Appendix J

Final Structural Replacement and Staging Alternatives Memorandum (Functional Design Report)

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Ministry of Transportation, Eastern Region
1355 John Counter Blvd., Postal Bag 4000
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Attention: Peter Freure, P. Eng.
Sr. Project Engineer

RE: G.W.P. 4203-15-00
SITE NO. 27-50 & 27-51 – HAWKESBURY CREEK & CNR OVERHEAD AND HIGHWAY 34 OVERPASS
FINAL STRUCTURAL REPLACEMENT AND STAGING ALTERNATIVES MEMORANDUM

Dear Sir:

Following the re-scoping of agreement No. 4014-E-0015 – Mega 6 Bridges, MMM has been engaged by the Ministry of Transportation Ontario (MTO) to carry out preliminary design for the replacement of Hawkesbury Creek & CNR Overhead (Site No. 27-50) and Highway 34 Overpass (Site No. 27-51). In this memorandum, MMM presents a review of replacement and construction staging alternatives for both structures. First, a preliminary screening of potential structure types and span configurations was undertaken based on existing site characteristics, past experience, and engineering judgement. Following the screening, the three most promising replacement alternatives were further developed and a recommended structural alternative identified. Various construction staging and final highway alignments for the new structures were also explored including a review of the lane configuration to determine the feasibility of reducing the County Road 17 cross-section to two lanes across the structures.

1. EXISTING STRUCTURE ARRANGEMENTS

Hawkesbury Creek & CNR Overhead and Highway 34 Overpass are located on County Road 17 south of the Town of Hawkesbury in the United Counties of Prescott and Russell (Figure 1). The structures lie on the same tangent horizontal alignment and vertical crest curve and are separated by approximately 52 m of earth embankment.

1.1. Hawkesbury Creek & CNR Overhead

The Hawkesbury Creek & CNR Overhead structure was constructed circa 1955. The bridge is a three span continuous cast-in-place reinforced concrete girder structure with a total length of 56.39 m (16.31 m, 23.77 m and 16.31 m spans). The structure spans over CNR tracks in the eastern span and Hawkesbury Creek in the center span. The structure has no skew and crosses the CNR tracks at an angle of approximately 4˚47’00”. The overall structure width is 16.31 m which is comprised of a 15.35 m wide roadway (four lanes barrier-to-barrier) and two 0.48 m wide

concrete barriers. The superstructure consists of nine rectangular haunched cast-in-place concrete girders with an existing vertical clearance from the top of the CNR tracks to the underside of the girder of approximately 7.22 m. The superstructure is supported on a reinforced concrete counterfort abutment wall at the east abutment, five reinforced concrete columns at each pier and six buried reinforced concrete columns at the west abutment. The foundations of the abutments and piers are spread footings founded on rock. A reinforced concrete retaining wall extends from both sides of the west pier foundation and retains the slope in front of the west abutment.

1.2. Highway 34 Overpass

Highway 34 Overpass, also constructed circa 1955, is a single span cast-in-place reinforced concrete rigid frame with a total span of 17.98 m. The structure is skewed at approximately 7˚57'00" to the centerline of County Rd. 17 and has an overall structure width of 18.13 m which is comprised of a 16.15 m roadway (four lanes curb-to-curb) and two 0.99 m curbs with parapet walls. The structure crosses four lanes (two each direction), a sidewalk and a safety curb on Highway 34 below. Interchange on/off-ramps to the County Rd. 17 are present at intersections located to the north and south of the structure. The original design drawings for the structure are not available at this time therefore there is no detailed information on the foundations or the size of structural elements.

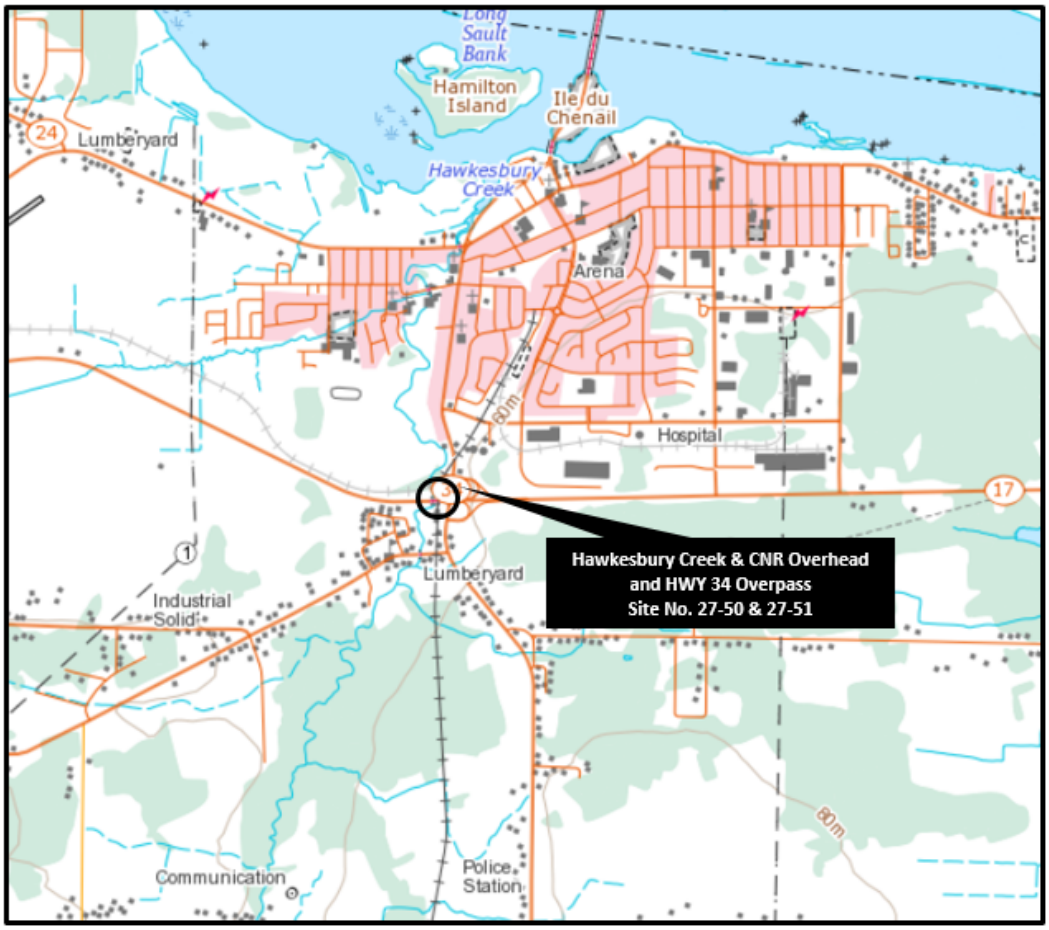


Figure 1

2. PRELIMINARY SCREENING OF POTENTIAL STRUCTURAL ALTERNATIVES

Two general conceptual replacement alternatives for Hawkesbury Creek & CNR Overhead and Highway 34 Overpass were reviewed. The first is the replacement of the two existing structures with a single multi-span structure. The second is the replacement of the two existing structures with two new structures, similar to the existing configuration, bridging Hawkesbury Creek and the CNR tracks, and Highway 34, respectively.

During the preliminary screening of alternatives, the vertical clearance above the CNR tracks and above Hwy 34 were identified as design constraints. The vertical clearance from the top of rail to the underside of the existing deck at the Hawkesbury Creek and CNR Overhead structure was surveyed and found to be approximately 7.22 m. Comparing this to the standard required vertical clearance of 7.01 m for CNR tracks, there is little room for deeper deck sections without raising the vertical profile on County Rd. 17. Based on past experiences working on railway overhead bridges, a permanent reduction of the clearance to CNR tracks is not considered a feasible alternative. The maximum depth of the superstructure without raising the roadway profile is approximately 1.16 m.

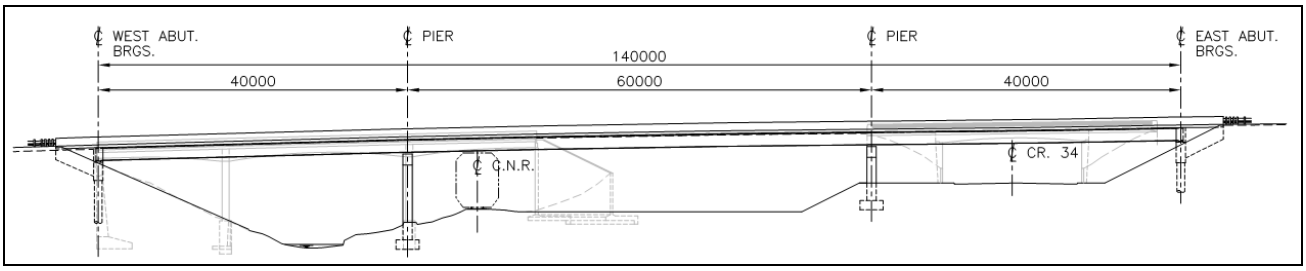
The existing vertical clearance to the soffit of the Hwy 34 Overpass structure remains to be verified; however, 2007 rehabilitation drawings report the existing vertical clearance to vary from 5.8 m ± at the centreline of Hwy 34 to 4.7 m ± at the abutments. Based on field survey data points taken on the roadway surface of County Rd. 17 and Hwy 34, the maximum depth of a new superstructure over Hwy 34 would be limited to approximately 1.12 m if the existing roadway profiles on County Rd. 17 and Hwy 34 are maintained.

In the following two sections, multiple replacement options are explored and screened based on engineering experience and judgement. The advantages and disadvantages of each preliminary alternative are summarized in Table 1 and the most promising alternatives are carried forward for further development.

2.1. Single Bridge Alternatives

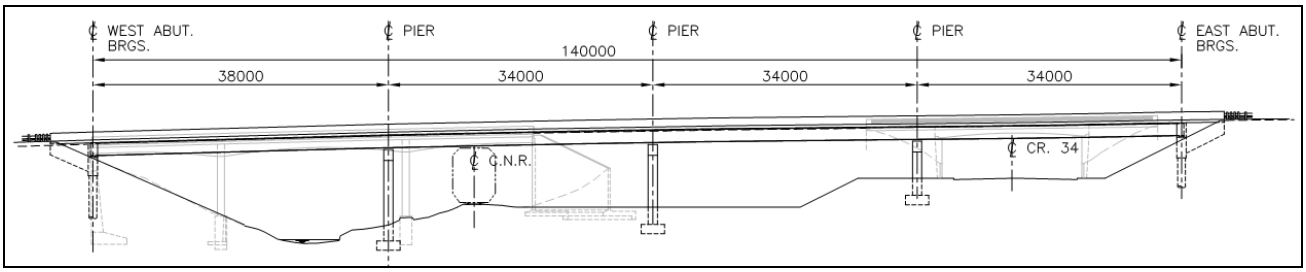
Three single bridge span configurations were considered at this site. Each span configuration considered is based on a total length of approximately 140 m with the west abutment at the same location as the existing west abutment and the east abutment offset approximately 10 m from the edge of Hwy 34. A significant drawback to the single bridge alternatives is that removing the approximately 52 m long embankment between the existing structures and replacing it with a bridge structure will increase the structural costs of the project.

3 Span Continuous (40m, 60m, 40m)



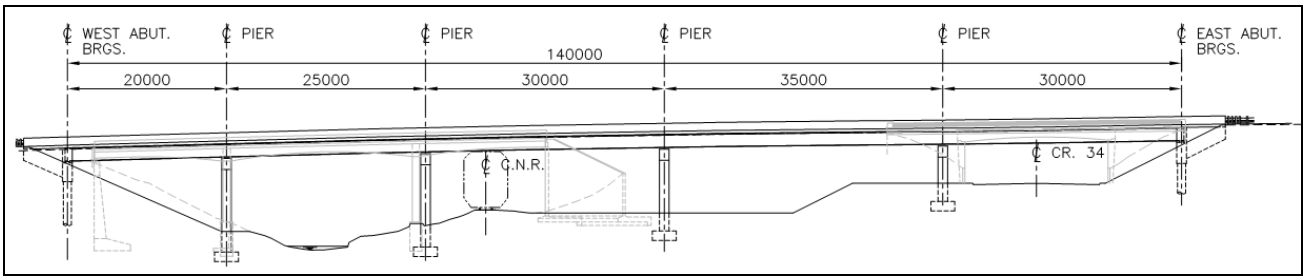
This three span configuration presents an efficient span ratio for a continuous structure and requires only four substructure elements. Due to the length of the spans (and associated depth of superstructure), the roadway profile would be required to be raised by approximately 0.5 to 0.8 m in order to respect the vertical clearances over CNR tracks and Hwy 34.

4 Span Continuous (38m, 34m, 34m, 34m)



This four span configuration increases the number of substructure elements to five while reducing the length, and therefore depth, of superstructure over the clearance critical spans. Despite the reduced span lengths, the roadway profile would still have to be raised by approximately 0.2 to 0.5 m in order to respect the vertical clearance over the CNR tracks.

5 Span Continuous (20m, 25m, 30m, 35m, 30m)

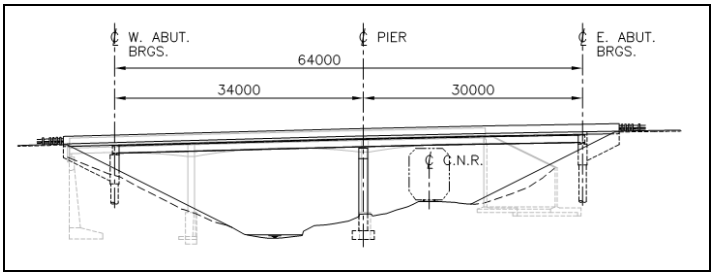


This five span option has been arranged such that the vertical clearance above the CNR tracks and Hwy 34 can be respected without significant adjustments to the roadway profile. This option requires six substructure elements and has spans with various lengths to accommodate crossings over Hawkesbury Creek, the CNR tracks and Hwy 34.

2.2. Multi-Bridge Alternatives

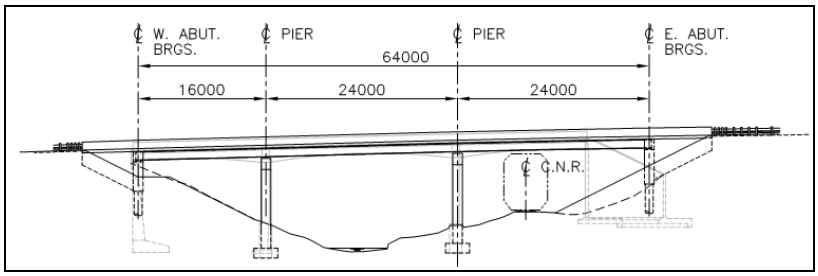
In order to discuss multi-bridge alternatives, the Hawkesbury and Hwy 34 structures have been considered separately. Three different span configurations for Hawkesbury and two for Hwy 34 were considered as part of the preliminary screening.

Hawkesbury - 2 Span Continuous (34m, 30m)



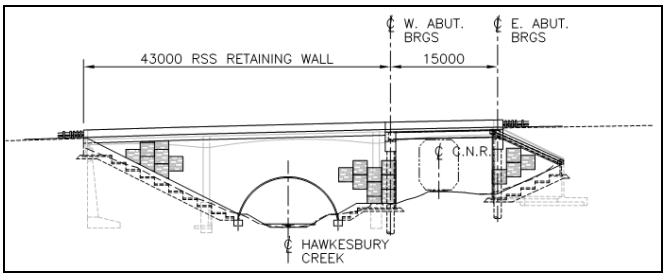
This option for the replacement of the Hawkesbury Creek structure consists of a two span continuous structure with a central pier in the same location as the existing east pier. The west abutment is offset by approximately 6 m and the east abutment is offset by approximately 12 m from the existing abutments. The location of the east abutment eliminates the requirement for a large abutment wall and the spans are short enough such that the vertical clearance to the CNR tracks can be respected without significant modification to the County Rd. 17 roadway profile.

Hawkesbury - 3 Span Continuous (16m, 24m, 24m)



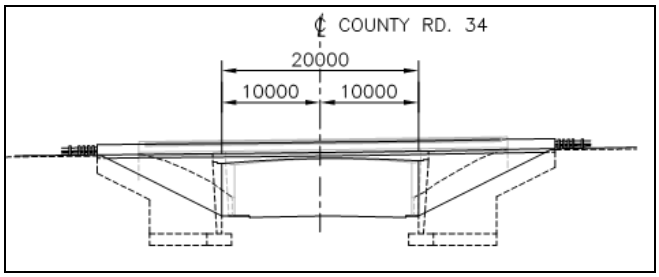
This option considers the replacement of the Hawkesbury Creek structure with a three span continuous structure with substructure elements at the same support points as the existing structure with the exception of the east abutment, which is offset by approximately 8 m to eliminate the need for a large abutment wall. The spans have been proportioned such that the vertical clearance to the CNR tracks can be respected without significant modification to the County Rd. 17 roadway profile.

Hawkesbury - Precast Concrete Arch & CNR Span (20m & 15m)



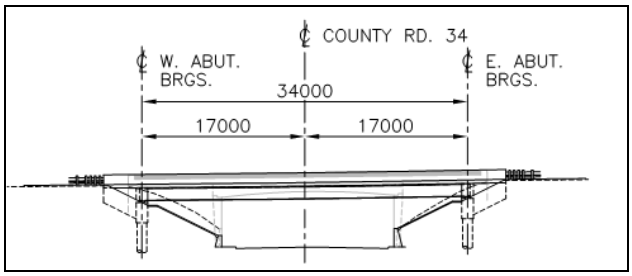
This option considers the replacement of the Hawkesbury Creek structure with a 20 m precast concrete arch structure over Hawkesbury Creek and a 15 m long simply supported span over the CNR tracks. The existing western span would be replaced by a Retained Soil System (RSS) embankment/header wall that would continue over the concrete arch and up to the abutment of the 15 m long simply support span. The 15 m span over the CNR tracks would be supported on RSS wall false abutments at both the west and east abutments.

Hwy 34 - Rigid Frame (20m)



This option for the replacement of the Highway 34 Overpass considers replacement of the existing rigid frame with a similar reinforced concrete rigid frame. The new rigid frame would be skewed at 9˚± to Country Road 17 and have a span of 20 m ±. The rigid frame will provide sufficient vertical clearance over Highway 34 without the need for modifications to the roadway profile.

Hwy 34 - Simple Span (34m)



This option considers the replacement of the existing rigid frame with a single 34 m span structure with a 9˚± skew. The longer span will result in a deeper superstructure that may require modifications of the vertical profile on Country Road 17 by approximately 0.3 m ±. Offsetting the new abutments will create more space for potential future widening of the Hwy 34 roadway and will

also facilitate the use of different superstructure types including steel and pre-stressed concrete girders.

Table 1 – Preliminary Screening - Advantages and Disadvantages of Structural Alternatives

Alt.	Advantages	Disadvantages
Single Bridge Alternatives		
3 Span Continuous *(40-60-40)*	• Least amount of substructure elements of the single bridge alternatives • Structurally efficient and aesthetically pleasing span configuration	• County Rd. 17 roadway profile raise by 0.5-0.8 m to maintain vertical clearances requires additional roadway works • Significant cost increase associated with replacing the embankment with a bridge structure (25-35% increase in superstructure area) • Increased future maintenance costs
4 Span Continuous *(38-34-34-34)*	• Less substructure elements	• County Rd. 17 roadway profile raise by 0.2-0.5 m to maintain vertical clearances requires additional roadway works • Significant cost increase associated with replacing the embankment with a bridge structure (25-35% increase in superstructure area) • Increased future maintenance costs
5 Span Continuous *(20-25-30-35-30)*	• Minimal impact on County Rd. 17 roadway profile	• High number of substructure elements • Uneven span arrangements • Significant cost increase associated with replacing the embankment with a bridge structure (25-35% increase in superstructure area) • Increased future maintenance costs
Multi-Bridge Alternatives		
Hawkesbury 2 Span Continuous *(34-30)*	• Minimal impact on County Rd. 17 roadway profile • Less substructure elements • 25-35% less superstructure area than single bridge alternatives	• Unbalanced span configuration
Hawkesbury 3 Span Continuous *(16-24-24)*	• Minimal impact on County Rd. 17 roadway profile • 25-35% less superstructure than single bridge alternatives	• Higher number of substructure elements

Table 1 – Preliminary Screening - Advantages and Disadvantages of Structural Alternatives		
Alt.	**Advantages**	**Disadvantages**
Hawkesbury Precast Concrete Arch & CNR Span *(20-15)*	• Minimal impact on County Rd.17 roadway profile • Minimized structural costs • Concrete arch may be constructed prior to existing structure removal	• Significant excavation at existing east abutment required to install RSS false abutment. • Significant engineered backfill required for RSS walls
Hwy 34 Rigid Frame *(20)*	• Minimal impact on County Rd. 17 roadway profile • 35% less superstructure than single bridge alternatives	• Elements are cast-in-place (not prefabricated) • Reduced construction vertical clearance due to formwork/falsework
Hwy 34 Simple Span *(34)*	• 25% less superstructure than single bridge alternatives • Allows for future widening of Hwy 34	• County Rd. 17 roadway profile raise of 0.3 m to maintain vertical clearances requires additional roadway works

2.3. Preliminary Screening Discussion

In general, the single bridge alternatives will require structures between 25% and 35% longer than the multiple bridge alternatives. This increase in bridge area is anticipated to translate into a similar increase in overall construction costs.

