YORK REGION

CLASS ENVIRONMENTAL ASSESSMENT STUDY FOR IMPROVEMENTS TO LANGSTAFF ROAD FROM WESTON ROAD TO HIGHWAY 7

PRELIMINARY STRUCTURAL DESIGN REPORT METROLINX GO TRANSIT OVERHEAD BRIDGE

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PROJECT NO.: 16M-01457-01

DATE: NOVEMBER 26, 2021

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SIGNATURES

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KEY PLAN

Metrolinx GO Rail Overhead Bridge

1 INTRODUCTION

The Regional Municipality of York (York Region) retained WSP Canada Inc. (WSP) to undertake the Municipal Class Environmental Assessment (MCEA) Study of Langstaff Road from Weston Road to Highway 7 in the City of Vaughan.

As part of the study, the proposed improvements on Langstaff Road include:

- Widening of Langstaff Road to six lanes from Weston Road to Dufferin Street;
- A connection across the CN MacMilan Yard from Creditstone Road to Keele Street;
- Replacement of the existing bridge over the West Don River;
- New bridge over at Metrolinx GO Transit Barrie Line;
- Intersection improvements; and
- Improvements of pedestrian and cycling facilities, and provision for transit amenities.

The following Preliminary Structural Design Report (PSDR) presents structural recommendations for the Metrolinx GO Transit Overhead bridge.

2 EXISTING CONDITIONS

2.1 GENERAL DESCRIPTION

The Metrolinx GO Transit Barrie Line crosses Langstaff Road at grade, approximately 730 m east of Keele Street (south of the Rutherford GO Station). Metrolinx currently maintains and operates two existing tracks and has a plan to expand with an additional track in the future.

Currently, Langstaff road carries one eastbound lane and one westbound lane at this crossing

2.2 TRAFFIC DATA

The posted speed along this section of Langstaff Road is 60 km/h.

The average daily traffic (ADT) volumes were 14, 836 vehicles (November 2014) and 18,125 vehicles (June 2015). The percentages of trucks were 6.6% and 5.6%, respectively.

3 GEOTECHNICAL INVESTIGATION AND RECOMMENDATIONS

3.1 GENERAL

A geotechnical investigation was carried out by Thurber Engineer Ltd. (Thurber) on behalf of WSP. The findings are provided in the Preliminary Geotechnical Investigation Report dated February 11, 2021.

The following summarizes the findings of the investigation and its recommendations.

3.2 EXISTING CONDITIONS AND FOUNDATION RECOMMENDATIONS

3.2.1 SUB-SURFACE CONDITIONS

The stratigraphy encountered in Borehole 19-12 drilled at the GO Transit crossing consisted of sand and gravel shoulder material over silty clay fill to a depth of 1.7 m (Elev. 202.0), underlain by successive deposits of very stiff to firm silty clay till, compact to very dense sand, hard silty clay till, and compact to very dense sand to gravelly sand to the exploration depth of 27.7 m. Groundwater was measured at a depth of 2.9 m (Elev. 200.8) in the monitoring well.

3.2.2 FOUNDATION DESIGN RECOMMENDATIONS

Based on the borehole data, the preferred means of supporting the replacement bridge comprises steel H-piles driven into the very dense sand deposits. For the purpose of preliminary design, a factored geotechnical resistance at ULS of 1,200 kN and a factored geotechnical resistance at SLS of 1,000 kN are recommended for HP310x110 piles driven to a tip depth of 27 m (Elev. 177). It is difficult to predict the depth at which the piles will achieve the required resistance at this site, and it is possible that the piles may encounter refusal in the very dense sand zone between depths of 10 m to 15 m.

The use of H-piles at the abutment allows for the design of an integral abutment structure. To reduce resistance to lateral movement and provide a relatively flexible pile system, the top of each pile should be installed in a pre-augered hole supported by a CSP and filled with loose sand as per MTO Structural Office Report SO-96-01.

