6.0 CONSTRUCTABILITY

6.1 Options and Analysis

Three different constructions options were considered along the bridge route: dredging a channel and using barges, construction of a temporary work bridge, and installation of a temporary earth berm / causeway. The Class EA recommended dredging a channel as it would only involve one in-water disturbance and one related set of mitigation measures; would be more economical than the temporary work bridge and earth berm / causeway; and the channel could accommodate the east-west watermain that was being planned by UK at that time. During the current project phase, each option was further investigated and evaluated.

6.2 Dredging

Dredging a channel would consist of dredging approximately 1.5 m below the mudline which is mostly peat and vegetation. Oversized barges would be used to transport equipment and personnel to each pier location. After construction, the dredged channel would either be back-filled or left in place. During construction, multiple barges would be required, including crane barges, material barges, tug boats and service boats. The dredging could be conducted via mechanical (e.g. clamshell) or hydraulic (e.g. cutter suction dredge) methods.

The bottom width of the dredged channel would be 20 m with 3:1 to 6:1 side slopes to accommodate the oversized barges required for the cranes. The overall in-water footprint of the dredged channel would be approximately 36,500 m^2.

It would take approximately two months to fully dredge the channel. Using barges would slow down construction, as the movement of personnel and material would be governed by the movement of the barges. In addition, the barges may not be able to run in the winter due to the river freezing.

6.3 Temporary Earth Berm

The earth berm / causeway would consist of infilling an access road with rock fill to provide a temporary east / west access road extending from the shore to the navigational channel on both sides as shown in **Figure 6.3.1**. A boat would be used to transport material, equipment and personnel from one side of the navigation channel to the other. The rock fill would be placed on removable fabric / geotextile such that after construction, the earth berm could be removed without significantly affecting the riverbed.

The causeway would be 10 m to 12 m wide to accommodate vehicle movement and the depth of fill would range from 2 m to 2.5 m. The in-water footprint of the causeway would be approximately 17,000 m^2 which is less than half of the dredged channel footprint.

It would take approximately one to two months to construct the causeway, which could be completed in conjunction with the substructure construction. After construction, it is estimated that it would take one to two months to remove the causeway.

Figure 6.3.1: Construction of Causeway / Earth Berm (Des Allumettes Bridge)

While in-place, the causeway would have significant effects on the river, as it could create stagnant areas which would reduce water quality and the constricted water flow may cause flooding. A hydraulic and flooding assessment would be required to determine the potential impacts that the causeway will have on the river. Furthermore, the wetland at the bridge site is considered rare and an earth berm would result in significant impact.

6.4 Temporary Work Bridge

The temporary work bridge would consist of either end bearing or friction piles driven into the riverbed every 10 m to 12 m supporting a cap beam and track beams with a timber crane mat. At the pier locations, there would be extensions of the work bridge to allow for additional material and equipment for the construction of the piers. The temporary work bridge would extend from the shore to the navigation channel on both sides of the river. A boat would be used to transport material, equipment and personnel from one side of the navigation channel to the other. The work bridge could be approximately 11 m wide to accommodate the large cranes and equipment required to construct the piers and lift the girders into place as shown in **Figure 6.4.1**. The total estimated work bridge area is 10,000 m^2.

Figure 6.4.1: Construction of Temporary Work Bridge.

It would take approximately three to four months to construct the work bridge. The construction of the work bridge would likely not occur continuously but would rather be advanced in conjunction with other construction activities, i.e. pier construction.

The temporary work bridge would have the least effects on the river as the in-water footprint is estimated at 3000 m^2. It is not anticipated that a temporary work bridge would have any long-term effects on the river due to the small effected area and would not have any effect on the water quality or flow. Generally, the piles could either be removed or cut below the riverbed and left in place.

6.5 Comparison of Alternatives

An evaluation matrix was created for the comparison between the three construction options as shown in **Table 6.6.1**. The evaluation matrix compares the alternatives based on associated costs, Parks Canada's priorities, project risks, uncertainties, implications and additional assessments that need to be completed in addition to those undertaken during the current project phase.

6.6 Environmental Impact / Footprint

Through further consultation with Parks Canada, it was determined that Parks Canada's main goal is to minimize the effects to the rare wetland; and that dredging a channel and the temporary causeway was not an option as it would have the greatest impact. Parks Canada preferred the temporary work bridge option, as it has the least impact on the wetland and there are no long-term effects expected on the vegetation, habitat and water quality of the Cataraqui River. The impacted area is minimal and can be mitigated.

6.7 Preferred Method – Temporary Work Bridge

The preferred method for the construction of the bridge is the use of a temporary work bridge. The temporary work bridge has the smallest impact on the wetland with no anticipated long term effects. The work bridge will consist of pipe piles driven into the riverbed which support an access platform as shown in . The dredging of the riverbed is limited to the v-pier footings which would have had to be completed for all three construction options. The temporary work bridge provides the greatest access for the construction as there will be continuous and uninterrupted access to all pier locations.

Table 6.6.1: Evaluation Matrix for Construction Options

Variable	Temporary Earthen Berm / Causeway	Dredging	Temporary Work Bridge
Description of Project			
Overview	Infilling an access road with rock fill to provide a temporary east / west access road extending from the shore to the navigational channel on both sides. Use of a boat to transport equipment and personnel from one side of the channel to the other. The rock fill would be placed on removal fabric/geotextile and removed after construction.	Dredge approximately 1.5m below the mudline which consists of mostly peat and vegetation. Barges will be used to transport equipment and personnel to each pier location. Dredged channel will either be back-filled or left in place. This operation will require multiple barges including crane barges, material barges, tug boats and service boats. Could be conducted via mechanical (e.g., clamshell) or hydraulic (e.g., cutter suction dredge) methods.	Construction of a temporary work bridge from the shore to the navigation channel on both sides. Temporary work bridge supported on piles which would be removed or cut-off below top of riverbed after construction. Barges would be used to transport equipment and personnel from one side of the channel to the other. The work bridge would be designed to support cranes as well as construction material
Conceptual Access Schedule	1 to 2 months to construct 1 to 2 months to remove This work can be completed in conjunction with other construction operations.	2 months to dredge channel.	3 to 4 months to construct work bridge. This work will not be completed continuously. It will be built in sections in conjunction with other construction activities.
Conceptual Construction Schedule		Slowest in comparison to causeway and work bridge as a barge will be required to access shore.	
Constructability	Simple to construct. Material and equipment readily available.	Requires dredging equipment and over-sized barges to accommodate large cranes for construction.	Requires multiple pieces of equipment to construct including Engineering and Barges.
Safety/Winter work	Safest option for labour and equipment. Can be used all year.	Working from a barge would require extra safety precautions. Limitations during winter freezing conditions	Safe. Can be used year round
Access to Site	Would allow continuous access to each pier location during construction	Access between each pier location and shore will be governed by barge movement.	Would allow continuous access to each pier location
Size	Berm would be at between 10 m to 12 m wide (adjusted to accommodate vehicle movement). Depth of fill would range of 2.0 to 2.5m. Berm would be removed after construction.	The barge required would be ~18.3 m wide, ~45.7 m long with a draft of ~1.8 to 2.4 m to support the crane. Bottom width of dredged channel would be 20 m with 3:1 side slopes (total channel affected width of 29m). Boats required to move the barge would require a draft of about 2.4 m. The channel will be dredged by about 1.5 to 2.0 m	Work bridge would be up to 10 m wide (30'). (At the locations of the piers and crane pick-up locations the bridge will be expanded to allow vehicles to pass the crane). Total work bridge area is estimated at 10,000 m^2
In-water footprint	~17,000 m^2	~36,500 m^2	~3000 m^2
Costs			
Construction (excluding sediment management and dredging)(from Parsons Comparisons Matrix October 20, 2016)	~$2.35 to 2.9 M (~$65 to 80 /m^3)	~$3.0 to 4.0M (~$65 to 80 /m^3)	~$16M - $19 M (|$1,600 to 1,900 /m^2)
Environmental controls/ mitigation (e.g., silt curtain)	$100,000	$100,000	$100,000
Construction environmental monitoring	$100,000 to 200,000	$100,000 to 200,000	$100,000 to 200,000
Dredged material management (dewatering, water treatment, staging area, disposal)	$3 to 4.5 M ($85 to 125/m^3)	$4 to 5 M ($85 to 125/m^3)	Only cost for a 3000 m^2 maximum footprint for the actual bridge piers – at 2 m average depth
Reinstatement of river bed	$2.0 to 2.4 M	$3.0 to 4.0 M	N/A
Re-establish Wetland with security and contingency	$200,000	$200,000	N/A
Supporting Studies/Plans	$300,000 to 600,000	$300,000 to 600,000	$300,000 to 600,000

Table 6.6.1: Evaluation Matrix for Construction Options

Variable	Temporary Earthen Berm / Causeway	Dredging	Temporary Work Bridge
Parks Canada Considerations			
• Area of wetland affected	63,000 m^2 "One of the largest impacts on any wetland within the jurisdiction of Parks Canada"	43,000 m^2 "One of the largest impacts on any wetland within the jurisdiction of Parks Canada"	600 m^2 (at work bridge pile support locations).
• Changes to substrate	• Construction of a berm will cause compaction of substrate	• Removal of riverbed may result in change in substrate that subsequently changes species composition.	• Effects to several smaller areas; long-term effects not expected.
• Re-vegetation	• Re-establishment of aquatic vegetation expected to be slow (greater than 1 to 2 years) • Change in bathymetry of riverbed expected to reduce potential for natural re-propagation of vegetation.	• Re-establishment of aquatic vegetation expected to be slow (greater than 1 to 2 years)	• Effects to several smaller areas; long-term effects not expected.
• Habitat	• Berm will cause loss of access while the berm is in place as well as fragmentation of habitat. • Hard substrates used in construction may attract turtles and put them at greater risk of mortality or non-viable nests.	• No physical barrier to mobility of aquatic animals. • Value of "different habitat type" after dredging considered to be low.	• Effects to several smaller areas, as a result post-disturbance rehabilitation expected to be faster and therefore long-term effects not expected.
• Water quantity	• Berm may affect water flow and result in flooding.	• Potential for change in water flows due to change in riverbed elevation along dredged channel.	• Small footprints, no effects expected.
• Water quality	• Potential for creation of stagnant zones with reduced water quality. • Potential for re-suspension of sediment and dispersion of associated contaminants	• Re-suspension of sediment and dispersion of associated contaminants during dredging • Potential change in sediment dynamics and subsequent elevation in ambient turbidity following dredging	• Localized potential for sediment re-suspension. • No expected long term change to sediment dynamics and ambient turbidity.
Project Risks, Uncertainties, and Implications			
Geotechnical			
• Slumping (inward)	• Not expected	• Due to soft nature of substrates, there is potential for slumping of side walls during dredging.	• Not expected.
• Displacement (outward)	• Potential for displacement (i.e., forcing of soft substrates laterally) of soft substrates during placement of material to construct berm.	• Not expected. Displacement inward may occur due to unstable material, resulting in larger volumes of dredged material than calculated.	• Not expected.
• Compaction	• Placement of material may cause compaction of underlying substrates. • Settlement of the placed Berm/Causeway may impair project (needs analysis) • Behaviour of placed material with loads from construction material needs geotechnical assessment.	• Not expected.	• Not expected except in localized area of pile supports.
Risks and Uncertainties	• Larger footprint disturbed, potentially exceeding area stipulated in the EA approval for the project. Regulatory implications of exceeding permitting spatial area of impact need to be considered. Potentially could result in a regulatory or injunctive termination of the project. • Compaction of substrate a concern of Parks Canada – may influence ability to receive permission for project.	• Larger footprint disturbed, potentially exceeding area stipulated in the EA approval for the project. Regulatory implications of exceeding permitting spatial area of impact need to be considered. Potentially could result in a regulatory or injunctive termination of the project. • Depth of dredged channel may require maintenance dredging (going back to dredge and material management costs currently not accounted for).	• Risk of exceeding approved project footprint area low because of large approved area of work.
River Hydraulics			
• Flooding	• Berm may temporarily alter flows and result in flooding (Parks Canada) • Note: Berm is part way across, water expected to flow around the Berm but Parks Canada may require a river hydraulics/flooding assessment.	• Not expected	• Not expected

