The Afghanistan Engineering Support Program assembled this deliverable. It is an approved, official USAID document. Budget information contained herein is for illustrative purposes. All policy, personal, financial, and procurement sensitive information has been removed. Additional information on the report can be obtained from Firouz Rooyani, Tetra Tech Sr. VP International Operations, (703) 387-2151.

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ENGINEERING SUPPORT PROGRAM

WO-A-0009 PRT Technical Engineering Support Bridge Study, Matun and Lakan, Afghanistan

April 28, 2011

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech, Inc.

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April 28, 2011

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USAID – Office of Infrastructure, Engineering and Energy (OIEE)
Café Compound
U.S. Embassy
Great Masood Road
Kabul, Afghanistan

Re: WO-A-0009 PRT Technical Engineering Support
Bridge Study, Matun and Lakan, Afghanistan

[redacted],

Enclosed is the Bridge Study for the proposed Matun and Lakan bridges. This submittal includes a report and attached Figures. The Bridge Study is based on preliminary analyses and design calculations performed for the Sagai bridge crossing, using reinforced concrete deck beams with a reinforced concrete deck slab supported on solid piers and abutments.

If requested by USAID, Tetra Tech will prepare a scope and man-hour estimate for the Final Design and Construction Phase Services for these bridge projects.

We trust this meets your requirements at this time.

Very truly yours,

[redacted]
Chief of Party (OIEE-AESP)
Tetra Tech, Inc

Cc: [redacted] Tetra Tech
[redacted], Tetra Tech

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AFGHANISTAN ENGINEERING SUPPORT PROGRAM

WO-A-0009 PRT Technical Engineer Support
Bridge Study
Khost, Afghanistan

April 28, 2011

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1.0 General

Based on the Scope of Work dated 04/14/2011, Tetra Tech has prepared the following Bridge Study. The purpose of the Bridge Study is to develop construction cost estimates for the proposed Matun and Lakan bridges, located in Khost province. Both bridges are proposed to cross an existing wadi which is subject to flooding.

This report is based on the Bridge Type Study report prepared for the Sagai crossing in Khost province, dated 03/05/2011. A summary of assumptions is presented in the following table:

Table 1-1 General Assumptions

Superstructure Type	Reinforced concrete rectangular beams and deck
Substructure Type	Reinforced concrete solid piers and abutments, supported on spread footings.
Span Configuration	Simple spans, 15.0 m long
Concrete Strength	Compressive Strength - f'c = 4000 psi
Reinforcement Strength	Yield Strength - Fy = 60 ksi
Design Vehicle	AASHTO HS-25 Truck, MLC-70 Military Vehicle
Roadway Width	Two 3.7m lanes, one 1.2m sidewalk, bridge railings or ribbon guardrail each side.
Channel Geometry	Water elevation assumed to be 1.0m above maximum grade. Bottom of structure set at 0.5m above water, existing grade assumed to slope at a rate of 0.5% between abutments.
Footing Embedment	850 mm below grade
Seismic Parameters	Ss=0.21g, S1=0.17g, SPC D PGA=0.17g (2% exceedance within 50 years)
Assumed Geotechnical Parameters	Unit Weight of Soil = 120 pcf, Ka = 0.3 Allowable Bearing Pressure = 4.0 ksf
Drainage	2% roadway cross-slope and 0.5% roadway profile grade were assumed to drain the water off the bridge.

2.0 Preliminary Structural Analysis

2.1 Design Vehicle

The superstructures for each bridge were analyzed for two design vehicles: an AASHTO HS25 truck (tractor trailer) and an MLC-70 (both a tracked and wheeled vehicle meeting the rating of a 622.7 kN (70-ton) Military Load Combination). The MLC-70 vehicle selection, as directed by the Client, accounts for a response vehicle carrying a disabled MRAP.

2.2 Superstructure

The traditional solution to a long bridge crossing is using a concrete deck, supported on girders, supported on piers and abutments. There are many different types of girders used for long-span bridges – typically precast / prestressed concrete or steel plate girders. Since these girder types are not locally available, rectangular concrete beams are used. Rectangular concrete beams can be precast or cast-in-place, and can accommodate spans up to approximately 18.3 m (60 feet). Reinforcement is used to tie the beams and the deck together, known as composite action. Span lengths of 15.0 m (50 feet) have been used in the analysis. See Figures S-1 to S-9 for additional information.

Since each option maintains a minimum of 0.5 meters (1.64 feet) above the design water elevation, the superstructure depth translates directly to roadway approach work which will be required to transition from existing grade to the bridge. The following table summarizes the span configuration and superstructure depth for the two bridges:

Table 2-1 Span Configuration and Superstructure Depth

Bridge	Span m (ft)	Number of "Spans"	Proposed Superstructure Depth m (ft)
Matun	15.0 (50.00)	12	1.47 (4.82)
Lakan	15.0 (50.00)	10	1.47 (4.82)

2.3 Substructure

Both bridges are based on the superstructure supported on reinforced concrete piers and abutments. This type of substructure has the following advantages when compared to other substructure types:

- Longest span lengths
- Minimizes the number of piers in the channel
- Minimizes the required excavation
- Unlikely to "dam" and create hydraulic problems
- Meets seismic design requirements for the region
- Meets frost protection guidelines for the region

For the purposes of preparing this report, it has been assumed that abutments and piers will be supported on shallow foundations (spread footings). During the next phase of the project, a geotechnical investigation will be performed. This investigation will result in substructure recommendations and design parameters. Depending on the results of their investigation, the geotechnical engineer may recommend that the bridge is supported on deep foundations (piles). Any quantities and costs associated with deep foundations are not included in this report.

3.0 Construction Quantities

The following table provides an Order-of-Magnitude construction material quantity summary for the major items of both bridges. See Appendix B for a more comprehensive Bill of Quantities (BOQ).

Table 3-1 Construction Quantities Summary

Bridge	General Excavation Volume, cm	Backfill Volume, cm	Total Concrete Volume, cm	Total Reinforcing Steel Weight, kg	Total Structural Steel Weight, kg
Matun	730	490	1,960	168,600	59,600
Lakan	630	430	1,630	139,900	49,700

It is important to note that the above quantities are based on analyses which include the greater of the standard AASHTO truck weight and the military truck weight. Since the MLC-70 vehicle governed the analysis, Tetra Tech performed subsequent quantity calculations to estimate the impact of designing for the MLC-70 on the overall project. The calculations reflected an overall increase in concrete quantity of approximately 5%. Since many of the significant costs associated with this project (mobilization, equipment, excavation, etc.) are not dependant on the design vehicle, the impact on the overall project cost using the higher standard of MLC-70 would be an increase of less than 5% over using AASHTO.

4.0 Additional Construction Considerations

The true cost of construction includes not only materials, but also costs associated with construction duration, complexity, constructability and performance.

In comparison with other bridge types, the substructure construction duration of the rectangular beam superstructure is shorter, due to minimizing the number of piers. If a crane is available, the superstructure construction could be accelerated by precasting the beams either offsite or on the approaches and setting in place using a crane. The schedule efficiencies associated with using a crane are largely dependent on site conditions. Subsequently, the formwork for the slab construction could be attached to the beams.

In terms of complexity and constructability, the bridge type presented uses materials and techniques which are familiar to local contractors. Therefore, with the exception of the availability of a local precaster, the bridge construction can be performed using local labor.