Consideration could be given to supporting the structure on spread footings founded on the very stiff clay till encountered at depth of 1.7 m (Elev. 202.0). The presence of the firm zone between 4.1 m and 5.6 m depth from the existing ground would require use of a relatively low geotechnical resistance and thus the spread footing design is not expected to be practical. Extending the footing down to the compact to very dense sand below the clay till is also

considered impractical. In view of these conditions, the use of spread footings is not recommended at this site.

Augered caissons extended to the very dense sand at a depth of approximately 12.0 m (Elev. 192.0) could be considered at this site. However, installation of caissons may be particularly problematic due the presence of the cohesionless sand deposit and high groundwater levels. Construction would require use of a steel liner to maintain stability of the caisson sidewalls as well as techniques such as drilling slurry to prevent disturbance of the caisson base. As a result, the use of caissons is less preferred from a geotechnical point of view.

The depth of frost penetration at this site is approximately 1.2 m. All spread footings or piles caps should be provided with a minimum of 1.2 m of earth cover as protection against frost action.

4 PROPOSED STRUCTURE

4.1 GENERAL

Overhead grade separations (i.e. road over rail) is typically preferred rather than subway grade separations (i.e. road under rail) as there are generally fewer impacts on the rail operation, and complicated rail detours are not required during construction. A complete evaluation has been carried out on overpass and underpass alternatives. Considerations in the evaluation included road design, property impact, access, stormwater management, utility impact, staged construction, and construction cost. An overpass option has been selected to be the preferred option Detailed evaluation can be found in Environmental Study Report.

A single span (34.0 m) precast NU girder is proposed at this site for the 6-lane Langstaff Road configuration. Precast NU girders are typically more economical than steel girders or concrete rigid frames for a given span. NU girders would be erected without falsework after the construction of the abutment shaft; as a result, the disruption of the CN operation would be minimized.

Through consultation with Metrolinx, it was noted that Metrolinx has a plan for a future third track at the Langstaff Road crossing. The span length of 34.0 m between the centre of the bearings was determined to accommodate the future third track on either side of the existing two tracks. as it is unknown at the time of the writing, which side of existing tracks the future third will be located. The location of the future third track is to be confirmed during detail design through further review and consultation with Metrolinx. This span length is to be reduced once the location of the third track is confirmed during detail design. The superstructure will consist of 225 mm thick reinforced deck with 90 mm waterproofing and asphalt.

An integral abutment configuration was chosen to eliminate the expansion joints at each abutment location as per the geotechnical recommendations from the Preliminary Geotechnical Investigation Report as described on Section 3.2. Due to the height of the abutment, RSS walls are placed in front of the abutment and at each corner of the bridge.

The proposed bridge elevation view is shown in Figure 1. A preliminary General Arrangement drawing of the proposed work is included in Appendix A.

