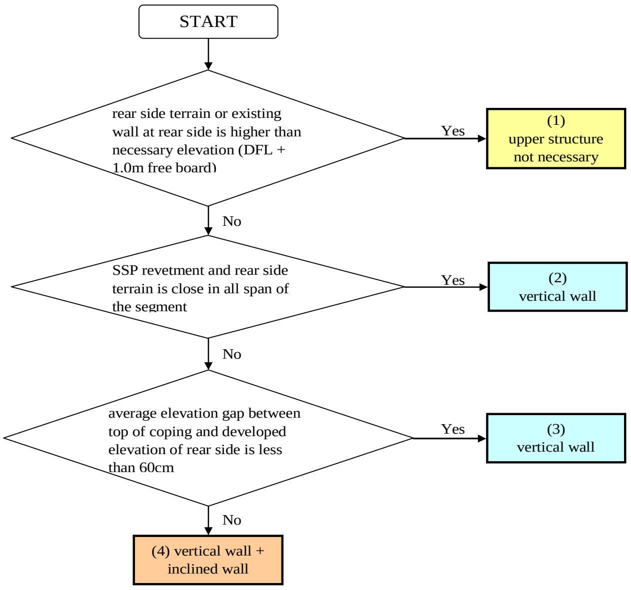
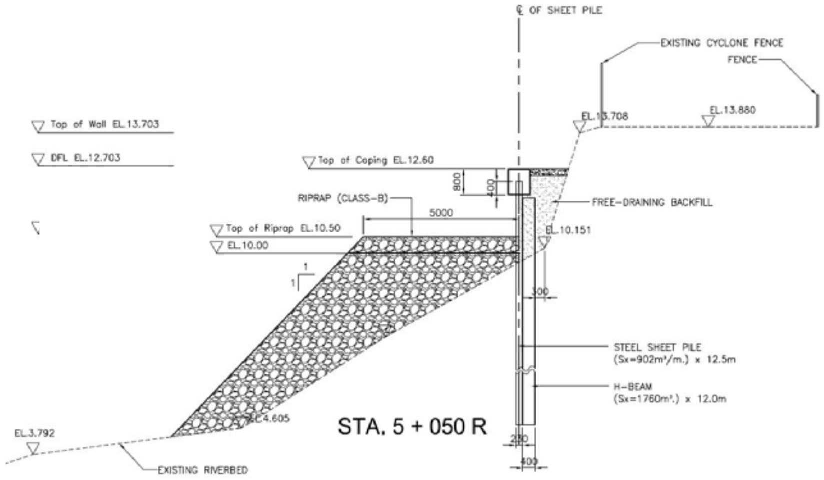
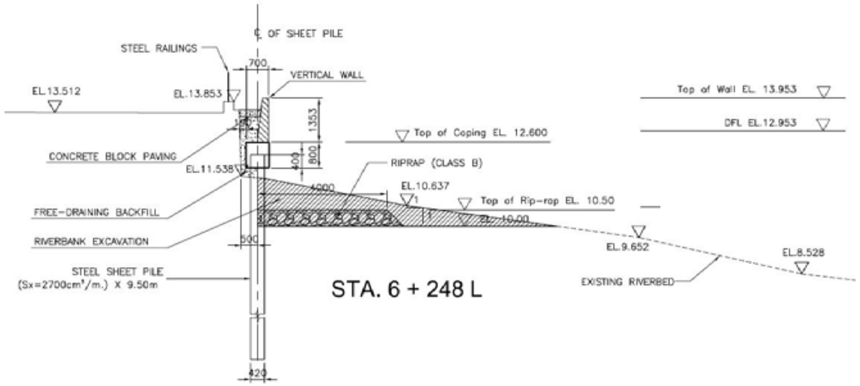


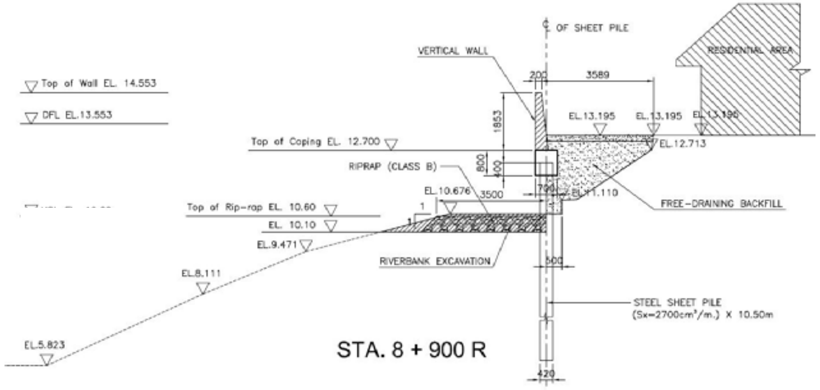
Figure R 3.1.4 Flow Chart for Selection of Upper Structure



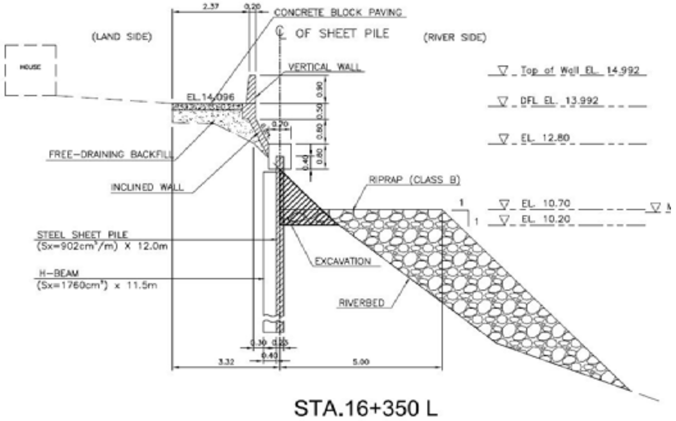
(1) upper structure is not necessary (rear side terrain is higher than necessary elevation)



(2) vertical wall is installed (steel sheet pile revetment and rear side terrain is close)



(3) vertical wall is installed (elevation gap between top of coping concrete and developed elevation of rear side is less than 60cm)



(4) inclined wall and vertical wall are installed (other case of (1), (2) and (3))

Figure R 3.1.5 Typical Section of Each Type of Upper Structure

3.1.3 Basic Design of Harbor

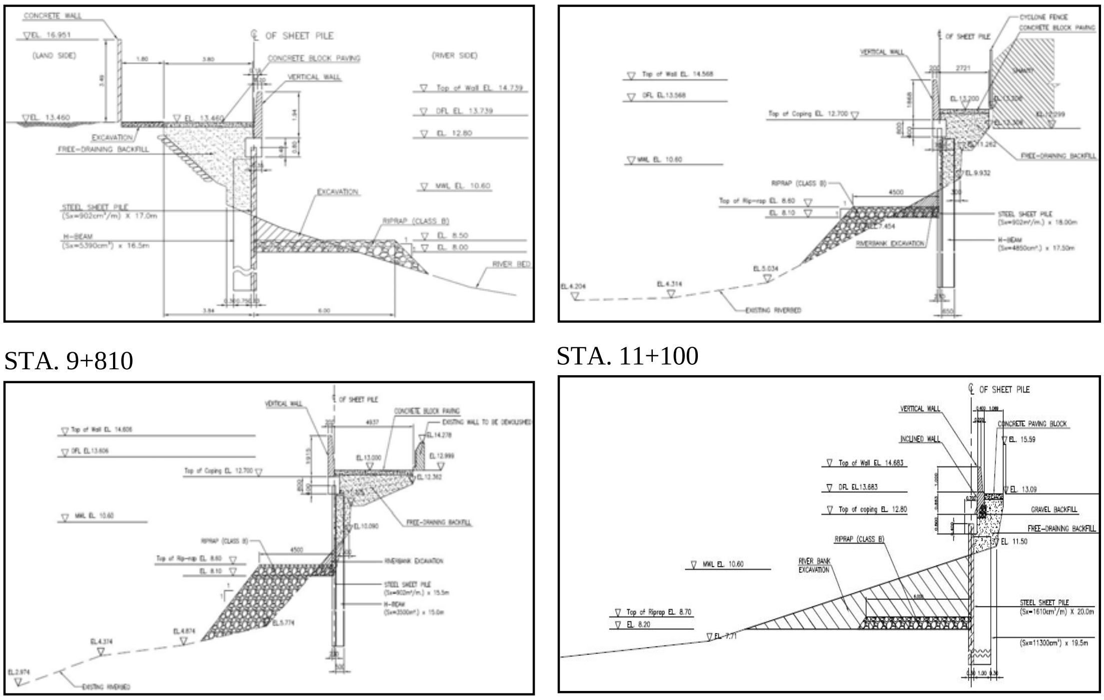
(1) Inventory of Harbor Revetments

Information regarding the detailed locations of harbor areas has been verified with the Coast Guard and PPA, but the negotiations with the stakeholders about the harbors have not been completed. As of the latest inventory, the required water depth of harbor areas has also been provided during the preparatory study as shown in **Table R 3.1.14.**

Table R 3.1.14 Design Condition of Harbor Areas in Preparatory Study

PHASE III: HARBOR AREA							
Location	Bank	Station	Elev. Of Riprap	Depth of Water (m)	Foundation		Length of Bank (m)
					Type	Pile Length (m)	
27	Leftbank	12+024～12+173	8.500	2.100	Revetment (SP with H-Beam)	19.00	149.00
19C	Rightbank	9+150～9+200	8.600	2.000	Revetment (SP with H-Beam)	18.00	50.00
21B	Rightbank	9+770～9+790	8.600	2.000	Revetment (SP with H-Beam)	15.50	21.00
22A	Rightbank	9+810～9+830	8.600	2.000	Revetment (SP with H-Beam)	15.50	29.00
23	Rightbank	10+957～11+263	8.700	1.900	Revetment (SP with H-Beam)	20.00	320.00
TOTAL HARBOR AREA							569.00

From the table above, the design water depth from the existing riverbed is basically 2.0m. Designed sections of harbor in preparatory study are shown in **Figure R 3.1.6**.


STA. 12+050

STA. 9+150

STA. 9+810

STA. 11+100

Figure R 3.1.6 Typical Sections of Harbor Revetment Designed in the Preparatory Study

In addition, information regarding Ferryboat Stations, which was provided by PRRC is shown in **Table R 3.1.15**. From the latest Phase III Plan, one station (No.6 Lambingan Station) is near the proposed repair area but this will not cause any problem because the revetment repair will not be conducted right on the ferry station.

Table R 3.1.15 List of Ferryboat Stations, from PRRC, 2012

No.	River	Station	Address	Condition	Owners	Note
1	Pasig River	Plaza Mexico Station	Intramuros Metro Manila	Operational	Govement-PRRC	
2		Escolta Station	Muelle del Banco Nacio Bonondo, Manila City M.M.	Operational	Govement-PRRC	
3		Lawton Station	A. Villegas St. Ermita, Mnila City M.M.	Operational	Govement-PRRC	
4		PUP Station	Anonas St. Sta. Mesa, Manila City M.M.	Operational	Govement-PRRC	
5		Sta. Ana Station	2467 E. Pedoro Gil St. Sta. Ana Manila City, M.M.	Operational	Govement-PRRC	
6		Lambingan Station	1500 MEF. MANALO St. Punta Sta. Ana M.M.	Operational	Govement-PRRC	
7		Hulo Station	764 Coronado St. Hulo, Makati M.M.	Operational	Govement-PRRC	
8		Valenzuela Station	A. Bonificio Valenzuela, Makati M.M.	Operational	Govement-PRRC	
9		Guadalupe Station	JP RIZAL St. Guadalupe Nuevo, Makati City M.M.	Operational	Govement-PRRC	
10		San Joaquin Station	44 BE San Bernardo St. San Joaquin Pasig City M.M.	Operational	Govement-PRRC	
11	Marikina River	Riverbanks	Brgy. Barangka Riverbanks, Marikina City	Non-Operational	Govement-PRRC	Affected by Ondoy
12		Rosario	Brgy. Rosario, Pasig City	Non-Operational	Govement-PRRC	
13		Kapasigan	Brgy. Kapasigan, Pasig City	Non-Operational	Govement-PRRC	
14		Maybunga	Dr. Sixto Antonio Ave. Brgy Maybunga, Pasig City	Non-Operational	Govement-PRRC	
15		Unisphere	-	Non-Operational	Unisphere Holdings	
16		Eastwood	-	Non-Operational	Eastwood Properties	

Note: The Gray Cell Station is located in Phase III.

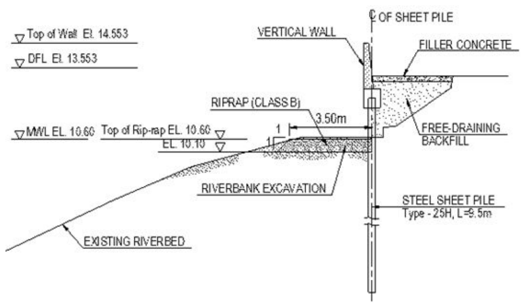
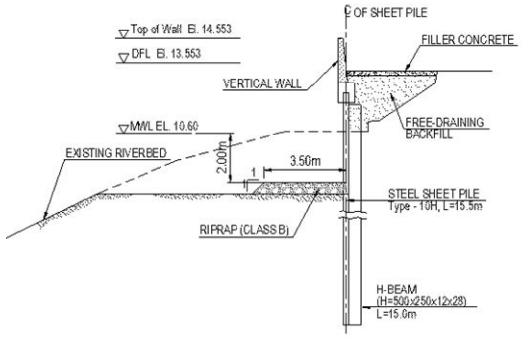
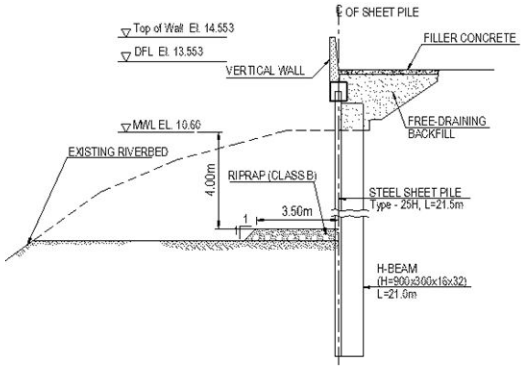
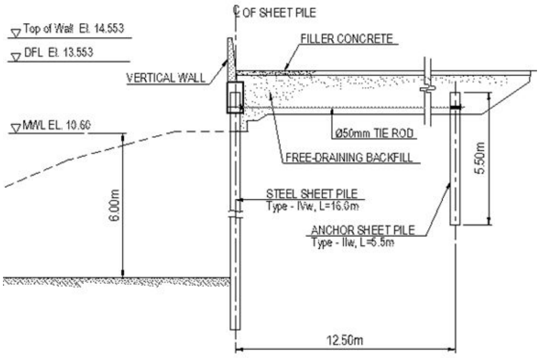
(2) Detailed Structural Design of Harbor Revetments

Three types of structural detail for the harbor are listed below. The appropriate design to adopt will be on case-by-case basis, depending on water depth. The estimated construction cost, required water depth, and standard structural drawing of harbor revetment is shown in **Table R 3.1.16.**

Case 1: Water depth is 2m, Cantilever Type Steel Sheet Pile Structure
Case 2: Water depth is 4m, Cantilever Type Steel Sheet Pile Structure
Case 3: Water depth is 6m, Tie Rod Type Steel Sheet Pile Structure

It shall be noted that the design water depth has to be set on present riverbed level or set as shallow as possible because the cost becomes expensive when water depth exceeds 2m. On the other hand, application of tie rod support shall be studied if there is ample easement space for supporting piles because tie rod support is more reasonable and cheaper than cantilever steel sheet pile in case the bed is deep.

Table R 3.1.16 Standard Structure of Harbors for Typical Water Depth

Water Depth & Type	Case-0: No-Consideration for Water Depth Cantilever Steel Sheet Pile	Case-1: Water Depth H=2m (for Boat) Cantilever Steel Sheet Pile
General Drawing		
Structural Variables	- Hat shape steel sheet pile, Type-25H, L=9.5m Riprap V=2m3 Parapet H=1.9m	- Hat shape steel sheet pile, Type-10H, L=15.5m H-500*250*12*28, L=15.0m Riprap V=2m3 Parapet H=1.9m
Cost (Peso/m)	Sheet Pile Costs 102,500 Riprap Costs 4,400 Vertical Wall 5,800 **Total Costs 112,700 Peso/m**	Sheet Pile Costs 414,600 Riprap Costs 4,400 Vertical Wall 5,800 **Total Costs 424,800 Peso/m**
Characteristics	- Inexpensive because of the shallow water depth	- Main assumed water depth for harbors in Pre-Study for Phase-III - Enough depth for boat which is used to crossing the river
Water Depth & Type	Case-2: Water Depth H=4m (for Barge/ Ferry Boat) Cantilever Steel Sheet Pile	Case-3: Water Depth H=4m (for Ship) Tie Rod Steel Sheet Pile
General Drawing		
Structural Variables	- Hat shape steel sheet pile, Type-25H, L=21.5m H-900*300*16*32, L=21.0m Riprap V=2m3 Parapet H=1.9m	- Wide shape steel sheet pile, Type-IVw, L=16.0m Anchor sheet pile, Type-IIw, L=5.5m Tie rod f50mm @2.4m, L=12.5m Riprap V=2m3 Parapet H=1.9m
Cost (Peso/m)	Sheet Pile Costs 920,900 Riprap Costs 4,400 Vertical Wall 5,800 **Total Costs 931,100 Peso/m**	Sheet Pile Costs 265,200 Anchor Sheet Pile 50,900 Tie Rod 40,000 Riprap Costs 4,400 Vertical Wall 5,800 Excavation & Restoration 100,000 **Total Costs 466,300 Peso/m**
Characteristics	- Very expensive because of the high wall height. Therefore, it is need that comparison between cantilever type and tie rod type which requires the additional space. - This water depth sturucure was partially adapted in on going Phase-II (Sta.6+613 to Sta.6+782, Water depth H=2.8-4.8m, with foot protection)	- Additional land space is required. - It is necessary that the mentioned above land should be purchased by the authority due to ensure the adequate river management. - One part of Phase-II was adapted to charge to the land owner based on his requirement. (Sta.10+146.8 to Sta.10+230, Water depth H=3.1m, without foot protection)

3.1.4 Review of Foot Protection

(1) Review Condition of Foot Protection

Foot protection works are placed at foot of the steel sheet pile to stabilize the revetment. Riprap as foot protection was constructed in Phase II but this has caused to damage some barges.

Therefore, a review of the appropriate foot protection method shall be conducted by considering its adverse effect on river navigation.

Enumerated below are the comments from DPWH concerning the design method of foot protection used in Phase II.

- No problem with respect to river cross-section constriction.
- There is a claim that damage to a barge was caused by the accidental collision with the foot protection,
- Re-examine other new technologies and structural methods of foot protection.

Hence, the above-mentioned points should be considered in the review of foot protection method.

(2) Review of Structural Method for Foot Protection

Four (4) types of revetment structures are compared as shown in **Table R 3.1.17**, namely:

Case-1: Riprap (On-going Phase II)
Case-2: Galvanized Gabion Mattress
Case-3: Geotextile Gabion Bag (Bottle Unit)
Case-4: Geotextile Gabion Mattress

Of these four types, Case-1 is selected due to least cost, adaptability to the project, durability against saline water, environmental safety, adjustability to riverbed deformation, low maintenance and repair cost, and workability.

The impact on river navigation, particularly the alleged damage to navigating barges, could be addressed by providing appropriate signboards.

In the following meetings, the basic concept for the river navigation and the countermeasure, which is the river navigation signboard, are explained and confirmed.

- July 10th, 2012: Coordination Meeting with DOTC, PPA and PRRC.
- August 1st, 2012: Pasig River Ferry Service Project- Briefer by DPWH Flood Control and Discussion with Attendees, DOTC, DPWH, MMDA, PRRC and PPA.

Table R 3.1.17 Comparison of Foot Protection

Construction Method	Case-1: Riprap (On going Phase II)		Case-2: Galvanized Gabion Mattress		Case-3: Geotextile Gabion Bag for Foot Protection (Bottle Unit)		Case-4: Geotextile Gabion Mattress	
Photography/ General Drawing								
Abstract of the Method	- Dry boulder riprap (300-400mm in diameter) - Standard method of foot protection in Philippines - No serious issue of workability and functionality based on the ongoing Phase II - Relatively expensive because of transportation form other islands		- Cage made of steel wires, which are galvanized because of countermeasures for brackish water - It is desirable not to use this at the places of the strong acidity and high salinity. - Use in the locations where boulders and driftwood must be careful.		- Geotextile gabion bags made of the recycled polyester form PET bottles - Due to the high strength chemical fibers, it is possible to be used at the low pH area and river mouth without rusting. - Use in the locations where boulders and driftwood must be careful.		- Geotextile gabions mainly made form polyethylene - It is used for alternative method in stead of gabion with retaining the characteristics of the gabion. - Due to the high strength chemical fibers, It is possible to be used at the low pH area and river mouth without rusting. - use in the locations where boulders and driftwood must be careful.	
Material	Fieldstone Gravel (Class-B)		Galvanized Wire		Geotextile: Recycled Polyester		Geotextile: Polyethylene	
General Allowable Velocity	Va = 5.0m/s > 3.0m/s（OK）	◎	Va = 6.0m/s > 3.0m/s (OK)	◎	Va = 4.3m/s > 3.0m/s (OK)	◎	Va = 6.0m/s > 3.0m/s (OK)	◎
Adaption for Project	Many projects especially in Philippines	◎	Many in Philippines and Japan, but a few in brackish water	◎/△	Recently increasing in Japan	○	Not many compared with Case-3 due to expensive cost	△
Durability for Brackish Water	- No problems of the fieldstone	◎	- Based on the result of Phase I investigation, the average chloride value of 1617 (ranged from 80 to 6000) mg/L in dry season is higher than 450 mg/L which is allowable content without the wire courting. - Because the salinity varies depending on the sampling depth, deep-water parts still remain of particular concern.	△	- No problems of the fieldstone - No issue about the bags due to the result against 3% sodium chloride test approved by Public Works Research Center	◎	- No problems of the fieldstone - No issue about the bags due to the result of sodium chloride and other tests	○
Environmental Aspect	- No problems of the fieldstone	◎	- For zinc used in rust prevention treatment, report (less than 30 mg/L) has been made of setting environmental standard form the Ministry of the Environment in Japan. - Because of the large mesh size, it is difficult to greening by plants.	△	- Hazardous substances, such as environmental hormones, do not contain because it is made form recycled PET bottles and polyester fibers. - Because of the small mesh size, it is easier than Case-2 to greening by plants.	○	- Hazardous substances, such as environmental hormones, do not contain because It is made form high strength chimerical fibers. - because of the small mesh size, It is easier than Case-2 to greening by plants.	○
Followability against Riverbed Deformation	- It is possible to adjust the deformation of the riverbed.	◎	- It is concerned about mal-function for foot protection due to spaces between each others caused by deformations of riverbed. - The wire diameter of gabion in Philippines is generally thinner than Japan's one, so it is easier to follow the deformation.	△	- It is possible to follow the deformation of the riverbed because of the flexible material bags.	◎	- It is concerned about mal-function for foot protection due to spaces between each others caused by deformations of riverbed.	△
Effect against River Navigation	- The request for changing foot protection method form the river navigation's stakeholders, because barges have been damaged by contact.	△	- Less influences against river navigation due to weak strength of the cage and small size particles of fill materials	◎	- Less influences against river navigation due to flexible bag and small size particles of fill materials	◎	- Less influences against river navigation due to flexible gabion cage and small size particles of fill materials	◎
Maintenance and Repair	- Easy due to dumping and leveling on the top layer	◎	- Relatively not so easy for repair due to dry work needed	△	- easy due to additional setting on the top of geotextile bag	○	- Relatively not so easy for repair due to dry work needed	△
Workability: Site Preparation	- Only rough leveling	◎	- Need for elaborate leveling before construction	△	- Only rough leveling due to good flexibility	○	- Need for elaborate leveling before construction	△
Mechanized Construction	- Possible		- Manual set on the site and backfill by the manual and machine		- Possible		- Manual set on the site and backfill by the manual and machine	
Under Water Execution	- Possible		- Basically dry work condition - Coffering or diver is required for some cases.		- Possible		- Basically dry work condition - Coffering or diver is required for some cases.	
Construction Speed	- Speedy due to dumping and leveling mainly by backhoe		- Relatively slow due to the man-power construction		- Relatively fast due to mainly mechanized construction		- Relatively slow due to the man-power construction	
Cost (Peso/m)	Material Costs 8,000 Const. Costs 9,000 **Total Costs 17,000 Peso/m**	1	Material Costs 24,000 Const. Costs 25,000 **Total Costs 49,000 Peso/m**	2	Material Costs 34,000 Const. Costs 19,000 **Total Costs 53,000 Peso/m**	3	Material Costs 94,000 Const. Costs 25,000 **Total Costs 119,000 Peso/m**	4
Evaluation	- The most of the evaluations, especially including the cost, are better than the others and the damages of the barges are not so serious problems.		- The improvement for the river navigation is well, but the cost is greatly more expensive than the Case-1. In addition, the durability against the brackish water is questionable. Therefore, it is difficult to select this method.		- The improvement for the river navigation is well, but the cost is more expensive than the Case-1 and the Case-2. However, it is still possible to be adapted in the partial areas, such as foot protections about the piers because of the characteristics.		- The cost is most expensive than the others. Structure life is longer than the Case-2.	
	◎: Selection		△: Third Place		○: Second Place		△: Fourth Place	

Symbol Legend - ◎:Very Good, ○:Good, △:Fare, ×:Poor or Problem

(3) Calculation of Riprap Diameter

Stability of the riprap is checked using the following equation,

$$Dm1' = \frac{V_0^2}{E_1^2 2g(\rho_s/\rho_w - 1)}$$

Where:

D_m = Average Diameter (m)
V_o = Representative Velocity (m/s)
V_o = $\alpha1 \times \alpha2 \times Vm$ (Average Velocity)
= 1.35x0.90x2.315 = 2.951 = 3.0m/s
g = Gravitational Acceleration (m/s^2)
ρ_S = Stone Density, $\rho_S / \rho_W = 2.5$ (Approximately)
E_1 = Experimental Coefficient for Disturbance
(Ordinarily 1.20, Big Disturbance 0.86)

Standard specifications for riprap materials are shown in **Table R 3.1.18**.

Table R 3.1.18 Diameter of Riprap Materials

Unit Weight of Stones = 2.5 t/m3 (g/cm3)

Class	Minimum		Maximum		50% Weighting		
	Weight (kg)	Radius (cm)	Weight (kg)	Radius (cm)	Weight (kg)	Radius (cm)	Diameter (cm)
A	15	11.3	25	13.4	20	12.4	24.8
B	30	14.2	70	17.9	50	16.8	33.7
C	60	17.9	100	21.2	80	19.7	39.4
D	100	21.2	200	26.7	150	24.3	48.6

(Riverbed Slope = Level)

Dm1’=$3.0^2/\{1.2^2\times2\times9.8\times[2.5-1]\}$=0.213m

$$K = \frac{1}{\cos\theta\sqrt{1 - \frac{\tan^2\theta}{\tan^2\phi}}} = \frac{1}{\cos 0\sqrt{1 - \frac{\tan^2 0}{\tan^2 41}}} = 1.000$$

Dm1=K×Dm1’=100×0.213 = 21.3cm

Therefore, Average Diameter Dm = 21.3cm

→Riprap material = Class-B (33.7cm)

(Riverbed Slope = 1:2)

Dm1’=3.0^2 / $\{1.2^2\times2\times9.8\times[2.5-1]\}$= 0.185m

$$K = \frac{1}{\cos\theta\sqrt{1 - \frac{\tan^2\theta}{\tan^2\phi}}} = \frac{1}{\cos 26.6\sqrt{1 - \frac{\tan^2 26.6}{\tan^2 41}}} = 1.368$$

Dm1=K×Dm’=1.368×0.213=29.1cm

Therefore, Average Diameter Dm = 29.1cm

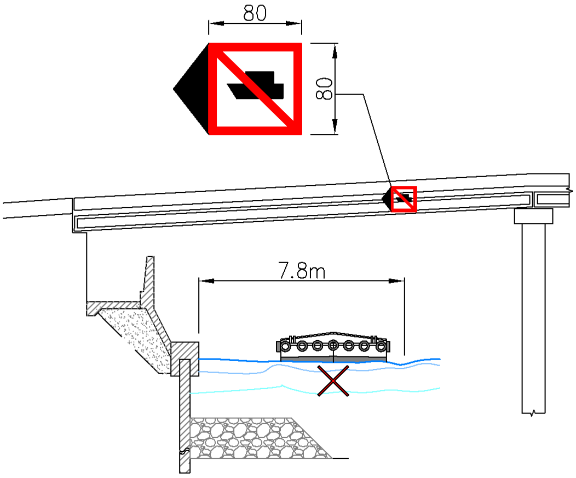
→Riprap material = Class-B (33.7cm)

(4) River Navigation Signboard

For safety in river navigation, watercrafts such as barges should not be allowed within at least 7.8m of the foot protection works.

River navigation signboard sized 0.80m square **(Figure R 3.1.7)** should be attached where they are visible, instructing all watercraft to stay at least 7.8m away from the revetment.

The decision to use these signboards will be finalized in a meeting between the DPWH and the Philippines Coast Guard (PCG).



Note: 7.8m is a tentative agreement originated from a meeting with the Study Team and PCG and it was originally based on the width of barges.

Figure R 3.1.7 Signboards for Safe Navigation of Pasig River

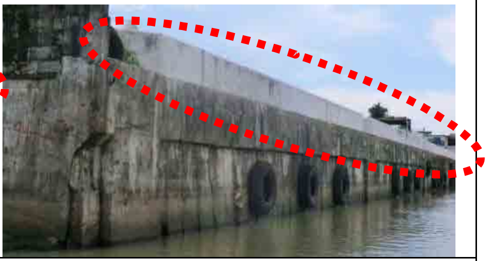
3.1.5 Basic Design of Reinforced Concrete Floodwall

3.1.5.1 Design Condition

In accordance with the specifications for repair as earlier shown, the reinforced concrete floodwall will be repaired under Phase III. This will be constructed where the elevation of top of coping concrete is not sufficient (i.e., DFL + 1.0m free board), even if the the foundation of the existing revetment is still in good condition. The features and design conditions of Type-II and Type-IV reinforced concrete floodwalls are shown in **Table R 3.1.19.**

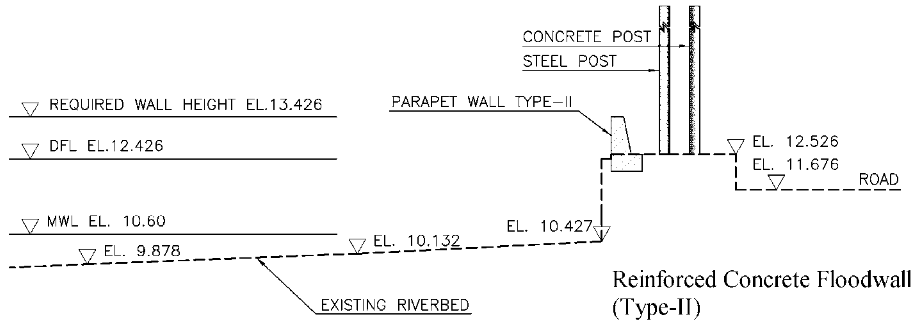
The figures of Type-II and Type-IV reinforced concrete floodwalls are shown in **Figure R 3.1.8**. The general sections of each type of floodwall are shown in **Figure R 3.1.9**. The most suitable type of floodwall will be designed and apllied based on thorough evaluation of existing site conditions.

Table R 3.1.19 Type and Design Condition of Reinforced Concrete Flood wall

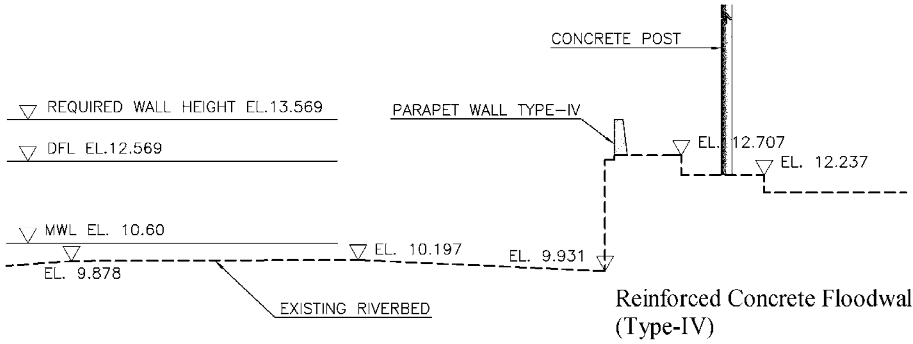
<table>
<tr><th>Item</th><th colspan="2">Floodwall (Type-II)</th><th>Floodwall (Type-IV)</th></tr>
<tr><td>Construction Method</td><td colspan="2">Demolish the existing pavement of the revetment - rear road section to lay the foundation of the floodwall
</td><td>Install the anchor bars on the existing retaining wall or existing revetment. Lay the concrete parapet wall on top of the retaining wall by jointing the reinforcing bar to the anchor bars.
</td></tr>
<tr><td>Design Condition</td><td>Load Cases</td><td colspan="2">Normal, Seismic, Wind, and Flood Condition</td></tr>
<tr><td></td><td>Material Unit Weight</td><td colspan="2">Same with the design of concrete revetment</td></tr>
<tr><td></td><td>Seismic Coefficient</td><td colspan="2">k=0.20</td></tr>
<tr><td></td><td>Wind Load</td><td colspan="2">qs=1.5kN/m²</td></tr>
<tr><td></td><td>Design Flood Level</td><td colspan="2">Highest Flood Water Level＋1m</td></tr>
<tr><td></td><td>Friction Coefficient Against Sliding</td><td colspan="2">f = 0.6 (assumed leveling concrete is installed before constructing of the floodwall)</td></tr>
<tr><td></td><td>Surcharge</td><td>Floodwall（Type-II）</td><td>Floodwall（Type-IV）</td></tr>
<tr><td></td><td></td><td>Normal：4.79kN/m²
Seismic：2.40kN/m²</td><td>Normal：10kN/m²
Seismic：5kN/m²</td></tr>
<tr><td></td><td>Calculation of Stability Condition</td><td>Overturning
Eccentricity should not exceed 1/3 of the base width.
Sliding
SF≥1.2
Bearing Capacity
SF=3</td><td>Necessary diameter and quantity of reinforcing bar is calculated and designed hence the floodwall is connected with foundation or top of retaining wall by anchor bars.</td></tr>
</table>

Reinforced concrete floodwall (Type-I) with handrail was recommended in Phase II. However PMO requested to modify this to type-III during construction, inasmuch as the former has not been constructed at all. It is deemed that floodwall Type-I will not be adopted in Phase III.

Furthermore, Type-III is the same section as Type-II and it is used in the case of the exsiting concrete block structures. Therefore, no calculation of the Type-III is conducted in the basic design, because the structural safety of the Type-III is equal to/ better than Type-II.



Reinforced Concrete Floodwall (Type-II)



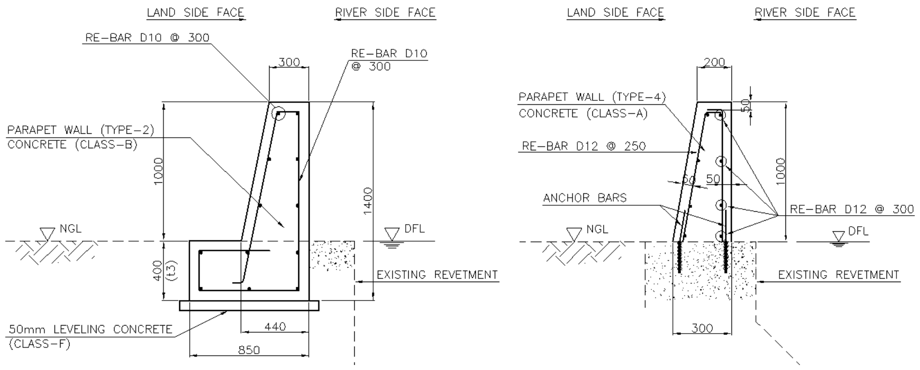
Reinforced Concrete Floodwall (Type-IV)

Figure R 3.1.8 General Sections of the Floodwall

3.1.5.2 Design Calculation of the Floodwall

The floodwall types enumerated below are recommended in Phase III. The result of design calculations is shown in **Figure R 3.1.9**.

- Reinforced concrete floodwall (Type-II) with 1m wall height
- Reinforced concrete floodwall (Type-IV) with 1m wall height



(Type-II Drawing) (Type-IV Drawing)

Figure R 3.1.9 Cross Sections of Reinforced Concrete Floodwall based on Design Calculation

3.2 Summary of Basic Design of Lower Marikina River Improvement

3.2.1 Scope of Basic Design of Lower Marikina River Improvement

3.2.1.1 Design Condition

Outline of revetment structures against flood along Lower Marikina River and accompanying facilities were put into execution in this Basic Design.

The conditions or prerequisites in Basic Design are as follows:

- The centerline of river follows the design in Phase I in 2002 is to be adopted.
- With reference to the sections of revetment structures and the types of structures, outputs in Phase I in 2002 and the Feasibility Study in 2010 (refer to **Figure R 3.2.1**) should be given serious consideration, however, they should be reviewed depending on the change of situations, such as expansion of ranges of houses into the river and new construction and so on, and the result of geological survey and so on.

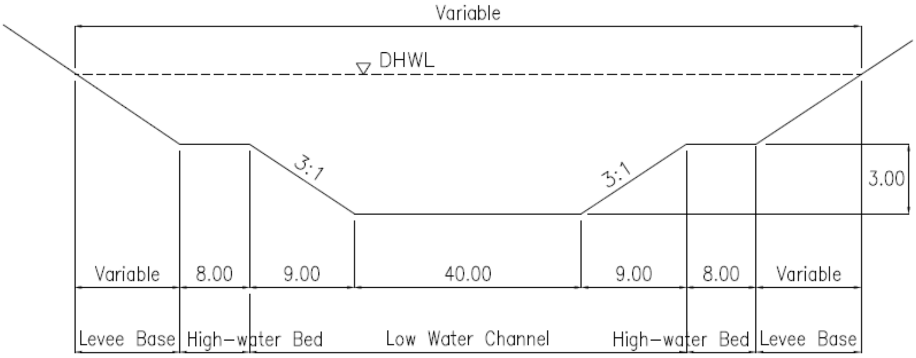


Figure R 3.2.1 Standard Cross Section of River

- Design river bed level and design high water level (DHWL) in Phase I in 2002 is to be adopted.
- Pasig City is planning to build roads along whole river sides of Lower Marikina River, and Basic Design follows its planning. An elevation of roads is uniformly 15.0m.
- Centerline of dredging shall be reviewed because of large change of river bed, such as progress of sedimentation of soil more than 1.0m, new bridge construction, change of water route and so on.
- In order to process dredge earth and sand effectively, perform the basic design about a temporary soil storage site and a soil disposal site. However, in this time, a final agreement with the landowner about lot lease of Laguna soil disposal site has not been reached yet.

3.2.1.2 Design Range in Lower Marikina River

The items of design and study with their contents implemented in the Basic Design are as shown in **Table R 3.2.1** and **Table R 3.2.2**.

Table R 3.2.1 Design Items and Contents

	Design Item	Bill of Quantities		Contents
1	Alignment of revetment	Whole river line	5,400m×2	Proposal of an alignment of river revetment along a river
2	Design of Revetment (Dike Structure)	3 sections	1,890m	Study of basic structures at dike sections and their design
3	Dredging	Whole river line	5,400m	Design of an alignment for dredging and sections
4	Temporary Soil Storage Site	Napindan	1 set	Study of jetties for soil transportation , muck pits, a sand basin, temporary soil storage facilities and so on
5	Backfill Site	Laguna	1set	Design of a backfill site, a jetty and so on
6	Boundary Bank	Whole river line	5,400m×2	Comparison of dehydrate tubes for dredging soil and study of locations
7	Foot Protection around Piers		5 places	Study of protection method and its design

Table R 3.2.2 Site Investigation Items and Contents

	Study Items	Bill of Quantities		Contents
1	Evaluation of Existing Revetment	Whole River line	5,400m×2	Study of hazard evaluation for both sides against flood and ranges of installation of revetments
2	Evaluation of stability of new-built wall	1 place		Investigation on a wall in Rizal High School

3.2.2 Site Investigation

(1) Evaluation of Existing Revetment

The review of the Preparatory Study in 2010 was made in consideration of the change of land forms etc. based on the site reconnaissance investigation and hearing conducted on the whole areas along Lower Marikina River from a view point of flood protection. Evaluated areas are shown in **Figure R 3.2.2**.

Evaluation items are as follows:

- Flood area and flood water level
- Condition of land use and building (house and factory)
- Flood Duration at 2009 (Typhoon Ondoy)
- Experience of flood from river
- Evacuation center, distance and time
- Existence of wall

Figure R 3.2.2 Hazard Evaluation of the Sections along Lower Marikina River

(2) Site Investigation on Built Wall

The floodwall in Rizal High School, which location was shown **Figure R 3.2.3**, was built by Pasig City was investigated and evaluated. It was found that the wall is located at a high ground elevation, and it can withstand flood pressure in the view point of structural stability.

(a) Site Investigation on Existing Floodwall

Site investigation on the existing floodwall was made as follows;

Site : a ground of Rizal High School on river side in Caniogan Barangay of Pasig City (refer to **Figure R 3.2.3**)

Date : June 6, 2012

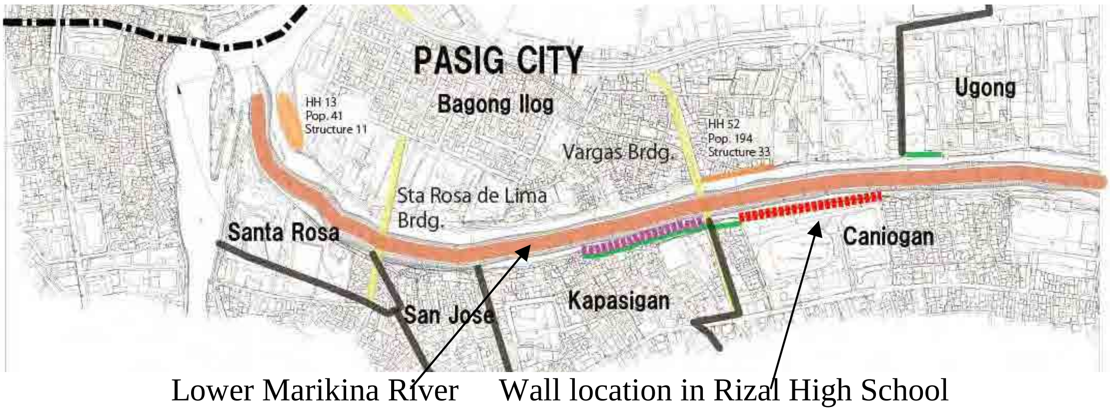


Figure R 3.2.3 Location of Rizal High School

(b) Section

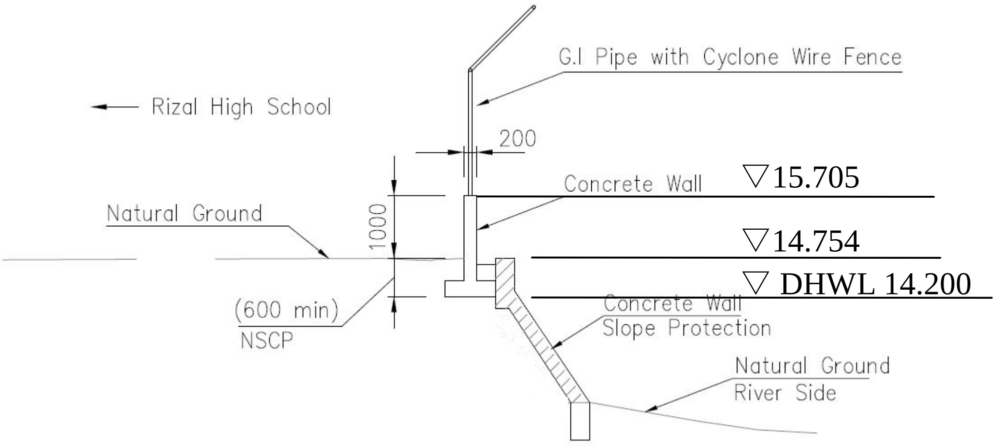


Figure R 3.2.4 Section of Wall in Rizal High School

(c) Wall Structure

The wall is an inverted T-shaped reinforced structure with a height of 1.60m from ground, and 0.2m in thick. Foundation is estimated to be 0.60m in depth in Philippines Standard Code and also estimated to touch on an existing slope wall from sizing up of location. A distance of 30cm between both walls would lead to that of a foundation would be 0.25m~0.30m thick and 0.80~0.90m wide. And there is a opening section on the side of wall. Cross-Section of the floodwall was shown in **Figure R 3.2.4**.

(d) Evaluation as structure

The wall is planned by Pasig City after Typhoon Ondoy in 2009, and the construction completed in 2011. Therefore conditions of concrete and wire net fence are well and no damaged portion can be seen at the moment. The wall is designed mainly to set the net, and it can be estimated to stand up the water pressure as an inverted T-shaped wall in a structural view point.

The height of this wall has cleared the height which added margin quantity Fb to the design high water level. Moreover, it is necessary to work on a certain measure about an opening section.

3.2.3 Basic Design of Dike

3.2.3.1 Arrangement of Design Conditions

(1) General

About the design criteria arranged in the Basic Design Report (I), the Design Criteria of the Philippines and Japan were compared and they were reconfirmed. In the process of comparison, the following main conditions were determined.

- Calculation method shall be Allowable Stress Method. (ASM)
- Seismic force, wind load, etc. are with the standard of the Philippines about that out of which the characteristic of the area in the Philippines comes.
- About the strength of material, it carries out according to the standard of the supply country. (Example: Japan in case of steel)

(2) Lower Marikina River

Geological condition of Lower Marikina River features a higher rate of cohesive soil and lower N values than Pasig River. Although liquefaction does not occur, generating of consolidation settlement is expected. Side resistance must also be weak, therefore it must be the structure which suited revetment form at it.

Alignment of revetments shall be as smooth as being able to reduce the friction by a flood. Since there is a possibility that the dredge consists of new sediments on a surface according to a flood, evaluation of a soil property shall be performed carefully. Moreover, the dredging volume shall be considered as the quantity which carried out extra embankment in the dredging, and was considered as the thing near an actual construction situation. Structures shall be the one that maintenance services can be reduced.

3.2.3.2 Study of Basic Structure of Dike

The bank inhibited the influence by scouring, corrosion, penetration, sucking, etc. to the 550m^3/s plan flood discharge with probability of 30 years, and determined specifications, such as top width, a paste slope, and a berm, so that the stability of the bank could be secured.

Moreover, since the flow velocity at the time of a flood is about 2.0m/s, the revetment as paste side protection shall be installed. In addition, in consideration of residents' movement, about 3.00m width on the land side of the present way shall be planned to keep so that not only under construction but after construction can secure the width. Existing roads consist of double 0.20m concrete walls with nets and 5.60m concrete pavement between them. Residents are requiring to keep 3m road within concrete pavement, so the range which can be used for the Dikes is 2.80m.of the rest.

3.2.3.3 Study of Dike Form and Location

(1) Review of Former Idea

This bank bears the dual functions of flood prevention, and also as road of Pasig City, and therefore needs to be designed in consideration of both functions. To meet this idea, the former proposal shown in the Phase I in 2002 (**Figure R 3.2.5**) is necessary to be reviewed and improved.

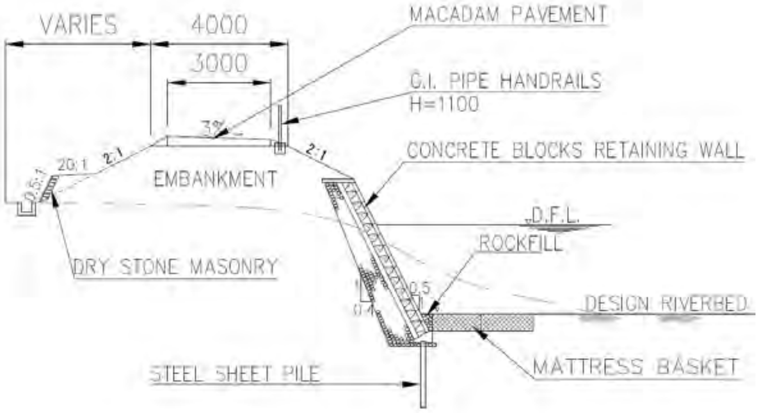


Figure R 3.2.5 Former Idea

Since the present bank proposal can secure only a 4m wide road to dike top, it is not the functional recovery to the 6-m road for which Pasig City asks. Therefore, change of form is needed in order to secure the width of street of 6m. Moreover, when the paste toes at the land side are set as a lot border, lot width required for bank construction will exceed 10m at least, and the necessity of reducing this will also be required from the point of securing cross sectional area.

Moreover, maintaining exchange of the place of residence of the right and left (the direction of north and south) of the bridge which the present road has achieved as another side of functional compensation and functional recovery is raised. For the purpose, the alignment of revetment needed to be planned in the form which connects the right and left of a bridge, therefore the original plan was changed, and revetment alignment was moved inside the abutments of a bridge.

(2) The reason for not adopting a both-sides embankment bank

Penetration and consolidation settlement of the foundation occur as a phenomenon which the foundation ground under a bank gives to a bank. It is thought that Lower Marikina River has much cohesive soil or quality of silt, and its water permeability is small. However, it is very weak: whose N value is about 1~2, and when carrying out the embankment of the banking to this poor subsoil, a possibility of subsidence of banking arising, and losing stability and producing large slide destruction. These are considered synthetically and the both-sides embankment bank is not adopted.

3.2.3.4 Qualitative Study of Dike Structure

As solution to the functional compensation in consideration of the policy which suppresses the increase in the bank lot by dike top extension as much as possible, while securing the lot of a 6-m road at a level with dike on top of a concrete block wall, in order to secure the 1.00m margin quantity Fb, the method of preparing a parapet wall on top of a concrete block wall is considered to be best which decreases lot width. Over Lower Marikina River whole stretch, the height of concrete block wall top is made into the level of 15.00m which is higher than a plan high-water level, and considering convenience in construction.

The following three forms of the new bank are considered in the new proposal. All serve as the form where the parapet wall is prepared on top of the concrete block wall.

- Idea of Concrete Block Retaining Wall
- Idea of Steel Sheet Pile
- Idea of Inverted T-shaped Wall

Comparative examination of each proposal showed that the concrete block wall is in conformity to poor subsoil with lowest cost and therefore considered as most suitable.

3.2.4 Basic Design of Reinforced Concrete Flood Wall

The concrete block retaining wall was designed as a reinforced concrete flood wall.

(1) Height of Dike

Top of the concrete block retaining wall set to 15.00m higher than a design high-water level (14.036~14.636), set the parapet wall height to 80cm and the parapet top to 15.80m to exceed the 1.00m free board from a Design High Water Level.

(2) Revetment Section

Figure R 3.2.6 shows the standard section of the concrete block wall. The base concrete (foundation) is considered to be reinforced concrete and is made to support with an impervious wall and IIw steel sheet pile to serve as wall support. The slope of shore protection is set to 0.5:1, and 4.0m maximum as specified by the DPWH. The concrete block retaining wall was considered as the mortar type, where the parapet wall of reinforced concrete is constructed in the upper part.

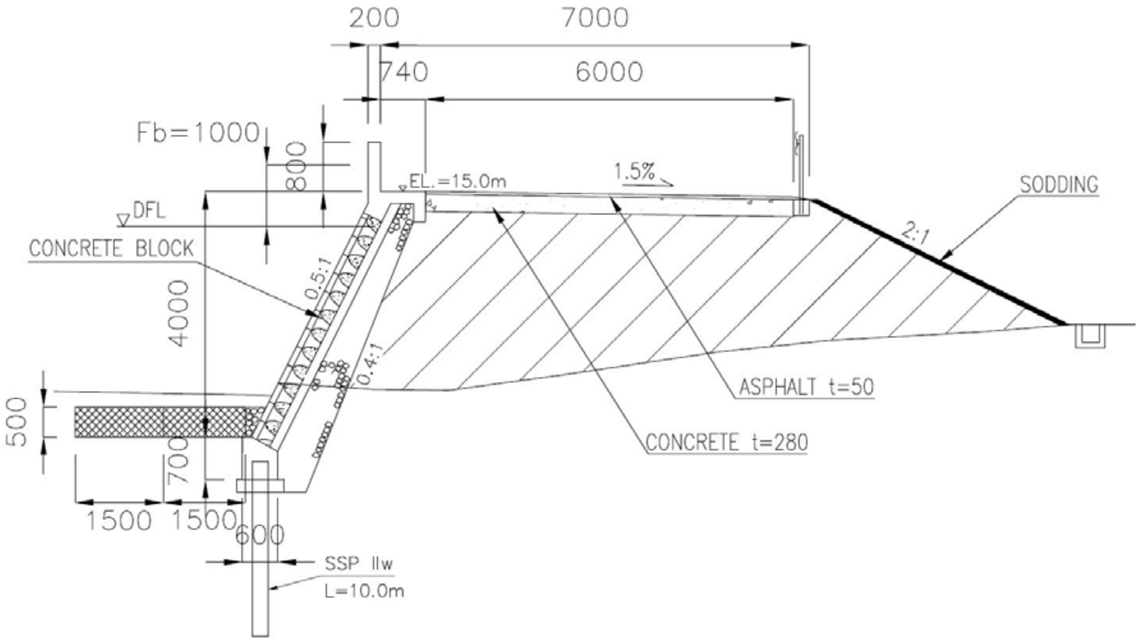


Figure R 3.2.6 Standard Drawing of Concrete Block Wall

(3) Base Structure

Since the Lower Marikina River coast cannot secure bearing power as it is directly in a weak zone, it needs to be supported with a steel sheet pile. Let the steel sheet pile be a 10-m friction pile. The foundation was 70cm in height so that 25.0cm could be secured from top of a steel sheet pile by the coping concrete of a steel sheet pile, and considered as reinforced concrete structure which set the breadth to 60.0cm.

Since the base setting depth at the present condition of the stream bed is in a quite low position and is not influenced by erosion, it aims at 1.0m or more. However, since it is steel sheet pile structure, and by constructing the gabion mattress for prevention of scouring to all of the base concrete, even if it is set at least 50cm or more, scouring problem would not arise. The steel sheet pile was used as common IIw type with the concrete block wall.

(4) Laying Blocks

Concrete blocks set in a depth of 35cm, and a concrete strength of 350kg/m^2 or more is used for it. A thickness of backfill concrete is 15cm. 16.5MN/m^2 concrete will be used for filling and backfill concrete.

(5) Expansion Joint

Expansion joint is of asphalt joint filler, and is planned to set at and interval of 10.20m in consideration of an interval of steel sheet piles.

(6) Drainage Works

One weep hole of φ50mm is set in 2.0~3.0m^2. However they are not set under a front water level.

(7) Parapet Wall

The parapet wall should serve both as top concrete and the head adjustment concrete of a block, and minimum thickness is 20cm and it considered it as the reinforced concrete structure which sets parapet height to 80cm.

(8) Partition Wall

Thickness of partition wall is 30cm, and is installed at the edge and medium of block walls, where partition wall is set at an interval of maximum 51m (10.2m×5 blocks). Thickness of partition wall in up-and-down direction is set to thickness of backfill +10cm.

(9) Road Pavement

The 6.00-m road as functional compensation is prepared. Pavement composition of the road is made into 28cm concrete pavement based on directions of DPWH in the 2012 fiscal year, and performed 5cm asphalt paving on it. The super elevation is made into 1.5%, and lowered the land side. The other design standards of the pavement are shown in **Table R 3.2.3**.

Table R 3.2.3 Thickness of Cement Concrete Slab etc.

Design of Pavement	**Design of Cement Concrete Slab**		**Interval of Contraction Joint**	**Tie bar (Lateral)**	**Dowel Bar (Longitudinal)**
	Design Bending Strength	**Thickness of Slab**			
Public	21.0 MPa	28cm	45m	φ16×600 40cm interval	φ16×600 40cm interval

(10) Guardrail

The guardrail for fall prevention was planned in the road shoulder.

(11) Foundation Embedment

Since bounding stones were few in the rivers, the gabion mattress is used for root hardening of the front of the foundation. The size of the gabion mattress is set to 0.50m x 1.00m x 2.00m, and was planned by 3 rows (1 m x 3= 3 m) from the foundation.

(12) Steel Sheet Pile

The steel sheet pile for base concrete support was considered as IIw type, and was made into the length of 10m in which the perpendicular support as a friction pile is possible.

3.2.5 Basic Design of Dredging

3.2.5.1 Dredging Section

Dredge section is planned as a low waterway which passes the maximum flow with recurrence interval of once in 30 years, the bottom width shall be 40m based on a section with side slope of 3:1 as shown in **Figure R 3.2.7**.

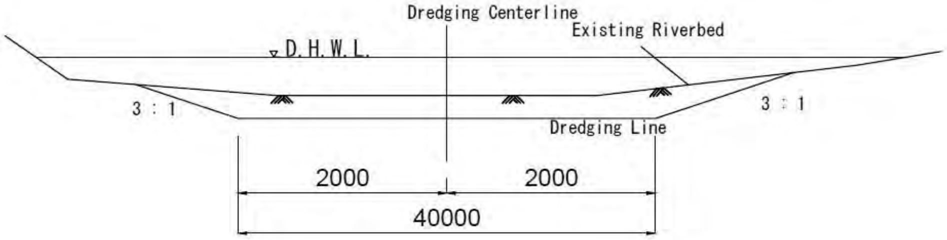


Figure R 3.2.7 Dredging Standard Section

3.2.5.2 Dredging Centerline

A dredge takes the bottom width of 40m as a low-water channel centering on a dredge center line. The dredge center line is considered as the center line between the planned revetment structures of both banks, and in order that to reduce resistance by running water and more flows, it was taken as smooth alignment.

3.2.5.3 Design Dredging Soil Volume

(1) Calculation of Soil Volume

The volume to be dredged is based on the new cross sections taken at 50m intervals. A calculation result is as follows. It differs largely from 600,000m^3 as the result of former investigation in 2002. It is because the deposition of earth and sand is increasing beyond an average of 1.0m quantity grade. Especially the increase by the side of the upper stream is remarkable.

・ Pure Soil Volume	:	970,280 m^3
・ Extra Dredging Volume	:	195,529 m^3
・ Dredging Volume	:	1,165,809 m^3

(2) Extra Dredging

Extra dredging (refer to **Figure R 3.2.8**) of 50cm thick at bottom and 2.0m wide at side as sandy soil are adopted.

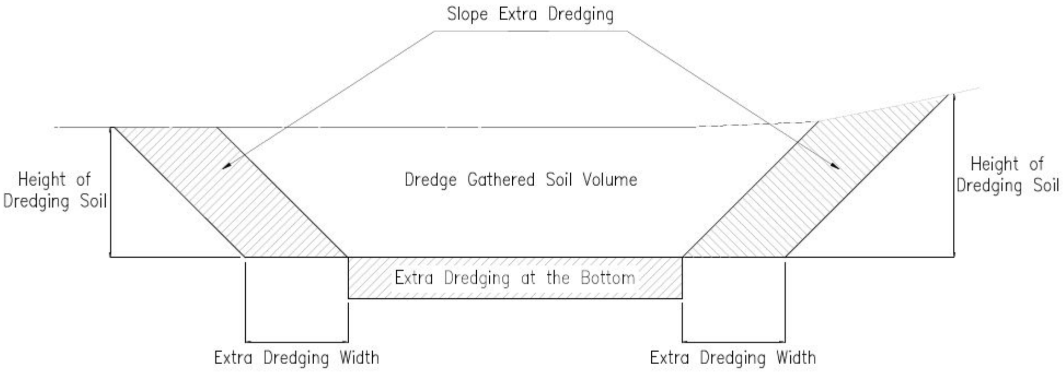


Figure R 3.2.8 Extra Dredging

3.2.6 Backfill Site Plan

(1) Temporary Soil Storage Site Plan

Dredging works are carried by barges from a dredge point to a temporary soil storage site. Then, soil is carried at a soil disposal site, with a part undergoing only drying, and the other part undergoing the process of lime or cement pre-mixing method of consolidation. Although negotiation with the present owners of the land is still in process, the temporary soil storage site is planned at Napindan and the soil disposal site is planned at Laguna near the mouth of Napindan River (Refer to **Figure R 3.2.9**).

(2) Storage Facilities

Facility planning at the temporary soil storage site has been formulated as to the availability of 2.8ha to be used now. The arrangement plan is shown in **Figure R 3.2.9**. About the stabilizing treatment storage part, it was presupposed as a primary storage facility that two sets of the pits (8m x 8m x 2sets) and two independent types (8m x 8m) are formed. Moreover, it presupposed the 30m * 8m mound that a maximum of 17 plans are prepared as secondary soil storage, and drainage canals for rain and outflow earth and sand are planned with trenches of 3m in width and 1m in height excavated between mounds.

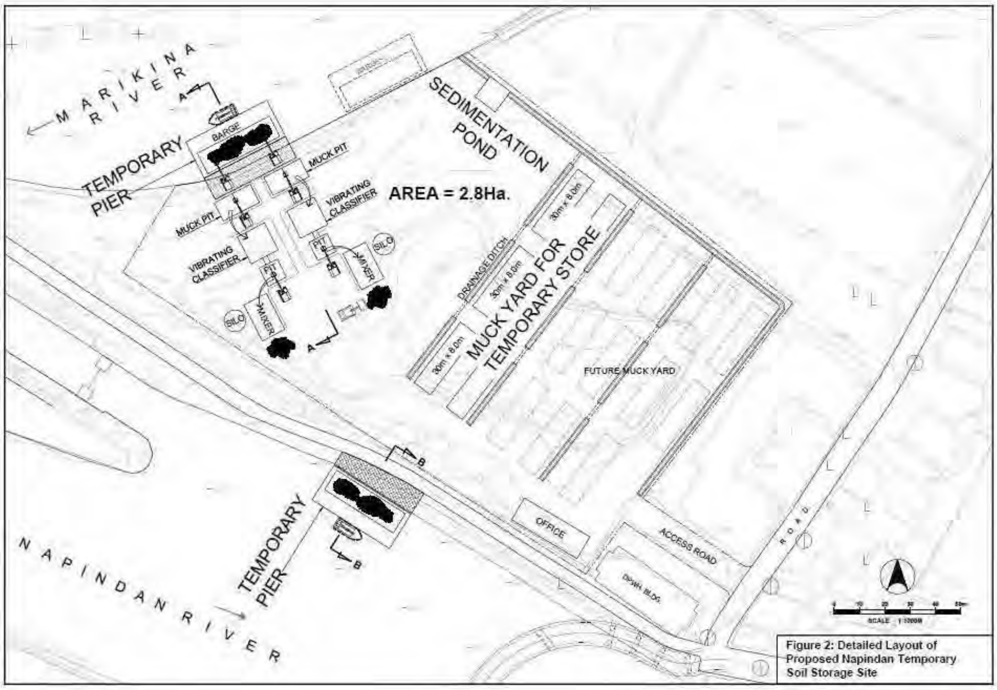


Figure 2: Detailed Layout of Proposed Napindan Temporary Soil Storage Site

Figure R 3.2.9 Plan Drawing of Napindan Temporary Soil Storage Site

(3) Temporary Pier

Piers with 50m long and 6m wide are installed at soil gathering and carrying out places. In this case, superstructures and approach slopes are fundamentally planned to be installed on land except that bearing piles are driven beside the wall on river side to reduce occupied areas on both rivers.

(4) Study of Backfill Site

(a) Basic Conditions

Study of the backfill site was made according to following items as basic condition

- Classification of soil: Dredged soil after stabilized treatment
- Necessary capacity: about 890,000m^3 (Disposal soil volume 810,000m^3, covering t=20cm 80,000m^3)
- If extra dredging occurs, the amount of part reclamation will increase.
- Site Area: 478,000m^2 (47.8 ha) is planned.
- Site Condition: grass field
- Maximum embankment height of dredged material is decided to 3.0 m by a circle slide method.

(b) Arrangement Plan

A soil disposal site banks with the dredged soil which undergone stabilizing treatment, and also consists of a carrying-in road, roads in site, settling basins, drainage installation, fences, an observation wells, temporary piers, etc. The arrangement plan is shown below in **Figure R 3.2.10**.

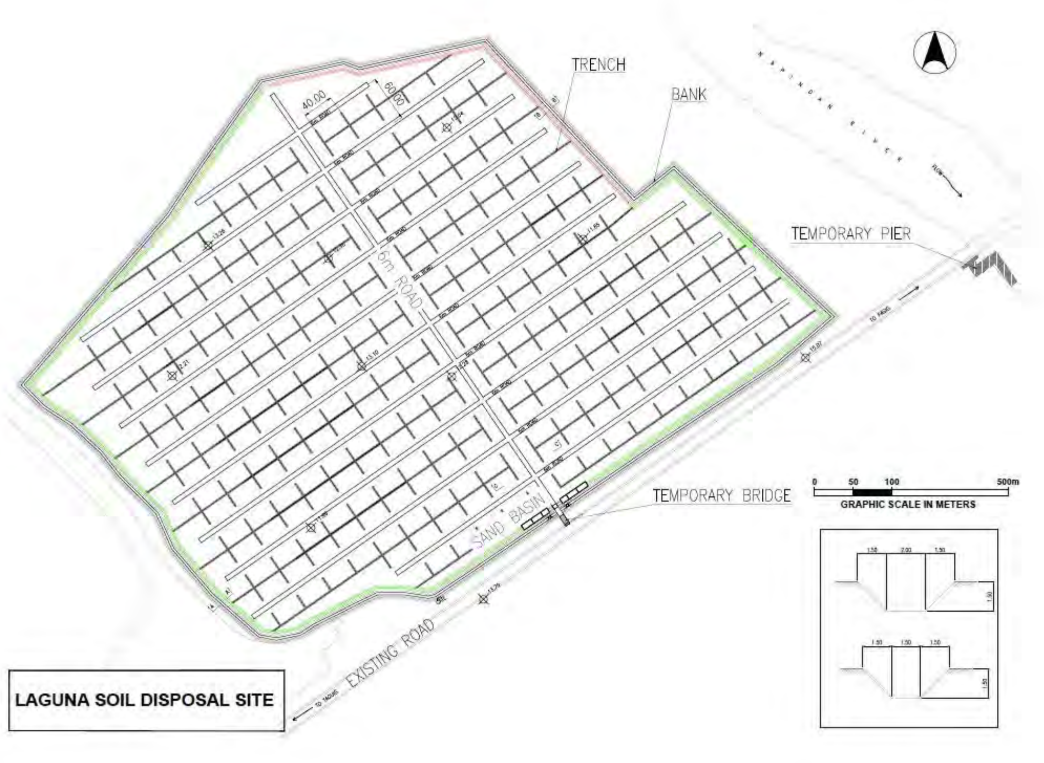


Figure R 3.2.10 Plan Drawing of Backfill Site

Rain is drained from the north-south side which is the topmost peg in a site through the ground waterway which has arranged the water collected with the trench along with the inner side of banking of a solid waste retaining structure based on geographical feature conditions. A settling basin is established in the end in the site which is low-order, the water which does not contain a part for sand will be poured to the drainage canal by the side of the Bicutan-Banglad road outside a site, and it processes. Trenches are made into a bottom 1m width grade, and are arranged at a 40 m interval.

Carrying in of soil crosses the temporary bridge through Bicutan-Banglad road side, and decided to carry in from the southeast side.

(5) Storage Structure (Embankment)

A storage structure (embankment) is made into the banking slope by the local generating material which gave the stable gradient 2:1. A top width of embankment shall be 3.00m and uses the existing road for drainage canal maintenance management in the Bicutan-Banglad road side. The circumference of the site constructed the zone stake by the precast, and secured security distance with banking 2m.

(6) Carrying-in and Site Road

The carrying-in road of earth and sand was 4.0m in width, and it planned it so that 10-cm-thick gravel paving might be performed in the range of 3.0m. A carrying-in road makes the maximum vertical slope 8%. About the site road, the 1.00-m road shoulder was established in a passing width of 4.0m, it was referred to as 6.0m in full width, and 20-cm gravel paving was planned about a 4.0-m portion. About a site road, a safe fence is prepared in both the road-shoulders portion. Moreover, a turnout is installed if needed.

(7) Embankment (Mound) Plan

Disposal soil are carried from site roads, and it is banked in the form of mound between trenches.

(8) Sand Basin

Sand basin is planned in consideration of the reclamation of a cell method as a RC tank with a 7.4m of longitudinal width, 40.4m breadth and maximum height of 4.0m. We divided the settling basin into 3 blocks, and decided to store sand in 2 blocks of the beginning. It was determined that the internal width of a settling basin will secure about 2 times waterway width.

(9) Drainage

In order that backfill soil may perform solidification processing by cement, the penetration drain system by under drain form does not make a meaning. Therefore, it was based on drainage by a ground waterway.

(10) Fence

People's invasion in a disposal site was avoided and the 2.0m or more-high fence was planned around the solid waste retaining structure to serve also as the splash prevention of soil (earth and sand).

(11) Temporary Jetty

Although referred to as 10m x 48m, the form of the temporary pier was planned, so that an about 30m approach part might be prepared. A temporary jetty is formed, which uses an H beam as a bearing pile. Although the position in which a temporary jetty is installed is carried out the right-bank side once near the project planning site on the right bank of a Napindan river, when use there is difficult, suppose that it prepares in the left-bank side on the opposite shore.

(12) Bench Mark

Bench marks are planned to the both ends of the road for maintenance management beside [by the side of southeast] a drainage canal.

(13) Observation Well (Water environmental monitoring system)

Two observation wells is planned at the lowest places at site and one is planned at northwest side and the highest portions.

3.2.7 Study of Boundary Bank

3.2.7.1 Comparison of Materials for Boundary Bank

In order to reduce dredged spoil fundamentally in boundary banking and to consider it as an aid of future full-scale banking construction, basic composition of banking is used as the tube which can perform the Bag-filling Dehydration Method where a dehydrating action occurs and can convert dredged spoil into a good soil property, and suppose it that cover soil of the surface is carried out.

There are two kinds of tube which are Japanese-made Eco-Tube and U.S. Geotube, for which comparative examination was performed. Eco-Tube was adopted as a result of the said comprehensive examination.

3.2.7.2 Purpose of Boundary Bank and Arrangement

Boundary banks are set so that a public-and-private boundary is clarified, and is installed for the purpose of a certain amount of flood prevention as banking. Moreover, making it get used with a future road, or the material in the case of banking construction and a part is also putting into the idea, and it uses the dried dredged spoil sand. Boundary banks are installed in the part except the part which cannot be installed like the places where new revetments are planned by this basic design in the Lower Marikina River, and also the places where houses, factories, or other institutions etc are.

3.2.7.3 Details of Boundary Bank

(1) Form of Boundary bank

Cover soil of the boundary bank is based on 30cm. The size of the bag of an Eco-Tube was based on 23m in length with the peripheral length of 4m in the general part (Refer to **Figure R 3.2.11**) .

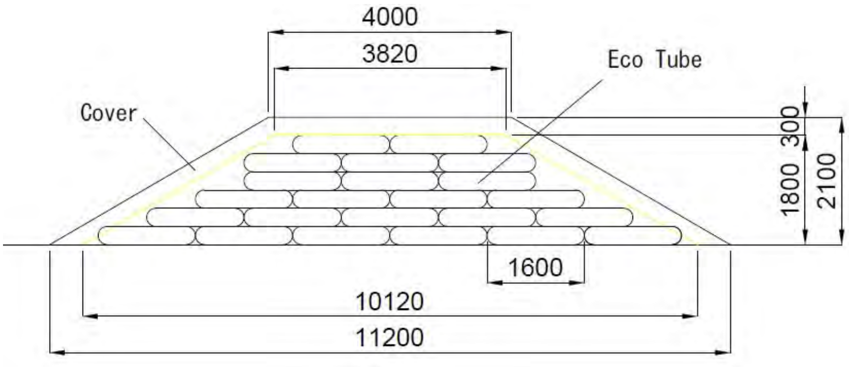


Figure R 3.2.11 Boundary Bank Section with Eco Tube

(2) Height of Bank

In the Lower Marikina River, the public-and-private boundary lines in a 3-m rule are mostly located in heights of a design high water level (DHWL) on the land. Therefore, banking height is made into the height which took margin quantity :Fb=1.00m into consideration from the design high water level (DHWL) from a viewpoint of the flood prevention as a role of banking.

(3) Estimation of Filling Soil Volume etc.

Basically with a fundamental expansion of 130% and dehydrating on the basis of 55% (Reduction ratio is 45%), treatment sediment volume was calculated for the amount of grounds with assumption shown in **Table R 3.2.4**.

Table R 3.2.4 Estimation Method of Filling Volume

Item	Calculated Amount	Remarks
Filling Volume per a bag (Conversion to ground volume) (A)	20m^3	
Expansion Ratio	130%	
Filling Volume per a bag (Conversion to Ground volume) (expansion conversion)	26m^3	(A)×Expansion ratio (130%)
Reduction Ratio	45%	
Filling Volume per a bag (after dehydration)	11m^3	(A)×(100 – Reduction ratio) / 100 Reduction ratio 45%
Bank area	12.55m^2	(3.82+10.12) / 2×1.80
Total bank area	15.960m^2	(4.00+11.20)*1/2*2.10
Surface area	3.41m^2	15.96-12.55
Embankment volume at 1,000m (B)	12,550m^3	Bank Area×1,000m
Ground Volume at 1,000 (C)	22,818m^3	(B) / (100 – Reduction ratio)×100% Reduction ratio45%
Transportation Volume at 1,ooom	29,663m^3	(C)×Expansion ratio (130%)

(4) Setting Range and Quantities

Setting of range and quantities, ground soil volume and ecotube bags, are estimated and shown below.

Total Construction Distance : 10,800 m
Ground Volume : 128,585 m^3
Nos of Bag (4.0mx23.0m) : 6,430 bags

3.2.8 Prevention of Piers Foot Protection Method

(1) Selection of Protection method of Piers

In order to prevent surrounding scouring of a bridge pier, when the height of basic top of a bridge pier has come out from 2m or less above a river bed, it is necessary to install foot protection on the upper and lower sides of stream.

As a foot protection, Riprap and Geotextile Gabion Bag (Bottle Unit) were selected with as high evaluation as the 1st place and the 2nd place as a candidate of bridge pier protection method using the result of **Table R 3.1.17**.

Next, we examined whether it would be suitable to protection of the bridge pier. Foot Protection needed to be correctly installed in the dredging section beside bridge piers, so we added the comparison from that viewpoint (refer to **Table R 3.2.5**).

Table R 3.2.5 Selection of Foot Protection for Pier

	Riprap	Bottle Unit
Work Progress Control	The work progress control is not easier than Bottle Unit, particularly on the slope under the water, due to large and inhomogeneous diameter of the boulder.	The work progress control is easier than Riprap due to relatively small and homogeneous diameter of the stone and flexible bag.
Impact on Pier	There is a possibility of doing damage at the time of installation.	Damage is not done in order to install the bag of polyester using a crane
Safety of Navigation	There is a possibility of damage caused by the hitting of boulder to barge. (Refer to 3.1.4 (1)) Since the existing piers is close to the ship course, the consideration must be given to this selection, particularly.	There is less possibility of damage caused by the hitting of stone to barge than Riprap, because of flexible bag and relatively small diameter of the stone.
Evaluation	×	○

As a result, the optimal Geotextile Gabion Bag (Bottle Unit) for protection of a bridge pier was selected because it had advantages on easiness of work progress control impact on piers and ship cruise.

(2) Range of Foot Protection around Piers

Range of foot protection works around the piers of Sta. Rosa Bridge, Old Vargas Bridge, New Vargas Bridge, Sandoval Bridge and Rosario Bridge after from the following calculation shown in **Table R 3.2.6**. The range of scouring is about 4~6m (3m is a temporary value), there is also a level difference of the design river bed by dredge from foundation , and planning of foot protection is being made in consideration of more widely encountered values than the following calculation range.

Table R 3.2.6 Range of Scouring

Bridge Name	Width of Piers		Range of Scouring(assumed β=L) L=1.45・D L=1+2.9・D /(H・tanθ)	Selected Range (From Edge of Foundation)
	D (m) Column (Foundation)	H (m) Column (Foundation)		
Sta. Rosa	1.50	6.50	2.79	3m or more
Vargas(Old)	1.50 (8.00)	8.00 (10.00)	(5.95) 5.02m	6m or more
Vargas (New)	Unknown	Unknown		
Sandoval	1.50 (4.10)	6.50 (7.40)	(5.95) 2.79m	6m or more
Rosario	1.40(2.40)	7.05(27.05)	(3.48) 1.45m	4m or more

θ：Angle of repose under water（Average 30°）

(3) Foot Protection Method with Bags (Bottle Unit)

Bottle unit method is the one that install a bag material in an exclusive form, fills material in it, ties up the neck with a rope, and moves and install it in a required place. Construction on land side is possible, and its setting work is also simple. Completed form is 1700mm in diameter, 550mm in height, and 300mm in perimeter height, and weight packs 50~100mm of broken stone into 1 ton. Therefore, when they installed, they are set to an average height of 425mm, and bridge piers shall be stacked with two layers of bags. Layouts of the bags are shown in **Figure R 3.2.12**.

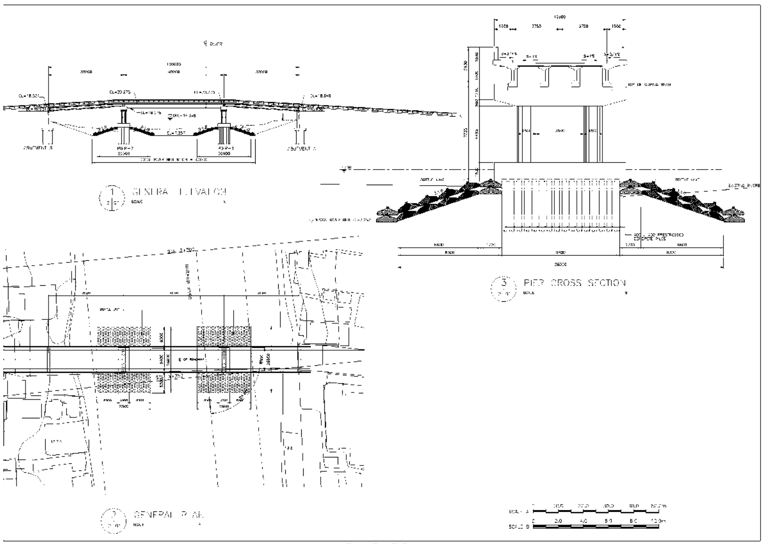


Fig. R4.7.2

Figure R 3.2.12 Foot Protection Works with Bags (Bottle Unit)

3.3 Summary of Basic Design of Drainage Works

3.3.1 Summary on Drainage Facilities

(1) Pasig River

The target areas for the detailed drainage design of Pasig River under Phase III have an aggregate length of 7.0km. These involve the stretches along Pasig River left from construction works in Phase II, which require Steel Sheet Pile (SSP) improvement works. A total of 777 existing sanitary and storm sewer outlets has been identified within these stretches.

Aside from allowing the unimpeded outflow of inland runoff, the drainage improvement plan aims to prevent or minimize backflow from these outlets during high flood stages of the Pasig River. Backflow is prevented by providing flapgates.

The number of outlets is minimized to reduce cost. For this purpose, the number of outlets, the geological characteristics, the network of existing outfalls and maintenance are considered. To reduce the number of outlets, collector pipes and U-ditches parallel to the sheet pile alignment are provided.

The proposed drainage facilities are summarized as shown in **Table R 3.3.1.**

Table R 3.3.1 Summary of Drainage Facilities for Pasig River

Proposed Facility	Quantity	Dimension
Outlet	172 RCP Locations	300mm ~ 1220 mm
	8 RCBC Locations	1570mm x 800mm, 1600mm x 1600mm
Manhole	231 Locations	Varying dimensions
Collector Pipe:		
RCP	500 m	300mm ~ 910 mm [1/]
RCBC	210 m	800mm x 800mm
PVC	910 m	100mm ~ 300mm
Steel	55 m	100mm ~ 300mm
U-Ditch	4490 m	W300mm x H300mm (min)
Flap Gate	39 Locations	300mm and 910 mm

[1/] The minimum of 300mm dia. indicated above is used only for roof and sanitary flows where the catchment area is too small. See Sub-section **3.3.1 (1)** for explanation.

(2) Lower Marikina River

The target areas for the detailed drainage design of Lower Marikina River under Phase III have an aggregate length of 1.8 km. These areas correspond to three linear park stretches along the Lower Marikina riverbank, namely, Kapasigan (left bank, 419m), Brgy. Ugong (right bank, 593m) and Rosario (left bank, 810m). These involve the construction of flood dikes with principal components consisting of cantilever steel sheet piles, earth embankment, asphalt paved maintenance road, concrete block slope protection, concrete parapet wall resting on the pile cap, and a drainage system.

The drainage system, which is an integral part of the dike structure, consists of sluiceways and collector pipes to drain inland runoff, and lateral ditch to drain the intervening area between the dike and the private property line.

Similar to the Pasig River, the number of existing outlets for the Lower Marikina River is also minimized to reduce cost by providing collector pipes to direct the flows into the sluiceway.

For the dike sections, 10 sluiceways with provision for new drainage outlets are proposed. The locations of proposed sluiceways are determined in consideration of the locations of existing drainage outlets as well as topographic features. The proposed sluiceways in basic design stage are shown in **Table R 3.3.2**. In detail design stage the length of dike become shorter, therefore the quantities and dimensions of drainage facilities are reviewed in **Chapter4**.

Table R 3.3.2 Proposed Sluiceway for Marikina River

Station Number	**Sluice Number**	**Sluice Dimension (m)**
STA. 1+104 (Left Bank)	MSL-1	1- Barrel 1.40 x 1.40
STA. 1+333 (Left Bank)	MSL-2	1- Barrel 1.50 x 1.50
STA. 3+945 (Left bank)	MSL-3	2- Barrel 1.20 x 1.20
STA. 4+233 (Left Bank)	MSL-4	1- Barrel 1.60 x 1.60
STA. 4+406 (Left Bank)	MSL-5	1- Barrel 1.00 x 1.00
STA. 4+503 (Left Bank)	MSL-6	1- Barrel 1.20 x 1.20
STA. 2+950 (Right Bank)	MSR-1	1- Barrel 1.20 x 1.20
STA. 3+157(Right Bank)	MSR-2	1- Barrel 1.40 x 1.40
STA. 3+258 (Right Bank)	MSR-3	1-Barrel 2.00 x 1.60
STA. 3+438 (Right Bank)	MSR-4	1- Barrel 1.50 x 1.50

Note: MSL: Marikina Sluiceway Left Bank
MSR: Marikina Sluiceway Right Bank

3.3.2 Existing Drainage Facilities

Ocular inspection/investigation was conducted before planning and designing the drainage facilities. Documents and drawings regarding the existing drainage lines and facilities were collected prior to the site inspection/investigation.

(1) Data Collection

Documents, drawings and reports were collected from the following:

- DPWH
- MWCI
- Mandaluyong City
- Report on “The Study on the Existing Drainage Laterals in Metro Manila in the Republic of the Philippines”, August 2000

(2) Site Investigation

(a) Conduct of Field Investigation

The Site Investigation of existing drainage lines and facilities was conducted from 28 May 2012 to 30 June 2012. The following main items were considered in the field investigation.

(b) River Side

- Field investigation was carried out along the river during sunny days/fair weather conditions when most of the outlets are visible which allows the observer to see whether water flows out from the outlet or not.

- Such observation is not possible during rainy days/adverse weather conditions.

(c) Land Side

- Consideration of land use around existing outfalls and pipes, for example, residential area, road, vacant area, etc., were noted.
- Point of origin of existing pipes coming for example from a catch basin, manhole, septic tank, house or building, conduit, etc., were noted.
- Type of usage of the pipes, for example rainwater or wastewater

(3) Extent of Site Investigation

The extent of investigation is as follows:

- Pasig River: the Stretch of remaining SSP gaps left from Phase II (about 7.0km).
- Marikina River: Stretch of dike (about 1.82km) and parapet wall segments (about 0.34km)

(4) Results of Site Investigation

(a) Pasig River

A total of 777 existing outlets were confirmed as discharging directly into the Pasig River as summarized in **Table R 3.3.3**. Each outlet is being used as point of disposal for various purposes such as those coming from downspouts, wastewater as well as services for the delivery or withdrawal of other liquids. In case of outlets less than 150mm, most of these are used for wastewater disposal. For outlets more than 300mm, these are used for rainwater and wastewater (combined).

Table R 3.3.3 Existing Pipes in Pasig River

Bank	RCPC	PVC	Box Culvert U-ditch	Steel Pipe	Total
Right	156	288	34	20	498
Left	124	117	18	20	279
Total	**280**	**405**	**52**	**40**	**777**

(b) Marikina River

A total of 87existing outlets were confirmed as directly discharging into the Lower Marikina River where the dikes are proposed. This is summarized in **Table R 3.3.4.** Each outlet is also used as point of disposal, same as those on the Pasig River. Several outlets are no longer functioning due to siltation.