Table 6.6.1: Evaluation Matrix for Construction Options

Variable	Temporary Earthen Berm / Causeway	Dredging	Temporary Work Bridge
• Flows and sediment dynamics	• Berm will temporarily constrict river during construction and thus may change flows and sediment dynamics • Note: assessment may be required by Parks Canada for possible effects of scour as water is confined through a smaller cross-section.	• Dredging will result in a near-term permanent lowering of the riverbed, which may change flows and sediment dynamics such as deposition and scour of habitats in the area. • Alternatives by using a cross braced sheet pile channel could be available at increased cost and would require similar hydraulic assessments as a berm. • Note: this presumes that replacement of dredged material will not be allowed. Some room for regulatory discussions may exist but this will add to project cost/complexity/uncertainty	• Minor localized temporary potential change in flows
Risks and Uncertainties	• Future liability for damages if such damages are caused. • Downstream water quality effects, particularly as a result of scour or turbidity from placement/removal of the material. • Change in sediment deposition which may affect existing habitats. The change need not be particularly negative in terms of functional ecology but objectives in Parks are oriented around environmental preservation (no change) vs conservation (change with compensatory habitat).	• Potential future downstream water quality effects if sediment transport and turbidity dynamics change. • Future change in sediment deposition which may affect existing habitats. • Parks Canada has, at present stipulated that dredged material may not be returned. This will change currently estimated costs for dredged material management. • Further regulatory negotiation may be needed to obtain permission to replace dredged material. Material will be poorly consolidated compared with existing.	• Localized temporary changes not expected to have substantial cumulative effect beyond new bridge supports where compaction will occur and some potential for scour along the sides of the supports could occur.
Disposal of Sediment			
• Water management and turbidity control	• Berm will need to removed. Disposal location will be needed. If material testing for Berm construction is not sufficient for land-based disposal, it may need to be tested to obtain regulatory approval for land disposal use. • Disposal location needed. • Cost of excavation/handling will need to be considered if not already included	• Project approval not likely (per communications from Parks Canada) to be received for returning dredged material to riverbed or for use in habitat offsetting therefore offsite disposal is likely. • Prior to transport for disposal, sediments will likely need to be dewatered to “spadeable” condition, which may need to be facilitated with the use of thickeners/flocculants or other methods.	• NA - disposal of sediment not anticipated. Potentially disposal of sediment for piers of final bridge
• Suitable disposal location	• Unless it can be returned to its source, a disposal location for the berm construction material will be needed.	• Location relative to site to be confirmed.	• NA - disposal of sediment not anticipated.
Risks and Uncertainties	• Regulatory standards to be applied will be based on disposal location • Disposal location is needed • Testing may be needed. • Methods of excavation?	• Project approval from Parks Canada for returning dredged sediment to riverbed not likely based on their letter; therefore, offsite disposal would likely be required – this has implications for cost and schedule. • Need to confirm that an off-site disposal location is available with sufficient volume, including slumping into the dredge cut. • Dewatering of sediment needs to be factored into overall schedule and costs if going offsite. • Additional equipment (water treatment) and suitable staging area would be needed.	• NA - disposal of sediment not anticipated.
Aquatic Habitat			
• Fish	• Relatively large aquatic footprint. • During construction, berm may be a barrier to fish migration	• Relatively large aquatic footprint. • Has potential to affect fish migration and spawning	• Potential to affect fish via underwater noise. Method dependent – could result in mortality • May require bubble curtain or other mitigation
• Turtles	• Berm may overlap habitat for hibernation • Hard substrates of berm may attract turtles for nesting and basking (Parks Canada)	• Dredging could result in mortality to hibernating turtles or incubating eggs. • Depending on the species’ conservation status, dredging could potentially be seasonally halted if turtles are buried in mud near the dredging area (e.g., Burnaby Lake dredging and painted turtles)	• May need to schedule pile driving around sensitive time period. • May need to halt work or conduct seismic surveys in pile locations if turtles are buried in mud at locations of driven piles. • Depending on method, underwater noise/”percussion” of diesel hammer (if used) may have negative effects on turtles. Unknown if mortality could/would be caused.

Table 6.6.1: Evaluation Matrix for Construction Options

Variable	Temporary Earthen Berm / Causeway	Dredging	Temporary Work Bridge
• Offsetting/ rehabilitation costs	• Potentially substantial costs associated with restoring footprint and functions due to importance of wetland	• Potentially substantial costs associated with restoring footprint and functions due to importance of wetland.	• Lowest area affected and therefore lowest costs expected. Parks Canada suggests relatively fast recovery due to overall small area associated with multiple small footprints.
Risks and Uncertainties	• Project approval from Parks Canada may not be issued due to concern with loss of habitat. • Rehabilitation or mitigation costs could be substantial. • Schedule may be affected by need to stage work around regulatory exclusions and sensitive life stages (e.g., spawning, spawning migration, hibernation).Future liability - proponent will be responsible for ongoing restoration or mitigation alternatives if planned work is not successful.	• Project approval from Parks Canada may not be issued due to concern with loss of habitat. • Amount of habitat disturbed is likely to be considerably higher than the dredge prism designed. For quantitative purposes, assume that the slope will "unravel" to a 5:1 (H:V) beyond the dredge prism for calculation purposes. • Re-dredging may be needed and may be constrained by seasonal effects. • Rehabilitation or mitigation costs could be substantial – these costs are currently unknown as the offsetting associated with this option has not been designed nor is there indication from Parks Canada that it would necessarily accept habitat offsets, what the offset ratios might be etc. • Schedule may be affected by need to stage work around sensitive life stages (e.g., spawning, spawning migration, hibernation). • Future liability - proponent may be responsible for ongoing restoration or mitigation alternatives if planned work is not successful.	• Relatively low rehabilitation costs expected. • Schedule may be affected by potential need to stage work around sensitive life stages. • Unknown effect of percussive blast wave propagation through mud on turtles. • May need to mitigate pile driving effects (underwater noise)
Terrestrial Habitat			
• Riparian Vegetation	• Access may require removal of vegetation if present in staging area.	• Access may require removal of vegetation	• Access may require removal of vegetation
• Birds	• Removal of trees may affect nesting birds (possible seasonal limitation)	• Removal of trees may affect nesting birds	• Removal of trees may affect nesting birds
• Wildlife	• Wildlife access and dens/burrows may be affected	• Wildlife access and dens/burrows may be affected	• Wildlife access and dens/burrows may be affected
• Offsetting/ rehabilitation costs	• Shoreline may need to be restored and vegetation replaced.	• Shoreline may need to be restored and vegetation replaced.	• Shoreline may need to be restored and vegetation replaced.
Risks and Uncertainties	• May need to be scheduled around sensitive life stages. • Permitting process associated with disturbing birds or wildlife. • Proponent will be responsible for ongoing restoration or mitigation alternatives if planned work is not successful	• May need to be scheduled around sensitive life stages. • Permitting process associated with disturbing birds or wildlife. • Proponent will be responsible for ongoing restoration or mitigation alternatives if planned work is not successful.	• Permitting process associated with disturbing birds or wildlife. • Proponent will be responsible for ongoing restoration or mitigation alternatives if planned work is not successful.
Water Quality			
• Induced turbidity	• Placement of material may be reasonably expected to mobilize riverbed sediments and cause elevated turbidity • Narrowing of river cross-section may result in higher velocity in constricted parts of the river and scour in those locations	• Dredging of sediment will mobilize sediments and cause elevated turbidity • Hydraulic dredging generates approximately 10:1 water to sediment ratio – water needs to be managed which may require treatment to reduce suspended solids. May require use of flocculants, thickeners, geotubes etc.	• Temporary, localized effects to water quality. • Temporary effects again during pile removal especially if pulled vs cut piles are used.
• Contaminant dispersion	• Sediments not contaminated – no effect expected	• Sediments not contaminated – no effect expected.	• Sediments not contaminated – no effect expected.
Risks and Uncertainties	• Project approval from Parks Canada may not be issued due to concern with water quality effects. • Schedule delays where construction slowed or stopped to meet performance objectives. • Can be managed with additional cost for environmental controls such as a silt curtain or other barrier	• Project approval from Parks Canada may not be issued due to concern with water quality effects. • Can be managed with additional costs associated with controls such as a silt curtain or other barrier. • Schedule delays where dredging slowed or stopped to meet performance objectives. • Use of flocculants increases potential risk of water quality concerns where the effluent discharge is to the river.	• Can be managed without substantial additional cost for specialized environmental controls. • To Consider: Parks Canada may require piling removal. This may or may not be feasible without a large disturbance. If Turtles like the hard substrate consider cutting to mudline and finishing off with a rock mound over the pile as a series of small habitat reefs

Table 6.6.1: Evaluation Matrix for Construction Options

Variable	Temporary Earthen Berm / Causeway	Dredging	Temporary Work Bridge
Navigation/Recreation			
• Boat passage	• Likely outside boundaries specified in Navigation Protection Act so no formal notification/permitting expected. • Navigation channel will be substantially reduced in width during period of construction	• Likely outside boundaries specified in Navigation Protection Act so no formal notification/permitting expected. • Safety perimeter around dredging equipment will be needed but relatively smaller width of channel expected to be affected.	• Likely outside boundaries specified in Navigation Protection Act so no formal notification/permitting expected. • Safety perimeter around dredging equipment will be needed but relatively smaller width of channel expected to be affected. • Temporary bridge may be a hazard to navigation (vertical clearance) and design will need to consider vessel passage provisions through a section
Risks and Uncertainties	• Relatively higher impact on vessel access restriction which may affect recreational users of the waterway. • Communications plan, navigation markers/lights may be needed	• Relatively lower likelihood that boating access will need to be restricted. • Communications plan, navigation markers/lights may be needed for certain parts of the project.	• Relatively higher likelihood that boating access will need to be restricted. • Communications plan, navigation markers/lights may be needed for the temporary structure
Archaeology			
Loss/ disturbance of artefacts	• Placement of construction materials may bury artefacts.	• Dredging may remove artefacts.	• Installation of piles may bury/damage artefacts, but in a relatively small area.
Risks and Uncertainties	• Can be managed with archaeological monitoring and appropriate chance find management. • Project shut-down if human remains found.	• Can be managed with archaeological monitoring and appropriate chance find management. • Project shut-down if human remains found.	• Can be managed with archaeological monitoring and appropriate chance find management. • Project shut-down if human remains found. • Overall footprint of disturbed materials is smaller and therefore risks of intersecting cultural materials is considered to be lower than for other options.
Noise and Air Quality / Nuisance			
Construction noise	• Some noise generated through placement of material (e.g., motors, metal upon metal, metal upon rock).	• Some noise generated through dredging (e.g., motors, metal upon metal).	• Depending on the method used, pile driving can be relatively noisy and result in nuisance complaints.
Air quality	• Typical emissions from construction equipment. • Truck traffic involved in two way material movement	• Typical emissions from construction equipment. • Dredged and dewatered sediment will need to be managed to minimize dust.	• Typical emissions from construction equipment.
Risks and Uncertainties	• Municipal bylaws may restrict when construction work can happen to minimize nuisance noise in residential areas, which may have an influence on the overall schedule.	• Municipal bylaws may restrict when construction work can happen to minimize nuisance noise in residential areas, which may have an influence on the overall schedule. • Additional controls may be needed for dust management.	• Municipal bylaws may restrict when construction work can happen to minimize nuisance noise in residential areas, which may have an influence on the overall schedule. • Communications plan to address complaints.
Traffic			
Import of material	• Additional traffic through adjacent communities if construction materials brought in by truck.	• Not expected.	• Additional traffic through adjacent communities if construction materials brought in by truck
Export of dredged material	• Not expected.	• Additional traffic through adjacent communities if dredged sediment transported to a landfill by truck.	• Not expected.
Risks and Uncertainties	• Intermediate number of truck trips for this option. • Municipal bylaws may restrict truck routes and schedules, which may have an influence on the overall schedule.	• Greatest number of truck trips for this option. • Municipal bylaws may restrict truck routes and schedules, which may have an influence on the overall schedule.	• Least number of truck trips for this option. • Municipal bylaws may restrict truck routes and schedules, which may have an influence on the overall schedule.
Studies/Plans Needed in Addition to Preliminary Design			
Geotechnical	• Plan for placement and recovery of material • Berm side-slope and confirmation of spatial impact zone • Deformation of existing sediment surface adjacent to the berm • Stability of work surface and settlement of material	• Assessment of potential for slumping of side walls of dredge channel	• Assessment of seating depth for temporary pilings. • Methodology of piling driving and development of mitigation plans (e.g., bubble curtain). • Type of piling and need for preservatives (e.g., creosote) if not steel pile