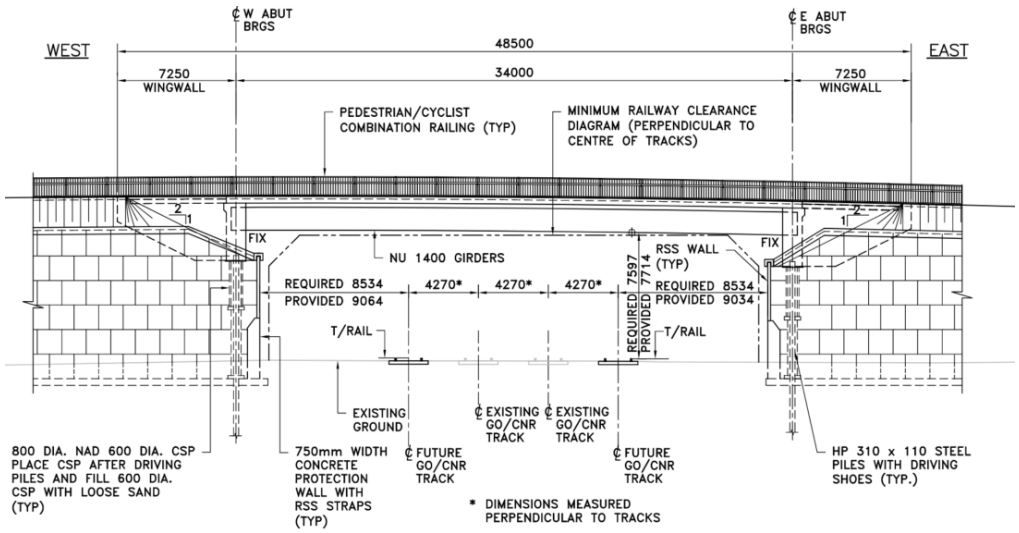


Figure 1: Proposed Elevation

4.2 HORIZONTAL ALIGNMENT AND VERTICAL PROFILE

The proposed structure is located on a tangent portion of the horizontal alignment. It is also located at/near a crest of the vertical alignment with the following parameters:

Crest Vertical Curve LVC = 231.310m
B.V.C. Station = 6+449.890 Elevation = 211.745 (Top of Pavement)
P.V.I. Station = 6+535.120 Elevation = 216.318
E.V.C. Station = 6+620.360 Elevation = 211.204 (Top of Pavement)

4.3 BRIDGE GEOMETRY

Bridge Depth

The overall structural depth from top of asphalt to underside of girder is 1790 mm.

Cross Section

The cross-section comprises the following, from north to south:

- 0.460 m north pedestrian/cyclist railing
- 3.000 m ~ 4.000 m north multi-use path
- 0.475 m north concrete barrier wall
- 1.000 m shoulder
- 3.500 m + 3.300 m + 3.300 m westbound lanes
- 1.700 m raised median
- 3.300 m + 3.300 m + 3.500 m eastbound lanes
- 1.000 m shoulder
- 0.475 m south concrete barrier wall

- 3.000 m ~ 4.000 m south multi-use path
- 0.460 m south pedestrian/cyclist railing

The proposed roadway cross-section has a normal crown with a 2% cross-fall. See Figure 2 below for the proposed cross-section.

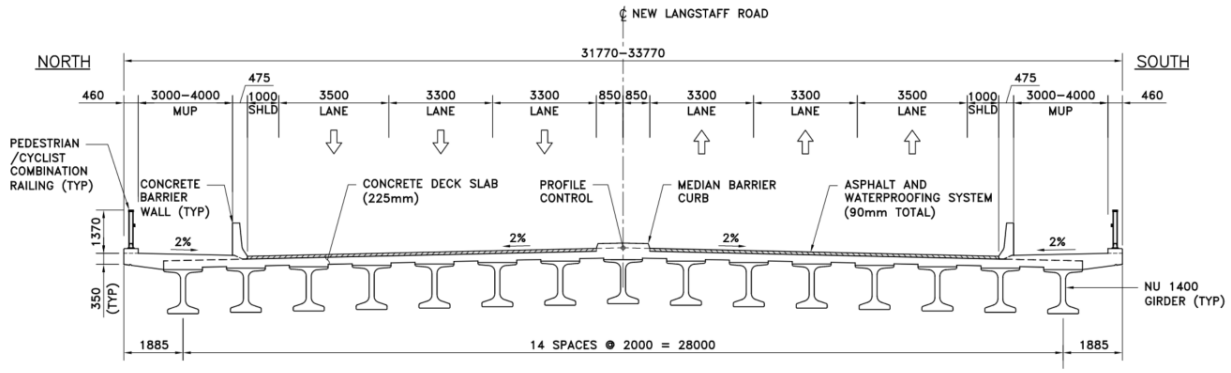


Figure 2: Proposed Cross Section

Skew Angle

The proposed structure will be constructed at a skew of approximately 7.6°.

5 MISCELLANEOUS

5.1 DESIGN STANDARD

The following design codes and references will be used during the detail design stage:

- Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6-19;
- MTO Structural Manual, 2016;
- MTO directives and standards; and
- OPSS.

5.2 MATERIALS AND AVAILABILITY

The concrete for precast NU girders will be class of 50 MPa. All other cast-in-place concrete will be class of 35 MPa. Precast girders and 35 MPa concrete are available in the area.

5.3 ENVIRONMENTAL ISSUES

This project is subject to the Ontario Environmental Assessment Act and will be completed in accordance with the Municipal Class Environmental Assessment process Schedule C.