Table R 3.3.4 Existing Pipes in Marikina River

Bank	RCPC	PVC	Box Culvert	Steel Pipe	Total
Right	31	2	1	0	34
Left	38	6	9	0	53
Total	**69**	**8**	**10**	**0**	**87**

3.3.3 Drainage Planning

(1) Basic Planning Conditions

(a) Design Scale

The Technical Standards and Guidelines for Planning and Design, Volume II: Urban Drainage, March, 2002 (referred herein as "Guideline") sets the design return period for drainage facilities at 5 to 10 years. Before this Guideline was published, the "Special Assistance for Project Formulation" (SAPROF), JICA, 1998, also stated that the design scale for main drainage and pumping station is 10 years. Existing main drainage systems and facilities including those constructed in PMRCIP-Phase II comply with this Guideline.

However, in lieu of these earlier guidelines, there was a DPWH Memorandum issued on June 2011 where Item 1b of the said Memorandum specifies the following to wit:

"1. The minimum flood return periods to be used for the design . . . .

b. Culverts

i. Box 25-year flood with sufficient freeboard to contain the 50-year flood.

ii. Pipe 15-year flood with sufficient freeboard to contain the 25-year flood."

Although freeboard, such as that of a pipe culvert, is not normally considered in closed conduit design, it is understood to mean that there should be enough allowance, in terms of cross-sectional area, to contain the next higher magnitude flood.

Along this line of reasoning, it is therefore enough to consider only the higher magnitude flood (i.e., 25-year for pipe) instead of the lower 15-year magnitude for pipe, as the latter would be of no significance.

In this regard, the design is conducted in accordance with the said memorandum.

(b) Minimum Size of Drainage Pipes

For storm runoff from the catchment, conduit size varies depending on the design discharge. In most cases, however, maintenance considerations govern the size of the conduit.

For the collector conduit that gathers the inland runoff of several parallel pipes from the catchment, the DPWH Memorandum of June 2011specifying the allowable minimum diameter of 0.91m, will govern. In addition, a minimum dimension of 0.80m x 0.80m box culvert would be adopted where they are more suitable.

In the case of roof and sanitary flows, however, a smaller diameter is adopted as the discharge is too small. Although this is also categorized as collector pipe, it is deemed that a smaller diameter ranging from 200 to 300 mm would be adopted.

(c) Land Use

Another aspect of the drainage planning is the consideration of land use. PMRCIP Phase I adopted a land use prevailing about 10 years ago which was also adopted in the review design of Phase II. Data gathered in Phase III reveals the following land use/zoning information (**Table R 3.3.5**):

Table R 3.3.5 Summary of Available Land Use [1/]

City/LGU	Land Use Issued
Manila	Year 2005
Mandaluyong	Year 2006
Makati	Year 2011
Pasig	No year (document issued is a proposed Zoning Map)
Marikina	Year 2000 (document issued is a Zoning Map)

[1/] These maps are on file

(d) Design Discharge

(i) Rational Formula

Peak discharge is proportional to the runoff coefficient, rainfall intensity and drainage area in accordance with the Rational Formula as shown below.

$$Q = \frac{CIA}{360}$$

Where:

Q = Design discharge (m^3/sec)
C = Runoff coefficient
I = Rainfall intensity (mm/hr)
A = Drainage area (ha)

According to the Manual for River Works in Japan, the rational formula is applied in case the catchment area is less than 200km^2. Almost all drainage catchment areas in Phase III are less than 0.1km^2 with a maximum catchment area of 0.9km^2. Therefore, design discharge is calculated using the rational formula.

(ii) Runoff Coefficient

The runoff coefficient, C, for various land use types, are shown in **Table R 3.3.6.** These were adopted in accordance with the "DPWH Design Guidelines".

Table R 3.3.6 Runoff Coefficient, C, for Land Use Type

Description of Area	C
Business (Downtown areas)	0.80
Industrial or Residential (with small garden)	0.65
Apartment or Residential (single unit)	0.50
Residential (suburban, with large garden)	0.35

Where multiple land use is found within a drainage area, the runoff coefficient for each sub-area was determined by taking the weighted average C value in proportion to the drainage area size as shown below:

$$C = \frac{A_1C_1 + A_2C_2 + ...A_NC_N}{A_T}$$

Where:

$C_1 \sim C_N$ = values of C for each sub-drainage area
$A_1 \sim A_N$ = sub-drainage areas
A_T = total drainage area

(iii) Rainfall Intensity

The 15-year and 25-year rainfall intensity probability have not been set in "The Preparatory Study for Pasig-Marikina River Channel Improvement Project (Phase III)", JICA, 2011, hence, additional calculation was done based on new data for Port Area, Manila as recorded by the PAGASA.

The general rainfall intensity formula for Port Area rainfall, using the Kimijima type equation, is shown below. Coefficients of the equation for different return periods are shown in **Table R 3.3.7.**

$$I_X = \frac{a}{T_C^n + b}$$

Where:

I_x = rainfall intensity for given return period (mm/hr)
T_c = time of concentration (min)
a, b and n are regression constants

Table R 3.3.7 Coefficients for the Kimijima Rainfall Intensity Formula

Return Period	Port Area		
	a	b	n
2	935.4	3.57	0.64
5	1,279.5	3.98	0.65
10	1,474.2	4.02	0.65
15	1,665.4	4.37	0.66
20	1,746.3	4.38	0.66
25	1,808.7	4.39	0.66
30	1,860.6	4.41	0.66
50	2,001.7	4.42	0.66
100	2,193.8	4.45	0.66

Time of concentration (Tc) is the sum of inlet time (Ti) and drain flow time (Td) as defined by the following formulas.

$$T_c = T_i + T_d$$

$$T_d = \frac{L_d}{V \times 60}$$

Where:

T_c = time of concentration (min)
T_d = drain flow time (min)
T_i = inlet time (min)

L_d = length of drain (m)
V = flow velocity along drain (m/sec)

Inlet time (Ti) is measured as the travel time of a water particle from the drainage divide to a point where a well defined channel starts. Suggested values of inlet times for different land use types are shown in **Table R 3.3.8.**

Table R 3.3.8 Minimum Inlet Time, T_i, for Land Use Type

Description area	**Inlet Time** (min)
High population density area	5
Low population density area	10
Average population density area	7

Note: Use 7 minutes minimum for this project.

With all of the above parameters known, the rainfall intensity, Ix, for any given return period is calculated using above equation. Alternatively, Ix could be calculated with the use of **Figure R 3.3.1**, which shows the relationship of rainfall intensity, duration and frequency (RIDF) in graphical format.

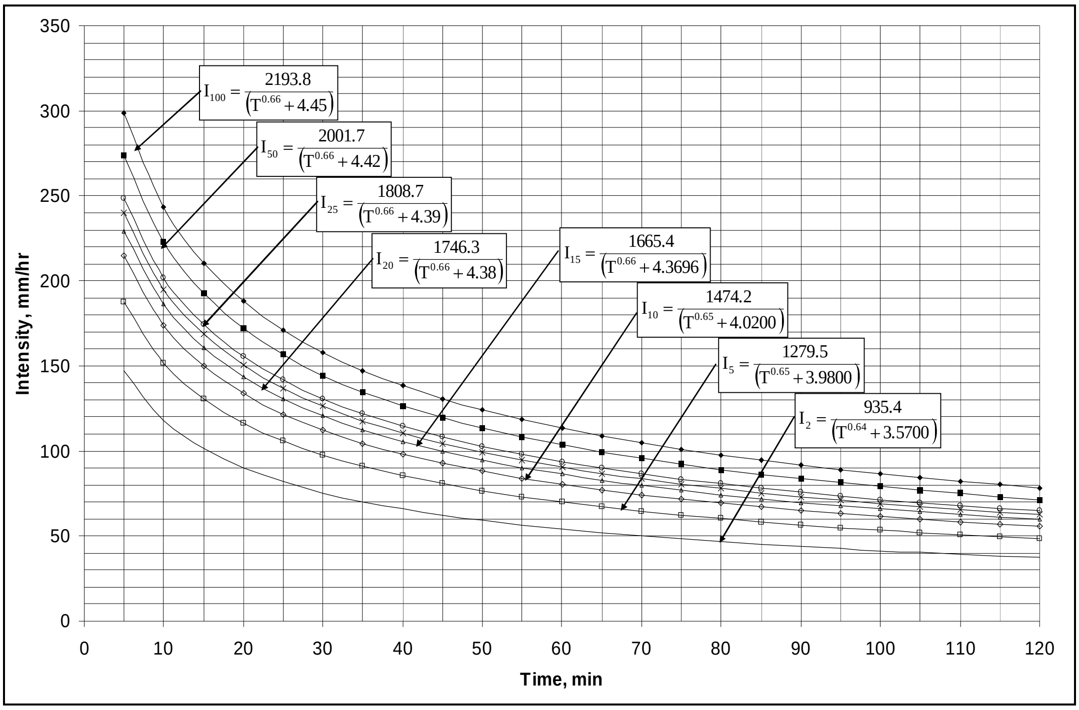


Figure R 3.3.1 Rainfall Intensity-Duration-Frequency Curves

(Port Area, Manila: 1906-1939, 1950-2005)

(iv) Catchment Area

Each of the sub-drainage areas draining into river is determined from a topographic map. (Most of the drainage areas are flat, hence, additional references are considered such as flow directions of existing drains, existing roads as well as other man-made structures that are possible indications of drainage boundaries.

Maps of the sub-drainage areas tributary to the whole stretch of the Pasig River and Lower Marikina River are shown in **Figures 3.3.1 and 3.3.2.**)

(v) Design Discharge

The design discharge of each outlet is calculated based on these conditions and consideration, the design discharge of each outlet is calculated and shown in **Table 3.3.1 and 3.3.2**.

(2) Drainage Planning for Pasig River

(a) Target Area

The Pasig River channel improvement consists of Steel Sheet Pile (SSP) works, parapet works and revetment repair works. For parapet and revetment repair works, the construction procedure will not affect the existing drainage system. Therefore, the target area for drainage planning for Pasig River will focus only on SSP segments.

However, In case, installing new parapet wall or renders an existing drain not to function properly, new outlet should be installed.

Under Phase III, the number of target existing outlets has increased remarkably as smaller diameter PVC pipes have to be considered. In the original drainage planning of Phase I and Design Review Stage of Phase II, the minimum diameter of the outlet is basically 300mm. Outlets less than 300mm were considered as illegally installed such that they have been excluded from the previous plan. The plan in Phase II was to seal off these outlets and that the owners must connect them to public manholes or inland drainage lines.

When the construction of Phase II started, LGUs deemed that it is the responsibility of the owner to redirect their sanitary outlets draining into the Pasig River towards existing sanitary lines inland as a matter of public responsibility. The Consultant, LGU and DPWH have commonly agreed on this arrangement. However, numerous complaints from residents suddenly cropped up as most of the owners do not have the financial capacity to redirect their pipeline to existing manholes or drainage lines.

(b) Drainage Planning

The drainage plan is to allow the unimpeded outflow of inland runoff and prevent or minimize backflow from the Pasig River through these outfalls during high river stage. The number of outlets shall be minimized by providing a collector pipe and/or U-ditch as well as manholes to gather flows from existing outlet pipes and direct them to a common manhole located with lowest elevation and to be disposed ultimately to the Pasig River. A flap gate is proposed at the main outlet as in Phase II to stem backflow at high river stage.

For the integration of these outlets into the collector pipe, consideration of the existing outlet elevation and amount of discharge had to be examined.

A typical system to collect the discharges is shown in **Figure R 3.3.2**.

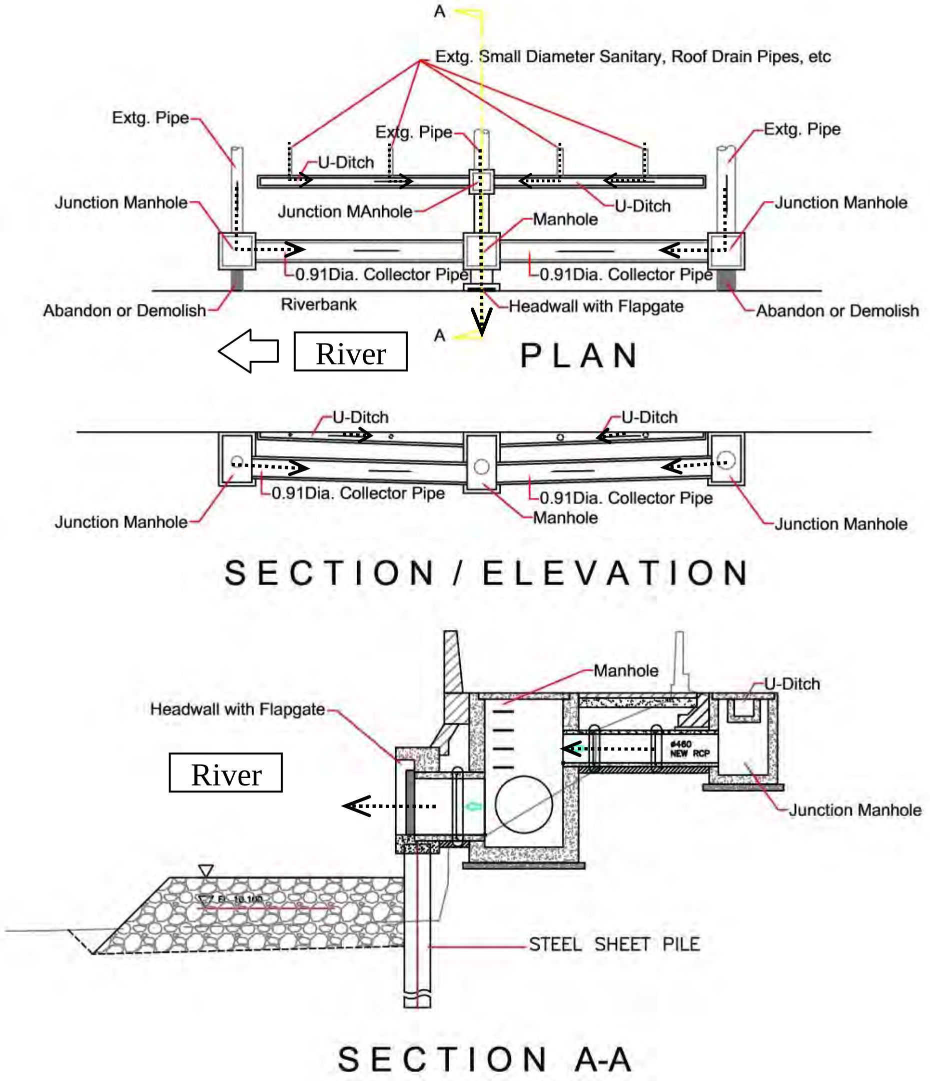


Figure R 3.3.2 Drain Collection System (Pasig River)

There are many instances of small diameter pipes used as sanitary sewer from households. In Metro Manila, the combined system has been in use for some time which discharges effluents directly into the Pasig River without passing through a residential septic tank. Basically the sanitary code dictates that sanitary effluents must not discharge directly into rivers.

Sewerage facilities, including septic tanks, are not provided under Phase III of the PMRCIP. In the future when Manila Water Co., Inc. (MWCI) shall provide its own sewerage system in the area, houses near the riverbank have to connect to this system.

(c) Design Discharge

Based on these conditions and considerations, the design discharge of each outlet is calculated. The results of hydraulic calculation are shown in **Table 3.3.1**.

(3) Drainage Planning for Marikina River

(a) Target Area

The target area for drainage planning in Lower Marikina River consists of 1.82 km of dike segments. The target area is shown in **Figure 3.3.2**.

(b) Drainage Planning

The basic concept is to allow the unimpeded outflow of inland runoff through the sluiceways and prevent or minimize backflow during high river stage by providing flap gates at the downstream ends of the conduits.

As mentioned beforehand, the number of outlets has to be minimized by providing a collector pipe to gather flows from existing outlet pipes and direct them to the sluiceways and to be disposed ultimately to the Lower Marikina River. A typical system of drainage in Lower Marikina River is shown in **Figure R 3.3.3**. Drainage planning for each area is described in following page.

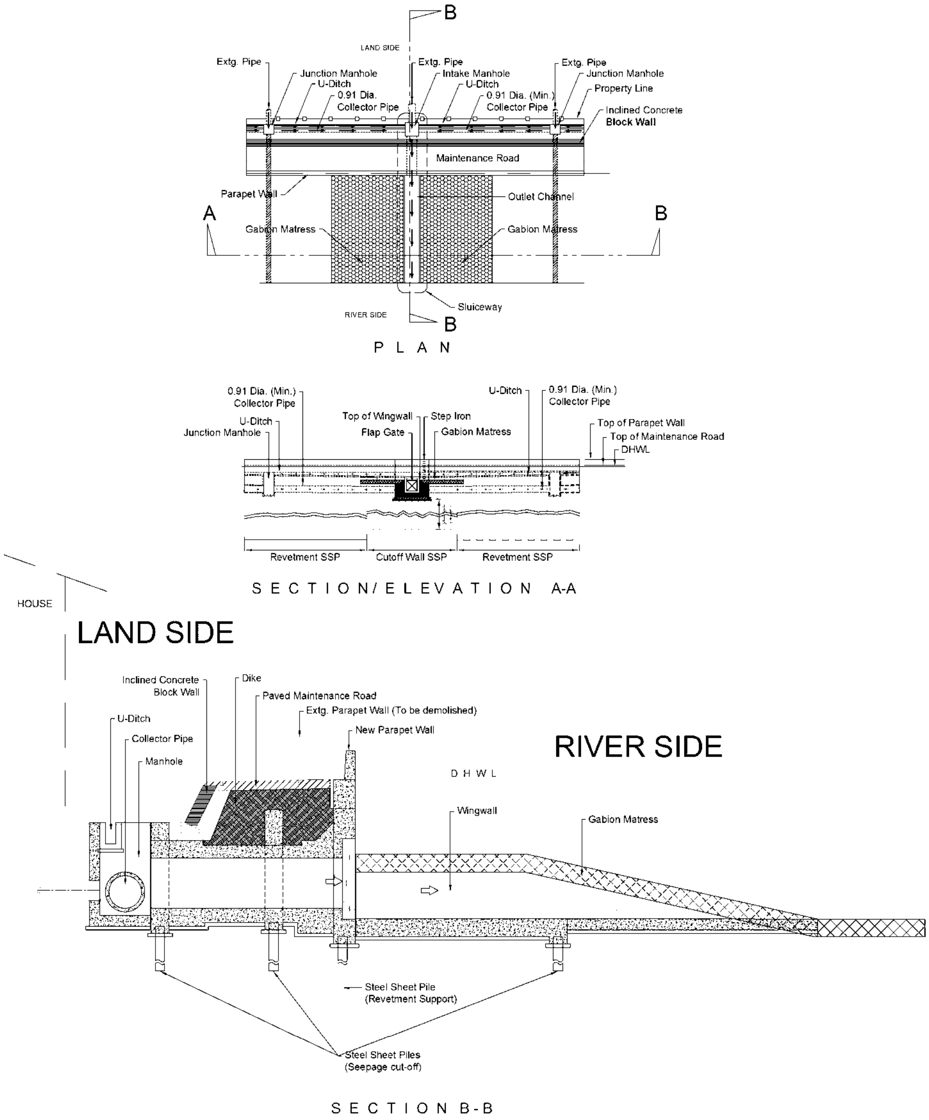


Figure R 3.3.3 Drain Collection System (Lower Marikina River)

(i) Sta. LM 0+950 – 1+350 (Left Bank)

This area is located on the left bank at the upstream and downstream side of the Vargas Bridge. There are two main outlets on both sides of the Vargas Bridge that have large catchments. Furthermore, the outlets are located at lower elevations so that the sluiceways shall be located at these two locations.

The summary of proposed sluiceways is shown in **Table 3.3.2**.

There are also minor outlets that shall be connected to the collector pipe along the liner park. The catchment area and location of proposed sluiceways are shown in **Figure 3.3.2**.

(ii) Sta. LM 2+880 – 3+610 (Right Bank)

This area is located on the right bank at the upstream and downstream sides of the Alfonso Sandoval Bridge. The catchment area and location of proposed sluiceways are shown in **Figure 3.3.2**.

There are 3 catchment areas Furthermore, downstream of Alfonso Sandoval Bridge is a huge RC pipe with 1600 mm diameter and this outlet has a large catchment area.

Catchment areas and proposed sluiceway are summarized in **Table 3.3.2**.

(iii) Sta. LM 3+825 – 4+650 (Left Bank)

Station LM 3+825 to LM 4+650 has a linear park. The location of existing outlets and proposed sluiceways, The catchment area and location of proposed sluiceways are shown in **Figure 3.3.2**..

There are several houses along the linear park from LM 3+825 to LM 4+400. A factory occupies the riverbank boundary from LM 4+400 to LM 4+650. The catchment area is divided into 4 catchments. The catchment areas served and proposed sluiceways are summarized in **Table 3.3.2**.

(c) Design Discharge

The design discharge of each outlet is calculated based on the above conditions and considerations, the design discharge of each outlet is calculated. The results of hydraulic calculation are shown in **Table 3.3.2**. And design discharge of collector pipe, box culvert and U-ditch is also shown in **Table 3.3.3** and **Table 3.3.4**.

3.3.4 Basic Design of Drainage Facilities

(1) Basic Design of Drainage Facilities for Pasig River

(a) Size of Conduit

The Manning’s Formula and Continuity Equation, as shown below, were used to calculate the flow capacity of the outlets (in accordance with the DPWH “Guidelines”).

$$V = \frac{1}{n} \times R^{2/3} \times S^{1/2}$$

$$Q = A \times V$$

Where,

Q = Discharge (m^3/sec)
V = Velocity (m/sec)
A = Area of Cross Section (m^2)
n = Roughness coefficient
R = Hydraulic radius (m)
S = Flow gradient or longitudinal slope

Manning's coefficient of roughness for different materials, as shown in **Table R 3.3.9** was applied in accordance with DPWH Guidelines.

Table R 3.3.9 Roughness Coefficient

Type	Roughness Coefficient
PVC Pipe	0.010
RC Pipe	0.013
In-situ Concrete	0.015

(b) Slopes and Velocities

Based on the guideline, the maximum velocity considered is 3.0m/sec for safe to avoid scouring by water flow and with a minimum of 0.8m/sec to avoid siltation or sedimentation.

(c) Pipe Connection

The pipe-top connection method, as found in the Guidelines, is adopted. In this method, the tops of the upstream and downstream ends of the pipes are aligned as illustrated in **Figure R 3.3.4.**

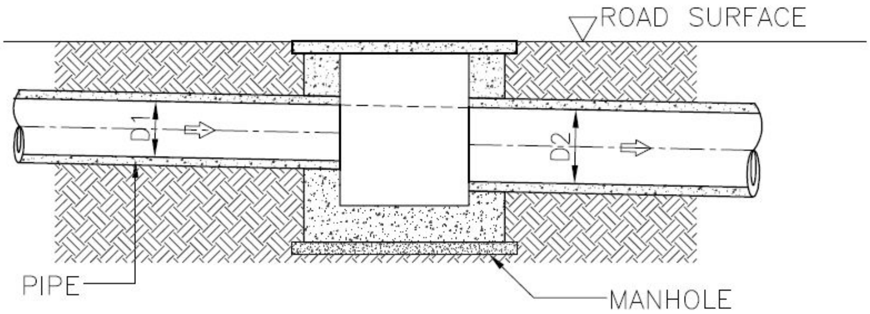


Figure R 3.3.4 Pipe-Top Connection Method

(d) Manhole Spacing

Manholes are normally located at changes in grade or alignment, at the junctions of laterals, and at points for maintenance. As a rule, maximum spacing of manholes should be 50m for easier maintenance. However, a Memorandum from the DPWH Secretary as mentioned beforehand states that the minimum spacing of manholes/inlets shall be 20m. Clarification with the DPWH-BOD indicates that this is adopted only for drainage lines on a straight alignment.

In Phase III, the manhole spacing of minimum 20m shall be adopted, except in cases where a change in alignment may require a shorter manhole distance.

(2) Basic Design of Drainage Facilities for Marikina River

Basic design for pipes and manholes is the same as Pasig River. Hence, in this sub-section, especially basic design of sluiceways specifically for Lower Marikina River is mentioned.

(a) Type of Sluiceway

Soft soil layers underlie the Lower Marikina River area. Based on residual settlement calculations indicated in sub-section **4.2.3.3**, residual settlement at all sluiceway site exceeds 5cm. According to “Guideline of flexible Sluiceway” in Japan (November 1998, Japan Institute of Construction Engineering), when residual settlement is more then 5cm, rigid type sluiceway cannot follow the ground displacement and flexible type should be adopted.

In this design, it is not possible to ignore the effect of ground deformation especially with the placement of a new embankment dike. In the case where piles are used under the sluiceway, the common observation is that the sluiceway does not settle evenly with the embankment dike. This usually results to a hollowing under the sluiceway, as shown in **Figure R 3.3.5,** which gives the dike an uneven, undulating surface. This type of design, therefore, shall not be adopted. Instead, the flexible type sluiceway which can allow the effect of settlement shall be adopted.

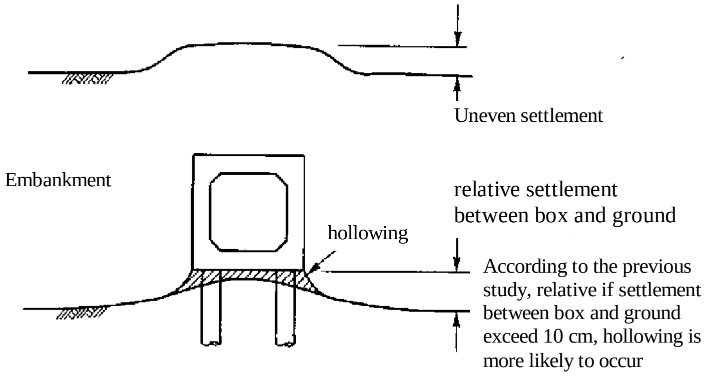


Figure R 3.3.5 Effect of Uneven Settlement with Sluiceway on Pile

(b) Cross-Section Shape

Preferably, a square cross section made of cast-in-place concrete shall be adopted for the following reasons:

- It is more difficult to make cast-in-place concrete circular culvert.
- Pre-cast concrete pipes are available but there would be problems on water-tightness on the joints and longitudinal deformation if the bedding is not properly constructed.
- In case of steel pipe, welding is needed on the joint. This type is inferior to the concrete type on the aspect of construction.

(c) Type of Gate

The floodgates for the Lower Marikina River require the following functions:

- Water-tightness, to avoid backwater entering into land area during flood.
- Drainage, to dispose water from the landside into the river at normal condition

The types of gate that can satisfy these required functions are classified as hinge type and slide type. For the sluiceway, the slide type gate is usually used, as there is less concern about complete gate closure due to accumulation of sediments. However, this type needs manual operation. Some hinge types have automatic operation feature similar to the flap gate, which was used in the Pasig River under Phase II. The flap gate has more advantages over the slide gate on the aspect of operation.

This study considered two types as follows.

✓ First Option : Flapgate

✓ Second Option : Slide gate

Based on **Table 3.3.5** comparison of the total running cost (i.e., initial cost plus O&M) between Type 1 and Type 2 show that the former is cheaper. Hence, the Flap Gate shall be adopted.

CHAPTER 4 DETAILED DESIGN OF RIVER AND DRAINAGE IMPROVEMENTS

4.1 Result of Design for Pasig River

4.1.1 Change in the Detail Design Stage

The following items are the changes in the detail design stage.

(1) River Structures

- Revetment structure and specifications (alignment, modulus, length and origin-destination) were partially changed due to the survey results and the field investigations. For instance, steel sheet pile revetment was converted to RCF revetment at Right2+283-341 and RCF revetment was modified to steel sheet pile revetment at Right9+722-750. In addition, RCF revetment was added at Left 6+269-6+323 and Right2+950-3+100 because of the lower existing revetment than the required wall height.
- Basically the slope of the riprap was “1:1.0” in accordance with Phase II. However, the some riprap slopes of the steep riverbed portions were converted to “1:1.5” based on the results of the slope stability.

(2) Drainage Facilities

- Regarding shape of manholes, the shape was circular in the basic design stage. However, in the detail design stage, rectangular shape is adopted based on the DPWH’s past practice. In Phase II, rectangular shape is used as well.
- Regarding manhole covers, in the basic design stage, circular and steel type which is used in sewerage facilities was considered. However, in the detail design stage, rectangular and concrete type is adopted based on the DPWH’s past practice. In Phase II, rectangular and concrete type is used as well.

4.1.2 Steel Sheet Pile (Revetment)

4.1.2.1 Design of Revetment Works for Pasig River

The list of areas to be improved was decided in accordance with the results of site investigation, the total project cost and subsequent discussions with the DPWH. The final improved areas are shown in **Table R 4.1.1**.

Table R 4.1.1 Final Improved Areas for Pasig River

No.	Channel Bank (Right or Left)	Station		Length of Bank (m)	Foundation Type	No.	Channel Bank (Right or Left)	Station		Length of Bank (m)	Foundation Type
		Start	End					Start	End		
1. Steel Sheet Pile											
1	Left	2+419	2+694	278.8	SSP	30	Right	14+835	14+943	125.8	SSP
2	Left	2+854	3+072	230.7	SSP	31	Right	14+983	15+075	96.6	SSP
3	Left	3+160	3+300	124.7	SSP	32	Right	15+409	15+441	24.9	SSP
4	Left	6+116	6+219	100.9	SSP	33	Right	15+476	15+494	20.2	SSP
5	Left	6+249	6+269	20.3	SSP	34	Right	16+667	16+724	56.3	SSP
6	Left	6+376	6+482	114.4	SSP	35	Right	16+760	16+840	101.8	SSP
7	Left	7+326	7+444	121.3	SSP	*Sub-Total*				*6734.6*	
8	Left	7+494	7+514	19.4	SSP	2. Reinforced Concrete Floodwall and Repair					
9	Left	11+500	11+628	128.5	SSP	1	Left	2+392	2+419	26.5	Repair
10	Left	12+024	12+173	148.4	SSP	2	Left	3+325	3+400	68.3	Repair
11	Left	13+806	14+272	454.7	SSP	3	Left	6+245	6+249	4.4	R.C. Floodwall
12	Left	15+236	15+424	195.9	SSP	4	Left	6+269	6+323	57.7	R.C. Floodwall
13	Left	15+443	15+548	113.1	SSP	5	Left	7+326-A	7+326	6.7	R.C. Floodwall
14	Left	15+747	15+870	107.5	SSP	6	Left	7+514	7+580	56.4	Repair
15	Left	15+965	16+564	614.9	SSP	7	Left	10+232	10+341	110.2	R.C. Floodwall
16	Right	3+649	3+753	98.9	SSP	8	Left	10+405	10+434	30.2	R.C. Floodwall
17	Right	5+046	15+223	153.7	SSP	9	Left	10+439	10+477	40.8	R.C. Floodwall
18	Right	5+262	5+414	170.9	SSP	10	Left	10+477	10+497	18.7	Repair
19	Right	5+545	5+639	103.3	SSP	11	Left	14+287	14+440	152.0	Repair
20	Right	6+337	6+510	151.2	SSP	12	Right	2+283	STA.A	250.4	R.C. Floodwall
21	Right	8+222	9+341	1048.9	SSP	12	Right	STA.A	STA.C	37.3	Repair
22	Right	9+430	9+792	380.0	SSP	13	Right	STA.D	3+100	625.5	R.C. Floodwall
23	Right	9+814	9+947	187.8	SSP	13	Right	3+410	3+492	88.2	Repair
24	Right	10+956-A	11+263	327.9	SSP	13	Right	7+516	8+219	612.7	R.C. Floodwall
25	Right	11+610	11+653	43.7	SSP	14	Right	10+140	10+179	43.5	R.C. Floodwall
26	Right	11+788	11+803-A	19.9	SSP	15	Right	15+494	16+472	979.7	R.C. Floodwall
27	Right	13+578	13+801-B	226.7	SSP	16	Right	16+840	16+843	2.9	R.C. Floodwall
28	Right	13+804-A	14+225	448.6	SSP	*Sub-Total*				*3,212.1*	
29	Right	14+234	14+395-A	174.0	SSP	Total Length (m)				9,946.7	

4.1.2.2 Details of Design Method

(1) Loads

SSPs are designed against the loads enumerated below:

- Earth pressure
- Hydraulic pressure
- Seismic load
- Surcharge load

Earth pressure is computed using a Coulomb's formula for lateral earth pressure, both for active and passive pressure.

Hydraulic pressure is hydrostatic pressure from the riverside daily water level, and a residual water pressure occurring from the landside after flood. A height of residual water is taken as same level of top of coping maximally in consideration of installation of drainage holes at the bottom of walls constructed on the coping.

Seismic load is expressed as an increase of earth pressure. An earth pressure coefficient during earthquake is also computed using a Mononobe-Okabe's formula revising Coulomb's formula, where a horizontal seismic coefficient, kh, equals to 0.20.

Surcharge load is live load which acts from upper position on land side above the head of SSPs. Surcharge load due to vehicle traffic shall be 10kN/m^2 in Normal Condition and 5kN/m^2 in Seismic Condition. For the area where pedestrians occupy, the surcharge load shall be 5kN/m^2.

Soil and other above the coping concrete shall be added to the surcharge load where a ground height is higher than the coping (refer to **Figure R 4.1.1**).

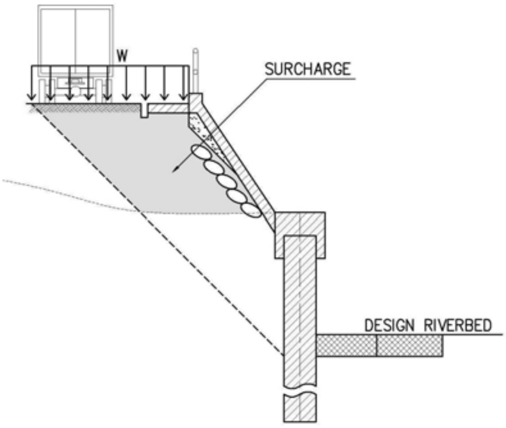


Figure R 4.1.1 Flow Chart of Design Work of SSP Revetment

(a) Earth Pressure in Normal Condition

Earth pressure acting on movable walls is calculated by the following Coulomb's formula:

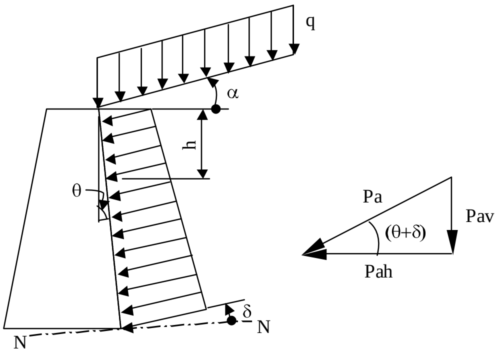


Figure R 4.1.2 Active Earth Pressure

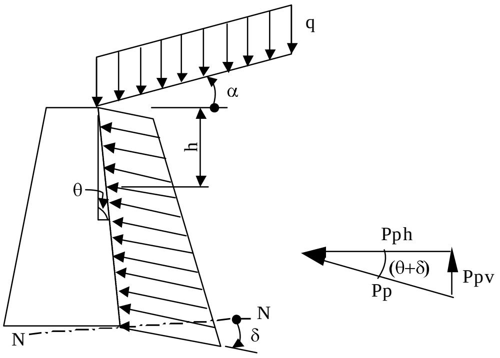


Figure R 4.1.3 Passive Earth Pressure

For Sandy Soil:

$Pa = Ka\ \gamma h + Ka\ q$

$Pp = Kp\ \gamma h + Kp\ q$

For Clayey soil

$$Pa = Ka\ \gamma h - 2c \quad Ka + Ka\ q$$

$$Ka = \frac{\cos^2(\phi - \theta)}{\cos^2 \cos(\theta + \delta)\left[1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \alpha)}{\cos(\phi + \delta)\cos(\theta - \alpha)}}\right]^2}$$

$$Pp = Kp\ \gamma h + 2c \quad Kp + Kp\ \ q$$

$$Kp = \frac{\cos^2(\phi + \theta)}{\cos^2 \cos(\theta + \delta)\left[1 - \sqrt{\frac{\sin(\phi - \delta)\sin(\phi + \alpha)}{\cos(\phi + \delta)\cos(\theta - \alpha)}}\right]^2}$$

Earth pressure acting on fixed walls is calculated by the following formula:

$$P_s = K_s\ \gamma h + K_s\ q$$

Where,

Pa = active earth pressure (kN/m²)
Pp = passive earth pressure (kN/m²)
Ps = earth pressure at rest (kN/m²)
γ = unit weight of soil (kN/m³)
Ka = coefficient of active earth pressure
Kp = coefficient of passive earth pressure
Ks = coefficient of earth pressure at rest ($Ks = 0.5$)
h = earth depth to acting point of earth pressures Pa, Pp and Ps (m)
c = soil cohesion (kN/m²)
q = surcharge in Normal Condition (kN/m²)
ϕ = internal friction angle of soil (degree)
θ = angle between back side surface of wall and vertical plane (degree)
α = angle between ground surface and horizontal plane (degree)
δ = angle of wall friction (degree)

(b) Earth Pressure in Seismic State

Lateral earth pressure due to earthquake is calculated by the Mononobe-Okabe formula based on the Coulomb's theory in consideration of seismic factor.

$$Pea = Kea\ \gamma\ h - 2c \quad Kea + Kea\ q'$$

$$Kea = \frac{\cos^2(\phi - \theta_o - \theta)}{\cos\theta_o \cos^2\theta \cos(\theta + \theta_o + \delta)\left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \alpha - \theta_o)}{\cos(\theta + \theta_o + \delta)\cos(\theta - \alpha)}}\right)^2}$$

$$Pep = Kep\ \gamma h - 2c \quad Kep + Kep\ q'$$

$$Kep = \frac{\cos^2(\phi - \theta_o + \theta)}{\cos\theta_o \cos^2\theta \cos(\theta - \theta_o + \delta)\left(1 - \sqrt{\frac{\sin(\phi - \delta)\sin(\phi + \alpha - \theta_o)}{\cos(\theta - \theta_o + \delta)\cos(\theta - \alpha)}}\right)^2}$$

Where,

Kea = coefficient of active earth pressure
Kep = coefficient of passive earth pressure
q’ = surcharge in Seismic Condition (kN/m²)
θ_o = angle expressed below (degree)

$$\tan\theta_o = \frac{Kh}{1 - Kv}$$

Where,

Kv = seismic coefficient in vertical direction
Kh = seismic coefficient in horizontal direction

(c) Hydraulic Pressure

Hydraulic Pressure

Hydrostatic pressure acting on the structure is calculated by the following formula:

$$P = \gamma_w h$$

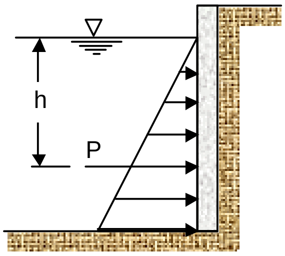


Figure R 4.1.4 Hydraulic Pressure on Wall

Where,

P = hydrostatic pressure at “h” (kN/m²)
H = water depth (m)
γ_w= unit weight of water (9.8kN/m³)

Dynamic Hydraulic Pressure due to Earthquake

Dynamic water pressure caused by earthquake acting on the wall structure facing on one side only is calculated by the following Westergaard’s formula:

$$Pp = Kp\ \gamma\ h + Kp\ q$$

$$P = \frac{7}{12} Kh\,\gamma_w\, b\, H^2$$

$$hg = \frac{2}{5} H$$

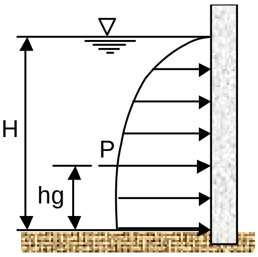


Figure R 4.1.5 Dynamic Water Pressure on Wall

Where,

P = dynamic water pressure caused by earthquake (kN)
Kh = coefficient of horizontal earthquake factor
γ_w = unit weight of water (kN/m³)
b = width of wall structure (m)
H = water depth (m)
h_g = dynamic water pressure acting depth caused by earthquake (m)

(d) Seismic Load

Seismic load is basically computed using Seismic Coefficient Method. Seismic coefficient Kh shall be one-half (1/2) of the acceleration coefficient (Kh = A/2 = 0.4/2 = 0.2).

(2) Calculation Case

SSP revetments are designed under following two cases:

- Normal Condition: an active earth pressure and a residual active load (10kN/m^2 as surcharge) are acting from the land side.
- Seismic Condition: a seismic active earth pressure is acting from the land side, where a half of residual active load of Normal Condition (5kN/m^2) is applied.

(3) Structural System and Analysis

SSP is designed as a cantilever member supported by soil below an imaginary riverbed (refer to **Figure R 4.1.6**).

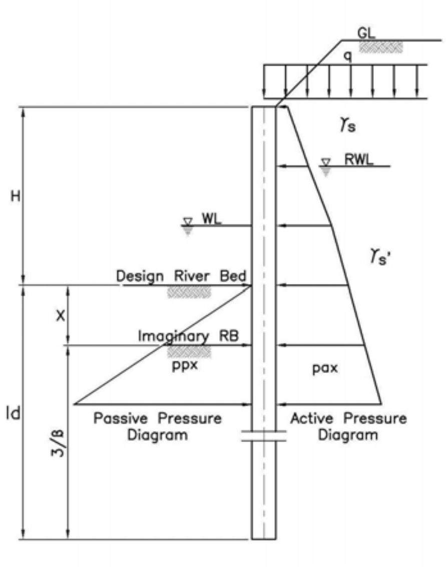


Figure R 4.1.6 Sheet Pile Loads Diagram

The depth of sheet pile embedment from the riverbed, ld, is determined using the following formula:

$ld = x + 3/\beta$

Where,

X = distance from a design river bed to a level where passive earth pressure becomes equal with the active earth pressure

$\beta = (K_H D / 4Es I)^{0.25}$
K_H = coefficient of lateral soil reaction
D = width of sheet pile considered
Es = modulus elasticity of sheet pile material
I = moment inertia of the sheet pile per width considered

(4) Formula of Maximum Moment and Displacement

Formulae to analyze maximum moment and displacement of SSP (Chang's Formulae) are as follows:

For Maximum Moment

$$M_{MAX} = M \bullet \varphi_m$$

where ,

M : *Bending Moment on the Imaginary Riverbed*

$$\varphi_m = \frac{\sqrt{(1+2\cdot\beta\cdot h_0)^2+1}}{2\cdot\beta\cdot h_0} \bullet \exp\left(-\tan^{-1}\frac{1}{1+2\cdot\beta\cdot h_0}\right)$$

M_{MAX} : *Maximum Bending Moment* $(kN\cdot m)\ (t\cdot m)$

$$\beta = \sqrt[4]{\frac{K_h\cdot B}{4\cdot E\cdot I}}\ (m^{-1})$$

K_h : *Coefficien t of lateral soil reaction* $(kN/m^3)\ (kg/cm^3)$

B : *Unit Calculatio n Width* $=1.0m=100\,cm$

E : *Young Modulus* $=2.0\times10^8\ (kN/m^2)=2.1\times10^6\ (kg/cm^2)$

I : *Geometric Moment of Inertia* $=(m^4)$

h_0 : *Dist ance between Imaginary Riverbed and point of applicatio n force*

For Displacement

$$\delta = \delta_1 + \delta_2 + \delta_3$$

where ,

δ : *Deflection at top of Steel Sheet Pile* $(m)\ (cm)$

δ_1 : *Deflection on Imaginary Riverbed* $(m)\ (cm)$

$$= \frac{(1+\beta\cdot h_0)\cdot P}{2\cdot E\cdot I\cdot\beta^3}$$

δ_2 : *Deflection by Incline* $(m)\ (cm)$

$$= \frac{(1+2\cdot\beta\cdot h_0)\cdot P\cdot H}{2\cdot E\cdot I\cdot\beta^2}$$

δ_3 : *Deformatio n by Bending of Sheet Pile* $(m)\ (cm)$

$$= \frac{B\cdot H^3}{6\cdot E\cdot I}\bullet\sum(3-\alpha_i)\cdot\alpha_i{}^2\cdot P_i = \frac{B\cdot H^3}{E\cdot I}\bullet\sum q_i$$

H : *Height of Steel Sheet Pile from Imaginary Riverbed to Top*

P : *Total Lateral Force* $(kN)\ (t)$

α_i : *Ratio of Force Point to Total Height from imaginary riverbed*

Q_i : *Deformatio n Coefficien t*

(5) Characteristics of SSP

Employed SSP Revetment

The type of sheet pile shall be determined in consideration of the stress and displacement in each section not to meet an allowable stress and displacement against outer loads. SSPs consist of Hat-shape SP-10H and SP-25H, and U-shape SP-IA to SP-VIL. In case that the calculated stress and/or displacement SSP revetment are/is not less than the allowable value, combined SSP with H-Beam shall be applied to secure the strength of SSP revetment and not to meet an allowable stress and displacement.

Section Efficiency

As shown in **Table R 4.1.2.** A 20% reduction of stiffness (e.g., Moment of Inertia of Area: I x 0.8) is applied to U-shape SSP. This reduction is caused by the joint efficiency of U-shape SSP during bending load. On the other hand, there is no reduction of the stiffness for Hat-shape SSP due to their connecting structural characteristic between SSPs.

Table R 4.1.2 Moment of Inertia of Area and Efficient Ratio in SSP Wall

Item	Classification of Calculation	Efficient Ratio of Sectional Factor	
		Hat-shape	U-shape
Moment of Inertia of Area	Calculation of Penetration Depth	Full cross section is effective (100%)	
	Calculation of Dispalcement and Sectional Force	Full cross section is effective (100%)	80% of full cross section is effective
Sectional Factor	Stress Calculation	Full cross section is effective (100%)	

Source: Cantilever Steel Sheet Pile Design Manual, 2007 Dec.

Structure

When SSP with H-Beam is employed as SSP revetment, welding structure is to be applied.

Type and Properties of SSP and H-Beam

As mentioned previously, SSP should conform to SYW295 specified in JIS A-5523 or equivalent with minimum yield strength (Fy) of 295MPa. General specifications of SSP of SYW295 defined in JIS A-5523 are shown in **Table R 4.1.3**.

Table R 4.1.3 Properties of SSP

Type of SSP	Dimension (mm)			Per 1.0m (original condition)				Per 1.0m (after corrosion)	
	W	H	t	A (cm^2)	I (cm^4)	Z (cm^3)	Weight (kg/m)	I' (cm^4/m)	Z' (cm^3/m)
U-Shape									
SP-I$_A$	400	85	8.0	113.0	4500	529	89	3420	402
SP-II$_W$	600	130	10.3	131.2	13000	1000	103	10500	810
SP-III$_W$	600	180	13.4	173.2	32400	1800	136	27500	1530
SP-IV$_W$	600	210	18.0	225.5	56700	2700	177	49900	2380
SP-V$_L$	500	200	24.3	267.6	63000	3150	210	57300	2870
SP-VI$_L$	500	225	27.6	306.0	86000	3820	240	79100	3510
Hat-Shape									
SP-10H	900	230	10.8	122.2	10500	902	96	8300	713
SP-25H	900	300	13.2	160.4	24400	1610	126	20000	1320

Source: Steel Sheet Pile Association Data

Applicable combinations of SSP and H-Beam, and expected values of strength of combined SSP are shown in **Table R 4.1.4**.

Table R 4.1.4 Combinations of SSP and H-Beam

SSP	H-Beam	Per 1.0m				
		Original condition		After corrosion		Weight (kg/m^2)
		I (cm^4/m)	Z (cm^3/m)	I’ (cm^4/m)	Z’ (cm^3/m)	
SP-10H	400x200x9x22	114000	3250	95900	2820	202
	450x200x12x25	145000	4070	128000	3580	226
	450x250x9x22	154000	4160	131000	3630	225
	450x250x12x28	177000	5050	152000	4500	261
	500x200x12x25	180000	4480	154000	3950	232
	500x250x12x28	212000	5560	183000	4960	266
	550x200x12x28	213000	4920	182000	4330	237
	550x250x12x28	252000	6090	217000	5430	271
	600x200x12x28	262000	5720	226000	5070	252
	600x250x12x28	295000	6640	255000	5920	276
	650x200x12x28	305000	6220	262000	5510	257
	650x250x12x28	342000	7200	296000	6420	282
	700x200x12x28	353000	6780	304000	6020	264
	700x250x12x25	375000	7330	323000	6480	275
	750x250x12x25	429000	7900	369000	6980	281
	750x250x14x28	462000	8730	401000	7810	305
	800x250x16x28	537000	9710	467000	872	324
	850x250x14x25	563000	9470	486000	8390	305
	900x250x16x28	681000	11200	593000	9990	338
SP-25H	450x250x12x28	228000	5890	198000	5250	290
	500x250x12x28	268000	6380	233000	5690	295
	550x250x12x28	312000	6900	271000	6160	301
	600x250x12x28	360000	7440	314000	6640	306
	600x300x12x28	396000	8410	345000	7530	330
	650x250x12x28	414000	8010	360000	7140	311
	700x250x14x28	484000	8950	422000	8010	329
	700x300x14x28	529000	10000	463000	9010	353
	750x250x14x28	548000	9590	479000	8580	335
	750x300x14x28	600000	10700	526000	9650	359
	750x300x16x32	649000	11900	573000	10800	391
	800x250x16x28	632000	10600	553000	9530	354
	800x300x14x28	676000	11500	593000	10300	365
	800x300x16x32	732000	12800	647000	11600	398
	850x250x16x28	709000	11400	621000	10200	361
	850x300x16x32	821000	13600	726000	12400	405
	900x250x16x28	792000	12100	694000	10900	368
	900x300x16x32	917000	14500	811000	13100	412
	1000x300x16x32	1130000	16300	998000	14800	426

Source: Steel Sheet Pile Association Data

(6) Geotechnical Conditions

Detailed geotechnical condition on the basis of drilling test results shall be applied to the design calculations of SSP revetment.

The general soil classification of Pasig River is shown in **Table R 4.1.5**.

Table R 4.1.5 The General Soil Classification of Pasig River

Age		Soil Classification		
		Formation	Lithic	
QUATERNARY	HOLOCENE	F	Embankment	Artificial soils as embankment and buried soils. The mean N value of F is mostly less than 15 partly over 20 in Pasig river area.
		AS1	Sand, Gravel	Sand layer characterized by the distribution in the surface ground. In lower Pasig area, AS1 is mainly originated by a natural levee and Delta plane. The mean N value of AS1 is mostly less than 10 in lower part of Pasig river, mostly over 20 in middle to upper part of Pasig river.
		AC1	Clay, Silt	Soft clayey soils sometimes alternating with AS1, distributed under AS1 in the mouth of Pasig River area, which originated by Delta front deposit. AC1 distributes in the surface ground in the middle to upper stream of Pasig River . The mean N value of AC1 is less than 3~5 in Pasig .
		AS2	Sand, Gravel	Sandy soil distributes in relatively deeper part as of beneath AC1. In lower Pasig area, there is thick distribution under AC2. The mean N value of AS2 is 10~20 in lower part of Pasig river, partly over 20 in upper part.
		AC2	Clay, Silt	Slightly soft clayey soil distributed under 10m depth from sea level in the area from the mouth to 5km upstream of Pasig River containing organic portions and tuffacious portions characteristically. The mean N value of AC2 is 12~17, partly less than 8 in Pasig river area.
	PLISTOCENE	GF	Guadalupe Formation tuff,sandstone,mudstone volcanic conglomerate	Soft rock layer mainly consisting of lapili-tuff and tuffacious sandstone correlated to Guadalupe Formation. The N value of GF is over 50 all areas.

Selection of geotechnical conditions for design calculation based on the drilling test result implemented in/around design section shall take the following viewpoints into account for proper design of SSP revetment:

- drilling test result conducted in river or on bank with higher elevation shall be selected for better estimation of actual active earth pressure from landside,
- drilling test result with typical geotechnical formation of the design section shall be selected as much as possible, and
- drilling test result with lower N-value shall be applied for the design of safety structure if there are multiple results with typical geotechnical formation in a design section.

Sandy soil

In consideration of result of geotechnical laboratory test, design method of Phase-II and generally used formula to calculate internal friction angle from N-value of sandy soil, cohesion of sandy soil shall net be considered, and then internal friction angle of sandy soil for design calculation shall be set as below:

Internal friction angle $\phi = 27° \leq 15+\sqrt{15N} \leq 45°$

Clayey soil

Relation between cohesion and N-value of clayey soil on the basis of laboratory test result is shown in **Table R 4.1.7**.

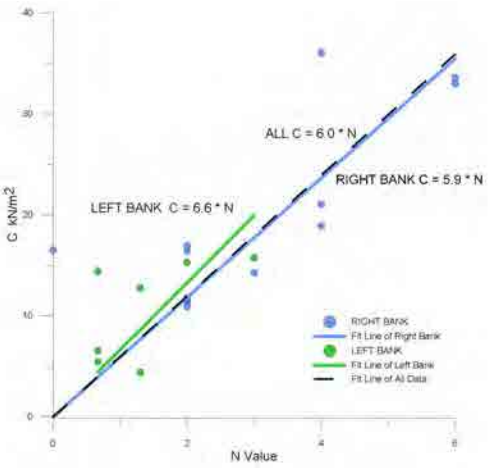


Figure R 4.1.7 Relation between N-value and Cohesion in Sandy Soil

In consideration this relation and generally used cohesion value applied from N-value of clayey soil, internal friction angle of clayey soil shall not be considered, and then cohesion of clayey soil shall be set as below:

Cohesion (kN/m^2) N≤4 : 6.0 x N
5≤N≤8 : 25
9≤N≤15 : 50
15≤N≤30 : 100
30<N : 200

Where, N: N-value

(7) Loads at Top of Coping Concrete

Following acting loads at the top of coping concrete shall be considered in structural calculation:

- Horizontal loads
  - ✓ Earth pressure and surcharge in Normal Condition
  - ✓ Seismic force due to coping concrete itself and walls installed on the top of coping concrete additionally in Seismic Condition only
- Moments in Normal Condition
  - ✓ Moment due to earth pressure and surcharge as active
  - ✓ Moment due to weight of walls installed on the top of coping concrete as passive
- Moments in Seismic Condition
  - ✓ Moment due to earth pressure, surcharge and horizontal force of the coping concrete and walls by seismic movement as active
  - ✓ Moment due to weight of walls installed on the top of coping concrete as passive

(8) Design Method of Parapet Walls

Loads

Minimum wind pressure to be used in this project shall be computed by the following formula:

P = Ce Cq qs I

Where,

P = Design wind pressure
Ce = Combined height, exposure and gust factor coefficient as given in NSCP Vol. I, Table 2-J
Cq = Pressure coefficient for the structure or portion of structure under consideration as given in NSCP Vol. I, Table 2-K or from Figures 2.3B to 2.3F
Qs = Wind stagnation pressures at height of 10 meters as specified in NSCP Vol. I, Fig. 2.3A
I = Importance factor as specified in NSCP Vol. I, Table 2.2D

Load Combination

All structures shall be designed for the largest stresses resulting from the worst combination of loads that may act on the structure at any given condition.

For safety reasons, each component of the structure shall be in proportion to bear all combinations of these forces:

Normal Condition : D + L + I + E +H + U +F
Seismic Condition : D + Ee + V + U + De
Wind Condition : D + E + H + U + F + W
Flood Condition : D + E + H + U + F

Where,

D = dead load
L = live load
I = impact/dynamic effect of live load
E = earth pressure
H = hydrostatic pressure
U = uplift
W = wind load on structure
V = seismic load
F = flowing water pressure
Ee = earth pressure due to earthquake
De = dynamic water pressure due to earthquake

4.1.2.3 Parameters of Material

The design parameters for design calculation of revetments are enumerated in **Table R 4.1.6**.

Table R 4.1.6 Parameters of Material for Design Calculation of Revetments

Item				Design Condition
Material Unit Weight	Concrete: Reinforced/Prestressed			24.0 kN/m^3
	Concrete: Plain			23.5 kN/m^3
	Mortar			21.0 kN/m^3
	Structural Steel			77.0 kN/m^3
	Cast Iron			71.0 kN/m^3
	Water			9.8 kN/m^3
Soil Condition	Sandy Soil	Unit weight	Damp or Wet Condition	18 kN/m^3
			Saturated Condition	20 kN/m^3
			Submerged Condition	10 kN/m^3
		N-value		Measured value by standard penetration test while drilling survey
		Angle of Internal Friction ϕ		$\phi = 27° \leq 15+\sqrt{15N} \leq 45°$
		Cohesion (kN/m^2)		0
	Clayey Soil	Unit weight	Damp or Wet Condition	16 kN/m^3
			Saturated Condition	18 kN/m^3
			Submerged Condition	8 kN/m^3
		N-value		Measured value by standard penetration test while drilling survey
		Angle of Internal Friction ϕ		0°
		Cohesion (kN/m^2)		$N \leq 4$: 6.0 x N $5 \leq N \leq 8$: 25 $9 \leq N \leq 15$: 50 $15 \leq N \leq 30$: 100 $30 < N$: 200
	Embanked Soil	Quality of Soil		dense sandy soil
		Unit weight	Damp or Wet Condition	18 kN/m^3
			Saturated Condition	20 kN/m^3
			Submerged Condition	10 kN/m^3
		N-value		15
		Angle of Internal Friction ϕ		30°
		Cohesion (kN/m^2)		0

Table R 4.1.7 Parameters for Design Calculation of SSP Revetments

Item		Design Condition		
SSP	Section Efficiency	Hat-shape	Moment of Inertia of Area	100%
			Sectional Factor	100%
		U-shape	Moment of Inertia of Area	80%
			Sectional Factor	100%
	Young’s Modulus of Elasticity	2.0×10^5N/mm^2		
	Level of Coping Concrete	Refer to **Figure R 4.1.8** (design condition in Phase II and elevation of existing coping are applied)		
Water Level Condition		[Water Level in Landside] Landside Ground Level ≥ Top of Coping concrete Underground Water Level: Top of coping concrete Landside Ground Level < Top of coping concrete Underground Water Level: Landside Ground Level		
		[Water Level in Riverside] Normal Condition：Mean Low Water (MLW) EL.10.10m Seismic Condition：Mean Sea Level (MSL) EL. 10.60m		
Horizontal Seismic Coefficient		k_h=0.20		
Surcharge		Normal Condition：10 kN/m^2 Seismic Condition ：5 kN/m^2		

Cross sectional shape of riprap is designed such that necessary active earth pressure is secured (refer to **Figure R 4.1.8** and **Figure R 4.1.9**).

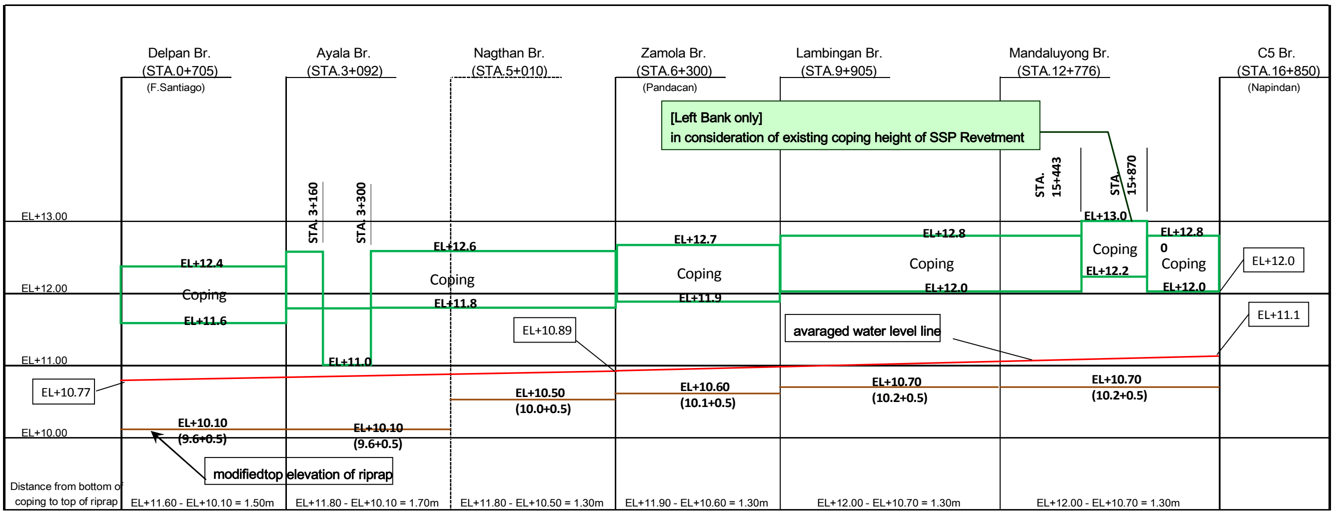


Figure R 4.1.8 Design Elevation of Coping Concrete and Riprap

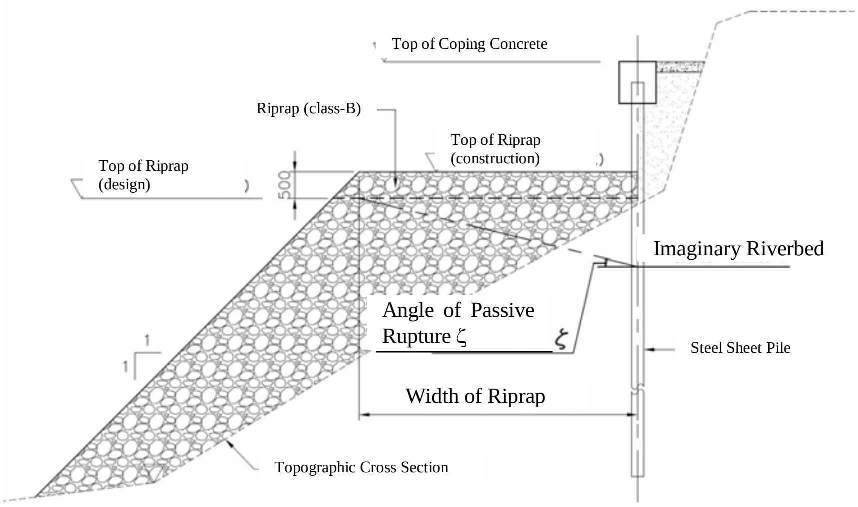


Figure R 4.1.9 Design Method of Necessary Width of Riprap

In consideration of viewpoints, geotechnical conditions for each design section are selected as shown in **Table R 4.1.8**.

Table R 4.1.8 Applied Geotechnical Conditions to Each Design Section

[Left Bank]

No.	Station		Applied Boring Log	
	from	to	Boring No.	on/off shore
1	2+419	2+550	ABL-1	on
2	2+550	2+694	ABL-4	off
3	2+854	2+950	ABL-6	off
4	2+950	3+072	BPLL-10	off
5	3+160	3+300	BHLP-4	off
6	6+116	6+219	ABL-9	on
7	6+249	6+269	BH-L5	off
8	6+376	6+482	BHLP-01	on
9	7+326	7+444	ABL-13	off
10	7+494	7+514	ABL-13	off
11	11+500	11+628	BPLL-38	on
12	12+024	12+173	BLR-8	off
13	13+806	13+900	BLR-11	off
14	13+900	14+000	BLR-12	off
15	14+000	14+150	BLR-14	off
16	14+150	14+250	BLR-16	off
17	14+250	14+272	BLR-17	off
18	15+236	15+315	BPLL-50	on
19	15+315	15+424	BPLL-50	on
20	15+443	15+548	BLR-21	off
21	15+747	15+870	BLR-24	off
22	15+965	16+150	BLR-25	off
23	16+150	16+200	BLR-27	off
24	16+200	16+300	BPLL-53	on
25	16+300	16+450	BLR-30	off
26	16+450	16+552	BLR-32	off
27	16+552	16+564	BLR-33	off

[Right Bank]

No.	Station		Applied Boring Log	
	from	to	Boring No.	on/off shore
1	3+649	3+753	ABR-8	off
2	5+046	5+100	ABR-9	off
3	5+100	5+223	ABR-11	off
4	5+262	5+340	Bh-R16	off
5	5+340	5+414	ABR-14	off
6	5+545	5+639	BH-R18	off
7	6+337	6+510	ABR-17	on
8	8+222	8+250	ABR-28	off
9	8+250	8+400	ABR-29	off
10	8+400	8+510	BPRL-28	off
11	8+510	8+650	ABR-32	off
12	8+650	8+800	ABR-35	off
13	8+800	8+900	ABR-37	off
14	8+900	9+000	ABR-38	on
15	9+000	9+150	ABR-40	off
16	9+150	9+200	ABR-42	off
17	9+200	9+341	ABR-43	off
18	9+430	9+550	ABR-45	off
19	9+550	9+650	ABR-46	off
20	9+650	9+723	ABR-48	off
21	9+723	9+750	BPRL-32	off
22	9+750	9+770	ABR-50	on
23	9+770	9+830	ABR-50	on
24	9+830	9+947	ABR-53	off
25	10+956	11+050	BPRL-36	off
26	11+050	11+150	BHUP-10	off
27	11+150	11+263	BHUP-12	off
28	11+610	11+653	AR-42	off
29	11+788	11+803	BPRL-39	on
30	13+578	13+700	BRR-2	off
31	13+700	13+802	BDP-7	on
32	13+802	13+914.5	BRL-3	on
33	13+914.5	14+000	BRR-6	off
34	14+000	14+100	BRL-4	on
35	14+100	14+200	BDP-8	on
36	14+200	14+300	BR-7	on
37	14+300	14+350	BPRL-47	on
38	14+350	14+395	BPRL-47	on
39	14+835	14+943	BRR-15	off
40	14+983	15+075	BRR-17	off
41	15+409	15+441	BHUP-20	on
42	15+476	15+494	BHUP-20	on
43	16+667	16+724	BRR-22	off
44	16+760	16+840	BPRL-55	on

4.1.2.4 Design Criteria

Based on the design considerations of Phase II, Design Criteria is set as below.

(1) Allowable Stress and Displacement of SSP and SSP with H-Beam

Allowable stress of SSP for design calculation shall be 180 (235) N/mm^2 in SYW295 (SYW390). In this design, 180N/mm^2 as allowable stress of SSP shall be applied since SYW295 is more general and reasonable as the material of SSP.

Allowable stress of H-Beam as structural steel in SM490 that is specified and required in technical specification is 185N/mm^2. Therefore, allowable stress of combined SSP with H-Beam shall be as 185N/mm^2 because dominant structure against load (tensile stress) from landside in the combined SSP is H-Beam portion installed at landside of combined SSP.

In Seismic Condition, allowable stress is increased by 50% as the load happens transiently in nature, then the applied allowable stress in Seismic Condition is set as 270N/mm^2 for SSP and 277.5N/mm^2 for SSP with H-Beam.

Aside from the strength requirement, SSP sections are determined from the displacement limit of 50mm in Normal Condition. For Seismic Condition as mentioned beforehand, a maximum allowable displacement is increased by 50%. To meet this requirement, steel pile sections shall be designed to be adequately stiff that the maximum displacement in Normal Condition is not more than 50mm, and 75mm in Seismic Condition.

(2) Required Conditions and Safety Factors for Design of Parapet Walls

Proposed structures should be adequately designed for and be safe from the following conditions.

4.1.2.5 Sliding

Minimum safety factor against sliding should be as follows:

$$SF = \frac{\text{Total Vertical forces x f}}{\text{Total Horizontal Force}}$$

$SF \geq 1.5$: in Normal Condition
$SF \geq 1.2$: in Seismic and Wind Condition
$SF \geq 1.0$: in Flood Condition

where f is as follows:

Concrete to rock base	;	f = 0.7
Concrete to boulder or cobble base	;	f = 0.6
Concrete to sandy base	;	f = 0.6
Concrete to clayey base	;	f = 0.5

4.1.2.6 Overturning

For stability of structures against overturning, the following conditions should be satisfied:

$$e = \left| \frac{b}{2} - \frac{M}{N} \right| \leq \frac{b}{6}$$: in Normal Condition

$$e = \left| \frac{b}{2} - \frac{M}{N} \right| \leq \frac{b}{3}$$: in Seismic, Wind and Flood Condition

Where,

b = width of base (m)
M = total moment about point A (kN-m)
N = total vertical forces (kN)
e = eccentricity (m)

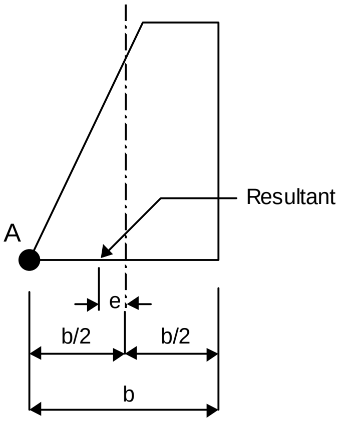


Figure R 4.1.10 Point of Resultant Force

4.1.2.7 Result of Design Calculation of Each Type of Revetment for Pasig River

Results of design calculation of each type revetment are described in the following Tables and Figures.

In addition, the general layout plan, the typical cross section of revetment and the standard river structural details are shown in **Figure 4.1.1**, **Figure 4.1.2** and **Figure 4.1.3** respectively as the results of the revetment design.

(1) SSP

Final design results are also shown in **Table R 4.1.9** and **Table R 4.1.10**.

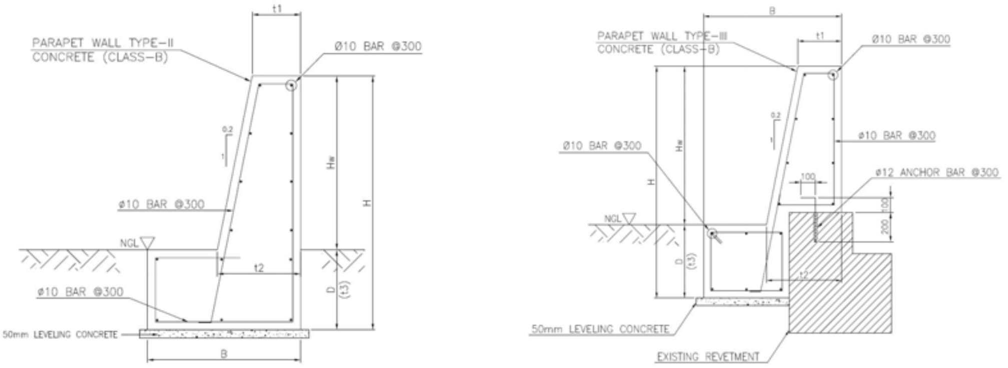
Table R 4.1.9 Design Results of SSP Revetment in Each Section (Left Bank)

No.	Section				Designed SSP Revetment			Result of Design Calculation			
								Stress (N/mm^2)		Dsiplacement (mm)	
	from	to	Bank	EL. of Design Riverbed (EL. m)	Type	Z_0 (cm^3)	Length (m)	Normal (acceptable)	Seismic (acceptable)	Normal (50)	Seismic (75)
1	2+419	2+550	L	9.6	IV_W	2700	11.0	67 (180)	90 (270)	35.17	50.05
2	2+550	2+694	L	9.6	IV_W	2700	11.5	77 (180)	99 (270)	45.22	62.90
3	2+854	2+950	L	9.6	V_L	3150	12.0	70 (180)	91 (270)	45.62	63.84
4	2+950	3+072	L	9.6	IV_W	2700	12.0	73 (180)	92 (270)	46.62	61.08
5	3+160	3+300	L	9.6	25H	1610	9.0	69 (180)	96 (270)	28.74	42.46
6	6+116	6+219	L	10.0	III_W	1800	10.0	76 (180)	103 (270)	40.51	58.56
7	6+249	6+269	L	10.0	VI_L	3820	12.5	69 (180)	107 (270)	42.72	72.08
8	6+376	6+482	L	10.1	V_L	3150	11.0	76 (180)	111 (270)	42.63	66.49
9	7+326	7+444	L	10.1	VI_L	3820	12.0	66 (180)	98 (270)	40.09	61.52
10	7+494	7+514	L	10.1	VI_L	3820	12.0	68 (180)	100 (270)	41.11	63.39
11	11+500	11+628	L	10.2	V_L	3150	11.0	81 (180)	116 (270)	46.54	70.68
12	12+024	12+173	L	8.2	10H + 750x250x12x25	902+5390	16.5	103 (185)	126 (278)	44.11	54.41
13	13+806	13+900	L	10.2	10H + 450x250x9x22	902+2490	13.0	103 (185)	145 (278)	40.86	58.10
14	13+900	14+000	L	10.2	10H + 600x200x12x28	902+3630	14.5	105 (185)	158 (278)	42.48	64.25
15	14+000	14+150	L	10.2	10H + 450x200x12x25	902+2320	12.5	90 (185)	166 (278)	29.48	60.53
16	14+150	14+250	L	10.2	IV_W	2700	10.0	78 (180)	118 (270)	36.56	57.83
17	14+250	14+272	L	10.2	10H + 400x200x9x22	902+1760	11.5	116 (185)	194 (278)	37.10	65.31
18	15+236	15+311	L	10.2	VI_L	3820	11.0	81 (180)	136 (270)	39.37	71.41
19	15+311	15+424	L	10.2	VI_L	3820	11.0	68 (180)	115 (270)	32.12	59.92
20	15+443	15+548	L	10.2	10H + 450x250x12x28	902+3070	13.0	102 (185)	168 (278)	41.61	70.56
21	15+747	15+870	L	10.2	10H + 450x250x9x22	902+2490	13.5	95 (185)	159 (278)	35.32	64.46
22	15+965	16+150	L	10.2	10H + 400x200x9x22	902+1760	12.0	94 (185)	153 (278)	31.70	55.46
23	16+150	16+200	L	10.2	10H + 400x200x9x22	902+1760	12.5	102 (185)	169 (278)	36.94	67.52
24	16+200	16+300	L	10.2	10H + 400x200x9x22	902+1760	12.5	106 (185)	168 (278)	37.91	65.70
25	16+300	16+450	L	10.2	10H + 400x200x9x22	902+1760	13.0	103 (185)	178 (278)	38.65	72.60
26	16+450	16+552	L	10.2	10H + 400x200x9x22	902+1760	12.5	91 (185)	154 (278)	32.03	59.46
27	16+552	16+564	L	10.2	25H + 850x250x16x28	1610+7240	19.0	91 (185)	146 (278)	45.11	72.99

Table R 4.1.10 Design Results of SSP Revetment in Each Section (Right Bank)

No.	Section			EL. of Design Riverbed (EL. m)	Designed SSP Revetment			Result of Design Calculation			
	from	to	Bank		Type	Z_0 (cm^3)	Length (m)	Stress (N/mm^2)		Dsiplacement (mm)	
								Normal (acceptable)	Seismic (acceptable)	Normal (50)	Seismic (75)
1	3+649	3+753	R	9.6	IV_W	2700	11.0	84 (180)	105 (270)	44.85	59.20
2	5+046	5+100	R	10.0	V_L	3150	12.0	62 (180)	94 (270)	38.92	64.94
3	5+100	5+223	R	10.0	VI_L	3820	12.5	66 (180)	90 (270)	41.86	61.62
4	5+262	5+340	R	10.0	VI_L	3820	13.0	53 (180)	81 (270)	36.53	61.33
5	5+340	5+414	R	10.0	VI_L	3820	13.0	60 (180)	92 (270)	38.83	65.28
6	5+545	5+639	R	10.0	10H + 450x200x12x25	902+2320	14.0	97 (185)	148 (278)	45.02	69.06
7	6+337	6+510	R	10.1	V_L	3150	12.0	65 (180)	88 (270)	43.3	62.39
8	8+222	8+250	R	10.1	10H + 550x250x12x28	902+3940	15.0	90 (185)	112 (278)	43.66	54.73
9	8+250	8+400	R	10.1	VI_L	3820	12.0	66 (180)	99 (270)	39.39	63.44
10	8+400	8+510	R	10.1	10H + 450x250x9x22	902+2490	13.5	110 (185)	151 (278)	44.71	61.74
11	8+510	8+650	R	10.1	VI_L	3820	12.5	63 (180)	96 (270)	39.34	65.21
12	8+650	8+800	R	10.1	10H + 400x200x9x22	902+1760	13.0	112 (185)	139 (278)	46.89	58.09
13	8+800	8+900	R	10.1	VI_L	3820	11.5	78 (180)	119 (270)	44.53	71.14
14	8+900	9+000	R	10.1	VI_L	3820	12.0	73 (180)	107 (270)	43.87	68.49
15	9+000	9+150	R	10.1	VI_L	3820	12.0	63 (180)	96 (270)	36.81	60.07
16	9+150	9+200	R	8.1	10H + 650x250x12x28	902+4850	16.5	100 (185)	127 (278)	47.39	64.03
17	9+200	9+341	R	10.1	IV_W	2700	10.5	81 (180)	121 (270)	39.29	64.16
18	9+430	9+550	R	10.1	VI_L	3820	12.5	64 (180)	98 (270)	40.83	66.06
19	9+550	9+650	R	10.1	VI_L	3820	12.0	64 (180)	98 (270)	38.59	61.89
20	9+650	9+723	R	10.1	VI_L	3820	12.0	64 (180)	98 (270)	40.10	63.28
21	9+723	9+750	R	10.1	10H + 400x200x9x22	902+1760	12.5	104 (185)	161 (278)	37.00	60.18
22	9+750	9+770	R	10.1	VI_L	3820	12.0	67 (180)	103 (270)	38.99	64.46
23	9+770	9+830	R	8.1	10H + 600x250x12x28	902+4390	15.5	105 (185)	127 (278)	47.65	60.19
24	9+830	9+947	R	10.1	VI_L	3820	12.0	64 (180)	99 (270)	38.87	64.22
25	10+956	11+050	R	8.2	10H + 500x200x12x25	902+2650	14.0	117 (185)	156 (278)	46.91	65.65
26	11+050	11+150	R	8.2	10H + 750x250x12x25	902+5390	18.0	97 (185)	147 (278)	42.57	70.16
27	11+150	11+263	R	8.2	10H + 650x200x12x28	902+4020	15.0	115 (185)	138 (278)	46.55	56.42
28	11+610	11+653	R	10.2	IV_W	2700	11.0	77 (180)	124 (270)	41.21	72.72
29	11+788	11+803	R	10.2	VI_L	3820	11.5	71 (180)	112 (270)	39.41	68.30
30	13+578	13+700	R	10.2	IV_W	2700	11.0	70 (180)	121 (270)	36.40	67.54
31	13+700	13+802	R	10.2	IV_W	2700	10.0	73 (180)	122 (270)	33.63	60.37
32	13+802	13+900	R	10.2	VI_L	3820	11.5	75 (180)	100 (270)	44.81	60.35
33	13+900	14+000	R	10.2	VI_L	3820	12.0	59 (180)	109 (270)	32.76	69.21
34	14+000	14+100	R	10.2	IV_W	2700	10.0	67 (180)	109 (270)	29.52	50.95
35	14+100	14+200	R	10.2	III_W	1800	8.5	105 (180)	162 (270)	43.44	69.47
36	14+200	14+300	R	10.2	V_L	3150	10.0	74 (180)	126 (270)	35.00	65.18
37	14+300	14+350	R	10.2	10H + 400x200x9x22	902+1760	12.0	76 (185)	203 (278)	23.24	69.65
38	14+350	14+395	R	10.2	10H + 500x250x12x28	902+3500	13.5	91 (185)	166 (278)	32.88	66.13
39	14+835	14+943	R	10.2	IV_W	2700	10.0	72 (180)	114 (270)	31.55	52.44
40	14+983	15+075	R	10.2	10H + 400x200x9x22	902+1760	11.5	97 (185)	178 (278)	30.17	58.36
41	15+409	15+441	R	10.2	10H + 450x250x9x22	902+2490	11.5	76 (185)	208 (278)	21.20	63.73
42	15+476	15+494	R	10.2	IV_W	2700	9.5	82 (180)	142 (270)	33.58	61.28
43	16+667	16+724	R	10.2	VI_L	3820	11.0	69 (180)	121 (270)	36.07	69.50
44	16+760	16+840	R	10.2	10H + 450x250x9x22	902+2490	13.0	79 (185)	158 (278)	26.14	61.14

(2) Parapet Wall Type-II, III



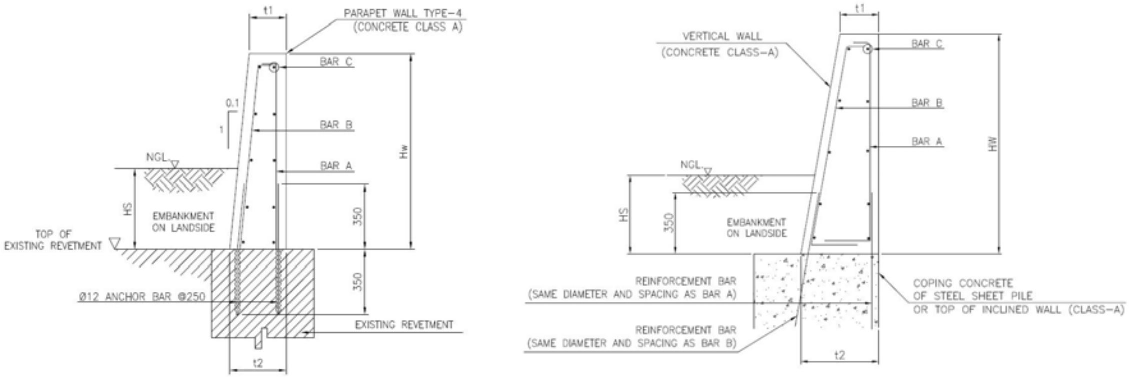
[Parapet Wall Type-II] [Parapet Wall Type-III]

Figure R 4.1.11 Typical Cross Section of Parapet Wall Type-II, III

Table R 4.1.11 Standard Dimensions of Parapet Wall Type-II, III

Hw Range (m)	H (m)	B (m)	D (m)	t1(m)	t2(m)	t3(m)
0.30	0.50	0.36	0.20	0.30	0.36	0.20
0.40	0.60	0.38	0.20	0.30	0.38	0.20
0.50	0.70	0.40	0.20	0.30	0.40	0.20
0.60	0.80	0.45	0.20	0.30	0.42	0.20
0.70	0.90	0.50	0.20	0.30	0.44	0.20
0.80	1.10	0.60	0.30	0.30	0.46	0.30
0.90	1.30	0.75	0.40	0.30	0.48	0.40
1.00	1.40	0.85	0.40	0.30	0.50	0.40
1.10	1.60	0.95	0.50	0.30	0.52	0.50
1.20	1.75	1.10	0.55	0.30	0.55	0.55
1.30	1.90	1.20	0.60	0.30	0.56	0.60
1.40	2.10	1.40	0.70	0.30	0.58	0.70
1.50	2.20	1.60	0.70	0.30	0.60	0.70
1.60	2.30	1.60	0.70	0.40	0.72	0.70
1.70	2.40	1.60	0.70	0.45	0.79	0.70

(3) Parapet Wall Type-IV and Vertical Wall



[Parapet Wall Type-IV] [Vertical Wall]

Figure R 4.1.12 Typical Cross Section of Parapet Wall Type-IV and Vertical Wall

Table R 4.1.12 Standard Dimensions of Parapet Wall Type-IV and Vertical Wall

Height Range		Thickness		Reinforcement					
				BAR A		BAR B		BAR C	
HW (m)	HS (m)	t1 (m)	t2 (m)	DIA (mm)	SPACING (mm)	DIA (mm)	SPACING (mm)	DIA (mm)	SPACING (mm)
0.0~1.5	0.0~0.5	0.20	t1 + HW*0.1	12	250	12	250	12	300
0.0~1.5	0.5~1.0	0.20	t1 + HW*0.1	12	250	12	250	12	300
0.0~1.5	1.0~1.5	0.20	t1 + HW*0.1	12	250	12	250	12	300

(4) Inclined Wall

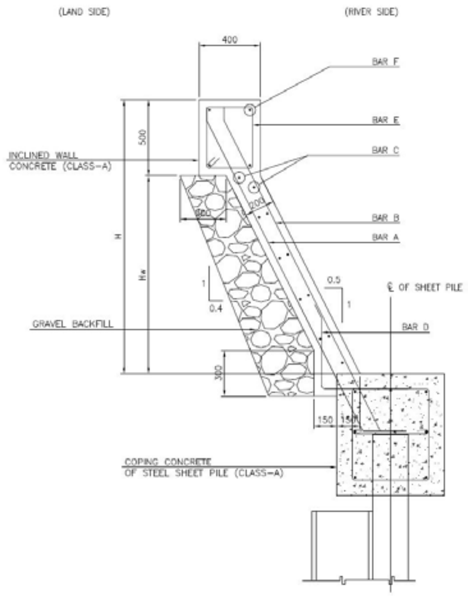
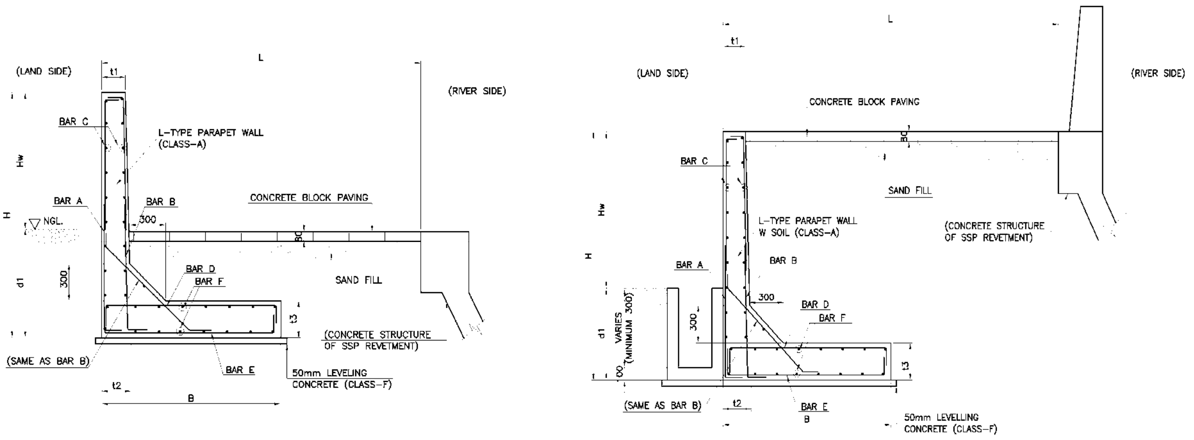


Figure R 4.1.13 Typical Cross Section of Inclined Wall

Table R 4.1.13 Standard Dimensions of Inclined Wall

Height Range		Reinforcement											
		BAR A		BAR B		BAR C		BAR D		BAR E		BAR F	
HW (m)	H (m)	DIA (mm)	SPACING (mm)	DIA (mm)	SPACING (mm)	DIA (mm)	SPACING (mm)	DIA (mm)	SPACING (mm)	DIA (mm)	SPACING (mm)	DIA (mm)	SPACING (mm)
0.0~1.5	0.5~2.0	16	250	16	250	12	300	12	250	12	250	12	-
1.5~2.5	2.0~3.0	16	125	16	125	12	300	12	125	12	125	12	-
2.5~2.75	3.0~3.25	16	125	16	125	12	300	12	125	12	125	12	-
2.75~3.0	3.25~3.5	20	125	20	125	12	300	12	125	12	125	12	-

(5) L-type Parapet Wall



[L-Type Parapet Wall] [L-Type Parapet Wall-SE]

Figure R 4.1.14 Typical Cross Section of L-type Parapet Wall

Table R 4.1.14 Dimensions of L-Type Parapet Wall

Hw Range (m)	B. base (m)	d1, Embankment (m)	t1 (m)	t2 (m)	t3 (m)	Reinforcement											
						BAR A		BAR B		BAR C		BAR D		BAR E		BAR F	
						Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)
0.00 ～ 0.50	1.00	0.50	0.20	0.20	0.20	12	250	12	250	12	300	12	250	12	250	12	300
0.51 ～ 1.00	1.35	0.50	0.20	0.20	0.20	12	250	12	250	12	300	12	250	12	250	12	300
1.01 ～ 1.10	1.50	0.50	0.20	0.20	0.20	12	250	12	250	12	300	12	250	12	250	12	300
1.11 ～ 1.20	1.65	0.50	0.20	0.20	0.20	12	250	12	250	12	300	12	250	12	250	12	300
1.21 ～ 1.30	1.87	0.50	0.20	0.20	0.20	12	250	12	250	12	300	12	250	12	250	12	300
1.31 ～ 1.40	1.90	0.50	0.20	0.20	0.20	12	250	16	250	12	300	16	250	12	250	12	300
1.41 ～ 1.50	2.05	0.50	0.20	0.20	0.20	12	250	16	250	12	300	16	250	12	250	12	300
1.51 ～ 1.60	2.20	0.50	0.20	0.20	0.20	12	250	16	250	12	300	16	250	12	250	12	300
1.61 ～ 1.70	2.35	0.50	0.20	0.20	0.20	12	250	12	125	12	300	12	125	12	250	12	300
1.71 ～ 1.80	2.45	0.50	0.20	0.20	0.20	12	250	20	250	12	300	20	250	12	250	12	300
1.81 ～ 1.90	2.60	0.50	0.20	0.20	0.20	12	250	20	250	12	300	20	250	12	250	12	300
1.91 ～ 2.00	2.75	0.50	0.20	0.20	0.20	12	250	16	125	12	300	16	125	12	250	12	300

Table R 4.1.15 Standard Dimensions of L-Type Parapet Wall-SE

Hw Range (m)	B. base (m)	d1, Embankment (m)	t1 (m)	t2 (m)	t3 (m)	Reinforcement											
						BAR A		BAR B		BAR C		BAR D		BAR E		BAR F	
						Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)	Dia (mm)	Spacing (mm)
0.00 ～ 0.50	0.50	0.40	0.20	0.20	0.20	12	250	12	250	12	300	12	250	12	250	12	300
0.50 ～ 0.60	0.50	0.40	0.20	0.20	0.20	12	250	12	250	12	300	12	250	12	250	12	300
0.60 ～ 0.70	0.55	0.40	0.20	0.20	0.20	12	250	16	250	12	300	16	250	12	250	12	300
0.70 ～ 0.80	0.65	0.40	0.20	0.20	0.20	12	250	16	250	12	300	16	250	12	250	12	300
0.80 ～ 0.90	0.75	0.40	0.20	0.20	0.20	12	250	20	250	12	300	20	250	12	250	12	300
0.90 ～ 1.00	0.85	0.40	0.20	0.20	0.20	12	250	16	125	12	300	16	125	12	250	12	300
1.00 ～ 1.10	0.95	0.40	0.20	0.20	0.20	12	250	25	250	12	300	25	250	12	250	12	300
1.10 ～ 1.20	1.00	0.40	0.20	0.30	0.30	12	250	20	250	12	300	20	250	12	250	12	300
1.20 ～ 1.30	1.15	0.40	0.20	0.30	0.30	12	250	16	125	12	300	16	125	12	250	12	300
1.30 ～ 1.40	1.25	0.40	0.20	0.30	0.30	12	250	25	250	12	300	25	250	12	250	12	300
1.40 ～ 1.50	1.35	0.40	0.20	0.30	0.30	12	250	20	125	12	250	20	125	12	250	12	250
1.50 ～ 1.60	1.45	0.40	0.20	0.35	0.35	16	250	20	125	12	250	20	125	16	250	12	250

(6) Slope Stability of Riprap

The slope stability of the riprap about the steep riverbed portion should be verified to confirm the adequate riprap slopes which were fundamentally based on Phase II. The result is shown in **Table R 4.1.16**.