Table 6.6.1: Evaluation Matrix for Construction Options

Variable	Temporary Earthen Berm / Causeway	Dredging	Temporary Work Bridge
River Hydrology	• Potential for flooding • Change in water flows and natural hydrologic and sediment transport processes • Ice scour • Bathymetry • Geophysical (sediment thickness)	• Change in water flows and natural hydrologic and sediment transport processes. • Ice scour • Bathymetry • Geophysical (sediment thickness)	• Hydraulic design of pier • Scour analysis
Sediment and erosion control	• Silt curtain configuration • SECP	• Silt curtain configuration • SECP	Silt curtain configuration
Sediment dewatering	• Methods for effective dewatering of dredged sediments • If flocculants are proposed, bench-scale testing and toxicity testing may be needed. • Water quality monitoring plan • Staging area	• Methods for effective dewatering of dredged sediments • If flocculants are proposed, bench-scale testing and toxicity testing may be needed. • Water quality monitoring plan. • Staging area	• Water quality monitoring plan
Water treatment	• Water treatment may be needed for the subaqueous portions of the berm material when it is removed.	• Methods for effective treatment of water generated during hydraulic dredging. • If flocculants are proposed, bench-scale testing and toxicity testing may be needed.	N/A
Sediment disposal	• Location of disposal of the Berm material (and over-excavated sediment) • Sampling and analysis of Berm material to support material management at the disposal location • Locations that can accept sediment of this type, cost analysis of transportation and tipping fees.	• Locations that can accept sediment of this type, cost analysis of transportation and tipping fees.	• Possibly required for permanent bridge piers. Volumes will be small. Can be managed with geotubes and local disposal or landfill disposal.
Noise/air	• Dust management plan • Odor Controls	• Dust management plan • Odor Controls	• Assessment of noise associated with installation of temporary pilings for work bridge • Noise monitoring plan • Communications plan for addressing complaints.
Archaeology	Management Plan	Management Plan	Management Plan
Restoration	• Restoration planning, including long-term monitoring	• Restoration planning, including long-term monitoring	• Method of pile removal and options for different methods (e.g., cut and cover, remove entire pile) • Environmental management planning

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

TEMPORARY WOR□ BRIDGE AND CONSTRUCTION IMPACT ON RIVERBED

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	6.7.1
Sheet No.:	-- of ---
Des: JJA	Chk'd: RO
Dwn: □RS	Chk'd: JJA
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

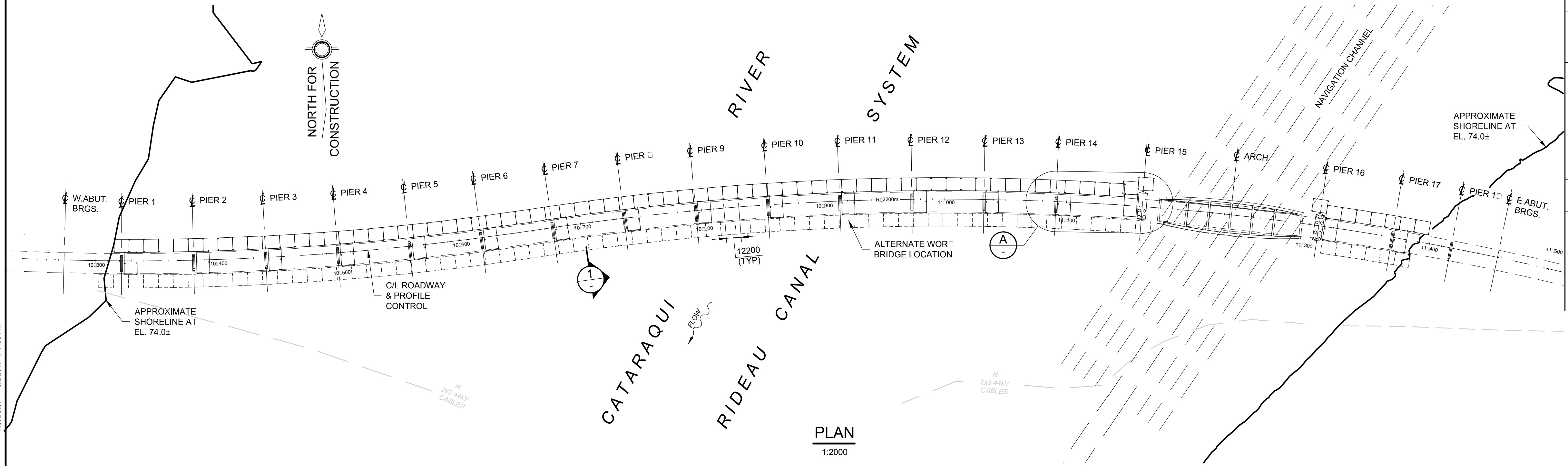
No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

LEGEND:

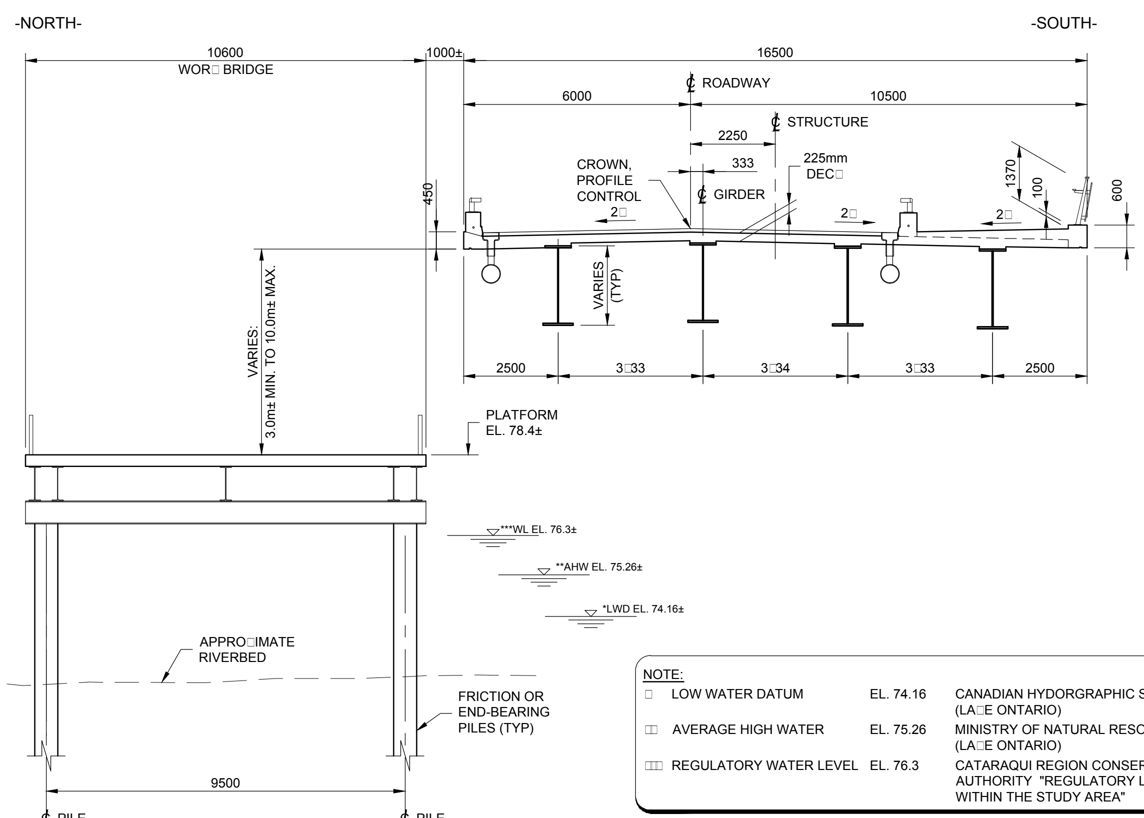
AREA OF RIVERBED IMPACTED BY CONSTRUCTION

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH SUGGESTED CONSTRUCTION SEQUENCE DRAWINGS.



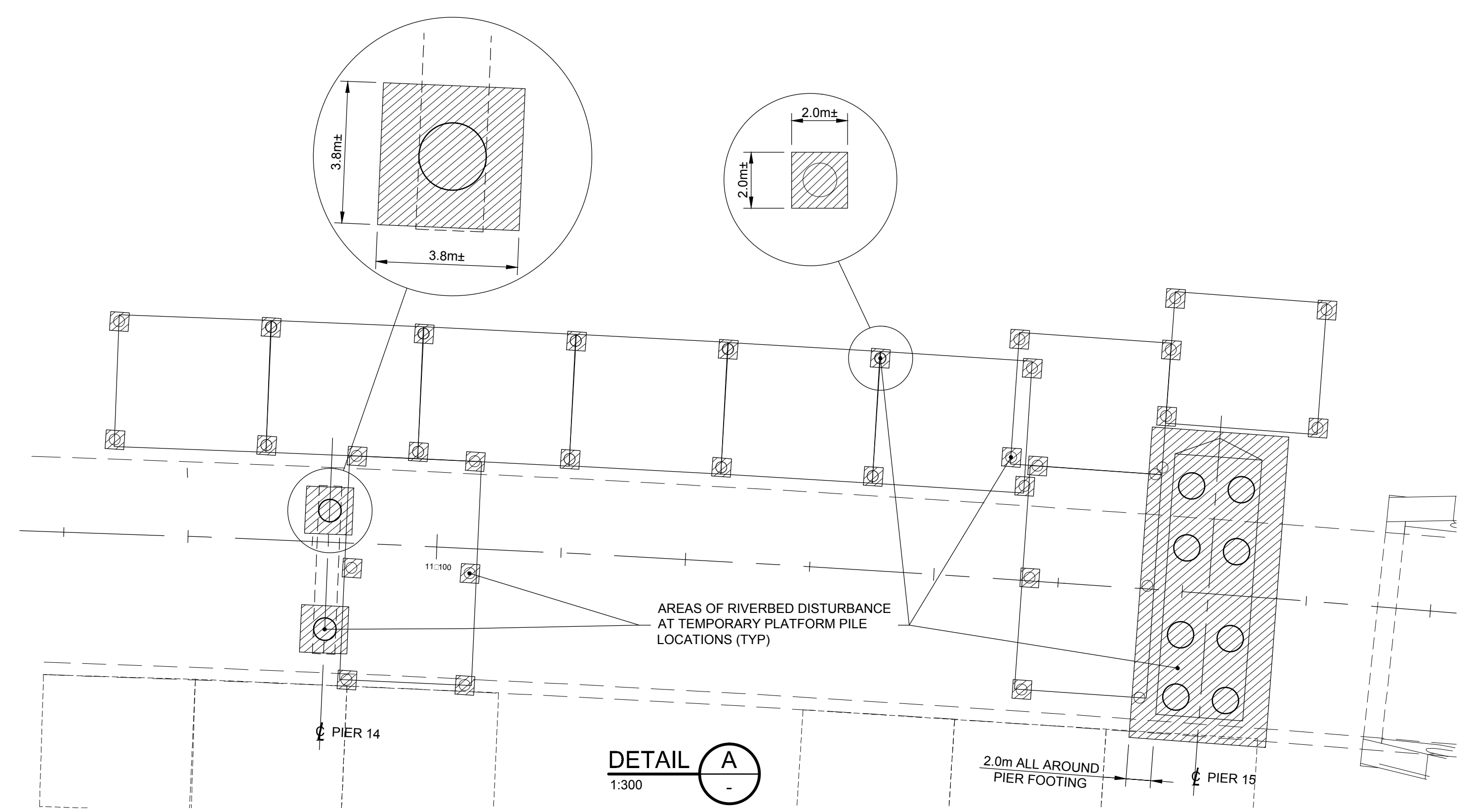
PLAN
1:2000



SECTION 1
1:100

NOTE:

□	LOW WATER DATUM	EL. 74.16	CANADIAN HYDROGRAPHIC SERVICE (LA□E ONTARIO)
□□	AVERAGE HIGH WATER	EL. 75.26	MINISTRY OF NATURAL RESOURCES (LA□E ONTARIO)
□□□	REGULATORY WATER LEVEL	EL. 76.3	CATARAQUI REGION CONSERVATION AUTHORITY "REGULATORY LIMIT WITHIN THE STUDY AREA"



DETAIL A
1:300

Plot Date: 5/2/2017 1:17:35 PM
Last Saved: Monday, May 01, 2017 □:12:23 AM
Consultant's Information: C:\pw_working\ontario\p004544\dms01335\6.7.1.dwg

7.0 DESIGN CONCEPT REFINEMENT

The City and Project Team collaborated extensively with Parks Canada to determine how the environmental and economic aspects associated with building the bridge could be balanced. The solution was to refine the v-pier design for the approach spans and convert them into conventional piers with pier caps supporting the superstructure. These conventional piers were shaped to form a cohesive part of the architectural design.

7.1 Conventional Piers versus V-Piers

7.1.1 Alternative Pier Design

The use of v-piers for all the pier locations would have an impact to the sensitive wetlands as each foundation would require excavation of the riverbed and create a permanent footprint in the river. Alternative pier options were investigated to minimize the impacts to the riverbed as well as reduce the overall cost of the substructure. The piers which support the arch span would remain unchanged for aesthetics reasons.