5.4 ACCESS

The site is readily accessible from eastbound and westbound lanes of Langstaff Road.

5.5 CONSTRUCTION CONSIDERATION

The site is accessible from the eastbound and westbound lanes of Langstaff Road.

The portion of Langstaff Road from Planchet Road to Spinnaker Way/Connie Crescent could be closed during construction as all the properties along this segment of Langstaff Road have alternative access from the north-to-south roads and Langstaff Road traffic could be detoured via other roads.

Alternatively, staged construction could be considered to maintain existing two lanes of traffic on Langstaff Road. For the first stage, the north and south portion will be constructed while maintaining the existing single lane of traffic in each direction. For the second stage, the remaining middle portion of the structure will be constructed after the traffic is shifted to the new structure.

The construction staging options are to be reviewed in detail design.

Two construction seasons will likely be required to complete the construction of the bridge.

5.6 UTILITIES

A complete utility investigation is will be carried out during detail design.

5.7 DRAINAGE

There will be no deck drains required. Catch basins are provided at the approaches.

5.8 TRAFFIC BARRIERS

In accordance with the CHBDC-S6-19 Clause 12.4.3.2.4, Test Level 4 (TL-4) barriers are required. A standard TL-4 stainless steel reinforced concrete barrier wall with railing (SS 110-54) or GFRP reinforced concrete barrier wall (SS 110-58) will be provided at the edge of the multi-use pathway on both sides of deck to separate pedestrian/cyclist from vehicular traffic.

This bridge will permit the use of an aesthetically attractive combination railing on the outside of the deck to protect pedestrians and cyclists from falling from the bridge.

5.9 APPROACH SLABS

Approach slabs will be constructed at both ends of the bridge in accordance with the standard MTO drawing SS116-1.

5.10 ILLUMINATION

An illumination plan along Langstaff Road will be confirmed during detail design.

5.11 DURABILITY

Structural durability will be in accordance with the CHBDC (CAN/CSA S6-19) and MTO Structural Manual. Black reinforcing steel will be used in the abutments, deck and approach slabs. Stainless steel or GFRP reinforcing will be used in the multi-use pathways and parapet walls.

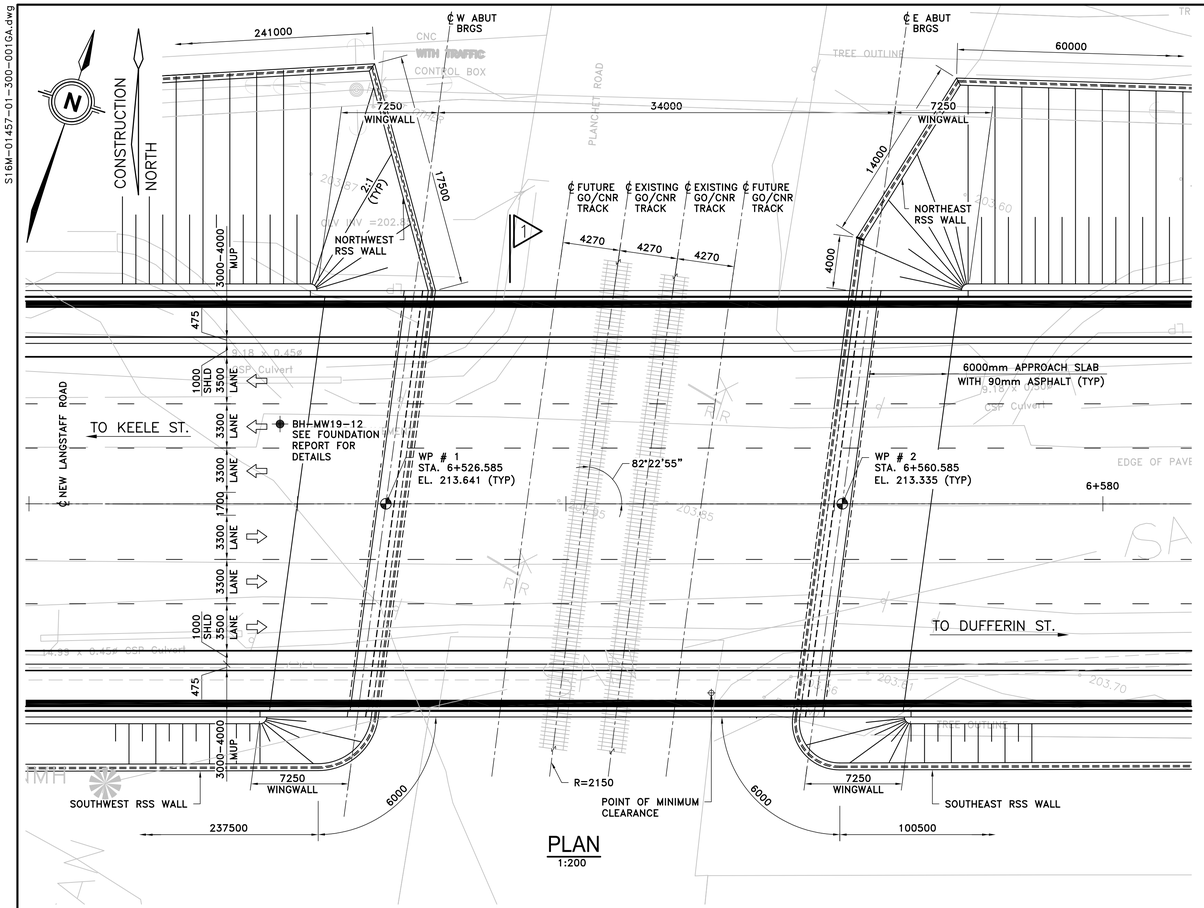
6 PRELIMINARY CAPITAL CONSTRUCTION COST ESTIMATE