Table R 4.1.16 Slope Stability Result of Riprap

No.	Bank	Station	Case-1: Riprap Slope 1.0		Case-2: Riprap Slope 1.5		Portion of the Slope 1.5
			Factor of Safety	Judgment	Factor of Safety	Judgment	
1	Left	2+600	1.133	NG	1.239	Safe	2+419-2+694
2		2+931	0.914	NG	1.215	Safe	2+854-3+072
3		3+050	1.102	NG	1.346	Safe	
4		14+200	1.184	NG	1.386	Safe	14+150-14+272
5		15+236	1.203	Safe	-	-	-
6		15+300	1.229	Safe	-	-	-
7		15+350	1.352	Safe	-	-	-
8		16+042	1.174	NG	1.457	Safe	16+000-16+100
9	Right	5+100	1.531	Safe	-	-	-
10		6+415	1.016	NG	1.215	Safe	6+337-6+510
11		6+471	0.955	NG	1.215	Safe	
12		8+600	1.085	NG	1.622	Safe	8+550-8+700
13		9+000	1.201	Safe	-	-	-
14		9+100	1.419	Safe	-	-	-
15		9+750	1.168	NG	1.510	Safe	9+723-9+792
16		13+700	1.524	Safe	-	-	-
17		13+914.5	1.049	NG	1.416	Safe	13+804-13+952
18		16+667	1.468	Safe	-		-

Note: Allowable Factor of Safety > 1.20

4.1.3 Drainage Facilities

The main components of the drainage system (**Figure R 4.1.15**) consist of U-ditch, collector pipe, manhole and flap gate. The flap gate is optional, which is used only at locations where the DHWL is higher than the existing ground inland.

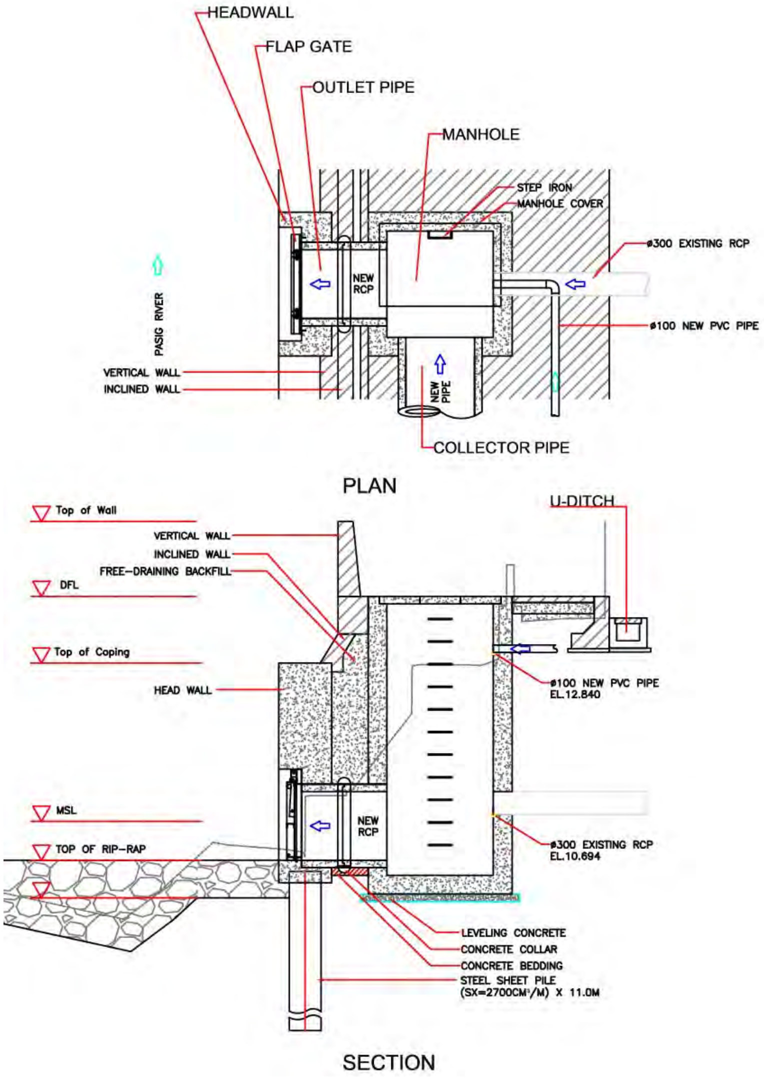


Figure R 4.1.15 Components of the Drainage Outlet in Pasig River

(1) U-Ditch

The U-ditch is designed to collect discharges from sanitary outlets, roof drains and surface runoff from the easement. Regarding sanitary and roof drains, quantity of discharge is calculated by assumed ¾ full flow. Regarding easement drain, the quantity of discharge of the existing pipe is calculated by the rational formula. The U-ditch cross section area is calculated by total of both discharge.

A minimum rectangular U-ditch size of 0.3m x 0.3m and a maximum of around 0.3m x 0.6m is adopted.

(2) Reinforced Collector Pipe

In order to reduce the number of outlets, collector pipe would be installed using reinforced concrete pipe basically. When many PVC pipes have to be connected to a collector pipe, installing manholes for each PVC pipes is uneconomical. In this case, box culvert should be applied instead of reinforced concrete pipe culvert.

(3) Manhole and Outlet

Basic dimensions and clearances of the manhole is designed based mainly on the size of the outlet pipe.

For maintenance access purposes, a manhole opening on the top slab is designed with not less than 0.60m x 0.60m. The cover is made of reinforced concrete instead of solid iron or iron grilles to prevent from vandalization. In addition, deformed steel bars are used as ladder rungs are provided for maintenance access for manholes deeper than 1.0m.

(a) Structural Calculation of Manhole

(i) Design Condition

The design conditions are shown in **Table R 4.1.17**.

Table R 4.1.17 Design Condition of Manhole in Pasig River

Item			Design Condition
Material Unit Weight	Concrete Reinforced		24.0 kN/m^3
	Concrete Plain		23.5 kN/m^3
	Structural Steel		77.0 kN/m^3
	Water		9.8 kN/m^3
Soil Condition	Quality of Soil		
	Unit Weight	Damped and Wet Condition	18.0 kN/m^3
		Saturated Condition	20.0 kN/m^3
		Submerged Condition	10.0 kN/m^3
Water Level Condition			[Inside water level] Bottom Elevation of Manhole [Outside water level] Ground Level – 0.9m* * The Pavement elevation is around 13.600 and the top elevation of coping concrete is 12.7000. Hence, Outside water level is assumed ground level – 0.9m.
Surcharge on the Ground			10 kN/m^2
Live load on Top Slab			T-2 * * Passenger vehicle and small truck which weighs less than 2 t is assumed

(ii) Results of Calculation

The dimension of manholes based on the results of structural calculation are shown in **Table 4.1.1**. And the detail of calculation is indicated in **Vol.III-1**.

(4) Junction Box

Junction Boxes are installed to properly connect a U-ditch to a manhole or outlet.

(5) Structural Calculation of Junction Box

Design Condition is same as manhole. The calculated dimensions based on the results of structural calculation are shown in **Table 4.1.2**. And the detail of calculation is indicated in **Vol.III-1**.

(6) Flap Gate

Flap gate is provided at outlets where DHWL is higher than the inland ground surface elevation.

Material for the flap gate leaf and frame is made of Fiberglass Reinforced Polyester (FRP) with Stainless Steel fastener and hinges.

Shown in **Table 4.1.3** is a comparison of the three types of flap gate materials based on their characteristics. These are the most common types that are commercially available.

4.2 Result of Design for Lower Marikina River

4.2.1 Changed in Detailed Design Stage

Changed in Detailed Design Stage is as summarized in Table R 4.2.1.

Table R 4.2.1 Changed in Detailed Design for Lower Marikina River

Item		Basic Design	Detailed Design	Reason for Change
(1) River Structure				
Sub-section : 3.2.1 Design Condition				
a	River Centerline	Utilization of river centerline of Phase I in 2002	Based on latest survey results	Readjustment of river centerline based on the latest survey results in 2012
Sub-section : 3.2.1.2 Design Range in Lower Marikina River				
b	BP, EP and Length of Each Section	Based on Preparatory Study for PMRCIP-III	Based on latest survey results	Readjustment of construction area based on the latest survey results in 2012
Sub-section : 3.2.4 Basic Design of Reinforced Concrete Flood Wall				
c	Height of Dike	EL+15.0 m along whole stretch of the dike	dike height is adjusted based on the DFL at each section	As a result of meeting with DPWH and LGU, dike height is revised based on the DFL at each section
d	Revetment and Dike Structure	Concrete Block Revetment, Width of crest: 6.0 m	SSP Revetment, Width of crest: 3.0 m	Modified revetment and dike structure based on the result of discussion with DPWH and LGU
e	Boundary Wall	None	Width: 0.3 m, Height: 1.0 m	Addition to boundary wall based on the result of meeting with DPWH and LGU
f	Railing	Guardrail (Corrugated beam)	Concrete Handrail (Bamboo railing)	Although road specification for dike crown was required as public road in basic design, the specification is decided as maintenance road during the coordination meeting with DPWH and LGU
Sub-section : 3.2.5.3 (2) Extra Dredging				
g	Extra-Dredging	0.5 m on the bottom and 2.0 on the slope of dredged line	No consideration of extra-dredging	In view of the past dredging work in Philippine, extra-dredging is not considered
Sub-section : 3.2.6 (1) Temporary Soil Storage Site Plan				
h	Napindan Temporary Staging Area	Confluence of Lower Marikina River and Napindan Channel, covering 5.95 ha	None	It is expected to be difficult to agree with the land owner. The dredged material is directly carried by barge to the backfill site without use of Napindan Temporary Staging Area
Sub-section : 3.2.6 (4) Study of Backfill Site				
i	Area of Backfill Site	47.8 ha	45.0 ha	Revision of area of backfill site based on the latest survey results in 2012
j	Backfill Site Drainage System	2 catchment point for surface drainage at the middle of backfill site	4 catchment point for surface drainage (2 locations at the middle of backfill site, 1 location at east and west respectively	Revision of the backfill site drainage system based on the latest survey results in 2012 and modified construction plan, like a carrying-in route
k	Backfill Site Outlet	Concrete Box Culvert	RC Pipe	Revised backfill site outlet based on the latest survey results in 2012 and mitigation of subsidence due to own weight
l	Temporary Jetty at Backfill Site	Length: 48 m, Width:10 m, at the Laguna Lake side of C6 bridge	Length: 108 m, Width:12 m, at the Lower Marikina River side of C6 bridge	Due to direct transport of dredged material in connection with the repeal of the Napindan Temporary Staging Area, the location and size of temporary jetty is revised

Item		Basic Design	Detailed Design	Reason for Change
(1) River Structure				
Sub-section : 3.2.7 Study of Boundary Bank				
m	Boundary Dike	Boundary Dike (Eco-tube)	Boundary Marker (Concrete Post)	During the basic design stage, eco-tube was planned to be used as a measure to contain heavy metals and marker for government property boundary. However, the results of analysis of riverbed sediments along Lower Marikina River showed that detection of heavy metals does not exceed the DENR Standard. In view of economical and constructional advantage, concrete boundary marker was adopted during the meeting with DPWH
Sub-section : 3.2.8 (3) Foot Protection Method with Bags (Bottle Unit)				
n	Foot Protection for Pier	FBU-10 type	SBU-10 type	To obtain information from supplier in relation to overseas-oriented product
(2) Drainage Facilities				
Sub-section : 3.3.3 (3) Drainage Planning for Marikina River				
MSR-1		Installation at Sta. 2+950	Deleted	Revision of dike/revetment area
MSL-2		Installation at Sta. 1+333	Installation at Sta. 1+323	Revision of dike/revetment area
MSL-4		Installation at Sta. 4+233	Installation at Sta. 4+221	Coordination with Construction Plan (Driving SSP for seepage cutoff wall under the existing bridge)
MSR-3		Installation at Sta. 3+258	Installation at Sta. 3+255	Coordination with Construction Plan (Driving SSP for seepage cutoff wall under the existing bridge)

(1) River Structure

There are changes made in the Basic Design which have been reflected in the Detailed Design due to several design conditions. These changes are as follows.

(a) River Centerline

Under time pressure, the past topographic survey result which was conducted during Phase I in 2002 was used for the Basic Design. It was found out in the topographic survey which was conducted during Phase III in 2012 that riverbed aggradation has resulted due sedimentation, landfill is changing due to culture, and a number of residential and commercial establishments are increasing and expanding along the banks of the Lower Marikina River and so on. Hence, new river centerline is decided on the basis of the latest survey results.

(b) BP, EP and Length of Each Section

In Detailed Design, BP, EP, and length of each section are changed for the following reasons.

- A more suitable treatment to terminate the dike was explored. Therefore shortening or extension of the dike due to change in the location of BP and EP was considered.
- Many houses are within the projected lines of the proposed dike. To avoid them the locations of some BP or EP are changed.
- Regarding end treatment of dike, the end of the linear park was adopted due to the existence of walls.

(c) Height of Dike

In the Basic Design, the top elevation of dike was set to 15.00m uniformly along the Lower Marikina River following the road plan of Pasig City. However there is a large difference between (DHWL+Fb) which leads to high increment of cost.

In subsequent deliberations with Pasig City, it turned out that uniform elevation is not necessary. For this reason, an agreement with the city was obtained wherein the margin of safety is still attained for the DHWL.

(d) Revetment and Dike Structure

The former proposal during the Basic Design consisted of concrete block retaining wall with steel sheet pile and gabion mattresses, 6m concrete paved road and earth slope. Through discussions with the DPWH and Pasig City to solicit further improvement of the design, it was found out that a 6m road is not necessary.

The main points of reexamination are as follows.

- The most suitable structure should be adopted such as reduction of dike width as well as other measures so as not to reduce the river cross sectional area of flow. Therefore concrete block retaining wall and steel sheet pile were compared. In both comparisons, the height of parapet wall is kept at 0.80m.
- The road width in the Basic Design is 6.0m, however the road width of 3.0m for vehicle maintenance management is adopted. Pavement is made simple by adopting gravel instead of concrete. The road dike, however, allows for future widening to 6m road.
- Since a flatter earth side slope of the dike would occupy larger space, this was changed to a concrete block retaining wall where the side slope is steeper and occupies lesser space.

(e) Boundary Wall

As a result of coordination meting with DPWH and LGU, the wall with the meaning as a boundary of ROW was prepared in the part of the low wall by the side of the private house of the linear park of the present condition.

(f) Railing

Since passing of 6m width common vehicles was considered in the basic design, the guardrail was planned. However, it became only passing of the vehicles for maintenance management in detailed design.

As this road prepared stairs and a child can put it in freely, DPWH asked for installation of a rail to prevent a child falling from walls just in case. And, concrete railing that imitated the bamboo which gave priority to the prevention from a fall of people over vehicles was provided by specification of DPWH.

(g) Extra-Dredging

Although extra-dredging with thickness of the bottom: 50cm, and side thickness of the slope: 2.0m according to the Japanese River Earthwork Manual was adopted in the basic design, as a result of the talks with DPWH and as it informed that accounting for extra dredging is not performing in the Philippines, we decided to omit extra-dredging in design drawings and quantity calculation in the detailed design.

However, in the execution scheme, the allowable extra-dredging is calculated according to the standard of DPWH from the necessity of considering it as the plan which saw the allowable extra-dredging in actual construction.

(h) Napindan Temporary Staging Area

Approval of land use for temporary soil storage near the confluence of Lower Marikina and Napindan River could not be obtained from the owner of a piece of land in Brgy. Sta. Rosa. Hence, a 45-ha lot located at the mouth of Laguna Lake in Brgy. Napindan shall be made as a site for premixing and ultimately as backfill site for the dredged soil.

(i) Area of Backfill Site

A backfill site area of 47.8ha was planned during the basic design stage. However based on the latest result of survey, the Backfill Site of 45ha was planned during the detailed design stage.

(j) Backfill Site Drainage System

In the basic design, in order to carry in the earth and sand which carried out intermediate treatment from the Laguna lake side (upstream side) of a bridge, it was considered as the system with which the whole site is backfilled from the center of a plan place. Therefore, drainage facilities were prepared in the center of site on canal side for maintenance management.

However, in the detailed design, the position of the ground of intermediate treatment was established in the end of site on the southeast side near the jetty which changed the position, the carry-soil of embankment was written with starting from there, and a large change arose from the changed carry-soil plan in the layout planning of facilities.

Moreover, since a request went up from residents that rainfall water from outside could be discharged to the existing maintenance drainage canal, and the drainage at the time of construction is also taken into consideration, the outlets were provided in the both ends by the side of the southeast and northeast of a project site.

Drainage of the site was made to process by one each of a block of the east and west which produced as a result of improving a national highway.

In these results, a large change of the drainage system arose.

(k) Backfill Site Outlet

In the basic design, outlets were a concrete box type.

However, settlement would be expected if weight is large, and road heights around site has to be lowered, RC pipe was adopted in the detailed design.

(l) Temporary Jetty at Backfill Site

In the basic design, a 48m-jetty for loading of dredging soil in Laguna Backfill Site was planned for one earth carrying barge in which intermediate treated dredging soil in Napindan Site is carried out.

However, since it was changed into performing intermediate treatment in Laguna and frequent arrival at a shore of the convoy of a backhoe was assumed, it changed into 108 m as a space at which the earth carrying barge (1000DWT class) of at least three boats can arrive at a shore.

Moreover, width changed 10 m of a basic design into 12 m so that the turn of a 10-t damp truck might be attained.

Since the planned position of the jetty was changed into the upper stream side from the lower stream side of a bridge at that time, a length of 30 m is not required for an approach part, and it changed into 6 m required in order to straddle a revetment wall.

(m) Boundary Dike

During the basic design stage, eco-tube was planned to be used as a measure to contain heavy metals and marker for government property boundary. However, the results of analysis of riverbed sediments along Lower Marikina River showed that detection of heavy metals does not exceed the DENR Standard. It shows that eco-tube is no longer appropriate for the measure against heavy metals.

Moreover, installation only as a boundary marker turned out to be too expensive. As a result of coordination meeting with DPWH, concrete posts is adopted as boundary markers in a 50-m interval instead of eco-tube.

(n) Foot Protection for Pier

Although the Bottle Unit was due to use the FBU-10 type of 1.7 m in width and 0.425m in average height at the beginning, this type has the information on the exclusive use only for domestic, and it changed it into the type of overseas-oriented SBU-10 type of 1.6 m in width and 0.400 m in average height.

(2) Drainage Facilities

Regarding drainage facilities, in the detail design stage, the location and number of sluiceway was changed due to the following reasons, and the final location is shown in the **Table R 4.2.2.**

- The beginning point of dike in Section II is changed from Right Bank STA.2+880 to Right Bank STA.3+33.6.
- Location of MSL2 in basic design is near the existing wall of Rizal high school, and the construction would affect to it.
- Location of MSL4 in basic design is near the pier of Rosario Bridge, and it is impossible to pile SSP for seepage cutoff wall.
- Location of MSR3 in basic design is near the Alfonso Sandoval Bridge, and there is problem about vertical clearance in piling the SSP with flexible joint would affect to it.

Table R 4.2.2 Change of the Sluiceway Location

Sluiceway Number	Side	Location/ Station	
		Basic Design	Detail Design
MSL-1	Left Bank	1+104	1+104
MSL-2		1+333	**1+323**
MSL-3		3+945	3+945
MSL-4		4+233	**4+221**
MSL-5		4+406	4+406
MSL-6		4+503	4+503
MSR-1	Right Bank	2+950	**Unnecessary**
MSR-2		3+157	3+157
MSR-3		3+258	**3+255**
MSR-4		3+438	3+438

Note: **Bold type** means the location/station changed from basic design stage.

4.2.2 River Structure

4.2.2.1 Design Concept

This chapter consists of the detailed design of shore protection structures, dredging as well as the design of appurtenant facilities which aims to reduce flood damage along Lower Marikina River.

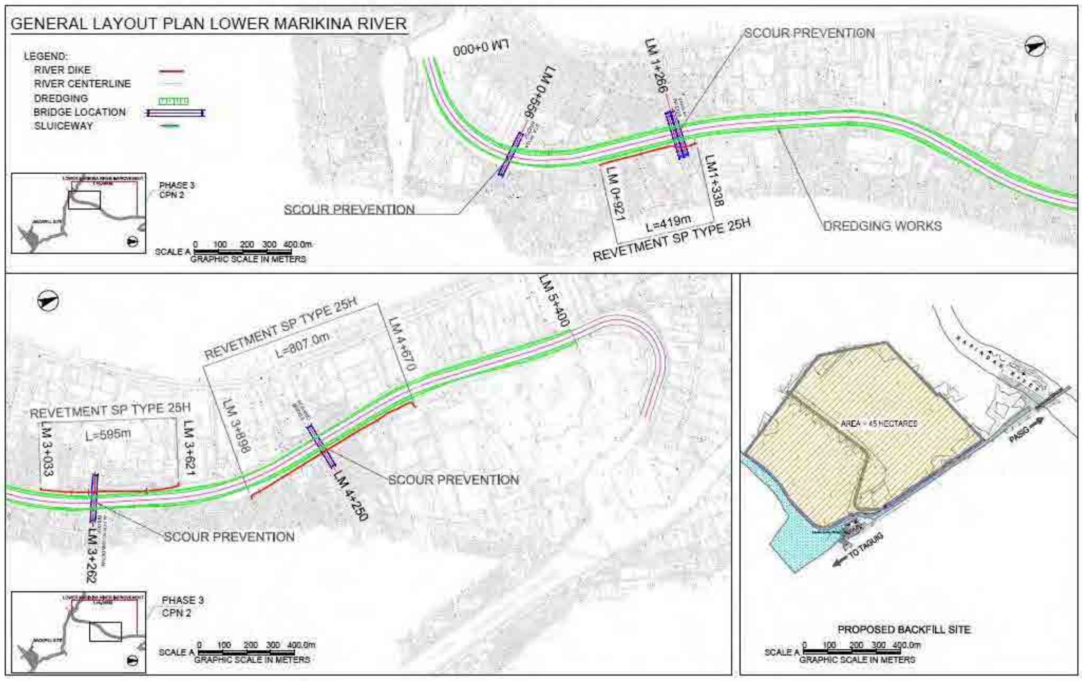


Figure R 4.2.1 Extent of Design for Lower Marikina River

4.2.2.2 Design Summary

(1) Summary of Results of Detailed Design

Table R 4.2.3 Design Activities

Design Item		Quantities		Scope of Design
1	Alignment of River Centerline	Whole river stretch	5,400m	Design of river centerline.
2	Alignment of revetments	Whole river, both banks	5,400m×2	Design of river alignment.
3	Design of revetments and dike structures	3 sections	1,821m	Design of dikes and related facilities.
4	Dredging	Whole river	5,400m	Design of dredging works along the river alignment.
5	Foot Protection around Piers	Bridges	4 bridges	Design of foot protection with bottle unit bags.
6	Backfill Site	Brgy. Napindan	1set 45ha	Design of backfill site, including drainage facilities, internal road network, etc.
7	Boundary Markers	Whole river, both banks	71 units	Determination of location and design of boundary markers.

(2) Determination of Centerline

Alignment of new centerline of Lower Marikina River was determined by the concept that the centerline must be located along the line that flood water might flow at maximum discharge and velocity, and must be positioned where the river flows smoothly to maximize the effect of dredging. (New Alignment of River Centerline, Refer to **Figure 4.2.2**.)

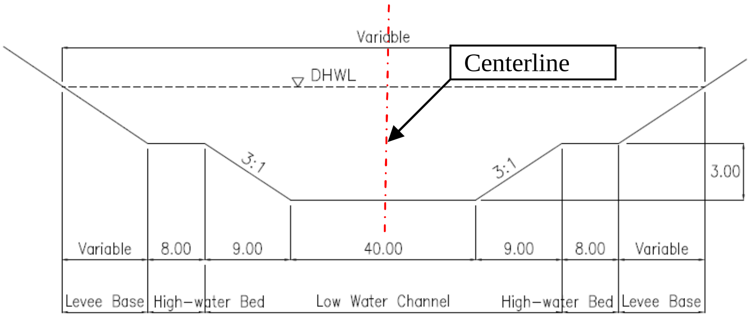


Figure R 4.2.2 Typical River Cross Section

(3) Profile of Lower Marikina River

Profile of Lower Marikina River is shown in **Figure 4.2.3**.

(4) Improvement Work Area

Improvement Works Area of Lower Marikina River is shown in **Figure R 4.2.3** and sectional location, length and structure are shown in **Table R 4.2.4**.

Table R 4.2.4 Improvement Work Area

Section	STA		Side of River	Length (m)	Structure	Remarks
	BP	EP				
1	0+921	1+338	Left	419	SSP + Concrete Block and Gravity Walls	
2	3+033	4+621	Right	595	SSP + Concrete Block and Gravity Walls	
3	3+898	4+670	Left	807	SSP + Concrete Block and Gravity Walls	

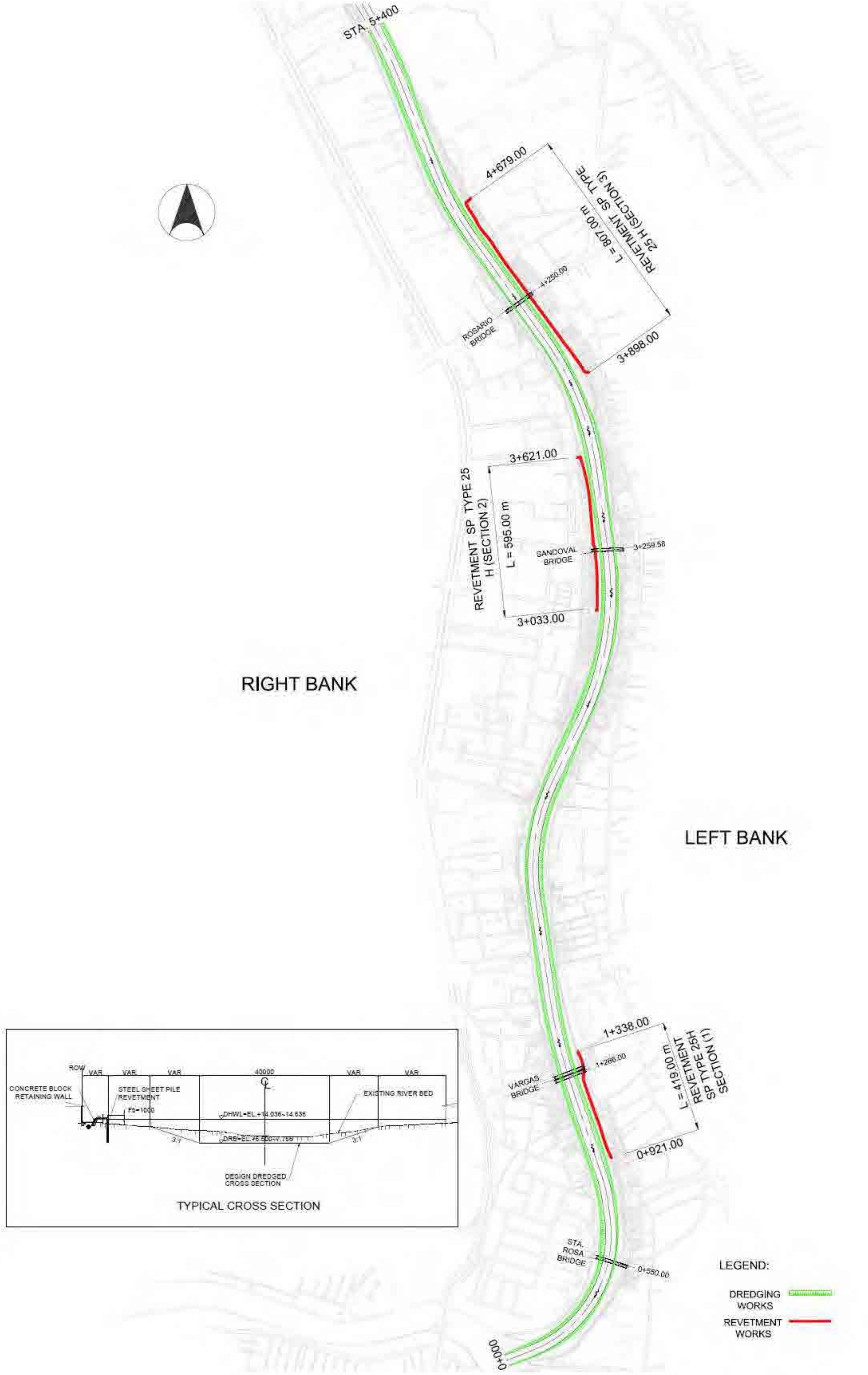


Figure R 4.2.3 Area of River Improvement Work

4.2.2.3 Revetment Components

(1) General

The revetment basically consists of three main components: steel sheet piles, earth embankment and concrete block retaining walls behind the dike. **Figure R 4.2.4** shows the standard dike section for the Lower Marikina River.

Dike Shape is decide by the following concepts.

- Vertical revetment structure consisting of steel sheet pile is adopted to maximize river cross-section of flow.
- ROW is set at the edge of linear park to have a space for drainage facilities and the dike structure can be approached on the land side. At least 2.0m of road is kept for movement of residents.
- Road width of 3.0m is decided to satisfy minimum requirement for maintenance of dike.
- Basically, wall at land side is made of concrete hollow blocks to reduce the vertical force on the ground.

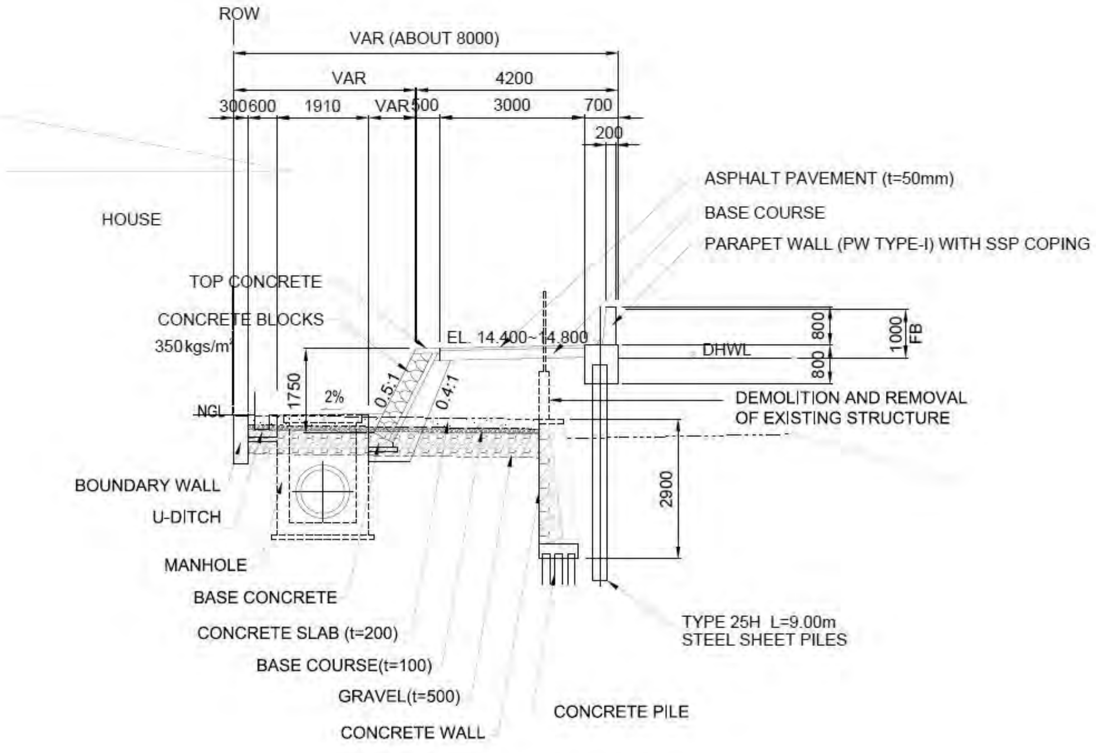


Figure R 4.2.4 Standard Drawing of Dike

(2) Steel Sheet Pile (SSP)

(a) Type of Steel Sheet Pile Revetment

Steel Sheet Pile Revetment is adopted for the river side. The type of steel sheet pile is HAT-Shape SP-25H, with 0.70m in width x 0.80m in height reinforced pile coping.

Properties of the HAT-Shape SP-25H are shown in **Table R 4.2.5**.

Table R 4.2.5 Properties of Steel Sheet Pile

Type of SSP	**W (mm)**	**h (mm)**	**t (mm)**	**A (cm^2)**	**I (cm^4)**	**Z (cm^3)**	**Weight (kg/m)**	**I' (cm^4)**	**Z' (cm^3)**
HAT-Shape	Per Piece			Per 1.0 meter					
SP-25H	900	300	13.2	160.4	24,400	1,610	126	20,000	1,320
Note:	*I', Z' : Values after considering corrosion depth of 2mm (1mm for each side)*								

(b) Elevation of Sheet Pile Revetments

Elevations of top of parapet walls and sheet pile copings are determined based on the DHWL. The top elevation of parapet wall and pile coping is shown in **Table R 4.2.6.**

Elevation: top of parapet wall ≥ DHWL + Fb (1.00m)
Top of pile coping ≥ (Top of parapet wall) – 0.80m※

Elevation of DHWL is at the elevation of upper and elevated edge of each section.

※*TECHNICAL STANDARDS AND GUIDELINES FOR DESIGN OF FLOOD CONTROL STRUCTURES (DPWH)、1.4.2 Floodwall*

Table R 4.2.6 Determination of Elevation of Tops of Structures

Section	**BP Ep**	**STA**	**DHWL (m)**	**DHWL +1.00m**	**Top of Parapet Wall(m)**	**Top of Pile Coping (m)**	**Remarks**
1	BP	0+921	14.138	15.138	15.200	14.400	
	EP	1+338	14.185	15.185	15.200	14.400	
2	BP	3+033	14.373	15.373	15.500	14.700	
	EP	3+621	14.438	15.438	15.500	14.700	
3	BP	3+898	14.469	15.469	15.600	14.800	
	EP	4+670	14.555	15.555	15.600	14.800	

(c) Result of Structural Calculation

Calculation of the adequacy and stability of steel sheet piles is based on the following assumptions (refer to **Figure R 4.2.5**).

- The maximum height of steel sheet pile from existing ground on river side is around 2.40m at Sta. 4+250. However, 3.00m of exposed length is adopted evenly for every steel sheet pile because of expected scouring in the future. Sta. 1+325 is located on land side where scouring is not expected, so 1.50m of exposed length is adopted for structure calculation and stability analysis.
- LWL is obtained as water level increasing by 1/9000 inclination from the surface water level of 10.10m at Sta. 0+000.

- Cohesive force is obtained by the equation C = 6N (kN/m^2), where N is N-value.
- Seismic force in the air and under water is 0.20.
- Points for calculation are selected as representative of the sections in consideration of geologic profile.
- Residual Water Levels (RWL) are 2/3 of differences between DWHL and ground water level.

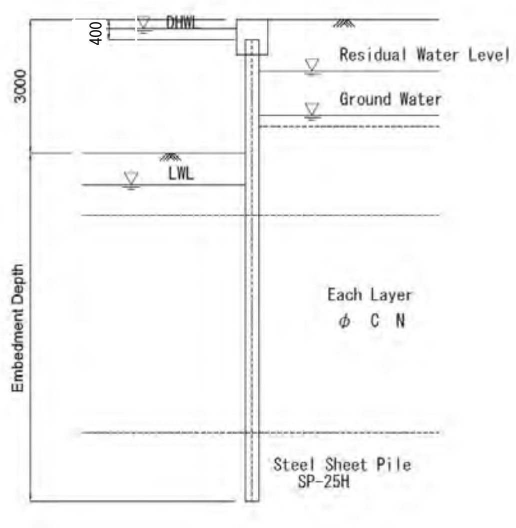


Figure R 4.2.5 Calculation Model for Steel Sheet Pile

The results of calculation are shown in **Table R 4.2.7**.

Table R 4.2.7 Results of Calculation of Steel Sheet Piles

Section	STA	State	Mmax (kmm/m)	Stress σ (N/mm^2)	Horizontal Deformation(mm)	Embedment Depth(m)
1	1+100	Normal	85.80	65	29.8	6.23
		Seismic	85.00	64	29.53	6.23
	1+325	Normal	108.33	82	38.17	6.33
		Seismic	145.34	110	57.40	6.83
	1+325 D=1.50	Normal	19.00	14	4.07	5.88
		Seismic	22.43	17	5.15	6.17
2	3+170	Normal	66.48	50	22.02	5.99
		Seismic	49.35	37	15.74	5.99
	3+240	Normal	111.45	84	49.32	7.47
		Seismic	82.97	63	30.32	6.48
	3+450	Normal	77.18	58	33.01	7.32
		Seismic	96.85	73	43.17	7.59
3	4+050	Normal	74.32	56	27.99	6.68
		Seismic	62.02	47	20.99	6.13
	4+250	Normal	77.12	58	33.06	7.33
		Seismic	95.53	72	42.86	7.59
	4+400	Normal	64.60	49	22.18	6.18
		Seismic	60.94	46	20.75	6.18
	4+500	Normal	78.22	59	33.60	7.33
		Seismic	96.89	73	42.38	7.46
Allowable Value		Normal		180	50	
Allowable Value		Seismic		270	74	

(d) Length of Steel Sheet Piles

Length of steel sheet piles is checked with its safety factor calculated by circular slip method. (Refer to **Figure R 4.2.6**).

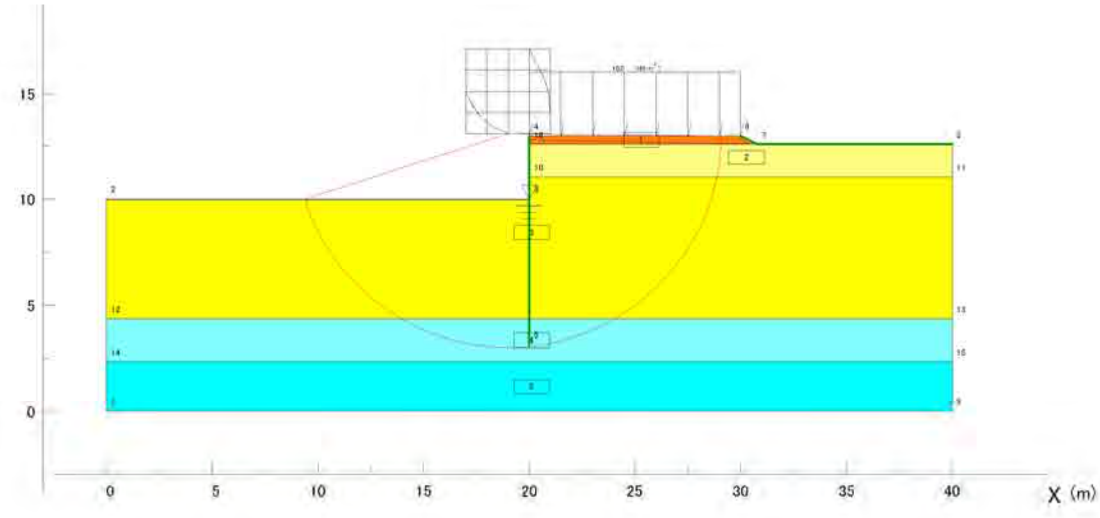


Figure R 4.2.6 Model of Circular Slip in case of Steel Sheet Pile

Calculation by the slip circle method is implemented to confirm the safety, 1.20, of steel sheet piles against sliding. Results were shown in **Table R 4.2.8** confirming that every case was satisfied with the required safety factor. After above mentioned checking, the steel sheet pile lengths are decided for every section and shown in **Table R 4.2.9**.

Table R 4.2.8 Results of Lengths of Sheet Pile

Section	STA	Length in Structural Calculation (m)	Safety factor in Circular Slip Calc. (Fs >1.20)	Adopted Length (m)
1	1+100	9.00	2.566	9.00
	1+325	9.40	1.224	9.50
	1+325 D=150	7.30	2.123	7.50
2	3+170	8.60	2.220	9.00
	3+240	10.00	1.689	10.00
	3+450	10.20	1.749	10.50
3	4+050	9.30	3.484	9.50
	4+250	10.20	3.772	10.50
	4+400	8.80	3.019	9.00
	4+500	10.10	2.274	10.50

Table R 4.2.9 Schedule of Steel Sheet Piles Type 25H

Section	**STA**		**Length (m)**	**Pile Length (m)**
	From	**To**		
1	0+922.40	1+200.00	283.80	9.0
	1+200.00	1+253.20	54.10	9.5
	1+253.20	1+335.10	80.20	7.5
2	3+033.00	3+144.90	119.10	9.0
	3+144.90	3+246.65	97.20	10.0
	3+246.65	3+621.20	387.00	10.5
3	3+898.00	4+211.10	331.70	9.5
	4+211.10	4+270.00	60.20	10.5
	4+270.00	4+395.20	124.70	9.0
	4+395.20	4+665.20	289.20	10.5
Total			1827.2	

The other components of steel sheet pile are designed and shown as follows;

(e) Expansion Joint

Coping : Joint Sealant and Cork Filler at an interval of 10m

Parapet Wall: Cork Filler, Joint Sealant and Water Stop at an interval of 20m
Construction Joint with Joint Sealant at an interval of 5m

(f) Rotation Angle and Minimum Radius of Steel Sheet Piles

Rotation angle at a joint (refer to **Figure R 4.2.7**) is within 4 degrees in HAT-Shape steel sheet pile. Therefore R=15.00m of minimum radius when driving is adopted in Lower Marikina River.

Figure R 4.2.7 Rotation Angle at Joint

(3) Concrete Block Retaining Wall

(a) Shape of Concrete Block Retaining Wall

Shape of Concrete Block Retaining Wall is shown in **Figure R 4.2.8** and its dimensions are shown in **Table R 4.2.10**.

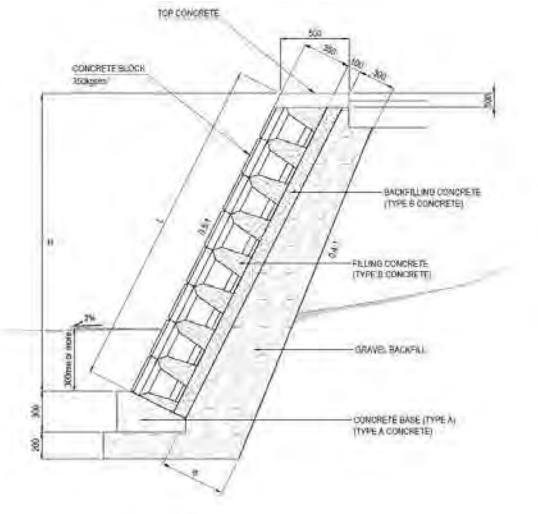


Figure R 4.2.8 Concrete Block Wall

Table R 4.2.10 Properties of Concrete Block Retaining Wall

Height H (m)	Foundation Height H1 (mm)	Slope Length L (mm)	Thickness a (mm)	Thickness of Laying Concrete	Thickness of Backfilling		Steel Sheet Pile SP-10H
					C (mm)	D (mm)	
1.50	300	1677	350	100	300	457	—
1.75	300	1957	350	100	300	478	—
2.00	300	2236	350	100	300	501	—
2.25	700	2516	350	100	300	524	2.00m
2.50	700	2795	350	100	300	546	2.00m

A concrete block retaining wall and a gravity wall classify use with height

Concrete Block Retaining Wall: Total height 1.80m or more
(H:150m+Base Height:0.30m).

Gravity Wall : Total height 1.50m or less

(b) Stability Analysis of Concrete Block Retaining Wall

Stability analysis of the concrete block retaining was made against overturning, sliding and bearing capacity. Result of the analysis was shown in **Table R 4.2.11**, confirming every height case was satisfied with stability.

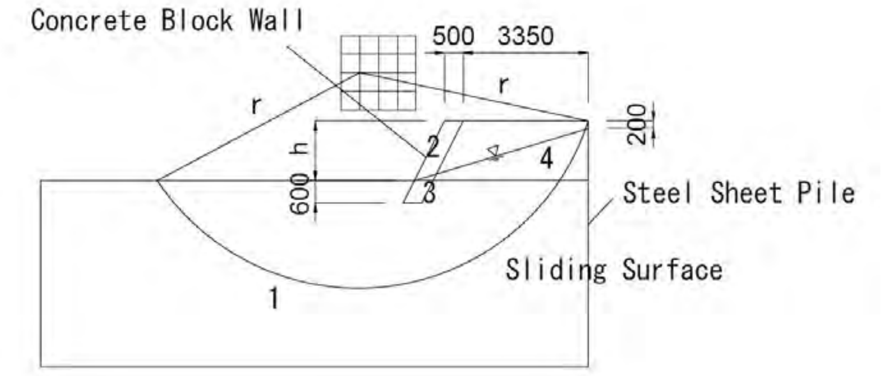
Table R 4.2.11 Result of Stability Analysis

Height H (m)	Overturning		Sliding		Bearing Capacity	
	Resultant Force Xh (m)	Middle Third X' (m)	Fs	Allowable Fs	Weight of Wall (kN/m)	Allowable Bearing Capacity (kN/m)
2.50	1.516	1.683	1.77	1.50	37.80	64.7
2.25	1.365	1.558	1.92	1.50	34.86	64.7
2.00	0.996	1.233	2.36	1.50	26.09	31.5
1.75	0.863	1.108	2.64	1.50	23.15	31.5
1.50	0.737	0.983	3.00	1.50	20.22	31.5
1.25	0.616	0.858	3.44	1.50	17.27	31.5
1.00	0.508	0.733	4.08	1.50	14.34	31.5

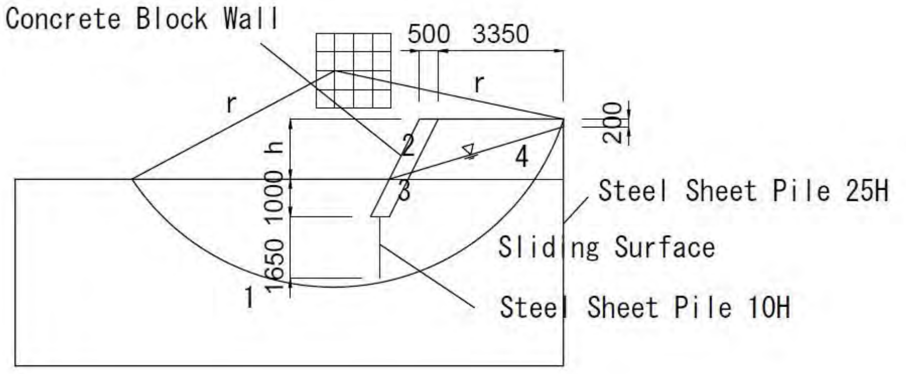
(c) Result of Analysis of Circular Slip

Circular Slip Method is also applied to analyze stability of the concrete block retaining wall.

If the safety factor is below 1.20, blocking with steel sheet pile shall be adopted. It will be installed under a base concrete.



Without SSP



With SSP

Figure R 4.2.9 Model in Analysis of Circular Slip of Concrete Block Retaining Wall

Results of analysis of circular slip (refer to **Table R 4.2.12**)show that two types of concrete block retaining wall are required: with (wall height 2.0m or less) and without (wall height 2.25m or more) steel sheet piles. Type of Steel Sheet Pile adopted for blocking is Sp-10H L=2.00m.

Table R 4.2.12 Results of Analysis

Wall Height (m)	Without Pile			With Steel Sheet Pile SP-10H L = 2.00m		
	Mr (kNm)	Md (kNm)	Fs = Mr/Md	Mr (kNm)	Md (kNm)	Fs = Mr/Md
1.00	36.3	16.9	2.148	—	—	—
1.50	44.8	31.3	1.431	—	—	—
2.00	74.3	61.6	1.206	—	—	—
2.25	93.0	81.8	1.137	667.1	389.4	1.713
2.50	98.8	94.2	1.049	677.7	445.2	1.522

Note: allowable safety factor = 1.20

(d) Base Concrete Structure

Base Concrete without Steel Sheet Pile: Type A

Base Concrete with Steel Sheet Pile : Type B (Friction Pile, L=2m)

(e) Embedment of Base Concrete

After demolition of existing concrete slab, foundation of concrete block retaining walls shall be set on the hard gravel layer under the slab of the linear park.

(f) Laying Blocks

Concrete blocks which weight is more than 350kg/m^2 is set at a depth of 35cm. A 10 cm thick backfill concrete with 16.5MN/m^2 strength will also be provided.

(g) Steel Sheet Pile for Base Concrete

Properties of HAT-Shape SP-10H are as shown in **Table R 4.2.13**.

Table R 4.2.13 Properties of Steel Sheet Pile

Type of SSP	W (mm)	h (mm)	t (mm)	A (cm^2)	I (cm^4)	Z (cm^3)	Weight (kg/m)	I' (cm^4)	Z' (cm^3)
HAT-Shape	Per Piece			Per 1.0 meter					
SP-10H	900	230	10.8	122.2	10,500	902	96	8,300	713
Note:	*I', Z' : Values after consideration of corrosion depth of 2mm (1mm for each side)*								

(h) Drainage Works

Weep holes of 50mm dia. are set at 2.0~3.0m^2 interval (staggered). These shall be set above normal water level.

(i) Partition Wall

Thickness of partition wall is 0.30m, and is installed at the edge and middle of block walls. The partition wall is set at an interval of 50m (10.0m×5 blocks).

(j) Schedule of Concrete Block Retaining Wall

Locations, lengths, height, elevations and types of base concrete of the concrete block retaining wall are shown in **Table R 4.2.14**.

Table R 4.2.14 Schedule of Concrete Block Retaining Wall

Section	**Stations**		**Length L (m)**	**Height H (m)**	**Elevation EL (m)**	**Base Concrete Type**
	BP	**EP**				
1	0+921.2	0+932.3	8.1	1.75	14.33	A
	0+934.2	0+975.0	40.0	1.75	14.33	A
	0+975.3	1+024.4	50.0	1.75	14.33	A
	1+024.7	1+074.8	50.0	1.75	14.33	A
	1+076.7	1+126.6	50.0	1.50	14.33	A
	1+126.9	1+177.0	50.0	1.50	14.33	A
	1+177.3	1+277.9	50.0	1.50	14.33	A
	1+228.2	1+247.0	20.0	1.50	14.33	A
2	3+092.8	3+142.8	50.0	1.75	14.63	A
	3+144.7	3+197.2	50.0	1.75	14.63	A
	3+197.5	3+249.9	50.0	1.75	14.63	A
	3+251.8	3+269.8	18.0	1.75	14.63	A
	3+272.0	3+315.8	50.0	1.75	14.63	A
	3+316.9	3+366.9	50.0	1.75	14.63	A
	3+367.2	3+418.2	50.0	2.00	14.63	A
	3+418.5	3+448.4	30.0	2.00	14.63	A
	3+450.7	3+490.3	40.0	2.00	14.63	A
	3+490.7	3+540.7	50.0	2.25	14.63	B: SP 2.0.
	3+542.6	3+594.0	50.0	2.25	14.63	B: SP 2.0
	3+595.9	3+606.4	10.0	2.25	14.63	B: SP 2.0
3	3+898.0	3+918.9	25.0	2.00	14.73	A
	3+920.8	3+966.0	50.0	2.00	14.73	A
	3+967.9	4+015.2	50.0	2.50	14.73	B: SP 2.0
	4+017.1	4+064.6	50.0	2.50	14.73	B: SP 2.0
	4+066.5	4+115.2	50.0	2.25	14.73	B: SP 2.0
	4+115.5	4+165.5	50.0	2.00	14.73	A
	4+167.4	4+217.4	50.0	2.00	14.73	A
	4+219.3	4+269.3	50.0	2.00	14.73	A
	4+271.2	4+321.2	50.0	2.00	14.73	A
	4+323.1	4+321.2	50.0	2.00	14.73	A
	4+374.7	4+373.1	50.0	2.00	14.73	A
	4+445.0	4+415.0	40.0	2.00	14.73	A
	4+486.9	4+536.9	50.0	2.00	14.73	A
	4+538.8	4+588.8	50.0	2.00	14.73	A
	4+590.7	4+640.7	50.0	2.00	14.73	A
	4+642.6	4+670.0	30.0	2.00	14.73	A
Total			1,551.1			

(k) Schedule of Partition Wall

Dimensions and section no. of the partition wall on every height are shown in **Table R 4.2.15**.

Table R 4.2.15 Schedule of Partition Wall

Height (m)	Area (m^2)	Thickness (m)	Volume (m^3)	Section Nos.			
				Section 1	Section 2	Section 3	Total
1.50	1.64	0.30	0.492	3			3
1.75	1.91	0.30	0.573	2	3		5
2.00	2.20	0.30	0.660		3	2	5
2.25	2.72	0.30	0.816			1	1
2.50	3.02	0.30	0.906				0

(4) Gravity Wall

(a) Type of Gravity Wall

Two types of gravity wall for the back of dike are used: front surface inclined and back surface inclined.

Front surface inclined type is used for the edges of sections where the differences between ground surface and top of dike are small. Back surface type is limited for use around Sta. 4+420, where there is no space between dike and a building.

(b) Front Surface Inclined Type (Normal Type)

Stability analysis calculation on the gravity wall is done under the following condition.

- Properties of dike soil used for calculation are: unit weight=18.0kN/m^3, internal friction angle = 30° , bearing capacity of ground=50kN/m^2. (Refer to **Figure R 4.2.10**)
- Seismic state is not considered in the calculation.
- The side slope of the front surface is 0.5 to 1, and top width = 0.50m for a height of 1.50m. And a top width is 0.3m where a wall height is 1.00m.

Results of stability analysis of the gravity wall is shown in **Table R 4.2.16** showing that the walls satisfied with safety against turnover, sliding and bearing capacity.

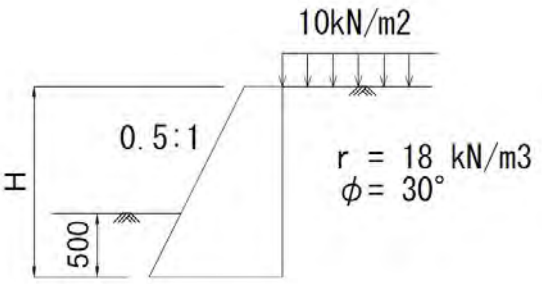


Figure R 4.2.10 Gravity Wall

Table R 4.2.16 Results of Calculation of Stability Analysis

Height	Turnover (m)		Sliding (Fs)		Bearing Capacity (kN/m^2)		
	e	Allowable	Fs	Allowable	q max	q min	Allowable
H=1.00	0.025	0.133	1.68	1.50	22.10	15.05	50.00
H=1.50	0.066	0.208	2.10	1.50	36.27	18.82	50.00

(c) Gravity Wall at around Sta. 4 + 420

For the 30m section at about Sta. 4+420 where the building and the end of a bank are close, a back surface inclined gravity wall as shown in **Figure R 4.2.11** was provided. Stability analysis of this type of wall is shown in **Table R 4.2.17** .

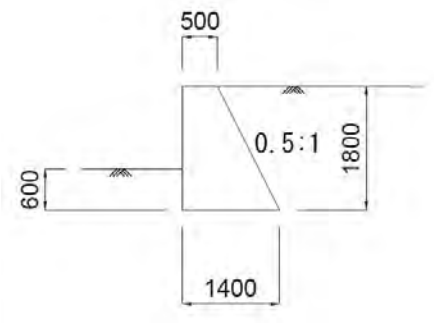


Figure R 4.2.11 Back Surface Inclined Gravity Wall

Table R 4.2.17 Results of Calculation of Stability Analysis

Height	Turnover (m)		Sliding (Fs)		Bearing Capacity (kN/m^2)		
	e	Allowable	Fs	Allowable	q max	q min	Allowable
H=1.80	0.18	0.23	1.95	1.50	75.37	9.73	91.29

(d) Result of Analysis of Circular Slip

Applied gravity walls also were checked with circular slip method. The result of the analysis was shown in **Table R 4.2.18** confirming that every height of the wall satisfied the allowable safety factor 1.20. After the above mentioned study, dimensions of the gravity wall in every construction section was decided and shown in **Table R 4.2.19**.

Table R 4.2.18 Results of Analysis

Wall Height (m)	Side of Inclined Surface	Mr (kNm)	Md (kNm)	Fs = Mr/Md	Allowable Fs
1.00	Front	50.0	22.6	2.21	1.20
1.50	Front	80.8	49.0	1.65	1.20
1.80	Back	132.2	75.4	1.75	1.20

Table R 4.2.19 Schedule of Gravity Walls

Section	STA		Dimension		Length (m)	Top Elevation
	From	To	Wall Height (m)	EL (m) Top Width (m)		
1	0+921.2	0+927.6	1.50	0.50	6.80	14.264
	1+247.0	1+297.0	1.50	0.50	50.00	14.33
	1+297.0	1+328.2	1.00	0.30	30.00	14.33
	1+335.1	1+337.8	1.50	0.50	1.90	14.33
2	3+039.8	3+045.5	1.50	0.50	8.60	14.63
	3+047.4	3+087.4	1.50	0.50	40.00	14.63
3	4+415.0	4+445.0	1.80	0.50	30.00	14.73
	4+670.0	4+670.0	1.00	0.30	3.00	14.73

(5) Maintenance Road

(a) Road Class

Road on top of the dike shall be primarily for dike maintenance and secondly for access of residents.

(b) Road Geometry

Width of Road : New road width is 3.0m.

(c) Cross Slope : 2% of gravel pavement

(d) Component of Pavement

The maintenance road has two major structural components, namely:

- The base course with thickness of 20cm consisting of gravel.
- Asphalt pavement with thickness of 5cm laid over the base course

(6) Other Revetment Details

(a) Connecting Method of Dike to Existing Houses

Connecting the end of the dike directly to an existing house is not suitable because of the action due to earth pressure from the dike. HAT-Shape 25H type steel sheet piles are driven 1.50m away from a house to avoid adverse vibration due to driving. Therefore a gap between the house and steel sheet piles is considered. This gap is to be protected with lean concrete revetment to seal off from floods. (Refer to **Figure R 4.2.12**).

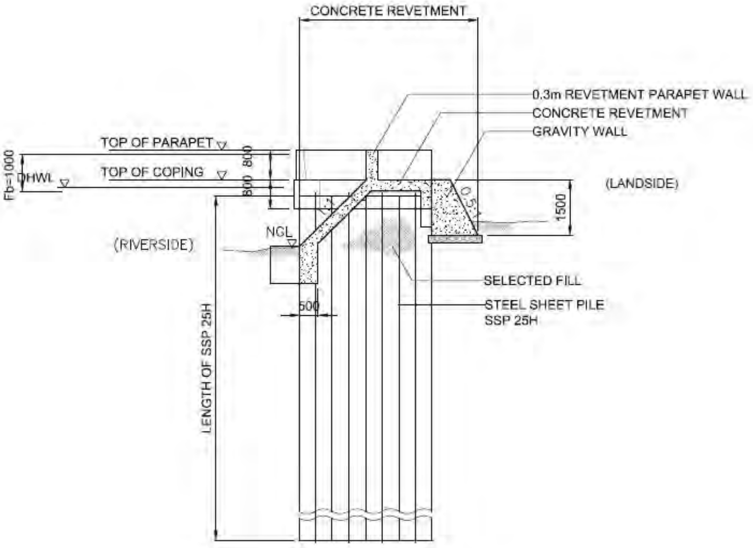


Figure R 4.2.12 Attaching Method of Dike to Existing House

(b) Boundary Markers

Boundary markers are provided to clarify the boundaries between DPWH and private properties at an interval of 50m along alignments of boundary line. (Refer to **Figure R 4.2.13**) Number of installation of the boundary markers are summarized to every bank and section as shown in **Table R 4.2.20**.

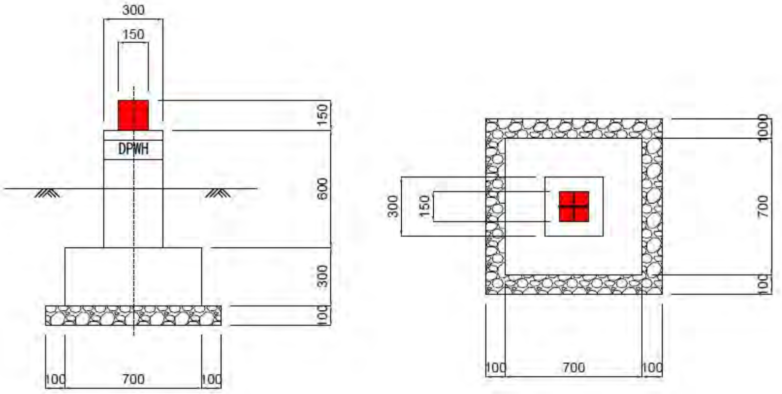


Figure R 4.2.13 Boundary Marker

Table R 4.2.20 Summary of Boundary Piles

Side	STA		Number	Remarks
	From	To		
Left Side	0+700	0+900	3	
	1+700	2+000	7	
	2+300	3+650	28	
	3+850	4+800	5	
Right Side	0+800	1+400	13	
	2+050		1	
	2+600	2+750	4	
	2+850	3+00	4	
	3+950	4+200	6	
Total			71	

(c) Steps on Concrete Block Slope

Steps on the concrete slope are to be provided at 22 points of convenient locations for residents to communicate with other residents. The steps are made of cast-in-place concrete with effective width of 1.50m. This width is allocated to two-way traffic considering that a person requires 0.75m of walking space.

Gradient of slope is about 30 degree (0.571:1). This is the usual slope wherein people could go up and down safely. (Refer to **Figure R 4.2.14**) Heights and lengths are adjusted to the locations and decided as shown in **Table R 4.2.21**.

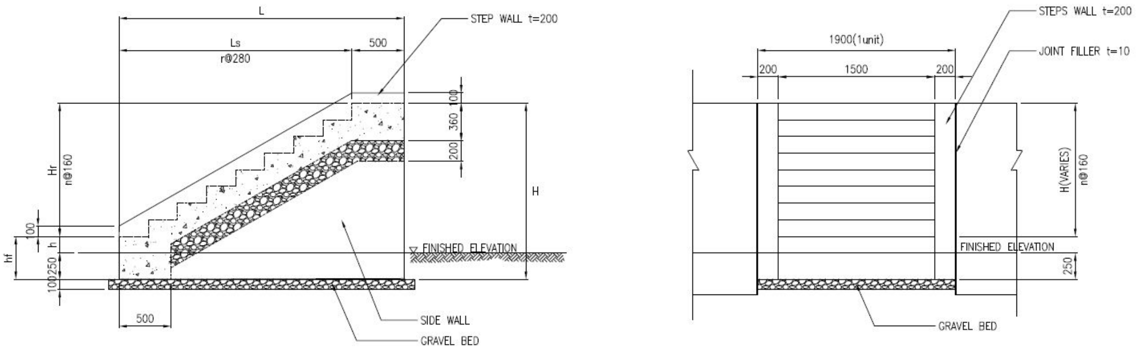


Figure R 4.2.14 Profile and Front View of Steps

Table R 4.2.21 Summary of Steps

Section	Sta.	H(m)	L(m)	n
1	0+933	1.50	2.48	7
	1+075	1.50	2.46	7
2	3+048	0.90	1.34	3
	3+144	1.35	2.18	6
	3+250	1.50	2.46	7
	3+272	1.20	1.90	5
	4+449	1.75	3.02	9
	3+540	1.60	2.74	8
	3+595	1.35	2.18	6
3	3+920	2.10	3.58	11
	3+967	2.30	3.86	12
	4+016	2.30	3.86	12
	4+065	2.10	3.30	11
	4+166	1.50	2.46	7
	4+218	1.35	2.18	6
	4+270	1.50	2.45	7
	4+322	1.50	2.45	7
	4+374	1.20	1.90	5
	4+486	1.50	2.45	7
	4+538	1.60	2.74	8
	4+590	1.75	3.02	9
	4+642	1.50	2.74	8

(d) Concrete Railing Type-4

U.S. Code (ASTM F 1292:1999): Standard Specification for Impact Attenuation of Surfacing Materials within the Use Zone of Playground Equipment shows that an impact exceeding HIC (The Head Injury Criterion) 1000 has a possibility to cause injury to a human head.

With the review of dike structures, railings shall be required to be installed on the places where there are some possibilities of exceeding HIC 1000. From the buffering effect of grass sodding level, a limitation of drop height shall be 1.50m, and it shows clearly that retaining walls shall provide handrails for prevention of drop accident, especially by children, if a difference of height between top of wall and design ground exceeds 1.50m.

Handrail was designed as concrete-made to place in the sections as shown in **Table R 4.2.22**.

Table R 4.2.22 Schedule of Concrete Railing

Section	STA		Length (m)	Remarks
	From	To		
2	3+374.7	3+479.4	100.0	
3	3+902.5	4+104.0	212.0	
Total			312.0	

(e) Boundary Wall to Linear Park

New boundary walls are installed instead of the walls at the edge of the linear park removed by construction. The size of a boundary wall is used as a concrete wall 0.30m in width, and 1.00m in height. The sections to install are as shown in **Table R 4.2.23**.

Table R 4.2.23 Schedule of Boundary Walls

Section	STA		Length (m)	Remarks
	From	To		
1	0+928	1+330	408.0	
2	3+041	3+614	546.0	
3	3+906	4+462	723.0	
Total			1,677	

4.2.2.4 Immediate Settlement and Consolidation Settlement of Dike

(1) Consolidation Settlement of Dike

Consolidation settlement is obtained from the settlement calculation based on the result of geotechnical survey.

(2) Immediate Settlement and Side Deformation

3m width of embankment in shape of rectangular is adopted for calculation

Table R 4.2.24 Results of Immediate Settlement

Section	STA	Boring No.	H (m)	q (kN/m^2)	Immediate Settlement		Side Deformation (m)
					Em (kN/m^2)	S at Center (m)	
1	1+100	BHML-2	1.40	25.2	4,751	0.019	-0.0017
2	3+170	BHLM-24	1.60	28.8	3,823	0.012	-0.0024
	3+450	BMRW-8	1.70	30.6	2,244	0.022	-0.0043
3	4+050	BHLM-14	2.30	41.4	3,481	0.019	-0.0038
	4+400	BHLM-17	1.70	30.6	2,957	0.017	-0.0033

(3) Consolidation Settlement

Cc method is adopted to consolidation settlement as follows;

$$S = \frac{C_c}{1+e_o} \times \log_{10} \frac{P_o + \Delta P}{P_o + q_o} \times H$$

Where, S : consolidation settlement (m)

Consolidation Time

$$t = Tv*d^2 / Cv$$

Where, t : time until consolidation index U

Results of Consolidation Settlement is shown in **Table R 4.2.25**.

Table R 4.2.25 Results of Consolidation Settlement

Section	STA	q (kN/m^2)	Layer	Consolidation Settlement			Residual Settlement (m)
				Settlement S (m)	C_v (m^3/day)	t (day)	
1	1+100	25.2	AC	0.027	0.02015	168	
			DC	0.004	0.02893	359	
			Total	0.031			0.050
2	3+170	28.8	AC	0.078	0.02044	283	
			DC	0.007	0.10124	253	
			Total	0.085			0.097
	3+450	30.6	AC	0.063	0.01500	712	
			DC	0.012	0.10352	991	
			Total	0.075			0.097
3	4+050	41.4	AC	0.134	0.04422	113	
			DC	0.011	0.05715	182	
			Total	0.145			0.164
	4+400	30.6	AC	0.089	0.06351	155	
			DC	0.004	0.08788	473	
			Total	0.093			0.110

The above-mentioned consolidation settlement calculation result is used for Quantity Calculation of embankment.

4.2.2.5 Seepage of Dike

Calculation of seepage is done with Lane's Creep Theory as shown below.

Creep distance L = v + 1/3 * h (Refer to **Figure R 4.2.15**)
= (7.90+1.30)*2 + 5.40*1/3 = 20.20m

Where, L : creep distance (m)

v : incremental vertical creep distance (=7.90m *2: sheet pile)
(=1.30m *2:Base)
h : incremental horizontal creep distance (=5.40m)

Difference H = 14.486 – 12.826 = 1.660m

Creep ratio : 8.5 (very fine sand or silt)

L (Creep distance) / H (Difference of water head) = 20.20 / 1.66
= 12.2 > 8.5 .OK (No seepage)

As a result of above, there is no problem with the seepage of dike.

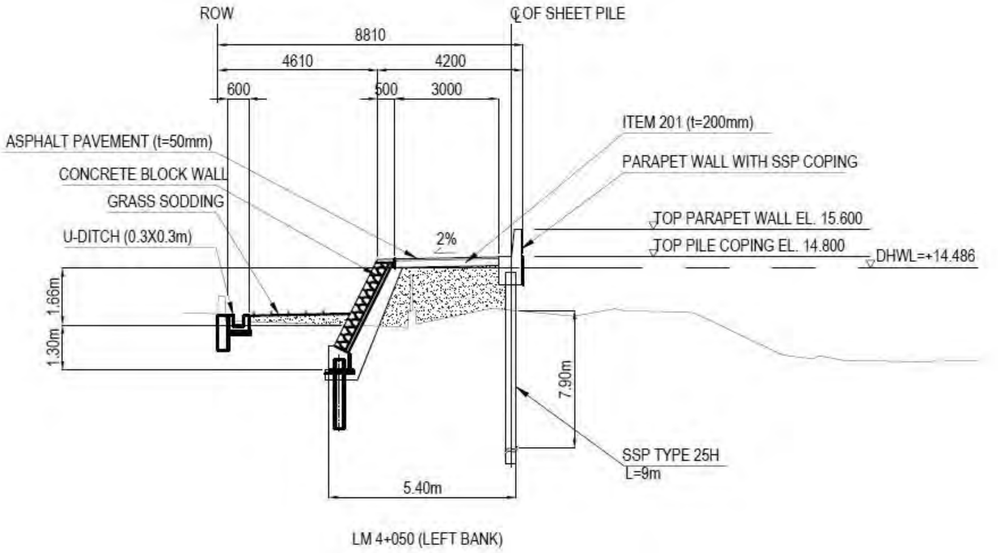


Figure R 4.2.15 Creep Distance

4.2.2.6 Foot Protection of Bridges

(1) Necessity and Method of Foot Protection Works

The river regimen will change after dredging as the level of river bed will lower considerably. Every pier will undergo instability of foundation due to deep excavation near the pier. Therefore the protection for all piers against scouring shall be necessary.

(2) Selection of Protection Method for Piers

In order to prevent scouring around the existing bridge piers and abutments, especially when the top of bridge pier foundation has protruded above riverbed, foot protection works is proposed. Foot protection works using the Bottle Unit is selected based on **Table R 3.2.5**. Basic concept of foot protection in Lower Marikina River is to keep the present condition without large-scale re-creation.

(3) Range of Foot Protection around Piers.

After considering the calculation result and DPWH direction, designed range of the foot protection works is shown, with Vargas Bridge as example, in **Figure R 4.2.16**.

Range of foot protection works around pier was shown, together with its calculation method, in **Table R 4.2.26**.

Table R 4.2.26 Range of Scouring (Foundation)

Bridge Name	Width of Piers		Range of Scouring		Selected Range (From Edge of Foundation)
	D (m) Foundation	H (m) Foundation	L=2.51D	L=1+2.9D /(H*Tanθ)	
Sta. Rosa	1.50	8.50	3.77	1.89	4m or more
Vargas (PC)	8.00	10.00	20.08	5.02	6m or more
Vargas (Steel)	8.00	8.00	20.08	6.03	6m or more
Sandoval	4.10	7.40	10.29	3.78	6m or more
Rosario	2.40	27.05	6.02	1.45	6m or more

θ: Angle of repose under water (Average 30°)
1/ Collection Papers of Japan Society of Civil Engineers, 415-7-12, Statistical Design Method about Weight and Construction Width of Anti-Scour Block around Pier Protection", Katsuya OKADA etc.

Range of transition of dredging is to be prepared in the range of 10 m or more from a bridge pier edge about the direction of the flow of a river as directions of DPWH besides the range according to the above-mentioned calculation about the range of foot protection.

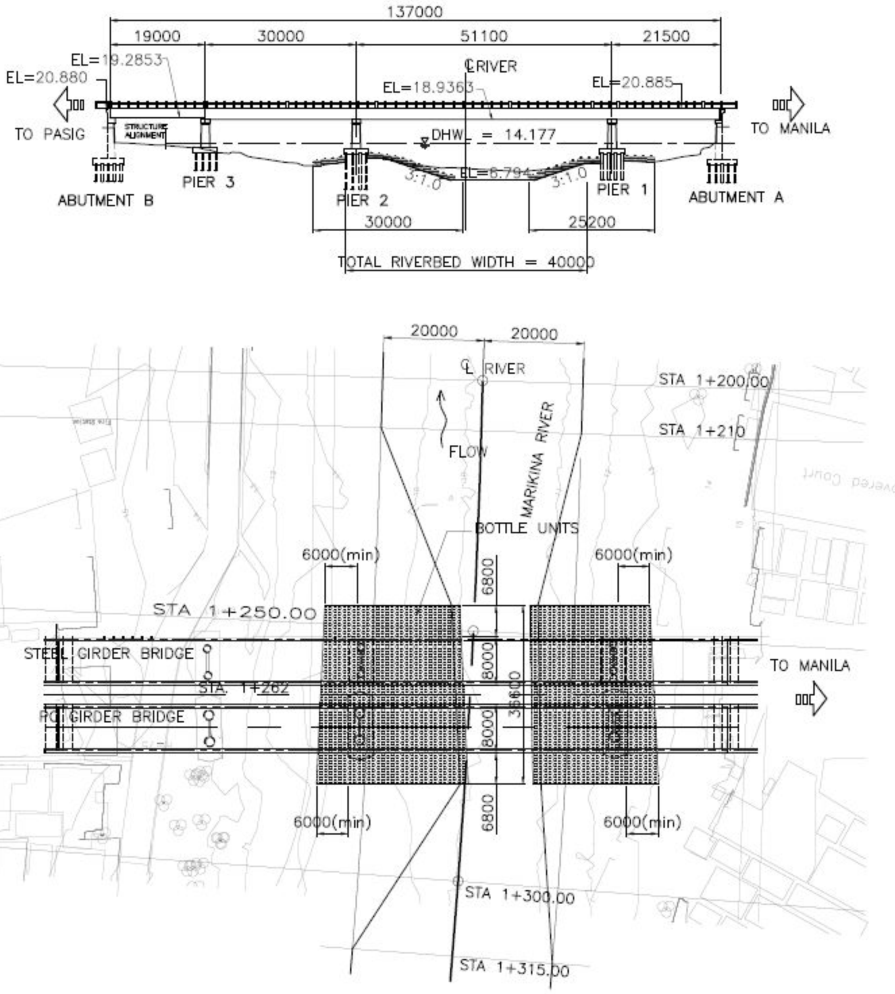


Figure R 4.2.16 Foot Protection at Vargas Bridge

(4) Bags (Bottle Unit) for Foot Protection Works

Foot protection works with bags (Bottle Unit) consist containing the stones in a bag and tying the neck of the bag with a rope (refer to **Figure R 4.2.17**). A typical bag: product number SBU-10, is 1.60m in diameter, 0.48m in height, and 0.32m in perimeter height. A pack of 0.05~0.10m of crushed rock weighs about one (1) ton. Bridge piers will be stacked with two layers of these bags within selected ranges. Capacity of a bag is approximately 0.5~0.62m^3.

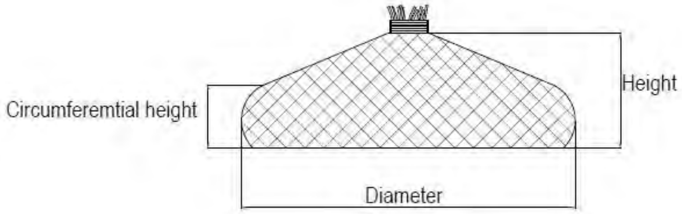


Figure R 4.2.17 Bottle Unit

Maximum velocities that Bottle Unit SBU-10 can bear are shown in **Table R 4.2.27**. The design flood velocity in Lower Marikina River is 1.0~2.0m/s, therefore Bottle Unit of SBU-10 type 1t can bear it in both case of single and group.

Table R 4.2.27 Maximum Velocity for moving of Bottle Unit

Type	SBU-10	
	Single	Group
1t	about 2.8m/s or less	about 4.2m/s or less

(5) The notes on construction

It is necessary to consider the following points during the construction for foot protection of existing piers.

- Foot protection work with swiftness and precision for protection of the existing piers promptly after the dredging
- Not to obstruct the traffic of other vessels/barges in terms of construction management
- Not to damage the existing bridges/piers in view of stability of the existing facilities

4.2.2.7 Dredging and Disposal

(1) Dredging

(a) Dredging Section

The dredging section shall be a low waterway with bottom width of 40m and side slope of 3H:1V to accommodate the 30-year flood. Dredging Standard Section was shown in **Figure R 4.2.18**.

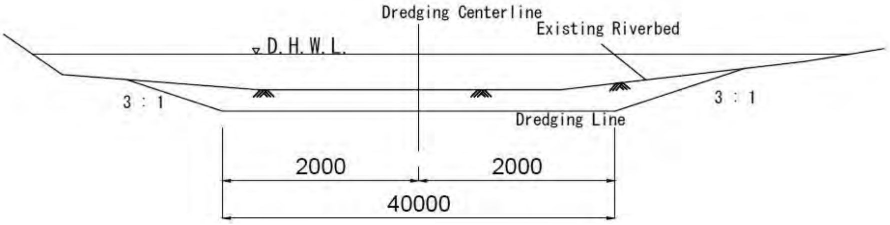


Figure R 4.2.18 Dredging Standard Section

(b) Dredging Centerline

The dredge centerline follows the river centerline. A smooth alignment is designed to reduce flow resistance.

(c) Calculation of Volume

The calculation is based on the cross sections taken at 50 m interval.

The volume increased by 260,000m^3 compared to that of 2002. This is attributed to new silt deposition, which has significantly increased the depth beyond an average of 1.0~1.5m

- Pure Soil Volume = about 872,000m^3
  (This volume is a value extruded the reduction of volume around bridges.)

(2) Backfill Site

(a) Basic Conditions

Dredging soil is carried to the premix site via the landing jetty, and is treated and distributed over the backfill site.

- Classification of soil: dredged soil after stabilization treatment in backfill site
- Required disposal capacity: about 872,000m^3. An average embankment height is about 2.10m.
- Site area : 450,000m^2 (45.0ha) is available: east side 29.1ha and west side 15.9ha.
- Site condition: low-lying grassland
- Maximum embankment height of dredged material is decided to 3.0m by circle slide method.

(b) Arrangement Plan

The backfill site has the following facilities: settling basins, drainage facilities, observation-wells, etc.

(c) Drainage Facilities

External drainage is provided along the outer circumference, and internal drainage along the existing outer drainage channels.

External drainage collects water from outside the backfill site and conveys it to the drainage canal leading to the existing Pumping Station.

Internal drainage collects water due to rainfall over the backfill site and conveys it to the external drainage line. RC pipes with a diameter of 910mm are installed to convey the discharge.

An existing drainage canal beside the backfill site shall serve as the main channel to convey the runoff. River bed level is 10.00m—LWL of this channel is 10.50m— Management Water Level (MWL) is 11.70m—and HWL is 12.00m. Therefore main drainage pipes are designed at the height over these MWL: 11.70m or HWL:12.00m.

Gradients of land are almost 1/1000, therefore, design gradients for most of drainage pipes and channels have to follow this gradient.

(d) Rainfall Intensity and Design Rainfall

<u>Discharge</u>

10-year rainfall intensity is adopted for the calculation of drainage facilities.

On inner side of the backfill site, Bricks Experimental Formula for obtaining Q_R is to be selected for very flat area like reclamation area.