The first option that was considered was conventional piers which consist of circular piers on top of the caissons with a pier cap as shown in **Figure 7.1.1.1**. With the use of conventional piers instead of v-piers, the foundation requirements reduced significantly. As there is less ice loading on the piers due to their circular shape and no footing at the river level, the foundation requirements can be reduced from five 2400 mm diameter caissons to two 1800 mm diameter caissons, using an ice loading of 1100 kPa at an elevation of 75.9 m, which is the high ice loading. The circular caissons would extend above the high-water level and be protected by a steel casing to add protection to the concrete from ice and abrasion.

7.1.2 Span Arrangement

Five additional piers will be required with the conventional pier option (four to the west of the arch and one to the east of the arch) as the elimination of the v-piers would have increased the span lengths, had a similar pier spacing been used for the conventional one. The span lengths to the west of the arch will be consistent at 59.2 m except for the first span which will be 47.2 m and the span adjacent to the v-pier which will be 58.9 m for geometrical reasons. To the east of the arch, there will be two spans at 49.0 m and one span at 38.1 m. shows the difference in the span arrangements from the v-pier option to the conventional pier option. Having consistent span lengths will create efficiencies during construction. As the span lengths are shorter overall than the span lengths with the v-piers, there is a reduction in the structural steel weight of approximately 450 tonnes and associated costs.

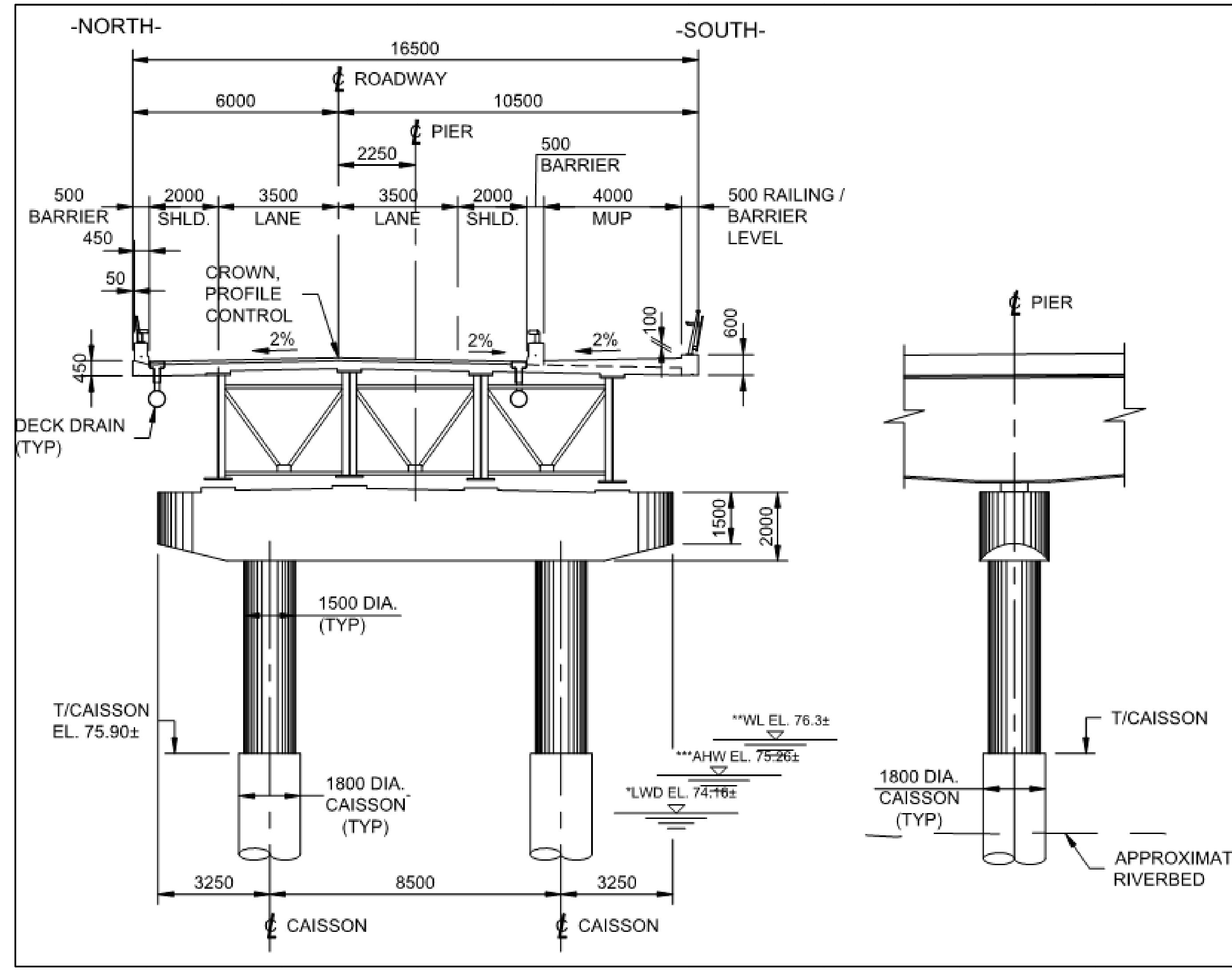


Figure 7.1.1.1: Conventional Circular Piers with Hammerhead Pier Cap

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT
COMPARISON OF V-PIERS AND CONVENTIONAL PIERS

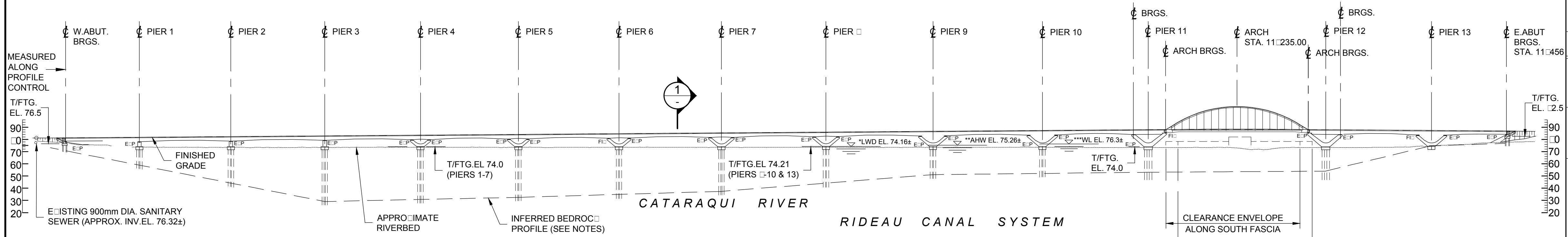
Mark Van Buren, P.Eng. — Director of Engineering & Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer
KINGSTON
J.L.Richards — ENGINEERS · ARCHITECTS · PLANNERS
PARSONS

Project No.:	27143
Drawing No.:	7.1.2.1
Sheet No.:	-- of --
Des: JJA	Chk'd: RO
Dwn: □RS	Chk'd: JJA
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

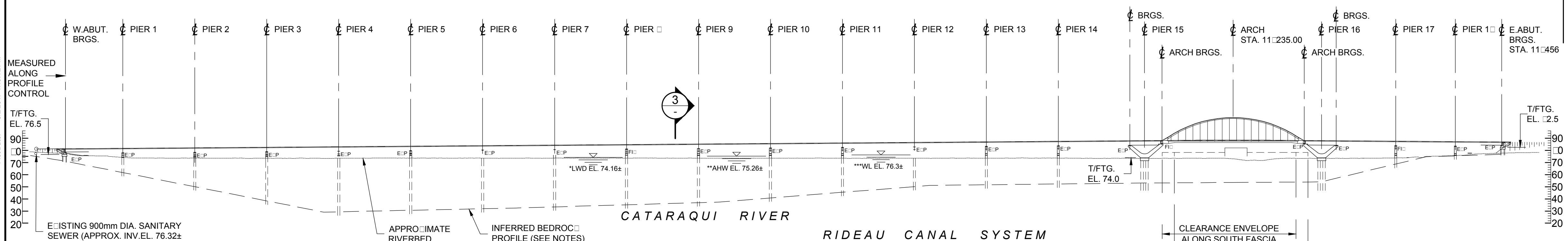
REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



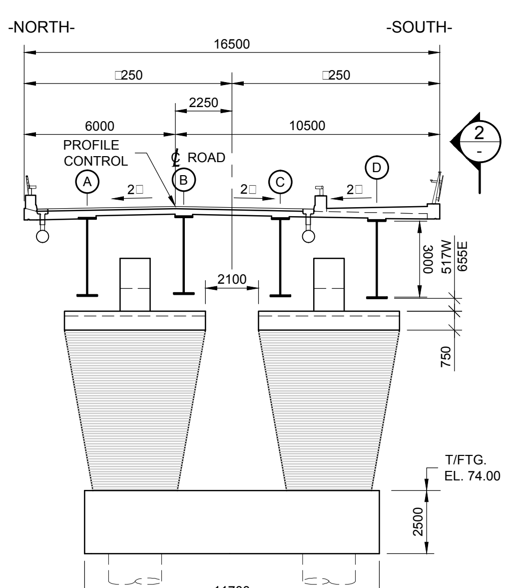
ELEVATION
1:2000

V-PIER CONFIGURATION

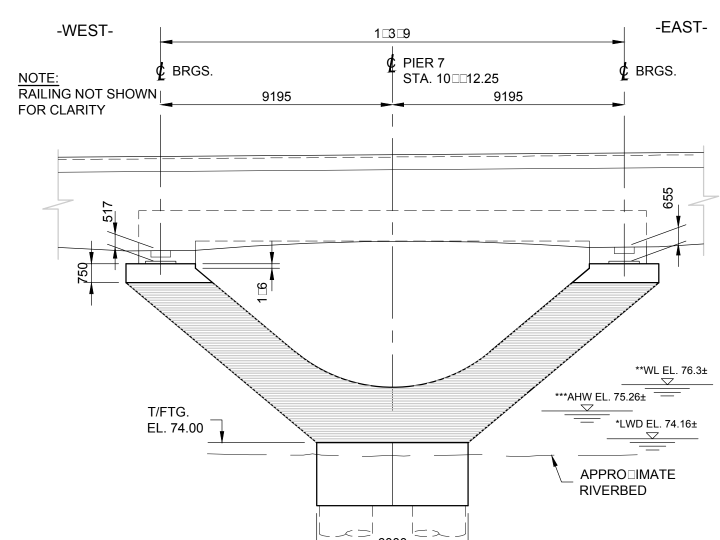


ELEVATION
1:2000

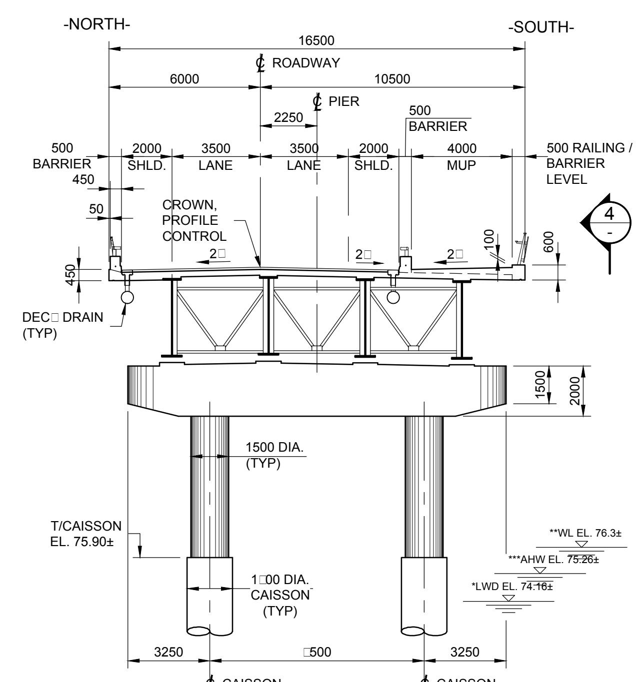
CONVENTIONAL PIER CONFIGURATION



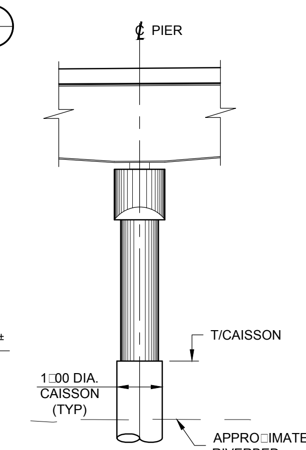
SECTION 1
1:150



ELEVATION 2
1:150



SECTION 3
1:150



SECTION 4
1:150

Plot Date: 5/2/2017 1:19:1□ PM
Last Saved: Monday, May 01, 2017 □:17:2□ AM
Consultant's Information: C:\pw_working\ontario\p004544\dms01335\7.1.2.1.dwg

7.1.3 Comparison with V-Piers

An evaluation matrix was created as shown in **Table 7.1.3.1** to compare the advantages and disadvantages of v-piers and conventional piers.