The preliminary construction cost estimate for the new bridge and the removal of the existing bridge is $5.7M including 20% contingencies. Prices are in 2021 dollars. Details of the cost estimate are included in Appendix B.

Note that the above cost does not include traffic control and roadwork costs.

APPENDIX

A PRELIMINARY GENERAL ARRANGEMENT



PLAN
1:200

LIST OF ABBREVIATIONS

WP	–	DENOTES WORKING POINT
T/P	–	DENOTES TOP OF PAVEMENT
U/ABUT.	–	DENOTES UNDERSIDE OF ABUTMENT
RSS	–	DENOTES RETAINED SOIL SYSTEM
NTS	–	DENOTES NOT TO SCALE
SHLD	–	DENOTES SHOULDER
MUP	–	DENOTES MULTI USE PATH

LIST OF DRAWINGS:

1. PRELIMINARY GENERAL ARRANGEMENT

APPLICABLE STANDARD DRAWINGS:

3941.2000 FIGURES IN CONCRETE – SITE NUMBER AND DATE LAYOUT

NOTE: METROLINX CONFIRMED THAT THERE IS A PLAN FOR A FUTURE THIRD TRACK AT THE LANGSTAFF ROAD CROSSING; HOWEVER, THE FUTURE THIRD TRACK ALIGNMENT IS NOT MADE AVAILABLE AT THE TIME OF GA DEVELOPMENT. AS PART OF THE EA, THE LANGSTAFF ROAD STRUCTURE IS DESIGNED TO ACCOMMODATE A TOTAL OF FOUR TRACKS, PROTECTING FOR A THIRD TRACK ON EITHER SIDE OF THE EXISTING TWO TRACKS. THE STRUCTURE SPAN IS TO BE REDUCED TO ACCOMMODATE THREE TRACKS ONLY DURING DETAIL DESIGN ONCE THE LOCATION OF THE THIRD TRACK IS CONFIRMED IN THE FUTURE.

