# CHAPTER 4

# STUDY OF EACH INTERCHANGE

## 4.1 DESIGN STANDARD AND TYPE OF SUPER STRUCTURE

### 4.1.1 Design Standard for Highway and Flyover

The consultant prepared proposed up-dated design standards for highways and flyovers. This had taken into consideration a review of previous design standards which had been used in the previous detailed design of highways and flyovers. The proposed design standards of highway and flyovers were discussed and confirmed with the BOD Highway and Bridge Divisions.

Major changes between previous and updated design standards as well as Highway Design Standards and Flyover Design Standards are shown in **Table 4.1-1** and **Table 4.1-2**, respectively. The major Changes are summarized as follows:

| | Previous | Updated |
|---|---|---|
| Highway Design Standards | | |
| (1) Design Speed | 70km/h for EDSA and<br>60km/h for C3 and C5 | 60km/h Desired,<br>50km/h minimum |
| (2) Width of Service Road | 3.35m | 3.05m |
| (3) Hydrology Design<br>Frequency Level<br>Pipe Culvert | 10 years | 15 years |
| Flyover Design Standards | | |
| (1) Seismic Acceleration | 0.4g | 0.5g |

Among these, the notable significant change is the increase of seismic acceleration coefficient from 0.4g to 0.5g which will require for bigger structural dimensions and increase reinforcing steel bars.

According to DPWH BOD, the ASEP (Association of Structural Engineering of the Philippines) is planning to issue a new version of seismic design code in the near future and the application to actual structural design will take place sometimes. In view of this, the BOD has advised consultant to adopt higher seismic acceleration coefficient for future design as a temporary measure.

## Table 4.1-1 Highway Design Standards

| DESCRIPTION | C-3 THROUGH | EDSA THROUGH | C-5 THROUGH | WEST AVE.- NORTH AVE. THROUGH | SERVICE LANE AT GRADE | MMICP VI Design Standard | |
|---|---|---|---|---|---|---|---|
| | | | | | | Through | Service lane |
| **Design Condition** | | | | | | | |
| Design Speed | 60 kph | 70 kph | 60 kph | 40 kph | 40 kph | 60kph : desirable<br>50kph : minimum | 40kph |
| Minimum Radius Curvature (Hor.) | 150 m | 200 m | 150 m | 60 m | 60 m | 150 m : 60kph<br>90 m : 50 kph | 60 m |
| Maximum Superelevation | 4.00% | 6.0% | | 6.0% | 6.0% | 6.0% | 6.0% |
| Min. Transition (Clothoid) Curve Length : L | | 60 m | | 25 m | 25 m | 60 m | 25 m |
| Min. Clothoid Parameter : A | | 110 | | 37.5 | 37.5 | 110 | 37.5 |
| Maximum Vertical Grade | 6.00% | 6.0% | 6.0% | 6.0% | 6.0% | 6.0% | 6.0% |
| Minimum Vertical Grade | 0.35% | 0.35% | 0.35% | 0.35% | 0.35% | 0.35% | 0.35% |
| Minimum Stopping Sight Distance | 85 m | 100 m | 85 m | 45 m | 45 m | 65m : 50kph<br>85m : 60kph | 45 m |
| Critical Length of Vertical Grade | | 3.0% - 500 m | | | - | 3.0% - 500 m | |
| | | 4.0% - 340 m | | | | 4.0% - 340 m | |
| | | 5.0% - 240 m | | 5.0% - 340 m | | 5.0% - 240 m | |
| | | 6.0% - 200 m | | 6.0% - 280 m | | 6.0% - 200 m | |
| Length of Taper<br>(S : design speed, W : offset) | | 0.6SW | | $WS^2/155$ | $WS^2/155$ | 0.6SW | $WS^2/155$ |
| **Minimum Length of Vertical Curve** | | 60 m | | 60 m | | | |
| K value @ Crest : | | K = 22 | | K = 5 | K = 5 | K = 11 | K = 5 |
| K value @ Sag : | | K = 20 | | K = 8 | K = 8 | K = 18 | K = 8 |
| **Vertical Clearance** | | 5.0 m | | 5.0 m | 5.0 m | 5.0 m | 5.0 m |
| **Cross Section** | | | | | | | |
| Lane Width | 3.25 m | 3.35 m | 3.25 m | 3.35 m | 3.35 m | 3.35 m | 3.05m |
| Lane Cross Slope | 1.50% | 1.50% | 1.50% | 1.50% | 1.50% | 1.5% ≤ 2 lanes<br>2.0% ≥ 3 lanes | 1.50% |
| Sidewalk Cross Slope | - | - | - | - | 2.0% | | 2.0% |
| **Hydrology Design Frequency Level** | | | | | | | |
| Inlet | 2 Years | 2 Years | 2 Years | 2 Years | 2 Years | 2 Years | |
| Ditches | 5 Years | 5 Years | 5 Years | 5 Years | 5 Years | 5 Years | |
| Pipe Culverts | 10 Years | 10 Years | 10 Years | 10 Years | 10 Years | 15 Years w/ adequate freeboard to contain 25 year flood | |
| Box Culverts | 25 Years | 25 Years | 25 Years | 25 Years | 25 Years | 25 Years w/ adequate freeboard to contain 50 year flood | |
| Bridges - small rivers (<40 sq. km catchment) | 50 years | 50 years | 50 years | 50 years | 50 years | 25 Years w/ adequate freeboard to contain 50 year flood | |
| Bridges - major rivers (≥40 sq. km catchment) | 50 years | 50 years | 50 years | 50 years | 50 years | 50 years w/ adequate freeboard to contain 100 year flood | |

*Source: JICA Study Team*

### Table 4.1-2 Structural Design Standards

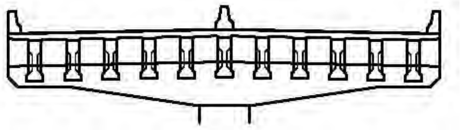
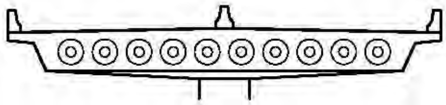
| DESCRIPTION | C-3/E. Rodriguez | EDSA/Roosevelt | EDSA/North/West | MMICP VI Design Standard |
|---|---|---|---|---|
| Material Properties | | | | |
| Concrete Substructure | 28.0 Mpa | 28.0 Mpa (20 mm) | 28.0 Mpa (20 mm) | 28.0 Mpa (20 mm) |
| Bored Pile | 28.0 Mpa | 28.0 Mpa (25 mm) | 28.0 Mpa (25 mm) | 28.0 Mpa (25 mm) |
| PCDG Girders | - | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) |
| Column to RC Slab | - | 28.0 Mpa (20 mm) | 28.0 Mpa (20 mm) | 28.0 Mpa (20 mm) |
| Column to PC Slab | - | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) |
| Coping Beam to RC Slab | - | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) |
| Coping Beam to PC Slab | - | 41.0 Mpa (20 mm) | 41.0 Mpa (20 mm) | 41.0 Mpa (20 mm) |
| RC Voided Slab | 34.5 Mpa | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) | 34.0 Mpa (20 mm) |
| PC Voided Slab | 34.5 Mpa | 41.0 Mpa (20 mm) | 41.0 Mpa (20 mm) | 41.0 Mpa (20 mm) |
| Bridge Railing | 21.0 Mpa | - | - | 21.0 Mpa |
| Reinforcing Steel | Grade 40 & 60 | Grade 60 | Grade 60 | Grade 60 |
| Prestressing Steel | Grade 270 and low relaxation with an ultimate strength Fu = 1,860 Mpa | Grade 270 and low relaxation with an ultimate strength Fu = 1,860 Mpa | Grade 270 and low relaxation with an ultimate strength Fu = 1,860 Mpa | Grade 270 and low relaxation with an ultimate strength Fu = 1,860 Mpa |
| Structural Steel | AASHTO M270 (ASTM A36) | Minimum yield strength Fy = 428 Mpa | Minimum yield strength Fy = 428 Mpa | Minimum yield strength Fy = 428 Mpa |
| Elastomeric Bearing Pads | 100% virgin chloroprene pads with durometer hardness 60 and laminated with non-corrosive mild steel sheets | 100% virgin chloroprene pads with durometer hardness 60 and laminated with non-corrosive mild steel sheets | 100% virgin chloroprene pads with durometer hardness 60 and laminated with non-corrosive mild steel sheets | 100% virgin chloroprene pads with durometer hardness 60 and laminated with non-corrosive mild steel sheets |
| Loads and Allowable Stresses | | | | |
| Reinforced Concrete | 24.0 kn/m$^3$ | 24.5 kn/m$^3$ | 24.5 kn/m$^3$ | 24.5 kn/m3 |
| Asphalt Wearing Course | - | 22.0 kn/m$^3$ | 22.0 kn/m$^3$ | 22.0 kn/m3 |
| Steel | 77.0 kn/m$^3$ | 77.0 kn/m$^3$ | 77.0 kn/m$^3$ | 77.0 kn/m3 |
| Compacted Earth | 19.0 kn/m$^3$ | 19.0 kn/m$^3$ | 19.0 kn/m$^3$ | 19.0 kn/m3 |
| Live Load | AASHTO MS18 (HS20-44) | AASHTO MS18 (HS20-44) | AASHTO MS18 (HS20-44) | AASHTO MS18 (HS20-44) Permit Load |
| Seismic Load | | | | |
| Seismic Performance Category | D | D | D | D |
| Soil Profile | - | Type II | Type II | Site Specific |
| Seismic Acceleration | 0.4 g | 0.4 g | 0.4 g | 0.5g |
| Site Coefficient | - | 1.2 | 1.2 | Site Specific |

*Source: JICA Study Team*

### 4.1.2 Type of Super Structure

Based on the comparison of flyover deck types presented hereunder and the DPWH comments for further consideration of aesthetic view, a PC Voided Slab is proposed to be utilized in this project.

**Table 4.1-3 Comparison of Flyover Deck Types**

| **Deck Type** | <br>**Type 1 – PC Girder & Slab** | <br>**Type 2 – PC Voided Slab** |
|---|---|---|
| **Construction Cost** | Typically more economical than Type 2 | Typically more expensive than Type 1 |
| **Constructability** | Girders cast in advance in casting yard.<br>Pre-stressing done in casting yard.<br>Shoring not required for girders.<br>Easy to construct span by span with conventional crane.<br>Erection of girder at night minimizes impact on traffic during construction.<br>Deck slab and diaphragms require in-situ concrete construction.<br>Quality control on site easier than Type 2 | Requires shoring for complete in-situ construction.<br>Shoring will partially occupy traffic lanes and will require greater traffic management during construction particularly at intersection.<br>In-situ post-tensioning required.<br>Greater quality control on site required than Type 1. |
| **Construction Time** | Shorter construction period than Type 2 - about 2 weeks less for typical flyover | Longer construction period than Type 1 - about 2 weeks more for typical flyover |
| **Structural Aspect** | Depth of deck greater than Type 2.<br>Can be made structurally continuous for live load over the pier. However this requires full depth pier coping beneath deck which is not favored.<br>Not torsionally stiff. Not suitable for highly curved alignments. Requires diaphragms to distribute loads transversely.<br>Requires bearings at each girder end.<br>All aspects less favorable than Type 2. | Shallower deck than Type 1.<br>Fully continuous for dead load and live load.<br>Expansion joints minimized.<br>Deck can be made monolithic with piers allowing maximum structural optimization.<br>Substantial torsional stiffness. Suitable for short radius alignments. Do not require diaphragms to distribute loads transversely.<br>Requires reduced number of bearings than Type 1. |
| **Maintenance** | Maintenance aspects similar - concrete construction offers minimal maintenance obligations. | |
| **Aesthetics** | Very poor utilitarian visual impact. Strongly disfavored in an urban setting. | Deck shape provides a highly attractive sculpted form. Highly favored in an urban setting. |
| **Remark** | Not recommended | Recommended |

*Source: JICA study team.*

## 4.2 C-3/E. Rodriguez Avenue

### 4.2.1 Review of Previous Detailed Design

The detailed design of the interchange was prepared by Nippon Engineering Consultant Co., Ltd. in association with DCCD Engineering Corporation and Pertconsult International in February 2005 (original contract) and July 2006 (Supplemental Contract).

**(1) Topographic Condition**

The project area has the following topographic conditions and features:

1) The alignment of C-3 (Circumferential Road 3) runs in a north–south direction while E. Rodriguez Avenue runs in an east–west direction.

2) At standard sections, there are 6 lanes along C-3 and 4 lanes along E. Rodriguez Avenue.

3) The alignment of C-3 has a gentle left curve from the north to southbound direction at the intersection.

4) E. Rodriguez Avenue has a gentle light curve from east to westbound direction at the intersection.

5) Both roads have about 85 degrees of skew at the intersection due to (c) and (d) above.

6) The lower section among the four road directions from the intersection is located along C-3 northbound. The length of the lower section between the intersection and the same elevation of the intersection along C-3 northbound (to Quezon Avenue) is 590m.

7) There is the area which is surrounded by the higher land on north, south and west sides and by the bank of the San Juan River on east side. There will be flooded easily when it rains heavily as it becomes like a collecting basin without spillways.

8) About 45m of the width of San Juan River crosses E. Rodriguez Avenue at approximately 134m from the center of the intersection.

9) The roadsides are lined with houses and commercial buildings.

There are no significant changes noted in the topographic conditions of the area during the time of the said detailed design up to the present.

**(2) Geotechnical Conditions**

The proposed area is located on the west in the center part of the Central Plateau, which is underlain by tuffs and tuffaceous sediments of the Pliocene-Pleistocene or the Holocene.

Tuffs (tuffaceous rock sequence) consist of siltstone, sandstone and high plastic soils, belonging to the Guadalupe formation of the Pliocene-Pleistocene. Tuffaceous sediments overlying the tuffs consist of pyroclastic flow deposits and lahar deposits (tuffaceous reworked deposits) of the Pleistocene-Holocene. Pyroclastic flow deposits are mainly composed of clayey gravel and lahar deposits are mainly composed of inorganic clay, silt and clayey sand.

The lower tuffaceous rock sequence is a stable bearing stratum for the important structures such as bridges, because the "N-value is over 50 generally" and "unconfined compression strength (qu) is 800-5200 kPa (corresponding to the soft rock)". But it is difficult that the upper tuffaceous sediments are stable bearing stratum for the important structures because pyroclastic flow deposits are changing to laharic deposits which have N-value of less than 10 laterally. Therefore, the bearing stratum in the proposed area is tuffaceous rock sequence that underlie deeper than 2–7m from ground surface.

The depth of bearing stratum and type of foundations at each borehole are shown in **Table 4.2-1**.

**Table 4.2-1 Depth of Bearing Stratum and Type of Foundations**

| Borehole No. | Depth of Bearing Stratum | Sub-Structure | Type of Foundations |
|---|---|---|---|
| **BH - 1A** | 2.80m | - | Spread footing |
| **BH - A** | 2.80m | A-A | Spread footing |
| **BH - P1** | 1.80m | P-1,2 | Spread footing |
| **BH - P2** | 2.75m | P-3 | Spread footing |
| **BH - P3** | 2.00m | P-4 | Spread footing |
| **BH - P4** | 3.00m | P-5 | Spread footing |
| **BH - P5** | 4.00m | P-6,7 | Spread footing |
| **BH - P6** | 4.00m | P-8 | Spread footing |
| **BH - B** | 7.30m | P-9 | Pile foundation |
| **BH - 2A** | 5.90m | A-B | Pile foundation |

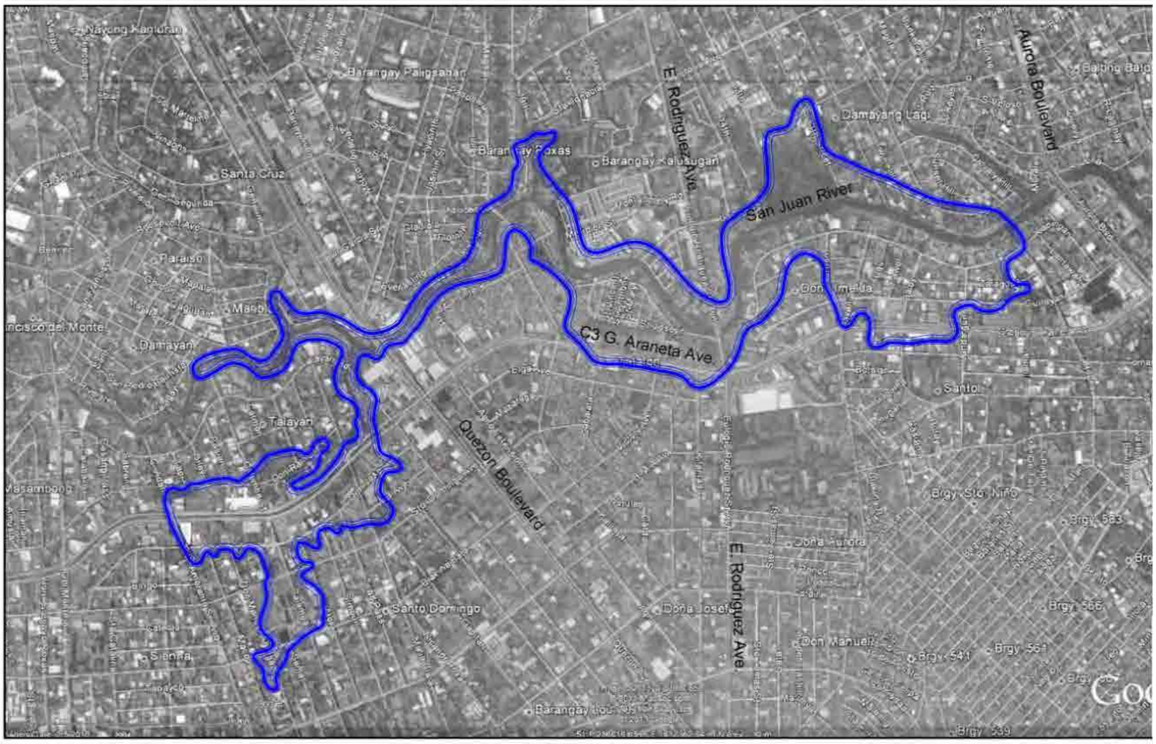
*Source: Detailed design done by NEC and associate consultants Feb 2005.*

### (3) Hydrological Conditions

The proposed area is flooded frequently by flooding of the San Juan River. The results of analysis of the flooding area for 2, 5, 10, 25 and 50 years return periods are shown in **Figures 4.2-1 – 4.2-5**. Comparison between the said figures and the flooding area identified from interviews with local residents (See **Figure 4.2-6**) shows that the flooding area for the 2 years return period is generally consistent with the flooding area based on the interviews which were conducted along the selected area of C-3. Therefore, the proposed area is flooded frequently based on the following flooding scales:

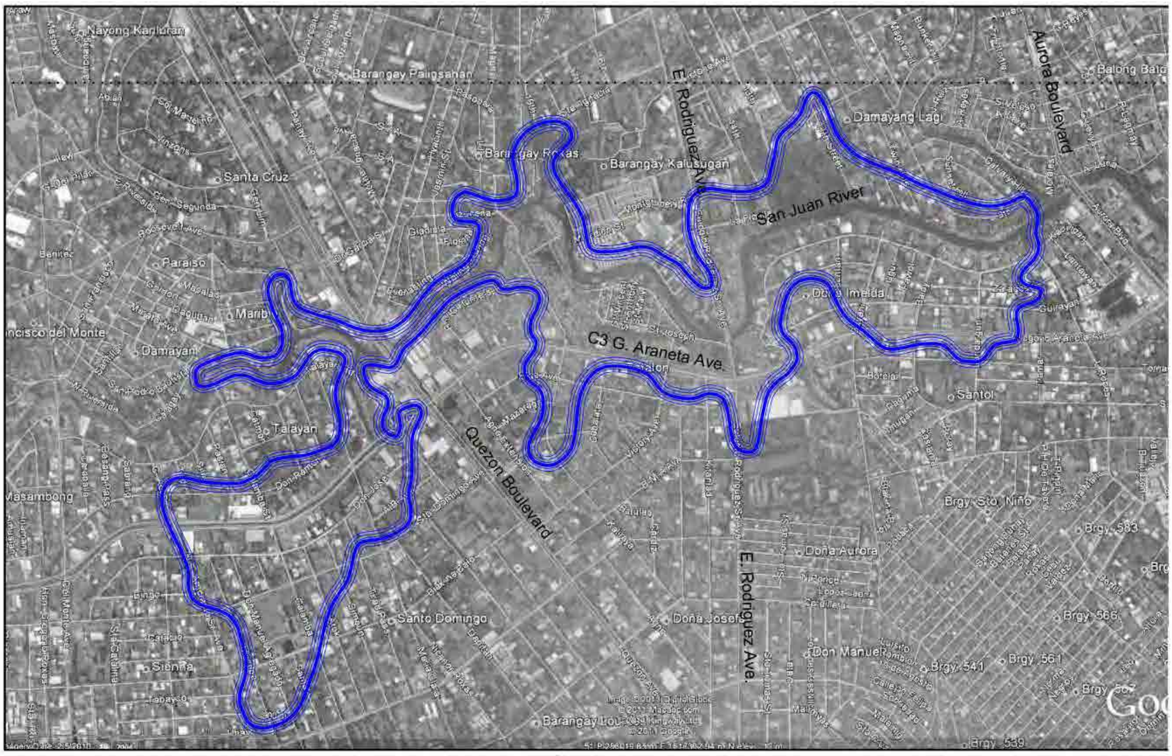
1) Along E. Rodriguez Avenue, flood elevation for the 10 years return period is 6.062m. The section of about 770m in length of E. Rodriguez Avenue is inundated with this flood. Flood elevation for the 50 years return period is 7.090m.

2) Along C-3, flood elevation for 10 years return period is 6.820m. The section of about 860m in length of C-3 is inundated with this flood.



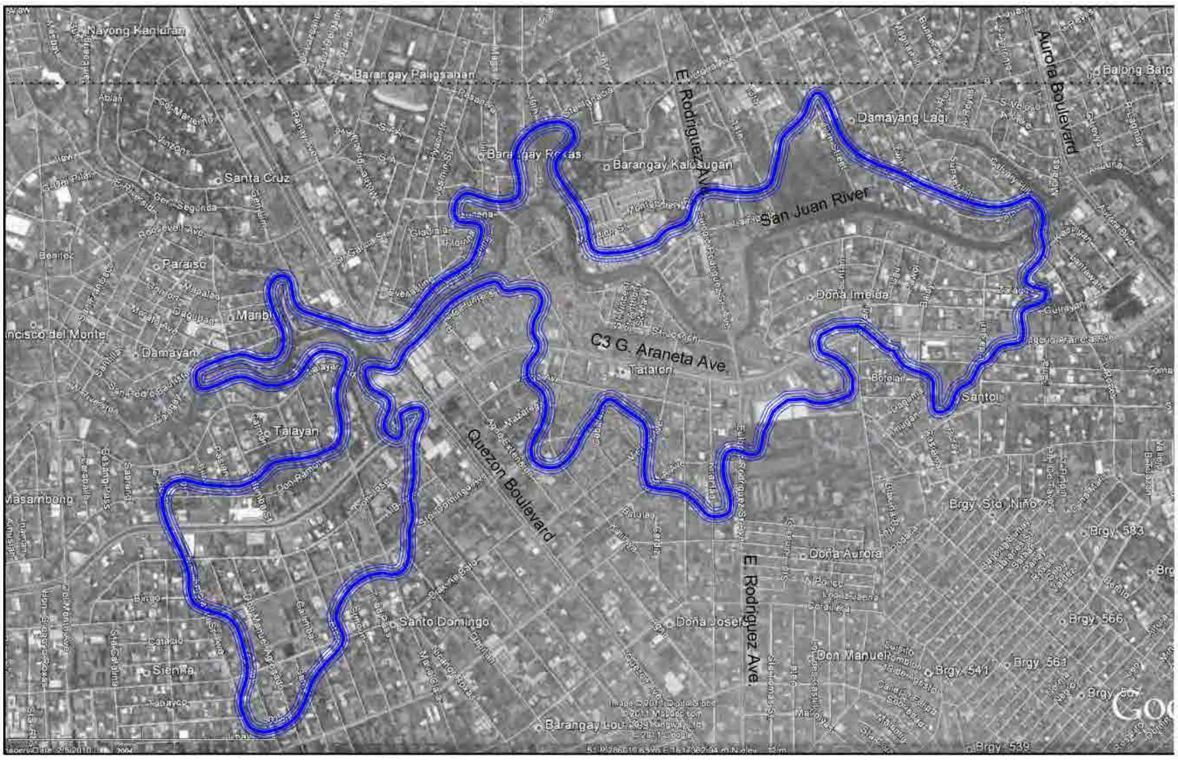

*Source: Detailed design done by NEC and associate consultants.*

**Figure 4.2-1 (C-3) Araneta Ave. – E. Rodriguez Ave. Flooding Study 2 Years Return Period Flooding**



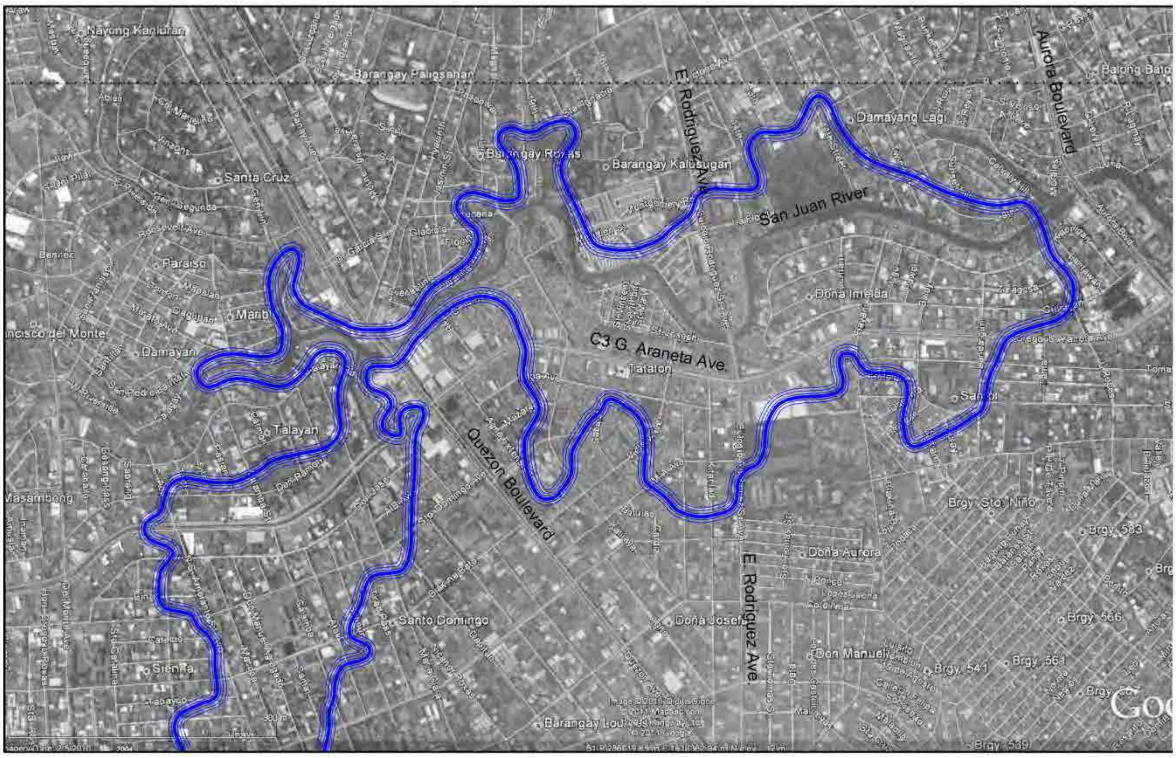

*Source: Detailed design done by NEC and associate consultants.*

**Figure 4.2-2 (C-3) Araneta Ave. E. Rodriguez Ave. Flooding Study 5 Years Return Period Flooding**



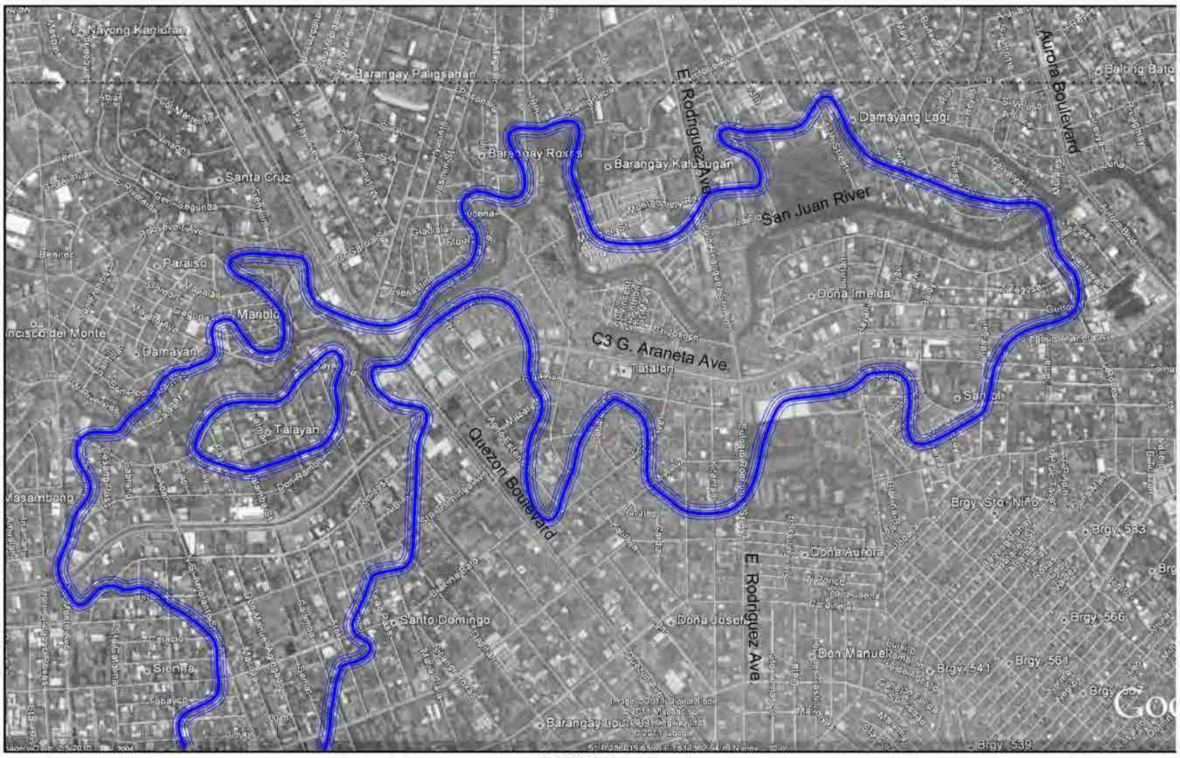

*Source: Detailed design done by NEC and associate consultants.*

**Figure 4.2-3 (C-3) Araneta Ave. E. Rodriguez Ave. Flooding Study 10 Years Return Period Flooding**



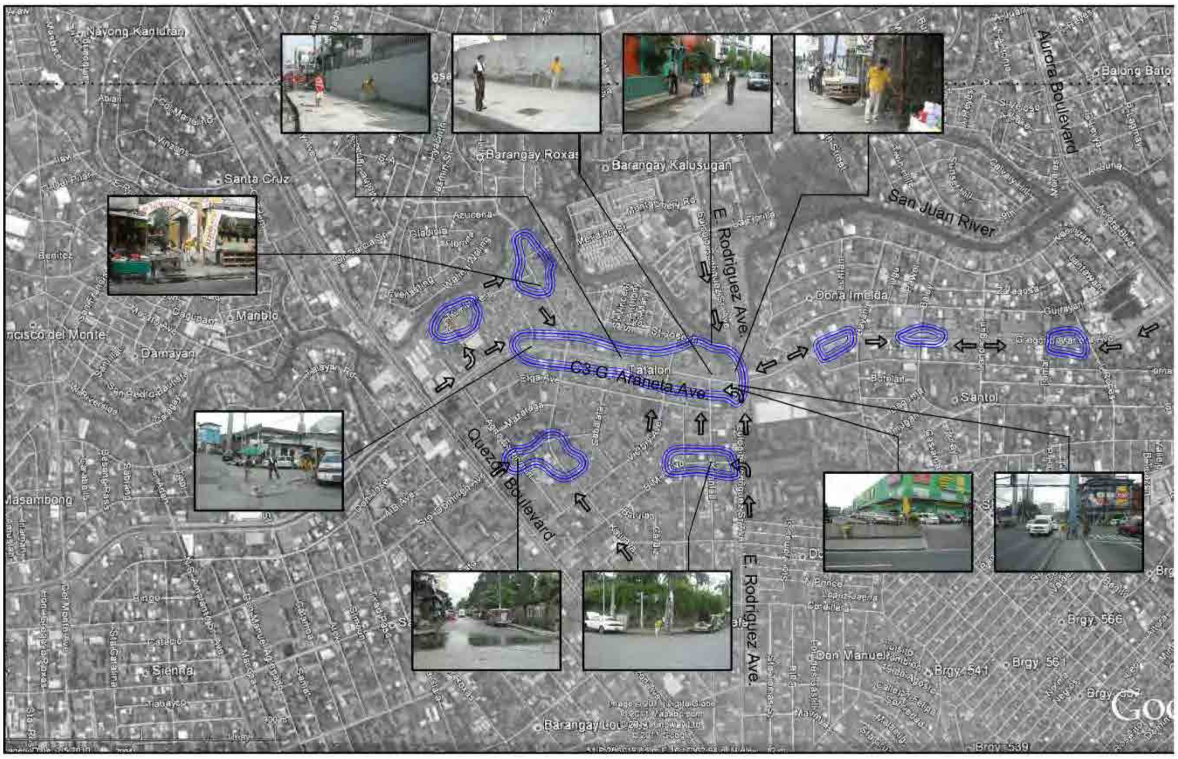

*Source: Detailed design done by NEC and associate consultants.*

**Figure 4.2-4 (C-3) Araneta Ave. E. Rodriguez Ave. Flooding Study 25 Years Return Period Flooding**




*Source: Detailed design done by NEC and associate consultants.*

**Figure 4.2-5 (C-3) Araneta Ave. E. Rodriguez Ave. Flooding Study 50 Years Return Period Flooding**




*Source: Detailed design done by NEC and associate consultants.*

**Figure 4.2-6 (C-3) Araneta Ave. E. Rodriguez Ave. Flooding Study Flooding Area Based on Interviews**

**(4) Design Standards**

Major design standards are as follows:

1) Highway Design

| | | |
|---|---|---|
| ⇨ Design Speed | : | 60km/h |
| ⇨ Stopping/Passing Sight Distance | : | 85m / 410m |
| ⇨ Minimum Radius Curve | : | 150.0m |
| ⇨ Maximum Superelevation | : | 4.0% |
| ⇨ Maximum/Minimum Vertical Grade | : | 6.0% / 0.35% |
| ⇨ Lane Width | : | 3.25m |
| ⇨ Cross Slope (Asphalt/Concrete) | : | 2.0% / 1.5% |

2) Hydrology and Hydraulics

| | | |
|---|---|---|
| ⇨ Design Frequency Level | | |
| • Ditches | : | 2 years |
| • Pipe Culverts | : | 10 years |
| • Box Culverts | : | 25 years |
| • Bridges | : | 50 years or maximum observed flood, whichever is greater |
| ⇨ Peak Runoff Rate | : | Rational Method |
| ⇨ Hydra Flow | : | Manning Formula |

3) Structural Design

| | | |
|---|---|---|
| ⇨ Material Properties | | |
| • Concrete | | |
| › Substructure | : | 28.0Mpa |
| › Bridge Riling | : | 21.0Mpa |
| › Superstructure | : | 34.5Mpa |
| › Bored Pile | : | 28.0Mpa |
| • Reinforcing Steel | | |
| › Diameter 10 and 12mm | : | Grade 40 |
| › Diameter greater than 12mm | : | Grade 60 |
| • Prestressing Steel | : | Grade 270 and low relaxation with an ultimate strength Fu = 1,862 Mpa |
| • Structural Steel | : | AASHTO M270 (ASTM A36) |
| • Elastomeric Bearing Pads | : | 100% virgin chloroprene pads with durometer hardness 60 and laminated with non-corrosive mild steel sheets |

⇨ Loads and Allowance Stresses

- Live Load : AASHTO MS-18 (HS20-44)
- Earthquake Load
  - › Ground Acceleration Coefficient : 0.4g
  - › Seismic Performance Category : D
- Earth Pressure
  - › Normal Time : Coulumb's Formula
  - › Earthquake Time : Mononobe-Okabe
- Weight
  - › Concrete Plan or Reinforced : 24.0KN/$m^3$
  - › Steel : 77.0KN/$m^3$
  - › Compacted Sand and Earth : 19.0KN/$m^3$

**(5) Road Alignment and Structural Conditions**

The road alignment and structural design of C-3 and E. Rodriguez Avenue shall have the following conditions and characteristics:

**<u>Along C-3</u>**

1) The total length of the project section along this road segment is 2,105m, consisting of 275m of flyover, 205m of approach roads and 1,625m of embankment roads.
2) The horizontal alignment has 250m radius curve with 90cm widening and vertical grade of viaduct is 6.0%.
3) The difference in elevation between original ground and the proposed elevation at the center of the intersection is 1.043m.
4) The flyover has four lanes. Original ground and proposed road elevation at the center of the interchange is 5.290m and 6.333m, respectively (embankment height is 1.043m).
5) The highest embankment height along C-3 – Quezon City direction is 2.504m, which is located at STA 6+620, 520m from the center of the intersection.
6) The highest embankment height along C-3 – Sta. Mesa direction is 1.847m, which is located at STA 5+500, 600m from the center of the intersection.
7) The total length, number of spans, span length and type of flyover are as follows:

⇨ Total Length of Flyover : 275.0m

⇨ No. of Spans : 10

⇨ Span Length and Type of Flyover

- 3 span continuous PC voided slab, 25.0m + 25.0m + 24.2m = 74.2m (Sta. Mesa side)
- 3 span continuous PC box girder, 29.2m + 40.0m + 29.2m = 98.4m (center)

- 4 span continuous PC voided slab, 24.2m + 3@25.0m = 99.2m (Quezon Ave. side)

8) Foundations are spread type (for abutment A and piers 1 to 8) and 1.5m diameter of bored pile (for pier 9 and abutment B).

9) The type of column is circular, 3.0m and 3.5m in diameter.

10) Shoring works are needed on all sections of the superstructure. These will entail longer construction period, disrupt traffic during construction and require the proposed road elevation to be higher due to the 3.0m height of shoring structure.

**Along E. Rodriguez Avenue**

1) The road has a total length of 827m and with a four lanes total width of 20.0m.
2) The highest embankment height along E. Rodriguez Avenue – Cubao direction is 1.55m, which is located at STA 7+100, and 370m from the center of the intersection.
3) The highest embankment height along E. Rodriguez Avenue – Quiapo direction is 1.118m, which is located at STA 6+680, and 50m from center of intersection.
4) The highest elevation of the new Mariabolo Bridge is 7.851m, which is about 2.40m higher than the elevation of the existing bridge.
5) The type, length, span configuration and type of foundation of the Mariabolo Bridge are follows:
   - ⇨ Type of Bridge : 9 span continuous RC slab
   - ⇨ Total Bridge Length : 102.00m
   - ⇨ No. of Spans and Span Length : 9.00m + 7@12.00m + 9.00m = 102.00m
   - ⇨ Type of Substructure : 1.2m diameter bored pile
6) There is no provision for widening of the river that will correspond to the increase in bridge length from the existing 45.0m to 102.0m.

### (6) Environmental and Social Conditions

An Environmental Compliance Certificate (ECC) had been issued by the Department of Environmental and Natural Resources, Environmental Management Bureau (DENR-EMB) in January 2005. The conditions imposed on the issued ECC by the DENR-EMB did not include any specific requirements. Although the ECC was thought to be applied with the Initial Environmental Examination (IEE) and the Land Acquisition Plan and Resettlement Action Plan (LAPRAP), the JICA Study Team could only obtain the LAPRAP.

1) LAPRAP (December 2005)

According to LAPRAP, the Project Affected Persons (PAPs) due to this interchange project are summarized as follows.

- 94 informal settlers (PAPs) encroaching along the Right of Way (ROW)

- 2 barangays (Barangay Tatalon and Barangay Doña Imelda) to be affected
- Only PAPs' residential structures in Tatalon would be severely affected
  - ✓ 11 single detached structures
  - ✓ 11 shanties
  - ✓ 72 apartment structures
- Estimated total cost of compensation for the PAPs was about PhP 2,368,706.65 which included replacement costs for fixed structures, value of trees and income loss.
- There would be no relocation site in Quezon City. Availability of relocation sites was to be properly coordinated with the inter-government agencies such as Urban Poor Affairs Office, Presidential Commission for Urban Poor and National Housing Authority.

2) Relocation Program implemented by Metropolitan Manila Development Authority

Informal settlers encroached in the ROW along C-3 (G. Araneta Avenue) including the aforementioned PAPs had been relocated by the Metropolitan Manila Development Authority (MMDA) in 2007. The details of the relocation program, namely, "METRO GWAPO project" are presented in Section 7.2.

**(7) Identified Problems and Recommendations**

**Identified Problems**

1) There has been no study yet on the possible impacts of flooding on the people, livelihood within the vicinity of the project area after the proposed raising of the current road elevation. Following two concerns have to be looked into:

- ⇨ Accessibility of the new road elevation;
- ⇨ Further effect(s) of the new road elevation on flooding already being experienced by the people.

2) There are no documents showing public acceptance of the increase of road elevation (1.043m at the center of the intersection and 2.504m of the highest embankment height).

3) The superstructures are all cast-in-place type, which will entail longer construction works at site and a longer total construction period.

4) Shoring height of the center span is 3.0m, which requires longer total grade separation and steeper vertical grade (6.0%).

5) Bridge length of Mariabolo was increased, from the existing 45.0m to the proposed 102.0m, but there has been no provision for widening of the river.

6) There are still no further details or discussion on road right-of-way and the construction limits.

**Recommendations**

1) Hydrological study should be conducted and this should particularly focus on the flood problem of the area – how frequently flooding occurs, what causes it, where it comes from.
2) The most appropriate countermeasure(s) against flood, such as raising present road elevations further, should be thoroughly studied.
3) The type of superstructure and type of shoring that will minimize the effects on traffic during construction, reduce the cost and provide better vertical alignment should be determined with a more detailed study.
4) Further study of the length of Mariabolo Bridge should also be made.
5) A study should be undertaken to confirm road right-of-way parameters and whether the required ROW should be subject to public hearings for acceptance of ROW acquisition.

### 4.2.2 Preliminary Design of Interchange

#### (1) Study and Countermeasure against Flood

The proposed area is frequently flooded caused by the overflow of the San Juan River during continuous rains or strong typhoons. The flood elevation of 10 years return period is 6.062m at E. Rodriguez Avenue (including Mariablo Bridge) while the flood elevation of 50 years return period is 7.090m. This is based on the results of the hydrological analysis that was carried out during the Detailed Engineering Design of C-3/Quezon Ave. and C-3/E. Rodriguez Sr. Ave. Interchange Projects Supplemental Agreement No.1, Proposed Improvement of Flood-Prone Road Sections along C-3 and along E. Rodriguez Sr. Ave. conducted by Nippon Engineering Consultants Co., Ltd. (NEC) in association with DCCD Engineering Corporation, Pertconsult, International completed in December 2005.

Moreover, there are other studies carried out before the above mentioned analysis. These studies include the "Flood Control and Drainage Study on the San Juan River Watershed" completed in August 1979 by Basic Technology and Management Corporation (BTMC), the "Detailed Engineering Design of Pasig-Marikina River Channel Improvement Project and Study on Comprehensive River Management" completed in March 2002 by the CTI Engineering Co., Ltd. in association with Nikken Consultants, Inc., Woodfields Consultants, Inc.. These two studies took into consideration river channel improvement (dredging and widening of the river channel). The design high water level determined by these studies was as follows:

- B T M C (August 1979) : 4.40m (30 years return period)
  - Dredging depth = 1.50m
  - Widening = 0 m
- CTI and others (March 2002) : 4.90m (50 years return period)
  - Dredging depth = 0.94m
  - Widening to = 53.5m (about 9m widening of existing river width)

The above design high water levels are notably lower than the road surface elevation of Mariablo Bridge (5.2-5.4m), and it shows that the problem of flooding will be mitigated if the river channel improvement is done. However, the implementation schedule of river channel improvement is undermined for now.

On the other hand, the approved detailed design shows that the road surface elevations of C-3 and E. Rodriguez Avenue are elevated to prevent flooding. Based on the result of hydrological analysis, the embankment section used flood elevation of 10 years return period while the bridge section used flood elevation of 50 years return period. It should be noted that when the road surface elevations are raised, the following issues will be a major concern:

- The access of the public/residents to the road from the roadside land will be difficult.
- The inundation inside a levee will be increased at the upstream side of the road because the elevated roads obstruct the surface flow as the dam (See **Figure 4.2-7**).


*Source: JICA study team.*

**Figure 4.2-7 Direction of the Surface Flow at around Intersection**

In conclusion, the problem of flooding has not been paid any attention in the proposed elevated highway but should be properly addressed by a flood control management project in the future.

### (2) Comparative Study

Based on the review of detailed design, updated site and traffic conditions, a comparative study was undertaken to consider the following basic conditions;

- Problem of frequent flood conditions along C3 alignment especially from the intersection towards Quezon Ave., are to be addressed through an appropriate flood control project.

- Elevated road embankment along E. Rodriguez Ave. will not be considered for implementation since it will affect a significant number of people and key business establishments along the road.
- Based on the above two conditions, the comparative study will be concentrated on the provision of a flyover along C3.
- Type of superstructure to be designed as voided slab type to provide an aesthetic view of the flyover.
- Road has a combination of 4 lanes with 2 lanes each direction.

The following three (3) alternatives are proposed as the most suitable schemes for comparison based on the site conditions such as topographic, geological, traffic, roadside business and structural conditions with required span length:

- Scheme-1 : 275.0m long flyover with 2 lanes per direction (PC Box and Voided Slab Bridge) and 630m long 6 lanes additional approach road (Original Design).
- Scheme-2 : 280.0m long (PC Box and Voided Slab Bridge) with 2 lanes per direction. No additional approach.
- Scheme-3 : 280.0m long PC Box and Voided Slab Bridge with 2 lanes per direction and 690m long 4 lanes additional approach road.

Among the three (3) schemes, scheme-3 was selected even with an approximate of 22% expensive than scheme-2 due to the 690m extent of elevated road to prevent from flood during heavy rain and typhoon and this scheme can provide 2-lanes per direction of service road at-grade section which sufficient for any activity of the people along this road section.

Detailed scheme comparison are shown in **Table 4.2-2** and plan profile of each scheme are shown in **Figures 4.2-8 ~ 13.**

## Table 4.2-2 Scheme Comparative Table of C-3/E. Rodriguez Interchange

| Scheme | SCHEME-1 ORIGINAL DESIGN (6-Lane Additional Approach) | | SHEME - 2 No Additional Approach | | Scheme-3 4-LANES ADDITIONAL APPROACH | |
|---|---|---|---|---|---|---|
| **Structure Schemes** | 4-Lane Flyover: L= 275.0m<br>PC VOIDED SLAB : 7@25.0m<br>PC Box Girder 2@30.0m + 40.0m<br>Approach Road : L=630m(6-lane) | | 4-Lane Flyover: L= 280.0m<br>RC VOIDED SLAB : 10@18.0m=180.0m<br>PC Box Girder : 2@30.0m+40.0m=100.0<br>Approach Road : L=207.7m | | 4-Lane Flyover : L= 280.0m<br>RC VOIDED SLAB : 10@18.0m=180.0m<br>PC Box Girder : 2@30.0m+40.0m=100.0<br>Approach Road : L=598.0m | |
| **Construction Cost** | Flyover: MP 343.8 (P1,250,000/m)<br>Approach : MP 163.8 (P260,000/m)<br>Others MP 19.0<br>Total MP 526.6 (130.9%) | △ | Flyover : MP 350.0 (P1,250,000/m)<br>Approach: MP 37.4 (P180,000/m)<br>Others MP 15.0<br>Total MP 402.4 (P100.0 %) | ◎ | Flyover: MP 350.0 (P1,250,000/m)<br>Approach: MP 124.4 (P180,000/m)<br>Others MP 17.5<br>Total MP 491.9 (122.2%) | ○ |
| **Construction Performance and Duration** | 18 Months<br>○ Construction method and procedure is standard<br>● Total 6-lanes embankment road construction affects to existing traffic during construction | △ | 14 Months<br>○ Construction method and procedure is standard<br>○ Less impact to traffic during construction due to no additional embankment approach | ◎ | 17 Months<br>○ Construction method and procedure is standard<br>○ Small impact to traffic during construction due to 4-lanes additional approach | ○ |
| **Environmental and Social Condition** | ● Requires R.O.W acquisition near I/C due to improvement of I/C (Demolish 3 building at I/C)<br>● The people on each side of C-3 disconnected from each other due to 630m extent of elevated thru road | △ | ○ No R.O.W acquisition due to improvement I/C is within R.O.W.<br>○ The people on each side of C-3 is still connected from each other as almost same condition as present | ◎ | ○ No R.O.W acquisition due to improvement of I/C is within R.O.W.<br>○ The people on each side of C-3 disconnected from each other can be prevented due to provide RCBC | ◎ |
| **Traffic Condition** | ○ No overflow of road during flood<br>● No direct access to elevated road section from side road due to no side road. | △ | ● No improvement against flood (road overflows during flood)<br>( Average unpassable day per year is 2 or 3 days) | △ | ○ No overflow of road during flood<br>○ Can provide 2-lanes each side road on both directions<br>● No direct side road traffic access due to 600m extent of elevated thru road section | ◎ |
| **Over all Evaluation** | ● More Expensive than other 2-schemes<br>● Requires R.O.W acquisition<br>● No direct access to elevated road section from side road and disconnects the community<br>● Big impact on traffic during construction due to 6-lanes additional approach<br>○ No flood on thru road permanently | △ | ○ Cheapest among the schemes<br>○ Can provide direct access to road<br>○ No R.O.W acquisition<br>● No traffic improvement during flood (road overflows during flood)<br>(average unpassable day per year is 2 or 3 days) | ○ | ● Expensive than scheme-2<br>● 600m extent of elevated thru road prevents direct side road access<br>○ No R.O.W acquisition<br>○ Can provide 2-lanes each side road on both directions<br>○ No flood on thru road permanently | ◎ |

**LEGEND :** ○ **advantage**
● **disadvantage**

*Source: JICA Study Team*

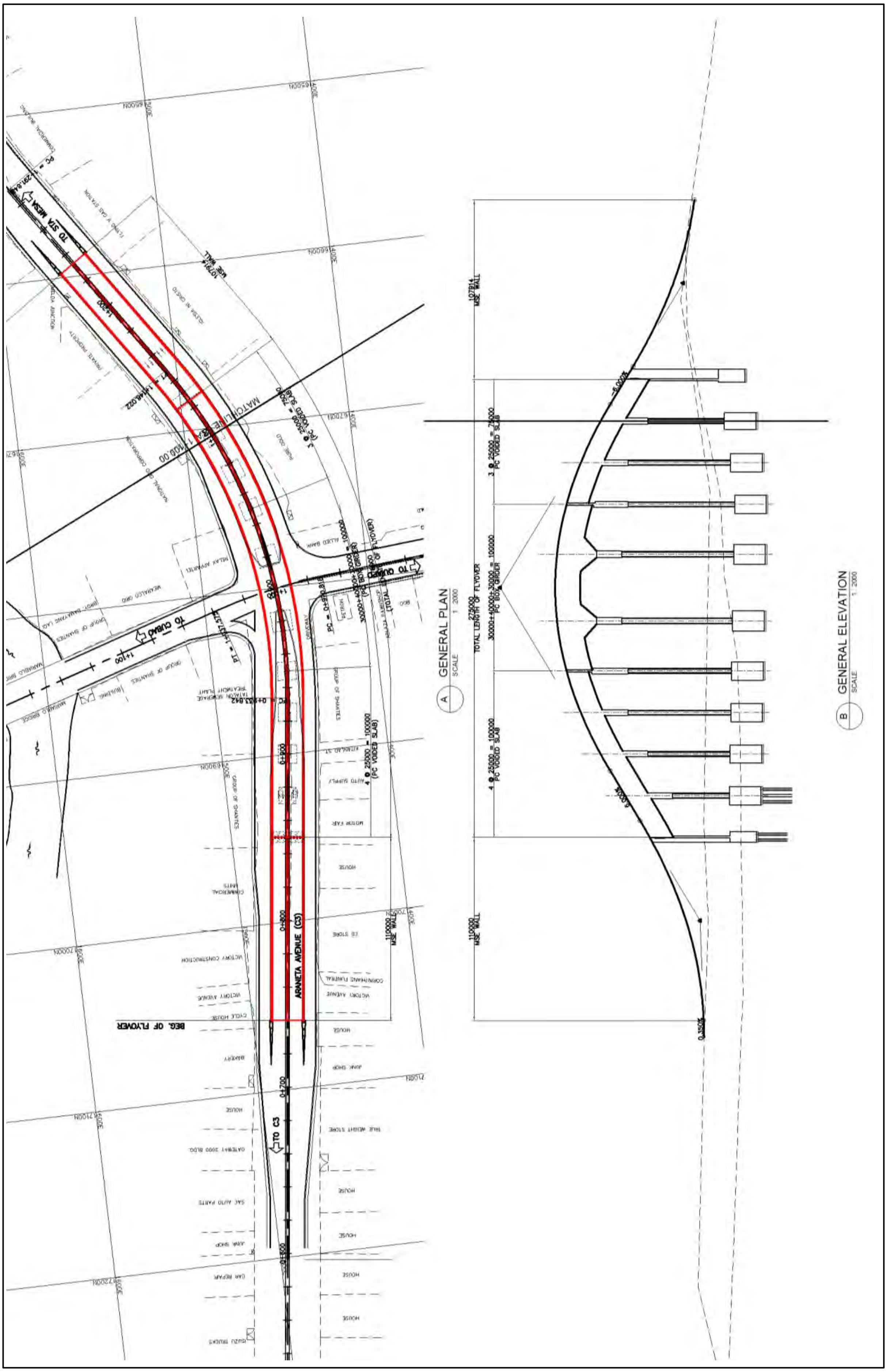



**Figure 4.2-8 Plan and Profile of Scheme-1 C-3/E. Rodriguez Interchange (1/2)**

*Source: JICA Study Team*

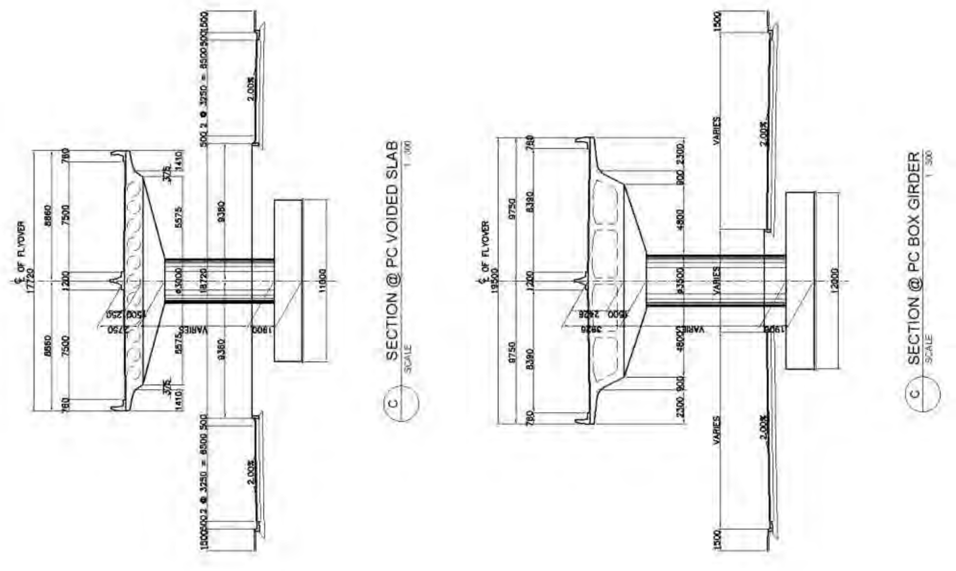



**Figure 4.2-9 Plan and Profile of Scheme-1 C-3/E. Rodriguez Interchange (2/2)**

*Source: JICA Study Team*

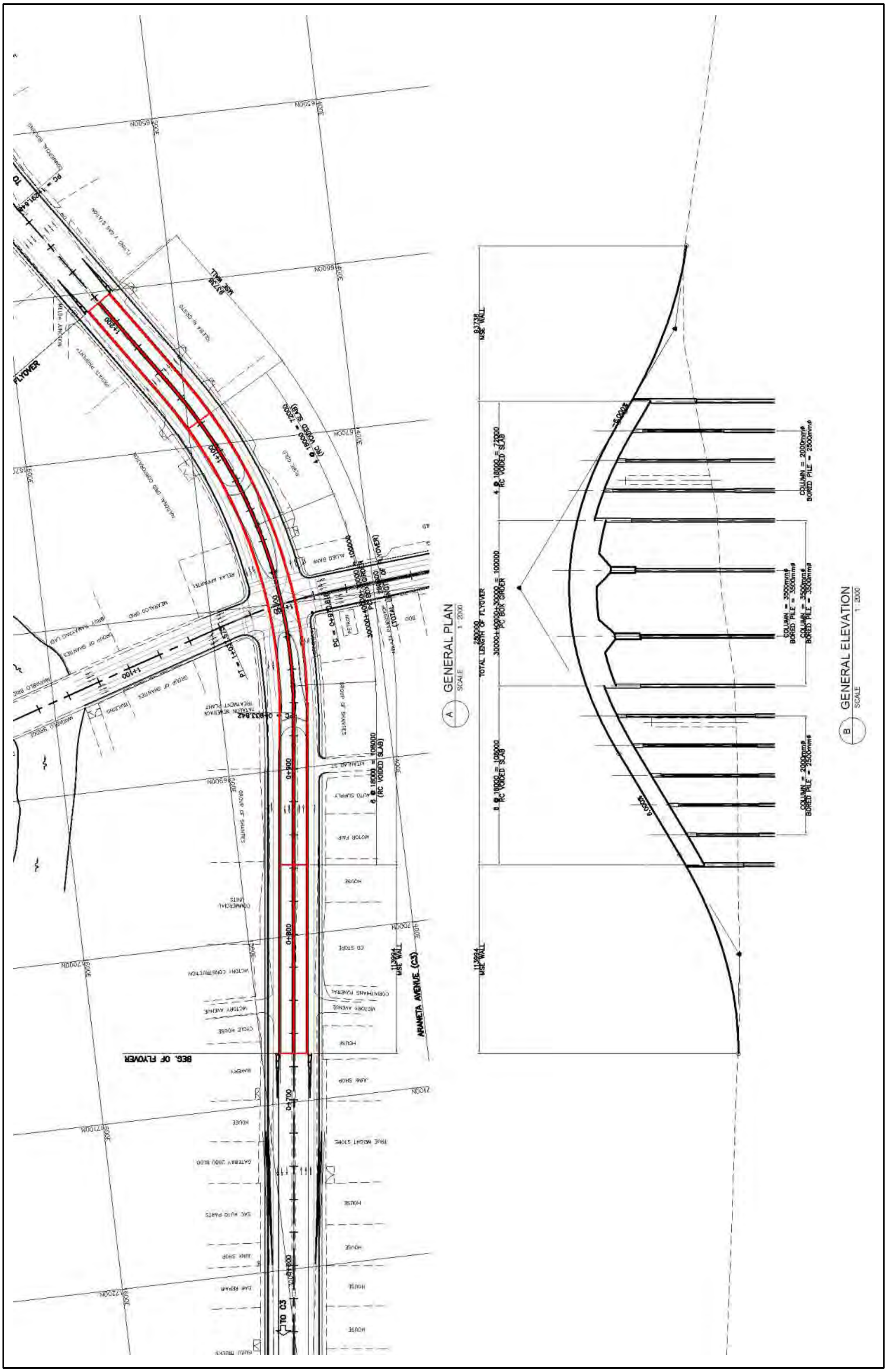



**Figure 4.2-10 Plan and Profile of Scheme-2 C-3/E. Rodriguez Interchange (1/2)**

*Source: JICA Study Team*

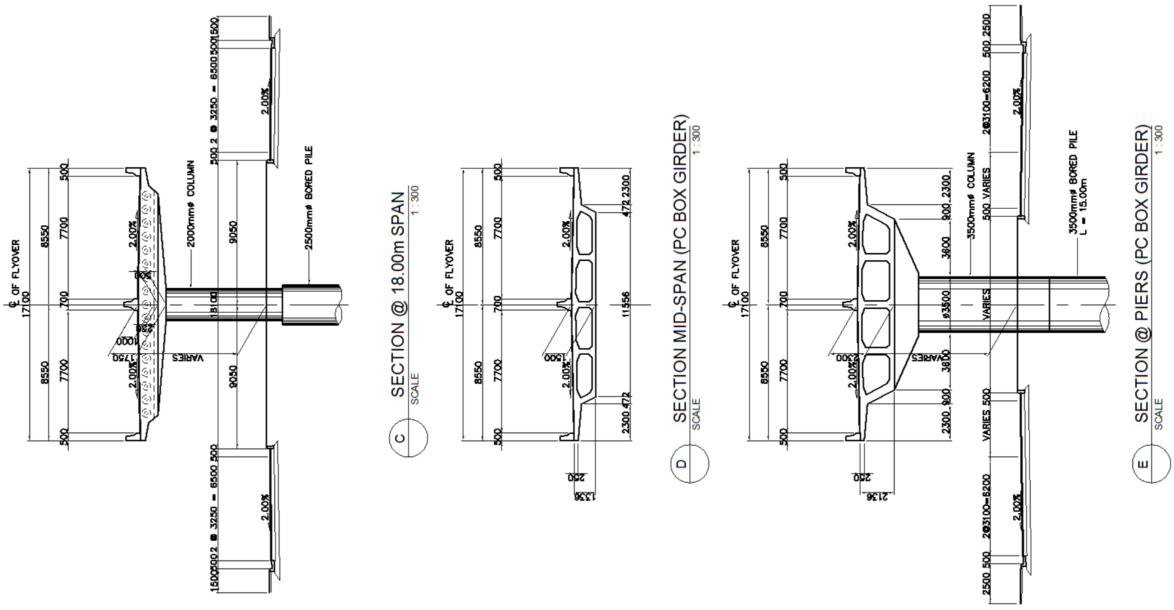



**Figure 4.2-11 Plan and Profile of Scheme-2 C-3/E. Rodriguez Interchange (2/2)**

*Source: JICA Study Team*

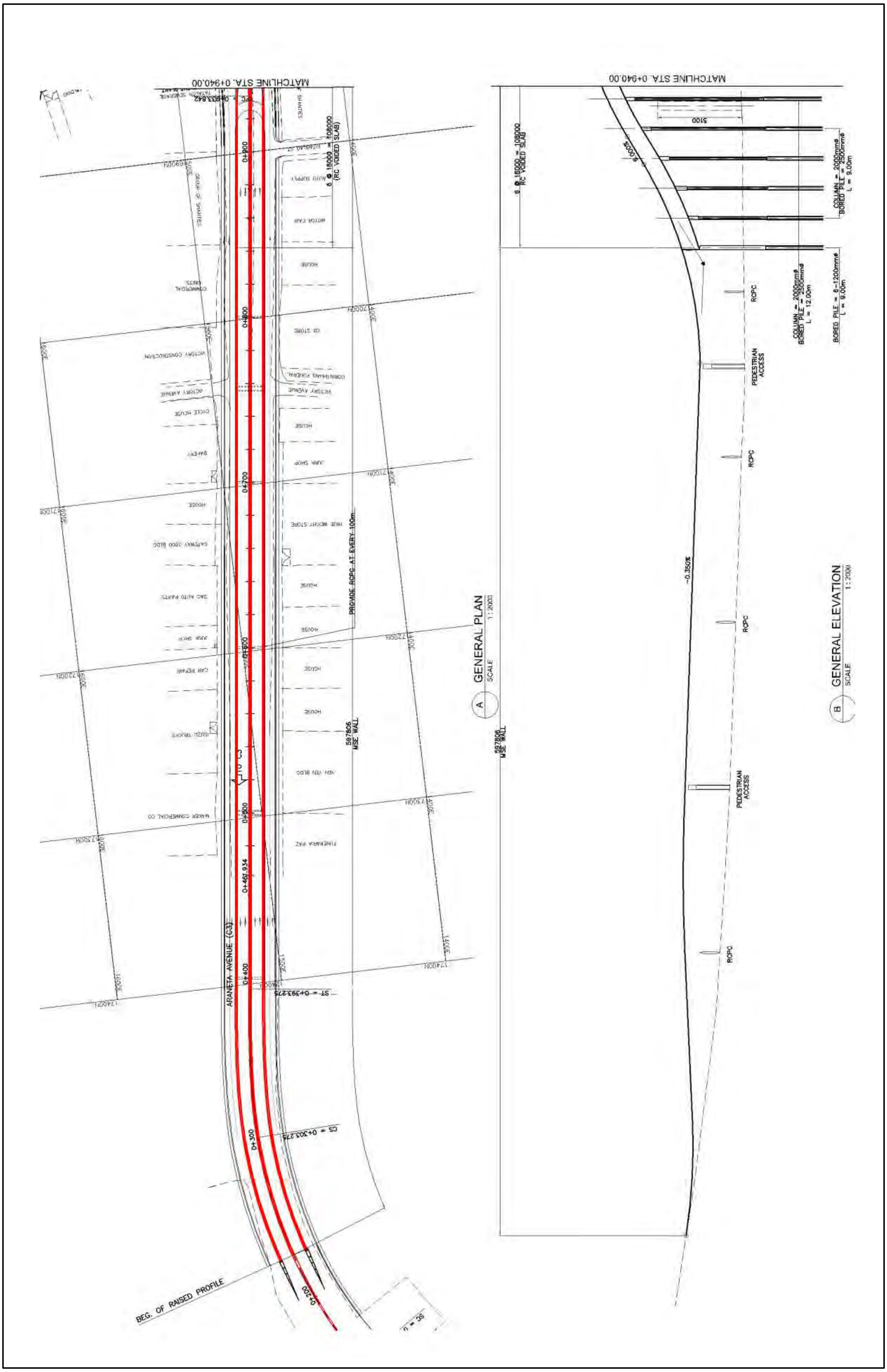



**Figure 4.2-12 Plan and Profile of Scheme -3 C-3/E. Rodriguez Interchange (1/2)**

*Source: JICA Study Team*

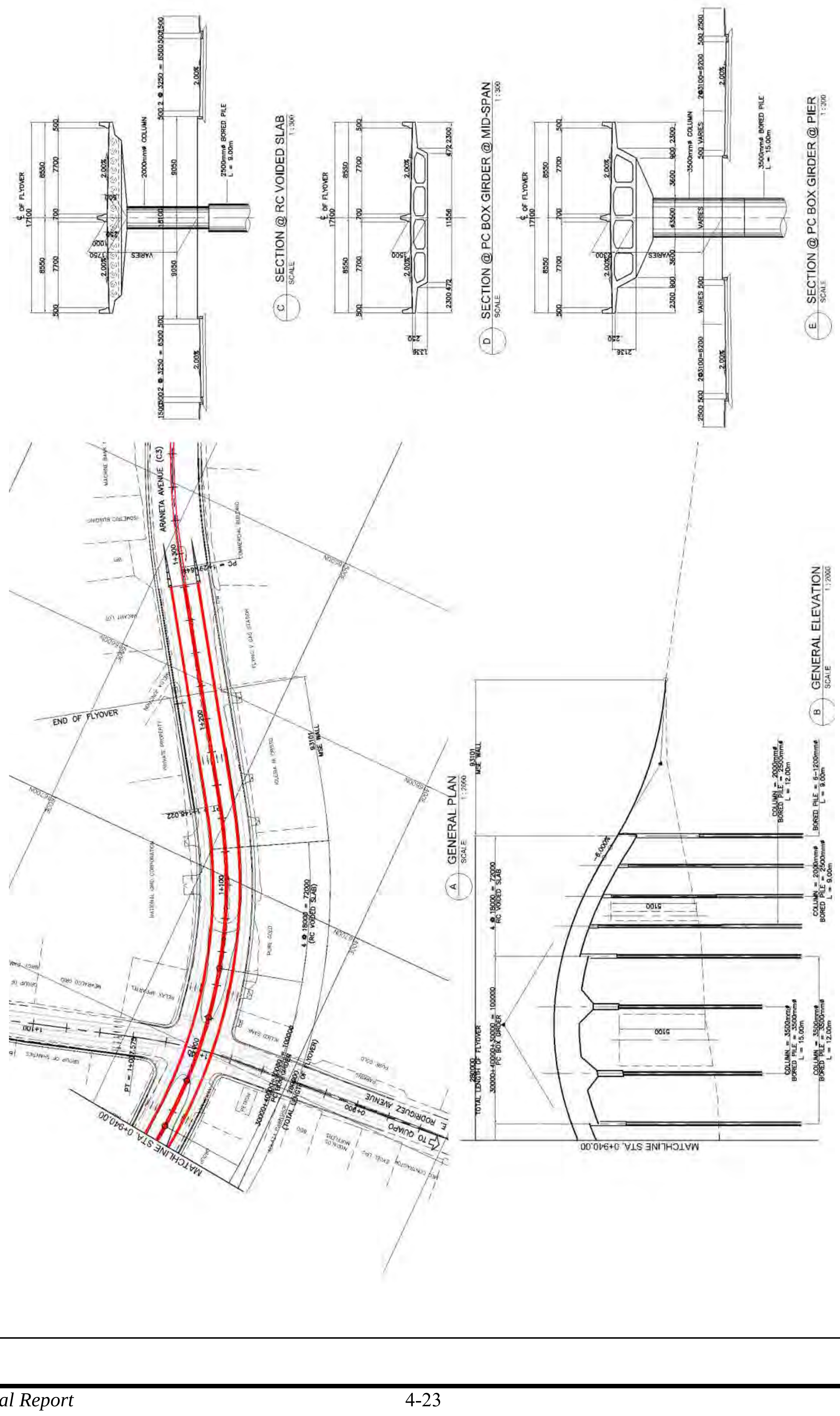



**Figure 4.2-13 Plan and Profile of Scheme -3 C-3/E. Rodriguez Interchange (2/2)**

*Source: JICA Study Team*

**(3) Preliminary design of Selected Scheme**

Scheme-3, RC voided slab and PC box girder type flyover with four (4) lanes embankment approach was selected based on the comparison study. Concepts of the preliminary design of the selected scheme are as follows;

1) Voided slab type and box girder type should be adopted for superstructure to consider aesthetic view of flyover.
2) One (1) column type pier foundation should be adopted to maximize the usage of under flyover.
3) 6% of vertical grade should be adopted for both side of flyover approaches to minimize the flyover length.
4) MSE wall should be adopted as retaining wall along embankment approach to maintain two (2) lanes service roads for both directions.
5) To provide RCBC under the embankment approach for the use of pedestrians.
6) To provide left turn lane at the intersection along E. Rodriguez Avenue (total 7 lanes) to maximize the traffic capacity.
7) To provide four (4) phase signalization plan at the at-grade intersection.
8) All of the at-grade plan and design to be done within RROW.

Preliminary design was carried out based on the above basic concepts. Plan and profile, at-grade intersection plan, typical cross sections of embankment approach, typical cross sections, slab layout plan and structural general view are shown in **Figures 4.2-14 ~21**.