Since the bridges are designed in accordance with AASHTO, the bridges have a design life of approximately 75 years. The actual service life will depend on whether the bridge and the channel received periodic maintenance. The service life is directly related to the environmental conditions encountered at the site and therefore to preserve and extend the useful life of a bridge a preventive maintenance plan should be implemented.

If the proposed construction is performed when the wadi is dry, dewatering and support of excavation will not be required. However, if construction occurs when there is water present, dewatering will be required. A cofferdam or other water control structure may be required to minimize dewatering efforts. Since the flow in the wadi is seasonal, it would be desirable to schedule construction during the dry season.

5.0 Recommendations

As discussed in greater detail in the Sagai report, the rectangular beam bridge is recommended since it minimizes excavation and backfill operations and is the least likely to create “dams” from debris and ice. No other bridge type options were evaluated as part of this report.

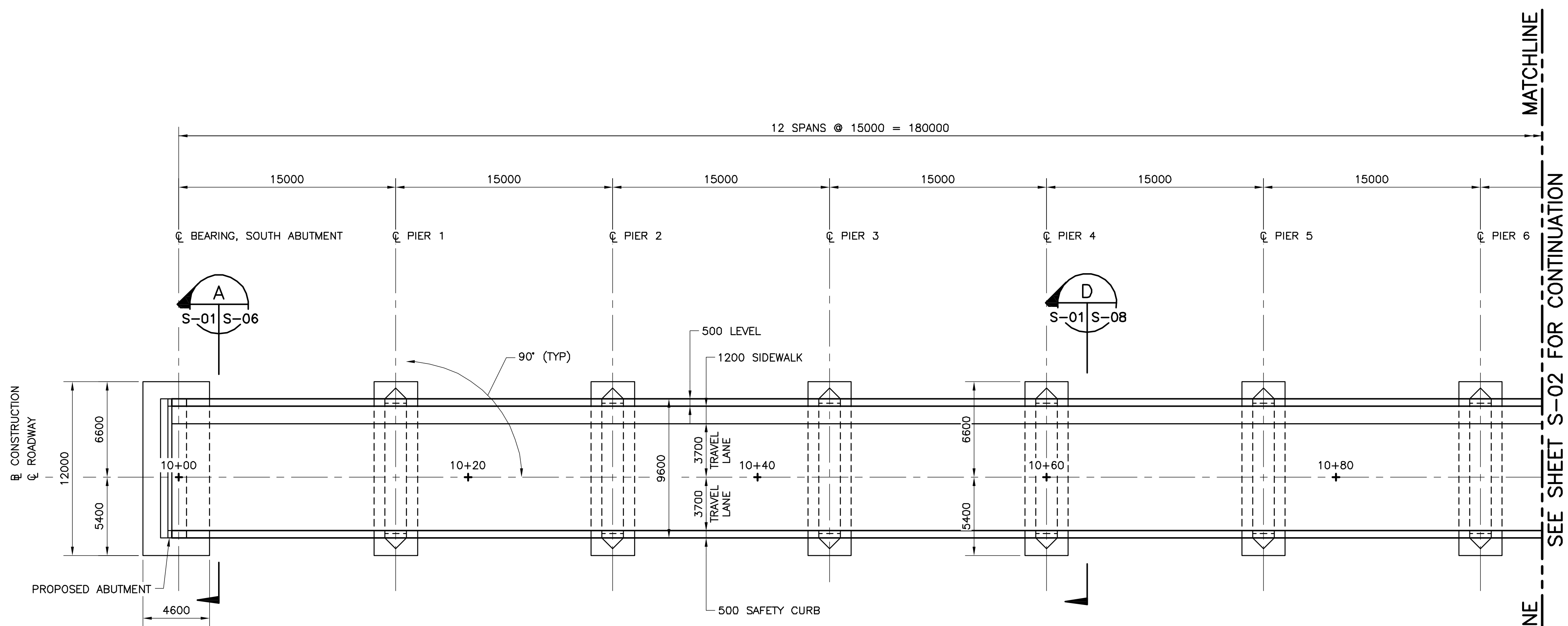
6.0 Next Steps

After USAID reviews these recommendations and identifies adequate funding for the two proposed bridges, the next step is to proceed with design documents and construction phase services. These phases consist of the following services:

- Final Design
    - Performing a site survey, geotechnical investigation, hydraulic and scour analysis
    - Roadway and Bridge Design
- Construction Phase Services
    - Reviewing Shop Drawing Submittals
    - Furnishing Advice
    - Development of As-Built Drawings

Tetra Tech looks forward to working with USAID and the Khost PRT in the future phases of this project.

Appendix A



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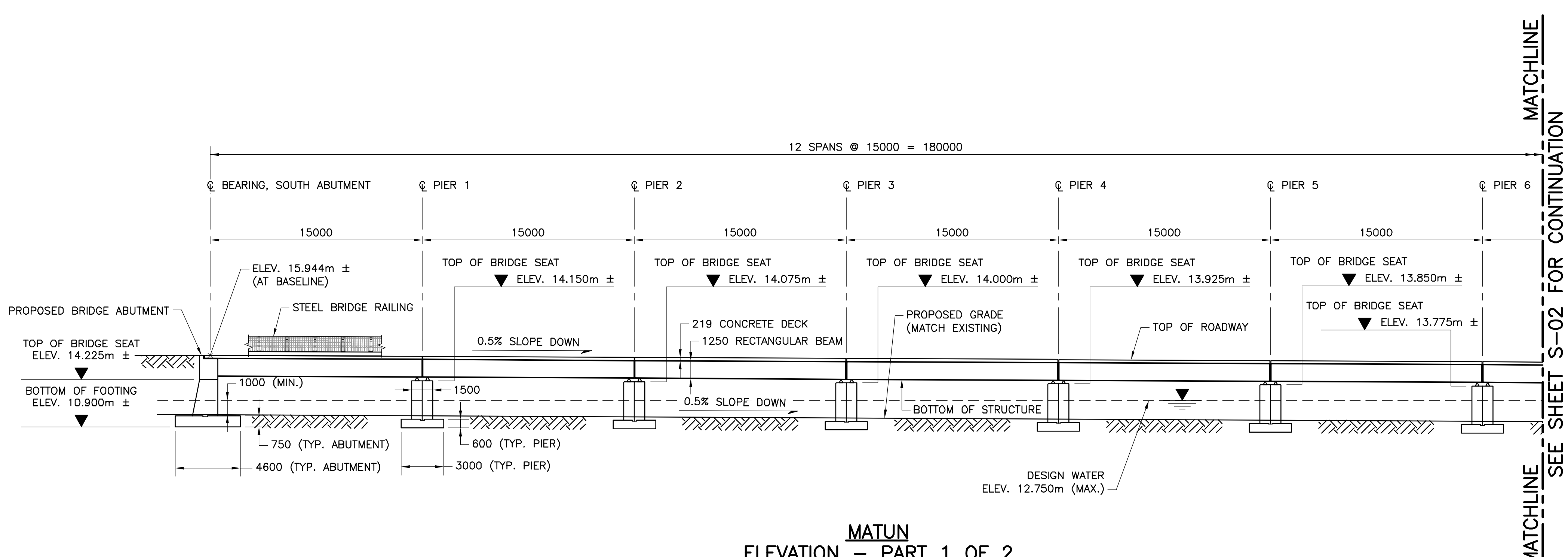

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ELEVATION – PART 1 OF 2
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NOTES:

1. THE LOWEST ABUTMENT FOOTING HAS BEEN SET AT ELEV. 10.000m. ALL OTHER ELEVATIONS ARE RELATIVE THERETO.
2. THE CONSTRUCTION BASELINE LAYOUT IS BASED ON STA. 10+00 AT THE ℄ BEARING OF THE SOUTH ABUTMENT.