METRIC

GENERAL NOTES:

DESIGN CODE AND LOADING

CHBDC CAN/CSA S6-19 CL-625-ONT

CLASS OF CONCRETE

GIRDER	50MPa
REMAINDER	35MPa

CLEAR COVER TO REINFORCING STEEL

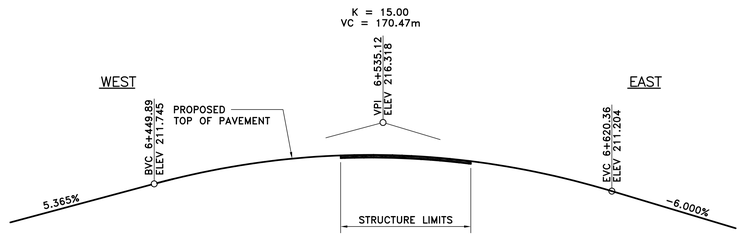
DECK	
TOP	70 ± 20mm
BOTTOM	40 ± 10mm
REMAINDER UNLESS OTHERWISE SPECIFIED	70 ± 20mm

REINFORCING STEEL

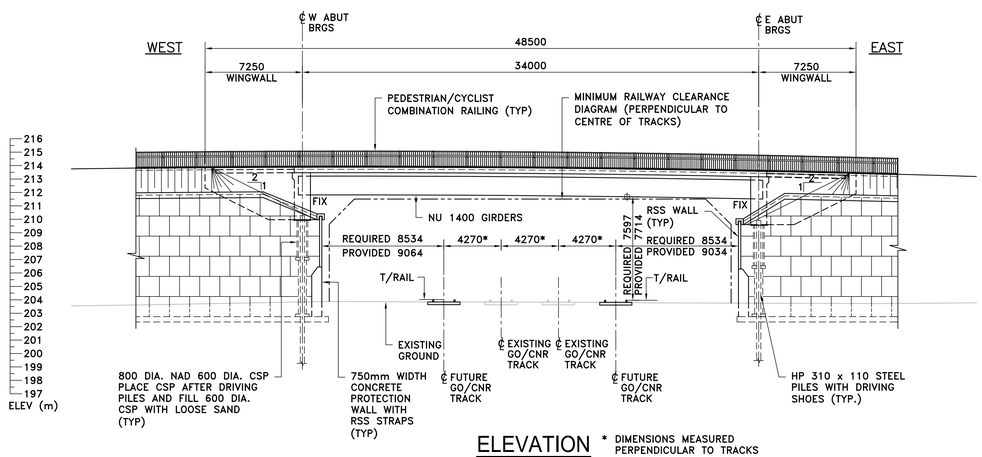
1. REINFORCING STEEL SHALL BE WELDABLE GRADE 400W.
2. UNLESS SHOWN OTHERWISE, TENSION LAP SPLICES FOR REINFORCING STEEL BARS SHALL BE CLASS B.
3. BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK, DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWING SS12-1 UNLESS INDICATED OTHERWISE.
4. STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE MINIMUM YIELD STRENGTH OF 500 MPa, UNLESS OTHERWISE SPECIFIED.
5. BAR MARKS WITH THE PREFIX "S" DENOTES STAINLESS STEEL BARS.

CONSTRUCTION NOTES

1. ALL ELEVATIONS ARE TO GEODETIC DATUM.
2. THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESSES FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.
3. THE CONTRACTOR SHALL SUPPLY TEMPORARY LATERAL BRACING FOR THE ABUTMENTS. FORMWORK AND LATERAL BRACING SHALL NOT BE REMOVED AND BACKFILL SHALL NOT BE PLACED UNTIL DECK CONCRETE HAS REACHED 75% OF ITS SPECIFIED 28-DAY STRENGTH.
4. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
5. THE CONTRACTOR IS TO PROVIDE TEMPORARY PROTECTION SYSTEMS DESIGNED TO PERFORMANCE LEVEL 1 FOR TRACK PROTECTION DURING CONSTRUCTION.