**(4) Construction Plan and Traffic Management during Construction**

1) Construction Plan and PERT CPM for the C3/E. Rodriguez interchange are presented in the **Figures 4.2-22 ~ 24**
2) Traffic Management plan during construction for the C3/Rodriguez interchange is shown in **Figure 4.2-25**

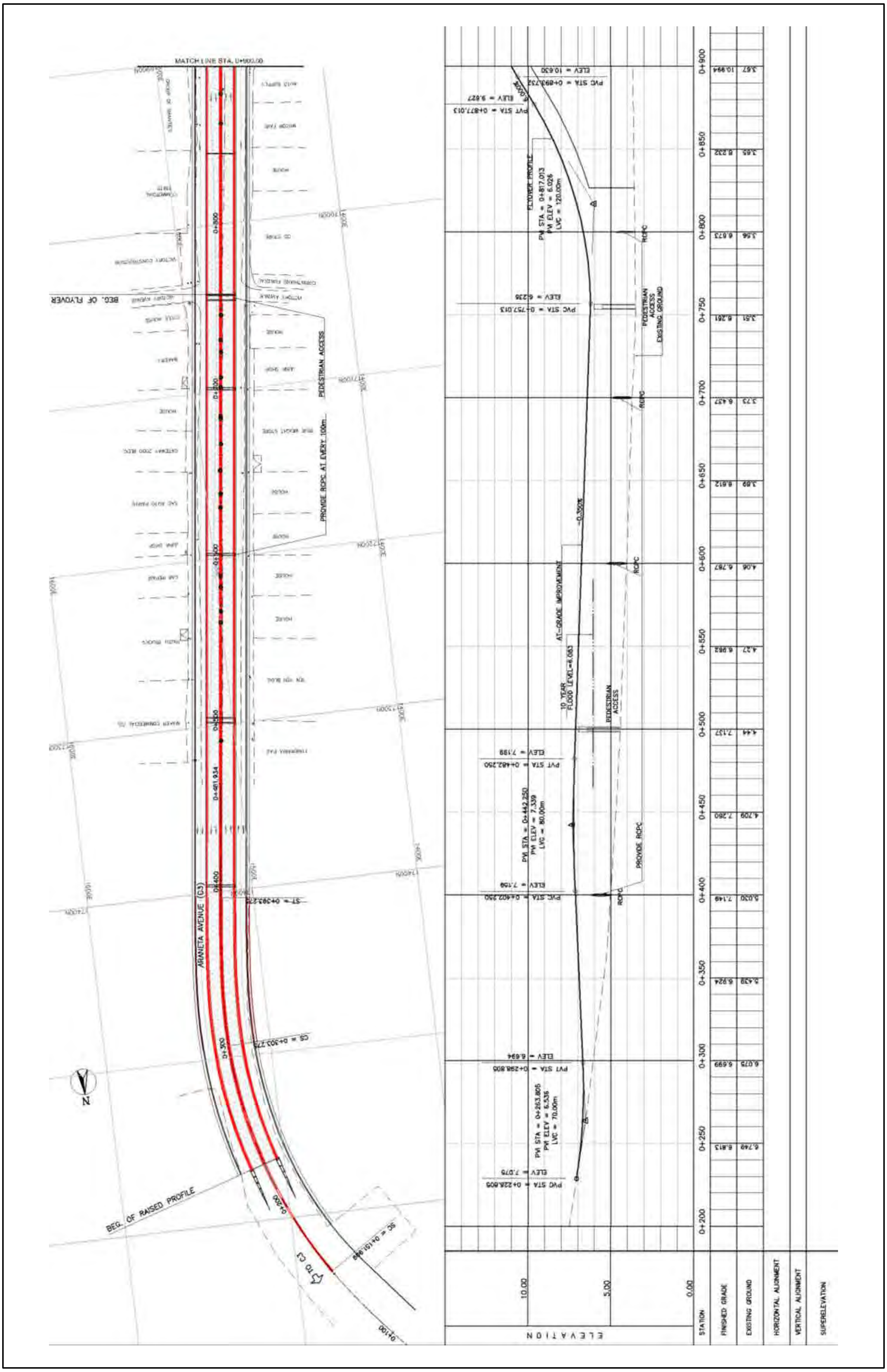


**Figure 4.2-14 Plan and Profile C-3/E. Rodriguez Interchange (1/2)**

*Source: JICA Study Team*

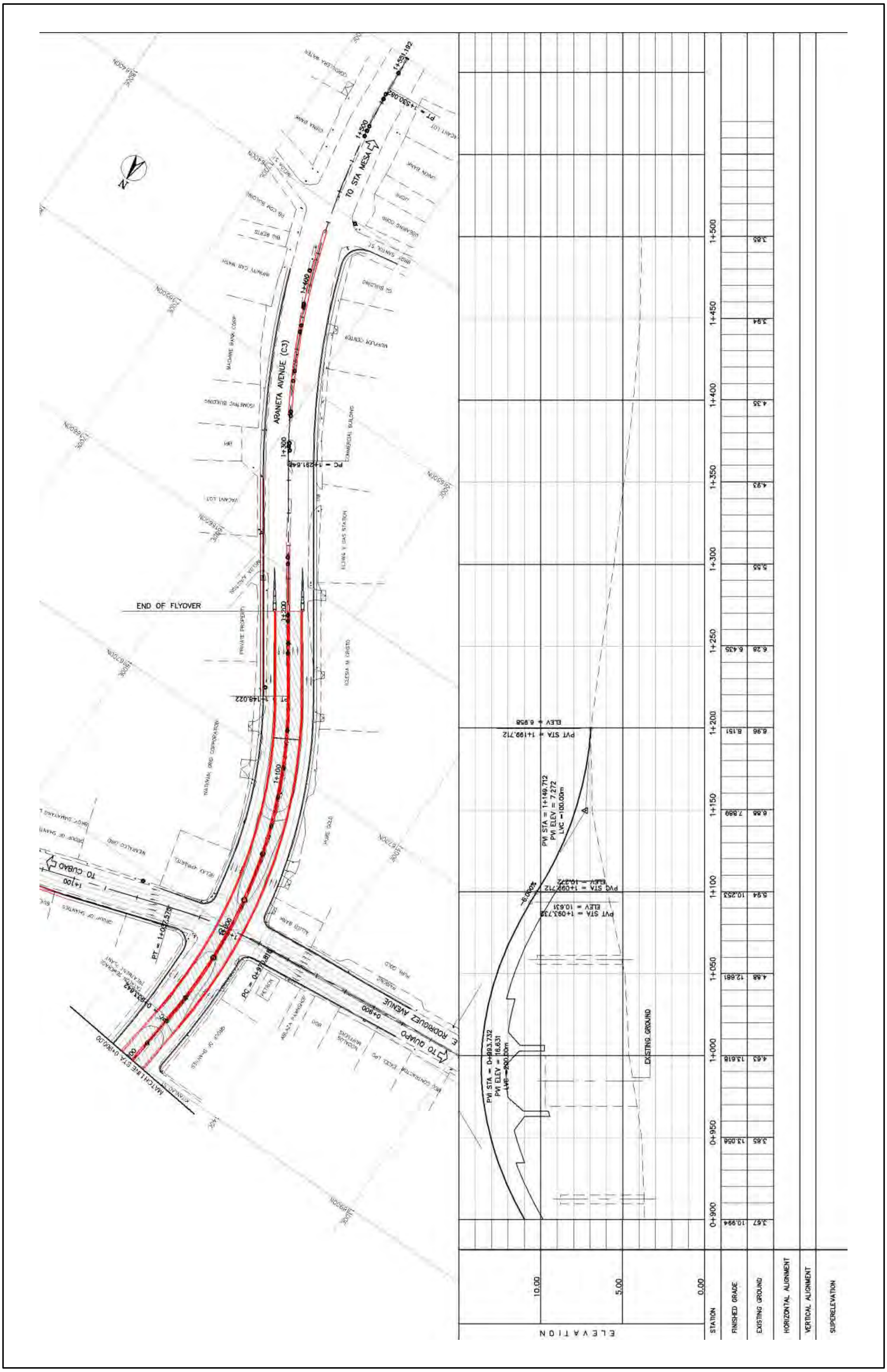



Figure 4.2-15 Plan and Profile C-3/E. Rodriguez Interchange (2/2)

*Source: JICA Study Team*

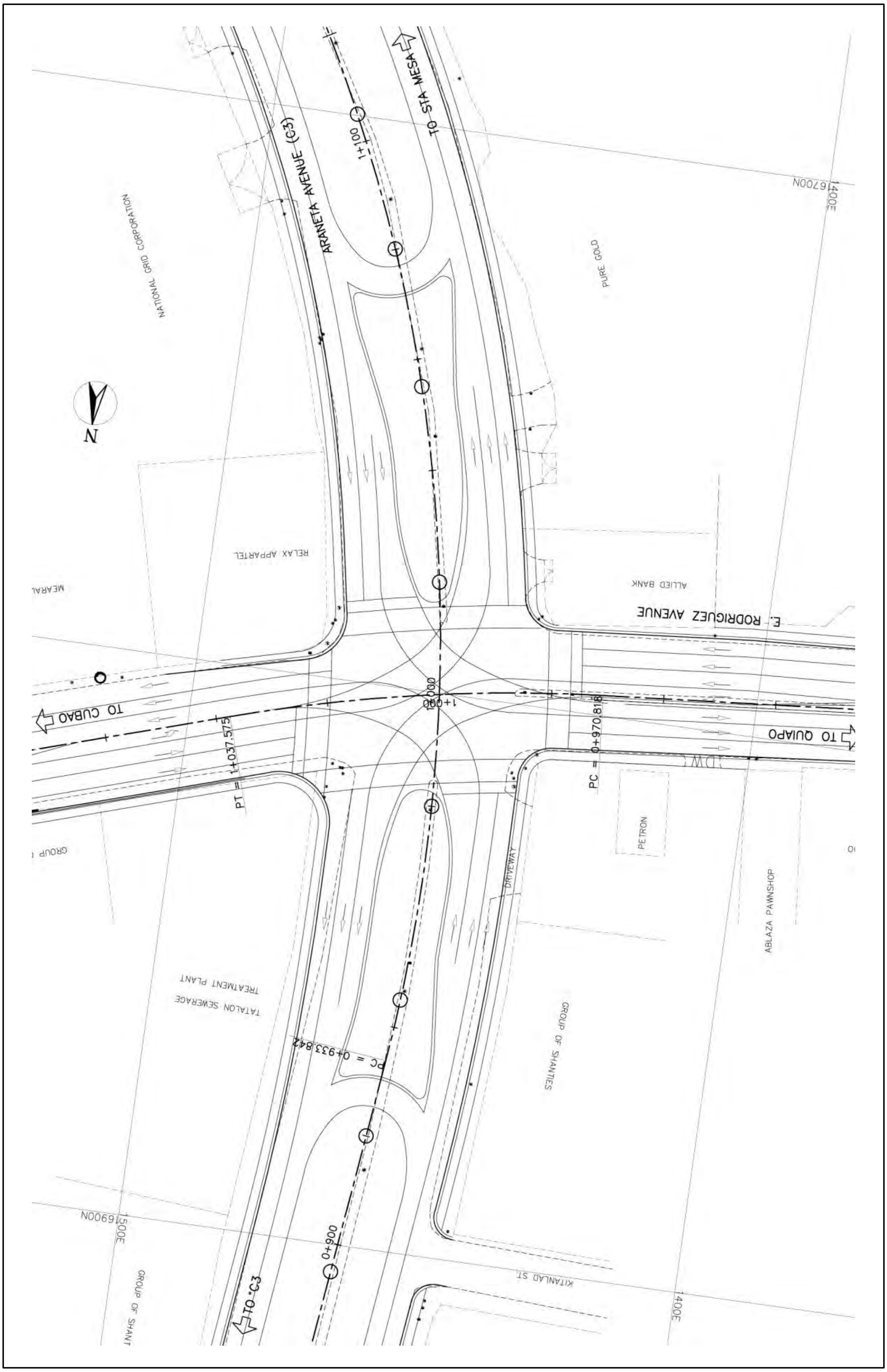



**Figure 4.2-16 AT-Grade Intersection Plan (C-3/E. Rodriguez Interchange)**

*Source: JICA Study Team*

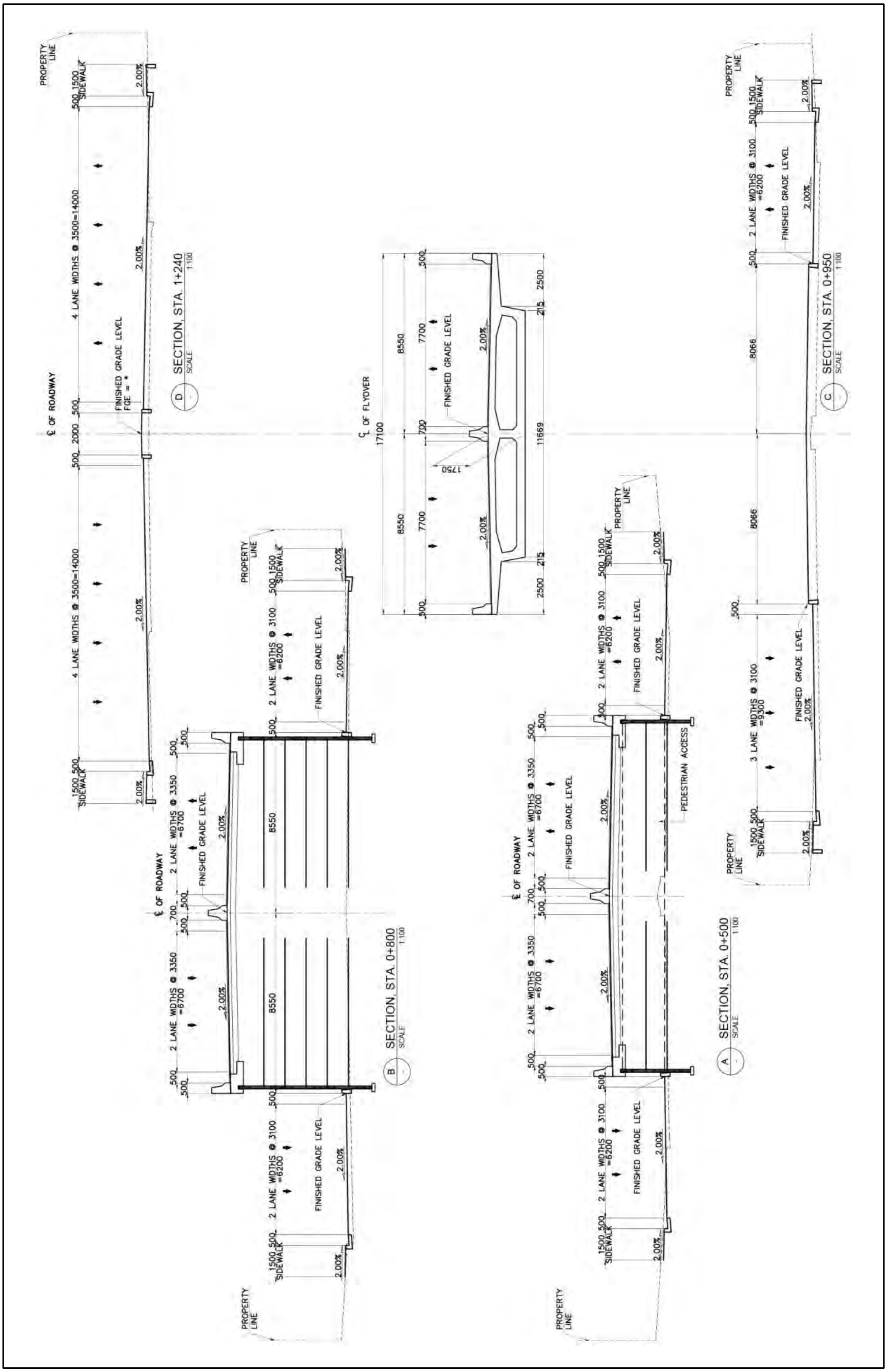
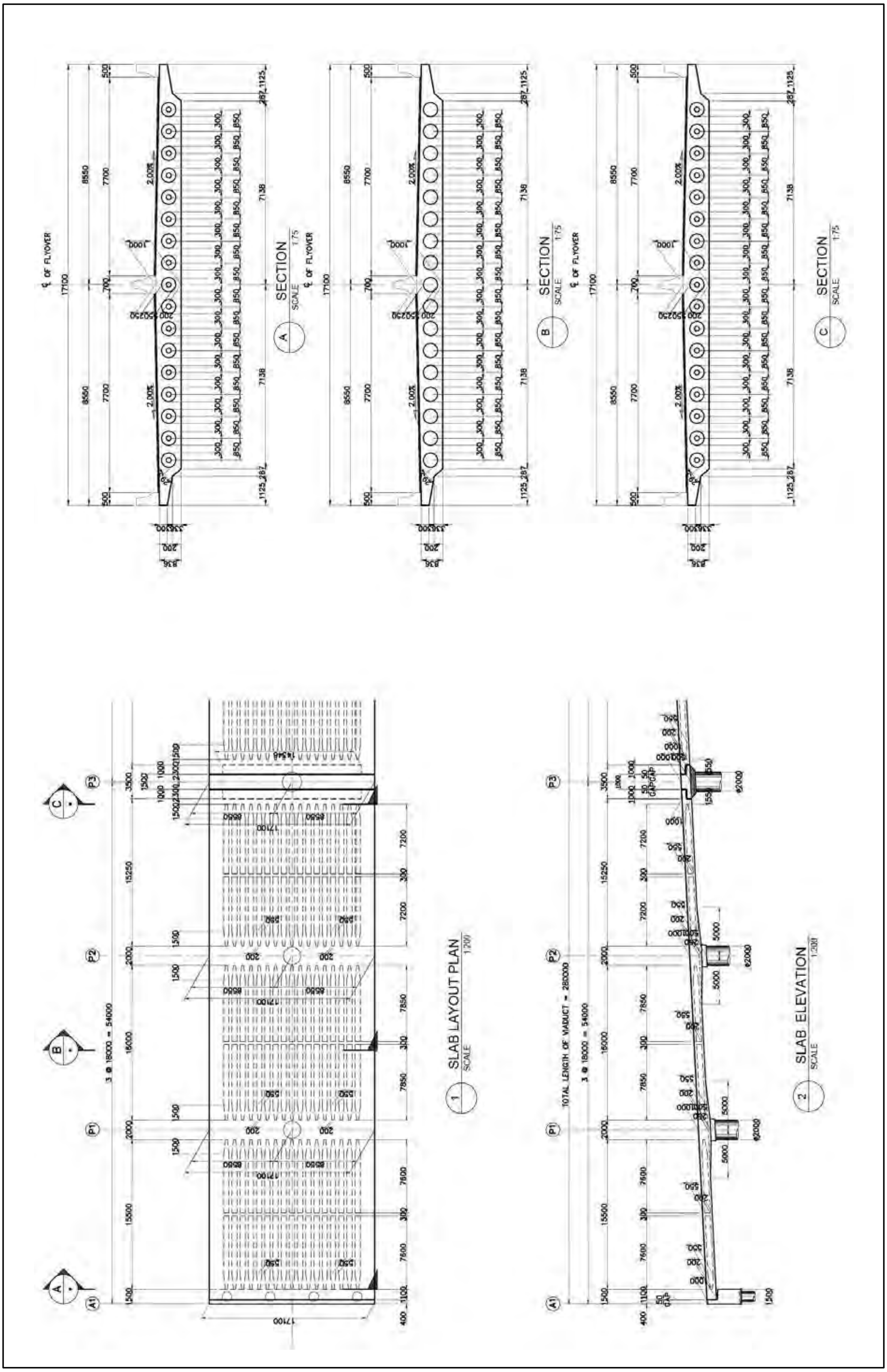



**Figure 4.2-17 Approach Typical Cross Sections (C-3/E. Rodriguez Interchange)**

*Source: JICA Study Team*




Source: JICA Study Team

**Figure 4.2-18 Slab Layout Plan (1/2) (C-3/E. Rodriguez Interchange)**

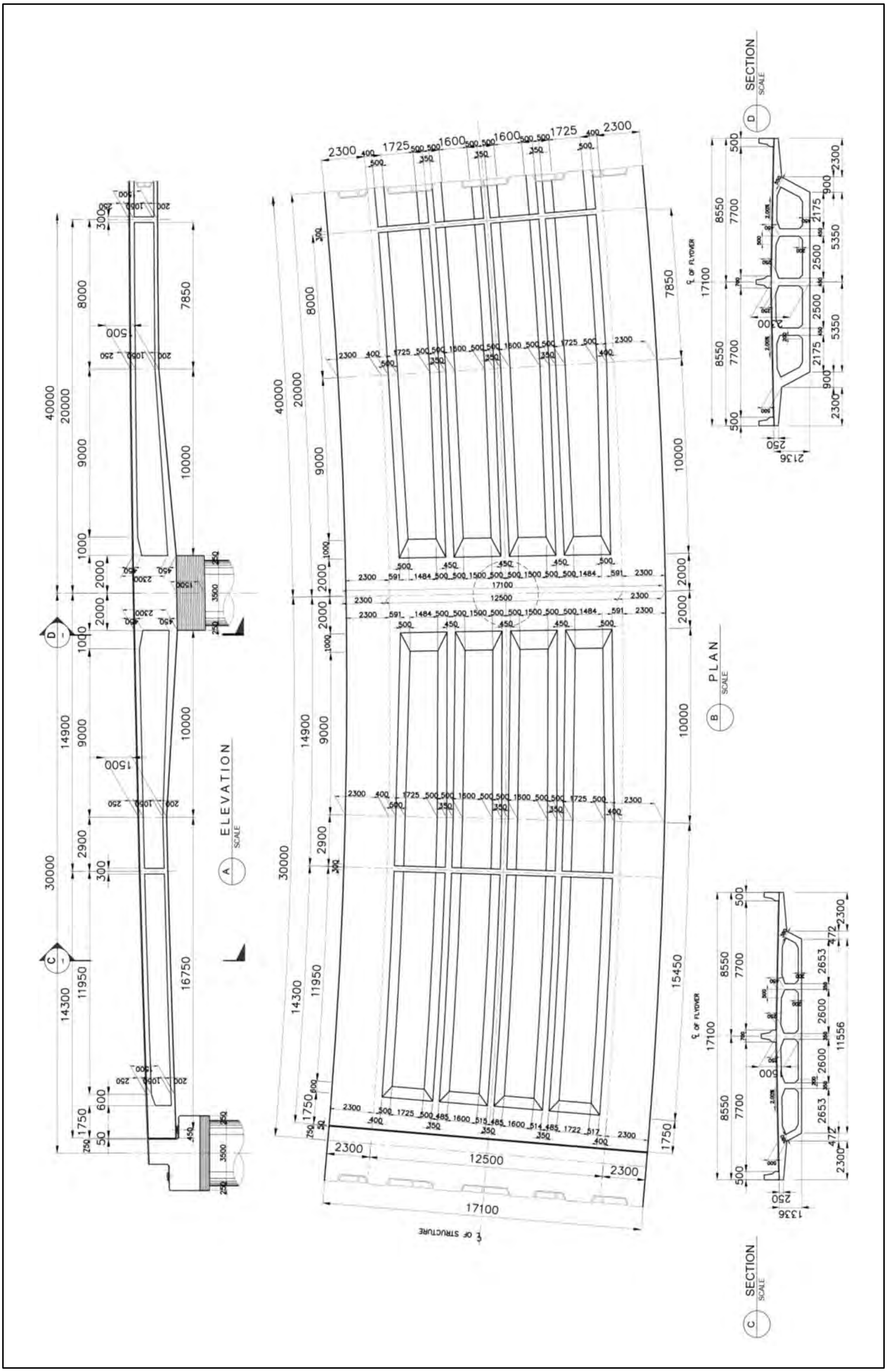
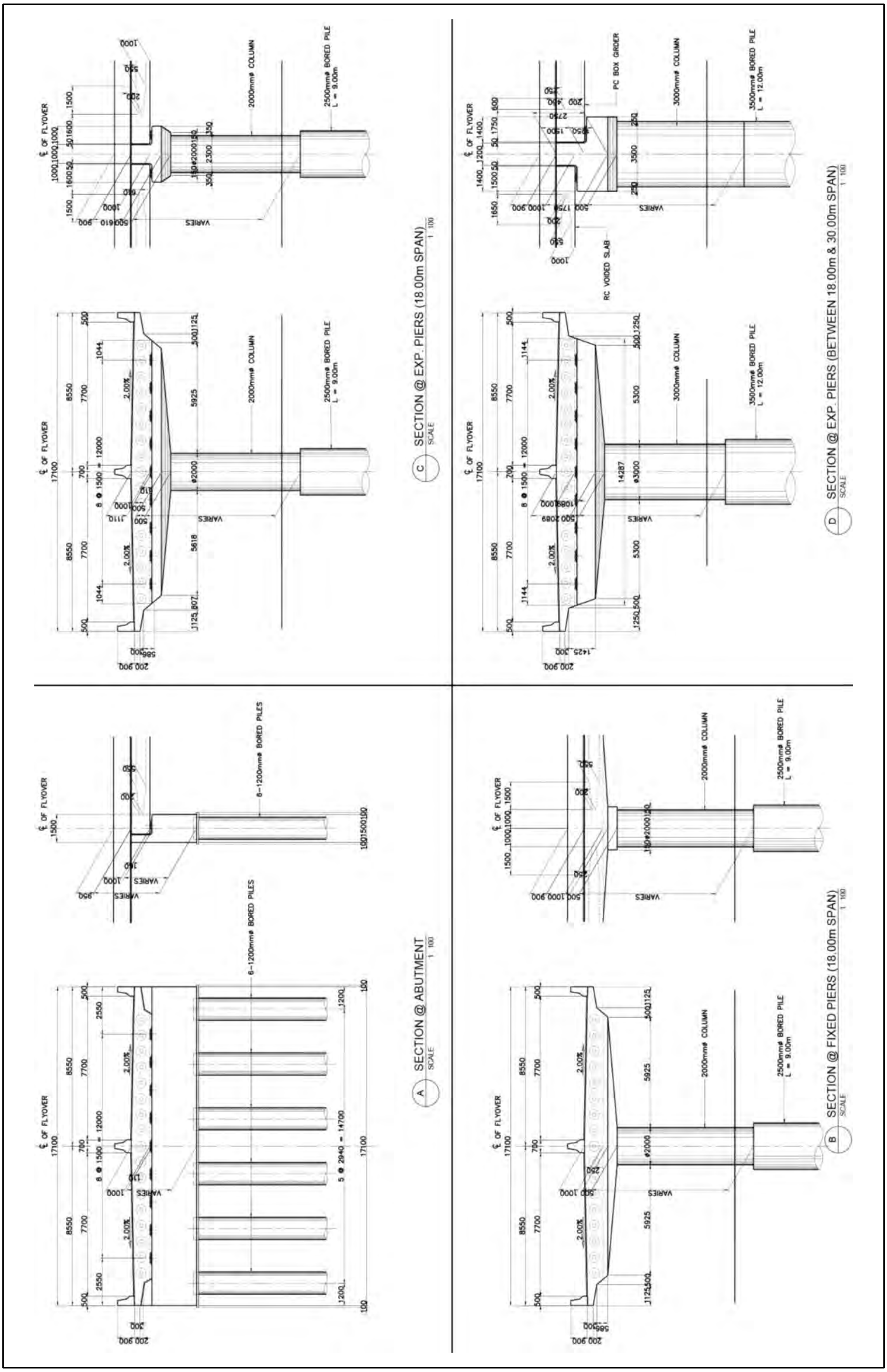



**Figure 4.2-19 Slab Layout Plan (2/2) (C-3/E. Rodriguez Interchange)**

*Source: JICA Study Team*




*Source: JICA Study Team*

**Figure 4.2-20 Structural General View (1/2) (C-3/E. Rodriguez Interchange)**

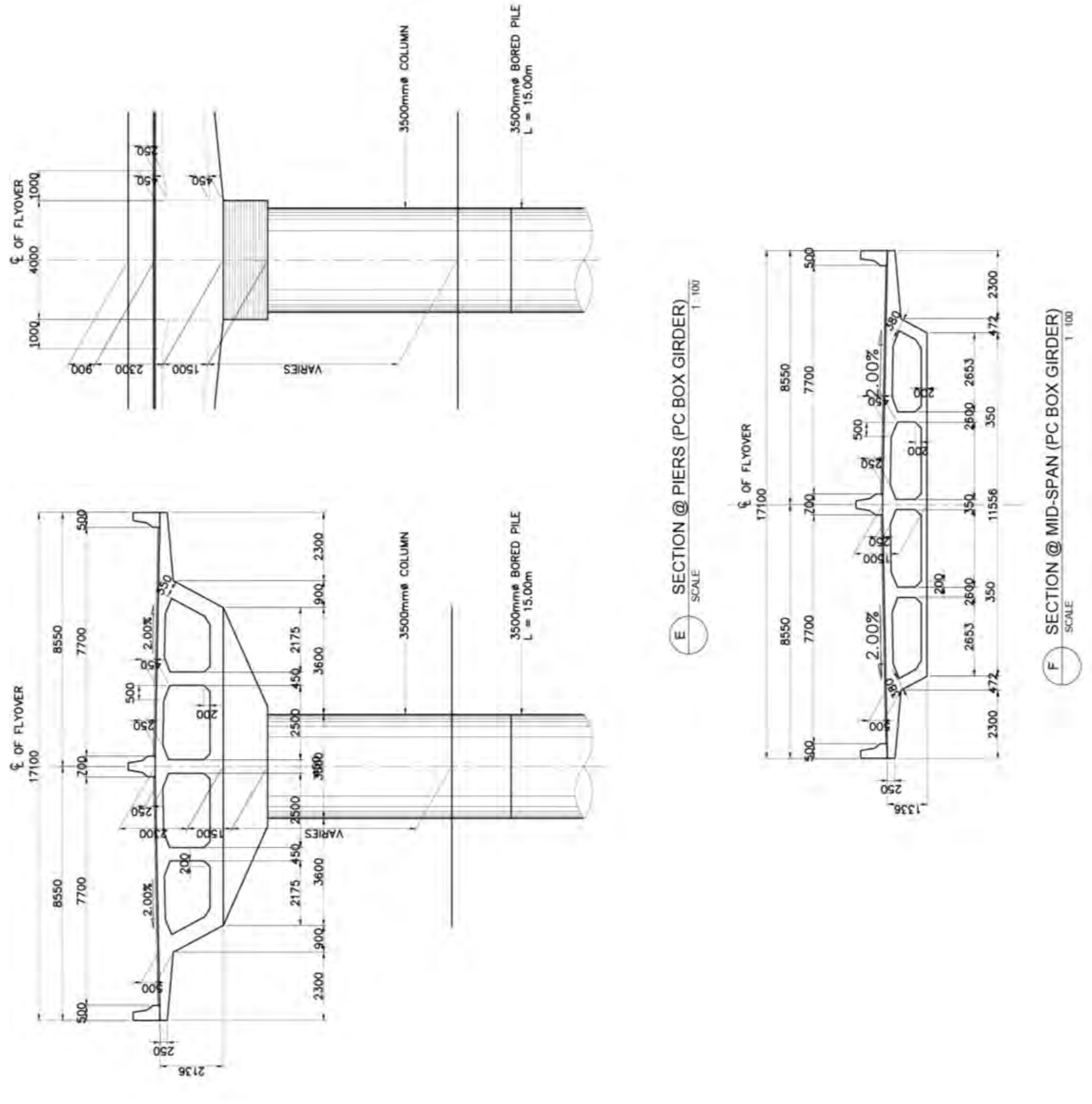
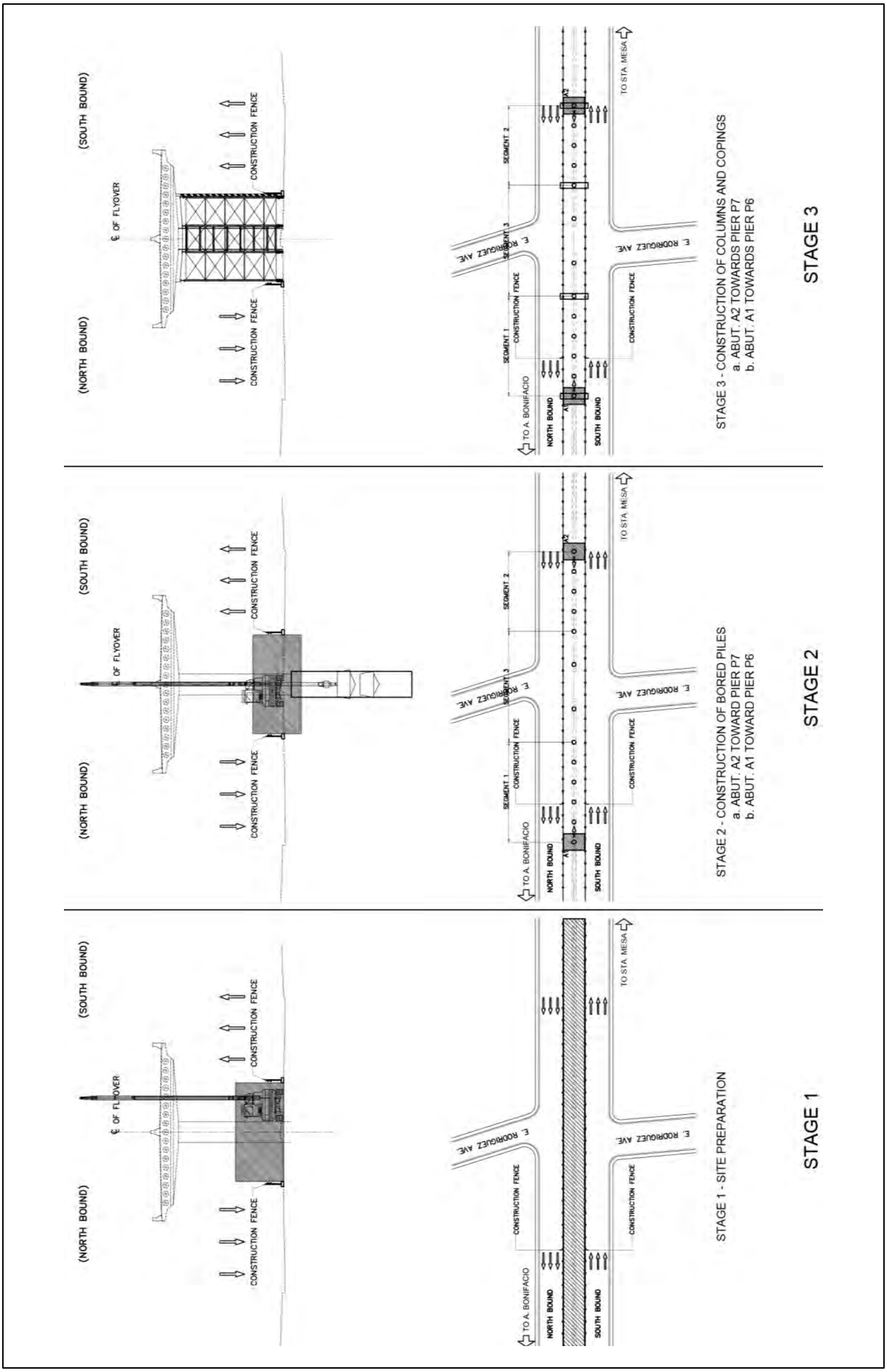


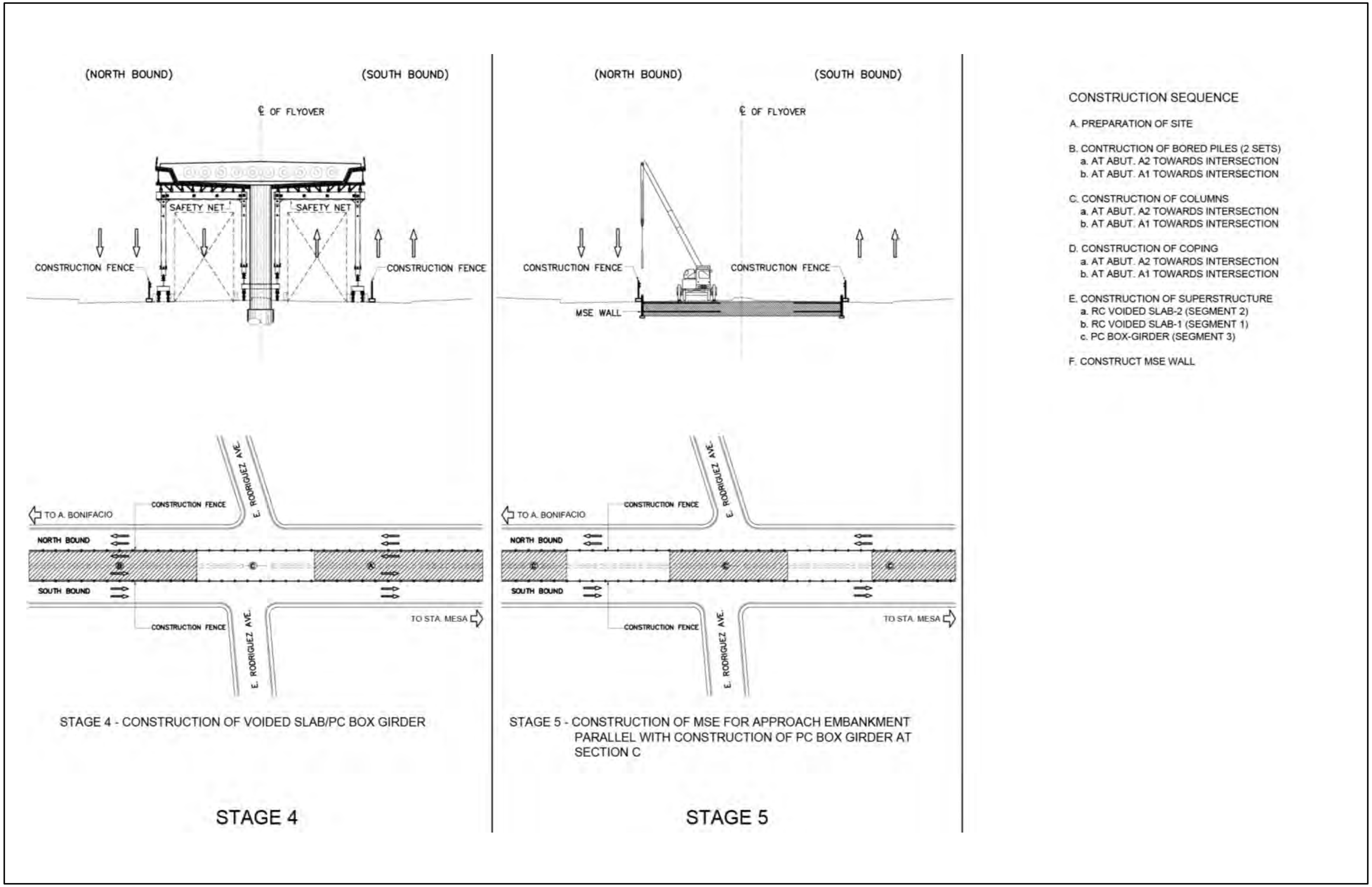

**Figure 4.2-21 Structural General View (2/2) (C-3/E. Rodriguez Interchange)**

*Source: JICA Study Team*



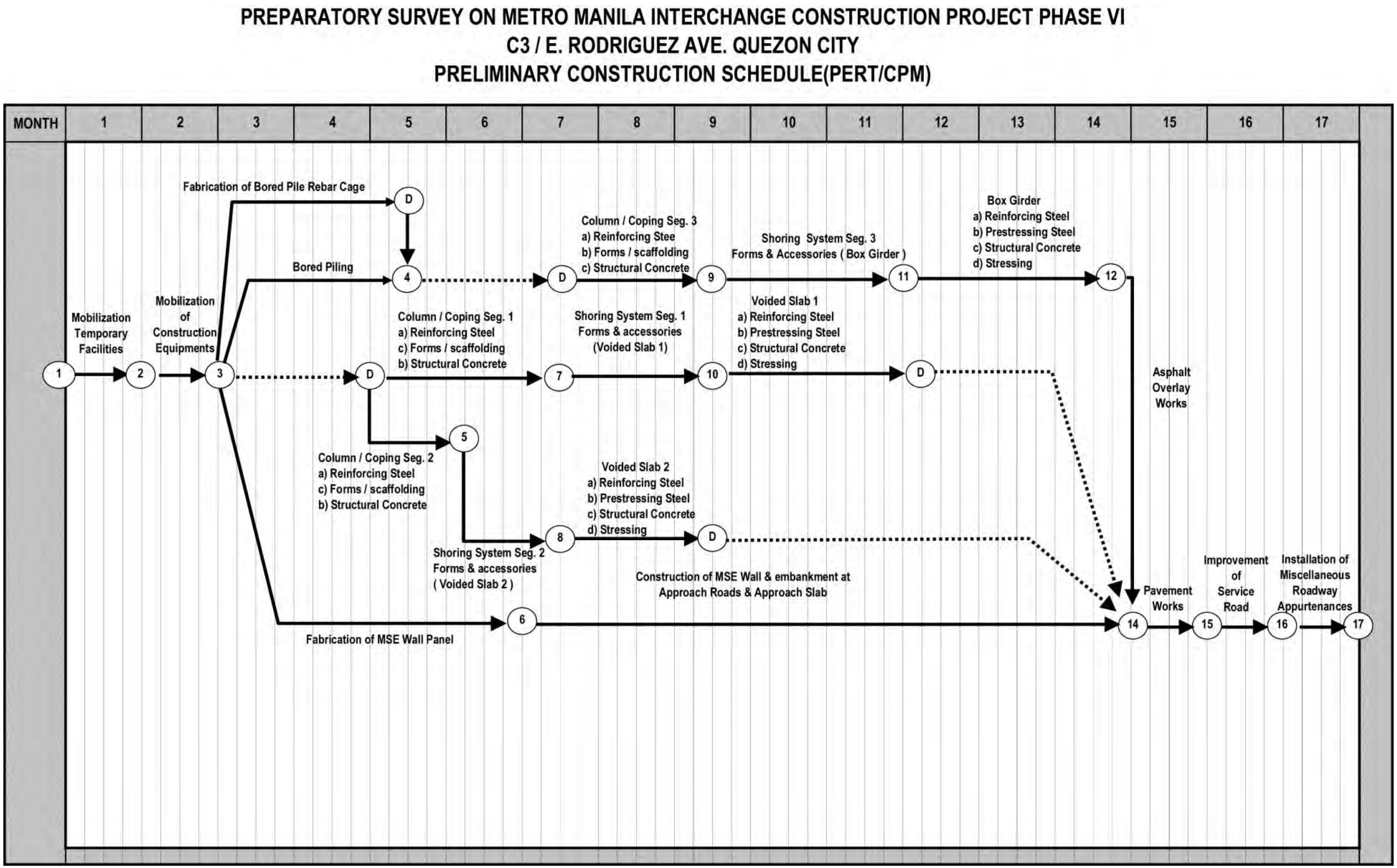

*Source: JICA Study Team*

**Figure 4.2-22 Construction Plan for C-3/E. Rodriguez Interchange (1/2)**



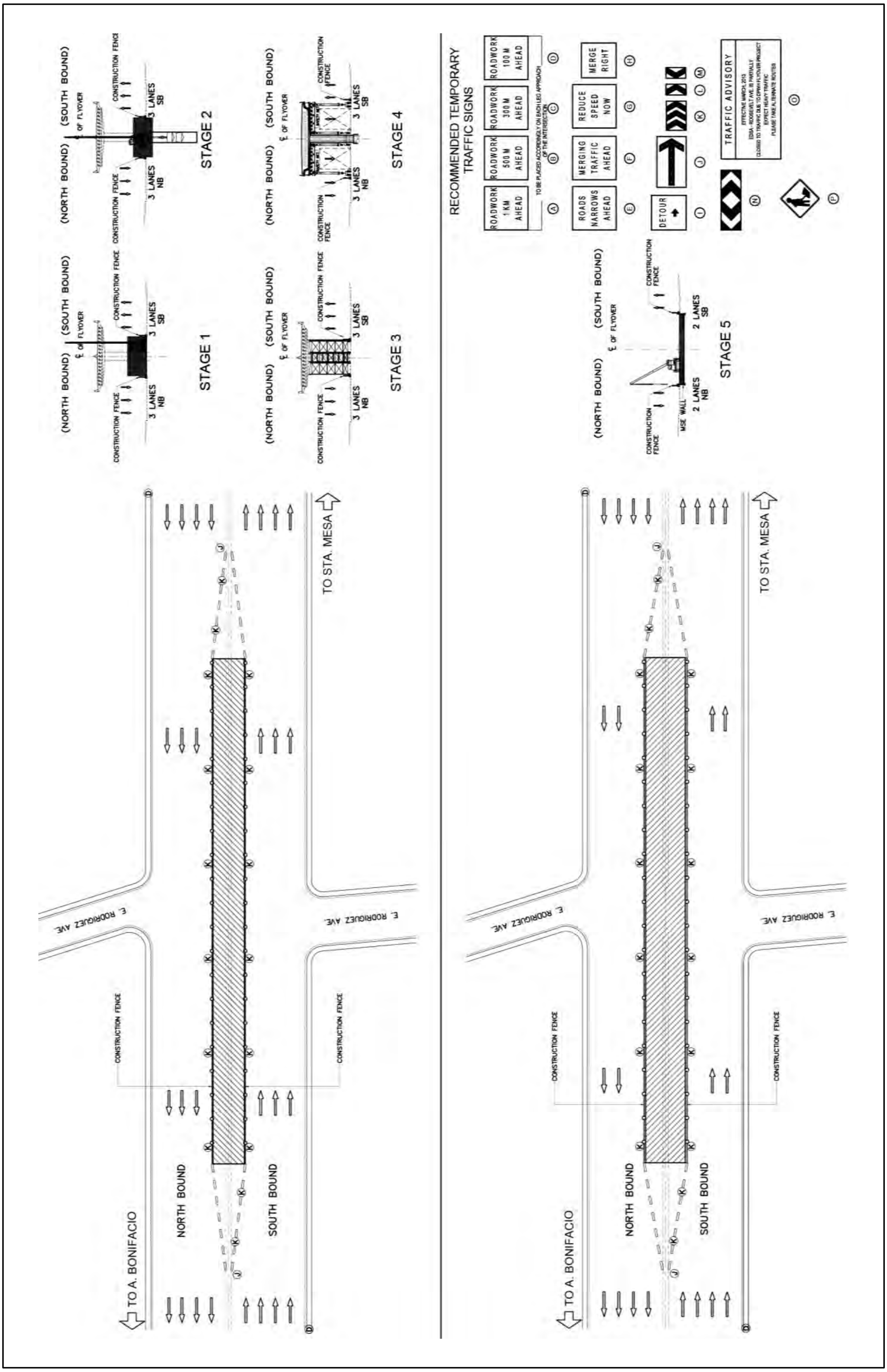

*Source: JICA Study Team*

**Figure 4.2-23 Construction Plan for C-3/E. Rodriguez Interchange (2/2)**




*Source: JICA Study Team*

**Figure 4.2-24 Pert CPM for C3/E. Rodriguez Interchange**




Source: JICA Study Team

**Figure 4.2-25 Traffic Management for C-3/E. Rodriguez Interchange**

**(5) Bill of Quantity and Cost Estimate**

The Civil Work cost estimate was estimated based on several factors as follows:

- Unit price used for similar GOP and BOT projects implemented or tendered from 2010-2011 was applied and also unit price for major item was estimated based on 2011 prices.
- Procedures and composition of base construction cost were derived from similar projects;

1) The Civil Work cost was divided into two components:

a) General requirement;

b) Interchange Construction with Viaduct;

2) Procedure of Construction Cost Estimate

The procedure for cost estimate uses unit price for the "base cost" approach, which is generally adopted for similar projects and some major item is estimated. From the previous similar projects, preliminary quantity takeoffs for construction item for the earth work, approach ramp and viaducts, drainage and slope protection, and other works are estimated. The cost estimate is based on the estimated quantity takeoffs from preliminary design and current market prices.

3) Procedure of Base Construction Cost Estimate

The following procedures were used to derive the base construction cost;

a) Assumptions necessary for the estimate were naked based on the results of the preliminary studies, market research, site investigation, and unit prices of recent similar projects;

b) Three (3) direct cost elements were identified:

- ✓ Labor Costs
- ✓ Material Costs (foreign/imported materials and local materials)
- ✓ Equipment costs (Association of Carriers and Equipment Lessors, ACEL)
- ✓ Note: ACEL is used for all of the foreign assisted and local DPWH projects.

c) The project was broken into its component activities and a list of corresponding work items including field activities were prepared in accordance with internationally accepted specifications and concept designs proposed for the Interchanges.

d) Based on the constraints or requirements and results obtained from the site investigation, standard construction sequences and methods for each work item were studied and formulated. The construction technology, sequences, and methods to be employed, approximate number of labor and equipment requirements, and other items were considered.

4) Condition of Unit Price

The construction cost estimate is basically composed of the direct cost and indirect cost. The computations are in accordance with the DPWH Standard Specifications implementing guidelines and memorandum order relative to unit price analysis.

a) Cost of Material

Materials are classified into two groups: commercial materials, available in the international and/or local markets (referred to as purchased materials) and material produced by the contractor (referred to as processed materials). The price of purchased materials are based on the quotations of various suppliers or agencies such as the Price Stabilization Council, the local markets, international and/or local prices of selected materials, the National Steel Corporation, and other private sector sources. The cost of transportation to the site is added to these costs. The cost of processed materials are estimated based on the analysis of outputs of necessary equipment, labor, royalties, and other items in accordance with recommended construction procedures.

b) Cost of Equipment

The cost of equipment is based on "ACEL" rental rates which include operator's wages, fringe benefits, fuel, oil, lubricants and equipment maintenance.

c) Cost of Labor

Labor costs used in the analysis are the wages authorized by the Department of Labor and Employment. All fringe benefits such as vacation and sick leaves, Workmen's Compensation Act, GSIS and SSS contributions, allowances, and bonus, are taken into account.

5) Indirect Costs

According to the Department Order No. 29/2011 of DPWH, the indirect cost consider following conditions:

a) Mobilization and demobilization (1 % of direct cost)

b) Value Added Tax (VAT):12% of total Direct and Indirect Cost

c) Mark-Up (14% of Estimated Direct Cost)

- ✓ Overhead Expenses : 5% of Estimated Direct Cost
- ✓ Contingencies : 0.5% of Estimated Direct Cost
- ✓ Miscellaneous Expenses : 0.5% of Estimated Direct Cost
- ✓ Profit : 8% of Estimated Direct Cost

6) Civil Works Cost Estimate

Civil Works Cost for C3/E. Rodriguez IC has been estimated based on the above conditions as well as procedures and the result is shown in **Table 4.2-3.**

### Table 4.2-3 Civil Works Cost Estimate for C3/E. Rodriguez IC

Unit: Php

| PAY ITEM NO. | DESCRIPTION | QUANTITY | UNIT | Unit Cost | Civil Work Cost | Remarks |
|---|---|---|---|---|---|---|
| 1.0 | **GENERAL REQUIREMENTS** | | | | | |
| A | **FACILITIES FOR THE ENGINEER** | 1.00 | l.s. | 10,000,000.00 | 10,000,000.00 | |
| | **SUB-TOTAL (PART A)** | | | | **10,000,000.00** | |
| B | **OTHER GENERAL REQUIREMENTS** | | | | | |
| SPL B.2.1 | Construction Health and Safety | 1.00 | P.s | 2,400,000.00 | 2,400,000.00 | |
| SPL B.2.2 | Mobilization / Demobilization (1.0% of Civil Works) | 1.00 | P.s | 4,295,116.12 | 4,295,116.12 | |
| SPL B.2-3 | Traffic Management During Construction | 1.00 | P.s | 5,000,000.00 | 5,000,000.00 | |
| SPL B.2-4 | Dayworks | 1.00 | P.s | 5,000,000.00 | 5,000,000.00 | |
| SPL B.2-5 | Removal, Relocation of Utilities | 1.00 | P.s | 10,000,000.00 | 10,000,000.00 | |
| SPL B.3.1 | Environmental Monitoring Action Plan | 1.00 | P.s | 2,000,000.00 | 2,000,000.00 | |
| | **SUB-TOTAL (PART B)** | | | | **28,695,116.12** | |
| | **SUB-TOTAL GENERAL REQUIREMENTS** | | | | **38,695,116.12** | |
| 2.0 | **INTERCHANGE CONSTRUCTION WITH VIADUCT** | | | | | |
| C | **EARTHWORKS** | | | | | |
| 100(1) | Clearing and Grubbing | 0.40 | ha. | 90,846.53 | 36,338.61 | |
| 100(3) | Individual Removal Trees (Small) | 5.00 | ea. | 1,013.26 | 5,066.30 | |
| 100(4) | Individual Removal Trees (Large) | 2.00 | ea. | 1,427.27 | 2,854.54 | |
| 100(5) | Removal and Earth Balling of Trees | 30.00 | ea. | 1,000.00 | 30,000.00 | |
| 101(1) | Removal of Structures and Obstruction | 1.00 | l.s. | 500,000.00 | 500,000.00 | |
| 101(3)a | Removal of Existing PCCP | 3,132.08 | sq.m. | 245.78 | 769,802.62 | |
| 101(3)b | Breaking of Existing PCCP | 10,347.98 | sq.m. | 335.00 | 3,466,573.30 | |
| 101(4)a | Removal of Existing Concrete Curb | 1,138.12 | l.m. | 60.00 | 68,287.20 | |
| 101(4)b | Removal of Existing Concrete Curb & Gutter | 2,702.24 | l.m. | 110.00 | 297,246.40 | |
| 101(4)c | Removal of Existing Sidewalk and Median | 5,744.07 | sq.m. | 120.00 | 689,288.40 | |
| 101(4)d | Removal of Existing RCPC | 1,628.69 | l.m. | 200.00 | 325,738.00 | |
| 101(4)e | Removal of Existing Covered canal | - | l.m. | 150.00 | - | |
| 105(1) | Subgrade Preparation | 4,961.33 | sq.m. | 37.18 | 184,462.25 | |
| | **SUB-TOTAL (PART C)** | | | | **6,375,657.62** | |
| D | **SUBBASE AND BASE COURSE** | | | | | |
| 200 | Sub Base Course | 4,619.04 | cu.m. | 879.97 | 4,064,616.63 | |
| | **SUB-TOTAL (PART D)** | | | | **4,064,616.63** | |
| E | **SURFACE COURSES** | | | | | |
| 302(2) | Bituminous Tack Coat, Emulsified Asphalt, SS-1 (0.45 L/m2) | 10.46 | tonne | 65,971.81 | 690,065.13 | |
| 310 (2) | Bituminous Concrete Wearing Course, Hot Laid (t=50mm) | 14,952.01 | sq.m | 924.31 | 13,820,292.36 | |
| 311 | Portland Cement Concrete Pavement t=300 mm | 14,320.68 | sq.m | 2,887.66 | 41,353,254.81 | |
| | **SUB-TOTAL (PART E)** | | | | **55,863,612.30** | |
| F | **BRIDGE CONSTRUCTION** | | | | | |
| | **Approch Ramp** | | | | | |
| 103(1) | Structure Excavation | 3,121.70 | cu.m. | 586.00 | 1,829,316.20 | |
| 103(2) | Structural Backfilling | 2,631.03 | cu.m. | 565.00 | 1,486,531.95 | |
| 104(2) | Embankment, Selected Borrow | 15,980.51 | cu.m. | 984.09 | 15,726,260.09 | |
| 401(a) | Cast in Place Concrete Railing | 1,381.81 | l.m. | 5,006.92 | 6,918,612.13 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 171,162.75 | kg. | 62.70 | 10,731,904.43 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 30,832.45 | kg. | 68.25 | 2,104,314.71 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 1,271.25 | cu.m. | 9,548.08 | 12,137,977.60 | |
| 405(1)b | Approach Slab | 51.40 | cu.m. | 6,233.40 | 320,396.76 | |
| 405(1)c | Concrete Leveling Pad | 68.70 | cu.m. | 80,462.16 | 5,527,750.39 | |
| 405(6) | Lean Concrete | 71.06 | cu.m. | 4,111.70 | 292,177.40 | |
| SPL 414 | Concrete Barrier | 690.01 | l.m. | 4,660.55 | 3,215,826.11 | |
| SPL 417 | Earthquake Resistant Type Mechanically Stabilized Earthwall | 2,792.02 | sq.m. | 14,163.00 | 39,543,379.26 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | **Substructure** | | | | | |
| 400(17)a | Concrete Piles Cast in Drilled Holes, Ø1200 mm | 108.00 | l.m. | 44,668.80 | 4,824,230.40 | |
| 400(17)b | Concrete Piles Cast in Drilled Holes, Ø2500 mm | 78.00 | l.m. | 106,248.81 | 8,287,407.18 | |
| 400(17)c | Concrete Piles Cast in Drilled Holes, Ø3500 mm | 54.00 | l.m. | 266,675.42 | 14,400,472.68 | |
| 400(22)a | Pile Integrity Test | 14.00 | ea. | 43,784.56 | 612,983.84 | |
| 400(22)b | Pile Dynamic Test | 7.00 | ea. | 583,087.25 | 4,081,610.75 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 158.40 | kg. | 62.70 | 9,931.68 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 422,077.70 | kg. | 68.25 | 28,806,803.03 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 1,287.96 | cu.m. | 14,057.94 | 18,106,022.23 | |
| 405(6) | Lean Concrete | 5.88 | cu.m. | 4,111.70 | 24,176.80 | |
| 407(1)a | Anchor Bar Ø36mm x 1500mm long, complete | 200.00 | ea. | 1,800.00 | 360,000.00 | |
| 407(1)b | Anchor Bar Ø36mm x 1000mm long, complete | 36.00 | ea. | 1,200.00 | 43,200.00 | |
| | | | | | | |
| | **Superstructure** | | | | | |
| 401(a) | Cast in Place Concrete Railing | 560.00 | l.m. | 5,006.92 | 2,803,875.20 | |
| 404(1)b | Reinforcing steel, Grade 40 (Superstructure) | 45,132.00 | kg. | 62.70 | 2,829,776.40 | |
| 404(2)b | Reinforcing steel, Grade 60 (Superstructure) | 621,230.00 | kg. | 68.25 | 42,398,947.50 | |
| 404(2)c | Prestressing steel | 24,431.80 | kg. | 152.90 | 3,735,622.22 | |
| 405(1)b | Structural Concrete, Class A (Hollow Slab) 27.6 Mpa | 2,092.79 | cu.m. | 16,971.01 | 35,516,760.02 | |
| 405(1)c | Structural Concrete Class P 34Mpa for PC Box | 1,447.25 | cu.m. | 18,900.00 | 27,353,025.00 | |
| 412(1)a | Elastomeric Bearing Pad (500 x 400 x 60 mm) | 54.00 | ea. | 14,500.00 | 783,000.00 | |
| 412(1)b | Elastomeric Bearing Pad (400 x 400 x 50 mm) | 48.00 | ea. | 12,000.00 | 576,000.00 | |
| 413(1) | Expansion Joint | 128.80 | l.m. | 29,418.63 | 3,789,119.54 | |
| SPL 414 | Concrete Barrier | 280.00 | l.m. | 4,660.55 | 1,304,954.00 | |
| SPL 415 | Waterproofing | 4,788.00 | sq.m. | 1,800.00 | 8,618,400.00 | |
| | | | | | | |
| | **SUB-TOTAL (PART F)** | | | | **309,100,765.48** | |
| | | | | | | |
| **G** | **DRAINAGE AND SLOPE PROTECTION STRUCTURES** | | | | | |
| | | | | | | |
| 404(1)b | Reinforcing steel, Grade 40 (Box Culvert) | 18,777.00 | kg. | 62.70 | 1,177,317.90 | |
| 405(1)b | Structural Concrete, Class A (Box Culvert) 27.6 Mpa | 125.18 | cu.m | 8,480.81 | 1,061,627.80 | |
| 500(1)a | RCPC, Class II | 1,580.00 | l.m. | 3,082.45 | 4,870,271.00 | |
| 500(1)b | RCPC, Class IV | 103.00 | l.m. | 7,005.56 | 721,572.68 | |
| 502(2)a | Storm Deck Drain with Grating | 152.00 | ea. | 19,679.57 | 2,991,294.64 | |
| 502(2)b | Curb Inlet Manhole | 96.00 | ea. | 25,000.00 | 2,400,000.00 | |
| 502(3) | Catch Basins | - | ea. | 35,000.00 | - | |
| 502(4) | Junction Box | - | ea. | 5,000.00 | - | |
| SPL 512 | Collector Pipe | 1,093.18 | l.m. | 1,153.20 | 1,260,655.18 | |
| | | | | | | |
| | **SUB-TOTAL (PART G)** | | | | **14,482,739.19** | |
| | | | | | | |
| **H** | **MISCELLANEOUS STRUCTURES** | | | | | |
| | | | | | | |
| 600(1) | Concrete Curb | 2,111.62 | l.m. | 1,333.21 | 2,815,232.90 | |
| 600(3)a | Concrete Curb and Gutter | 2,492.14 | l.m. | 1,661.30 | 4,140,192.18 | |
| 600(3)b | Concrete Side Strip | 1,058.57 | sq.m. | 350.00 | 370,499.50 | |
| 601(1)a | Concrete Sidewalk | 3,119.30 | sq.m. | 1,560.60 | 4,867,979.58 | |
| 601(1)b | Concrete Median | 4,245.17 | sq.m. | 1,560.60 | 6,625,012.30 | |
| 605(1) | Warning Sign | 3.00 | set | 34,912.46 | 104,737.38 | |
| 605(2) | Regulatory Sign | 8.00 | set | 34,912.46 | 279,299.68 | |
| 605(3)a | Informatory Sign, Gantry Support | 2.00 | set | 905,733.18 | 1,811,466.36 | |
| 605(3)b | Informatory Sign, Butterfly Support | 2.00 | set | 431,481.05 | 862,962.10 | |
| 605(3)c | Informatory Sign, Cantilever Support | 4.00 | set | 388,956.44 | 1,555,825.76 | |
| 605(3)d | Informatory Sign, Double Post | 7.00 | set | 42,944.99 | 300,614.93 | |
| 612(1) | Reflectorized Thermoplastic Pavement Markings, White | 1,524.49 | sq.m. | 1,092.83 | 1,666,008.41 | |
| | | | | | | |
| | **SUB-TOTAL (PART H)** | | | | **25,399,831.08** | |
| | | | | | | |
| **J** | **SPECIAL ITEM** | | | | | |
| | | | | | | |
| SPL 1 | 9m Pole, Single arm complete | 100.00 | set | 86,228.98 | 8,622,898.00 | |
| SPL 2 | 9m Pole, Double arm complete | 49.00 | set | 90,000.00 | 4,410,000.00 | |
| SPL 3 | Lighting system, (under carriageway) | 12.00 | set | 59,290.99 | 711,491.88 | |
| SPL 4 | Flood lights | 6.00 | set | 80,000.00 | 480,000.00 | |
| SPL 5 | Traffic Signal Light | - | P.s | 2,000,000.00 | - | |
| | | | | | | |
| | **SUB-TOTAL (PART J)** | | | | 14,224,389.88 | |
| | | | | | | |
| | **TOTAL** | | | | **468,206,728.32** | |

*Source: JICA study team*

*Note: Implementation of the C3/E. Rodriguez Interchange was cancelled by the DPWH to give priority to the construction of Skyway Stage 3, second level, along C3 under BOT scheme.*

## 4.3 EDSA-ROOSEVELT AVENUE/CONGRESSIONAL AVENUE

### 4.3.1 Review of Previous Detailed Design

The detailed design of the project was done by Katahira & Engineers International in association with Proconsult, Inc. and United Technologies, Inc. in February 2001.

#### (1) Topographic Conditions

The project road sections have the following topographic features:

1) The horizontal alignment has 1055m radius curve before the intersection from Cubao.

2) The vertical grade of the original ground elevation from Cubao side going Monumento gradually drops continuously.

3) The maximum vertical grade going down to north direction is 3.6%.

There are no significant changes in the topographic conditions of the area from the time of the detailed design to the present, except for the construction of MRT 3, Muñoz Station and the bus stop lanes on both directions.

#### (2) Geotechnical Conditions

The proposed area is located on the north in the center part of the Central Plateau, which is underlain by tuffs and tuffaceous sediments of the Pliocene-Pleistocene or the Holocene.

Tuffs (tuffaceous rock sequence) consist of siltstone (including claystone) and sandstone, belonging to the Guadalupe formation of the Pliocene-Pleistocene. Tuffaceous sediments overlying the tuffs consist of pyroclastic flow deposits and lahar deposits (tuffaceous reworked deposits) of the Pleistocene-Holocene. Pyroclastic flow deposits are mainly composed of gravelly silt and gravelly sand, and lahar deposits are mainly composed of inorganic clay and silt.

The lower tuffaceous rock sequence is stable bearing stratum for the important structures such as bridges, because “N-value is over 50 generally” and “Unconfined compression strength (qu) is 1200-6600 kPa (corresponding to the soft rock)”. But it is difficult that upper tuffaceous sediments are stable bearing stratum for the important structures because pyroclastic flow deposits are changing to laharic deposits which have N-value of less than 10 laterally. Therefore, the bearing stratum in the proposed area is tuffaceous rock sequence that underlie deeper than 1–6m from ground surface.

The depth of bearing stratum and the assumed type of foundations at each borehole are shown in **Table 4.3-1**.

**Table 4.3-1 Depth of Bearing Stratum and Type of Foundations**

| Borehole No. | Depth of Bearing Stratum | Type of Foundations |
|---|---|---|
| **BH - 2** | 2.20m | Spread footing |
| **BH - 3** | 2.00m | Spread footing |
| **BH - 4** | 3.20m | Spread footing |
| **BH - 5** | 1.10m | Spread footing |
| **BH - 6** | 1.00m | Spread footing |
| **BH - 7** | 2.00m | Spread footing |
| **BH - 8** | 6.00m | Pile foundation |

*Source: Detailed design done by KEI and associate consultants Feb 2001*

### (3) Hydrological Conditions

A river, the San Francisco River, crosses the road (EDSA) at 50m Balintawak side from EDSA–Roosevelt Avenue/Congressional Avenue intersection. Its width is 13–15m; depth is 5–6m. San Francisco River is equal to the tributary of the San Juan River and outcrops of the tuffs (sandstone and siltstone) are seen in both sides. The downward erosion of the river is remarkable from the outcrop conditions, which indicate that the riverbed is expected to decline.

From the available data (Figure 7.1.5-1 Flood Potential Area, "The Study of Master Plan on High Standard Highway Network Development in the Republic of the Philippines", Final Report, by CTI and associated firms), it can also be said that flooding will not occur in the project area.

Therefore, there are no specific issues on the hydrological conditions in the proposed area, except in the event of tunnel construction under the river. In addition, existing detailed designs provide only standard drainage system for the flyover and road.

### (4) Design Standards

Major design standards are as follows:

1) Highway Design

| Elements of Design | EDSAthrough ⇨ | Roosevelt– Congressional Avenues |
|---|---|---|
| **Design Speed** | 70km/h | 40km/h |
| **Minimum Radius Curvature** | 200m | 60m |
| **Maximum Vertical Grade** | 6.0% | 6.0% |
| **Minimum Vertical Grade** | 0.35% | 0.35% |
| **Minimum Stopping Sight Distance** | 100m | 45m |
| **Minimum Vertical Clearance** | 5.0m | 5.0m |
| **Lane Width** | 3.35m | 3.35m |
| **Standard Superelevation** | 1.50% | 1.50% |

*Source: Retailed design done by KEI and associate consultants Feb 2001*

2) Hydrology and Hydraulics

✓ Design Frequency Level

- Inlet : 2 years

- Ditches : 5 years
- Pipe Culverts : 10 years
- Box Culverts : 25 years
- Bridges : 50 years or maximum observed flood, whichever is greater

✓ Peak Runoff Rate : Rational Method

✓ Hydra Flow : Manning Formula

3) Structural Design

✓ Clearance to MRT

- MRT Guideway Structure Envelope : 9.0m wide
- MRT Station Structure Envelope : 9.0m wide
- Structure Gap between MRT and Flyover : 15.0cm
- Headroom Clearance above MRT Rail Level to Flyover : 5.6m

✓ Material Properties

- Concretes
  - › Substructure : 28Mpa (20mm)
  - › Bored Pile : 28Mpa (25mm)
  - › PCDG Girders : 34Mpa (20mm)
  - › Column to RC Slab : 28Mpa (20mm)
  - › Column to PC Slab : 34Mpa (20mm)
  - › Coping Beam to RC Slab : 34Mpa (20mm)
  - › Coping Beam to PC Slab : 41Mpa (20mm)
  - › RC Voided Slab : 34Mpa (20mm)
  - › PC Voided Slab : 41Mpa (20mm)
- Reinforcing Steel : Grade 60
- Prestressing Steel : Grade 270 and low relaxation with an ultimate strength Fu = 1,860Mpa
- Structural Steel : Minimum yield strength fy = 248Mpa
- Elastomeric Bearing Pads : 100% virgin chloroprene pads with durometer hardness 60 and laminated with non-corrosive mild steel sheets

✓ Loads and Allowable Stresses

- Reinforced Concrete : 24.5kn/$m^3$
- Asphalt Wearing Course : 22.0kn/$m^3$
- Steel : 77.0kn/$m^3$
- Compacted Earth : 19.0kn/$m^3$
- Live Load : AASHTO MS18 (HS20-44)

- Earth Pressure

| Description | Group I Load | Group VII Load |
|---|---|---|
| **Soil Internal Angle of Friction** | 30 degrees | 15 degrees |
| **Wall to Soil Friction Angle** | 0 degrees | 0 degrees |
| **Active Earth Pressure** | 0.297 | 0.452 |
| **Live Load Surcharge** | 0.6m of soil | none |

- Seismic Load
  - › Seismic Performance Category : D
  - › Soil Profile : Type II
  - › Seismic Acceleration : 0.4
  - › Site Coefficient : 1.2

**(5) Road Alignment and Structural Conditions**

Road alignment and structural conditions are as follows:

**Northbound**

1) The northbound section has three lanes and horizontal alignment is passing thru the right side of MRT 3 with 1,075m radius curve at before intersection. Vertical grade at each side of the approach sections is 5.0%.

2) Total length of the project section is 729m; total length of flyover is 502m.

3) The type, number of spans and span length and type of foundation of the flyover are as follows:

✓ Type of flyover and span configuration:

- 3 span continuous voided RC slab, 2x3@15.00m = 90.00m
- 5 span continuous voided RC slab, 5@15.00m = 75.00m
- 3 span continuous voided PSC slab, 20.00m + 2@22.275m = 66.55m
- 3 span continuous voided PSC slab, 30.00m + 35.00m + 30.00m = 95.00m
- 2 span continuous voided PSC slab, 2@27.50m = 55.00m
- 5 span continuous voided RC slab, 5@15.00m = 75.00m
- 3 span continuous voided RC slab, 3@15.00m = 45.00m

✓ Type of foundation : 1.00m, 2.50m, 3.00m and 4.00m diameter bored piles

**Southbound**

1) The southbound section has three lanes and horizontal alignment is passing thru the left side of MRT 3 with 1,055m radius curve at before intersection. Vertical grade of each side of the approach sections is 5.0%.

2) Total length of the project section is 729.000m; total length of flyover is 500.000m.

3) The type and number of spans of the flyover are as follows:

- ✓ Type of flyover and span configuration:
  - 2x3 span continuous voided RC slab, 2x3@15.00m = 90.00m
  - 5 span continuous voided RC slab, 5@15.00m = 75.00m
  - 3 span continuous voided PSC slab, 3@20.00m = 60.00m
  - 3 span continuous voided PSC slab, 30.00m + 35.00m + 30.00m = 95.00m
  - 2 span continuous voided PSC slab, 2@30.00m = 60.00m
  - 5 span continuous voided RC slab, 5@15.00m = 75.00m
  - 3 span continuous voided RC slab 3@15.00m = 45.00m
- ✓ Type of foundation : 1.00m, 2.50m, 3.00m and 4.00m diameter bored piles

**(6) Environmental and Social Conditions**

The ECC for EDSA/North Avenue-West Avenue and EDSA/Roosevelt/Congressional Interchanges Project had been issued by DENR-EMB in January 2002. The conditions imposed on the issued ECC by the DENR-EMB did not include any specific requirements. Although the ECC was thought to be applied with the Environmental Impact Statement (EIS), the JICA Study Team could not obtain the EIS and RAP documents so that these can be reviewed.

According to Right-of-Way and Utility Maps (2001), the number of lots affected along EDSA is 5 whereas in Roosevelt Avenue and Congressional Avenue are 4 and 4, respectively. The affected area is approximately 1,769 sq. m.

1) Environmental conditions

Environmental conditions including socio-economic environment will be reviewed when the EIS is obtained.

2) Social conditions

According to LAPRAP (2005), the Project Affected Persons (PAPs) on this interchange project are summarized as follows:
The PAPs and socio-economic conditions of project affected areas will be reviewed when RAP report is obtained. According to Right-of-Way and Utility Maps (2001), the number of lots affected along EDSA is 5, whereas in Roosevelt Avenue and Congressional Avenue these are 4 and 4, respectively. The affected area is approximately 1,769 sq. m.

**(7) Identified Problems and Recommendation**

**<u>Identified Problems</u>**

No problems were identified in the completed plans and detailed design of this interchange, but total re-planning and redesign will be required specially for the vertical and horizontal clearance due to the constructed MRT 3 and Muñoz Station as well as the Pedestrian Bridges at the intersection.

**Recommendations**

A careful study of the vertical and horizontal clearances against the constructed Muñoz Station and MRT 3 should be made.

### 4.3.2 Preliminary Design of Interchange

#### (1) Comparative Study

Based on the review of detailed design, updated site and traffic conditions, comparative study will be implemented with careful attention to the following three (3) subjects:

- Vertical clearance under Muñoz station and pedestrian bridges.
- Pier column of LRT-1 which are located within the intersection.
- Bus stops which are located along side of EDSA Munoz station.

North and south bound of the flyover are to be constructed individually due to existing LRT-1 located along the median of EDSA.

The following three (3) alternatives are proposed as the most suitable schemes for comparison based on the site conditions such as topographic and geological conditions, traffic conditions, roadside business and structural conditions with required span length;

- Scheme-1 : Flyover (maintain vertical clearance of all pedestrian bridges) 422m long and 3 lanes per direction. Superstructure is PC voided slab
- Scheme-2 : Flyover (No pedestrian bridge near Munoz station) 366m long and 3 lanes per direction. Superstructure is PC voided slab
- Scheme-3 : Flyover (maintain all pedestrian bridge and improve at grade intersection) 719m(NB) and 880m(SB) long and 3 lanes per direction. Superstructure is steel box girder and PC voided slab

Among the three (3) alternatives, scheme-2 was selected due to following reasons;

- Cheapest construction cost
- Shorter construction duration
- Superior vertical grade

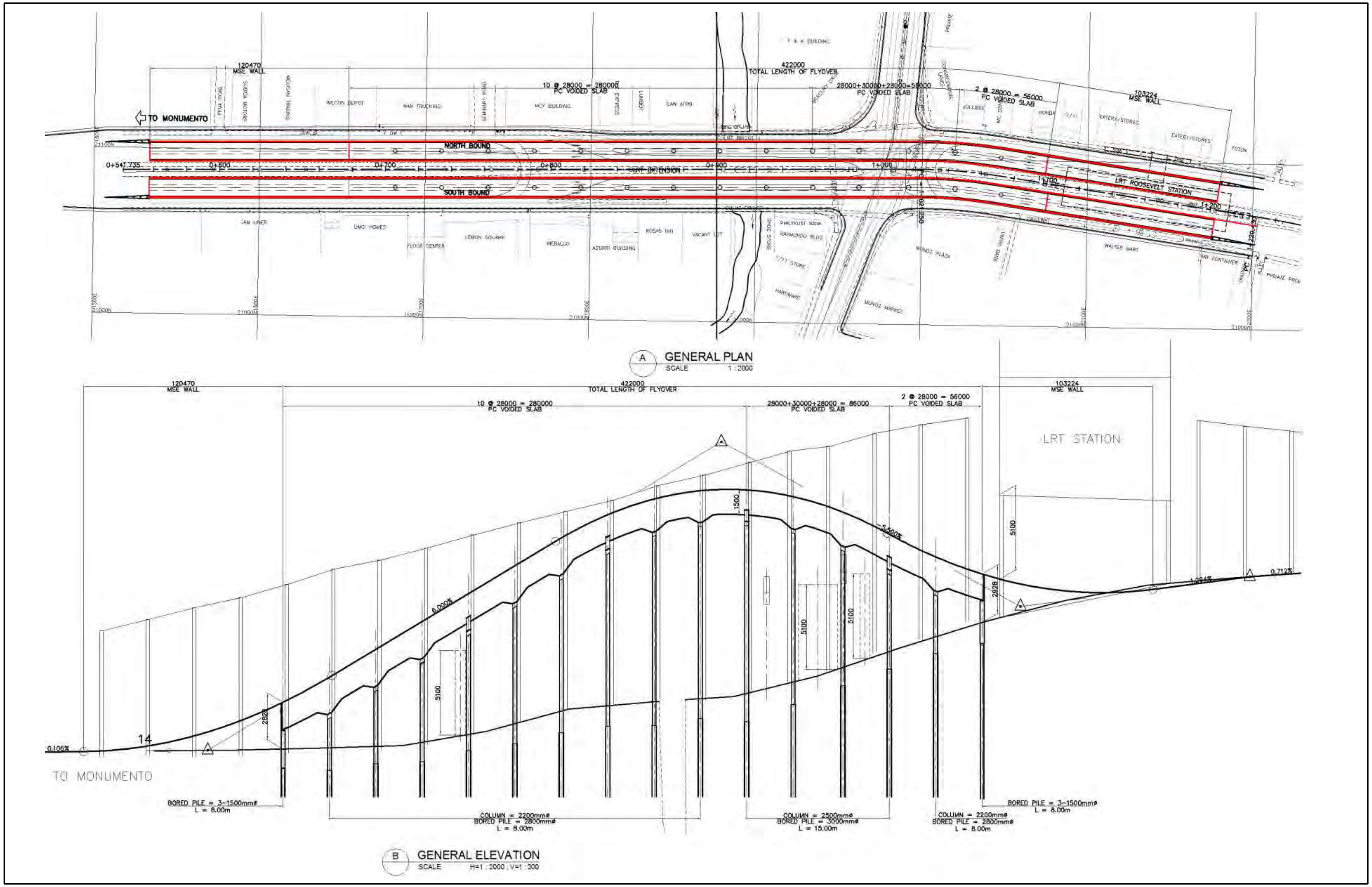
Not regular traffic flow alignment at the intersection due to pier of LRT-1 was located within intersection but still manageable by 4-phase signalization. (note: this issue is common to the other schemes) The detailed scheme comparison is shown in **Table 4.3-2** and the Plan and Profile of each of the schemes are shown in **Figures 4.3-1~ 6**.