Comparing the single bridge alternatives, the 3 span and 4 span options both require roadway profile modifications; however, the 3 span continuous option has the more efficient span configuration and has less substructure elements. The 5 span option increases the number of substructure elements required but eliminates the need for significant roadway profile modifications to meet vertical clearances over the CNR tracks and Hwy 34.

Although the single bridge options do not appear to be cost efficient, one single bridge alternative shall be carried forward for further development such that it can be compared and contrasted with the other options. The 3 span single bridge alternative will be carried forward for further consideration.

Looking at the multi-bridge options, the 2 span continuous and the 3 span continuous options for the Hawkesbury structure have similar advantages and disadvantages; however, the 3 span continuous option will have higher cost associated with the additional substructure elements. The 3

span continuous option for the Hawkesbury structure has therefore been eliminated from further consideration.

All other multi-bridge options have been considered to warrant further development as they present unique advantages and disadvantages that are difficult to account for with only a preliminary screening. The following span configurations/bridge combinations will be carried forward for further development:

Alternative 1: Single Bridge - 3 span continuous (40m, 60m, 40m)

Alternative 2: Hawkesbury Precast Concrete Arch & CNR Span (20m, 15m) & Hwy 34 Rigid Frame (20m)

Alternative 3: Hawkesbury 2 span continuous (34m, 30m) & Hwy 34 Simple Span (34m)

The multi-bridge alternatives have been presented in a combined manner due to staging considerations discussed in the following sections; however, any combination of the individual bridges is considered feasible.

3. DEVELOPMENT OF STRUCTURAL ALTERNATIVES

In this section, Alternatives 1 to 3 are explored and compared in more depth. Preliminary general arrangement drawings for each alternative are presented in APPENDIX A. The general arrangement drawings depict the structures with the preferred alignment and lane configuration discussed in Section 5.

The following key criteria were considered when comparing the structural alternatives:

- Vertical and horizontal clearance to CNR tracks;
- Vertical clearance over Hwy 34;
- Horizontal and vertical alignment of Country Road 17;
- Impact on existing utilities;
- Constructability;
- Durability; and
- Cost.

The following sections provide a detailed description of the structural alternatives, cost estimates for each alternative, and discussion on the recommended alternative.

3.1. Description of Structural Alternatives

Alternative 1 - 3 span continuous (40m, 60m, 40m)

Applicable superstructure types considered for this configuration are steel I-girder, steel box girder or cast-in-place post tensioned concrete. Continuous slab-on-steel structures can provide a high span to depth ratio (i.e. reduced structure depth) that will minimize the adjustments to the roadway profile on County Rd. 17. For spans of this length, steel girders are also easier to fabricate, transport and install than concrete sections. Cast-in-place post tensioned concrete would require

extensive formwork/false work to construct which would be complicated by the presence of Hawkesbury Creek and the CNR tracks. A slab-on-steel type structure has therefore been considered for preliminary comparison purposes.

Based on a maximum span to depth ratio of 31 for continuous steel girders (I-girders or box girders), the minimum superstructure depth would be about 1.9 m. The roadway profile will have to be raised approximately 0.69 m in order to maintain the required clearance over the CNR tracks and Hwy 34. Horizontal clearances between the structure and the CNR tracks will be maintained or improved upon.

During construction, the large spans may require temporary supports/bents during erection of the superstructure. Due to the length of the spans, steel box girders are considered more economical than steel I-girders; however, I-girders would be more practical if the structure is to be staged in halves. Roadway protection systems will also be required at multiple locations in order to install substructure elements if the structure is staged in halves.

Based on preliminary foundation design input provided by Golder Associates Ltd. (Golder), bedrock elevations at the existing Hawkesbury structure vary between 43.9 m and 47.6 m. Preliminary foundations considered feasible for the 3 span continuous structure are spread footings at the piers founded on bedrock and perched abutments with caissons/piles socketed into/driven to bedrock.

As a result of the proposed east pier location, the Enbridge gas main would have to be relocated. The underground Hydro One conduit would also have to be relocated in order to install the east abutment. A 400 mm watermain that passes under the east approach of the Hwy 34 structure is offset approximately 25 m from the edge of Hwy 34. The watermain is not anticipated to be impacted however; it should be protected during construction as required.

The total length of the bridge for this alternative is approximately 140 m, which is approaching the maximum acceptable bridge length for which semi-integral or integral abutment configurations can be considered (150 m as per MTO Semi-Integral and Integral Abutment Manuals). It is recommended that expansion joints be used to accommodate anticipated movements of the structure.

As established in the preliminary screening, the costs for the single bridge described in Alternative 1 come at a premium of between $2.5M and $4.0M compared to the multi-bridge alternatives outlined in Alternatives 2 and 3.

Alternative 2 - Hawkesbury Precast Concrete Arch & CNR Span (20m & 15m) & Hwy 34 Rigid Frame (20m)

Alternative 2a - Hawkesbury Precast Concrete Arch & CNR Span (20m & 15m)

This alternative presents the minimum feasible structure spans for crossing Hawkesbury Creek and the CNR tracks. Vertical clearance over the CNR tracks is not an issue in this alternative due to the short span over the tracks (15 m). Horizontal clearances to the centerline of the tracks respect the 5.486 m minimum required.

Preliminary design has considered a precast concrete arch with a span of 20 m supported on shallow foundations for the span over Hawkesbury Creek; however, confirmation of the required

hydraulic opening will be required should this alternative be pursued. RSS head walls and retaining walls will retain engineered backfill placed over the concrete arch to create the highway embankment.

As discussed in the preliminary screening, the 15 m span over the CNR tracks would be supported on RSS wall false abutments at both the west and east abutments. The false abutments will be composed of vertical caissons/piles socketed into/driven to bedrock with an RSS wall facing. The structure can be designed as either a semi-integral or integral structure type using steel I-girder or side-by-side pre-stressed box girders. Cast-in-place superstructures were not considered practical due to the requirement for formwork/falsework over the CNR tracks. Side-by-side pre-stressed box girders have been assumed for preliminary comparison purposes.

During construction, the concrete arch and a significant portion of the RSS walls to the west of the CNR tracks can be installed before removals of the existing structure are required. It may be possible to construct the RSS walls around the existing piers such that removal of the existing piers columns is not required. If staged replacement of the structure in halves is the preferred staging method, staged removal of the existing east reinforced concrete counterfort wall will require a robust roadway protection system (8 to 10 m in height). Roadway protection systems of this size are considered feasible to install; however, the installation of such a system will be technically challenging and add additional cost to the staging operations.

Alternative 2b - Hwy 34 Rigid Frame (20m)

This alternative considers replacement of the Highway 34 Overpass with a similar concrete rigid frame with a span of 20 m. A rigid frame type structure will provide sufficient vertical clearance above Hwy 34 without major changes to the existing roadway profile of County Rd 17. Horizontal clearances from the edge of roadway to the abutment face will be improved by the increased span of the new rigid frame; however, the abutment faces will remain in the splash zone and therefore the use of premium reinforcing steel is recommended.

The new rigid frame would be founded on bedrock at a similar elevation as the existing rigid frame. Preliminary foundation design input provided by Golder indicates that competent bedrock lays between the elevations of 50.8 m and 55.3 m. Excavation to bedrock to found spread footings may require the removal of up to 5 m of soil.

During construction, the vertical clearance above Highway 34 will be reduced to facilitate the installation of the formwork/falsework required to construct a cast-in-place rigid frame. Reduced vertical clearance during construction may require implementing detours for truck traffic.

If staged construction of the structure in halves is pursued, robust roadway protection systems at both abutments will be required, increasing the cost of staging operations. The original design drawings for the existing rigid frame are not available making it impossible to evaluate the existing structure in a staged configuration. Although rigid frames are inherently redundant structures, removal of half of the structure will involve some risk to the traffic being maintained on the remaining half of the structure.

An Enbridge gas main, an underground Hydro One conduit and an underground Bell utility conduit will need to be protected or relocated during construction. The 400 mm watermain is not anticipated to be impacted however; it should be protected during construction as required.

Alternative 3 - Hawkesbury 2 span continuous (34m, 30m) with Hwy 34 Simple Span (34m)

Alternative 3a - Hawkesbury 2 span continuous (34m, 30m)

This alternative considers the replacement of the Hawkesbury Creek structure with a two span continuous steel I-girder structure. The steel I-girder superstructure can be proportioned to minimize adjustments to the County Rd. 17 roadway profile needed to achieve the required vertical clearance over the CNR tracks. The design of shallow depth steel superstructures will often be governed not by load capacity, but by vibration criteria set out in the Canadian Highway Bridge Design Code (CHBDC). Should this alternative be pursued, vibration criteria should be reviewed during preliminary design to insure that the required depth of the structure meets the vertical clearance requirements as well as the vibration requirements.

Preliminary foundations considered for this alternative are spread footings at the pier founded on bedrock and perched abutments with caissons/piles socketed into/driven to bedrock. Semi-integral or integral configurations at each abutment are recommended to increase the long term durability of the structure.

If staged construction of the structure in halves is pursued, the east abutment can be constructed behind the existing counterfort retaining wall eliminating the need for an 8 to 10 m high roadway protection system. Excavation required for the east abutment will be reduced and the counterfort retaining wall can be removed after both stages of construction of the new bridge are complete.

Alternative 3b - Hwy 34 Simple Span (34m)

This alternative for the Hwy 34 Overpass considers a single span structure with a span of 34 m. In order to maintain vertical clearance requirements at Hwy 34, a raise in the roadway profile of 0.30 m ± will be required. Feasible superstructure types include steel I-girders and pre-stressed concrete girders. Pre-stressed concrete girders have been assumed for preliminary design. Semi-integral or integral configurations at each abutment are recommended to increase the long term durability of the structure.

Preliminary foundations considered for this alternative are perched abutments with caissons/piles socketed into/driven to bedrock with reinforced concrete toe/retaining walls at the edge of the sidewalks/roadway. There may be opportunity to repurpose the existing legs or foundation of the rigid frame into the retaining walls; however, determining the structural feasibility of this would require further analysis that is not possible due to the unknown structural details of the existing rigid frame. A common detail at the base of rigid frames constructed in the same era (1950's and 1960's) was to create a pinned connection that would not transfer moment to the footings. If this detail was used in the existing Hwy 34 rigid frame, it is not recommended to repurpose the legs of the rigid frames.

If staged construction of the structure in halves is pursued, offsetting perched abutments behind the existing rigid frame permits the installation of the new foundation elements before removal of the existing structure. Perched foundations will reduce the excavation required as well as reduce the size of the roadway protection systems necessary to complete the work. In addition, full removal of the existing concrete footings will be avoided. Removal of the structure in halves will involve some risk to the traffic being maintained on the remaining half of the structure.

An Enbridge gas main, an underground Hydro One conduit and an underground Bell utility conduit will need to be protected or relocated during construction to accommodate the new structure foundations. The 400 mm watermain is not anticipated to be impacted however; it should be protected during construction as required.

3.2. Estimated Cost of Structural Alternatives

To assist in determining the preferred structure alternative, preliminary cost estimates for each of the structures have been developed. The cost estimates include structural items only (i.e. no highways costs or costs for utility relocation) and are based on the assumed structure types and span configurations discussed in Section 3.1 above. It should be noted that the cost estimates have been developed only for the preferred roadway alignment and two-lane cross-section discussed in Section 5. A 20% contingency has been included in the estimates. A summary of the estimated costs for each alternative is presented in Table 2 with detailed breakdowns of preliminary cost estimates included in APPENDIX D.

Table 2 – Preliminary Structural Cost Estimates

Alternatives		Estimated Cost	Combined Cost
Alt 1	*3 Span Continuous*	$8,435,000	$8,435,000
Alt 2	*2a - Hawkesbury Precast Concrete Arch & CNR Span*	$4,068,000	$6,781,000
	2b - Hwy 34 Rigid Frame	$2,713,000	
Alt 3	*3a - Hawkesbury 2 span continuous*	$4,121,000	$6,315,000
	3b - Hwy 34 Simple Span	$2,194,000	

3.3. Discussion of Structural Alternatives

In order to facilitate comparison of the structural alternatives, a summary of their key attributes has been complied in Table 3.

Upon review of the preliminary cost estimates, the single bridge alternative (Alternative 1) can be seen to have a cost premium of between $1.65M and $2.1M compared to the multi-bridge alternatives (25% to 33% increase in structural costs). As the single bridge alternative does not provide any significant advantages that warrant the additional cost, Alternative 1 has been eliminated from further consideration.

Table 3 – Structural Alternatives Comparison							
Alt	**Length (Spans) (m)**	**Bridge Area (m^2)**	**Estimated Structural Cost**	**Grade Raise on CR. 17**	**Utilities Impact**	**Semi-integral or integral abutment**	**Constructability**
Single Bridge Alternative							
1	140 (40-60-40)	1830	\$8.44M (\$4,600/m^2)	Required 690 mm ±	-Relocate Hydro -Relocate Gas -Protect watermain	Feasible but not recommended	- Large spans may require temporary bents during erection - Removal of existing embankment required
Multi-Bridge Alternatives							
Hawkesbury & CNR							
2a	20 & 15	455	\$4.07M (\$9,000/m^2)	Not Required	N/A	Feasible	- Concrete arch and large portions of the RSS wall can be fully installed before existing structure removals - 8m to 10m high roadway protection systems required to replace east abutment
3a	64 (34-30)	830	\$4.12M (\$5,000/m^2)	Not Required	N/A	Feasible	- Vibration concerns for shallow steel structures - Perched abutment eliminates the requirement for large roadway protection schemes - Existing abutment footings may be left in place
Highway 34 Overpass							
2b	20	285	\$2.71M (\$9,500/m^2)	Not Required	-Relocate Hydro -Protect/Relocate Gas -Protect Bell -Protect watermain	N/A	- Reduced vertical clearance during construction may require detours for truck traffic - Half-half staging structure configuration cannot be properly evaluated - Large roadway protection systems required for half-half staged construction
3b	34	442	\$2.19M (\$5,000/m^2)	Required 300 mm ±	-Relocate Hydro -Protect/Relocate Gas -Protect Bell -Protect watermain	Feasible	- Perched abutment eliminates the requirement for large roadway protection schemes - Existing footings may be left in place or repurposed to support retaining walls at the edge of the roadway

Alternative 2 and 3 have comparable price points with Alternative 2 having approximately 7% higher structural costs. The structures described in Alternative 2 will require complicated roadway protection systems to be install in order to accommodate the preferred alignment of County Rd. 17 (see Section 5). In addition, the construction of a rigid frame over Highway 34 may require truck traffic to be detoured around the site. The structures outlined in Alternative 3 are less expensive and can better facilitate staged construction by utilizing the existing structures to retain the embankments instead of large protection systems. Based on the recommended highway alignment and the discussion presented herein, the 64 m two span continuous structure over the Hawkesbury Creek and CNR tracks and the 34 m single span over Hwy 34 (Alternative 3) is the recommended structural configuration due to lower cost and the advantages it presents when considering staged construction.

4. CONSTRUCTION STAGING & ROADWAY ALIGNMENT (4 Lane Cross Section)

Included in this section is an exploration of possible staging and traffic management alternatives that could be used with each structural alternative. The section concludes with a discussion on the preferred staging and roadway alignment configuration.

The following assumptions and objectives were used when reviewing staging and alignment alternatives:

- Maintain two lanes of traffic, one in each direction, along County Road 17, and all ramp access in one form or another. Preliminary analysis showed that temporary signalized single lane configuration was not feasible due in large part to the length between stop bars and the lengthy all red time associated with that distance.
- Carry out both structure replacements at the same time with same lane configuration.
- Structures are being replaced by two independent, symmetric structures.
- Final shoulder widths will be improved to 2.5 m throughout the construction zone. A reduction in shoulder width over the structures and along the speed change lanes is not anticipated to change the recommendations in this memo.
- Alignment shifts occur to the north of the existing highway to avoid significant impacts to the creek (which has a bend directly south of the highway), as well as ensuring any reductions to the interchange geometry occur to the entrance loops as opposed to exit loops.
- Lane shifts and transitions take place using appropriate curvature and avoid direct tapers in order to maintain safe free-flow conditions for traffic throughout construction.
- All staging alternatives will require temporary construction roads to access the west bank of the creek.
- All staging alternatives will require Temporary Limited Interests (TLI) for access purposes.
- Property limits are not known at this time, and have been interpolated from prior contracts to run approximately along the Hydro lines to the north.
- Design speed of County Road 17 is posted +20 (110km/h).
- Utility conflicts discussed in this section are in addition to issues discussed previously with regards to the structures.
- Highway 34 staging will consist of a single lane in each direction regardless of alignment or structure alternative chosen.

Multiple alignments were reviewed for the replacement of the existing Hawkesbury and Hwy 34 structures, and the three considered most feasible are discussed below. A brief overview of each alternative is discussed, followed by a review based on key design and construction aspects.

Refer to APPENDIX B and APPENDIX C for construction staging and alignment drawings including proposed configuration plans and sections.

4.1. Potential Alignments

Alignment A – Minor Alignment Shift (2 m)

In this option, the existing horizontal alignment and roadway will be utilized as much as possible. A slight shift of 2 m is required in order to accommodate the staging of the structure replacements.

The staging for this alternative involves shifting both lanes to the southernmost limits of the structure while the replacement of the structures takes place in a half-half construction configuration. Restrained Temporary Concrete Barrier (TCB) will be used to separate construction from traffic; with traffic being transitioned using back-to-back curves over 200 m and 300 m to the west and east respectively. Lane and shoulder widths will be reduced across the structure, with a single 3.5 m lane in each direction with 0.3 m shoulders. The NS-W and W-NS ramps be temporarily realigned and reconfigured from a direct on/off ramp configuration to independent T-Intersections.

Prior to structural work beginning, advanced 'pre-staging' work will be required in order build the roadway platform necessary to accommodate staging traffic. Due to the lack of existing pavement width beyond the limits of the auxiliary lanes, this work will need to be done using single lane flagged operations. The area west of the structures also requires that roadside safety barrier be maintained at all times, further complicating the pre-stage work.

This alternative has the least impact to utilities and property. It is estimated that there will be no permanent property requirements. In addition to utility conflicts discussed in the structural section, there is only one Hydro pole that will potentially require relocation.

The final configuration of the highway for this alternative will closely match the existing conditions with a resultant shift of the centreline of the roadway by 2 m. Minor changes to the NS-W and W-NS ramp alignments are required in order to tie into the new highway alignment.

The proposed roadway alignment to the west extends the existing R-850m curve slightly so that an R-5000m reverse curve can connect to the shifted structure alignment without producing any additional super elevation and providing a smooth transition for traffic. The alignment to the east uses back to back R-5000m curves in order to maintain a smooth transition with a normal crown cross-section, and reduced ramp transition lengths.

In order to accommodate the transition of traffic for staging purposes, portions of the highway will be required to be overbuilt beyond the limits required for the final configuration. This overbuild will result in an increased length to the auxiliary lanes to the west, and an increase shoulder width to the east.

This alternative is the most cost effective approach (maintaining the current 4 lane cross section at the structures); with a roadway construction cost approximately $2M less than Alignment B, and $1.2M less than Alignment C.

Alignment B – Full Alignment Shift (19m)

In this option, the centerline of the existing structures would be offset by 19 m and a full realignment of the highway would take place. The shift is determined by the final cross-section and an appropriate buffer to allow full offline construction of the new structure.

The staging for this alternative has the least impact to traffic and is therefore considered the safest. Traffic would remain in its existing configuration for the majority of the construction operations, as most of the realigned highway can be built completely offline and allows for the new structures to also be built offline in their entirety.

Minor impacts to traffic would occur while the realigned highway is tied into existing, which would likely occur in a series of short duration flagging operations and shifting of traffic from existing to new facilities.

Staging for this alternative also requires no overbuild or temporary ramps to accommodate traffic, and no pre-stage widening. Additionally the temporary access roads required to access west of the creek could be incorporated into the overall final highway embankment.

This alternative has the most significant impact in terms of property requirements. It is estimated that there will be permanent property requirements west of Highway 34 to accommodate the new embankment footprint and ditching requirements, as well as property north of the realigned E-NS ramp.

Utility impacts for the full highway realignment alternative include the relocation of all the Hydro poles adjacent to County Road 17 within the limits of the shift (six), as well as potential conflicts with the gas line that runs east-west along the north side of the highway.