Table 7.1.3.1: Evaluation matrix for Different Pier Options.

Criteria	Sub-Criteria	V-Piers	Conventional Piers
Description		This option would consist of three wall-type flared piers at the west side with ten v-piers. The v-piers will be supported on five 2400 mm diameter caissons with a pile cap. Each v-pier will require post-tensioned ties. The arch span will be supported by two v-piers on eight 2100 mm diameter caissons.	This option would consist of 16 simple piers that will comprise of two 1800 mm caissons with two 1500 mm circular piers and a pier cap. There will be 4 additional piers west of the arch and 1 additional piers east of the arch. The arch span will be supported by two v-piers on eight 2100 mm diameter caissons.
Permanent Foundation In-Water Footprint / Wetland Impacts (excluding scour protection)		~ 2400 m^2	~ 1100 m^2
Cost	Piers Only	~$53.8M	~$24.4M
	Superstructure	No change	-$2.2M
	Total	~$53.8M	~$22.2M
Ease of Construction	Caissons	Would require larger equipment to install the larger diameter caissons.	Equipment for caisson installation would be more readily available.
	Formwork / Falsework	V-piers would require specialty formwork / falsework or be made of precast box sections or varying geometry. Temporary supports would be required for some of the v-pier legs during construction.	The simple piers would require simple standard formwork.
	Reinforcement	Reinforcing will be more complex to match the geometry of the v-piers. Post-tensioning will be required in the ties.	Reinforcing could be tied off-site for the piers and simply lifted into place.
Construction Duration Per Pier[1]	Considerations	Five caissons required. Piers will take longer to form as each one is geometrically different. V-piers require post-tensioning in the ties and potentially in the v-pier legs. Five different pours – caissons, pile cap, base of v-pier, v-pier legs, and tie.	Two caissons required. Pier will be simple to form with standard formwork. Three different pours – caissons, circular piers and pier caps
	Estimated Total Duration	~15 weeks per pier	~7 weeks per pier
Aesthetics	Substructure	More aesthetically pleasing v-piers	V-Piers only at the arch, conventional piers elsewhere
	Superstructure	Similar	Similar
	Arch	Similar	Similar
User Experience	On the Bridge	Similar	Similar
	On Boat	Similar	Similar within navigation channel
Maintenance and Operation Costs	Bearings	More bearings to maintain - 96 bearings	Less bearings to maintain – 92 bearings
	Concrete	Greater surface area of exposed concrete	Lower portion of caissons will be jacketed with steel liner to provide extra protection. Smaller exposed concrete surface area.
Maximum Spacing Between Piers[2] (excluding arch span)		~90 m	~58m
Design	Advantages	N/A	Less area exposed to ice loads. Conventional pier design. Less demand on the substructure components.
	Disadvantages	Piers will require special treatment to break the ice.	N/A

1. This evaluation matrix does not account for the arch v-piers as they are the same for both options.
2. V-piers have two legs and two lines of supports, this criterion measures the spacing between the centerline of the v-piers.

Based on the matrix, the conventional pier option is preferred, as it is the least expensive; it has less impact to the wetland; it is easier to build; and it is easier to subsequently maintain and repair.

7.1.4 Class 'C' Cost Estimate

A Class 'C' comparative cost estimate was conducted to determine the cost difference between the two pier options as shown in **Table 7.1.4.1**. The use of conventional piers decreases the number and size of caissons required, even with the additional piers. This is because the ice loading is considerably less on the conventional piers due to their circular shape and smaller surface area. The cost savings from the use of conventional piers in caissons alone is approximately $13.8M. The conventional piers have less concrete than the v-piers, are less expensive to form and do not require a post-tensioned tie. The overall cost savings based on the Class 'C' Cost Estimate is $29.4M for the piers alone, which does not include the additional $2.2M in savings from the reduction in structural steel in the approach spans.

Table 7.1.4.1: Class 'C' Cost Comparison between V-Piers and Conventional Piers

Piers	Three Wall Type Piers, Remaining Piers are V-Piers	Sixteen Conventional Piers and Two Arch V-Piers	Difference
Item Description	**Total Cost**	**Total Cost**	
Dewatering Structure Excavations	$375,000	$375,000	
Supply Equipment for Installing Caisson Piles	$1,890,000	$1,890,000	
Caisson Piles	$11,600,000	$6,246,000	$5,174,000
Excavate Rock Sockets	$3,000,000	$2,100,000	$900,000
Tremie Concrete - Caissons	$8,376,000	$2,976,000	$5,400,000
Reinforcing Steel – Black – Caissons	$3,840,000	$1,504,000	$2,336,000
Concrete in Pile Cap	$2,980,000	$1,010,000	$1,970,000
Reinforcing Steel – Black – Pile Cap	$1,056,000	$384,000	$672,000
Concrete in Pier – Wall Type	$480,000	$290,000	$190,000
Concrete in V-Piers	$12,636,000	$4,716,000	$7,920,000
Reinforcing Steel – Galvanized – V-Piers	$5,070,000	$1,950,000	$3,120,000
Concrete in V-Pier Ties / Pier Caps	$1,056,000	$456,000	$600,000
Reinforcing Steel – Galvanized – V-Pier Ties / Pier Caps	$351,000	$195,000	$156,000
Pier – Stressing System	$1,075,000	$107,500	$967,500
Total for Piers Section	**$53,785,000**	**$53,785,000**	**$29,405,500**

7.2 Refinement of Conventional Pier Design

The City and Project Team continued to collaborate with Parks Canada in refining the conventional pier design to better match the aesthetics of the v-piers at the arch and the arch geometry. The use of inclined rectangular piers instead of circular piers provides a cohesive look along the bridge as the incline of the pier legs matches the inclination of the v-piers and the tilted arch. A standard transition from a circular caisson to a rectangular pier leg would be used to convert the circular form into the rectangular pier leg over a height of 1.5m. The use of a custom steel form could be used to form the transition which could be re-used multiple times. Keeping the inclination of the pier legs consistent at 10˚ and the pier cap width at 13.5 m, the caisson spacing would have to vary to maintain the same geometry. As the piers get taller, the caissons get closer together. The inside face of the pier legs would also be inclined at 10˚ to match the shape of the v-piers as shown in **Figure 7.2.1**. The refinement of the conventional piers to inverted u-frame piers is shown in **Drawing 7.2.1**.

The total additional costs for the inverted u-frame piers option over the circular piers with pier cap option is approximately $268,000 for all the piers. There is less concrete and reinforcement in the pier cap for the inverted u-frame option than the circular pier option. However, there is more concrete in the pier legs and it is slightly more expensive to form the inverted u-frame pier legs than the circular piers which is why there is an increase in cost as shown in **Table 7.2.1**.

Table 7.2.1: Cost Comparison between Circular Pier Option and Inverted U-Frame Pier Option

		Circular Piers with Pier Cap			Inverted U-Frame Piers			Difference
Item Description	Unit	Estimated Quantity	Unit Price	Total Cost	Estimated Quantity	Unit Price	Total Cost	Total Cost
Piers								
Caisson Piles – 1800 mm Dia.	m	1150	$ 4,200	$4,830,000	1150	$4,200	$4,830,000	$-
Caisson Piles – 2100 mm Dia.	m	350	$5,000	$1,750,000	350	$5,000	$1,750,000	$-
Tremie Concrete - Caissons	m3	4130	$800	$ 3,304,000	4130	$800	$3,304,000	$
Excavate Rock Sockets	m	190	$10,000	$1,900,000	190	$ 10,000	$1,900,000	$
Reinforcing Steel - Black - Caissons	t	990	$3,200	$3,168,000	990	$3,200	$3,168,000	$

Table 7.2.1: Cost Comparison between Circular Pier Option and Inverted U-Frame Pier Option

		Circular Piers with Pier Cap			Inverted U-Frame Piers			Difference
Item Description	Unit	Estimated Quantity	Unit Price	Total Cost	Estimated Quantity	Unit Price	Total Cost	Total Cost
Concrete in Pile Cap	m3	1010	$ 1,000	$1,010,000	1010	$1,000	$1,010,000	$-
Reinforcing Steel - Black - Pile Cap	t	120	$3,200	$384,000	120	$3,200	$384,000	$ -
Concrete in Pier	m3	180	$ 1,000	$180,000	420	$1,200	$504,000	$(324,000)
Concrete in Piers - V-Piers	m3	2620	$ 1,800	$4,716,000	2620	$1,800	$4,716,000	$ -
Reinforcing Steel - Galvanized - Piers	t	490	$3,900	$1,911,000	500	$3,900	$1,950,000	$(39,000)
Concrete in Pier Caps	m3	870	$1,200	$1,044,000	760	$1,300	$988,000	$56,000
Reinforcing Steel - Galvanized - Pier Caps	t	90	$ 3,900	$351,000	80	$3,900	$312,000	$39,000
Concrete in V-Pier Ties	m3	230	$1,200	$276,000	230	$ 1,200	$276,000	$ -
Reinforcing Steel - Galvanized - V-Pier Ties	t	30	$3,900	$117,000	30	$3,900	$117,000	$ -
Pier - Stressing System	t	1	$215,000	$107,500	1	$215,000	$107,500	$-
Total				**$25,048,500**			**$25,316,500**	**$(268,000)**

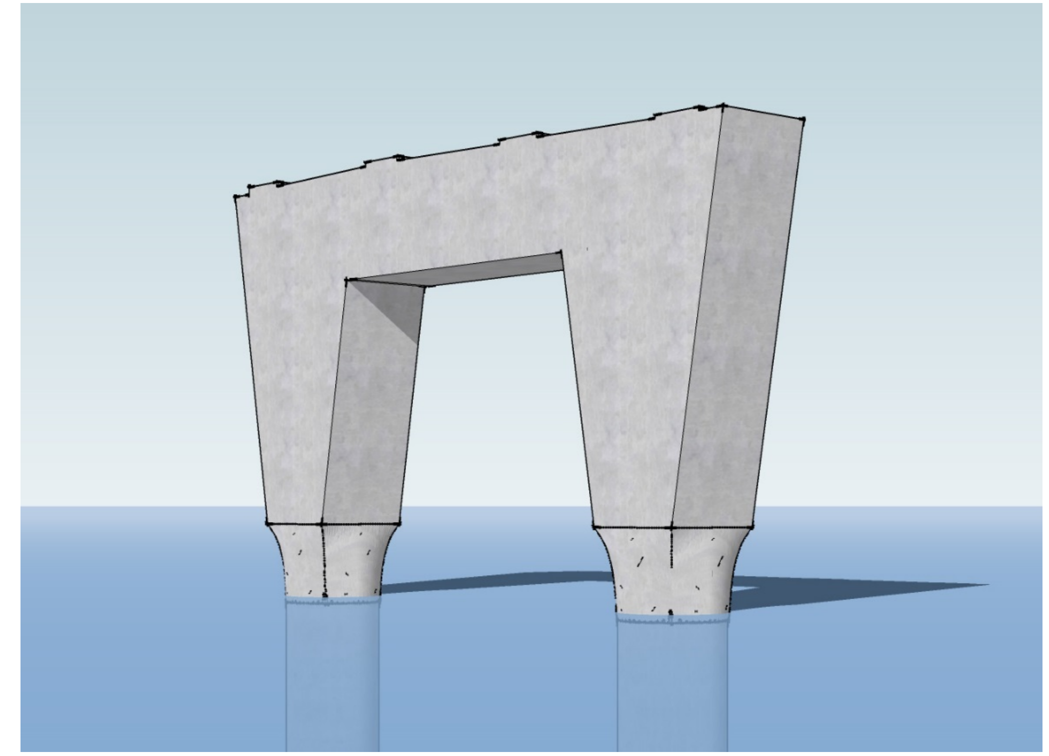


Figure 7.2.1: Rendering of Inverted U-Frame Pier

7.3 Benefits of Alternative Design

There are numerous benefits to the use of inverted u-frame piers over v-piers:

1. The reduction of the impact to the wetland.
2. Substantial cost savings with the v-pier option by over $30M.
3. The use of consistent spans which will simplify construction of the structural steel.
4. A simpler design which will simplify construction.
5. It will take substantially less time to construct as they are much simpler to form and do not require any complex formwork or post-tensioning.
6. Dewatering activities will not be required as the caisson liners extend above the water level.
7. The design adheres to the aesthetic guidelines as the consistent outside face angle of the piers match the tilted angle of the arches to provide a cohesive overall rhythm that gradually increases in height towards the arch.