Q_R : Design Rainfall Discharge (m^3/sec)
$Q_R = R \cdot C \cdot A \cdot \sqrt[6]{(S/A)}$ (Bricks Experimental Formula)

Where;

t : time of concentration (60minutes is selected because of flat area)
R : Rainfall Intensity in 10 years
r $= 1474.2 / (t^{0.65} + 4.02) = 1474.2 / (60^{0.65} + 4.02) = 80.4$mm/hr
R = (80.4 mm/hr) = 0.223 (m^3/sec・ha)
S : Grand Gradient (S/1000=1/1000)

However, on the outer side of the backfill site, Standard Rational Formula is adopted for drainage facilities. Areas that affect outer canal assumed to be about 100m from the canal.

Q_R : Design Rainfall Discharge (m^3/sec)
$Q_R = R \cdot C \cdot A$ (Standard Rational Formula)

(e) Size of Canal and Number of Pipe

After the above-mentioned study, dimensions of the designed canals and pipes are shown in **Table R 4.2.27** and **Table R 4.2.29**.

Table R 4.2.28 Discharge of Canal

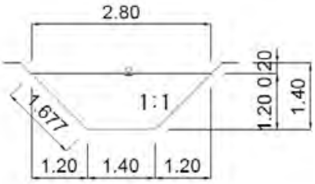
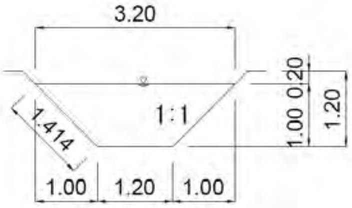
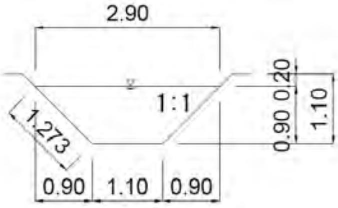
Case	Area (ha)	Design Discharge (m^3/s)	Section of Canal	Discharge of Canal (m^3/s)
Case 1 East Canal	28.65 I=1/1000	2.19		2.46
Case 2 West Canal	15.64 I=1/1000	1.32		1.54
Case 3 Outer Canal	7.00 I=1/1000	1.09		1.19

Table R 4.2.29 Number of Pipe

Case	Area (ha)	Design Discharge (m^3/s)	Diameter of Pipe (m)	Discharge per One Pipe (m^3/s)	Number	Adopted Number
Case 1 Outlet 1	28.65	2.19	0.91	1.49	1.47	2
Case 2 Outlet 2	15.64	1.32	0.91	1.49	0.89	1
Case 3 Outlet 3,4	7.00	1.09	0.91	1.49	0.73	1

4.2.3 Drainage Facilities

4.2.3.1 General

As shown in **Figure R 4.2.19**, the main components of the drainage outlet consist of U-ditch, collector pipe, manhole and sluiceway. Flap gate is provided at the downstream end of the sluiceway to prevent backflow against design flood.

The quantities and dimensions of proposed drainage facilities are summarized in **Table R 4.2.30**.

Table R 4.2.30 Summary of Drainage Facilities for Lower Marikina River

Proposed Facilities	Quantity	Dimension
Sluiceway/Outlet	9 locations	1.0m x 1.0m ~ 2.0m x 1.6m
Manhole	54 locations	Varying dimensions
Collector Pipe	Length= 680 m	910 mm,1070mm
Box culvert	Length= 400 m	W0.8m x H0.8m ~ W1.8m x H1.5m
U-ditch	Length= 1700m	W0.3m x H0.3m ~ W1.2m x H1.2m
Flap Gate	10 units	1.0m x 1.0m ~ 2.0m x 1.6m

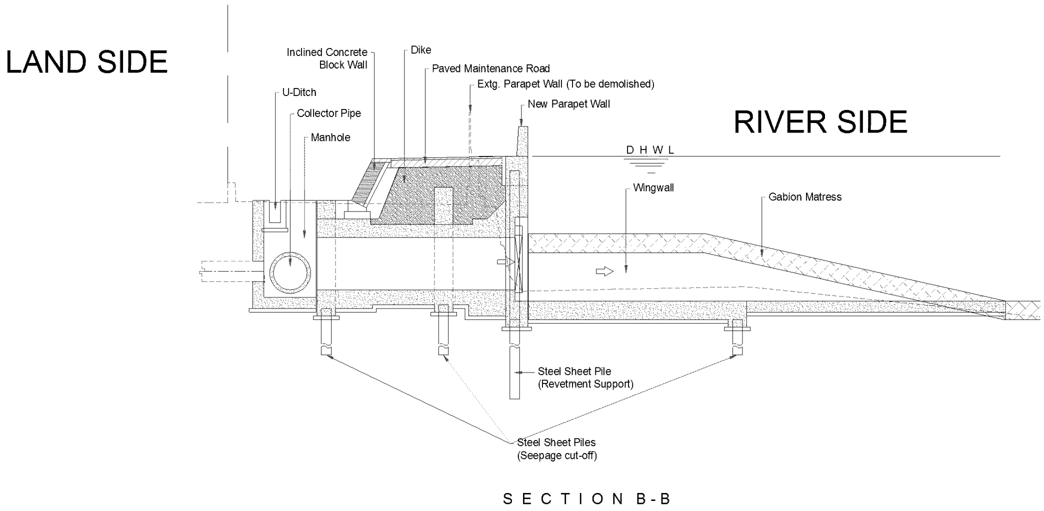


Figure R 4.2.19 Components of the Drainage Outlet in Lower Marikina River

4.2.3.2 Detailed Design of Drainage Facilities

(1) U-Ditch

U-ditch is designed to accommodate runoff from the dike surface. It is also constructed at the downstream end/edge of a sub-catchment where there is no existing surface drain to collect the discharge and direct the flow to the nearest manhole.

(2) Collector Pipe and Box Culvert

In order to reduce the number of sluiceway, collector pipe and box culvert would be installed similar to that of the Pasig River.

In Section II, there are also instances where several existing parallel pipes spaced at about 6m are used to drain the catchment. Providing a series of manholes to connect these drain pipes perpendicular to the collector conduit would be costly and the construction procedure is difficult. Instead, it is deemed that the collector conduit would be constructed as a box culvert such that all the existing drain pipes are punched through the wall of the culvert for ease of construction.

(3) Manhole

At the connection point of pipes and outlets, manholes would be installed. The detail of manhole is already mentioned in **Sub-section 4.1.3** .For Lower Marikina River, the same concept is applied.

(a) Structural Calculation of Manhole

The design conditions are shown in **Table R 4.2.31.** The determined dimension based on the results of structural calculation is shown in **Table 4.2.3**. Details of structural calculations are shown in **Vol. III-2**.

Table R 4.2.31 Design Condition of Manhole

Item			**Design Condition**
Material Unit Weight	Concrete Reinforced		24.0 kN/m^3
	Concrete Plain		23.5 kN/m^3
	Structural Steel		77.0 kN/m^3
	Water		9.8 kN/m^3
Soil Condition	Quality of Soil		
	Unit Weight	Damped and Wet Condition	18.0 kN/m^3
		Saturated Condition	20.0 kN/m^3
		Submerged Condition	10.0 kN/m^3
Water Level Condition			[Inside water level in rear side] Bottom Elevation of Manhole [Outside water level] Ground Level – 0.9m* * The minimum difference between GWL and Ground level (MSR-3, BHLM-25)
Surcharge on the Ground			10 kN/m^2
Live load on Top Slab			T-2 * * Passenger vehicle and small truck which weighs less than 2 t is assumed

(4) Sluiceway

The size of the sluiceway conduit is based on the expected runoff of the catchment. However, a minimum dimension of 1.0m x 1.0m is adopted if the calculated size based on the expected runoff is less than 1.0m x 1.0m for maintenance considerations.

In the case of Lower Marikina River, the dimension of box culvert is more than 1.0m x 1.0m. FRP flapgate which is more than 1.0m x 1.0m doesn't have enough marketability. Sluiceways should not become weak point of dikes and the gates require enough water tightness and durability as sluiceway structure. Hence, aluminum flapgate is adopted for the Lower Marikina River.

4.2.3.3 Detailed Design of Sluiceway

(1) Location of Sluiceway

Sluiceways are preferably located at straight alignments, with due consideration to ground level, land use and the presence of existing pipes. Other criteria and considerations are shown in **Table R 4.2.32**.

In this detailed design stage, the stretch length of dike is changed. Sluiceway No. MSR1, which was tentatively considered during the Basic Design Stage, is found to be unnecessary.

Table R 4.2.32 Locations of New Sluiceways and Outlets

Sluiceway Number	Location /Station		Verification
MSL-1	Left Bank	1+104	・ The Existing pipe elevation is lower than the others.
MSL-2		1+323	・ The culvert is a main drainage line with existing dimension of W1.5×H1.4, which is larger than the other existing outlets. ・ New outlet location keeps enough distance from existing structure, which is the wall of Rizal high school.
MSL-3		3+945	・ The ground level is lower than the other location in the area.
MSL-4		4+221	・ The existing pipe elevation is lower than the others. ・ The existing pipe is larger than the others. ・ New outlet location keeps enough distance from the pier of Rosario Bridge.
MSL-5		4+406	・ The existing pipe comes from a factory, and the dimension is as large as nearly 1.0m.
MSL-6		4+503	・ The existing culvert is a main drainage line with dimension of W1.1×H0.9, which is larger than the others.
MSR-1	Right Bank	-	・ Not necessary
MSR-2		3+157	・ The existing pipe elevation is lower than the others.
MSR-3		3+255	・ The existing pipe elevation is lower than the others. ・ The culvert is a main drainage line with existing dimension of 1.6m. ・ New outlet location keeps enough distance from the pier of Alfonso Sandoval Bridge.
MSR-4		3+438	・ The ground level is almost same in this area. ・ This sluiceway will be located around the center of this area

(2) Elevation of Sluiceway and Outlet

The elevation of the sluiceway and outlet is determined to minimize height of breast wall and excavation volume based on the following condition.

<u>Existing pipe elevation</u>

The elevation of the new sluiceway and outlet should be lower than the outlet of existing pipes to be able to completely drain the area.

Mean water level

Under normal condition, the elevation of the sluiceway outlet should be higher than the Mean Water level.

Mean water level is assumed from MWL at 0.0km in Lower Marikina River and slope of HWL in Lower Marikina River. MWL at 0.0km in Lower Marikina River (at its confluence with the Pasig River) is assumed at EL 10.600.

The elevations of the sluiceways are shown in **Table R 4.2.33.**

Table R 4.2.33 Proposed Elevation of Sluiceways

Sluiceway Number	**Location/Station**		**Proposed Elevation, m**	**Verification, E.L.m**		
				Mean Water Level	**Existing Elevation**	**Elevation Based on Ground Height** [1/]
MSL-1	Left Bank	1+104	10.800	10.723	11.020	**10.800**
MSL-2		1+323	11.200	10.748	**11.340**	11.500
MSL-3		3+945	11.100	**11.038**	12.030	11.100
MSL-4		4+221	11.190	11.070	12.030	**11.190**
MSL-5		4+406	11.230	11.090	13.510	**11.230**
MSL-6		4+503	11.200	11.100	11.600	**11.200**
MSR-2	Right Bank	3+157	11.060	**10.951**	11.720	11.000
MSR-3		3+255	10.970	10.962	**10.970**	10.700
MSR-4		3+438	11.090	**10.982**	13.020	10.500

[1/] *Considers 0.5m height of Breast wall above the box culvert*

Note: **Bold type** means the value mainly considered at each site.

(3) Determination of the Dimension of Box Culvert

The dimensions of box culverts, which satisfy the design discharges, are shown in **Table R 4.2.34**. The dimension is determined based on varied flow calculation. The calculation results are shown in **Vol. III-2**.

Table R 4.2.34 Proposed Dimension of Sluiceways

Sluiceway Number	**Location/Station**		**Design Discharge (m^3/sec)**	**Dimension of Existing Outlet (m)**	**Proposed Dimension (m x m)**
MSL-1	Left Bank	1+104	4.52	W2.00 x H0.55	1.4 x 1.4
MSL-2		1+323	5.72	W1.50 x H1.40	1.5 x 1.5
MSL-3		3+945	6.25	φ 0.45	2 x 1.2 x 1.2
MSL-4		4+221	7.27	W1.80 x H1.50	1.6 x 1.6
MSL-5		4+406	0.97	φ 0.90	1.0 x 1.0
MSL-6		4+503	3.27	φ 0.80	1.2 x 1.2
MSR-2	Right Bank	3+157	4.70	φ 0.45	1.4 x 1.4
MSR-3		3+255	9.24	φ 1.60	2.0 x 1.6
MSR-4		3+438	4.80	No pipe	1.5 x 1.5

(4) Ground Settlement

The sluiceway should allow the effect of ground settlement; hence, the use of the box section should consider the effect of ground settlement. The residual settlement of the ground is the arithmetic summation of immediate settlement and consolidation settlement. It is the distribution of the residual settlement that must be considered after installing the box culvert on the base level.

(a) Considering Pre-load Effect

Based on the construction plan, the dikes would be constructed first. The dikes will then be excavated temporarily for the construction of the sluiceways. The embankment work will proceed in parallel with the revetment work. It would take more than three months to complete the embankment work in every stretch of dike. Considering these conditions, the ground will undergo the pre-load effect. Duration of embankment works for considering pre-load effect is shown in **Table R 4.2.35.**

Table R 4.2.35 Duration of Embankment Works

Section	Bank	Location	Days
Section I	Left	Sta. LM 0+921~Sta. LM 1+338	95 days
Section II	Right	Sta. LM 3+033~Sta. LM 3+621	105 days
Section II	Left	Sta. LM 3+899~ Sta. LM 4+679	105 days

Regarding cohesive soil, pre-load effect should be considered with enhancing the modulus of deformation of ground. And consolidation settlement during the embankment work should be deducted from the total settlement.

(b) Immediate settlement

Immediate settlement is calculated with the aid of the following formula, on the assumption that the ground is elastic.

$$Sx = \sum_{i=1}^{n} \frac{-3ai\cdot qi}{Em\cdot\pi}\log\cdot\sin\left(\tan^{-1}\frac{ai}{H}\right)\cdot\left\{1.0-\frac{0.75}{\pi}\left[\left(1+\frac{x}{ai}\right)\log\left|1+\frac{x}{ai}\right|+\left(1-\frac{x}{ai}\right)\log\left|1-\frac{x}{ai}\right|\right]\right\}$$

Where,

S = Immediate Settlement on x_i , m
q_i = Load of Embankment, tf/m^2 or kN/m^2
E_m = Modulus of Deformation of the ground, tf/m^2 or kN/m^2
$2a_i$ = Load width, m
H = Depth for considering the effect of immediate settlement, m
n = Number of uniform load
x = Distance from the center of the ach uniform load, m

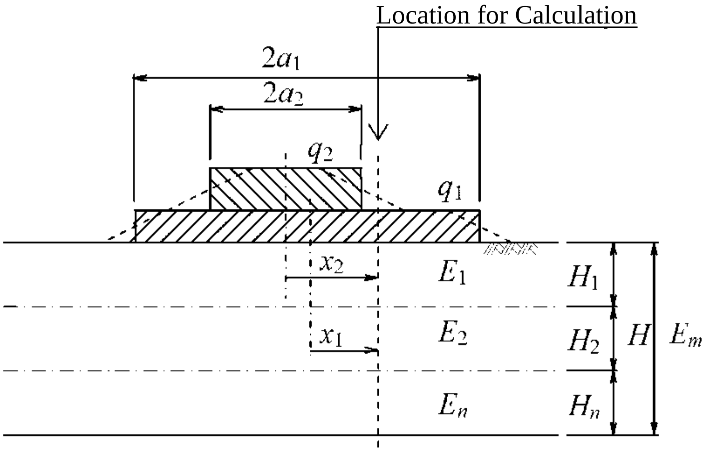


Figure R 4.2.20 Calculation Model for Immediate Settlement

$$E_m = \frac{\log \dfrac{(B + 2h_n \tan\theta)\cdot L}{(L + 2h_n \tan\theta)\cdot B}}{\sum_{i=1}^{n} \dfrac{1}{E_{mi}} \log \dfrac{(B + 2h_i \tan\theta)(L + 2h_{i-1} \tan\theta)}{(L + 2h_i \tan\theta)(B + 2h_{i-1} \tan\theta)}}$$

Where,

E_m = Converted modulus of deformation of the ground, in $B \neq L$ considering several layers, kgf/cm^2 or kN/m^2

B = Load width, m

L = Load Length, m

h_n = Depth for considering the effect, more than 3 times of load width, m

h_i = Depth to the bottom of each layer, m

E_{mi} = Modulus of deformation of the ground of the layer i, kgf/cm^2 or kN/m^2

θ = Angle of load distribution, $\theta = 30°$

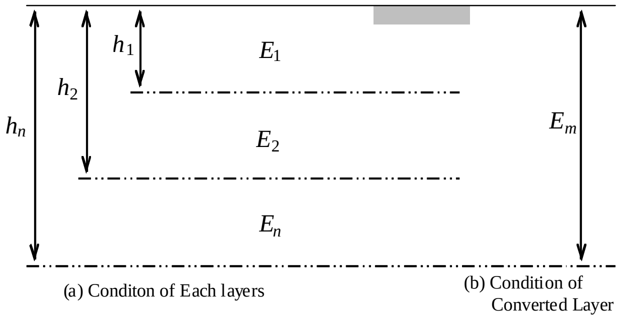


Figure R 4.2.21 Converted Modulus of Deformation in Case of Each Layer Having Different Depth

Table R 4.2.36 shows the maximum immediate settlement on each sluiceway. Details of calculations are shown in **Vol. III-2**.

Table R 4.2.36 Immediate Settlement

Sluiceway Number	Location/Station		Boring	Immediate Settlement (cm)
MSL-1	Left Bank	1+104	BHLM-02	4.9
MSL-2		1+323	BL-9	10.3
MSL-3		3+945	BHLM-14	9.8
MSL-4		4+221	BMLM-09	12.4
MSL-5		4+406	BHLM-17	5.2
MSL-6		4+503	BHLM-10	9.8
MSR-2	Right Bank	3+157	BMLM-24	10.5
MSR-3		3+255	BHLM-25	10.2
MSR-4		3+438	BMRW-8	12.8

(c) Consolidation Settlement

Consolidation settlement is calculated wherein the vertical stress in the ground is increased by the weight of the embankment and is the summation of the settlement of each silt layer.

In case that the boring, which is used in the calculation model, has no previous consolidation test data, the test data near this boring would be applied in this study.

Table R 4.2.37 shows the maximum consolidation settlement of each sluiceway. Details of calculations are shown in **Vol. III-2**.

Table R 4.2.37 Consolidation Settlement

Sluiceway No.	Location/Station		Borehole Number	Consolidation Settlement (cm)
MSL-1	Left Bank	1+104	BHLM-02	3.7
MSL-2		1+323	BL-9	1.0
MSL-3		3+945	BHLM-14	6.0
MSL-4		4+221	BMLM-09	0.8
MSL-5		4+406	BHLM-17	2.6
MSL-6		4+503	BHLM-10	4.0
MSR-2	Right Bank	3+157	BMLM-24	4.6
MSR-3		3+255	BHLM-25	8.8
MSR-4		3+438	BMRW-8	9.3

(d) Residual Settlement

Residual settlement is the summation of immediate and consolidation settlement. The allowable amount of residual settlement should not be greater than 30cm without considering the camber of the embankment. **Table R 4.2.38** shows the maximum residual settlement on each sluiceway.

Table R 4.2.38 Residual Settlement

Sluiceway No.	Location /Station		Borehole Number	Residual Settlement (cm)
MSL-1	Left Bank	1+104	BHLM-02	8.6
MSL-2		1+323	BL-9	11.3
MSL-3		3+945	BHLM-14	15.8
MSL-4		4+221	BMLM-09	13.2
MSL-5		4+406	BHLM-17	7.80
MSL-6		4+503	BHLM-10	13.8
MSR-2	Right Bank	3+157	BMLM-24	15.1
MSR-3		3+255	BHLM-25	19.0
MSR-4		3+438	BMRW-8	22.1

From the above results, the residual settlement does not exceed 30cm. Therefore any countermeasure against ground deformation is not required. Since the residual settlement exceeds 5cm, the sluiceway design must be such that it follows the deformation of the ground.

(5) Structural Details

(a) Sealing Works

Sealing works is essential to avoid the adverse effect of piping and migration of soil particles.

(i) Horizontal Direction

The proposed dikes are supported by SSP. The SSP also acts as horizontal seepage cutoff wall. For the horizontal direction, enough length of path against percolation could also be developed. Therefore the horizontal length of SSP should be determined by excavation line.

(ii) Vertical Direction

Regarding the vertical direction of seepage, the required creep length is distributed by the steel sheet piles which are installed at the wing wall, breast wall and See page cut off wall.

In this project, the length of SSP for sealing is decided considering the following:

- When there is a thin layer of clayey soil under the subgrade and sandy soil layer is below the clayey soil, seepage would flow through the porous sandy soil layer. Sealing would not be effective.
- When there are alternate layers of sandy and clayey soil and SSP is driven down to deep clayey soil layer (Ac2), sealing would be most effective.

The required length is calculated based on Lane's Creep Theory as expressed by the following formula:.

$$C \leq \frac{\left(\sum H\right)/3 + \sum V}{\Delta H}$$

Where:

C : Creep Ratio (**Table R 4.2.39**)
H = Horizontal path length of percolation of main body and wing wall(m)
V = Vertical path length of percolation of sheet pile for sealing (m)
ΔH = Hydraulic head or the difference between headwater and tailwater (m)

Water level condition is shown in **Table R 4.2.40**. At HWL, the time difference in water level on the landside and the sluiceway is small. Hence, full flow on the sluiceway is always assumed.

Table R 4.2.39 Creep Ratio

Material	**Ratio**[1/]
very fine sand or silt	8.5
fine sand	7.0
medium sand	6.0
coarse sand	5.0
fine gravel	4.0
medium gravel	3.5
coarse gravel including cobbles	3.0
boulders with some cobbles and grave	2.5
soft clay	3.0
medium clay	2.0
hard clay	1.8
very hard clay or hardpan	1.6

[1/] *"Design of Small Dams", US Bureau of Reclamation (USBR), 1974, p.341*

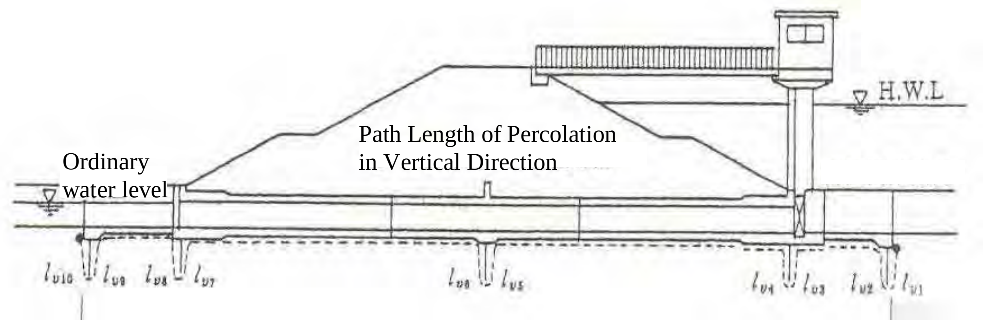


Figure R 4.2.22 Path of Percolation in Sluiceway

Table R 4.2.40 Water Level Condition

	River Side	**Land side**
Water Level	HWL	Full Flow of Sluiceway

The length of each SSP based on calculation is shown in **Table R 4.2.41**. Creep distance at each SSP and verification of SSP length is shown in **Table 4.2.4** and **Figure 4.2.4**.

Table R 4.2.41 Length of SSP Cut off wall

Sluiceway No.	**Length of SSP (m)**				**Remarks**
	Wing Wall	**Breast Wall in River Side** [1/]	**Seepage Cut Off Wall**	**Breast Wall in Land Side**	
MSL1	2.00	6.10	2.00	5.50	
MSL2	2.00	4.00	2.00	2.00	
MSL3	2.00	7.05	2.00	7.00	
MSL4	2.00	7.14	2.00	7.50	
MSL5	2.00	6.68	2.00	6.50	
MSL6	2.00	6.65	2.00	4.50	
MSR2	2.00	6.56	2.00	6.00	
MSR3	2.00	6.52	2.00	6.50	
MSR4	8.20	6.59	2.00	2.00	

[1/] *SSP of Breast wall in the river side is made by cutting the SSP for revetment, hence, the length is from underside of bottom slab to bottom edge of SSP*

(b) Flexible Joint and SSP with Flexible Joint

In order to make sluiceway to allow for the effect of ground settlement, flexible joint and SSP with Flexible Joint are applied.

(i) Flexible Joint

Flexible joint should be installed at the following location.

- Between box culvert and wing wall
- Between box culvert and manhole

Capability of joint for settlement and expansion is 100mm based on the results of structural calculation. Detailed structural calculations are shown in **Vol. III-2**.

(ii) SSP with Flexible Joint

In order to allow for the difference of the settlement between sluiceway location and the dike around sluiceway, SSP with Flexible Joint should be installed. Based on the difference of settlement, capability of SSP with flexible joint which is shown in **Table R 4.2.42** should be applied. Detailed calculations are shown in **Vol. III-2**.

Table R 4.2.42 Capability of SSP with flexible joint

Sluiceway No.	**Breast Wall in River Side (mm)**	**Seepage Cut Off Wall (mm)**	**Breast Wall in Land Side (mm)**	**Remarks**
MSL1	100	100	100	
MSL2	100	100	100	
MSL3	100	100	100	
MSL4	200	200	200	
MSL5	100	100	100	
MSL6	100	100	100	
MSR2	100	200	100	
MSR3	100	200	100	
MSR4	200	200	200	

Note: Capability of SSP with flexible joint is the difference of settlement.

(c) Box Culvert

(i) Design Condition

The design conditions are shown in **Table R 4.2.43**.

Table R 4.2.43 Design Condition of Box Culvert

Item			**Design Condition**
Material Unit Weight	Concrete Reinforced		24.0 kN/m^3
	Concrete Plain		23.5 kN/m^3
	Structural Steel		77.0 kN/m^3
	Water		9.8 kN/m^3
Soil Condition	Quality of Soil		
	Unit Weight	Damped and Wet Condition	18.0 kN/m^3
		Saturated Condition	20.0 kN/m^3
		Submerged Condition	10.0 kN/m^3
Surcharge on the Ground			Normal: 10 kN/m^2 Seismic 5 kN/m^2 [1]
Live load on Top Slab			T-25

[1/] *Seismic Condition is Considered only in calculation of longitudinal direction.*

(ii) Results of Calculation

The dimensions based on the results of structural calculation are shown in **Table 4.2.5**. Detailed structural calculations are shown in V**ol. III-2**.

(d) Breast Wall

(i) Design Condition

The Breast wall should be considered as cantilever with the end fixed on the box culvert. The design conditions are shown in **Table R 4.2.44**. And the detail of calculation is indicated in **Vol.III-2**. Material unit weight and soil conditions of backfill are the same as previous assumptions, hence, they are omitted.

Table R 4.2.44 Design Condition of Breast Wall

Item	Design Condition
Water Level Condition	[Water Level in Front] <Normal Condition> Low Water Level <Seismic Condition> Low Water Level [Water Level in Back Side] <Normal Condition> RWL = LWL + 2/3(HWL – LWL) <Seismic Condition> Ordinal Water Level Higher level of MWL or Ground Water Level in Bore hole
Surcharge on the Ground	<Normal Condition> 10 kN/m^2 <Seismic Condition> 5 kN/m^2

(ii) Results of Calculation

The dimensions based on the results of structural calculation are shown in **Table 4.2.6.** Detailed structural calculations are shown in **Vol. III-2**.

(e) Wing Wall

(i) Design Condition

The design conditions are shown in **Table R 4.2.45**. Material unit weight and soil conditions of backfill are same as previous assumptions, hence, they are omitted.

Table R 4.2.45 Design Condition of Wing Wall

Item	Design Condition
Water Level Condition	[Outside water Level] <Normal Condition> Residual Water Level <Seismic Condition> Ordinal Water Level Higher level of MWL or Ground Water Level in Bore hole [Inside Water Level] <Normal Condition> Low Water Level <Seismic Condition> Low Water Level
Surcharge on the Ground	<Normal Condition> 10 kN/m^2 <Seismic Condition> 5 kN/m^2

(ii) Results of Calculation

The dimensions based on the results of structural calculation are shown in **Table 4.2.7**. Detailed structural calculations are shown in **Vol. III-2**.

CHAPTER 5 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

5.1 EIA Study for the Backfill Site

5.1.1 Purpose and Background

In June 1998, an Environmental Impact Statement (EIS) was prepared to apply for the Environmental Compliance Certificate (ECC) for the PMRCIP, which was issued in December 1998 with the condition that another ECC shall be secured for the Backfill Site for dredged material. The validity of the ECC was confirmed by the Department of Environment and Natural Resources – Environmental Management Bureau (DENR-EMB) on March 7, 2008, before the Phase II project commenced construction. However, to confirm and address the gap coming from the additional requirements of the JICA Guidelines for Environmental and Social Considerations revised in April 2010, the Supplemental EIS was conducted in 2011 by the Preparatory Study.

In this D/D Study, the EIA study has been implemented to acquire another ECC for the Backfill Site with the construction components of the jetty area and the access road.. Application for applying ECC documents are submitted to DENR on December 2012. ECC was issued on February 4, 2013.

5.1.2 Laws and Regulation

The process of EIA and the related organization are detailed in the Supplemental EIS (2011) and are same as the current ones according to DENR.

The EIS was prepared in accordance with the Revised Procedural Manual of Administrative Order 2003-30 (DAO 2003-30) of the DENR. DAO 2003-30 is the Implementing Rules and Regulations (IRR) of Presidential Decree No. 1586 or the Philippine Environmental Impact Statement System (PEISS).

The study was also guided by the relevant laws and regulations of the Philippines, and relevant environmental policy issuances of the DENR, including the following:

- DENR MC 2011-005 Incorporating Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) concerns in the Philippine EIS System
- DENR MC 2010- 14, Standardization of Requirements and Enhancement of Public Participation In the Streamlined Implementation of the Philippine EIS System
- DENR MC 2010-002, Clarification to DENR Memorandum Circular No. 2010-14 and other EIS System Policy Issuances
- RA 8749, Philippine Clean Air Act of 1999, and its IRR
- RA 9003, Ecological Solid Waste Management Act of 2000, and its IRR
- RA 9275, Philippine Clean Water Act of 2003, and its IRR
- RA 6969, Toxic Substances and Hazardous and Nuclear Wastes Control Act
- RA 7972 and BP 220 on housing and subdivision development projects
- PD 984, Pollution Control Law
- PD 1067, Water Code of the Philippines of 1976
- DOH AO 2007-012, Philippine National Standards for Drinking Water of 2007
- DAO 1990-35, Revised Effluent Regulation of 1990

- DAO 1990-34, Revised Water Usage and Classification/Water Quality
- DAO 2003-27, Procedural and Reference Manual for Self-Monitoring Reports
- DAO 2004-36, Revised Procedural Manual on Hazardous Waste Management
- DAO 2007-01, Establishing the List of Threatened Species and their Categories, and the List of other Wildlife
- DAO 2007-24, Amending DAO 2007-01 Establishing the List of Threatened Species and their Categories, and the List of other Wildlife
- EMB MC 2010-004, Guidelines on the Use of ECA Map
- Philippine Occupational Safety and Health Standards
- DOLE DO 13, s. 1998, The Guidelines Governing Safety and Health in the Construction Industry

5.1.3 The EIA Study Works

During this Study, DPWH has conducted EIA Study for the Backfill Site with support of JICA Study Team. DPWH submitted the Project Description to DENR-EMB on September 7, 2012. On September14, in order to decide the TOR of survey items, the technical scoping of DENR was conducted at the EIA Review Committee whose members composed of EIA experts outside of DENR. The outcome is attached in **Table 5.1.1**. Then the public scoping was held on September 25, where Taguig City officials, Barangay leaders, and the concerned residents attended. The requests from the participants and the responses by DPWH-PMO are summarized in **Table 5.1.2**. The TOR of EIA Study was revised as requested during these two scoping meetings, which is shown in **Table R 5.1.1**.

Table R 5.1.1 Revised TOR of EIA Study

Category	Survey Items/Remarks	Quantity
Installation of Groundwater Monitoring Wells		4 wells
Groundwater Quality Survey	・ All the parameters listed in PD856	4 samples
Fresh Water Quality Survey	・ Color, Temperature, pH, DO, BOD, TSS, TDS, MBAS, Oil/Grease, Nitrate as N, Phosphate as P, Phenol, Total Coliform, Chloride as Cl, Copper, As, Cd, Cr6+, CN, Pb, Total Hg, Organophosphate, Turbidity, Salinity, EC	3 samples
Terrestrial Survey	・ Flora ・ Fauna	1 location
Air Quality Survey	・ TSP, Pb, SOx, NOx	4 stations
Noise Survey	・	4 stations
Traffic Survey	・	1 location
Aquatic Biota	・ Phytoplankton ・ Zooplankton ・ Macro Benthic organism ・ Nekton (Fish) ・ Aquatic Flora	2 stations
Social Survey (Initial)	・	1 location
Social Economy Survey	・ Census Tagging	100 respondents
Public Consultation	・ Feedback of EIA Study results	1 time
Acquisition of a ECA map		1 copy
Workshop for training DPWH staff	・ Regarding EMP and EMoP	1 event
Technical Scoping	・ Project briefing ・ Site visit	1 for each

Category	Survey Items/Remarks	Quantity
	・Technical scoping meeting ・EIA review meeting ・Scoping report ・EIA Review Committee Funds	
Public Scoping	・For the people residing in the primary and secondary impacted area ・For land owners within the proposed Backfill Site	1 time 1 time
Newspaper advertisement/public notices	・Advertisements on both English and Tagalog newspapers	3 consecutive weekends
EIA Report Preparation	・Including EMB filing cost	1

The Backfill Site, indeed, composes of about 50 private lots. Thus, DENR required DPWH to attach to the EIS the authorization of backfilling from all of the land owners within the proposed Backfill Site. The percentage of authorization DPWH obtained is about 62% although DPWH placed the advertisements on the newspapers three times for the public notice. Furthermore, DPWH has been able to defiled with all of the land owners.

DPWH submitted the draft EIS to DENR on December 6, requesting for the ECC with the condition that DPWH shall obtain all the authorizations from the land owners before commencing the Phase III construction work. The EIA Review Committee of DENR is conducted on December 14. DPWH modified the EIS in accordance with the recommendation of DENR. Finally ECC was issued by DENR on February 4, 2013.

The major findings of EIA Study are presented in the **Table R 5.1.2**. Based on the results of EIA Study, EMP and EMoP are proposed. The proposed EMP and EMoP are shown in **Tables 5.1.3** and **5.1.4** respectively.

Table R 5.1.2 Key Findings of the Results of EIA Study.

Category	Findings
Land	• No endangered species were found within the site. • The official land use classification of this site is socialized housing zone. • The project site is either within or near three types of ECA: areas hard-hit by natural calamities (project site), tourism area, and water bodies for domestic and wildlife/fishery support (Laguna Lake) but is not a protected area. • Most of the lots within the project site are privately owned.
Soil Characteristics/ Classification	• Clay materials underlie the ground surface down to depths of 10 to 11 meters. Particle sizes are fairly uniform.
Soil/Sediment Quality	• All the results of the leaching tests for both river sediment and soil of the Backfill Site were below the criteria.
Flooding and Flood	• Low-lying areas of the Pasig-Marikina-Laguna Lake watershed are at high risk from high water flows and river overbanking during heavy rains or typhoons. The Project site belongs to the high risk areas.
Groundwater Quality	• The groundwater samples did not pass the PNSDW standards for color, odor, taste, aluminum, iron, manganese, TDS, and all the microbiological parameters; E. Coli, HPC, and Fecal coliform. • The groundwater is not used for drinking in this area.
Surface Water Quality	• Both the canal and Labasan Creek are highly contaminated with organic wastes as manifested in the very low DO, high BOD and very high coliform bacteria. • Other parameters are within the guideline values of DAO 1990-34 for Class C waters.
Aquatic biota	• The most dominant species of aquatic plants in Napindan River and Labasan Creek is water hyacinth. • The high density of Euglena, a green alga, in Labasan Creek suggests moderate to high nutrient content or abundance of organic matter in the water. • There were no endangered aquatic species identified in the three sampling sites.
Air Quality	• The concentrations of all the parameters measured-TSP, Lead, SO2, NO2- were lower than the DENR standard.
Noise	• Ambient noise levels around the project sites throughout the day are naturally high and exceeded the NPCC allowable limits for residential and commercial areas.
Demography	• There are 25 households within the 45ha backfill site, 21 households were covered by the survey; 4 households have no occupants at the time of survey. • At the time of survey, there were twenty-three households at the jetty site and the area that will be occupied by the access road.
Economic Activities	• The 58 HH members residing in the 45-ha backfill site are economically active. Income sources include wholesale/retail trade, manufacturing, community/social/personal services, agriculture, fishing and construction. • Of the residents at the jetty and access road sites, 85 are economically active. Primary sources of income include community, social and personal services; transport, storage and communication; construction, fishing, wholesale, retail trade; construction; forestry and agriculture. • Monthly income ranges from PhP1,001 to PhP25,000.
Knowledge and Perception about the Project	• The residents of the 45-ha backfill site and jetty site are aware of the project and they are willing to be temporarily relocated when the project starts. Should their houses be affected, they are willing to be paid compensation for the damages of materials etc. If they are to be permanently relocated, they would still be amenable, but a specific area should be designated as relocation site. • During the consultation with the market vendors, the group leader stated that with relocation, their main source of livelihood will be affected. The respondents stated that if possible, the relocation should be in the market area only. It will be difficult for them to totally leave the place. As for fishing, they need to be near the river. The market vendors are generally amenable with the relocation as long as they continue their businesses.

5.2 Quality of Sediment to be Dredged

5.2.1 Purpose and Background

Dredging the whole stretch of Lower Marikina River is one component of Pasig-Marikina River Channel Improvement Project (PMRCIP) Phase III. As part of the preparation for its implementation and for the selection of proper site for disposal of the dredged materials, the JICA Study Team has conducted sampling and analysis of the riverbed sediments and surface water of the Lower Marikina River. The purpose of this survey was to confirm in advance if the sediment is contaminated with toxic heavy metals as well as toxic inorganic and organic substances before the Phase III construction work begins. This is also to establish methodology on the proper disposal of the dredged/excavated materials based on the results of the analysis. If the dredged/excavated materials are not contaminated with toxic substances, then it would be safe to dispose them to any viable site available. However, if the dredged/excavated materials are contaminated, then these materials should be disposed in a sanitary landfill instead.

A proposed 45-hectare area located in Barangays Napindan and Ibayo-Tipas in Taguig City was sighted as most economically viable site for the dredged materials in terms of proximity and accessibility. The proposed site will be filled or backfilled with the dredged materials to increase area elevation of up to 1 meter to 2 meters. In order to establish baseline data of the existing soil quality of the proposed site, a soil quality analysis was also conducted for soils within the 45-hectare property.

Leaching procedure such as TCLP (toxicity characteristic leaching procedure) test and Elutriate test were conducted for the collected sediment and soil samples. The TCLP extracts and Elutriate extracts were then analyzed for presence of toxic substances such as heavy metals, cyanides, polychlorinated biphenyls (PCB), and organophosphorus pesticides (OPP). As the results of sediment analysis, all toxic substances were found below the criteria. Therefore, riverbed sediments of Lower Marikina River are considered safe and not hazardous.

5.2.2 Sampling Procedure

(1) Sediment Sampling

Sampling procedures for river sediment and river water are summarized in the previous report, Basic Design II. For the chemical substances detected above the standards, additional tests were conducted. The procedures will be documented in the report on environmental and social consideration.

(2) Soil Sampling

Ten (10) soil samples were collected on August 23, 2012 from 10 identified locations within the proposed backfill site with the use of a suitable soil auger or hand auger and/or shovel. Soil sampling was carried out by taking composite samples from 0 to 1-meter depth using soil auger. If a sampling station is watery and it is impossible to use a soil augur, sampling was done by grabbing surface soil using a shovel. The soil samples are then transferred into a pre-labelled sample container and sealed tightly to ensure that no moisture leakage or cross-contamination will occur. The samples were stored in coolers and sent to a laboratory for analysis. Sample identification, location, depth, and other pertinent data were recorded including map, drawing, etc.

The soil sampling locations with the geographic coordinates and sampling descriptions are listed in **Table R 5.2.1** below. The soil sampling locations is shown in **Figure 5.2.1**.

Table R 5.2.1 Soil Sampling Type and Locations

Sampling Stations	Location/ Geographical Coordinates		Type of Sampling	Sampling Station Description
	Lat_WGS84	Long_WGS84		
Stn-1	14°31'53.2"	121°05'33.4"	Grab at surface using shovel	Watery vacant lot near dump site of plastic wastes
Stn-2	14°31'51.9"	121°05'44.0"	Composite soil sample of a fill material using scoop	Vacant lot with a backfilled soil of oily appearance
Stn-3	14°32'00.0"	121°05'42.4"	Composite soil sample from 0 to 1-meter depth using an auger	Vacant lot
Stn-4	14°32'03.3"	121°05'35.9"	Composite soil sample from 0 to 1-meter depth using an auger	Ricefield
Stn-5	14°32'05.5"	121°05'36.4"	Composite soil sample from 0 to 1-meter depth using an auger	Ricefield
Stn-6	14°32'03.9"	121°05'32.2"	Composite soil sample from 0 to 1-meter depth using an auger	Ricefield
Stn-7	14°32'10.4"	121°05'39.8"	Grab at surface using shovel	Watery vacant grassy lot
Stn-8	14°32'09.8"	121°05'38.7"	Grab at surface using shovel	Watery vacant grassy lot
Stn-9	14°32'09.6"	121°05'41.6"	Grab at surface using shovel	Watery vacant grassy lot
Stn-10	14°32'02.6"	121°05'56.0"	Grab at surface using shovel	Vacant lot at back of junkshop

5.2.3 Analytical Procedure

Analytical methodologies for this study include:

- Leaching Test for Sediment: Elutriate Test and TCLP Test.
- Analytical Methods of Water Quality

Sediment samples taken from 60 sampling stations were analyzed through Leaching test by both Elutriate test and TCLP (Toxicity characteristic leaching procedure) test.

The Elutriate Test is an extraction method used to predict the potential release of contaminants from sediment at the point of dredging the riverbed sediments; and at confined disposal area, when the dredged material touches with water or rain. This was originally developed by the U.S. Army Corps of Engineers to simulate a situation that occurs during the dredging operation by testing if the target parameters will be leached out in the process. The test procedure includes sample preparation, sample homogenization, sample sieving, quartering, shaking, moisture content determination, filtration, digestion and analysis. The volume of elutriate sample needed for chemical analyses will vary depending on the number and types of analyses to be conducted. For this project, Elutriate Test covers the following parameters: Cadmium (Cd), Hexavalent Chromium (Cr6+), Lead (Pb), Total Mercury (T-Hg), Arsenic (As), Free Cyanide (CN-), Organophosphate Pesticides (OPP) and Polychlorinated Biphenyls (PCB).

The TCLP Test, on the other hand, is an extraction method for chemical analysis that simulates leaching in a landfill. It aims to determine if the waste to be disposed of is characteristically hazardous or not, or whether these wastes need further treatment before disposal. The extraction procedure is as shown in the USEPA Method for Evaluating Solid Waste (SW-846) - Method 1311. TCLP comprises of four fundamental procedures: sample preparation, sample leaching, preparation of leachate for analysis, and leachate analysis. The parameters of leachate analysis include Cadmium (Cd), Total-Chromium (T-Cr), Lead (Pb), Total Mercury (T-Hg), and Arsenic (As).

A summary list of parameters and the corresponding methods of analysis are listed in **Table R 5.2.2**.

Table R 5.2.2 Parameters and Analytical Methodologies Applied

Parameters	Analytical Method	Sediment and Soil Quality Analysis		Water Quality Analysis
		Elutriate Test	TCLP Test	
Arsenic (As), mg/L	SDDC Spectrophotometer	/		/
Arsenic (As), mg/L	Gaseous Hydride AAS		/	
Cadmium (Cd), mg/L	Flame AAS	/	/	/
Lead (Pb), mg/L	Flame AAS	/	/	/
Mercury (Hg-total), mg/L	Manual Cold Vapor AAS	/	/	/
Copper (Cu), mg/L	Flame AAS			/
Cyanide (CN-free), mg/L	Ion Selective Electrode	/		/
Hexavalent Chromium (Cr^{6+}), mg/L	Diphenylcarbazide Colorimetric Method	/		/
Chromium (T-Cr), mg/L	Flame AAS		/	
Polychlorinated Biphenyls (PCB), µg/L	EPA 8082A	/		
Organophosphate Pesticides, µg/L	EPA 8141	/		/
Total Coliforms, MPN/100 mL	Multiple Tube Fermentation Technique			/
pH (on site)	Electrometric Method			/
Temperature (on site), °C	Laboratory and Field Method			/
Color (apparent), PCU	Visual Comparison			/
Turbidity, NTU	Nephelometric			/
Conductivity, µS/cm	Conductimetry			/
Dissolved Oxygen (onsite), mg/L	Membrane Electrode Method			/
Biological Oxygen Demand, mg/L	Azide Modification Winkler			/
Total Dissolved Solids, mg/L	Gravimetry			/
MBAS (Surfactants), mg/L	Colorimetry - Chloroform Extraction			/
Phenols, mg/L	Chloroform Extraction - Colorimetry			/
Total Suspended Solids, mg/L	Gravimetry			/
Oil and Grease, mg/L	Petroleum Ether Extraction			/
Chloride, mg/L	Argentometric Method			/
Cyanide (free), mg/L	Ion Selective Electrode			/
Nitrate – N, mg/L	Brucine			/
Phosphate – P, mg/L	Stannous Chloride Method			/
Salinity as NaCl, mg/L	Titrimetry by Calculation			/

Note: The symbol "/" means to be targeted substances for each category of analysis.

The soil samples from the disposal site will also be analyzed for leaching characteristics by both Elutriate Test and TCLP Test. The parameters shall be the same as with the sediment samples.

Particle Size Distribution Test (PSD) was also undertaken for the riverbed sediment samples. The water content or percent moisture content shall be used for a calculation on a dry basis.

Trial treatment of sediment samples with cement and lime has also been conducted to determine which mixing ratio is the most effective to convert dredged muck/sediments into suitable filling materials. For this purpose, the treated samples were again analyzed by leaching tests to examine the effectiveness of cement/lime mixing treatment for containing the contaminants after the material is disposed. It should be noted that even if the quality of raw sediment is safe, the mixture might be contaminated due to the contribution from cement/lime mixed. Also another purpose was to double check if the analytical results are still below the criteria after the mixing treatment to stabilize sediment physically.

As for water quality analysis, the water samples from Lower Marikina River were tested for these parameters: Copper (Cu), Cadmium (Cd), Hexavalent Chromium (Cr6+), Lead (Pb), Total Mercury (T-Hg), Free Cyanide (CN-), Arsenic (As), and Organophosphate Pesticides (OPP), plus basic parameters including Color, Temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Surfactants, Oil/Grease, Nitrate as N, Phosphate as P, Phenol, Total Coliforms, Chloride as Cl, Turbidity, Salinity, and Electrical Conductivity .

5.2.4 Results of River Sediment Quality Analyses and Evaluation of the Investigations Results

The surveys intend to obtain information on the current pollution load. This is a factor being considered in deciding on the appropriate methodology to be used in the proposed riverbed sediment dredging and excavation works. The results of the first surveys revealed that sediment is not contaminated with hazardous chemical substances for all the parameters except for cyanide and chlorpyrifos. For cyanide and chlorpyrifos which exceeded the standards, re-sampling, treatment with cement, and/or retesting was conducted to confirm whether the detections were true or error. All the additional test results showed below the standard. The details of the additional test results will be summarized with the procedures in the report on environmental and social consideration.

According to PRRC, who leads the regular environmental monitoring activities for Pasig River watershed including LOWER MARIKINA RIVER, it has the same understanding for the water and sediment qualities. Additionally, MMDA says that the companies located on the riversides conduct dredging of sediment on a regular basis. Thus, even if contaminants accumulated with sediment in the past, the contaminated sediment was already removed. The sediment sampled in the upstream of LOWER MARIKINA RIVER is mostly sandy. Contaminants are much less likely to be adsorbed on sand. Therefore, the detection of the contaminants in sediment taken in the upstream is considered probably due to an analytical error.

Water depth and sediment height were measured during the sampling. **Figure R 5.2.1** shows the results of water depth and sludge height measurement along Lower Marikina River.

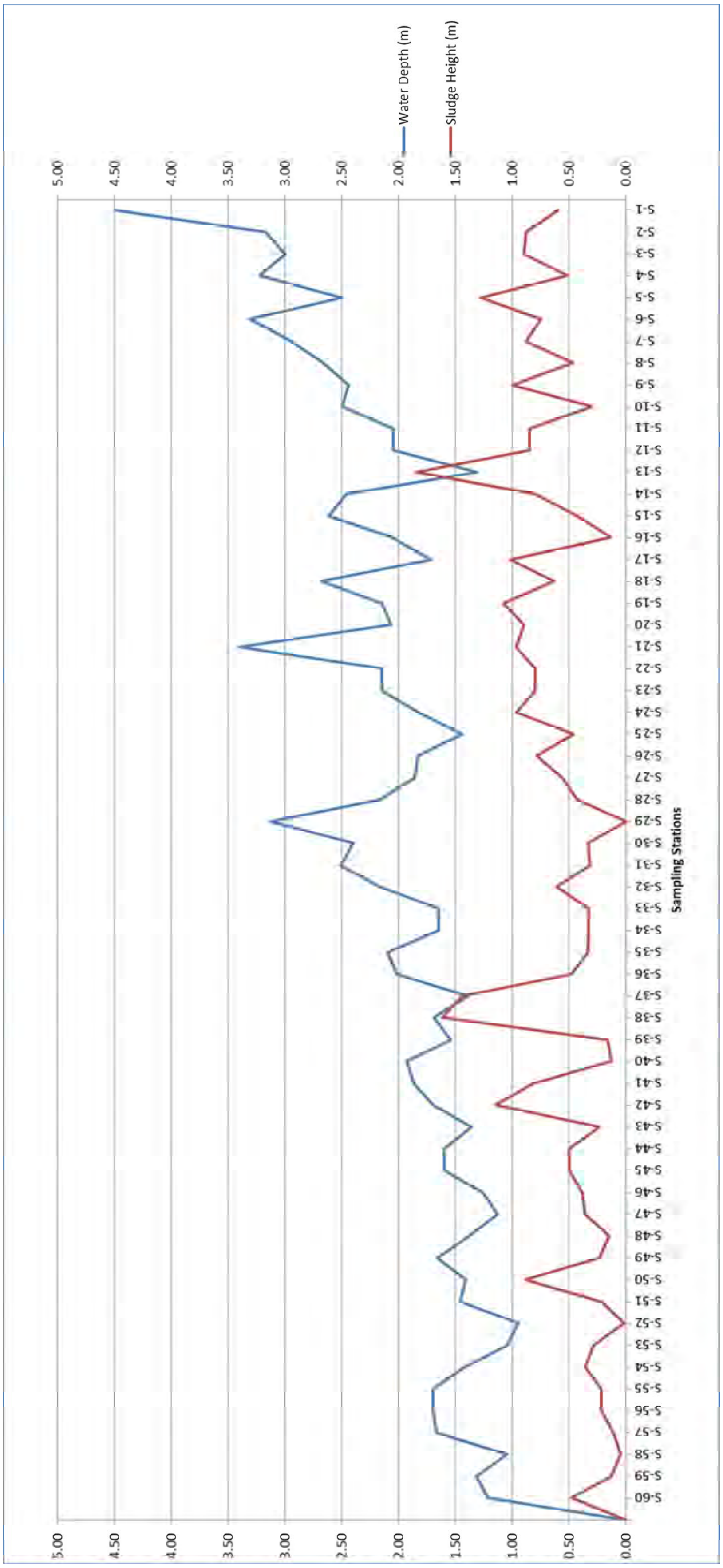


Figure R 5.2.1 Water Depth and Sludge Height Measurement along Lower Marikina River

5.2.5 Results of Soil Quality Analyses and Evaluation of the Investigations Results

Similar to the riverbed sediments, the existing soil at the proposed backfill site was also analyzed for heavy metal contamination as well as PCBs and OPPs through leaching tests, Elutriate and TCLP. The purpose of the analyses is to establish baseline data at the proposed disposal or backfill site of the dredged materials and to evaluate any toxic characteristics at the proposed site.

5.2.5.1 Results of Soil Quality by Elutriate Test

The soil quality analysis of heavy metals, cyanide, hexavalent chromium, PCBs and OPPs in the Elutriate extracts of the 10 soil samples were completed on September 21, 2012. The Elutriate test results were evaluated based on DAO 34 standards for Class C freshwater. The results of the analysis are presented in the following Tables:

Table R 5.2.3 Results of Analysis for Inorganic Chemicals in Elutriate Extracts of Soil Samples from the Backfill Site

Sampling Location	**Sampling Type**	**As (mg/L)**	**Cd (mg/L)**	**Pb (mg/L)**	**T-Hg (mg/L)**	**CN^- (mg/L)**	**Cr^{6+} (mg/L)**
MDL*		**0.01**	**0.01**	**0.04**	**0.0001**	**0.02**	**0.004**
Class-C River[3]		0.05	0.01	0.05	0.002	0.05	0.05
Effluent to Class-C inland[4]		0.2	0.05	0.3	0.005	0.2	0.1
S-1	Grab at surface	ND	ND	ND	ND	ND	ND
S-2	Grab at surface	ND	ND	ND	ND	ND	ND
S-3	Deep at 1-m	ND	ND	ND	ND	ND	ND
S-4	Deep at 1-m	ND	ND	ND	ND	ND	ND
S-5	Deep at 1-m	ND	ND	ND	ND	ND	ND
S-6	Deep at 1-m	ND	ND	ND	ND	ND	ND
S-7	Grab at surface	ND	ND	ND	ND	ND	ND
S-8	Grab at surface	ND	ND	ND	ND	ND	ND
S-9	Grab at surface	ND	ND	ND	ND	ND	ND
S-10	Grab at surface	ND	ND	ND	ND	ND	ND

Notes:
ND – not detected or below MDL
*MDL – Method Detection Limit

Source:
CRL Environmental Corporation (Results of Laboratory Analyses);
DAO 90-34 Water Quality Criteria;
DAO 90-35 Table 1 Effluent Standards (maximum limits for the protection of public health): Discharge limit from new/proposed industry to Inland water (Class C).

Table R 5.2.4 Results of PCB Analysis in Elutriate Extracts of Soil Samples from the Backfill Site

Sampling Location	**Polychlorinated Biphenyls (PCBs), µg/L**								
	Aroclor 1016	**Aroclor 1221**	**Aroclor 1232**	**Aroclor 1242**	**Aroclor 1248**	**Aroclor 1254**	**Aroclor 1260**	**Aroclor 1262**	**Aroclor 1268**
S-1	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-2	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-3	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-4	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-5	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-6	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-7	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-8	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-9	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-10	ND	ND	ND	ND	ND	ND	ND	ND	ND
MDL	**0.5**	**1.0**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
DLR	**0.5**	**1.0**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
Class-C River[3]	-	-	-	-	-	-	-	-	-
Effluent to Class-C[4]	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003

Notes:
ND = Not Detected (below DLR for PCB)
MDL = Method Detection Limit
DLR = Detection Limits for Reporting (MDL x Dilution Factor)

Source:
1. CRL Environmental Corporation (Results of Laboratory Analyses);
2. DAO 90-34 Water Quality Criteria;
3. DAO 90-35 Table 1 Effluent Standards (maximum limits for the protection of public health): Discharge limit from new/proposed industry to Inland water (Class C).

Table R 5.2.5 Results of OPP Analysis in Elutriate Extracts of Soil Samples from the Backfill Site

Sampling Stations	Organophosphorus Pesticides (OPPs), µg/L																					
	Azinphosmethyl	Bolstar (Solprofos)	Chlorpyrifos	Coumaphos	Demeton-O	Demeton-S	Diazinon	Dichlorvos	Disulfoton	Ethoprop	Fensulfothion	Fenthion	Malathion	Merphos	Mevinphos	Naled	Parathion, methyl	Phorate	Ronnel	Tetrachlorvinphos	Tokuthion	Trichloronate
S-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Reporting Limit	2.0	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
Class-C River[3]	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Effluent to Class-C[4]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ND = Not Detected
MDL = Method Detection Limit
DLR = Detection Limits for Reporting (MDL x Dilution Factor)

Source:
1. CRL Environmental Corporation (Results of Laboratory Analyses);
2. DAO 90-34 Water Quality Criteria;
3. DAO 90-35 Table 1 Effluent Standards (maximum limits for the protection of public health): Discharge limit from new/proposed industry to Inland water (Class C).

As the results of analysis, concentrations of arsenic, cadmium, lead, mercury, cyanide, hexavalent chromium, PCBs, and OPPs in the elutriate extracts are not detected, or below the method detection limit of the laboratory instrument used. Hence, the proposed disposal or backfill site is free from the subject toxic contaminations analyzed.

5.2.5.2 Results of Soil Quality by TCLP Test

The TCLP extracts of the soil samples taken from the backfill site were analyzed for toxic heavy metals such as arsenic, cadmium, lead, mercury, and chromium. The results of analyses are presented in **Table R 5.2.6**. Results showed that the concentrations of these contaminants are not detected or below the standards. This means that the existing backfill site is free from toxic contaminants and leaching of these contaminants from existing soils may not occur.

Table R 5.2.6 Results of Analysis for Inorganic Chemicals in TCLP Extracts of Soil Samples from the Backfill Site

Sampling Location	Sampling Type	As (mg/L)	Cd (mg/L)	Cr-total (mg/L)	Pb (mg/L)	Hg-total (mg/L)
MDL		**0.001**	**0.01**	**0.03**	**0.04**	**0.0001**
DAO2004-36[2]		5	5	5	5	0.2
USEPA-TCLP Regulatory[3]		5	1	5	5	0.2
S-1	Grab at surface	0.005	ND	ND	ND	0.003
S-2	Grab at surface	0.002	ND	ND	ND	ND
S-3	Deep at 1-m	0.003	ND	ND	ND	ND
S-4	Deep at 1-m	0.004	ND	ND	ND	ND
S-5	Deep at 1-m	0.003	ND	ND	ND	ND
S-6	Deep at 1-m	0.002	ND	ND	ND	ND
S-7	Grab at surface	0.02	ND	ND	ND	ND
S-8	Grab at surface	0.008	ND	ND	ND	ND
S-9	Grab at surface	0.006	ND	ND	ND	ND
S-10	Grab at surface	0.002	ND	ND	ND	ND

Notes:
ND = Not Detected (below MDL / Reporting Limit/s)
MDL = Method Detection Limit

Source:
1. CRL Environmental Corporation (Results of Laboratory Analyses);
2. DAO2004-36 - Procedural manual Title III of DAO 92-29 “Hazardous Wastes Management”;
3. US EPA.

5.2.6 Evaluation and Consideration of the Results for the Construction Phase

Throughout a series of tests of the riverbed sediments in Lower Marikina River and confirmatory retest in some sampling stations, all concentrations of heavy metals and other inorganic and organic toxic substances analyzed were generally not present in concentrations that are considered harmful to humans. All the concentrations are less than the regulatory levels set by the Government of the Philippines. This indicates that the sediments along Lower Marikina River are not hazardous and no significant levels of toxicity will occur in the river water during dredging. The sediment to be dredged from this stretch of Lower Marikina River is also considered safe for the use for embankment or for land reclamation purposes.

5.3 Tree Inventory Survey

5.3.1 Purpose and Background

The Philippine Government through the Department of Public Works and Highways (DPWH) intends to implement the Phase III of the Pasig-Marikina River Channel Improvement Project. Like in Phase II, the construction of different flood-control structures along the riverbanks will unavoidably alter or destroy some of the existing physical and natural features of the riverbanks which include trees and other crops. By law, legitimate owner or claimant of the tree/s to be cut from a privately-owned land must also be given due compensation. Further, the actual cutting of trees also requires some amounts for their removal. Important tree species such as those belonging to the classification of heritage tree, endangered, premium and or banned tree species shall in as much as possible be spared from cutting. Tree Inventory Survey therefore is necessary in order to get detailed data as basis for budget allocation and in order to comply with the laws of the land in so far as removal/cutting of trees is concerned.

5.3.2 Laws and Regulations

Presidential Decree No. 953, dated 06 July 1976, authorizes among others the DENR to issue a cutting permit for trees to be removed from the public areas like riverbanks for public works. Pursuant to PD 953, DENR Secretary Jose L. Atienza, Jr., issued a Memorandum dated 27 November 2009 attaching the “guidelines and procedures on the planting, maintenance and removal of trees and other vegetation in urban areas and in areas affected by government infrastructure projects”. It provides the following conditions:

(1) cutting of trees or other vegetation may be allowed in public and private places that shall be unavoidably affected by infrastructure projects such as construction or widening of roads and bridges, port areas, building construction, etc”,
(2) when the place or area where trees shall be cut is along the banks or rivers and creeks, the issuing authority for a cutting permit is the concerned DENR Regional Executive Director,
(3) requires that for every tree cut, there would be a need to replace the same with some seedlings ranging from 10-50 pieces per tree depending upon its diameter, and
(4) all cut trees and parts thereof cut from public places for public works shall be turned over to the nearest DENR Office for disposition provided however that trees cut from private places shall belong to the land owner.

Executive Order No. 23 issued on 01 February 2011 by the current President of the Republic of the Philippines Benigno S. Aquino, III declares a moratorium on the cutting and harvesting of timber in natural and residual forests and creating the Anti-Illegal Task Force. Section 2, item 2.2 states that “the DENR is likewise prohibited from issuing /renewing tree cutting permit in all natural and residual forests nationwide, except for clearing of road right of way by the DPWH”. It also emphasizes that all logs derived from such cutting permits shall be turned over to the DENR for proper disposal.

On 30 April 2012, the DENR issued a Memorandum No. 196 suspending the processing of all requests for cutting permits. On 22 June 2012, the DENR issued another Memorandum clarifying the content of Memorandum 196, among others, the cutting permits not covered by suspension are those:

(1) Naturally growing trees within the private/titled property;
(2) Planted trees within public forest/timberland and private lands; and
(3) Tree cutting activities covered by exemptions provided in the Memorandum from Secretary dated 20 October 2012 regarding “similar activities” of Section No. 2, item 2.2 of EO 23.

The same Memorandum states that all requests for tree cutting permits referred to item B include :

(1) appropriate justifications that tree cutting can no longer be avoided, and
(2) possible options to minimize the impact/damage to the environment.

It also stated that the request shall be processed at the field/regional offices and shall be properly endorsed by concerned regional Executive Director to the Office of the Secretary through the Forest Management Bureau.

5.3.3 Methodology

One (1) Tree Inventory Survey Team was organized composed of a forester, surveyor/atuoCAD operator, recorder, and a laborer. As a rule, through a pre-arranged meetings, the Team made a prior coordination with different agencies/offices such that of the concerned LGUs, DENR and DPWH. Collection of available documents such as rules and regulations including written procedures/guidelines related to the inventory and/or cutting of trees has been conducted.

In the absence of any existing written guidelines, the JICA study Team came up with its own procedure by incorporating important information/conditions gathered from the LGUs and DENR. Among others, the procedure provides that the inventory of trees shall be done only in areas along the riverbanks with an approved structural alignments and only after proper marking of the alignments including ROW and working space, and if possible seek a representative from the LGUs to join in the actual conduct of tree inventory. Trees and other crops has to be identified, recorded and marked with paint. The survey team shall submit detailed tally sheets indicating the designated reference number of trees, species, diameter in cm, height in meter, specific location and claimant, and the estimated required cost.

5.3.4 Tree Inventory Survey

The conduct of tree inventory survey and the preparation and tabulation of the required reports were completed in two (2) months. It started in September 26, 2012 and by November 26, 2012, the tabulated reports have been signed/approved by the DENR and DPWH. Preparation and submission however of the Narrative reports including various supporting documents is done by the 2nd week of December 2012. Outlined below is the summary status of the Tree Inventory Survey:

(1) Location

Within the area which may be affected by the construction works of flood-control engineering structures as part of the Pasig-Marikina River Channel Improvement Project, Phase III.

Manila City - Brgy. Nos. 306, 384, 647, 650A, 663A, 644,636, 628, 836, 838, 621, 865, 888, 894, 897, 896, 900, 905, 903, 902, 201, & 899
Mandaluyong - Brgy. Mabini-Rizal, Namayan, Vergara, Barangka Ibaba, Barangka Itaas, Barangka Ilaya & Buayang Bato
Makati City - Brgy. Olympia, Valenzuela, Guadalupe Viejo, Guadalupe Nuevo, Cembo & West Rembo
Pasig City - Brgy. Pineda, Bagong-Ilog, Kapasigan, Caniogan, Ugong & Rosario

(2) Coordination

Coordinating the Tree Inventory Survey works through meetings with Manila City, Mandaluyong City, Makati City & Pasig City were done on October 17, September 24, September 19, and October 10, 2012, respectively. Coordination meetings with the DENR-NCR-FMS were also conducted on September 21 and October 11, 2012.

(3) LGU's Representatives

Manila City -	Juancho Capuchino/ Rod Legaspi/Jojo Montecillo
Makati City-	Jun Petancio/Fernando Paraiso/Noel Casasola
Mandaluyong City-	Jonathan Cruz
Pasig City -	Teresita Francisco/Cristy Enriquez

(4) Trees Inventoried:

Table R 5.3.1 Trees/Crops Inventoried

LGUs	**Total No. (Trees/ Crops)**	**Breakdown**					
		Trees^ (No.)	**Malung-gai (No.)**	**Banana (No.)**	**Papaya (No.)**	**Orna-mental (No.)**	**Dead/ Cut^^ (No.)**
Manila	544	541	5	0	0	8	0
Mandaluyong	43	43	0	0	0	0	0
Makati	443	344	57	7	13	11	11
Pasig	340	340	0	0	0	0	0
Grand Total	**1,380**	**1,268**	**62**	**7**	**13**	**19**	**11**

^: includes palms (coconut, other palms, bamboos);
^^: died/cut about a month after the conduct of inventory.

Of the 1,380 trees/other crops, only 1,268 pieces were identified to be subjected for the replacement of seedlings in case cutting is to be push through. The rest were included in the inventory as the same as found growing within the approved structural alignments where there are individuals claiming to have actually planted the trees. The Malunggai, a vegetable tree, and most of the ornamental plants can be planted and grown easily through cuttings compared to most of the trees which will require seedlings and careful tending.

5.3.5 Results and Discussion

Below is the table showing the dominant species counted.

Table R 5.3.2 Dominant Species

Top Species	Manila		Mandaluyong		Makati		Pasig		Total	
	No.	%	No.	%	No.	%	No.	%	No	%
1. Balete	82	15%	6	14%	43	13%	29	9%	160	13%
2. Bo	7	1%	6	14%	16	5%	2	1%	31	2%
3. Ipil-Ipil	148	27%	7	16%	29	8%	18	5%	202	16%
4. Aratelis	32	6%	3	7%	30	9%	6	2%	71	6%
5. Narra	18	3%	0	0%	17	5%	3	1%	38	3%
6. Coconut	25	5%	2	5%	14	4%	63	19%	104	8%
7. Alagao	22	4%	0	0%	7	2%	1	0%	30	2%
8. Is-is	18	3%	0	0%	9	3%	0	0%	27	2%
9. Labnog	31	6%	0	0%	15	4%	3	1%	49	4%
10.Tuba-Tuba	18	3%	1	2%	3	1%	0	0%	22	2%
11. Neem	31	6%	2	5%	2	1%	2	1%	37	3%
12. Palm	28	5%	3	7%	0	0%	2	1%	33	3%
13. Kawayan	0	0%	0	0%	0	0%	18	5%	18	1%
14. Mangga	5	1%	1	2%	8	2%	47	14%	61	5%
15. Bangkal	1	0%	0	0%	0	0%	53	16%	54	4%
16. Guyabano	1	0%	0	0%	2	1%	14	4%	17	1%
17. Mahogany	3	1%	0	0%	41	12%	6	2%	50	4%
13. Others^	71	13%	12	28%	108	31%	73	21%	264	21%
Total	**541**		**43**		**344**		**340**		**1,268**	

^: refer to the total of other species with low population

It is apparent that Balete tree, Ipil-Ipil and Aratelis are the dominant tree species found naturally growing along the stretch of Pasig_Marikina River.

(1) Important Tree Species

Of all the tree species identified and marked, only Narra and Molave Trees belong to the category of premium or banned species as listed by the DENR. There are 38 Narra and 2 Molave Trees in the area investigated.

(2) Cost to be allocated for Phase III

The overall cost including seedling and compensation to be needed during Phase III was calculated. The seedling cost and compensation cost for tree cutting estimated are PhP 2,030,500 and PhP1,678,231 respectively. Additionally, the cutting work requires PhP170,690. As a result, the estimated overall cost to be allocated for Phase III is PhP3,879,421.

The details of each are tabulated below.

Seedling cost for the replacement of cutting trees is summarized in the **Table R 5.3.3**.

Table R 5.3.3 Seedling Cost

City	No. of Trees^	No. of Seedlings-Replacement	Cost (PhP)
Manila	541	14,070	878,000.00
Mandaluyong	43	1,210	82,000.00
Makati	344	8,360	443,500.00
Pasig	340	9,390	627,000.00
Total	**1,268**	**33,030**	**2,030,500.00**

Table R 5.3.4 presents the summary of compensation cost for trees.

Table R 5.3.4 Cost for Compensation for Trees

LGUs/Cities	Private Lands		Public Lands		Total	
	No. of Trees	Value (PhP)	No. of Trees	Value (PhP)	Trees (No.)	Value (PhP)
Manila	329	193,641.37	225	239,845.13	554	433,486.50
Mandaluyong	5	50,084.00	38	55,505.30	43	105,589.30
Makati	125	183,031.95	318	291,227.98	443	474,259.93
Pasig	242	428,625.37	98	236,269.90	340	664,895.27
Total	701	855,382.69	679	822,848.31	1,380	1,678,231.00

Table R 5.3.5 summarizes the overall cost for tree cutting to be allocated for Phase III.

Table R 5.3.5 Summary of the Overall Cost of Tree Cutting needed for Phase III

LGUs/City	Seedlings-Replacement (No.)	Cost (PhP)			Total Cost (PhP)
		Seedlings	Cutting	Compensation	
Manila	14,070	878,000.00	55,010.00	433,486.50	1,366,496.50
Mandaluyong	1,210	82,000.00	5,750.00	105,589.30	193,339.30
Makati	8,360	443,500.00	60,240.00	474,259.93	977,999.93
Pasig	9,390	627,000.00	49,690.00	664,895.27	1,341,585.27
Total	33,030	2,030,500.00	170,690.00	1,678,231.00	3,879,421.00

5.4 Promotion of Reducing Poverty and Consideration of Gender Aspects

5.4.1 Purpose and Background

The Phase III construction work may affect not a few residents, especially vulnerable people such as the poor, residing along the river alignment and in the backfilling site where the construction work is planned. When those poor people lose their lands, houses, and/or livelihoods, they are likely placed in a severer situation than the other project affected people.

In this regard, this section describes the governmental framework of anti-poverty measures and also addresses the job opportunities and the job training program for their livelihoods expected to be supported by the government.

5.4.2 Related Organizations and Laws and Regulations

5.4.2.1 Related Organizations

There are several governmental organizations addressing anti-poverty issue, which include:

- The Presidential Commission for the Urban Poor (PCUP)
- National Anti-Poverty Commission (NAPC)
- Department of Social Welfare and Development (DSWD)

On the other hand, LGUs implement the related policies and offer the support by cooperation with the governmental organization such as DSWD.

5.4.2.2 The Presidential Commission for the Urban Poor

Executive Order No. 82 (1986) requires creating the PCUP and stipulates its functions and responsibilities. Executive Order No. 111 (1986) directs all concerned governmental agencies in cooperation with the PCUP to participate in tri-sectoral dialogues and activities in response to the concerned of the urban poor. Executive Order No. 69 (2012) was established to strengthen the Presidential Commission for the Urban Poor.

PCUP is the organization tackling urban poor matters in coordination with other agencies. PCUP stipulates the clear vision, mission, and goals in accordance with 10-point covenant of the President with the urban poor. The items of presidential covenant relative to this project include:

- No eviction without due process
- Provide support for area upgrading and in city resettlement
- Jobs
- Post Ondoy rehabilitation programs
- Participation and stakeholdership

The vision of PCUP is “to be a society where the poor are empowered, economically productive and actively participating in the poverty reduction program and sustainable development of the country.”

The mission is to undertake:

- improved coordination and monitoring for the speedy implementation of government programs and policies for the urban poor;
- enhanced accreditation of legitimate urban poor organizations for purposes of representation and policy formulation.

The seven goals of PCUP can be seen in its website.

5.4.2.3 National Anti-Poverty Commission

The National Anti-Poverty Commission (NAPC) was created by virtue of Republic Act (RA) 8425, otherwise known as the "Social Reform and Poverty Alleviation Act," which took effect in June 1998. RA 8425 institutionalizes the government's Social Reform Agenda (SRA), which enjoins NAPC to strengthen and invigorate the partnerships between the national government and the basic sectors.

NAPC published “National Anti-Poverty Program (2010-2016).” The centerpiece of this program is “Pantawid Pamilyang Pilipino Program (4Ps)” which is a human development program of the national government that invests in the health and education of poor households.

Pantawid Pamilya has dual objectives:

- Social Assistance - to provide cash assistance to the poor to alleviate their immediate need (short term poverty alleviation); and

- Social Development - to break the intergenerational poverty cycle through investments in human capital.

Pantawid Pamilya helps to fulfill the country’s commitment to meet the Millennium Development Goals.

This program aims to construct a carefully designed framework maximizing the convergence of economic programs and local initiatives.

The program thrusts related to this project are the following:

(1) Focus on the poorest of the poor

Anti-poverty interventions are focused towards expanding access of the poor to basic social services, especially education, health and family planning services; providing risk mitigation; and expanding social protection programs so poor households can cope better with economic, social and natural disasters. These will also entail the expansion of economic and social opportunities for the poor so they can increase their incomes and build their assets.

(2) Focus on poorest areas

NAPC will focus on the poorest regions and provinces so that those who are especially in need of public support can be provided with the mechanisms to improve their lives. NAPC will incorporate projects that address the vulnerabilities of the poor and marginalized, especially those affected by social conflict and environmental disasters, into the anti-poverty programs.

(3) Environmental aspects of the anti-poverty strategy

Specific programs should be designed to reduce the impacts of environmental changes on the poor, who suffer disproportionately from climate change.

JICA Study Team visited NAPC and interviewed Mr. Joseph M. Aquino, Senior Technical Officer about the framework and policy of the anti-poverty issue. According to him, NAPC organizes the technical working group (TWG) which is the intergovernmental committee with several sub-working groups. NAPC also coordinates stakeholders such as LGUs, representatives of basic sectors, NGO, and/or project affected people. TWG summarized the activities into the report, which are planned to be established as an Executive Order. One of the focused issues of TWG is to resettle the people living near the riverside to safer location and to provide them with their houses, because NAPC specifies riverside as high risk area of flooding for the poor.

5.4.3 Creating Job Opportunity and Offering Job Training during the Phase III Construction Work

DPWH, the proponent of this project, has the policy (RA 6685) to preferentially employ the project-affected people and/or the residents living near the planned project site, if they have necessary skills for the position.

On the other hand, in order to understand the policy and the support of LGUs, the Study Team visited Department of Social Welfare and Development of Taguig City where the backfilling site is located. The Administrative officer has informed the study team that the City offers a free training program for women in terms of livelihood and in partnership with the Technical Education and Skills Development Authority (TESDA). The program aims to train qualified women to run and manage simple micro-business with great income. A free Starter Kit is provided (no CASH) to the participants to enable them to start the business and augment their livelihood. Monitoring by DSWD is conducted to check if the participants are succeeding or failing. Aside from that, the City also offers free livelihood trainings to all interested and qualified residents of Taguig City also in partnership with the Technical Education and Skills Development Authority (TESDA). In terms of health services, the City has provided free medical and dental services, free consultation with Medical Doctors, free medicines, and free wheelchairs and walking sticks to disabled poor patients. In case that a patient cannot go to hospital, doctor's home visit service is provided by free. Furthermore, the variety types of scholarship programs are also available to qualified students and residents of Taguig City. The Pantawid Pamilyang Pilipino Program (4Ps) which is mandated by the National Government through the DSWD is also implemented in the City.

5.4.4 Consideration of Gender Aspects in the Affected Area

Poor households headed by female, elderlies, and persons with physical disabilities are likely to be affected the most by the implementation of projects. In particular, the loss of present livelihood and income sources may cause severe economic displacement leading to impoverishment of these particularly vulnerable groups.

The results of the socio-economic survey among potentially affected families of this project showed that 12.6% of all the households are headed by women. Moreover, among the female working population of the resettling PAPs, more than 65% have incomes below the poverty threshold. The National Statistical Coordination Board (NSCB) defines the "poor" as having a monthly income below Php7,017 for a family of five (2009). This is the minimum amount necessary to meet basic needs including those for food, housing, education and health. Special attention shall be given to restore the income base and/or provide new livelihoods to these women after resettlement, in order to prevent them from becoming more impoverished in the new place of residence.

It needs mentioning that the PMRCIP Phase III includes non-structural measures such as the organization of the inter-agency Flood Mitigation Committee. The FMC will plan and implement community-based Flood Warning System, Information Campaign and Publicity (ICP), and other related flood hazard mitigation measures. Specific target groups of such activities would include women and children.

5.5 Land Acquisition and Resettlement Action Plan

5.5.1 Agency Responsibility for Compensation and Resettlement

Makati City and Pasig City have on-going relocation activities for the informal settlers living on the danger areas (10 m river easement) based on RA 7279 and in compliance with the Supreme Court's continuing mandamus to clean up Manila Bay. These resettlement programs include the informal settlers living within the project's work area along the Pasig and Lower Marikina Rivers.

Pasig City, on July 5, 2011, and Makati City, on October 30, 2012, confirmed that these LGUs shall undertake the resettlement and clearance of the work areas within their jurisdiction before the commencement of the construction work, which is expected in September 2013. Therefore, at the Inter Agency Meeting between DPWH, concerned agencies and LGU as shown in Table R 5.5.1, it was decided that informal settlers in these cities are not covered by the resettlement plan under this project. However, DPWH shall compensate all affected formal settlers from the four (4) concerned LGU for their lost assets. It shall also coordinate with the Manila LIAC, PRRC and NHA to resettle the informal settlers from Manila.

There were no informal settlers residing on public land within the work areas in Mandaluyong City.

Table R 5.5.1 Agency Responsibility for Compensation and Resettlement

LGUs	Formal Settler	Informal Settler
Manila	DPWH	Manila LIAC/PRRC/NHA/DPWH
Mandaluyong	DPWH	Not Applicable
Makati	DPWH	Makati
Pasig	DPWH	Pasig

5.5.2 Public Participation and Consultation, Stakeholder Participation

Prior to the commencement of the Census Tagging Survey, the Information Campaign meetings regarding the benefit and process of the Phase III Project were held in the 6 barangays, and were attended by the barangay officials and all interested residents and concerned parties.

Comments raised by the participants were mainly about the area to be affected by the project, the timing of the commencement of the construction works and livelihood assistance programs for the residents along the river, the request for the control of dumping of wastes in the river, and the necessity of water level monitoring in the area including the backfill area

DPWH answered that the construction works and the livelihood assistance program would be started in 2013, and that DPWH, MMDA and concerned LGU will be made member to solve any issues arise from the Project, including the water monitoring at the outlet of the backfill site toward the Napindan river .

Table R 5.5.2 Public Consultations in 2012 for Project Introduction and Resettlement

No.	Date	Barangay / No. of Participants	Contents of the consultation	Comments from Participants	Correspondences
1	Fri. Sep. 28	Brgy 900, 894, Manila / 41 participants	Information campaign and publicity (ICP) about the Project, including the flood control objectives and the possible activities during the operation and maintenance phase.	What will be the sanction to those residents clearing/throwing garbage in the river.	In the sustainability activity of PMRCIP II Project, we are coordinating with LGU and Barangay to organize a group "The Pasigandahan River Patrol" volunteer to assist the LGU/Brgy. to stop the influx of Informal Settlers Families (ISF) and prevent the throwing of garbage to the river.
2	Wed. Oct. 10	Brgy 896, 897, Manila / 46 participants		Is San Juan River that also causes flooding in our area, included in the Project?	This Project is for Pasig-Marikina River only. We understand that there is separate project for San Juan River.
				How far from the dike, are the areas to be affected by the project?	Will be confirmed when the Detailed Design is completed in December 2012.
3	Thu. Oct. 11	Brgy West Rembo, Makati / 40 participants		When will the Project be started?	Next year.
				Somebody continue dumping waste near the Pasig River. Where can we bring up the matter?	To the Barangay Office concerned with waste management.
				Will there be training in bag making (during the operation phase)?	Details will be explained during the launching of the Program.
1	Fri. Nov. 23	Brgy. Napindan, Taguig City / 50 participants	1) Introduction of the Project 2) Design/Plan of backfill works	1) I welcome the project because the value of land will increase in the area and many investors will come in.	Noted with appreciation.
				2) The backfilling area serves as catch basin for the Pumping Station. If filled-up by 2 m, it will cause flooding in the surrounding residential area. 3) Proper management of the Pumping Station is crucial to avoid the flooding in the area after the backfill.	Ms. Santiago, DPWH-PMO, answered that where will be a Multi-Party Monitoring Team headed by the DENR, and all affected Barangays will be made member to solve any issues arise from the Project. Ms. Santiago also mentioned the possibility that part of the dredged material may be used in other low area.

Besides the meetings with the barangays and residents, following meetings with officials from Project-related institutions were held to formulate the policy framework for the resettlement.

Prior to the each above meetings, the Study Team met and consulted nine times with DPWH-PMO and ESSO to monitor the progress of DPWH, and to share and discuss the information and concerns related to the D/D phase of the Phase III Project.

Table R 5.5.3 Inter-Agency Meetings and Workshop in 2012

No.	**Date**	**Inter-Agency Meetings**
1st	May 29	DPWH-ESSO, IROW, PMO-MFCP I, PRRC, MAKATI-SWD, JICA Study Team
2nd	June 28	DPWH-ESSO, IROW, PMO-MFCP I, PRRC, JICA Study Team, PMRCIP II
3rd	July 30	DPWH-ESSO, IROW, PMO-MFCP I, PRRC, MAKATI-SWD, JICA Study Team, PMRCIP II
4th	August 30	DPWH-ESSO, IROW, PMO-MFCP I, PRRC, MAKATI-SWD, JICA Study Team, PMRCIP II
5th	September 26	DPWH-ESSO, IROW, PMO-MFCP I, PRRC, MAKATI-SWD, JICA Study Team, NHA
6th	November 6	DPWH-ESSO, IROW, PMO-MFCP I, PRRC, MAKATI-SWD, MAKATI-CEO, JICA Study Team, PMRCIP II, NHA
7th	November 27	DPWH-ESSO, IROW, PMO-MFCP I, PRRC, MAKATI-CEO, JICA Study Team, PMRCIP II, NHA
No.	**Date**	**Resettlement Policy Framing Workshop**
1	October 9	DPWH-PMO-MFCP I, DPWH-IROW, DPWH-ESSO, Legal Officer DPWH, PCUP, OIC, West Sector-NHA, Community Relation Chief-NHA SWD -Makati City, OIC-Survey & Land-Makati City Urban Settlement Office-Manila City Social Welfare Officer -Manila City JICA Study Team
No.	**Date**	**Consultation with Manila LIAC**
1	October 5	DPWH-PMO-PMRCIP, PMRCIP II-DPWH DSI, DPS, Manila City, USO, Manila City SCDS City Engineer Office, Manila City NHA-NCR-West PCUP DOE, MMDA JICA Study Team

Table R 5.5.4 Meetings with DPWH-PMO/ESSO for Monitoring and Discussion

Date	Office	Purpose of the Meeting
April 26	DPWH-ESSO, PMO-MFCP I, JICA Study Team	Coordination regarding Resettlement Activities to be conducted by December
April 30	DPWH-ESSO, IROW, PMO-MFCP I, JICA Study Team	Coordination regarding Resettlement Activities to be conducted by December
May 23	DPWH-ESSO, PMO-MFCP I, JICA Study Team	Monthly Progress Monitoring and Discussion
June 21	DPWH-ESSO, PMO-MFCP I, JICA Study Team	Monthly Progress Monitoring and Discussion with the PMO for the month of June
July 23	DPWH-ESSO, IROW, PMO-MFCP I, JICA Study Team, PMRCIP II	Monitoring of July Activities
August 22	DPWH-ESSO, IROW, PMO-MFCP I, JICA Study Team	Work Schedule for RAP update
September 19	DPWH-ESSO, JICA Study Team	Preparation of the Census Tagging and Socio-Economic Survey
September 25	DPWH-ESSO, JICA Study Team	Preparation of the Census Tagging and Socio-Economic Survey
November 9	DPWH-ESSO, JICA Study Team	Reports on the outcome of the 6th Inter-Agency Meeting and other matters

Starting from July 2013, community preparation meetings will be organized in each barangays where relocation of PAFs is planned. In addition, the preparation and negotiation with the landowners regarding land acquisition will be started in July 2013.