## Table 4.3-2 Scheme Comparison Table of EDSA/Roosevelt/Congressional Interchange

| Schemes | SCHEME-1 FLYOVER<br>(Maintain all Pedestrian Bridges) | | SHEME - 2 FLYOVER<br>(No Pedestrian Bridge near Muñoz Station) | | SHEME - 3 FLYOVER<br>(Maintain all Pedestrian Bridges and Improve At-grade Intersection) | |
|---|---|---|---|---|---|---|
| **Structure** | 3-Lane Flyover : 14@28.0m+30.0m=422.0m (PC Voided Slab)<br>Approach Road : 223.7m<br>4-Pedestrian Bridges : 150m<br>Same structures between South and North bound | | 3-Lane Flyover : 12@28.0m+30m=366.0m (PC Voided Slab)<br>Approach Road : 207.5m<br>3-Pedestrian Bridges : 95m<br>Same structures between South and North bound | | 3-Lane Flyover : 18@28.0m+2@40m+3@45m=719.0m (N.B)<br>24@27.9m+5@42.2m=880.5 (S.B)<br>Approach Road : 291.5m(NB) +261.0m(SB)=552.5m<br>4-Pedestrian Bridges : 150m | |
| **Construction Cost** | Flyover MP 633.6 (P1,500,000/ m /6 Lane)<br>Approach MP 53.7 (P240,000/ m /6 Lane)<br>Pedestrian Bridge MP 15.0 (P100,000/ m )<br>Others MP 25.0<br>Total MP 727.3 (115.4%) | ○ | Flyover MP 549.0 (P1,500,000/ m/6 Lane)<br>Approach MP 49.8 (P240,000/ m/6 Lane)<br>Pedestrian Bridge MP 9.5 (P100,000/ m )<br>Others MP 21.7<br>Total MP 630.0 (100.0%) | ◎ | Flyover MP 1.439.6 (P900,000/ m/3 Lane)<br>Approach MP 66.3 (P120,000/ m/3 Lane)<br>Pedestrian Bridge MP 15.0 (P100,000/ m )<br>Others MP 54.0<br>Total MP 1,574.9 (250.0%) | △ |
| **Construction Performance and Duration** | 23 Months<br>○ Construction method and procedure is standard<br>● Requires demolition and reconstruction of 4 existing pedestrian bridges | ○ | 22 Months<br>○ Construction method and procedure is standard<br>○ Requires demolition of 4 existing pedestrian bridges but reconstructionis only 3 Pedestrian Bridges.<br>(Can't construct one bridge at near side of Muñoz Station, due to lower vertical grade) | ◎ | 30 Months<br>○ Construction method and procedure is standard<br>● Requires demolition and reconstruction of 4 existing pedestrian bridges<br>● Too closer construction activities to existing Muñoz Station | △ |
| **Environmental and Social Condition** | ○ No additional R.O.W<br>● Lower volume of exhaust fumes than Scheme-3 | ○ | ○ No additional R.O.W<br>○ Low volume of exhaust fumes and noise due to lowest vertical grade | ◎ | ○ No additional R.O.W<br>● Very high volume of exhaust fumes and noise due to longer vertical grade | △ |
| **Traffic Condition at Grade I/C** | ○ No regular traffic flow alignment at the at-grade I/C due to pier of Line 1 was located within I/C but still manageable by 4 phase-signalization | ○ | ○ No regular traffic flow alignment at the at-grade I/C due to pier of Line 1 was located within I/C but still manageable by 4 phase- signalization<br>● Long route for pedestrian over EDSA given us no construction of pedestrianbridge at near side of Muñoz Station but pedestrian can utilize Muñoz Station | △ | ○ Better traffic flow alignment at grade movement compare to other 2 schemes | ◎ |
| **Over all Evaluation** | ● Expensive than Scheme -2<br>○ Reconstruction of 4 Pedestrian Bridges<br>● Higher volume of exhaust fumes and noisier than Scheme - 2 due to higher vertical grade | ○ | ○ Cheapest among the schemes<br>○ Shorter construction duration<br>○ Reconstruct 3-pedestrian bridges but no construction of pedestrian bridge at near side of Muñoz Station<br>○ Lower vertical grade among the schemes | ◎ | ● Most expensive among the schemes<br>○ Reconstruct of 4 pedestrian bridges<br>● Heavily affects traffic during construction of high pier and construction activities are too closer to existing Muñoz Sta.<br>● Longer Construction duration | △ |

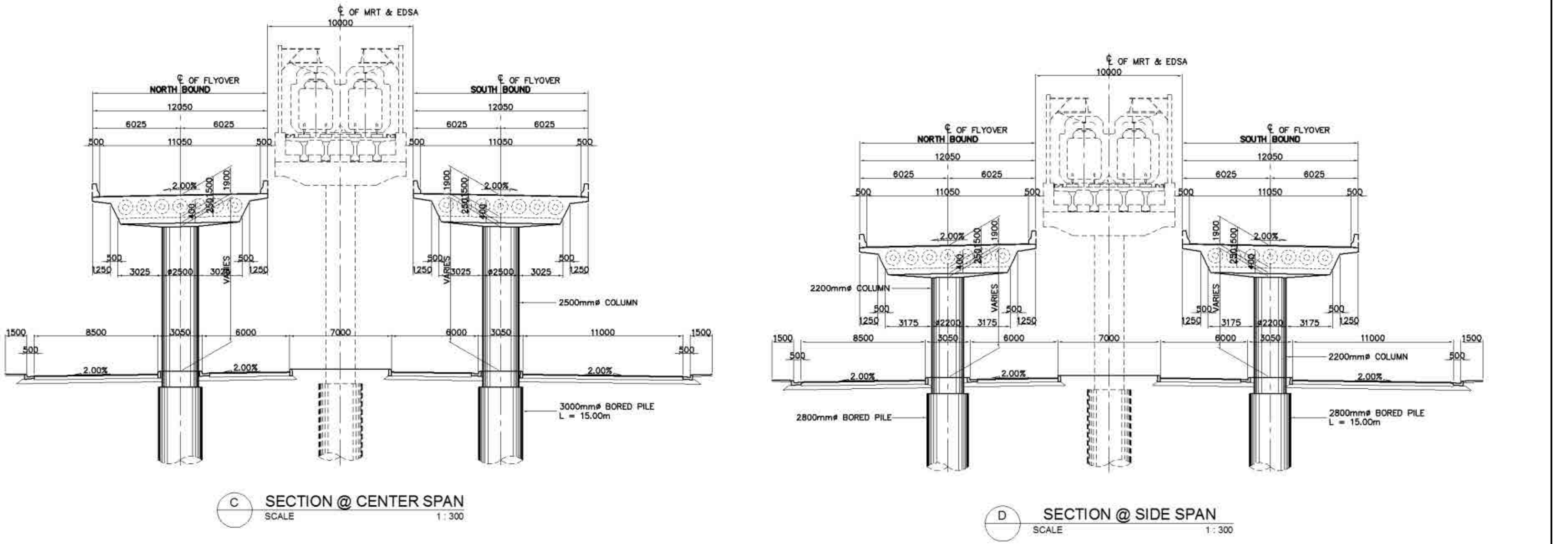
**LEGEND :** ○ **advantage**
● **disadvantage**

*Source: JICA Study Team*



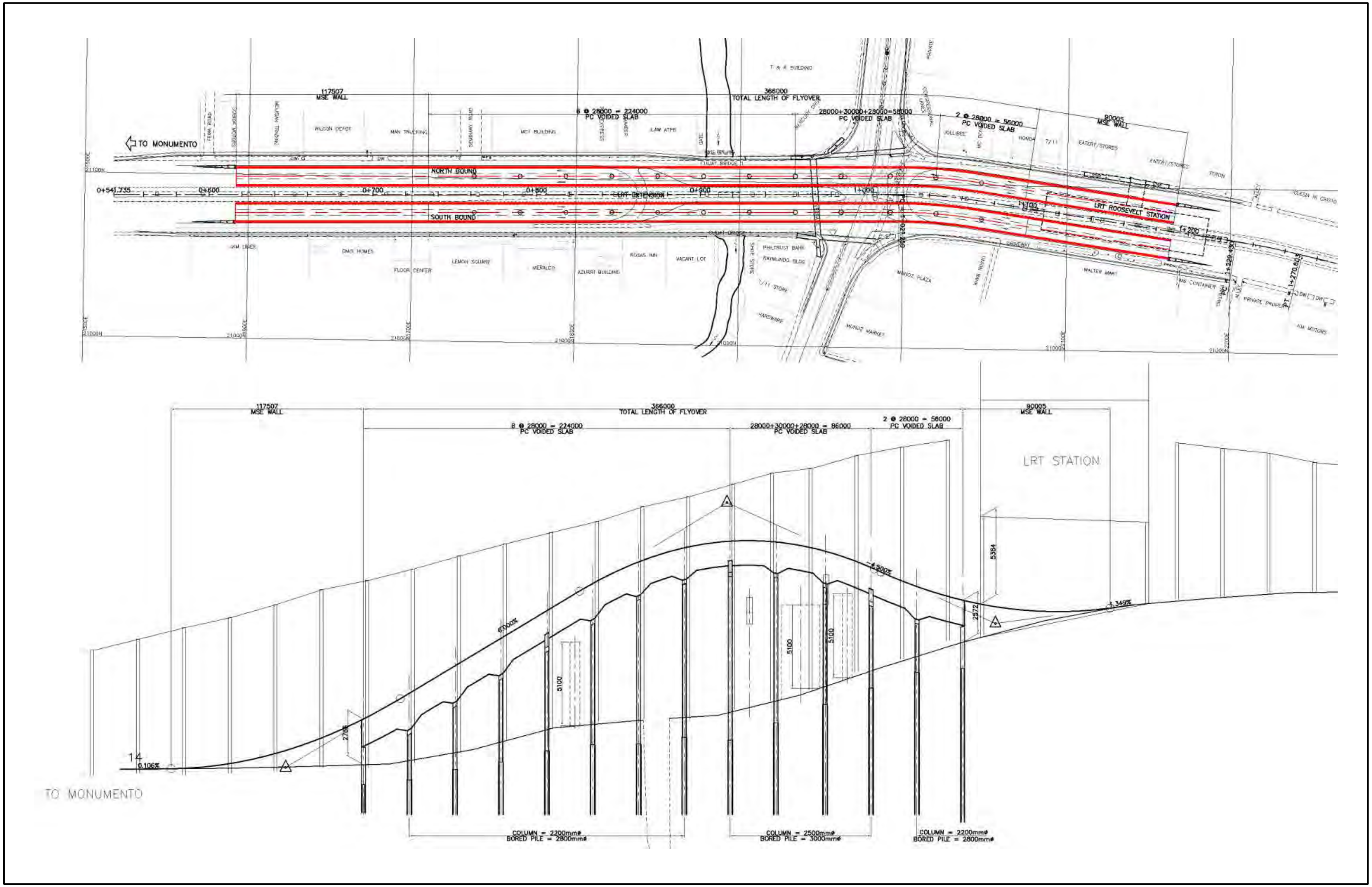

*Source: JICA Study Team*

**Figure 4.3-1 Plan and Profile of Scheme-1 (EDSA/Roosevelt/Congressional Interchange) (1/2)**



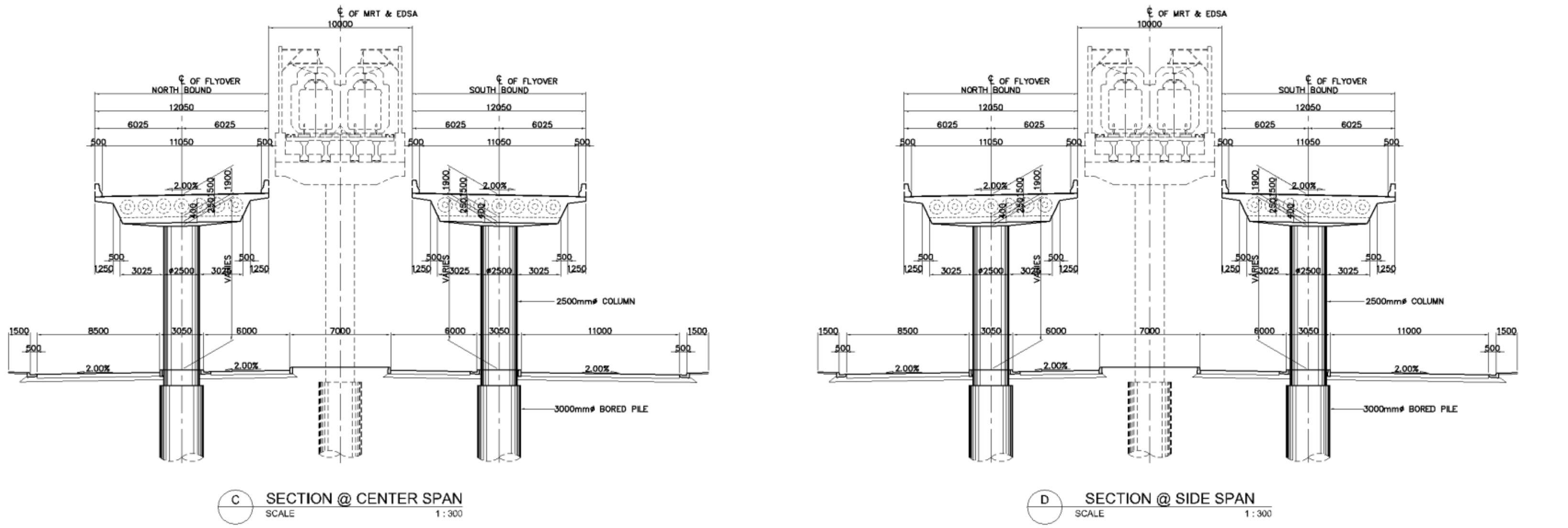

*Source: JICA Study Team*

**Figure 4.3-2 Plan and Profile of Scheme -1 (EDSA/Roosevelt/Congressional Interchange) (2/2)**



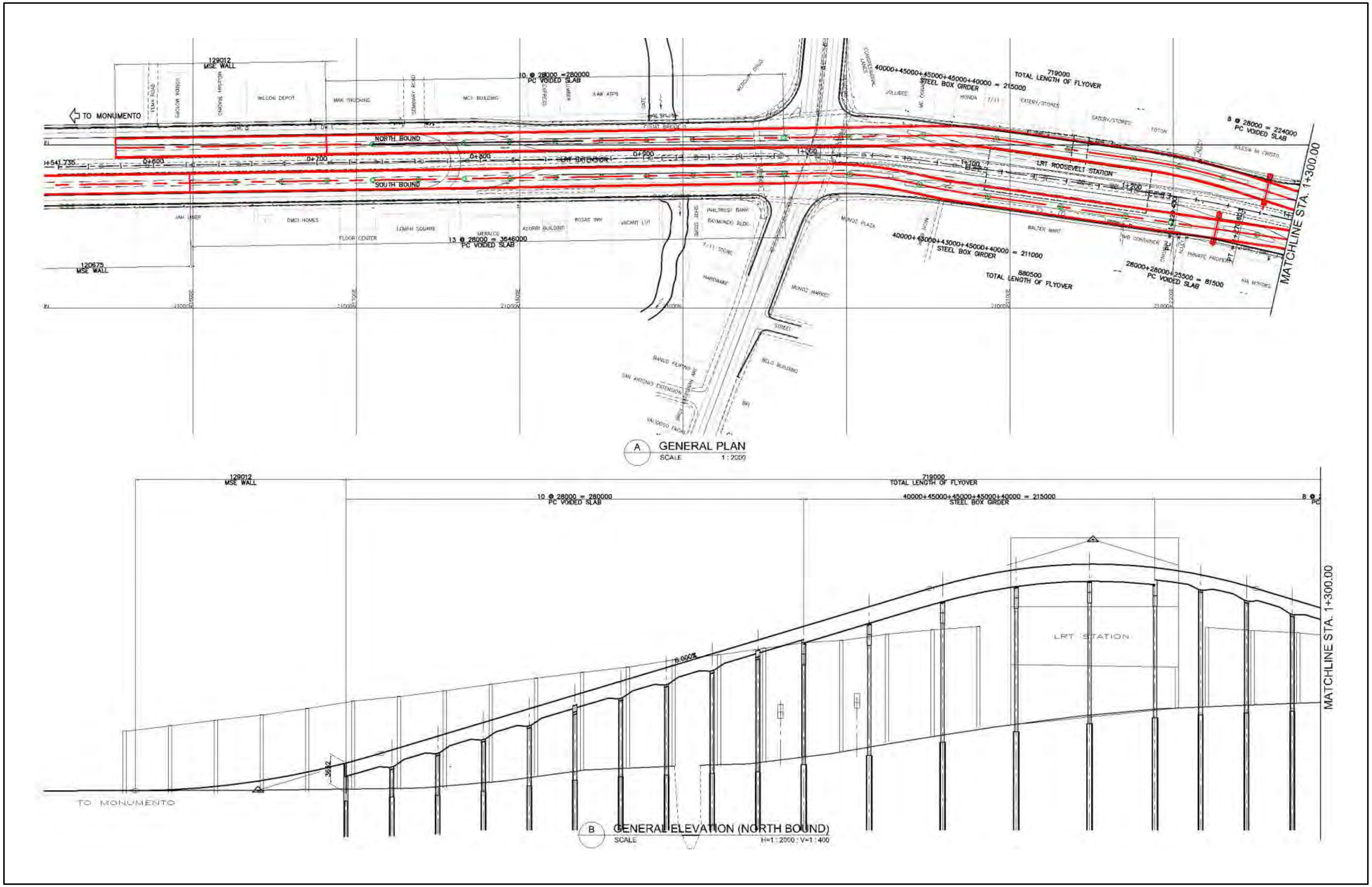

Source: JICA Study Team

**Figure 4.3-3 Plan and Profile of Scheme -2 (EDSA/Roosevelt/Congressional Interchange) (1/2)**



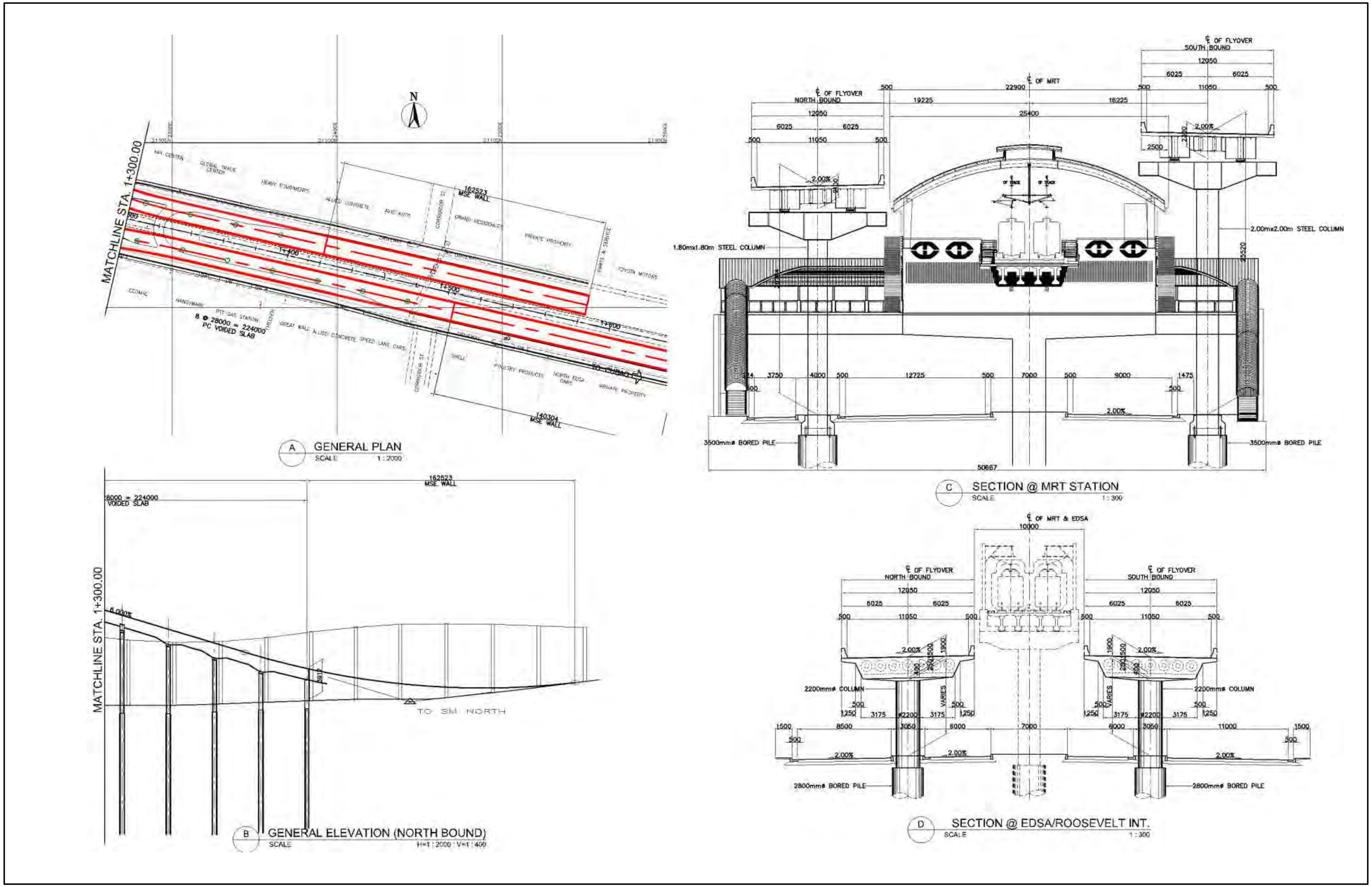

*Source: JICA Study Team*

**Figure 4.3-4 Plan and Profile of Scheme -2 (EDSA/Roosevelt/Congressional Interchange) (2/2)**




*Source: JICA Study Team*

**Figure 4.3-5 Plan and Profile of Scheme -3 (EDSA/Roosevelt/Congressional Interchange) (1/2)**




Source: JICA Study Team

**Figure 4.3-6 Plan and Profile of Scheme -3 (EDSA/Roosevelt/Congressional Interchange) (2/2)**

**(2) Preliminary Design of Selected Scheme**

Scheme-2, PC voided slab type flyover with no construction of a pedestrian bridge near Muñoz station was selected in the comparative study. The concepts of the preliminary design of the selected scheme are as follows;

1) Voided slab type should be adopted for superstructure to consider aesthetic view of the flyover.

2) One (1) column type pier foundation should be adopted to maximize the usability and usage of the area underneath the flyover.

3) MSE wall should be adopted as retaining wall at both side of approach sections to minimize the effects to traffic during construction as well as provide aesthetic view.

4) Three (3) directions of pedestrian bridges (except one bridge near Munoz station) should be reconstructed.

5) To provide four (4) phases signalization plan at grade intersection.

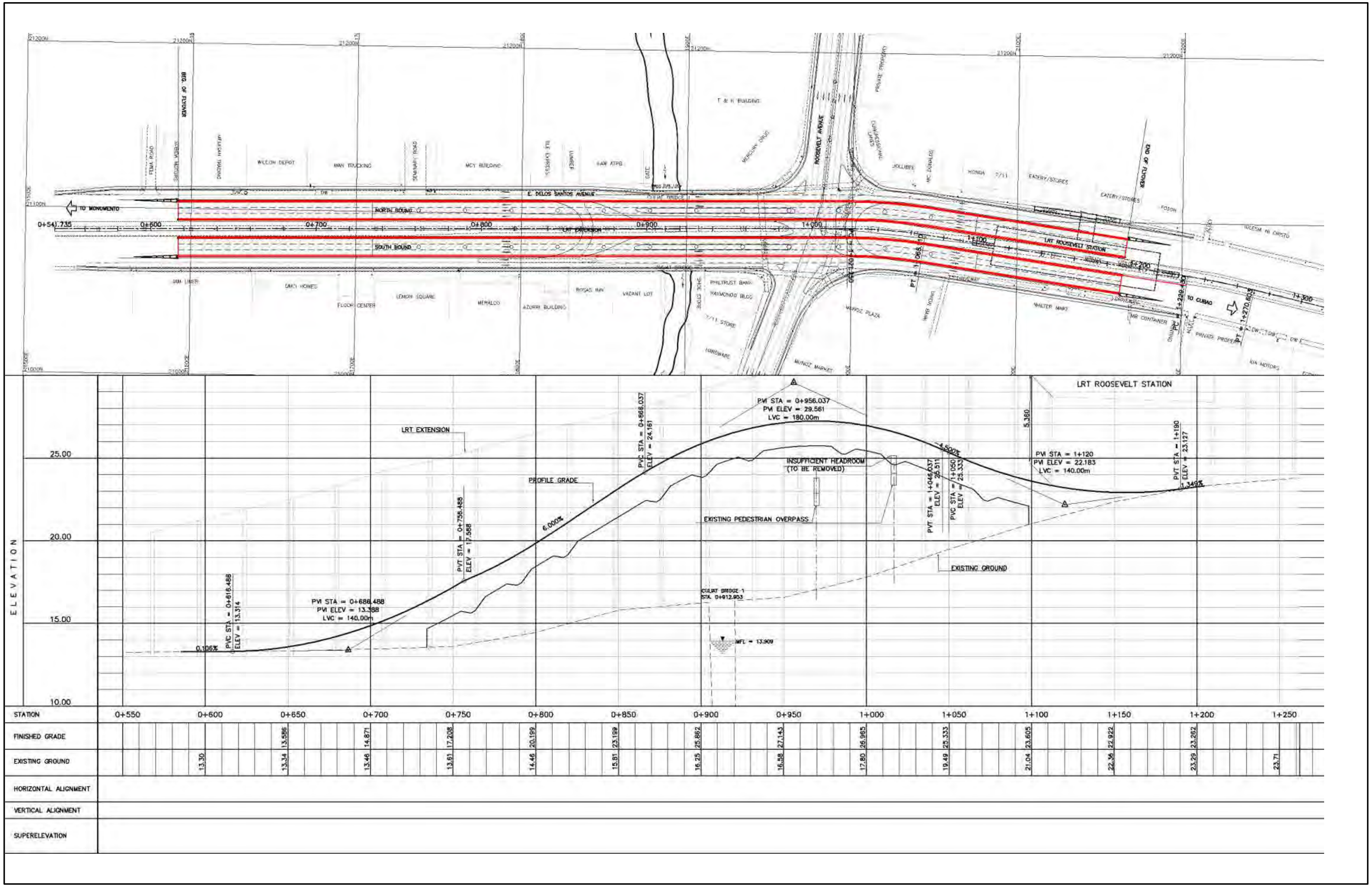
6) All of the at-grade plan and design should be done within the RROW.

Preliminary design was carried out based on the above basic concepts. Plan and profile, at grade intersection plan, typical cross sections, slab layout plan and structural general view of bridge are shown in **Figures 4.3-7 ~ 11.**

**(3) Construction Plan and Traffic Management during Construction**

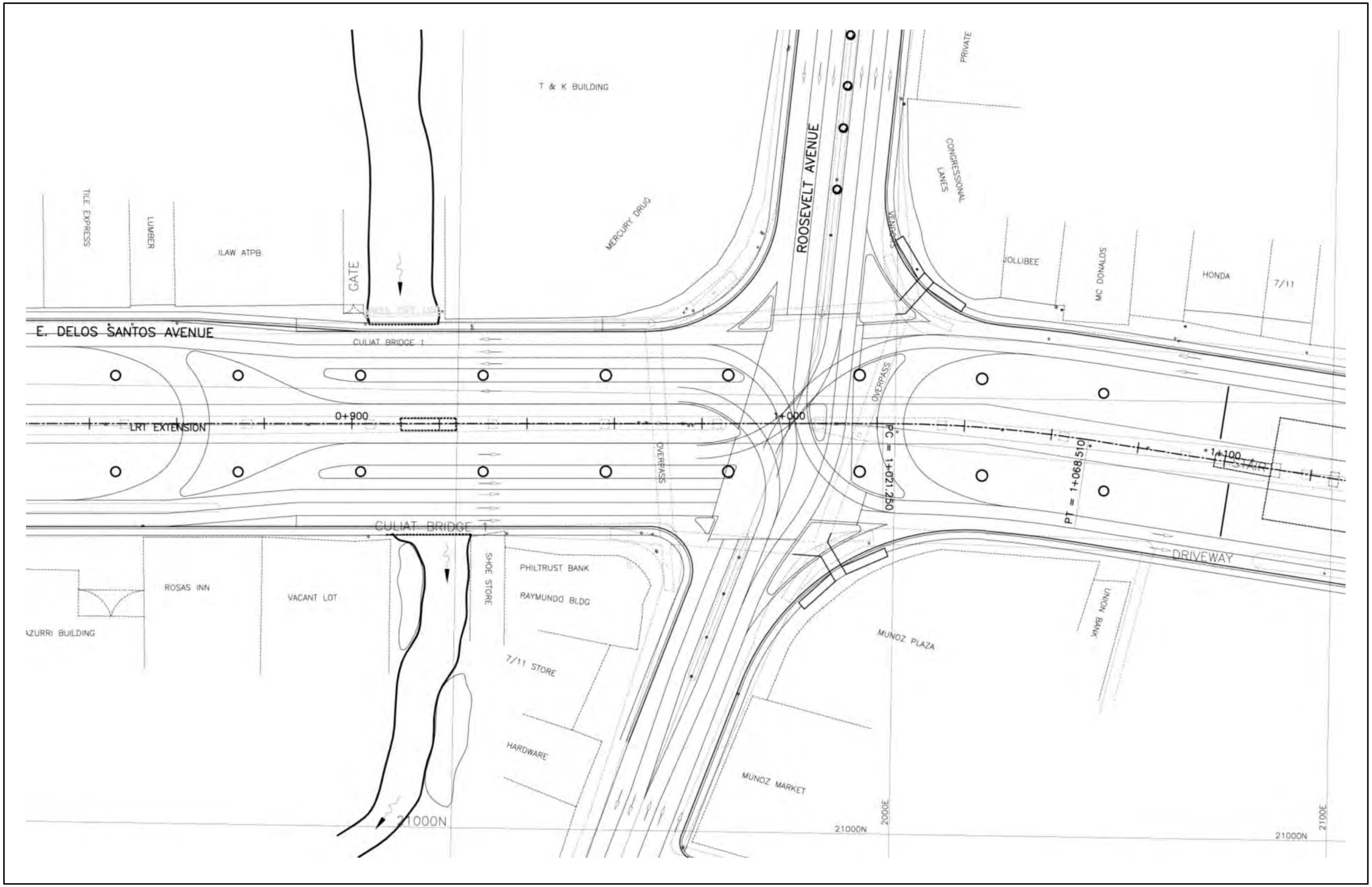
1) The Construction Plan and PART CPM for EDSA/Roosevelt/Congressional interchange has been evaluated and these are presented in the **Figure 4.3-12** and **Figure 4.3-13**.

2) The Traffic Management plan during construction for EDSA/Roosevelt/Congressional interchange has been studied and is shown in **Figure 4.3-14**



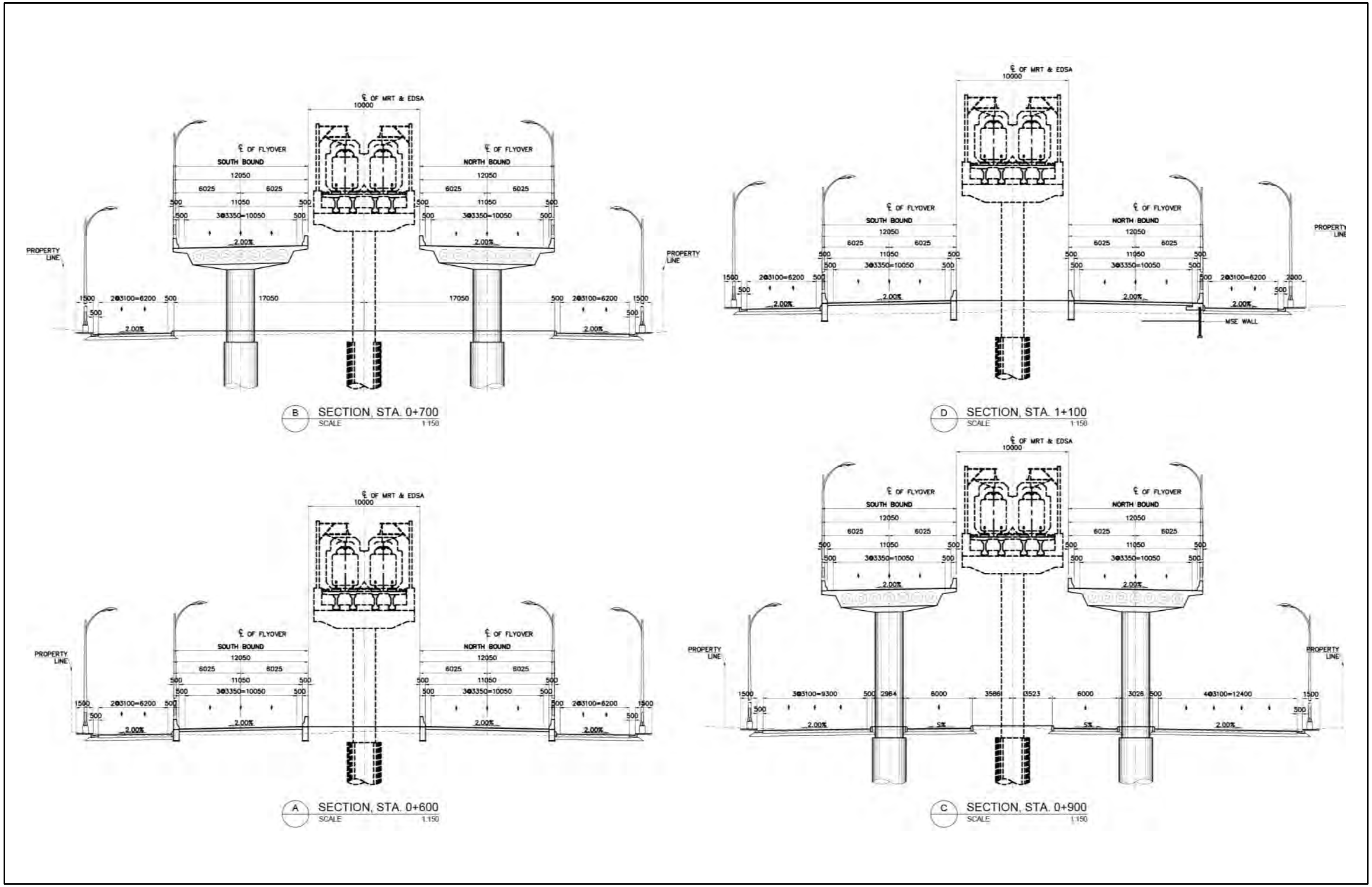

Source: JICA Study Team

**Figure 4.3-7 Plan and Profile (EDSA/Roosevelt/Congressional Interchange)**



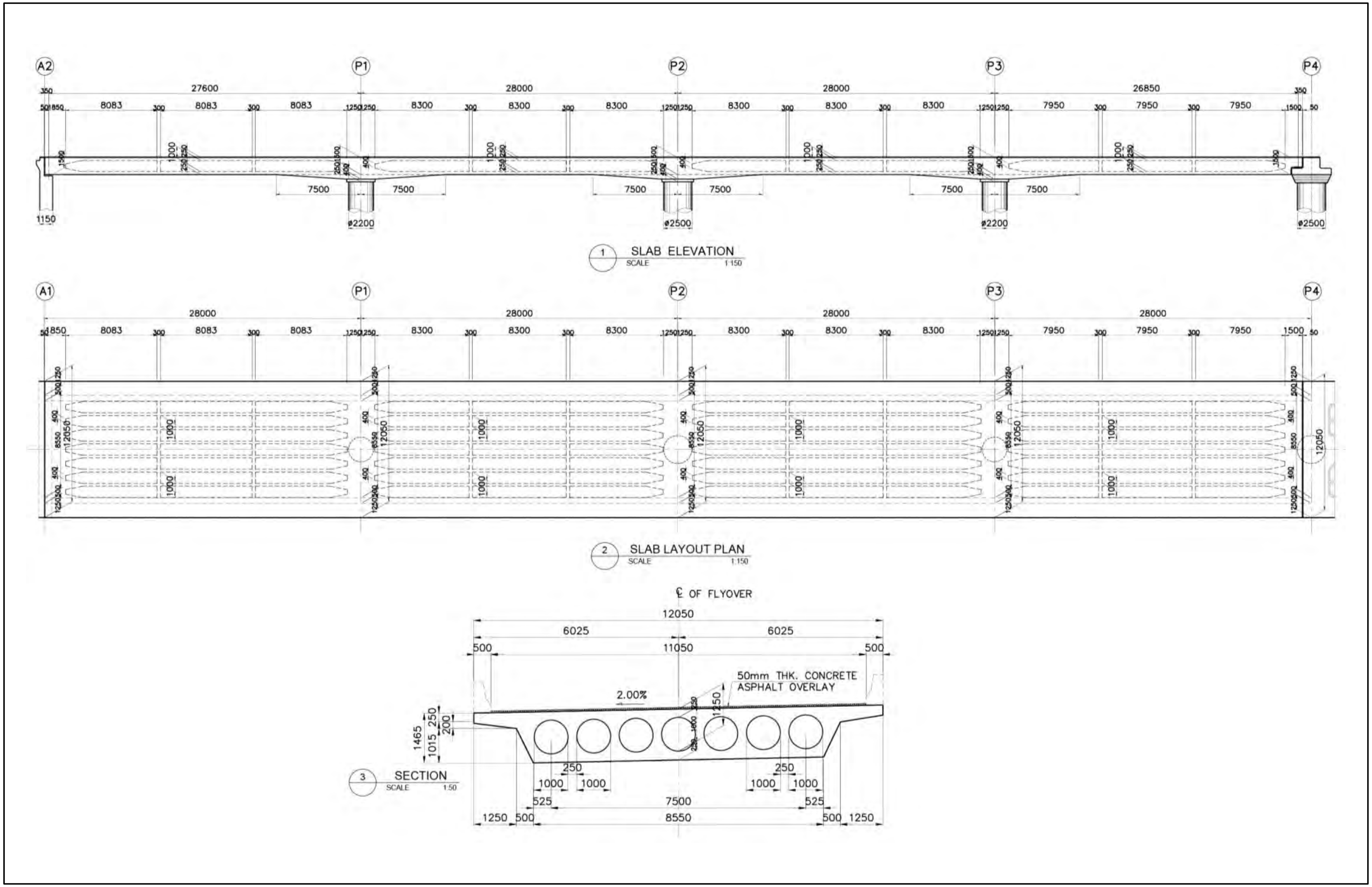

Source: JICA Study Team

**Figure 4.3-8 AT-Grade Intersection Plan (EDSA/Roosevelt/Congressional Interchange)**



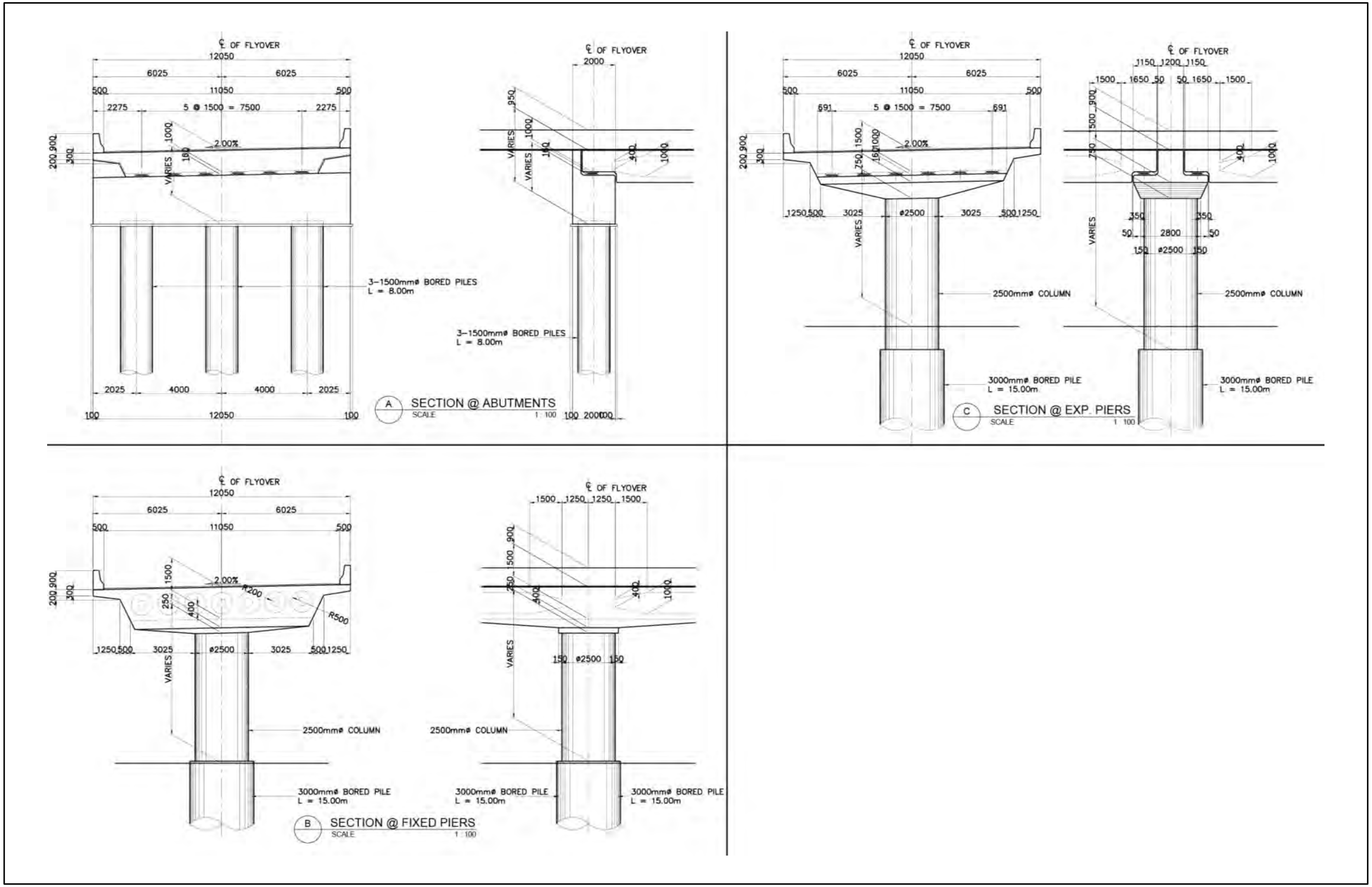

Source: JICA Study Team

**Figure 4.3-9 Typical Cross Section (EDSA/Roosevelt/Congressional Interchange)**



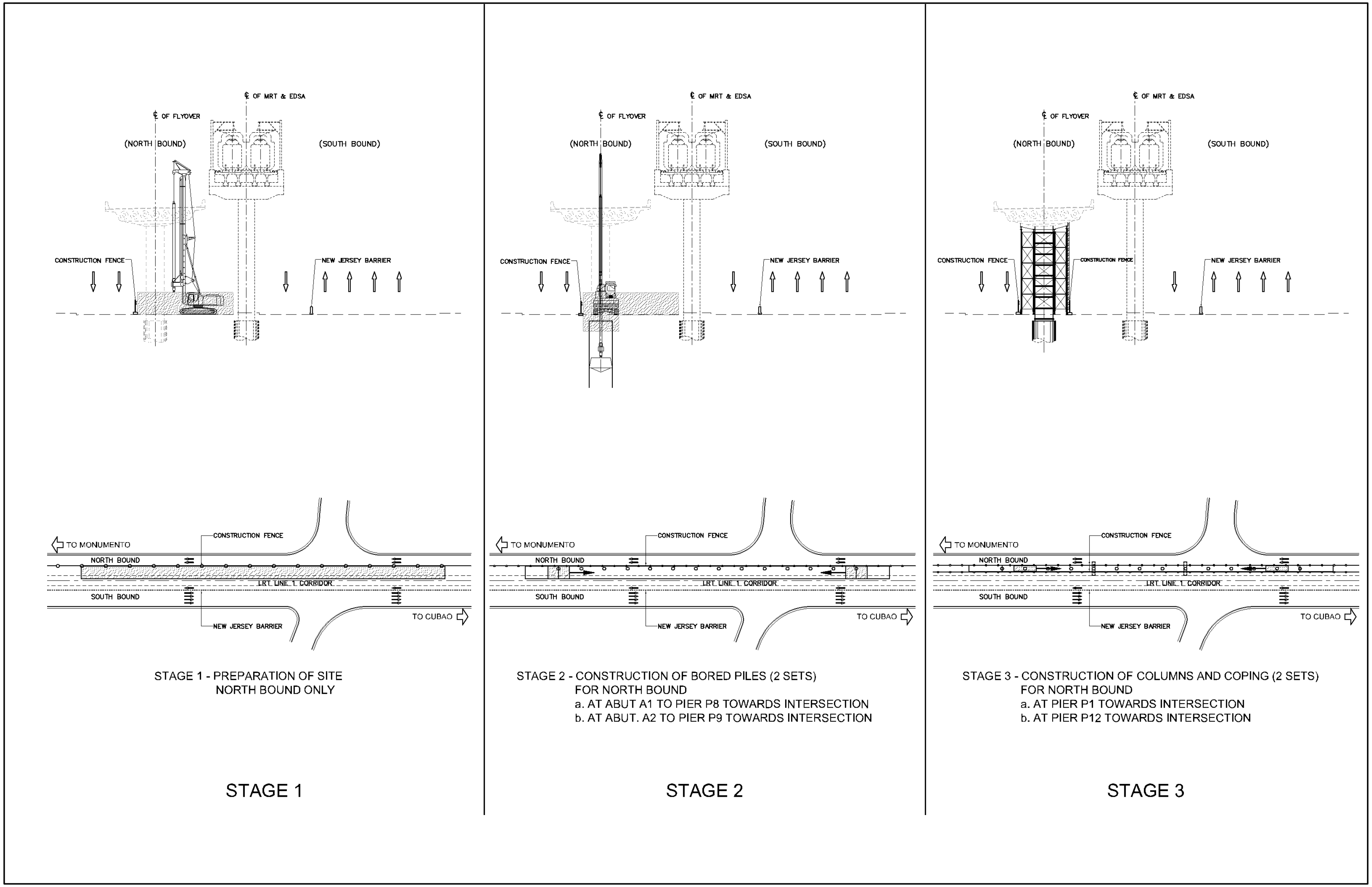

Source: JICA Study Team

**Figure 4.3-10 Slab Layout Plan (EDSA/Roosevelt/Congressional Interchange)**



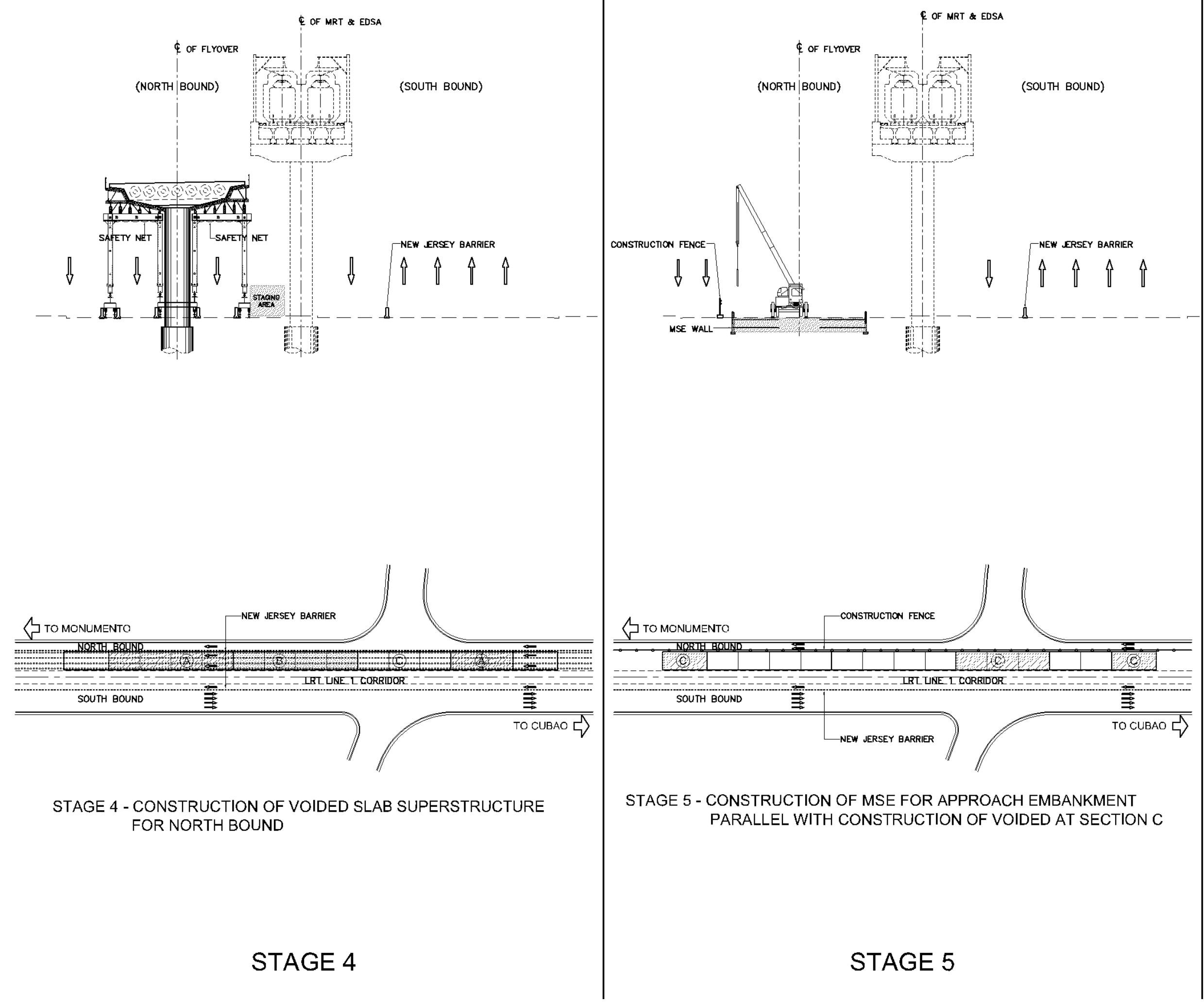

Source: JICA Study Team

**Figure 4.3-11 Structural General View (EDSA/Roosevelt/Congressional Interchange)**




Source: JICA Study Team

**Figure 4.3-12 Construction Plan for EDSA/Roosevelt/Congressional Interchange (1/2)**




CONSTRUCTION SEQUENCE

A. PREPARATION OF SITE

B. CONTRUCTION OF BORED PILES (2 SETS)
- a. AT ABUT. A1 TOWARDS INTERSECTION
- b. AT ABUT. A2 TOWARDS INTERSECTION

C. CONSTRUCTION OF COLUMNS
- a. AT ABUT. A1 TOWARDS INTERSECTION
- b. AT ABUT. A2 TOWARDS INTERSECTION

D. CONSTRUCTION OF COPING
- a.AT ABUT. A1 TOWARDS INTERSECTION
- b.AT ABUT. A2 TOWARDS INTERSECTION

E. CONSTRUCTION OF SUPERSTRUCTURE ( VOIDED SLAB )

F. CONSTRUCT MSE WALL

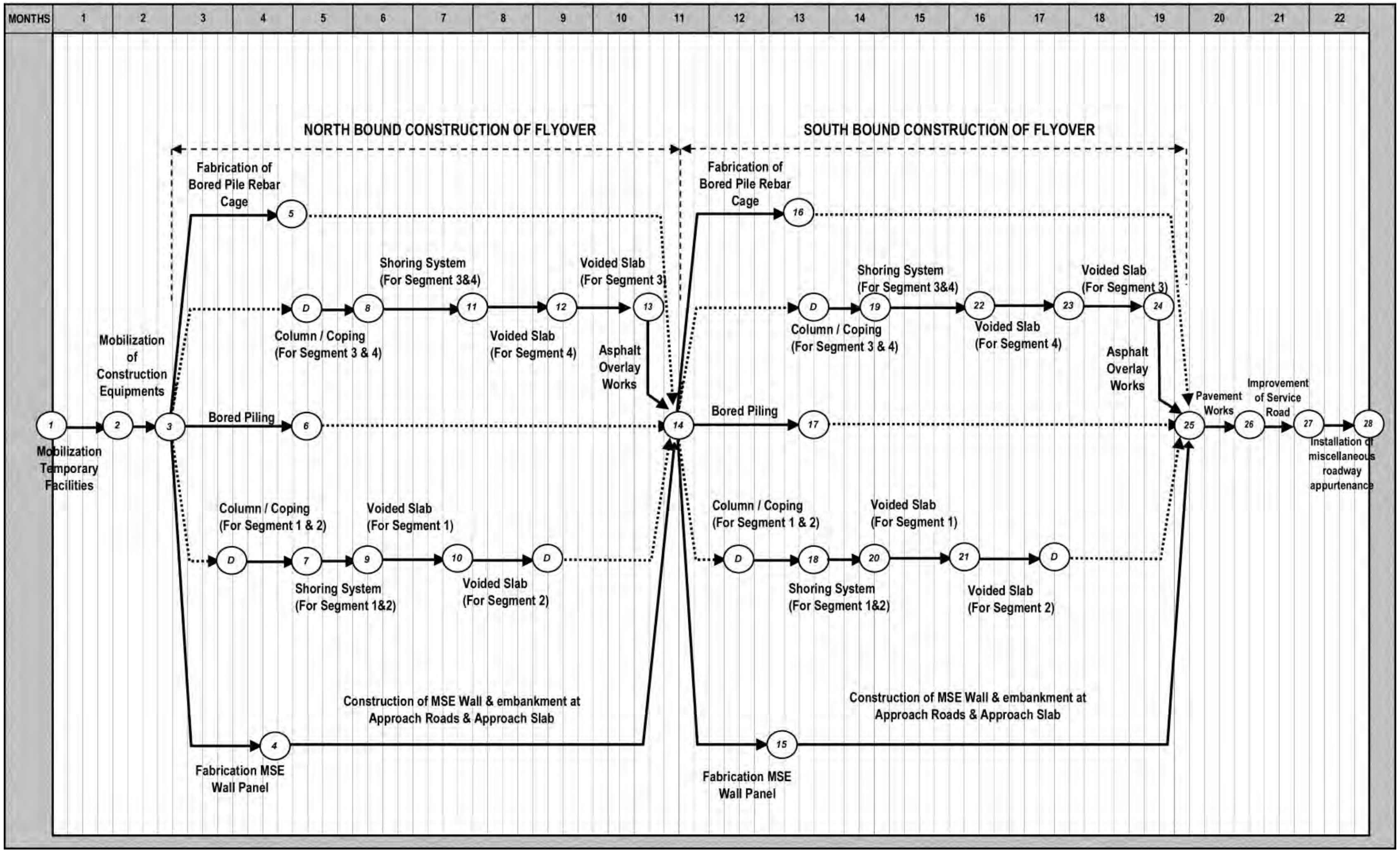
NOTE :

THE SEQUENCE OF CONSTRUCTION FOR SOUTH BOUND SHALL BE THE SAME AS AND WILL FOLLOW AFTER NORTH BOUND CONSTRUCTION.

*Source: JICA Study Team*

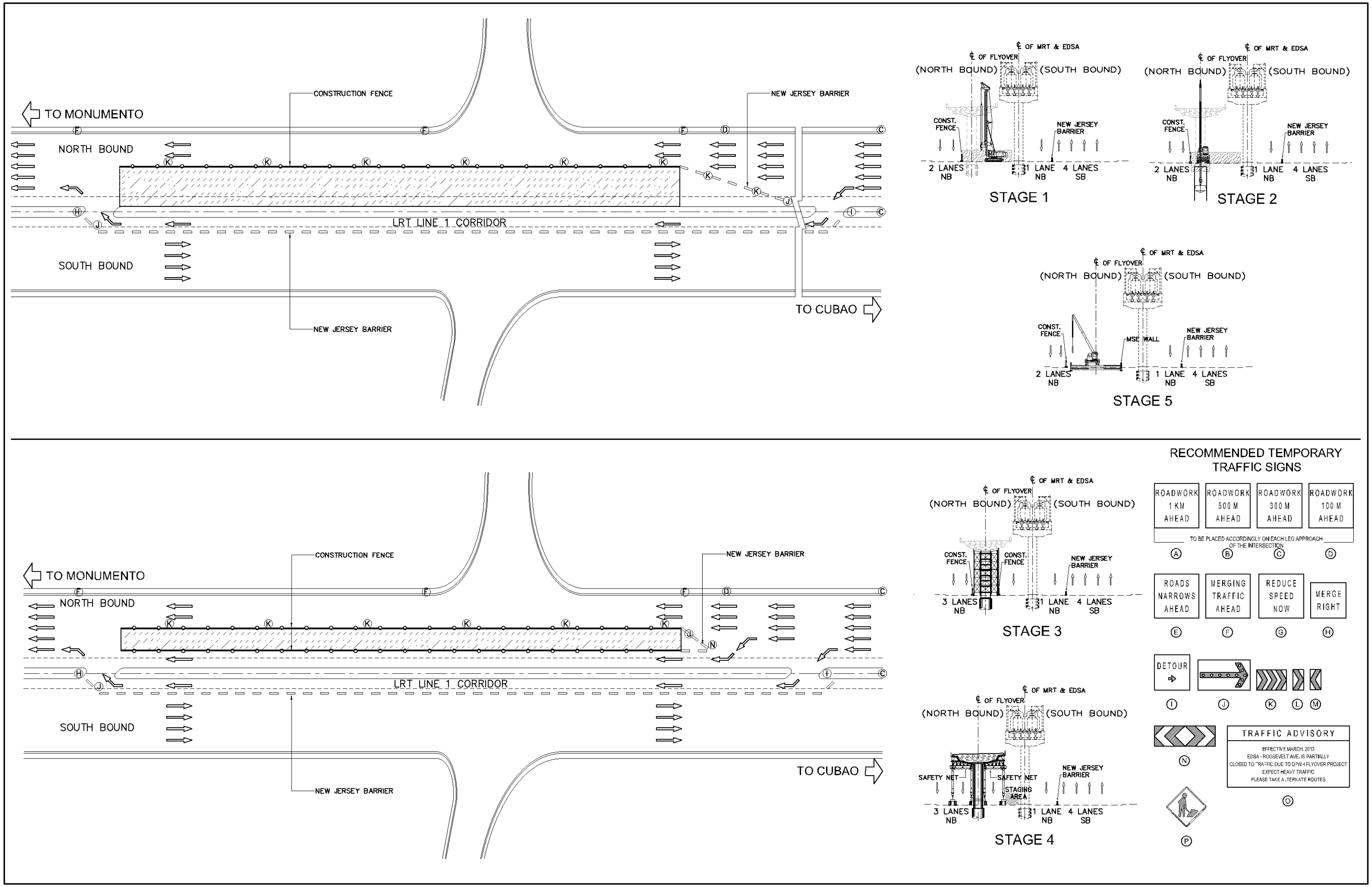
**Figure 4.3-13 Construction Plan for EDSA/Roosevelt/Congressional Interchange (2/2)**

**PREPARATORY SURVEY ON METRO MANILA INTERCHANGE CONSTRUCTION PROJECT PHASE VI**
**C4 / ROOSEVELT AVE. QUEZON CITY**
**PRELIMINARY CONSTRUCTION SCHEDULE(PERT/CPM)**



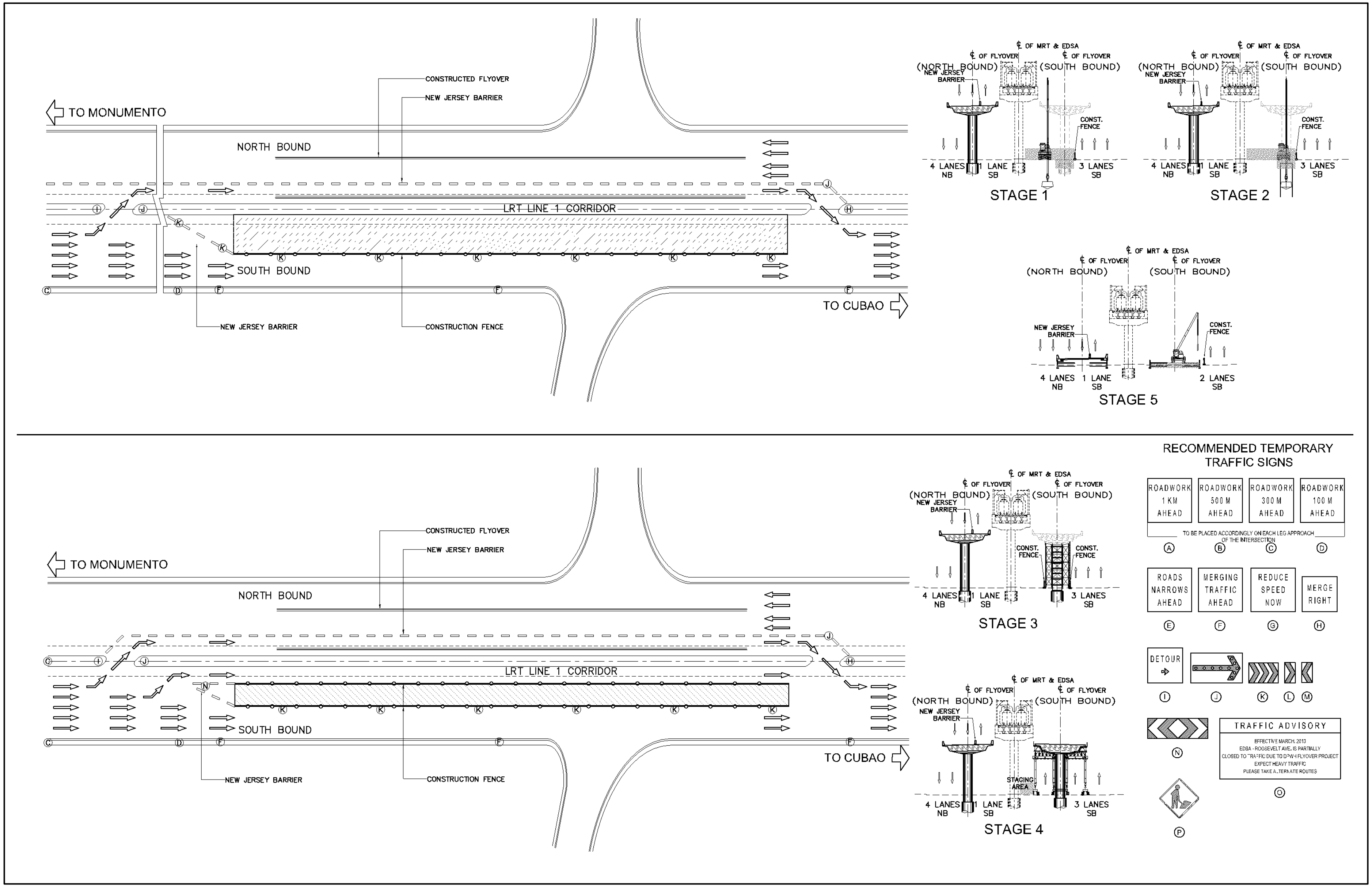

Source: JICA Study Team

**Figure 4.3-14 Pert CPM for EDSA/E. Roosevelt/Congressional Interchange**




Source: JICA Study Team

**Figure 4.3-15 Traffic Management for EDSA/Roosevelt/Congressional Interchange North Bound (1/2)**




Source: JICA Study Team

**Figure 4.3-16 Traffic Management for EDSA/Roosevelt/Congressional Interchange South Bound (2/2)**

### (4) Bill of Quantity and Cost Estimate

Civil Works Cost for EDSA/Roosevelt/Congressional IC has been estimated based on same condition of C-3/E. Rodriguez IC and its result is shown in **Table 4.3-3**

**Table 4.3-3 Civil Works Cost Estimate for EDSA/Roosevelt/ Congressional IC**

Unit: Php

| PAY ITEM NO. | DESCRIPTION | QUANTITY | UNIT | Unit Cost | Civil Work Cost | Remarks |
|---|---|---|---|---|---|---|
| 1.0 | GENERAL REQUIREMENTS | | | | | |
| A | FACILITIES FOR THE ENGINEER | 1.00 | l.s. | 10,000,000.00 | 10,000,000.00 | |
| | SUB-TOTAL (PART A) | | | | 10,000,000.00 | |
| B | OTHER GENERAL REQUIREMENTS | | | | | |
| SPL B.2.1 | Construction Health and Safety | 1.00 | P.s | 2,400,000.00 | 2,400,000.00 | |
| SPL B.2.2 | Mobilization / Demobilization (1.0% of Civil Works) | 1.00 | P.s | 5,602,420.48 | 5,602,420.48 | |
| SPL B.2-3 | Traffic Management During Construction | 1.00 | P.s | 5,000,000.00 | 5,000,000.00 | |
| SPL B.2-4 | Dayworks | 1.00 | P.s | 5,000,000.00 | 5,000,000.00 | |
| SPL B.2-5 | Removal, Relocation of Utilities | 1.00 | P.s | 10,000,000.00 | 10,000,000.00 | |
| SPL B.3.1 | Environmental Monitoring Action Plan | 1.00 | P.s | 2,000,000.00 | 2,000,000.00 | |
| | SUB-TOTAL (PART B) | | | | 30,002,420.48 | |
| | SUB-TOTAL GENERAL REQUIREMENTS | | | | 40,002,420.48 | |
| 2.0 | INTERCHANGE CONSTRUCTION WITH VIADUCT | | | | | |
| C | EARTHWORKS | | | | | |
| 100(1) | Clearing and Grubbing | - | ha. | 90,846.53 | - | |
| 100(3) | Individual Removal Trees (Small) | - | ea. | 1,013.26 | - | |
| 100(4) | Individual Removal Trees (Large) | - | ea. | 1,427.27 | - | |
| 100(5) | Removal and Earth Balling of Trees | - | ea. | 1,000.00 | - | |
| 101(1) | Removal of Structures and Obstruction | 1.00 | l.s. | 500,000.00 | 500,000.00 | |
| 101(3)a | Removal of Existing PCCP | 1,605.68 | sq.m. | 245.78 | 394,644.03 | |
| 101(3)b | Breaking of Existing PCCP | 11,971.40 | sq.m. | 335.00 | 4,010,419.00 | |
| 101(4)a | Removal of Existing Concrete Curb | 1,030.00 | l.m. | 60.00 | 61,800.00 | |
| 101(4)b | Removal of Existing Concrete Curb & Gutter | - | l.m. | 110.00 | - | |
| 101(4)c | Removal of Existing Sidewalk | - | sq.m. | 120.00 | - | |
| 101(4)d | Removal of Existing RCPC | - | l.m. | 200.00 | - | |
| 101(4)e | Removal of Existing Covered canal | - | l.m. | 150.00 | - | |
| 105(1) | Subgrade Preparation | - | sq.m. | 37.18 | - | |
| | SUB-TOTAL (PART C) | | | | 4,966,863.03 | |
| D | SUBBASE AND BASE COURSE | | | | | |
| 200 | Sub Base Course | 1,903.42 | cu.m. | 879.97 | 1,674,952.50 | |
| | SUB-TOTAL (PART D) | | | | 1,674,952.50 | |
| E | SURFACE COURSES | | | | | |
| 302(2) | Bituminous Tack Coat, Emulsified Asphalt, SS-1 (0.45 L/m2) | 9.45 | tonne | 65,971.81 | 623,433.60 | |
| 310 (2) | Bituminous Concrete Wearing Course, Hot Laid (t=50mm) | 13,501.78 | sq.m | 924.31 | 12,479,830.27 | |
| 311 | Portland Cement Concrete Pavement t=300 mm | 4,530.64 | sq.m | 2,887.66 | 13,082,947.90 | |
| | SUB-TOTAL (PART E) | | | | 26,186,211.78 | |
| F | BRIDGE CONSTRUCTION | | | | | |
| | Approch Ramp | | | | | |
| 103(1) | Structure Excavation | 1,792.56 | cu.m. | 586.00 | 1,050,440.16 | |
| 103(2) | Structural Backfilling | 1,583.04 | cu.m. | 565.00 | 894,417.60 | |
| 104(2) | Embankment, Selected Borrow | 2,711.73 | cu.m. | 984.09 | 2,668,586.38 | |
| 401(a) | Cast in Place Concrete Railing | 776.88 | l.m. | 5,006.92 | 3,889,776.01 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 58,068.45 | kg. | 62.70 | 3,640,891.82 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 15,906.00 | kg. | 68.25 | 1,085,584.50 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 387.12 | cu.m. | 9,548.08 | 3,696,281.37 | |
| 405(1)b | Approach Slab | 72.30 | cu.m. | 6,233.40 | 450,674.82 | |
| 405(1)c | Concrete Leveling Pad | - | cu.m. | 80,462.16 | - | |
| 405(6) | Lean Concrete | 143.90 | cu.m. | 4,111.70 | 591,673.63 | |
| SPL 414 | Concrete Barrier | - | l.m. | 4,660.55 | - | |
| SPL 417 | Earthquake Resistant Type Mechanically Stabilized Earthwall | 724.00 | sq.m. | 14,163.00 | 10,254,012.00 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Substructure** | | | | | |
| 400(17)a | Concrete Piles Cast in Drilled Holes, Ø1000 mm | 160.00 | l.m. | 35,098.96 | 5,615,833.60 | |
| 400(17)b | Concrete Piles Cast in Drilled Holes, Ø2500 mm | 288.00 | l.m. | 146,178.83 | 42,099,503.04 | |
| 400(17)c | Concrete Piles Cast in Drilled Holes, Ø3000 mm | 144.00 | l.m. | 202,409.64 | 29,146,988.16 | |
| 400(22)a | Pile Integrity Test | 14.00 | ea. | 43,784.56 | 612,983.84 | |
| 400(22)b | Pile Dynamic Test | 5.00 | ea. | 583,087.25 | 2,915,436.25 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 724.68 | kg. | 62.70 | 45,437.44 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 831,977.85 | kg. | 68.25 | 56,782,488.26 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 1,973.95 | cu.m. | 14,057.94 | 27,749,670.66 | |
| 405(6) | Non Shrink Grout 41Mpa including wiremesh for Girder Riser | 1.30 | cu.m. | 80,462.16 | 104,600.81 | |
| 405(6) | Lean Concrete | 8.34 | cu.m. | 4,111.70 | 34,291.58 | |
| 407(1)a | Anchor Bar Ø36mm x 1500mm long, complete | - | ea. | 1,800.00 | - | |
| 407(1)b | Anchor Bar Ø36mm x 1000mm long, complete | - | ea. | 1,200.00 | - | |
| | | | | | | |
| | **Superstructure** | | | | | |
| 401(a) | Cast in Place Concrete Railing | 1,464.00 | l.m. | 5,006.92 | 7,330,130.88 | |
| 404(1)b | Reinforcing steel, Grade 40 (Superstructure) | - | kg. | 62.70 | - | |
| 404(2)b | Reinforcing steel, Grade 60 (Superstructure) | 1,932,940.00 | kg. | 68.25 | 131,923,155.00 | |
| 404(2)c | Prestressing steel | - | kg. | 152.90 | - | |
| 405(1)b | Structural Concrete, Class A (Hollow Slab) 27.6 Mpa | 7,731.76 | cu.m. | 16,971.01 | 131,215,776.28 | |
| 412(1)a | Elastomeric Bearing Pad (500 x 400 x 60 mm) | 60.00 | ea. | 14,500.00 | 870,000.00 | |
| 412(1)b | Elastomeric Bearing Pad (400 x 400 x 50 mm) | - | ea. | 12,000.00 | - | |
| 413(1) | Expansion Joint | 192.80 | l.m. | 29,418.63 | 5,671,911.86 | |
| SPL 414 | Concrete Barrier | 1,098.00 | l.m. | 4,660.55 | 5,117,283.90 | |
| SPL 415 | Waterproofing | 8,820.60 | sq.m. | 1,800.00 | 15,877,080.00 | |
| | | | | | | |
| | **SUB-TOTAL (PART F)** | | | | **491,334,909.84** | |
| | | | | | | |
| **G** | **DRAINAGE AND SLOPE PROTECTION STRUCTURES** | | | | | |
| | | | | | | |
| 500(1)a | RCPC, Class II | - | l.m. | 3,082.45 | - | |
| 500(1)b | RCPC, Class IV | 1,000.00 | l.m. | 7,005.56 | 7,005,560.00 | |
| 502(2)a | Storm Deck Drain with Grating | 74.00 | ea. | 19,679.57 | 1,456,288.18 | |
| 502(2)b | Curb Inlet Manhole | 56.00 | ea. | 25,000.00 | 1,400,000.00 | |
| 502(3) | Catch Basins | 28.00 | ea. | 35,000.00 | 980,000.00 | |
| 502(4) | Junction Box | - | ea. | 5,000.00 | - | |
| SPL 512 | Collector Pipe | 958.35 | l.m. | 1,153.20 | 1,105,169.22 | |
| | | | | | | |
| | **SUB-TOTAL (PART G)** | | | | **11,947,017.40** | |
| | | | | | | |
| **H** | **MISCELLANEOUS STRUCTURES** | | | | | |
| | | | | | | |
| 600(1) | Concrete Curb | 1,416.00 | l.m. | 1,333.21 | 1,887,825.36 | |
| 600(3)a | Concrete Curb and Gutter | 243.00 | l.m. | 1,661.30 | 403,695.90 | |
| 600(3)b | Concrete Side Strip | - | sq.m. | 350.00 | - | |
| 601(1)a | Concrete Sidewalk | - | sq.m. | 1,560.60 | - | |
| 601(1)b | Concrete Median | 7,295.00 | sq.m. | 1,560.60 | 11,384,577.00 | |
| 605(1) | Warning Sign | 4.00 | set | 34,912.46 | 139,649.84 | |
| 605(2) | Regulatory Sign | 8.00 | set | 34,912.46 | 279,299.68 | |
| 605(3)a | Informatory Sign, Gantry Support | 2.00 | set | 905,733.18 | 1,811,466.36 | |
| 605(3)b | Informatory Sign, Butterfly Support | 2.00 | set | 431,481.05 | 862,962.10 | |
| 605(3)c | Informatory Sign, Cantilever Support | 2.00 | set | 388,956.44 | 777,912.88 | |
| 605(3)d | Informatory Sign, Double Post | 6.00 | set | 42,944.99 | 257,669.94 | |
| 612(1) | Reflectorized Thermoplastic Pavement Markings, White | 806.37 | sq.m. | 1,092.83 | 881,225.33 | |
| | | | | | | |
| | **SUB-TOTAL (PART H)** | | | | **18,686,284.39** | |
| | | | | | | |
| **J** | **SPECIAL ITEM** | | | | | |
| | | | | | | |
| SPL 1 | 9m Pole, Single arm complete | 36.00 | set | 86,228.98 | 3,104,243.28 | |
| SPL 2 | 9m Pole, Double arm complete | - | set | 90,000.00 | - | |
| SPL 3 | Lighting system, (under carriageway) | 26.00 | set | 59,290.99 | 1,541,565.74 | |
| SPL 4 | Flood lights | 10.00 | set | 80,000.00 | 800,000.00 | |
| SPL 5 | Traffic Signal Light | - | P.s | 2,000,000.00 | - | |
| | | | | | | |
| | **SUB-TOTAL (PART J)** | | | | 5,445,809.02 | |
| | | | | | | |
| | **TOTAL** | | | | **600,244,468.44** | |

*Source: JICA study team*

## 4.4 EDSA/ NORTH AVENUE/ WEST AVENUE/ MINDANAO AVENUE

### 4.4.1 Review of Previous Detailed Design

The detailed design of this proposed interchange was prepared by Katahira & Engineers International in association with Proconsult, Inc. and United Technologies, Inc. in February 2001.

**(1) Topographic Conditions**

The project coverage area has the following topographic conditions and characteristics:

1) The horizontal alignment of EDSA has about 240m radius curve from right to left from Makati toward Monumento at the intersection.

2) The horizontal alignment of West Avenue intersects with about 40 degrees skew to EDSA – Makati direction.

3) The horizontal alignment of North Avenue intersects with about 40 degrees skew to EDSA – Makati direction.

4) The lowest ground elevation of 31.55m along EDSA, North Avenue and West Avenue is located almost at the center of the intersection.

5) The ground elevation from the lowest point at the center of the intersection toward Cubao gently increases continuously.

6) The highest elevation of about 33.92m along EDSA toward the Monumento direction is located 260m from the center of the intersection and elevation gently decreases toward the direction of Monumento after the highest point.

7) The ground elevation from the intersection toward North Avenue gently increases continuously.

8) The ground elevation from the intersection toward West Avenue are gently repeating up and down.

9) Commercial buildings are continuously lined alongside the four directional roads.

10) There are no significant changes in the topographic conditions from the time of the detailed design to present, except for the construction of pedestrian bridges and bus stop lanes at the intersections and the developments in front of SM North within its properties.

**(2) Geotechnical Conditions**

The proposed area is located on the north in the center part of the Central Plateau, which is underlain by tuffs and tuffaceous sediments of the Pliocene-Pleistocene or the Holocene.

Tuffs (tuffaceous rock sequence) consist of siltstone (including claystone) and sandstone, belonging to the Guadalupe formation of the Pliocene-Pleistocene. Tuffaceous sediments overlying the tuffs consist of pyroclastic flow deposits and lahar deposits (tuffaceous reworked deposits) of the Pleistocene-Holocene. Pyroclastic flow deposits are mainly composed of gravelly silt and gravelly sand, and lahar deposits are mainly composed of inorganic clayey silt, and silty sand.

The lower tuffaceous rock sequence is stable bearing stratum for the important structures such as bridges, because "N-value is over 50 generally" and "Unconfined compression strength (qu) is 900-7900 kPa (corresponding to the soft rock)". But it is difficult that upper tuffaceous sediments are stable bearing stratum for the important structures because pyroclastic flow deposits are changing to laharic deposits which have N-value of less than 10 laterally. Therefore, the bearing stratum in the proposed area is tuffaceous rock sequence that underlie deeper than 1-4m from ground surface.

The depth of bearing and the assumed type of foundations at each borehole are shown in **Table 4.4-1**.

**Table 4.4-1 Depth of Bearing Stratum and Type of Foundations**

| Borehole No. | | Depth of Bearing Stratum | Type of Foundations |
|---|---|---|---|
| Boreholes along EDSA | BH - 1 | 3.00m | Spread footing |
| | BH - 2 | 3.00m | |
| | BH - 3 | 3.00m | |
| | BH - 4 | 3.50m | |
| | BH - 5 | 2.00m | |
| | BH - 6 | 1.00m | |
| | BH - C | 2.00m | |
| Boreholes along North Avenue | BH - B | 3.20m | |
| | BH - 10 | 3.50m | |
| | BH - 11 | 1.00m | |
| | BH - 12 | 1.00m | |
| | BH – D | 2.00m | |
| | | 6.00m | |
| Boreholes along West Avenue | BH - F | 1.00m | |
| | BH - E | 2.00m | |
| | BH - 7 | 4.00m | |
| | BH - 8 | 3.00m | |
| | BH - 9 | 4.00m | |
| | BH - A | 3.00m | |

*Source: Detailed design done by KEI and associate consultants Feb 2001*

### (3) Hydrological Conditions

There are no rivers and creeks nearby the project area and elevations of the proposed area are higher than the surrounding areas.

From the available data (Figure 7.1.5-1 Flood Potential Area, "The Study of Master Plan on High Standard Highway Network Development in the Republic of the Philippines", Final Report, by CTI and associated firms), it can also be said that flooding will not occur in the project area.

Therefore, there are no specific issues on the hydrological conditions in the proposed area. In addition, existing detailed designs provide only standard drainage system for the flyover and road.

**(4) Design Standards**

Major design standards are shown hereunder.

1) Highway Design

| Elements of Design | EDSA through | West Avenue–North Avenue through | Left Turn Flyover |
|---|---|---|---|
| Design Speed | 70km/h | 40km/h | 40km/h |
| Minimum Radius Curvature | 200m | 60m | 60m |
| Maximum Superelevation | 6.0% | 6.0% | 6.0% |
| Maximum Vertical Grade | 6.0% | 6.0% | 6.0% |
| Minimum Vertical Grade | 0.35% | 0.35% | 0.35% |
| Minimum Stopping Sight Distance | 100m | 45m | 45m |
| Minimum Vertical Clearance | 5.0m | 5.0m | 5.0m |
| Lane Width | 3.35m | 3.35m | 3.35m |
| Standard Superelevation | 1.50% | 1.50% | 1.50% |

*Source: JICA study team*

2) Hydrology and Hydraulics

✓ Design Frequency Level

- Inlet : 2 years
- Ditches : 5 years
- Pipe Culverts : 10 years
- Box Culverts : 25 years
- Bridges : 50 years or maximum observed flood, whichever is greater

✓ Peak Runoff Rate : Rational Method

✓ Hydra Flow : Manning Formula

3) Structural Design

✓ Clearance to MRT

- MRT Guideway Structure Envelope : 9.0m wide
- MRT Station Structure Envelope : 9.0m wide
- Structure Gap between MRT and Flyover : 15.0cm
- Headroom Clearance above MRT Rail Level to Flyover : 5.6m

✓ Material Properties

- Concretes
  - › Substructure : 28Mpa (20mm)
  - › Bored Pile : 28Mpa (25mm)
  - › PCDG Girders : 34Mpa (20mm)
  - › Column to RC Slab : 28Mpa (20mm)
  - › Column to PC Slab : 34Mpa (20mm)
  - › Coping Beam to RC Slab : 34Mpa (20mm)
  - › Coping Beam to PC Slab : 41Mpa (20mm)
  - › RC Voided Slab : 34Mpa (20mm)
  - › PC Voided Slab : 41Mpa (20mm)
- Reinforcing Steel : Grade 60
- Prestressing Steel : Grade 270 and low relaxation with an ultimate strength Fu = 1,860Mpa
- Structural Steel : Minimum yield strength fy = 248Mpa
- Elastomeric Bearing Pads : 100% virgin chloroprene pads with durometer hardness 60 and laminated with non-corrosive mild steel sheets

✓ Loads and Allowable Stresses

- Reinforced Concrete : 24.5kn/$m^3$
- Asphalt Wearing Course : 22.0kn/$m^3$
- Steel : 77.0kn/$m^3$
- Compacted Earth : 19.0kn/$m^3$
- Live Load : AASHTO MS18 (HS20-44)
- Earth Pressure

| Description | Group I Load | Group VII Load |
|---|---|---|
| **Soil Internal Angle of Friction** | 30 degrees | 15 degrees |
| **Wall to Soil Friction Angle** | 0 degrees | 0 degrees |
| **Active Earth Pressure** | 0.297 | 0.452 |
| **Live Load Surcharge** | 0.6m of soil | None |

- Seismic Load
  - › Seismic Performance Category : D
  - › Soil Profile : Type II
  - › Seismic Acceleration : 0.4
  - › Site Coefficient : 1.2

**(5) Road Alignment and Structural Conditions**

The road alignments and structural conditions have the following characteristics:

**EDSA Southbound**

1) This section has three lanes and its horizontal alignment is passing thru the right side of MRT 3 with 230m radius curve at the intersection. Vertical grade at each side of the approach sections is 5.0%.