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

REFINEMENT OF CONVENTIIONAL PIERS

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

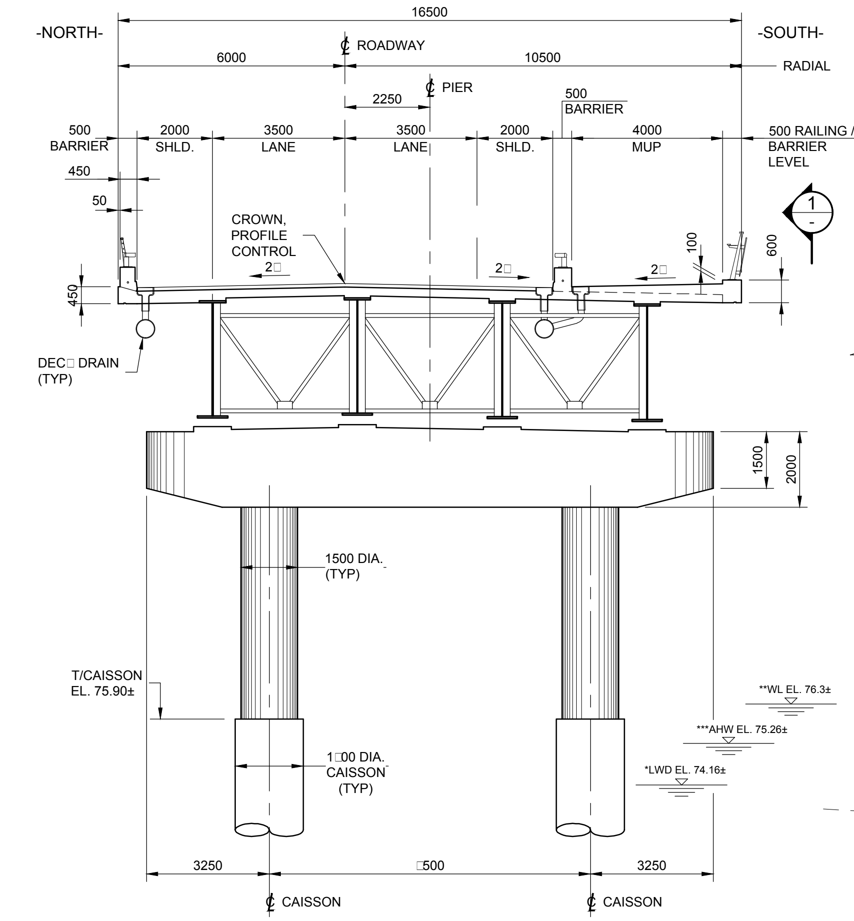
PARSONS

Project No.:	27143
Drawing No.:	7.2.1
Sheet No.:	-- of ---
Des: JJA	Chk'd: RO
Dwn: □RS	Chk'd: JJA
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

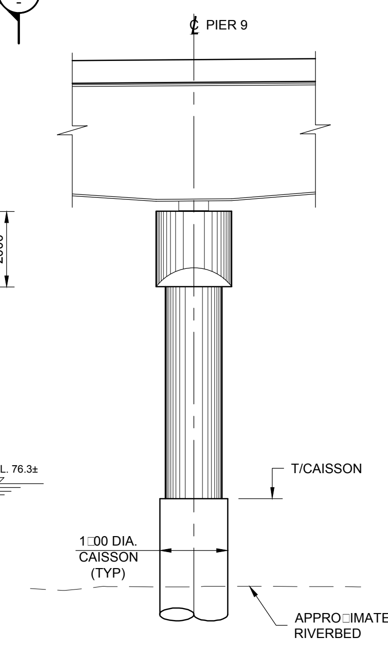
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

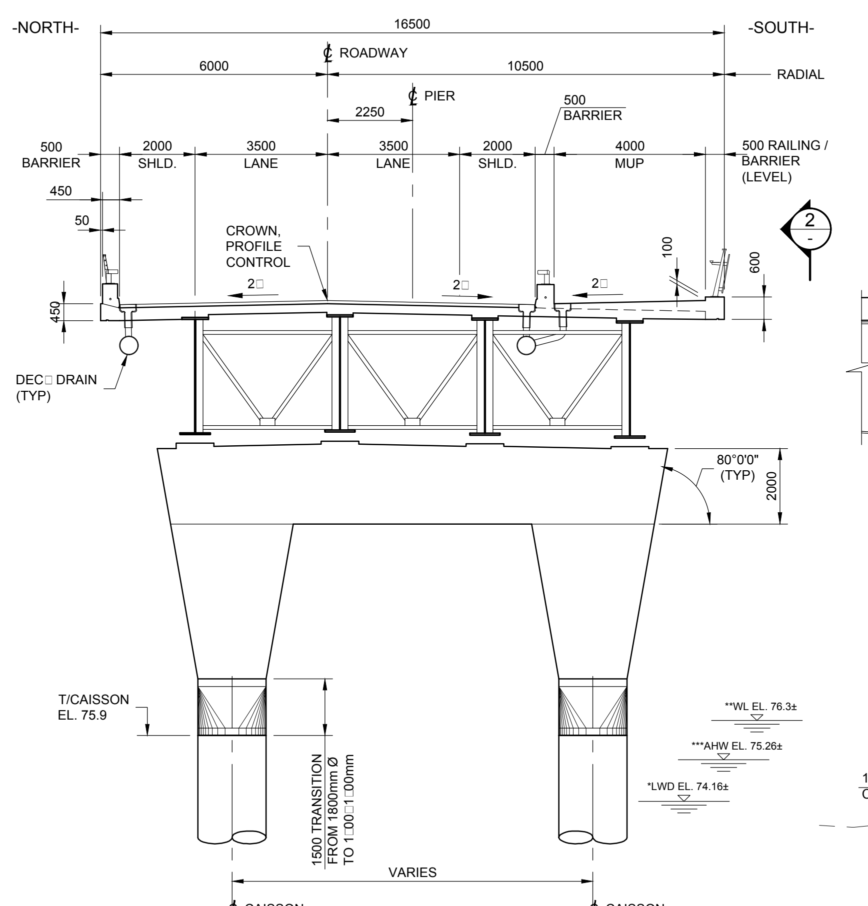
No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



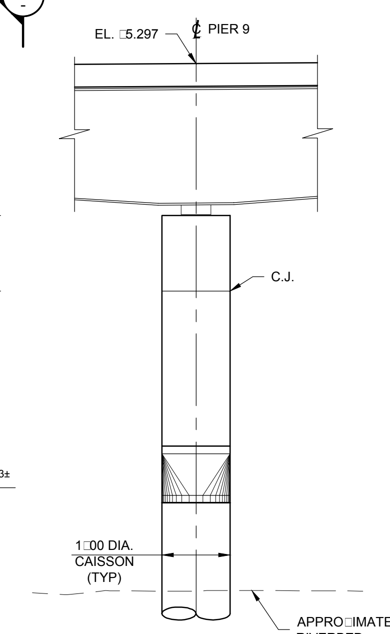
TYPICAL SECTION - HAMMERHEAD PIER
1:100



SECTION 1 / -
1:100



TYPICAL SECTION - INVERTED "U" FRAME PIER WITH TRANSITION PIECE
1:100



SECTION 2 / -
1:100

Plot Date: 5/2/2017 1:21:04 PM
Last Saved: Monday, May 01, 2017 □:20:57 AM
Consultant's Information: C:\pw_working\ontario\p004544\dms01335\7 2 1.dwg

8.0 PROJECT DESCRIPTION

8.1 Overall

The Third Crossing is a 21-span, 1.2 km long bridge on an s-curve which will cross the Cataraqui River and connect Gore Road on the east shore to John Counter Boulevard on the west shore. The bridge will have a vertical curve centered on the main span which will consist of an inclined outward tied arch over the navigational channel. The arch will have five transverse braces and a total of 32 multi-strand cables which will support the floorbeams to suspend the concrete deck from the arch. The arch will be supported on concrete v-piers on both sides and the remaining 16 piers will be inverted u-frame piers with flared pier legs to match the inclination of the arch which support the approach spans. The approach spans consist of four structural steel plate girders that are haunched at the piers.

The bridge will have an overall width of 16.5 m which consists of two 3.5 m wide vehicular lanes with a 2 m wide asphalt shoulder on each side, and a 4 m wide multi-use pathway on the south side. The bridge will have a 225 mm thick reinforced concrete deck with 90 mm of asphalt and waterproofing at the roadway and two storm sewer pipes that run underneath the bridge to collect the stormwater. A preliminary general arrangement is shown in **Drawing 8.1.1**. Renderings of the preferred option can are shown in **Figure 8.1.1** to **Figure 8.1.6**.

The preliminary drawing package (provided under separate cover) includes drawings associated with the approach roadways, bridge structure and electrical and signal layout as well as landscape restoration and enhancement. Approach roadway drawings include lane arrangement, grading, stormwater management, underground infrastructure, and conceptual construction staging and laydown drawings. Bridge structure drawings include general arrangement, caisson and footing layout, abutment details, inverted u-frame pier details, v-pier details, bearing and girder layout, arch details, and temporary work bridge and riverbed impact details.

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

PRELIMINARY
GENERAL ARRANGEMENT I

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

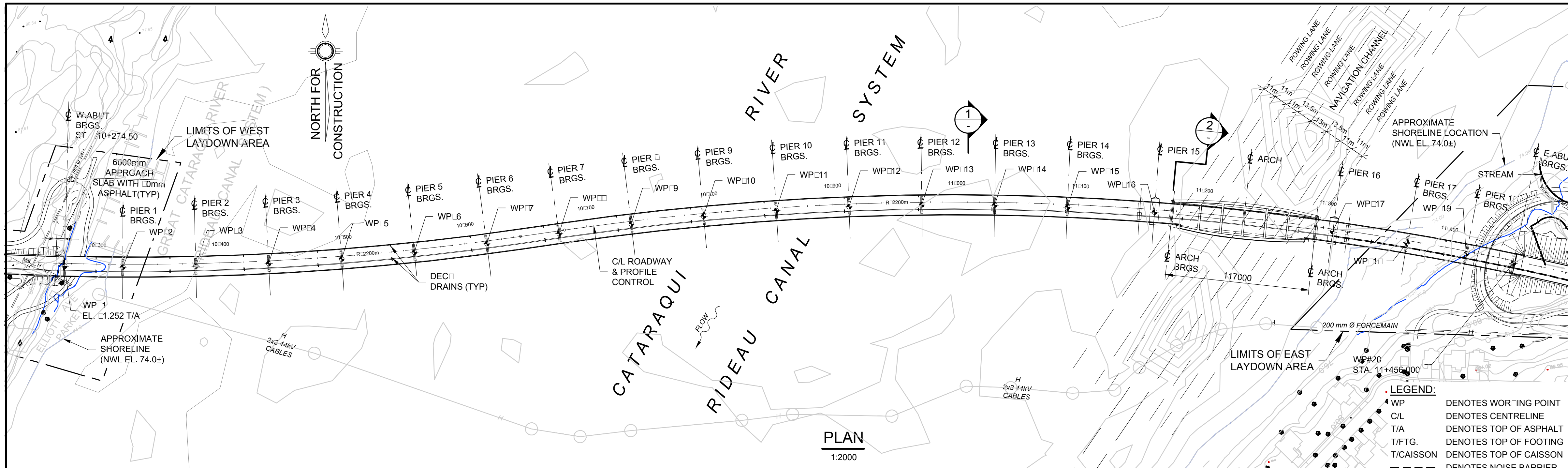
PARSONS

Project No.:	27143
Drawing No.:	□1.1
Sheet No.:	-- of --
Des: JJA	Chk'd: RO
Dwn: □RS	Chk'd: JJA
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CSA-S6-14
Load:	CL625ONT

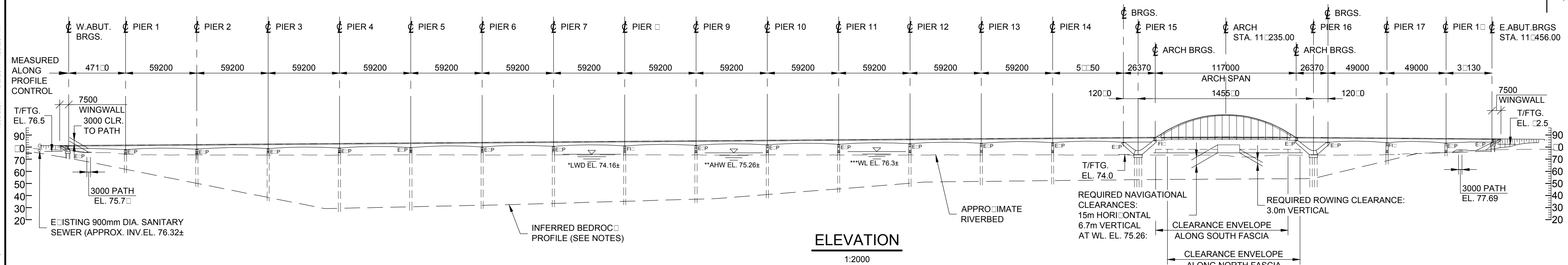
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



PLAN
1:2000



ELEVATION
1:2000

GENERAL NOTES:

DESIGN LOADS

BRIDGE: CL-625-ONT TRUC□ LOAD, CL-625-ONT LANE LOAD OF CHBDC.