This Land Acquisition and Resettlement Action Plan will be finalized with information obtained from below meetings

Information such as following shall be the additional information.

1. Proceedings of Public Consultation Meetings for Resettlement
    - 1-1. List of Venues and Dates of Orientation Meetings and Public Consultations
    - 1-2. Questions, Issues, and Concerns rose during the Meetings and Consultations, and Responses to Them
2. Proceedings of Information Campaign on Land Acquisition

5.5.3 Definition of Informal Settlers and Resettlement Eligibility

During the 7th Inter Agency Meeting on Resettlement, held on November 27, 2012, it was confirmed that only the informal settlers living on the public land shall be eligible for resettlement and/or resettlement assistance.

Informal settlers living on privately owned lot shall be under the care of the lot owner in case the settlers are to be affected by the project.

Formal settlers whose land parcels are to be affected by the project shall be justly compensated in accordance with the standard procedures adopted by the DPWH-IROW, with which, the DPWH firstly offers the price based on the zonal value, secondly the price assessed by an independent assessor as market value, thirdly the negotiation of request price presented by the owner, and finally the DPWH shall ask the judgment of the court, if the two parties could not reach an agreement.

Table R 5.5.5 Category of PAPs and Resettlement Eligibility

Land	Tenurial Status	Land title	Structure ownership	Payment of rent	PAP Category	Resettlement eligibility
Private lot	Land title holder	○	○	−	FS	×
	Structure owner on private lot w/ consent of land owner(Residing / Not residing)	×	○	−	IS	×
	Renter (Land, Structure, Room) on private lot	×	×	○	Renter	×
	Sharer/care-taker (Land, Structure) on private lot	×	×	×	Sharer/ care-taker	×
	Structure owner on private lot w/out consent of land owner	×	○	×	IS	×
Public land	Structure owner on public land (Residing)	×	○	−	IS	○
	Structure co-owner on public land (Residing)	×	○	−	IS	○
	Structure owner on public land (Not residing)	×	○	−	Absentee house owner	×
	Renter/sharer/care-taker on structure on public land	×	×	○/×	IS	○

○:YES, ×: NO FS: Formal Settler, IS: Informal Settler

5.5.4 Entitlement Matrix

During the 7th Inter Agency Meeting on Resettlement, and follow-up discussions with the attending institutions, the policies on compensations and other forms of resettlement assistances were decided as follows.

There are two (2) decisions which are unique compared to the regular operation of resettlement activities in Metro Manila.

The first is that renters and rent-free occupants (sharers) on public land shall be included in the list for pre-qualification for NHA resettlement housing program, with the same priority as the structure owners. In usual operation, the priority for resettlement is given to the structure owner first; renters and sharers will be next in priority and can be resettled only when vacant slots are available.

The second is that those whose structures are to be marginally affected may chose either to apply for resettlement or to remain in the same structure. DPWH usually compensate for the lost portion of the structure, and does not assist resettlement of the owner. This time, the marginally affected PAPs have the option to resettle under the PRRC, which is determined to clear the 10-m river-easement of informal settlers, in compliance with the Supreme Court mandamus concerning Manila Bay.

Those two (2) conclusions were reached among NHA, PRRC, and DPWH, by compromise, so that the project would facilitate the clearance of danger areas at the same time contribute optimum benefit to the project affected population.

5.5.5 Cut-Off Dates

The structure tagging for the structures to be located within the work area of the project, and the census of the residents and owners of those structures were conducted in October and November 2012.

The cut-off dates for the eligibility of the compensation and other assistances described in the Entitlement Matrix are defined as the starting date of the tagging and census work.

The following table is the list of the cut-off dates to be used for the compensation and resettlement activities in 2013.

Table R 5.5.6 Cut-Off Dates by Barangay

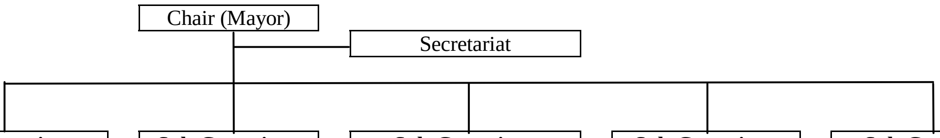
Cut-Off Date	Barangay	City
2012-10-05	900	Manila
2012-10-08	894	Manila
2012-10-12	896	Manila
2012-10-12	897	Manila

5.5.6 Institutional Organization for Implementation of Land Acquisition and Resettlement Action Plan

The Land Acquisition and Resettlement Action Plan will be implemented by DPWH (vis-à-vis land acquisition) and Manila LIAC/PRRC (vis-à-vis resettlement of ISFs from Manila), in coordination with concerned agencies and institutions shown in **Figure R 5.5.1 .**

Representatives of the PAPs shall be invited as one of the POs (Peoples' Organization) during LIAC meetings that concern resettlement involving the PAPs.

LIAC is the central decision-making, coordinating and consultative body, a pool of manpower, resources and expertise of concerned local government units and national government agencies, as well as the working group that implements and/or causes the carrying out of the various activities, plans, programs and projects regarding resettlement. LIAC members gather periodically, attend all open dialogues, and observe all demolition works to secure the right of the affected families/persons as well as to prevent rough conflicts.



	Sub-Committee 1	Sub-Committee 2	Sub-Committee 3	Sub-Committee 4	Sub-Committee 5
Name	**Relocation and Dismantling**	**Social Preparation**	**Beneficiary Selection, Awards and Arbitration**	**Legal and Security**	**Resettlement**
Roles	* Resettlement options * Relocation package * Alternative programs * Work plan and budget for movement of families * Actual dismantling and transfer * Issuance of 30-day Dismantling Notice	* Information dissemination * Adequate consultation * Community assemblies * Orientation of leaders	* Census and Tagging operation * Validation of census list of affected households * Formulation of Code of Policies * Census claims resolution * Pre-Qualification of Households against NHA Alpha listing * Final list of qualified households	* Legal support * Security during actual movement * Pease and order	* Identification of resettlement site * Acquisition and development of site * Coordination with receiving LGU, if Off-city * Provision of basic utilities and community facilities
Members	* **IROW-PMO DPWH-Chair** * LGU Engineering * LGU Social Welfare and Development * LGU Public Service * CHR * PRRC * PCUP * POs/NGOs, Representatives of PAFs * Dep. of Health (DoH) * National Police * Private sector	* LGU-Chair * Brgy. chairpersons * PCUP * POs/NGOs, Representatives of PAFs * DepEd * **PMO-MFCP I**	* LGU-Chair * Brgy. chairpersons * DSWD * PCUP * POs/NGOs, Representatives of PAFs * **IROW-PMO DPWH**	* PNP-Chair * City legal officer * Brgy. chairpersons	* DPWH/ PRRC -Chair * POs/NGOs, Representatives of PAFs * DoH * DepEd * Power / water providers

Note: CHR : Commission on Human Rights, PCUP : Presidential Commission for the Urban Poor

Figure R 5.5.1 Organization Chart of Manila LIAC

Specifically, the LIAC shall:

a. Serve as the local clearing house of all relocation and resettlement activities, and resolve issues and concerns that may arise in the actual conduct of census and tagging operations and dismantling operations, as well as in the planning and development of resettlement sites;

b. Facilitate the orderly, peaceful and humane relocation of the ISFs occupying the affected areas;

c. Ensure that all qualified families are relocated to acceptable, secure, and affordable resettlement sites that are provided with basic utilities, facilities and services;

d. Enable all project stakeholders to participate in planning and implementing the program through a coordinative and integrated multi-sectoral approach; and

e. Monitor the implementation of plans, programs and projects as well as the operations of the subcommittees under it.

5.5.7 Schedule for Implementation of Resettlement Action Plan

During the 7th Inter Agency Meeting on Resettlement, held on November 27, 2012, the draft schedule for implementation of resettlement action plan was discussed. The results are shown in **Table 5.5.1**.

Community preparation for resettlement shall be started in July 2013, physical resettlement to start in August, and the clearance of the work area shall be finished in September 2013. An implementation procedure is shown in **Table 5.5.2** and **Figure R 5.5.2**.

Monitoring of the resettlement procedure and the livelihood condition after the relocation is the responsibility of DPWH, and the monitoring of the living condition shall continue until one year after the completion of the project, which is currently expected in 2016.

		Responsible Organization	2013											2014	2015	2016	2017
			2	3	4	5	6	7	8	9	10	11	12				
1	Construction supervision consultant to be assigned	DPWH	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
2	Construction work for PMRCIP Phase III	DPWH								▨	▨	▨	▨	▨	▨	▨	
3	Verification of eligibility of PAFs for NHA resettlement Master list submission from DPWH to LIAC and NHA	DPWH/LIAC/NHA **(LIAC includes**	▨														
	Pre-qualification results out from NHA.	**PRRC)**					▨										
	Mid-Term Election(2013.5.13) **45-days moratorium of major public activities before and after the election, as well as 45-days transition period of governance after the election will be observed.**					▨											
	PRE-RESETTLEMENT PHASE																
4	Coordination and implementation of the 3 consecutive Open Start preparation	DPWH/LIAC					▨										
	Dialogue with attendance of LIAC= Finalization of Resettlement Action Plan ESSO monitoring starts						▨										
	1st meeting							▨									
	2nd meeting							▨									
	3rd meeting							▨									
	Issuance of 30-days notice for demolition and clearance	LIAC						▨									
5	RAP authorization by DPWH Submission to JICA	DPWH						▨	▨								
6	Grievance redress regarding the eligibility decision	DPWH/LIAC						▨	▨								
7	Decision of PAFs regarding the choice or acceptance of compensation, resettlement and/or assistances DPWH-PMO will record the addresses of relocatees for monitoring.	PAF/ DPWH/LIAC						▨	▨								
8	Preparation of necessary documents and funding by PAFs and LGUs for demolition, relocation, and financial assistance							▨	▨								
	PHYSICAL RESETTLEMENT PHASE																
9	Resettlement Activities Monitoring at Project Site	DPWH/LIAC							▨								
10	Voluntary demolition by PAFs Payment of compensation before physical relocation, resettlement	PAF DPWH/LIAC							▨	▨							
11	Demolition of structures by DPWH/City Engineering Dept. with the attendance of the affected settler(s) and LIAC members DPWH, in coordination with other related institution, provide man power and equipment to clear and level the site of demolition	PAF DPWH/LIAC								▨							
12	Demolition of structures Payment of compensation, resettlement	PAF DPWH/LIAC								▨							
13	Grievance redress regarding the physical resettlement activities	DPWH/LIAC							▨	▨							
14	After demolition and clearing the affected area, the Barangay Police patrols/monitor the cleared area to prevent the returnees(turn-over of responsibility will be done lot by lot)	DPWH/LGU/ Barangay							▨	▨							
	POST-RESETTLEMENT PHASE																
15	Monitoring at resettled locations End (1 yr after the project completion)	DPWH/PRRC/ NHA							▨	▨	▨	▨	▨	▨	▨	▨	▨
16	Livelihood rehabilitation program to be provided or introduced based on the monitoring results (Customary continues for 2 yrs after resettlement. Later the period, receiving LGU shall be the responsible institution for assistance)	Funded by : DPWH Coordinated by : NHA Operated by : Various							▨	▨	▨	▨	▨	▨	▨		
17	Grievance redress regarding the post resettlement activities	DPWH/LIAC							▨	▨	▨	▨	▨	▨	▨	▨	▨

Figure R 5.5.2 Resettlement Schedule

CHAPTER 6 CONSTRUCTION PLAN

6.1 General

6.1.1 Basic Planning Condition

The following are the basic planning conditions for the construction work:

(1) The project is to be financed by Japanese Official Development Assistance (ODA) Yen Loan under the Special Terms for Economic Partnership (STEP).

(2) In accordance with the Sample Bidding Documents, which is the basis for ODA Loan, the Employer's obligations include but not limited to securing right of access to and possession of all parts of the site and all the required permits, licenses or approvals necessary, before the Commencement Date.

(3) Selection of civil works contractor shall be through International Competitive Bidding (ICB).

(4) Construction period is three-years for each package.

(5) There will be two (2) contract packages, one for Pasig River and one for Lower Marikina River.

6.1.2 Contract Packages of Phase III

The construction area for Phase III consists of priority sections selected from remaining potential areas in the Phase II project along the stretch of Pasig River in addition to the Lower Marikina River, as shown in **Table R 6.1.1**.

Table R 6.1.1 Phase III Construction Area

Name of Package	From	To	Distance (km)
Improvement of Pasig River (Selected Sections of Potential Areas)	Delpan Bridge	Immediate Vicinity of NHCS	9.9*
Improvement of Lower Marikina River	Immediate Vicinity of Napindan Hydraulic Control Structure (NHCS)	Downstream of Rosario Weir	5.4

*Selected sections of Pasig River included.

6.1.3 Scope of Work

(1) Main Structures for Construction

The improvement works aim to mitigate flood damage caused by channel overflow. Main civil works include the construction of new revetments and parapet walls, improvement and heightening of existing revetments, and drainage works along the Pasig River. Aside from the above works, dredging works for the Lower Marikina River, dike and sluiceway will be carried out. Basically, the construction material for the dike shall be purchase from the nearest source, but if it is possible, the suitable dredged material will be used.

(2) Construction Length of Major Works

The construction works for Phase III covers the some of stretches of Pasig River and Lower Marikina River as shown in **Table R 6.1.2** below.

Table R 6.1.2 Main Civil Works of Phase III Project

River	Main Civil Works	Length (m)
Pasig	Revetment Works with Steel Sheet Pile	6,735
	Parapet Wall (including repair works)	3,212
Lower Marikina	Dredging of Riverbed	5,400
	Dike with Revetment (Steel Sheet Pile Foundation)	1,821
	Bridge Pier Protection Works	4 bridges

The new dike with revetment and the repair of the existing damaged revetment works also include concrete works, strengthening works, earthworks and other appurtenant works. In addition, drainage works require reinforced concreting works, earthworks and other appurtenant works. Bridge pier protection involves net packed riprap works following the same procedure as the other repair works.

The volume of these main construction works for Pasig River and Lower Marikina River are as estimated in **Table R 6.1.3**.

Table R 6.1.3 Volume of Main Construction Works of Phase III

Item	Unit	Pasig River	Lower Marikina River
Steel Sheet Pile/ H-Beam	t	17,896	2,432
Concrete	m^3	11,922	5,375
Rebar	t	757	217
Excavation (incl. Riverbed Excavation)	m^3	52,909	20,438
Dredging (design)	m^3	0	871,552
Backfill (Common/Sand)	m^3	40,518	24,268
Improved Dredging Soil	m^3	0	565,438
Riprap / Rock fill	m^3	64,571	0
Drainage Outlet	Location	180	9

6.2 Construction Planning Method

6.2.1 Construction Conditions

The climate at the project area is dominated by rainy season from May to October and dry season for the rest of the months. The total rainfall from May to October accounts for about 80% of the annual rainfall.

6.2.2 Available Working Days

In determining the number of working days available for construction activities, the following factors are considered:

- Normal Workweek
- Public Holiday
- Rainfall
- Type of Activity

The normal workweek consisting of six (6) working days is adopted for developing the program of work. The following public holidays are excluded from the working calendar:

National Public Holidays	Date
New Year's Day	January 1
Maundy Thursday	One day in March or April
Good Friday	One day in March or April
Labor Day	May 1
Independence Day	June 12
National Heroes Day	August 30
All Saints Day	November 1
Bonifacio Day	November 30
Christmas Day	December 25
Rizal Day	December 30
Total Number of Public Holidays	10 days

In addition, seven (7) special holidays may be declared as non-working holidays by the President on account of special events; thus, the total number of non-working days may add up to 17 days.

The time lost due to rainfall is based on the rainfall data and the number of rainy days on record at the Science Garden Station of PAGASA in Quezon City, for the period 1987-1998. It is, therefore, anticipated that the effect of rain on different types of construction activity will vary.

The schedule of time losses for the key activities due to weather condition is as summarized in **Table R 6.2.1**.

Table R 6.2.1 Average Number of Rainy Days at the Project Site

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rainfall over 10mm	0.42	0.25	0.42	0.92	4.33	8.00	11.92	11.92	11.33	6.25	3.50	2.75	62.00
Rainfall over 50mm	0.08	0.00	0.00	0.00	0.67	1.50	2.50	2.58	2.17	1.42	0.42	0.33	11.67
Source : Science Garden Station of PAGASA (1987-1998)													

$\textit{The ratio of rainy days per year is}:$

$^{62}\!/_{365} = 0.17$

$\textit{The number of rainy days on Sundays and Public Holidays are}:$

$(52 + 17) \times 0.17 = 11.73\,\textit{days}$

$\textit{Therefore,}$

$\textit{Rainy days on weekdays are}:$

$62 - 11.73 = 50.27\ \textit{days} \approx 51\,\textit{days}$

$\textit{Rainfall of more than}\ 50\ \textit{mm will cause a}\ 1-\textit{day suspension for}$

$\textit{structure excavation, backfilling, slope protection, drainage work and pavement work}.$

$\textit{The suspension days for such works above are}:$

$11.67 \approx 12\ \textit{days}$

The total number of working days available annually for different activities is established by incorporating all assessed time losses into the eight (8) items shown in the following **Table R 6.2.2:**

Table R 6.2.2 Workable Days

Work Items	Sundays	Public Holidays	Rainy Day on Weekdays	Suspension Days	Available Working days
Structural Excavation	52	17	51	12	233
Dredging	52	17	51		245
Embankment/Backfill	52	17	51	12	233
Concrete Works	52	17	51		245
Revetment Works	52	17	51		245
Repair Works	52	17	51		245
Drainage Works	52	17	51	12	233
Road Works	52	17	51	12	233

6.2.3 Available Work Hours

All construction schedules are based on an 8-hour work-day for usual works, and a 10-hour work-day for dredging and its consequent works such as pre-mixing, intermediate dredged soil transfer and backfilling works.

6.2.4 Tidal Levels

Since some works are controlled by tidal conditions in Manila Bay, tidal levels at Manila Bay are considered in the construction plan.

Table R 6.2.3 Tidal Levels of Manila Bay

Items	Tide Level
Mean Spring Higher High Water Level (MSHHW)	EL. +11.40 m
Mean Higher High Water Level (MHHW)	EL. +11.10 m
Mean Water Level	EL. +10.60 m
Datum Line / Mean Lower Low Water Level	EL. +10.00 m

6.2.5 Site Condition

(1) Method of Approach for Each Construction Site

The major civil works along the Pasig River stretch are revetment including drainage work and river wall. Construction site can be approached from the riverside and landside depending on the actual site conditions. In these works, there would be some difficulties in approaching from landside due to inadequate width, lack of access and obstruction on approach roads. Based on the ongoing Phase II, most of the works are approached from the river side because of the above problems.

The major civil works along the Lower Marikina River stretch are dredging including bridge pier protection and dike with revetment and drainage facilities. Since the channel of Lower Marikina River is shallow, dredging works shall be started by the contractor for the deepening(shallow/widening) of the channel to make the river navigable and to increase the draft passage of the construction vessels. This preparatory work will ensure unhampered passage and access of the dredger including loading vessels to and from the construction site.

The three stretches of dikes along Lower Marikina are planned to be approached from the access road, since this is highly possible. Thus, the structural works need not wait for dredging operations nor depend on riverside access to be able to proceed according to the construction schedule.

(2) Obstructions at Construction Site

Pasig River is one of the major navigable rivers flowing through Metro Manila. It is used for various industrial, commercial, agricultural and other private purposes. For this reason, there are many existing river structures and facilities occupying both sides of the river, which might become obstructions during the construction work. Regarding the ongoing Phase II project, the PRRC conducted a sonar survey of Pasig River during the PRRC's dredging operations. However, the survey was confined only to the middle part of the river channel up to about 15 meters away from each river bank. Therefore, the area from each river bank to 15m within the riverbed channel was left to be undertaken during the implementation of the Phase II Project.

The typical obstructions observed were boat stations, abandoned barges and mooring facilities. There are also many types of mooring facilities noted along the riverside, such as jetty, oil and water pipelines, loading equipment and mooring posts, which are either private or government-owned. Abandoned barges and ships shall be towed by the contractor in coordination with the Philippine Ports Authority (PPA). Negotiations must be done by the implementing office (DPWH-PMO MFCP I) prior to the commencement of construction work. Moreover, garbage materials shall be hauled by MMDA. Except for garbage hauling, the cost of the above clearing activities is included in the project cost based on the ratio of civil works. Major obstructions against ship works are as listed in **Table 6.2.1** and **6.2.2** except for simple debris mounds. And **Table 6.2.3** shows Height of Bridges which working ships pass under.

Through this present Study, there are One(1) submerged water pipeline crossing Pasig river and three (3) submerged water pipelines crossing Marikina River. General information and treatment principles are as shown on **Table R 6.2.4** .

Table R 6.2.4 Submerged Water Pipelines across Marikina River

Sta	EL(m)	OD (mm)	Dredge Design	Embankment Design
Pasig River				
16+430	Unknown	1500	—	Nothing special is considered for SSP design but the investigation cost is considered.
Lower Marikina River				
1+550	Unknown	1800	Sounding work is required. The dredge may be revised based on the sounding result.	No special design is required, because the area is out of the embankment range.
3+067	EL+1.0	1050	No special design is required, because the depth looks deep enough; however, sounding confirmation is required before dredging.	SSP design is amended, because the pipeline is assumed to be shallow at the embankment point. Sounding confirmation is required before SSP driving work.
4+263	EL+12.0	750	Sounding work is required. The dredge may be revised based on the sounding result.	SSP design is amended, because the pipeline is assumed to be shallow at the embankment point. Sounding confirmation is required before SSP driving work.

(3) Backfill Site

During Phase I, the Detailed Design Stage (D/D), five (5) locations were evaluated as potential backfill site for excess excavated materials. Two (2) of them were finally selected and proposed as final backfill sites considering hauling distance; namely, the Rizal Laguna Lakeshore Road and Reclamation Project (RLLRRP) Area and the Calzada Area. At present, through an additional study, one more site is being considered to be more realistic. The site is located near the west corner of Napindan Laguna junction, north of Laguna Ring Road, and belongs to the barangays of Napindan, Ibayo-Tipas, and Ligid-Tapas in Taguig City.

There is also an option for dumping the dredged materials offshore in Manila Bay. However, this option is not feasible for the PMRCIP Phase III Project due to high cost, the unpredictable coastal and offshore current weather patterns in Manila Bay area, and the difficulty of documentation to prepare the construction plan.

(4) Pre-Mixing Site

Pre-mixing will improve the strength as well as the suitability of dredged materials during transportation and reclamation. For this purpose, a site between Lower Marikina River and Napindan Channel is being considered as the pre-mixing site in this Phase III basic design study stage, although negotiation among parties concerned reveal that there seems to have little possibility that the site is available. Therefore, in this present study a comparative study between the two (2) identified sites is done, pre-mixing sites are compared with each other in relation to the backfill area, i.e., at a middle point along the navigation way and just at the back side of dredging vessel.

(5) Compensation for Lots and Structures Affected by the Project

Since the construction work will be at the river side, there will be no land acquisition involved in the PMRCIP Phase III Project. Compensation for structures, if any, will be based on the number of houses affected as determined in the RAP.

(6) Implementing Agencies

The overall responsibility for overseeing the construction work is with the DPWH-PMO Flood Control Project and the Flood Mitigation Committee (FMC), which is proposed to be created. Close coordination between these parties, will ensure the smooth implementation of the Phase III Project.

6.3 Resources

6.3.1 General

Most of the construction materials, including aggregates, cement, formwork materials, and construction machinery and equipment will be procured generally in Metro Manila or the nearby provinces. On the other hand, steel materials for revetment, geo-textile bags for pier protection and special driving equipment to penetrate hard core strata (Guadalupe Formation) shall be imported from Japan.

6.3.2 Labor

All classes of labor identified above are available in Metro Manila and the surrounding areas.

6.3.3 Materials

(1) Shaped Steel Materials and Sheet Piles

Main steel materials for the construction of revetment shall be imported from Japan. However, some shaped steel materials for temporary use are available in the Philippines. Based on the ongoing Phase II Project, Hat Type SSP and H-beam are imported from Japan, directly.

(2) Reinforcing Bar

Reinforcing bars are available in the local market.

(3) Ready-Mixed Concrete

Ready-mixed concrete is available in Metro Manila. However, it might not be possible to supply some sites with ready-mixed concrete due to lack of access from the main roads. In such situations, middle sized concrete batching plant barge(s), together with concrete pump with a capacity of 30m^3/hour, shall be provided. Other barges will be needed, to supply concrete aggregates, cement and water to these batching plant barges.

(4) Dike Embankment Materials

Dike Embankment materials can be purchased from suppliers in Metro Manila. As far as possible, dredged materials of good quality shall be utilized.

(5) Filling Materials

Filling and backfilling materials are to be selected from excavated materials; otherwise, these are to be purchased. Most filling materials can be purchased from suppliers in Metro Manila.

(6) Rock Materials

Rock materials are to be used for riprap, wet stone masonry and repair of existing flood dike. Suppliers for small volume of works can be found easily in Metro Manila. On the other hand, big volume of rocks can be sourced from the Bataan area, which is about 50 km from the construction site.

(7) Soil Improvement Admixture

Cement or quick lime is proposed as soil improvement material. These can be purchased from suppliers in Metro Manila. It should be noted that procurement of quick lime may require a few months lead time.

(8) Other Construction Materials

Gabion cages, welded wire fabrics, etc., to be used for the permanent works are available in Metro Manila and nearby provinces.

(9) Imported Materials

Materials for the steel sheet piles for revetment such as corrugated steel sheet piles and H-beam, are to be imported from other countries, specifically, Japan. In addition, flap gates to be installed at designated drainage outlets are to be imported from Japan to ensure the quality and durability. The costs of these materials are estimated as imported materials. The list of materials to be imported is given in **Table R 6.3.1** .

Table R 6.3.1 List of Materials Imported for PMRCIP Phase III

Materials	Purpose
Steel Sheet Pile and H-beam	For revetment foundation
Flap Gate	For drainage outlet
Net Gabion	For foot protection of existing bridge foundation

6.3.4 Construction Equipment

The major categories of construction equipment required for the works are classified and explained as follows:

- Earthmoving equipment
- Pile driving/drilling/extracting equipment
- Equipment for on-water works
- Equipment for concrete works
- Lifting equipment

(1) Earthmoving Equipment

For excavation, dredging and hauling, backhoe, dredger, barges, wheel loader, bulldozer or dump trucks are to be utilized. Besides, tire compactor is a must for dike embankment.

(2) Pile Driving/Drilling/Extracting Equipment

Pile driving works shall utilize crawler crane, vibro-hammer, water-jet unit, generator, truck crane, backhoe with special low-head arm for piling and barge for on-water works.

(3) Consideration for On-Water Works

Appropriate number of barges, tugboats, anchor boats and watch boats are to be utilized for on-water works. Crawler crane are to be set on a barge when construction is approached from the river side.

(4) Equipment for Concrete Works

Concrete pump, transit mixer, movable mixing batch and internal vibrator are to be adopted for concrete works.

(5) Lifting Equipment

Crawler crane or truck mounted crane is to be used for the loading/unloading of materials.

Table 6.3.1 shows work monthly equipment list, and **Table 6.3.2** shows breakdown of work monthly equipment list.

6.3.5 Procurement Plan

Procurement procedures should be managed so as not to delay site works. The main materials and equipments to be procured are as listed in the following tables.

Table R 6.3.2 List of Materials for Procurement

Materials	Places of Procurement	Remarks
Shaped Steel Material & Steel Sheet Pile	Japan	Consider the duration of roll-order, transportation and assembly welding.
Flap Gate	Japan	Consider the duration of fabrication and transportation.
Re-bar	Philippines	
Concrete	Philippines	
Soil	Philippines	For dike, backfill and boundary bank, soil is to be procured only when good dredged soil is not available.
Bolder & Gravel	Philippines	
Soil Improvement Admixture	Philippines	Quick lime may need a few to several months of lead time to procure; with ordinary normal cement, this will be not be a problem.
Gabion Mattress, Normal Geo-textile Material and Welded Wire Mesh	Philippines	
Net Gabion	Japan	

Table R 6.3.3 Equipment for Procurement

Equipment	Procured from	Remarks
Vibro-hammer	Philippines	
Water-jet Injection Unit	Japan	Consider the duration of transportation.
Cranes of 50t to 80t Class	Philippines	
Barges of 300DWT to 1000DWT	Philippines	
Tugboat	Philippines	
Anchor Boat	Philippines	
Watch Boat	Philippines	
Backhoe	Philippines	
Wheel Loader	Philippines	
Bulldozer	Philippines	
Dump Truck	Philippines	
Sealed-Type Dump Truck	Japan or Philippines	Here, Philippines means conversion of usual dump trucks.
Pre-Mixing Unit	Japan	Consider the duration of transportation and in-site installation.
In-Site Batching Mixer	Japan/Other countries	Consider the duration of transportation and mounting on barge.

6.4 Construction Method

6.4.1 General

In this Section, the major works are identified for the PMRCIP Phase III Project and the construction procedures are explicitly explained. The major civil works along the Pasig River are SSP revetment works, drainage works and parapet walls. On the other hand, the Lower Marikina River works contain dredging, bridge pier protection, dike and sluice gate works.

6.4.2 Steel Sheet Pile Pilling and Reinforced Concrete Floodwall

Two (2) types of revetment have been considered for implementation along Pasig River; namely, corrugated steel sheet pile (SSP) and SSP combined with H-beam. The construction procedures of the SSP and the SSP combined with H-beam type are almost similar.

(1) Steel Sheet Pile Pilling

SSP piling works are basically executed from the riverside. Some methodology for pile driving are considered such as vibro-hammer, vibro-hammer with water-jet, earth-auger piling and clear-method for hard layer strata. The "vibro-hammer with water-jet" is recommended for this project in consideration of hard foundation (SPT value is around 150) and size of combined SSP hat type plus H-shaped beam type. **Table R 6.4.1** below shows the comparison between these drivers.

Table R 6.4.1 Comparison of SSP Drivers

Driver	**Vibro-Hammer**	**Vibro-Hammer with Water-jet,**	**Earth-Auger Piling**	**Clear-Method**
Driving Mechanism	Vibration	Vibration plus Water Jet	Pre-boring plus Vibration or Hydraulic Insert	Pre-boring plus Hydraulic Insert
Base Machine	Crane	Crane	Rig Type Crane	Special Machine
Available N (SPT) Value	N<50	N<180	Up to Rock	Up to Rock
Note		PMRCIP Phase II construction adopted it.	Bridge passage requires dismantling and re-erection of the rig; besides, it is dangerous work.	It is available only for SSP less than 600mm in width; nevertheless, it has merit for piling beneath bridges.
Evaluation	Not Applicable	Good	Not Applicable	Possible

According to the Japanese "Standard for Cost Estimate on Harbor Works, Ministry of Land, Infrastructure, Transport and Tourism, 2010" (Ref. 1), the Vibro-Hammer with Water-jet is able to pile 45 pile per day for 25Hat Type SSP and 37 pile per day for H400 beam. Thus, the suitability of 20piles per day is simply estimated for the combination of the two types. However, only 70% of this value, i.e., 14 piles or 12.6m per day, is adopted, in consideration of frequent SSP alignment variations on site and the observed progress of work using this method during the Phase II project construction work.

There are special sections in the SSP drive: one section is for underwater pipeline bridges and four sections are for under high voltage electricity. At the section under bridge, the same method as the Lower Marikina River mentioned later which uses the low-head attached backhoe and 15kW vibro-hammer may be adopted,. At the sections under high voltage electricity, all equipment are required to keep the clearance of 3m from the cable, the same as in Phase II, and the work is planned with 90kW vibro- hammer of 3.5m in length that is available to GF layer and 2.5m length lifting equipment. The lengths of SSP segment are shown on **Figure R 6.4.1.**

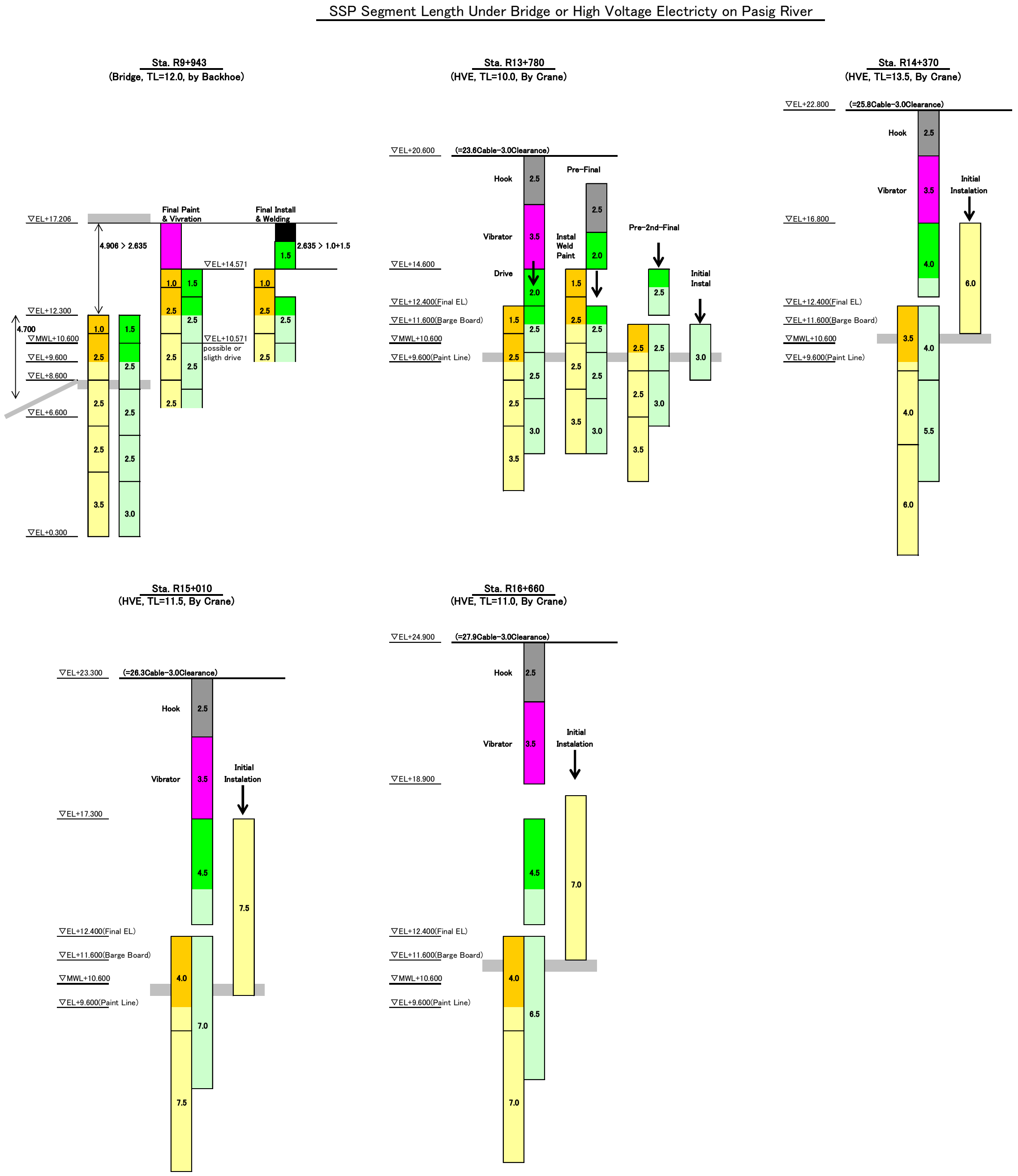


Figure R 6.4.1 SSP Segments for Peculiar Sections in Pasig River

(2) Reinforced Concrete Floodwall

Reinforced concrete wall on SSP is constructed from river side and/or land side, depending on each site’s field condition. This work is usually executed together with drainage works. The construction method is as shown in **Figure R 6.4.2** .

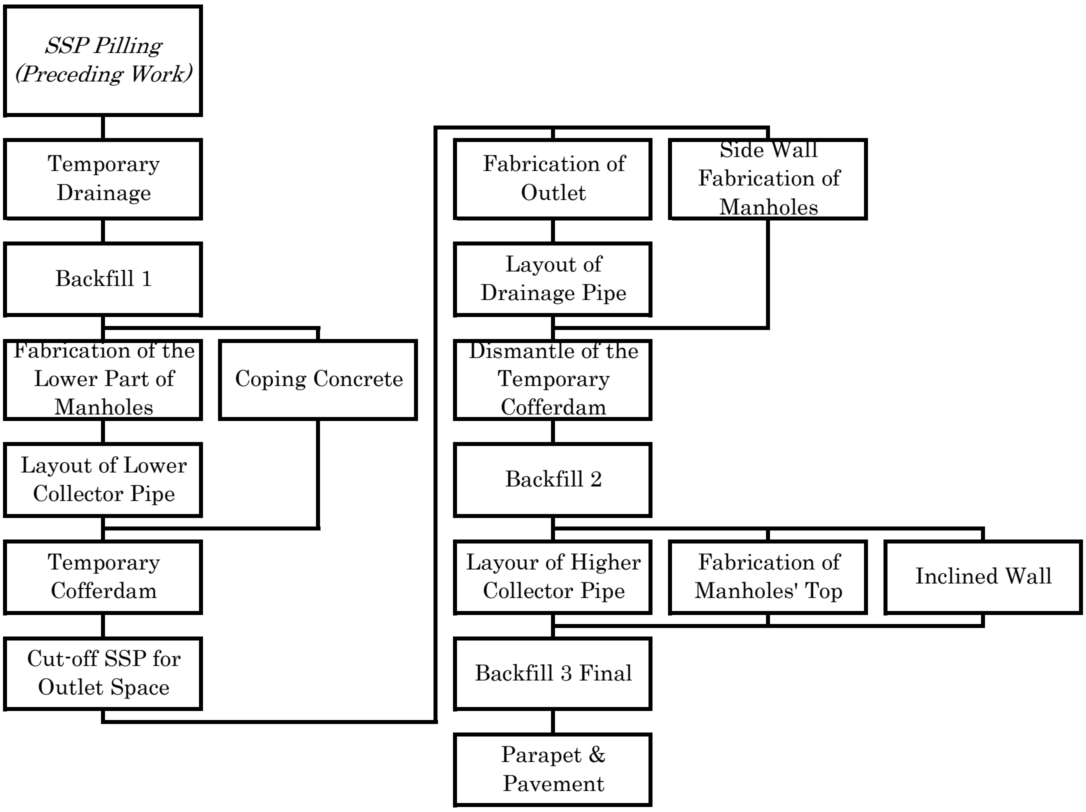


Figure R 6.4.2 Work Procedure for Reinforced Concrete Floodwall

The construction method consists of the following steps:

(1) Temporary Drainage: Water in the gap between SSP stretch and existing land is drained with pump.

(2) Backfill 1: The gap is backfilled up to the lowest manhole bottom with proper compaction.

(3) Fabrication of lowest part of manholes: The lowest part of manholes, bottom and sidewall, is fabricated based on the lower collector pipe layout.

(4) Layout of lower collector pipes: Lower collector pipes are laid through sleeper set, collector pipe set, collar ring concreting and concrete bed. After the curing period, on-going drain will be diverted into these new collector pipes and manholes.

(5) Coping Concrete: During steps (3) to (4) above, coping concrete of SSP top is fabricated.

(6) Temporary Cofferdam: For the outlet work, temporary cofferdam with steel structure (for shallow water) or SSP (for deep water) is set before outlet portion, and then inner water is drained.

(7) Cut-off SSP for Outlet Space: Top of the SSP revetment is cut and removed.

(8) Fabrication of Outlet: RC structure is fabricated.

(9) Layout of Drainage Pipe: Drainage pipe between outlet and final manhole is laid through sleeper set, collector pipe set, collar ring concreting and concrete bed. After the curing period, existing drain will be diverted into these new drainage pipe and outlet.

(10) Side Wall Fabrication of Manhole: During steps (8) and (9) above, side walls of manholes are fabricated for use in the higher collector pipes.

(11) Dismantling of Temporary Cofferdam

(12) Backfill 2: The gap is backfilled until the higher collector pipe level with proper compaction.

(13) Layout of Higher Collector Pipe: Higher collector pipes are laid in the same way as the lower ones. After the curing period, existing drain will be diverted into these new collector pipes and manholes.

(14) Fabrication of Manhole Top: During step (13), top portion of manholes is fabricated.

(15) Inclined Wall: During step (13), river side inclined wall is fabricated.

(16) Backfill 3 Final: It will be backfilled up to the final height.

(17) Parapet and Pavement: Parapet and Pavement are fabricated.

6.4.3 Drainage Works

Drainage works will consist of outlet, drainage pipe, manhole, collector pipe, and junction manhole(s). There are several structural types and dimensions of existing drainage outlets along the Pasig River. The design concept is the same as adopted in Phase II. Structural measures are provided in this study based on the necessity. In addition, flap gate will be provided to prevent inland area from inundation due to adverse effects of reverse flow especially if the ground elevation is lower than the design flood level.

The procedure of constructing the outlet structure, manhole and other appurtenant works as mentioned above is explained in detail in accordance with the flow chart shown in **Figure R 6.4.3** . A typical section of the drainage outlet works is shown in **Figure R 6.4.4** .

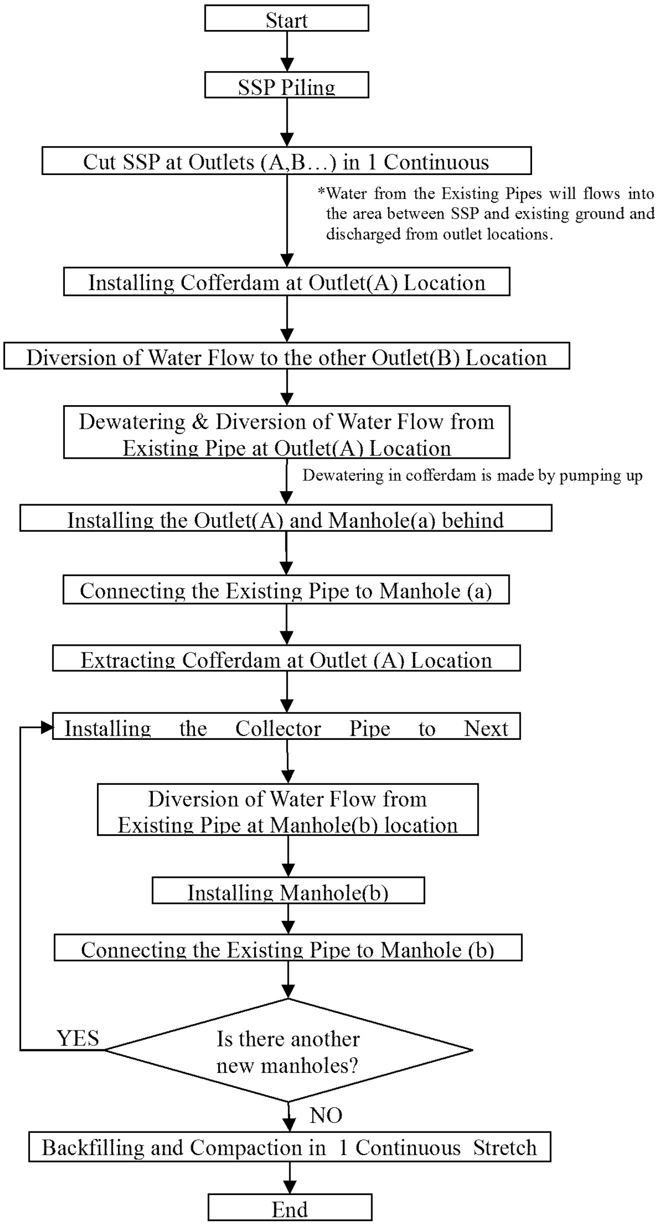


Figure R 6.4.3 Flowchart of Drainage Facilities Construction

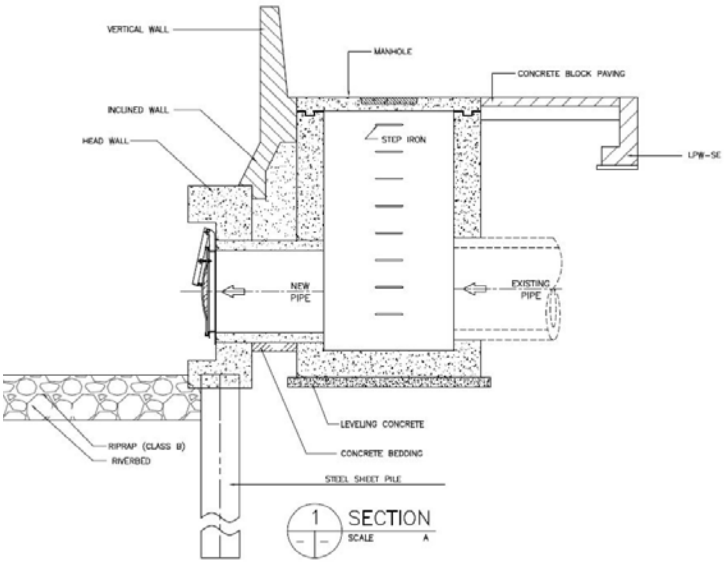


Figure R 6.4.4 Typical Section of Drainage Outlet Works

6.4.4 Parapet Wall and Step-Type Parapet Wall

Reinforced concrete flood walls without SSP support are also planned. There are two types: one is the parapet wall with subsurface foundation portion, and the other is the step-type parapet wall which is fabricated on existing concrete after surface treatment. Both structures are mostly constructed on land, but can be constructed on the waterway, if inevitable.

6.4.5 Dredging

(1) Main Characteristics of the Dredging Works in the Project

- Dredging work is expressed in mass volume. The planned dredge volume is approximately 872,000m^3 excluding the expected overcut volume of around 194,000m^3 in the case of backhoe dredge or around 408,000m^3 in the case of pump dredge. A simple calculation of daily average or a period of 3 years assuming 240 days of available work days each year yields approximate 1,200m^3, the practical maximum daily volume which is around 1.5 to 2.0 times of this is estimated volume. Thus, careful consideration should be given to measures that will mitigate potential profit congestion and other environmental impacts due to dredging, transport and backfill of riverbed materials.

- The area to be dredged in Lower Marikina River is 5.4km long and 40m wide at full depth. Also, both side slopes have steep gradients of about 1:3. The design depth is 3.50m at the most downstream end and 2.24m at the most upstream end. The average calculated dredge depth is around 4.5m, which means that the present channel is too shallow and needs to be dredged ahead to allow unimpeded access by the work barges.

- The flood during Typhoon Ondoy in 2009 brought most of the sediment, including garbage and debris. However, an in-depth study of the garbage and debris characteristics is rather difficult. This aspect should be taken into account in the selection of construction method.

- In the previous study, JICA investigated the possibility of heavy metal contamination of riverbed sediments. The results were published in the 'EIA Supplementary Report (JICA, September 2011)", which confirmed that heavy metal content was way below environmental threshold levels. In July 2012, the present Detailed Design Study conducted new sampling at 100-m interval along the 5.4km stretch of Lower Marikina River. Laboratory results again showed that the possibility of contamination with heavy metals is nil. Thus, both past and ongoing JICA studies showed that dredging works were least likely to cause environmental problems on site and at the final backfill area due to heavy metal contamination.

- At this stage, the final backfill site is identified to be the 450,000m^2 low-lying area located west of the outflow of Napindan Channel from Laguna Lake mouth. This implies that it is advisable to fully utilize both the Marikina River and the Napindan Channel as navigation route for sediment transport so as to avoid causing heavy traffic in the case of land route. Also, the possibility of backfill offshore of Manila Bay was also considered but was judged to be unfeasible during the JICA Preparatory Study.

- The navigability of the Napindan Channel has been confirmed through site survey and water depth survey in this study.

(2) Selection of the General Dredging Scheme

(a) Dredging Equipment

Dredging equipment usually includes suction barge, backhoe and grab-bucket. Dredging equipment and back up facilities should be carefully selected. **Table R 6.4.2** below shows the comparison between dredging equipment and their applicability in the Phase III Project.

Table R 6.4.2 Comparison of Dredging Equipment with Back-up Facilities and their Applicability in the Phase III Project

Dredger	Suction barge	Backhoe	Grab-Bucket
General Features	Applicable if there is a suitably sized suction barge. A long transportation pipe and a large sedimentation pond are a must.	The unit capability is small but this may be solved by increasing the number of units.	Cycle time for one dredge is longer than that of a backhoe, and larger bucket is necessary to address this constraint. Usually it is more effective for deep and huge dredge.
Suitability for Soil Type	*Most suitable for sand. *Not suitable for cohesive soil because of sedimentation issue. *Not suitable for rock or gravel.	* Suitable for sand. * Suitable for cohesive soil. * Suitable for rock and gravel (Usually bucket is attached depending on soil type)	*Suitable for sand. * Suitable for cohesive soil. * Suitable for rock and gravel (Usually bucket is attached depending on soil type)
Dredged soil Transport	The practical limit for pipe length is around 2 km; for longer lengths, a booster pump and effective management technique is necessary. A float type pipe is a nuisance to navigation and problematic to maintain; thus a bridge type installation is recommended.	By Dredged Soil Barge	By Dredged Soil Barge
Sediment Pond	Large sedimentation pond is necessary.	Not needed	Not needed
Dredge under Bridges	Impossible, because the dredger needs to be dismantled to be able to pass the bridge.	Possible	Impossible to reach areas under the bridge.
“	Another backhoe dredge unit is required.	Not needed	Another backhoe dredge unit is required.
Garbage and Debris	Vulnerable	No problem	No problem
Allowable Overcut（m^3）	Large (408,000)	Small (194,000)	Medium (232,000)
Environmental Impact	Turbidity problem is less than other methods	Turbidity problems may occur but not expected to be worse than the original turbidity of the river.	Turbidity problems may occur but not expected to be worse than the original turbidity of the river.
Odor	No odor	Foul odor may be observed during transport on a dredged soil barge although this problem is temporary and not so critical.	Foul odor may be observed during transport on a dredged soil barge although this problem is temporary and not so critical.
Pipe Leakage	Pipe leakage can affect the neighboring site	No concern	No concern
Remarks on Overcut	The larger the allowable overcut volume, the greater the general impact expected.	The lesser the allowable overcut volume, the lesser the general impact expected.	The larger allowable overcut volume, the larger general impact expected.

(b) Comparison of Dredging Schemes

Table R 6.4.3 below compares the different dredging schemes that are considered to be technically feasible for use in the Phase III Project.

In this table, Case 1 to Case 3 shows the dredging with backhoe. In these cases sandy dredged soil will be conveyed directly to the unloading pier near Laguna Lake, then transferred onto dump truck and carried into the final backfill point for reclamation. Clayey or fine soil will be pre-mixed at the backfill site (Case 1), at a middle point on navigation root (Case 2), or at the back side of dredging ship (Case 3). Case 4 is dredging with a Suction barge with five (5) booster pumps at maximum along the rivers and directly pumped out at the backfill area, which is used as a sedimentation pond site. The table shows that the latest case is less economical, thus further explanation is omitted.

Figure R 6.4.5 illustrates the fleet of Case 1 to 3. **Figure 6.4.1** indicates the diagram showing that the fleet has enough ships and boats for operation. The required strength level for pre-mixed soil is 200 in cone penetration index after 24 hours of mixing in consideration of both quality and reduction of improvement admixture. This required level realizes the handling easiness for dump truck carriage and reclamation workability. In Case 1, it is judged that only short distance carriage is available from pre-mixing plant to a site and the soil is reclaimed after 24 hours of curing on site.

Table R 6.4.3 Comparison of Dredging Schemes

Item	Case 1		Case 2		Case 3		Case 4
Dredged Soil	Fine Soil	Sandy Soil	Fine Soil	Sandy Soil	Fine Soil	Sandy Soil	None Selective
Location of Pre-Mix	Backfill Site	None	Middle Point	None	Dredging Site	None	None
Soil Volume ($m^{3)}$	656,000	314,000	656,000	314,000	656,000	314,000	970,000
Dredging Work Scheme	Backhoe	Backhoe	Backhoe	Backhoe	Backhoe	Backhoe	Suction barge
Pre-Mixing after Dredge	None	None	None	None	On Plant Barge	None	None
Soil Transportation	By Barge 1	By Barge 1	By Barge 1	By Barge 1	By Barge 1	By Barge 1	Continuous Transportation
Pre-Mixing at Middle Point	None	None	On Plant Barge	None	None	None	None
Soil Transportation	By Barge 1	By Barge 1	By Barge 2	By Barge 1	By Barge 1	By Barge 1	Continuous Transportation
Transportation to the Final Site	By Sealed Dump Truck	By Dump Truck	By Dump Truck	By Dump Truck	By Dump Truck	By Dump Truck	Continuous Transportation
Pre-Mixing at Backfill Site	At Site	None	None	None	None	None	None
Additional Transport	By Dump Truck	None	None	None	None	None	None
Reclamation	By Bulldozer	By Bulldozer	By Bulldozer	By Bulldozer	By Bulldozer	By Bulldozer	Levee and Sedimentation Ponds are necessary
Sub-Total (Million ¥)	1,676	272	1,760	272	1,801	272	2.215
Allowable Overcut Volume ($m^{3)}$	131,200	62,800	131,200	62,800	131,200	62,800	408,000
Overcut Cost (Million ¥)	335	54	352	54	360	54	932
Sub-Direct Cost (Million ¥)	2,011	327	2,112	327	2,161	327	3,147
Total Direct Cost (Million ¥)	2,338		2,439		2,488		3,147
Environmental Issue	None	None	None	None	None	None	Possibility of Mud spillage, large over cut volume and causing nuisance for navigating vessels
Maintenance in Service Stage	None	None	None	None	None	None	Reclamation with soft material
Other Issues	None	None	Plant barge occupies part of the river during construction period	None	None	None	Pump Vulnerability to garbage and debris. Technical difficulty in pump Operation
Comprehensive Evaluation	Most Favorable		Favorable		Favorable		Unfavorable

Note: The volume of overcut will be different in each of the above schemes. Therefore, the total cost depends on the total volume of dredged volume plus the overcut, and corresponding costs are compared. The same unit price of dredged volume is used for the overcut.

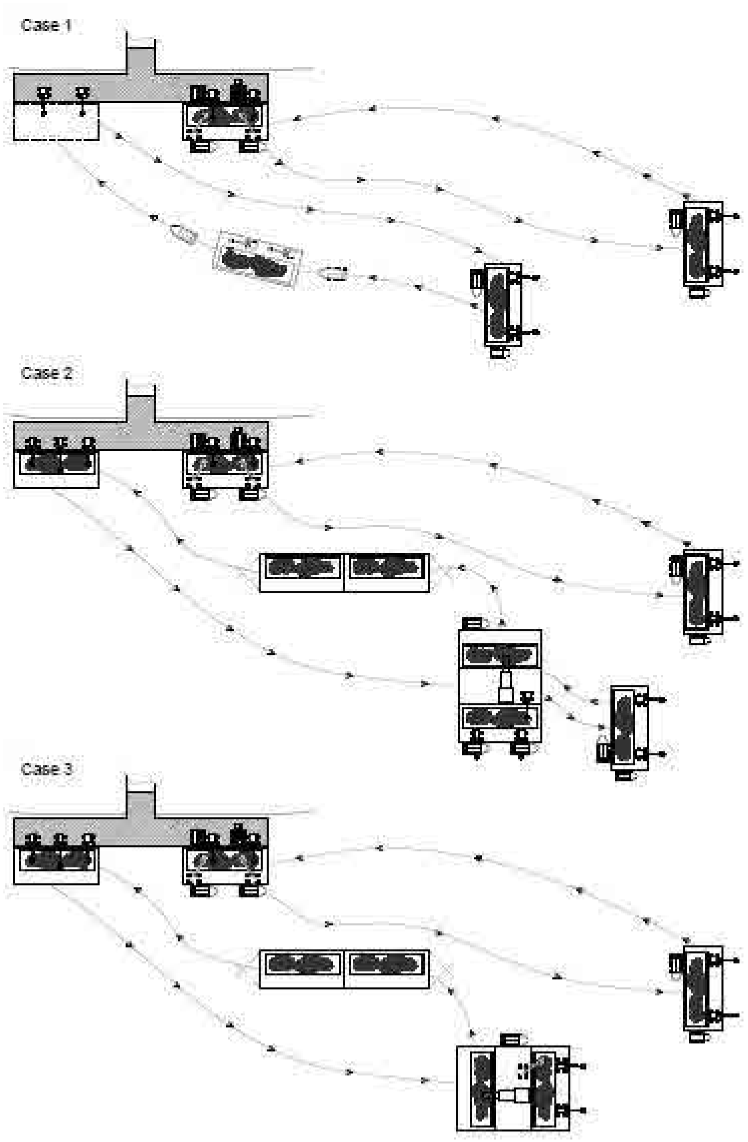


Figure R 6.4.5 Composition of Backhoe Dredging Fleet

(3) Treatment of Overcut

Overcut is excess dredging over the design line and frequently becomes a controversial issue in dredging work. In this section, the allowable overcut volume and its effect is discussed.

(a) Effect of Overcut

An overcut have the following effects:

Allowance for over excavation to ensure that the design limit line for dredging work is achieved:

- Overcut simply addresses the accuracy issue on underwater inherent in dredging works.

Actual work volume:

- When the overcut volume is big, other aspects of dredging work such as backfill, land preparation, selection of construction equipment and construction duration are affected and therefore calls for proper judgment.

Payment limit:

- There is no general rule on the payment of overcut. Obviously, however, when overcut involves a volume to the extent that other related aspects of actual work are affected, these need to be considered rationally.

Allowable overcut volume against structural safety:

- It is implicit that the allowable overcut volume could sometimes implicate safety of structures. In this project, dredging and overcut around bridge piers must be carefully considered.

(b) Overcut Design Criteria

The overcut design criteria of DPWH is as follows

- Vertical allowance: 0 to 200mm overcut is allowed.
- Side allowance: DPWH Design Guidelines prescribe that “All dredging slopes shall be to the specified gradient and within the limits specified on the approved Plans,” but does not give explicit value.

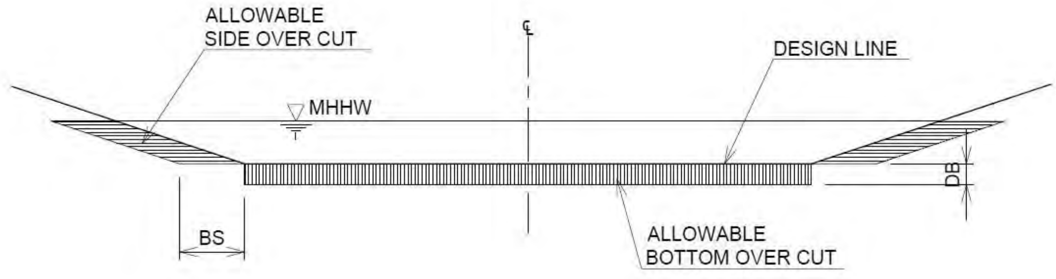


Figure R6.4.6 Schematic View of Overcut Allowance

The overcut volume estimated in accordance with the DPWH criteria does not clear indicate a standard. In this calculation, side allowance of 80cm is derived from the average of Philippine-Japan allowance ratio of 0.2m is to 0.5m.

Table R 6.4.4 Overcut Volume in the Case of Backhoe Dredge

In Accordance with DPWH Criteria	**Bottom Depth = 0.2m**	**Side Width = 0.8m**	**Total**
Volume (m^3)	43,200	34,318	77,518
Ratio (%)	4.4%	3.5%	8.0%
In accordance with Japanese criteria	**Bottom Depth = 0.5m**	**Side Width = 2.0m**	**Total**
Volume (m^3)	108,000	85,795	193,795
Ratio (%)	11.1%	8.8%	20.0%
Note: The ratio in table is the ratio to net required volume of 872,000 cum			

Based on the Japanese “Standard for Cost Estimate on Harbor Works, Ministry of Land, Infrastructure, Transport and Tourism, 2012,” the allowable bottom and side overcut width are as shown below in **Table R**

6.4.5 and **Table R 6.4.6** , respectively. This applies when water depth is less than 5.5m under the same condition as this project.

Table R 6.4.5 Bottom Overcut Volume in the Case of Backhoe Dredge

Material	Dredger	Bottom Over Cut	Remarks
Soil	Pump	0.6m	Water depth < 5.5m
Soil	Grab Bucket	0.5m	Water depth < 5.5m
Soil	Backhoe	0.5m	Water depth < 5.5m

Table R 6.4.6 Side Overcut Volume in the Case of Backhoe Dredge

Material	Dredger	Side Over Cut	Remarks
Soil	Pump	6.5m	
Soil	Grab Bucket	4.0m	
Soil	Backhoe	2.0m	

(4) Dredging, Transportation and Pre-Mixing

Below is the description of the basic construction methods for backhoe dredging with pre-mixing work at the backfill site of Case 1. Pre-mixing site differs in the case of Case 1 and Case 2, and additional description is covered for these cases hereunder. **Figure 6.4.1** shows the sample of working ship diagram and **Figure 6.4.2** to **Figure 6.4.6** show the yard and plant plan of each sites.

(a) Description of General Conditions

- Total Volume of Net Dredge of Materials: 872,000m^3 (Along 5.4 km length)
- Channel Shape: 40m wide with 1 by 3 slope, both sides
- Volume of Each Soil: Sandy Soil: 306,0000m^3, Fine Soil: 566,000 m^3
- Unit Weight of Each Soil: Sandy Soil: 1.85 ton/m^3; Fine Soil: 1.60t/m^3
- Design Riverbed Elevation: From EL + 6.500 to EL +7.756m
- Tidal Level : MSHHWL = EL+11.400m
  : MHHWL = EL+11.100m
  : MSL = EL+10.475m
  : MLLWL = EL+10.000m
- The Lowest Bridge in Pasig River : EL+14.470m
- The Lowest Bridge in Marikina River : EL+17.051m
- The Lowest Bridge in Napindan Ch. : EL+17.000m

(b) Dredge Work 1 (for Sandy Soil)

The total dredging volume of sandy soil is estimated to be 306,000 cubic meters, and continuous distribution is expected upstream from Sta. 2+800. Sandy soil is dredged with backhoe, transported on a soil barge directly to the pier in Laguna Lake and transferred onto dump trucks, and then carried to the backfill site (the same for Case 1, 2 and 3).

<u>Composition of Work Ship Fleet</u>
The composition the fleet for sandy soil dredge is as follows:

- Backhoe with 1.0cm bucket, 25-ton : 4

  Two (2) backhoes are mounted on a flat barge as specified below:

- Flat Barge of 1000DWT : 2

  These will be used both as backhoe base and carriage vessel for dredged material. Standard size of 1000DWT is around 36m*16m*2.7m, with full draft of 2.5m and vacant draft of 0.5m. Each flat barge is arranged with 6.0m backhoe working area on one side, and 9m width space for dredged materials and 1m width aisle on the other side. The space for dredged materials is 9m wide and 34m long. It is separated with a 2.0m wall erected on deck surrounded by 1m wide aisle for three directions. Two spats are also equipped for the purpose of positioning during dredging.

- Tugboat of 500PS : 3

  Standard draft is 2.0m. Two are for towage, and one remains at dredging site for tender service.

- Anchor and Commute Boat of 200PS : 1

  Standard draft is 1.5m.

- Watch Boat of 16PS : 2

  Two boats of 16PS will keep watch on the safety of other ships upstream and downstream of the dredging barge.

The general dredging scheme is illustrated in **Figure R6.4.7** and **Figure R6.4.8**. Dredging work will be carried out using two (2) backhoes on a flat barge. After full loading, the flat barge with backhoe is tugged to the staging area. Here, unloading will be carried out using the other two backhoes onshore with some support of backhoes on board. The actual performance of tugboat and flat barge are reflected in this plan.

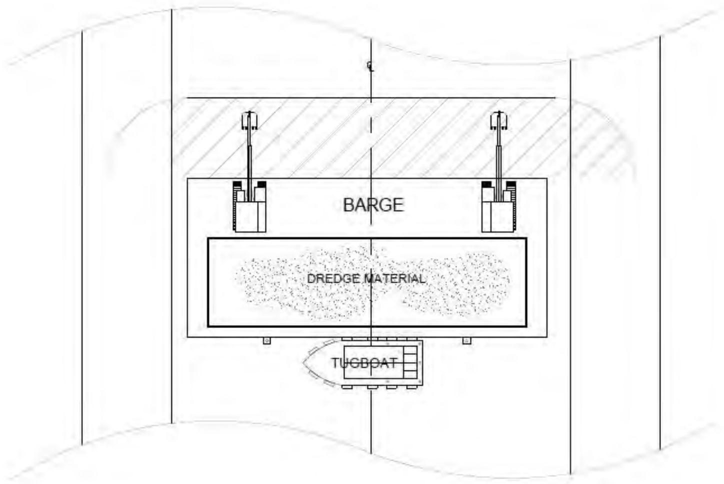


Figure R6.4.7 General Dredging Scheme, Front Dredging

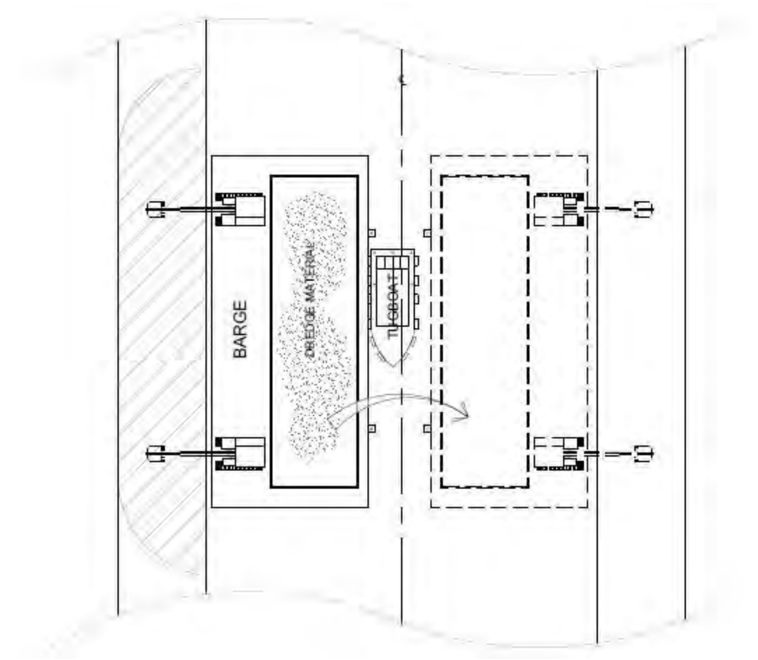


Figure R6.4.8 General Dredging Scheme, Side Dredging

Cycle Time

Duration of dredging for one flat barge Td is calculated with the full volume of $513m^3$ for 1000 DWT barge and hourly dredge volume capacity of backhoe with $45m^3$ (“Civil Engineering Work Estimation Standard, Japan”);

Td = 513 / (2* 45) = 5.71h

On the other hand, the following activities are done simultaneously:

Carriage of dredged material to the unloading pier in Laguna Lake, assuming the length of 10.2 km which is the average of maximum and minimum distance of 11.4km and 9.0km for sandy portion and carriage speed of 7.4km/h:

Tg = 10.2 / 7.4 = 1.38h

Unloading will be done with two backhoes operating at a capacity of $520m^3/7m^3/h \fallingdotseq 74m^3$ per hour shift (“Civil Engineering Work Estimation Standard, Japan”). Two backhoes will operate onshore and one on board.

Tu = 513 / (2* 74)) = 3.47h

Return trip to the dredge point is as the same as the go trip:

Tr = 10.2 / 7.4 = 1.38h

Total hour is:

Tt = 1.38 + 3.47 + 1.38 = 6.23h > 5.71h (Dredge time)

This means that the critical activity is not dredging work, and the dredge work efficiency is 5.71/6.23= 0.917, or daily dredging ability is 0.917 * 45 * 2 * 10hour = 825/m^3 day. The total duration on sandy soil of 306,000m^3 dredging is estimated to be 371 working days.

(c) Dredge Work 2 (for Fine Soil)

The total dredging volume of fine soil is estimated to be 566, 000 m^3.

Composition of Work Ship Fleet

Table R 6.4.7 shows the work ship fleet for fine soil.

Table R 6.4.7 Work Ship Fleet for Fine Soil

Item	**Case 1 (Pre-Mix at Backfill Site)**	**Case 2 (Pre-Mix at Middle Point)**	**Case 3 (Pre-Mix at Dredge Site)**
1000DWT Flat Barge	2	2(Front)+4(Backward) = 6	1(Front)+4(Backward) = 5
1.0m^3 Backhoe for Dredging	4	4	2
500PS Tug Boat	3	3(Front)+3(Backward) = 6	2(Front)+2(Backward) = 4
200PS Anchor Boat	1 (Front)	1 (Front)	1 (Front)
20PS Watch Boat	2 (Front)	2 (Front)	2 (Front)
1000DWT for Pre-Mix Plant	None	1 (Middle)	1 (Front)
Combo for Pre-Mix Transport	None	None	1000DWT FB * 1 500PS Tug * 1 20t Mill Lorry * 4
Backhoe for Unloading	1.0m^3 Clam Backhoe * 2	1.0m^3 Backhoe * 2 0.6m^3 Telescopic Backhoe *1	1.0m^3 Backhoe * 2 0.6m^3 Telescopic Backhoe *1

Cycle Time

In the following investigations, unit wet of fine soil is assumed to be 1.55/ m^3 mainly for Case 1. Dredging time of 613m^3 onto the 1000DWT barge with two backhoes of 45m^3 per hour is:

Td = 613 / (2* 45) =6.81h

On the other hand, the following activities are done simultaneously:

Carriage of dredged material to the unloading pier in Laguna Lake, assuming the average distance of 8.7km from maximum and minimum distance of the site of 11.4km and 6.0km, respectively, and carriage speed of 7.4 km/h:

Tg = 8.7/ 7.4 = 1.18h

Unloading will be done with two backhoes operating at a capacity of 74m^3/h (Japan Guidelines, 2011). Two backhoes will operate onshore and one on board:

Tu = 613 / (2* 74)) = 4.14h

Return trip to the dredge point is the same as the go trip:

Tr = 8.7/ 7.4 = 1.18h

Total hour is:

Tt = 1.18 + 4.14 +1.18 = 6.51h < 6.81h (Dredge time)

This means that the dredging time is the critical activity. The total duration on fine soil of 566,000m^3 is estimated to be 629 working days.

(d) Pre-Mixing Work

The purpose of pre-mixing is to improve fine soil to make it suitable for land transportation and reclamation by admixing with admixture such as cement and quick lime. The required soil quality after pre-mixing and curing depends on the usage of soil, as follows:

For Reclamation : qc > 200 kN/m^2 (24 hours)
For in Site Road : qc > 1200 kN/m^2 (24 hours)

Where; qc : cone penetration index (kN/m^2)

Figure R6.4.9 and **6.4.10** show the general layout of the pre-mixing plant inland (Case 1) and on-barge (Case 2 and 3) respectively. The pre-mixing process begins from the first soil pit, vibratory screen for garbage removal, a middle pit, admixture mixer in sequence and auxiliary equipment such as admixture silo/feeder and a generator. For on-barge plant, some variations are adopted to reduce the necessary area; for example, mounting vibratory screen on the inlet of the admixture mixer, using dredging barge as well as the first soil pit. **Table R 6.4.8** shows an example of pre-mixing plant with effective capacity of 70m^3/hour. The total electricity demand for this set is assumed to be 280kVA, and is operational with a usual generator.

Table R 6.4.8 Equipment for Pre-Mixing Plant

Item	Dimensions in Plane	Remarks
Soil Pit 1	8m * 8m	
Backhoe 1		1.0m^3 clam type
Vibratory Screen	5m * 5m	
Soil Pit 2	8m * 8m	
Backhoe 2		1.0m^3 clam type
admixture mixer	9m * 4m	
Outlet Conveyer	9m * 2m	
Admixture Silo	2.5m OD	50ton class
Generator	4m * 1.4m	300 kVA

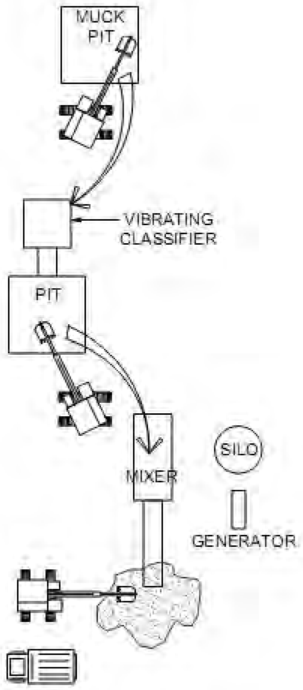


Figure R6.4.9 General Layout of the Pre-Mixing Plant Inland (Case 1)

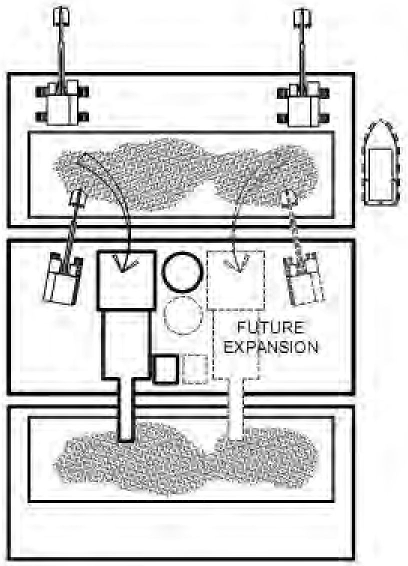


Figure R6.4.10 General Layout of the Pre-Mixing Plant On-Barge (Case 2 and 3)

In Case 3, the pre-mixing plant barge travels with the dredging barge and it requires passage under bridges. It means that the plant has the elevation limit of around 7m including freeboard of barge, and it requires some consideration for equipment arrangement such as adaptation of low-head admixture silo, but is judged to be practicable. Another note for the case is the supply of admixture in the river. For this aspect, it is planned that admixture will be transported with a few mill lorry on a 1000DWT barge.

In Case 2, the pre-mixing plant is moored at a certain position, and has no need to pay attention on the height. The supply of admixture is planned to be achieved from near shore.

(e) Unloading Pier

General Description

Unloading pier for soil is to be constructed along the west bank of Napindan Channel and north of the ring road at the outlet from Laguna Lake. The length is 108m and enables three (3) 1000DWT barges, one is for sandy soil and the other for fine soil, moor simultaneously. The berth for sandy soil is available for fine soil and the other vice versa. The width is 12m and enables 10t class dump truck to divert direction on it. The pier will be connected to the backfill site with a new temporary road so that the dump trucks have no need to go through the ring road. **Figure R6.4.11** shows the general plan of the pier.

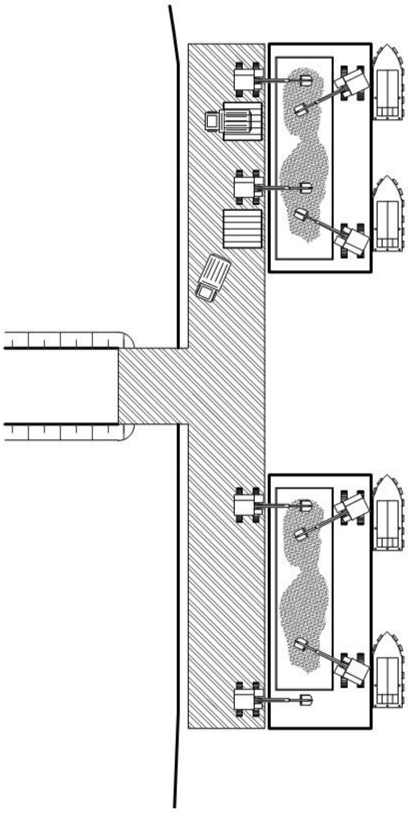


Figure R6.4.11 General Plan of Dredged Soil Unloading Pier

For sandy soil unloading, two backhoes with 1.0m^3 bucket are used, with the support of two backhoes on a barge for soil hauling. Two frame structures along the sandy soil berth are garbage screens. They are used for soil that contains a lot of garbage. Garbage weight is planned on the basis of 20kg/m^3 for 1/3 of whole sandy soil. For fine soil unloading, two 1.0m^3 clam backhoes are used in Case 1 with the support of two other backhoes on a barge. For

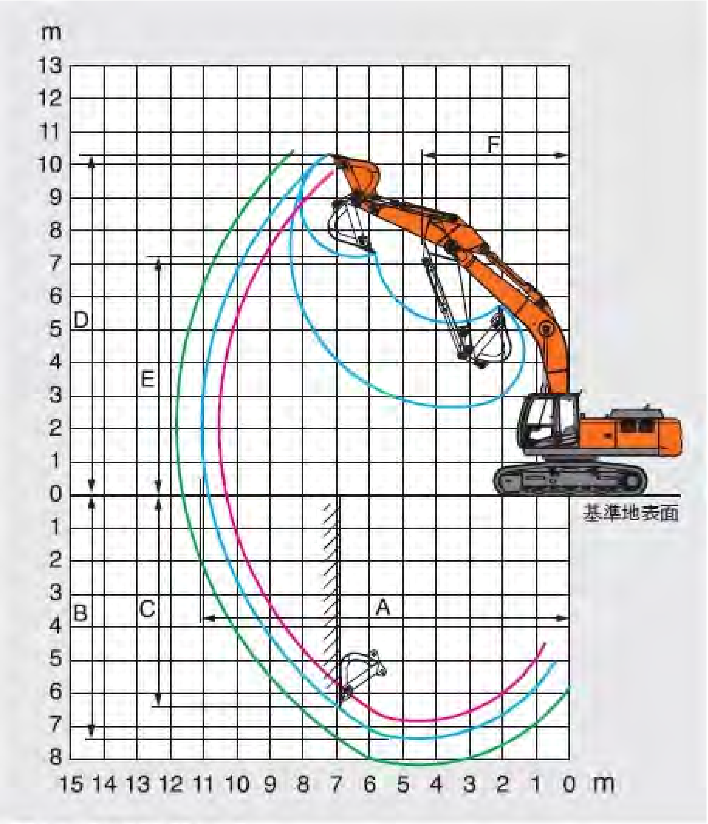
Cases 2 and 3, one telescopic backhoe is used for hauling as well as other two 1.0 m^3 bucket backhoes for unloading, since no backhoe is mounted on any barge.

Elevation of Pier and Moored Barge

The elevation of the unloading pier is decided to be EL+15.000 in consideration of water level. In this consideration, the water level of EL+10.475 which is the same as that of MSL as low water and EL+13.000 as high water for the water level of Laguna Lake is adopted. In accordance with the Phase I Detail Design Report in March, 2002, the average of annual maximum water level of Laguna Lake is EL+12.340m, and the number of year when the maximum water level surpass EL+13.000m is 6 years through 51 years of 1949 to 1999. The elevation of Ring Road is around EL+14.0m (**Figure R6.4.12**). These data and the support of on-board backhoes indicate that there is no difficulty in unloading work.

Table R 6.4.9 Dredged Soil Carrier and Pier Platform Height

Water Level and Load Conditions	Location	Elevation	Difference from Platform Level (m)
High Level (+13.000) & Light Load (+2.20) = (15.200)	Wall Top (+2.00)	EL+17.200	+2.200
High Level(+13.000) & Light Load (+2.20) = (15.200)	On Board(+0.000)	EL+15.200	+0.200
Low Level (+10.475) With Full Load (+0.20) = (10.675)	Wall Top (+2.00)	EL+12.675	-2.325
Low Level (+10.475) With Full Load (+0.20) = (10.675)	On Board(+0.000)	EL+10.675	-4.325



〈注〉図は ZAXIS 330です。

Figure R6.4.12 Suitability of Backhoe

(f) Carriage to the Final Backfill Site

Dredged Soil loaded onto 10ton dump trucks at the Laguna pier is carried to the final backfill site via the entrance 0.2km west from pier, and average distance to the site is 0.8km.

"Civil Engineering Work Estimation Standard, Japan" shows that a 10ton dump truck can carry 100m^3 of soil in 0.7day in no DID. This ability can be translated into hourly rate:

Qh = (100 / 0.7) / 7 = 20 m^3/h

The quantity of dump trucks is calculated to fulfill the unloading capacity of two backhoes for one berth:

N = 148 / 20 = 7.4; then eight (8) dump trucks are necessary.

For the quantity of dump trucks for distribution of pre-mixed soil in Case 1, the average carriage distance is estimated to be 0.8km and the carriage capacity of dump trucks is in the same category as the above case; namely, 20m^3/h. To keep the pay out from the plant, which is in the same place as the front dredging and is 90m^3/h, the required quantity of dump trucks is:

N = 90 / 20 = 4.5; then five (5) dump trucks are necessary.

(5) Embankment Works

(a) General Explanation on Present and Design Features of the Site

Present Features

Backfill site ("the Site" hereunder) has a total area of 450,000m^2 more or less. and has rectangular in shape with 800m in east-west direction and 600m in north-south direction. **Figure R6.4.13** illustrates the present situation of the Site.

The south and west edges of the Site are bordered with small banks. The west bank faces a natural creek and the water of this creek is drained through the Labasan Pumping Station in Laguna Lake. There is an open outlet at the middle of this west bank, and it lets the water freely go in and out between the creek and the Site. The south bank lies along a small channel outside and the Ring Road over it. The water of this south channel is also drained through the above-mentioned pump station. The Site and the south channel are connected with some concrete conduit pipes; the water of the channel can also go in and out from the Site. The elevation of these banks is around EL+12.5m, and ground surface elevation in the Site is around EL+11.5m.

The north and east edges of the Site are bordered with neighboring residential areas, which elevation is the same level as the south and west embankment. The width of the eastern residential area is around 100 to 200m, and there is a drainage channel at the eastern edge of the area just at the toe of the Napindan Channel parapet wall. The drainage system flows into the eastern edge of the above-mentioned south stream. No other drainage system can be found in this area, and thus it is supposed that around half of water run-off from this area runs into the Site. The north residential area spreads out northward to a considerable length. There is no apparent drainage system in the neighboring area to the Site, thus water run-off from the area within 100m from the Site has large possibility to run into the Site.

There is another road which runs on the south-north direction as the bank at the center of the Site, but the western and eastern portions are connected with one concrete conduit pipe and it allows the free flow of water between both sides.

Figure R6.4.13 Illustration of Present Features

Design Features after Completion

Embankment height is planned to be around 2.0m on to the present surface of EL+11.5m, and the ground surface will surpass the present levee crown and residential area which is around EL+12.5m. The run-off from the northern and eastern residential areas will be drained through ditch along the board, which is connected to the western creek and southern channel at the edges. To keep the size of drainage economical, the run-off from the Site is planned to be drained not through this channel but directly into the western creek and southern channel.

Figure R6.4.14 Illustration of Completion Design

(b) Basic Condition and Work Procedures of the Embankment

Embankment work is planned based on the following conditions and principles:

- To keep the drainage from northern and eastern residential areas free: For this purpose, same kind of channel as the final design is planned also for the construction period.
- To keep the run-off from the Site not flowing into the above-mentioned channel: For this purpose, small embankment is planned along the above mentioned channel.
- To monitor the drain water from the Site and to neutralize it when necessary: The water from the Site may be very alkaline because of the pre-mixing admixture. For this purpose, all drain water from the Site shall be gathered into settlement ponds before the existing outlet at western bank, and be flowed into the creek through temporary control sluice gate. Another measure is to set small embankment or something like this along all periphery of the Site during whole work period, keeping all run-offs to the control gate.
- The location of the soil unloading pier is planned so that soil transportation does not affect the traffic of the Ring Road. The lesser transportation distance to the pre-mixing plant is better. A short distance from the pier is also preferable for early development of the basic yard;

thus, the pre-mixing plant is planned to be located at the south-east corner of the Site. For the supply of admixture lorry and plant equipment, one temporary bridge is planned directly from the Ring Road to this base yard.

- One fundamental scheme of the embankment is two steps in height. This scheme gives the landowner an impression and relief that their land is equally embanked, and also enables the contractor to monitor the soil volume, original height and settlement, and reflect those data back to the finishing plan. Another scheme is from east to west and also from south to north in plan. This scheme fits the whole drainage schemes.
- In detail, temporary roads shall precede the general embankment. The temporary road will have 12m width for direction of diversion. The above-mentioned small embankment along boundary shall be additionally counted. Branch roads will be laid down at the interval of 120m. The top elevation of the temporary road will be around 1m higher than the original surface, and embankment between roads shall be around 20cm lower than the roads to promote natural dehydration.
- 21t class bulldozers with hourly capacity of 85m^3 ("Civil Engineering Work Estimation Standard, Japan") will be used for embankment. The calculated one day volume with 10 hour work becomes 850m^{3}for one. Planned work distance of bulldozers is 60m, which is half of the temporary road intervals and within the acceptable limits of the bulldozer work range.
- During the embankment, water spray shall be carried out so that the dust from the site never affects the neighboring residential area.
- Tree cutting, grubbing and weeding shall be done before all the embankment work throughout in the Site. Removal, curing and replanting of trees shall be done in accordance with the environmental requirement and instructions.
- 27,000m^3 of surface soil, which is equivalent to 20% of area times 30cm in thickness, shall be previously removed, then kept during embankment, and finally provided to those who require it.