2) Total length of the project section is 854m; total length of flyover is 361m; length of retaining wall for depressed section is 367m.

3) 286m of the length of the left turn flyover (EDSA-North Avenue) between P1N and P19N is located above the EDSA northbound flyover (3rd level).

4) The type, number of spans and span length and type of foundation of the flyover are as follows:

- ✓ Type of flyover and span configuration:
  - 4 span continuous RC voided slab, 4@15.00m = 60.00m
  - 3 span continuous PSC voided slab, 15.00m + 20.00m + 30.00m = 65.00m
  - 3 span continuous PSC voided slab, 30.00m + 40.00m + 30.00m = 100.00m
  - 2 span continuous PSC voided slab, 2@30.00m = 60.00m
  - 5 span continuous RC voided slab, 5@15.00m = 75.00m
- ✓ Type of foundation : 1.00m, 2.50m, 3.00m and 4.00m diameter bored piles

**EDSA Northbound**

1) This section has three lanes and its horizontal alignment is passing thru the left side of MRT 3 with 241m radius curve at the intersection. Vertical grade at each side of the approach sections is 5.0%.

2) Total length of the project section and the flyover are 569m and 343m, respectively.

3) The type of flyover, number of spans and span length and type of foundation are as follows:

- ✓ Type of flyover and span configuration:
  - 4 span continuous RC voided slab, 4@15.00m = 30.00m
  - 2 span continuous PSC voided slab, 2@24.586m = 49.172m
  - 3 span continuous PSC voided slab, 30.00m + 38.00m + 30.00m = 98.00m
  - 2 span continuous PSC voided slab, 2@30.00m = 60.00m
  - 5 span continuous RC voided slab, 5@15.00m = 75.00m
- ✓ Type of foundation : 1.00m, 2.50m, 3.00m and 4.00m diameter bored piles

**EDSA–North Avenue Left Turn Flyover**

1) The flyover has two lanes and its horizontal alignment is almost straight and passing thru above EDSA northbound. Vertical grade at the north and south side approaches are 6.0% and 5.535%, respectively.

2) Lengths of the project sections and flyovers are as follows:

✓ North Avenue Straight

- Total length of project section : 1,228.1m
- Total length of flyover : 1,011.5m

✓ North Avenue–Mindanao Avenue

- Total length of project section : 306.4m
- Total length of flyover : 180.0m

3) The type of flyover, number of spans and span length and type of foundation are as follows:

✓ Type of flyover and span configuration

**North Avenue**

- 4x4 span continuous RC voided slab, 4@15.00m x 4 = 240.00m
- 3 span continuous PSC voided slab, 15.00m + 20.00m + 18.50m = 53.50m
- 3 span continuous PSC voided slab, 30.00m + 2@22.217m = 80.434m
- 2 span continuous PSC voided slab, 2@27.00m = 54.00m
- 3 span continuous PSC voided slab, 3@27.00m = 81.00m
- 4 span continuous RC voided slab, 4@25.035m = 100.140m
- 4 span continuous RC voided slab, 4@15.00m = 60.00m
- 6 span continuous RC voided slab, 6@15.00 = 90.00m
- 5 span continuous RC voided slab, 5@15.00m = 75.00m
- 3 span continuous PSC voided slab, 28.00m + 37.00m + 28.00m = 93.00m
- 3 span continuous PSC voided Slab, 3@28.00 = 84.00m

**North Avenue–Mindanao Avenue**

- 3 span continuous PSC voided slab, 3@30.00m = 90.00m
- 6 span continuous RC voided slab, 6@15.00m = 90.00m

✓ Type of foundation : 1.00m, 2.50m, 3.00m and 4.00m diameter bored piles

**West Avenue–North Avenue Flyover**

1) The flyover has two lanes and horizontal alignment of 80m radius right curve at the intersection which merges with EDSA–North Avenue Left Turn Flyover after the curve. Vertical grade at Quiapo side is 6.0%.

2) Lengths of the project section and flyover are 483m and 392m, respectively.

3) The type of flyover, number of spans and span length and foundation type are as follows:

✓ Type of flyover and span configuration

- 3 span continuous RC voided slab, 3@15.00m = 45.00m
- 2x4 span continuous RC voided slab, 4@15.00m x 2 = 120.00m

- 3x2 span continuous PSC voided slab, 2@30.00 x 3 = 180.00m
- 2 span continuous RC voided slab, 2@23.5m = 47.00m

✓ Type of foundation : 1.00m, 2.50m, 3.00m and 4.00m diameter bored piles

**(6) Environmental and Social Conditions**

The ECC for EDSA/North Avenue-West Avenue and EDSA/Roosevelt Interchanges Project had been issued by DENR-EMB in January 2002. The conditions imposed on the issued ECC by the DENR-EMB did not include any specific requirements. Although the ECC was thought to be applied with the EIS, the JICA Study Team could not obtain the EIS and RAP documents to be reviewed.

According to Right-of-Way and Utility Maps (2001), the number of lots affected along EDSA is 14 while in West Avenue and North Avenue are 2 and 2, respectively. The affected area is approximately 5,768 sq. m.

1) Environmental conditions

Environmental conditions including socio-economic environment will be reviewed when the EIS is obtained.

2) Social conditions

The PAPs and socio-economic conditions of project affected areas will be reviewed when the RAP report is obtained. According to Right-of-Way and Utility Maps (2001), the number of lots affected along EDSA is 14 while in West Avenue and North Avenue are 2 and 2 , respectively. The affected area is approximately 5,768 sq. m.

**(7) Identified Problems and Recommendations**

**Identified Problems**

1) The constructed LRT 1 horizontal alignment was not the same as the agreed alignment between DPWH and DOTC.

2) No problems were identified in the completed plans and detailed design of this interchange but total re-planning and redesign are required due to the planned construction of a new station, the Common Station along LRT 1 in front of SM North, and of the proposed MRT 7 which will pass along North Avenue. Said Common Station will not only be a station along LRT 1 but will also serve as the first station of MRT 7 in the north.

3) The construction of a Left Turn Flyover from EDSA to North Avenue will not be possible with the planned construction of the Common Station.

**Recommendations**

1) Proper coordination and discussions with the Department of Transportation and

Communications (DOTC), the Light Rail Transit Authority (LRTA) and other concerned agencies should be made and as built plans of MRT 3 and LRT Line 1 extension and detailed design of the Common Station and MRT 7 should be obtained in order for the flyover to be appropriately designed, but also for its design to be properly coordinated and harmonized with the design of the Common Station and MRT7.

2) Based on the foregoing traffic survey and analysis, the Consultant will prepare a new conceptual design of the flyover as soon as possible in order for its feasibility study to be finished on time.

### 4.4.2 Preliminary Design (EDSA/North/West Interchange)

#### (1) Comparative study

Based on the review of detailed design, updated site and traffic conditions, the added issue of a Common station along LRT-1 and proposed construction plan of MRT-7, the comparative study will be undertaken with following conditions:

- Proposed location of the Common station will be maintained at the same location with the concept design.
- Alignment and structural plans of MRT-7 should be adjusted properly with the flyover plan and design.
- Number of the lane is 3 lanes in each direction and north and south bound structures will be planned individually due to LRT-1 operating along the middle of EDSA.
- Type of superstructure shall be designed as voided slab type to provide aesthetic view of the flyover.

The following two (2) alternatives schemes are proposed as the most suitable for comparable purposes based on the above conditions and site and traffic conditions.

Scheme-1 : Flyover, 342m long north bound and 319m long south bound.
Scheme-2 : Cut and cover tunnel, 231m long north bound and 131m long south bound.

Between the two (2) schemes of flyover and cut and cover tunnel, flyover scheme was selected due to following reasons;

- Construction cost is much cheaper than scheme-2.
- No ROW acquisition.
- Construction duration is shorter and traffic will be easier to manage during the construction.
- No specific O & M.

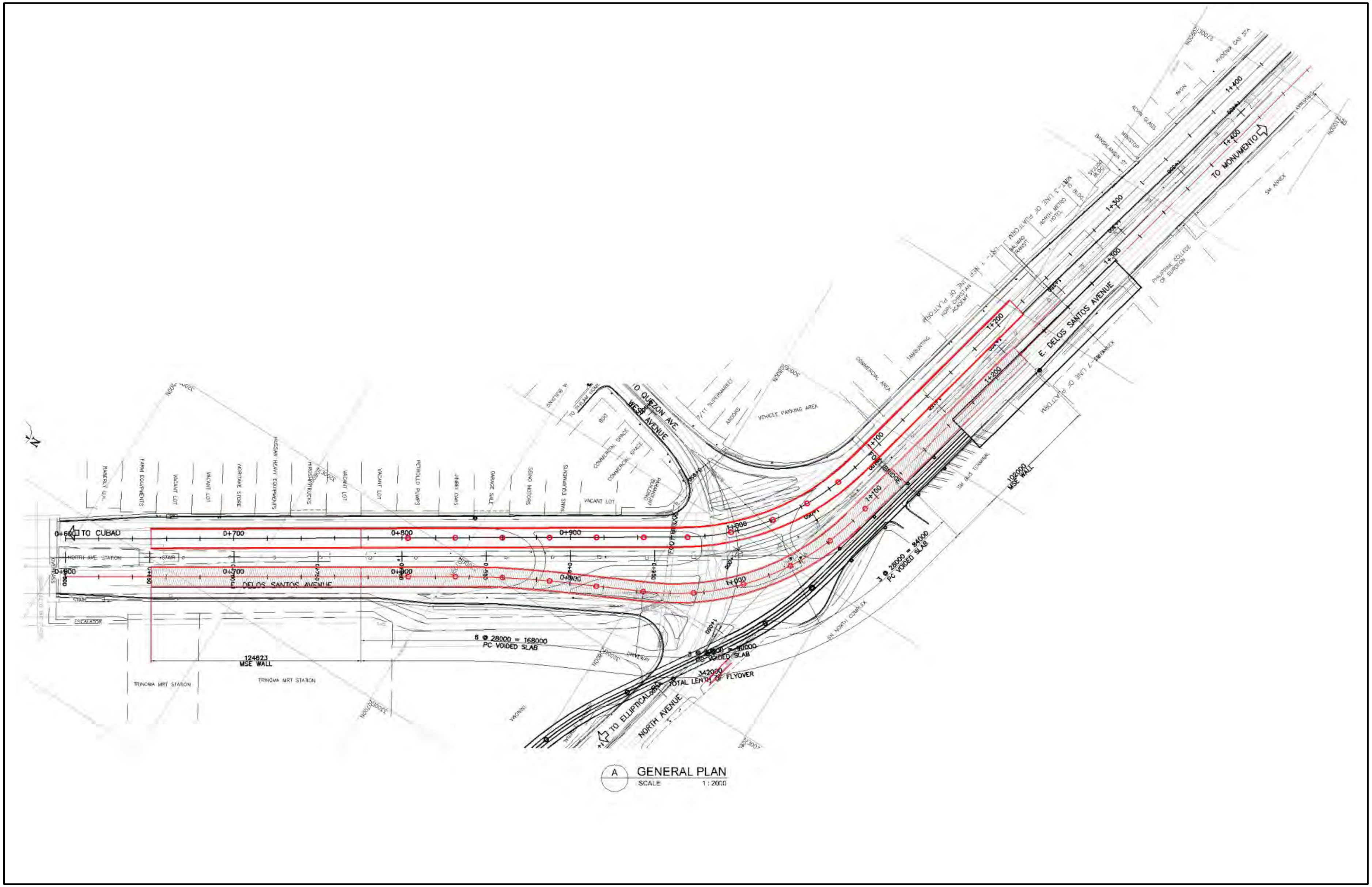
The Detailed Scheme comparison is shown in **Table 4.4-2** and Plan and Profile of each of the Schemes presented in **Figures 4.4-1 ~ 4**.

## Table 4.4-2 Scheme Comparison Table of EDSA/North/West Interchange

| Description | Scheme-1 Flyover | | Scheme-Cut and Cover Tunnel | |
|---|---|---|---|---|
| **Structure** | 3-lane flyover<br>North Bound : 9@28.0m+3@ 30.0m (pc voided slab)=342.0m<br>South Bound: 7@28.0m+3@ 26.0m+2@22.5m(pc voided slab)=319.0m<br>Approved Section : North Bound: 226.6m<br>South Bound: 244.6m | | 3-lane North Bound Tunnel: 231.4m<br>Approach: 523.6m<br>3-lane South Bound Tunnel: 131.3m<br>Approach: 535.9m | |
| **Construction Cost** | Flyover: MP 528.8 (P800,000/m/3-lane)<br>Approach: MP 56.5 (P120,000/m/3-lane)<br>Others MP 9.7<br>Total MP 595.0 (100.0%) | ◎ | Tunnel MP 2,214.8 (included approach section)<br>Sump Pit MP 30.0 (H=10.0m)<br>R.O.W MP 20.0 ($20m \times 20m \times P50,000/m^2$)<br>Total MP 2,264.8 (381.3%)<br>● Requires 4-line tunnel revetment due to North and South bound has individual alignment | △ |
| **Construction Performance and Duration** | 22 months<br>○ Construction method and procedure is standard<br>○ Provide at least 2-lanes traffic per direction during construction | ◎ | 30 Months<br>● Requires to find dumping place for $84,800m^3$ of excavated soil<br>● Requires special construction method and procedure for construction of sump pit and cross pipe about 10m deep under ground<br>● Provide 1.5 lane per direction only during construction | △ |
| **Environmental and Social Condition** | ○ No R.O.W acquisition<br>○ Traffic noise is severe than scheme-2 but not concentrated | ◎ | ○ Aesthetic view of area will be preserved<br>● Requires about $400m^2$ R.O.W acquisition for sump pit<br>● Greater Impact on traffic due to longer construction duration<br>● Noise and exhaust funs are concentrated at both entrance | △ |
| **Traffic Condition at Grade I/C** | ○ Easier traffic management during construction | ◎ | ● Difficult traffic management during construction | ○ |
| **O & M** | ○ No specific O & M required | ◎ | ● Requires periodic monitoring and maintenance of sump pit drain water pump up system and illumination | ○ |
| **Over all Evaluation** | ○ Much cheaper than scheme-2<br>○ Shorter construction duration and easier to manage existing traffic during construction<br>○ No specific O & M required<br>○ No R.O.W. acquisition | ◎ | ● More than 3-times expensive than scheme-1<br>● Longer construction duration and hard to manage existing traffic during construction<br>● Sump pit requires $400m^2$ of R.O.W and difficult construction method and sequence | △ |

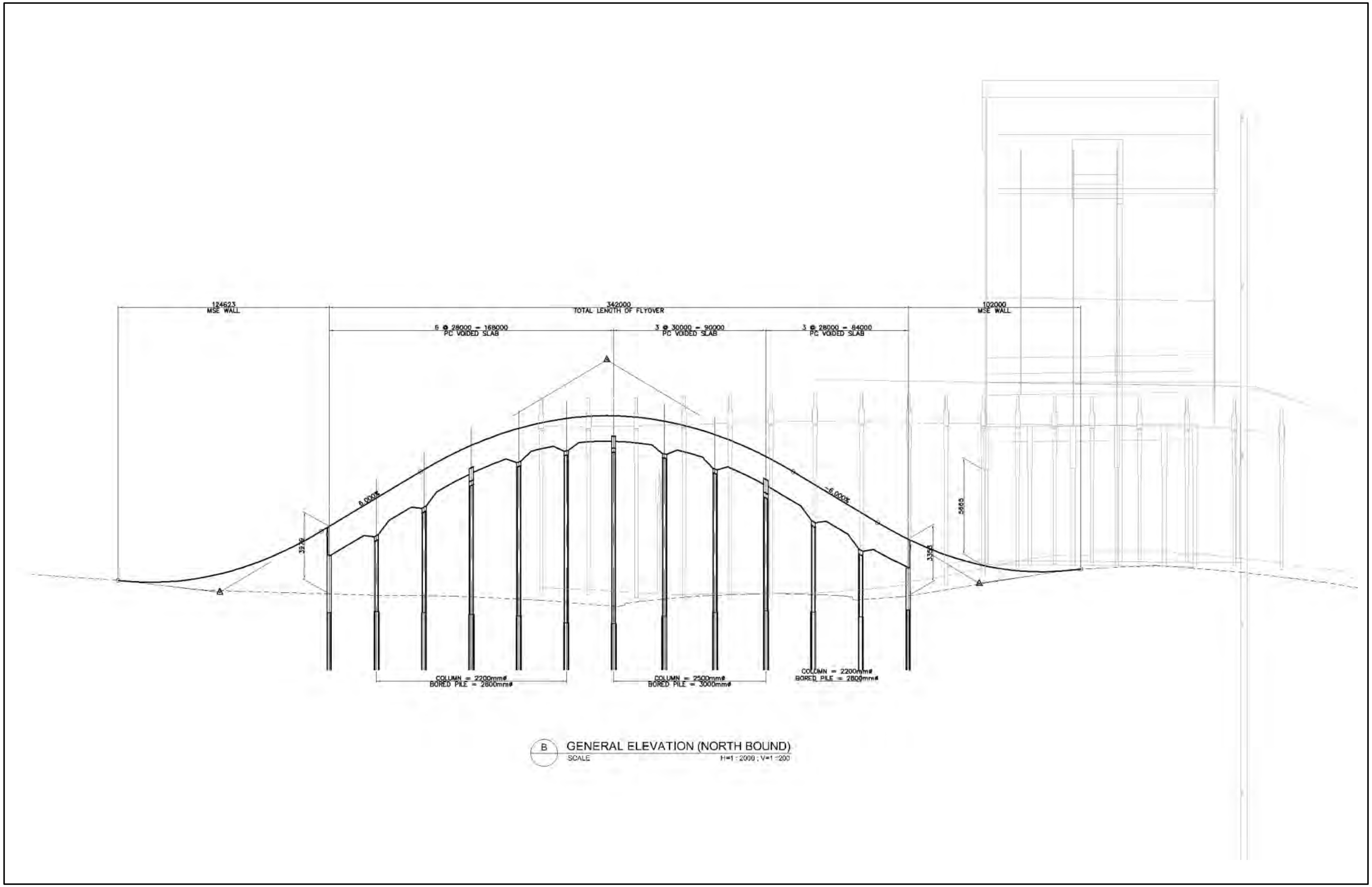
**LEGEND :** ○ **advantage**
● **disadvantage**

*Source: JICA Study Team*



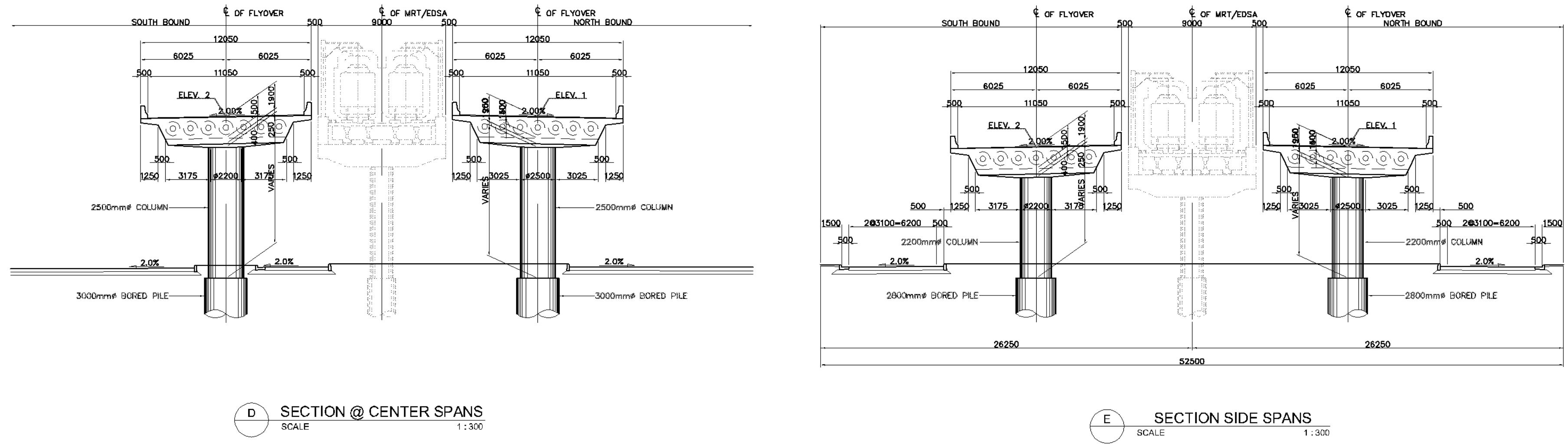

Source: JICA Study Team

**Figure 4.4-1 Plan and Profile of Scheme-1 (EDSA/North/West Interchange) (1/3)**



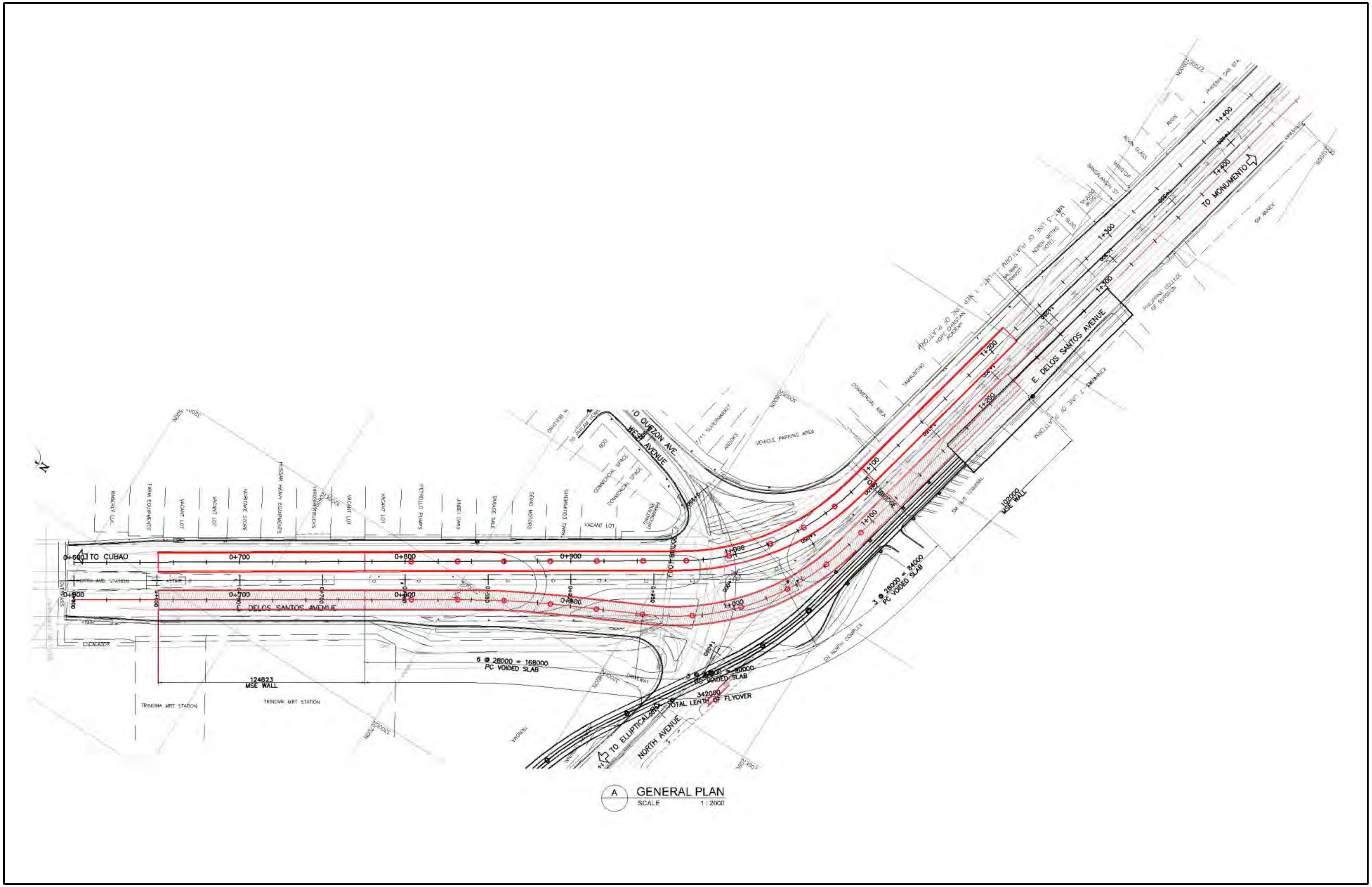

Source: JICA Study Team

**Figure 4.4-2 Plan and Profile of Scheme -1 (EDSA/North/West Interchange) (2/3)**



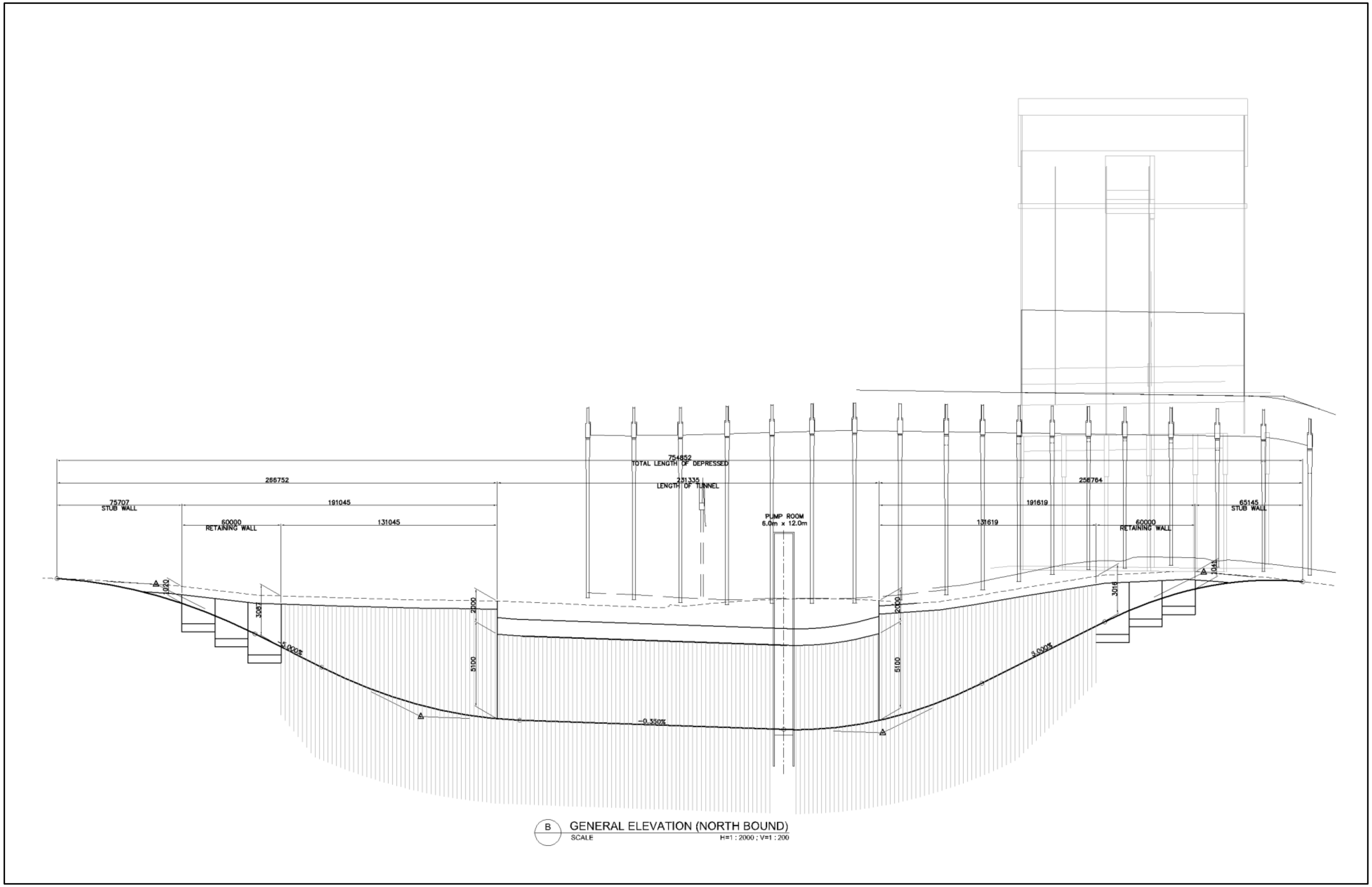

Source: JICA Study Team

**Figure 4.4-3 Plan and Profile of Scheme -1 (EDSA/North/West Interchange) (3/3)**



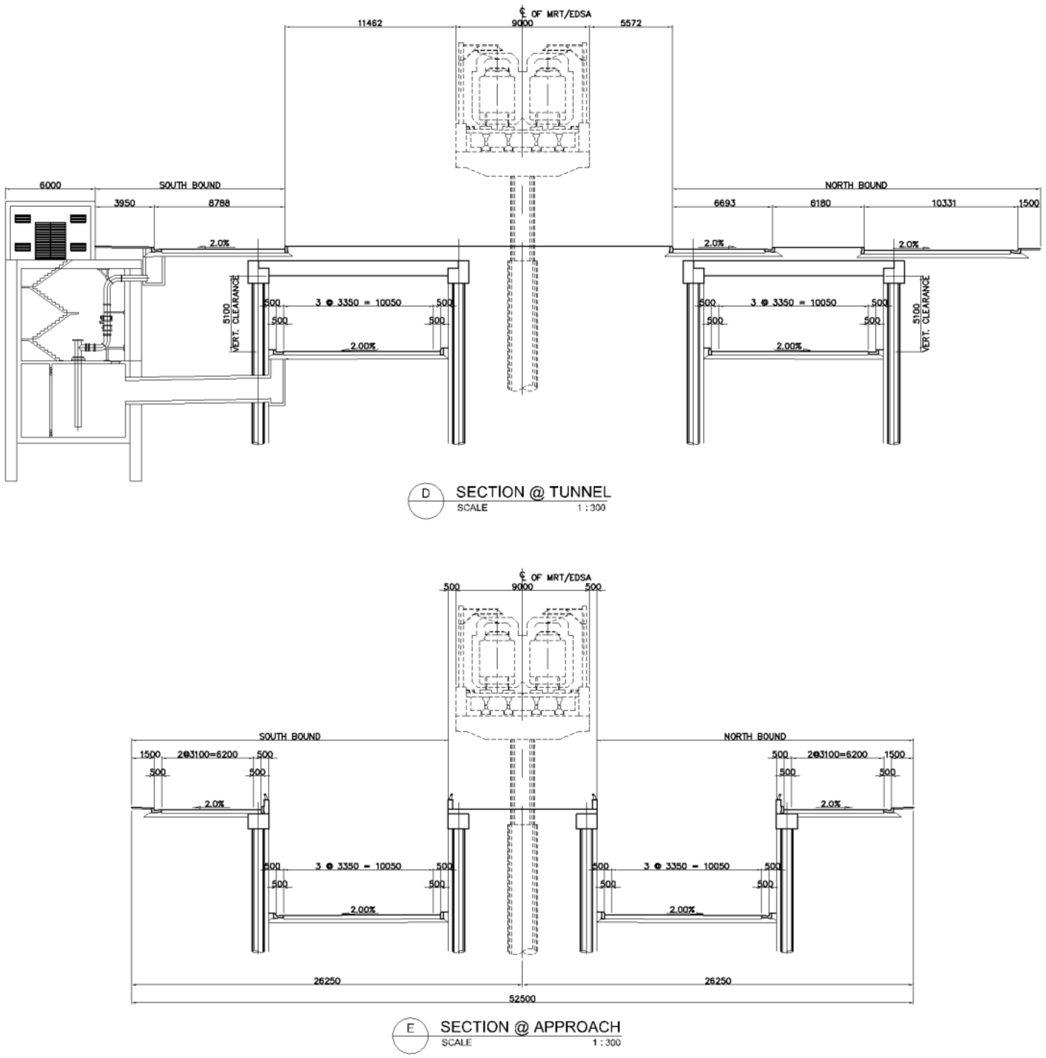

Source: JICA Study Team

**Figure 4.4-4 Plan and Profile of Scheme -2 (EDSA/North/West Interchange) (1/3)**




Source: JICA Study Team

**Figure 4.4-5 Plan and Profile of Scheme -2 (EDSA/North/West Interchange) (2/3)**




*Source: JICA Study Team*

**Figure 4.4-6 Plan and Profile of Scheme -2 (EDSA/North/West Interchange) (3/3)**

P reliminary Design of Selected Scheme (EDSA/North/West Interchange)

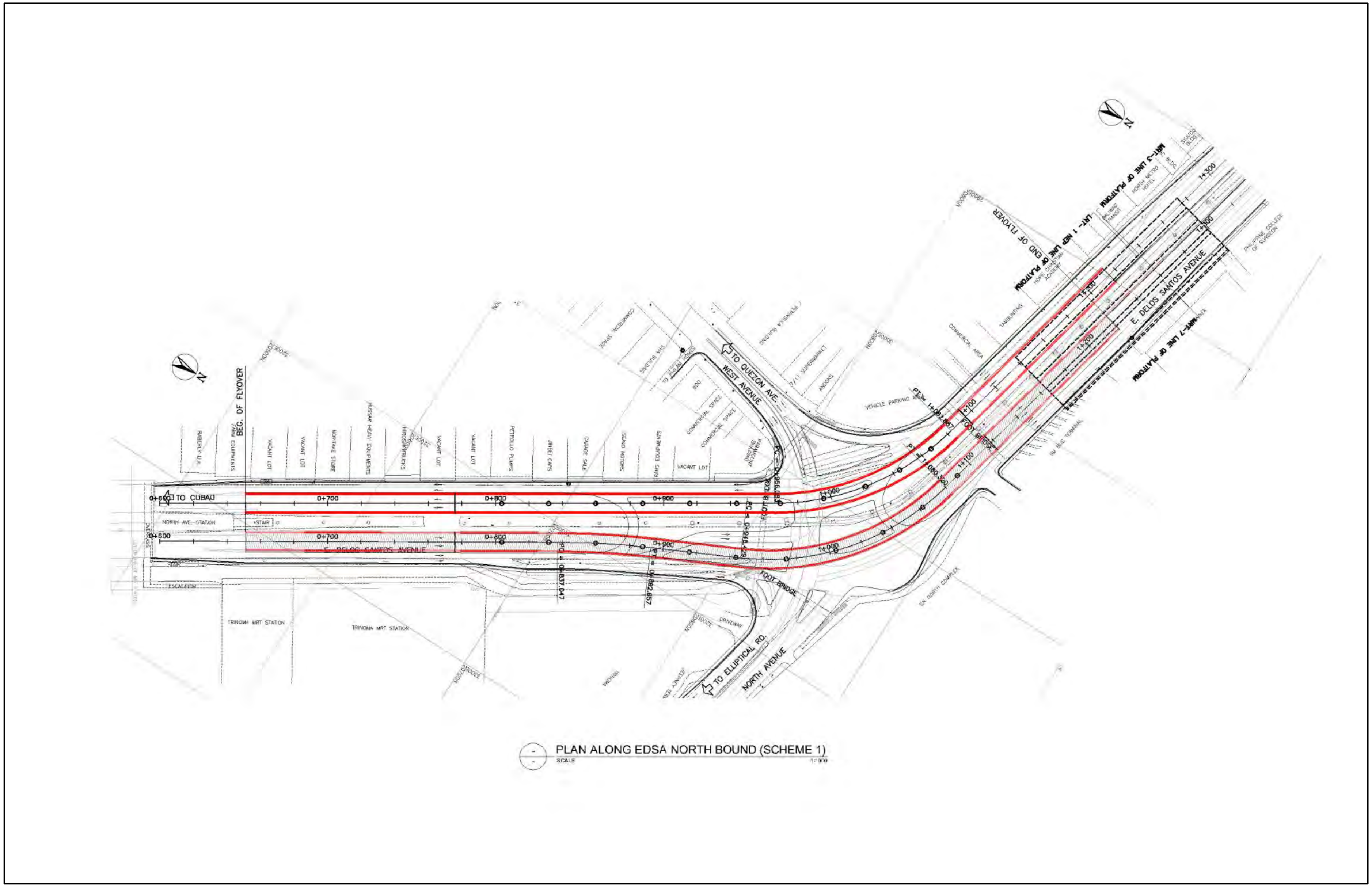
Scheme-1, PC voided slab type flyover was selected based on the comparative study. Concepts of the preliminary design of selected scheme are as follows:

1) Voided slab type should be adopted for superstructure to consider aesthetic view of flyover.
2) One (1) column type pier foundation should be adopted to maximize usability and usage of the area underneath the flyover.
3) 6% of vertical grade should be adopted for both sides of the flyover approaches to minimize flyover length.
4) MSE wall should be adopted as retaining wall on both side of flyover approaches to minimize the effects to traffic during construction as well as provide an aesthetic view.
5) To provide four (4) phase signalization plan at the at-grade intersection.
6) All of the at-grade plan and design to be done within RROW.

Preliminary design was carried out based on the above basic concepts. Plan and profile, at-grade intersection plan, typical cross sections, slab layout plan and structural general view are shown in **Figures 4.4-5 ~ 10**.

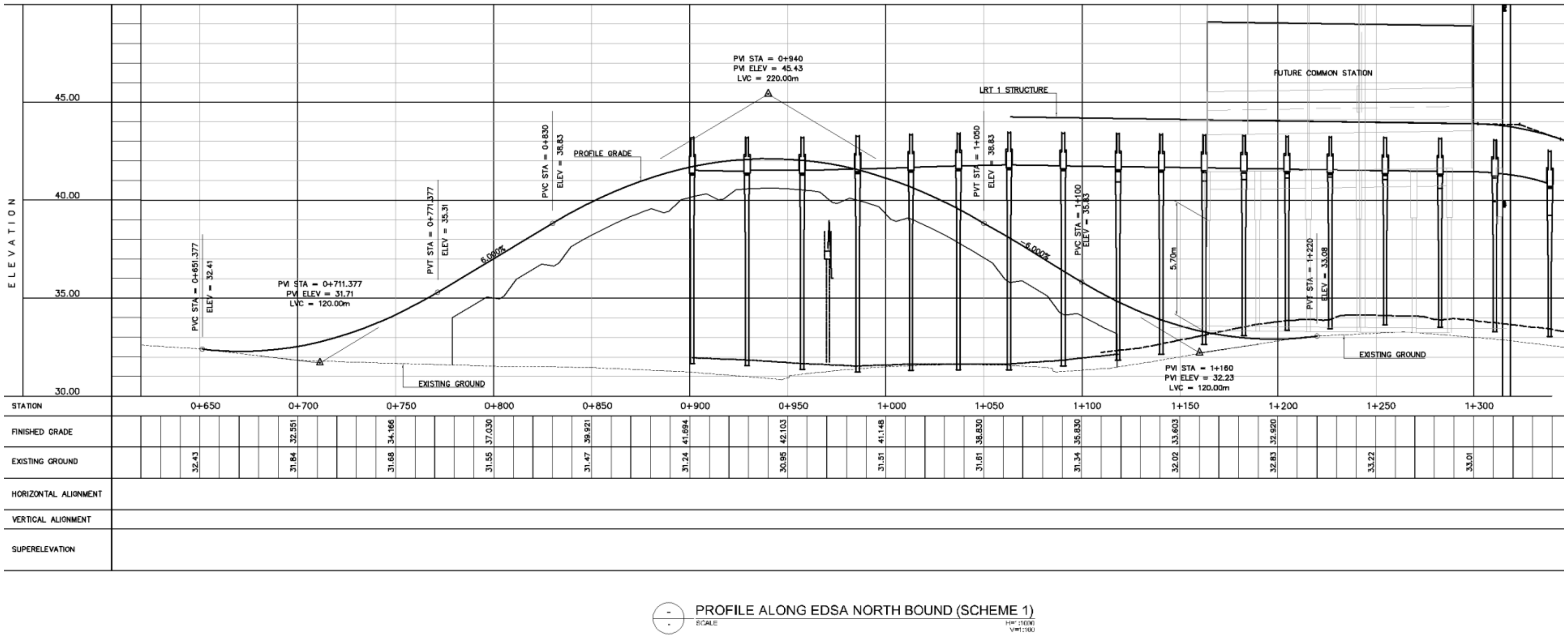
**(2) Construction Plan and Traffic Management during Construction**

1) Construction Plan and PART CPM for EDSA/North/West interchange have been studied as shown in **Figures 4.4-11** ~ **13**.
2) Traffic Management plan during construction for EDSA/North/West have likewise been studied as shown in **Figure 4.4-14**.



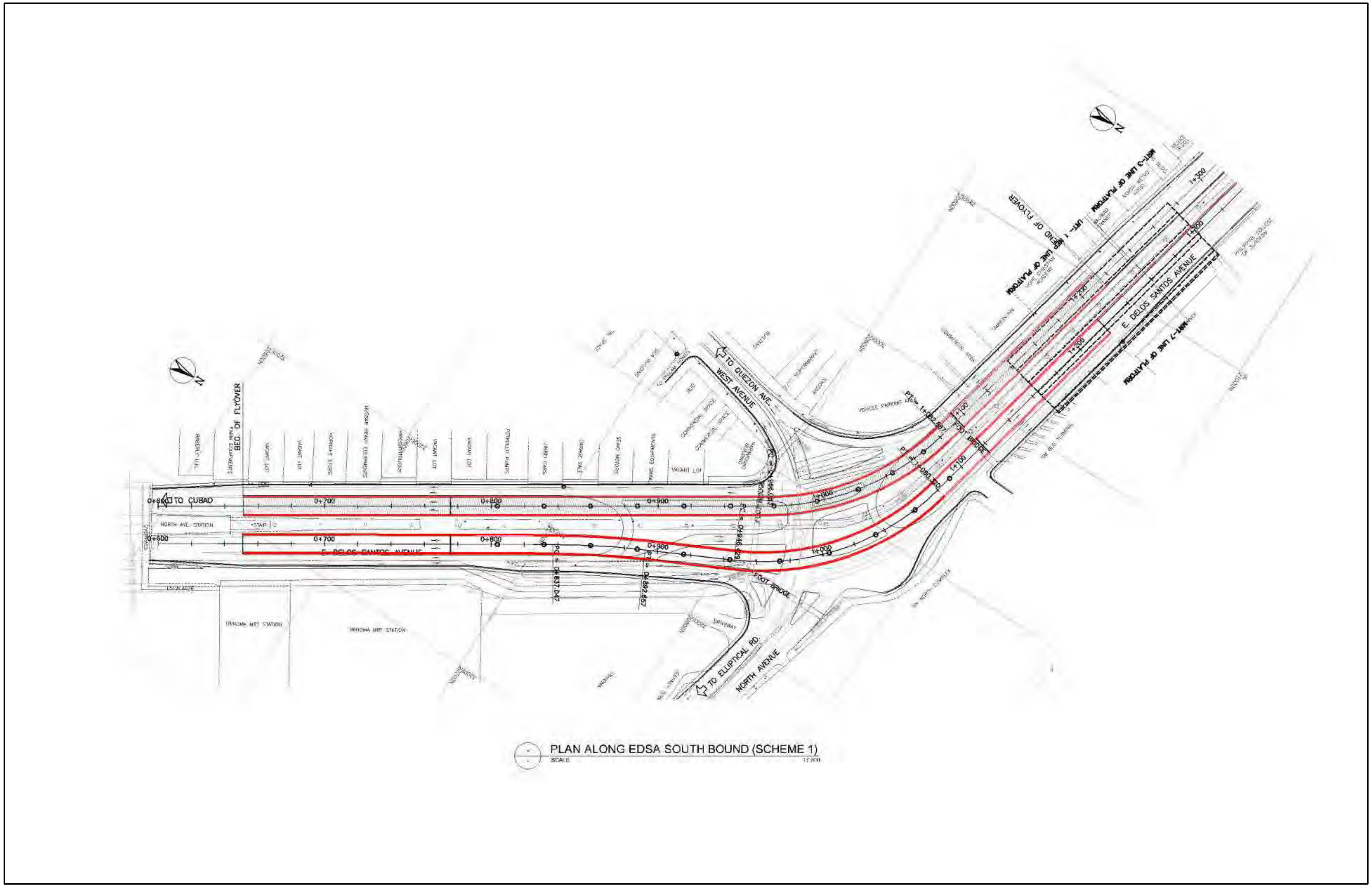

*Source: JICA Study Team*

**Figure 4.4-7 Plan and Profile North Bound (EDSA/North/West Interchange) (1/2)**



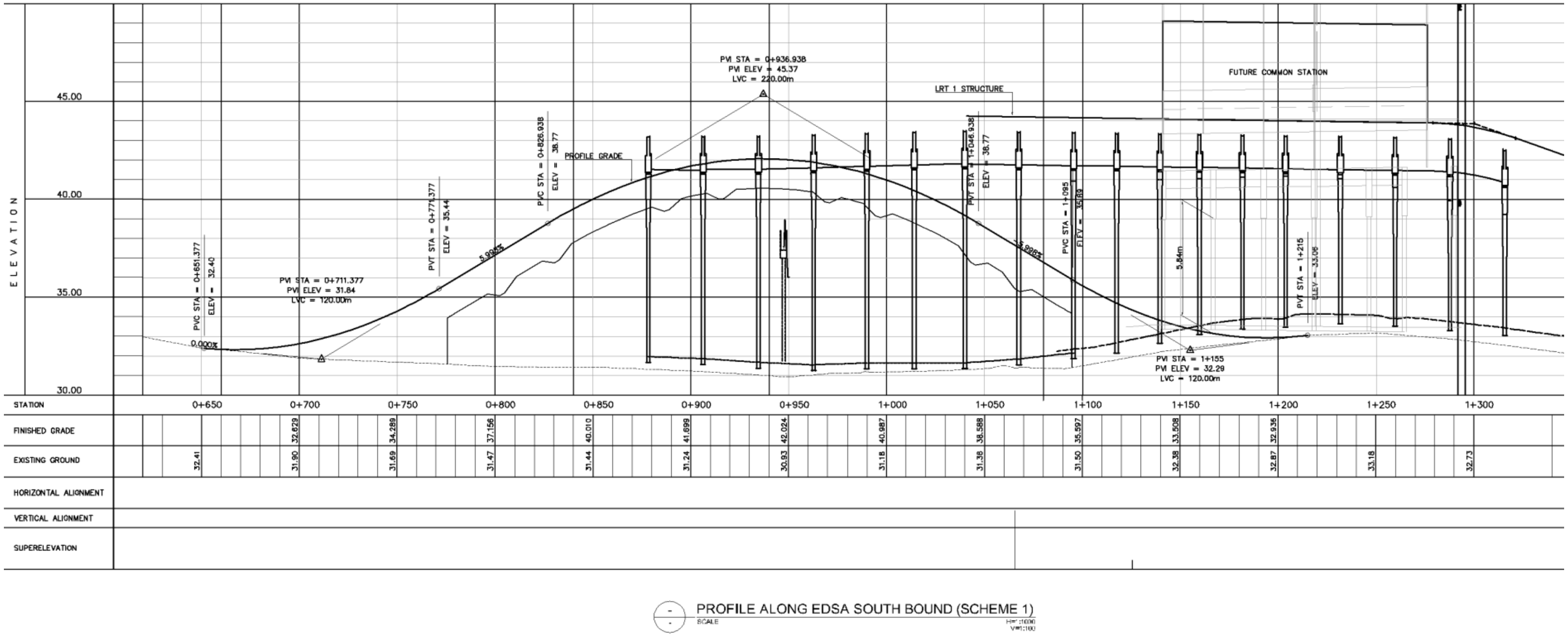

*Source: JICA Study Team*

**Figure 4.4-8 Plan and Profile North Bound (EDSA/North/West Interchange) (2/2)**



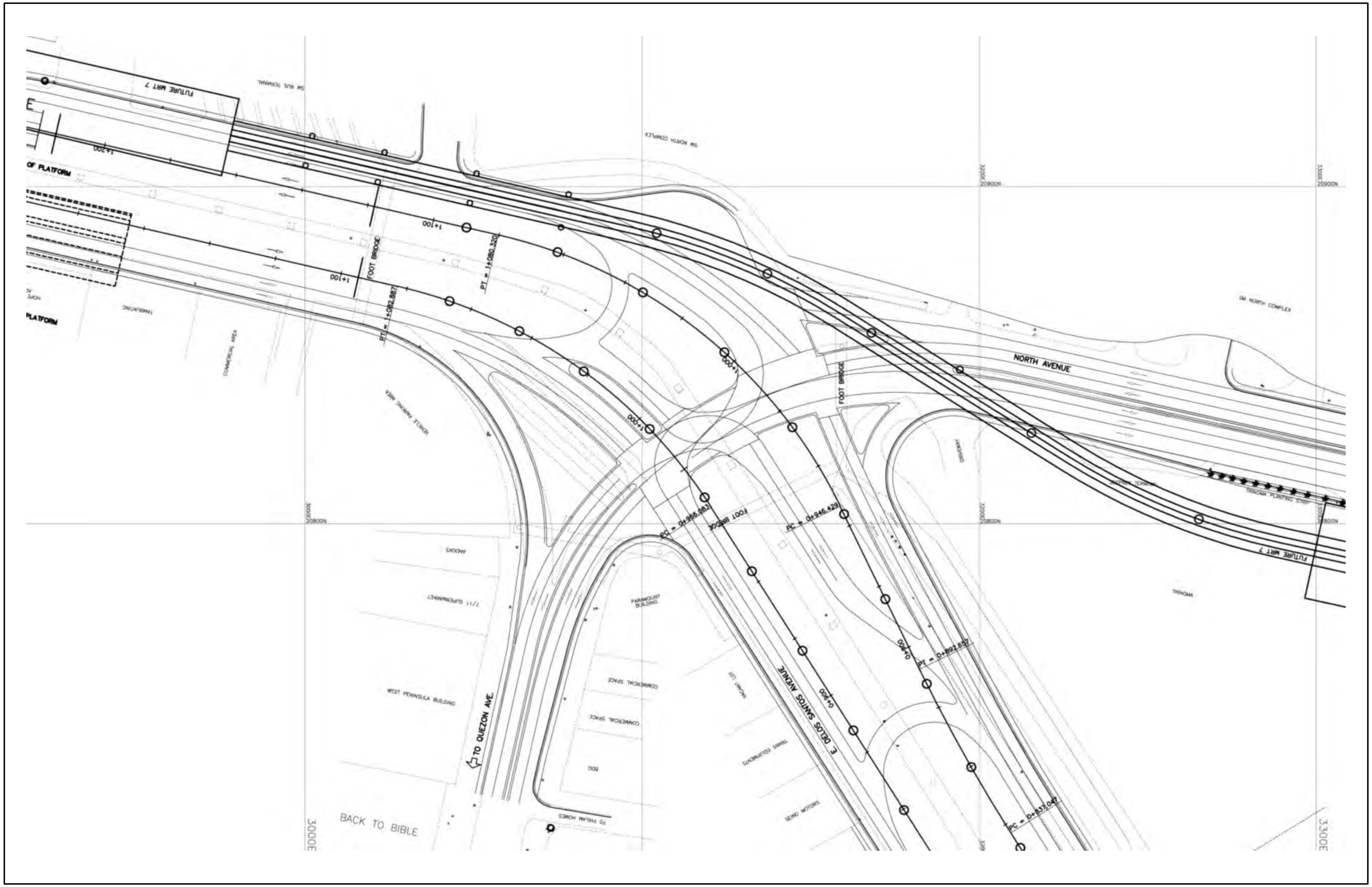

*Source: JICA Study Team*

**Figure 4.4-9 Plan and Profile South Bound (EDSA/North/West Interchange) (1/2)**



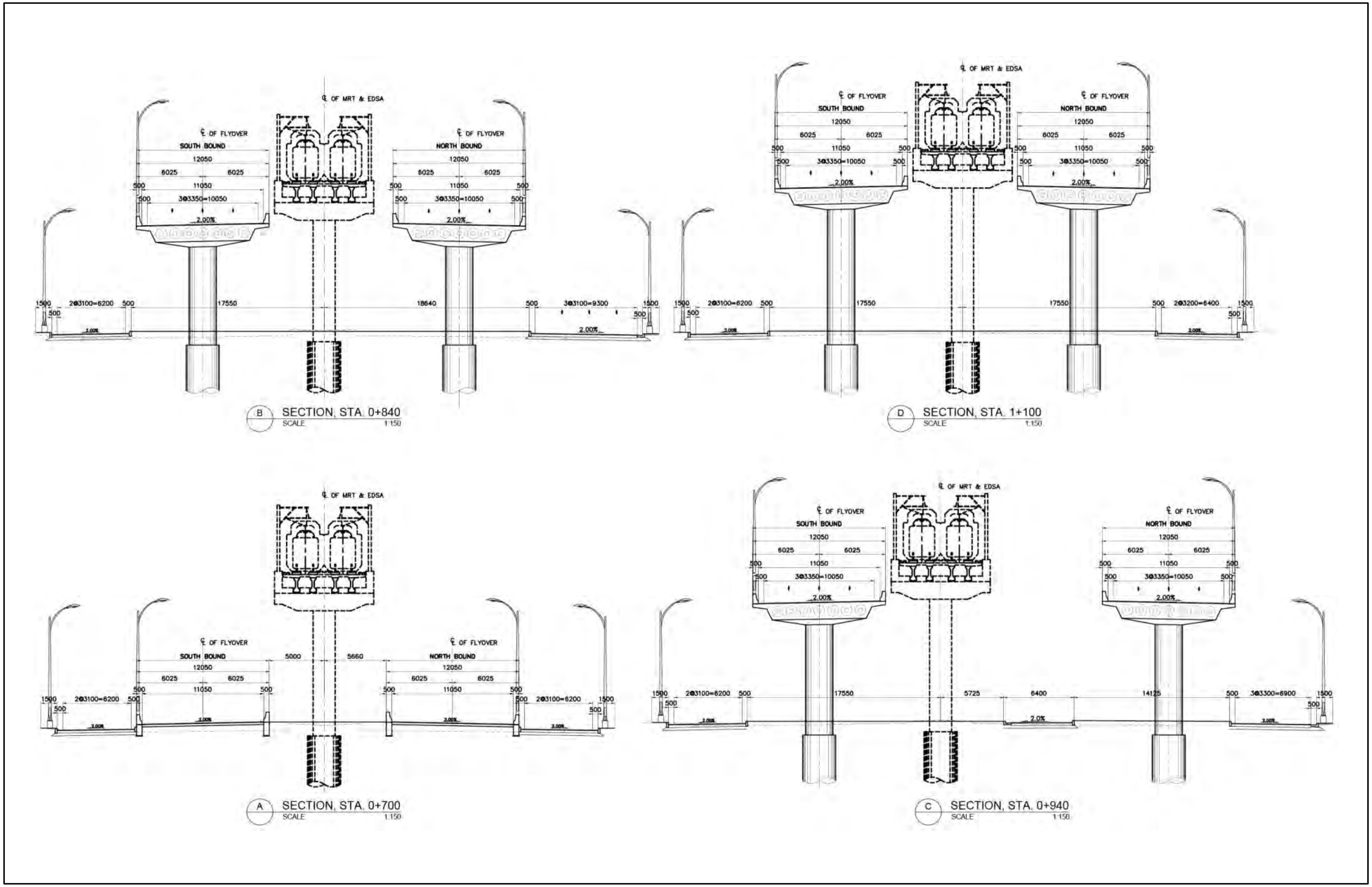

Source: JICA Study Team

**Figure 4.4-10 Plan and Profile South Bound (EDSA/North/West Interchange) (2/2)**



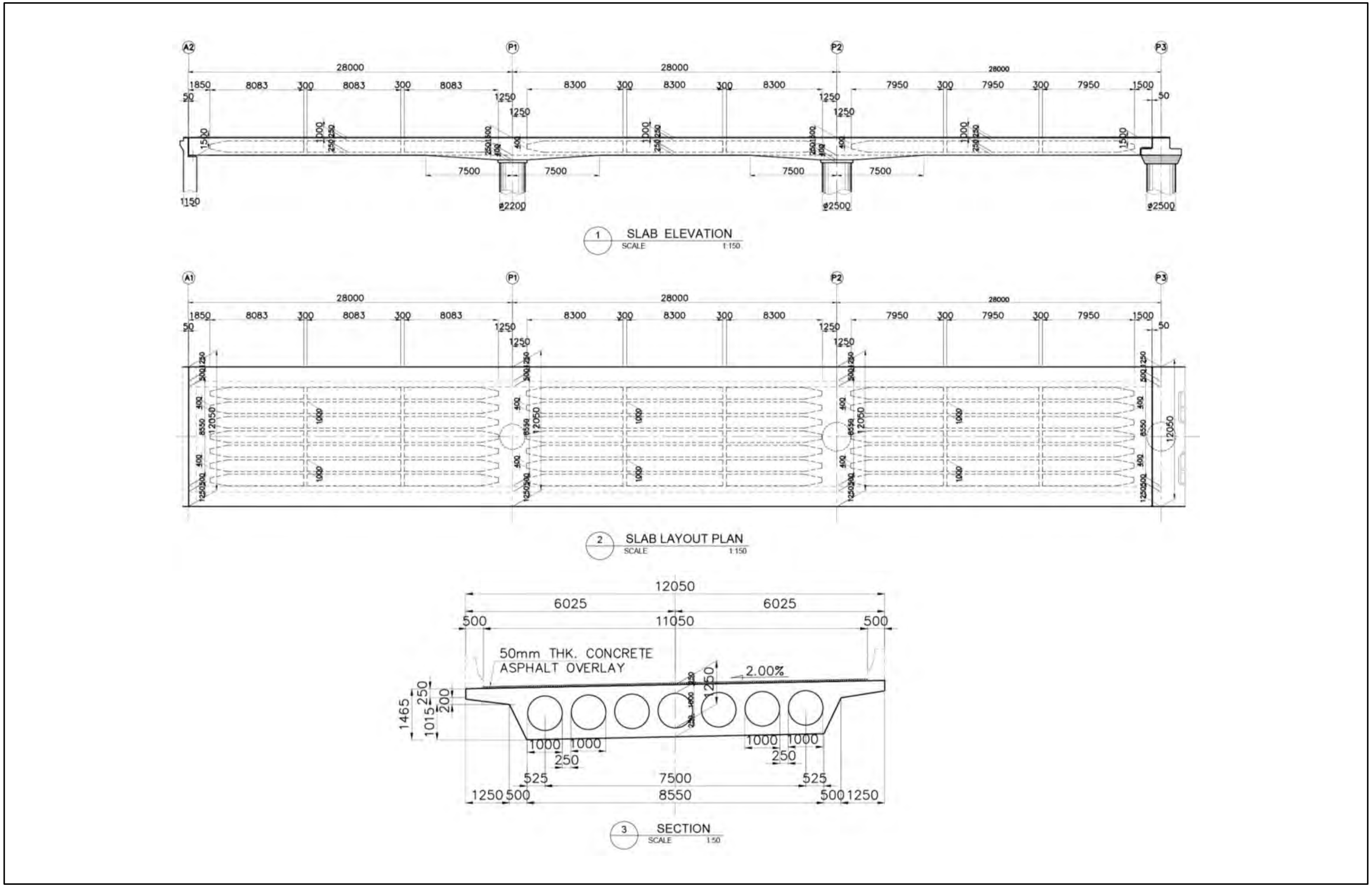

Source: JICA Study Team

**Figure 4.4-11 AT-Grade Intersection (EDSA/North/West Interchange)**



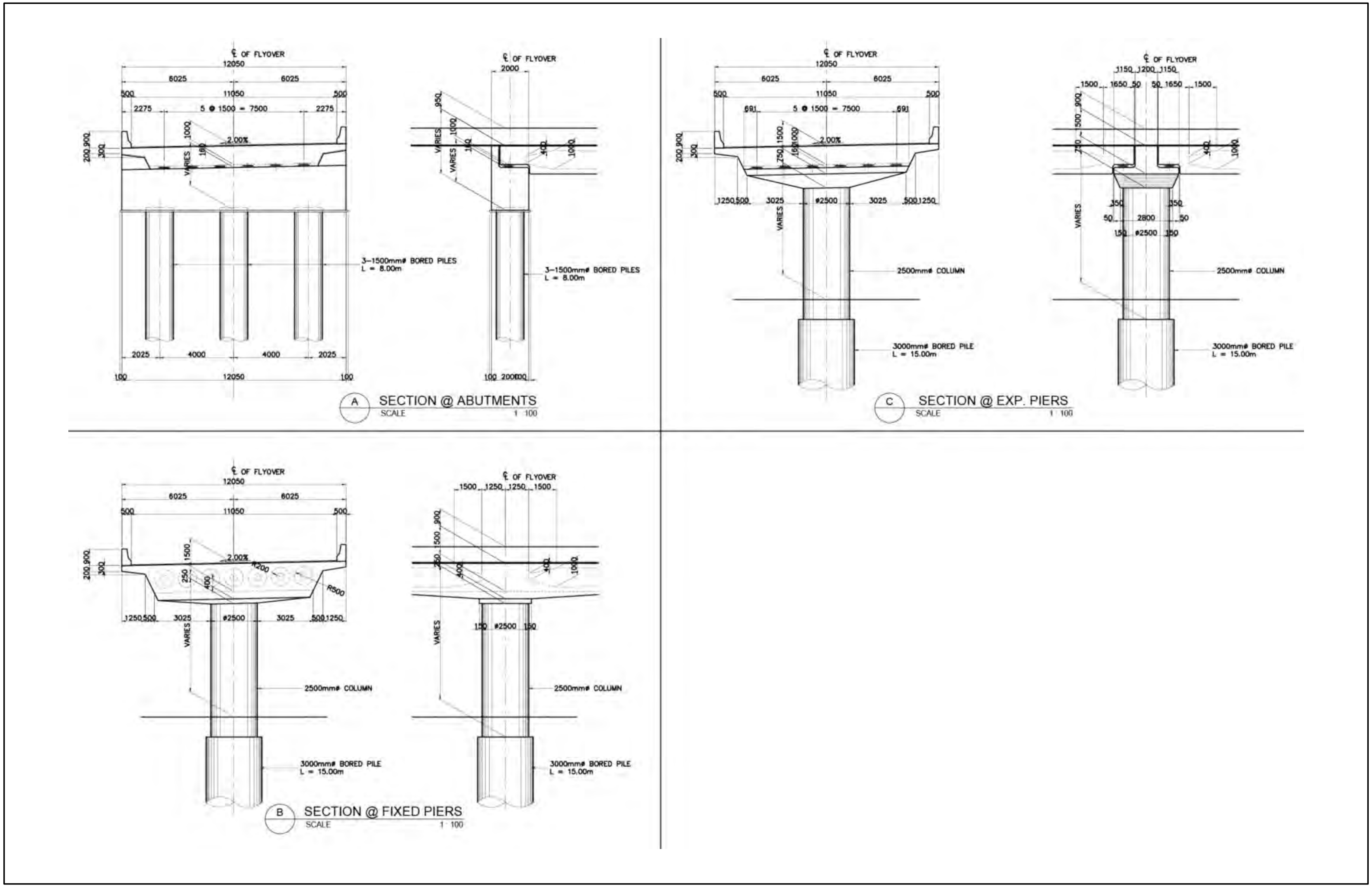

*Source: JICA Study Team*

**Figure 4.4-12 Typical Cross Sections (EDSA/North/West Interchange)**



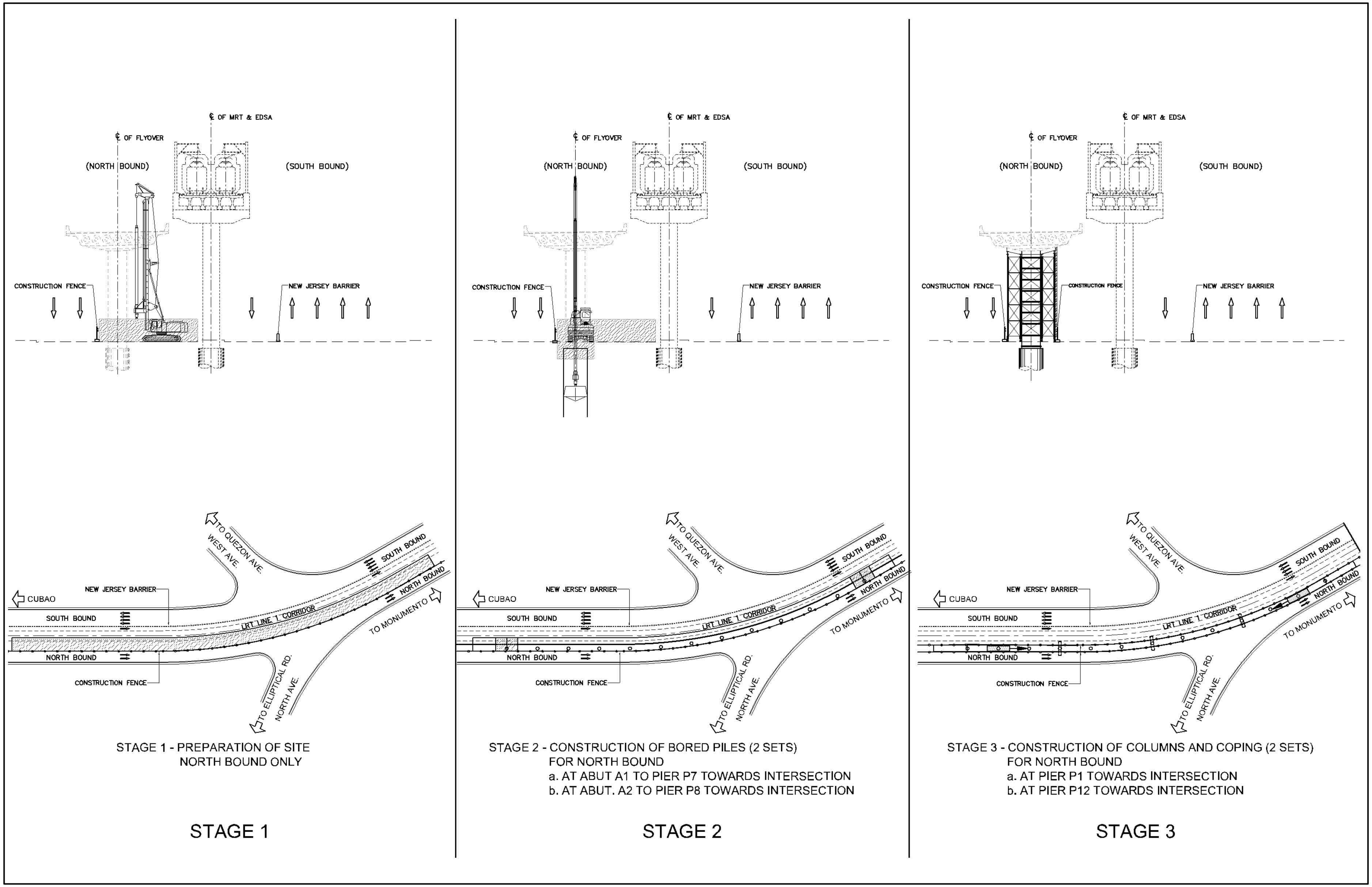

*Source: JICA Study Team*

**Figure 4.4-13 Slab Layout Plan (EDSA/North/West Interchange)**



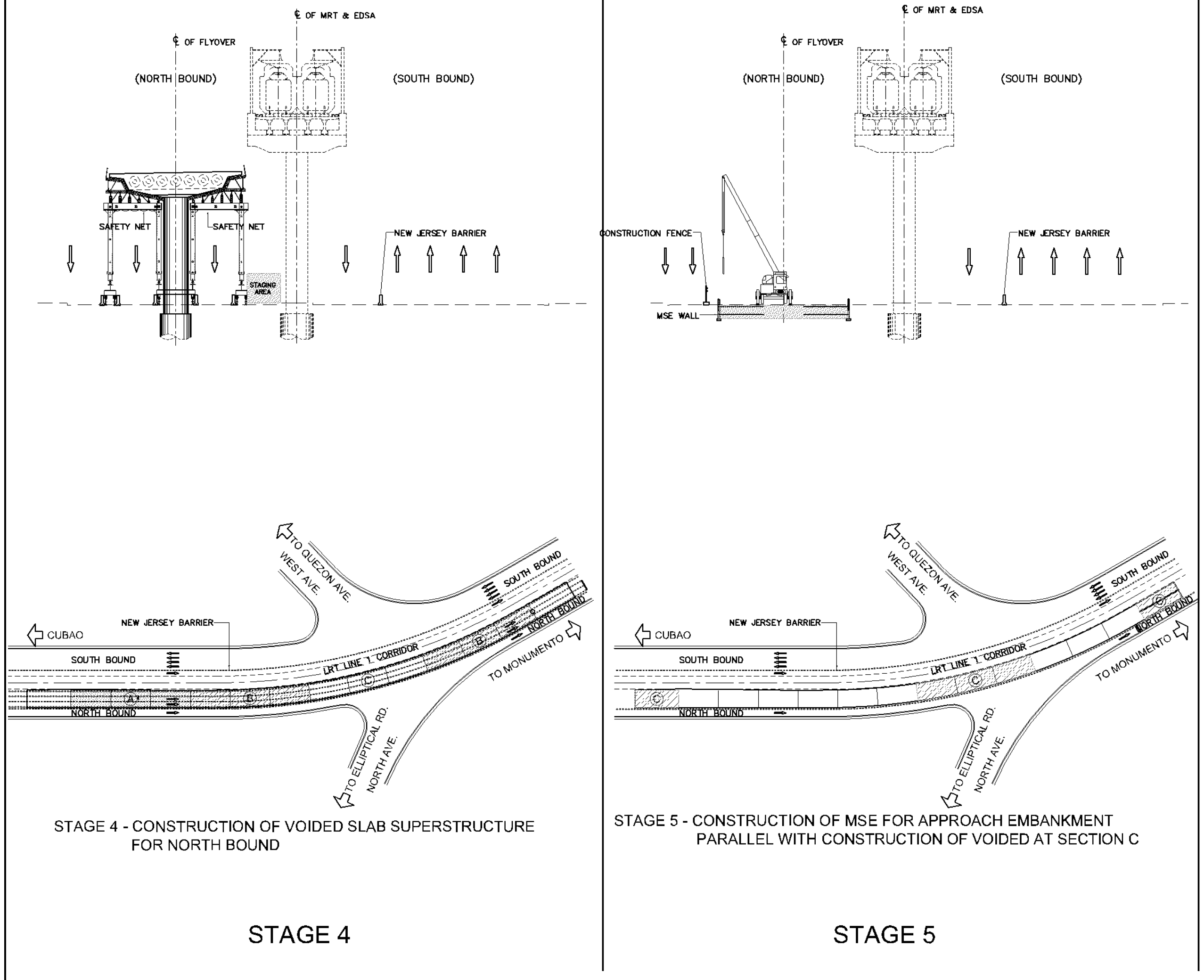

Source: JICA Study Team

**Figure 4.4-14 Structural General View (EDSA/North/West Interchange)**




*Source: JICA Study Team*

**Figure 4.4-15 Construction Plan for EDSA/North/West Interchange (1/2)**




CONSTRUCTION SEQUENCE

A. PREPARATION OF SITE

B. CONTRUCTION OF BORED PILES (2 SETS)
  a. AT ABUT. A1 TOWARDS INTERSECTION
  b. AT ABUT. A2 TOWARDS INTERSECTION

C. CONSTRUCTION OF COLUMNS
  a. AT ABUT. A1 TOWARDS INTERSECTION
  b. AT ABUT. A2 TOWARDS INTERSECTION

D. CONSTRUCTION OF COPING
  a.AT ABUT. A1 TOWARDS INTERSECTION
  b.AT ABUT. A2 TOWARDS INTERSECTION

E. CONSTRUCTION OF SUPERSTRUCTURE
  ( VOIDED SLAB )

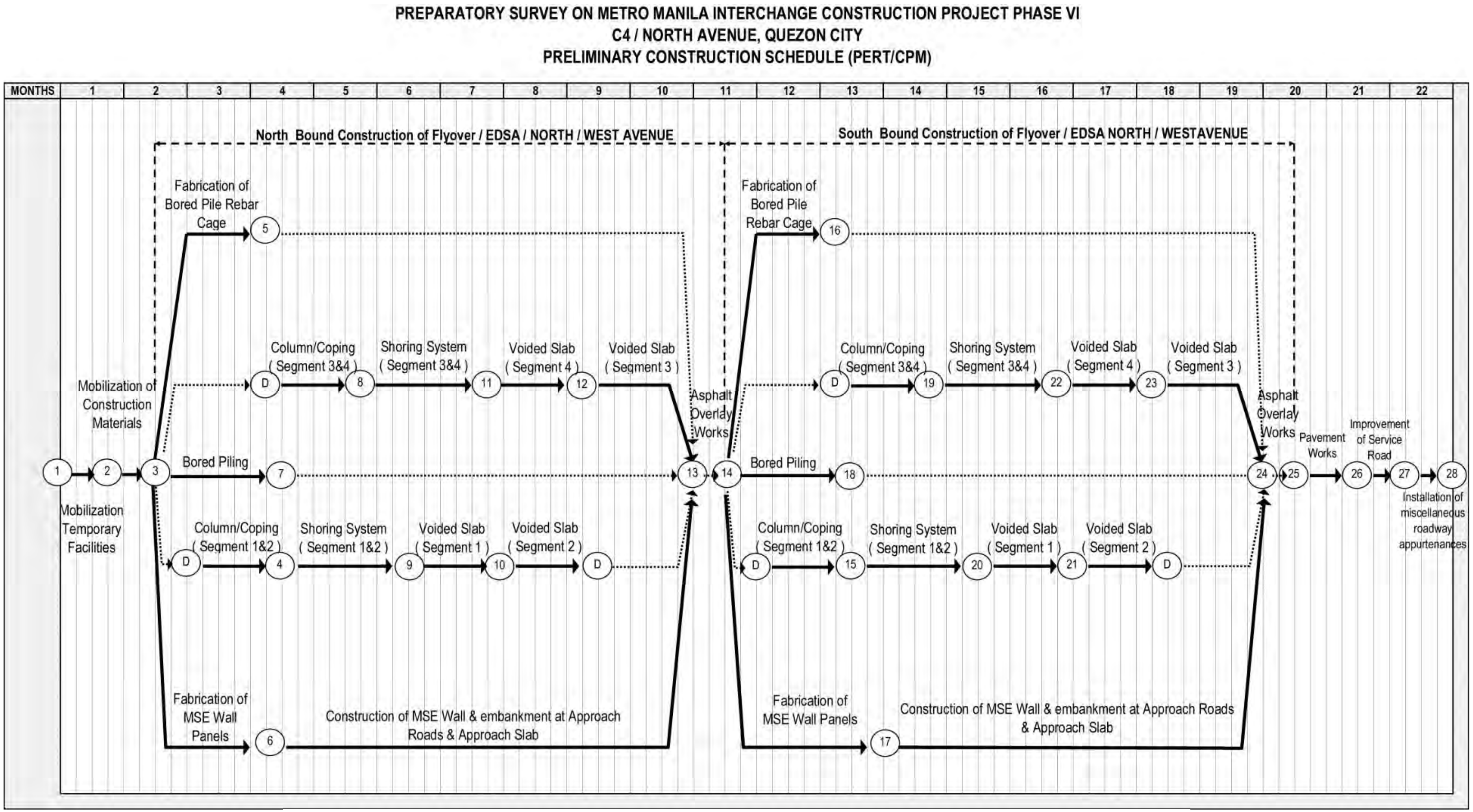
F. CONSTRUCT MSE WALL

NOTE :

THE SEQUENCE OF CONSTRUCTION FOR SOUTH BOUND SHALL BE THE SAME AS AND WILL FOLLOW AFTER NORTH BOUND CONSTRUCTION.