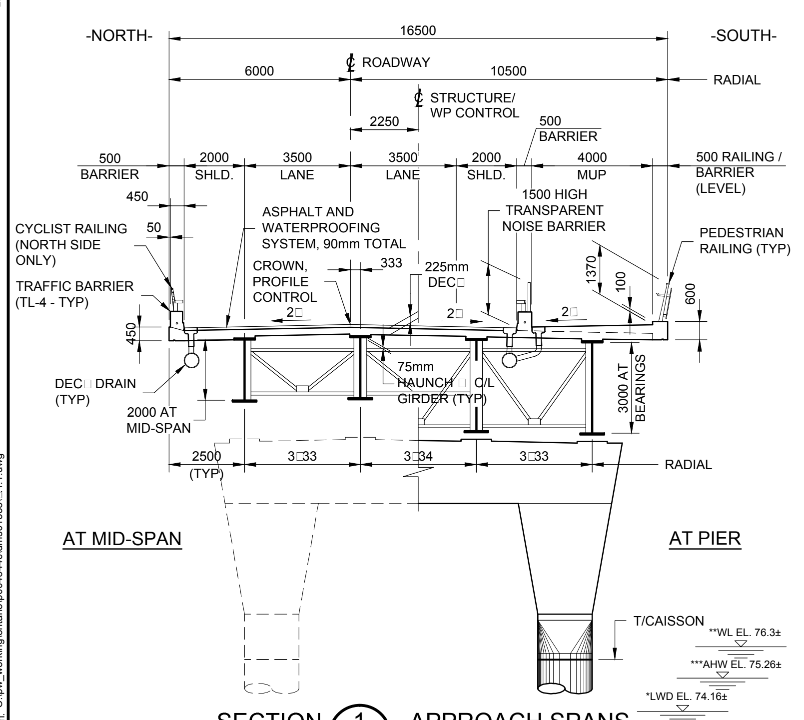
SIDEWAL□: PEDESTRIAN LOADS AND MAINTENANCE VEHICLE OF CHBDC S6-14.

CONSTRUCTION NOTES

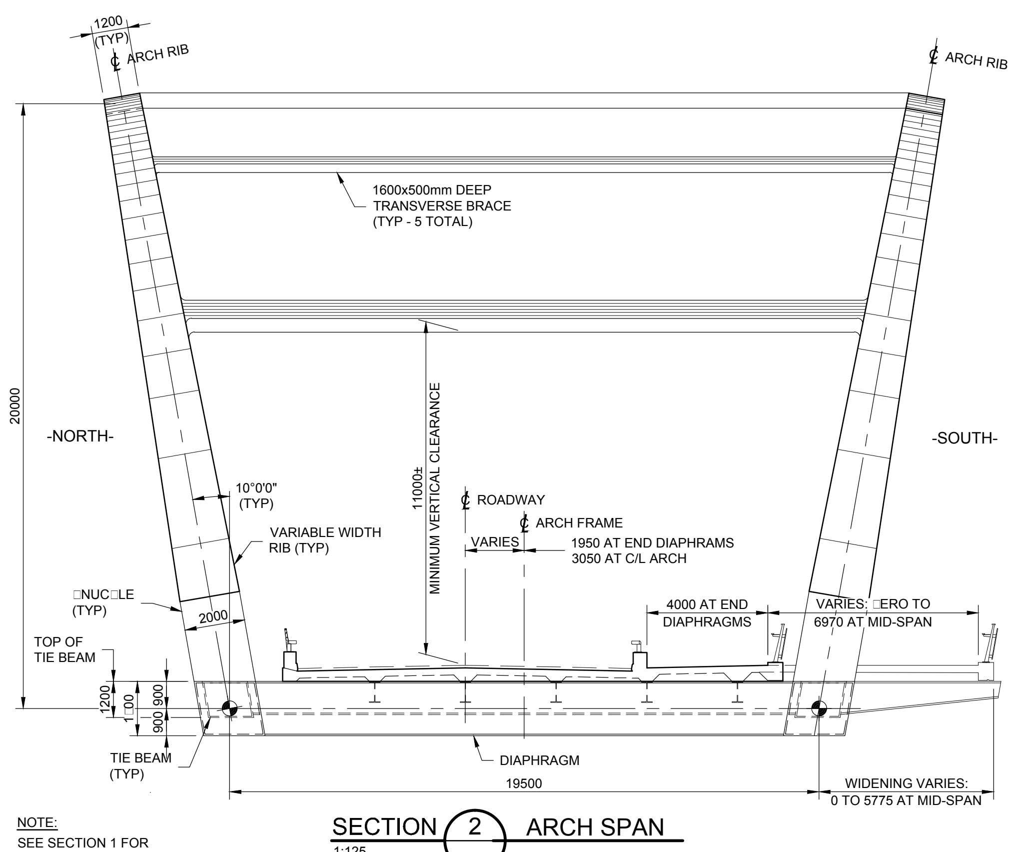
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. CHAINAGES AND ELEVATIONS ARE IN METRES.
2. MAINTAIN FULL NAVIGATIONAL CLEARANCE THROUGHOUT CONSTRUCTION.
3. INFERRED BEDROC□ PROFILE IS BASED ON BOREHOLE LOGS FROM GOLDER ASSOCIATES REPORT ENTITLED "PRELIMINARY GEOTECHNICAL INVESTIGATION - THIRD CROSSING OF CATARAQUI RIVER - JOHN COUNTER BOULEVARD TO GORE ROAD, □INGSTON, ONTARIO", DATED MARCH 2017, REPORT NO. 1541774/2000/003.

NOTE:

□ LOW WATER DATUM	EL. 74.16	CANADIAN HYDROGRAPHIC SERVICE (LA□E ONTARIO)
□□ AVERAGE HIGH WATER	EL. 75.26	MINISTRY OF NATURAL RESOURCES (LA□E ONTARIO)
□□□ REGULATORY WATER LEVEL	EL. 76.3	CATARAQUI REGION CONSERVATION AUTHORITY "REGULATORY LIMIT WITHIN THE STUDY AREA"

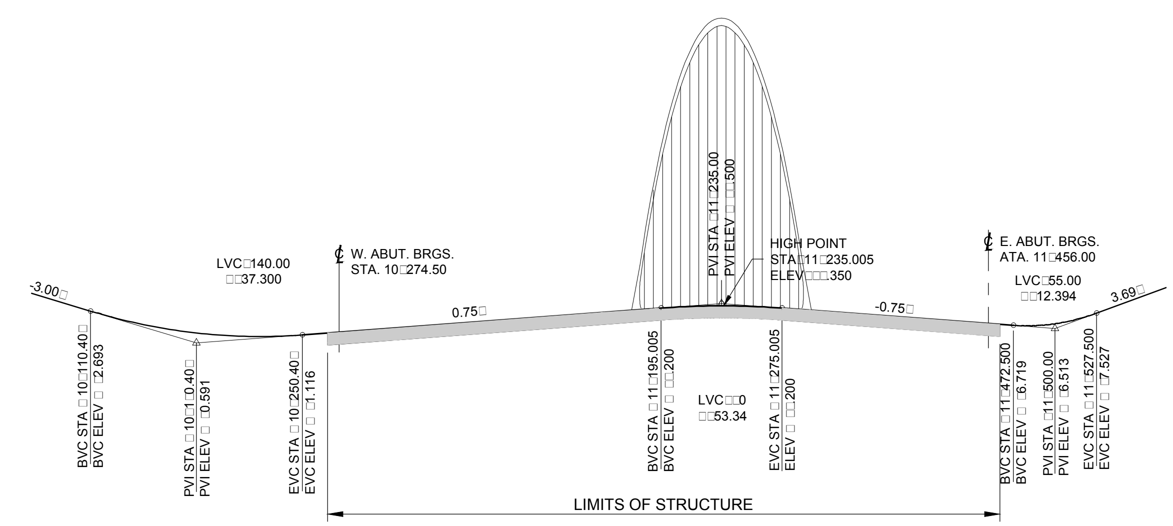


SECTION 1 APPROACH SPANS
1:125



NOTE:
SEE SECTION 1 FOR ROADWAY DIMENSIONS

SECTION 2 ARCH SPAN
1:125



PROFILE THIRD CROSSING
N.T.S.

Figure 8.1.1: Bridge Rendering from the Elliott Avenue Parkette

Figure 8.1.2: On-Water Bridge Rendering Looking South (Close to Buoy S33)

Figure 8.1.3: On-Water Bridge Rendering Looking South at Night (Close to Buoy S33)

Figure 8.1.4: Bridge Rendering Looking from Point St. Mark During Winter

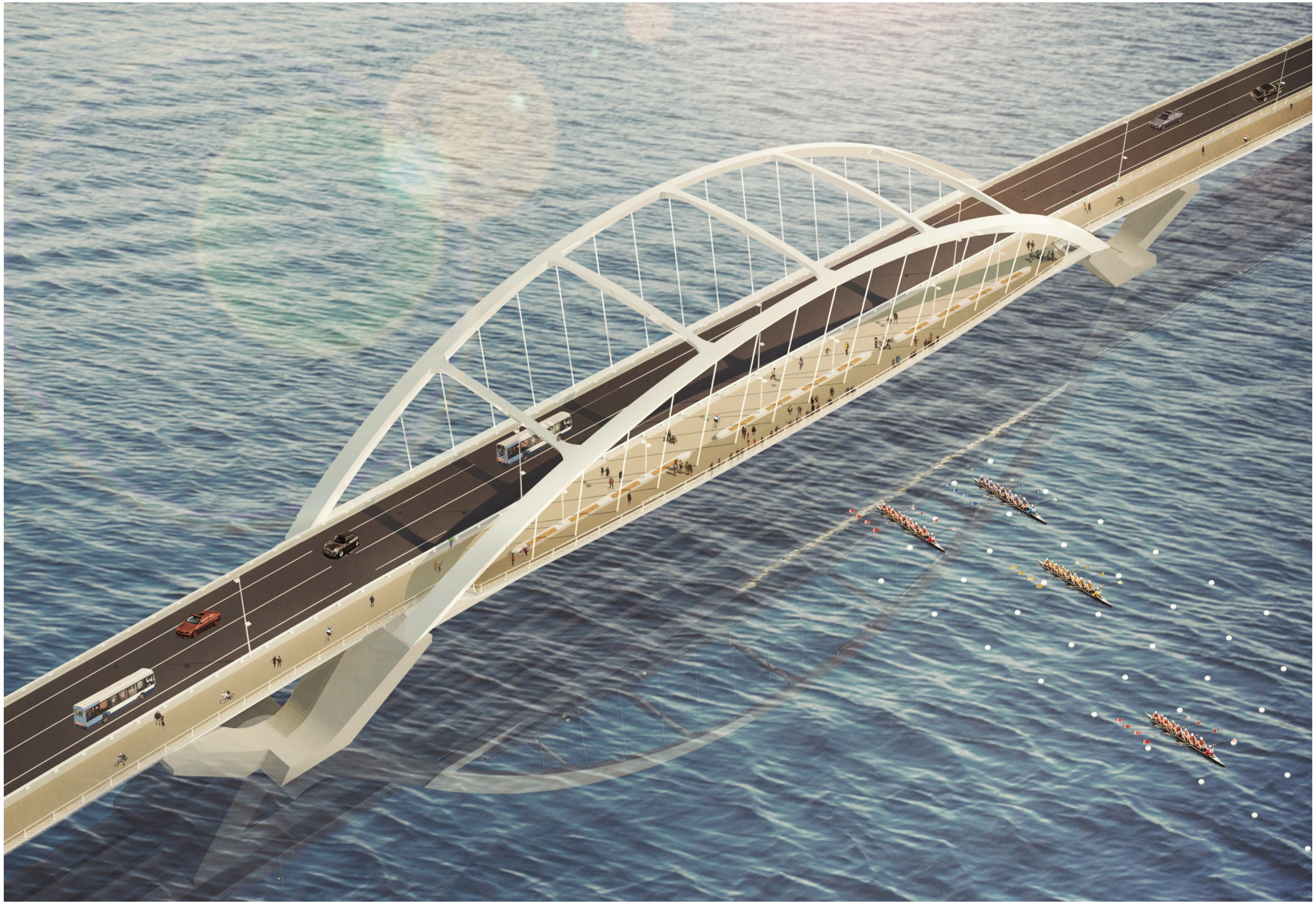


Figure 8.1.5: Bridge Rendering of Birdseye View of Arch

Figure 8.1.6: On-Water Bridge Rendering Looking North (Close to Buoy S15)

8.2 Bridge Cross Section

The vehicular bridge cross-section is uniform throughout, except at the arch where the multi-use pathway curves outward to provide a wider lookout area, with a varying width of up to 9.5 m over the navigable channel, and the rowing lanes. This is shown on **Drawing 8.2.1**.