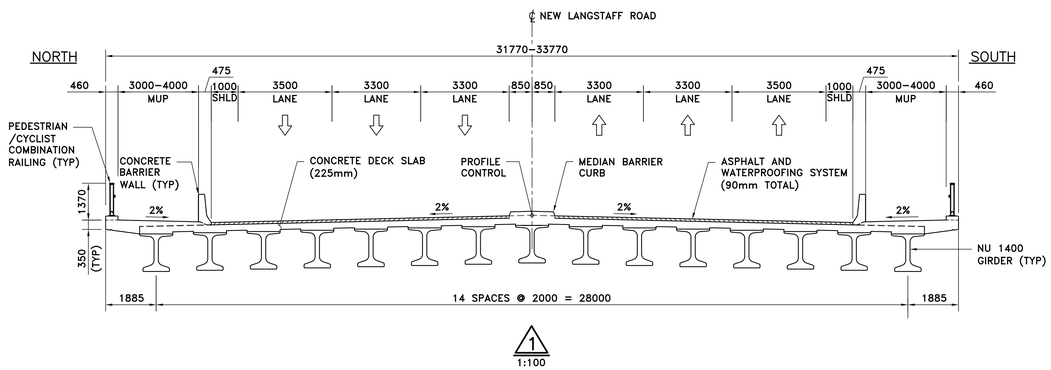


LANGSTAFF ROAD PROFILE
N.T.S.



ELEVATION
1:200

* DIMENSIONS MEASURED PERPENDICULAR TO TRACKS



1:100

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

NOTE:
THE LOCATION OF UTILITIES IS APPROXIMATE ONLY, AND THE EXACT LOCATION SHOULD BE DETERMINED BY CONSULTING THE MUNICIPAL AUTHORITIES AND UTILITY COMPANIES CONCERNED. THE CONTRACTOR SHALL PROVE THE LOCATION OF UTILITIES AND SHALL BE RESPONSIBLE FOR ADEQUATE PROTECTION FROM DAMAGE DURING CONSTRUCTION.

No.	DATE	REVISIONS	BY

York Region Transportation Services

DESIGN DESIGN	NEW LANGSTAFF ROAD	DWG. NO. DWG_NUM
DRAWN DRAWN	METROLINX GO TRANSIT OVERHEAD BRIDGE PRELIMINARY GENERAL ARRANGEMENT	CONT. NO. CONT_NUM
CHECKED CHECKED		SHEET NO. SHEET_NUM

APPENDIX

B PRELIMINARY COST ESTIMATE

Preliminary Cost Estimate

NEW Bridge - GO Rail Overhead Bridge

Single Span 34.0m
precast concrete NU girders NU1400
Integral Abutments
Skew 7.6 degree

* Cost Estimate is based on 3m Multi-Use Path.

Description of Item	Unit	Unit Price	Quantity	Total
Earth Excavation for Structure	m^3	$35	2020	$70,700
Supply Equipment for Driving Piles	LS	$75,000	1	$75,000
H-Piles - HP 310x110	m	$350	1452	$508,200
Driving Shoes	each	$250	44	$11,000
CSP for Integral Abutment	each	$2,000	44	$88,000
Concrete in Substructure	m^3	$1,650	234	$386,100
Concrete in Deck	m^3	$1,900	400	$760,000
Concrete in Sidewalk	m^3	$1,900	100	$190,000
Concrete in Barrier Walls	m^3	$2,500	30	$75,000
Concrete in Apporach Slab	m^3	$750	100	$75,000
NU1400 Prestressed Girder Fabrication	m	$1,600	519	$830,400
NU1400 Prestressed Girder Delivery	m	$150	519	$77,850
NU1400 Prestressed Girder Erection	m	$310	519	$160,890
Elastomeric Laminated Bearings	each	$750	30	$22,500
Bicycle Railing with Pickets	m	$500	97	$48,500
Reinforcing Steel Bars	t	$3,000	81	$243,000
Stainless Steel Bars	t	$13,000	15	$195,000
Waterpoofing	m^2	$45	848	$38,160
Form and Fill Grooves	m	$75	48	$3,600
RSS Wall	m^2	$900	908	$817,200
Granular B Type II Backfill	t	$30	2290	$68,700
			Sub-total	$4,744,800
			Contingency (20%)	$948,960
			Total	**$5,693,760**

Deck Area		1,080	m^2
Cost/m^2 of deck area without contingencies	$	4,393	
Cost/m^2 of deck area with contingencies	$	5,272	