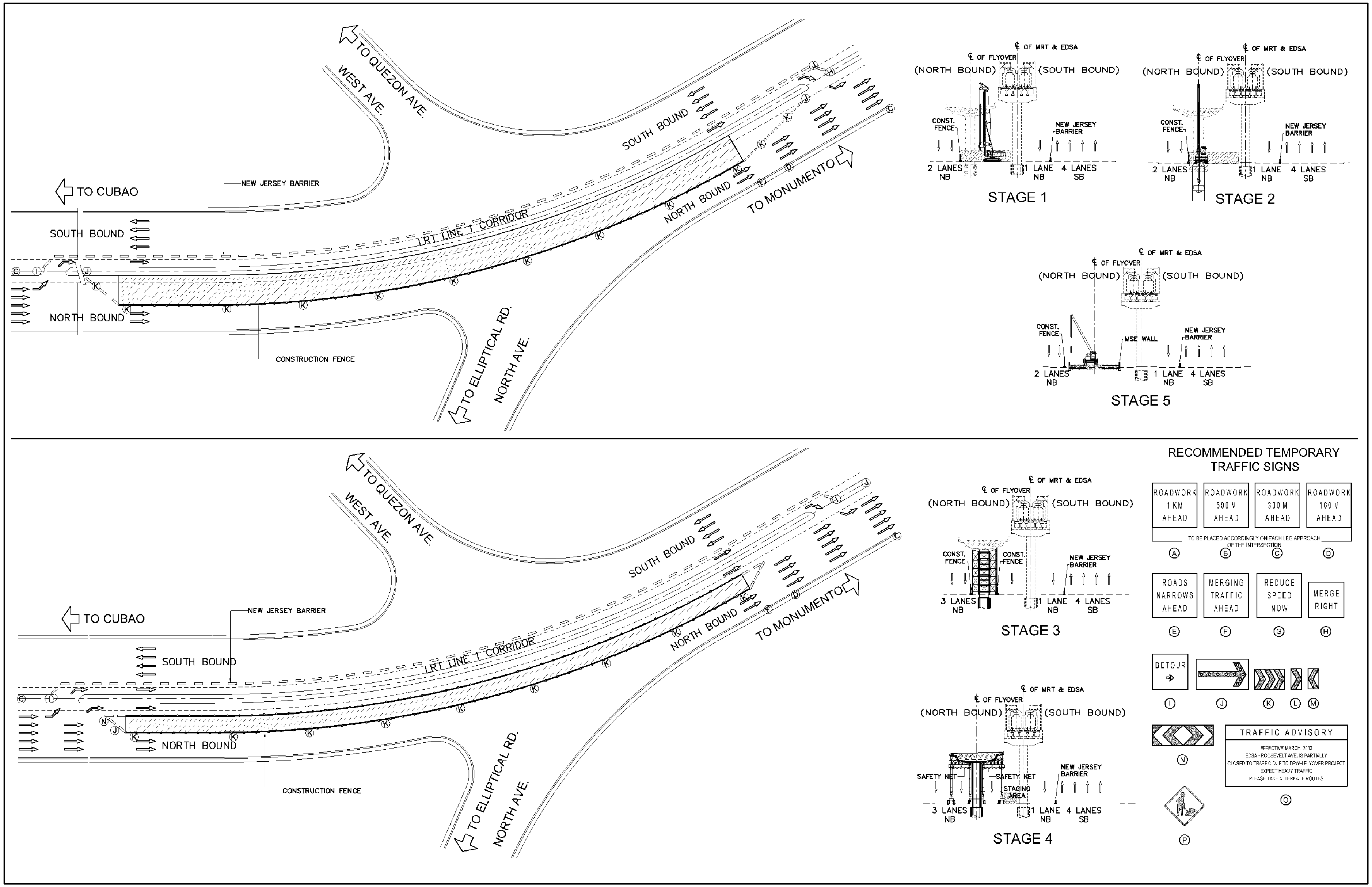
*Source: JICA Study Team*

**Figure 4.4-16 Construction Plan for EDSA/North/West Interchange (2/2)**



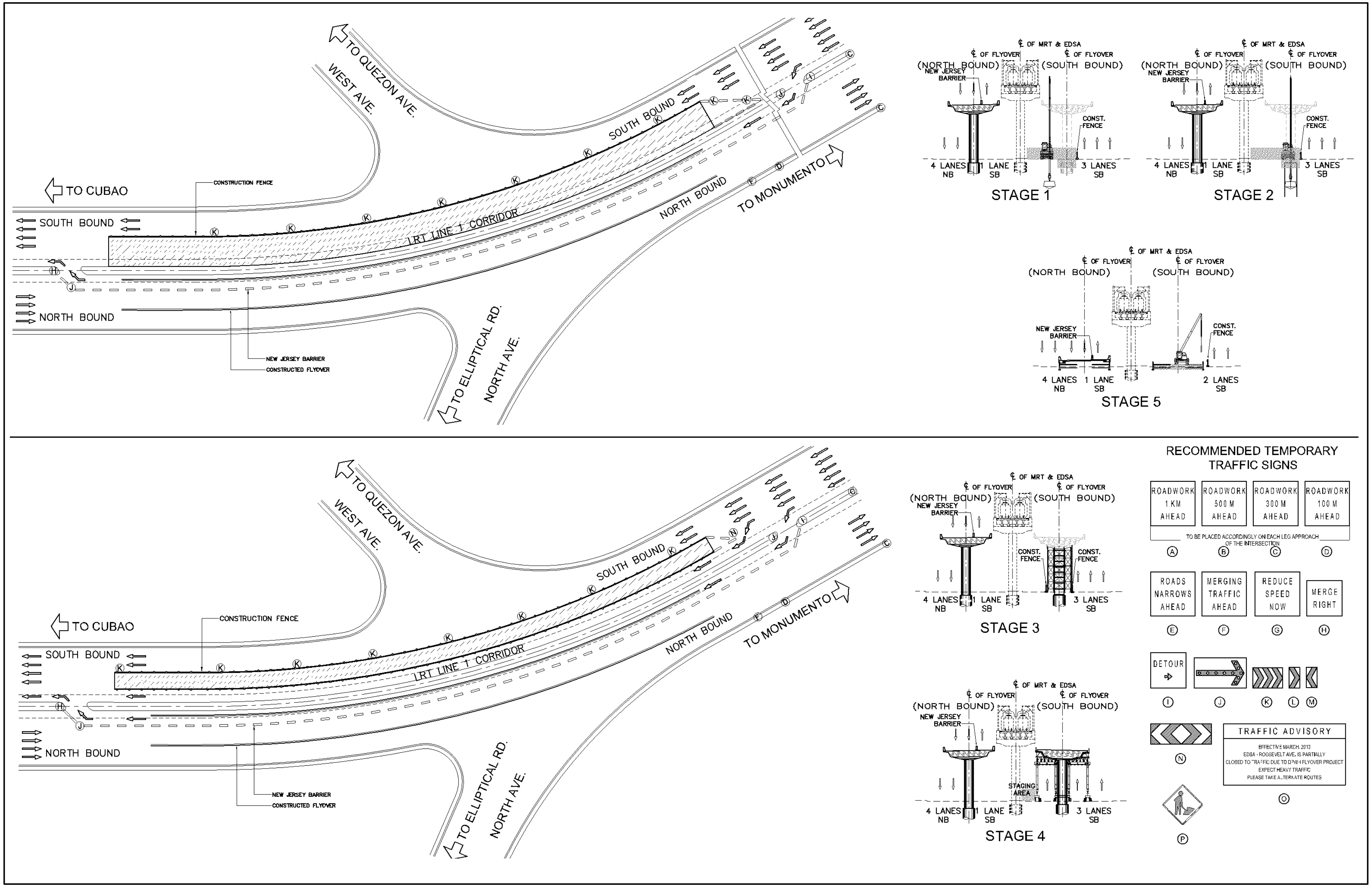

*Source: JICA study team*

**Figure 4.4-17 Pert CPM for EDSA/North/West Interchange**




Source: JICA Study Team

**Figure 4.4-18 Traffic Management for EDSA/North/West Interchange (1/2)**




Source: JICA Study Team

**Figure 4.4-19 Traffic Management for EDSA/North/West Interchange (2/2)**

### 4.4.3 Preliminary Design (North/Mindanao Interchange)

#### (1) Comparative study

Based on the review of detailed design, up-dated site and traffic conditions and the added issue of proposed construction plan of MRT-7, comparative study considered the following conditions:

- Proposed construction of MRT-7 alignment and station in-front of Trinoma should be properly adjusted to consider the flyover and tunnel plan and design.
- The number of the traffic lanes for each of the schemes are 2 lanes.
- Type of superstructure should be designed as voided slab type to provide an aesthetic view of the flyover.

The following two (2) alternative schemes are proposed as the most suitable for comparison based on the above conditions and site and traffic conditions:

- Scheme-1 : Left turn flyover from North Ave to Mindanao Ave (3rd level) and left turn flyover from Mindanao Ave to North Ave (2nd level)
- Scheme-2 : Left turn cut and cover tunnel from North Ave to Mindanao Ave (under pass) and left turn flyover from Mindanao Ave to North Ave (2nd level)

Between two (2) schemes, scheme-2 was selected due to following reasons:

- Construction cost is cheaper
- Environment related conditions are better (aesthetic, noise and exhaust fumes)
- Traffic conditions are better (ensuring access to The Block SM North, EDSA)

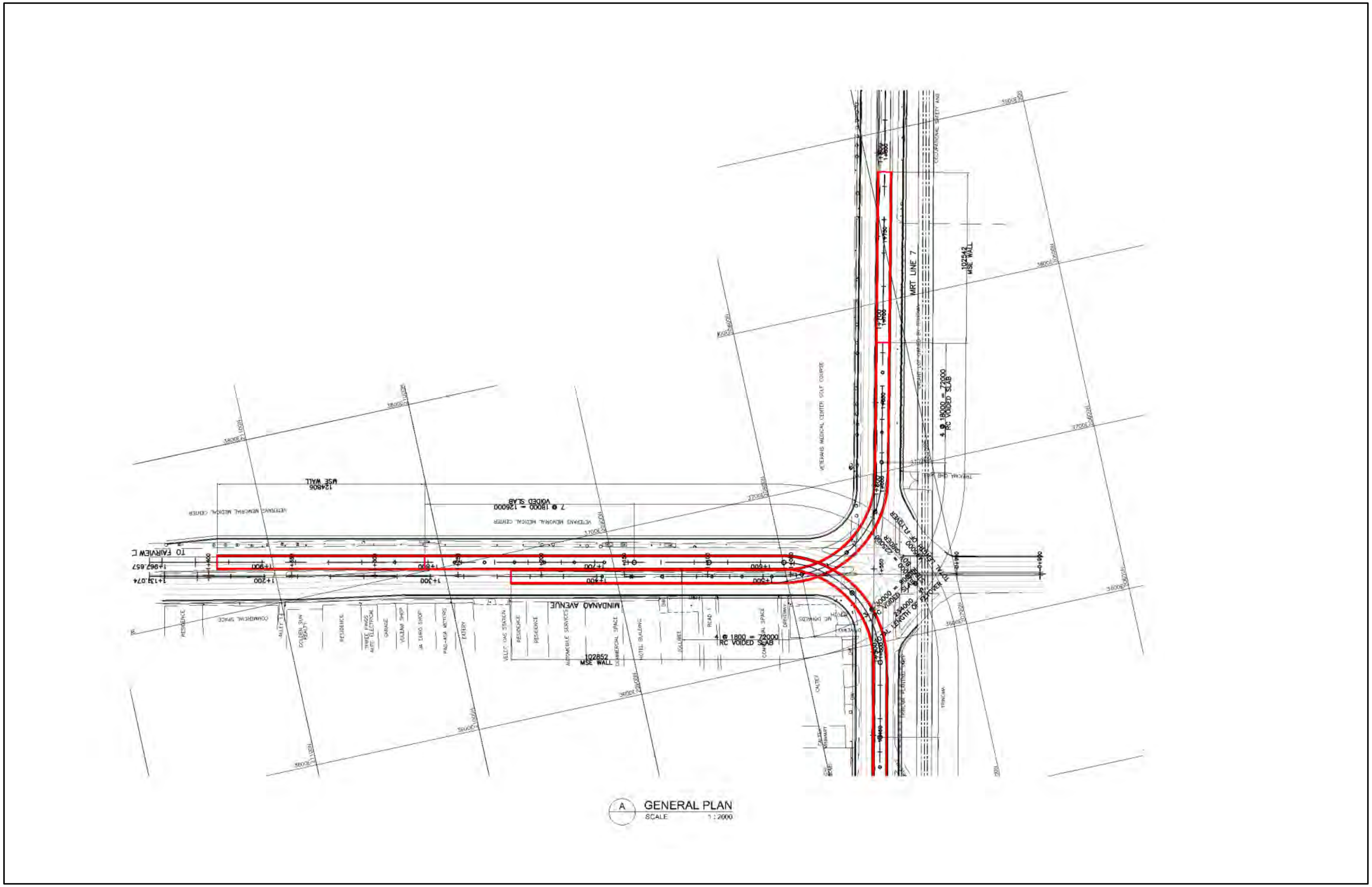
The comparison of Detailed Scheme is shown in **Table 4.4-3** and Plan and Profile of each scheme is shown in **Figures 4.4-16 ~ 21**

## Table 4.4-3 Scheme Comparison of North Ave. / Mindanao Ave. Interchange

| Description | Scheme-1 Left Turn Flyover North-Mindanao (3rd Level)<br>Left Turn Flyover Mindanao-North (2nd Level) | | Scheme-2 Left Turn North-Mindanao (Underpass)<br>Left Turn Flyover Mindanao-North (2nd Level) | |
|---|---|---|---|---|
| **Structure** | Flyover (N-M) : 495.0m 15@18.0m+5@45.0m (RC voided and steel box)<br>Approach: 214.5m<br>Flyover (M-N): 318m, 11@18.0m+4@30.0m (RC and PC voided slab)<br>Approach: 205.4m | | Tunnel : 95m+open section 363.5m<br>Flyover (M-N) : 318m, 11@18.0m+4@30.0m (RC and PC voided slab)<br>Approach : 205.4m | |
| **Construction Cost** | Flyover (N-M) : MP 402.3 (P960,000/m Steel, P720,000/m RC)<br>Flyover (M-N) : MP 190.8 (P600,000/m)<br>Approach : MP 25.2 (P60,000/m)<br>R.O.W. : MP 6.0 (5m x 30m x P40,000)<br>**Total MP 624.3 (109.0%)** | ○ | Tunnel : MP 347.9<br>Sump Pit : MP 20.0 (height:10m)<br>ROW : MP 4.0 (10m x 10m x P40,000)<br>Flyover : MP 190.8 (MP 600,000/m)<br>Approach : MP 12.3 (MP 60,000/m)<br>**Total MP 575.0 (100.0%)** | ◎ |
| **Construction Performance and Duration** | **26 months**<br>● Construction method is standard but complicated due to double flyovers<br>● Requires steel box girder due to over the 3rd level flyover | △ | **24 months**<br>● Construction method is standard but complicated due to 2-layer of structure<br>● Requires special construction method and procedure for const. of sump pit | ○ |
| **Environmental and Social Condition** | ● Aesthetic view is worthier than scheme-2<br>● Requires R.O.W at the entrance of 3rd level flyover along North Ave.<br>● Noise and exhaust fumes are greater than scheme-2 due to long and steep slope | △ | ○ Aesthetic view is better than scheme-1<br>○ Requires R.O.W acquisition for sump pit location<br>○ Noise an exhaust fumes are smaller than scheme-1 | ◎ |
| **Traffic Condition at Grade I/C** | ● Close access to The Block SM Edsa<br>● Restrict section is longer than scheme-2 | △ | ○ No close access to The Block SM North Edsa<br>○ Restict section is shorter than Scheme-1 | ◎ |
| **O & M** | ● Requires painting for steel members which is harder due to above road and flyover | ○ | ● Requires periodic monitoring and maintenance of water pump up system | ○ |
| **Overall Evaluation** | ● Construction cost expensive than scheme-2<br>● Constructionof 3rd level steel box girder is complicated<br>● Environmental condition is worthier than scheme-2<br>● Traffic condition is worthier than scheme-2 | ○ | ○ Construction cost is cheaper than scheme-1<br>● Requires special construction method and procedure for const. of sump pit<br>○ Environmental issue is much better than scheme-1<br>○ Traffic condition is better than scheme-1 | ◎ |

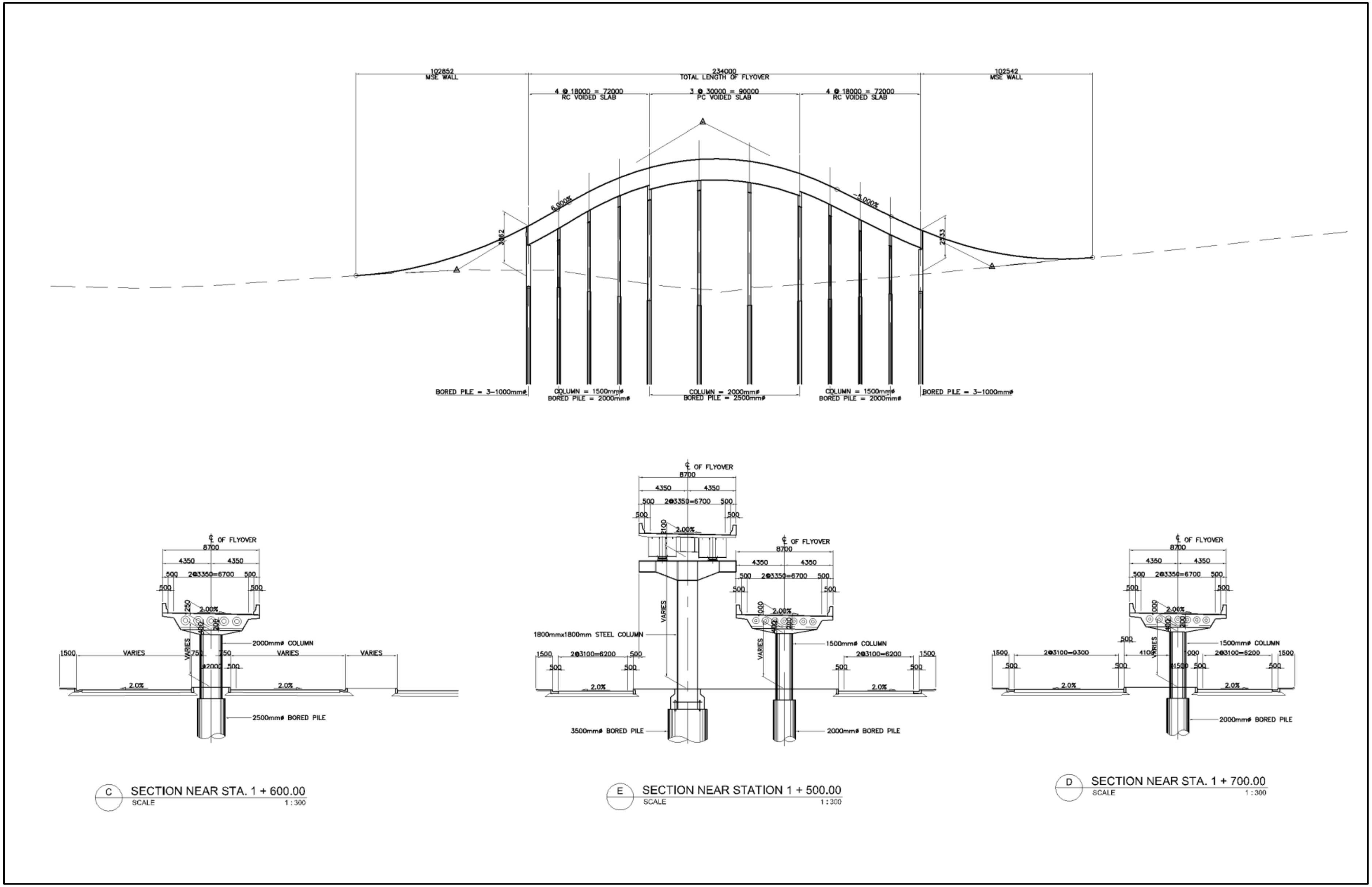
**LEGEND :** ○ **advantage**
●**disadvantage**

*Source: JICA Study Team*



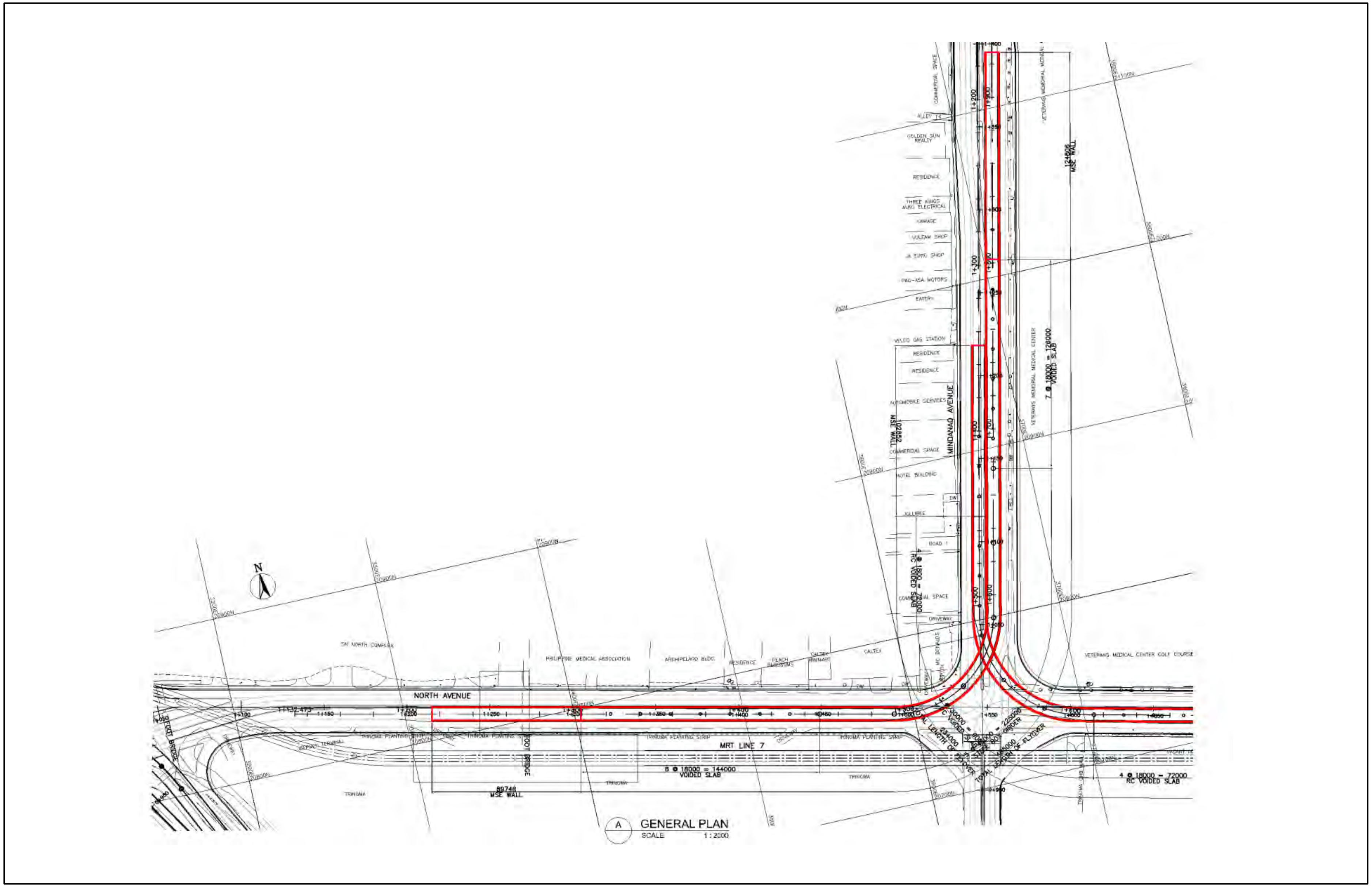

*Source: JICA Study Team*

**Figure 4.4-20 Plan and Profile of Scheme-1 & 2 Second Level Flyover (Common North/Mindanao Ave.) (1/2)**



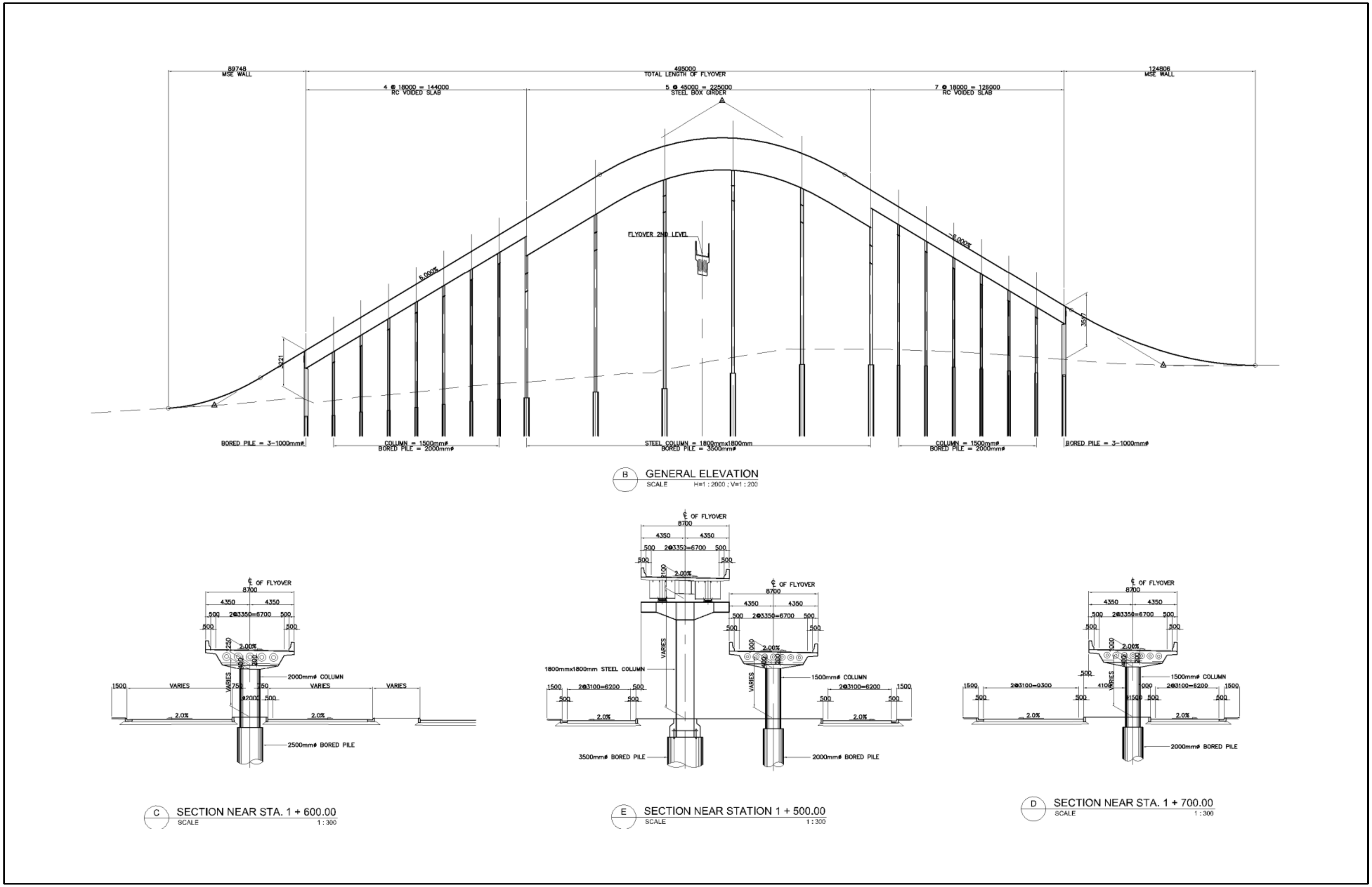

*Source: JICA Study Team*

**Figure 4.4-21 Plan and Profile of Scheme -1 & 2 Second Level Flyover (Common North/Mindanao Ave.) (2/2)**



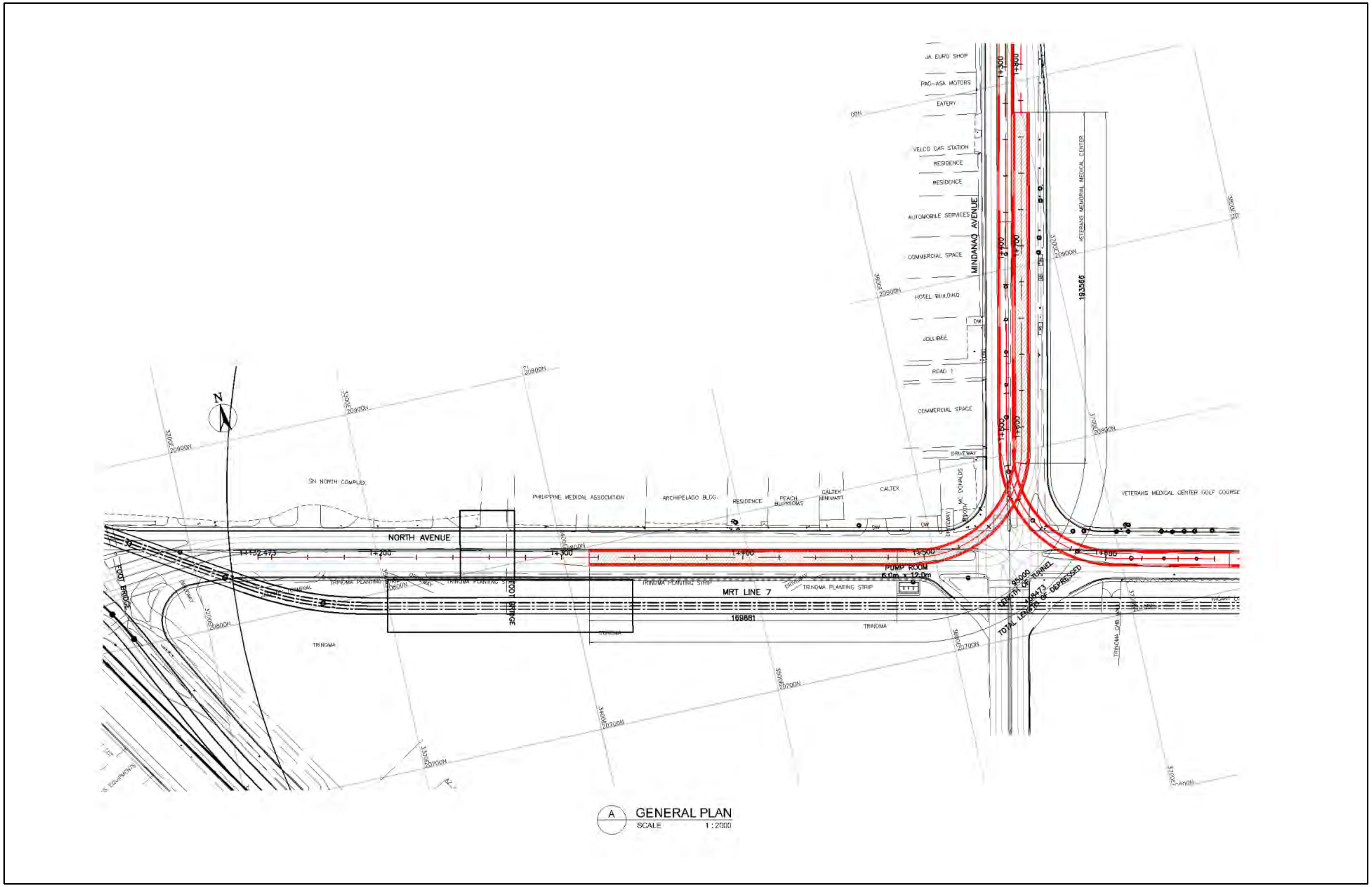

Source: JICA Study Team

**Figure 4.4-22 Plan and Profile of Scheme -1 3rd Level Flyover (North/Mindanao Ave.) (1/2)**



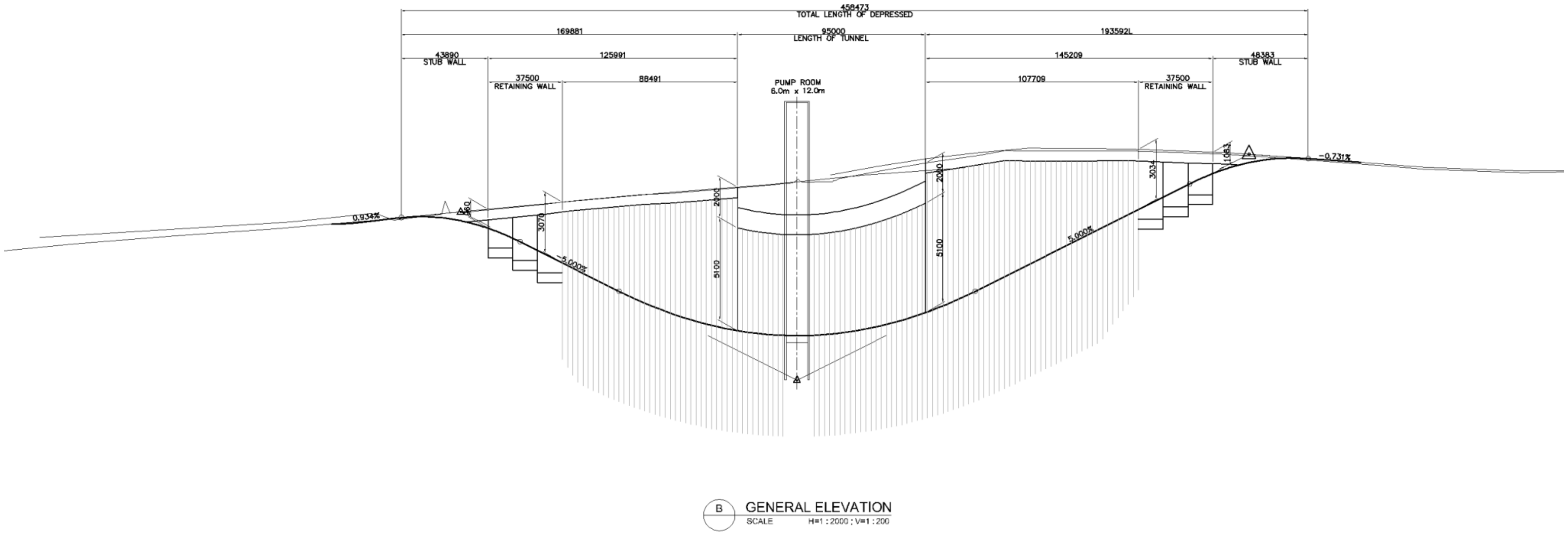

Source: JICA Study Team

**Figure 4.4-23 Plan and Profile of Scheme -1 3rd Level Flyover (North/Mindanao Ave.) (2/2)**



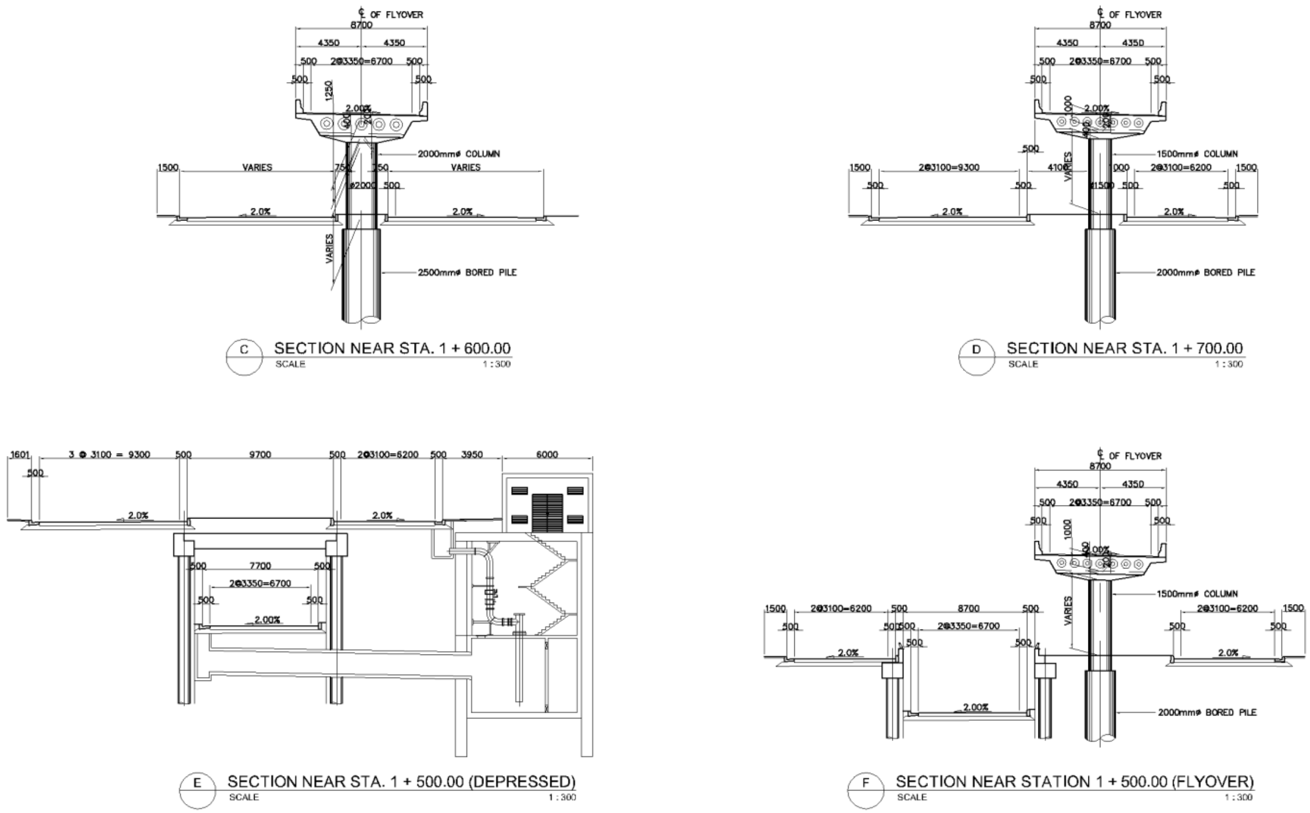

Source: JICA Study Team

**Figure 4.4-24 Plan and Profile of Scheme -2 Cut and Cover Tunnel (North/Mindanao Ave.) (1/3)**




*Source: JICA Study Team*

**Figure 4.4-25 Plan and Profile of Scheme -2 Cut and Cover Tunnel (North/Mindanao Ave.) (2/3)**




*Source: JICA Study Team*

**Figure 4.4-26 Plan and Profile of Scheme -2 Cut and Cover Tunnel (North/Mindanao Ave.) (3/3)**

**(2) Preliminary Design of Selected Scheme**

Scheme-2, combination of left turn flyover from Mindanao Avenue to North Avenue and left turn cut and cover tunnel from North Avenue to Mindanao Avenue was selected based on the comparative study. The concept of preliminary design of the selected scheme is as follows:

1) Voided slab type bridge should be adopted for superstructure to consider aesthetic view of flyover.

2) One (1) column type pier foundation should be adopted for the flyover design to maximize the usability and usage of the spaces underneath the flyover.

3) 6% of vertical grade should be adopted for both sides of the flyover approaches to minimize the flyover length.

4) 5% of vertical grade should be adopted for both sides of the tunnel approaches to consider traffic safety (less sight distance compared to flyover).

5) MSE wall should be adopted as retaining wall at both sides of the flyover approaches to minimize its affects on traffic during construction as well as provide an aesthetic view.

6) Provide signalized traffic management at the at-grade intersection.

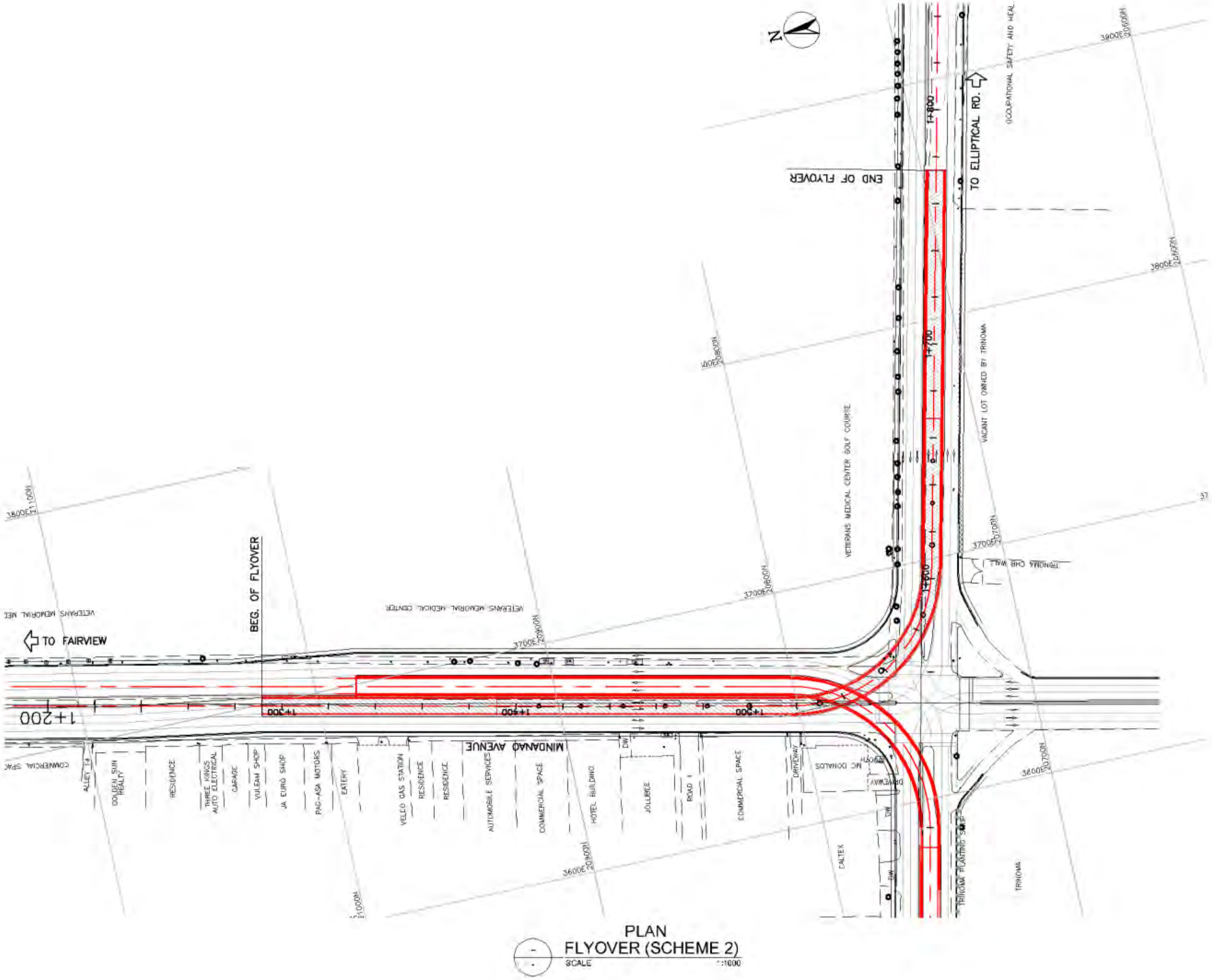
7) Minimize RROW requirement for sump pit construction.

Plan and profile, at-grade intersection plan, typical cross sections, slab layout plan and structural general view are shown in **Figures 4.4-22 ~ 28**

**(3) Construction Plan and Traffic Management during Construction**

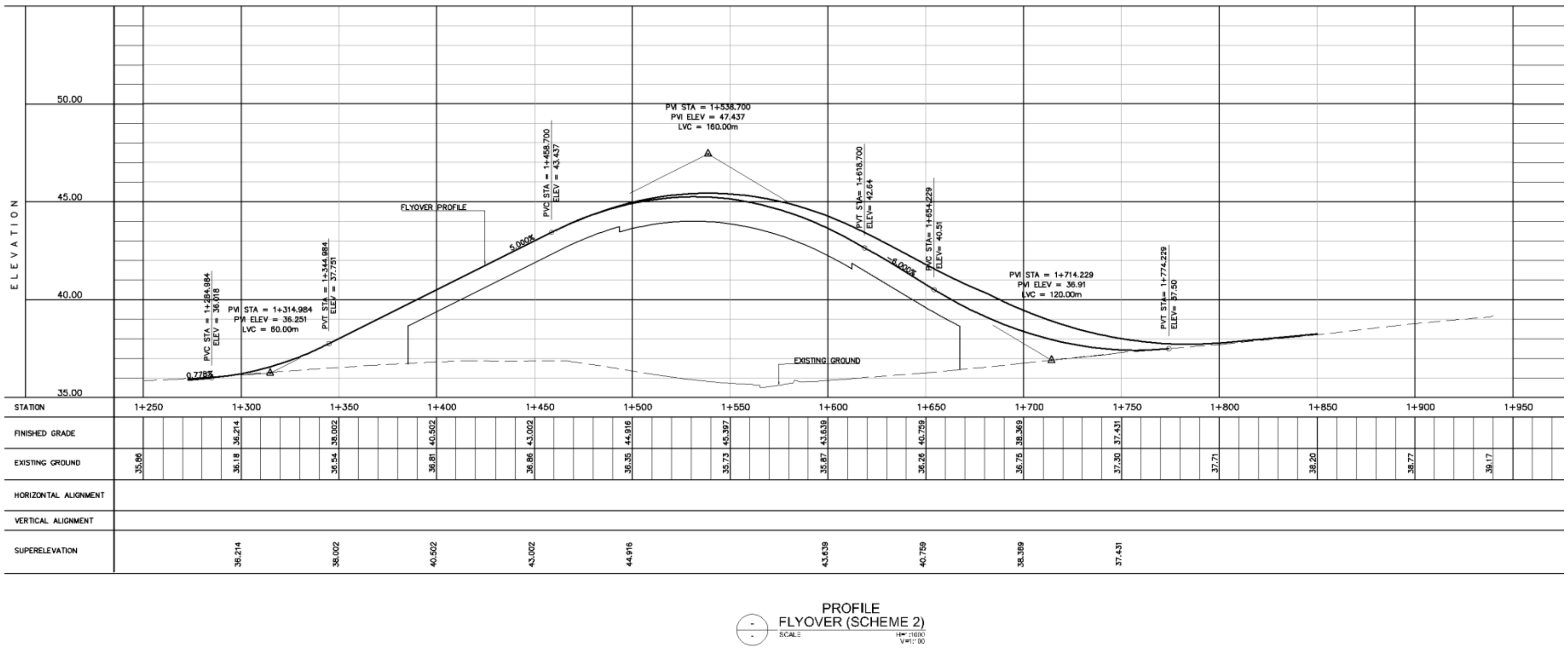
1) Construction Plan and PERT CPM for North/Mindanao interchange have been studied as shown in **Figures 4.4-29** ~ **32**

2) Traffic Management plan during construction for North/Mindanao interchange have been studied as presented in **Figure 4.4-33.**