The final configuration of the highway for this alternative requires realignment of all four ramps, as well as significant changes to highway curvature at the east and west limits. The alignment to the west extends the tangent on the structure until an R-850m curve can be used to replace the existing curve. This method was used to prevent excessive curvature and a roller coaster effect at the structure approach, and allows for super-elevation correction to the existing sub-standard curve. The limits of the realignment extend approximately 650m west beyond the new bridges.

The east portion of the alignment utilizes back to back R-5000m curves with a normal crown in order to provide a smooth transition and prevent an excessive swerving motion of traffic. Additionally, this allows for smooth on/off ramp transitions. The limits of the realignment extend approximately 600m east beyond the new bridges.

The existing ramp terminals appear to follow standards for right turn lanes at channelized intersections, and not standard interchange entrance/exit terminals. The realigned interchange ramps maintain similar curvature to what exists, with minor changes to inner loop radii in order to tie-in and avoid impacts at the intersections on Hwy 34.

This alternative is the most expensive with a roadway construction cost approximately $2M and $0.8M more than Alignments A and C, respectively.

Alignment C – Intermediate Alignment Shift (12m)

In this option, the centerline of the existing structures would be offset by 12m and a full realignment of the highway would take place. This shift is determined by the final cross-section and buffer to allow the new structures construction, as well as staging the removal limits in conjunction with existing girders.

The staging for this option is a mix between the Minor and Full shift alternatives. The initial staging configuration will be the same as Alignment A, including pre-staging work to accommodate traffic. The amount of overbuild is significantly less as it is only required on the south side, however it will not be incorporated into the final conditions.

The second stage will be a series of short duration flagging operations similar to, but more substantial than, Alignment B. This is possible because this option allows the full construction of the new structures to be done in one stage.

This alternative will have the same impacts to the Hydro poles along the north side of the highway as Alignment B, however there will not likely be any conflicts with the gas line that runs parallel to County Rd 17 on the north side.

As property limits are only estimates, it is unknown whether permanent property will be required, as the footprint of the roadway is very close to the estimated ROW. In order to be conservative, it is assumed that permanent property will be required.

The final configuration and alignments follow the same principles as Alignment B for both the highway and interchange, with slightly less impacts and shorter limits due to the reduced offset of the structures. Limits of the highway realignment extend approximately 600m to the east and west beyond the new bridges.

This option has a median cost in terms of roadway construction, at approximately $1.2M more than Alignment A, and $0.8M less than Alignment C.

4.2. Discussion of Construction Staging & Highway Alignment

The above alignment alternatives are based on maintaining the current configuration of the County Road 17 and the associated interchange. If the current configuration is maintained then, Alignment A would be the preferred alternative from a staging and roadway standpoint. The significant cost savings, reduction in property requirements and impacts to utilities are believed to outweigh the more complex highway staging of Alignment A. The cost savings associated with Alignment B's compromise between the other two approaches are not substantial enough to be recovered by the savings associated with building the structure in a single segment.

Following the development of the above staging alternatives, a constructability meeting was held to review the staging alternatives from a construction perspective. During the constructability review meeting, the purpose of the interchange style connection between Highway 34 and County Road 17 was called in to question, along with the possibility of a reduction in structure width to accommodate two lanes instead of four. MMM's view is that this interchange was likely built for two reasons, one being that the grade separation over the CNR line directly west prevents an 'at-grade' intersection between these two roadways. The second possibility being that County Road 17 was originally part

of the Trans-Canada highway and would one day require expansion, which is no longer the case. The interchange layout as it stands does not follow a particular set of geometry standards, and is not technically required based on roadway classification and traffic volumes.

5. REVISED INTERCHANGE CONFIGURATION OPTIONS

T-Intersection Option

In order to achieve a two lane structure cross-section, modifications are required to the County Road 17 westbound (WB) entrance terminal and eastbound (EB) exit terminal (Refer to APPENDIX C). The two exit/entrance terminals to the east can maintain existing conditions as free flow auxiliary lanes.

The entrance terminal for traffic heading west on CR17 will be replaced by a stop condition T-Intersection, modified slightly to minimize the risk of vehicles turning the wrong way on the roadway. In addition, the intersection would be signed accordingly to ensure vehicles are aware of which movements are allowed and which are not.

A preliminary traffic analysis was completed using 2013-14 volumes for Hwy 34 provided by MTO and 2015 volumes for CR 17 provided by the local municipality projected to 2018 construction year, and determined that the change in movement due to the required stop condition would result in an average delay of 10 seconds for this turn (LOS A), with minimal queuing as a large portion of peak hour WB traffic exits on the off-ramp to the east (See APPENDIX E for Traffic Analysis). Due to the straight flat nature of the roadway to the east of the intersection, adequate sight distance is available. The movement at the intersection would be restricted to right turns only, as noted above. Commercial traffic was considered in the analysis as was the impact on heavy trucks now required to come to a stop approaching CR17. The new T-intersection would meet the side road entrance requirements in OPSD 300.010.

The exit terminal for traffic heading east will be modified slightly by reducing the length of the speed change lane but maintaining the right turn taper with a parallel lane. This will allow vehicles to exit without impact or delay to the CR17 EB thru traffic. The right turn configuration follows MTO's Geometric Design Standards for Ontario Highways Table E.7.1, with a length that accommodates a 90km/h design speed. A portion of the lane development will occur on the structure itself in order to achieve the required length. This would be done by reducing the shoulder to 1m at the south-east corner, in order to accommodate the length required. It should be noted that the design does not meet the usual MTO method of posted +20 design speed (110km/h), however the curvature and super-elevation to the west only meets 90km/h design, and it is not uncommon for a county road to have a posted +0km/h design speed.

County Road 17 itself would require an alignment shift of approximately 8m in order to accommodate traffic during staging, and complete the structure(s) in one stage (See APPENDIX C for Typical Section Drawing). The overall footprint of the shift would be similar to Alternative A (2.0m shift) from the original four lane alternative, however it would be slightly wider in order to accommodate staging differences between the two and four lane configuration. The centerline location of a two lane cross-section relative to a four lane section results in the difference of the alignment's offset (8m vs 2m), while maintaining a similar footprint and staging approach (See Figures 5 & A5 in appendices).

The final alignment of CR17 follows the same principles as Alignments B and C. To the west, it extends the tangent on the structure until an R-850m curve can be used to replace the existing curve, while the east portion of the alignment utilizes back to back R-5000m curves with a normal crown. The selected geometry was chosen to avoid drastic curvature and provide a smooth transition between existing and new highway alignments.

For the 2 lane option the grading costs would be marginally increased over the 4 lane Alternative A due to the additional footprint requirements of the highway realignment; however these costs would be more than offset by the savings that come with building in a single stage, and the reduced structure size. It is estimated that the overall cost savings for reducing the structure size from four lanes to two would be approximately $3.0M, when compared to the preferred 4 lane structure and staging alternatives.

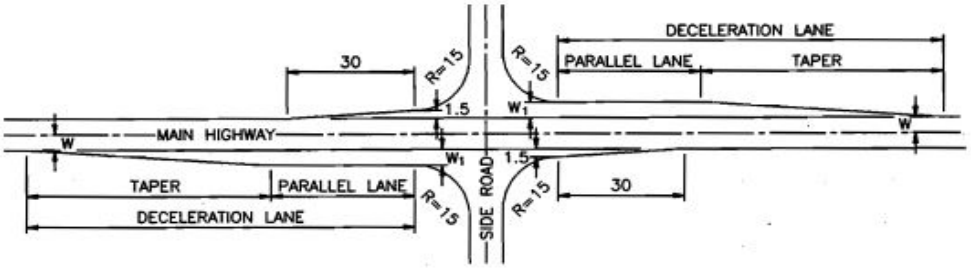


Figure E7–3

Right Turn Taper with Parallel Deceleration Lane Design

Highway Design Speed (km/h)	Length of Taper (m)	Length of Parallel Lane (m)	Total Length of Deceleration Lane (m)
50	40	20	60
60	50	30	80
70	60	45	105
80	70	60	130
90	75	70	145
100	80	85	165
110	85	100	185
120	90	110	200

Table E7-1

Right Turn Taper with Parallel Deceleration Lane Lengths
Flat Grades 2% or Less

Source: Geometric Design Standards for Ontario Highways, Chapter E, Page E7-2

Roundabout Option

An initial review of the connection between County Road 17 and the Highway 34 on and off ramps was also undertaken from a roundabout perspective.

Currently the two on ramps and two off ramps operate in a free-flow condition. The goal of modifying the interchange would be to eliminate the two speed change lanes to the west that result in 4 lanes structures at Hwy 34 and the CNR/Hawkesbury Creek. In theory the speed change lanes could be replaced with a roundabout located to the east of the structure. The resulting configuration would be a 4 leg roundabout, where County Road 17 comprises the east west legs (2 lanes), the eastbound off ramp comprises the south leg (single lane) and the westbound on ramp comprises the north leg (single lane).

Including the on and off ramp to the east within the roundabout is not logical as they are currently free flow and are not impacted by the change in bridge configuration, and adding this extra traffic to the roundabout does not have a benefit.

With two of the four legs of the roundabout operating as single lanes, the only advantage to this over the option presented above is that the westbound on movement does not need a stop control. In our opinion the benefit of eliminating the ramp stop condition does not outweigh the impacts to County Road 17 geometry and required speed reduction to navigate the roundabout safely.

6. SUMMARY

Based on the review of the alternatives for the replacement of the Hawkesbury Creek & CNR Overhead and Highway 34 Overpass structures developed herein, it is recommended that the existing structures be replaced by two new structures with a reduced 2 lane cross-section along a 8.2m shifted alignment. This alignment entails a shift north from the existing roadway alignment and will have a comparable highway cost to the 4 lane alternative, reduced property requirements and minimized impacts on utilities. The reduced cross-section to 2 lanes will minimize structural costs and the number of stages required to complete the work. The recommended replacement structure configuration is the 64 m two span continuous structure over the Hawkesbury Creek and CNR tracks and a 34 m single span over Hwy 34 (Alternative 3). The structures outlined in Alternative 3 can utilize the existing structures to eliminate the requirement for robust roadway protection systems and avoid the significant excavation required to remove the existing foundations. The estimated construction cost for the recommended alternative is $9.22M ($2.91M highways and $6.31M structural) Refer to APPENDIX D for cost estimates and comparisons.

Discussions with the MTO, the Town of Hawkesbury and the United Counties of Prescott and Russell are required to determine if the needs of all stakeholders are met with the preferred alternative.

Yours truly,
MMM Group Limited

Prepared by:

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Ottawa Bridge Department

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Project Manager
Ottawa Highways Department

APPENDIX A

Structural Alternative Drawings

NORTH FOR CONSTRUCTION

DISTRICT 42
CONT. No.
WP No.

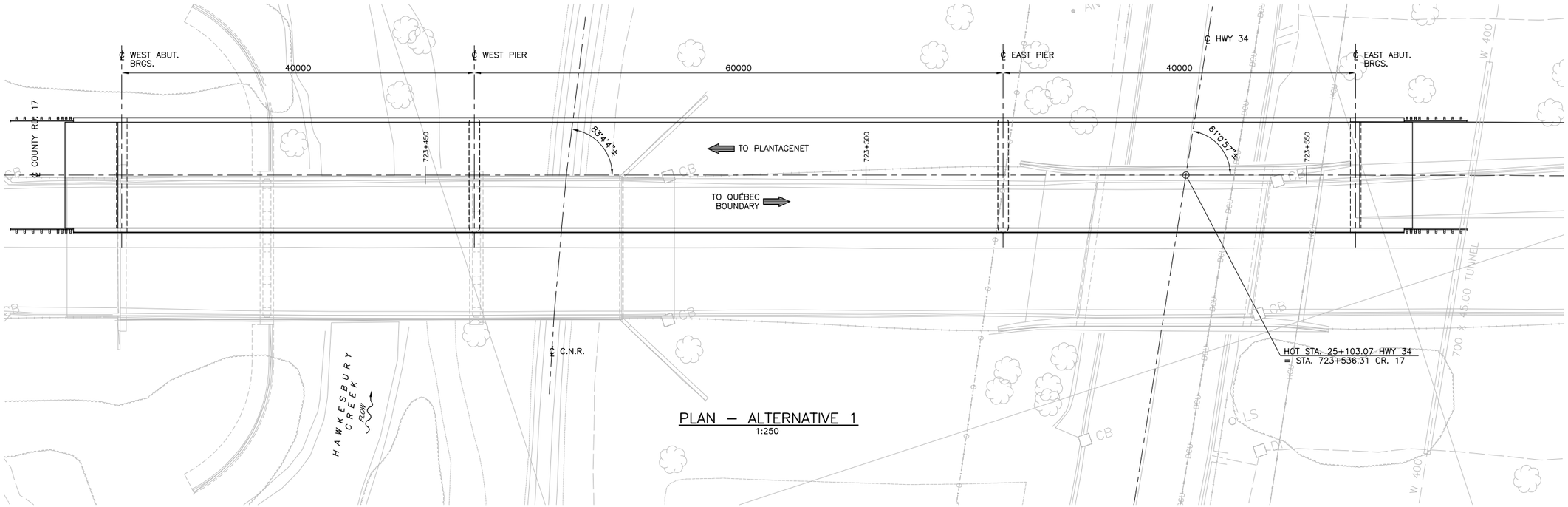
HAWKESBURY CREEK & CNR O/H AND HWY 34 O/P BRIDGE REPLACEMENT

ALTERNATIVE 1
GENERAL ARRANGEMENT

SHEET

MMM GROUP

METRIC



PLAN – ALTERNATIVE 1
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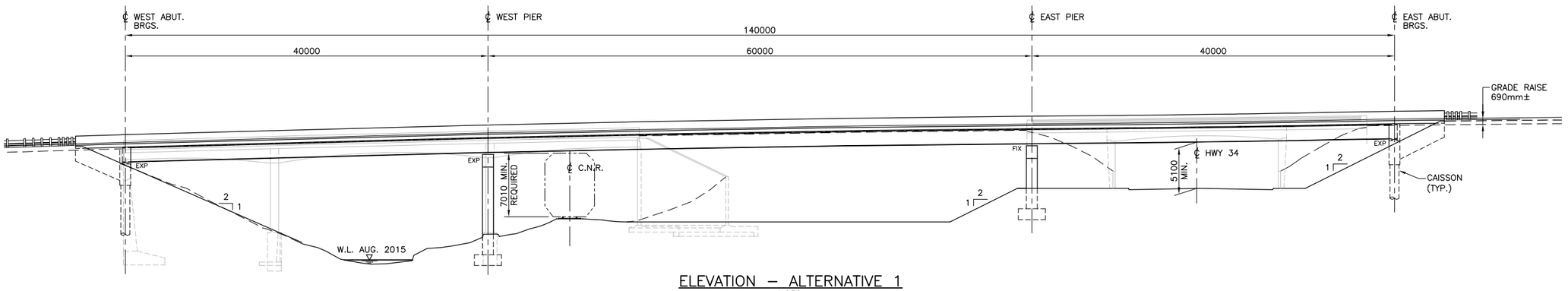

ELEVATION – ALTERNATIVE 1
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REVISIONS			DESCRIPTION

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MINISTRY OF TRANSPORTATION, ONTARIO PR-D-707 88-05

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DATE PLOTTED: 4/28/2017 1:53:26 PM BY: GREENANG

NORTH FOR CONSTRUCTION

DISTRICT 42
CONT. No.
WP No.

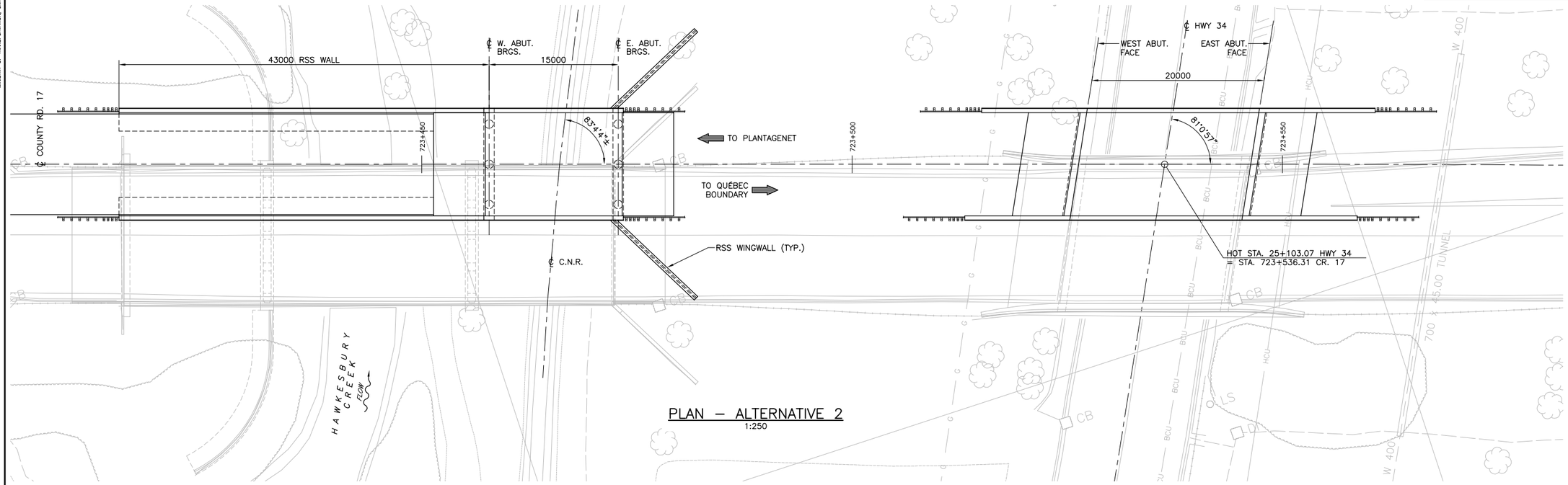
HAWKESBURY CREEK & CNR O/H AND HWY 34 O/P BRIDGE REPLACEMENT

ALTERNATIVE 2
GENERAL ARRANGEMENT

SHEET

MMM GROUP

METRIC



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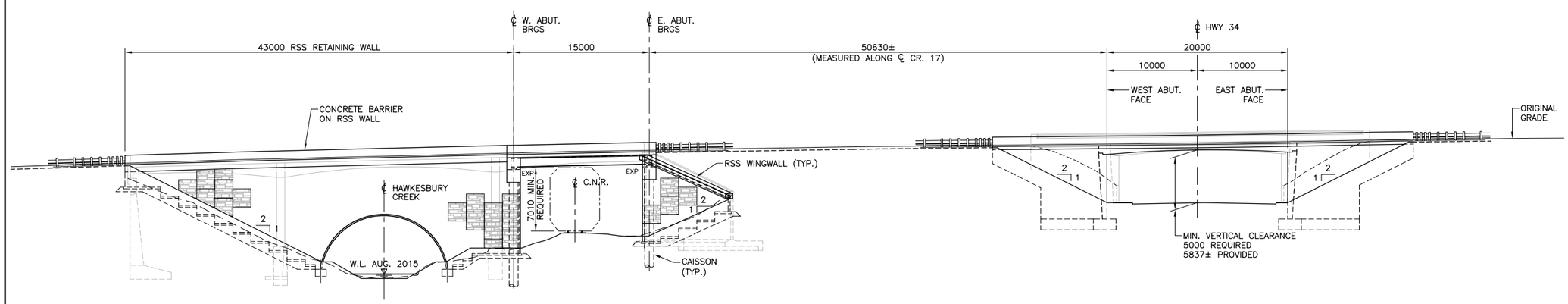

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DISTRICT 42

CONT. No.

WP No.