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NOT FOR CONSTRUCTION

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DATE: 04/28/11
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SUBMITTED BY: TETRA TECH
CHECKED BY: APL
CAD FILE NAME: LT0009-S-01

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KHOST PRT
MATUN
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SHEET 1 OF 2

SHEET REFERENCE NUMBER:
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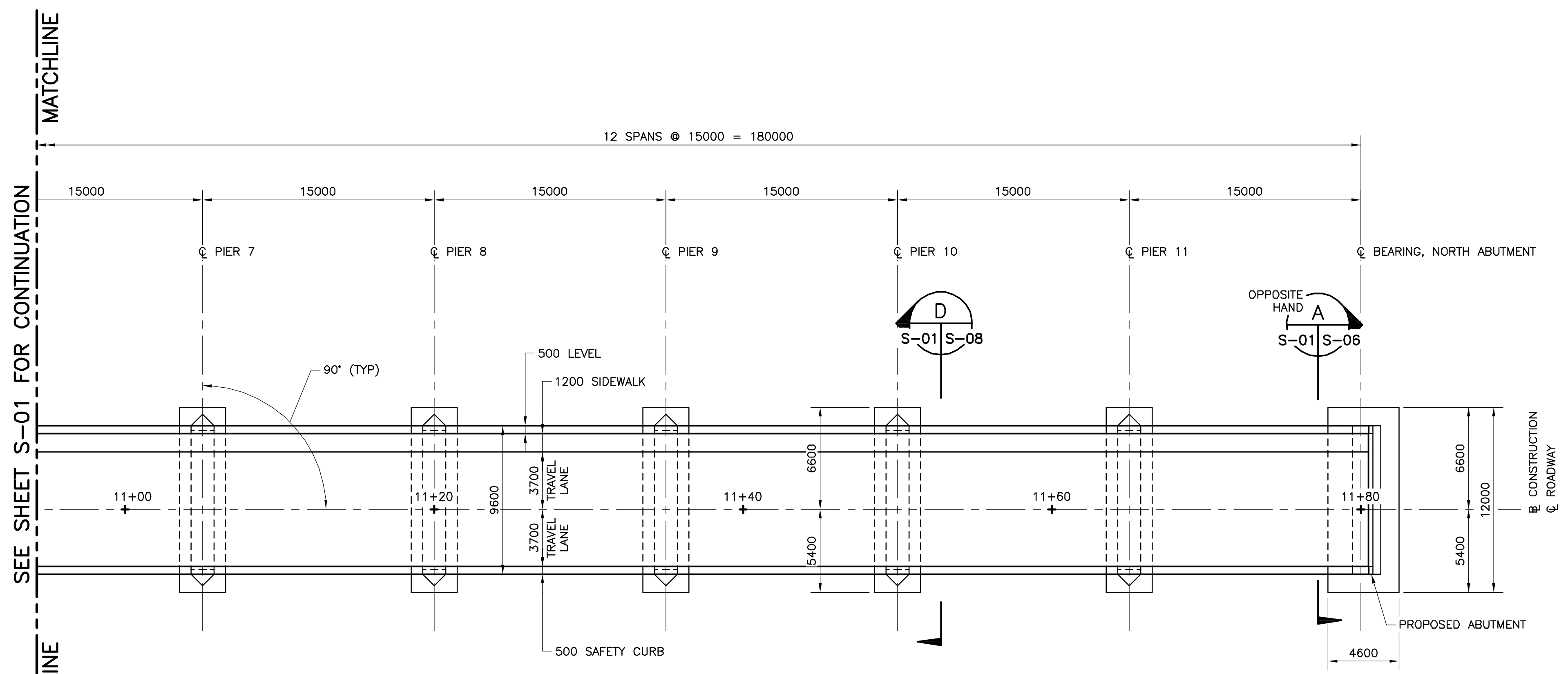
S-01



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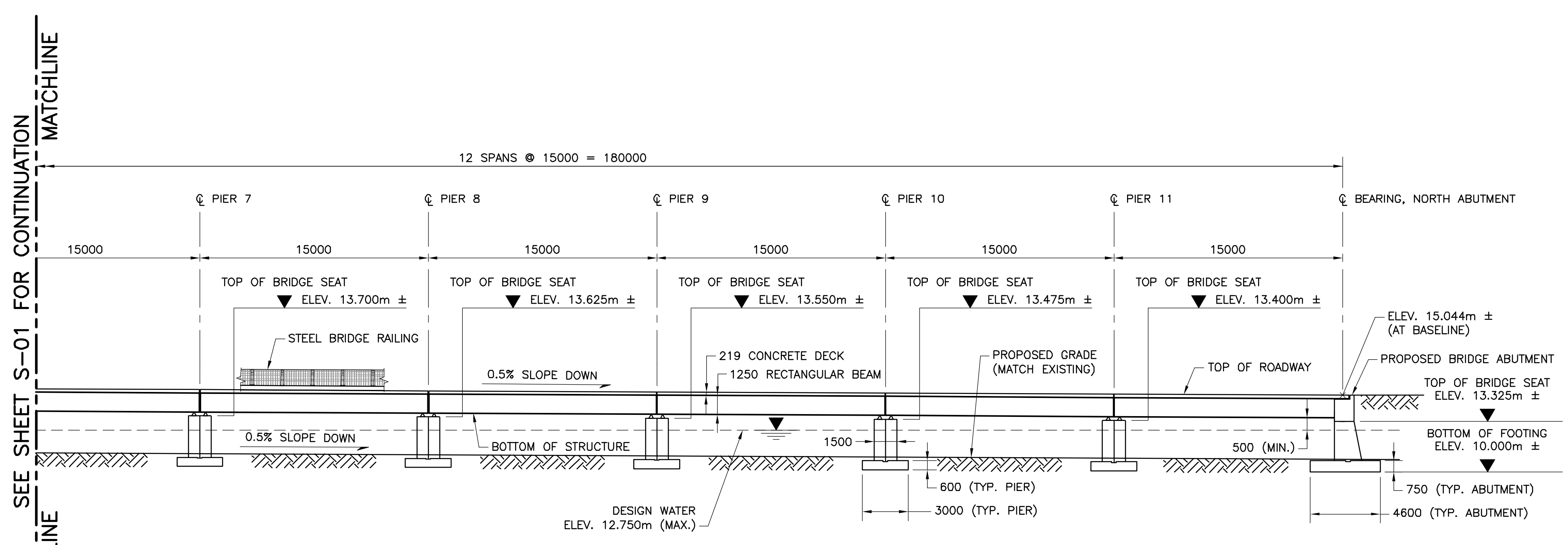