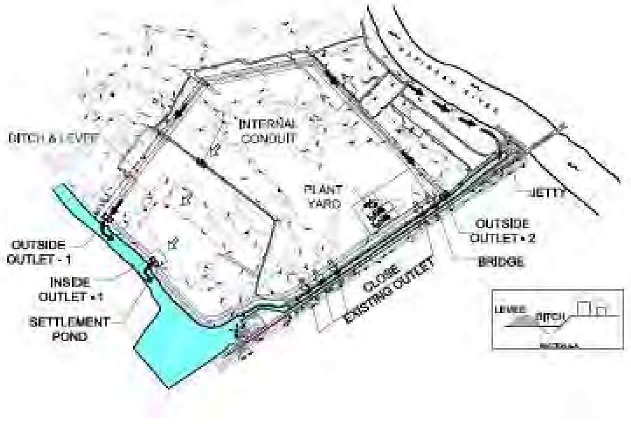


Figure R6.4.15 Embankment 1 – Initial Works

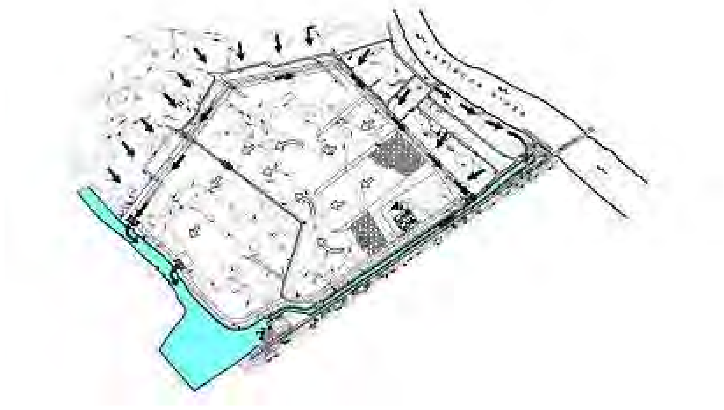


Figure R6.4.16 Embankment 2 – Lower Eastern Area

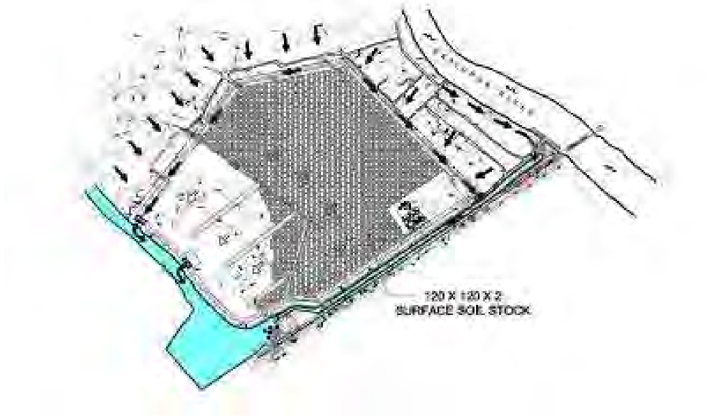


Figure R6.4.17 Embankment 3 –Lower Western Area

6.4.6 Bridge Pier Protection

(1) General Description

Bridge pier protection work using net gabion bag (Bottle Unit) should be carried out soon after dredging work. Net with cobblestone should be placed around the bridge piers and each weight becomes approximately 1 ton.

(2) Work Equipment

The following equipment will be used for the work:

- Mini-crane of 2T Class: 1

  This will be mounted on the barge and used for installing the net gabion bag. Both fixed type and movable type are available, but need to fit the barge adequately to prevent it from falling.

- Backhoe of $0.45m^3$ Bucket: 1

  This will also be mounted on the barge and used to support the crane work.

- 300DWT Flat Barge: 1

  This will be used as a floating work base and carrier for pre-fabricated geo-textile gabion bag.

- 500PS Tugboat:1

  This will be used for towing the barge.

- 200PS Anchor Boat: 1

  This will be used for anchorage boat. It is necessary as watch boat.

- 16PS Watch Boat: 2

  The boats will be on the lookout for incoming boats from both upstream and downstream.

(3) Work Procedure

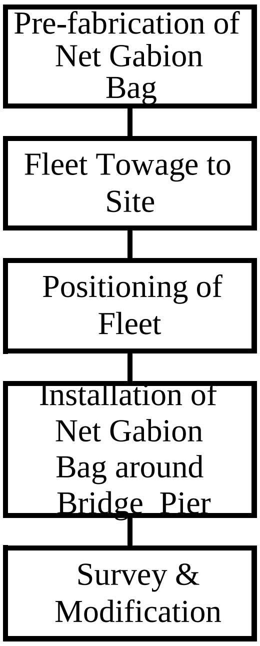


Figure R6.4.18 Work Procedures for Bridge Pier Protection

- Pre-fabrication of Bottle Unit: Boulders will be packed onto a bottle unit either on land or on barge. If packed on land, require additional crane to load them on the barge.
- Fleet Towing to Site: A barge with 2 mini-cranes, backhoe and bottle unit will be towed to the site by a 500PS tugboat.
- Positioning of Fleet: Anchors will be settled with anchor boat, and the barge is positioned with anchor wire and spud on it. Care must be taken to ensure that suspended anchor wires do not become a nuisance to navigating vessels.
- Installation of Bottle Unit around Bridge Pier: Bottle Unit will be installed one after another with 2t class mini-crane. Suspension wire or rope from the bag should not to be removed until final position is decided, and marked with a buoy.

- Survey and Modification: After setting all bags, the final position is surveyed and inspected by the Engineer. No further position modification will be made without the Engineer's approval. Then remove the ones marked with a buoy.

6.4.7 Dike with SSP Revetment

(1) Planning Conditions

(a) Location and Main Features of Dikes

The proposed location and main features of levees are listed in **Table R 6.4.10** . The total length is 1,821m**. Figure R6.4.19** shows a general section.

Table R 6.4.10 Location and Main Features of Dikes

No.	1	2	3
STA	0＋921 ~ 1＋338	3＋033 ~ 3＋621	3＋898 ~ 4＋679
Length	419m	595m	807m
Side	Left	Right	Left
HWL	EL +14.138 ~14.185	EL +14.373 ~14.438	EL +14.469 ~14.556
Freeboard	1.0m	1.0m	1.0m
Parapet Top EL	EL +15.200	EL +15.500	EL +15.600
Bank Crown EL	EL +14.400	EL +14.700	EL +14.800
Present Surface EL	EL +11~ 13	EL +11~ 13	EL +11 ~ 13
Size of Steel Sheet Pile	Type 25H L = 7.5 ~ 9.5m	Type 25H L = 9.0 ~ 10.5m	Type25H L = 9.0 ~ 10.5m
Distance from Full Depth Water	17 ~ 20m	20 ~ 30m	8 ~ 27m
Others	Bridge Underpass	Bridge Underpass	Bridge Underpass

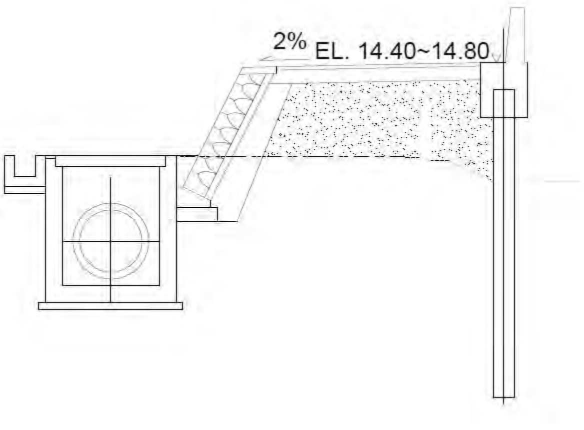


Figure R6.4.19 General Section of SSP Dyke

(b) Other Conditions

Levee Crown Width : net width of 3.0m
Crown Edge Slope : 0.5 to 1.0 (for land side)
Steel Sheet Pile (SSP) : Type-25H, B = 900mm, w = 113kg/m

Top EL ≒ Top of Dike - 400mm
Length = 7.5-10.5m
STP value N of Foundation : N <40

(2) Construction Plan

(a) General

The dike works will be carried out from the land side for the following reasons:

- Embankment height is expected to reach 3m and has the possibility of settlement due to consolidation. To avoid this defect, pre-loading with early embankment will be done at the earliest of implementation.
- Working within the river channel will require enough water depth for the barges. This may not be possible during the initial stages of dredging work. Dredging will be carried out from downstream and working upward, ensuring that water depth is adequate for the dredger. On the other hand, dikes will be constructed in two (2) locations upstream of Lower Marikina River. Thus, the levee work, including gate and subsequent sluice work will constitute an extremely critical part of the Project. Hence, it is recommended to separate the dike work from the dredging work so as to rationalize the total construction plan.
- The three sites have adequate proper lengths of 419m, 595m and 807m respectively and each has proper road access. The length of the SSP is assumed to be around 7.5m to 10.5m and will have no problem with hauling truck transportation.

(b) Access to Dike and Site

Each site can be accessed from the land side but still some difficulties are expected. Alternative access routes are also introduced below.

<u>Portion No. 1 (0+921~1+338, L=419m), Left Side</u>

Large trucks can access via a road located east of Vargas Bridge. However, large vehicles will have difficulty turning the corner for this road. The area adjacent to this corner may be reclaimed and widened to allow large vehicles to change direction. There is another road 150m west of this bridge; it can allow access by small cars but not large trucks.

<u>Portion No. 2 (3+033~3+621, L=595m), Right Side</u>

There is no existing access to this site for any vehicle. There is one route on the east side of Alfonso Sandoval Bridge that leads to the center of the site but this is too narrow, only around 2m, and also has a 50cm step, so that three properties are removed to make access. Another access road can be provided which will pass through an area of a plant next to the bridge, and another small portion of a private property, which is used for backyard poultry-raising. It is further recommended to use this area as a work yard for all three dike sites.

Another consideration of riverside access should be given to this site, because the site is not far from the upstream dredge start point, which is set at around Sta. 3km, and it means that ships can operate at the site a few months after dredge commencement. For riverside work, the disadvantage is that the distance from the levee to the stream is very long, around 30m, which situation is completely different from Pasig River, and ship works may require over-dredge of 20m width leading to 70.000m^3 additional dredging volume with problems both in construction period and cost. Other alternative is to make a small bay dredged and a jetty on a certain portion in order to unload equipment and materials. This case seems rather moderate. The difference between this and landside access is cost up by a bay, jetty and unloading and loading with a large size crane, but the fundamental construction scheme is the same as that of from landside access.

Portion No. 3 (3+898~4+679, L=807m), Left Side

The site can be accessed by large trucks via a road west of Rosario Bridge. This space passing under the bridge is highly recommended as a work yard. There may be some difficulties unloading long materials such as SSP; hence, it is advisable to use a crane during night shifts or else provide a temporary work yard by the river side.

(c) Work Procedures

The work procedures for dike construction are as shown in **Figure R6.4.20**.

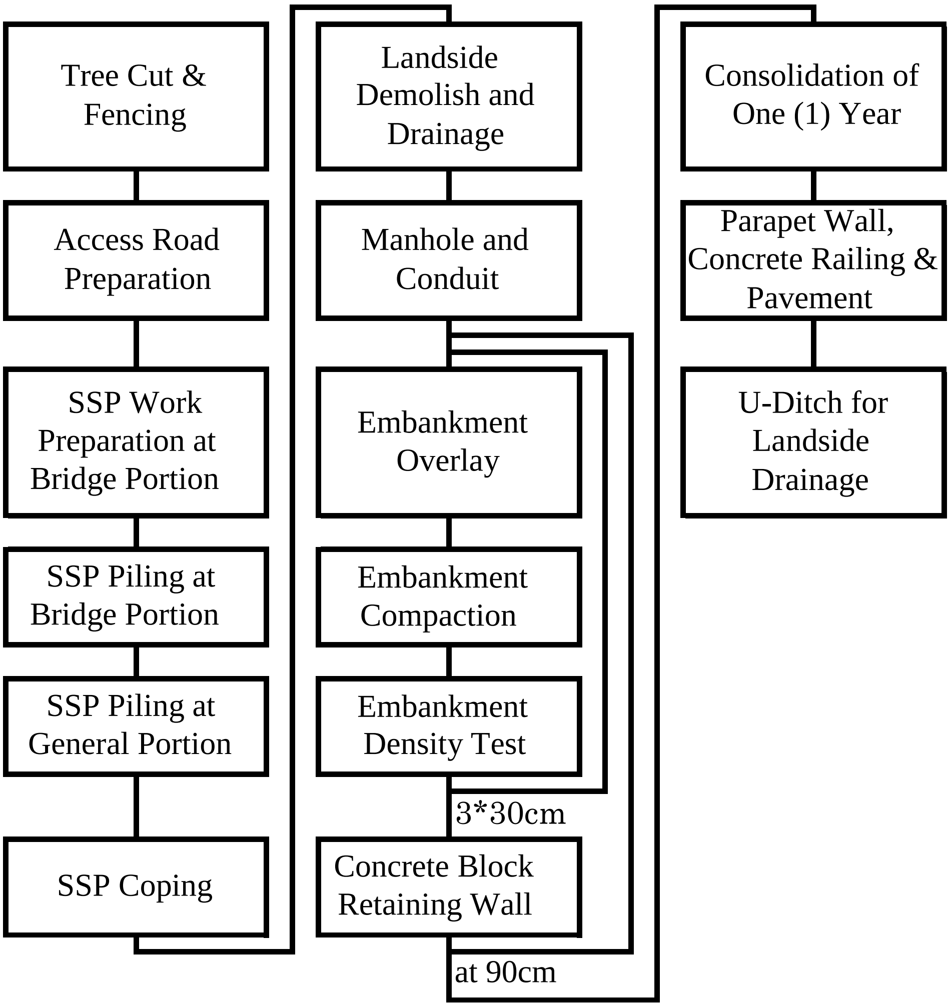


Figure R6.4.20 Work Procedure for SSP Dike Construction

1) Clearing, Grubbing and Perimeter Fencing: Install fence at the boundary of the construction site after tree cutting and clearing.

2) Access Road Preparation: Prepare access roads to the sites, including the widening of present road area by embankment at steep corners to enable turning of construction vehicles at the corner.

3) SSP Work Preparation at Bridge Portion: As the preparation for SSP works at bridge portion, pile temporary SSP or small temporary cofferdam, in response to the site conditions, and then excavate the surface downward to the working stage. One 3B pump is to be provided for drainage.

4) SSP Piling at Bridge Portion: First of all, install SSP at bridge portion. These SSP shall be driven piece by piece. A backhoe of 1m^3 is to be used as base machine, which is as the same as in the Phase II work, and SSP is to be driven with 15kw vibro-hammer mounted at the top of the backhoe. The required clearance for vibro-hammer is 2.635m and the same figure is used in this planning. Alignment of SSP piece and general procedure is illustrated in **Figure R 6.4.21.** Temporary SSP or small cofferdam is removed after this work.

5) SSP Piling: After the bridge portion, general portion SSP in both sides shall be driven successively with 40kw vibro-hammer. A 25-ton class truck crane shall be used as a base machine, and the present promenade or expanded temporary road from it is to be used as working stage. SSP will be hauled from stockyard to the driving point one by one using small vehicles such as rails with track trailers. **Figure R 6.4.22** shows the rotation radius of the 25-ton class truck crane, and it is 4.41m (=3.10+2.62/2) as clearly shown. This value is small enough compared with the minimum promenade width of 6.1m, 5.9m and 4.9m for western, middle and eastern site promenade width respectively. **Table R 6.4.11** shows the lifting capacity of the 25-ton class truck crane in the case of no outreach extension against a few boom lengths. The left columns show the case of forward lifting and the right ones show the case of all direction lifting. The expected lifting radius is less than 5.0m and it can be read that it has 4.0ton capacity. This value is larger than the 3.0ton of expected vibro hammer or 1.5ton of SSP 25H with 12m in length.

6) SSP Coping: After cutting and leveling SSP top, rebar arrangement, formwork and concreting shall be implemented. Cross-section of the coping is around $0.6m^2$ and unit length of coping work is around 20 or 30m.

7) Landside Demolition and Drainage: Old linear park pavement shall be demolished and temporary drainage shall be installed along the river axis. Large size pump(s) for flood season and small size pump(s) for dry season drainage shall be provided at each sluiceway point.

8) Manhole and Conduit: Fabricate manholes and conduits. Procedures are basically the same as those in Pasig River, i.e., fabricate manholes at first then put sleeper, lay down conduit pipes, cast collar concrete and shot-bed concrete.

9) Embankment Works: One layer is to be laid with thickness of 35cm to 45cm; this thickness shall become less than 30cm after compaction. Embankment material shall be carried to the site by dump trucks and laid at site by using a 15t class bulldozer. Dump trucks shall approach the unloading point directed by a guide worker whenever there is not enough space for U-turn. The planned unit length of Embankment is 100m.

10) Embankment Compaction: Compaction work shall be carried out using a 20t class tire roller.

11) Embankment Density Test: After compaction, density shall be confirmed with RI test. Test frequencies are one for every 100sm. After success in all tests, next overlay can be commenced.

12) Concrete Block Retaining Wall: For every 90cm of embankment, block retaining wall at landside shall be fabricated by concrete partition wall erection, concrete block positioning, gravel backfilling between partition wall and embankment, and concrete pouring into the void behind blocks. After completion of each block type wall, the next step embankment is re-started.

13) Consolidation: One (1) year period shall be allowed for consolidation after embankment completion. Sluiceway works, which is described in a later section, shall be done during the latter half of this period.

14) Parapet Wall, Concrete Railing and Pavement: After the consolidation period, parapet, concrete Railing and both concrete and asphalt pavement works shall be carried out.

15) U-Ditch for Landside Drainage: After the consolidation period, a concrete U-ditch for landside drainage shall be provided.

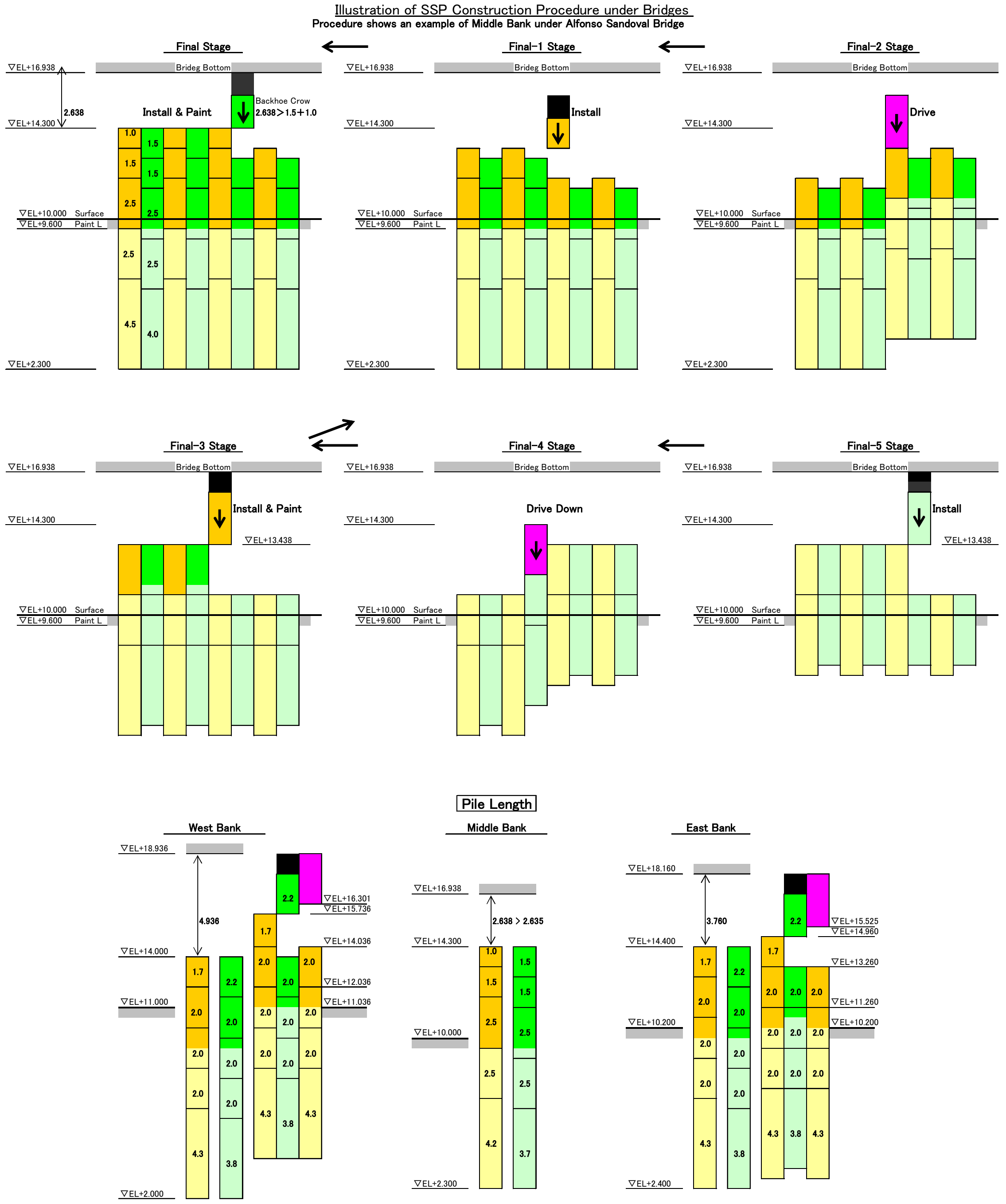


Figure R 6.4.21 Illustration of SSP Segment at Bridge Portion

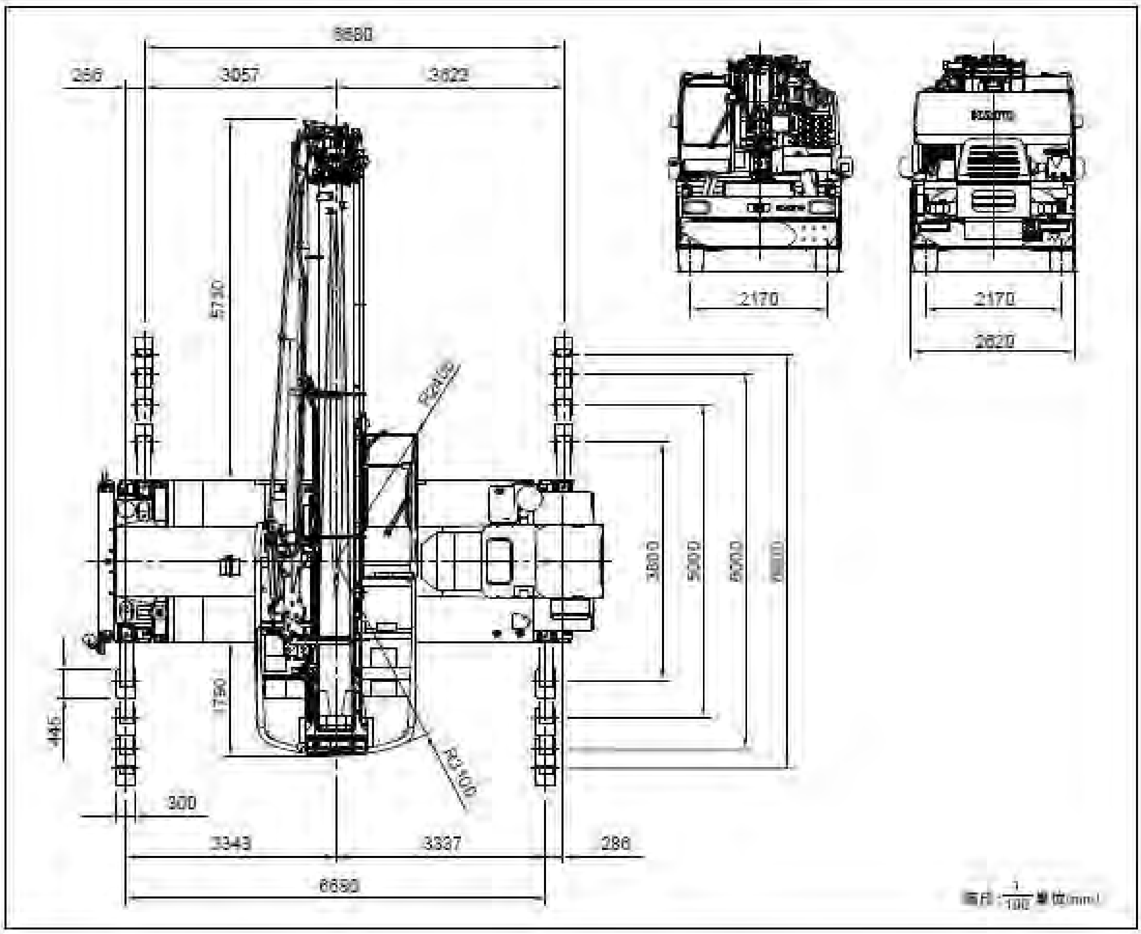


Figure R 6.4.22 Minimum Length for Rotation – 25ton Truck Crane

Table R 6.4.11 Lifting Capacity of 25ton Truck Crane

作業半径 (m)	定置つり					
	9.35mブーム		16.4mブーム		23.45mブーム	
	前方	全周	前方	全周	前方	全周
3.0	13.50	8.10	9.00	7.30		
3.5	12.00	6.90	9.00	6.70	6.50	4.50
4.0	10.75	5.80	9.00	5.65	6.50	4.50
4.5	9.65	5.00	9.00	4.75	6.50	4.50
5.0	8.70	4.30	8.20	4.00	6.50	4.30
5.5	7.80	3.60	7.40	3.30	6.05	3.70
6.0	7.00	3.00	6.60	2.80	5.65	3.20
6.5	6.25	2.50	5.90	2.35	5.25	2.75
7.0			5.20	1.95	4.85	2.40
8.0			4.00	1.30	4.10	1.80
9.0			3.15	0.75	3.50	1.40

(d) Efficiency of Main Works

Work efficiencies shall be in accordance with “Civil Engineering Work Estimation Standard, Japan.”

1) General SSP Driving

Work efficiency of SSP driving in general portion is to be 20 piles, or 18.0m, per day in accordance with the requirement in p297 of “Civil Engineering Work Estimation Standard, Japan” for 25H type of 12m drive into N<50 strata.

2) SSP Driving under Bridges

One pile is to be divided into 5 pieces at most at bridge portions. The work efficiency is to be calculated in accordance with Japanese “Estimate Standard for Vibro-Hammer Works, Vibro Hammer Method Engineering Association, 2007.” Page 9 of this book stipulates 7 pile per day in the case of one splice for the same given other conditions. This description can be read that one splice treatment requires at most 8.0/7=1.14h. If the splices are four (4), then the work time becomes 1.14h*4=4.56h (or 0.57days) and this time is used in the scheduling. Furthermore some portions need painting at site. It is assumed that primer, body and finish painting requires 10hour curing time, thus 5 day work is divided for in-site paint including pre- and after-works.

3) Embankment

The following work efficiency of main equipment shall be adopted:

- 15ton bulldozer: 690m^3/day
- 20ton tire roller: 1,330m^3/day

6.4.8 Sluiceway

(1) General

(a) Location and Main Features of Sluiceway

The location and main features of the sluiceway are as shown in **Table R 6.4.12** . Total number of the sluiceways are 9.

Table R 6.4.12 Location and Main Features of Sluiceway

Sr. No.	Size	EL	Bank No.	STA
MSL-1	1-1.4×1.4	10.80	1-West	1+104
MSL-2	1-1.5×1.5	11.20	1-West	1+323
MSR-1	cancelled	cancelled	cancelled	cancelled
MSR-2	1-1.4×1.4	11.06	2-Middle	3+157
MSR-3	1-2.0×1.6	10.97	2-Middle	3+255
MSR-4	1-1.5×1.5	11.09	2-Middle	3+438
MSL-3	2-1.2×1.2	11.10	3-East	3+945
MSL-4	1-1.6×1.6	11.09	3-East	4+221
MSL-5	1-1.0×1.0	11.23	3-East	4+406
MSL-6	1-1.2×1.2	11.20	3-East	4+503

(b) Access to Each Site

The same access road to the dike works will be used to access each sluiceway site. Therefore, in order to carry materials to each site, trucks and vehicles will pass on the top of dike.

(c) Other Conditions

As for the consolidation period of dikes and commencement date of sluiceway construction, it is assumed that the embankment requires 105 calendar days and it is carried in equal speed. The consolidation result on this assumption shows that there is no harmful affect afterward by the construction of sluiceway.

(2) Construction Planning

(a) Basic Conditions

Sluiceways shall be constructed after the completion of dike embankment. Temporary pipes shall be provided in each sluiceway to divert water during embankment construction. These pipes will be abandoned after construction.

Sluiceway is to be constructed after the removal of soil embankment and then filled again. The construction work should be done during the dry season, because of temporary removal of the soil embankment

(b) Work Procedure

The work procedure for sluiceway works is shown in **Figure R6.4.23** and as described below.

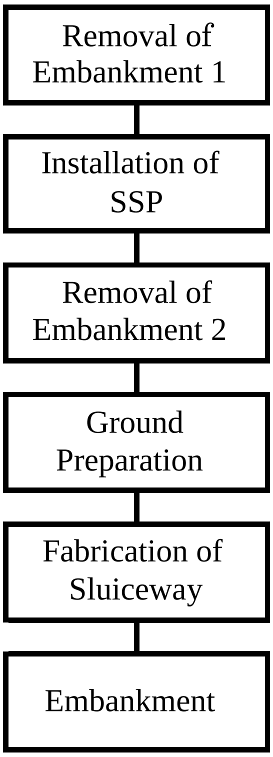


Figure R6.4.23 Work Procedure for Sluiceway

1) Removal of Embankment 1: Two (2) backhoes has to be used to remove the embankment. One backhoe shall work on the access side and the other is on the opposite side. The first excavation is to stop at the highest elevation of the watertight SSP.
2) Installation of SSP: The SSP has to be piled using a proper guide. Longer SSPs shall be driven to the final depth of this stage, but shorter SSPs shall be driven step by step in the next excavation stage.
3) Removal of Embankment 2: The embankment has to be excavated down to the bottom level. Installation of all the shorter SSPs may also be allowed at this stage.
4) Ground Preparation: Cutting and leveling of the SSP top, gravel and leveling concrete has to be carried out next.
5) Fabrication of Sluiceway: Sluiceway has to be fabricated in the following order: bottom slab, side wall, top slab and appended portions.
6) Embankment: After completion, the sluiceway structure has to be filled with embankment materials. This work has to be carried out in the same manner as the dike. One layer of embankment should be less than 30cm and properly compacted. Soil density shall be verified with R test for every layer.

6.4.9 Supplementary Notes

(1) Laws and Regulations

Table R 6.4.13 Laws, Regulation and Governmental Documents

Item No.	Short Name	Full Title	Publication	Responsible Person
1	**Labor Code:** Labor Code of the Philippines, Presidential Decree No. 442, as Amended	A Decree Instituting a Labor Code thereby Revising and Consolidating Labor and Social Laws to Afford Protection to Labor, Promote Employment and Human Resources Development and Insure Industrial Peace Based on Social Justice	http://www.ilo.org/dyn/travail/docs/1131/Labor%20Code%20of%20the%20Philippines%20-%20DOLE.pdf	President
2	**Occupational Safety and Health in the Construction Industry:** Department Order No. 13 Series of 1998	Guidelines Governing Occupational Safety and Health in the Construction Industry	http://ncr.dole.gov.ph/fndr/mis/files/DO_13.pdf	By Department of Labor and Employment (DOLE)
3	**Ditto:** DPWH Dept. Order No. 56-2005	Guidelines for the implementation of DOLE D.O. No. 13, Series of 1998, on Occupational Safety and Health in the Construction Industry	http://www.bwc.dole.gov.ph/userfiles/file/DO%2013-98.pdf	Published Internal Document
4	**Ditto:** DPWH Internal Document	Standard Specifications for Public Works and Highways, 2004	http://ja.scribd.com/doc/83313490/REVISED-DPWH-Standard-Specification	Published Internal Document
5	**Ditto:** DPWH Internal Document	Manual on Construction Supervision of Flood Control Project		Prepared under JICA support
6	**Water Pollution:** DENR Administrative Order No. 35, Series of 1990	Revised Effluent Regulation of 1990, Revising and Amending the Effluent Regulations of 1982	http://www.emb.gov.ph/laws/water%20quality%20management/dao90-35.html	By Department of Environment and Natural Resources
7	**Noise:** NPCC Memorandum Circular No. 002 Series of 1980	Amendments to Article 1 (Noise Control Regulations) Chapter IV, Rules and Regulations of the National Pollution Control Commission (1978)	Official Gazette, Vol. 76, No. 40, page7545-7547. October 6,1980	Ministry of Human Settlements
8	**Vibration:** Presidential Decree No. 984, August 18, 1976	Providing for the Revision of Republic Act No. 3931, commonly known as the Pollution Control Law, and for Other Purposes	http://www.lawphil.net/statutes/presdecs/pd1976/pd_984_1976.html	President
9	**Air Pollution:** Clean Air Act of 1999 (Republic Act No. 8749)	An Act Providing for a Comprehensive Air Pollution Control Policy and for Other Purposes	http://emb.gov.ph/ECA%20Center/RA8749.pdf	House of Representatives and Senate
10	**Waste Management:** Presidential Decree No. 825	Philippine Environmental Code	http://www.lawphil.net/statutes/presdecs/pd1977/pd_1152_1977.html	President
11	**Traffic Rule in Manila:** MMDA Act of 1994 (Republic Act No. 7924)	An Act Creating the Metropolitan Manila Development Authority, Defining its Powers and Functions, Providing Funding thereof and for Other Purposes	http://www.mmda.gov.ph/Legal-Matters/RA7924.html	House of Representatives and Senate
12	**Truck Ban in Manila:** Metro Manila Council Ordinance No. 5	Further Amending MMC Ordinance No. 78-04, as Amended by MMA Ordinance No. 19, S. 1991 RE: Truck Ban	Collected. (Summary Introduction can be seen through FAQ of MMDA HP.)	Metro Manila Council

Item No.	Short Name	Full Title	Publication	Responsible Person
13	**Entity for Coast Guard:** Philippine Coast Guard Act of 2009 (Republic Act No. 9993)	An Act Establishing the Philippine Coast Guard as an Armed and Uniformed Service Attached to the Department of Transportation and Communications, thereby Repealing Republic Act No. 5173, as Amended, and for Other Purposes	http://www.lawphil.net/statutes/repacts/ra2010/ra_9993_2010.html	House of Representatives and Senate
14	**Pasig River Safety:** Memorandum Circular No. 05-07	PASIG RIVER SAFETY, SECURITY, AND THE GOVERNANCE OF ITS ECOSYSTEM	http://www.coastguard.gov.ph/index.php?option=com_content&view=article&id=93:memorandum-circular-no-05-07-&catid=38:circulars&Itemid=38	Memorandum by Coast Guard Admiral
15	**Pasig River Safety:** Standard Operating Procedure No. 04	Guidelines to Vessel Transiting Malacañang Restricted Area (MRA)	Not Found	Presidential Security Group

The fundamental law on labor in the Philippines is listed as the No. 1 Code in the table above. Pursuant to this Code, No. 2 “Guidelines Governing Occupational Safety and Health in the Construction Industry” was issued by the Department of Labor and Employment (DOLE). This Department Order of DOLE includes fundamental principles and penalty for the implementation of safety and health in construction works, and also describes that “the cost of labor and equipment for the safety and health shall be independently estimated from other construction items”. The No. 3 document was published in pursuant to the No. 2 order and seems to be the internal order of DPWH, providing the same stipulation on “the cost of labor and equipment for the safety and health.” DPWH also published No. 4 documents and holds the No. 5 document, both of them containing safety provisions.

Effluent from industry shall conform to No. 6 “Revised Effluent Regulation of 1990, Revising and Amending the Effluent Regulations of 1982,” and it is the same as prescribed for the effluent in this project. Noise shall conform to No. 7 “Amendments to Article 1 (Noise Control Regulations) Chapter IV, Rules and Regulations of the National Pollution Control Commission (1978).” No. 8 “Providing for the Revision of Republic Act No. 3931, Commonly Known as the Pollution Control Law, and for Other Purposes” provides all aspects of the pollution though there is no concrete regulation value for vibration, Air pollution is regulated by No. 9 “An Act Providing for a Comprehensive Air Pollution Control Policy and for Other Purposed,” but it mainly describes the national policy for atmosphere improvement and regulations for that purpose, and does not directly concern the dust at the backfill site in this project. Waste shall generally confirm to No. 10 “Philippine Environmental Code,” which has no classification between house and industrial waste, except for hazardous wastes.

The law governing law on the transportation and traffic in Metropolitan Manila is No. 11 “An Act Creating the Metropolitan Manila Development Authority, Defining its Powers and Functions, Providing Funding thereof and for Other Purposes” that provides that MMDA has control over “transport and traffic management” and, eventually, all large projects in Metropolitan Manila are required to submit their traffic plans and get approval from MMDA. Real control of MMDA is however limited to the national roads only. City and barangay roads are controlled by each city and barangay concerned, in view of autonomy, and discussions on road restriction are done with the concerned authority. It is said that reporting one (1) week beforehand is preferable in the case of MMDA for those discussions. One issue that needs caution in Metropolitan Manila is that some sections of main roads have time restriction on trucks in accordance with No. 12 “Metro Manila Council Ordinance No. 5” that fundamentally bans the transfer of trucks of over 4.5 tons from 6AM to 9AM and 5PM to 9PM that has been amended frequently with some exemptions such as national flag projects, so that the recent situation is recommended to be confirmed from MMDA.

Traffic safety regulation of the river is derived from the No. 13 “Philippine Coast Guard Act of 2009” that provides that PCG is established under DTOC in order to enforce regulations in accordance with all relevant maritime conventions, treaties or instruments and national law at sea within the maritime jurisdiction of the Philippines. The act also provides that, subject to the approval of the Secretary of the DOTC, this department can issue and enforce rules and regulations for the promotion of safety and life and property at sea on all maritime-related activities. No. 14 “PASIG RIVER SAFETY, SECURITY, AND THE GOVERNANCE OF ITS ECOSYSTEM” has been issued by PCG admiral, stipulating that its authority derives from item No. 13 and others, and declaring that PCG “shall spearhead the promotion of safety, security of transportation, … of the Pasig River and its tributaries,” and is deemed to be the legislative standard of the PCG’s river traffic control. A stretch from Ayala Bridge to Pandacan Bridge is designated as Malacañang Restricted Area (MRA) because of presidential area and regulated for ship and vessel traffic by No. 15 “Guidelines to Vessels Transiting Malacañang Restricted Area” issued by the Presidential Security Group, which is under the Office of President.

(2) Safety Issues

- General Safety Management: shall conform to the general provisions and specifications of the contract, and the local safety regulations are generally imposed on the Contractor through them.
- Peculiar Safety Issue: is the electricity cut-off prevention during SSP driving both for high and low voltage lines. For high voltage line, the construction adopts a 3-meter net clearance which is the same as that adopted for the Phase II works. For low voltage lines and other cables, it is required for the Contractor to negotiate with the concerned entity and take proper measures, and for the Employer to make necessary support for this implementation.
- Evacuation of Fleet during Storm: is planned to be moved to the nearest rather wide portion of the river and moored in line along flow direction, then let the crew remove trees and floating objects to prevent piling up all days and night. This principle is also adopted in the Phase II project.

(3) Other Issues and Measures

(a) Electricity Cut-off

Electricity cut-off sometimes happens in Manila. The supply of electricity is planned to be fundamentally by generators, because this scheme is flexible both in site and time, and also not vulnerable to commercial electricity cut-off. The base yard at Lambingan adopts commercial electricity for its office part and laboratory, but it needs to provide emergency generator because the laboratory needs permanent power source for curing facilities, thus generator of 50kW is planned including office electricity.

(b) Water Cut-off

It is assumed that there is little possibility that water cut-off affects construction works. Works that require water as material include water-jet for SSP drive and batching of concrete at site. The water in such cases is stocked on the barge, therefore, no problem is supposed. A water tank shall be provided at the Lambingan base yard to supply water to those kinds of barges.

(c) Traffic Congestion

In this project, many of works vulnerable to traffic congestion are planned to be implemented from river side. For example, SSP drive and drainage works carried out from river side along Pasig River, dredge work and soil transportation along Lower Marikina River are typical. Furthermore, soil transportation from unloading jetty to the backfill area is separate from transportation in the Lake Ring Road, and this ensures the independence of traffic between the public and project construction work.

Embankment and sluiceway works at Marikina are supposed to be a little vulnerable to traffic congestion, and embankment overlay is one of the most vulnerable works in them, because materials supplied is in large volumes. One measure is to make buffer action by stocking material at site, but this is both expensive and space demanding and not recommendable. Nighttime work is an alternative, but it needs another consideration of noise at night. Concreting works also get affected by traffic congestion especially on quality. Work at night and batching at site or on barge with pump transfer are alternative measures, but the latter is possible only when the concrete volume is not so large. The embankment and concrete works will begin several months after work commencement so that the observation at site is to be reflected in the selection of countermeasures.

The road of 200m between the unloading jetty and backfill area is literally narrow for traffic. The present situation allows only one-way traffic, so that widening it to a two-way traffic is inevitable for back and forth transport. An alternative to this method is to use a temporary bridge between near the Ring Road point and another road just north of the Ring Road and make a circular one-way route, but it needs further consideration as to the existing small market.

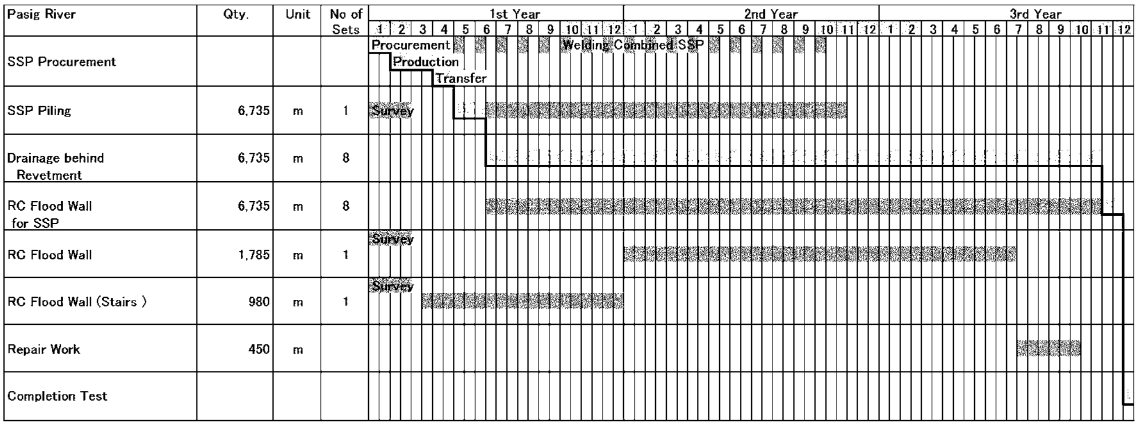
6.5 Construction Schedule

For planning purposes, the total work is arranged in accordance with the up-to-date drawings and the construction planning under Phase II. The whole program is derived from all component works.

Each of the scheduled activities carefully considers labor, equipment and resources most appropriate for the method employed in a given condition. Major equipment items are selected based on the equipment capacity quoted from the publication of the Association of Carriers and Equipment Lessors, Inc. (ACEL - Equipment Guidebook of 2009, Edition 24). Labor requirements are assessed using a mix of current productivity rates and the rates recorded on similar overseas projects. Unit construction schedules for each work item has been analyzed and fixed.

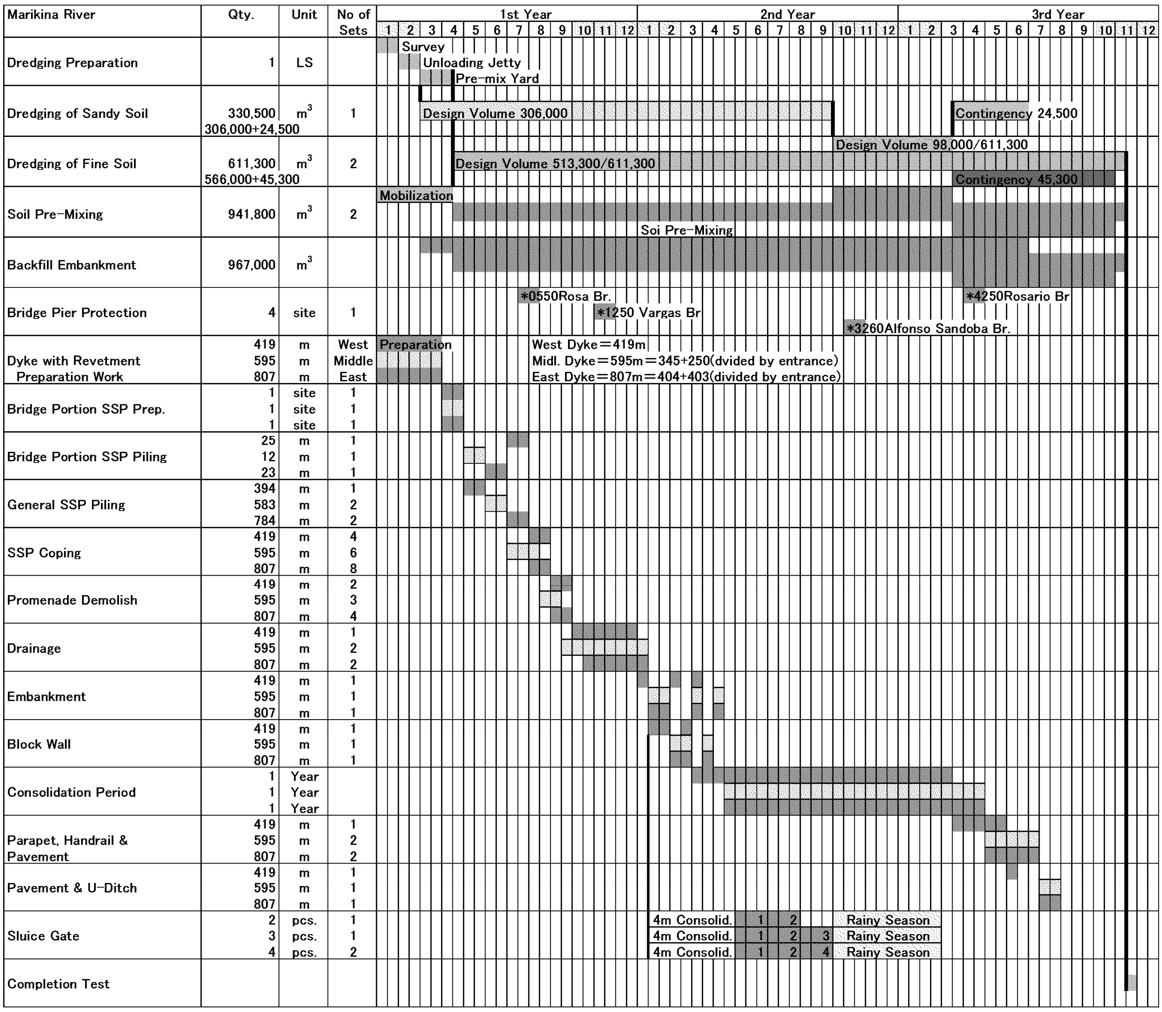
The construction schedules for the Pasig River and the Lower Marikina River are as shown in **Table R 6.5.1** and **Table R 6.5.2**, respectively. The construction could be completed in three (3) years. Detailed program for Psig river and Lower Marikina river is indicated in **Figure 6.5.1** and **6.5.2**.

Table R 6.5.1 Construction Schedule for Pasig River



Pasig River	Qty.	Unit	No of Sets
SSP Procurement			
SSP Piling	6,735	m	1
Drainage behind Revetment	6,735	m	8
RC Flood Wall for SSP	6,735	m	8
RC Flood Wall	1,785	m	1
RC Flood Wall (Stairs)	980	m	1
Repair Work	450	m	
Completion Test			

Table R 6.5.2 Construction Schedule for Lower Marikina River



6.6 Quality Control Management

6.6.1 General

The Contractor shall be responsible for ensuring that the Works comply with the specified requirements. It shall also maintain an effective and adequately documentation system of Quality Management necessary to satisfy the Contract requirements. The Contractor shall see to it that with each procedure only acceptable work is delivered to the Employer.

The Engineer shall inspect the Contractor’s system of Quality Management, monitor its implementation and instruct any modification when he considers it is necessary.

6.6.2 Staffing

For the duration of the Works, The Contractor shall employ accredited Quality Control Engineer, and sufficient staff to carry out the inspections, testing, etc., required by the Contract. These staff shall have no involvement in other functions such as programming or managing the Works and shall be employed solely on quality assurance functions.

6.6.3 System and Procedures

The Contractor shall:

- implement a quality system which complies with the requirements of ISO 9001 and includes a Quality Manual and Procedures as required by ISO 9001;
- provide a Quality Plan which encompasses the planning requirements of ISO 9001 and the requirements set out in the Specifications;
- within 28 days of the Commencement Date, submit three controlled copies of the current edition of the Quality Manual and the first edition of the Quality Plan to the Engineer for approval;
- review the Quality Plan monthly and revise it when necessary to address changes in the construction process and promptly submit the revised Quality Plan to the Engineer for approval; and
- review the Quality Manual, if necessary, and promptly submit any revision to the Engineer for approval.

6.6.4 Control of Non-Conformance

A “Non-Conformance Report” is a report issued by the Contractor when a non-conformance with the contract specification occurs. The report must summarize in what manner the non-conformance does not comply with the contract specification and shall attach relevant inspection and test records. It must also include the Contractor's proposed disposition (e.g., accept as is, rework or replace).

In the event of a non-conformance related to the Specification and the Contractor does not take appropriate action when informed, the Engineer shall issue a Corrective Action Request (CAR) to the Contractor. The Contractor shall respond by issuing a Non-Conformance Report which shall indicate the proposed method of disposition.

The Contractor shall review and analyze the cause of all non-conformances and develop a plan of corrective action to minimize the likelihood of recurrence. Details of such corrective action shall be entered in a non-conformance report.

6.6.5 Subcontractors

The Contractor shall be fully responsible for the integration of all subcontractors' quality systems into its own system, or alternatively for the subcontractor to work within the Contractor's Quality Plan.

The Contractor shall be the single point of responsibility for the production, implementation and auditing of the quality system required under the Contract.

6.6.6 Amendments

The Engineer may at any time instruct the Contractor to amend the Quality Manual or Quality Plan. The Contractor shall thereupon promptly amend the Quality Manual or Quality Plan and resubmit it to the Engineer for approval.

6.6.7 Testing of Materials

The Contractor is responsible for ensuring that the testing, inspection and examination necessary to verify conformance with the Contract is undertaken.

The Contractor shall provide, maintain and operate until the completion of the Works a laboratory complete with furnishings, fixtures and equipment sufficient to carry out all required quality control testing. Alternatively, the Contractor may nominate a commercial testing laboratory where the testing can be carried out. Such an alternative laboratory shall only be used with the specific approval of the Engineer.

The laboratory shall be provided within 56 days of the Commencement Date and the Contractor shall utilize the services of the BRS of DPWH for testing until the laboratory is operational.

6.6.8 Quality of Materials and Samples

Before placing any order for materials for incorporation in the Works, the Contractor shall submit to the Engineer for information the names of the firms supplying materials giving the origin, manufacturer's specification, quality, weight, strength and description. When requested, the Contractor shall provide such samples and test certificates as the Engineer may require.

6.6.9 Quality Records and Reports

The Contractor shall maintain a system of records that provides objective evidence that the requirements of the Contract have been met. The Contractor shall ensure that subcontractors’ records pertinent to the Contract are included in this system.

All applicable records shall be available for audit and review by the Engineer during the period of the Contract and for at least certain years after the date of Taking-Over.

The Contractor shall provide a monthly quality report to the Engineer containing the following:

- Identification of all work in progress; and
- Details of all actions taken on the Quality System since the last monthly report.

CHAPTER 7 COST ESTIMATE

7.1 Cost Estimation Conditions

The following are the conditions for cost estimation:

- Type of Scheme: Japan's ODA Loan Scheme (STEP: Special Terms for Economic Partnership),
- Procurement Conditions: Prime contractors must be Japanese firms. Subcontractors may be from any country.
- Procurement of Goods and Services under STEP: Not less than 30% of the total amount of contracts (excluding consulting services) must be from Japan or provided by Japanese firms.
- Procurement Method: International Competitive Bidding (ICB).
- Contract Method: Unit-Cost Contract with Bill of Quantities (BOQ)

7.2 Basic Conditions of Cost Estimate

7.2.1 Price Level

The cost estimates are updated on the price level as of November 2012.

7.2.2 Exchange Rate

Exchange rates are referred to the monthly average in November 2012 of Central Bank of the Philippines.

1.0 PHP = 1.968 JPY
1.0 USD = 80.940 JPY = 41.123 PHP.

7.2.3 Currency for Cost Estimates

The project cost component shall consist of foreign currency and local currency portions. Philippine Peso shall be used for both the local and foreign currency portions.

The classifications of foreign and local portions are as given below.

7.2.3.1 Local Currency Portion

- All Labor Costs
- Cost of construction material and equipment lease locally procured;
- Value Added Tax (VAT)

7.2.3.2 Foreign Currency Portion

- Cost of construction materials, equipment and services procured from Japan and/or third countries

7.2.4 Reference Guidelines/Manuals

The cost estimates are referred to the following guidelines/manuals indicated below:

- DPWH Department Order No. 72, Series of 2012 (Amendment to D.O. 29 Series of 2011 Re: Revised Guidelines on the Preparation of Approved Budget for the Contract)
- DPWH Department Order No. 71, Series of 2012 (Guidelines for the Establishment of Construction Materials Price, Standard Labor and Equipment Rental Rates Data Base)
- DPWH Department Order No. 03, Series of 2010 (Guidelines on the Acquisition of Motor Vehicles for Use in Infrastructure Project Supervision)
- DPWH Department Order No. 46, Series of 2007 (Application of Daywork and Provisional Sum Items in Contract Management)
- Civil Engineering Work Estimation Standard for Ministry of Land, Infrastructure, Transport and Tourism of Japan
- Ports and Harbors Work Estimation Standard for Ministry of Land, Infrastructure, Transport and Tourism of Japan

7.3 Methodology of Cost Estimate

Costs for construction works are essentially estimated on the unit price basis. The construction cost consists of direct cost and indirect costs. The direct cost consists of equipment, material and labor costs. Indirect cost includes overhead expenses, contingencies, miscellaneous expenses, contractor's profit margin and VAT.

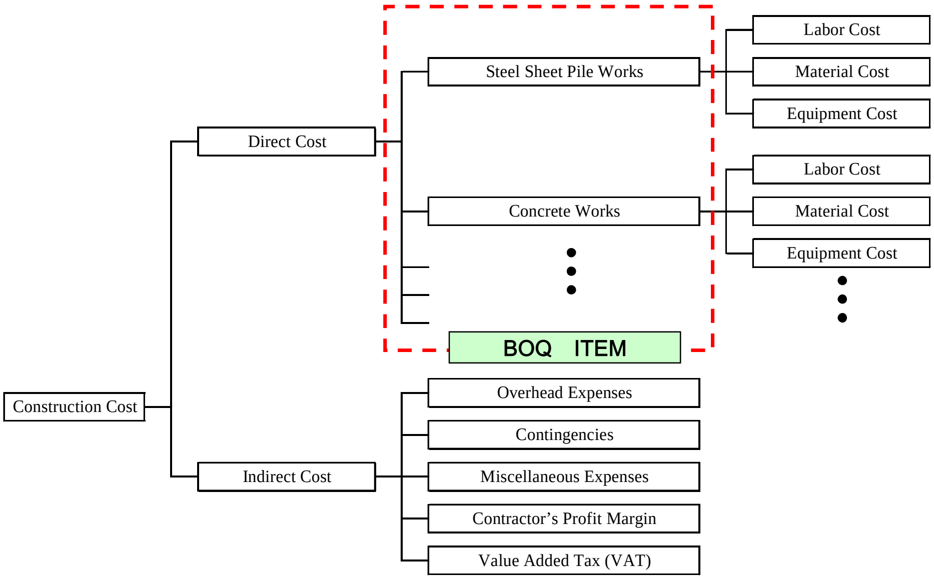


Figure R 7.3.1 Composition of Construction Cost

Composition of the unit price as well as production rates are basically referred to the past construction records in the Philippines and on the approved cost estimate report by the DPWH, such as the Pasig-Marikina River Channel Improvement Project, Phase I and Phase II. Moreover, the adopted unit price is verified by the unit price analysis from DPWH as well as from Japanese estimation standards.

The composition of unit price is as described below.

7.3.1 Direct Cost

7.3.1.1 Labor Cost

The labor rates are estimated based on the minimum labor rate approved by the Department of Labor and Employment (DOLE) – National Capital Region (NCR). The labor wages used in the cost estimates include leave, bonus, Social Security System (SSS), Phil Health, Pag-ibig Fund, and all other mandatory benefits, all in accordance with the Labor Code of the Philippines.

7.3.1.2 Material Cost

In accordance with the "DPWH Department Order No. 72, Series of 2012," allowance for waste and/or losses shall not exceed 5% of materials requirement.

On the other hand, the "Manual on Design and Cost Estimates for JICA Preparatory Study, March 2009" mentions the allowance as follows:

- Re-Bars : 8%
- Form : 7%
- Unreinforced Concrete : 6%
- Reinforced Concrete : 6%

Based on DPWH Department Order No. 72, the allowance adopted in this project is 5%.

The costs of construction materials and supplies including the delivery cost to the site were obtained mostly from local suppliers in Metro Manila. Material procurement from Japan is considered if Japanese technology is applied, including transportation cost from Japan to the site.

The costs for locally produced and supplied materials cost were estimated based on the quarterly updated report by the Price Monitoring Committee (PMC) of DPWH, and on the obtained quotations from the three (3) or more suppliers or distributors.

7.3.1.3 Equipment Cost

The hourly-operated rental rates issued by the Association of Carriers and Equipment Lessors, Inc. (ACEL) through its Equipment Guidebook are presently applied for DPWH projects. This book as well is being used in this Project for the equipments considered in the unit price analysis.

For the special equipment and machinery, such as water-jet machine and drilling equipment for hard soil strata, their operation costs have been estimated with reference to the "Depreciation Estimate Table of Construction Machinery and Equipment" by the Japan Construction Mechanization Association (JCMA).

In accordance with DPWH Department Order No. 72, Series of 2012, "Mobilization and Demobilization shall be treated as a separate equipment cost. The amount shall not exceed 1% of estimated direct cost". This percentage of the estimated direct cost has been referred in this project.

7.3.2 Indirect Cost

The computation of indirect cost has been referred to "DPWH Department Order No. 72, Series of 2012" as well as the past yen-loan-financed project, as prescribed below:

7.3.2.1 Overhead Expenses

Overhead expenses range from 5 to 8% of the estimated direct cost, which includes Engineering and Administrative Supervision, Transportation Allowance, Office Expenses (for office equipment, power and water consumption, and maintenance), Premium on Contractor's All Risk Insurance (CARI), Financing Cost (Premiums on Bid Security, Performance Security, Surety for Advance Payment and Warranty Bond for one (1) year).

7.3.2.2 Contingencies

Contingencies range from 0.5 to 3% of the estimated direct cost. These include expenses for meetings, coordination with other stakeholders, billboards, stages during ground breaking and inauguration ceremonies, and other unforeseen events.

7.3.2.3 Miscellaneous Expenses

Miscellaneous Expenses range from 0.5 to 1% of the estimated direct cost. These include laboratory tests for quality control and plan preparation.

7.3.2.4 Contractor’s Profit Margin

Contractor’s Profit Margin shall be 8% and 10% of the estimated direct cost for projects costing above five (5) million pesos and for projects of up to five (5) million pesos, respectively. As a result of the cost estimate, the computed direct cost exceeded to five (5) million pesos. Hence, the Contractor’s Profit Margin shall be 8%.

7.3.2.5 Value Added Tax (VAT)

VAT component shall be 12% of the sum of Estimated Direct Cost, Overhead Expenses, Contingencies, Miscellaneous Expenses and Contractor’s Profit Margin.

The percentages of the Estimated Direct Cost regarding, Overhead Expanses, Contingencies, Miscellaneous Expenses and Contractor’s Profit Margin are as given in the table below.

Table R 7.3.1 Indirect Cost List by Estimated Direct Cost

Estimated Direct Cost	Indirect Cost (%)*		Total Indirect Cost excluding VAT (%)*
	Overhead, Contingencies, Miscellaneous Expenses (%)*	Contractor’s Profit Margin (%)*	
Up to 5 Million Pesos (MP)	12	10	22
Above 5 MP up to 50 MP	9	8	17
Above 50 MP up to 150 MP	7	8	15
Above 150 MP	6	8	14
* Percentage of Estimated Direct Cost			

7.4 Composition of Project Cost

Project Cost consists of construction cost, consulting services cost, compensation cost, administration expenses, and contingencies.

7.4.1 Construction Cost

The composition of Construction Cost is as stipulated in Section 7.3 . Each item quantity in the BOQ shall be multiplied by the unit price derived. The sum of the estimated direct cost and the indirect cost is the construction cost of the Project

Imported materials are counted as STEP materials.

7.4.2 Consulting Services Cost

The Consulting Services Cost is composed of construction supervision cost excluding detailed engineering design cost.

7.4.3 Compensation Cost

Compensation Cost consists of land acquisition, resettlement, structural improvement and tree cutting are estimated based on the outsourcing survey results.

7.4.4 Administrative Cost

In accordance with the internal regulations of DPWH, the administrative cost is computed at three and a half percent (3.5%) of the total of construction cost, consulting services cost and compensation cost.

7.4.5 Physical and Price Contingencies, and Price Escalation

7.4.5.1 Physical Contingency

The physical contingency for unforeseen conditions is assumed at about five percent (5%) of the sum of construction cost, consulting services cost and compensation cost.

7.4.5.2 Price Contingency and Price Escalation

The annual inflation rates applied for the price contingency are:

- 4.0% for local currency portion
- 1.6% for foreign currency portion

7.5 Estimated Construction Cost

The estimated construction cost is referred to “1.4 Summarization of Construction Cost” in “VOLUME-V COST ESTIMATE”.

CHAPTER 8 PROJECT EVALUATION

8.1 Evaluation of the Project

Project evaluations are based on the technical, social and environmental point of view, the results of which proved the viability of the project. Economic evaluation was conducted during the Preparatory Study (2011) and will not be included in this report.

8.2 Technical Evaluation of the Project

The typical structures being proposed including the revetment with steel sheet pile, parapet wall, and drainage facilities were already done during Phase II project implementation. Therefore it can be said that the facilities are proven feasible for the particular river conditions in this project.

The utilization of dredged sediment as earth embankment materials was given careful consideration and is now recommended, on the basis of new sampling and laboratory analysis undertaken in this D/D Study. Results of this recent water quality and sediment study showed that none of the samples exceeded the DENR standard for heavy metals.

The critical path of this project involves the construction of the steel sheet pile revetment works for Pasig River and dredging works for Marikina River. The target completion is within three (3) years.

The proposed improvements are basically common flood control structures in the Philippines. The project management agency (DPWH-PMO-MFCP I) will conduct a regular inspection and monitoring of the construction, operation and maintenance activities.

8.3 Social and Environmental Evaluation of the Project

8.3.1 Assessment of Project Impacts

Overall, the project will generate significant socio-economic benefits by reducing potential flood damages on individual households and business sectors in Metro Manila where approximately 33 percent (33%) of the country’s GDP is generated.

The involuntary resettlement of people who will be affected by the construction of the river structures will be minimized by restricting the extent of river works, as far as possible, within the publicly owned land and avoiding damage to existing houses and other improvements.

The sampling and analysis of riverbed sediments was done at 100 m intervals along the Lower Marikina River. The purpose is to evaluate whether or not the sediments to be dredged are contaminated. Preliminary results of the Study have confirmed that as far as heavy metals is concerned, the levels detected were way below the threshold criteria.

Table R 8.3.1 below shows the temporary or short-term environmental impacts identified during the 1998 Master Plan Study and reviewed in this Study. The negative environmental impacts are predicted and summarized below for further consideration of their mitigation. The project site is either within or near three types of Environmentally Critical Area (ECA): areas hard-hit by natural calamities (project site), tourism area, and water bodies for domestic and wildlife/fishery support (Laguna Lake), while this area is not included in the National Integrated Protected Area System (NIPAS).

Table R 8.3.1 Assessment of Negative Impacts

Items			Negative Impact		Explanations
			EIS (98)	This Review	
Social Environment:	1	Involuntary Resettlement	—	A	Resettlement is necessary along the Pasig River. The number of resettlement is under investigation. Survey is also being conducted for the backfill site.
	2	Local Economy such as Employment and Livelihood, etc	—	D	There are no negative impacts expected due to construction activities.
	3	Land Use and Utilization of Local Resources	—	D	Since project area is already urbanized, no negative impacts might be anticipated for change in land use and utilization of local resources.
	4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	—	D	Since construction activities are limited to the narrow strips along the river in urban environment, no negative impacts on existing community activities or services could be anticipated.
	5	Existing Social Infrastructures and Services	D	B	Several infrastructures such as covered courts and ferry stations are recognized within the work areas. River navigation might be affected slightly during the construction phase, but will be greatly improved after the dredging work of the Lower Marikina River. Use of existing liner parks along the Lower Marikina River will be affected due to the construction work of revetment and the re-construction of pavement.
	6	Poor, Indigenous and Ethnic People	—	D	Livelihood of general low income people is not dependent on resources from the rivers, such as fish and drinking water. Also, no Indigenous and Ethnic People were identified.
	7	Misdistribution of Benefits and Damage	—	D	Residents in the project affected area do not think construction work is a problem for their daily life according to the interview conducted.
	8	Cultural heritage, historical and religious sites	—	D	No cultural heritage sites or spiritually important places are identified in the project affected areas.
	9	Local Conflicts of Interest	—	D	No negative impact on local conflict could be predicted based on the information of Phase II Project.
	10	Water Usage or Water Rights and Communal Rights	—	D	There are no people who depend on river water for drinking water, irrigation, etc.
	11	Sanitation	—	B	Inadequate sanitation during construction will be a major cause of disease and dirty the area.
	12	Hazards (risk) Infectious Diseases such as HIV/AIDS	—	D	Almost no demand is anticipated for commercial sex workers who are potentially HIV positive and might spread the disease, based on the result of Phase II Project.
Natural Environment	13	Topography and Geographical Features	—	D	In the construction, dredging of river bed and filling low-lying area with dredged materials are planned. However, such works are conducted in the limited scale.
	14	Soil Erosion	—	D	During the construction, no soil erosion which affects on wide area by earth excavation might occur.
	15	Groundwater	—	D	No changes in volume, flow direction, lowering water level, etc., for groundwater are anticipated.

Items			**Negative Impact**		**Explanations**
			EIS (98)	**This Review**	
Natural Environment	16	Hydrological Situation	—	D	Revetments are planned to be constructed along the existing river banks. Although the channel will be deepened by the dredging, there is no change in normal water level because dredged section is within tidal affected area of Manila Bay. Thus, no change in hydrological situation is anticipated by the project.
	17	Coastal Zone	—	D	No damage to coastal zone is anticipated since the site is far from coastal zone.
	18	Flora, Fauna and Biodiversity	—	D	Construction works will damage some terrestrial flora, which can be naturally revived in time. No endangered or concerned species are identified in the construction affected area.
	19	Meteorology	—	D	Not affected or least likely affected by the construction work.
	20	Landscape	—	D	Dike will be heightened to small extent in a part of the construction area, where the view might be limited slightly.
	21	Global Warming	—	D	Not affected or least likely affected by the construction work.
Pollution Measures	22	Air Pollution	D	B	Exhaust and fumes from construction machinery will add pollutants to the air, but the pollution will be very light, temporary, and localized, and it will not be as significant an issue as the already heavily polluted air in Metro Manila Area. As Phase II project monitoring results show that exhausts from machineries and vehicle used for the construction works are likely just infusing with the existing air pollution in the area. More dust will be generated due to construction activities such as spreading and backfilling at the backfill area especially during dry season.
	23	Water Pollution	B	B	Dredging may cause temporary pollution by temporary increase of suspended solids and increase turbidity.
	24	Soil Contamination	D	D	The results of sediment analysis of this Study showed below the criteria. Thus, basically no soil/groundwater contamination will occur at the disposal site. However, Cr (VI) might be eluted from cement when treating sediment with cement.
	25	Wastes (including Dredged Material)	B	B	In the project construction period, generation of garbage, demolished structures, dredged material (about 900,000 m^3), etc. are expected.
	26	Noise and Vibration	B	B	During construction period, construction activities could generate noise and vibration to surroundings, but the pollution will be very light, temporary and localized, and it will not be as significant an issue as the already existing ones in the Metro Manila area. Phase II project monitoring results show that the machineries and vehicle used for river channel improvement work least likely aggregate already existing noise and vibration.
	27	Ground Subsidence	—	D	No ground subsidence was reported in Phase II. Also, the same result is expected for Phase III. No ground water extraction is planned in the construction.
	28	Offensive Odor	C	D	During the sediment sampling of this Study, almost no odor was felt from sediment.
	29	Bottom Sediment	—	D	Since the dredging works remove polluted sediments of river, no pollution of bottom sediments is predicted.
	30	Accidents	—	B	In the project construction period, construction related accidents might occur.

A: Significant impact, B: Slight impact, C: Unknown, D: Few impact. — : Not Applicable

*EIS (1998) did not use JICA's method to evaluate the impact using "A, B, C and D". Evaluation results of EIS (1998) were converted to JICA's method.

8.3.2 Social and Environmental Mitigation Measures and Monitoring during Phase III Construction Stage

Table R 8.3.2 summarizes the possible impact mitigation measures that will be considered against the predicted negative environmental impacts relative to the Phase III construction works. The EIS on the backfill site was submitted to DENR on December 6 ,2012 and ECC was issued on February 4, 2013.

Table R 8.3.2 Mitigation Measures for Negative Impacts during Phase III Construction Works

Items			Impact Evaluation	Mitigation Measures
Social Environment	1	Involuntary Resettlement	A	The resettlement of and compensation for Project Affected People (PAP) will be implemented according to the Resettlement Action Plan prepared in accordance with JICA Guidelines/World Bank's safeguard policies.
	2	Local Economy such as Employment and Livelihood, etc	D	Hire local construction workers first in priority in coordination with construction contractor and Barangay captains.
	3	Land Use and Utilization of Local Resources	D	Not necessary
	4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	D	Not necessary
	5	Existing Social Infrastructures and Services	B	Sufficient community consultations and careful phasing of construction works will be necessary to minimize the negative impacts on the public structures within the work areas and their functions. Make a good coordination with Coastal Guard, related LGUs and Barangays on operations time between the barges, ferry, and boats and construction equipment so that the negative impacts on river navigation from dredging activities and construction operation will be minimized. During construction of revetment and re-construction of pavement along the Lower Marikina River, temporary access will be provided for the residents, based on the consultation with related LGUs, Barangays and local residents ahead of time.
	6	Poor, Indigenous and Ethnic people	D	Not necessary
	7	Misdistribution of Benefit and Damage	D	Not necessary
	8	Cultural heritage, historical and religious sites Recreational area	D	Not necessary
	9	Local Conflicts of Interest	D	Not necessary
	10	Water Usage or Water Rights and Communal Rights	D	Not necessary
	11	Sanitation	B	Install sanitary facilities at each construction site and conduct the cleaning and disposal of them regularly by construction contractor.
	12	Hazards/ Risk; Infectious Diseases such as HIV/AIDS	D	Hold seminars for educating construction workers by a construction contractor.

Items			**Impact Evaluation**	**Mitigation Measures**
Natural Environment	13	Topography and Geographical Features	D	Not necessary.
	14	Soil Erosion	D	For small scale of erosion, excavation works should be conducted properly in accordance with the design of civil works for stability.
	15	Groundwater	D	Groundwater quality should be monitored at least for Cr^{6+} and pH at the backfill site.
	16	Hydrological Situation	D	Not necessary
	17	Coastal zone	D	Not necessary
	18	Flora, Fauna and Biodiversity	D	Not necessary
	19	Meteorology	D	Not necessary
	20	Landscape	D	Not necessary
	21	Global Warming	D	Not necessary
Pollution	22	Air Pollution	B	Air quality is monitored as the same as Phase II especially at the backfill site. Fumes and exhaust from machinery and equipment used for Project can be reduced or prevented by properly installed and maintained mufflers and filters. CO_2 level is suppressed by frequent and timely changing of machine/engine oil and stopping excessive idling of engines. Hosing of ground/cover-sheets are done during earth work in order to prevent dust from dispersing into the air. Regular water sprinkling using tank lorries to exposed areas at the backfill site especially during dry weather.
	23	Water Pollution	B	Due to rapid flowrate of Marikina River water, erosion control measures such as putting of steel sheets, gabions, or watertight eco-grab techniques during dredging may be difficult to implement, thus, regularly monitoring on turbidity and other regulated parameters will be conducted instead. The final measure is to ensure that the contractor uses; (i) good construction practices (ii) that major excavation work are scheduled during the low flow season and (iii) that a Site Soil Protection and Rehabilitation Program is included within the Contract Documents and is the Contractor's responsibility
	24	Soil Contamination	D	For dredged materials, cement will be added to stabilize the fine dredged sediments. The dredged materials were found to be free from leached contaminats, however leaching from dredged materials at disposal/backfill site will still be monitored during and even after the implementation phase.
	25	Waste	B	Generated solid wastes/sediments are taken care of according to Republic Act 9003. Construction debris and work related garbage are transported to the construction contractor's office unit, separated properly, and received for disposal by a licensed treater. Eco-tube or cement-base pre-mix method for solidification can be used properly as mentioned above. Create a waste monitoring plan and manage the waste based on the plan.
	26	Noise and Vibration	B	Noise and vibrations are reduced by using machines installing mufflers/noise reduction devices. If necessary, construction work that generates nuisance noise and vibration should be operated during less noticeable/affective times. Inform and get understanding from the residents who may be affected.
	27	Ground Subsidence	D	Not necessary
	28	Offensive Odor	D	Not necessary
	29	Bottom Sediment	D	Not necessary
	30	Accidents	B	Inform the concerned people of off-limit or dangerous area on bulletin boards or via Information, Education and Campaign (IEC) Educate workers and residents on the environment and safety of the construction workplace.

A: Significant impacted, B: Slight impact, C: Unknown, D: Few impact. — : Not applicable.

*EIS(1998) did not use JICA's method to evaluate the impact using "A, B, C and D". Evaluation results of EIS (1998) were converted to JICA's method.

CHAPTER 9 STUDY ON PLAN OF OPERATION AND MAINTENANCE

9.1 General

9.1.1 Purpose of Operation and Maintenance

Even if the flood control facilities have been completed, the facilities become old and damaged by flowing water, heavy rainfall, man-made, dumping garbage, illegal encroachment, siltation, erosion, scouring during long time.

The Operation and Maintenance (O&M) is an important component of the Flood Control Project to achieve and maintain project purposes. Inadequate maintenance of the completed flood control works will lead to an increase in the risk of flooding.

The purposes of O&M are itemized below:

(1) For public safety
(2) To promote public welfare
(3) To use waterways appropriately
(4) To flow floods in safety without any obstruction
(5) To ensure that the facility is operated according to the planning/design
(6) To extend the useful life of the facilities constructed
(7) To protect the environmental landscapes

9.1.2 Necessity of Operation and Maintenance Plan

The O&M Plan gives the guideline to ensure the effective, efficient and sustainable operation and maintenance. The O&M Plan may target 5-year duration. The said established Plan should be reviewed and revised based on the accomplishment of O&M activities. In addition, annual action plan for O&M should be prepared based on the established O&M Plan.

9.1.3 Scope of Operation and Maintenance Plan

The object of O&M Plan is the channels and facilities which are to be improved/constructed under the Phase III Project. Existing facilities which were constructed previously under the several projects including Phase II Project are basically not considered. The O&M Plan for Phase II will be prepared under the Consulting Services of Phase II. The O&M Plan in considering both Phase II and III should be prepared when the Phase III is completed

9.1.4 Approach for Operation and Maintenance

In order to ensure purpose of flood control, target for maintenance of channel and facilities shall be set up, considering the required functions of facilities, appropriate use of river area, and good river environment, etc.

To achieve the target, the present conditions of river area and facilities are to be confirmed through patrol and inspection. Based on the patrol and inspections conducted, operation and maintenance works should be carried out.

9.1.5 River Basin Conditions and Facilities of Phase III Project

(1) River Basin Conditions

The following table shows the present conditions of river basin and channels taking into O&M account:

Table R 9.1.1 Conditions of Pasig-Marikina River

	Item	Description
1	Natural Condition of River Basin	a) Basin Area: 635km^2 (20% in Metro Manila) b) Climatologic Region: Type I (Rainy Season from May to October. Dry Season from November to April) c) Annual Rainfall: 3,000mm in mountain area and 2000mm in low-land area.
2	Natural/Social Conditions along River Channel Areas	a) Topography Topographic features along the Pasig River compose of reclaimed land, sand bar/spit, delta, flood plain and hill from downstream and area along the Marikina River featuring flood plain area, natural levee and mountain area. b) Geology Volcanic pyroclastic sediment Guadalupe Formation and alluvial deposits consisting of clay, sand and gravel. c) Vegetation There are only few trees in the river areas. d) Population in Metro Manila：over 11million e) Number of City/Municipality in Metro Manila：16 Cities and 1 Municipality f) Cities along the Stretches to be Improved: 7 cities – Manila, Makati, Mandaluyong, Pasig, Quezon, Marikina, and San Juan g) River Bank Area: Urban congested areas
3	Features of River Channels	a) Pasig River - 700m River Mouth up to Delpan Bridge: Utilization as wharves for port of Manila - River Channel Length to be Improved: 17.1km - Average Channel Slope: 1/10,000 - River Width: 60m to 250m - Channel Depth: 6m to 12m - Utilization for Navigation - Many Factories with Wharves - 11 big-scale and 6 small scale pumping stations along the river to discharge inland rainwater b) Marikina River - River Channel Length to be Improved up to Marikina Bridge: 13.3km - Average Channel Slop: 1/5,000 - River Width:70m-200m - Channel Depth: 4m to 9.5m - Natural levees on both banks - No Utilization of Channel except for few Wharves and Drainage
4	River Environment	a) Pasig River PRRC has been conducting riverbank development. Environmental Preservation Areas with 10m easement along the whole stretch of Pasig River have been developed into continuous linear parks, river-walks and promenades. Also, improvement of the water quality of the river is initiated by PRRC. b) Marikina River City Governments of Pasig and Marikina have undertaken the beatification along the banks of Marikina River as parks. Relocation of informal settlers along the river has being carried out.

9.1.6 Facilities along the Channels of Pasig River and Lower Marikina River

The following facilities are to be constructed under the Phase III Project:

Table R 9.1.2 Types of Structures to be Constructed under Phase III Project

River	Structure Type	Remarks
1. Pasig River	1) Steel Sheet Pile Revetment	a) Steel Sheet Pile only b) Steel Sheet Pile with H-beam c) Painting for Corrosion Protection
	2) Floodwall	Reinforced Concrete
	3) Riprap	Stone
	4) Stone Masonry Revetment	Repairing Existing Stone Masonry Revetment
	5) L-type Retaining Wall (Parapet Wall)	
	6) Concrete Block Pavement	
	7) Drainage Facilities	Drainage canal and outlets along Floodwall and Pavement
2. Lower Marikina River	8) Dredging	Channel deepening
	9) Steel Sheet Pile Revetment	Steel Sheet Pile only
	10) Floodwall	Reinforced Concrete
	11) Dike Embankment	Slopes to be Covered by Steel Sheet Pile Revetment and Concrete Block Wall
	12) Concrete Block Retaining Wall	Land side for Protection of Dike Embankment
	13) Asphalt Pavement	Top of Dike
	14) Foot Protection of Bridge Pier	Bottle Unit
	15) Drainage Facilities	Box/Pipe Culverts and Open Canal along Dike Embankment

9.1.7 Organizational Setup for O&M

(1) Agreement between DPWH and MMDA on O&M

A Memorandum of Agreement (MOA) was executed in July 9, 2002 between DPWH and MMDA which was supplemented by issuance of the Guidelines for the Transfer of Flood Control Responsibilities in Metro Manila in August 2002. These documents stipulate the institutional commitments for the transfer of responsibilities from the DPWH to the MMDA for the operation and maintenance of the completed flood projects.

MOAs for implementation of Phases II and III stipulates that after completion of the Project and its acceptance by DPWH, it will be turned over to the MMDA and all necessary measures shall be undertaken to ensure its proper and efficient O & M management. Above concern was confirmed by MOA between DPWH, MMDA, and PRRC on January 2012.

In order to confirm the coordination, DPWH and MMDA shall enter into a supplemental MOA on O&M including the following information during the implementation of the Phase III Project, at least one (1) year prior to the completion;

(a) Specification of demarcation of the roles and responsibilities and a coordination framework between DPWH and MMDA on O&M of the structures.

(b) O&M Manual including explanation of specific activities/works and necessary budget for the budget for the next ten (10) years.

9.2 MMDA's Organization for Flood Control

The MMDA was established under the Office of the President in 1994, pursuant to Republic Act No. 7924. The total number of MMDA personnel is 7,140 in total, covering 16 cities and 1 municipality of Metro Manila.

The MMDA-Flood Control and Sewerage Management Office (FCSMO) is responsible for flood control. Its mandates include the formulation and implementation of policies, standards, programs and projects for an integrated flood control, drainage and sewerage system.

9.2.1 MMDA Organization on Flood Control

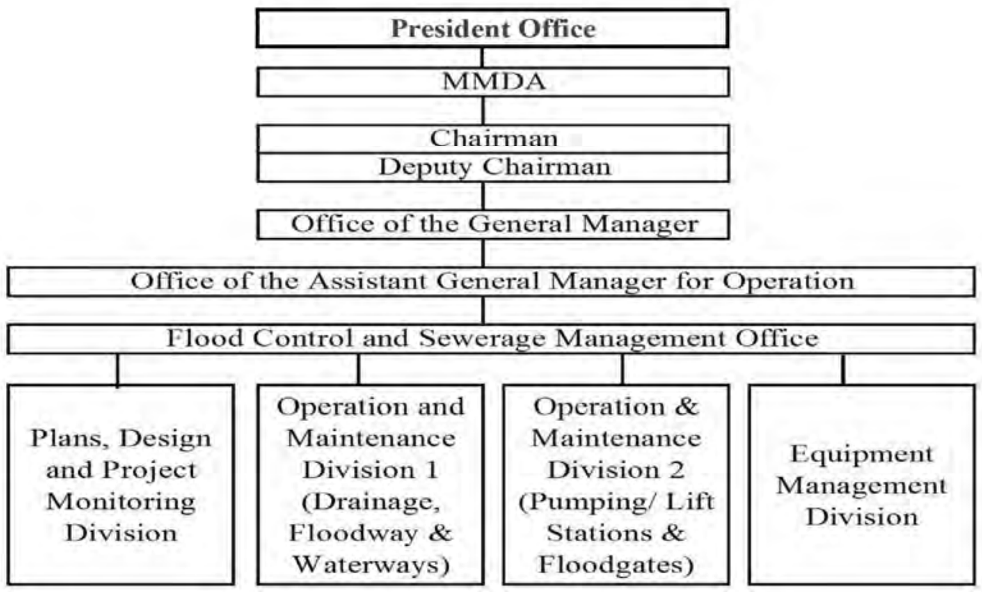


Figure R 9.2.1 Organization Chart of MMDA-Flood Control and Sewerage Management Office

The Division 1 of FCSMO oversees and supervise the operation of eleven (11) Flood Control District Offices; five (5) of which have jurisdiction over the Phase II and Phase III Projects, as shown in below **Table R 9.2.1**.

Table R 9.2.1 List of Flood Control District Offices

No.	Flood Control District	Areas Covered
Along the Pasig-Marikina River Channel		
1	North Manila	Tondo, Binondo and Sta. Cruz in Manila City
2	Central Manila	Sampaloc and Sta. Mesa in Manila City
3	South Manila	Ermita, Malate, Paco, Sta. Ana, San Andres, Port Area, and Intramuros in Manila City
4	First East Metro Manila	Pasig City and Marikina City
5	First South Metro Manila	Pasay City and Makati City
Other Areas		
6	First Quezon City	1st and 2nd Congress Districts in Quezon City
7	Second Quezon City	3rd and 4th Congress Districts in Quezon City
8	Second East Metro Manila	San Juan City, Taguig City and Pateros Municipality
9	Second South Metro-Manila	Las Pinas City, Paranaque City and Muntinlupa City
10	First North Metro-Manila	Malabon City and Navotas City
11	Second North Metro-Manila	Caloocan City and Valenzuela City

Figure R 9.2.3 shows locations of areas covered by the above five district offices along the Pasig-Marikina River. As a example, the following chart (**Figure R 9.2.2**) shows an organization of First East Metro Manila Flood Control District Office.