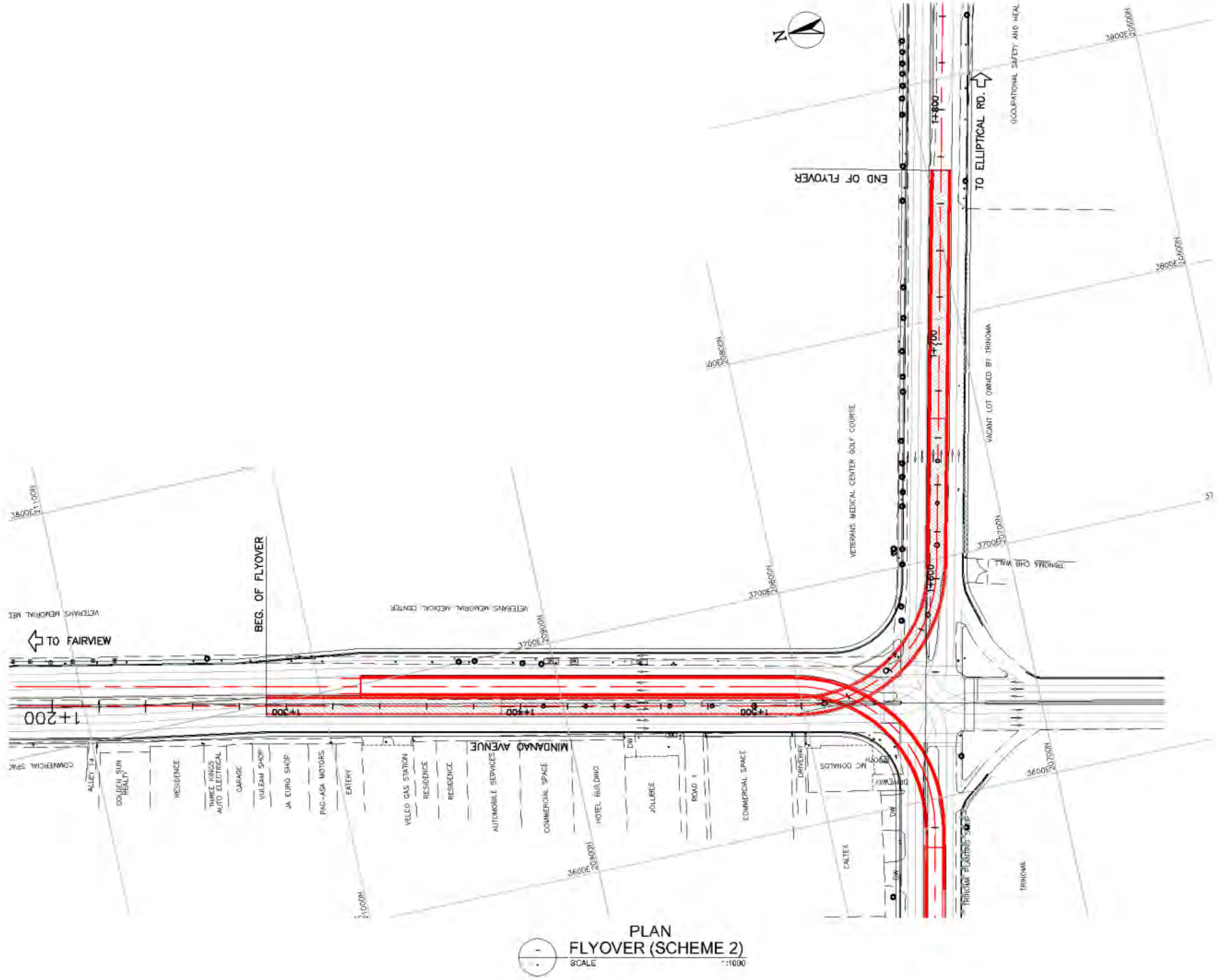

Source: JICA Study Team

**Figure 4.4-27 Plan and Profile of Flyover (North/Mindanao Ave.)**



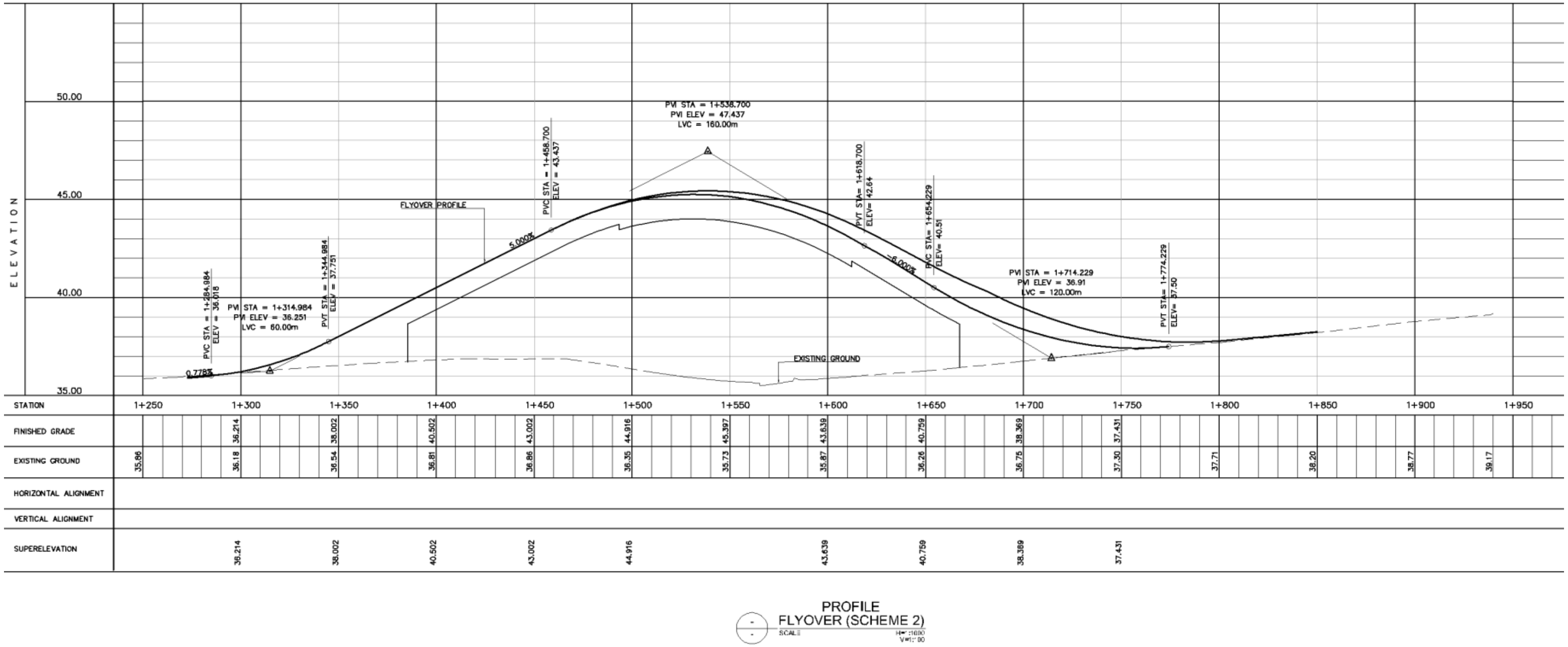

*Source: JICA Study Team*

**Figure 4.4-28 Plan and Profile of Cut and Cover Tunnel (North/Mindanao Ave.)**



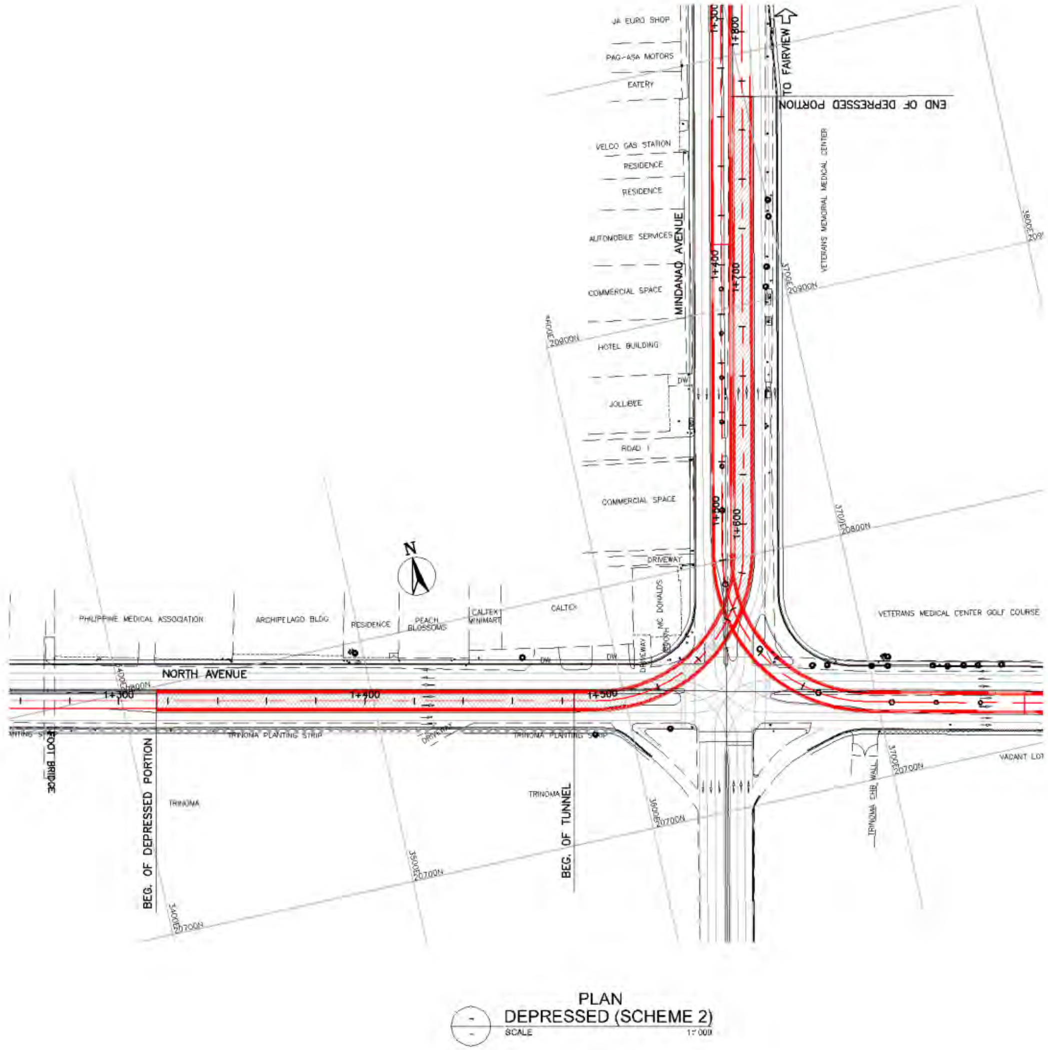

Source: JICA Study Team

**Figure 4.4-29 Plan and Profile of Flyover (North/Mindanao Ave.) (1/2)**



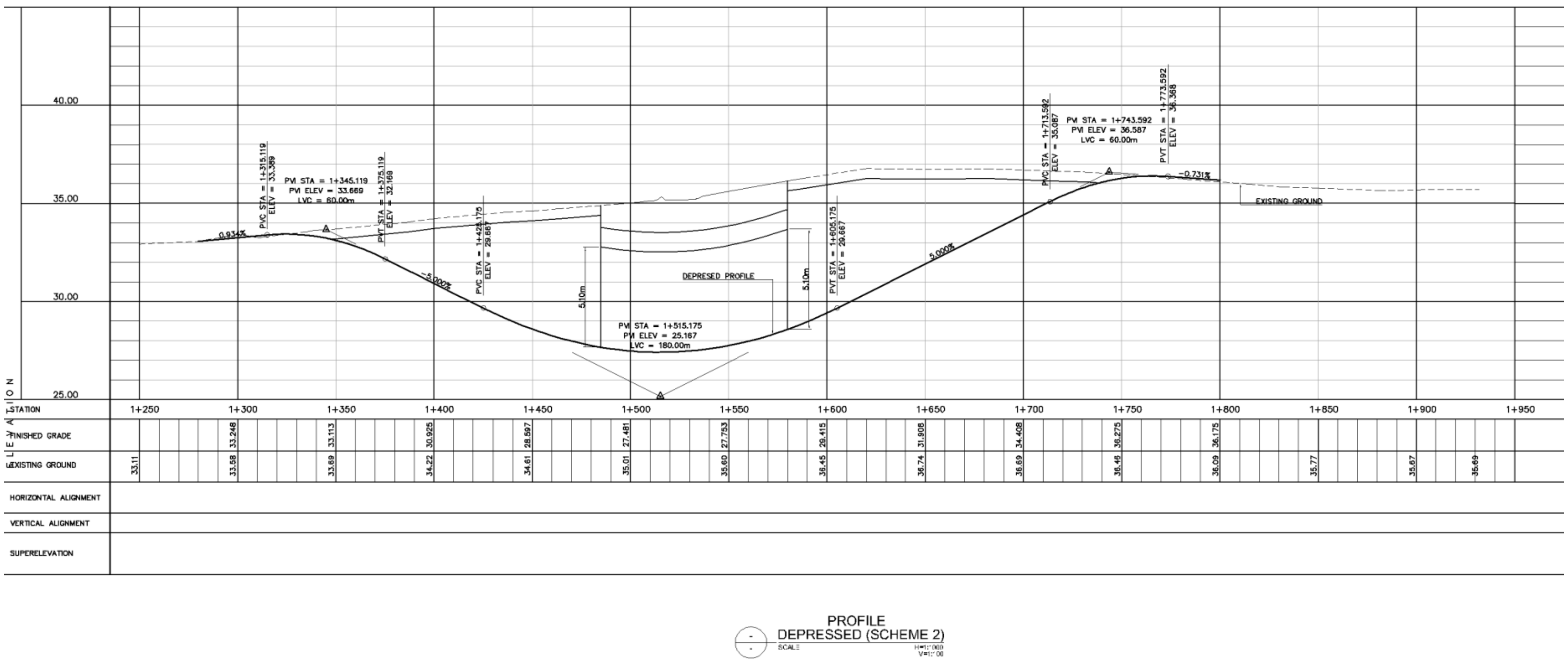

*Source: JICA Study Team*

**Figure 4.4-30 Plan and Profile of Flyover (North/Mindanao Ave.) (2/2)**



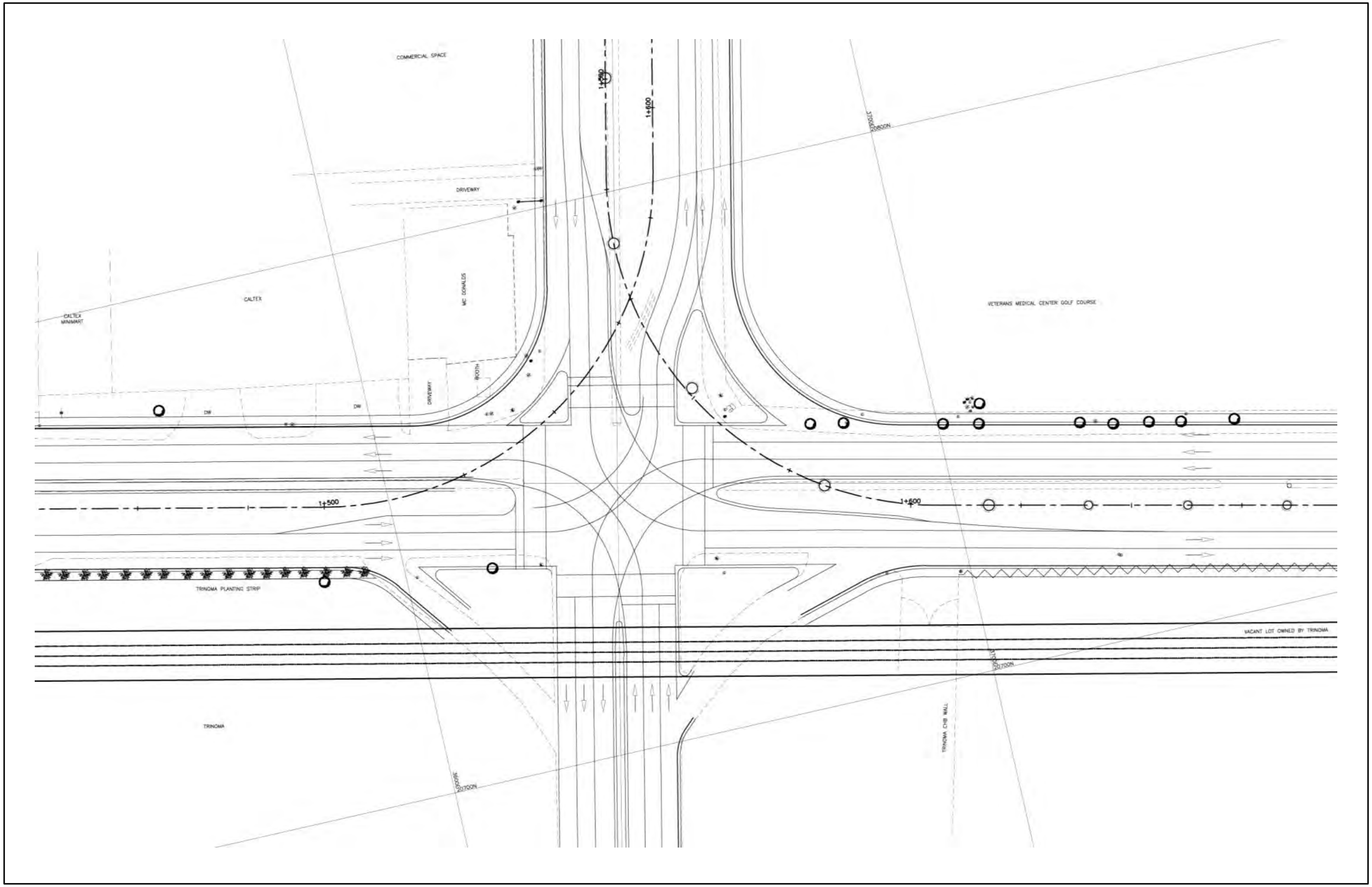

*Source: JICA Study Team*

**Figure 4.4-31 Plan and Profile of Cut and Cover Tunnel (North/Mindanao Ave.) (1/2)**



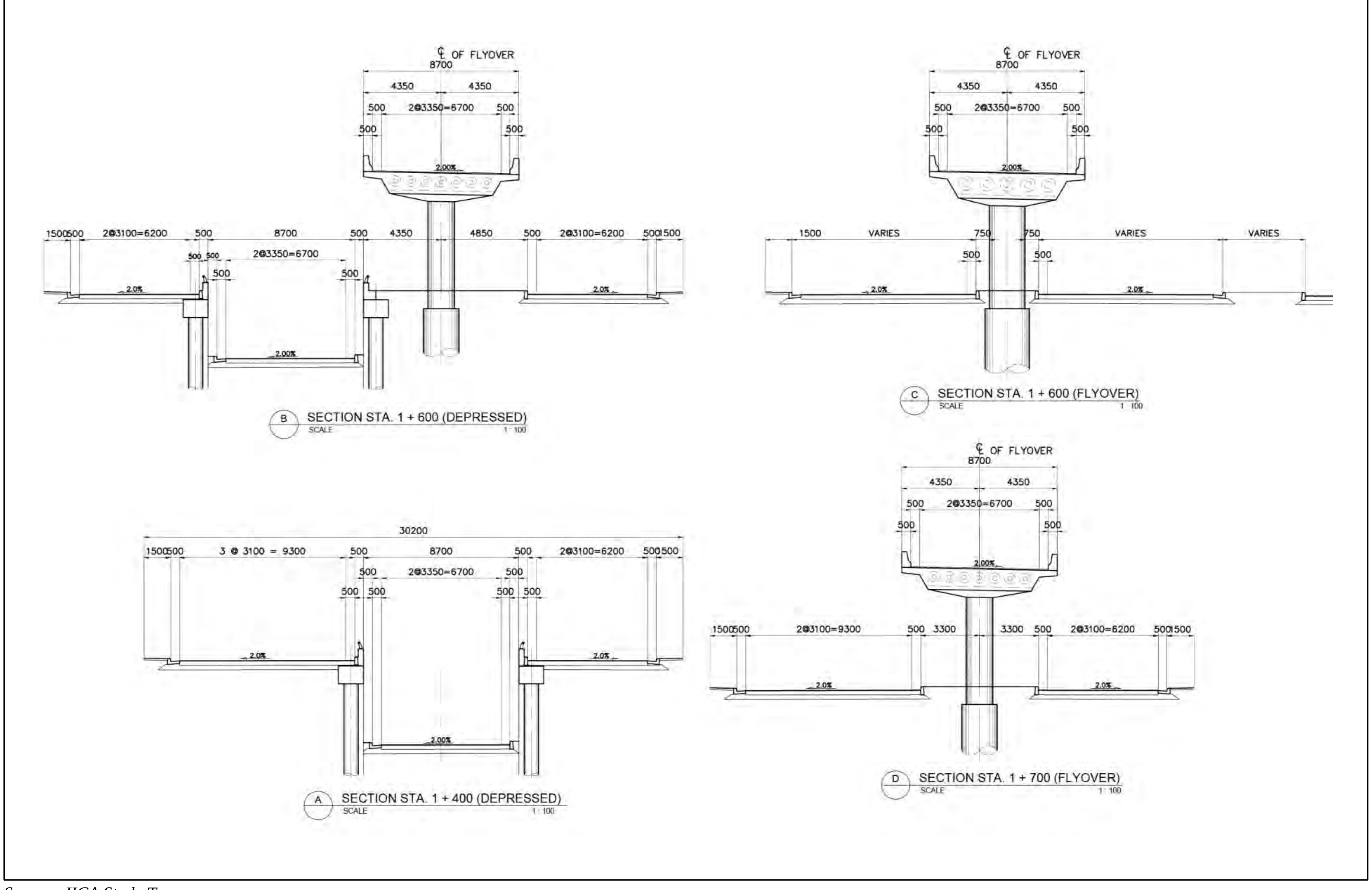

Source: JICA Study Team

**Figure 4.4-32 Plan and Profile of Cut and Cover Tunnel (North/Mindanao Ave.) (2/2)**



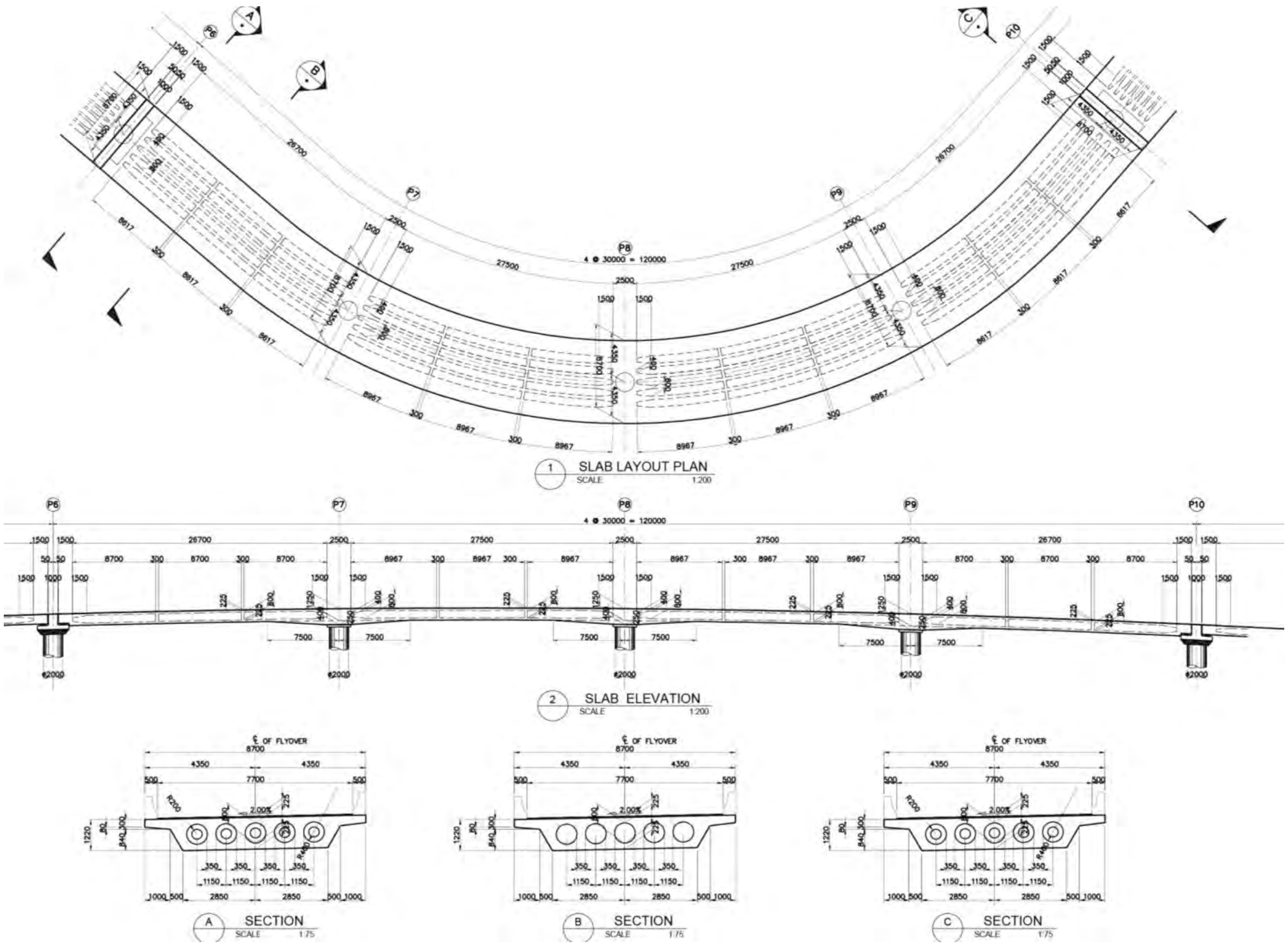

*Source: JICA Study Team*

**Figure 4.4-33 At-Grade Intersection Plan (North/Mindanao Ave.)**



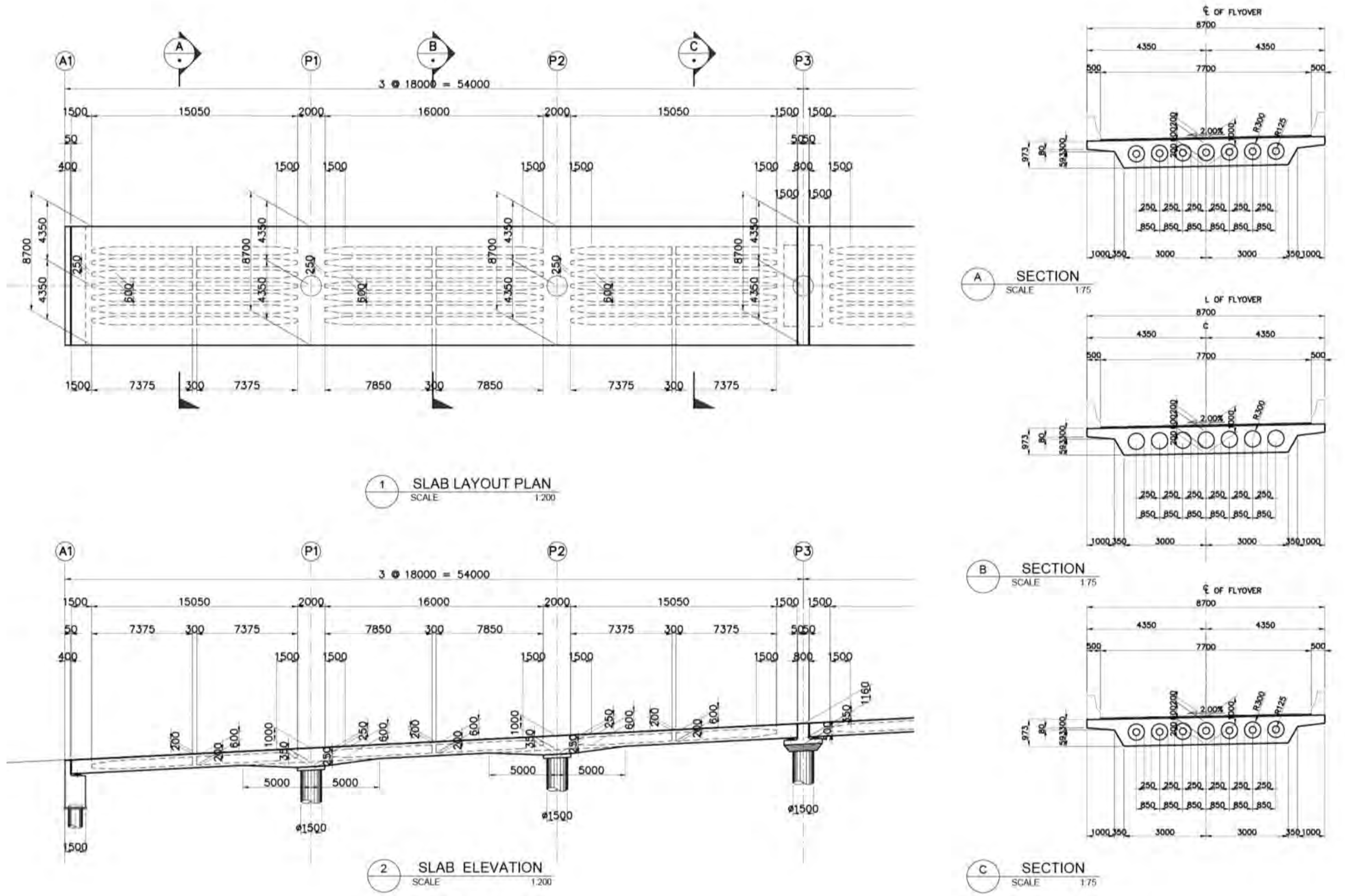

Source: JICA Study Team

**Figure 4.4-34 Typical Cross Section (North/Mindanao Ave.)**



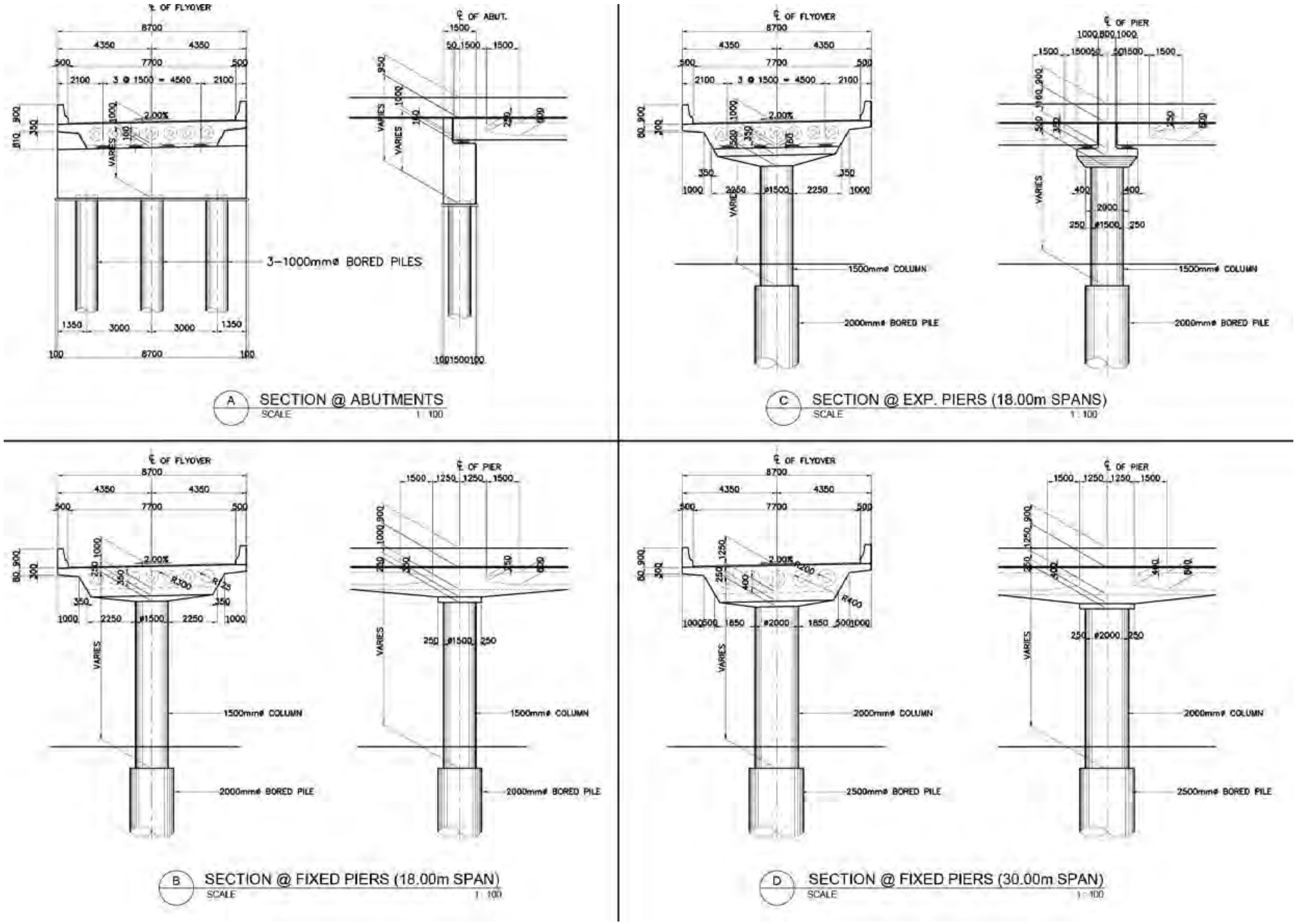

Source: JICA Study Team

**Figure 4.4-35 Slab Layout Plan-PC Voided (North/Mindanao Ave.)**



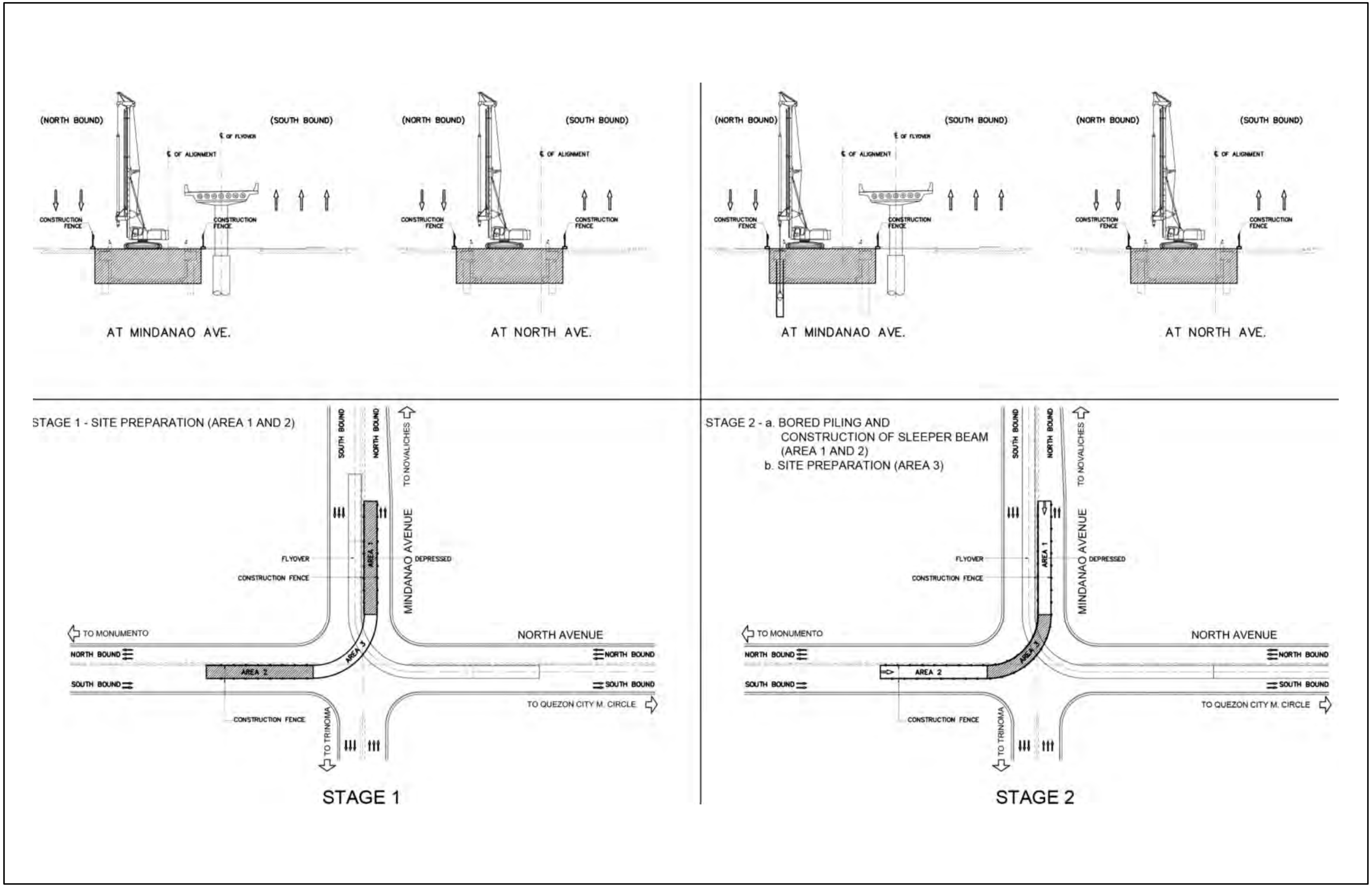

*Source: JICA Study Team*

**Figure 4.4-36 Slab Layout Plan-PC Voided (North/Mindanao Ave.)**



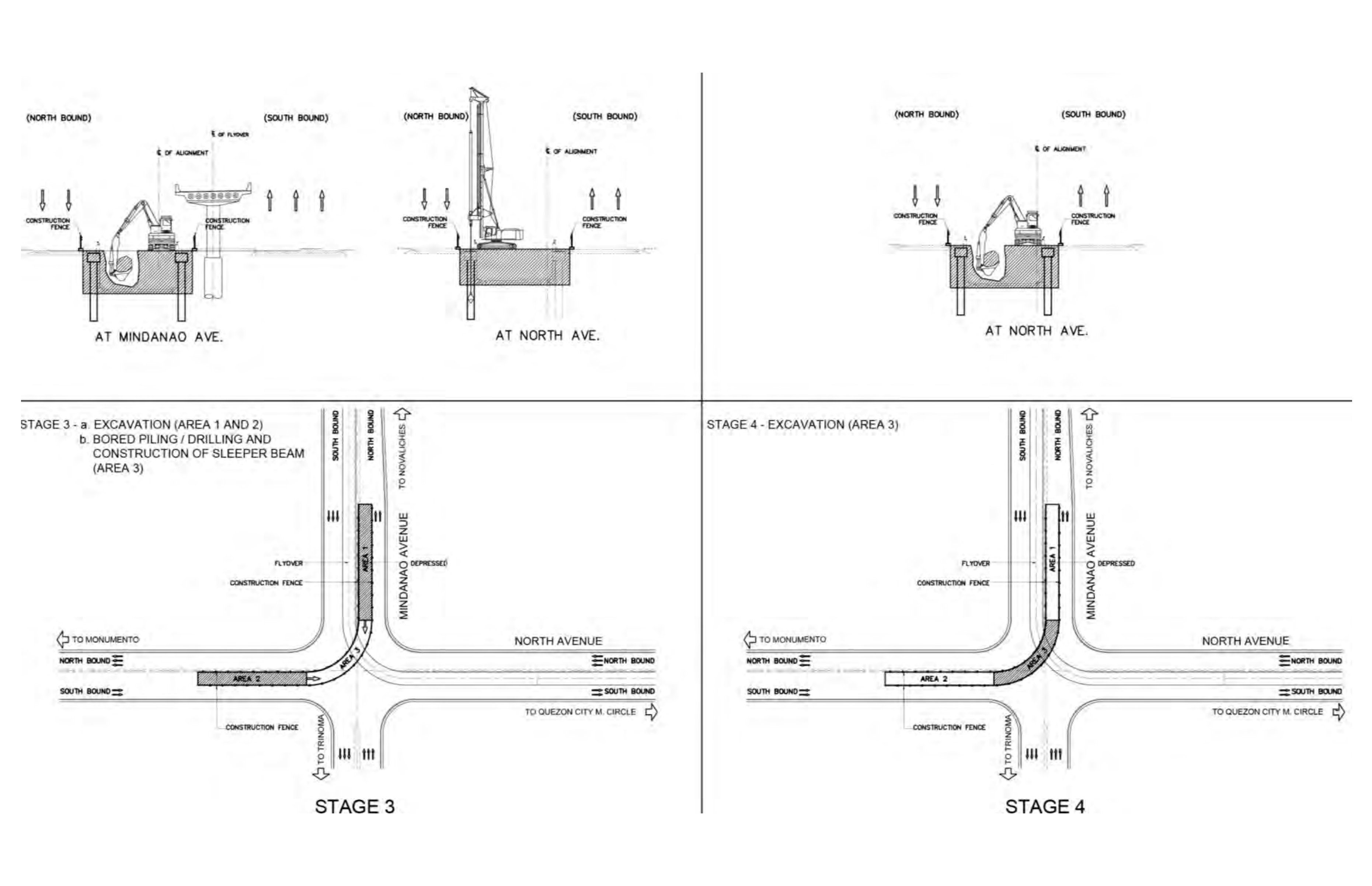

*Source: JICA Study Team*

**Figure 4.4-37 Structural General View (North/Mindanao Ave.)**



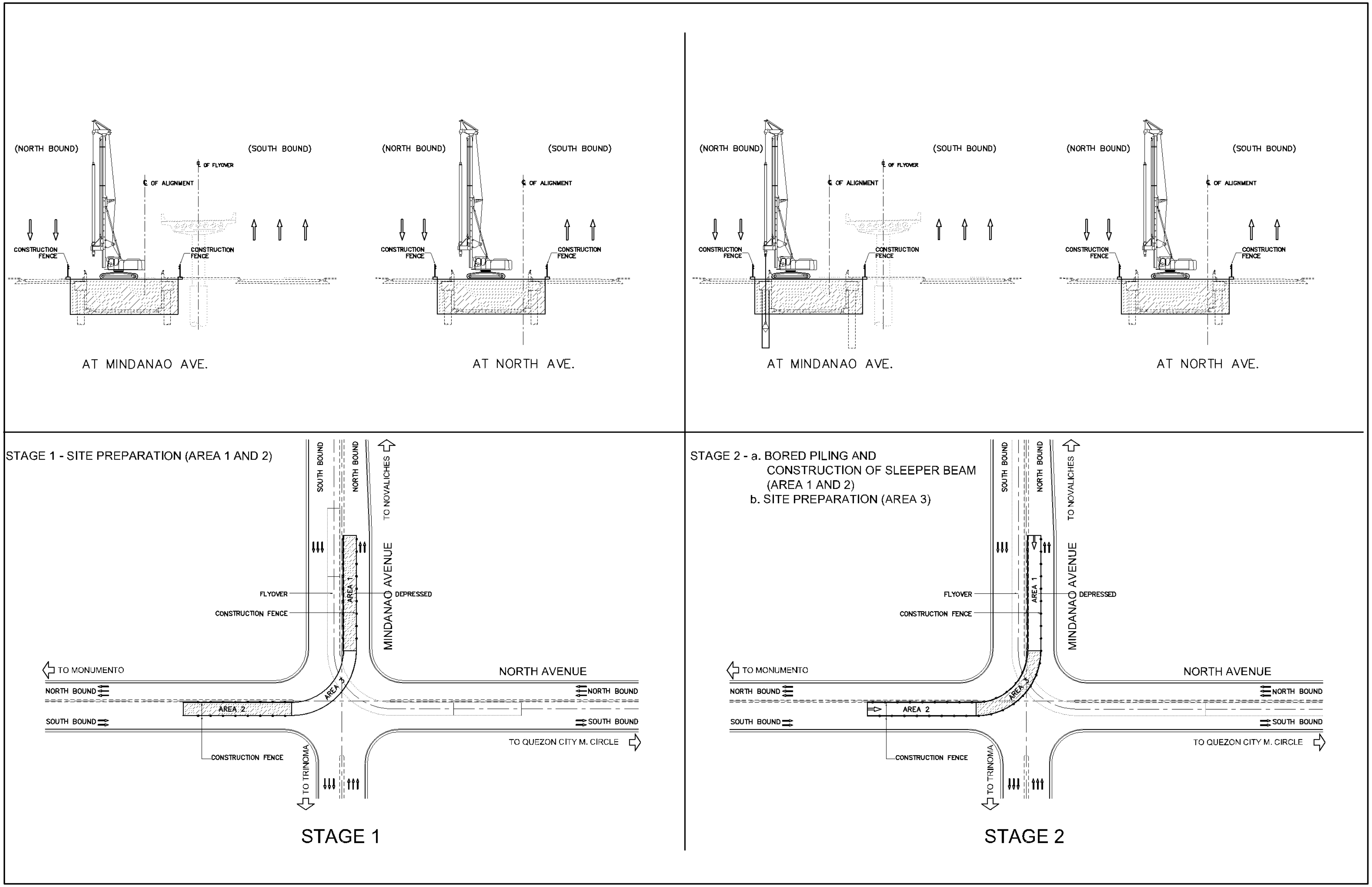

Source: JICA Study Team

**Figure 4.4-38 Construction Plan for North/Mindanao Ave. Interchange (1/4)**



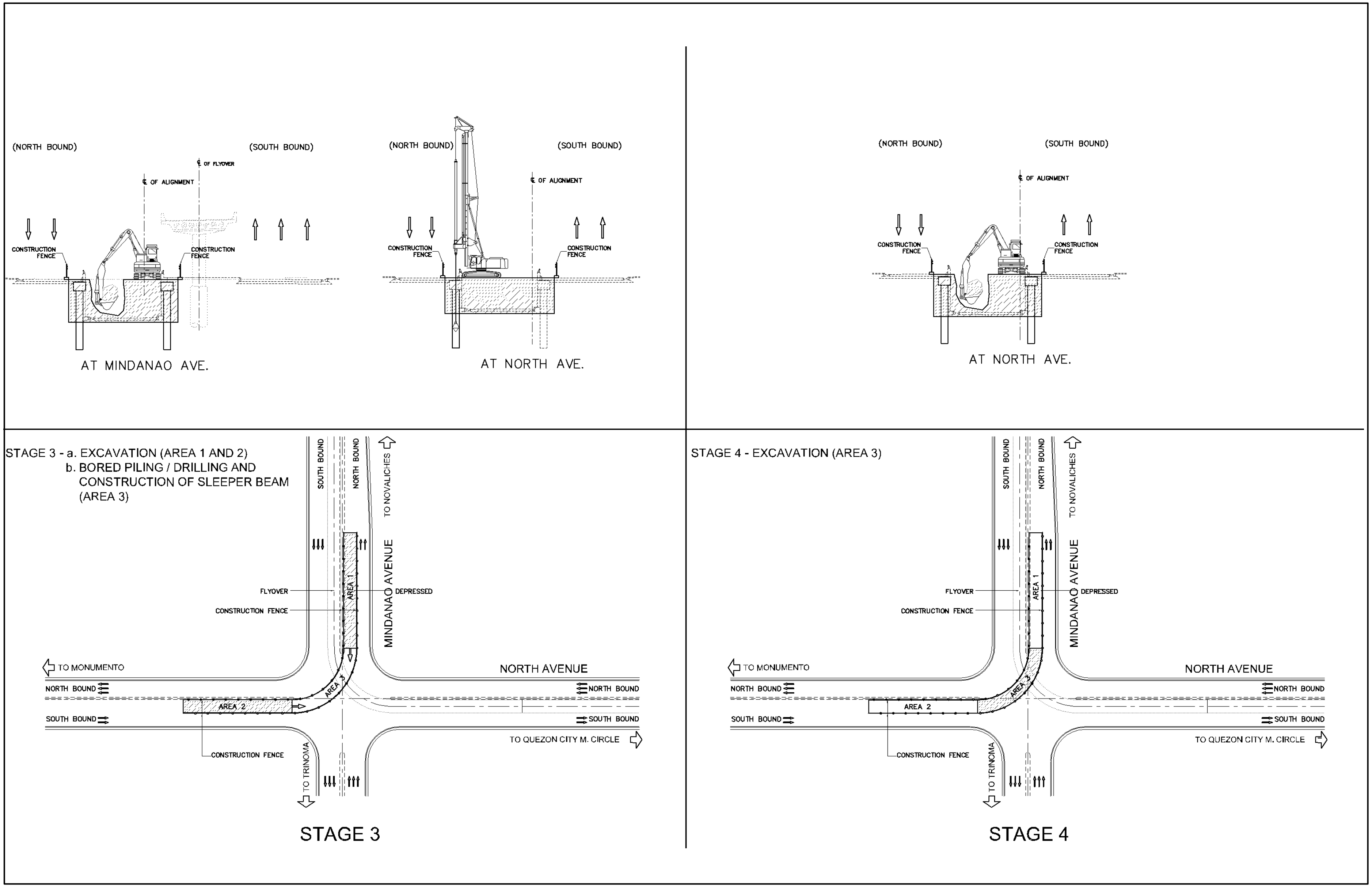

Source: JICA Study Team

**Figure 4.4-39 Construction Plan for North/Mindanao Ave. Interchange (2/4)**




*Source: JICA Study Team*

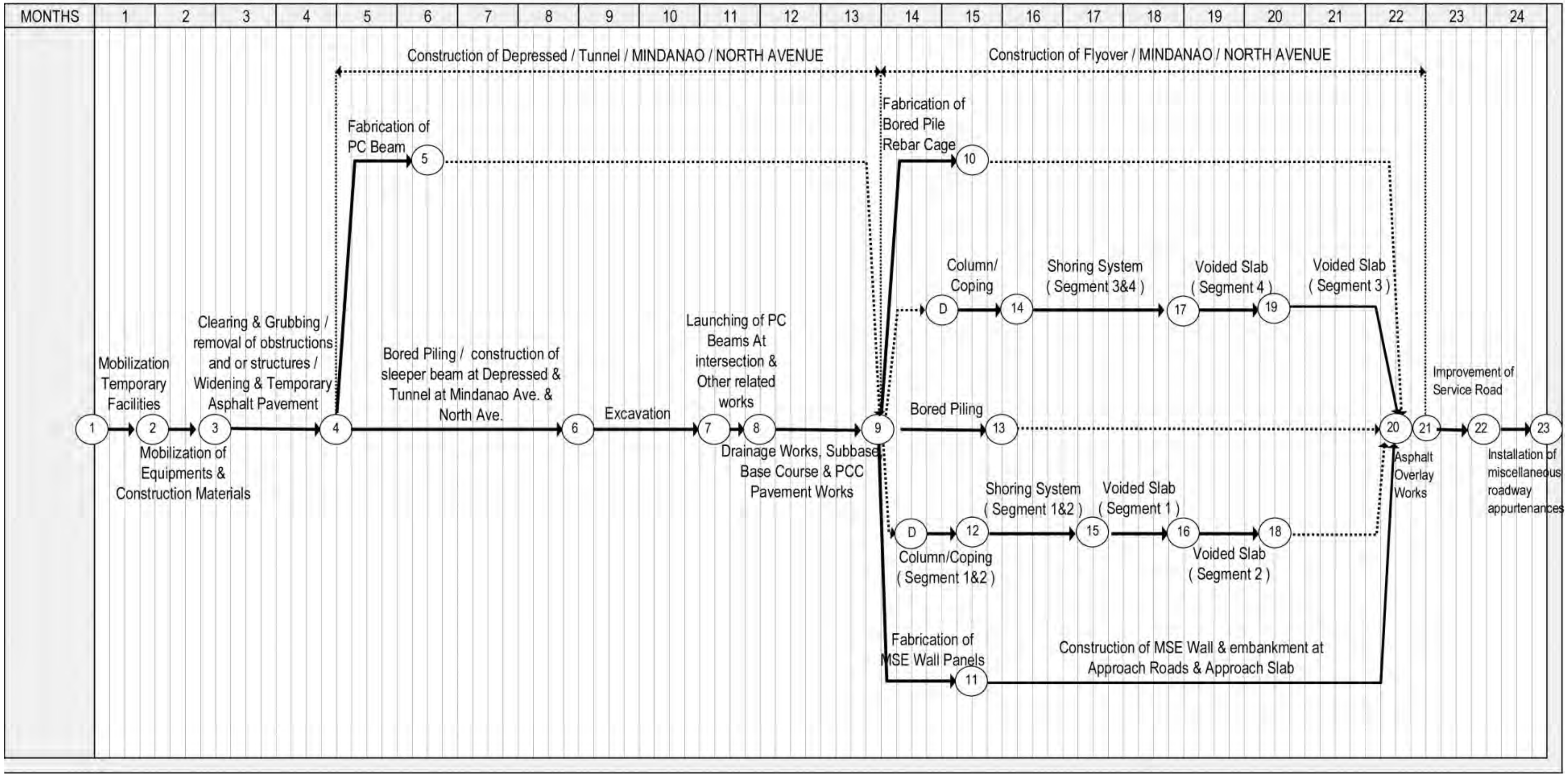
**Figure 4.4-40 Construction Plan for North/Mindanao Ave. Interchange (3/4)**




Source: JICA Study Team

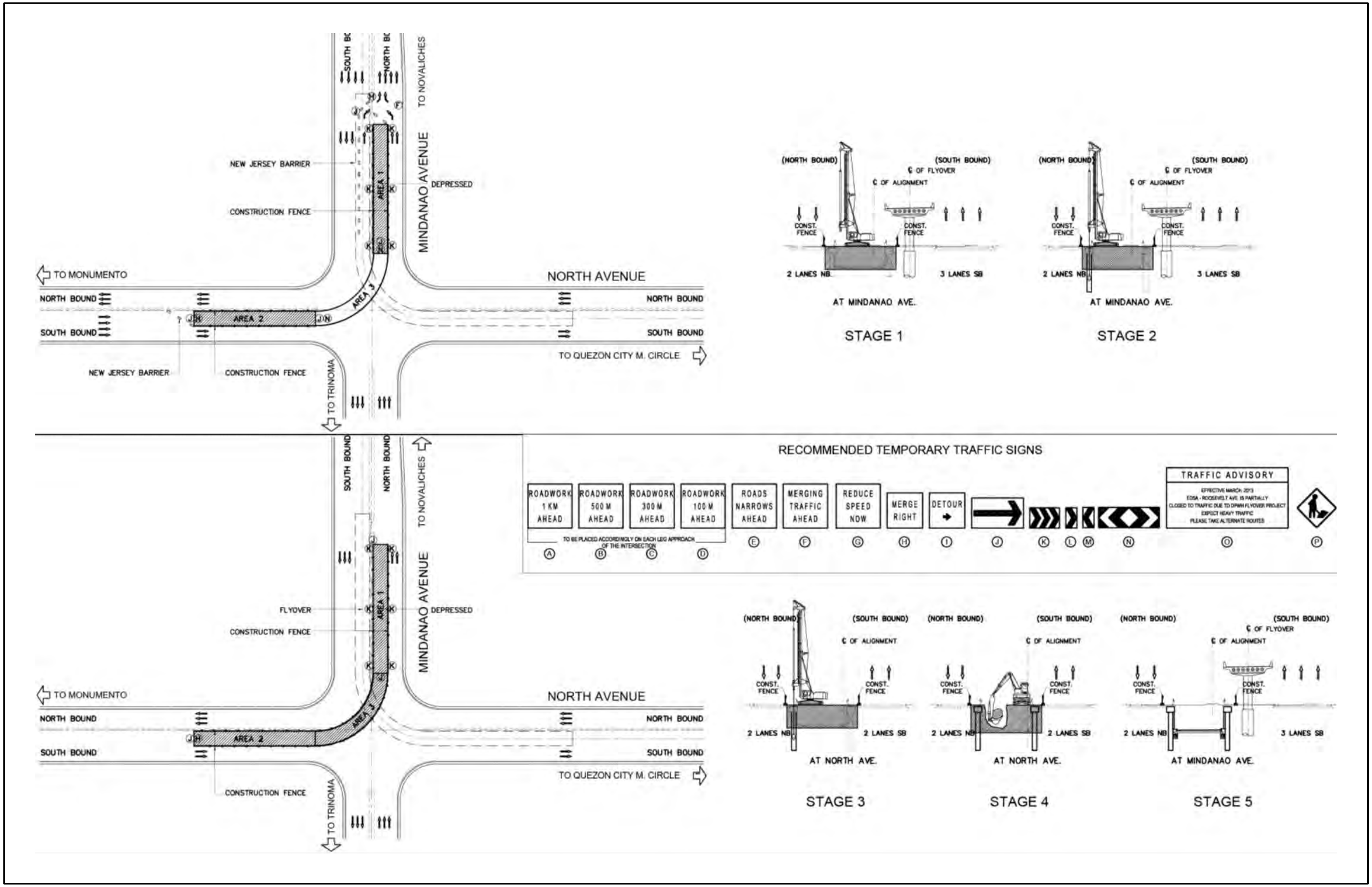
**Figure 4.4-41 Construction Plan for North/Mindanao Ave. Interchange (4/4)**

**PREPARATORY SURVEY ON METRO MANILA INTERCHANGE CONSTRUCTION PROJECT PHASE VI**
**NORTH / MINDANAO AVENUE, QUEZON CITY**
**PRELIMINARY CONSTRUCTION SCHEDULE (PERT/CPM)**



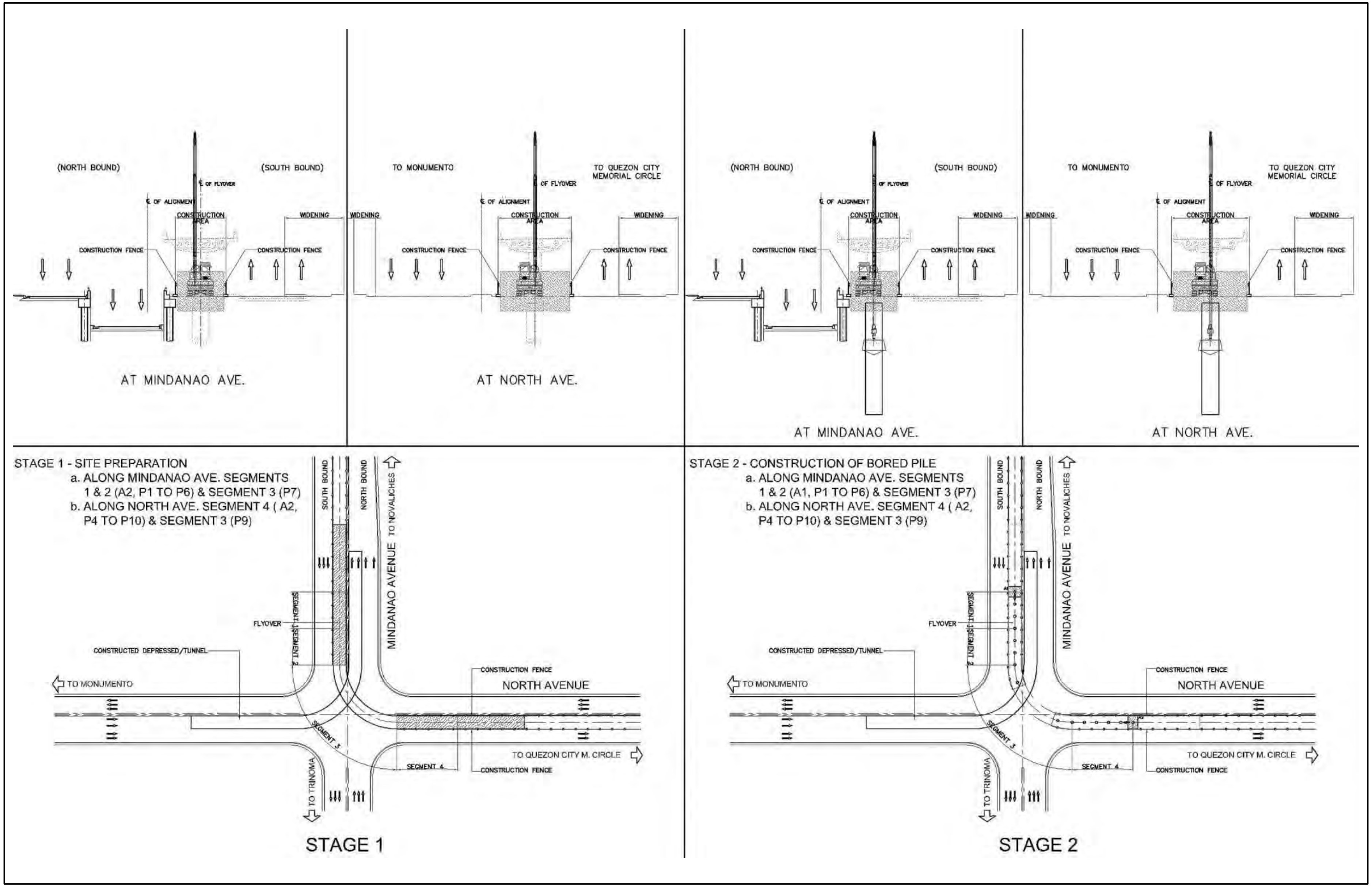

*Source: JICA Study Team*

**Figure 4.4-42 Pert CPM for North/Mindanao Interchange**



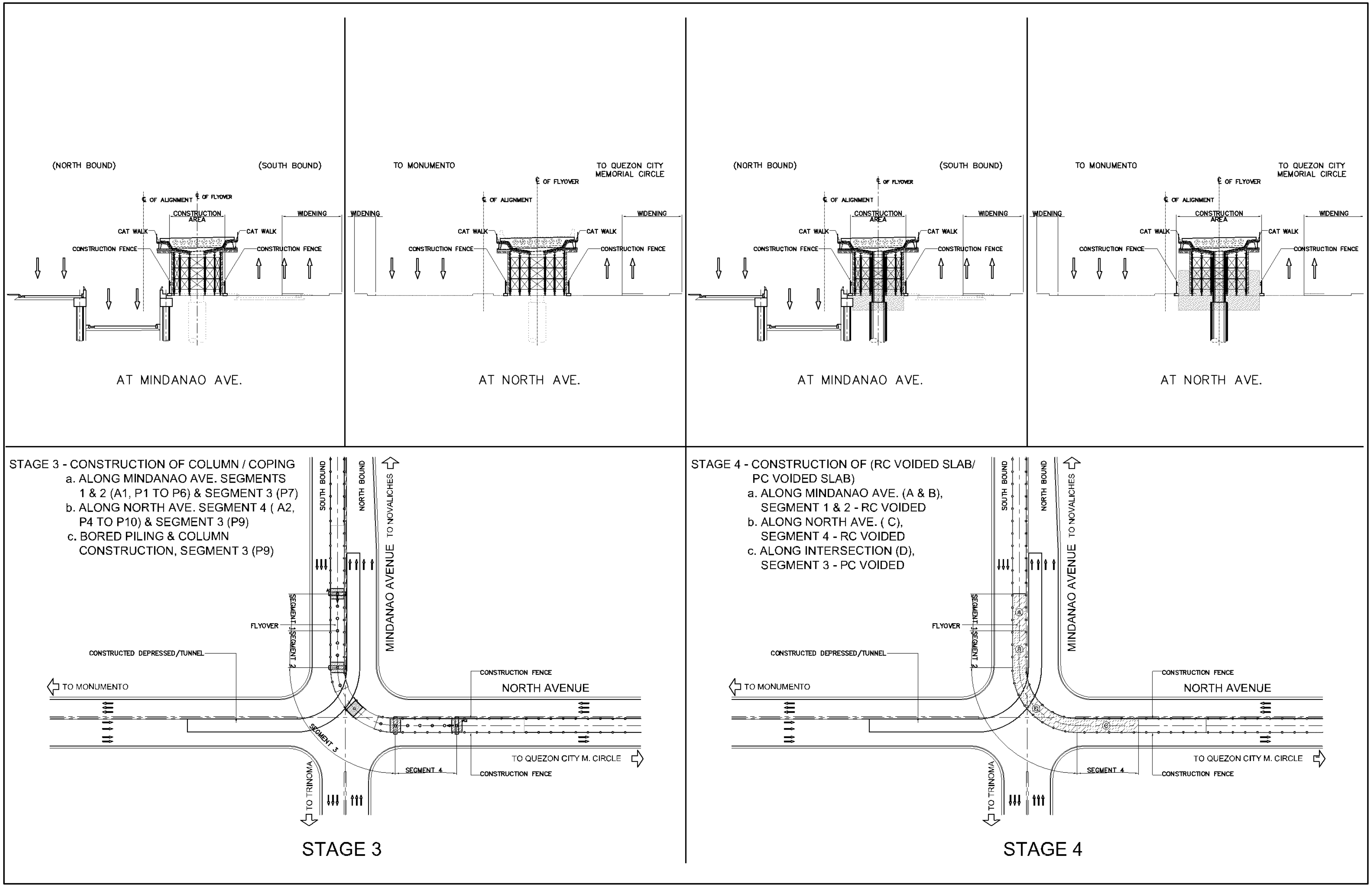

*Source: JICA Study Team*

**Figure 4.4-43 Traffic Management for North/Mindanao Ave. Interchange**



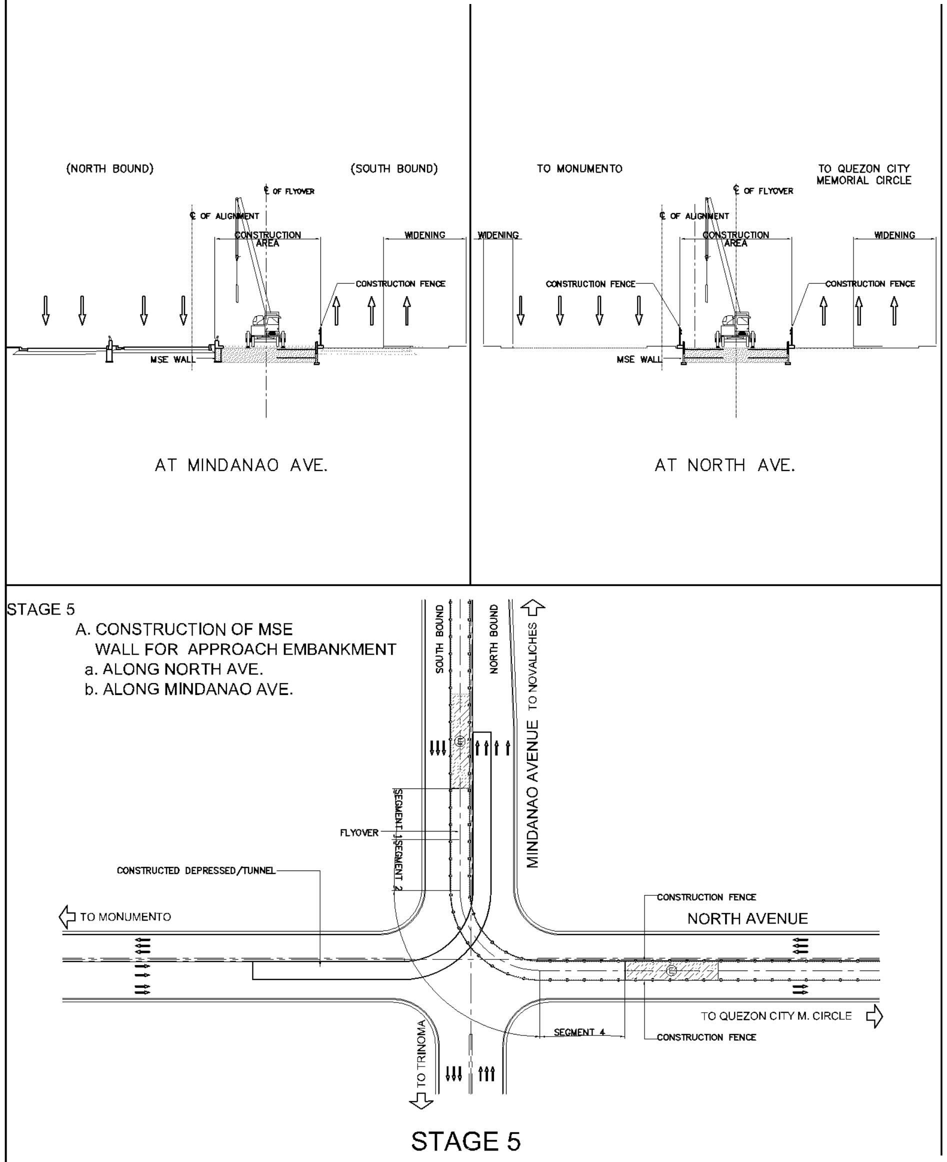

Source: JICA Study Team

**Figure 4.4-44 Traffic Management for North/Mindanao Ave. Interchange (1/4)**




Source: JICA Study Team

**Figure 4.4-45 Traffic Management for North/Mindanao Ave. Interchange (2/4)**




CONSTRUCTION SEQUENCE

A. PREPARATION OF SITE

B. CONTRUCTION OF BORED PILES (2 SETS)
 a. AT ABUT. A2 TOWARDS INTERSECTION
 b. AT ABUT. A1 TOWARDS INTERSECTION

C. CONSTRUCTION OF COLUMNS
 a. AT ABUT. A2 TOWARDS INTERSECTION
 b. AT ABUT. A1 TOWARDS INTERSECTION

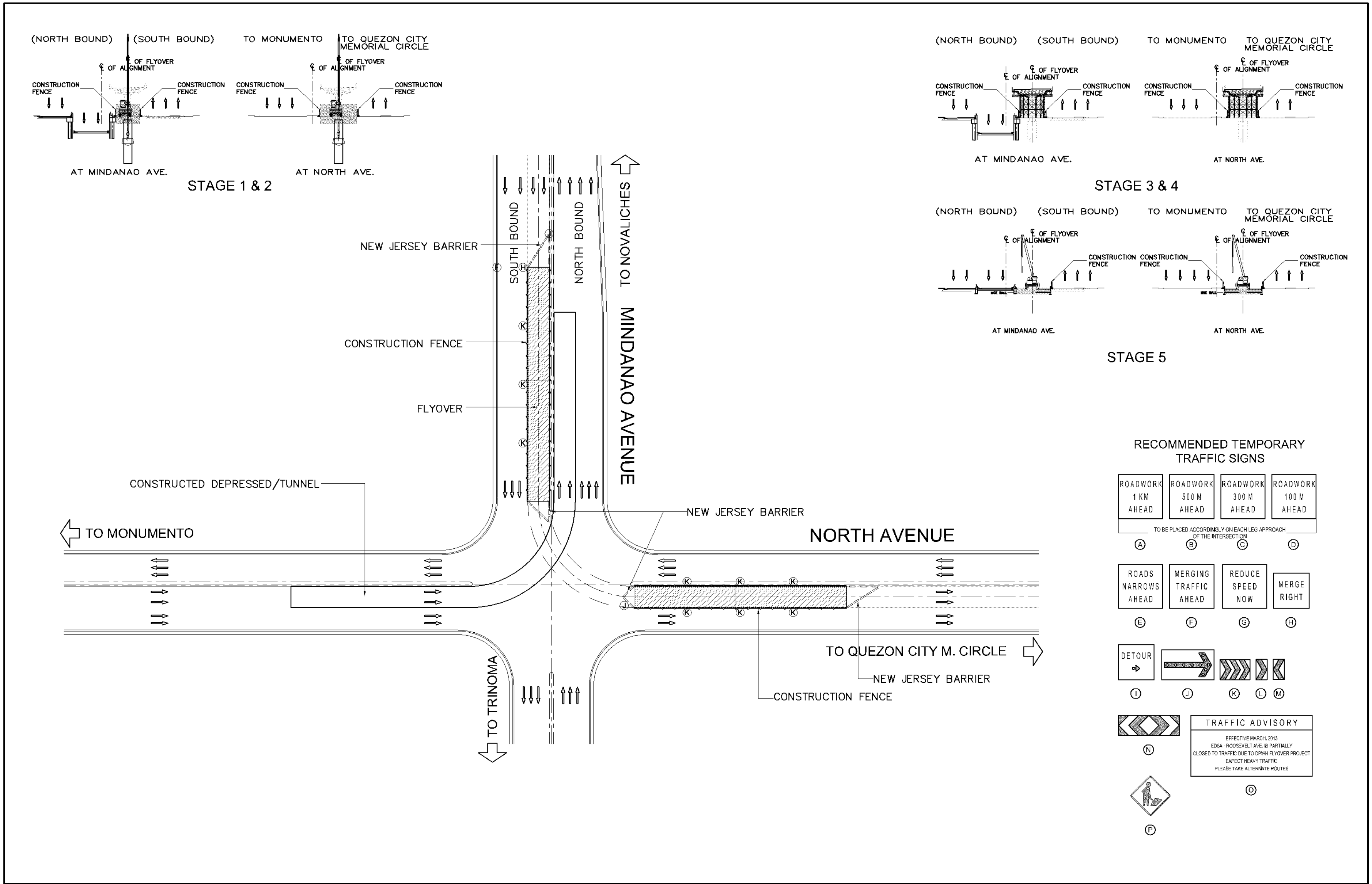
D. CONSTRUCTION OF COPING
 a. AT ABUT. A2 TOWARDS INTERSECTION
 b. AT ABUT. A1 TOWARDS INTERSECTION

E. CONSTRUCTION OF SUPERSTRUCTURE
 a. RC VOIDED SLAB-2 (SEGMENT 2)
 b. RC VOIDED SLAB-1 (SEGMENT 1)
 c. PC BOX-GIRDER (SEGMENT 3)

F. CONSTRUCT MSE WALL

*Source: JICA Study Team*

**Figure 4.4-46 Traffic Management for North/Mindanao Ave. Interchange (3/4)**




Source: JICA Study Team

**Figure 4.4-47 Traffic Management for North/Mindanao Ave. Interchange (4/4)**

### (4) Bill of Quantity and Cost Estimate

Civil Works Cost for EDSA/North/West/Mindanao IC had been estimated based on similar conditions of C3/E. Rodriguez IC and is shown in **Table 4.4-4**.

**Table 4.4-4 Civil Works Cost Estimate for EDSA/North/West/Mindanao IC**

Unit: Php

| PAY ITEM NO. | DESCRIPTION | QUANTITY | UNIT | Unit Cost | Civil Work Cost | Remarks |
|---|---|---|---|---|---|---|
| 1.0 | GENERAL REQUIREMENTS | | | | | |
| A | FACILITIES FOR THE ENGINEER | 1.00 | l.s. | 20,000,000.00 | 20,000,000.00 | |
| | SUB-TOTAL (PART A) | | | | 20,000,000.00 | |
| B | OTHER GENERAL REQUIREMENTS | | | | | |
| SPL B.2.1 | Construction Health and Safety | 1.00 | P.s | 2,400,000.00 | 2,400,000.00 | |
| SPL B.2.2 | Mobilization / Demobilization (1.0% of Civil Works) | 1.00 | P.s | 10,374,092.47 | 10,374,092.47 | |
| SPL B.2-3 | Traffic Management During Construction | 1.00 | P.s | 9,000,000.00 | 9,000,000.00 | |
| SPL B.2-4 | Dayworks | 1.00 | P.s | 8,000,000.00 | 8,000,000.00 | |
| SPL B.2-5 | Removal, Relocation of Utilities | 1.00 | P.s | 19,200,000.00 | 19,200,000.00 | |
| SPL B.3.1 | Environmental Monitoring Action Plan | 1.00 | P.s | 4,000,000.00 | 4,000,000.00 | |
| | SUB-TOTAL (PART B) | | | | 52,974,092.47 | |
| | SUB-TOTAL GENERAL REQUIREMENTS | | | | 72,974,092.47 | |
| 2.0 | INTERCHANGE CONSTRUCTION WITH VIADUCT | | | | | |
| C | EARTHWORKS | | | | | |
| 100(1) | Clearing and Grubbing | 0.69 | ha. | 90,846.53 | 62,684.11 | |
| 100(3) | Individual Removal Trees (Small) | - | ea. | 1,013.26 | - | |
| 100(4) | Individual Removal Trees (Large) | - | ea. | 1,427.27 | - | |
| 100(5) | Removal and Earth Balling of Trees | 16.00 | ea. | 1,000.00 | 16,000.00 | |
| 101(1) | Removal of Structures and Obstruction | 1.00 | l.s. | 1,000,000.00 | 1,000,000.00 | |
| 101(3)a | Removal of Existing PCCP | 18,463.35 | sq.m. | 245.78 | 4,537,922.16 | |
| 101(3)b | Breaking of Existing PCCP | - | sq.m. | 335.00 | - | |
| 101(4)a | Removal of Existing Concrete Curb | 4,485.56 | l.m. | 60.00 | 269,133.60 | |
| 101(4)b | Removal of Existing Concrete Curb & Gutter | 2,407.83 | l.m. | 110.00 | 264,861.30 | |
| 101(4)c | Removal of Existing Sidewalk and Median | 8,807.13 | sq.m. | 120.00 | 1,056,855.60 | |
| 101(4)d | Removal of Existing RCPC | 1,502.41 | l.m. | 200.00 | 300,482.00 | |
| 102(2) | Surplus Common Excavation | 19,773.01 | cu.m | 586.00 | 11,586,983.86 | |
| 105(1) | Subgrade Preparation | 9,914.06 | sq.m. | 37.18 | 368,604.75 | |
| | SUB-TOTAL (PART C) | | | | 19,463,527.38 | |
| D | SUBBASE AND BASE COURSE | | | | | |
| 200 | Sub Base Course | 6,000.37 | cu.m. | 879.97 | 5,280,145.59 | |
| | SUB-TOTAL (PART D) | | | | 5,280,145.59 | |
| E | SURFACE COURSES | | | | | |
| 302(2) | Bituminous Tack Coat, Emulsified Asphalt, SS-1 (0.45 L/m2) | 11.40 | tonne | 65,971.81 | 752,078.63 | |
| 310 (2) | Bituminous Concrete Wearing Course, Hot Laid (t=50mm) | 16,294.41 | sq.m | 924.31 | 15,061,086.11 | |
| 311(1)a | Portland Cement Concrete Pavement t=300 mm | 11,671.23 | sq.m | 2,887.66 | 33,702,544.02 | |
| 311(1)b | CRC Pavement Reinforced | 3,071.50 | sq.m | 4,935.16 | 15,158,343.94 | |
| | SUB-TOTAL (PART E) | | | | 64,674,052.70 | |
| F | BRIDGE CONSTRUCTION | | | | | |
| | Approch Ramp | | | | | |
| 103(1) | Structure Excavation | 4,550.83 | cu.m. | 586.00 | 2,666,786.38 | |
| 103(2) | Structural Backfilling | 3,359.76 | cu.m. | 565.00 | 1,898,264.40 | |
| 104(2) | Embankment, Selected Borrow | 9,157.97 | cu.m. | 984.09 | 9,012,266.70 | |
| 401(a) | Cast in Place Concrete Railing | 1,304.78 | l.m. | 5,006.92 | 6,532,929.08 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 103,077.00 | kg. | 62.70 | 6,462,927.90 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 62,381.50 | kg. | 68.25 | 4,257,537.38 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 980.31 | cu.m. | 9,548.08 | 9,360,078.30 | |
| 405(1)b | Approach Slab | 92.06 | cu.m. | 6,233.40 | 573,846.80 | |
| 405(1)c | Concrete Leveling Pad | 45.50 | cu.m. | 80,462.16 | 3,661,028.28 | |
| 405(6) | Lean Concrete | 180.36 | cu.m. | 4,111.70 | 741,586.21 | |
| SPL 414 | Concrete Barrier | - | l.m. | 4,660.55 | - | |
| SPL 417 | Earthquake Resistant Type Mechanically Stabilized Earthwall | 1,407.28 | sq.m. | 14,163.00 | 19,931,306.64 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Substructure** | | | | | |
| 400(17)a | Concrete Piles Cast in Drilled Holes, Ø800 mm | 7,800.00 | l.m. | 24,592.89 | 191,824,542.00 | |
| 400(17)b | Concrete Piles Cast in Drilled Holes, Ø1000 mm | 54.00 | l.m. | 35,098.96 | 1,895,343.84 | |
| 400(17)c | Concrete Piles Cast in Drilled Holes, Ø1500 mm | 108.00 | l.m. | 60,716.52 | 6,557,384.16 | |
| 400(17)d | Concrete Piles Cast in Drilled Holes, Ø2000 mm | 135.00 | l.m. | 101,704.06 | 13,730,048.10 | |
| 400(17)e | Concrete Piles Cast in Drilled Holes, Ø2500 mm | 75.00 | l.m. | 146,178.83 | 10,963,412.25 | |
| 400(17)f | Concrete Piles Cast in Drilled Holes, Ø2800 mm | 270.00 | l.m. | 177,476.50 | 47,918,655.00 | |
| 400(17)g | Concrete Piles Cast in Drilled Holes, Ø3000 mm | 60.00 | l.m. | 202,409.64 | 12,144,578.40 | |
| 400(22)a | Pile Integrity Test | 52.00 | ea. | 43,784.56 | 2,276,797.12 | |
| 400(22)b | Pile Dynamic Test | 26.00 | ea. | 583,087.25 | 15,160,268.50 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 212,089.68 | kg. | 62.70 | 13,298,022.94 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 859,498.75 | kg. | 68.25 | 58,660,789.69 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 4,227.85 | cu.m. | 14,057.94 | 59,434,861.63 | |
| 405(6) | Lean Concrete | 147.96 | cu.m. | 4,111.70 | 608,367.13 | |
| 407(1)a | Anchor Bar Ø36mm x 1500mm long, complete | 56.00 | ea. | 1,800.00 | 100,800.00 | |
| 407(1)b | Anchor Bar Ø36mm x 1000mm long, complete | 38.00 | ea. | 1,200.00 | 45,600.00 | |
| 416 | PC Panel | 7,729.91 | sq.m | 1,500.00 | 11,594,865.00 | |
| | | | | | | |
| | **Superstructure** | | | | | |
| 401(a) | Cast in Place Concrete Railing | 1,958.00 | l.m. | 5,006.92 | 9,803,549.36 | |
| 404(1)b | Reinforcing steel, Grade 40 (Superstructure) | 99,814.00 | kg. | 62.70 | 6,258,337.80 | |
| 404(2)b | Reinforcing steel, Grade 60 (Superstructure) | 1,636,636.00 | kg. | 68.25 | 111,700,407.00 | |
| 404(2)c | Prestressing steel | 159,626.00 | kg. | 152.90 | 24,406,815.40 | |
| 405(1)b | Structural Concrete, Class A (Hollow Slab) 27.6 Mpa | 8,682.25 | cu.m. | 16,971.01 | 147,346,551.57 | |
| 405(1)c | Structural Concrete Class P 34Mpa for PC Box | - | cu.m. | 18,900.00 | - | |
| 412(1)a | Elastomeric Bearing Pad (500 x 400 x 60 mm) | 126.00 | ea. | 14,500.00 | 1,827,000.00 | |
| 412(1)b | Elastomeric Bearing Pad (400 x 400 x 50 mm) | - | ea. | 12,000.00 | - | |
| 413(1) | Expansion Joint | 223.00 | l.m. | 29,418.63 | 6,560,354.49 | |
| SPL 414 | Concrete Barrier | - | l.m. | 4,660.55 | - | |
| SPL 415 | Waterproofing | 10,731.65 | sq.m. | 1,800.00 | 19,316,970.00 | |
| | | | | | | |
| | **SUB-TOTAL (PART F)** | | | | **838,532,879.45** | |
| | | | | | | |
| **G** | **DRAINAGE AND SLOPE PROTECTION STRUCTURES** | | | | | |
| | | | | | | |
| 404(1)b | Reinforcing steel, Grade 40 (Box Culvert) | - | kg. | 62.70 | - | |
| 405(1)b | Structural Concrete, Class A (Box Culvert) 27.6 Mpa | - | cu.m | 8,480.81 | - | |
| 500(1)a | RCPC, Class II | 2,730.87 | l.m. | 3,082.45 | 8,417,770.23 | |
| 500(1)b | RCPC, Class IV | 8.00 | l.m. | 7,005.56 | 56,044.48 | |
| 502(2)a | Storm Deck Drain with Grating | 98.00 | ea. | 19,679.57 | 1,928,597.86 | |
| 502(2)b | Curb Inlet Manhole | 358.00 | ea. | 25,000.00 | 8,950,000.00 | |
| 502(3) | Catch Basins | - | ea. | 35,000.00 | - | |
| 502(4) | Junction Box | - | ea. | 5,000.00 | - | |
| SPL 512 | Collector Pipe | 1,346.05 | l.m. | 1,153.20 | 1,552,264.86 | |
| | | | | | | |
| | **SUB-TOTAL (PART G)** | | | | **20,904,677.43** | |
| | | | | | | |
| **H** | **MISCELLANEOUS STRUCTURES** | | | | | |
| | | | | | | |
| 600(1) | Concrete Curb | 4,381.38 | l.m. | 1,333.21 | 5,841,299.63 | |
| 600(3)a | Concrete Curb and Gutter | 3,511.57 | l.m. | 1,661.30 | 5,833,771.24 | |
| 600(3)b | Concrete Side Strip | - | sq.m. | 350.00 | - | |
| 601(1)a | Concrete Sidewalk | 5,050.15 | sq.m. | 1,560.60 | 7,881,264.09 | |
| 601(1)b | Concrete Median | 15,118.47 | sq.m. | 1,560.60 | 23,593,884.28 | |
| 605(1) | Warning Sign | 12.00 | set | 34,912.46 | 418,949.52 | |
| 605(2) | Regulatory Sign | 26.00 | set | 34,912.46 | 907,723.96 | |
| 605(3)a | Informatory Sign, Gantry Support | 4.00 | set | 905,733.18 | 3,622,932.72 | |
| 605(3)b | Informatory Sign, Butterfly Support | 4.00 | set | 431,481.05 | 1,725,924.20 | |
| 605(3)c | Informatory Sign, Cantilever Support | 9.00 | set | 388,956.44 | 3,500,607.96 | |
| 605(3)d | Informatory Sign, Double Post | 11.00 | set | 42,944.99 | 472,394.89 | |
| 612(1) | Reflectorized Thermoplastic Pavement Markings, White | 2,411.91 | sq.m. | 1,092.83 | 2,635,807.61 | |
| | | | | | | |
| | **SUB-TOTAL (PART H)** | | | | **56,434,560.10** | |
| | | | | | | |
| **J** | **SPECIAL ITEM** | | | | | |
| | | | | | | |
| SPL 1 | 9m Pole, Single arm complete | 283.00 | set | 86,228.98 | 24,402,801.34 | |
| SPL 2 | 9m Pole, Double arm complete | - | set | 90,000.00 | - | |
| SPL 3 | Lighting system, (under carriageway) | 33.00 | set | 59,290.99 | 1,956,602.67 | |
| SPL 4 | Flood lights | 22.00 | set | 80,000.00 | 1,760,000.00 | |
| SPL 5 | Traffic Signal Light | 1.00 | P.s | 4,000,000.00 | 4,000,000.00 | |
| | | | | | | |
| | **SUB-TOTAL (PART J)** | | | | 32,119,404.01 | |
| | | | | | | |
| | **TOTAL** | | | | **1,110,383,339.13** | |

*Source: JICA study team*

## 4.5 C-5/KALAYAAN AVENUE

### 4.5.1 Review of Previous Detailed Design

The detailed design of the interchange was prepared by Nippon Engineering Consultant Co., Ltd. in association with DCCD Engineering Corporation and Pertconsult International in March 2003.

#### (1) Topographic Conditions

The project area has the following topographic conditions and features:

1) The alignment of C-5 (Circumferential Road 5) is almost horizontally straight and vertical grade generally rises continuously from the intersection on both directions.

2) The horizontal alignment of Kalayaan Avenue is a gentle right curve towards the intersection from Pateros and a gentle left curve towards EDSA from the intersection.

3) The vertical grade along Kalayaan Avenue rises continuously toward EDSA by 2~3%.

4) In view of (a), (b) and (c) above, rainfall water flows down to the Pateros direction along Kalayaan Avenue.

5) The highest difference of about 10m between road and ground elevation was observed on both sides of the road along C-5 toward south expressway immediately after the intersection.

There were no significant changes noted in the topographic conditions of the area between the time of the detailed design to the present, except for the U-Turn flyovers constructed on both sides of the interchange along C-5 and the on-going construction of another flyover from Bonifacio Global City to C-5 towards Pasig City.

#### (2) Geotechnical Conditions

The proposed area is located on the eastern edge in the center part of the Central Plateau, which is underlain by tuffs and tuffaceous sediments of the Pliocene-Pleistocene or the Holocene.

Tuffs (tuffaceous rock sequence) consist of siltstone and sandstone, belonging to the Guadalupe formation of the Pliocene-Pleistocene. Tuffaceous sediments overlying the tuffs consist of pyroclastic flow deposits and lahar deposits (tuffaceous reworked deposits) of the Pleistocene-Holocene. Pyroclastic flow deposits are mainly composed of silty gravel and gravel, and lahar deposits are mainly composed of silt and silty sand.

The lower tuffaceous rock sequence is stable bearing stratum for important structures such as bridges because N-value is over 50 and it corresponds to the soft rock. But the upper tuffaceous sediments are not stable bearing stratum for the important structures, because pyroclastic flow deposits are changing to laharic deposits which have N-value of less than 30 laterally. Therefore, the bearing stratum in this proposed area is tuffaceous rock sequence that underlie deeper than 1-3m from ground surface.

The depth of bearing and the assumed type of foundations at each borehole are shown in **Table 4.5-1**.

**Table 4.5-1 Depth of Bearing Stratum and Type of Foundations**

| Borehole No. | Depth of Bearing Stratum | Type of Foundations |
|---|---|---|
| **BH - 4** | 3.00m | Spread footing |
| **BH - 5** | 1.30m | |
| **BH - 6** | 1.40m | |
| **BH - 7** | 1.30m | |
| **BH - 8** | 1.50m | |
| **BH - 9** | 1.30m | |
| **BH -10** | 1.40m | |
| **BH -11** | 1.50m | |
| **BH -12** | 1.60m | |
| **BH -13** | 1.40m | |

*Source: Detailed design done by KEI and associate local consultants. March 2003.*

### (3) Hydrological Conditions

There is a creek located 250m eastside from C-5–Kalayaan intersection. However, it is generally considered that this area is not flooded because elevations of the proposed area are about 5m higher than the ground elevations near the creek.

Therefore, there are no significant issues on the hydrological conditions in the proposed area. However, the design of the rain water tank and the pump up system must be prepared as these have not been covered in the existing detailed designs and these are necessary because the proposed designed of the interchange is an underpass type.

### (4) Design Standards

Major design standards are as follows:

1) Highway Design

- ⇨ Design Speed : 60km/h
- ⇨ Stopping/Passing Site Distance : 85.0m / 410m
- ⇨ Minimum Radius Curvature : 150.0m
- ⇨ Maximum/Minimum Vertical Grade : 6.0% / 0.35%
- ⇨ Lane Width : 3.25m
- ⇨ Cross Slope : 2.0%

2) Hydrology and Hydraulics

- ⇨ Design Frequency Level
  - Ditches : 5 years
  - Pipe Culverts : 10 years
  - Box Culverts : 25 years

- Bridges : 50 years or maximum observed flood, whichever is greater

3) Structural Design

⇨ Material Properties

- Concretes
  - › Concrete Deck Slab on PCDG : 35Mpa
  - › Substructure : 28Mpa
  - › Retaining Wall/Slab : 28Mpa

⇨ Design Load

- Dead Load
  - › Concrete Plain or Reinforced : $24.0KN/m^3$
  - › Steel or Cast Steel : $77.0KN/m^3$
  - › Compacted Sand and Earth : $19.0KN/m^3$
- Live Load
  - › Truck Load : AASHTO HS-20
  - › Uniform Load : Lane Load $9.36KN/m^3$
- Earth Pressure
  - › Normal Time : Coulumb's Equation
  - › Earthquake Time : Mononobe-Okabe
- Seismic Lateral Load
  - › Ground Acceleration : 0.4g
  - › Seismic Performance Category : D

⇨ Design Stresses

- Concrete : 27.6Mpa (Substructure, Superstructure, Bored Pile and Bridge Railing)
- Reinforced Bar
  - › Grade 40 : 276.0Mpa
  - › Grade 60 : 414.0Mpa

### (5) Road Alignment and Structural Conditions

A depressed structure is being proposed and designed along C-5. The road alignment and structural designs have the following conditions:

1) 490m of depressed structure shall have a horizontal straight alignment with C-5, only 20m length provide 1,000m radius curve almost at the center of intersection.

2) 6.0% of vertical alignment was provided at both sides of the depressed section along C-5.

3) The standard section along C-5 has three lanes for each direction at the depressed section and

two lanes each for each direction at the ground section.

4) 226m and 675m radius curves were provided at before and after intersection along Kalayaan Avenue towards EDSA.

5) 2.14% and 3.19% rise in vertical grade were provided at before and after the intersection along Kalayaan Avenue towards EDSA.

6) The standard section along Kalayaan Avenue has three lanes for each direction.

7) A reverse T-type RC retaining wall with a maximum height of 10.86m was designed at the depressed section along C-5.

8) 24.5m long AASHTO type-IV PCDGs were placed over the reverse T-type RC retaining walls at the intersection.

**(6) Environmental and Social Conditions**

The ECC for the C-5/Lanuza St.-Julia Vargas St. and C-5/Kalayaan Ave. Interchanges Project had been issued from DENR-EMB in December 2001. The conditions imposed on the issued ECC by the DENR-EMB did not include any specific requirements. Although the ECC was thought to be applied with the EIS, the JICA Study Team could not obtain the EIS and RAP documents to be reviewed.

1) Environmental conditions

Environmental conditions including the socio-economic environment will be reviewed when the EIS is obtained.

2) Social conditions

The PAPs and socio-economic conditions of project affected areas will be reviewed when the RAP report is prepared.

**(7) Identified Problems and Recommendations**

**Identified Problems**

1) No problems were identified in the detailed design. However, the U-Turn Flyovers constructed at both sides of the intersection along C-5 are considered to be substandard structures under the prevailing design code.

2) Traffic conditions should be observed after completion of the on-going construction of the flyover from Bonifacio Global City towards Pasig City which will merge before the southern side of U-Turn Flyover.

**Recommendations**

After completion of the flyover under construction, a more comprehensive study of actual traffic at the intersection shall be necessary to ensure that its smooth flow is maintained in accordance with the appropriate technical and economic parameters.

### 4.5.2 Advice on Technical Issue and Design Option

#### (1) C-5 Improvement Plan of DPWH

DPWH intends to hire a local consultant to undertake the "Feasibility Study on the Completion of Metro Manila Circumferential Road 5 (C-5) and Other Priority Road/Interchange Projects (PRIP) and Traffic Mitigation Measure Cum Environmental, Social and Gender Aspects (C-5&PRIP)". The major long term goal of this study is to decongest and resolve the traffic problems along the entire section of C-5. Objectives of this study regarding C-5 are as follows;

1) To enhance economic efficiency of C-5 road and pursue its completion to support the rapidly expanding population and urbanization of the metropolis and guide sound urbanization development of the Metro Manila outskirts.

2) To enhance international competitiveness of the country and export industries via improving, faster and reliable passenger and freight movement through this vital Metro Manila corridor.

3) To provide measures for easing traffic congestion of Metro Manila.

The proposed scope of work for C-5 are summarized in **Table 4.5-2~4.5-4** below and the project location map along C-5 road is shown in **Figure 4.5-1.**

**Table 4.5-2 C-5 Segment A: From C-5 SLEX-R1 Coastal Expressway and NAIA Connectors**

| Name of Project | Existing Condition | Current Proposal (Indicative Improvement) | Length |
|---|---|---|---|
| A-1: Construction of Flyover/Interchange at C-5/SLEX | - No connector across SLEX | Flyover crossing SLEX (switch alignment with left turn ramp towards SLEX at grade North Bound or without switch alignment to reduce ROW | 4.42 m<br>6.15 km. |
| A-2: Completion at SLEX-Sucat Section | Incomplete portion due to RROW problem | Complete the section | 7.035 km |
| A-3 Flyover at C-5 Multinational Avenue | At-grade 4-legged intersection | 2nd Level Flyover Structure to bypass Multinational Avenue | |
| A-4: C-5 Existing – R1 Coastal Expressway Connector | Missing link from Quirino Avenue/C-5 to Coastal Road | To connect C-5 from Quirino Avenue to R-1 Coastal Expressway with Flyover structure at Quirino and Interchange ramp at R-1 | |
| A-5: C-5 Multinational-R1 Coastal Expressway Connector via San Dionisio or Pacific Avenue | New link with ROW affected areas | Alternative alignment to connect with C-5 at R-1 Expressway | 1.52 km and 2.10 km |
| A-6: C-5- NAIA 1 & 2 Connectors | Along Multinational and Ninoy Aquino Avenues | Upgrading and provision of viaduct connecting C-5 Multinational towards NAIA Terminals 1 & 2 | |

*Source: DPWH, PMO-URPO*

**Table 4.5-3 C-5 Segment B: From SLEX to C.P. Garcia Avenue**

| Name of Project | Existing Condition | Current Proposal (Indicative Improvement) | Length |
|---|---|---|---|
| B-1: Levi Mariano Avenue (Commando Interchange) Improvement Project | 3 lanes each direction of C-5 & 2-lane each direction service road North Bound and South Bound. | Widening of Service Road from 2 to 3 lanes both directions, two lanes left turning fly-over from Mariano Avenue | 400m EDSA & West Service Rd. 500 m left Turning Fly-over |
| B-2: C-5 Kalayaan and C-5 Bagong Ilog Flyover | Two lanes each direction of fly-over from Danny Floro st. (formerly Canley St.) up to the approach of Pasig bridge | Close north bound down ramp and widen flyover up to Pasig Boulevard Ext. and transfer the down ramp. | 700m |
| | Three lanes each direction crossing Pasig river from West Rembo, Makati City to Bagong Ilog in Pasig City | One lane widening of the bridge south bound | 500m |
| B-2a; Fort Bonifacio Global City to Meraclo Avenue Link Road project | Existing three lanes each direction, at Ft. Bonifacio up to Kalayaan avenue, two lanes each direction from kalayaan up to Guadalupe Pateros Road, two lanes at Sta Monica St. Intl. and two lanes in each direction at | Construct viaduct/bridge 2 lanes each direction crossing Pasig river up to near Meralco Avenue Intersection with JuliaVargas Avenue | 2,500m |

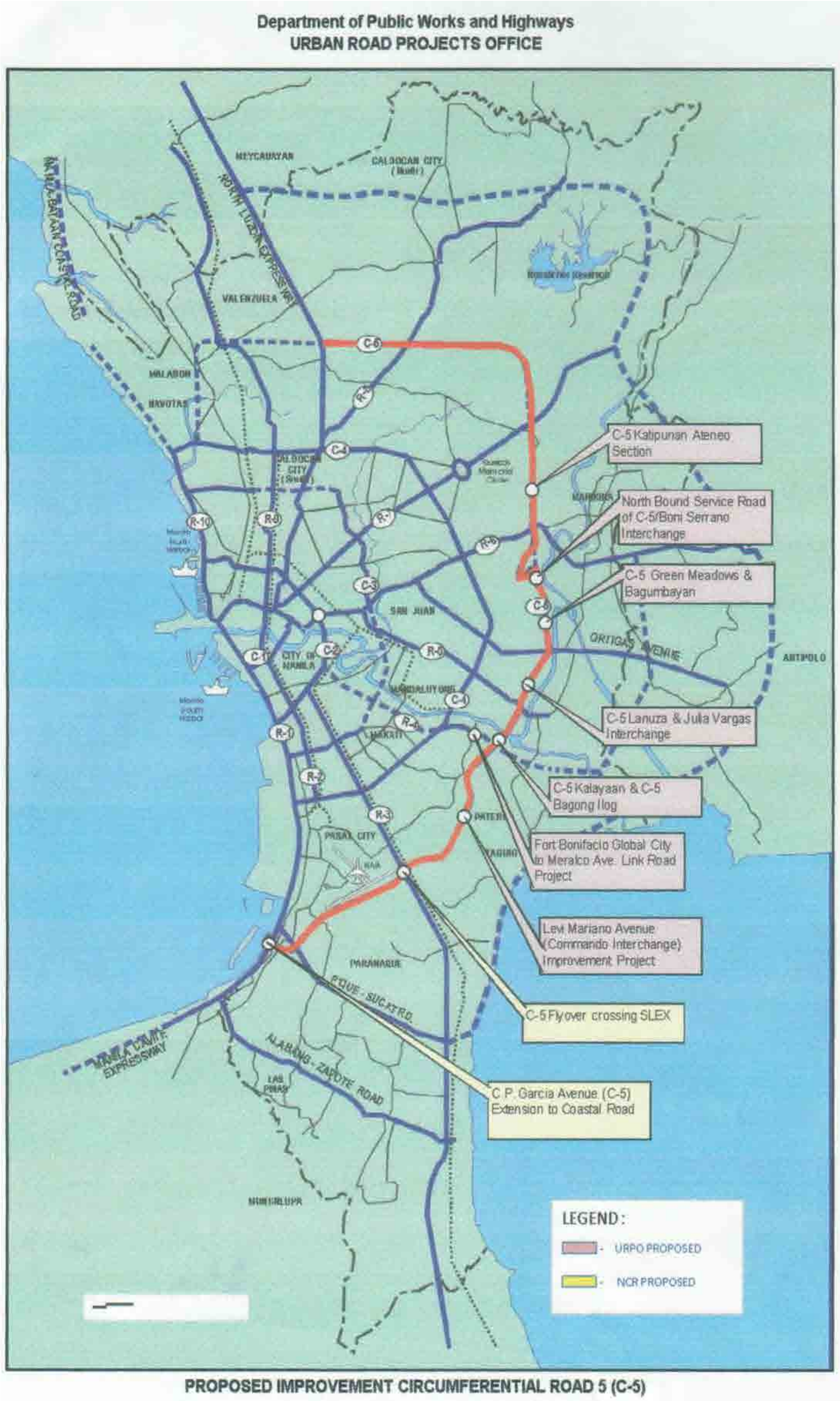
| | | | |
|---|---|---|---|
| | West Capitol Drive and three lanes sub-standard width at Meralco Avenue up to near intersection at ULTRA. | | |
| B-3: C-5 Lanuza to connect to Mercedez Avenue | | Construct four lanes to connect Ortigas Center via lanuza at C-5 towards Mercedes Avenue | 3,000m |
| B-4 North Bound Service Road of C-5/Boni Serrano Interchange | 2 lanes north bound service road at E. Rodriguez Avenue approaches | Widening form 2 to 3 lane Service Road | 300m |
| B-4: C-5 Katipunan, Ateneo section up to C. P. Garcia Ave | At grade intersection with three u-turns provision at the gates of Ateneo, Miriam College and other subdivision entrances | 1. Construct additional one lane at Ateno/Mirriam property with geometric improvement at entrances street of the subdivision abutting Katipunan Ave.<br>2. Construct viaduct two lanes each direction near the approach of the existing fly-over at Katipunan and ends after C.P. Garcia Ave. | 1000 m<br><br>1500 m |

*Source: DPWH, PMO-URPO*

**Table 4.5-4 C-5 Segment C : From C.P. Garcia Avenue (C-5) to Mindanao Avenue**

| Name of Project | Existing Condition | Current Proposal (Indicative Improvement) | Length |
|---|---|---|---|
| C-1: Congressional Avenue and Visayas Avenue Intersection | Signalized intersection | To explore further improvement as the intersection is potential choke point | |
| C-2: Congressional Avenue and Mindanao Avenue Intersection | Signalized intersection | To explore further improvement as the intersection is a potential choke point | |
| C-3: Mindanao Avenue and Tandang Sora Avenue Intersection | U-turn Provision | To explore further improvement as the intersection is a potential choke point | |
| C-4 Quirino Avenue and Mindanao Avenue Intersection | Currently With ROW constraints | To explore further improvement as the intersection is a potential choke point | |
| C-5: Commonwealth/ Luzon avenue to Republic Avenue | Two level road with Development & Individual Settler | To provide 6 lane road | |
| C-6: Republic/Luzon Avenue to Mindanao/NLEX Connector | With several Development & Informal Settler | To provide 6 lane road | |

*Source: DPWH, PMO-URPO*




*Source: DPWH, PMO-URPO*

**Figure 4.5-1 Envisaged Projects Location along C-5 Road**

These proposed projects are generally categorized into the following three (3) schemes:

1) Construction of missing link sections

2) Construction of flyovers

3) Widening of approach section of existing flyover

In view of the above, the C-5 improvement projects will not be affected on the proposed flyover projects.

**(2) Site Condition and Traffic survey**

Two (2) issues were found during the site investigation and detailed topographic surveys which may cause of bottle neck of C-5 thru traffic at the intersection.

1) Carriageway width of C-5 thru traffic in substandard is as follows:

Survey dimension at the transverse section of U-turn flyover

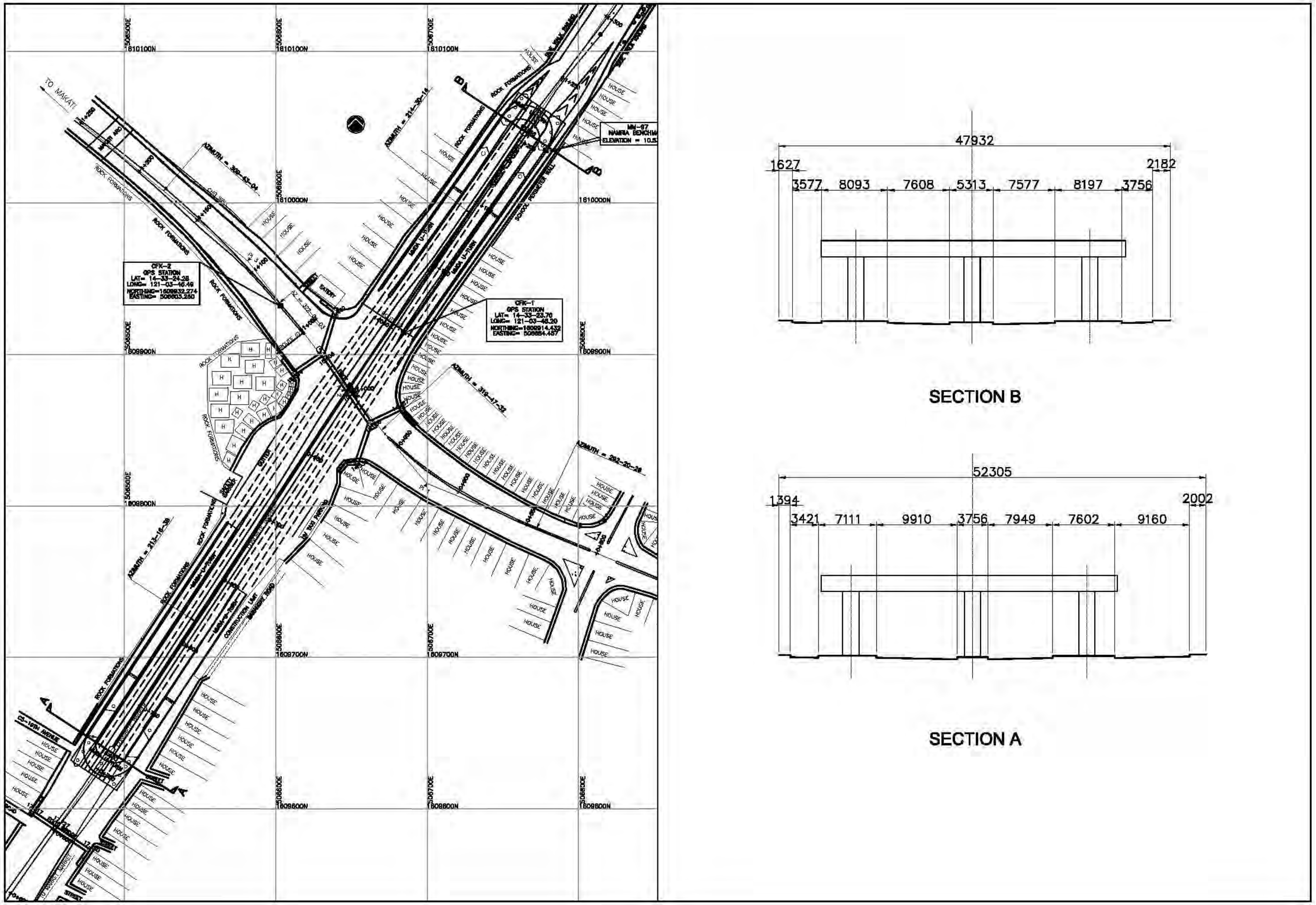
- South side U-turn flyover section
  Southbound: total width = 9.910m/3-lanes = 3.303m/lane < 3.35m
  Northbound: total width = 7.949m/3-lanes = 2.605m/lane < 3.35m
- North side U-turn flyover section
  Southbound: total width = 7.608m/3-lane = 2.536m/lane < 3.35m
  Northbound: total width = 7.577m/3-lane = 2.525m/lane < 3.35m
  Note: 3.35m is standard carriageway width of national road

2) Subtle curve alignments along C-5 thru traffic for both directions were observed around the U-turn flyover.