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GENERAL PLAN AND ELEVATION
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SHEET REFERENCE NUMBER:
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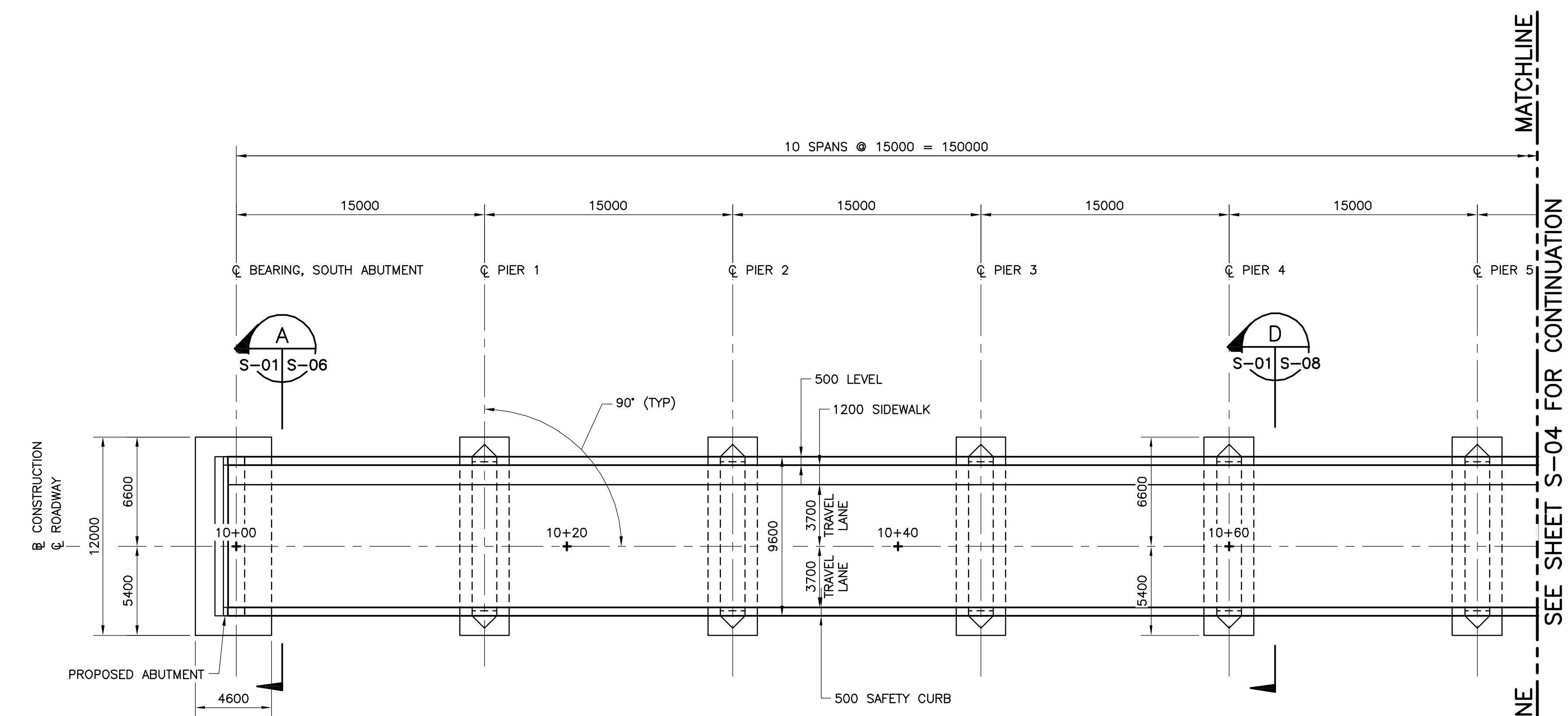

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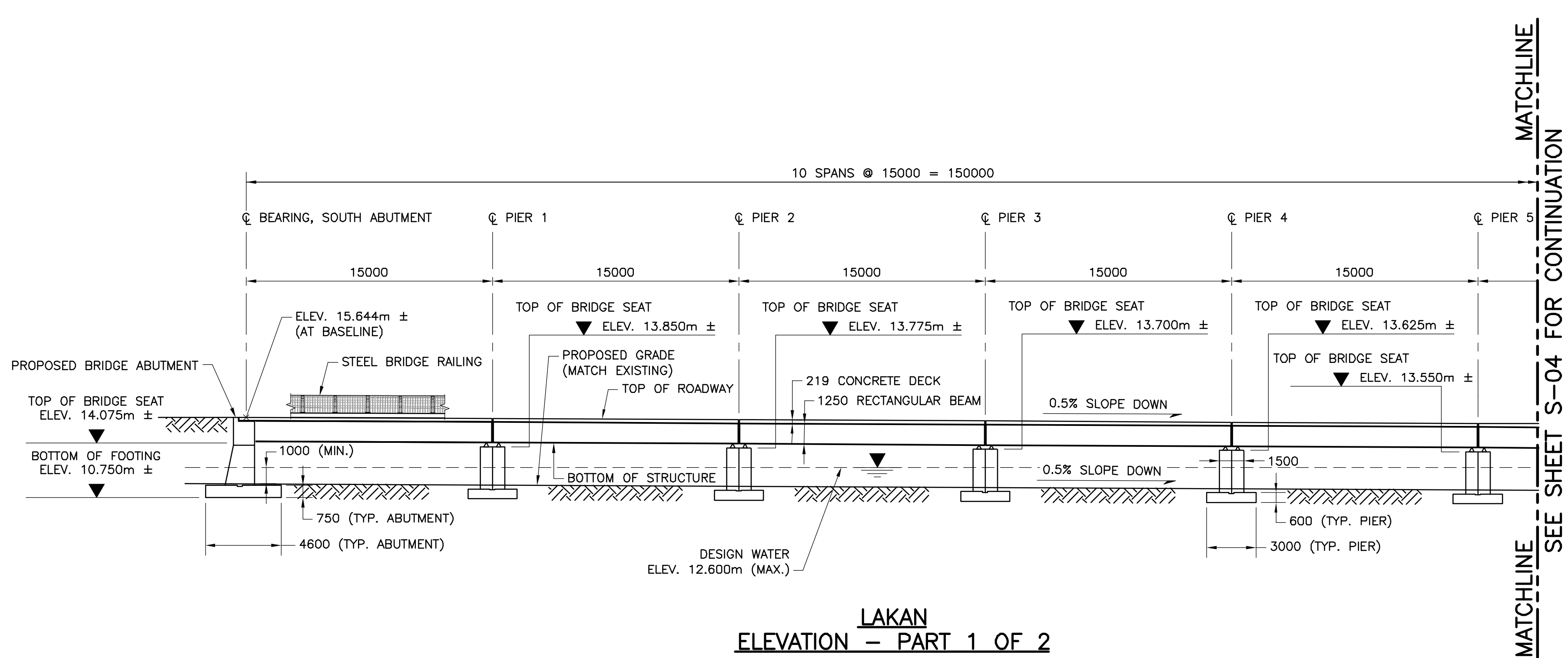