HAWKESBURY CREEK & CNR O/H AND HWY 34 O/P BRIDGE REPLACEMENT

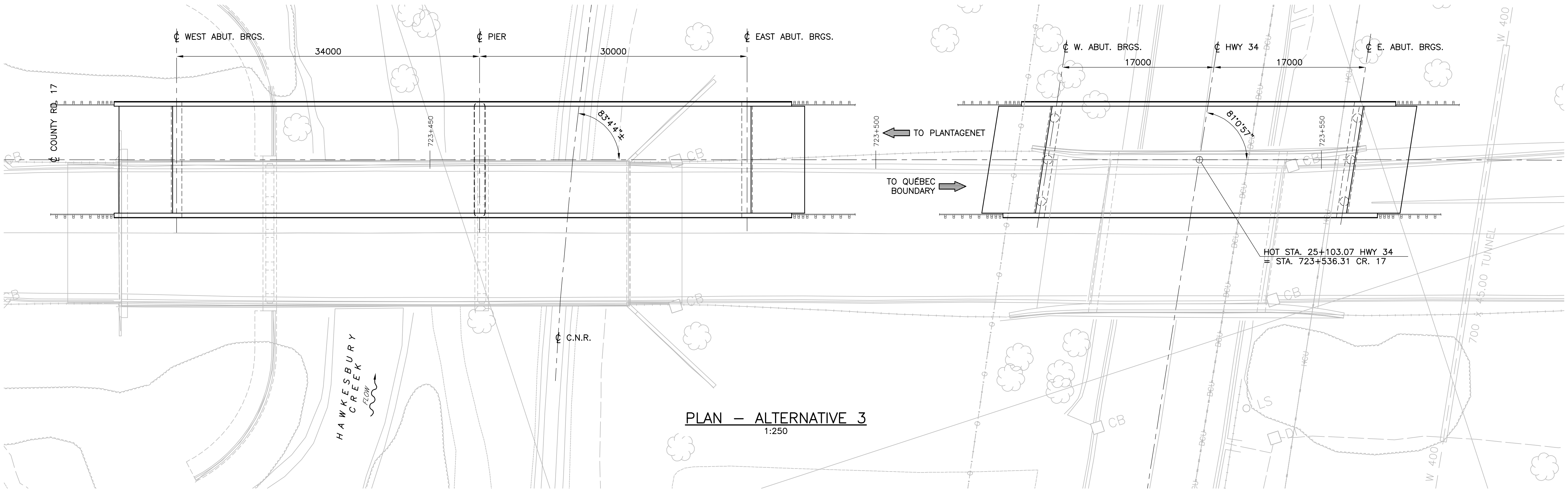
ALTERNATIVE 3 GENERAL ARRANGEMENT

MMM GROUP

SHEET

METRIC

NORTH FOR CONSTRUCTION



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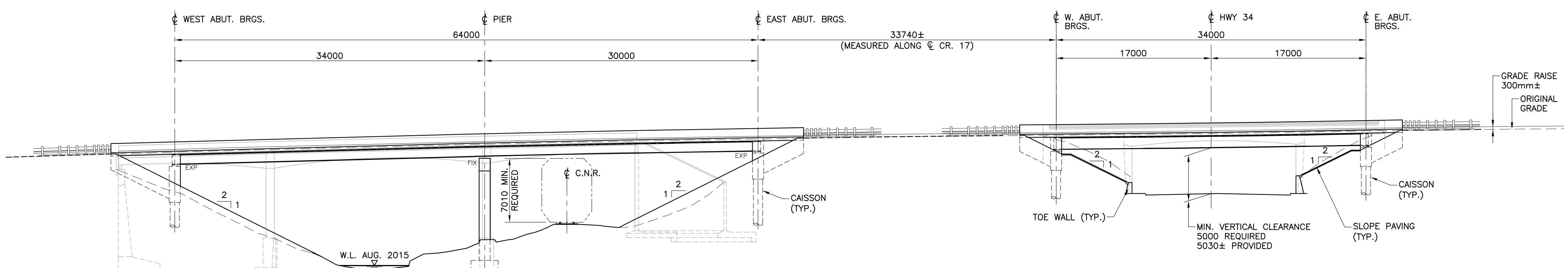

ELEVATION – ALTERNATIVE 3
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MINISTRY OF TRANSPORTATION, ONTARIO
PR-D-707 88-05
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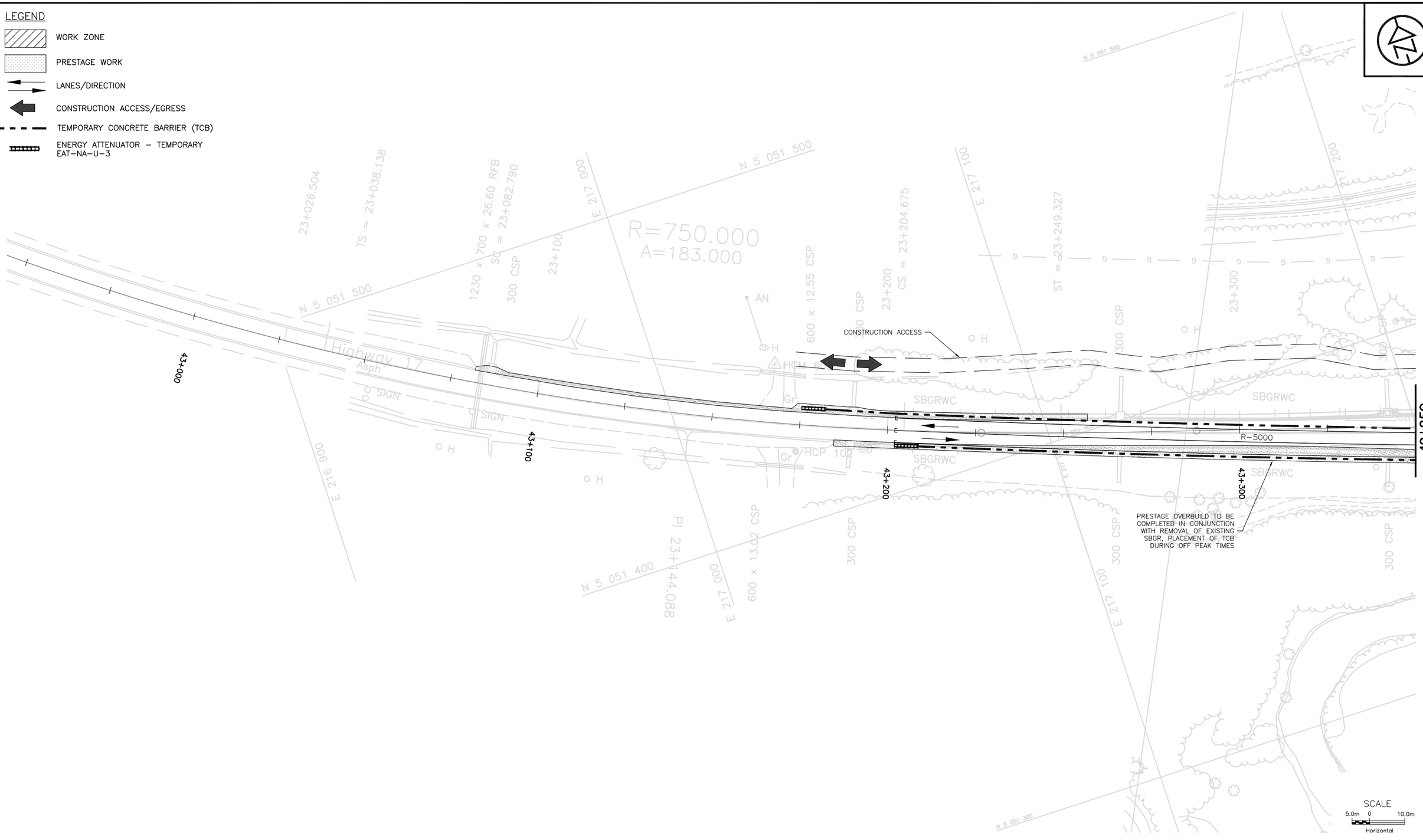
APPENDIX B

Construction Staging & Highway Alignment Drawings
Other Alternatives

LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3



MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT A - 2m SHIFT
STAGE 1

FIGURE
A1

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LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3

ACCESS OVER TRACKS REQUIRED TO REMOVE EXISTING PIER (AND CONSTRUCT NEW PIER DEPENDING ON STRUCTURAL OPTION)

SIGNIFICANT PROTECTION SYSTEM REQUIRD TO CONSTRUCT NEW ABUTMENT/REMOVE EXISTING ABUTMENT

43+350 43+400 43+500 43+600 43+700 43+750

R–5000

43+750 R–5000 43+800

SCALE
5.0m 0 10.0m
Horizontal

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT A - 2m SHIFT
STAGE 1

FIGURE
A2

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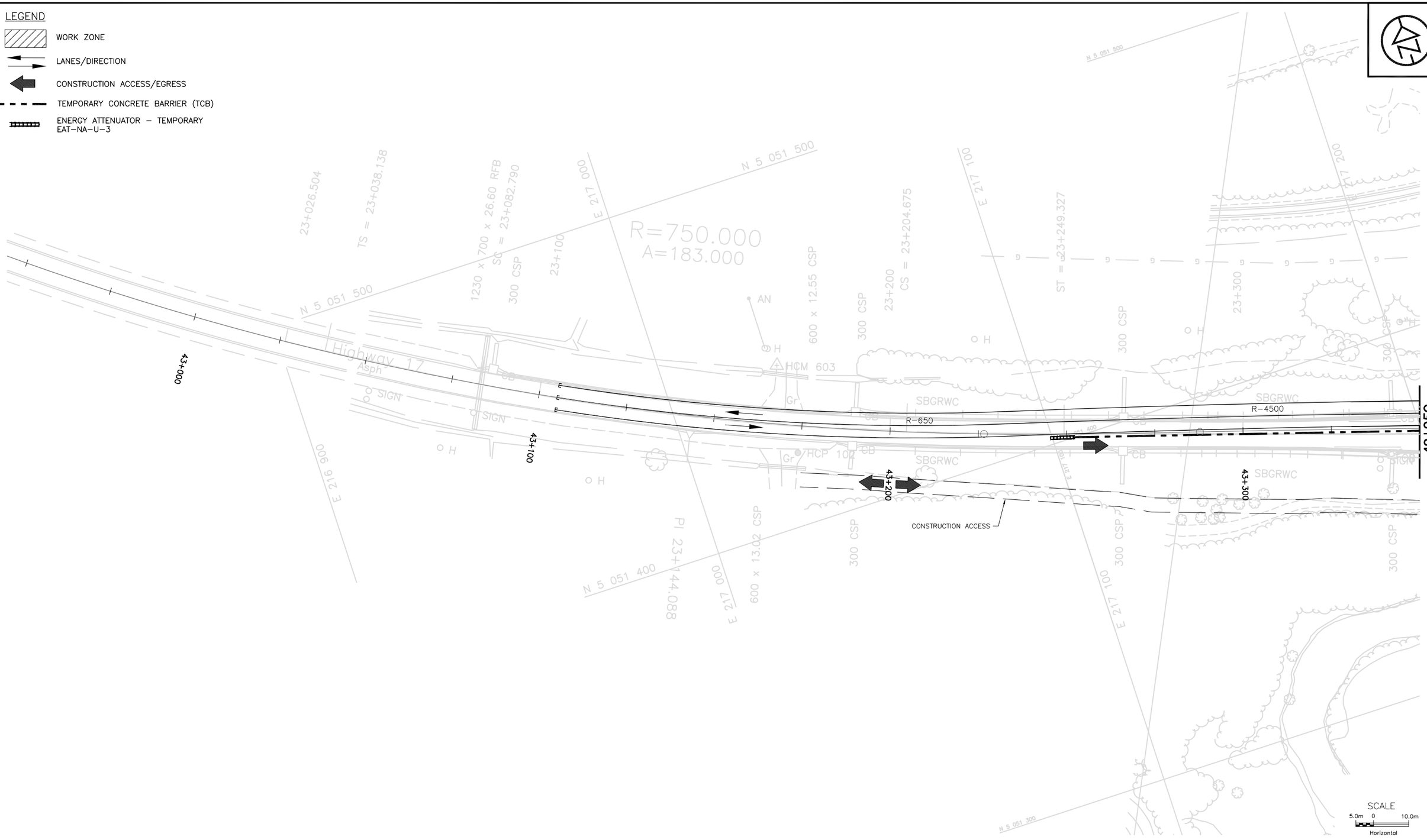
LEGEND

- WORK ZONE
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3



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MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT A - 2m SHIFT
STAGE 2

FIGURE
A3

LEGEND

- WORK ZONE
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3

43+350

43+400

43+500

43+600

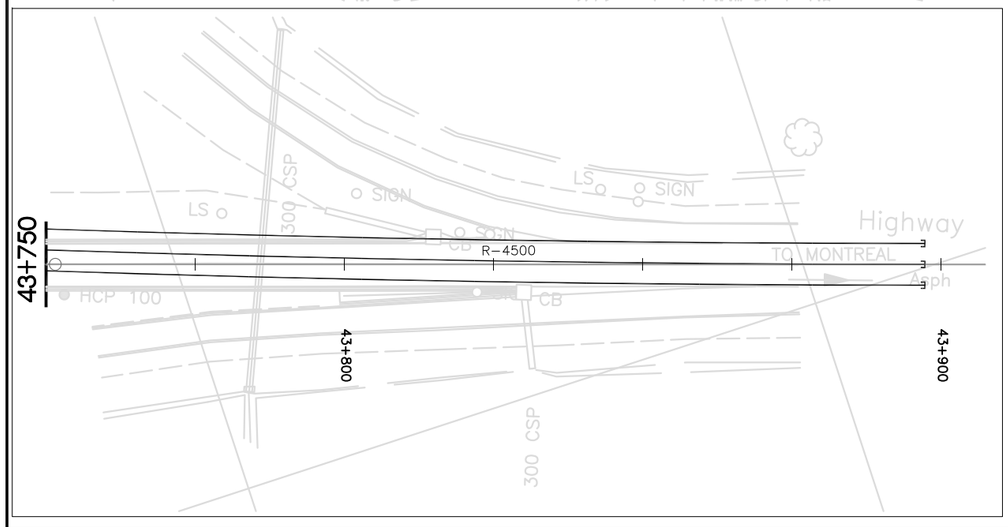
43+700

43+750

R–4500

ACCESS OVER TRACKS REQUIRED TO REMOVE EXISTING PIER (AND CONSTRUCT NEW PIER DEPENDING ON STRUCTURAL OPTION)

SIGNIFICANT PROTECTION SYSTEM REQUIRD TO CONSTRUCT NEW ABUTMENT/REMOVE EXISTING ABUTMENT



SCALE
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Horizontal

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT A - 2m SHIFT
STAGE 2

FIGURE
A4

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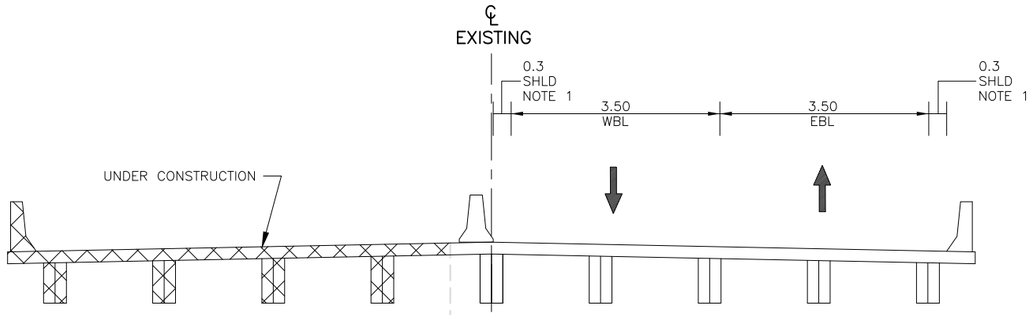
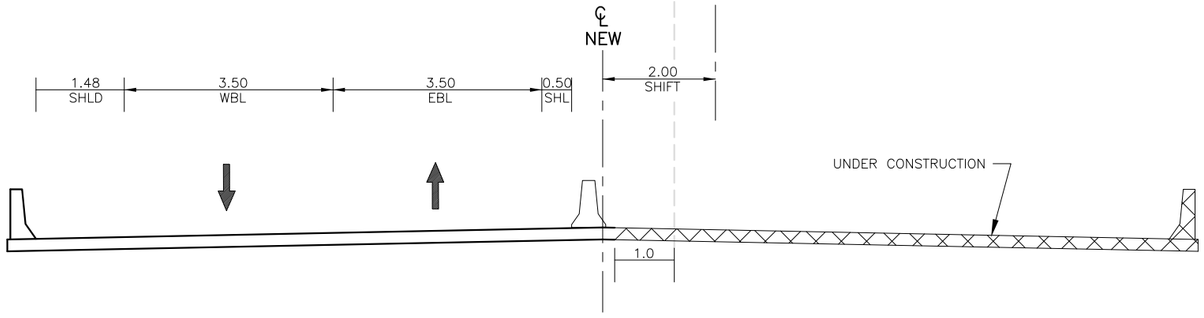
NOTE:

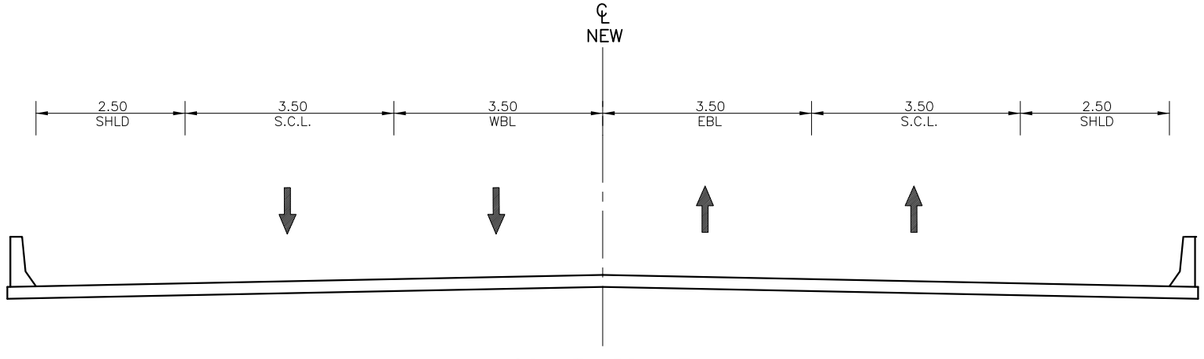
1. NARROW SHOULDERS REQUIRED TO ENSURE CONSTRUCTION JOINT BETWEEN GIRDERS 4 AND 5, OTHERWISE JOINT WOULD SHIFT TO NEXT GIRDER AND ENTIRE FINAL ALIGNMENT WOULD SHIFT FURTHER.



COUNTY RD. 17
STAGE 1 CONFIGURATION



COUNTY RD. 17
STAGE 2 CONFIGURATION



COUNTY RD. 17
FINAL CONFIGURATION

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT A - 2m SHIFT
TYPICAL SECTIONS

FIGURE
A5

LEGEND

OVERBUILD REQUIRED FOR STAGING

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT A - 2m SHIFT
NEW CONSTRUCTION

FIGURE
A6

MMM GROUP

PLOTTED BY: PepinJ PLOTTED: 5/16/2017 2:12 PM FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 1- 1.89m\SHEETS\3415003-HAWK-OPT 1-N01-S01.dwg

LEGEND

OVERBUILD REQUIRED FOR STAGING

POTENTIAL HYDRO CONFLICT

43+350

43+400

43+500

43+600

43+700

43+750

43+800

R-5000

R-1200

R-600

R-55

A-47.3

SCALE
5.0m 0 10.0m
Horizontal

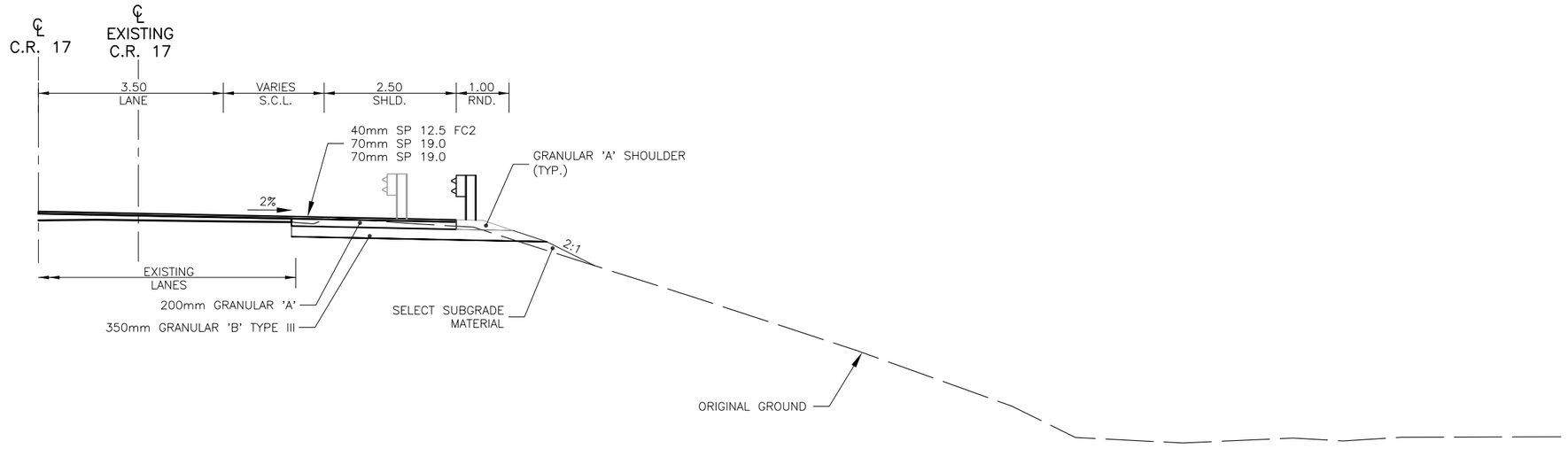
PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