The Aforementioned survey result is shown in **Figure 4.5-2.**
Traffic survey was conducted after opening of the new flyover from global city to north bound of C-5 road last March 6, 2012. The traffic survey data showed that passing vehicles along the U-turn flyover at south side and north side are about 25,132 vehicles per day and 18,600 vehicles per day, respectively. Summarized and actual traffic intersection flow graphics are presented in **Figures 4.5-3** and **4.5-4**, **Figure 4.5-5** shows the present traffic flow identifying that five (5) are conflicted.

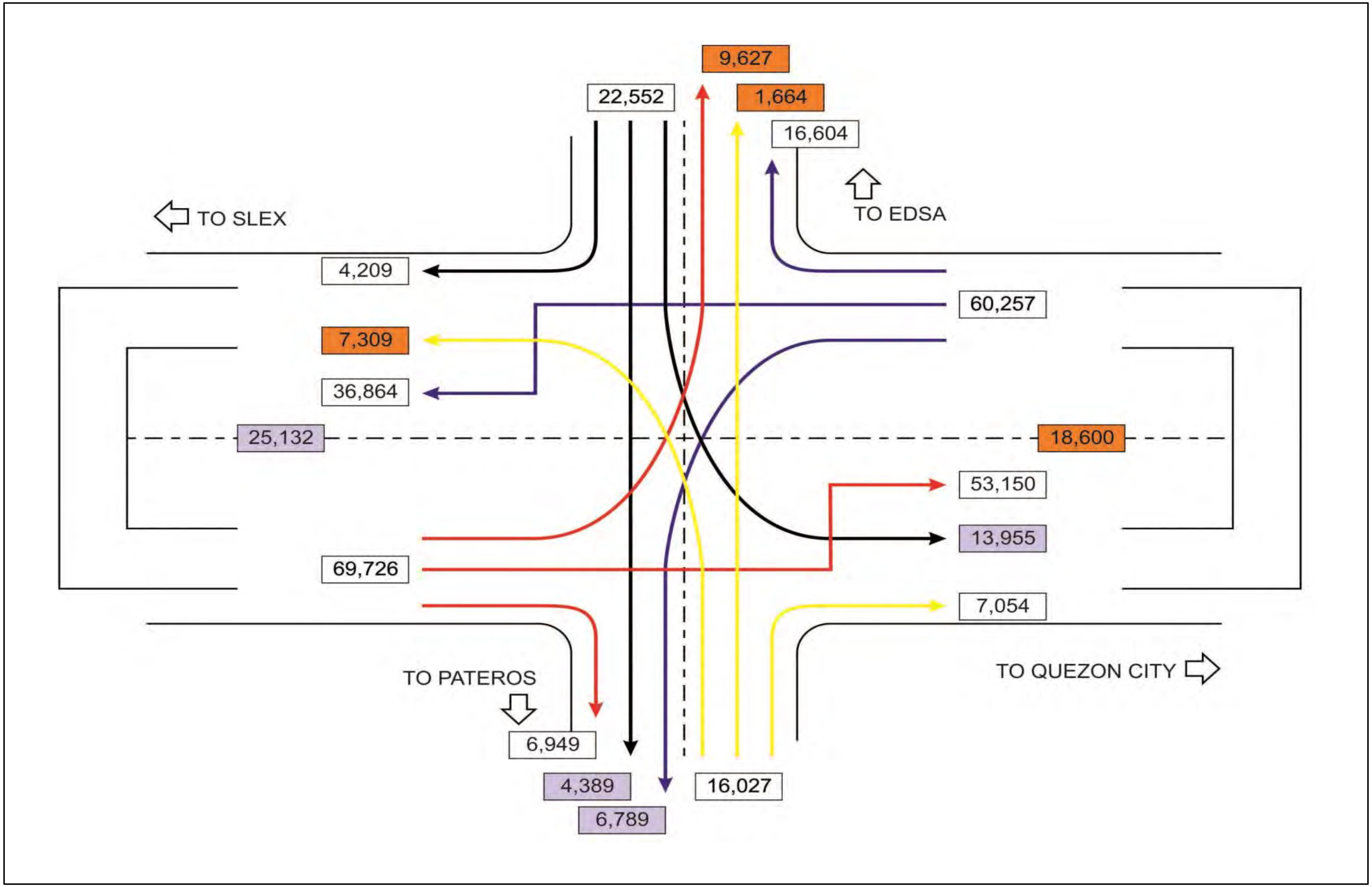
**(3) Technical study to maintain existing U-turn flyover**

In maintaining the existing U-turn flyover and from traffic data aforementioned, the summary of available options and findings for improving future traffic flows and capacities are shown in **Table 4.5-5**



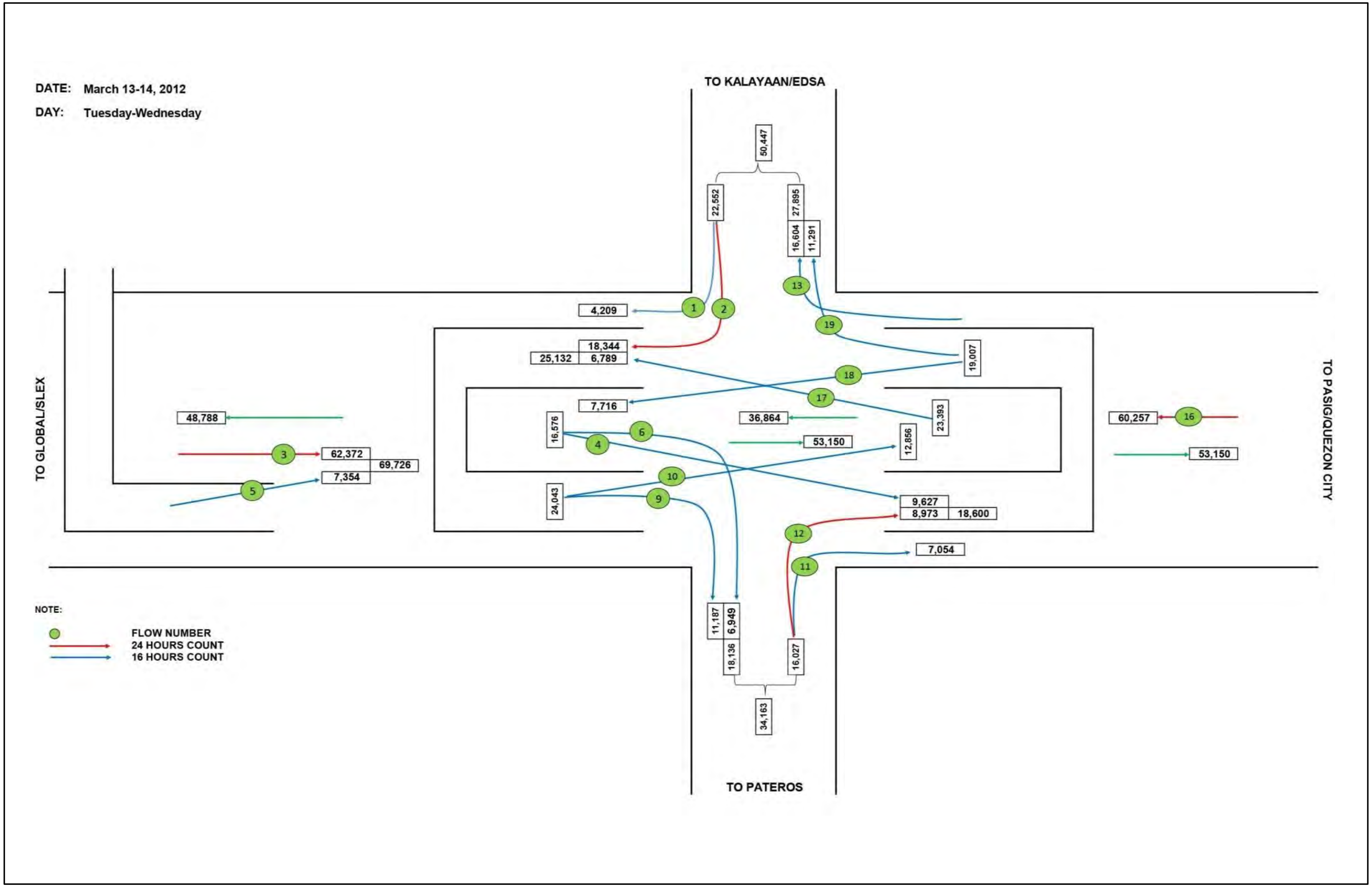

Source: JICA Study Team

**Figure 4.5-2 Typical Cross Section of C-5 of U-Turn Flyover**



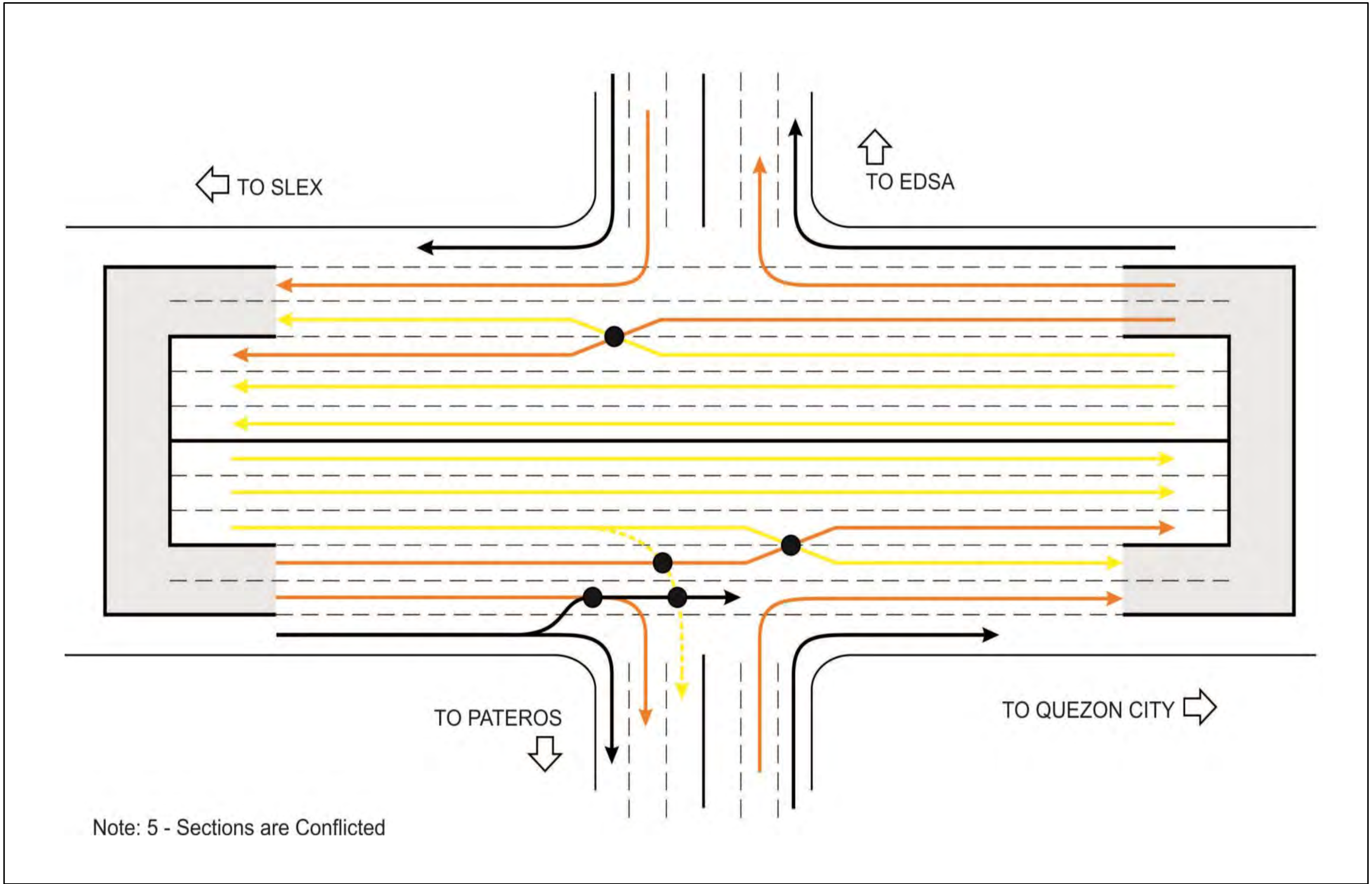

*Source: JICA Study Team*

**Figure 4.5-3 Summarized Intersection Flow Graphic Summary (AADT)**




Source: JICA Study Team

**Figure 4.5-4 Intersection Flow Graphic Summary (AADT) Vehicle Type: All Types C5/Kalayaan**




*Source: JICA Study Team*

**Figure 4.5-5 Present Traffic Flow**

**Table 4.5-5 Proposed Options and Findings**

| Option | | AADT | Findings | Reduced Conflict No. (Present conflict is 5) |
|---|---|---|---|---|
| 1 | Construct left turn flyover from Kalayaan Avenue to C5 north bound | 13,955 | Require ROW acquisition but Tibagan elementary is located along C5 north bound. | -2 |
| 2 | Construct left turn flyover from Pateros to C5 north bound | 7, 309 | Comparatively traffic volume is small and requires ROW acquisition | -1 |
| 3 | Construct straight flyover along Kalayaan Ave | 6,053 | Traffic volume is small | -1 |
| 4 | Construct left turn flyover from C5 south bound to Pateros | 6,789 | Not enough transition length | -1 |
| 5 | Construct left turn flyover from C5 north bound to EDSA | 9,627 | Not enough transition length | 0 |

*Source: JICA study team*

The alignments of the above (5) options are shown in **Figure 4.5-6** and improvement in traffic flow by option are presented in **Figure 4.5-7.**

In summary, the most effective option is to construct a left turn flyover from Kalayaan Avenue to C-5 north direction. However, it should be noted that Tibagan elementary school is located just beside the road along C-5 north direction. Improvement of future traffic flow and capacity for this intersection while maintain existing U-turn flyover will have only two (2) possible options: option 2 and 3 of the above summary. It should further be noted that both options will not be effective due to small traffic volume and improvement traffic flow is small or will only be minimal.

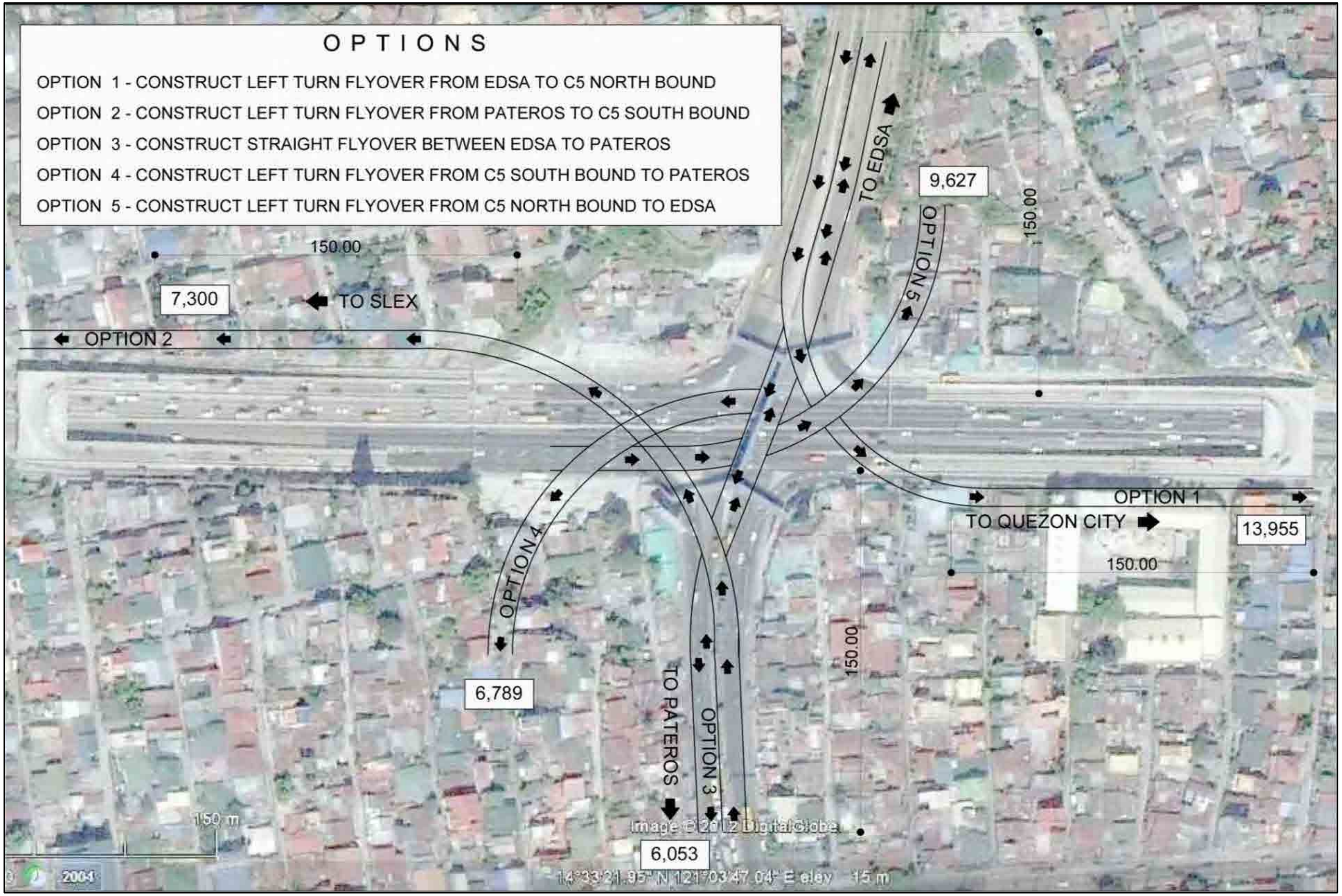
### (4) Technical study with demolition of existing U-turn flyover

The number of traffic lanes along C-5 can be provided six (6) lanes each per direction after demolition of the U-turn flyovers on both sides of the intersection.

New intersection plans provide three (3) lanes in each direction along C-5 thru traffic. Based on traffic volume and traffic flow at the intersection, the following four (4) schemes can be considered as new intersection plans after construction of a six lane (6) underpass structure for thru traffic along C-5 road;

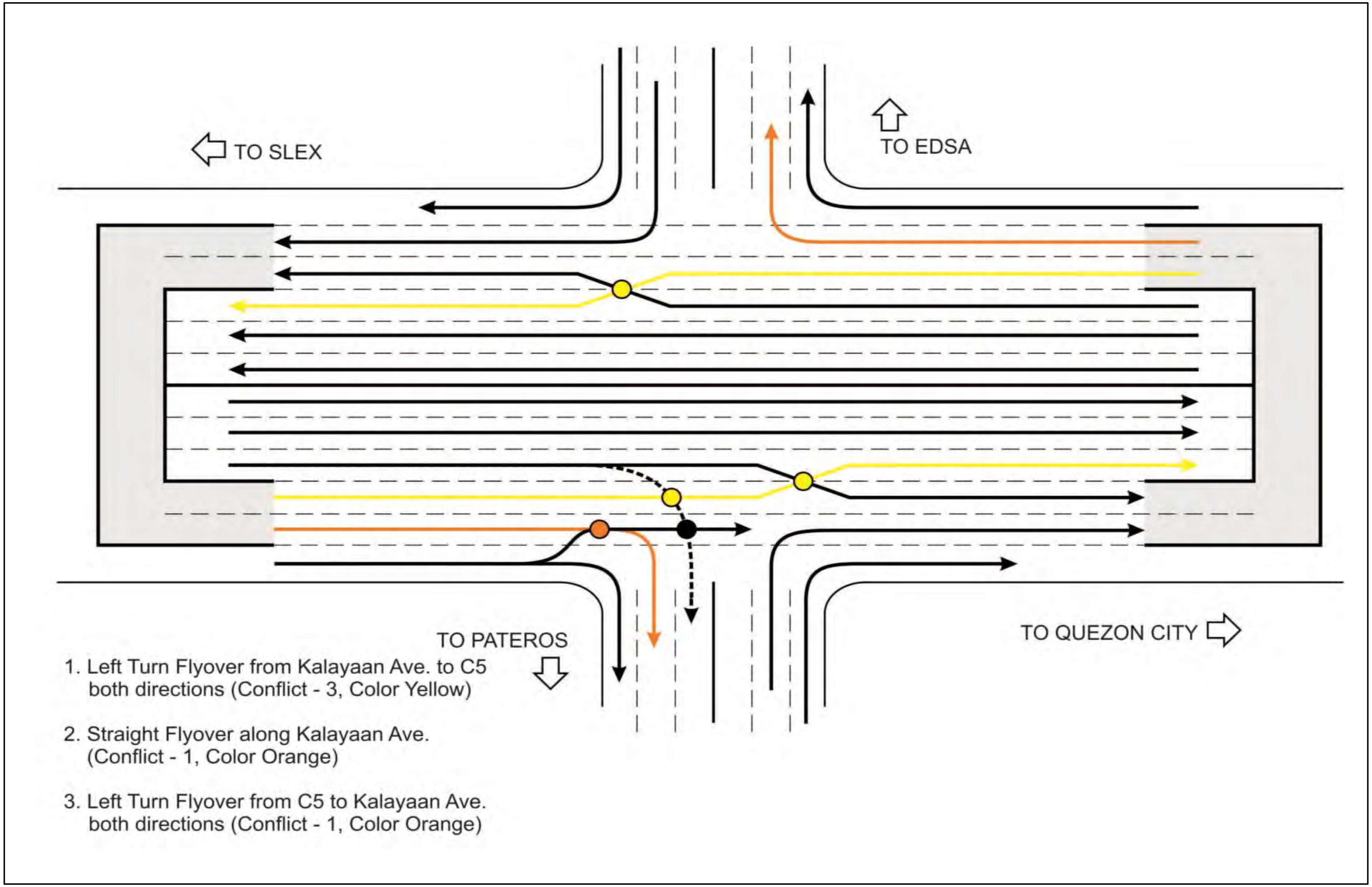
- Scheme-1 : No provision of any structures for grade separation
- Scheme-2 : 2- Left turn flyover from Kalayaan Ave. to C-5 in both directions.
- Scheme-3 : Straight flyover along Kalayaan Ave.
- Scheme-4 : 2- Left turn flyover from both directions of C-5 to Kalayaan Ave

Comparative evaluation of the above four (4) schemes is shown in **Table 4.5-6** and proposed alignments are shown in **Figures 4.5-8 ~ 11**.




Source: JICA Study Team

**Figure 4.5-6 Alignment of Five Options**




*Source: JICA Study Team*

**Figure 4.5-7 Traffic Flow by Option**

**Table 4.5-6 Scheme Comparison without U-turn Flyover**

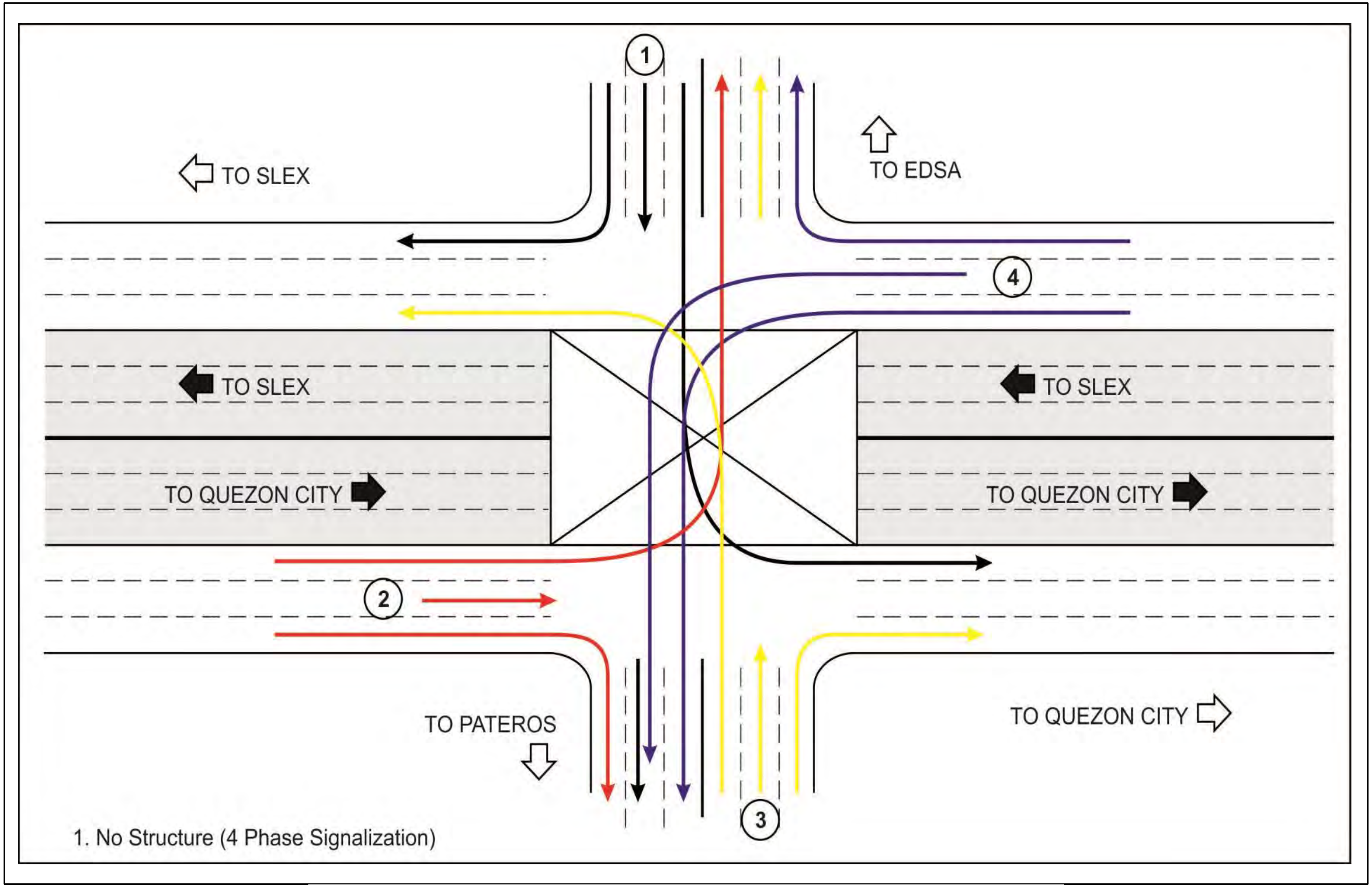
| Description | Signal Phase | Traffic Reduction Ratio | Length and Cost of Flyover (m) | Overall Evaluation/Ranking | |
|---|---|---|---|---|---|
| **Scheme-1**<br>No structure for grade separation | 4-Phase | 0 / 43.733 = 0% | Om<br>MP0 | * Manage 4-phases signalization<br>* No cost, no improvement | 4 |
| **Scheme-2**<br>2-lanes Left turn flyover from Kalayaan Ave. to C5 both direction | 3-Phase | 21.264 / 43.733 = 48.6% | 370m x 2 = 740m<br>MP 444 | * Most effective plan due to almost 50% of traffic is free flow | 1 |
| **Scheme-3**<br>2-lanes Straight flyover along Kalayaan Ave. | 3-Phase | 6.053 / 43.733 = 13.8% | 360m<br>MP 216 | * Requires budget is reasonable but effeteness to the traffic flow is small | 3 |
| **Scheme-4**<br>2-lanes Left turn flyover from C5 both direction to Kalayaan Ave. | 3-Phase | 16.416 / 43.733 = 37.5% | 370m x 2 =740 m<br>MP 444 | * 2nd effective plan due to almost 40% of traffic is free flow | 2 |

Note: 1) Traffic rate : Ratio of number of traffic vehicle pass the flyover against total volume of traffic at intersection except along C5 thru traffic and right turn traffic (total volume of traffic for calculation is 43.733 vehicles)

2) Number of lane for all flyover is 2-lane

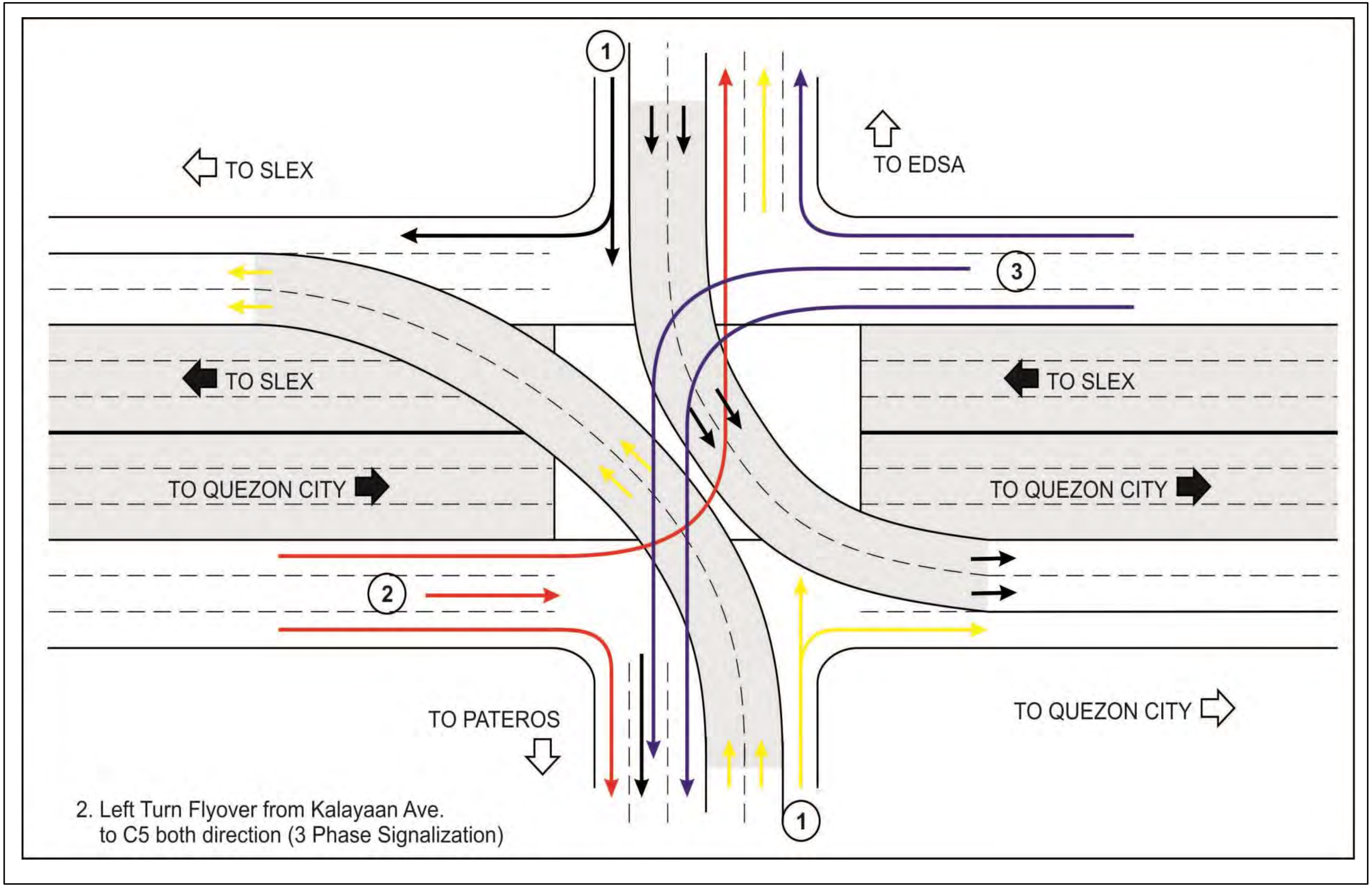
3) Cost of flyover : P 300,00/m/lane

*Source: JICA Study Team*



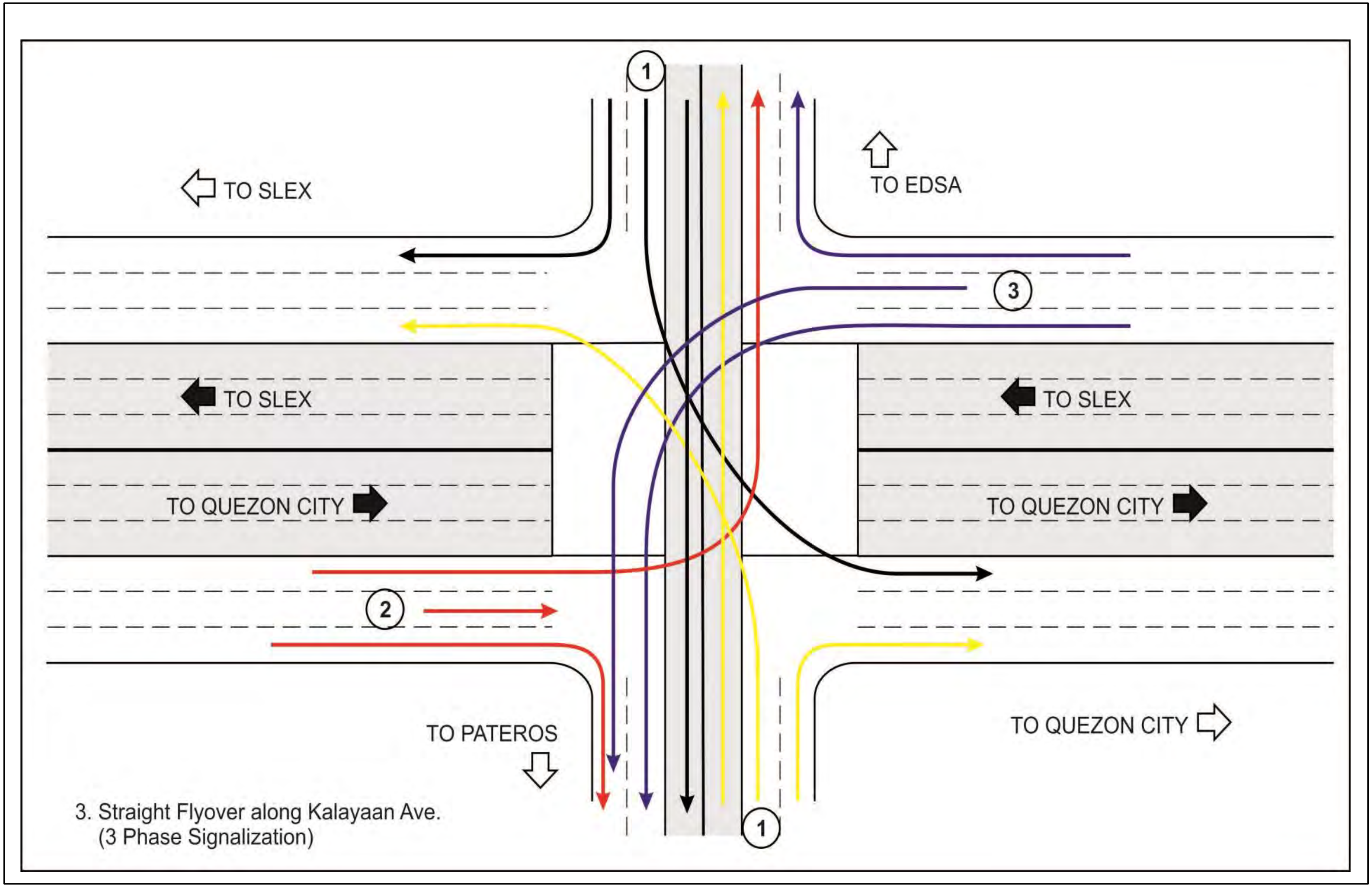

*Source: JICA Study Team*

**Figure 4.5-8 Alignment of Scheme-1 without U-Turn Flyover**



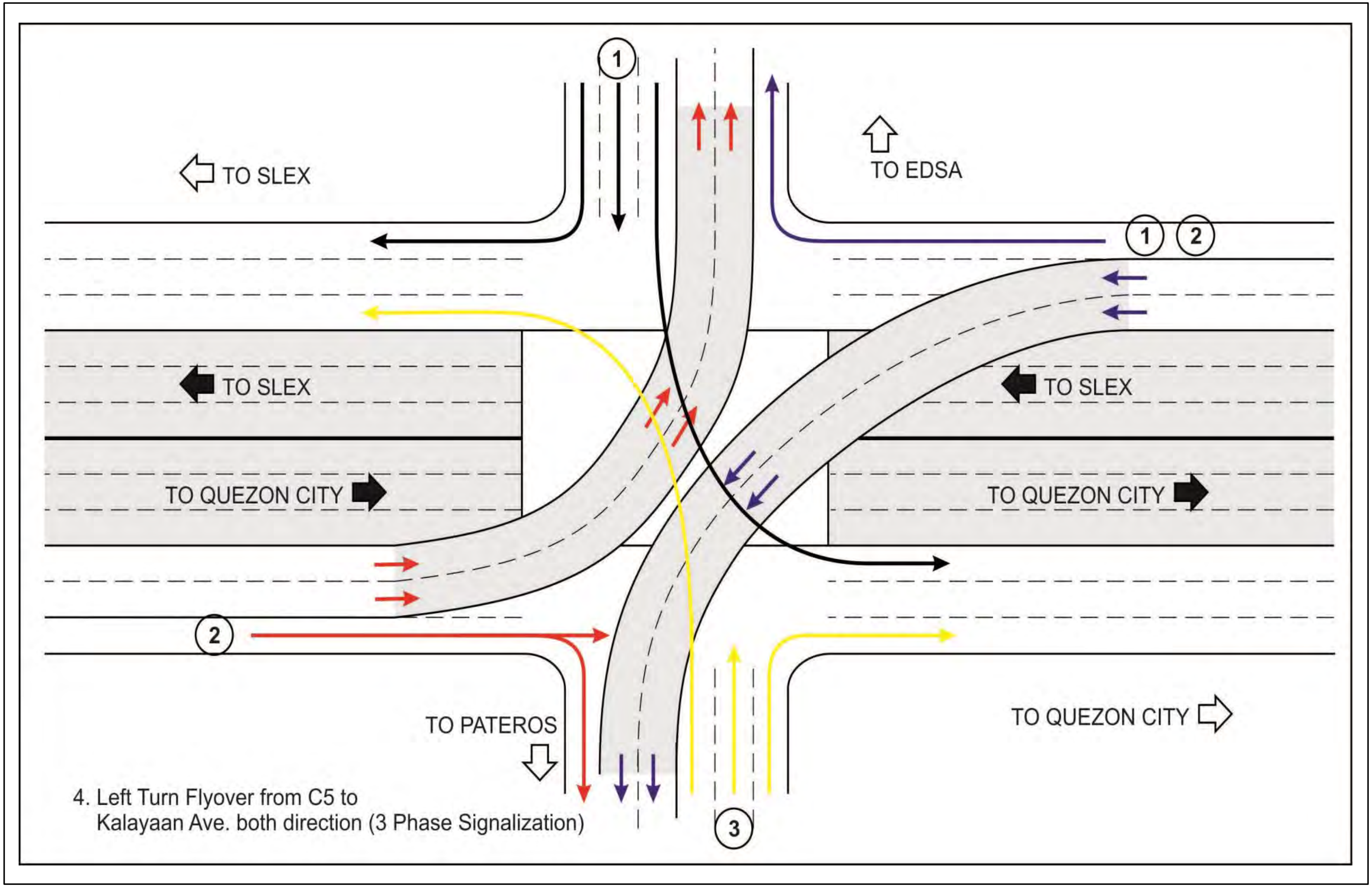

Source: JICA Study Team

**Figure 4.5-9 Alignment of Scheme-2 without U-Turn Flyover**




*Source: JICA Study Team*

**Figure 4.5-10 Alignment of Scheme-2 without U-Turn Flyover**




*Source: JICA Study Team*

**Figure 4.5-11 Alignment of Scheme-4 without U-Turn Flyover**

### (5) Overall evaluation

**With existing U-turn flyover**

- Existing substandard carriageway widths and subtle curve alignments are the cause of unsmooth traffic around both sides of the U-turn flyover and that will become bottleneck of C-5 thru traffic and problems with these defects have no remedial measures without demolishing the existing U-turn flyover.
- The most optimum option among the proposed improvement schemes is the construction of a left turn flyover from Kalayaan Ave to C-5 both directions. However, it should be noted that a ROW problem exists (i.e. Tibagan elementary school is located at just beside of C-5 northbound)
- Options 2 and 3 are possible options but will not be effective due to small traffic volume.

**Without existing U-turn flyover**

- Construct 3-lanes in each direction with underpass along C-5
- Construct flyover from kalayaan Ave. to C-5 both directions will be the most effective scheme considering that almost 50% of current traffic will become free flow
- Cost requirements are estimated as follows:

| | | |
|---|---|---|
| Construction of 2-lanes Flyover (total length 740m) | = | MP 444 |
| Construction of 6-lanes Underpass structure | = | MP 520 |
| Demolition of existing U-turn flyover | = | MP 64 |
| Total | = | MP 1,028 |

### (6) Recommendation

**With U-turn flyover**

- To resolve the ROW problem (Tibagan elementary school) necessary for the improvement of the intersection with the present condition of U-turn flyover.

**Without U-turn flyover**

- To construct a 6-lane underpass for thru traffic and 2-lanes left turn flyover from Kalayaan Ave. to C-5 both directions. The traffic flow system to dissolve problems of traffic flow conflict, unsmooth thru traffic alignments and substandard carriageway width.

**Total Recommendation**

- Implementation of the above without a U-turn flyover is recommended because the study shows that there is no ultimate solution that could fully address the expected yearly increase traffic without demolition of the existing U-turn flyover.

## 4.6 C-5-GREEN MEADOWS AVENUE

### 4.6.1 Review of Previous Detailed Design

The detailed design of the project was prepared by the Japan Overseas Consultants Co., Ltd. in association with TCGI Engineers in October 2004.

#### (1) Topographic Conditions

The project area has the following topographic conditions and characteristics:

1) The horizontal alignment of this proposed flyover section has a left curve from Ortigas Avenue toward Quezon City, which starts before Industrial Street up to the portion immediately before Eastwood Avenue.

2) The highest elevation of about 24.0m and the lowest, which is about 18.5m, are located within the construction limits at Green Meadows Avenue intersection and White Plains Creek, respectively, and average vertical grade of these sections is 0.86%. The average vertical grades before the highest point and after lowest point are 1.8% and 0.2%, respectively.

3) C-5 has four lanes on each direction.

4) The White Plains Creek, about 12m wide and 4m high, crosses C-5 between Industrial Avenue and Eastwood Avenue.

5) Four access roads, namely Green Meadows Avenue, Calle Industria, Eastwood Avenue and Poseidon Street, are located within the construction limits.

6) Subdivisions and small commercial shops line on the left side of C-5 towards Quezon City while the right side is lined with big commercial establishments and industrial developments.

#### (2) Geotechnical Conditions

The proposed area is located on the eastern edge of the center part of the Central Plateau, which is underlain by "tuffs and tuffaceous sediments" of the Pliocene–Pleistocene or the Holocene. In the section from Green Meadows to Calle Industria, the subsoil is distributed until the depth of 0.7-1.0m below ground surface. For the White Plains Creek to end section, the subsoil (CL/CH sandy, ML sandy silt, and SM silty sand) is distributed until the depth of 12.0m below ground surface. The range of SPT (Standard Penetration Test) of the subsoil varies from 5 to 69. Also, SPT was not carried out in tuffs, but N-value of tuffs is estimated over 100. (As previous detailed design does not have geotechnical data available, above data were obtained by the JICA study team).

#### (3) Hydrological Conditions

There is a creek (White Plains creek) which crosses the road (C-5) at 500m Katipunan side from C-5–Green Meadows intersection. The creek consists of both of the high and low water channels.

The high water channel width is about 12m with 4m, depth, and the low water channel width is about 4m,with 2m depth.

The White Plains Creek is located in the basin of the Marikina River. It joins to the Marikina River after flowing down about 600m from the crossing point with the road. However, it is believed that no flooding will be experienced in the proposed area because an elevation of the crossing point with the road is about 5m higher than that of the confluence with Marikina River.

Therefore, there is no specific issue on the hydrological conditions in the proposed area, except if the interchange is constructed as an underpass type. There was also no information on the hydrological conditions in the feasibility study.

**(4) Design Standards**

The detailed design did not have a section that particularly discusses the design standards. The following information were gathered from various parts of the design plans:

1) Highway Design

- ✓ Lane Width : 3.25m
- ✓ Maximum Vertical Grade : Tunnel = 4.53%
- ✓ Standard Super elevation : 1.5%
- ✓ Vertical Clearance of Tunnel : 5.0m
- ✓ Minimum Earth Covering of Tunnel : 2.0m

2) Hydrology and Hydraulics

No information available.

3) Structural Design

No information available.

**(5) Road Alignment and Structural Conditions**

The 925m long tunnel will start before Green Meadows Avenue intersection and terminate after Eastwood Avenue intersection from Ortigas Avenue. The tunnel has four lanes, two-directional, (3.5m x 2 x 2) and with 5.0m vertical clearance while the tunnel top has a 2.0m earth covering. The vertical grades be at 2.0% in average and 4.5% at the tunnel exit. The tunnel's first approach is 152m while the second approach is 203m passing through under the existing creek. A 350m radius curve alignment is located almost at the center of the tunnel. About 12m height of Sump pit for drain water pump up system is provided at the lowest point of the tunnel and also ventilation fans are provided at four locations in each direction.

Tunnel structures were designed as concrete retaining wall with ground anchor.

### (6) Environmental and Social Conditions

The detailed design did not cover the environmental aspect of the project. According to the feasibility study report, the following environmental and social issues were addressed.

1) Environmental conditions

Scheme I – Cut and Cover Tunnel is recommended because this would have the least air and noise pollution effects among the alternatives. Aesthetic view of the area would also be preserved.

2) Social conditions

The existing road ROW from sidewalk to sidewalk is 36.0 m and would be enough to accommodate proposed level of improvement. Therefore, no additional property acquisition is needed.

### (7) Identified Problems and Recommendations

**Identified Problems**

1) The detailed design was done and signed only by the consultant. (There was no signature of the plans from DPWH as per DO#50 series 2002).
2) Proper widening was not provided at the curve section.
3) The tip of the ground anchors were in private lots.
4) About 13m height of sump pit was located under the carriageway and sidewalk which would be hard to arrange for traffic management during construction.
5) No study on the complicated construction procedure of tunnel underneath the existing creek and construction of sump pit under the carriageway and sidewalk.

**Recommendations**

The problems identified above should be carefully and thoroughly studied.

### 4.6.2 Preliminary Design of Interchange

#### (1) Study of White Plains Creek

There is a creek (White Plains Creek) which crosses the road (C-5) at 500m Katipunan side from C-5/Green Meadows intersection. If the interchange is constructed as underpass, the creek may be moved below the underpass by inverted siphon. However, the proposed inverted siphon cannot be adopted for the following reasons:

1) Rise in water level at upstream side

The calculation result of the loss of head of inverted siphon is 1.3 m. Therefore, at the time of freshet, the water level will rise to 1.3m higher than the present condition at the upstream side of the road and will cause flooding.

2) Blockage due to garbage

It is expected that much garbage will flow at the time of freshet because the creek is flowing through a residential area. Therefore, frequent cleaning of the screen of inverted siphon will be needed.

Moreover, the water level mentioned above was calculated assuming that drainage is not clogged with garbage. Then, its level should be raised further in case that drainage is clogged with garbage.

Therefore, “Underpass passing under the creek” or “Flyover passing over the creek” can both be proposed as alternatives. The following considerations for the construction of both alternatives should be taken into account:

| | |
|---|---|
| Underpass passing under the creek | When a structure crosses under the creek, in order to prevent the influence by scouring of a stream bed, a distance between a structure and the creek is required more than 2.0m generally. However, the stream bed of White Plains Creek will not be scoured because it is protected by concrete. Thus, the distance is just required for the construction of the structure. |
| Flyover passing over the creek | The arrangement of piers shall be decided so that it will not affect the future improvement of the river.<br>The structure shall be planned so that it will not obstruct the surface flow because it traverses the road (C-5) at the time of freshet. |

#### (2) Comparative Study

Based on review of detailed design, updated site and traffic conditions, comparative study was undertaken considering with following basic conditions ;

- Local traffic due to four intersections are located within the proposed construction limit.
- About 100m long 4% of existing steep vertical grade which located at before Green Meadows intersection from Ortigas Ave.
- White Plains creek which located at near Calle Industria intersection.

- The number of lane is 2-lanes for each direction and total 4 lanes in both directions are combined.
- Type of superstructure should be designed as voided slab type to provide aesthetic view of the flyover.

The following three (3) alternatives are proposed as the most suitable for comparison based on the above conditions:

- Scheme-1 : 1098m long flyover and with PC and RC voided slab superstructure
- Scheme-2 : 808m long cut and cover tunnel
- Scheme-3 : 432m long flyover and 80m long cut and cover tunnel

Among the three (3) schemes, scheme-1 was selected due to the following reasons:

- Construction cost is cheaper than schemes
- No ROW acquisition
- Construction is much easier than the other schemes
- Provide four (4) lanes per each direction at-grade along the total stretch underneath the viaduct
- Does not requires specific O&M compared to the other two (2) schemes

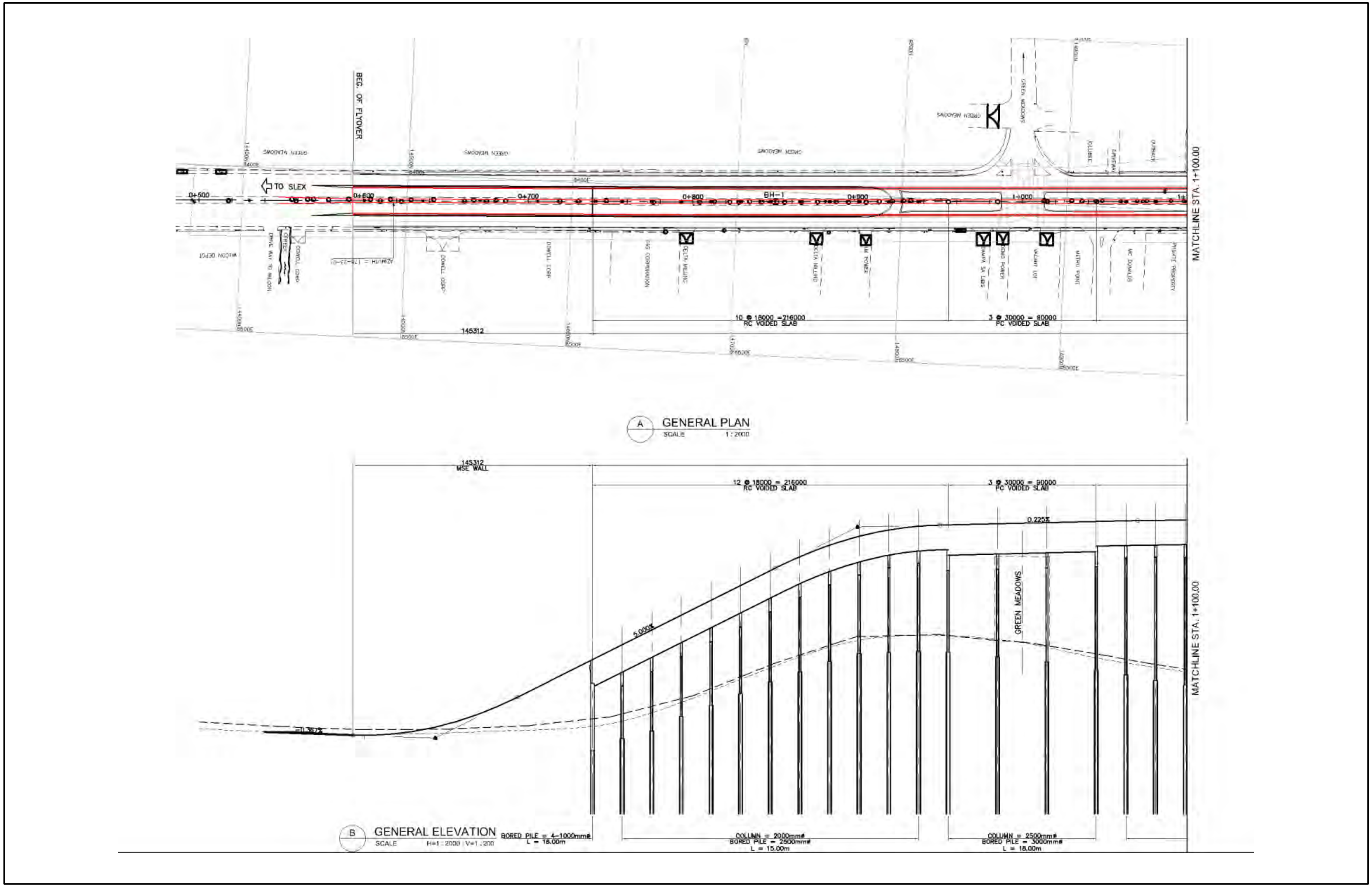
The detailed scheme comparison is presented in **Table 4.6-1** and the Plan and Profile for each of the Schemes are shown in **Figures 4.6-1 ~ 9.**

## Table 4.6-1 Scheme Comparison Table of C-5 / Green Meadows / Acropolis / Calle Industria Interchange

| Schemes | SCHEME -1 FLYOVER | | SCHEME - 2 CUT AND COVER TUNNEL | | SCHEME - 3 FLYOVER AND CUT & COVER TUNNEL | |
|---|---|---|---|---|---|---|
| **Structure Schemes** | 4-Lane Flyover : L= 1098m<br>PC Voided Slab : 6@30m=180.0m<br>RC Voided Slab : 51@18m=918.0m<br>Approach Road : 276.4m | | 4-Lane Tunnel : 807.7m<br>Approach Road : 513.3m | | 4-Lane Flyover 3@30m+17@18m=432.0m<br>PC Voided Slab : 3@30.0m=90.0m, RC Voided Slab 19@18.0 m=342.0 m<br>4-Lane Tunnel : 80m + Under Pass Section 559.4m<br>Approach Road : 219.6m | |
| **Construction Cost** | Flyover MP 1.010.2 (P920,000/m)<br>Approach MP 33.2 (P120,000/m)<br>Others MP 43.3<br>Total MP 1097.7 (100.0%) | ○ | Tunnel MP 2,456.3 (included approach section)<br>Ventilation System MP 60.0 (4 Nos.)<br>Sump Pit MP 40.0 (H = 16m)<br>R.O.W. MP 20.0 (20m x 20m x P50,000/m$^2$)<br>Total MP 2,576.3 (234.7%) | △ | Flyover MP 397.4 (P920,000/m)<br>Tunnel MP 706.4 (included under pass section)<br>Approach MP 35.1 (P160,000/m)<br>Sump Pit MP 30.0 (H=12m)<br>ROW MP 20.0 (20 m x 20 m x P50,000/m$^2$)<br>Others MP 47.0<br>Total MP 1,235.9 (112.6%) | ◎ |
| **Construction Performance and Duration** | 24 months<br>○ No impact on existing creek<br>○ Construction method and procedure is standard<br>○ Provide 2-Lanes per each direction during construction | ◎ | 38 months<br>● Requires several construction sequences to maintain creek water flow.<br>● Requires to find dumping place for 199.000 m$^3$ of excavated soil<br>● Require special method and procedure for construction of sump pit and cross pipe about 12 m deep under ground<br>● Provide 1.5 lane per each direction only during construction | △ | 24 months (Tunnel & Flyover Construction Simultaneously)<br>○ No impact on existing creek<br>● Requires 2-kind equipments and material for tunnel and flyover construction<br>● Requires to find dumping place for 62.000m$^3$ of excavated soil<br>● Require special construction method and procedure for construction of sump pit and cross pipe about 10 m deep under ground<br>● Provide 1.5 lane per each direction only during construction | ○ |
| **Environmental and Social Conditions** | ○ No ROW acquisition<br>● Traffic noise is severe than scheme 3 but not concentrated. | ◎ | ○ Aesthetic view of area will be preserved<br>● Requires about 400 m$^2$ ROW acquisition for sump pit<br>● Greater impact on traffic with longer construction duration<br>● Noise and exhaust fumes are concentrated at both entrances | △ | ● Requires about 400 m$^2$ ROW acquisition for sump pit location<br>● Higher volume of exhaust fumes due to longer and steep slope section<br>● Less traffic noise than Scheme-1 but concetrated at both sides of entrances | △ |
| **Traffic Condition** | ○ Provide 4-lanes per each direction at grade along entire section of under the viaduct<br>○ Easiest traffic management during construction | ◎ | ○ Provide 4-lanes per each direction at grade along entire section of tunnel<br>● Difficult traffic management during construction | ○ | ● Provide only 2-lanes per each direction at grade tunnel section<br>● Not advisable for steep slope (4.0%) with 400m long vertical alignment<br>● Very dangerous at the point of change vertical grade between depressed and elevated | △ |
| **O & M** | ○ No specific O & M required | ◎ | ● Requires daily monitoring and maintenance for tunnel facilities such as ventilation, water supply,water pump system, fire detection, traffic safety , etc. | △ | ● Requires periodic monitoring and maintenance of water pump up system and illumination | ○ |
| **Over all Evaluation** | ○ Cheapest among the schemes<br>○ No R.O.W. Acquisition<br>○ Construction is much easier than other 2-schemes<br>○ Not require specific O & M compared to other two schemes<br>○ Provide 4-lanes at-grade per each direction at grade | ◎ | ● Most expensive<br>● Longest Construction duration<br>● Difficult construction activity due to existing creek and sump pit<br>● Requires permanent O & M system<br>○ Provide 4-lanes at grade per each direction | △ | ● About 12%expensive than scheme-1<br>● Sump Pit requires difficult construction method and sequence<br>● Requires 400 m$^2$ R.O.W. acquisition and periodic monitoring , maintenance of water pump-up system and illumination<br>● Provide only 2-lanes for each direction at-grade tunnel and approach section<br>● Vertical alignment is very much worse than other 2-Schemes | ○ |

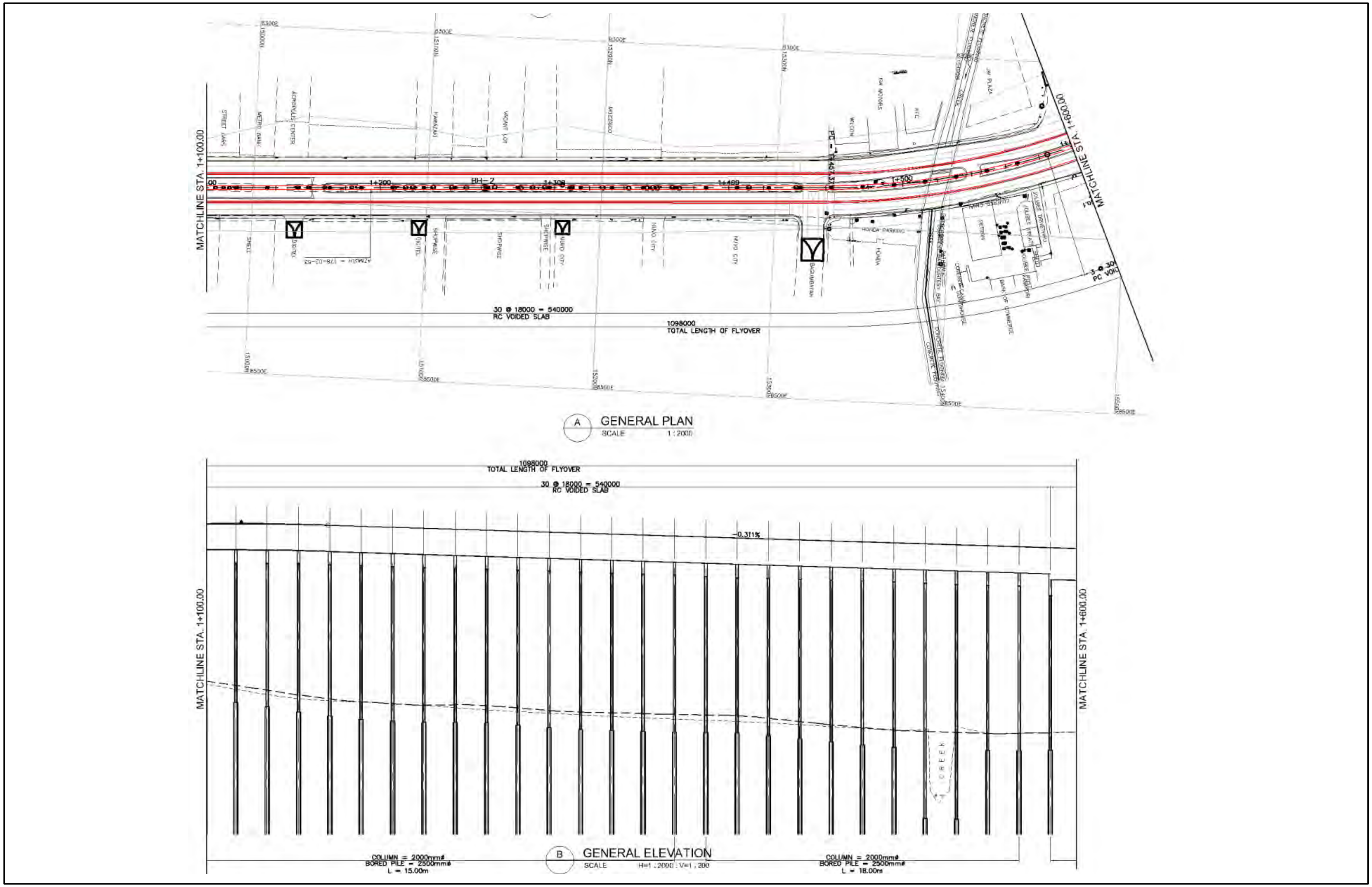
**LEGEND :** ○ **advantage**
● **disadvantage**