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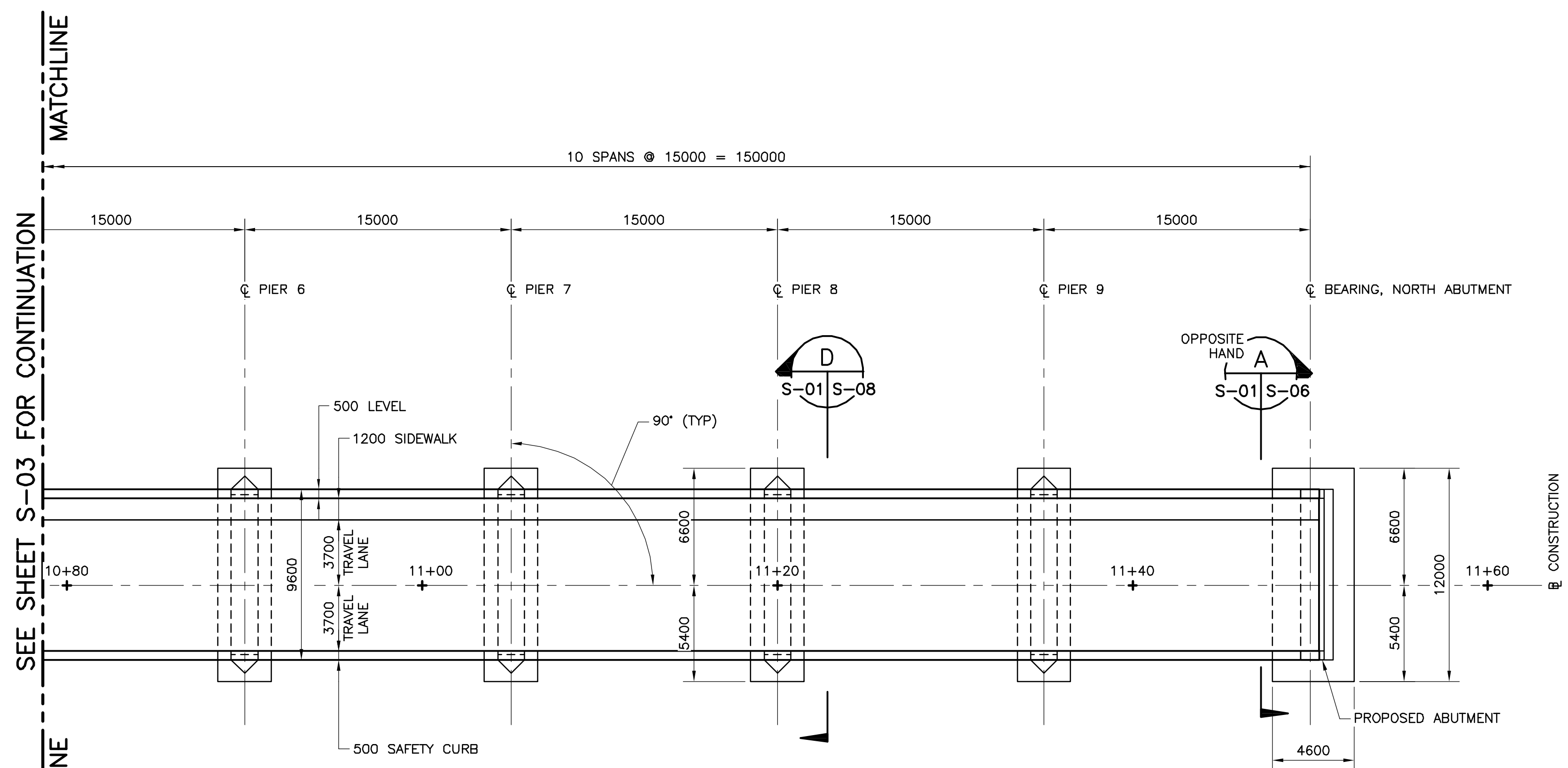

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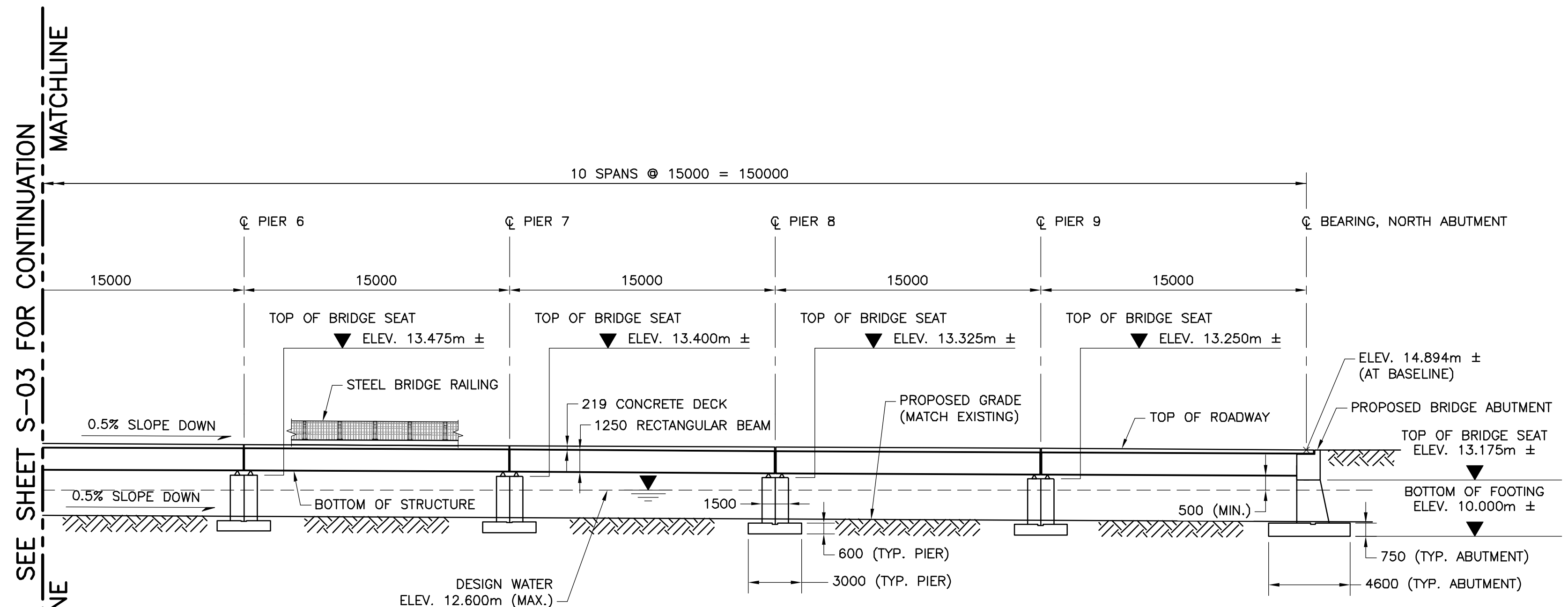