MMM GROUP

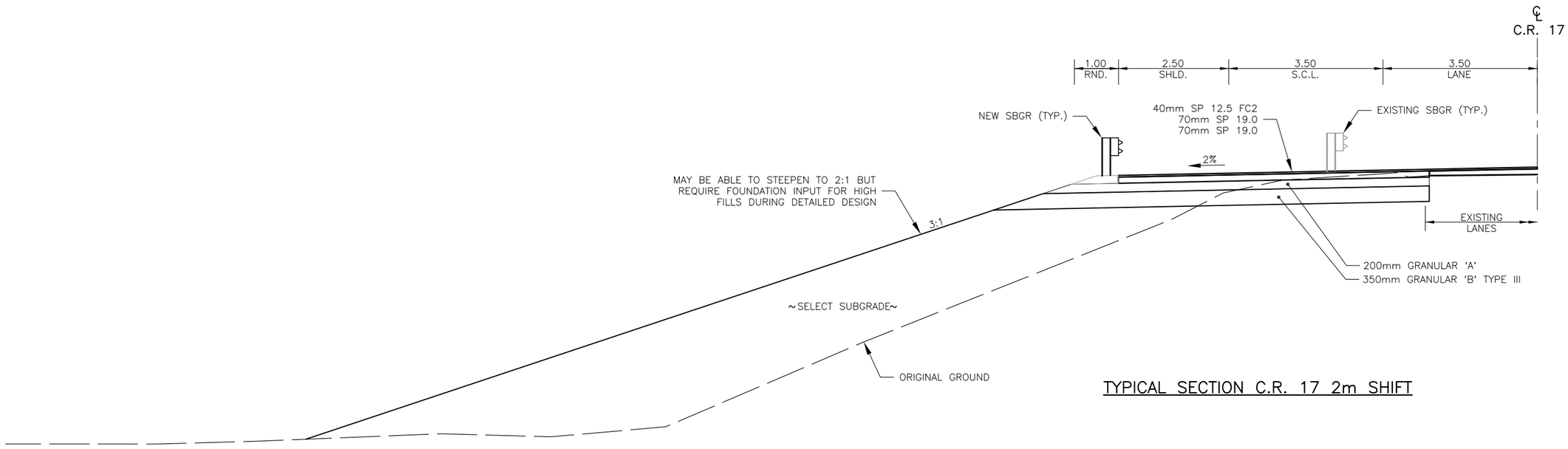
ALIGNMENT A - 2m SHIFT
NEW CONSTRUCTION

FIGURE
A7

PLOTTED BY: PepinJ
PLOTTED: 5/16/2017 2:12 PM
FILE: 0:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 1- 1.89m\SHEETS\3415003-HAWK-OPT 1-N01-S02.dwg



TYPICAL SECTION C.R. 17 2m SHIFT



TYPICAL SECTION C.R. 17 2m SHIFT

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT A - 2m SHIFT
TYPICAL SECTIONS

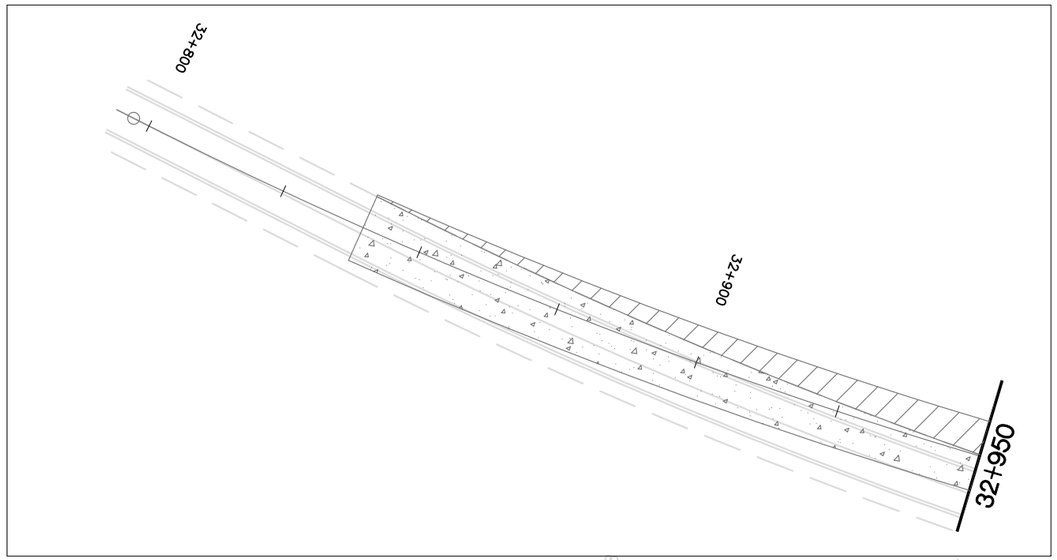
FIGURE
A8

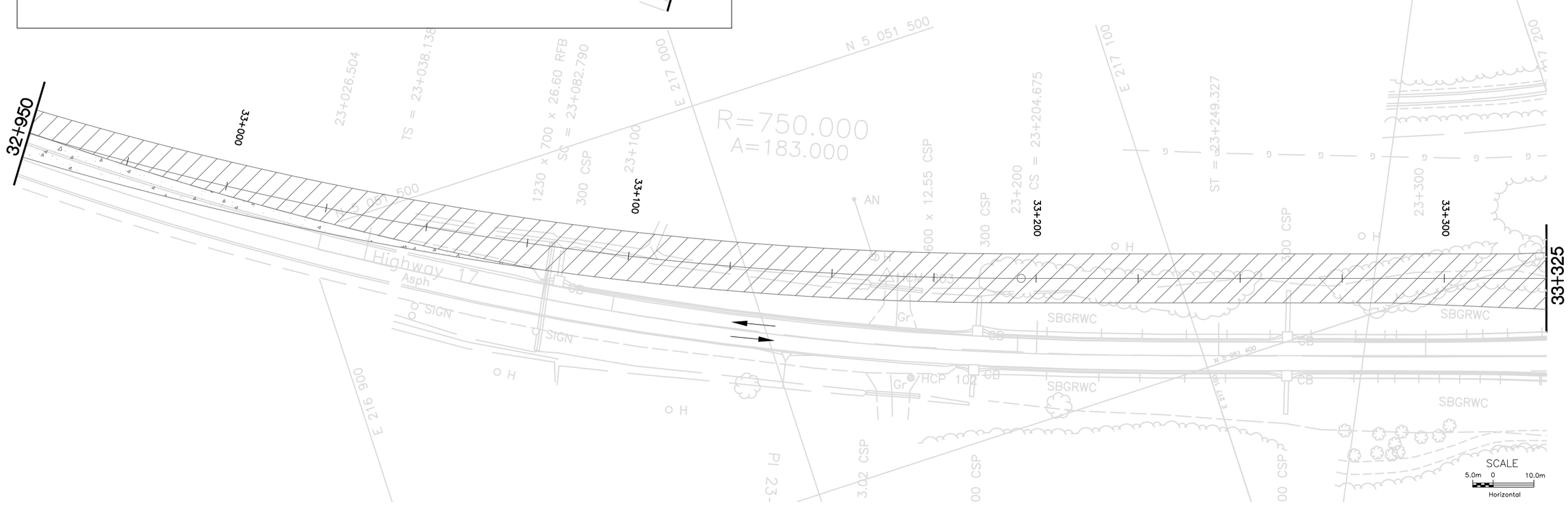
LEGEND

UNDER CONSTRUCTION (OFFLINE)

TIE–IN CONSTRUCTION
(FLAGGING AND TRAFFIC TRANSITION)

LANES/DIRECTION





MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT B - 19m SHIFT
STAGE 1

FIGURE
B1

PLOTTED BY: PepInJ PLOTTED: 5/16/2017 2:27 PM FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 2– 19.11m\SHEETS\3415003–HAWK–OPT 2–ST01–S01.dwg

LEGEND

- UNDER CONSTRUCTION (OFFLINE)
- TIE–IN CONSTRUCTION (FLAGGING AND TRAFFIC TRANSITION)
- LANES/DIRECTION

433+675
533+675
433+700
533+600
333+600
233+800
233+700
333+700
BC 33+553.850
33+325
33+400
33+500
33+600
33+700
33+725
433+600
533+725
533+700
HWY 17
TO HAWKESBURY
SBGRWC
NAIL 997
SCALE
5.0m 0 10.0m
Horizontal

PLOTTED BY: PapinJ
PLOTTED: 5/16/2017 2:32 PM
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 2– 19.11m\SHEETS\3415003–HAWK–OPT 2–ST01–S02.dwg

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT B - 19m SHIFT
STAGE 1

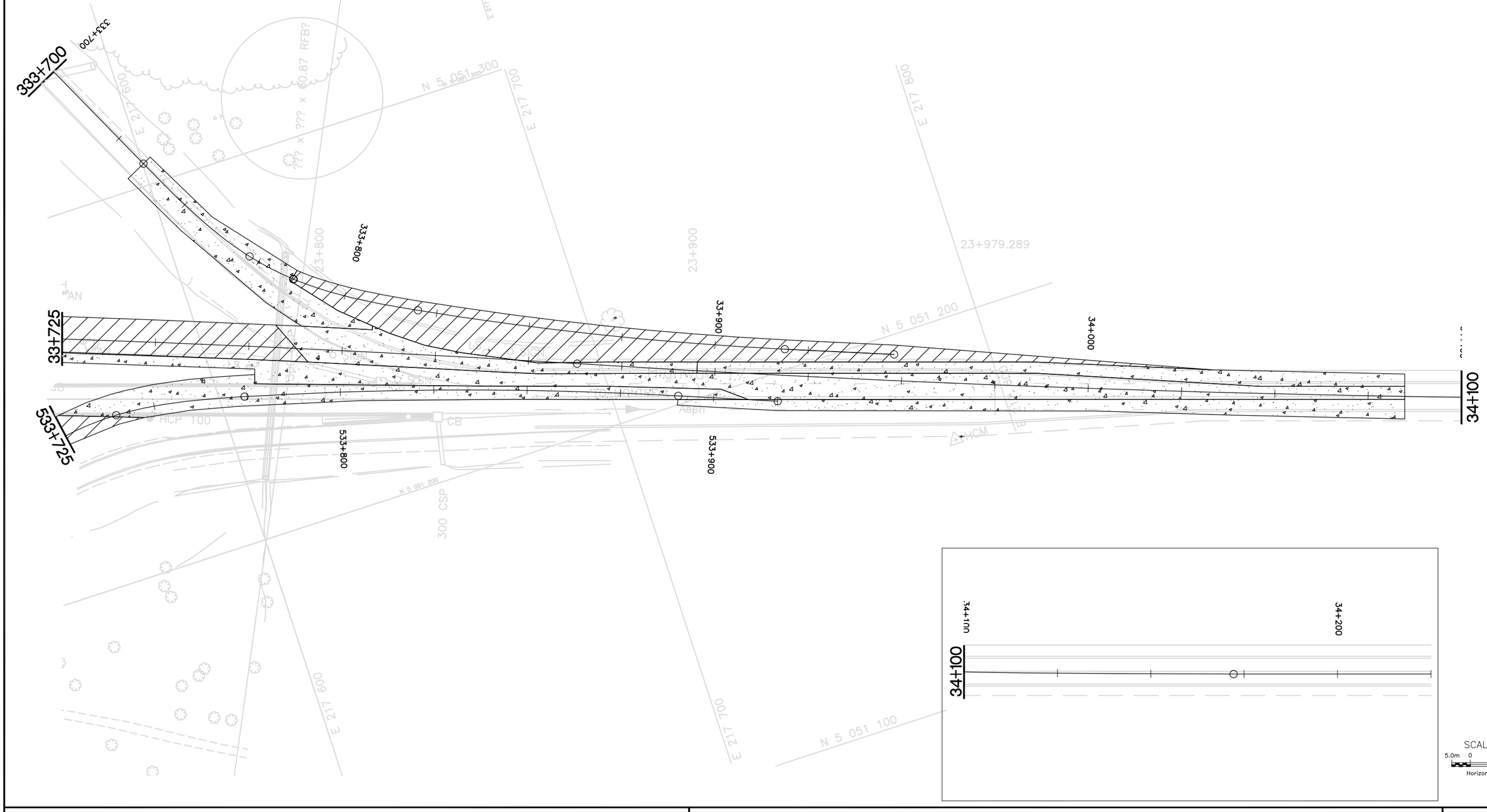
FIGURE
B2

LEGEND

UNDER CONSTRUCTION (OFFLINE)

TIE–IN CONSTRUCTION
(FLAGGING AND TRAFFIC TRANSITION)

LANES/DIRECTION



MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

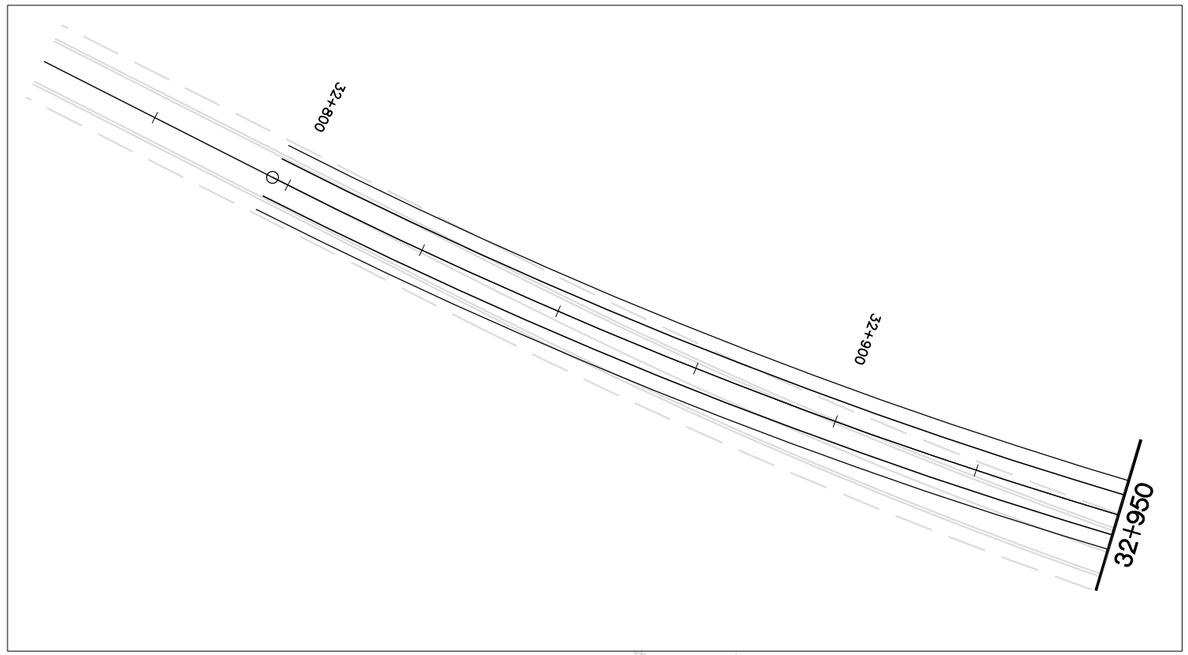
ALIGNMENT B - 19m SHIFT
STAGE 1

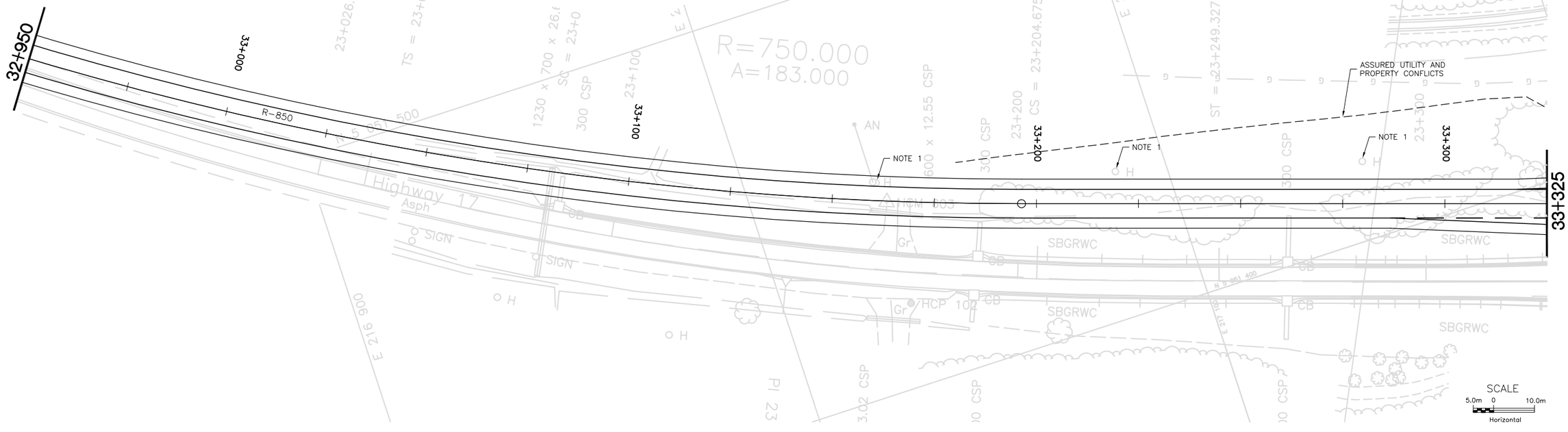
FIGURE
B3

PLOTTED BY: PepinJ PLOTTED: 5/16/2017 2:39 PM FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 2– 19.11m\SHEETS\3415003–HAWK–OPT 2–S03–ST01–S03.dwg

NOTE:

1. HYDRO POLE TO BE RELOCATED.





MMM GROUP	PRELIMINARY DESIGN C.R. 17 HAWKESBURY G.W.P. 4203-15-00	ALIGNMENT B - 19m SHIFT NEW CONSTRUCTION
		FIGURE B4

PLOTTED BY: PepInJ PLOTTED: 5/16/2017 2:40 PM FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 2- 19.11m\SHEETS\3415003-HAWK-OPT 2-S05-N01-S01.dwg

NOTE:

1. HYDRO POLE TO BE RELOCATED.

POTENTIAL GAS CONFLICT

ASSURED UTILITY AND PROPERTY CONFLICTS

NOTE 1

ASSURED UTILITY AND PROPERTY CONFLICTS

NOTE 1

NOTE 1

LIGHTING CONFLICTS

CONCERNS WITH STEEP GRADE OF RAMP

433+675

533+675

433+700

R=55

A=45

R=62.63

533+600

333+600

233+800

R=47

233+700

333+700

33+400

33+500

33+600

33+700

33+325

33+725

R=1000

A=60

R=5000

R=600

A=55

433+600

R=80

533+725

A=55

533+700

533+675

433+675

SCALE

5.0m 0 10.0m

Horizontal

PLOTTED BY: PepinJ

PLOTTED: 5/16/2017 2:52 PM

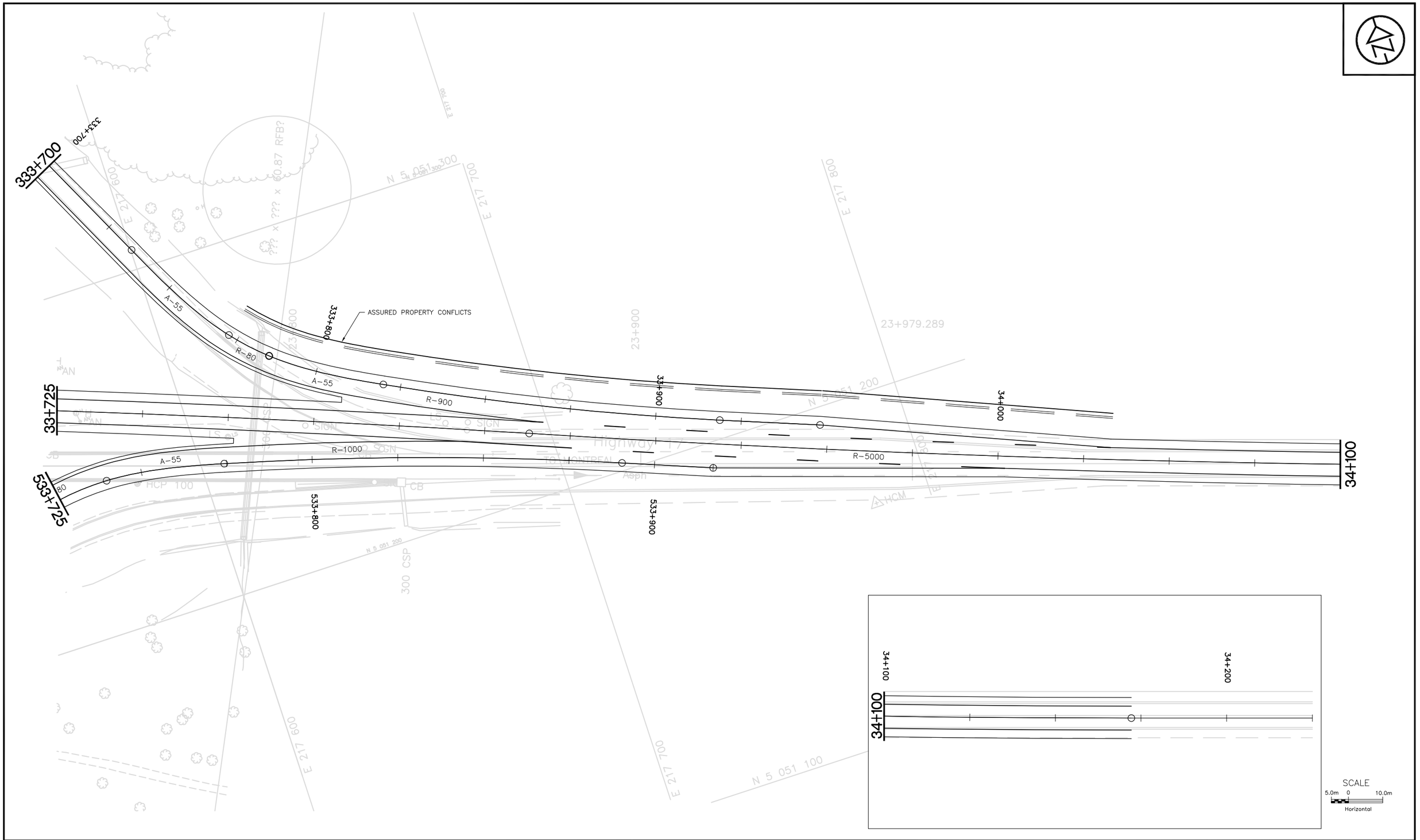
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 2- 19.11m\SHEETS\3415003-HAWK-OPT 2-S05-N01-S02.dwg