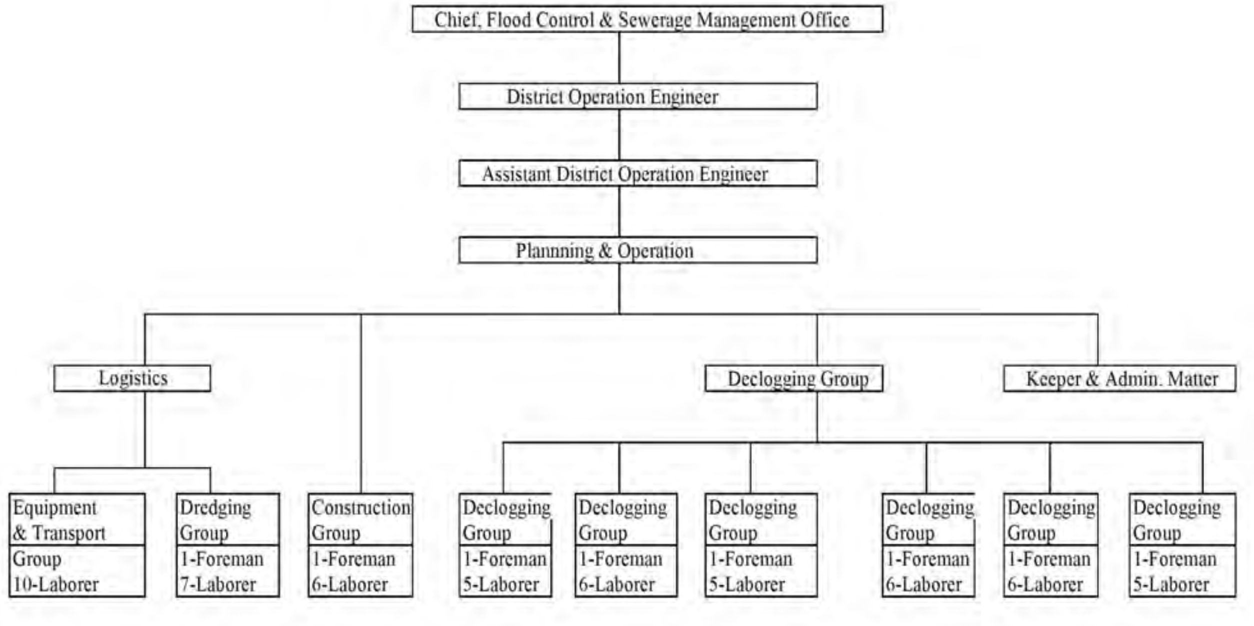


Figure R 9.2.2 Organization of Flood MMDA Control District Office (1st East Metro Manila)

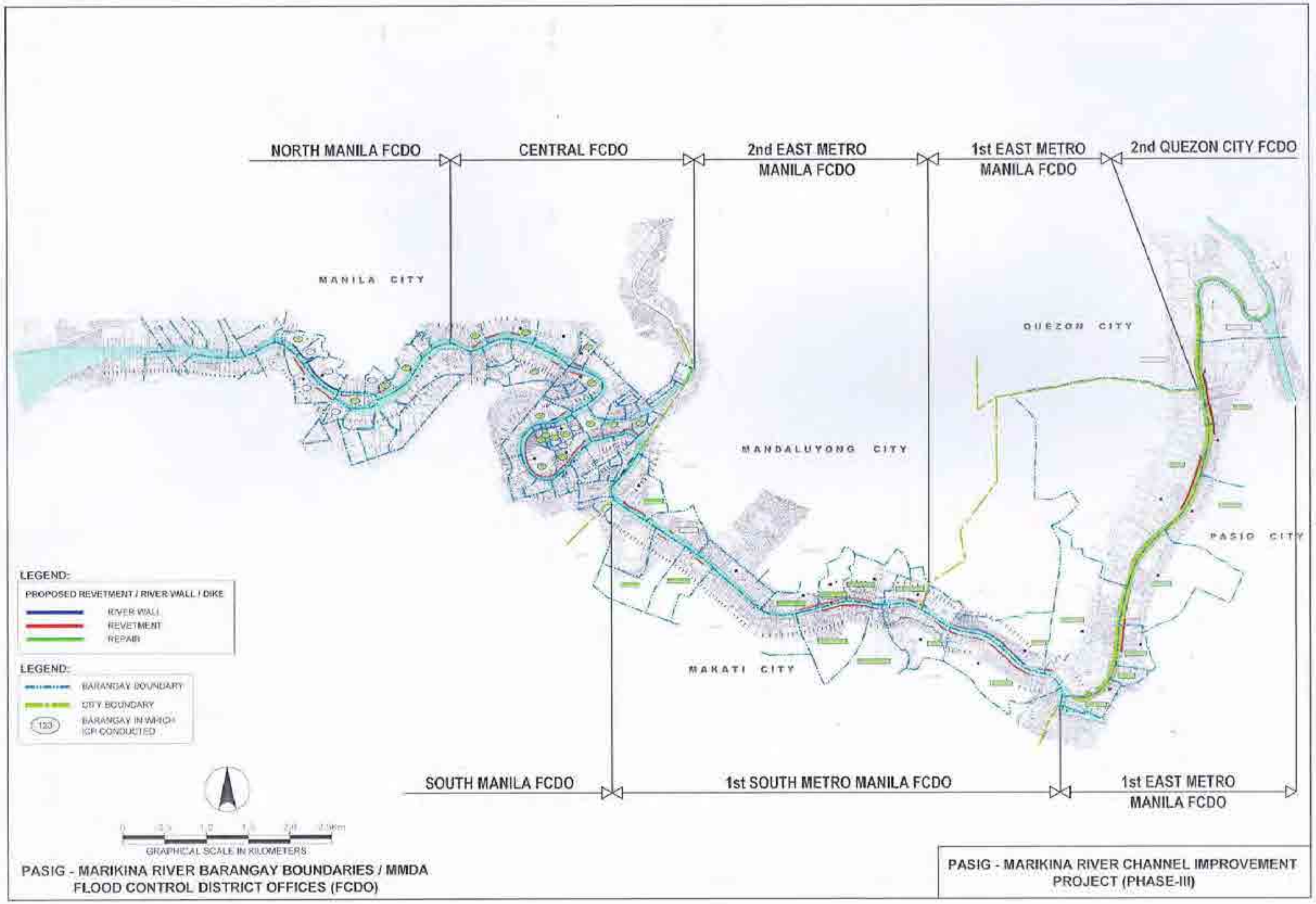


Figure R 9.2.3 Locations of Areas Covered by MMDA Flood Control District Offices

9.2.2 Major Task of Work of Operation and Maintenance Division 1

The Operation and Maintenance Division 1 of FCSMO for Drainage, Floodway and Waterways is directly responsible for operation and maintenance of the facilities to be constructed under Phase III of the Project.

The major task of the Operation and Maintenance Division 1 is the protection of roads/streets of Metro Manila from the inundations and flooding. Specially, this involves the following works:

(a) Dredging and cleaning of waterways
(b) Removal of siltation of drainage Main
(c) Removal of clogging and siltation of drainage laterals and waterways due to indiscriminate dumping of garbage which obstruct the free flow of water.
(d) Repair of drainage mains and laterals
(e) Construction of drainage intakes/outlets

9.3 Personnel of FCSMO

The total number of personnel of the FCSMO is about 1,294, which comprises 18% of MMDA's total workforce, as shown in **Table R 9.3.1**.

Table R 9.3.1 Personnel of FCSMO

Technical	Office	Skilled Workers	Laborers	Total
160	140	320	674	1,294

The MMDA Personnel are categorized by employment status, as below:

Table R 9.3.2 Personnel of FCSMO by Employment Status

	Permanent	Daily Basis (long period)	Daily Basis (short period)	Total
Total	95	658	541	1,294

(Source: Flood Control & Sewerage Management Office of MMDA, as of Jan.2011)

9.4 Equipment for O&M

The equipment of FCSMO are managed by the Equipment Management Division. As of July 2012, this Office has 152 equipment including the major ones identified in **Table R 9.4.1**. Of these equipment, 115 are operational and 37 need repair.

Table R 9.4.1 List of Equipment Owned by MMDA-FCSMO

	Equipment	Type	No. of Unit
1	Dump Truck	2 ton	5
2	Dump Truck	3 ton	10
3	Dump Truck	4 ton	7
4	Dump Truck	10 ton	9
5	Cargo Truck	6W	4
6	Wing Van	10W	4
7	Water Truck	6W	4
8	Vacuum Truck	6W	8
9	Sewer Jet	6W	2
10	Jet Washer		1
11	Sreco Flushing Machine	4W	3
12	Sreco Bucket Machine	2W	2
13	Pumper Truck	6W	4
14	Backhoe/Excavator		28
15	Crane		13
16	Dredger		2
17	Boom Truck/ Wrecker		1
18	Truck Tractor		2
19	Tug Boat		2
20	Generator Set	20,25,45.65KVA	4
21	Hooklift Truck		4
22	Service Vehicle		23
23	Others (Trailer, etc.)		6

9.5 Budget

The annual revenue of MMDA are derived from the following:

- The General Appropriations Act, otherwise known as the National Budget;
- The Internal Revenue Allotment (IRA) from the National Budget
- Five percent (5%) of the total annual gross revenue from each LGU under the jurisdiction of MMDA
- Levies, impositions and charges for various services rendered

Table R 9.5.1 shows the annual budget of MMDA:

Table R 9.5.1 Budget Allocation of MMDA

(Unit: million pesos)

Year	2008	2009	2010	2011	2012
a) National Budget	1,772	1,800	2,075	979	1,374
b) IRA	262	165	198	211	
Total	2,034	1,965	2,273	1,180	1,374

Source: DBM Website

Table R 9.5.2 shows the budget allotted for Flood Control and Sewerage Management Office in the recent years:

Table R 9.5.2 Budget of FCSMC

Year	2008	2009	2010	2011	2012
Budget	568	560	629	559	551

Source: MMDA Flood Control and Sewerage Management Office

9.6 Operation Plan of the Phase III Project

9.6.1 General

Operation of the Phase III project is defined as monitoring, analyzing and evaluating the performance of improved channels and constructed facilities. MMDA will coordinate with DPWH in order to conduct monitoring, analysis and evaluations about a benefit of the project.

9.6.2 Flood Observation System

(1) EFCOS

DPWH has established the observation network of rainfall and water levels in the Pasig-Marikina River Basin by 2011 (EFCOS: Effective Flood Control Operation System). At present, EFCOS composed of the following facilities is managed by the MMDA.

Table R 9.6.1 Facilities of MMDA-EFCOS

	Type of Facilities	Name of Facility
1	1- Master Control Station	Rosario Master Control Station, Barangay Mangahan, Pasig City
2	4- Monitoring Station	(1) DPWH Central Office (2) DPWH-NCR Head Office (3) PAGASA (4) Napindan HCS
3	1- Relay Station	Antipolo Relay Station
4	7- Rain Gauge Station	(1) Boaso-Boso (2) Mt. Campana (3) Aries (4) Mt. Oro (5) Nangka (6) Science Garden (PAGASA) (7) Napindan HCS
5	11- Water Level Gauge Station	(1) Montalban (2) Nagka (3) Sto. Nino (4) Rosario Weir (Marikina River) (5) Rosario Weir (Laguna Lake) (6) Napindan HCS (Marikina River) (7) Napindan HCS (Laguna Lake) (8) Pandacan (9)Fort Santiago (10) San Juan (11) Angono (in Laguna Lake)

(2) PAGASA

PAGASA-KOICA Project aims to construct a flood forecasting and warning system in Pasig-Marikina River basin to supplement the EFCOS project. The result of observation data can be also used for O&M.

9.6.3 Flood Warning System

Flood Warning System (Flood Level) for the Pasig-Marikina River was established by the PAGSA as follows:

(1) Alert (Yellow Color)

If water has been rising continuously beyond this level, there is possibility of flooding in low-lying areas.

(2) Alarm (Orange Color)

If water has reached this level, residents should prepare for possible evacuation due to threat of flooding.

(3) Critical (Red Color)

If water has reached this level, serious flooding is expected.

Table R 9.6.2 Flood Warning Water Levels along Pasig-Marikina River (PAGASA)

(EL.m)

	Water Level Station	Alert (Yellow)	Alarm (Orange)	Critical (Red)
1	Wawa Dam	24.40	25.00	25.60
2	Montalban	22.40	23.00	23.60
3	Burgos	22.40	23.00	23.60
4	San Mateo-1	17.10	17.70	18.30
5	Nangka	17.10	17.70	18.30
6	Mindanao	28.00	29.00	30.00
7	Tumana Bridge	17.10	17.70	18.30
8	Sto. Nino	14.40	15.00	16.00
9	Marcos Highway	13.00	14.10	14.90
10	Rosario JS	12.50	13.20	13.80
11	Rosario LS	12.50	13.20	13.80
12	Napindan-1	10.90	11.90	12.90
13	Napindan-2	10.90	11.90	12.90
14	San Juan School	11.00	11.50	12.00
15	Pandacan	11.00	11.50	12.00
16	Port San Tiago	11.00	11.50	12.00

9.7 Maintenance Works

9.7.1 General

Maintenance works for completed project are defined as evaluating facility function according to the planning/design, extending the useful life of the facilities constructed, and repairing works of facilities damaged/deteriorated.

9.7.2 Target for Maintenance

The targets for maintenance of flood control facilities are set up to prevent the deterioration or damages caused by flooding, earthquake, or vandalism after completion of the facilities which result in the decrease in function of facilities.

	Item	**Maintenance Target**
1	Flow Capacity of Channel	a) Flow Capacity of Channel It is essential to secure the required channel sections for design discharges. b) Design Elevation of Floodwall To upkeep the design elevation of Floodwall which is basic element to secure the flow capacity.
2	Channel Fluctuation	Channel fluctuation such as lowering riverbed, scouring, deposition does not affect the stability of revetment, floodwall, bridge pier protection, drainage facilities, etc.
3	Floodwall	To secure function of facilities from deterioration and deformation.
4	Revetment/ Riprap	
5	Bridge Pier Protection	
6	Drainage Facilities	
7	To Secure River Area	To secure the river area from illegal encroachment, activities, etc., necessary action should be taken.

9.7.3 Patrol and Inspection

Maintenance activities begin with patrol and inspection of present river features and facilities. Periodical inspections to grasp the present condition are basic requirement for sustaining the benefit to be derived from the Project (Phase III). Damages without urgent rehabilitation will hamper effective operation and thereby endanger the stable river condition and increase the vulnerability against further flood damage.

The following activities to obtain the present status of rivers should be done:

	Items	Description
a	Collection of Data/Information	a) Rainfall, Water Levels, Discharge for every flood (PAGASA and MMDA-EFCOS) b) Conduct of River Topographic Survey (basically once a 5-year and once a big flood occurred)
b	Patrol	a) Frequency of the patrols by car, boat or foot shall be at least once a month. b) During flooding period, patrol shall be undertaken to obtain overview of function condition of facilities and flood flow condition.
c	Inspection	Through the inspections, identification of places/facilities where maintenance and repair works are required shall be inventoried. a) Dry Season: conduct of overall inspection b) Flooding: flow direction, velocity, critical channel section, etc., by eye-observation c) After Flood: channel scouring, sedimentation, bank erosion, debris, flood survey including level marked and extended flooded area d) After Earthquake: check of conditions of structures
d	Record/Report	Information obtained through the patrol and inspection shall be reported and recorded. These records are important basic data for future O&M activities. Reports shall be submitted to FMC.

9.7.4 Details of Maintenance Works

Items to be carefully inspected on each facility are described as follows. Based on the detailed inspections, necessity of maintenance/repair works should be judged and carried out.

(1) Secure Channel Flow Capacity (Scouring/Erosion/Deposition/Vegetation/ Man-Induced Causes of Flooding

Reduction in the flood carrying capacity of the river channels may be caused by accelerated watershed erosion and associated sediment accumulation in the rivers. Accelerated erosion occurs due to the removal of natural vegetation cover cultivation. This erosion causes sedimentation in rivers. Sedimentation in rivers results in heightening river beds and this raises the risk of floods.

If deposition in channels affects considerably on designed flow capacity, removal of deposition/sedimentation should be considered.

Decreasing the surface roughness of a channel may be accomplished by removing vegetation and natural or man-made obstructions, re-shaping the channel cross section, and construction of surface liners. Heavy brush was cleared from river bank and the manning roughness coefficient was reduced.

Watershed changes such as deforestation, agricultural development and urban development can accentuate flooding problems by increasing the magnitude of flood discharges. The occurrence of informal settler housing along river channels and floodway may obstruct the flow. Garbage, litter, and debris resulting from indiscriminate dumping of these materials into channels raises flood levels by obstructing the flow in ditches and urban drainage conduits. The MMDA coordinated with FMC should discuss these problems and seeking solution.

(2) Concrete Structures (Floodwall, Parapet Wall, Drainage Facilities, etc.)

Reinforced concrete structures should be checked on such as crack (width and extent), material deterioration (fall, expose of re-bar, leakage of water), movement (sliding, turnover, sinking, deformation).

(3) Steel Sheet Piling Revetment

Corrosion of materials, opening of structural joint, deformation, scouring, etc., should be checked.

(4) Riprap (Revetment Protection)

Riprap is planned to protect revetment from scouring. Washed-out, sinking and scouring should be carefully observed during inspection.

(5) Bridge Pier Protection

After floods, occurrence of scouring should be carefully inspected to know maximum depth and extent.

(6) Drainage Facilities

Flapgates open and close automatically by the difference in water level between inside and outside. When the small garbage is left behind and in front of the gate, the gates cannot keep enough water-tightness, and needs to be monitored and cleaned periodically.

In case there is small difference between outlet or sluiceway elevation and normal water level, sedimentation is likely to occur in outlets and manholes behind outlets. Periodical monitoring and cleaning is required.

After flooding, garbage and sediments are likely to be left. Hence monitoring and cleaning is required as well.

Regarding drainage pipes and U-ditches behind the dike or river wall, in order to prevent to be blocked by garbage and sediments, these facilities also should be monitored carefully

9.7.5 Coordination with Flood Mitigation Committee, Disaster Risk Reduction and Management Council and Barangays

(1) Flood Mitigation Committee for Pasg-Marikina River Basin

The Flood Mitigation Committee (FMC) to be created shall conduct the monitor of the O&M activities in accordance with the O&M Plan and its Manual to ensure the proper O&M and also to facilitate the coordination among the GOP agencies and LGUs concerned.

(2) Coordination with Disaster Risk Reduction and Management Council

When floods occurs, the MMDA-FCSMO, as a responsible organization for O&M, should coordinate well with Disaster Risk Reduction and Management Councils of National Government, Rizal Province Government in Region IV, and Local Government Units such as Manila, Makati, Mandaluyong, Pasig, Quezon, Marikina, San Juan in Metro Manila and Cainta and Taytay in Rizal Province, namely:

(a) Utilization of Equipment and Materials for Flood Fighting
(b) Information of Heavy Equipment owned by Private for Flood Fighting
(c) Information of flood water levels
(d) Others

Flood fighting is one the activities embodied in Presidential Decree No.1566, dated June 11, 1978. This decree calls for *"Strengthening the Philippine Disaster Preparedness"*. The objective is to save lives, prevent needless suffering, protect property, and minimize damages during disaster and calamities such as the occurrence of earthquake, floods, volcanic eruptions, tidal waves, conflagrations, and others.

A follow-up to this law is the "Philippine Disaster Risk Reduction and Management Act of 2010", dated July 27, 2009, strengthening the Philippine disaster risk reduction and management system providing for the national disaster risk reduction and management framework and institutionalizing the national disaster risk reduction and management plan, appropriating funds therefore and for other purposes.

At the national level, National Disaster Risk Reduction and Management Council (NDRRMC) highest policy making body, and as the highest allocator of resources in the country to support the efforts of the lower level councils in the system. The NDRRMC is headed by the Secretary of the Department of National Defense (DND) as Chairperson with the following 42 Vice Chairperson and members: Secretary of Central Government Agencies, Red Cross, representative of private organization and so on.

At the regional level including Metro Manila (National Capital Region), the Regional Disaster Risk Reduction and Management Council (RDRRMC) coordinates the activities of all national government agencies assigned to a particular administrative region. The Metro Manila DRRMC (MMDRRMC) shall be responsible in ensuring disaster sensitive regional development plans, and in case of emergencies shall convene the different regional line agencies and concerned institutions and authorities. The RDRRMC shall be composed of the executives of regional offices and field stations at the regional level of the government agencies. The civil defense officer of OCD who is or may be designated as Regional Director of the OCD shall serve as Chairperson of the MMDRRMC.

At the local government level, the Provincial/City/Municipal Disaster Risk Reduction and Management Council (PDRRMC, CDRRMC, and MDRRMC) shall be organized as a Local Disaster Risk Reduction and Management Council (LDRRMC). Number of Members is 18 to 22 and Chairperson is a chief of Local government.

(3) Coordination with Communities (Barangays)

The flood control facilities to be constructed under the Phase III are located in the following 42 Barangays, as shown in **Table R 9.7.1** below.

Table R 9.7.1 Barangays Affected by Phase III

City	Barangay	City	Barangay	City	Barangay
Manila(21)	No. 306		No. 903	Makati(5)	Olympia
	No. 384		No. 905		Valenzuela
	No. 647		No. 900		Guadalupe Viejo
	No. 659		No. 896		Cembo
	No. 663-A		No. 897		West Rembo
	No. 644		No. 894	Pasig(9)	Pineda
	No. 636		No. 888		Bagong Ilog
	No. 628	Mandaluyong(6)	Namayan		Ugong
	No. 836		Vergara		Santa Rosa
	No. 621		Barangka Ibaba		San Jose
	No. 838		Barangka Itaas		Kapasigan
	No. 865		Barangka Ilaya		Caniogan
	No. 899		Buayang Bato		Maybunga
	No. 901				Rosario
	No. 902			Quezon(1)	Ugong Norte

At the community level, MMDA is expected to perform roles and responsibilities in corporation with: each Barangay:

(1) Barangay takes an active role in monitoring and reporting to the O&M implementing body all illegal activities undertaken within the project, such as:
  - (a) Construction of illegal structures
  - (b) Throwing of garbage
  - (c) Detrimental utilization of maintenance road and its facilities
  - (d) Illegal parking
  - (e) Removal of sign boards
  - (f) Displacement of construction materials
  - (g) Wastewater disposal
  - (h) Other related activities causing damage to the facilities

(2) Initiate/Spearhead Barangay level program in instilling awareness and in-depth responsibility to the residents in the basic ways of caring for the river environment.

(3) Cooperate in monitoring/reporting the water level during flood time at their respective areas.

(4) Assist the implementing body in the evaluation of damages caused by the flood through their eye-witness account.

9.7.6 Resources Requirement for O&M

(1) General

After completion of the Phase III, necessary personnel, equipment, materials and budge for O&M during initial ten (10) years are studied. Except dredging work, facilities are constructed using concrete and steel materials. Generally, O&M cost will increase due to gradual deterioration and damages.

(2) O&M Personnel

Necessary personnel will be arranged in the office for Flood Control in MMDA for part-time base working.

(a) 1-Chief Engineer
(b) 1-Engineer as a staff
(c) 1-Administrative Staff
(d) 1-Drivers
(e) Foreman/Labor Force as required

(3) O&M Equipment

As listed in Section 9.3.2(4), necessary O&M equipment are all available in the MMDA such as dredger, tag boat, back hoe, crane, etc.

(4) O&M Materials

The necessary construction materials to be used for O&M in minimum are cement, sand, stone materials, re-bar, selected soil, etc.

(5) Estimated Annual O&M Budget Requirement for Initial Ten (10) Years

Annual budget for O&M is estimated at PHP3.5 million for initial ten (10) years, as follows:

(6) Cost for Personnel

Staff	No.	Months	Days	Monthly Salary (PHP)	Amount (PHP)
Chief Engineer	1	1		50,000	50,000
Engineer	1	1		35,000	35,000
Administrator.	1	1		20,000	20,000
Driver	1	1		15,000	15,000
Foreman	1	1		15,000	15,000
Labors	10		25	500	125,000
SUB-TOTAL					**260,000**

(7) Cost for Materials

	Quantity	Unit	Unit Price	Amount (PHP)
Fuel	10,000	Liter	43	430,000
Cement	500	Bag	220	110,000
Sand	500	m^3	700	350,000
Aggregate	500	m^3	900	450,000
Rebar	1,000	kg	40	40,000
Gravel	500	m^3	900	450,000
Stone	500	m^3	600	300,000
Selected Soil	500	m^3	1,000	500,000
Miscellaneous	1	L.S.	610,000	610,000
SUB-TOTAL				**PHP3,240,000**

CHAPTER 10 ASSISTANCE IN NON-STRUCTURAL MEASURES CONDUCTED

10.1 General

In the JICA Preparatory Study conducted in 2010/2011, the following non-structural flood mitigation measures have been proposed to be implemented together with structural flood mitigation works:

(1) Information Campaign and Publicity (ICP)
(2) Building Website
(3) Preparation and Delivery of Hazard Map of Pasig City
(4) Establishment of Flood Mitigation Committee (FMC)

During this Detailed Design Study for the Phase III, the implementation of above (1) and (4) are proposed. The results of implementation are described in the following sections.

10.2 Public Information Campaign and Publicity

10.2.1 Scope of ICP under the Detailed Design Study of Phase III Project

The activities to be conducted on Information Campaign and Publicity (ICP) during the Detailed Design Study from April to December 2012 are as follows:

(1) Formulation of Campaign Work Plan
(2) Conceptualize, Design and Produce Information Materials
(3) Conduct Community-based Explanatory Discussion
(4) Public Hearing
(5) Caravan Operation involving Schools, Government Officials, Barangay Officers, etc.
(6) Development of Community-based Project Motivators.
(7) Establishment of Community-based Information Centers.
(8) Undertake Mass Media Exposure and Public Relation Activities
(9) Continuous Linkages with National/Local Government Units.

10.2.2 Conducted Information Campaign and Publicity

The ICP activities conducted are summarized as follows. Moreover, the detailed results have been reported in the By-monthly Progress Reports and Service Completion Report (January 2013).

(1) Collection of Data/Information on ICP and Review of ICP Conducted in the Previous Phases I and II and Preparation of ICP Work Plan

The study reports, work plans and results of ICP conducted during Phases I and II have been collected and reviewed. Formulation/preparation of ICP Plan based on these collected data/information and baseline survey for target areas of Phase III.

(2) Preparation of ICP Staff and Materials

The ICP Team composed of the following 7 experts: JICA Experts (Japanese and Local), Media Specialist (Local), Community Organizer (Local), Graphic Artist, Videographer/Production Assistant and Encoder.

The following ICP Materials were prepared:

(a） Pamphlet (both English and Tagalog versions)
(b） Poster with 2012/2013 Calendar
(c） Project Description on Tarpaulins (medium and big sizes)
(d） Video and Power Point Presentation Materials

(3) Conduct Community-based Explanatory Discussion, Development of Community-based Project Motivators, Development of Community-based Information Centers and Public Hearing

Before conducting caravan operations, the ICP Team carried out community-based discussions for setting meetings, with Barangay Officials/School Teachers who are proposed to be Project Motivators. On the other hand, several information centers were also established at Barangay Halls and Schools. Through the coordination for meetings for Caravan Operations, project presentation and explanatory discussion were conducted with Barangay officials.

Public Hearings have been conducted in the Continuous Linkages with national agencies/local government units and Caravan Operation for Government Officials, Barangay Residents and School Students, etc., as an Open Forum.

(4) Continuous Linkage with National/Local Government Units

Several ICP meetings using ICP materials for continuous linkage with offices of national/local government units were held. These meetings include public consultation meetings for proposed disposal area as shown in the following table:

Table R 10.2.1 Conducted ICP Meetings with National/Local Government Units

	Purpose	Participant	Date (Participants)	Venue
1	Information Dissemination	LGU-Taguig (City Planning & Development, City Local Housing Office)	May 22 (Tue.) (17)	Taguig City Hall
2	Public Information Dissemination	8 LGUs-Pasig, Mandaluyong, Taguig, Makati, Marikina, Manila, Quezon, & San Juan. 6 National Government Agencies - Phil. Coast Guard, DND, MMDA, NHA, PPA, PRRC. 13 Private Sectors. 1 – NGO.	June 26 (Tue) (67)	DPWH Multipurpose Hall, 5/F DPWH Central Office
3	Information Dissemination	DPWH-National Capital Region (NCR) District Engineers	July 10 (Tue.) (20)	NCR Director's Conference Room
4	Information Dissemination	LGU-Taguig Officers (Administrator, City Planning, DRPMO)	July 23 (Mon.) (9)	Taguig City Hall
5	Information Dissemination	Assistant General Manager for Operation	Aug. 2 (Thu.) (11)	MMDA Office in Makati City
6	Information Dissemination	Manila City Councilors, Brgy Chairmen and its Officials	Aug. 3 (Fri.) (45)	Manila City Hall
7	Taguig (Public Consultation for Disposal Area)	Brgy Napindan & Ibayo Tipas	Nov. 23 (Fri.) (50)	Napindan Elementary School

In particular, the project dissemination held on June 26, 2012 at DPWH Central Office has presented the overall Project and Phase III Project to the concerned national government agencies, local government agencies, private sectors, and NGOs. This is actually a kick-off meeting for ICP caravan activities.

(5) Caravan Operations involving Schools, Government Officials, Barangay Officers

After a Kick-off project dissemination meeting on June 26, a total of forty (40) Caravan Operation meetings of ICP have been held from July to November for Barangay Officials and Barangay People at the directly affected forty two (42) Barangays along the Pasig River and Lower Marikina River in Cities of Manila, Mandaluyong, Makati, and Pasig, including 3 schools. In the caravan meetings, the necessity of immediate organization and activation of the Flood Mitigation Committee (FMC) for the Pasig-Marikina River Basin has publicly been informed.

Table R 10.2.2 Conducted Caravan Operation Meetings

	City	**Barangay**	**Date**	**Venue**	**Participant**	**No. of Questions/ Opinions in Open Forum**
1	Pasig	Ugong	July 21 (Sat.)	Brgy Hall	182	10
2	- do -	Rosario	July 21 (Sat.)	Brgy Hall	100	9
3	- do -	Maybunga	July 24 (Tue.)	Brgy Hall	67	4
4	- do -	Pineda	July 24 (Tue.)	Brgy Hall	107	5
5	- do -	Caniogan	July 25 (Wed.)	Brgy Hall	65	10
6	- do -	Kapasigan	July 25 (Wed.)	Brgy Hall	120	2
7	- do -	Sta. Rosa	July 31 (Tue.)	Brgy Hall	125	4
8	- do -	San Jose	Aug. 1 (Wed.)	Brgy Hall	70	3
9	Mandaluyong	Namayan	Aug. 4 (Sat.)	Brgy Hall	65	2
10	- do -	Buayang Bato	Aug. 13 (Mon.	Brgy Hall	51	6
11	- do -	Barangka Itaas	Aug. 14 (Tue.)	Brgy Hall	91	7
12	- do -	Barangka Ibaba	Aug. 22 (Wed.)	Brgy Hall	122	6
13	- do -	Barangka Ilaya	Aug. 22 (Wed.)	Brgy Hall	63	5
14	Makati	Guadalupe Nuevo	Sept. 5 (Wed.)	Brgy Hall	55	4
15	- do -	Olympia	Sept. 6 (Thu.)	Brgy Hall	52	4
16	- do -	Guadalupe Viejo	Sept. 11 (Tue.)	Brgy Hall	47	2
17	Manila	899	Sept. 12 (Wed.)	Brgy Hall	40	3
18	Makati	Cembo	Sept. 13 (Thu.)	Brgy Hall	38	-
19	Manila	901	Sept. 13 (Thu.)	Brgy Hall	48	6
20	Makati	Valenzuela	Sept. 14 (Fri.)	Brgy Hall	40	5
21	Manila	903	Sept. 17 (Mon.)	Brgy Hall	38	3
22	- do -	902	Sept. 17 (Mon.)	Brgy Hall	43	-
23	- do -	905	Sept. 18 (Tue.)	Brgy Hall	35	4
24	- do -	621	Sept. 24 (Mon.)	Brgy Hall	46	1
25	- do -	628	Sept. 24 (Mon.)	Brgy Hall	38	-
26	- do -	636	Sept. 25 (Tue.)	Brgy Hall	42	-
27	- do -	644	Sept. 25 (Tue.)	Brgy Hall	42	1
28	- do -	865	Sept. 27 (Thu.)	Brgy Hall	42	2
29	- do -	643	Sept. 27 (Thu.)	Brgy Hall	33	2
30	- do -	900/894	Sept. 28 (Fri.)	Cardinal Sin Village	51	3
31	- do -	836	Sept. 29 (Sat.)	Brgy Hall	30	2
32	- do -	838	Oct. 3 (Wed.)	Multi-purpose Hall	30	2
33	- do -	663-A	Oct. 3 (Wed.)	Sacred Heart	51	4
34	- do -	896/897	Oct. 10 (Wed.)	896 Hall	46	2
35	Makati	West Rembo	Oct. 11 (Thu.)	Brgy Hall	40	4
36	Pasig	Bagong Ilog	Oct. 11 (Thu.)	Brgy Hall	25	2
37	Manila	306	Oct. 17 (Wed.)	Brgy Hall	31	-
	Sub-Total for Barangays			**37**	**2,211**	**129**
38	Amado T. Reyes Elementary School, Mandaluyong		Oct. 19 (Fri.)	School	40	5
39	Pasig City Science High School		Nov. 8 (Thu.)	School	39	6
40	Pitogo High School, Makati		Nov. 9 (Fri.)	School	47	11
	Sub-Total for Schools			**3**	**126**	**22**
	Total			**40**	**2,337**	**151**

10.3 Establishment of Flood Mitigation Committee (FMC) for Pasig-Marikina River Basin

10.3.1 Necessity of FMC

In the course of JICA Preparatory Study for Phase III Project, it has been confirmed the necessity of immediate implementation of the next Phase III. Moreover, it is recognized that non-structural measures in and/around the areas to be protected by the Pasig-Marikina River Channel Improvement Project (PMRCIP) are indispensable to achieve alleviation of flood damages, especially by floods beyond the design scale, together with the creation of the Flood mitigation Committee (FMC).

It is necessary for DPWH, MMDA, PRRC and the concerned city governments of Manila, Makati, Mandaluyong, Pasig, Quezon, Marikina and San Juan to create a FMC, to act as the coordination body in handling issues relating to project implementation as well as operation and maintenance and controlling land encroachment and disorderly land development, including the issuance of requests to the responsible agency/agencies on the necessary measures to be taken whenever flood disasters occur.

The DPWH, MMDA and PRRC have already agreed to the creation of FMC in the MOA for implementation of Phase III dated on January 27, 2012.

10.3.2 Scope of Work for Assistance in Establishment of FMC

To attain the agreement among the DPWH, MMDA, PRRC and LGUs concerned on creation of FMC, the Study Team assist the DPWH in the matters of discussions, explanation paper, information campaign, coordination meetings, workshops, etc. Scope of Work for assistance in the establishment of FMC is summarized:

a) Elaboration in the details of FMC
b) Consultation with the government agencies and LGUs concerned
c) Drafting the prospectus for FMC
d) Conducting Workshops and/or seminars on the creation of FMC

10.3.3 Steps for Establishment of FMC

The following steps have been taken to establish the FMC for the Pasig-Marikina River Basin:

1）Review of JICA Preparatory Study on Establishment of FMC.
2）Elaboration in the Details of FMC.
3）Preparation of Minutes of Agreement (MOA) for Establishment of FMC proposed by DPWH (draft MOA).
4）Request for Comments of Standing Members on draft MOA for Establishment of FMC (Concerned National Agencies/LGUs).
5）Consultation with Standing Members of FMC.

6） Comments from Standing Members.
7） Finalization of MOA for Establishment of FMC incorporating Comments on draft MOA.
8） Organization Meeting for Establishment of FMC.
9） Signing on final MOA for Establishment of FMC.

Detailed activities of assistance in establishment of FMC are reported in the Monthly Progress Reports and Service Completion Report (January 2013).

10.3.4 Comments of Standing Members on DPWH’s draft MOA

Memorandum of Agreement (MOA) for establishment of FMC for Pasig-Marikina River Basin was initially drafted by the JICA Study Team and submitted for review and comments of DPWH on May 28, 2012. After some comments/clarifications on the draft MOA, the Secretary approved draft MOA on July 9. Then, copies of draft MOA were transmitted from DPWH to the standing members composed of MMDA, PRRC and LGUs (Manila, Mandaluyong, Makati, Pasig, Quezon, Marikina, and San Juan) concerned for their comments on July 11 and 12. As the result of their review and evaluation on draft MOA by the legal section and concerned other offices of the standing members, there were no comments except minor comments of PRRC and Makati City.

10.3.5 Finalization of MOA incorporating Comments and Signing on MOA

The MOA as finalized incorporating comments of standing members was submitted to DPWH for perusal and signatures of the Secretary and Witnesses on November 22, 2012, thence to the counterpart signatories for the MMDA, PRRC and LGUs concerned. DPWH Secretary has signed the MOA on Dec. 3, 2012 as a Chairperson of FMC. Then, Chairman of MMDA has signed as a Co-chairperson. After their signing, all signatories including witnesses have signed on January 24 2013. (refer to **ANNEX 1** for the signed MOA).

10.3.6 Summary of MOA for Establishment of FMC

The contents of signed MOA including functions, roles and responsibilities of FMC are itemized as follows:

1） Facilitate and assist in the PMRCIP implementation.
2） Facilitate and assist in monitoring the O&M activities.
3） Facilitate and assist in the introduction and operation of non-structural measures.
4） Facilitate and assist in the resettlement and acquisition of right-of-way for the Project.

5） Monitor, coordinate and take necessary actions for illegal activities (encroachment, disorderly land development, etc.).
6） Set-up a “Query Window” for the Project implementation.
7） Enhance/strengthen the publicity and awareness on the flood mitigation activities.
8） Convene meeting once every three months or as necessary.
9） DPWH shall act as Chairperson in implementation of the Project and MMDA shall take the chairmanship for O&M.
10） Observer members shall participate in the meetings as required and provide information, comments and solutions.
11） FMC operation expenses required for holding meetings, activities of the Secretariat and Query Windows. Shall be allocated from the DPWH and MMDA budgets.
12） Functions, roles and responsibilities of each standing member are stipulated.

10.3.7 Organization Meeting for Establishment of FMC

The Organization Meeting of the FMC was convened on December 6, 2012 at Bayview Park Hotel along Roxas Boulevard in Manila City. All standing members with a total of 38 participants attended, including the representatives of JICA Philippines. The major agenda items in the program of the Organization Meeting are as follows:

1） Presentation of Phase III Project Summary (JICA Study Team)
2） Accomplishment of ICP under Phase III Project (JICA Study Team)
3） Summary of Proposed FMC (JICA Study Team)
4） Necessity of Declaration of “Flood Control Area” (JICA Study Team) and Status of Easement along Upper Marikina River Declared by Marikina City (LGU-Marikina)
5） Open Forum

10.4 CONCLUSION AND RECOMMENDATION

10.4.1 Conclusions

The exigency of a coordination body to handle issues relating to the implementation of the PMRCIP has been recognized by the DPWH, MMDA and PRRC by initiating the proposed creation of a Flood Mitigation Committee (FMC) in the MOA for the implementation of PMRCIP (Phase III) dated January 27, 2012. The creation of the FMC for Pasig-Marikina River Basin through a MOA, January 24 2013. among DPWH, MMDA, PRRC and the City Government of Manila, Mandaluyong, Makati, Pasig, Quezon, Marikina and San Juan attest to the firm resolve of these agencies to facilitate the smooth and efficient implementation of the whole PMRCIP.

(1) The FMC will essentially provide the avenue for a common basis for understanding floods and flood mitigation approaches which advocate comprehensive structural and non-structural flood plain management.

(2) The FMC will also provide a forum for long-term coordination and well-informed efforts in the resolution of Right-of-Way problems and related concerns that exacerbate flooding conditions in the Pasig-Marikina River Basin.

10.4.2 Recommendations

In order to provide enabling environment for the efficient and sustainable operation of the FMC, the followings, among others as may be deemed necessary, are submitted for consideration:

(1) Immediate establishment of the FMC Secretariat with support staff and related facilities for the timely activation and long-term operation of the FMC.

(2) For the FMC to identify and articulate policy issues for consideration and appropriate action of the concerned authority, for instance: construction of Marikina Control Gate Structure (MCGS), construction of Marikina Dam, etc.

(3) For the FMC to deliberate on the extent of the river area to be recommended in the Declaration of Flood Control Area in accordance with the Water Law or Promulgation of City Ordinance as deemed appropriate.

(4) To provide a course of action for the committee, the proposed schedule of FMC Activity shown in the **Figure R 10.4.1**.

a) Preparatory Stage – February to June 2013:
Organize a Working Group between DPWH and MMDA to:
  - Discuss the membership (regular and alternate) of the Committee
  - Prepare the FMC Road Map/Action Plan
  - Identified role and responsibility

b) Initial Operation Stage – July to December 2013
Initial Operation Stage will be concentrated to:
  - Regular Meeting of the Committee
  - Approval of the Road Map/Action Plan
  - Schedule of Annual Activity
    - Budget Requirement
    - Manpower Requirement
    - Meeting Schedule, etc.
  - Joint Inspection of Target Areas in each City
    Manila, Makati, Mandaluyong, Pasig, Quezon, Marikina and San Juan

(c) Full Operation Stage (Jan.2014-)

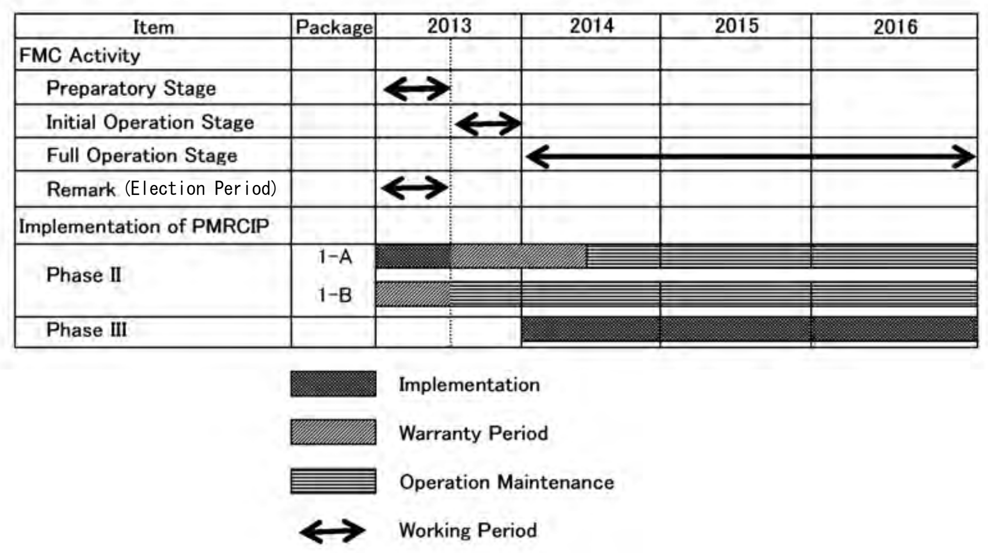


Figure R 10.4.1 Proposed Schedule of FMC Activity

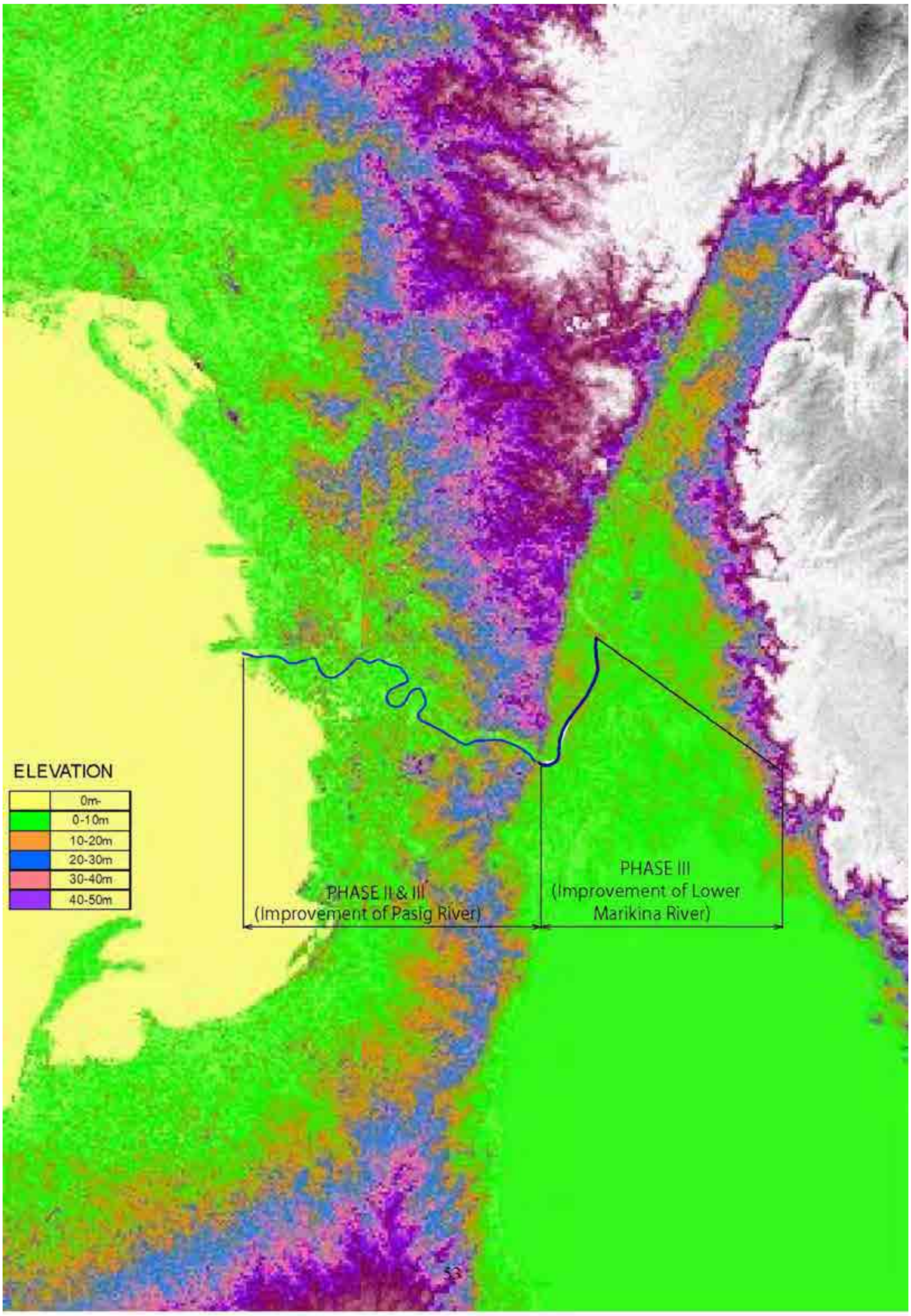


Figure 2.3.1 Elevation Map of Pasig-Marikina River

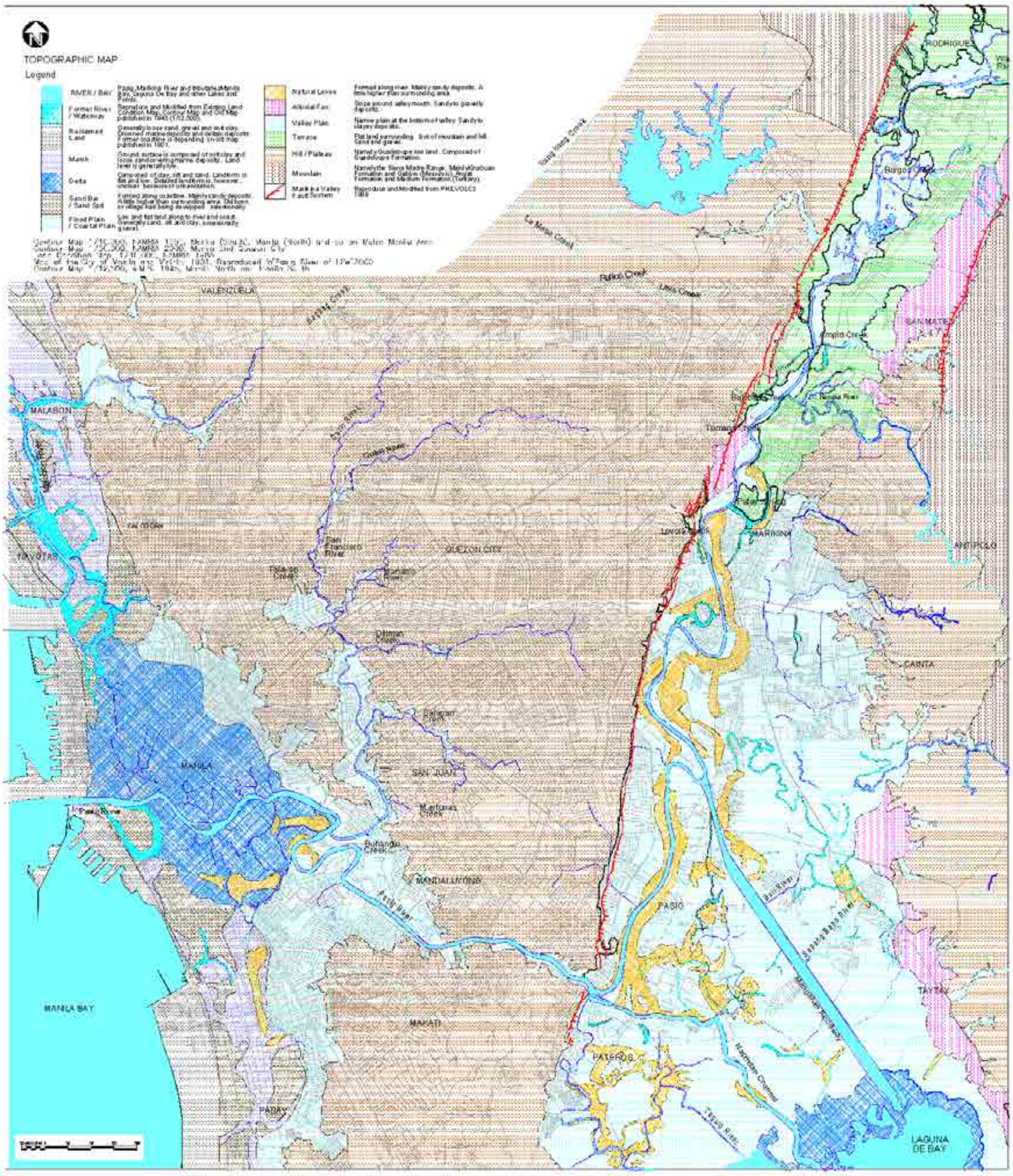


Figure 2.3.2 Topographic Map of Pasig-Marikina River

Fg 2.3

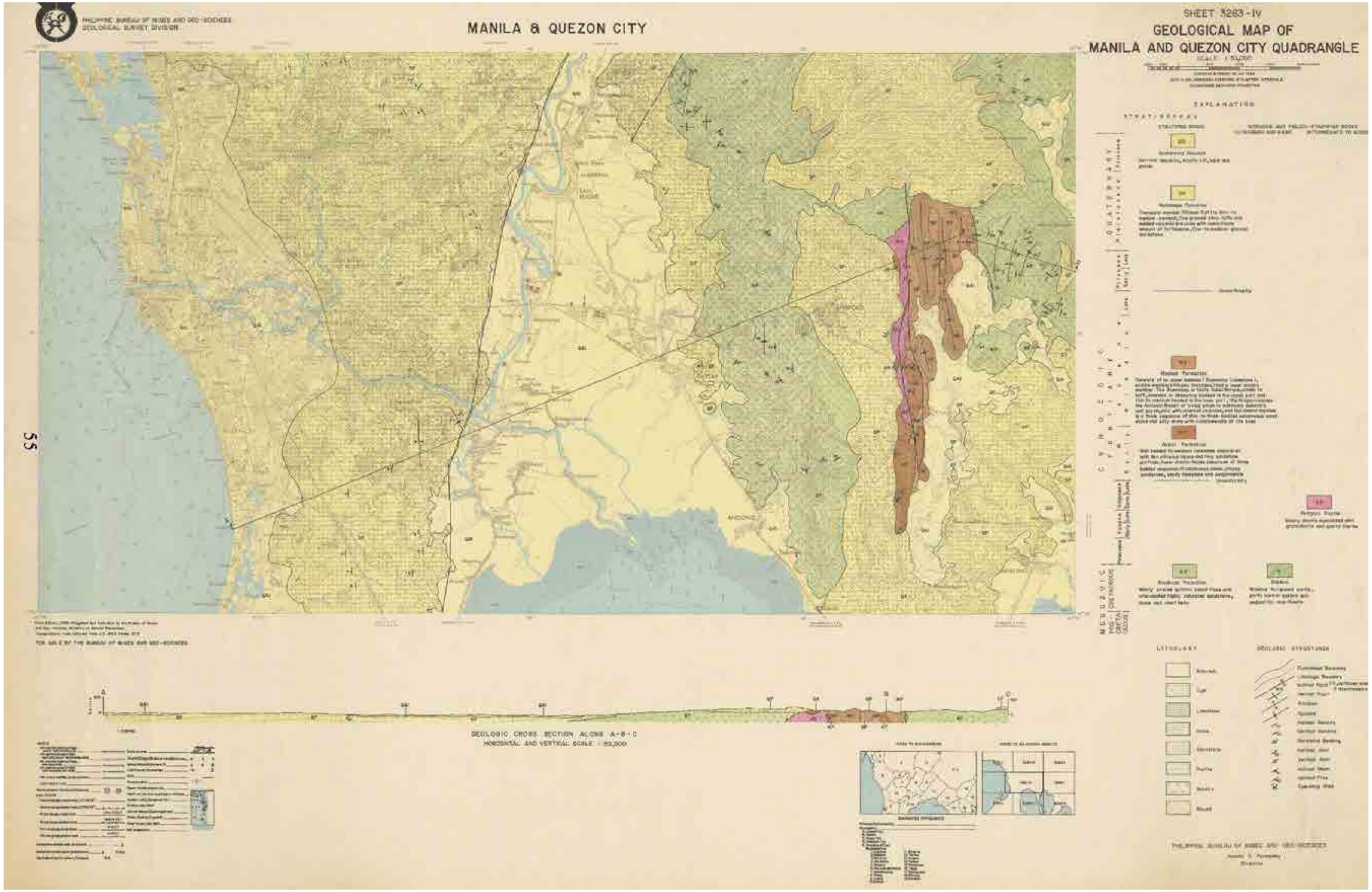
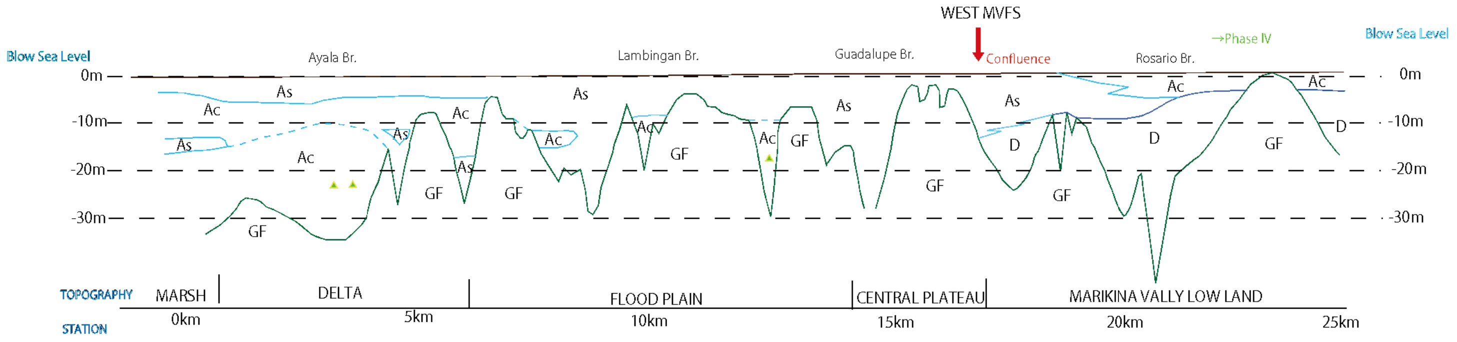


Figure 2.3.3 Geological Map of Pasig-Marikina River

Fg 2.4

Figure 2.3.4 Schematic Geological Section and Soil Classification and Distribution along Pasig-Marikina River

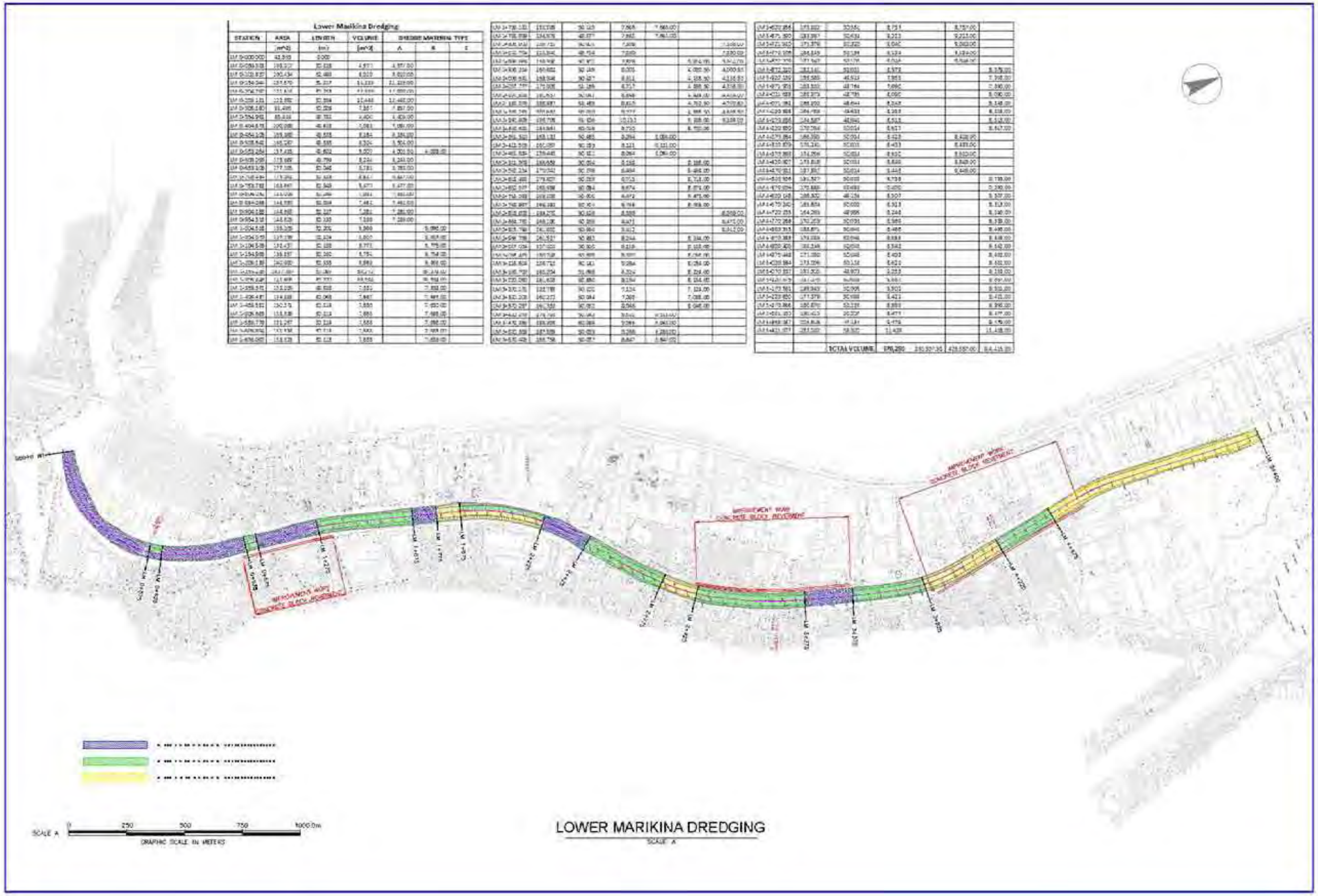
Schematic Geological Section Along Pasig-Marikina River



Age		Layer Classification		
		Formation	Lithic	
QUATERNARY	HOLOCENE	F	Embankment	unconsolidated
		As1	Sand, Gravel	
		Ac1	Clay, Silt	
		As1	Sand, Gravel	
		Ac2	Clay, Silt	
	PLISTOCENE	D	Silt, Sand	
		GF	Guadalupe Formation tuff,sandstone,mudstone volcanic conglomerate	consolidated

▲ Volcanic Sand

Figure 2.3.5 Dredging Material Distribution Map of Marikina River



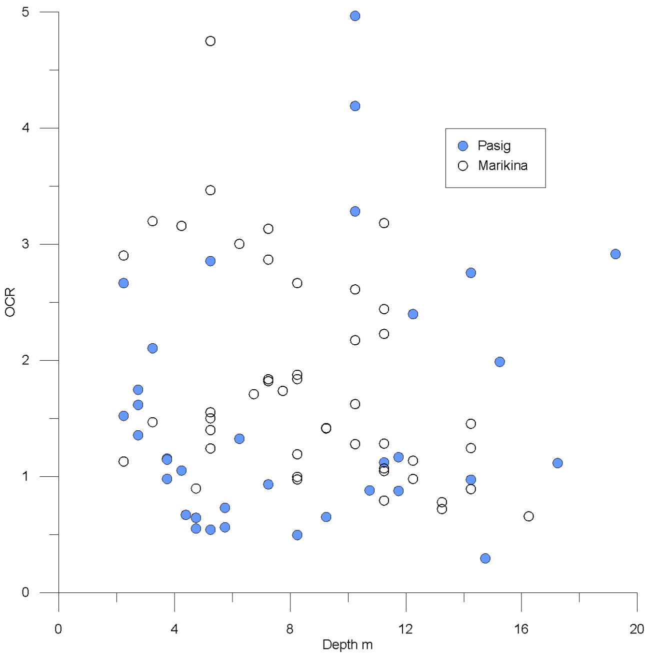
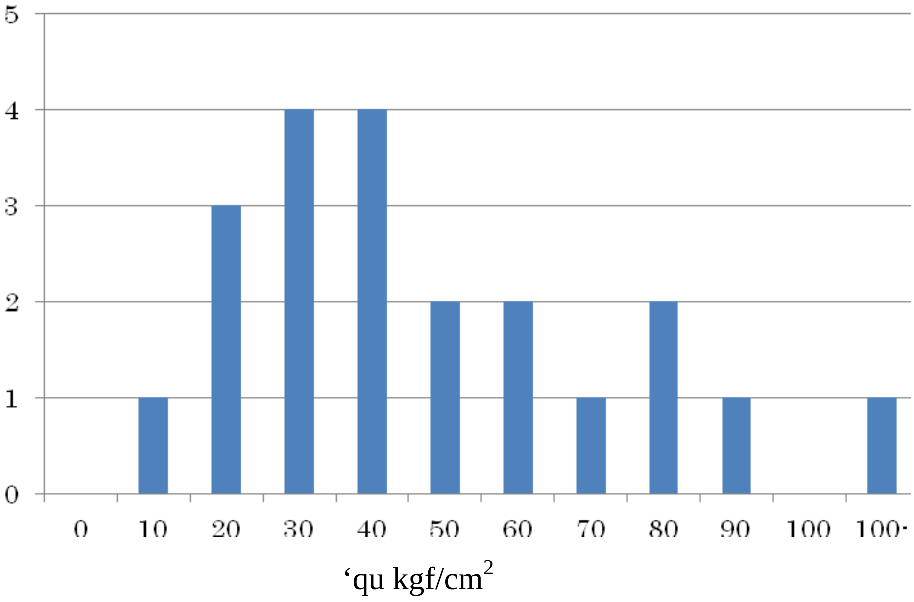


Figure 2.3.6 OCR



‘qu kgf/cm^2

Figure 2.3.7 qu histogram of Guadalupe Formation

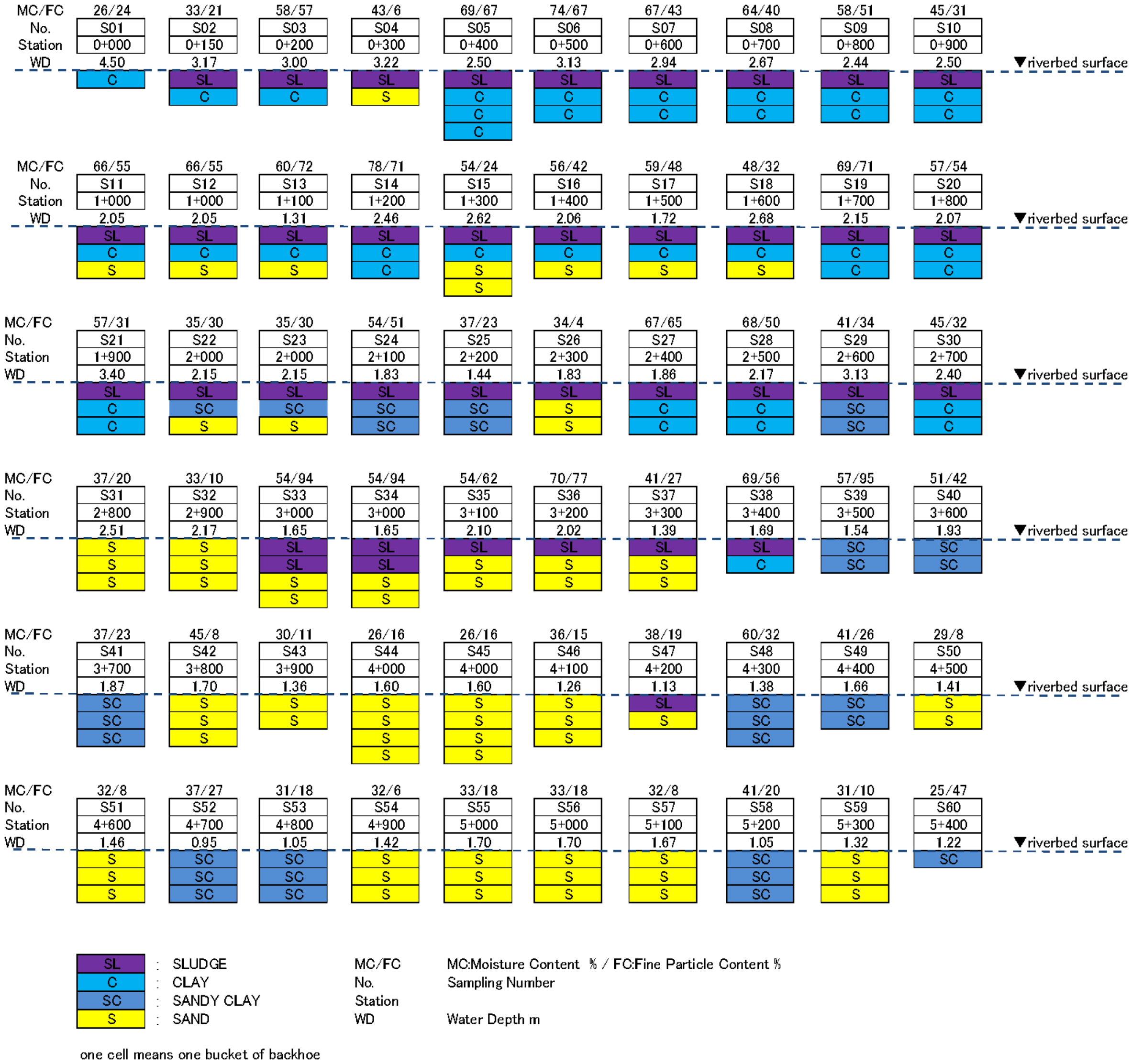


Figure 2.3.8 Soil Distribution of Sampled Dredging Materials

MC/FC	26/24	33/21	58/57	43/6	69/67	74/67	67/43	64/40	58/51	45/31
No.	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10
Station	0+000	0+150	0+200	0+300	0+400	0+500	0+600	0+700	0+800	0+900
WD	4.50	3.17	3.00	3.22	2.50	3.13	2.94	2.67	2.44	2.50
▼riverbed surface	C	SL	SL	SL	SL	SL	SL	SL	SL	SL
		C	C	S	C	C	C	C	C	C
					C	C	C	C	C	C
					C					

MC/FC	66/55	66/55	60/72	78/71	54/24	56/42	59/48	48/32	69/71	57/54
No.	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
Station	1+000	1+000	1+100	1+200	1+300	1+400	1+500	1+600	1+700	1+800
WD	2.05	2.05	1.31	2.46	2.62	2.06	1.72	2.68	2.15	2.07
▼riverbed surface	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL
	C	C	C	C	C	C	C	C	C	C
	S	S	S	C	S	S	S	S	C	C
					S					

MC/FC	57/31	35/30	35/30	54/51	37/23	34/4	67/65	68/50	41/34	45/32
No.	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30
Station	1+900	2+000	2+000	2+100	2+200	2+300	2+400	2+500	2+600	2+700
WD	3.40	2.15	2.15	1.83	1.44	1.83	1.86	2.17	3.13	2.40
▼riverbed surface	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL
	C	SC	SC	SC	SC	S	C	C	SC	C
	C	S	S	SC	SC	S	C	C	SC	C

MC/FC	37/20	33/10	54/94	54/94	54/62	70/77	41/27	69/56	57/95	51/42
No.	S31	S32	S33	S34	S35	S36	S37	S38	S39	S40
Station	2+800	2+900	3+000	3+000	3+100	3+200	3+300	3+400	3+500	3+600
WD	2.51	2.17	1.65	1.65	2.10	2.02	1.39	1.69	1.54	1.93
▼riverbed surface	S	S	SL	SL	SL	SL	SL	SL	SC	SC
	S	S	SL	SL	S	S	S	C	SC	SC
	S	S	S	S	S	S	S			
			S	S						

MC/FC	37/23	45/8	30/11	26/16	26/16	36/15	38/19	60/32	41/26	29/8
No.	S41	S42	S43	S44	S45	S46	S47	S48	S49	S50
Station	3+700	3+800	3+900	4+000	4+000	4+100	4+200	4+300	4+400	4+500
WD	1.87	1.70	1.36	1.60	1.60	1.26	1.13	1.38	1.66	1.41
▼riverbed surface	SC	S	S	S	S	S	SL	SC	SC	S
	SC	S	S	S	S	S	S	SC	SC	S
	SC	S		S	S	S		SC		
				S	S					

MC/FC	32/8	37/27	31/18	32/6	33/18	33/18	32/8	41/20	31/10	25/47
No.	S51	S52	S53	S54	S55	S56	S57	S58	S59	S60
Station	4+600	4+700	4+800	4+900	5+000	5+000	5+100	5+200	5+300	5+400
WD	1.46	0.95	1.05	1.42	1.70	1.70	1.67	1.05	1.32	1.22
▼riverbed surface	S	SC	SC	S	S	S	S	SC	S	SC
	S	SC	SC	S	S	S	S	SC	S	
	S	SC	SC	S	S	S	S	SC	S	

SL	:	SLUDGE	MC/FC	MC:Moisture Content % / FC:Fine Particle Content %
C	:	CLAY	No.	Sampling Number
SC	:	SANDY CLAY	Station	
S	:	SAND	WD	Water Depth m

one cell means one bucket of backhoe

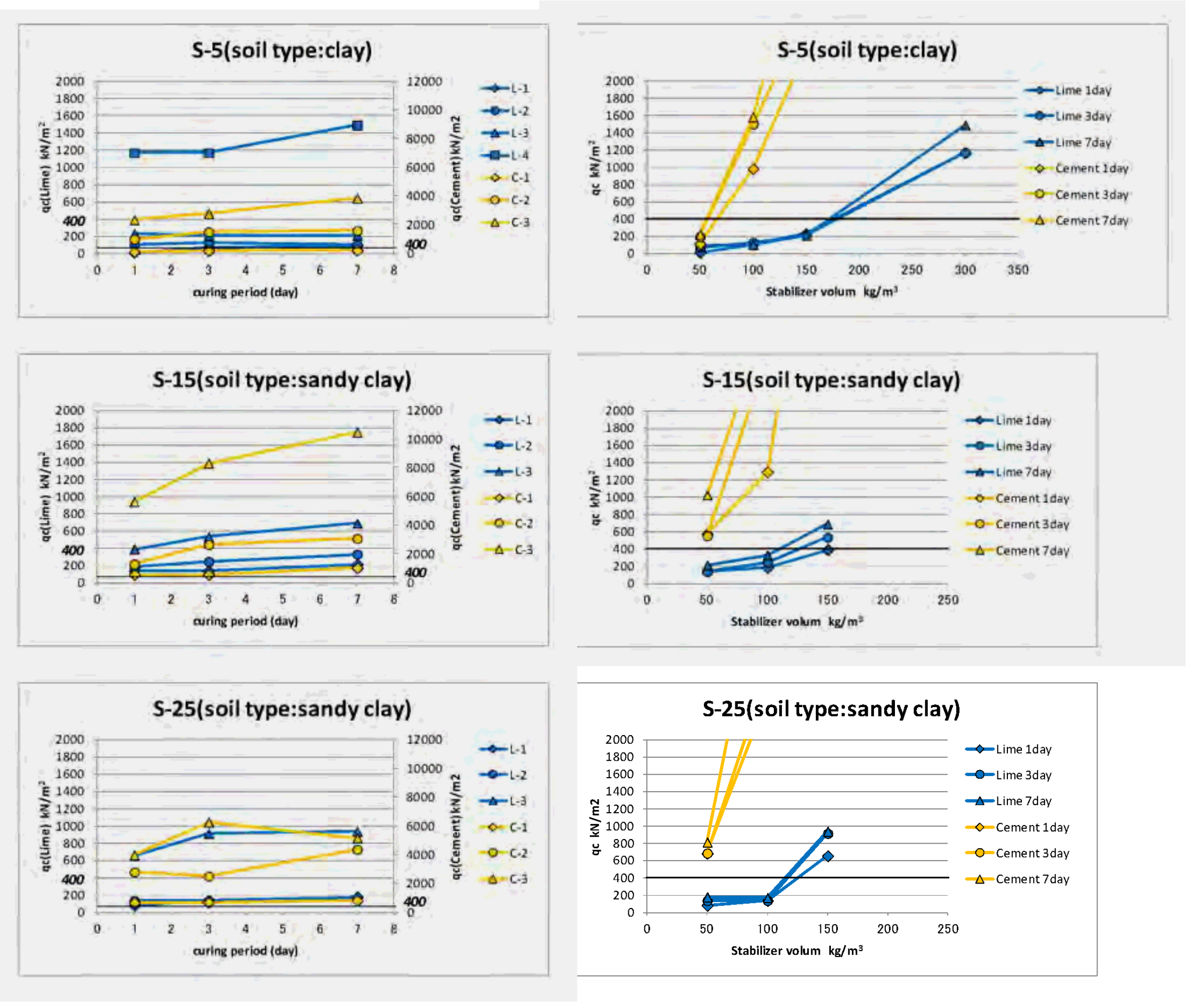


Figure 2.3.9 Stabilization Test Result (1/2)

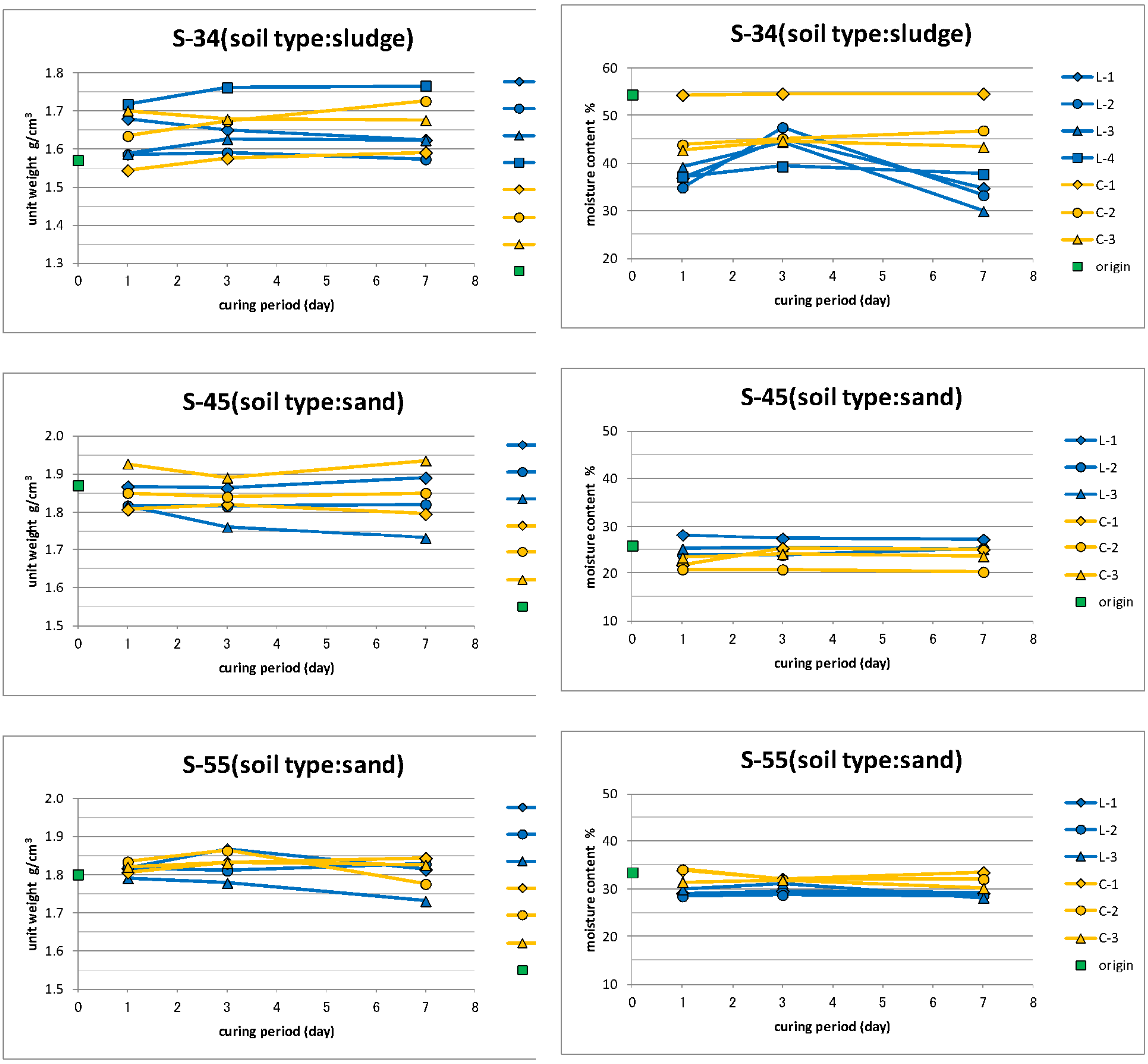
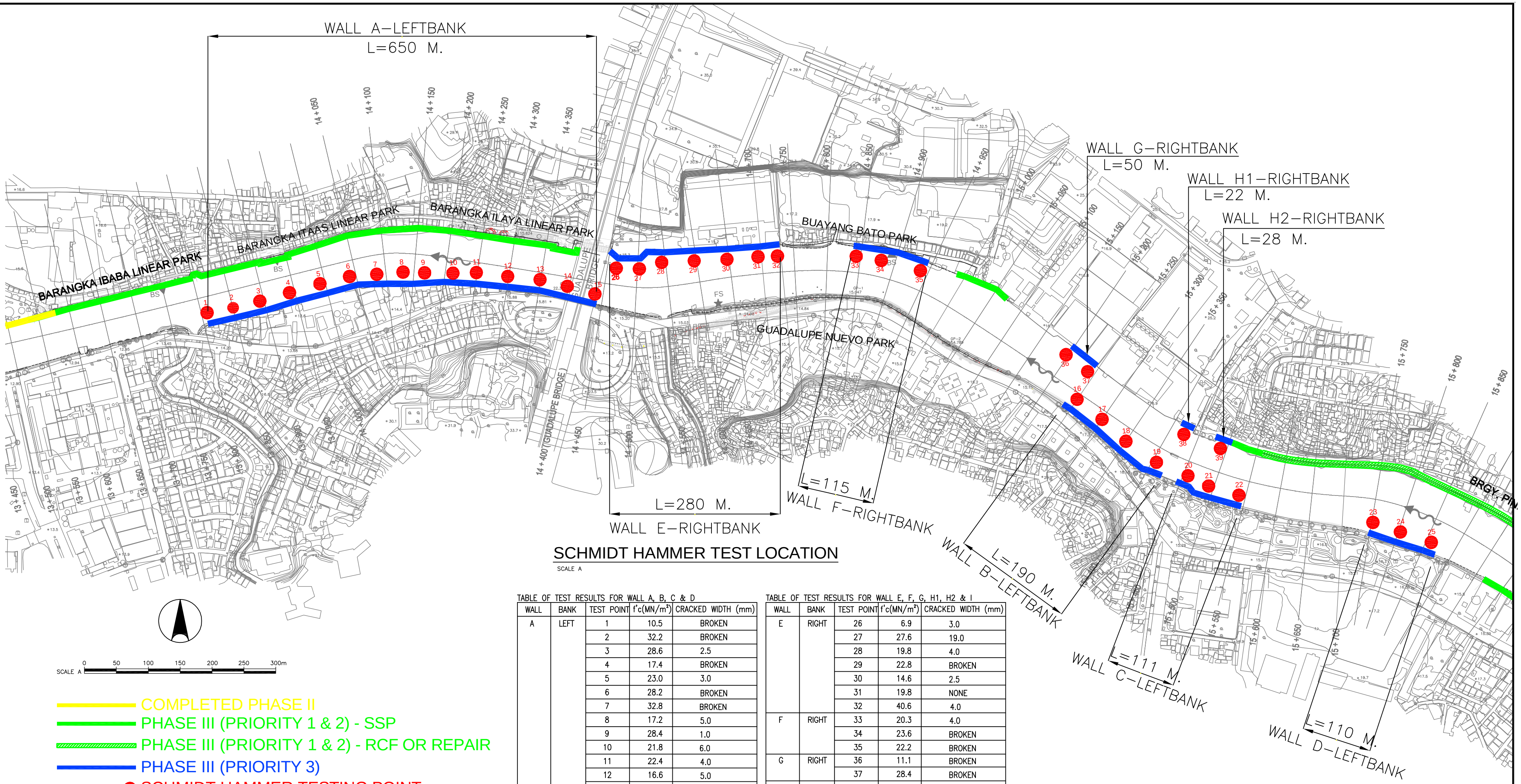


Figure 2.3.9 Stabilization Test Result (2/2)



SCHMIDT HAMMER TEST LOCATION

SCALE A

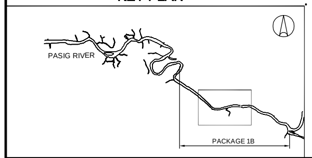
TABLE OF TEST RESULTS FOR WALL A, B, C & D

WALL	BANK	TEST POINT	f'c(MN/m²)	CRACKED WIDTH (mm)
A	LEFT	1	10.5	BROKEN
		2	32.2	BROKEN
		3	28.6	2.5
		4	17.4	BROKEN
		5	23.0	3.0
		6	28.2	BROKEN
		7	32.8	BROKEN
		8	17.2	5.0
		9	28.4	1.0
		10	21.8	6.0
		11	22.4	4.0
		12	16.6	5.0
		13	14.2	2.0
		14	23.5	4.0
		15	38.0	6.0
B	LEFT	16	24.1	BROKEN
		17	22.9	NONE
		18	29.3	BROKEN
		19	37.8	NONE
C	LEFT	20	22.6	NONE
		21	27.0	BROKEN
		22	30.0	6.0
D	LEFT	23	20.9	BROKEN
		24	19.8	BROKEN
		25	15.7	BROKEN

TABLE OF TEST RESULTS FOR WALL E, F, G, H1, H2 & I

WALL	BANK	TEST POINT	f'c(MN/m²)	CRACKED WIDTH (mm)
E	RIGHT	26	6.9	3.0
		27	27.6	19.0
		28	19.8	4.0
		29	22.8	BROKEN
		30	14.6	2.5
		31	19.8	NONE
		32	40.6	4.0
F	RIGHT	33	20.3	4.0
		34	23.6	BROKEN
		35	22.2	BROKEN
G	RIGHT	36	11.1	BROKEN
		37	28.4	BROKEN
H1	RIGHT	38	28.3	2.5
H2	RIGHT	39	25.3	BROKEN
I	RIGHT	40	19.5	7.0
		41	13.8	NONE
		42	18.8	NONE
		43	23.7	NONE
		44	18.3	16.0
		45	24.9	4.0
		46	18.0	NONE
		47	32.2	BROKEN

KEY PLAN



LEGEND:

★ FERRY STATION/COAST GUARD

▲ BOAT/BANCA STATION

NOTE :

*1 - ALL STATIONS ARE RECKONED AT ℄ OF RIVER
*2 - LENGTHS SHOWN ARE LINEAR METRES UNLESS OTHERWISE SPECIFIED
*3 - FIGURES GOVERN OVER SCALED DIMENSIONS

R E V I S I O N S

NO.	DESCRIPTION	APPROVED	DATE

NOTE :

PURSUANT TO SECTION 4 OF ANNEX "A" OF THE REVISED IMPLEMENTING RULES AND REGULATIONS OF R.A. 9184, APPROVAL BY THE AUTHORIZED DPWH OFFICIALS OF DETAILED ENGINEERING SURVEYS AND DESIGN UNDERTAKEN BY CONSULTANTS NEITHER DIMINISHES THE RESPONSIBILITY OF THE LATTER FOR THE TECHNICAL INTEGRITY OF THE SURVEYS AND DESIGN NOR TRANSFER ANY PART OF THAT RESPONSIBILITY TO THE APPROVING OFFICIALS.

JICA CONSULTANT FOR DETAILED ENGINEERING DESIGN

CTI ENGINEERING
INTERNATIONAL
CO., LTD.