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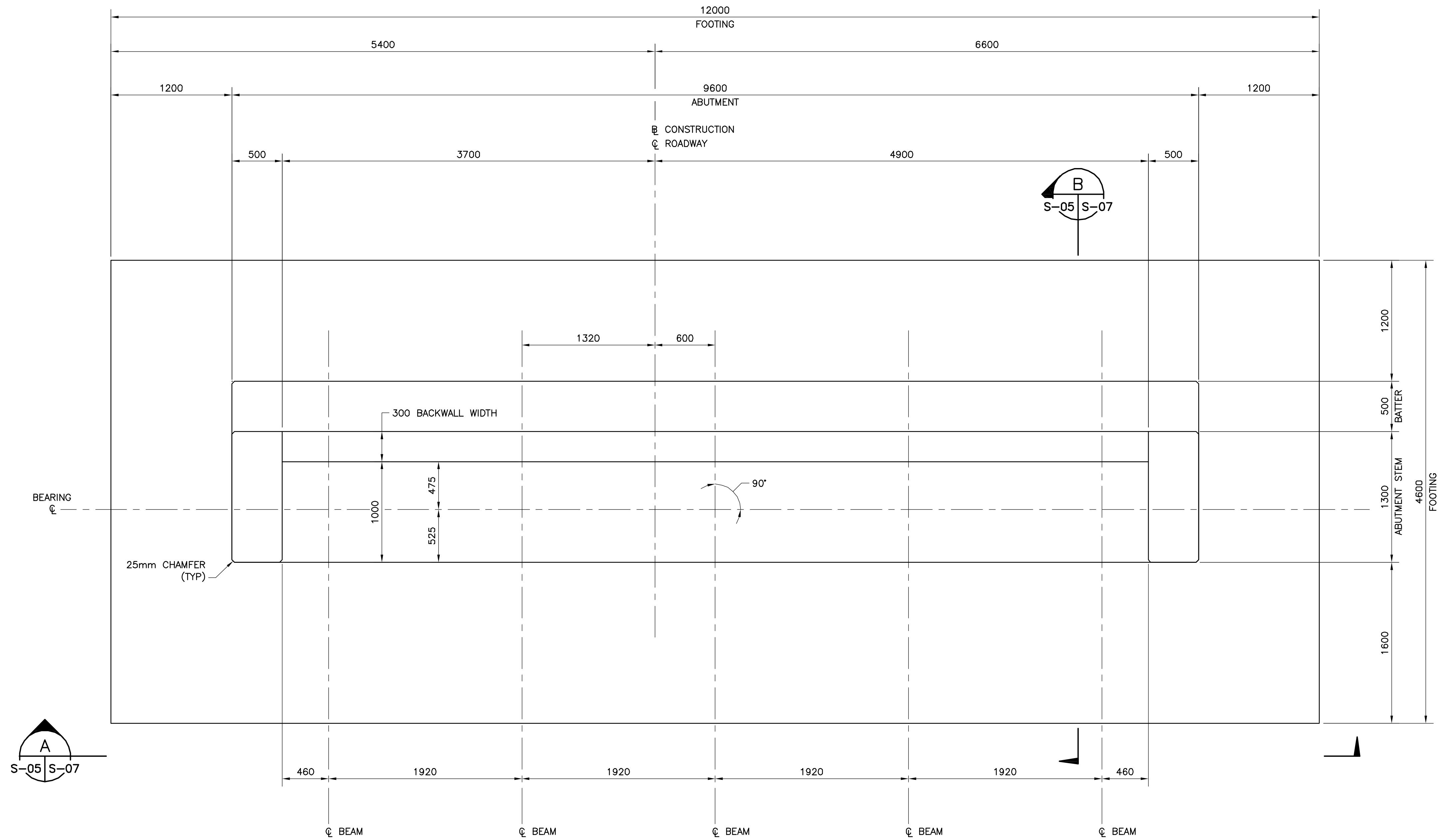

PROPOSED ABUTMENT PLAN

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MATUN AND LAKAN
ABUTMENT PLAN

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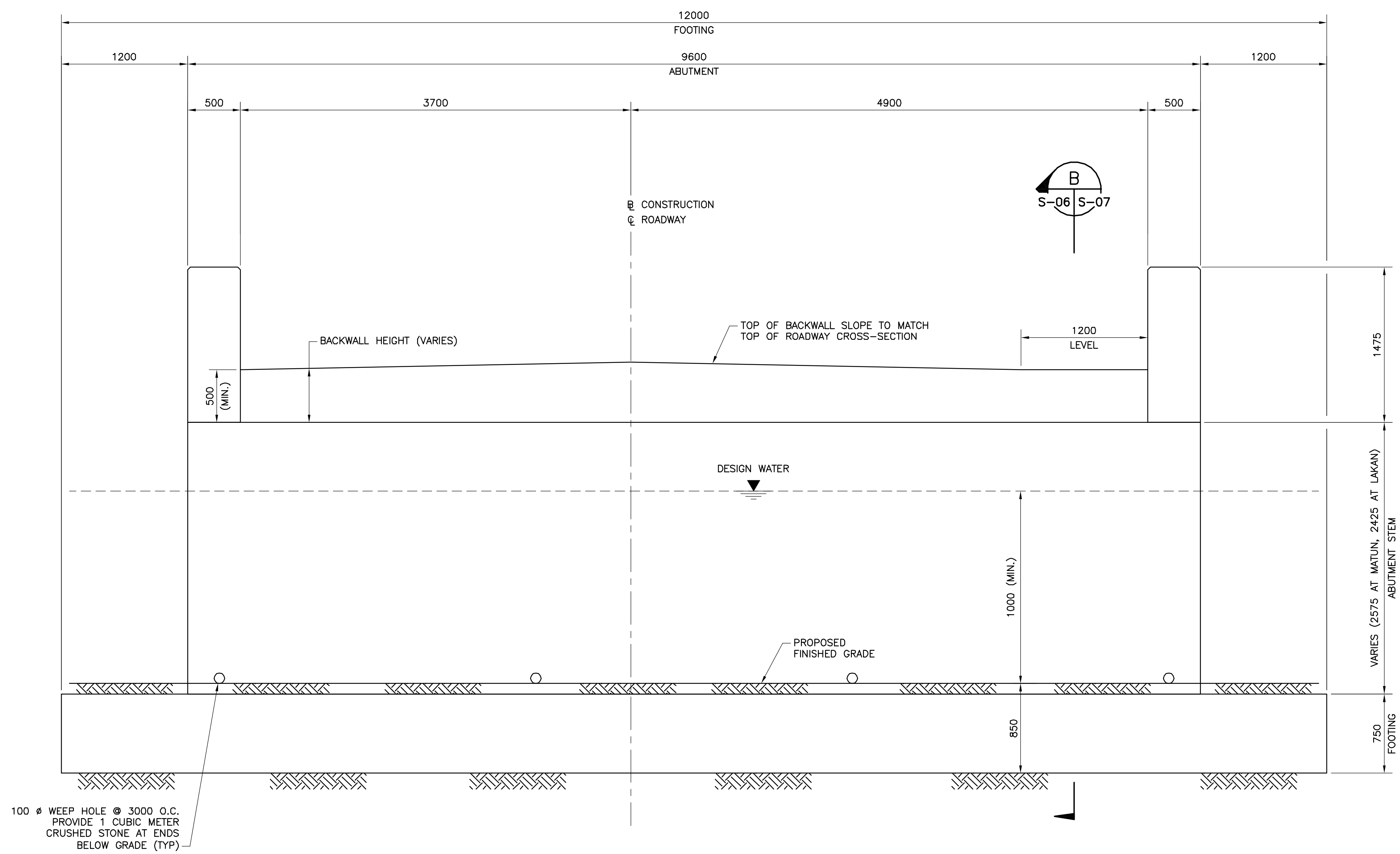

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MATUN AND LAKAN
ABUTMENT ELEVATION