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

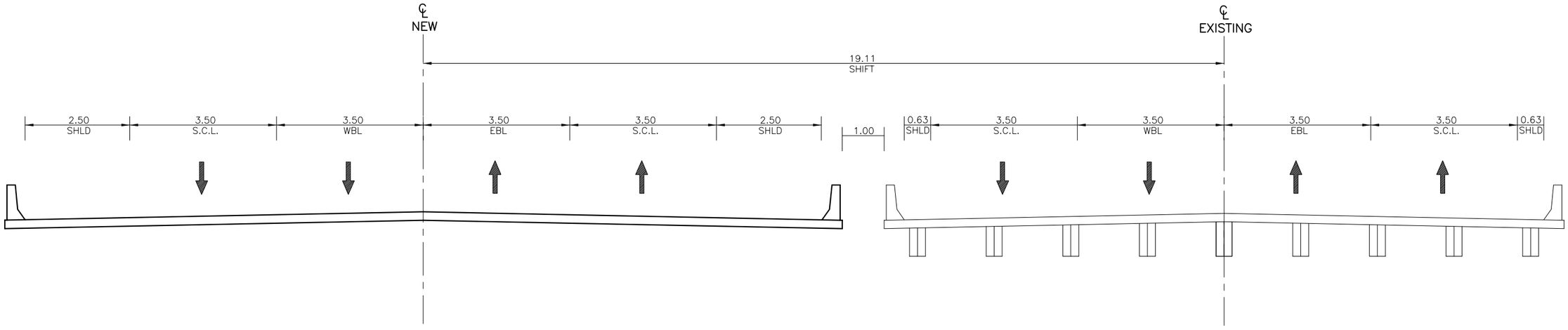
ALIGNMENT B - 19m SHIFT NEW CONSTRUCTION

FIGURE
B5



MMM GROUP	PRELIMINARY DESIGN C.R. 17 HAWKESBURY G.W.P. 4203-15-00
	ALIGNMENT B - 19m SHIFT NEW CONSTRUCTION
	FIGURE B6

PLOTTED BY: PepinJ PLOTTED: 5/16/2017 2:49 PM FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 2- 19.11m\SHEETS\3415003-HAWK-OPT 2-S06-N01-S03.dwg



COUNTY RD. 17
FINAL CONFIGURATION

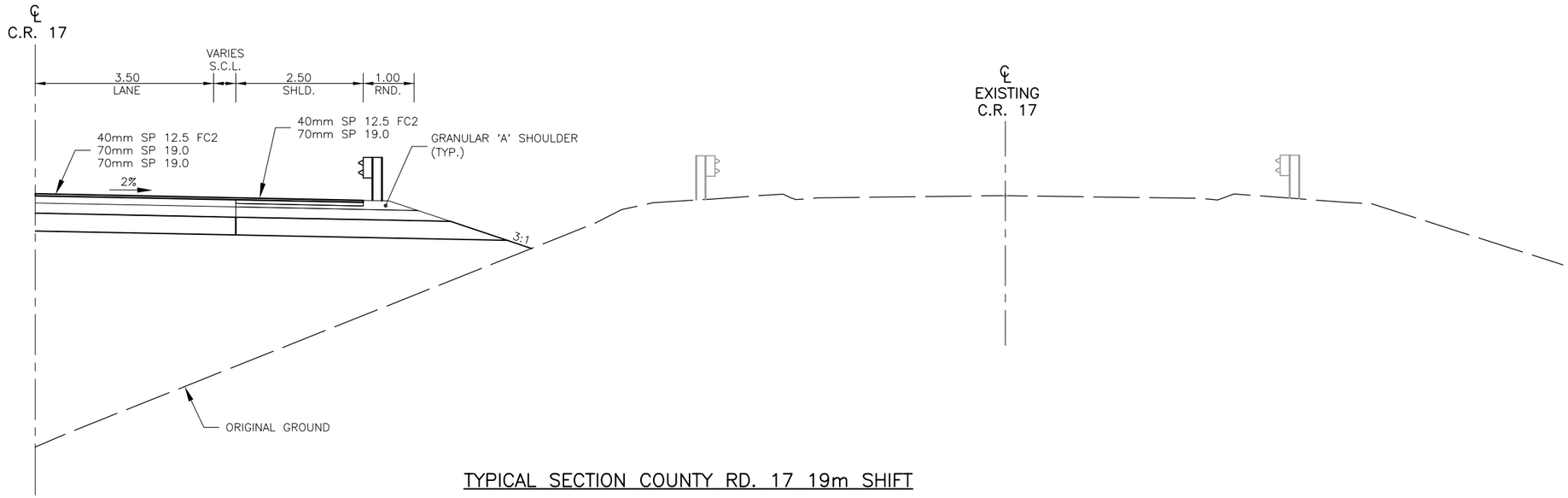
COUNTY RD. 17
STAGED CONFIGURATION

MMM GROUP

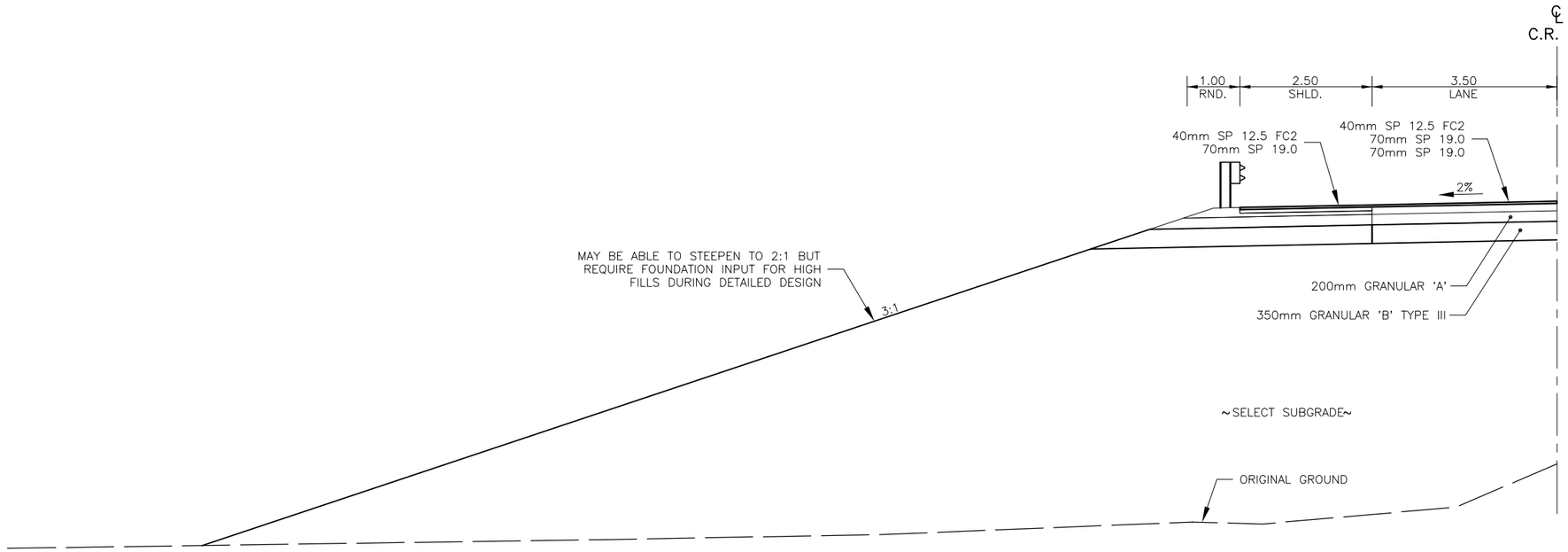
PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT B - 19m SHIFT
TYPICAL SECTIONS

FIGURE
B7



TYPICAL SECTION COUNTY RD. 17 19m SHIFT



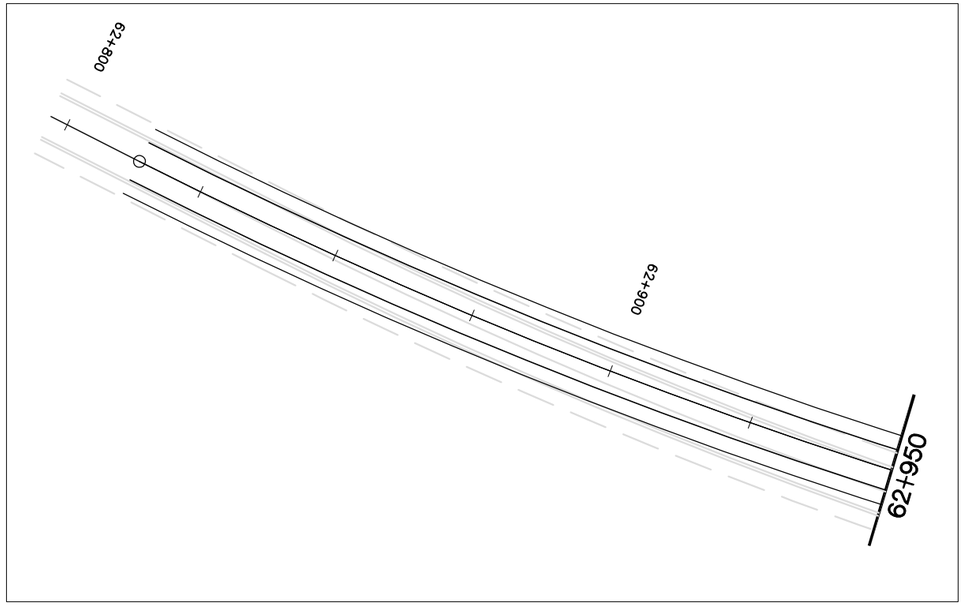
TYPICAL SECTION COUNTY RD. 17 19m SHIFT

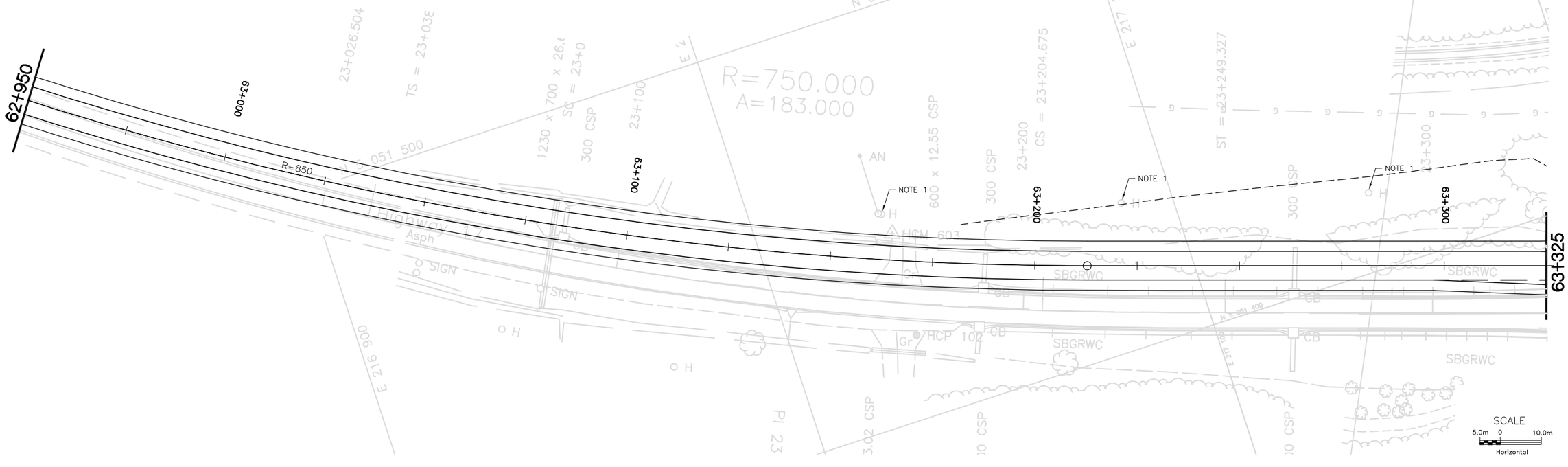
MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT B - 19m SHIFT
TYPICAL SECTIONS

FIGURE
B8





MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

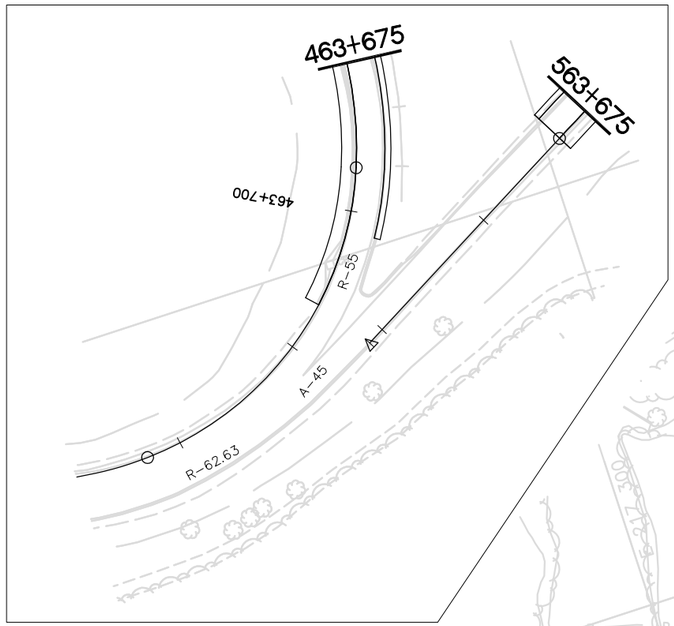
ALIGNMENT C - 12m SHIFT
NEW CONSTRUCTION

FIGURE
C1

PLOTTED BY: PepInJ
PLOTTED: 5/16/2017 2:56 PM
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 3 - 11.67m\SHEETS\3415003-HAWK-OPT 3-N01-S01.dwg

NOTE:

1. HYDRO POLE TO BE RELOCATED.



SCALE
5.0m 0 10.0m
Horizontal

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT C - 12m SHIFT
NEW CONSTRUCTION

FIGURE
C2

PLOTTED BY: PapinJ
PLOTTED: 5/16/2017 2:58 PM
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 3 - 11.67m\SHEETS\3415003-HAWK-OPT 3-N01-S02.dwg

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

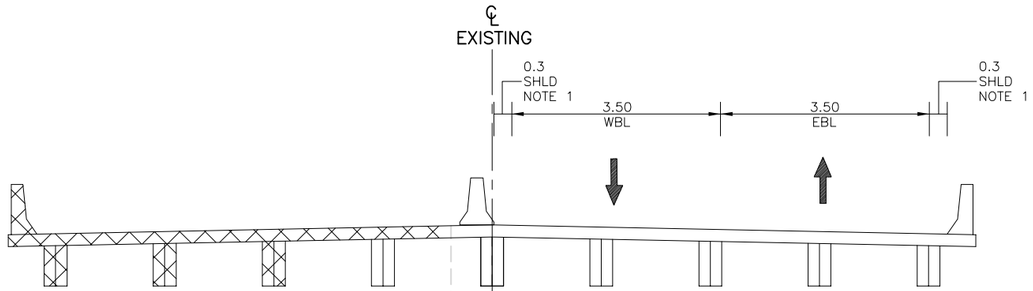
ALIGNMENT C - 12m SHIFT
NEW CONSTRUCTION

FIGURE
C3

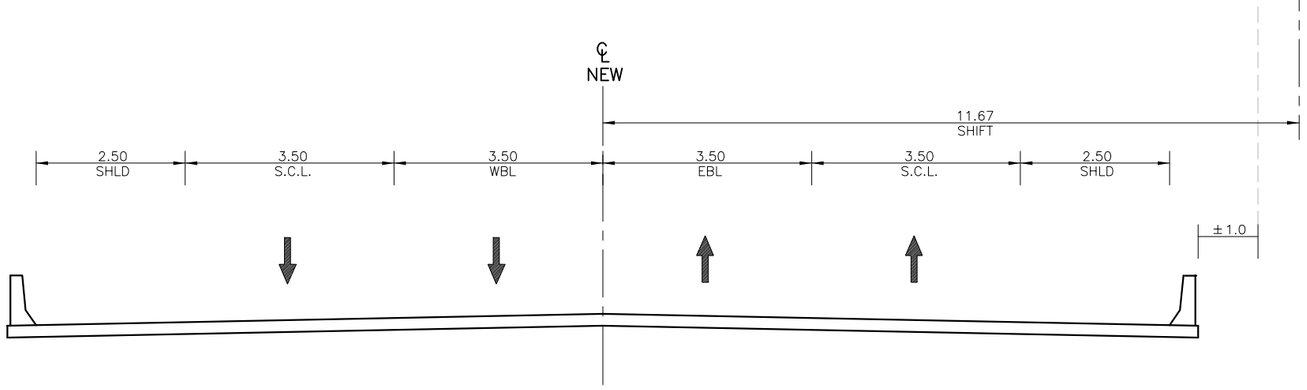
PLOTTED BY: PapinJ
PLOTTED: 5/16/2017 2:58 PM
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT 3 - 11.67m\SHEETS\3415003-HAWK-OPT 3-N01-S03.dwg

NOTE:

1. NARROW SHOULDERS REQUIRED TO ENSURE CONSTRUCTION JOINT BETWEEN GIRDERS 4 AND 5, OTHERWISE JOINT WOULD SHIFT TO NEXT GIRDER AND ENTIRE FINAL ALIGNMENT WOULD SHIFT FURTHER.