*Source: JICA Study Team*



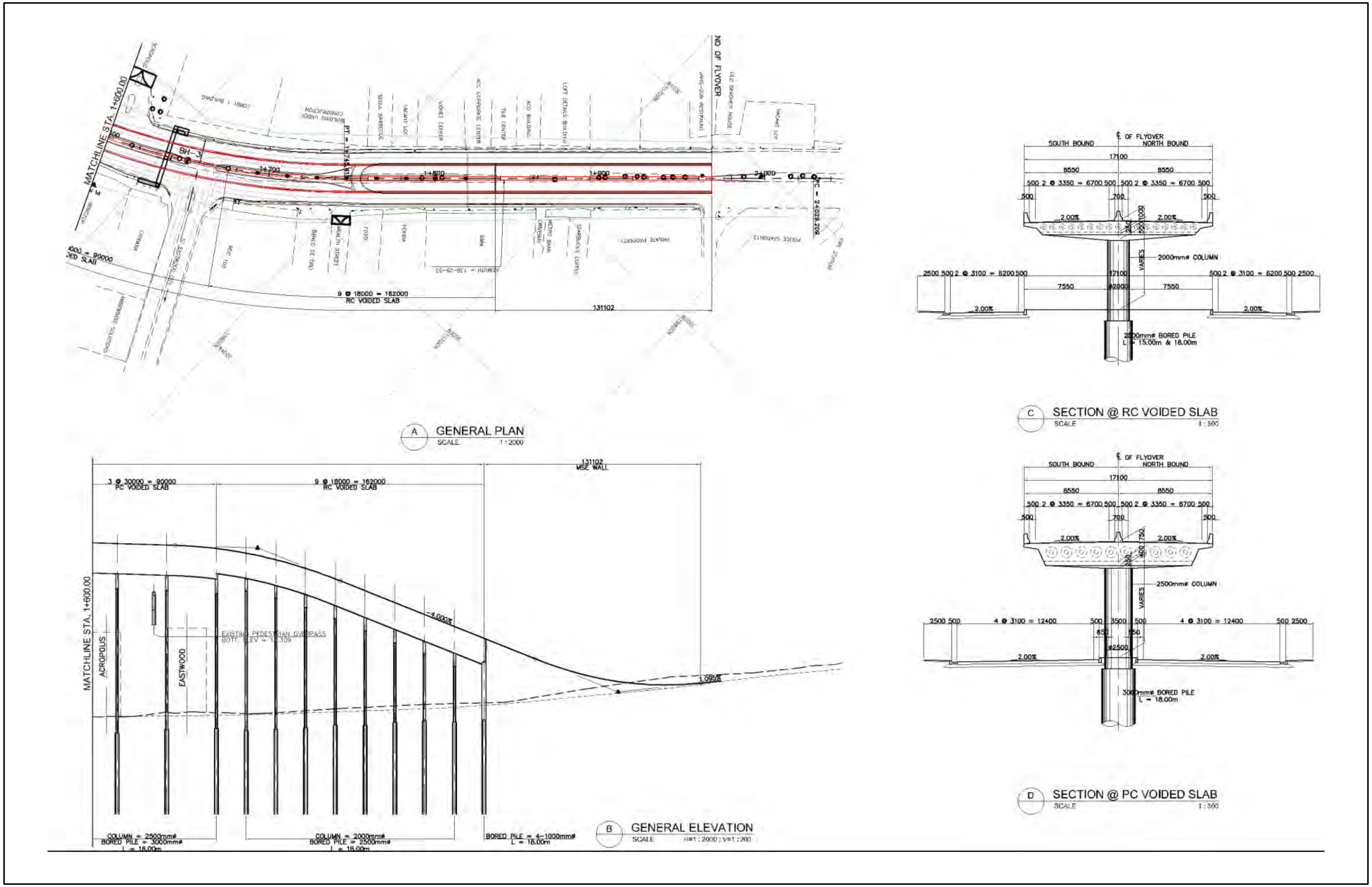

*Source: JICA Study Team*

**Figure 4.6-1 Plan and Profile of Scheme-1 (Flyover C-5/Green Meadows) (1/3)**



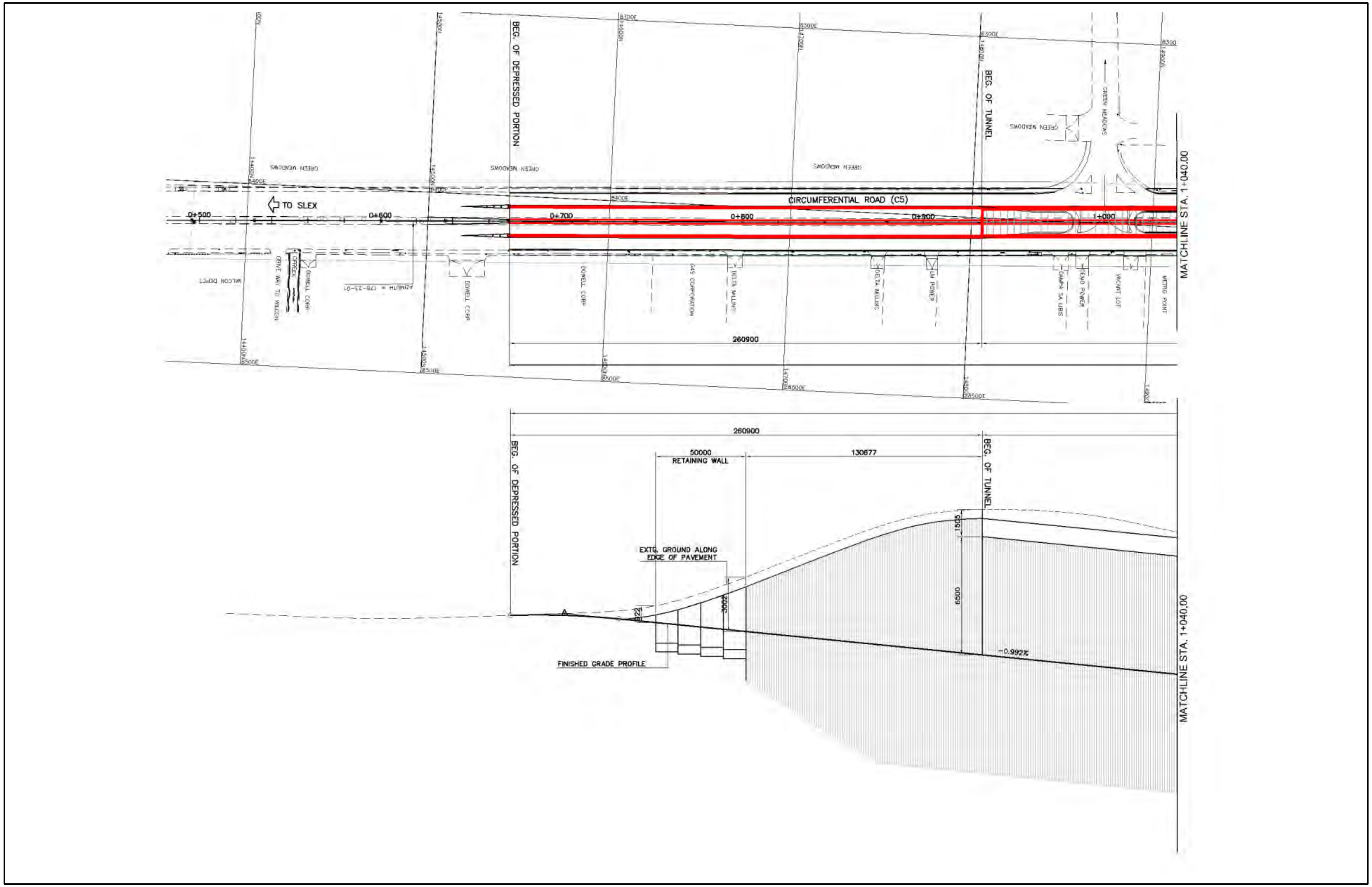

*Source: JICA Study Team*

**Figure 4.6-2 Plan and Profile of Scheme-1 (Flyover C-5/Green Meadows) (2/3)**



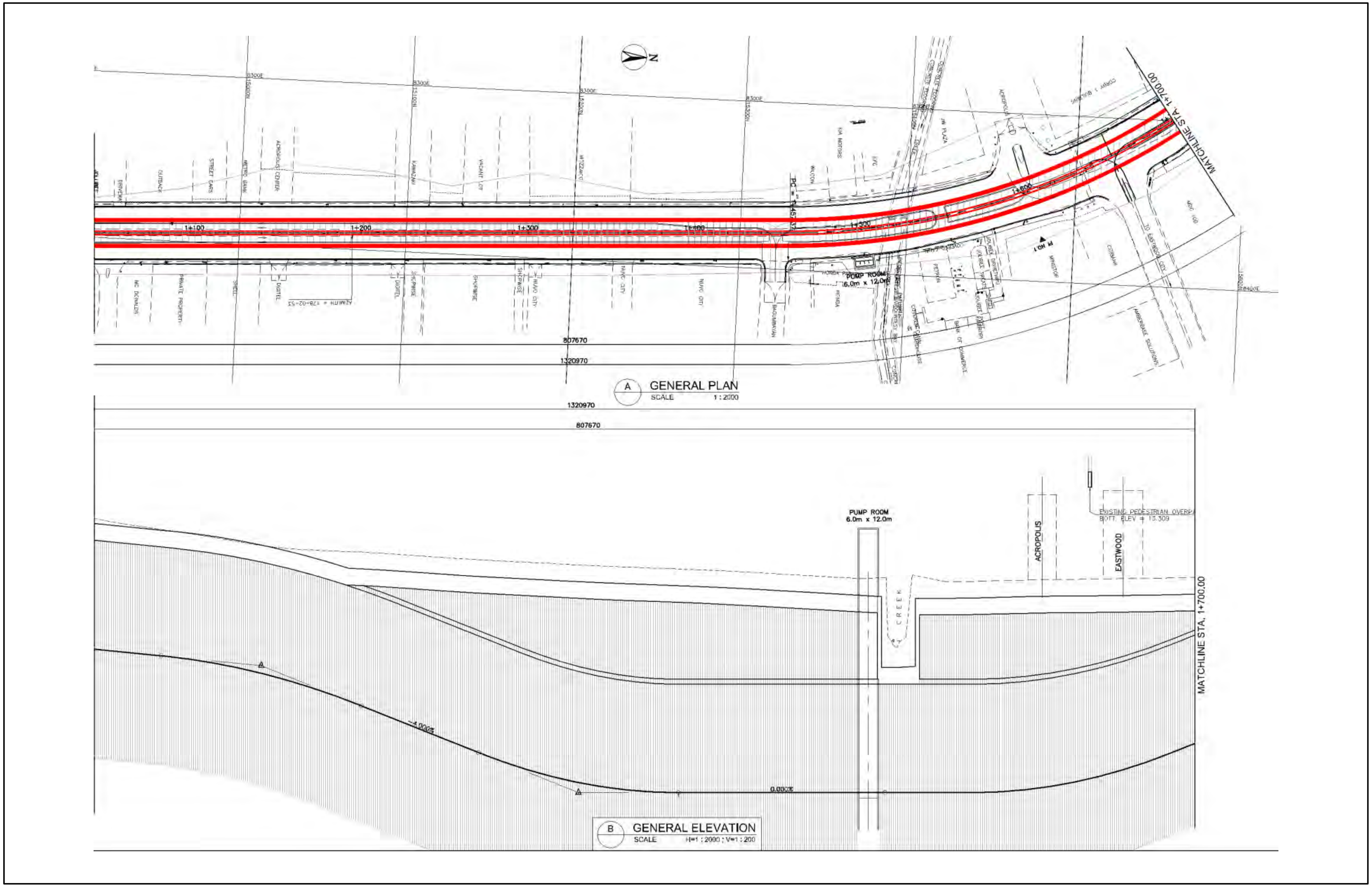

*Source: JICA Study Team*

**Figure 4.6-3 Plan and Profile of Scheme-1 (Flyover C-5/Green Meadows) (3/3)**



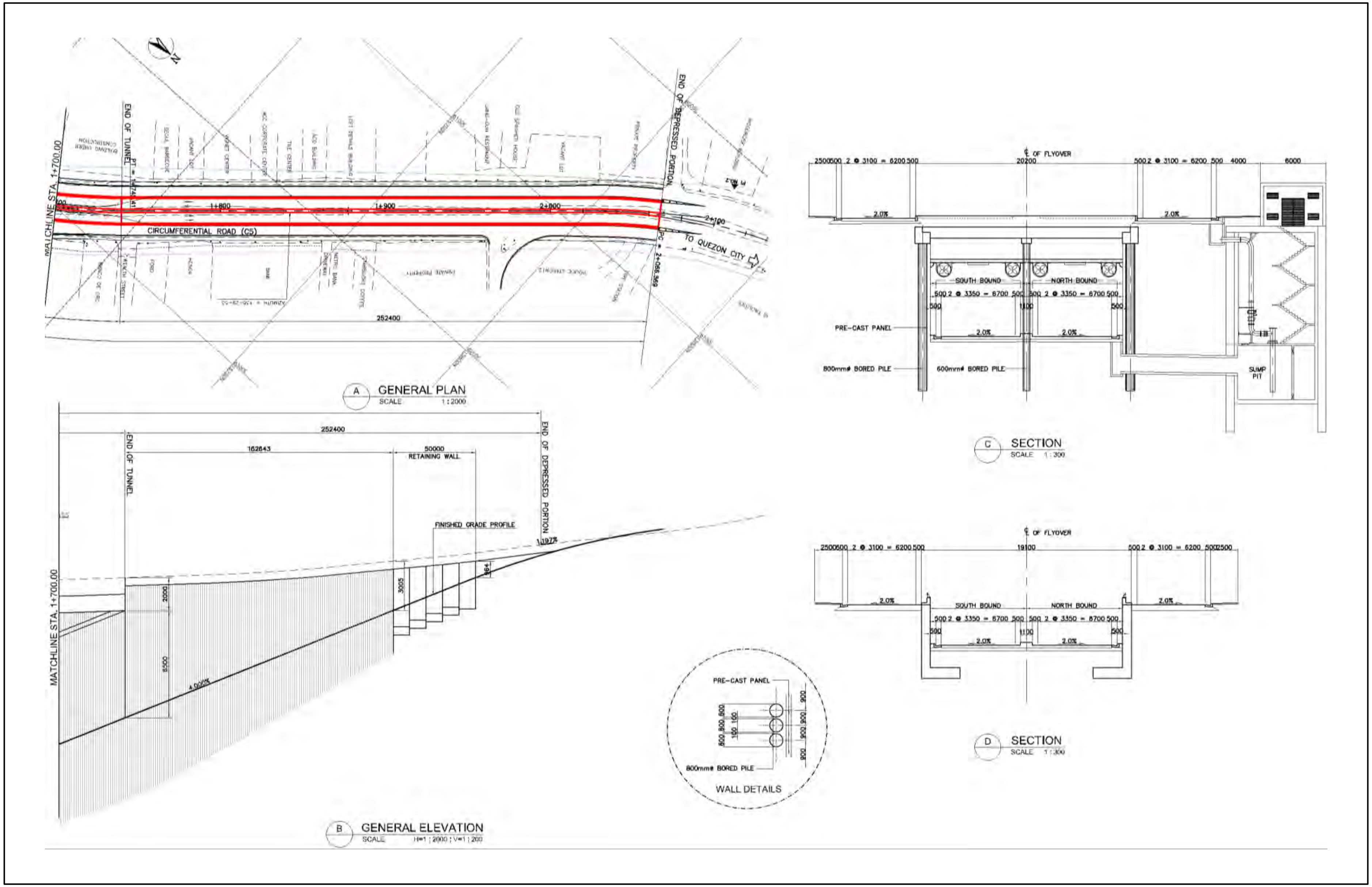

Source: JICA Study Team

**Figure 4.6-4 Plan and Profile of Scheme-2 (Cut and Cover Tunnel C-5/Green Meadows) (1/3)**



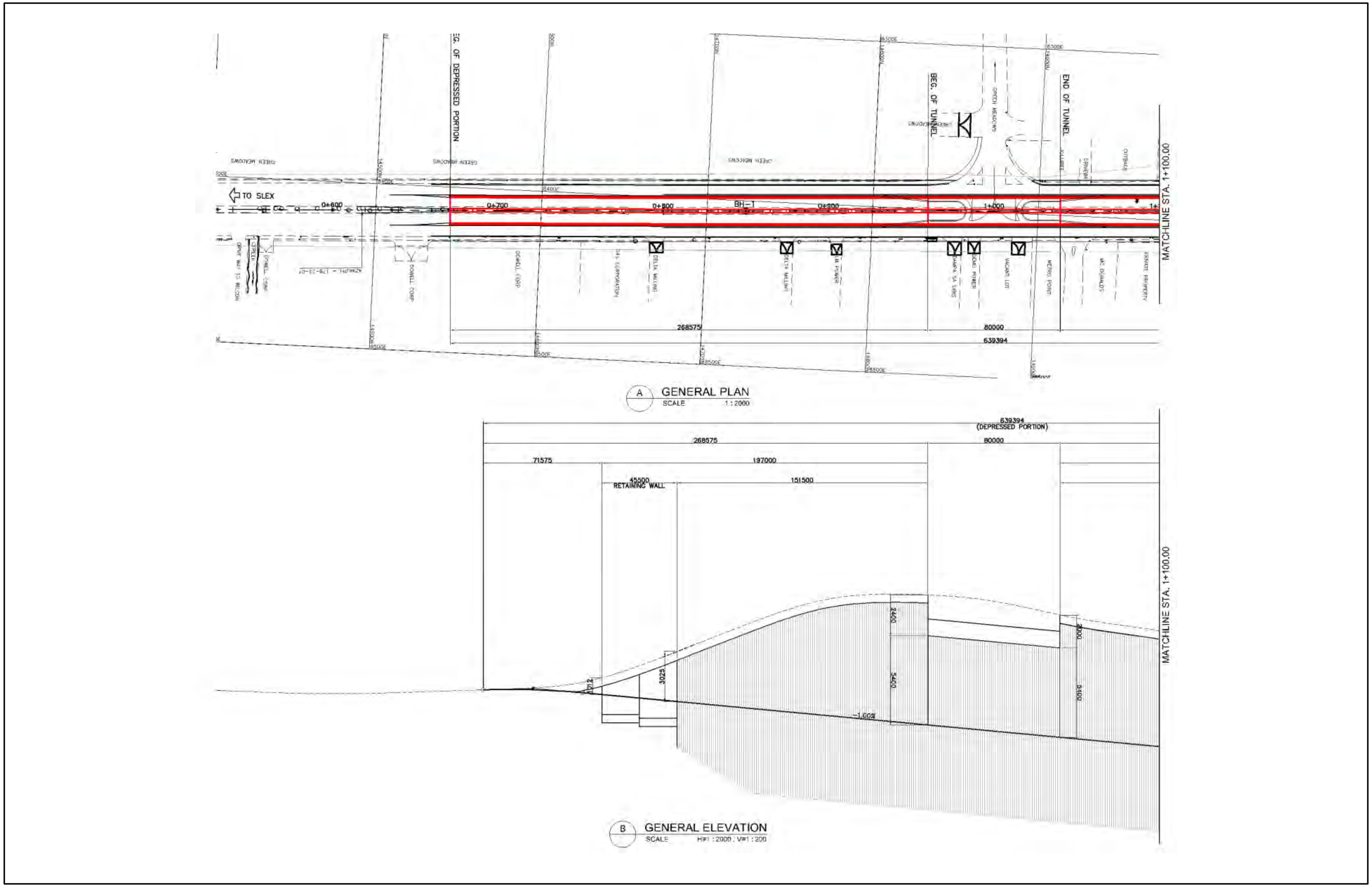

*Source: JICA Study Team*

**Figure 4.6-5 Plan and Profile of Scheme-2 (Cut and Cover Tunnel C-5/Green Meadows) (2/3)**



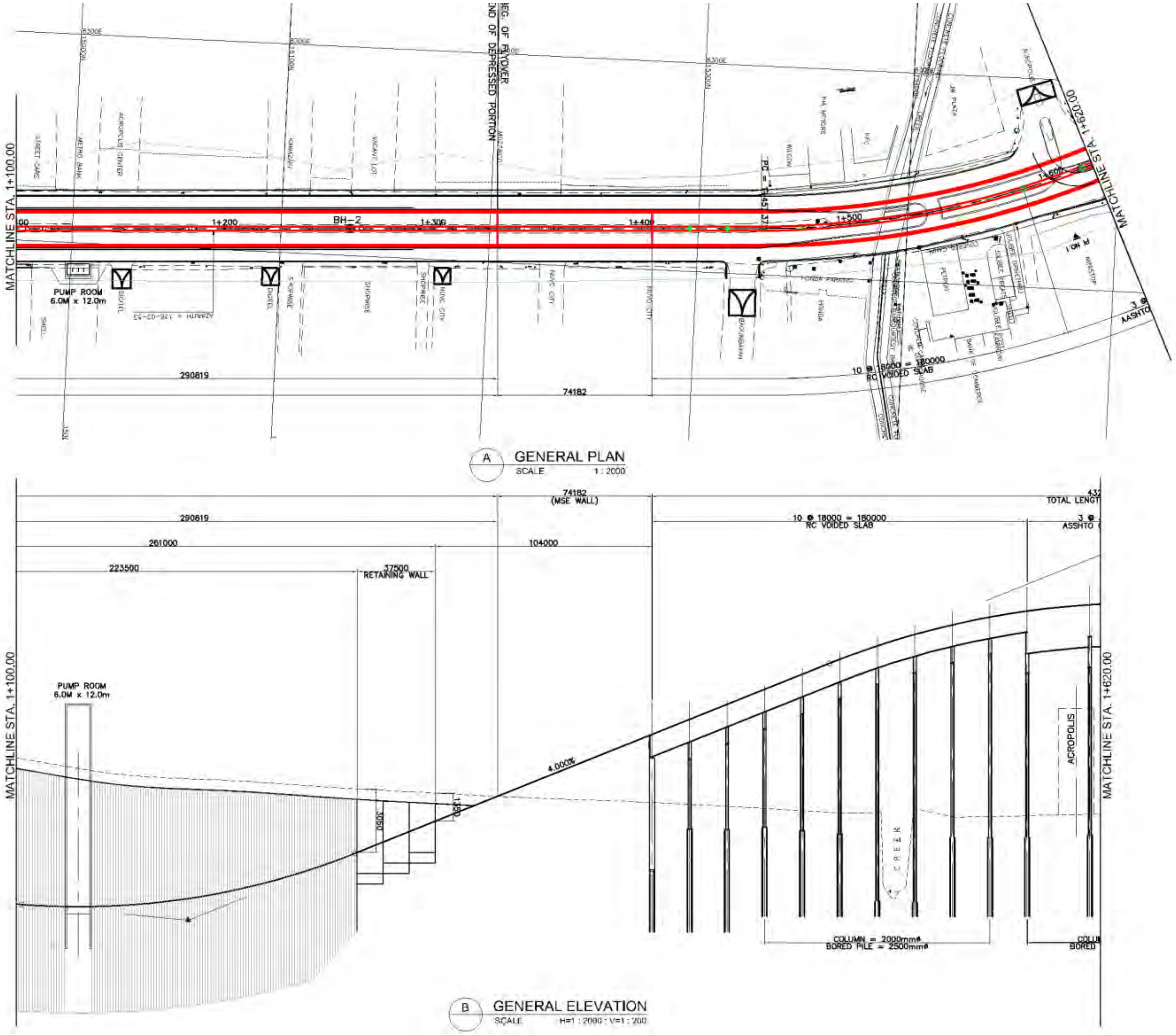

Source: JICA Study Team

**Figure 4.6-6 Plan and Profile of Scheme-2 (Cut and Cover Tunnel C-5/Green Meadows) (3/3)**



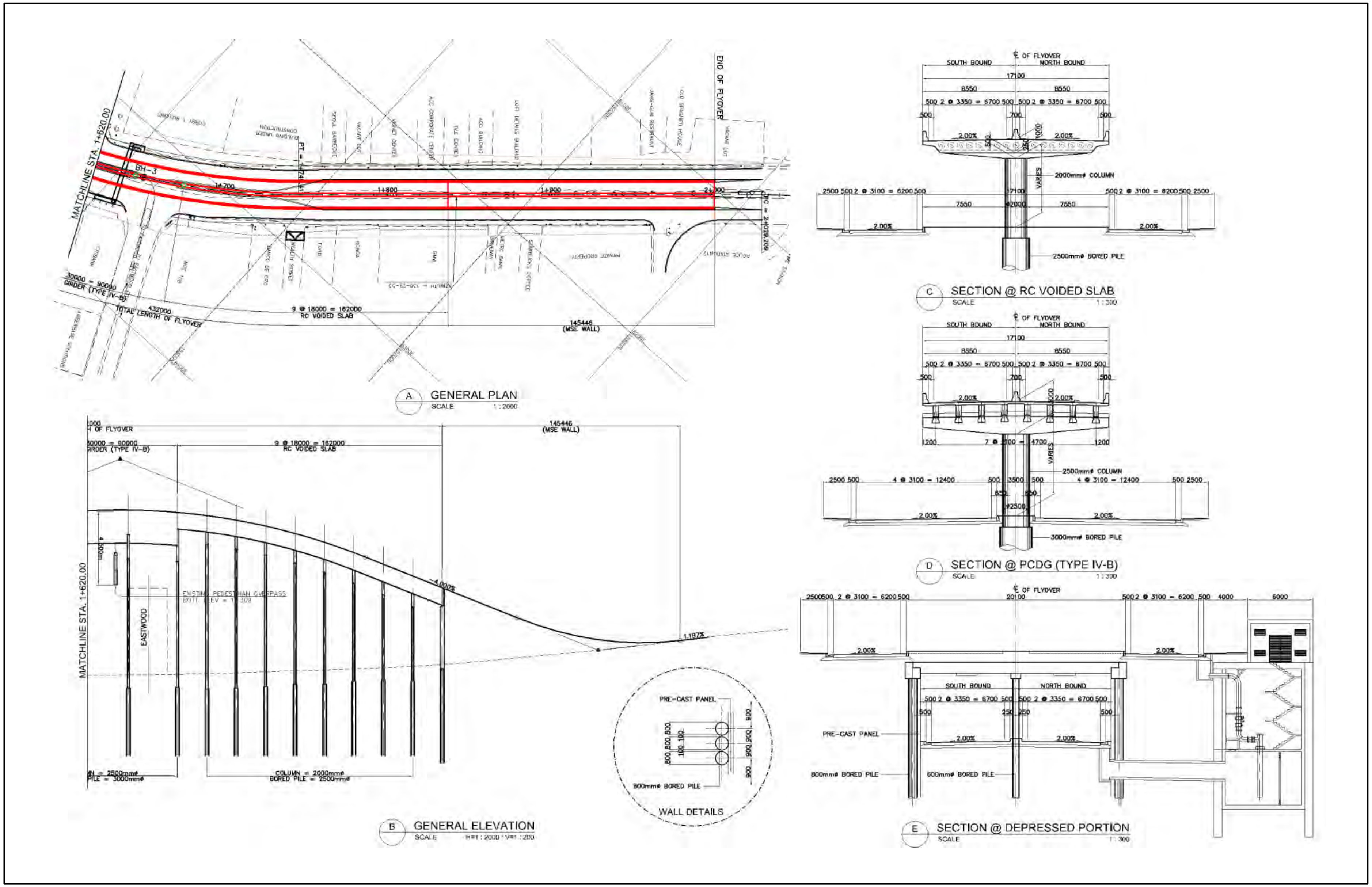

*Source: JICA Study Team*

**Figure 4.6-7 Plan and Profile of Scheme-3 (Tunnel and Flyover C-5/Green Meadows) (1/3)**




Source: JICA Study Team

**Figure 4.6-8 Plan and Profile of Scheme-3 (Tunnel and Flyover C-5/Green Meadows) (2/3)**




Source: JICA Study Team

**Figure 4.6-9 Plan and Profile of Scheme-3 (Tunnel and Flyover C-5/Green Meadows) (3/3)**

**(3) Preliminary Design of Selected Scheme**

Scheme-1, RC and PC voided slab type flyover were selected based on the comparative study. Concepts of the preliminary design of the selected scheme are as follows:

1) Voided slab type should be adopted for superstructure to consider aesthetic view of flyover.

2) One (1) column type pier and foundation should be adopted to maximize the usability of the area underneath the flyover.

3) Maximum 5% vertical grade should be adopted to minimize noise and air pollution due to entire section on the west side of flyover is residential area.

4) MSE wall should be adopted as retaining wall at both sides of the flyover approaches to minimize effects on traffic during construction as well as to provide aesthetic view.

5) Provide signalized traffic management at the Green Meadows intersection, Calle Industrial intersection and Eastwood intersection.

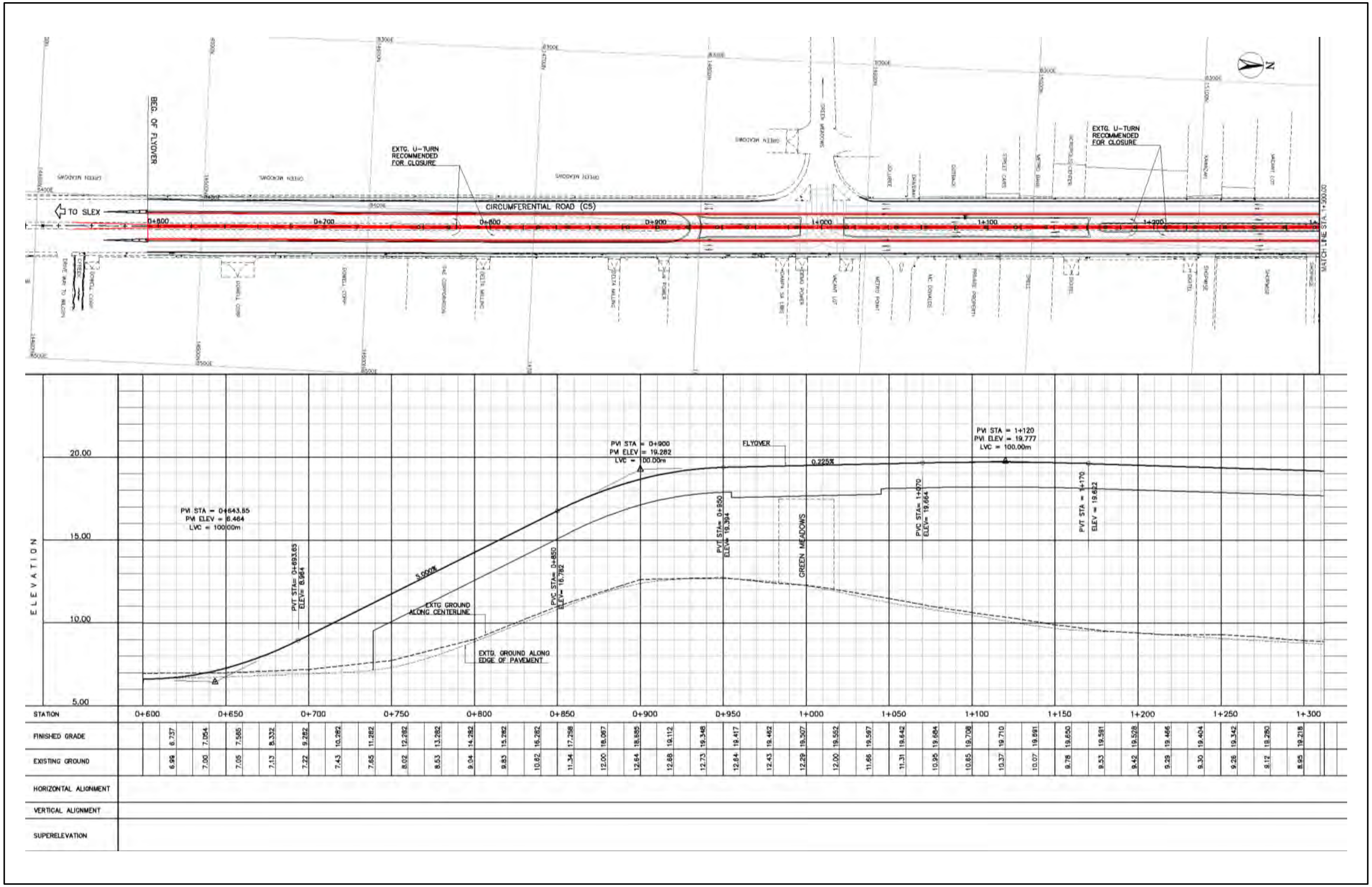
6) All of the at grade plan and design will be done within RROW.

7) Plan and profile, at grade intersection plan, typical cross sections, slab layout plan and structural general view are shown in **Figures 4.6-10 ~ 17**.

**(4) Construction Plan and Traffic Management during Construction**

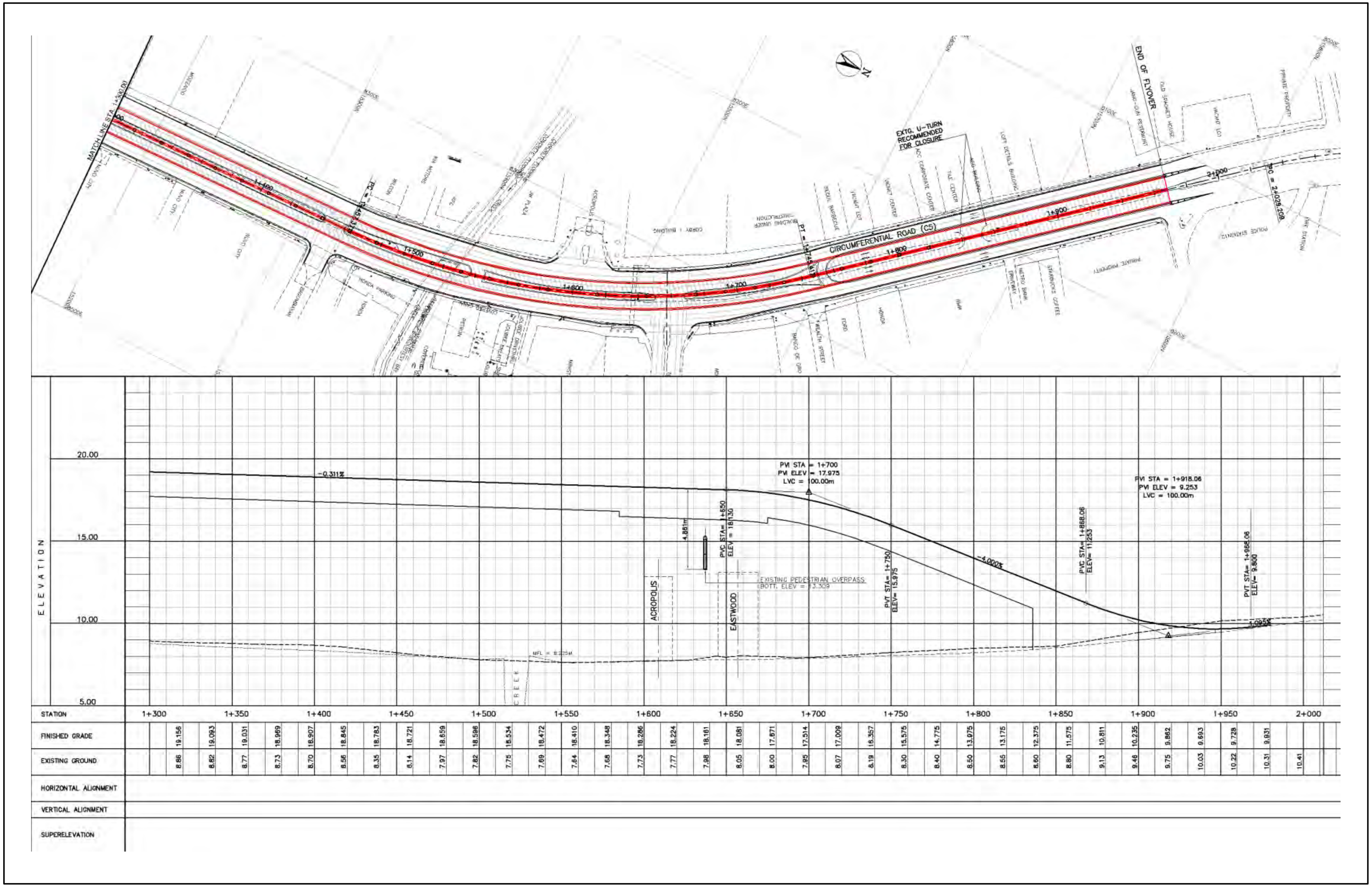
1) Construction Plan and PERT CPM for C-5/Green Meadows/Acropolis interchange have been studied and are shown in the **Figures 4.6-18 ~ 20**.

2) Traffic Management plan during construction for C-5/Green Meadows/Acropolis Interchange have been studied as shown in **Figures 4.6-21.**



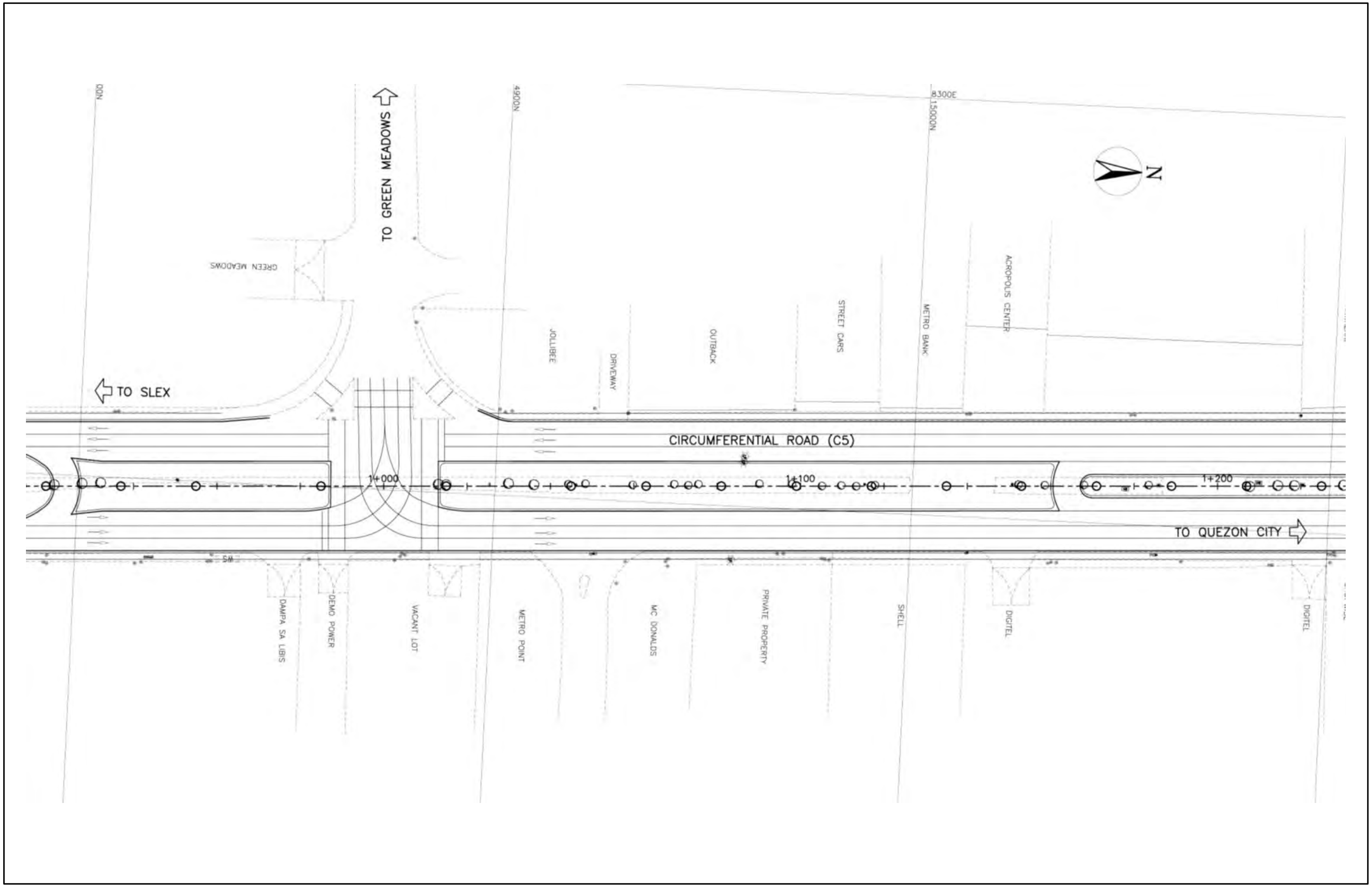

*Source: JICA Study Team*

**Figure 4.6-10 Plan and Profile (C-5/Green Meadows) (1/2)**



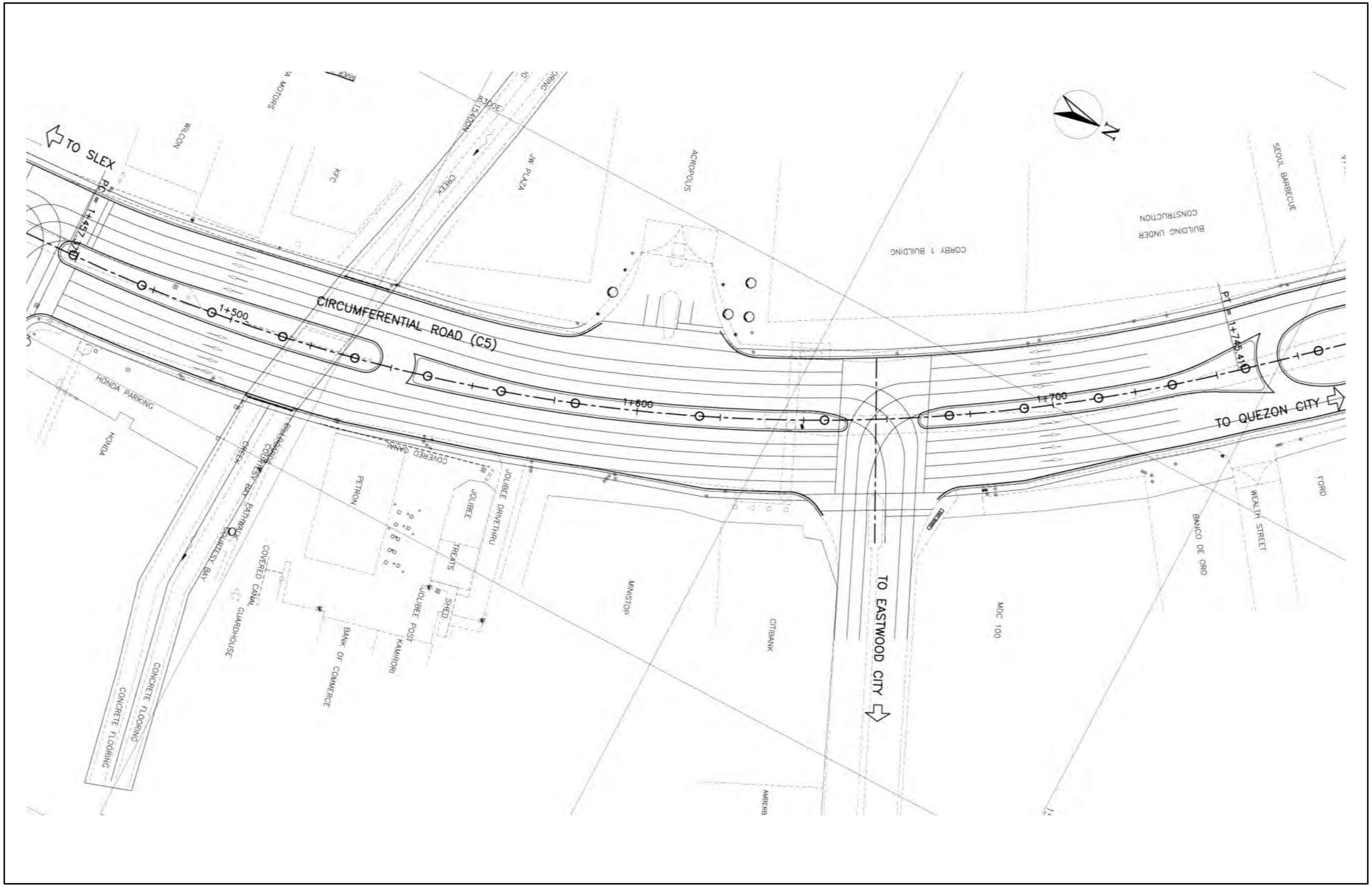

*Source: JICA Study Team*

**Figure 4.6-11 Plan and Profile (C-5/Green Meadows) (2/2)**



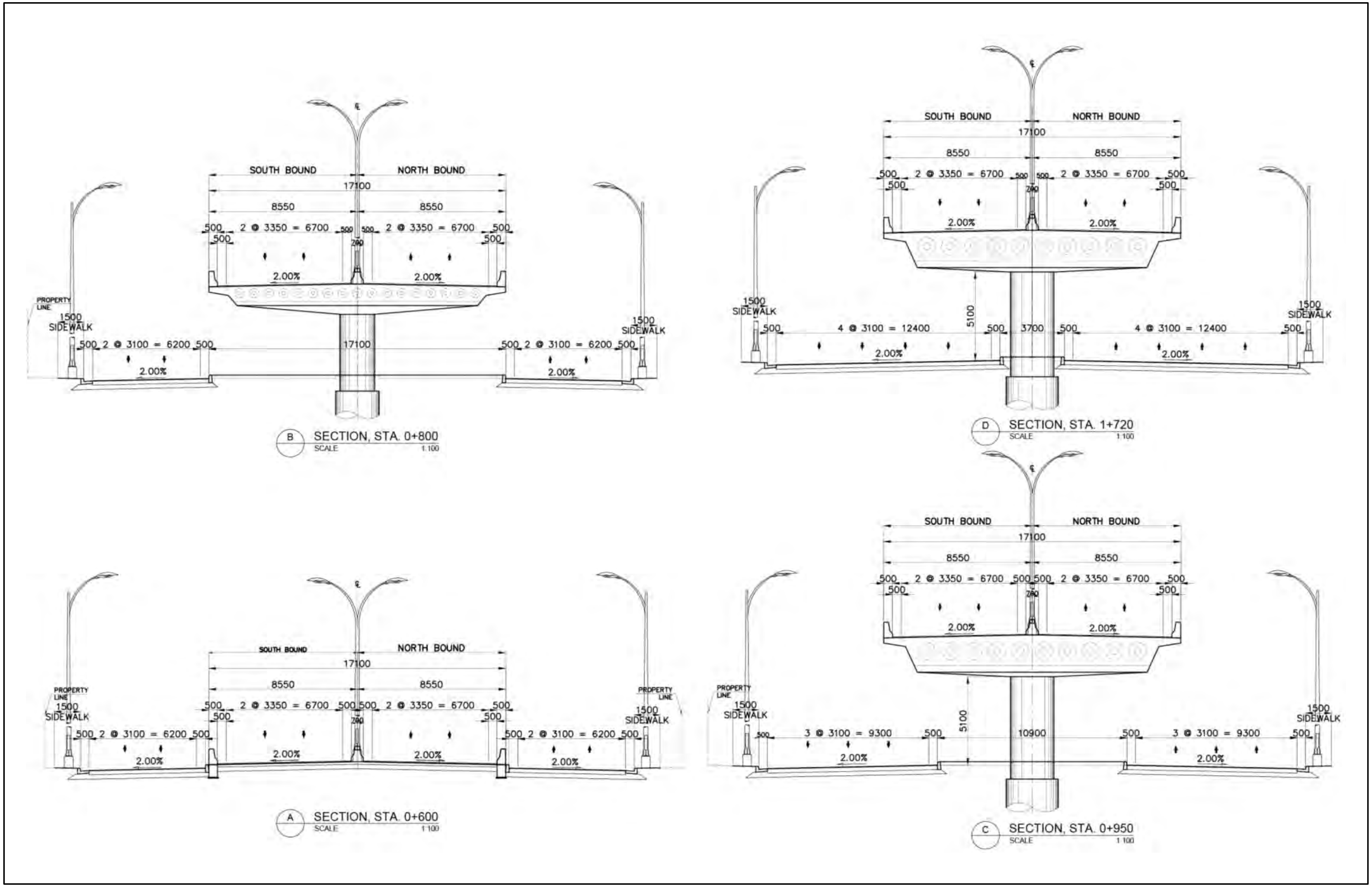

*Source: JICA Study Team*

**Figure 4.6-12 AT-Grade Intersection Plan (C-5/Green Meadows) (1/2)**



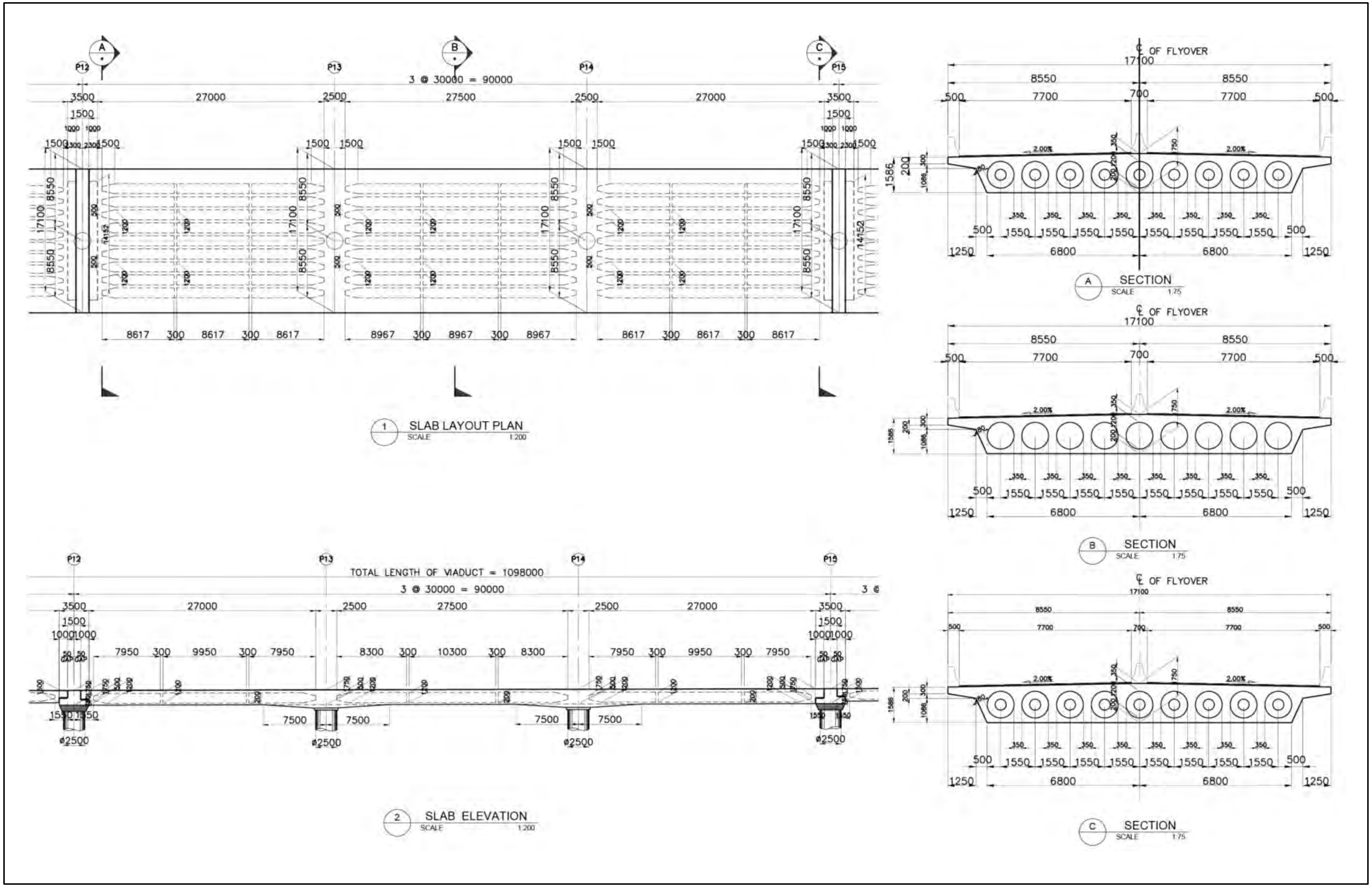

Source: JICA Study Team

**Figure 4.6-13 AT- Grade Intersection Plan (C-5/Green Meadows) (2/2)**



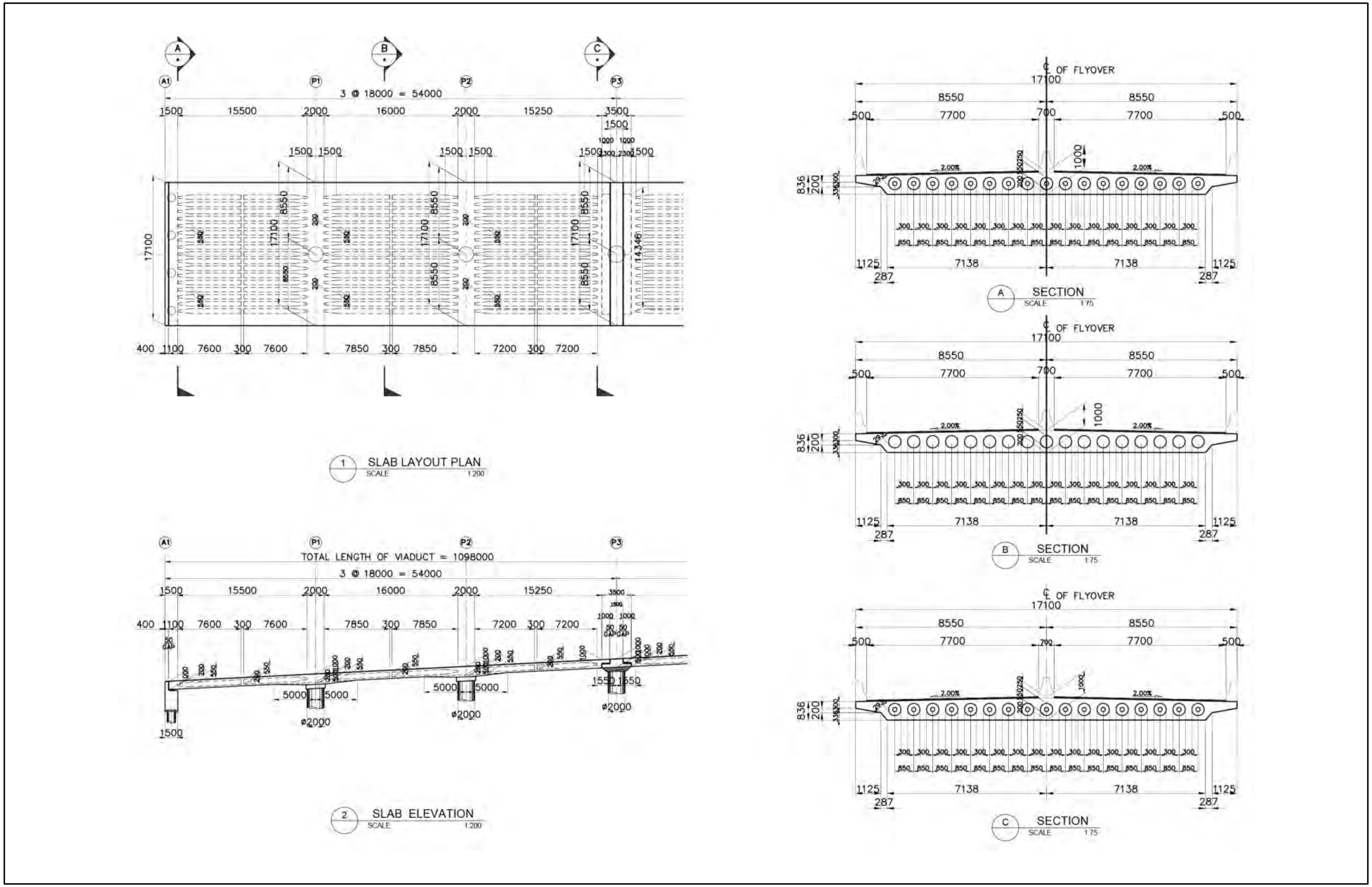

*Source: JICA Study Team*

**Figure 4.6-14 Cross Section (C-5/Green Meadows)**



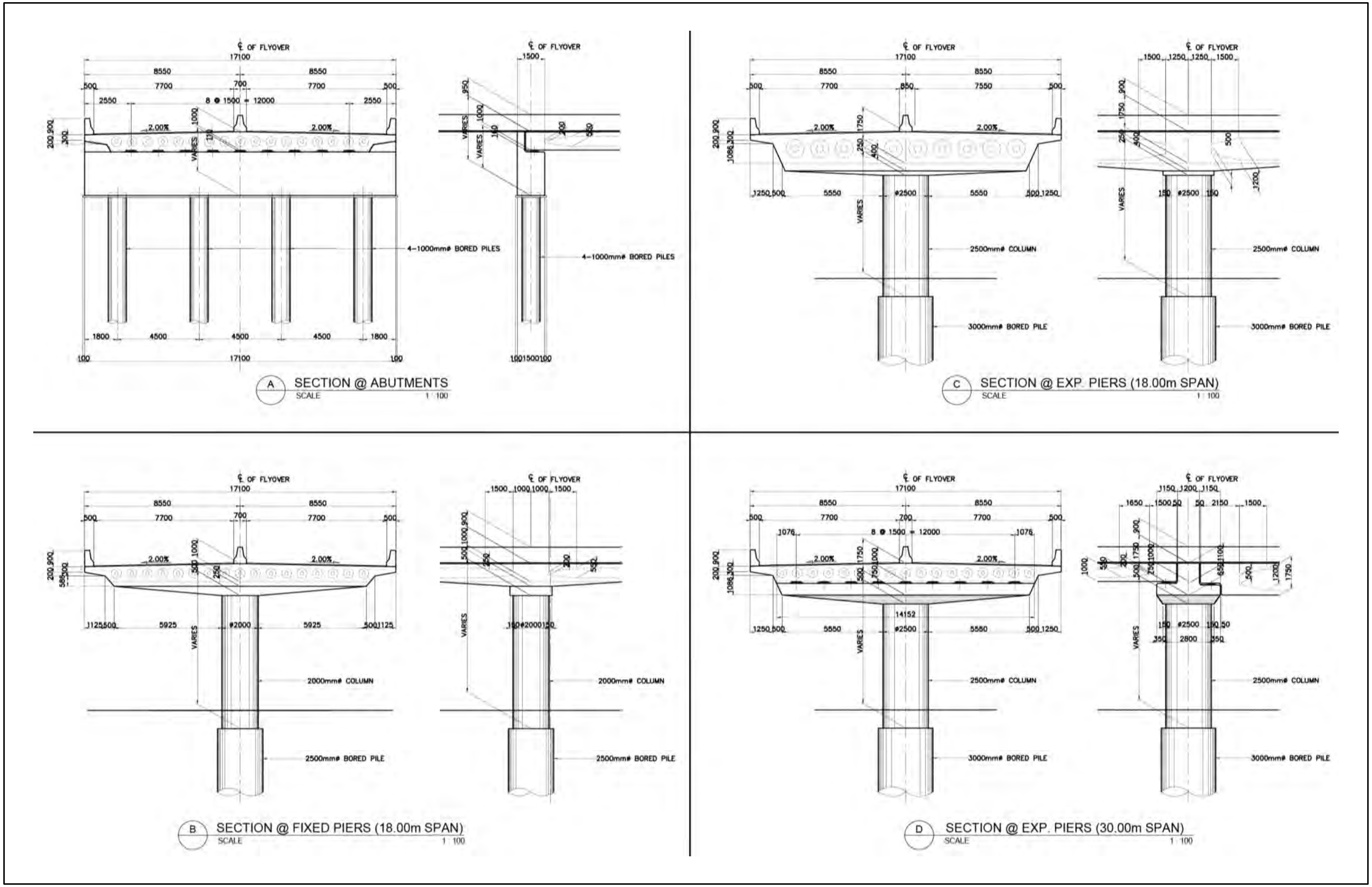

*Source: JICA Study Team*

**Figure 4.6-15 Slab Layout (PC-Voided) (C-5/Green Meadows)**



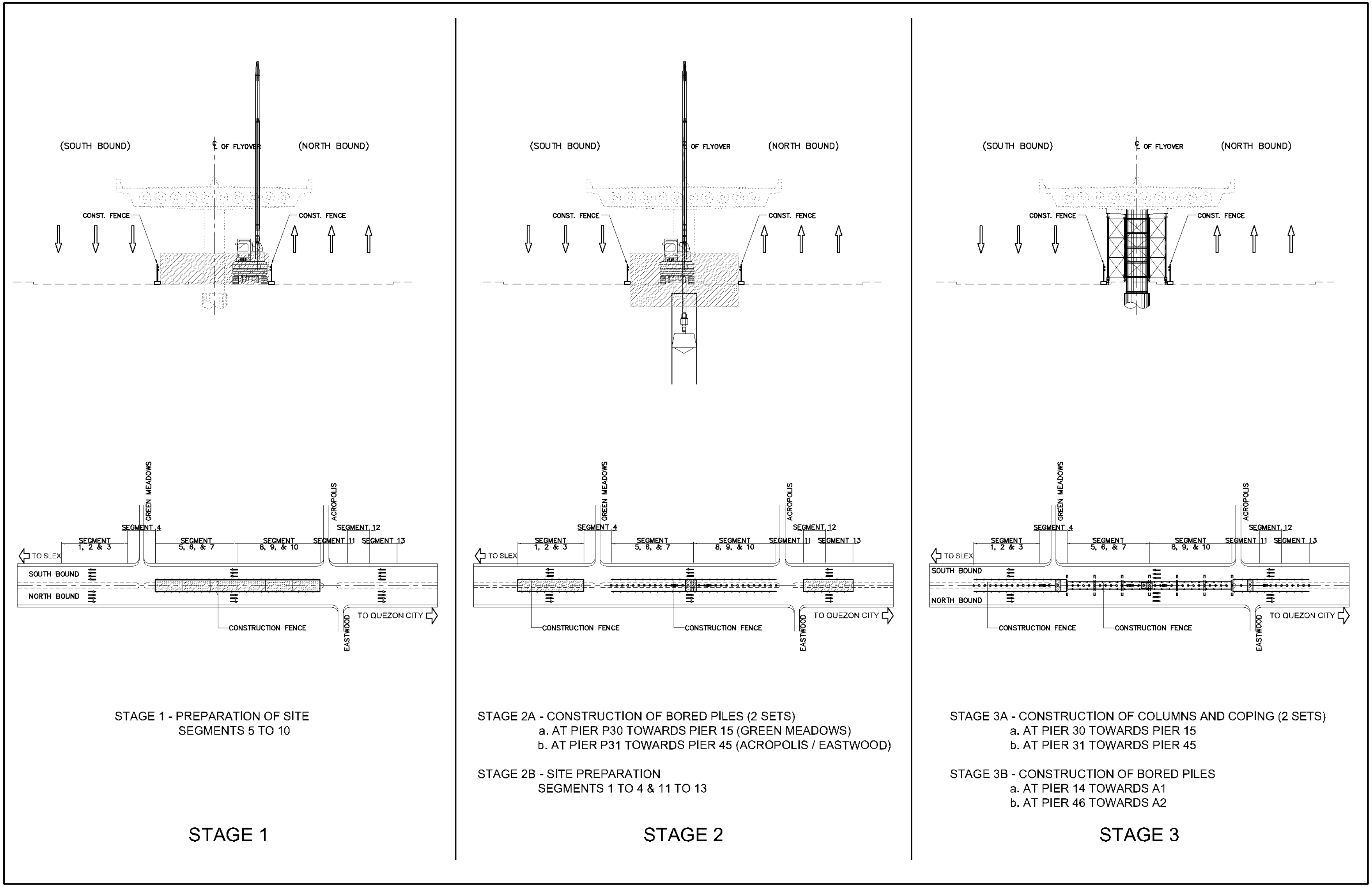

Source: JICA Study Team

**Figure 4.6-16 Slab Layout Plan (RC-Voided) (C-5/Green Meadows)**



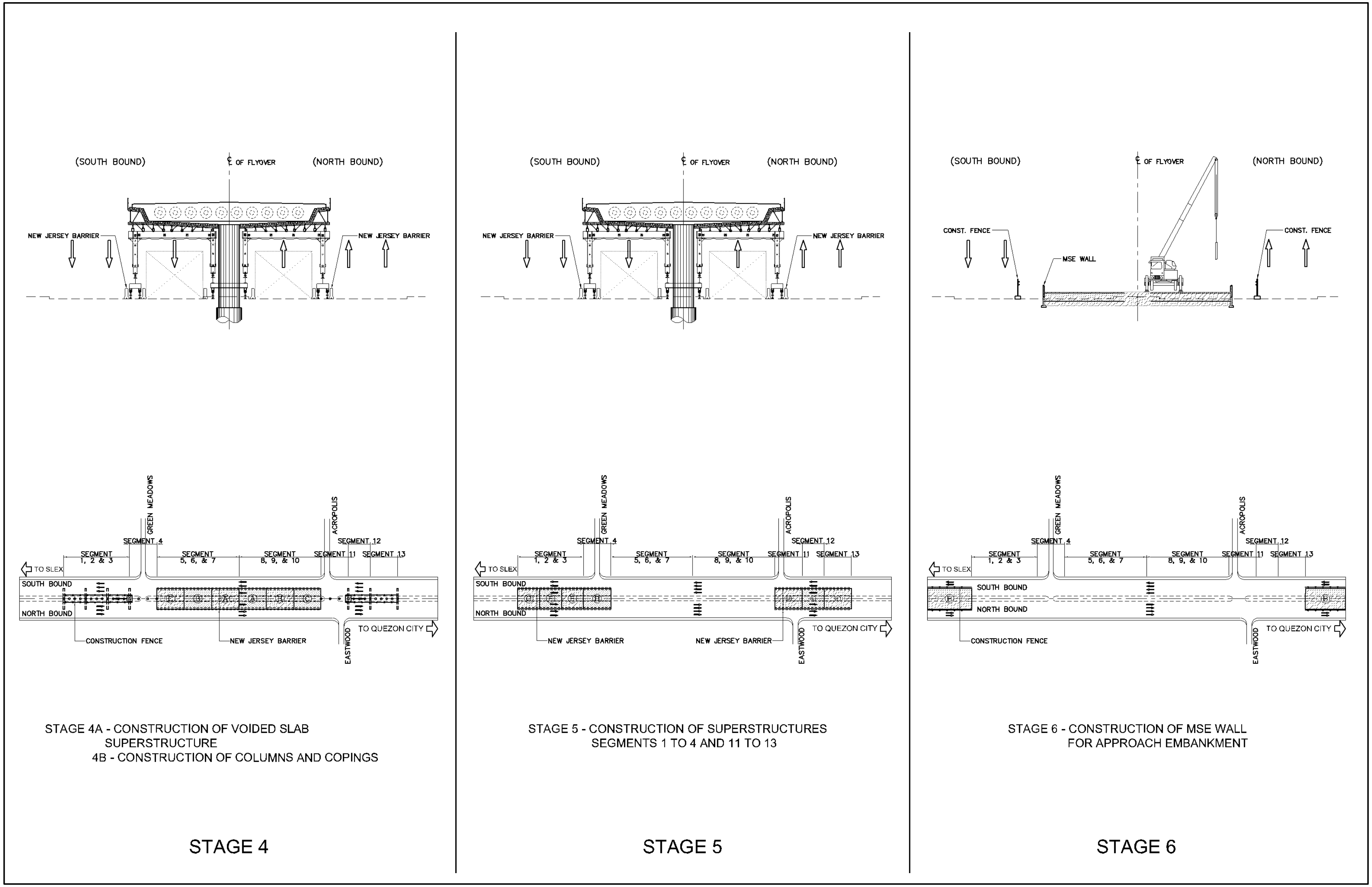

*Source: JICA Study Team*

**Figure 4.6-17 Structural General View (C-5/Green Meadows)**




*Source: JICA Study Team*

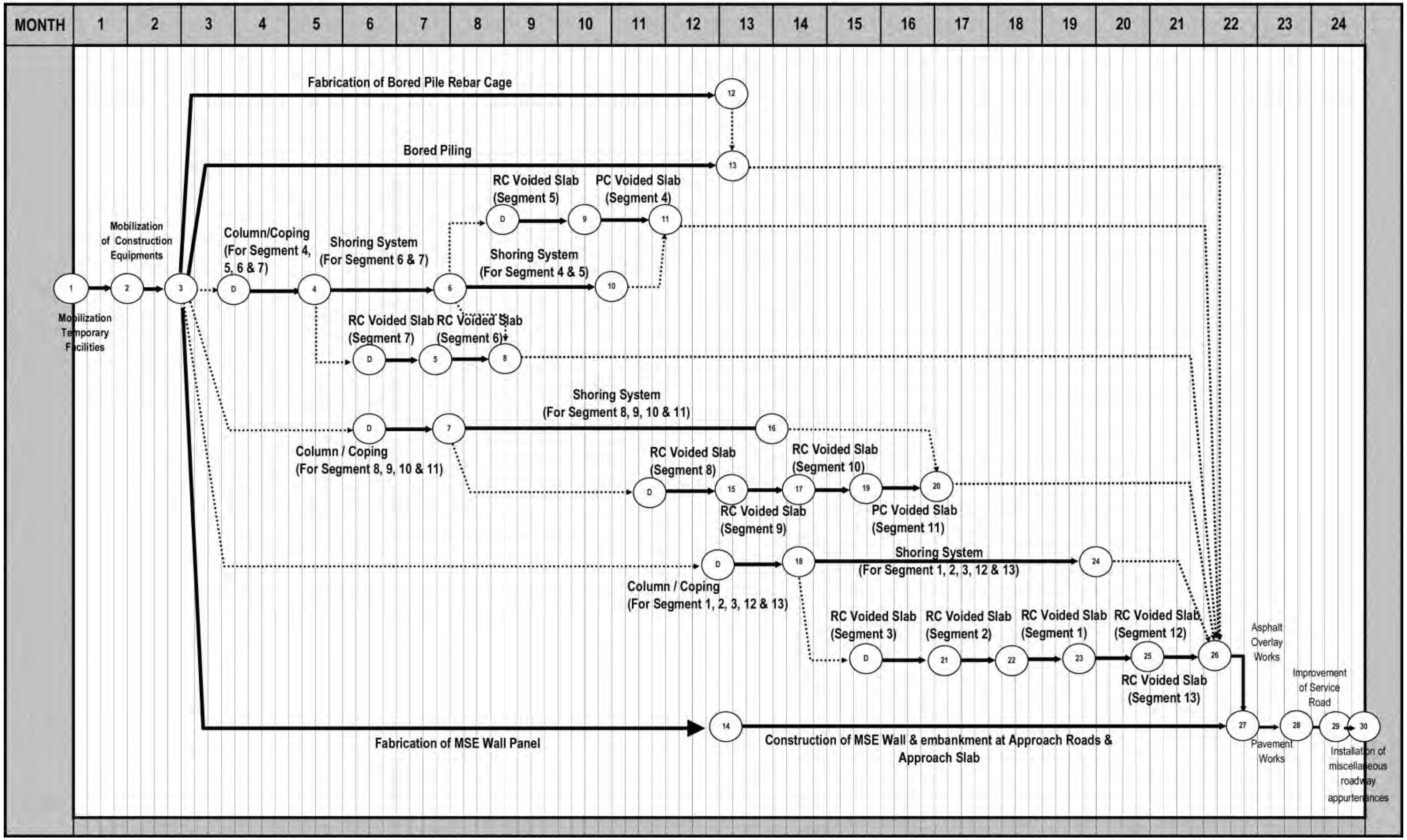
**Figure 4.6-18 Construction Plan for C-5/Green Meadows Interchange (1/2)**




*Source: JICA Study Team*

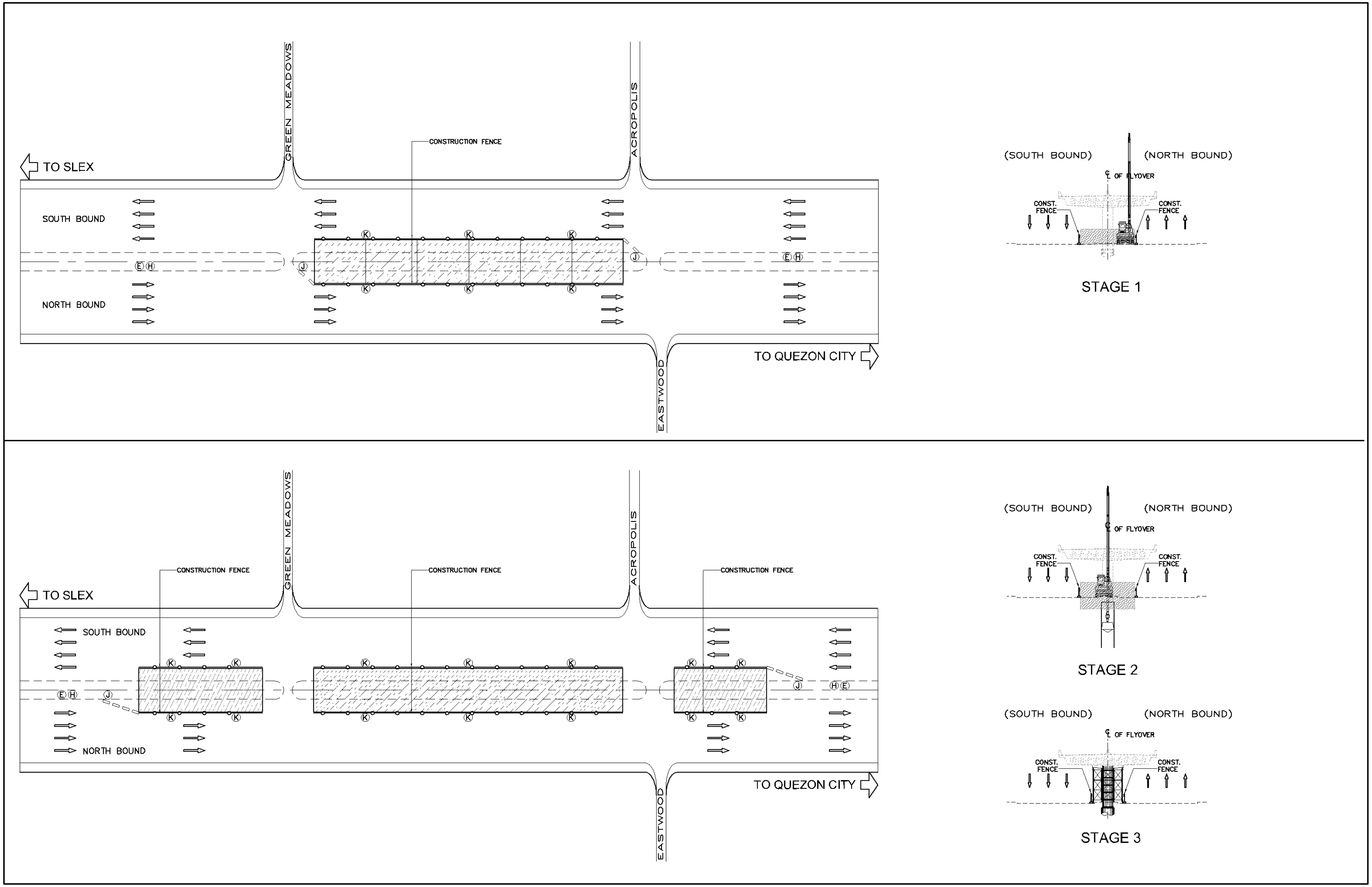
**Figure 4.6-19 Construction Plan for C-5/Green Meadows Interchange (2/2)**

**PREPARATORY SURVEY ON METRO MANILA INTERCHANGE CONSTRUCTION PROJECT PHASE VI**
**C5 / GRREN MEADOWS / CALLE INDUSTRIA / EASTWOOD, PASIG CITY**
**PRELIMINARY CONSTRUCTION SCHEDULE(PERT/CPM)**



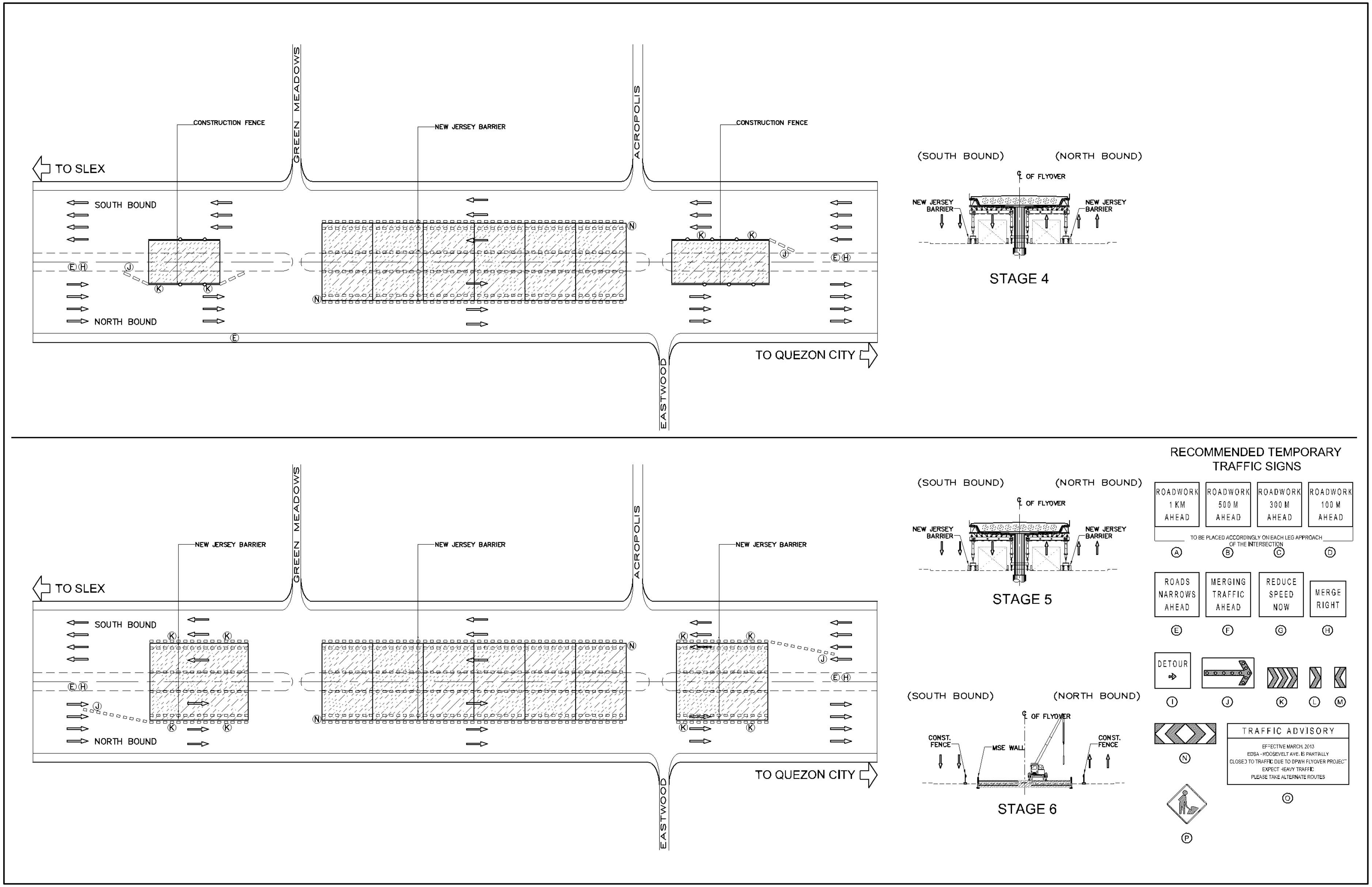

*Source: JICA Study Team*

**Figure 4.6-20 Part CPM for C-5/Green Meadows/Acropolis Interchange**




*Source: JICA Study Team*

**Figure 4.6-21 Traffic Management for C-5/Green Meadows Interchange (1/2)**




Source: JICA Study Team

**Figure 4.6-22 Traffic Management for C-5/Green Meadows Interchange (2/2)**

## (5) Bill of Quantity and Cost Estimate

Civil Works Cost for C-5/Green Meadows/Acropolis/Calle Industria Interchange has been estimated based on similar conditions of C3/E. Rodriguez IC and is shown in **Table 4.6-2.**

**Table** 4.6-2 **Civil Works Cost Estimate for C-5/Green Meadows/Acropolis/Calle Industria IC**

Unit: Php

| PAY ITEM NO. | DESCRIPTION | QUANTITY | UNIT | Unit Cost | Civil Work Cost | Remarks |
|---|---|---|---|---|---|---|
| 1.0 | GENERAL REQUIREMENTS | | | | | |
| A | FACILITIES FOR THE ENGINEER | 1.00 | l.s. | 20,000,000.00 | 20,000,000.00 | |
| | SUB-TOTAL (PART A) | | | | 20,000,000.00 | |
| B | OTHER GENERAL REQUIREMENTS | | | | | |
| SPL B.2.1 | Construction Health and Safety | 1.00 | P.s | 2,400,000.00 | 2,400,000.00 | |
| SPL B.2.2 | Mobilization / Demobilization (1.0% of Civil Works) | 1.00 | P.s | 9,762,596.00 | 9,762,596.00 | |
| SPL B.2-3 | Traffic Management During Construction | 1.00 | P.s | 8,000,000.00 | 8,000,000.00 | |
| SPL B.2-4 | Dayworks | 1.00 | P.s | 10,000,000.00 | 10,000,000.00 | |
| SPL B.2-5 | Removal, Relocation of Utilities | 1.00 | P.s | 15,000,000.00 | 15,000,000.00 | |
| SPL B.3.1 | Environmental Monitoring Action Plan | 1.00 | P.s | 4,000,000.00 | 4,000,000.00 | |
| | SUB-TOTAL (PART B) | | | | 49,162,596.00 | |
| | SUB-TOTAL GENERAL REQUIREMENTS | | | | 69,162,596.00 | |
| 2.0 | INTERCHANGE CONSTRUCTION WITH VIADUCT | | | | | |
| C | EARTHWORKS | | | | | |
| 100(1) | Clearing and Grubbing | 0.50 | ha. | 90,846.53 | 45,423.27 | |
| 100(3) | Individual Removal Trees (Small) | 10.00 | ea. | 1,013.26 | 10,132.60 | |
| 100(4) | Individual Removal Trees (Large) | 5.00 | ea. | 1,427.27 | 7,136.35 | |
| 100(5) | Removal and Earth Balling of Trees | 96.00 | ea. | 1,000.00 | 96,000.00 | |
| 101(1) | Removal of Structures and Obstruction | 1.00 | l.s. | 500,000.00 | 500,000.00 | |
| 101(3)a | Removal of Existing PCCP | 2,997.09 | sq.m. | 245.78 | 736,624.78 | |
| 101(3)b | Breaking of Existing PCCP | 12,291.56 | sq.m. | 335.00 | 4,117,672.60 | |
| 101(4)a | Removal of Existing Concrete Curb | 2,469.80 | l.m. | 60.00 | 148,188.00 | |
| 101(4)b | Removal of Existing Concrete Curb & Gutter | 2,546.85 | l.m. | 110.00 | 280,153.50 | |
| 101(4)c | Removal of Existing Sidewalk | 454.87 | sq.m. | 120.00 | 54,584.40 | |
| 101(4)d | Removal of Existing RCPC | 100.00 | l.m. | 200.00 | 20,000.00 | |
| 101(4)e | Removal of Existing Covered canal | 42.02 | l.m. | 150.00 | 6,303.00 | |
| 105(1) | Subgrade Preparation | 438.61 | sq.m. | 37.18 | 16,307.52 | |
| | SUB-TOTAL (PART C) | | | | 6,038,526.02 | |
| D | SUBBASE AND BASE COURSE | | | | | |
| 200 | Sub Base Course | 2,824.20 | cu.m. | 879.97 | 2,485,211.27 | |
| | SUB-TOTAL (PART D) | | | | 2,485,211.27 | |
| E | SURFACE COURSES | | | | | |
| 302(2) | Bituminous Tack Coat, Emulsified Asphalt, SS-1 (0.45 L/m2) | 14.82 | tonne | 65,971.81 | 977,702.22 | |
| 310 (2) | Bituminous Concrete Wearing Course, Hot Laid (t=50mm) | 21,165.91 | sq.m | 924.31 | 19,563,862.27 | |
| 311 | Portland Cement Concrete Pavement t=300 mm | 4,514.68 | sq.m | 2,887.66 | 13,036,860.85 | |
| | SUB-TOTAL (PART E) | | | | 33,578,425.35 | |
| F | BRIDGE CONSTRUCTION | | | | | |
| | Approch Ramp | | | | | |
| 103(1) | Structure Excavation | 1,201.60 | cu.m. | 586.00 | 704,137.60 | |
| 103(2) | Structural Backfilling | 939.65 | cu.m. | 565.00 | 530,902.25 | |
| 104(2) | Embankment, Selected Borrow | 6,616.99 | cu.m. | 984.09 | 6,511,713.69 | |
| 401(a) | Cast in Place Concrete Railing | 552.82 | l.m. | 5,006.92 | 2,767,925.51 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 47,747.70 | kg. | 62.70 | 2,993,780.79 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 32,098.00 | kg. | 68.25 | 2,190,688.50 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 456.92 | cu.m. | 9,548.08 | 4,362,689.62 | |
| 405(1)b | Approach Slab | 51.40 | cu.m. | 6,233.40 | 320,396.76 | |
| 405(1)c | Concrete Leveling Pad | 19.16 | cu.m. | 80,462.16 | 1,541,654.99 | |
| 405(6) | Lean Concrete | 70.02 | cu.m. | 4,111.70 | 287,901.23 | |
| SPL 414 | Concrete Barrier | 276.41 | l.m. | 4,660.55 | 1,288,222.63 | |
| SPL 417 | Earthquake Resistant Type Mechanically Stabilized Earthwall | 791.42 | sq.m. | 14,163.00 | 11,208,881.46 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Substructure** | | | | | |
| 400(17)a | Concrete Piles Cast in Drilled Holes, Ø1200 mm | 198.00 | l.m. | 44,668.80 | 8,844,422.40 | |
| 400(17)b | Concrete Piles Cast in Drilled Holes, Ø2500 mm | 777.00 | l.m. | 106,248.81 | 82,555,325.37 | |
| 400(17)c | Concrete Piles Cast in Drilled Holes, Ø3000 mm | 144.00 | l.m. | 164,602.64 | 23,702,780.16 | |
| 400(22)a | Pile Integrity Test | 58.00 | ea. | 43,784.56 | 2,539,504.48 | |
| 400(22)b | Pile Dynamic Test | 29.00 | ea. | 583,087.25 | 16,909,530.25 | |
| 404(1)a | Reinforcing steel, Grade 40 (Minor/Substructure) | 724.68 | kg. | 62.70 | 45,437.44 | |
| 404(2)a | Reinforcing steel, Grade 60 (Minor/Substructure) | 1,047,337.73 | kg. | 68.25 | 71,480,799.73 | |
| 405(1)a | Structural Concrete, Class A (Minor/Substructure) 27.6 Mpa | 1,997.19 | cu.m. | 14,057.94 | 28,076,440.45 | |
| 405(6) | Lean Concrete | 5.88 | cu.m. | 4,111.70 | 24,176.80 | |
| 407(1)a | Anchor Bar Ø36mm x 1500mm long, complete | 32.00 | ea. | 1,800.00 | 57,600.00 | |
| 407(1)b | Anchor Bar Ø36mm x 1000mm long, complete | 208.00 | ea. | 1,200.00 | 249,600.00 | |
| | | | | | | |
| | **Superstructure** | | | | | |
| 401(a) | Cast in Place Concrete Railing | 2,196.00 | l.m. | 5,006.92 | 10,995,196.32 | |
| 404(1)b | Reinforcing steel, Grade 40 (Superstructure) | 227,256.00 | kg. | 62.70 | 14,248,951.20 | |
| 404(2)b | Reinforcing steel, Grade 60 (Superstructure) | 3,067,486.00 | kg. | 68.25 | 209,355,919.50 | |
| 404(2)c | Prestressing steel | 49,224.60 | kg. | 152.90 | 7,526,441.34 | |
| 405(1)b | Structural Concrete, Class A (Hollow Slab) 27.6 Mpa | 16,473.71 | cu.m. | 16,971.01 | 279,575,497.15 | |
| 412(1)a | Elastomeric Bearing Pad (500 x 400 x 60 mm) | 216.00 | ea. | 14,500.00 | 3,132,000.00 | |
| 412(1)b | Elastomeric Bearing Pad (400 x 400 x 50 mm) | 36.00 | ea. | 12,000.00 | 432,000.00 | |
| 413(1) | Expansion Joint | 450.80 | l.m. | 29,418.63 | 13,261,918.40 | |
| SPL 414 | Concrete Barrier | 1,098.00 | l.m. | 4,660.55 | 5,117,283.90 | |
| SPL 415 | Waterproofing | 18,775.80 | sq.m. | 1,800.00 | 33,796,440.00 | |
| | | | | | | |
| | **SUB-TOTAL (PART F)** | | | | **846,636,159.91** | |
| | | | | | | |
| **G** | **DRAINAGE AND SLOPE PROTECTION STRUCTURES** | | | | | |
| | | | | | | |
| 500(1)a | RCPC, Class II | 50.00 | l.m. | 3,082.45 | 154,122.50 | |
| 500(1)b | RCPC, Class IV | 549.00 | l.m. | 7,005.56 | 3,846,052.44 | |
| 502(2)a | Storm Deck Drain with Grating | 220.00 | ea. | 19,679.57 | 4,329,505.40 | |
| 502(2)b | Curb Inlet Manhole | 131.00 | ea. | 25,000.00 | 3,275,000.00 | |
| 502(3) | Catch Basins | 57.00 | ea. | 35,000.00 | 1,995,000.00 | |
| 502(4) | Junction Box | 25.00 | ea. | 5,000.00 | 125,000.00 | |
| SPL 512 | Collector Pipe | 3,281.96 | l.m. | 1,153.20 | 3,784,756.27 | |
| | | | | | | |
| | **SUB-TOTAL (PART G)** | | | | **17,509,436.61** | |
| | | | | | | |
| **H** | **MISCELLANEOUS STRUCTURES** | | | | | |
| | | | | | | |
| 600(1) | Concrete Curb | 2,668.03 | l.m. | 1,333.21 | 3,557,044.28 | |
| 600(3)a | Concrete Curb and Gutter | 2,615.90 | l.m. | 1,661.30 | 4,345,794.67 | |
| 600(3)b | Concrete Side Strip | 1,352.16 | sq.m. | 350.00 | 473,256.00 | |
| 601(1)a | Concrete Sidewalk | 1,698.25 | sq.m. | 1,560.60 | 2,650,288.95 | |
| 601(1)b | Concrete Median | 11,493.99 | sq.m. | 1,560.60 | 17,937,514.55 | |
| SPL | Noise Barrier | 200.00 | lm | 48,456.58 | 9,691,316.01 | |
| 605(1) | Warning Sign | 3.00 | set | 34,912.46 | 104,737.38 | |
| 605(2) | Regulatory Sign | 29.00 | set | 34,912.46 | 1,012,461.34 | |
| 605(3)a | Informatory Sign, Gantry Support | 2.00 | set | 905,733.18 | 1,811,466.36 | |
| 605(3)b | Informatory Sign, Butterfly Support | 2.00 | set | 431,481.05 | 862,962.10 | |
| 605(3)c | Informatory Sign, Cantilever Support | 3.00 | set | 388,956.44 | 1,166,869.32 | |
| 605(3)d | Informatory Sign, Double Post | 6.00 | set | 42,944.99 | 257,669.94 | |
| 612(1) | Reflectorized Thermoplastic Pavement Markings, White | 1,888.54 | sq.m. | 1,092.83 | 2,063,853.17 | |
| | | | | | | |
| | **SUB-TOTAL (PART H)** | | | | **45,935,234.06** | |
| | | | | | | |
| **J** | **SPECIAL ITEM** | | | | | |
| | | | | | | |
| SPL 1 | 9m Pole, Single arm complete | 140.00 | set | 86,228.98 | 12,072,057.20 | |
| SPL 2 | 9m Pole, Double arm complete | 72.00 | set | 90,000.00 | 6,480,000.00 | |
| SPL 3 | Lighting system, (under carriageway) | 50.00 | set | 59,290.99 | 2,964,549.50 | |
| SPL 4 | Flood lights | 7.00 | set | 80,000.00 | 560,000.00 | |
| SPL 5 | Traffic Signal Light | 1.00 | P.s | 2,000,000.00 | 2,000,000.00 | |
| | | | | | | |
| | **SUB-TOTAL (PART J)** | | | | 24,076,606.70 | |
| | | | | | | |
| | **TOTAL** | | | | **1,045,422,195.92** | |

*Source: JICA study team*