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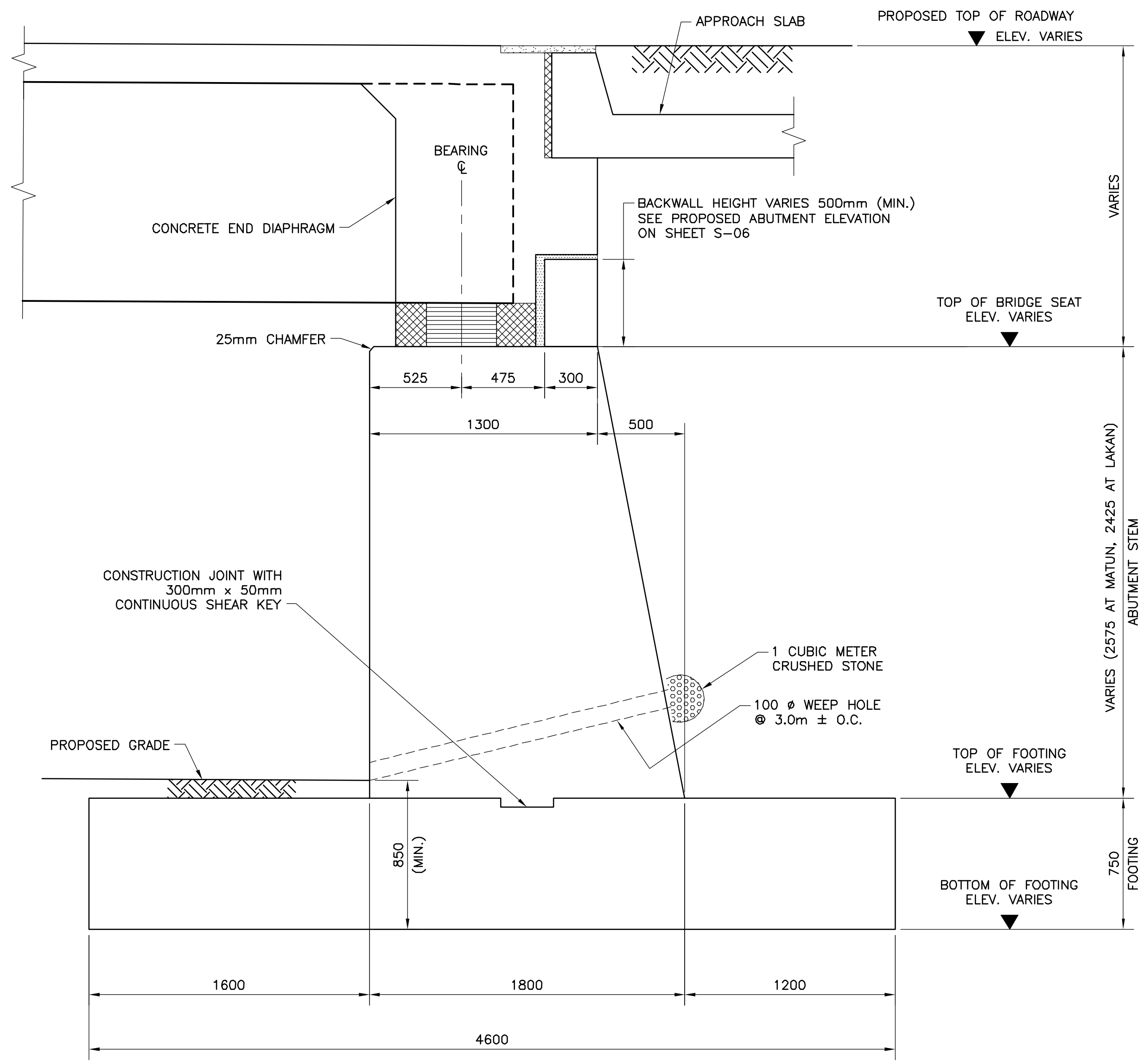

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MATUN AND LAKAN
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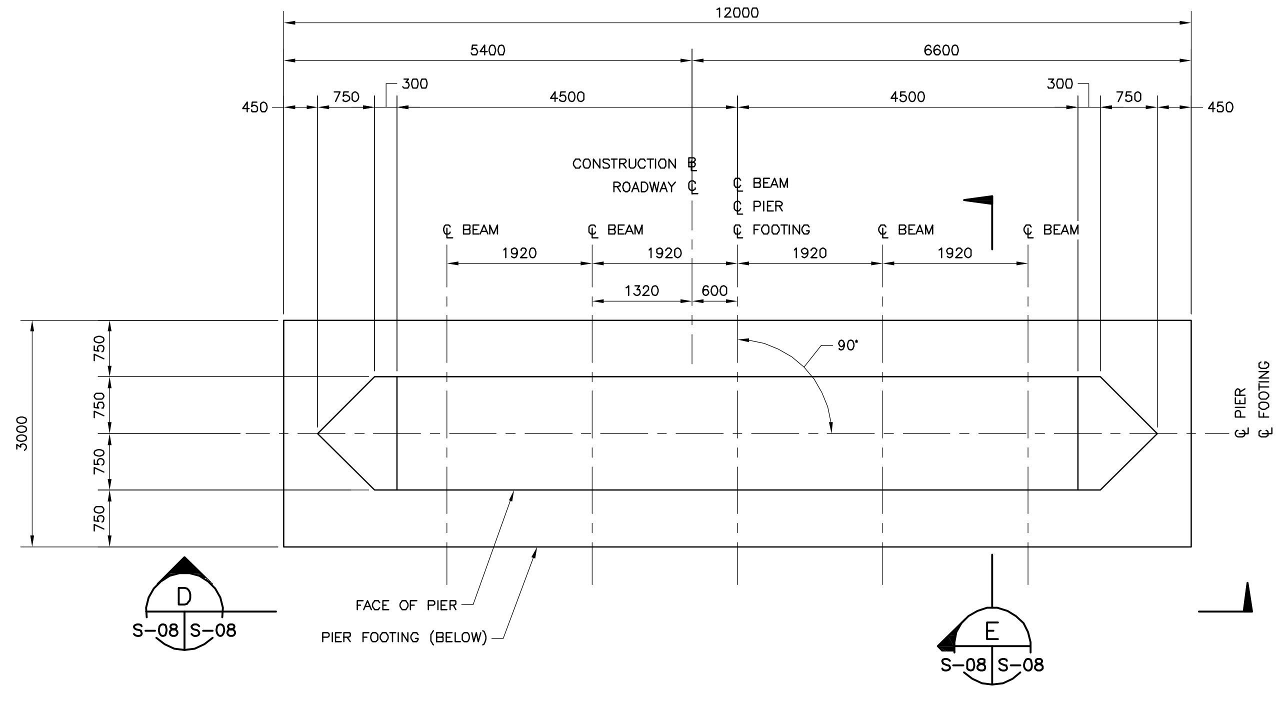

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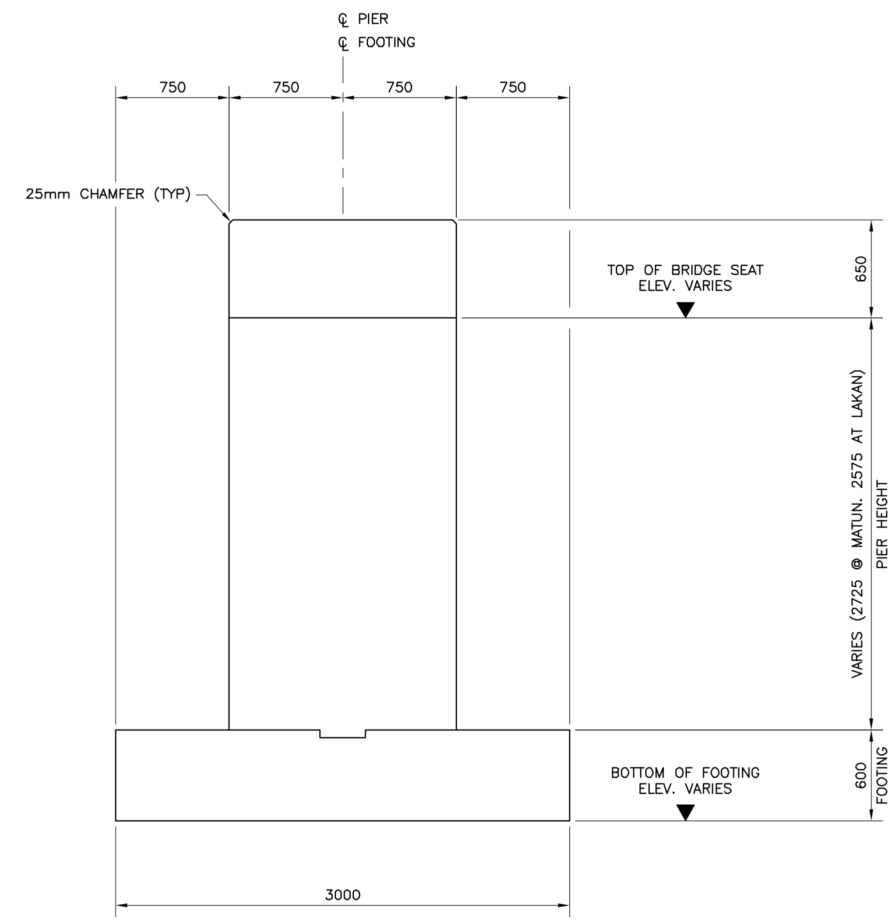