COUNTY RD. 17
STAGED CONFIGURATION



COUNTY RD. 17
FINAL CONFIGURATION

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

ALIGNMENT C - 12m SHIFT
TYPICAL SECTIONS

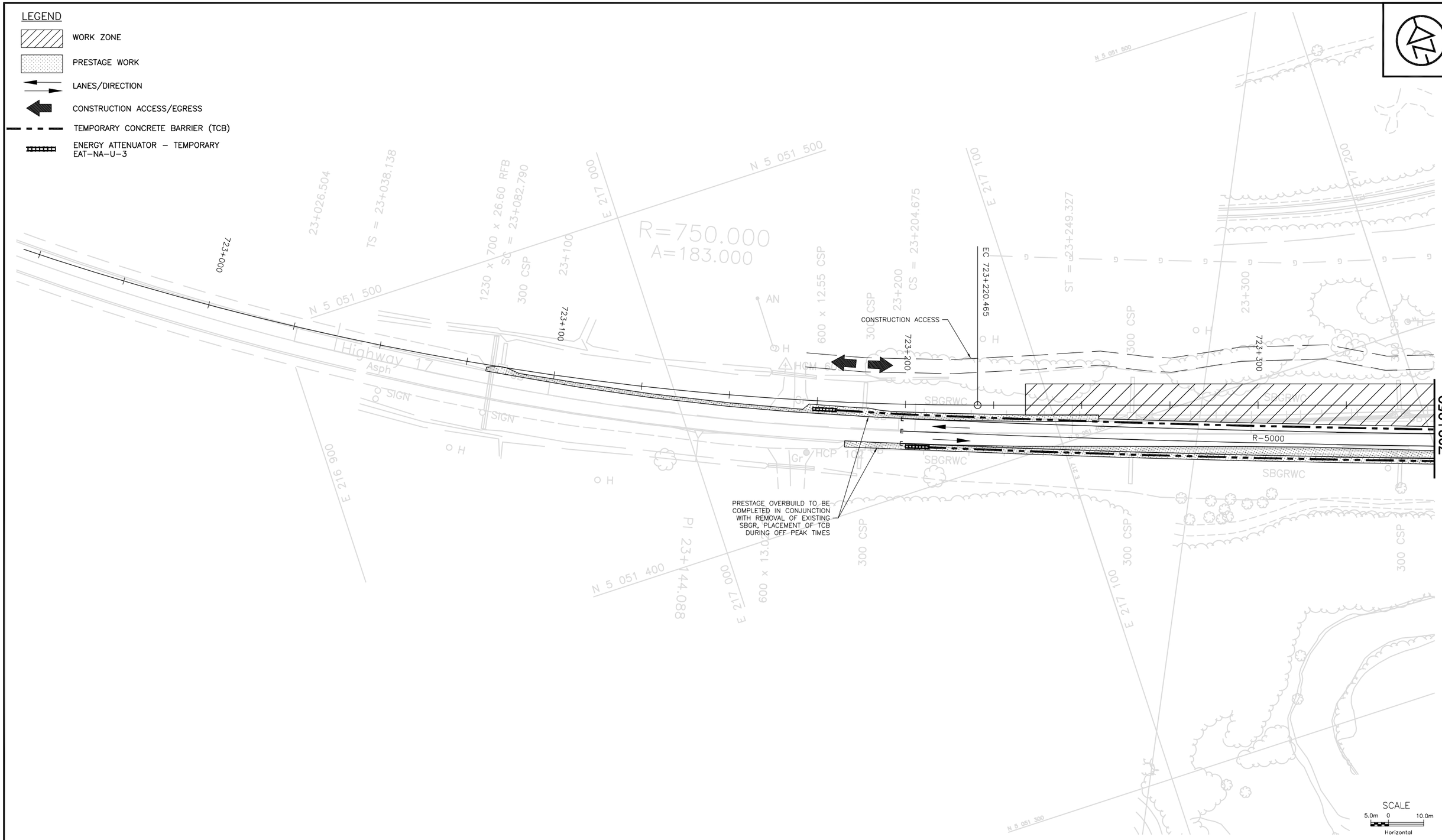
FIGURE
C4

APPENDIX C

Construction Staging & Highway Alignment Drawings
Preferred Alternative

LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3



PLOTTED BY: PepinJ
PLOTTED: 5/16/2017 3:07 PM
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MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

PREFERRED ALTERNATIVE
STAGE 1

FIGURE
1

LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3

ACCESS OVER TRACKS REQUIRED TO REMOVE EXISTING PIER (AND CONSTRUCT NEW PIER DEPENDING ON STRUCTURAL OPTION)

SIGNIFICANT PROTECTION SYSTEM REQUIRD TO CONSTRUCT NEW ABUTMENT/REMOVE EXISTING ABUTMENT

723+350

723+400

723+500

BC 723+554.952

723+600

723+700

PRC 723+724.380

723+750

R–5000

723+800

SCALE
5.0m 0 10.0m
Horizontal

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

MMM GROUP

PREFERRED ALTERNATIVE
STAGE 1

FIGURE
2

PLOTTED BY: PepinJ
PLOTTED: 5/16/2017 3:08 PM
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT R – 2 Lane\SHEETS\3415003-HAWK-OPT R-S02-ST01-S02.dwg

LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3

723+000

723+100

723+200

723+300

723+350

EC 723+220.465

CONNECTION BETWEEN EXISTING ROADWAY AND STAGE ONE CONSTRUCTION TO BE COMPLETE DURING OFF PEAK TIMES.

CONSTRUCTION ACCESS

SCALE
5.0m 0 10.0m
Horizontal

FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT R – 2 Lane\SHEETS\3415003–HAWK–OPT R–S03–ST02–S01.dwg
PLOTTED: 5/16/2017 3:08 PM
PLOTTED BY: PepinJ

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

PREFERRED ALTERNATIVE
STAGE 2

FIGURE
3

LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3

COUNTY RD. 17

723+350

723+750

723+400

723+500

723+600

723+700

BC 723+554.952

PRC 723+724.380

Rb–42

RA–101

STOP

CONNECTION BETWEEN EXISTING AND STAGE ONE CONSTRUCTION TO BE COMPLETE DURING OFF PEAK TIMES.

75m TAPER

70m PARALLEL LANE

ACCESS OVER TRACKS REQUIRED TO REMOVE EXISTING PIER (AND CONSTRUCT NEW PIER DEPENDING ON STRUCTURAL OPTION)

SIGNIFICANT PROTECTION SYSTEM REQUIRD TO CONSTRUCT NEW ABUTMENT/REMOVE EXISTING ABUTMENT

HWY 34

723+750

723+800

723+894

TO MONTREAL

CONNECTION BETWEEN EXISTING ROADWAY AND STAGE ONE CONSTRUCTION TO BE COMPLETE DURING OFF PEAK TIMES.

SCALE
5.0m 0 10.0m
Horizontal

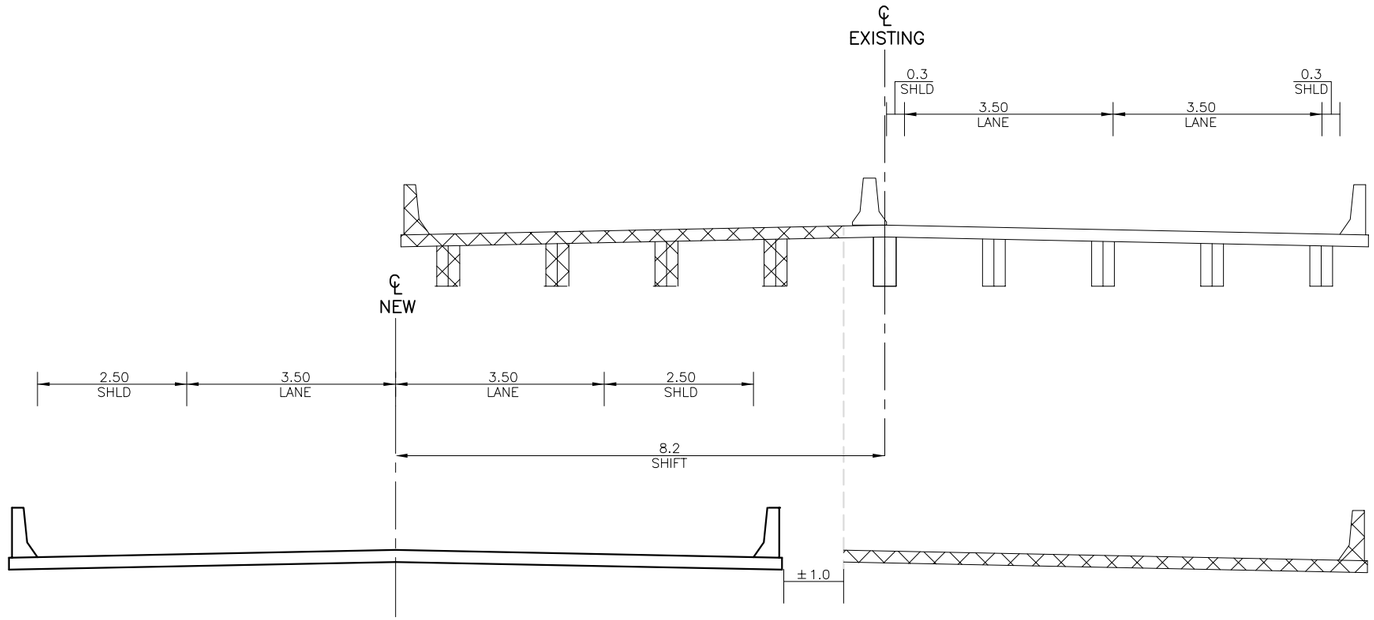
MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

PREFERRED ALTERNATIVE
STAGE 2

FIGURE
4

PLOTTED BY: PepinJ
PLOTTED: 5/16/2017 3:09 PM
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\WMM Working\OPTIONS\OPT R – 2 Lane\SHEETS\3415003-HAWK-OPT R-S04-ST02-S02.dwg



PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

MMM GROUP

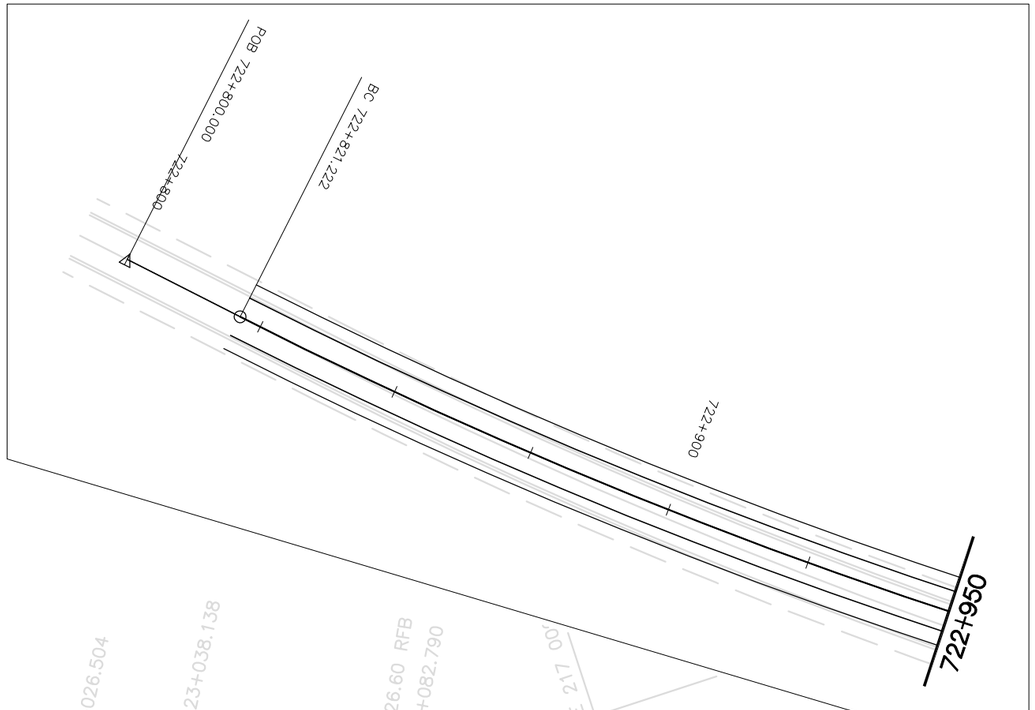
PREFERRED- ALTERNATIVE TWO LANE STRUCTURE CONFIGURATION TYPICAL SECTIONS

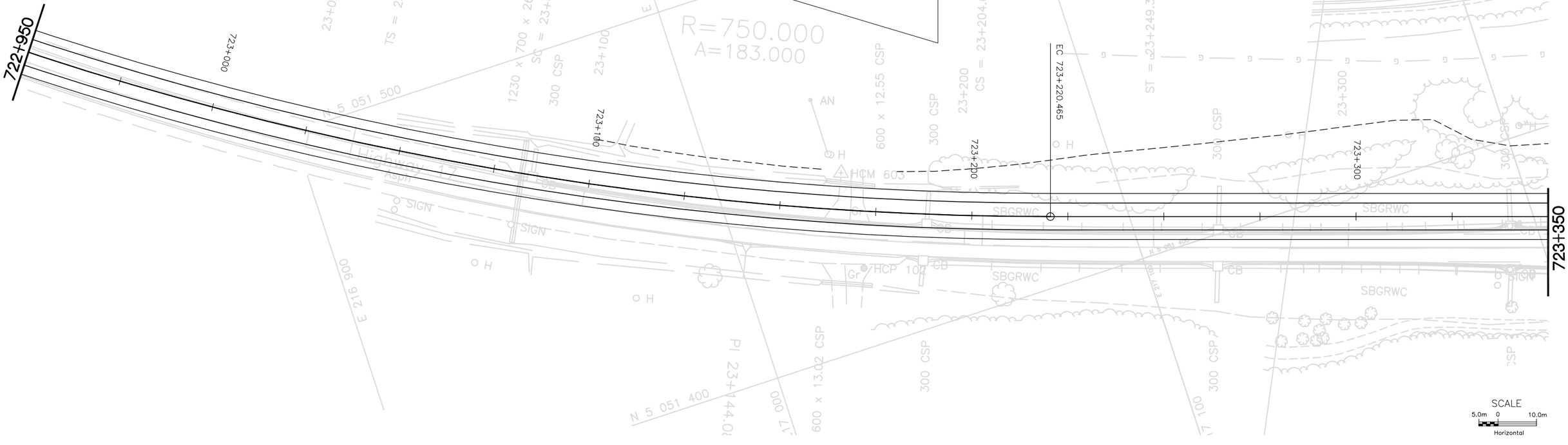
FIGURE
5

FILE:
PLOTTED:
PLOTTED BY: PepinJ

LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3





SCALE
5.0m 0 10.0m
Horizontal

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

PREFERRED ALTERNATIVE-INTERCHANGE & ROADWAY MODIFICATION SINGLE LANE - TWO DIRECTION STRUCTURES

FIGURE 6

PLOTTED BY: PapinJ 5/16/2017 3:13 PM PLOTTED:
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\MMM Working\OPTIONS\OPT R - 2 Lane\SHEETS\3415003-HAWK-OPT R-S06-N01-S01.dwg

LEGEND

- WORK ZONE
- PRESTAGE WORK
- LANES/DIRECTION
- CONSTRUCTION ACCESS/EGRESS
- TEMPORARY CONCRETE BARRIER (TCB)
- ENERGY ATTENUATOR – TEMPORARY EAT–NA–U–3

723+350

723+750

COUNTY RD. 17

HWY 17

HWY 34

723+400

723+500

723+600

723+700

723+800

BC 723+554.952

EC 723+893.807

723+894

PRC 723+724.380

Rb–42

RA–101

STOP

75m TAPER

70m PARALLEL LANE

TO MONTREAL

SCALE
5.0m 0 10.0m
Horizontal

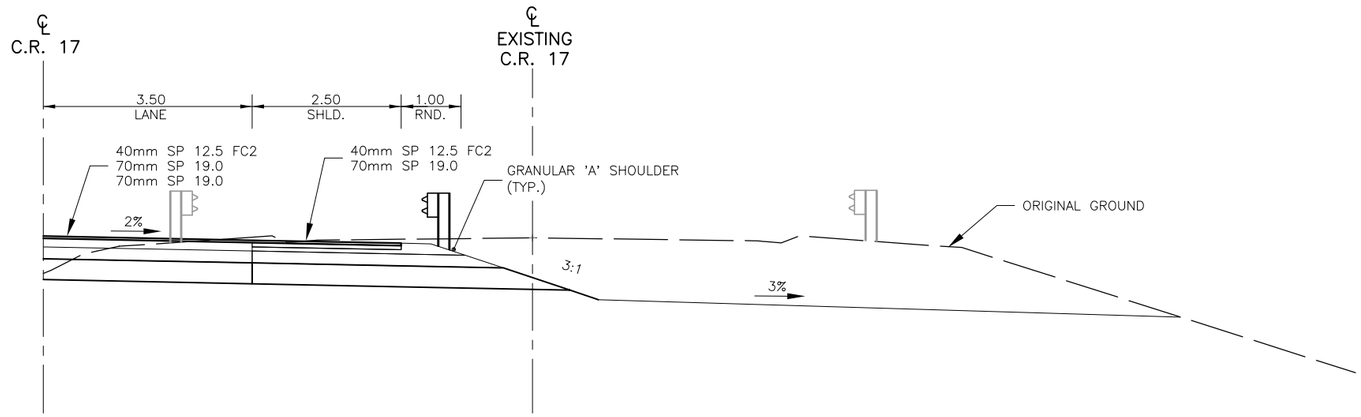
FILE: O:\3415003 MTO Mega6 Bridges\Hawkesbury Creek & CNR\WMM Working\OPTIONS\OPT R - 2 Lane\SHEETS\3415003-HAWK-OPT R-S07-N01-S02.dwg
PLOTTED: 5/16/2017 3:13 PM
PLOTTED BY: PapinJ

MMM GROUP

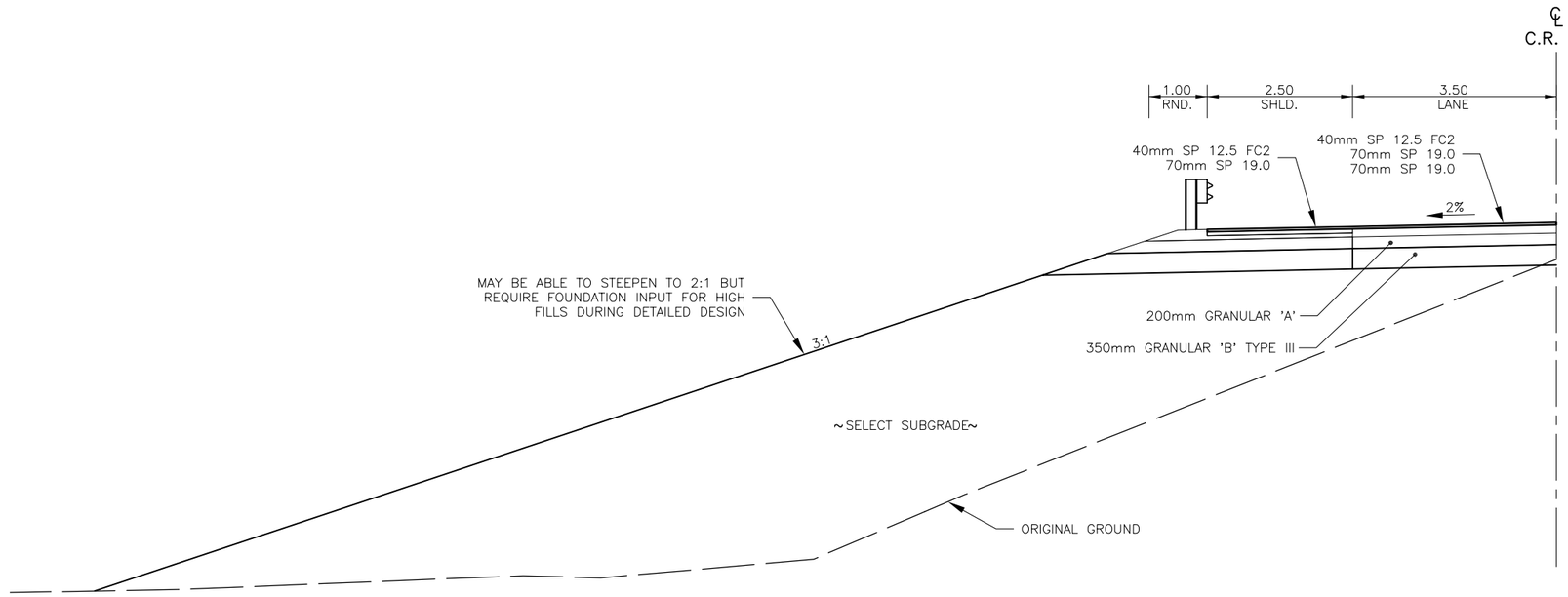
PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

PREFERRED ALTERNATIVE-INTERCHANGE & ROADWAY MODIFICATION SINGLE LANE - TWO DIRECTION STRUCTURES

FIGURE
7



TYPICAL SECTION COUNTY RD. 17



TYPICAL SECTION COUNTY RD. 17

MMM GROUP

PRELIMINARY DESIGN
C.R. 17 HAWKESBURY
G.W.P. 4203-15-00

PREFERRED ALTERNATIVE
SINGLE LANE-TWO DIRECTION TYPICAL SECTIONS

FIGURE
8

APPENDIX D

Cost Estimates

Preliminary Cost Estimate

Hawkesbury Creek & CNR Overhead

Alternative 3a - 2 Span Continuous (34m & 30m)