DESIGNED BY:	CHECKED BY:	SUBMITTED BY:
EIJI MOKI STRUCTURAL ENGINEER I	TOSHIKI KAWAKAMI THE CHECKER	SHUJI KAKU TEAM LEADER

REPUBLIC OF THE PHILIPPINES

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS
AND HIGHWAYS

REVIEWED BY:	RECOMMENDING APPROVAL :			APPROVED BY:
PERFECTO L. ZAPLAN, JR. CHIEF, HYDRAULIC DIVISION, BOD	PATRICK B. GATAN PROJECT DIRECTOR PMO - MFCP I	GILBERTO S. REYES DIRECTOR BOD	RAUL C .ASIS UNDERSECRETARY FOR TECHNICAL SERVICES	ROGELIO L. SINGSON SECRETARY

PROJECT & LOCATION	SHEET CONTENTS	SHEET NO.
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA	SCHMIDT HAMMER TEST RESULTS	1/2

Figure 3.1.1 Schmidt Hammer Test Result (1/2)

Fg 3.1

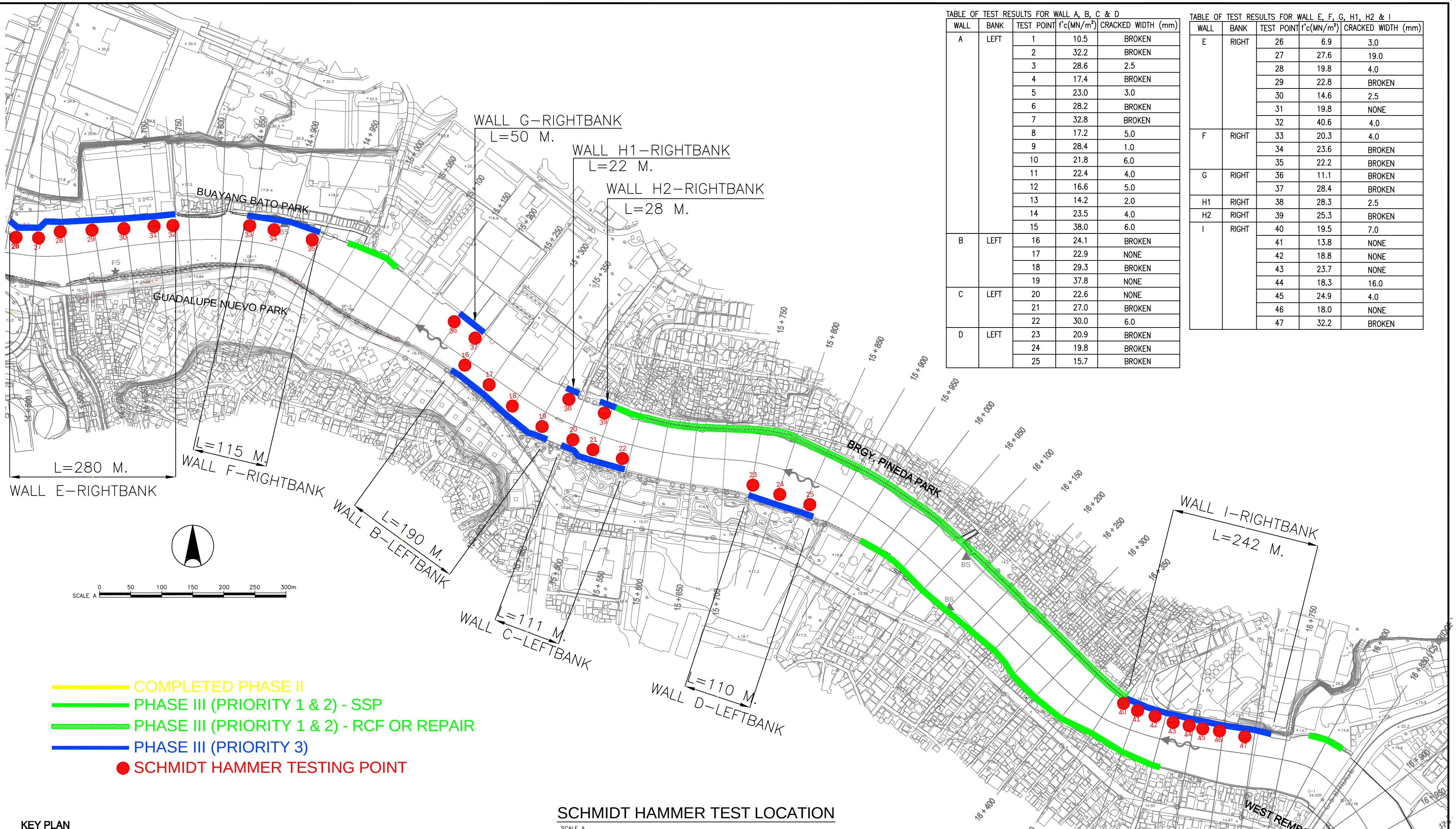


TABLE OF TEST RESULTS FOR WALL A, B, C & D

WALL	BANK	TEST POINT	f'c(MN/m²)	CRACKED WIDTH (mm)
A	LEFT	1	10.5	BROKEN
		2	32.2	BROKEN
		3	28.6	2.5
		4	17.4	BROKEN
		5	23.0	3.0
		6	28.2	BROKEN
		7	32.8	BROKEN
		8	17.2	5.0
		9	28.4	1.0
		10	21.8	6.0
		11	22.4	4.0
		12	16.6	5.0
		13	14.2	2.0
		14	23.5	4.0
		15	38.0	6.0
B	LEFT	16	24.1	BROKEN
		17	22.9	NONE
		18	29.3	BROKEN
		19	37.8	NONE
C	LEFT	20	22.6	NONE
		21	27.0	BROKEN
		22	30.0	6.0
D	LEFT	23	20.9	BROKEN
		24	19.8	BROKEN
		25	15.7	BROKEN

TABLE OF TEST RESULTS FOR WALL E, F, G, H1, H2 & I

WALL	BANK	TEST POINT	f'c(MN/m²)	CRACKED WIDTH (mm)
E	RIGHT	26	6.9	3.0
		27	27.6	19.0
		28	19.8	4.0
		29	22.8	BROKEN
		30	14.6	2.5
		31	19.8	NONE
		32	40.6	4.0
F	RIGHT	33	20.3	4.0
		34	23.6	BROKEN
		35	22.2	BROKEN
G	RIGHT	36	11.1	BROKEN
		37	28.4	BROKEN
H1	RIGHT	38	28.3	2.5
H2	RIGHT	39	25.3	BROKEN
I	RIGHT	40	19.5	7.0
		41	13.8	NONE
		42	18.8	NONE
		43	23.7	NONE
		44	18.3	16.0
		45	24.9	4.0
		46	18.0	NONE
		47	32.2	BROKEN

Figure 3.1.1 Schmidt Hammer Test Result (2/2)

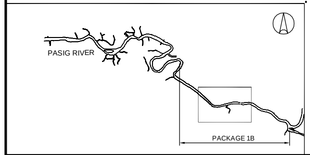
Fg 3.2

🟨	COMPLETED PHASE II
🟩	PHASE III (PRIORITY 1 & 2) - SSP
▨	PHASE III (PRIORITY 1 & 2) - RCF OR REPAIR
🟦	PHASE III (PRIORITY 3)
●	SCHMIDT HAMMER TESTING POINT

SCHMIDT HAMMER TEST LOCATION

SCALE A

KEY PLAN



LEGEND:

★	FERRY STATION/COAST GUARD
▲	BOAT/BANCA STATION

NOTE :

*1 - ALL STATIONS ARE RECKONED AT ℄ OF RIVER
*2 - LENGTHS SHOWN ARE LINEAR METRES UNLESS OTHERWISE SPECIFIED
*3 - FIGURES GOVERN OVER SCALED DIMENSIONS

R E V I S I O N S

NO.	DESCRIPTION	APPROVED	DATE

NOTE :

PURSUANT TO SECTION 4 OF ANNEX "A" OF THE REVISED IMPLEMENTING RULES AND REGULATIONS OF R.A. 9184, APPROVAL BY THE AUTHORIZED DPWH OFFICIALS OF DETAILED ENGINEERING SURVEYS AND DESIGN UNDERTAKEN BY CONSULTANTS NEITHER DIMINISHES THE RESPONSIBILITY OF THE LATTER FOR THE TECHNICAL INTEGRITY OF THE SURVEYS AND DESIGN NOR TRANSFER ANY PART OF THAT RESPONSIBILITY TO THE APPROVING OFFICIALS.

JICA CONSULTANT FOR DETAILED ENGINEERING DESIGN

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INTERNATIONAL
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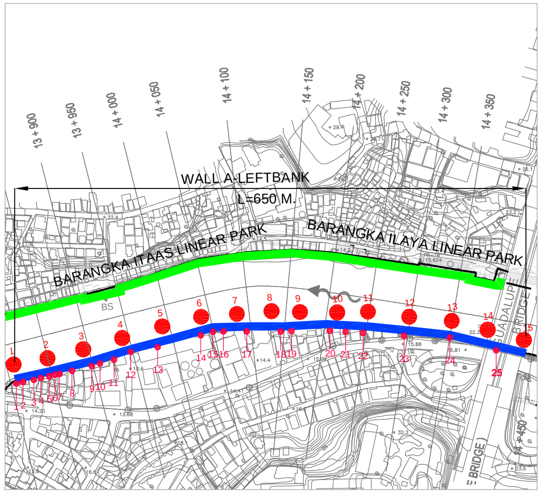
PROJECT & LOCATION	SHEET CONTENTS	SHEET NO.
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA	SCHMIDT HAMMER TEST RESULTS	2/2

Figure 3.1.2 Broken Condition of Priority III (1/3)

Fg 3.3



PHASE III-PRIORITY 3 WALL A

SCALE A


1


2


3


4


5


6


7


8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11


12


13


14


15


16


17


18


19


20


21


22


23


24

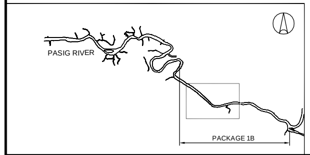

25

WALL A

SCALE A 0 50 100 150 200 250 300m

🟥 COMPLETED PHASE II
🟩 PHASE III (PRIORITY 1 & 2) - SSP
▨ PHASE III (PRIORITY 1 & 2) - RCF OR REPAIR
🟦 PHASE III (PRIORITY 3)
● SCHMIDT HAMMER TESTING POINT
📍 PHOTO LOCATION

KEY PLAN



LEGEND:

★ FERRY STATION/COAST GUARD
▲ BOAT/BANCA STATION

NOTE :
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*2 - LENGTHS SHOWN ARE LINEAR METRES UNLESS OTHERWISE SPECIFIED
*3 - FIGURES GOVERN OVER SCALED DIMENSIONS

REVISIONS

NO.	DESCRIPTION	APPROVED	DATE

NOTE :
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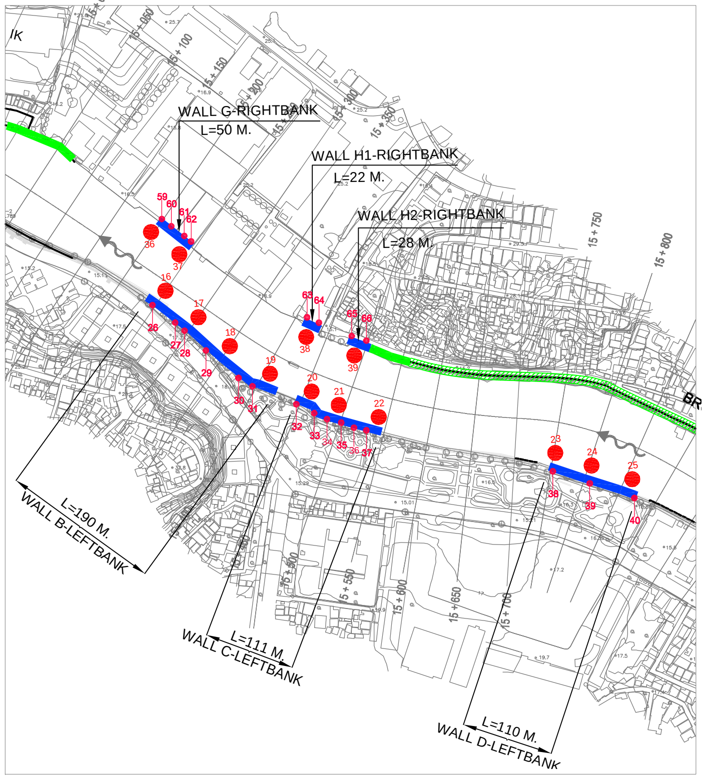
PROJECT & LOCATION	SHEET CONTENTS	SHEET NO.
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA	PHASE III-PRIORITY 3 WALL A PLAN (PHOTOS OF CRACKED & BROKEN WALLS)	1/3

Figure 3.1.2 Broken Condition of Priority III (2/3)

Fg 3.4



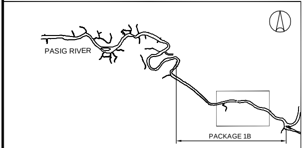
PHASE III-PRIORITY 3 WALL B,C,D,G,H1,&H2

SCALE A

SCALE A 0 50 100 150 200 250 300m

- 🟧 COMPLETED PHASE II
- 🟩 PHASE III (PRIORITY 1 & 2) - SSP
- ▨ PHASE III (PRIORITY 1 & 2) - RCF OR REPAIR
- 🟦 PHASE III (PRIORITY 3)
- ● SCHMIDT HAMMER TESTING POINT
- 📍 PHOTO LOCATION

KEY PLAN



LEGEND:

★	FERRY STATION/COAST GUARD
▲	BOAT/BANCA STATION

NOTE :

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WALL B

WALL C

WALL D

WALL G

WALL H1

WALL H2

R E V I S I O N S

NO.	DESCRIPTION	APPROVED	DATE

NOTE :

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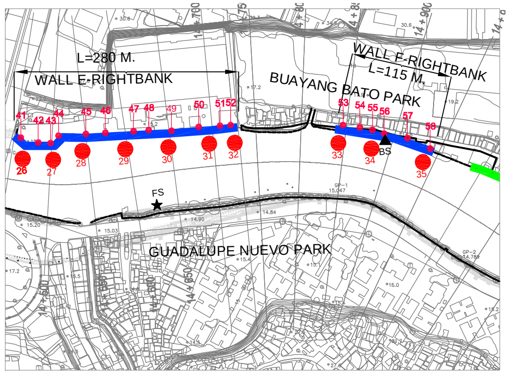
PROJECT & LOCATION	SHEET CONTENTS	SHEET NO.
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA	PHASE III-PRIORITY 3 WALL B,C,D,G,H1&H2 PLAN (PHOTOS OF CRACKED & BROKEN WALLS)	2/3

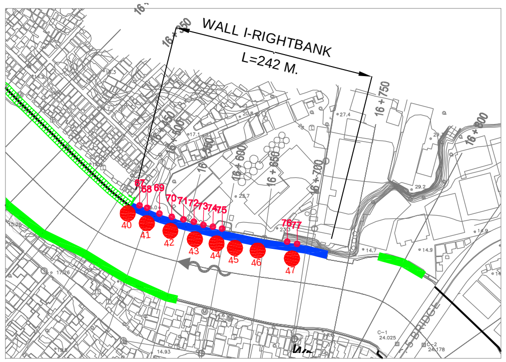
Figure 3.1.2 Broken Condition of Priority III (3/3)

Fg 3.5



PHASE III-PRIORITY 3 WALL E & F

SCALE A



PHASE III-PRIORITY 3 WALL I

SCALE A

SCALE A 0 50 100 150 200 250 300m

COMPLETED PHASE II

PHASE III (PRIORITY 1 & 2) - SSP

PHASE III (PRIORITY 1 & 2) - RCF OR REPAIR

PHASE III (PRIORITY 3)

● SCHMIDT HAMMER TESTING POINT

PHOTO LOCATION


41


42


43


44


45


46


47


48


49


50


51


52

WALL E


53


54


55


56


57


58

WALL F


67


68


69


70


71


72


73


74

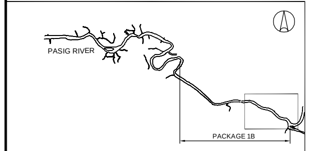

75

WALL I


76


77

KEY PLAN



LEGEND:

★ FERRY STATION/COAST GUARD

▲ BOAT/BANCA STATION

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RAUL C .ASIS, UNDERSECRETARY FOR TECHNICAL SERVICES
APPROVED BY: ROGELIO L. SINGSON, SECRETARY

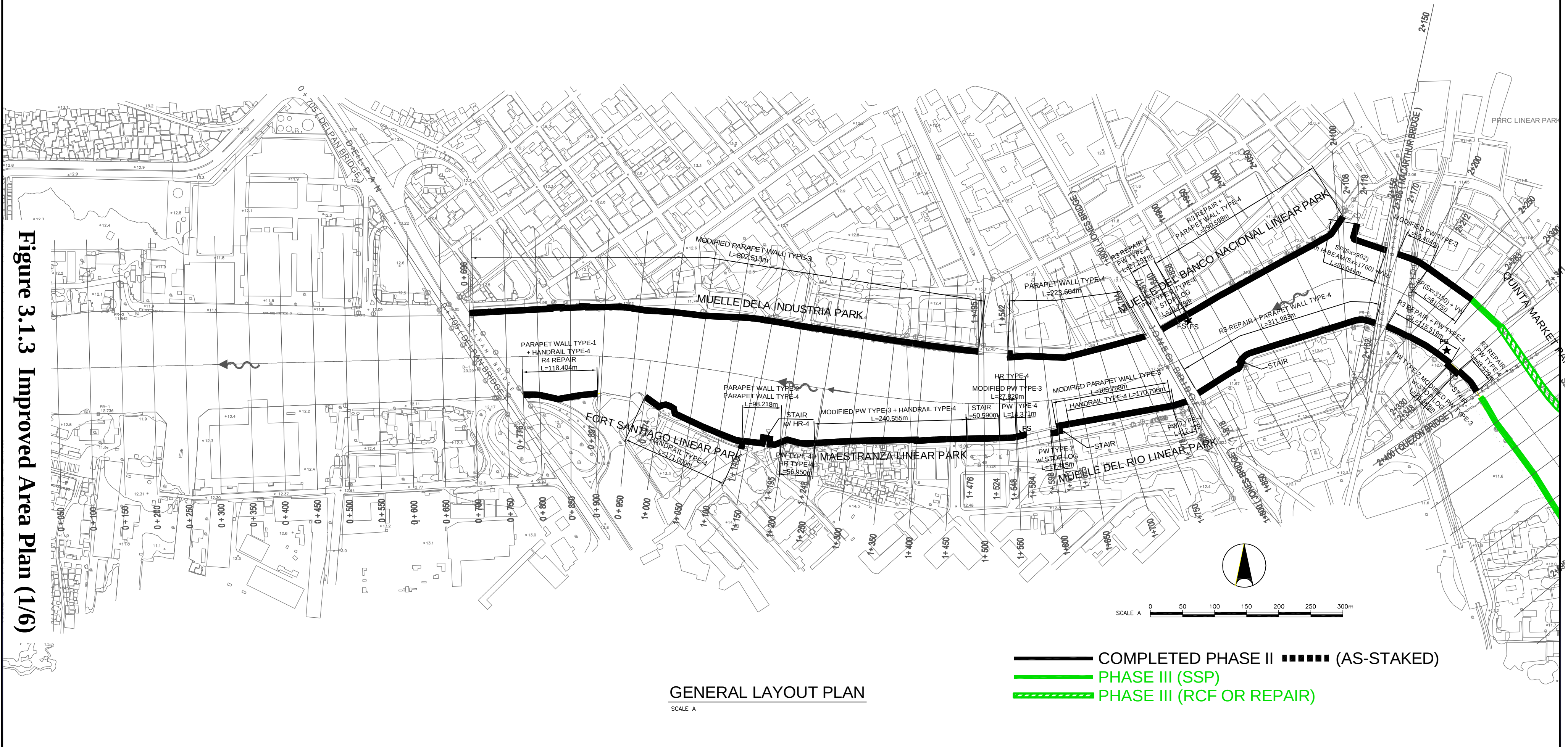
PROJECT & LOCATION: PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA

SHEET CONTENTS: PHASE III-PRIORITY 3 WALL E,F&I PLAN (PHOTOS OF CRACKED & BROKEN WALLS)

SHEET NO. 3/3

Figure 3.1.3 Improved Area Plan (1/6)

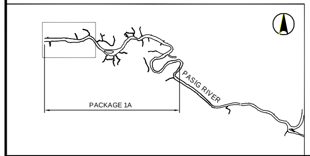
Fg 3.6



GENERAL LAYOUT PLAN

SCALE A

KEY PLAN



LEGEND:

★ FERRY STATION/COAST GUARD

▲ BOAT/BANCA STATION

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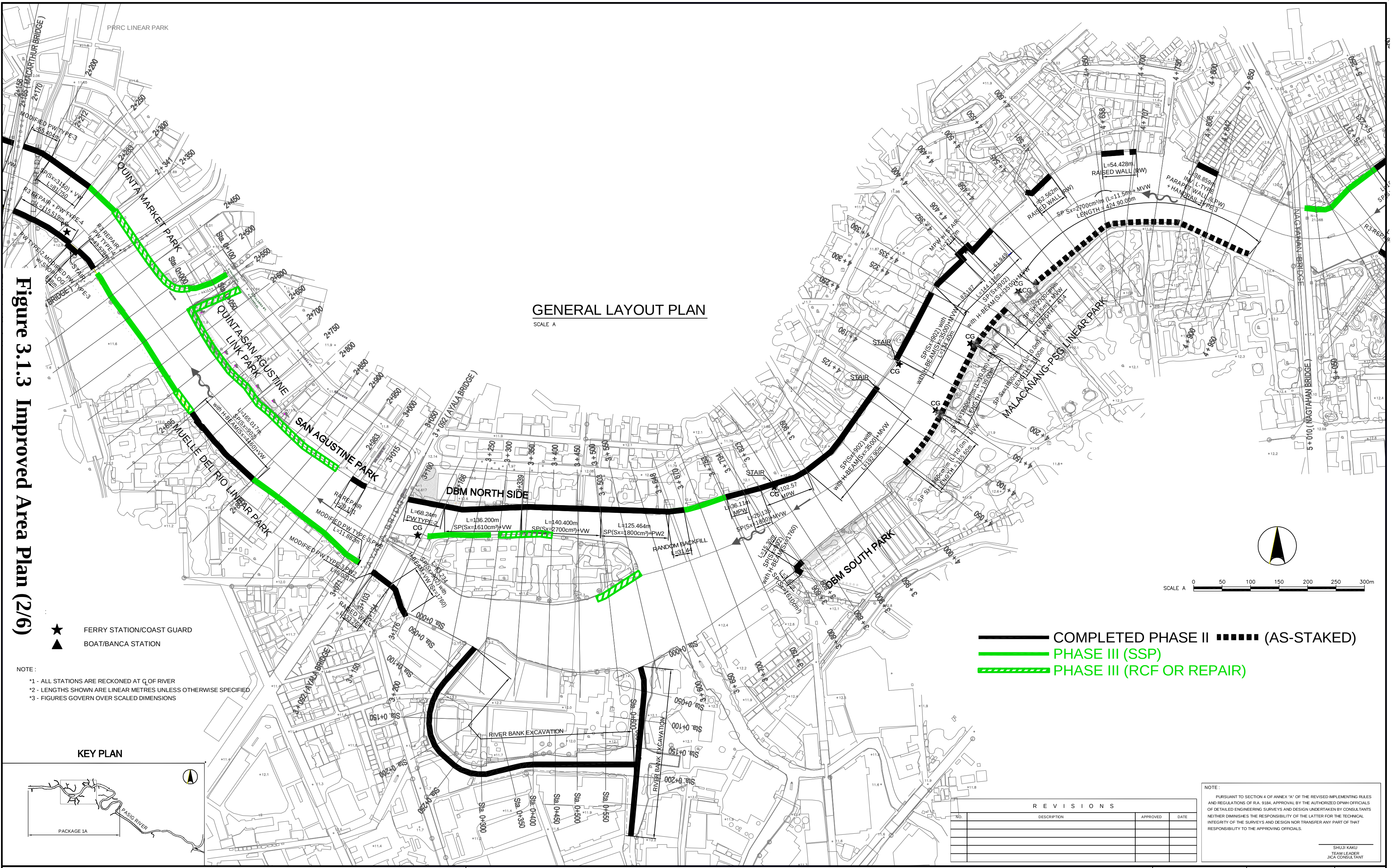
PROJECT & LOCATION	SHEET CONTENTS	SHEET NO.
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA	GENERAL LAYOUT PLAN	1/6



COMPLETED PHASE II ■■■■■■ (AS-STAKED)

PHASE III (SSP)

PHASE III (RCF OR REPAIR)

★ FERRY STATION/COAST GUARD

▲ BOAT/BANCA STATION

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Figure 3.1.3 Improved Area Plan (2/6)

Fg 3.7

R E V I S I O N S

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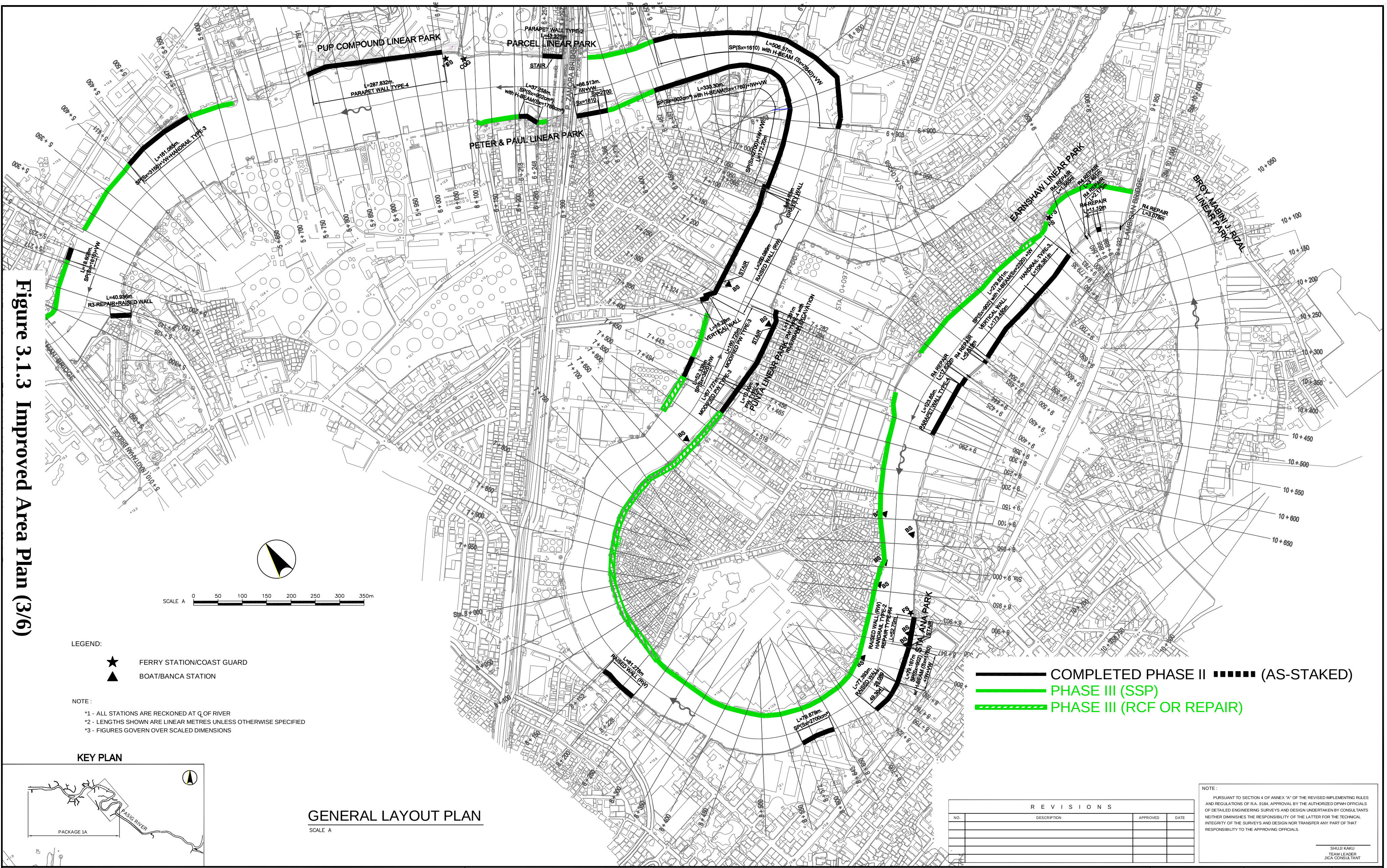
PROJECT & LOCATION	SHEET CONTENTS	SHEET NO.
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA	GENERAL LAYOUT PLAN	2/6

Figure 3.1.3 Improved Area Plan (3/6)

Fg 3.8



LEGEND:

★ FERRY STATION/COAST GUARD

▲ BOAT/BANCA STATION

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KEY PLAN

GENERAL LAYOUT PLAN

SCALE A

R E V I S I O N S

NO.	DESCRIPTION	APPROVED	DATE

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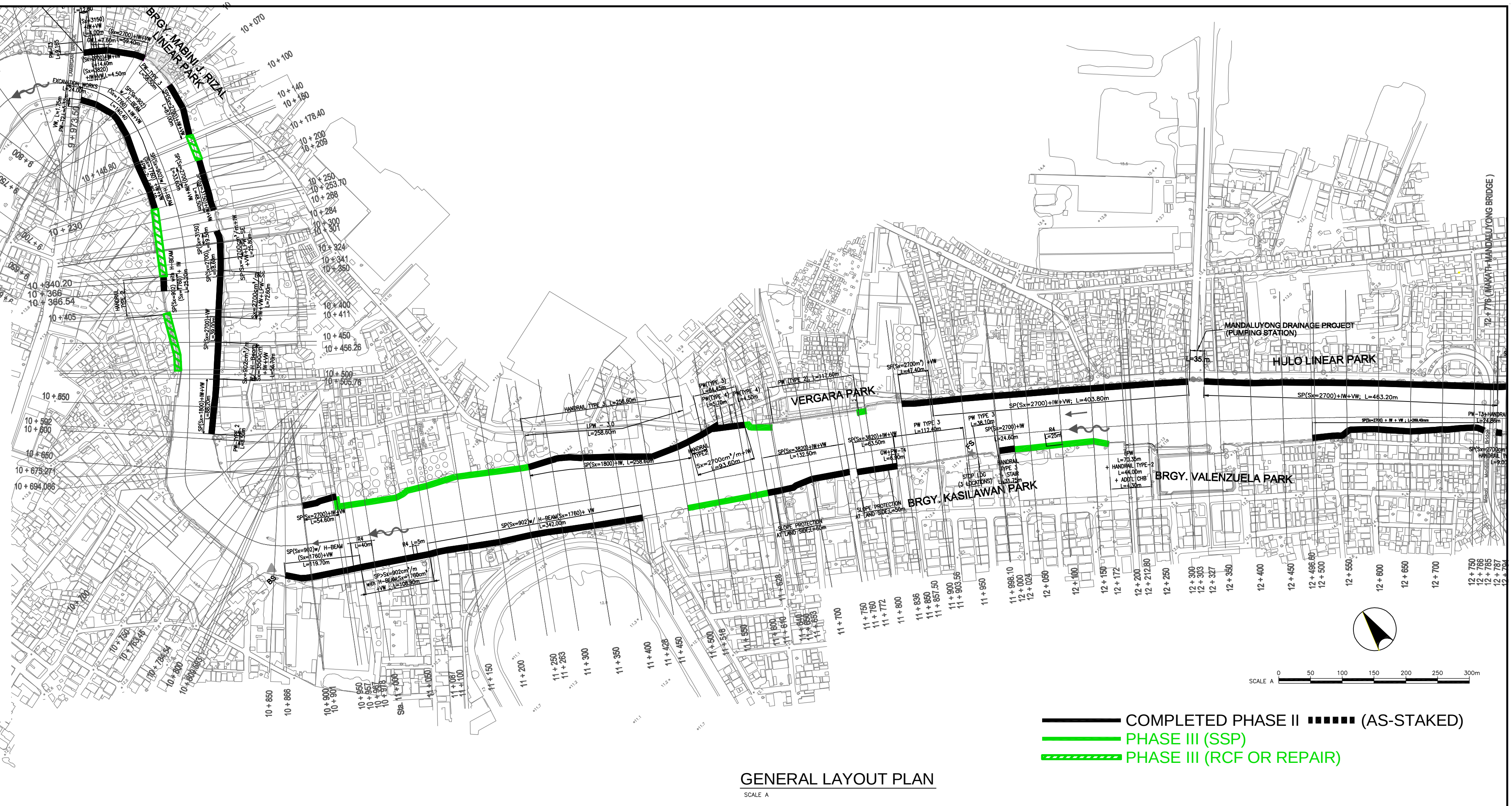
PROJECT & LOCATION
PASIG-MARIKINA
RIVER CHANNEL
IMPROVEMENT
PROJECT (PHASE III),
METRO MANILA

SHEET CONTENTS
GENERAL LAYOUT PLAN

SHEET NO.
3/6

Figure 3.1.3 Improved Area Plan (4/6)

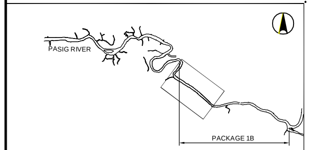
Fg 3.9



GENERAL LAYOUT PLAN

SCALE A

KEY PLAN



LEGEND:

★ FERRY STATION/COAST GUARD

▲ BOAT/BANCA STATION

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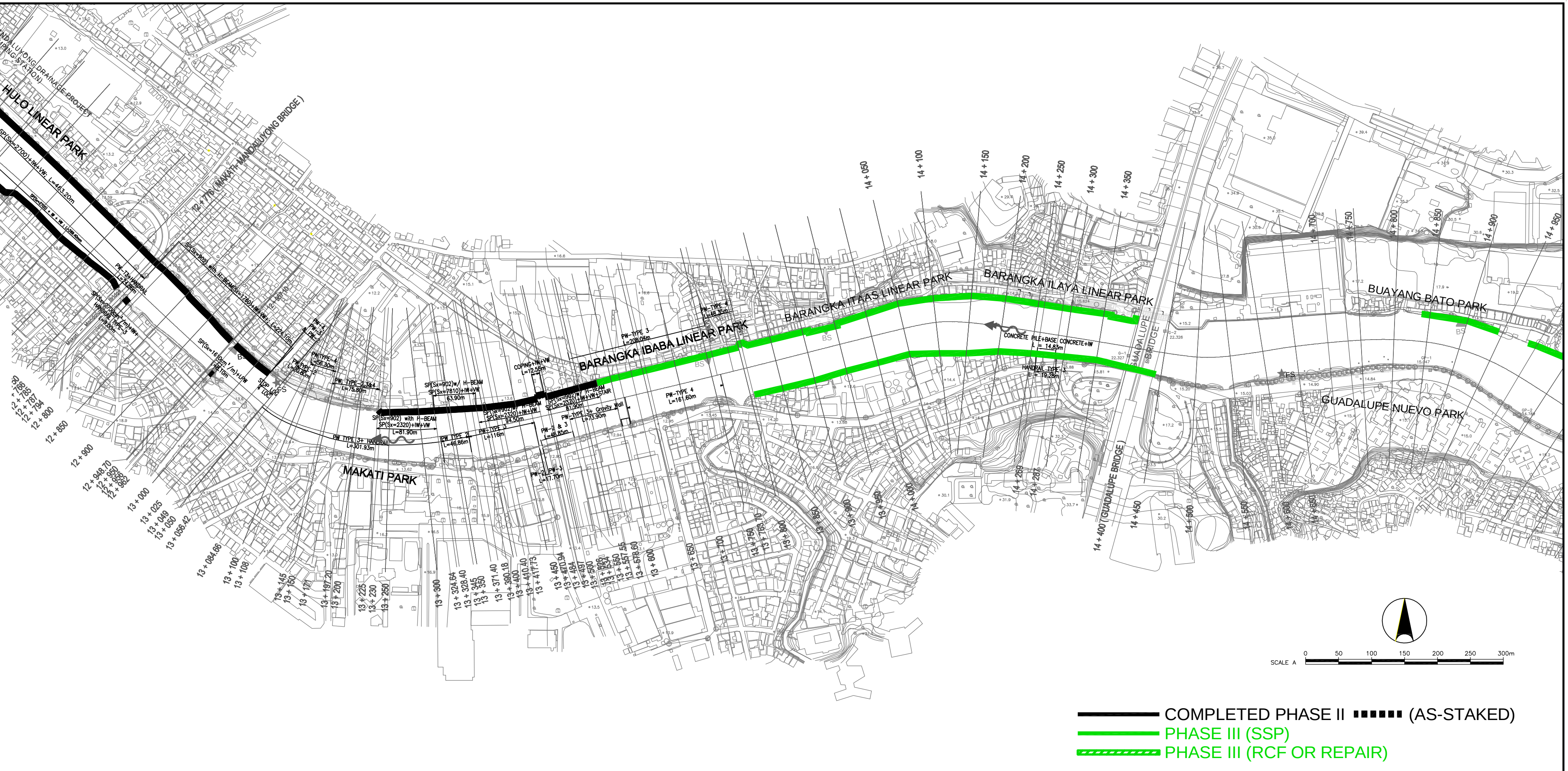
PROJECT & LOCATION	SHEET CONTENTS	SHEET NO.
PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA	GENERAL LAYOUT PLAN	4/6

Figure 3.1.3 Improved Area Plan (5/6)

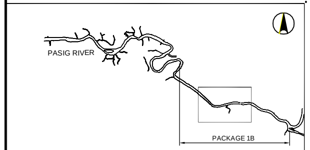
Fg 3.10



GENERAL LAYOUT PLAN

SCALE A

KEY PLAN



LEGEND:

- ★ FERRY STATION/COAST GUARD
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APPROVED BY: ROGELIO L. SINGSON, SECRETARY

PROJECT & LOCATION: PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III), METRO MANILA

SHEET CONTENTS: GENERAL LAYOUT PLAN

SHEET NO. 5/6

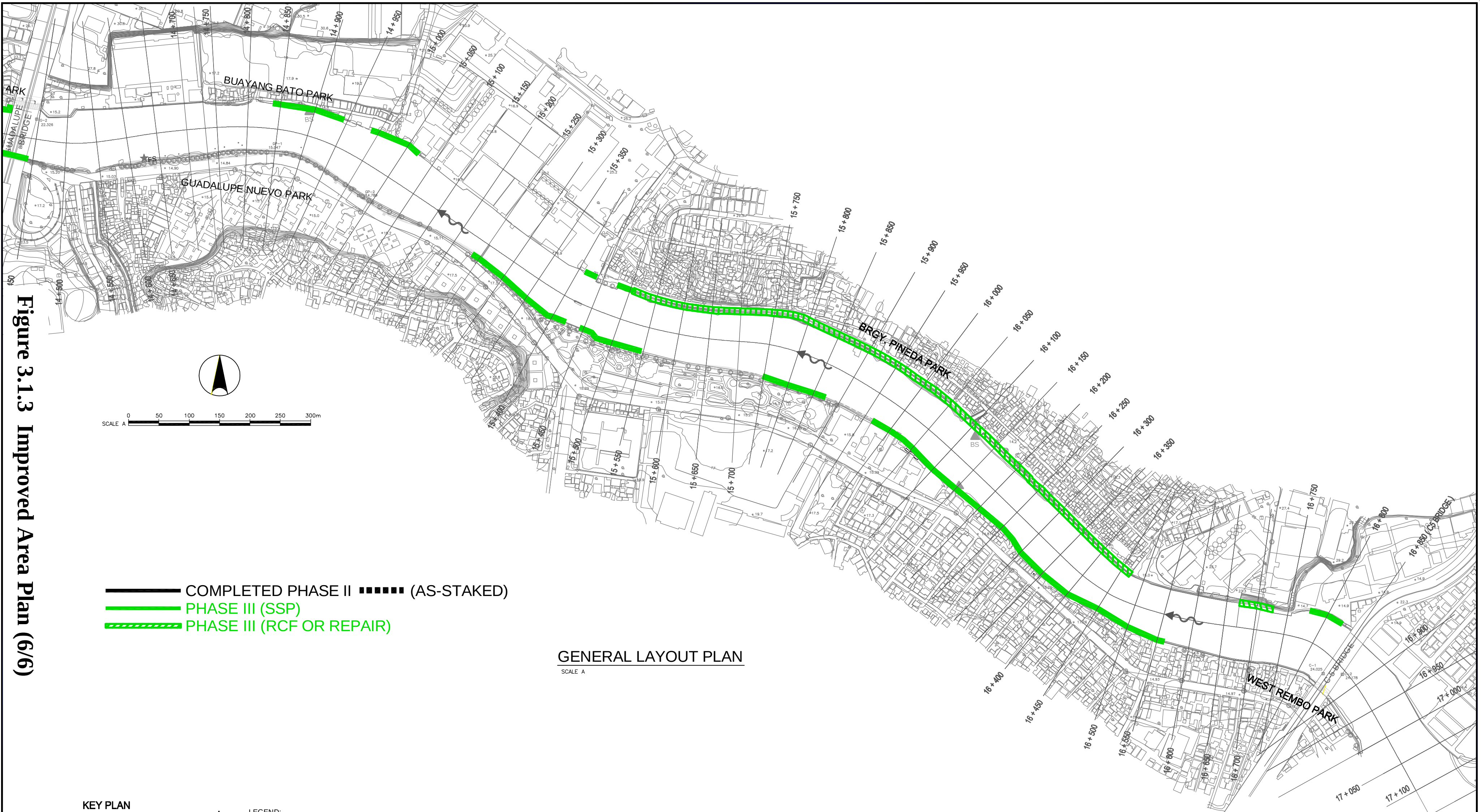


Figure 3.1.3 Improved Area Plan (6/6)

Fg 3.11

COMPLETED PHASE II ▪▪▪▪▪▪ (AS-STAKED)

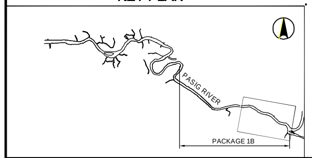
PHASE III (SSP)

PHASE III (RCF OR REPAIR)

GENERAL LAYOUT PLAN

SCALE A

KEY PLAN



LEGEND:

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NO.	DESCRIPTION	APPROVED	DATE

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JICA CONSULTANT

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INTERNATIONAL
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CHECKED BY: TOSHIKI KAWAKAMI, THE CHECKER
SUBMITTED BY: SHUJI KAKU, TEAM LEADER

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PMO - MFCP I

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BOD

RAUL C .ASIS
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FOR TECHNICAL SERVICES

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SECRETARY

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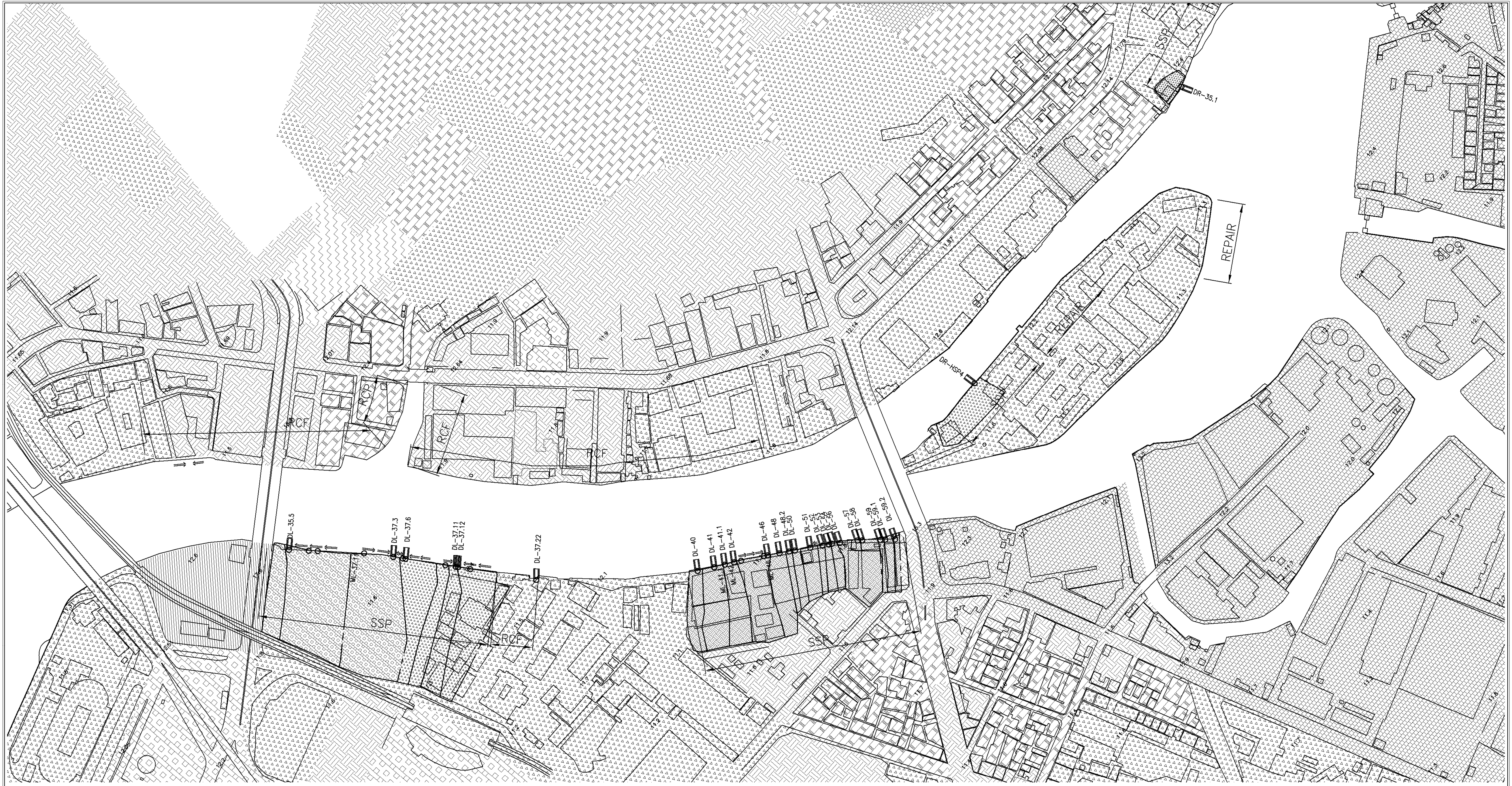
SHEET CONTENTS: GENERAL LAYOUT PLAN

SHEET NO. 6/6



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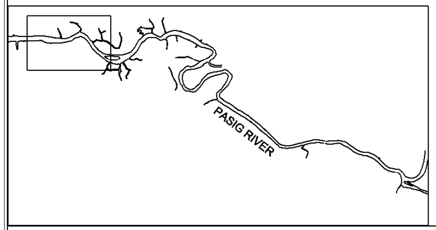

LEGEND:

- ▦ RESIDENTIAL (MANILA CITY)
- ▦ COMMERCIAL (MANILA CITY)
- ▦ INDUSTRIAL (MANILA CITY)
- ▦ INSTITUTIONAL (MANILA CITY)
- ▦ PARKS AND RECREATION (MANILA CITY)
- ▨ UNCLASSIFIED LAND (MANILA CITY)
- — CATCHMENT AREA BOUNDARY

GENERAL LAYOUT PLAN
SCALE A

SCALE A 0 0.5 1.0 1.5 2.0 2.5 3.0m

NOTE :

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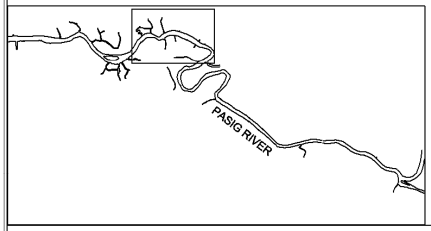
PASIG-MARIKINA
RIVER CHANNEL
IMPROVEMENT
PROJECT (PHASE III),
METRO MANILA

SHEET CONTENTS

SHEET NO.

Figure 3.3.1 Catchment Area and Land use in Pasig River (1/8)

KEY PLAN



LEGEND:

- ▦ RESIDENTIAL (MANILA CITY)
- ▦ COMMERCIAL (MANILA CITY)
- ▦ INDUSTRIAL (MANILA CITY)
- ▨ INSTITUTIONAL (MANILA CITY)
- ▨ PARKS AND RECREATION (MANILA CITY)
- ▨ UNCLASSIFIED LAND (MANILA CITY)
- — CATCHMENT AREA BOUNDARY

GENERAL LAYOUT PLAN
SCALE A

SCALE A 0 0.5 1.0 1.5 2.0 2.5 3.0m

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NO.	DESCRIPTION	APPROVED	DATE

NOTE :

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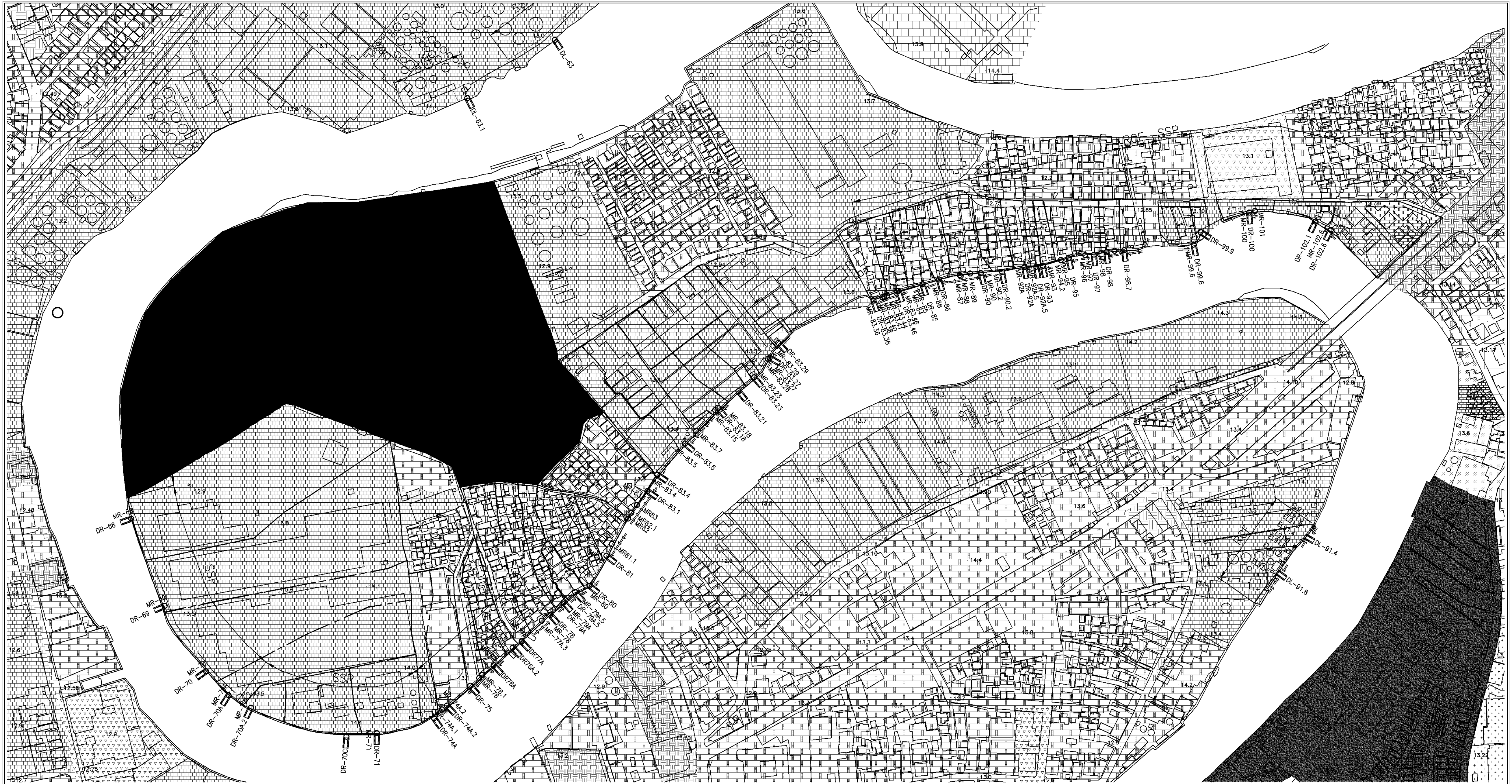
IMPROVEMENT
PROJECT (PHASE III),
METRO MANILA

SHEET CONTENTS

SHEET NO.

Figure 3.3.1 Catchment Area and Land use in Pasig River (2/8)



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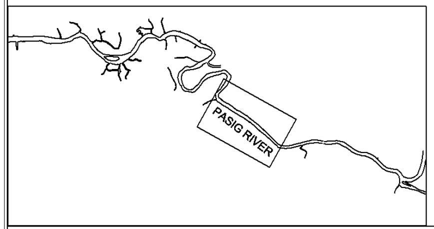

LEGEND:

▨	MEDIUM DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
▨	HIGH DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
▨	INSTITUTIONAL (MAKATI CITY)
▨	PLANNED UNIT DEVELOPMENT (MAKATI CITY)
▨	RIVERSIDE DEVELOPMENT ZONE (MAKATI CITY)
▨	RECREATIONAL (MAKATI CITY)
▨	RESIDENTIAL (MANDALUYONG CITY)
▨	INDUSTRIAL (MANDALUYONG CITY)
▨	COMMERCIAL (MANDALUYONG CITY)
▨	CEMETERY (MANDALUYONG CITY)
▨	VACANT IDLE PROPERTY (MANDALUYONG CITY)
▨	INSTITUTIONAL (MANDALUYONG CITY)
—	CATCHMENT AREA BOUNDARY

GENERAL LAYOUT PLAN
SCALE A

SCALE A 0 0.5 1.0 1.5 2.0 2.5 3.0m

REVISIONS

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NOTE :

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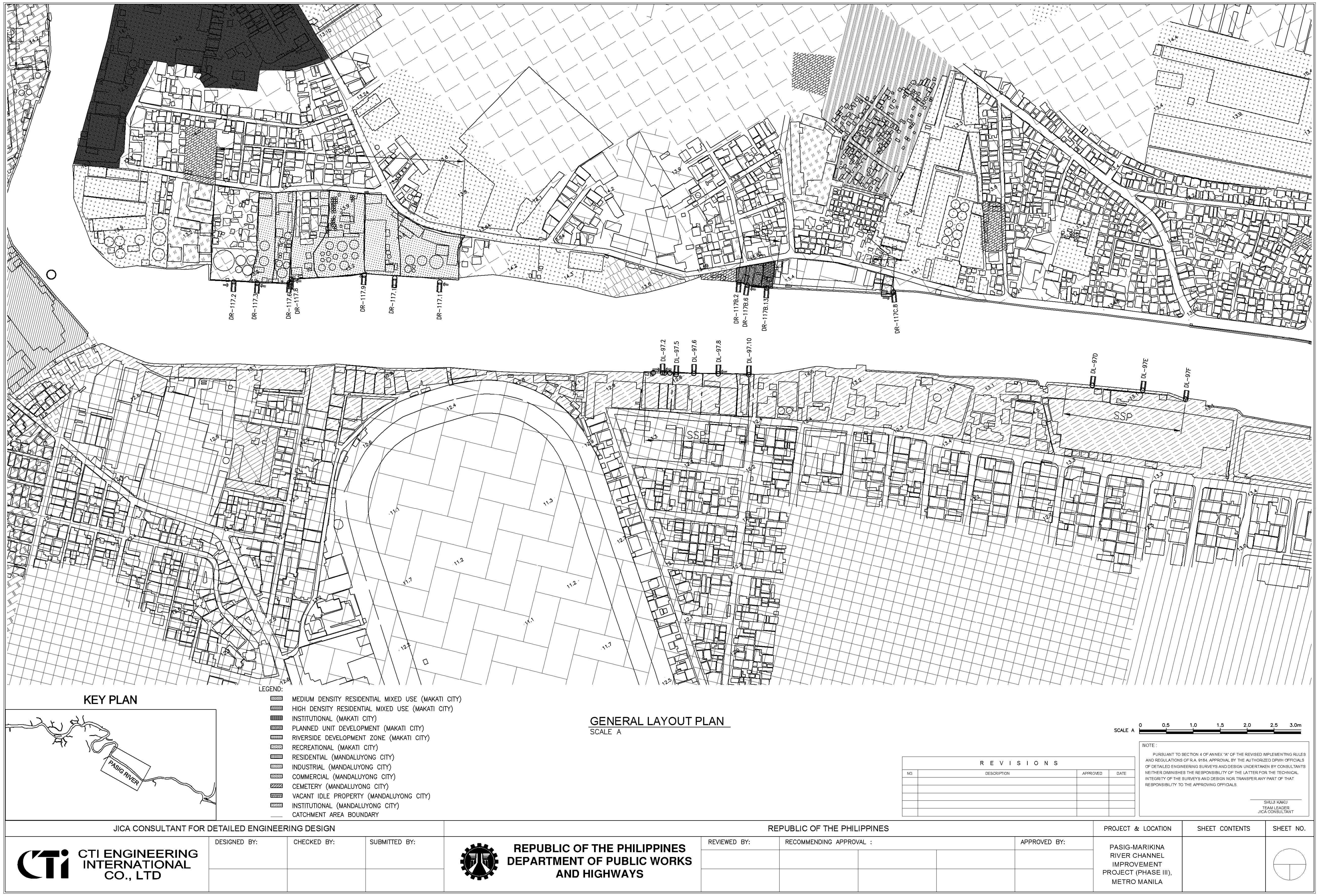
SHEET CONTENTS

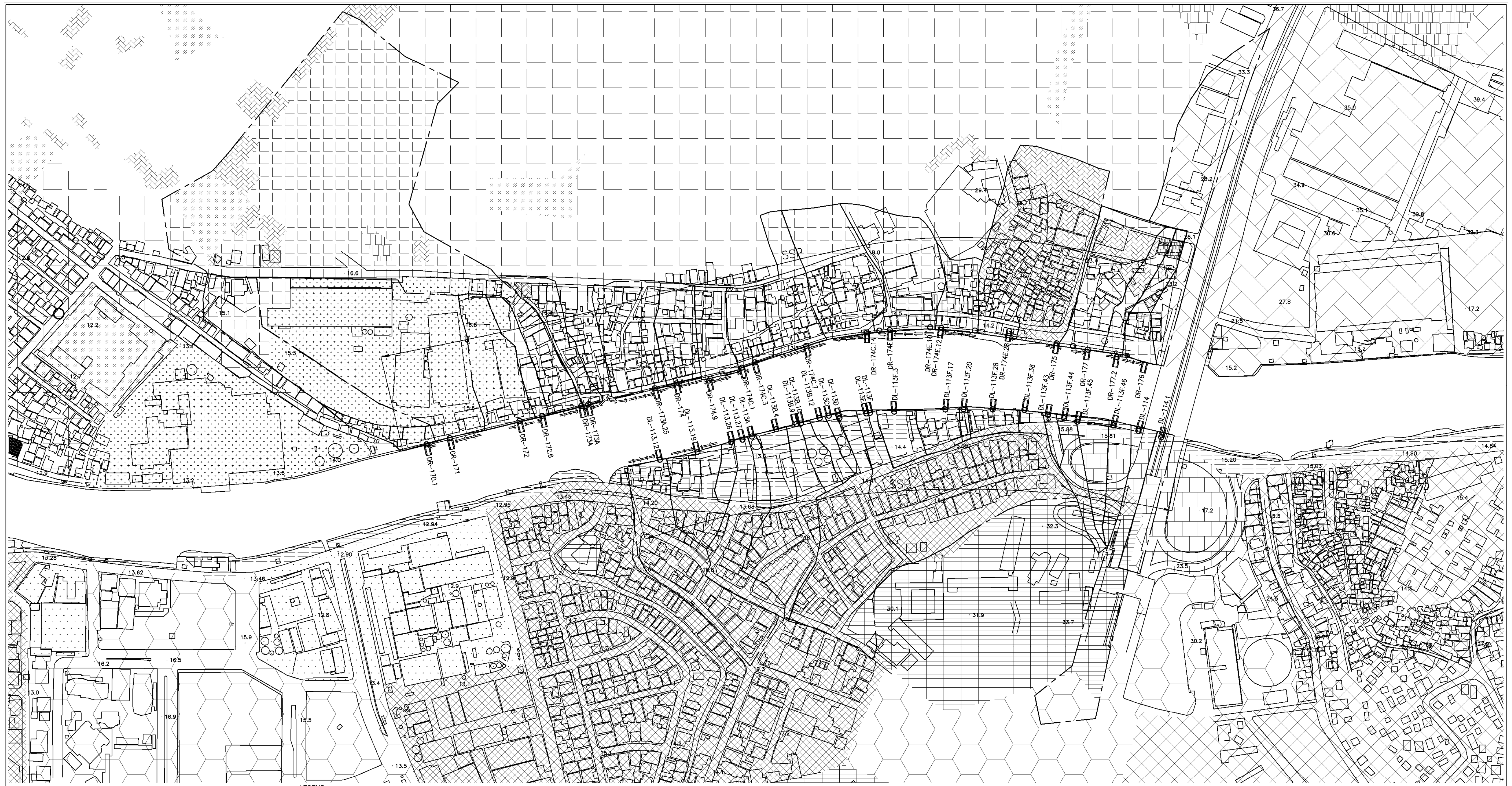
SHEET NO.

Figure 3.3.1 Catchment Area and Land use in Pasig River (3/8)



PURSUANT TO SECTION 4 OF ANNEX "A" OF THE REVISED IMPLEMENTING RULES AND REGULATIONS OF R.A. 9184, APPROVAL BY THE AUTHORIZED DPWH OFFICIALS OF DETAILED ENGINEERING SURVEYS AND DESIGN UNDERTAKEN BY CONSULTANTS NEITHER DIMINISHES THE RESPONSIBILITY OF THE LATTER FOR THE TECHNICAL INTEGRITY OF THE SURVEYS AND DESIGN NOR TRANSFER ANY PART OF THAT RESPONSIBILITY TO THE APPROVING OFFICIALS.

Figure 3.3.1 Catchment Area and Land use in Pasig River (4/8)



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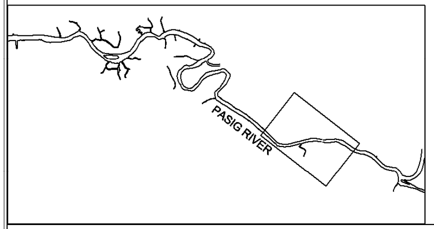

LEGEND:
- ▨ MEDIUM DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
- ▨ HIGH DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
- ▨ INSTITUTIONAL (MAKATI CITY)
- ▨ PLANNED UNIT DEVELOPMENT (MAKATI CITY)
- ▨ RIVERSIDE DEVELOPMENT ZONE (MAKATI CITY)
- ▨ RECREATIONAL (MAKATI CITY)
- ▨ RESIDENTIAL (MANDALUYONG CITY)
- ▨ INDUSTRIAL (MANDALUYONG CITY)
- ▨ COMMERCIAL (MANDALUYONG CITY)
- ▨ CEMETERY (MANDALUYONG CITY)
- ▨ VACANT IDLE PROPERTY (MANDALUYONG CITY)
- ▨ INSTITUTIONAL (MANDALUYONG CITY)
- — CATCHMENT AREA BOUNDARY

GENERAL LAYOUT PLAN
SCALE A

SCALE A 0 0.5 1.0 1.5 2.0 2.5 3.0m

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TEAM LEADER
JICA CONSULTANT

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PROJECT (PHASE III),
METRO MANILA

SHEET CONTENTS

SHEET NO.

Figure 3.3.1 Catchment Area and Land use in Pasig River (5/8)

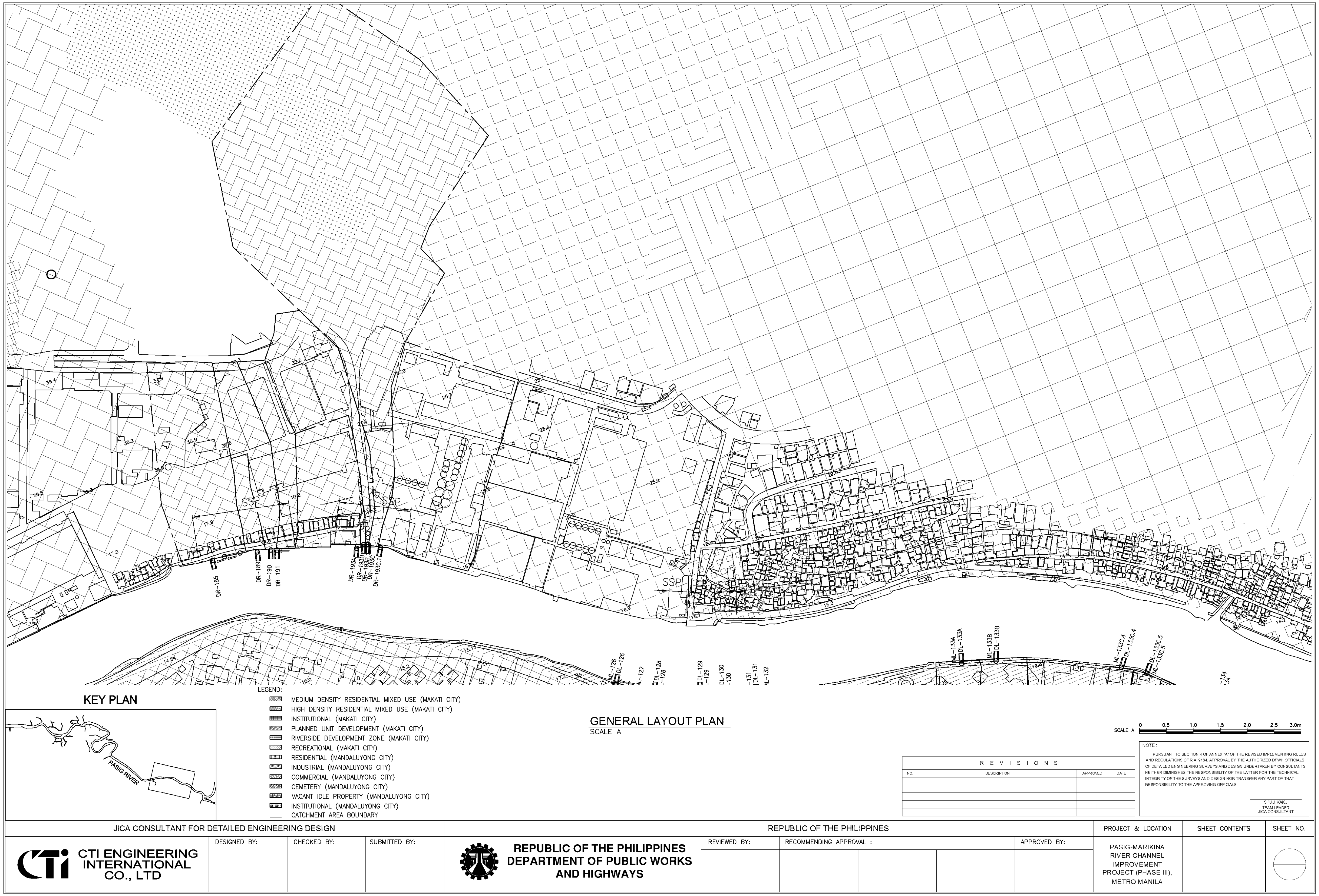

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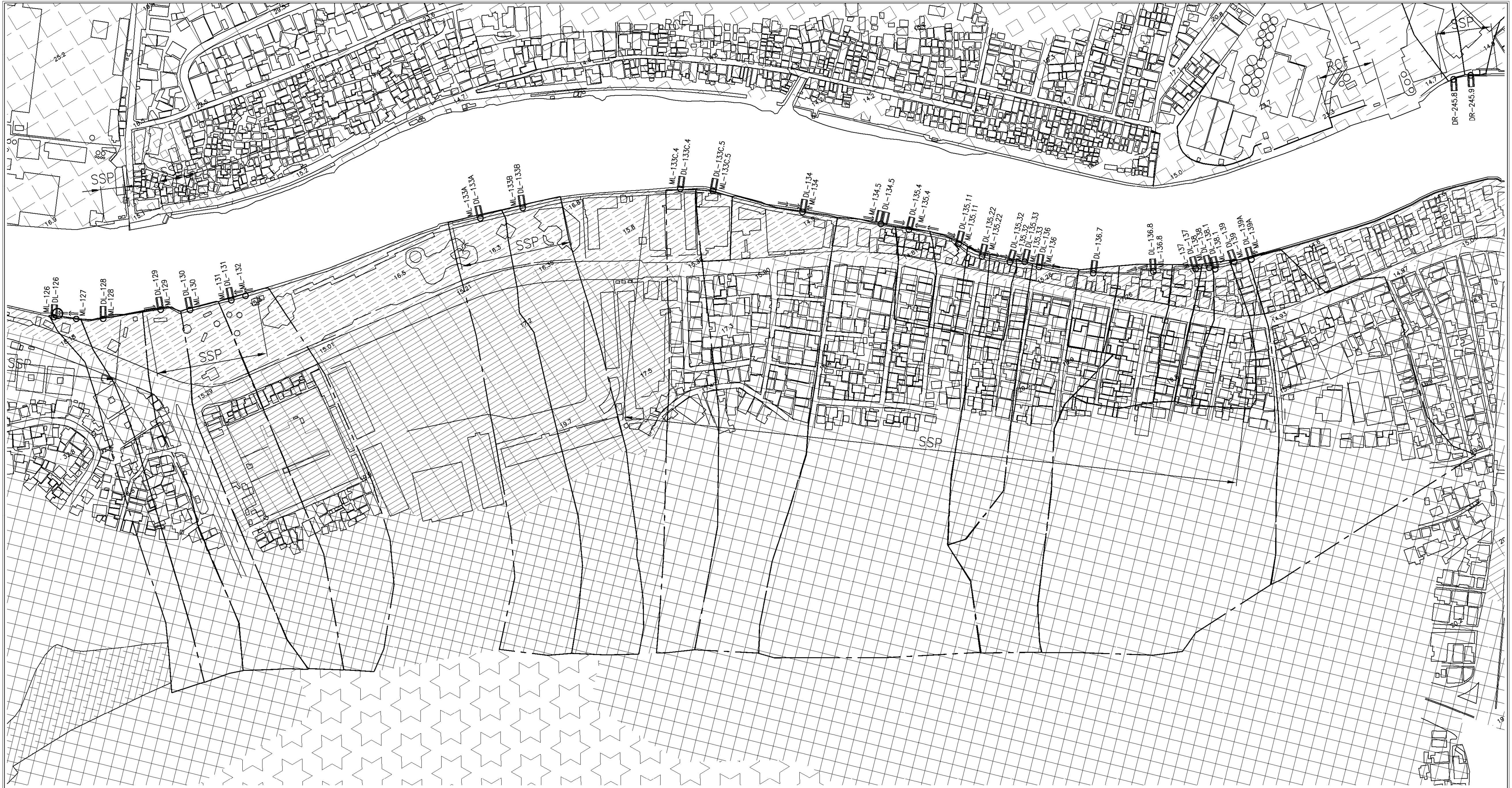
Figure 3.3.1 Catchment Area and Land use in Pasig River (6/8)



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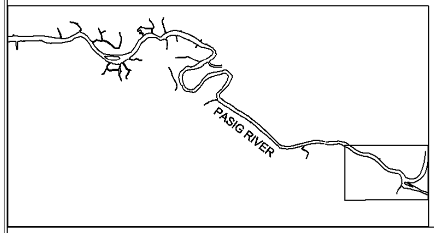

LEGEND:

- ▨ MEDIUM DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
- ▨ HIGH DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
- ▨ INSTITUTIONAL (MAKATI CITY)
- ▨ PLANNED UNIT DEVELOPMENT (MAKATI CITY)
- ▨ RIVERSIDE DEVELOPMENT ZONE (MAKATI CITY)
- ▨ RESIDENTIAL 3 (PASIG CITY)
- ▨ RESIDENTIAL 2 (PASIG CITY)
- ▨ MEDIUM INDUSTRIAL ZONE (PASIG CITY)
- ▨ COMMERCIAL 1a (PASIG CITY)
- — CATCHMENT AREA BOUNDARY

GENERAL LAYOUT PLAN
SCALE A

SCALE A 0 0.5 1.0 1.5 2.0 2.5 3.0m

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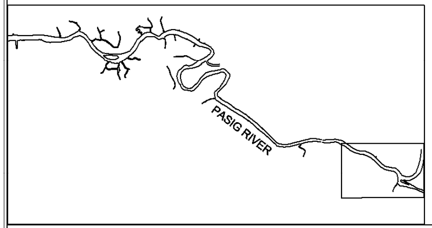
IMPROVEMENT
PROJECT (PHASE III),
METRO MANILA

SHEET CONTENTS

SHEET NO.

Figure 3.3.1 Catchment Area and Land use in Pasig River (7/8)

KEY PLAN



LEGEND:

- ▨ MEDIUM DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
- ▨ HIGH DENSITY RESIDENTIAL MIXED USE (MAKATI CITY)
- ▨ INSTITUTIONAL (MAKATI CITY)
- ▨ PLANNED UNIT DEVELOPMENT (MAKATI CITY)
- ▨ RIVERSIDE DEVELOPMENT ZONE (MAKATI CITY)
- ▨ RESIDENTIAL 3 (PASIG CITY)
- ▨ RESIDENTIAL 2 (PASIG CITY)
- ▨ MEDIUM INDUSTRIAL ZONE (PASIG CITY)
- ▨ COMMERCIAL 1a (PASIG CITY)
- — CATCHMENT AREA BOUNDARY

GENERAL LAYOUT PLAN
SCALE A

SCALE A 0 0.5 1.0 1.5 2.0 2.5 3.0m

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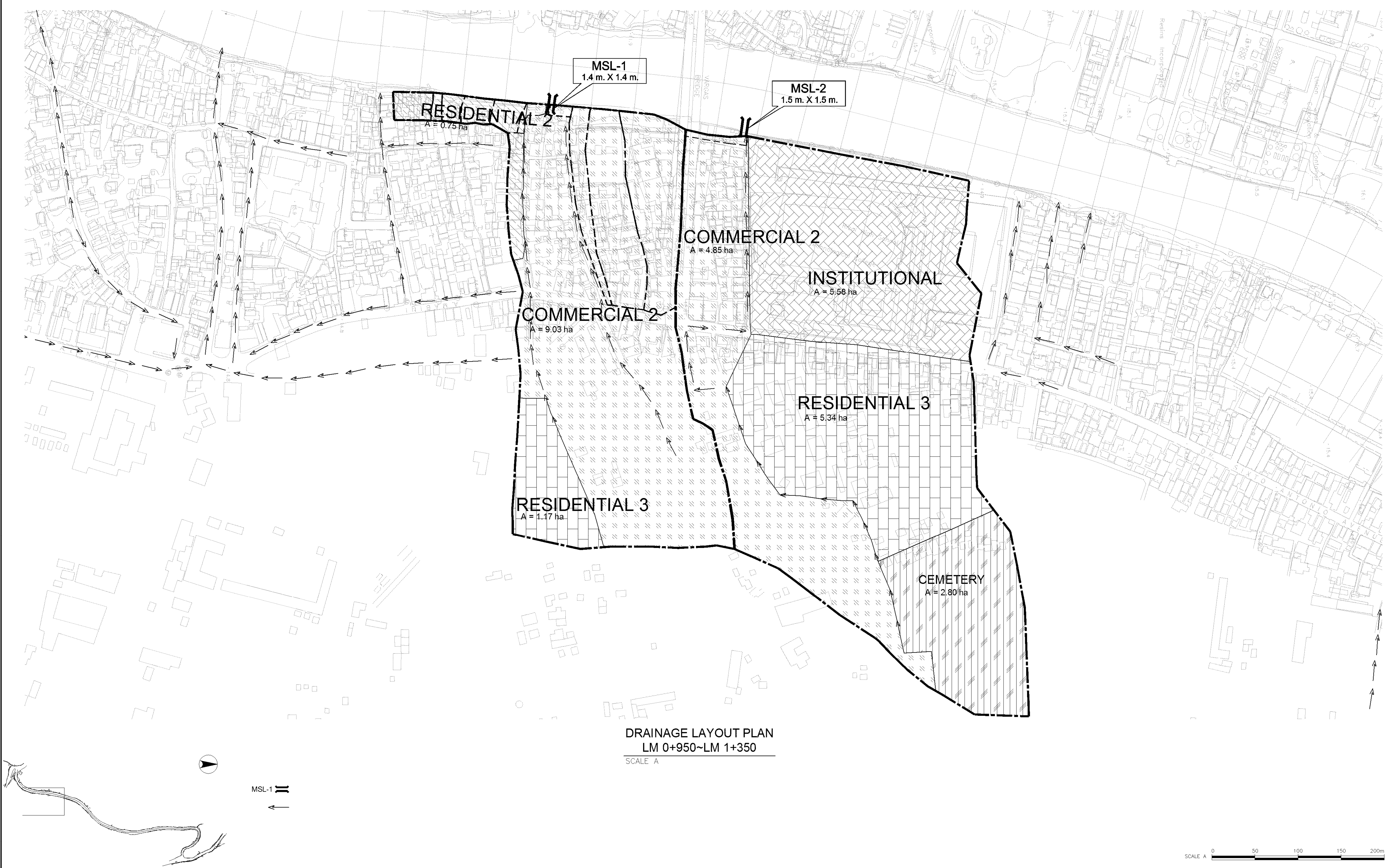
Figure 3.3.1 Catchment Area and Land use in Pasig River (8/8)



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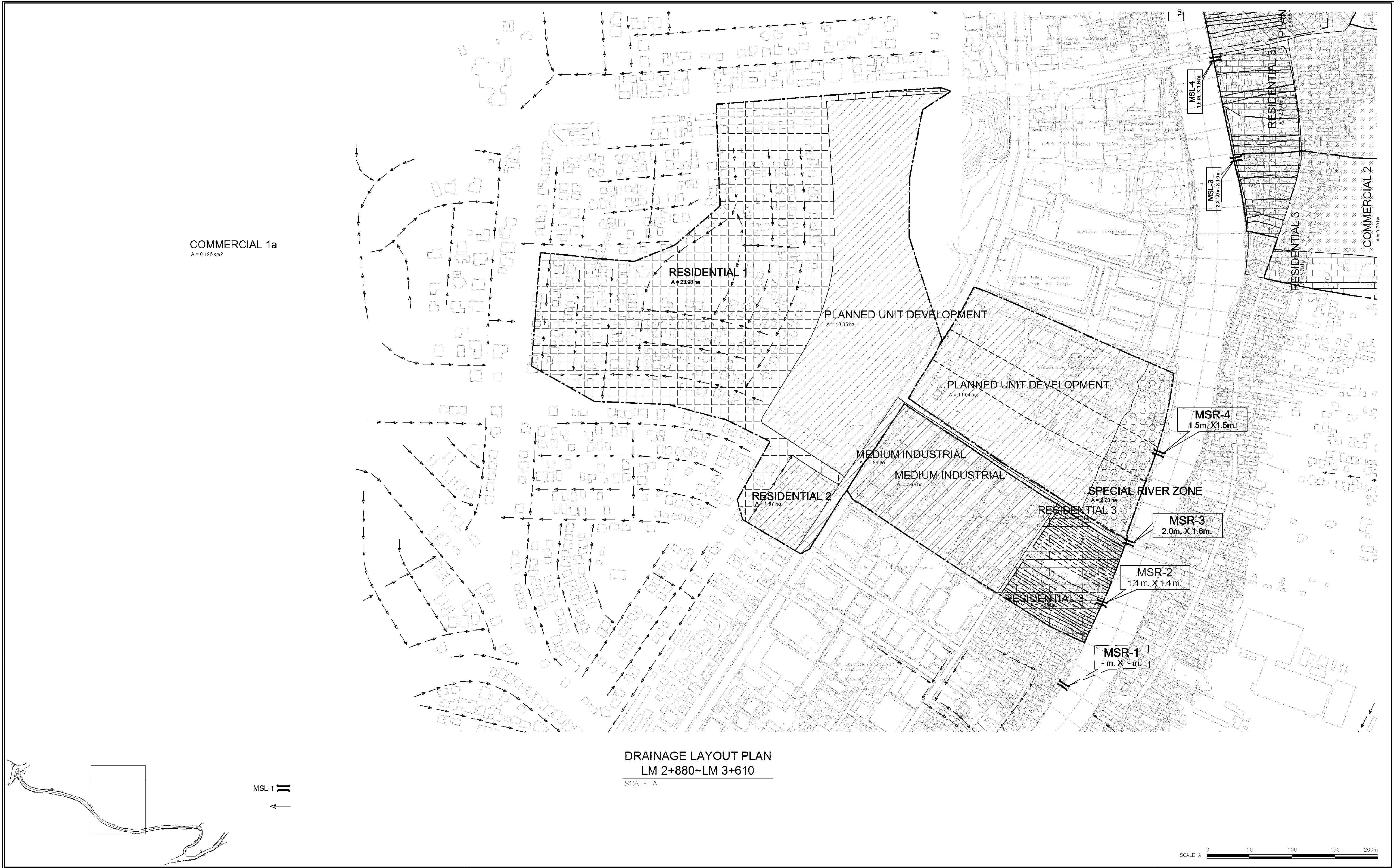
DRAINAGE LAYOUT PLAN
LM 0+950~LM 1+350

Figure 3.3.2 Catchment Area and Land Use in Lower Marikina River (1/3)



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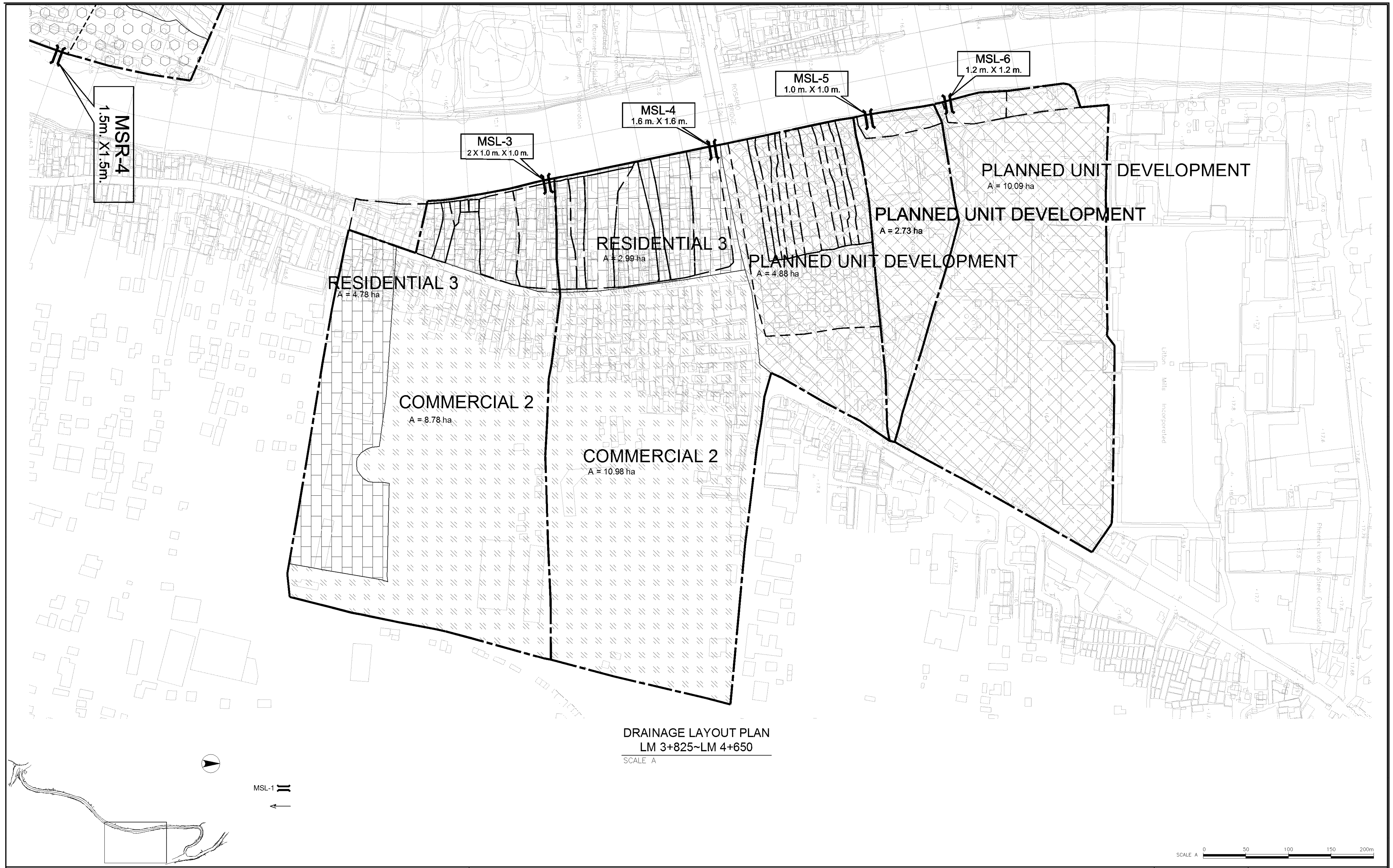
RIVER CHANNEL
IMPROVEMENT
PROJECT (PHASE III),
METRO MANILA

DRAINAGE LAYOUT PLAN
LM 2+880~LM 3+610

Figure 3.3.2 Catchment Area and Land Use in Lower Marikina River (2/3)



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RIVER CHANNEL
IMPROVEMENT
PROJECT (PHASE III),
METRO MANILA

DRAINAGE LAYOUT PLAN
LM 3+825~LM 4+650

Figure 3.3.2 Catchment Area and Land Use in Lower Marikina River (3/3)