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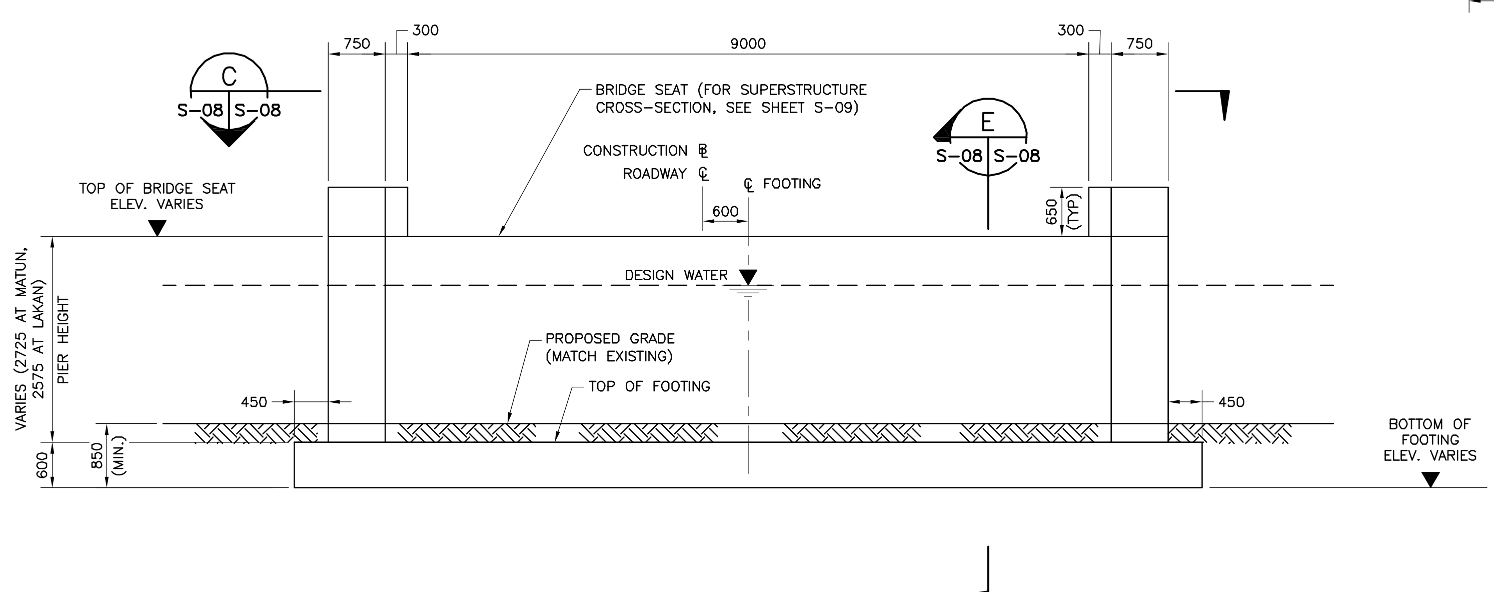

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MATUN AND LAKAN
PIER PLAN, ELEVATION AND SECTION

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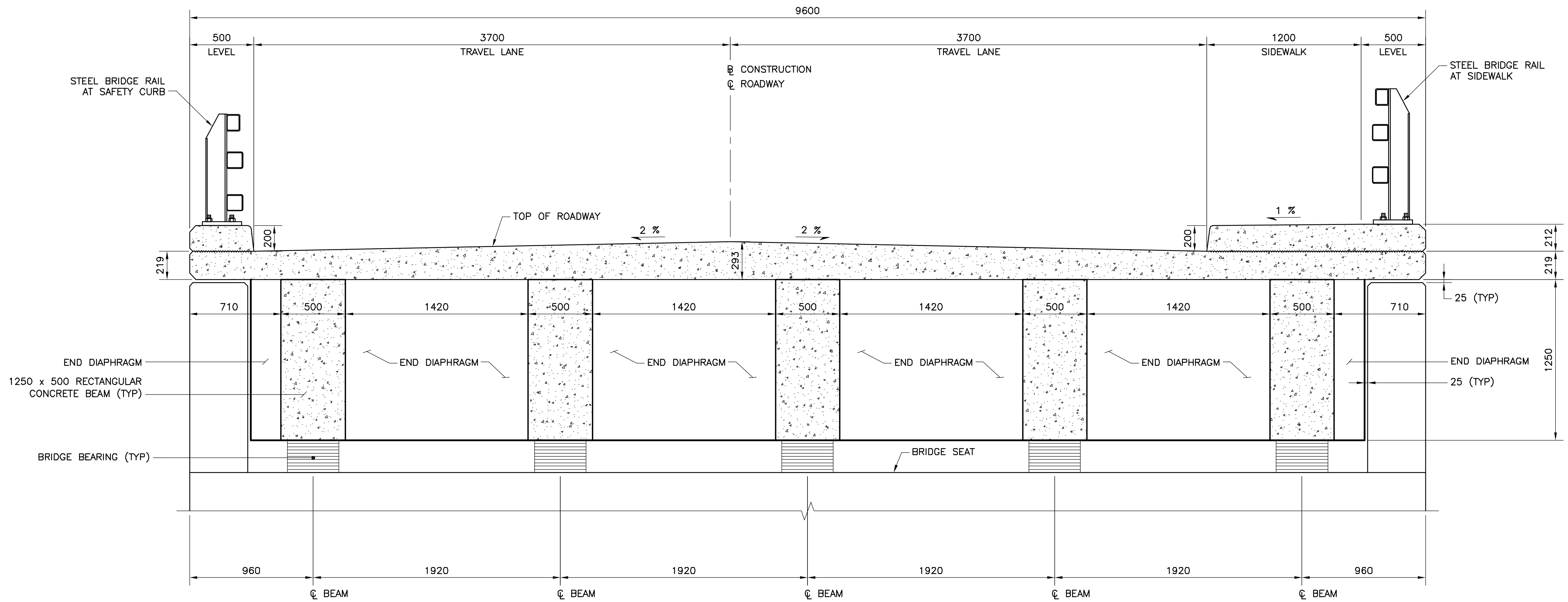

SUPERSTRUCTURE CROSS-SECTION

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MATUN AND LAKAN SUPERSTRUCTURE DETAILS

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Appendix B

USAID/Afghanistan.
U.S. Embassy Cafe Compound
Great Masood Road
Kabul, Afghanistan
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http://afghanistan.usaid.gov