Item No.	Item Code	**Title**	**Unit**	**Quantity**	**Unit Price**	**Total**
1	0314-0190	Granular B, Type II	t	1,750	$25.00	$43,738.50
2	0510-9010	Removal of Bridge Structure (Hawkesbury)	LS	1.00	$650,000.00	$650,000.00
3	0539-0040	Protection System	LS	1.00	$20,000.00	$20,000.00
4	0902-0010	Earth Excavation for Structure	m3	1,625	$35.00	$56,875.00
5	0902-0030	Dewatering Structure Excavations	LS	1.00	$25,000.00	$25,000.00
6	0903-0012	Supply Equipment for Installing Caisson Piles	LS	1.00	$45,000.00	$45,000.00
7	0903-0090	Caisson Piles	m	72.00	$3,500.00	$252,000.00
8	0904-0055	Concrete in Footings	m3	60.0	$1,000.00	$60,000.00
9	0904-0085	Concrete in Substructure	LS/M3	170.00	$1,800.00	$306,000.00
10	0904-0105	Concrete in Deck	LS/M3	190.00	$1,800.00	$342,000.00
11	0904-0115	Concrete in Barrier Walls	LS/M3	47.00	$2,000.00	$94,000.00
12	0904-0135	Concrete in Approach Slabs	LS/M3	36.00	$1,000.00	$36,000.00
13	0904-0145	Concrete in Slope Paving	LS/M3	34.00	$1,500.00	$51,000.00
14	0905-0010	Reinforcing Steel Bar	LS/T	53.00	$3,500.00	$185,500.00
15	0905-0025	Stainless Steel Reinforcing Bar	LS/T	5.00	$13,000.00	$65,000.00
16	0906-0011	Fabrication of Structural Steel	LS/T	175.00	$4,000.00	$700,000.00
17	0906-0020	Delivery of Structural Steel	LS/T	175.00	$500.00	$87,500.00
18	0906-0030	Erection of Structural Steel	LS/T	175.00	$1,250.00	$218,750.00
19	0911-0012	Coating New Structural Steel	LS/M2	100.00	$100.00	$10,000.00
20	0914-0011	Bridge Deck Waterproofing	LS/M2	770.00	$45.00	$34,650.00
21	0922-0010	Bearings	LS	1.00	$126,000.00	$126,000.00
22	0928-0055	Access to Work Area, Work Platform and Scaffolding	LS	1.00	$25,000.00	$25,000.00
				SUBTOTAL		**$3,434,013.50**
				CONTINGENCY (20%)		**$686,802.70**
				TOTAL		**$4,120,816.20**

Preliminary Cost Estimate

Hwy 34 Overpass

Alternative 3b - 34m Simple Span

Item No.	Item Code	**Title**	**Unit**	**Quantity**	**Unit Price**	**Total**
1	0314-0190	Granular B, Type II	t	758	$25.00	$18,953.35
2	0510-9010	Removal of Bridge Structure (Hwy 34)	LS	1.00	$420,000.00	$420,000.00
3	0539-0040	Protection System	LS	1.00	$30,000.00	$30,000.00
4	0902-0010	Earth Excavation for Structure	m3	1,200	$35.00	$42,000.00
5	0903-0012	Supply Equipment for Installing Caisson Piles	LS	1.00	$45,000.00	$45,000.00
6	0903-0090	Caisson Piles	m	36.00	$3,500.00	$126,000.00
7	0904-0085	Concrete in Substructure	LS/M3	160.00	$1,800.00	$288,000.00
8	0904-0105	Concrete in Deck	LS/M3	100.00	$1,800.00	$180,000.00
9	0904-0115	Concrete in Barrier Walls	LS/M3	26.00	$2,000.00	$52,000.00
10	0904-0135	Concrete in Approach Slabs	LS/M3	36.00	$1,000.00	$36,000.00
11	0904-0145	Concrete in Slope Paving	LS/M3	20.00	$1,500.00	$30,000.00
12	0905-0010	Reinforcing Steel Bar	LS/T	34.00	$3,500.00	$119,000.00
13	0905-0025	Stainless Steel Reinforcing Bar	LS/T	3.00	$13,000.00	$39,000.00
14	9999-9231	Prestressed Concrete Members NU 1400 Fabrication	LS/M	170.00	$1,100.00	$187,000.00
15	9999-9232	Prestressed Concrete Members NU 1400 Delivery	LS/M	170.00	$200.00	$34,000.00
16	9999-9233	Prestressed Concrete Members NU 1400 Erection	LS/M	170.00	$400.00	$68,000.00
17	0914-0011	Bridge Deck Waterproofing	LS/M2	410.00	$45.00	$18,450.00
18	0922-0010	Bearings	LS	1.00	$70,000.00	$70,000.00
19	0928-0055	Access to Work Area, Work Platform and Scaffolding	LS	1.00	$25,000.00	$25,000.00
				SUBTOTAL		**$1,828,403.35**
				CONTINGENCY (20%)		**$365,680.67**
				TOTAL		**$2,194,084.02**

Revised Interchange - Two Lane Structure Cost Breakdown	
Item	Estimate
Grading	$1,630,000
Removals	$120,000
Misc. New Construction	$320,000
Traffic Staging	$420,000
Utilities	$20,000
Structural	
Subtotal	$2,510,000
Contigency (15%)	$400,000
Total	**$2,910,000**

Total Cost Estimate (Recommended Alternative)	
Grading	$2,910,000
Hawesbury Creek &CNR Structure	$4,120,816
Highway 34 Structure	$2,194,084
Total	**$9,224,900**

Comparitive Estimates (4-Lane Section Alternatives)	
Alternative A	$12,220,000
Alternative B	$14,220,000
Alternative C	$13,420,000

APPENDIX E

Traffic Analysis

MMM GROUP

MEMO

To:	Darren Pascoe, P.Eng.	Date:	March 20, 2017
From:	Adam Howell, P.Eng	Job No.:	15M-00657-06-00C
Subject:	Mega 6 – Traffic Analysis for Replacement of Hawkesbury Creek and CNR Overhead (Site 27-50) and Highway 34 Underpass (Site 27-51)	CC:	Don Stephens, P.Eng.

Background

MTO's Mega 6 group of contracts includes the replacement of the structures carrying County Road 17 across Hawkesbury Creek, a CN Rail corridor and Highway 34 in Hawkesbury, Ontario. Construction is scheduled to commence in 2017; this memo includes a summary of an analysis of traffic operations at the interchange of County Road 17 and Highway 34 under existing conditions and the proposed construction staging and final interchange configuration.

Existing Conditions

The interchange of Highway 34 and County Road 17 includes ramps that provide full access for all movements between the two roads. Movements to and from County Road 17 provide direct merges and diverges for traffic; the westbound ramp terminal at Highway 34 is signalized and the eastbound ramp terminal is unsignalized with stop control on the off-ramp approach. The structures carrying County Road 17 over Hawkesbury Creek, the CNR corridor and Highway 34 include a four lane cross section with two lanes in each direction; the inner lanes are the continuous through lanes along County Road 17 while the outer lanes configured as speed change lanes from the on/off-ramps to and from Highway 34. Through the interchange, County Road 17 has a posted speed limit of 90 km/h and Highway 34 has a posted speed limit of 60 km/h.

2014 traffic volumes at the two ramp terminal intersections with Highway 34 were provided by MTO. Historical volumes for County Road 17 were provided by the United Counties of Prescott and Russell; additional volumes on County Road 17 were provided as part of a September 2015 Environmental Study Report for Prescott-Russell County Road 17 – Hawkesbury Area Class Environmental Assessment Study. A review of the historical volumes along these corridors indicated annual traffic growth rates of approximately 2%; this 2% has been used as a basis for the projection of future volumes for the traffic analysis.

Existing 2017 traffic volumes have been projected based on the volumes provided; these volumes and the existing configuration of the interchange are illustrated in Figure 1.

Figure 1: Existing Interchange Configuration and Traffic Volumes

A traffic analysis using Synchro-9 has been undertaken for the existing weekday peak hour traffic volumes and signal timings; this analysis is summarized in Table 1.

Table 1: Analysis of Weekday Peak hour Traffic Operations - Existing Volumes (2017)

	AM Peak Hour					PM Peak Hour				
	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)
Highway 34 / County Road 17 Westbound Ramps										
EB	A	0.01	0.0	0.0	0.0	A	0.03	0.1	0.0	0.0
WBLT	B	0.19	17.3	6.8	26.3	C	0.52	27.6	28.5	79.2
WBR	A	0.20	5.6	0.0	11.9	B	0.34	13.0	7.1	32.7
NBTR	B	0.44	14.4	22.2	46.6	B	0.40	13.0	23.8	52.3
SBL	B	0.28	16.4	5.4	18.7	B	0.32	15.2	7.3	24.6
SBTR	B	0.61	19.2	34.4	80.9	C	0.83	26.4	65.6	157.3
Highway 34 / County Road 17 Eastbound Ramps										
WBL	B	0.11	13.4	*	3.1	**F**	**0.76**	**60.6**	*	**39.3**
WBR	B	0.11	13.4	*	3.1	**F**	**0.76**	**60.6**	*	**39.3**
NBT	A	0.15	0.0	*	0.0	A	0.16	0.0	*	0.0
NBR	A	0.11	0.0	*	0.0	A	0.11	0.0	*	0.0
SBL	A	0.11	9.6	*	2.9	A	0.15	10.0	*	4.4
SBT	A	0.26	0.0	*	0.0	A	0.51	0.0	*	0.0

*: Synchro does not report average queues for unsignalized intersections.
~: Approach is over capacity and queue could be longer
#: Queue reported is based on maximum of two cycles; could be longer
m: Queue is metered by an upstream signal. Reported Q95 may be shorter than Q50 in this case, Q95 is valid as Q50 calculation does not account for upstream metering.

The analysis indicates that the signalized intersection of the County Road 17 westbound ramps with Highway 34 operates with all peak hour movements at acceptable levels of service under existing traffic volumes. Queues on the westbound off-ramps are relatively short and can be accommodated within the available space on the ramp without impacting traffic on the County Road 17 mainline. Existing 95th percentile queues on Highway 34 southbound approaching the interchange are expected to extend beyond the CN rail corridor during weekday AM and PM peak hours.

The analysis of the intersection of the eastbound ramps with County Road 34 indicates that all movements operate at an acceptable level of service during the AM peak hour, but the delay to traffic on the eastbound off-ramp during the PM peak hour corresponds to a level of service F.

Analysis of Staging and Preferred Configuration

Staging for the replacement of the Hawkesbury Creek/CNR and Highway 34 structures will be undertaken through the partial closure of the existing structures during construction of a new parallel structure and the ultimate realignment of County Road 17 to the new structure. During this construction it is anticipated that County Road 17 over the structures will be reduced to a single lane in each direction.

During the Constructability Review meeting, the purpose of the interchange style connection between Highway 34 and County Road 17 was called in to question, along with the possibility of a reduction in structure width to accommodate two lanes instead of four. The interchange layout as it stands does not follow a particular set of geometry standards, and is not technically required based on roadway classification and traffic volumes. The technically preferred final configuration for the structure replacements will include a single lane in each direction.

In order to achieve a two lane cross section, modifications are required to the County Road 17 Westbound (WB) entrance terminal and Eastbound (EB) exit terminal. The two exit/entrance terminals to the east can maintain existing conditions as free flow auxiliary lanes. A short deceleration lane beginning after the structure will be maintained for eastbound vehicles exiting to Highway 34. The entrance terminal for traffic heading West on CR17 will be replaced by a stop condition T-Intersection, modified slightly to minimize the risk of vehicles turning the wrong way on the roadway. In addition, centreline rumble strips could be employed in this area to ensure vehicles do not turn the wrong way down the ramp. Do not enter signs would also be required. The proposed ultimate configuration for the interchange is illustrated in Figure 2.

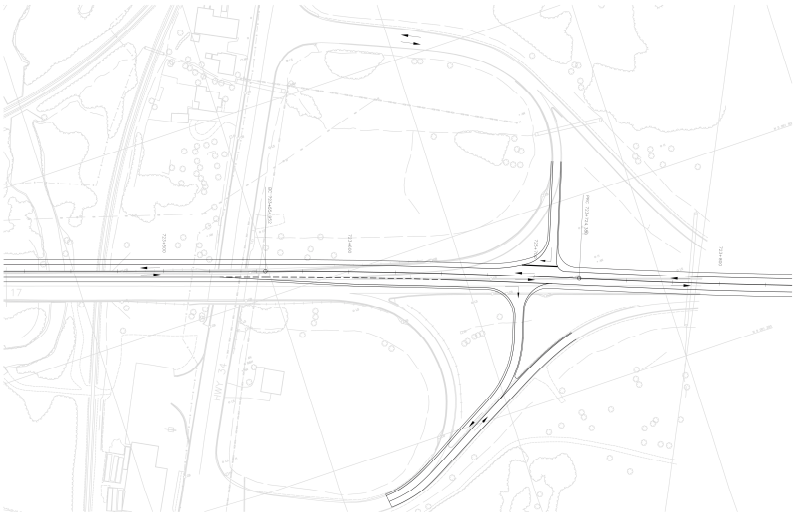


Figure 2: Technically Preferred Interchange Configuration

An analysis of traffic operations for the proposed interchange configuration under existing (2017) volumes has been undertaken using Synchro-9. It is noted that as both the staging and ultimate configurations will include the proposed ramp modifications and a two-lane cross section on County Road 17, this analysis will reflect operations during both the staging and final conditions. The results of this analysis for the intersection of the realigned interchange ramps with County Road 17 is summarized in Table 2; the proposed modifications will not impact the volumes or lane configurations at the ramp terminal

intersections on Highway 34 and as such these intersections will operate at an identical level of service as described in Table 1.

Table 2: Analysis of Weekday Peak Hour Traffic Operations - Existing Volumes and Proposed Ultimate Interchange Configuration (2017)

	AM Peak Hour					PM Peak Hour				
	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)
County Road 17 / Eastbound Ramps / Westbound Ramps										
EBT	A	0.07	0.0	*	0.0	A	0.10	0.0	*	0.0
EBR	A	0.06	0.0	*	0.0	A	0.08	0.0	*	0.0
WBT	A	0.04	0.0	*	0.0	A	0.10	0.0	*	0.0
WBR	A	0.13	0.0	*	0.0	A	0.28	0.0	*	0.0
NBR	B	0.31	10.7	*	10.5	B	0.35	11.4	*	12.9
SBR	A	0.11	9.3	*	3.1	A	0.14	9.9	*	4.0

*: Synchro does not report average queues for unsignalized intersections.
~: Approach is over capacity and queue could be longer
#: Queue reported is based on maximum of two cycles; could be longer
m: Queue is metered by an upstream signal. Reported Q95 may be shorter than Q50 in this case, Q95 is valid as Q50 calculation does not account for upstream metering.

The analysis of the reconfigured unsignalized ramp movements at County Road 17 indicates that all movements will operate at an acceptable level of service under existing volumes. Delays to the right turns from the ramp to County Road 17 westbound will average approximately 10 seconds per vehicle with very low queuing, indicating that vehicles will readily be able to find gaps in traffic on County Road 17 to make these turns. Results for the northbound right turn onto County Road 17 from the eastbound on-ramp are based on stop control as well, and are therefore conservative compared with the direct merge that will be maintained.

Additional traffic analysis has been undertaken for the 2027 horizon year, 10 years after the proposed reconstruction of the County Road 17 structures; 2027 volumes have been projected using the same 2% annual growth rate identified previously. The results of the 2027 traffic analysis for the proposed ultimate interchange configuration are summarized in Table 3.

Table 3: Analysis of Weekday Peak Hour Traffic Operations – Projected 2027 Volumes and Proposed Ultimate Interchange Configuration

	AM Peak Hour					PM Peak Hour				
	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)
Highway 34 / County Road 17 Westbound Ramps										
EB	A	0.01	0.0	0.0	0.0	A	0.04	0.3	0.0	0.0
WBLT	B	0.23	19.9	9.1	35.0	D	0.73	40.0	51.3	#106.9
WBR	A	0.23	6.0	0.0	14.1	A	0.40	6.3	0.0	18.4
NBTR	B	0.52	14.9	28.0	56.3	B	0.41	12.4	32.0	64.5
SBL	B	0.41	19.4	7.0	23.6	B	0.38	16.6	10.1	32.3
SBTR	C	0.72	22.0	44.2	100.3	C	0.84	27.2	95.6	#230.7
Highway 34 / County Road 17 Eastbound Ramps										
WBL	C	0.19	17.2	*	5.4	**F**	**2.93**	**1034.3**	*	**132.0**
WBR	C	0.19	17.2	*	5.4	**F**	**2.93**	**1034.3**	*	**132.0**
NBT	A	0.18	0.0	*	0.0	A	0.19	0.0	*	0.0
NBR	A	0.13	0.0	*	0.0	A	0.19	0.0	*	0.0
SBL	A	0.15	10.4	*	4.1	B	0.21	6.3	*	6.3
SBT	A	0.32	0.0	*	0.0	A	0.61	0.0	*	0.0
County Road 17 / Eastbound Ramps / Westbound Ramps										
EBT	A	0.09	0.0	*	0.0	A	0.12	0.0	*	0.0
EBR	A	0.07	0.0	*	0.0	A	0.09	0.0	*	0.0
WBT	A	0.05	0.0	*	0.0	A	0.12	0.0	*	0.0
WBR	A	0.16	0.0	*	0.0	A	0.34	0.0	*	0.0
NBR	B	0.38	11.5	*	14.4	B	0.45	18.5	*	18.5
SBR	A	0.14	9.5	*	3.9	B	0.18	5.3	*	5.3

*: Synchro does not report average queues for unsignalized intersections.
~: Approach is over capacity and queue could be longer
#: Queue reported is based on maximum of two cycles; could be longer
m: Queue is metered by an upstream signal. Reported Q95 may be shorter than Q50 in this case, Q95 is valid as Q50 calculation does not account for upstream metering.

The analysis indicates that most traffic movements at the interchange will continue to operate at an acceptable level of service under 2027 volumes and the proposed ultimate configuration. Queues on the westbound off-ramp are expected to extend to approximately 110m during the PM peak hour; these queues are expected to be accommodated within the available space on the ramp without impacting traffic operations on County Road 17. Queues approaching the realigned right turns onto County Road 17 are also anticipated to remain short with minimal delay. Future growth in traffic volumes is expected to increase delays and queuing on Highway 34 approaching the interchange, but this will not be exacerbated by the proposed interchange modifications.

Future traffic growth is expected to increase traffic passing the eastbound ramp terminal on Highway 34, reducing the potential to make turns from the eastbound off-ramp. As a result, it is anticipated that the eastbound off-ramp will exceed capacity by the 10-year horizon and the signalization of the eastbound off-ramp terminal intersection will be required. Table 4 provides a summary of the 2027 traffic analysis with this intersection under signalized operation.

Table 4: Analysis of Weekday Peak Hour Traffic Operations – Projected 2027 Volumes and Proposed Ultimate Interchange Configuration (Eastbound Ramp Terminal Signalized)

	AM Peak Hour					PM Peak Hour				
	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)	LOS	V/C	Delay (s)	Qavg (m)	Q95 (m)
Highway 34 / County Road 17 Eastbound Ramps										
WBL	B	0.04	14.9	1.1	5.1	D	0.16	35.2	4.7	14.7
WBR	A	0.23	6.0	0.0	9.3	B	0.38	11.4	0.0	14.2
NBT	A	0.31	7.0	15.0	23.5	A	0.26	4.1	16.2	21.5
NBR	A	0.22	1.9	0.0	7.3	A	0.18	0.9	0.0	4.3
SBL	A	0.24	8.6	5.1	13.2	A	0.28	5.7	7.7	14.8
SBT	B	0.52	10.2	30.0	54.8	B	0.78	12.9	96.9	142.2

*: Synchro does not report average queues for unsignalized intersections.
~: Approach is over capacity and queue could be longer
#: Queue reported is based on maximum of two cycles; could be longer
m: Queue is metered by an upstream signal. Reported Q95 may be shorter than Q50 in this case, Q95 is valid as Q50 calculation does not account for upstream metering.

The analysis indicates that the signalization of the eastbound ramp terminal intersection with Highway 34 will allow all movements at this intersection to operate at an acceptable level of service, mitigating the existing LOS F for turning movements from the eastbound off-ramp. This signalization will keep queues on the ramp short, but will introduce additional queueing on both approaches to this intersection on Highway 34; the 142m projected queue on the southbound approach is expected to fit within the available space between the eastbound and westbound ramp terminals.

Conclusions

The structures carrying County Road 17 over Hawkesbury Creek, CN rail corridor and Highway 34 in Hawkesbury, Ontario are scheduled to be replaced, with construction scheduled to commence in 2017. The replacement structures are proposed to be constructed with a two-lane cross section on County Road 17, with the interchange ramps to and from the west being modified to accommodate the removal of the speed change lanes on the existing structures.

An analysis of existing traffic volumes on the interchange indicates that most existing traffic movements operate at an acceptable level of service with queues that can be accommodated within the existing lanes. However, traffic along Highway 34 during the weekday PM peak hour creates sufficient delays for vehicles attempting to turn from the eastbound off-ramp for this approach to operate at a LOS F under existing conditions.

The proposed bridge and ramp modifications resulting from the reconstruction will allow all movements at the interchange to continue to operate at an acceptable level of service as far as the 2027 horizon year; the signalization of the eastbound ramp terminal will be required to mitigate the capacity constraint on the ramp as traffic on Highway 34 continues to grow. The ramp modifications are not anticipated to result in queues that will impact upstream intersections or traffic on the County Road 17 mainline; future traffic growth will result in longer queues on Highway 34 but these are not expected to have an impact in upstream intersections.