More specific bridge cross-section components are as follows:

1. Where benches are integrated into the center barrier, the multi-use pathway width is narrower than 4 m. However, it is still wider than the standard 3 m wide multi-use pathways adopted by the City, and is in keeping with the two-way shared pedestrian lane width of 3 m to 4 m, as recommended by the TAC. This is shown in **Figure 8.2.1.1**.

2. At the lookout there will be benches that line the exterior of the multi-use path to provide a continuous multi-use pathway through the lookout area and separate the pathway from the lookout area. On the benches, there will be additional light standards to light up the lookout area as shown in **Figure 8.2.1.2**. The hangers will be protected from maintenance vehicles by curbs.

3. Cyclists will be encouraged to utilize the separated multi-use pathway. Provisions are included in the design to direct cyclists on the north side of the road (westbound direction) to cross to the separated multi-use pathway on the south side of the bridge, and then return to the north side of the approach roadway.

4. The paved shoulders provide for temporary snow storage, drainage, cyclist travel (should cyclists choose to use the shoulder instead of the multi-use pathway), and for passing, should there be a vehicle break-down or maintenance vehicle stopped on the bridge.

5. A normal crown on the vehicular portion of the bridge is provided with a 2% cross-fall in either direction towards drains located adjacent to the vehicular barriers. On the south side of the bridge, the multi-use pathway will incorporate a 2% cross-fall inwards from the south edge of the bridge deck to the concrete barrier separating the vehicular lanes and multi-use pathway. This is to facilitate drainage and snow removal activities. In the case of heavy snowfall or built up windrows, snow plowing within the multi-use pathway area will push snow to the center barrier. The windrows could then be blown over the barrier and into trucks for transport off the bridge.

Figure 8.2.1.1: Multi-Use Pathway West of Arch

Figure 8.2.1.2: Multi-Use Pathway with Lookout Area

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

PRELIMINARY CROSS-SECTIONS

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

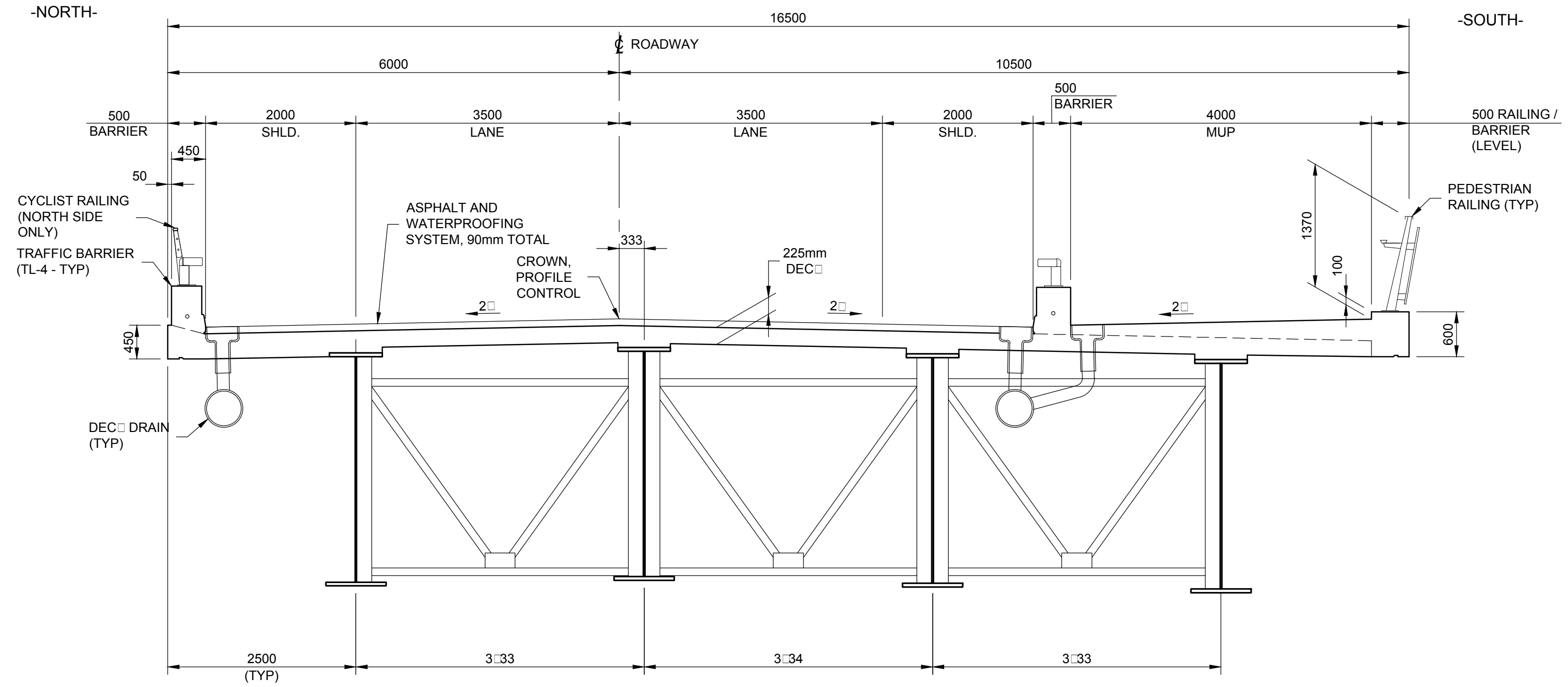
PARSONS

Project No.:	27143
Drawing No.:	□2.1
Sheet No.:	-- of ---
Des: JJA	Chk'd: RO
Dwn: □RS	Chk'd: JJA
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

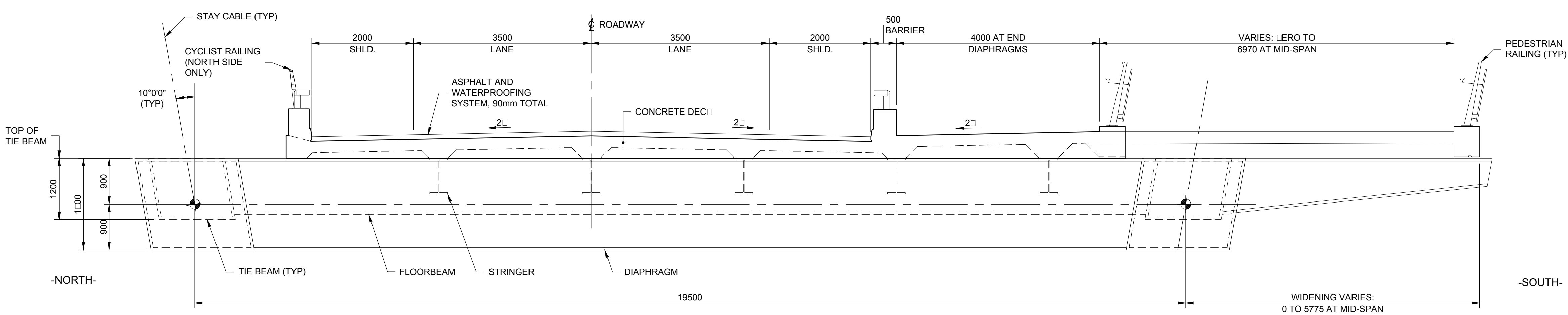
REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



TYPICAL CROSS-SECTION - APPROACH SPANS

1:50



CROSS-SECTION - ARCH SPAN

1:50

Plot Date: 5/2/2017 1:25:24 PM
Last Saved: Monday, May 01, 2017 □:29:26 AM
Consultant's Information: C:\pw_working\ontario\p004544\dms01335\□2.1.dwg

8.3 Approach Roadway Cross Section

The approach roadway lane widths are also 3.5 m, but the shoulders are 1.5 m wide, as per current City standards for cycling infrastructure. The bridge approaches also include a normal center roadway crown with 2% cross-fall in either direction, except for the superelevation near the east approach, where a cross-fall of up to 4% northwards is provided.

8.4 Horizontal Alignment

As shown earlier on **Drawing 5.1.1**, the horizontal alignment of the bridge includes two 2200 m radii horizontal curves. This achieves a normal crown on the bridge deck and avoids the need for superelevation on the structure, based on the design speed and posted speed criteria.

8.5 Vertical Profile

The 0.75% vertical profile option as described earlier in this Report is recommended. More specific components are as follows:

1. The vertical crest is centered on the arch span to facilitate design and construction.
2. The grade on both sides of the crest is the same to allow for repeatability in the arch piers.
3. Sags on the approaches to bridge are incorporated to allow for bridge deck drainage.
4. The bridge clearance above the water accommodates existing topographic conditions on both shorelines and exceeds the Rideau Canal's minimum 6.7 m Federally regulated navigable requirement.
5. Adequate vertical clearance of the pathway is also provided at the west abutment.

8.6 Span Arrangement

The 1.2 km bridge is separated into 21 spans with a main span of 117 m supported on v-piers which have a jump span of 26.4 m. The distance pier-to-pier at the arch span provides unencumbered through-navigation for the Canal's navigable channel and adjacent rowing lanes. There are 14 inverted u-frame piers to the west of the arch and 2 inverted u-frame piers to the east. The span lengths on east side are consistent at 59.2 m except Span 1, which is from the west abutment to Pier 1, has a span length of 47.2 m. The span lengths to the east are consistent at 49 m except Span 21 (from Pier 18 to east abutment) is 38.1 m. The arch v-piers are similarly configured to facilitate construction.

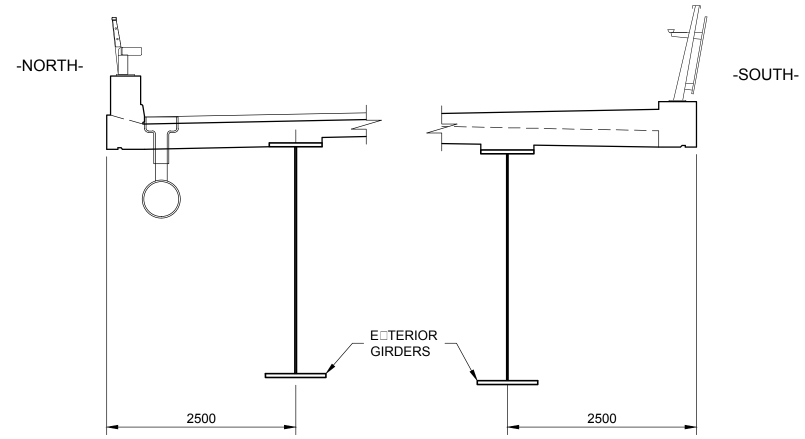
8.7 Superstructure

8.7.1 Structural Steel - Approaches

The selected superstructure for the approach spans consists of four plate girders supporting a reinforced concrete deck. The framing system for the girders consists of a combination of diaphragms and cross-frames as required for lateral stability during construction and for live load sharing. The structural steel girders will have variable depths from 2 m at mid-span to 3 m at the pier locations to maximize the efficiency of the steel superstructure. This efficiency can be achieved if girders are erected from the work bridge.

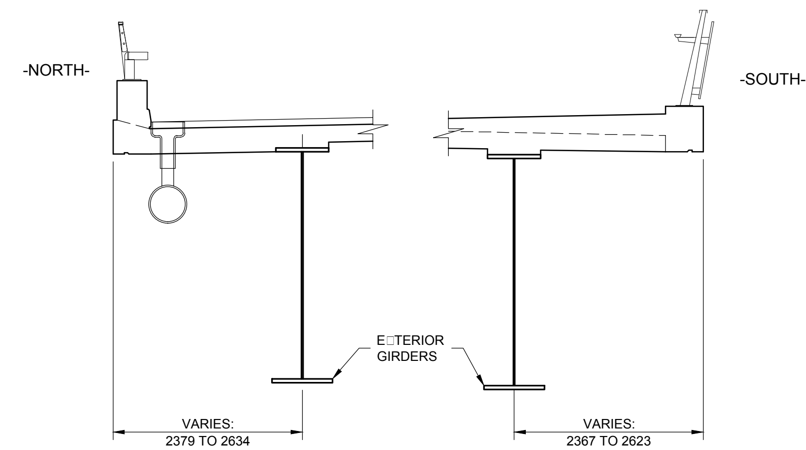
Consideration should be given to having a constant depth girder if launching the girders from the approaches is selected as the construction means. In plan, the girders can either be curved to match the horizontal alignment or kinked to simplify fabrication. The girders would be kinked at the field splice locations which are located approximately 20% of the span length away from supports. Given the large horizontal radii of the roadway alignment, kinked girders would have a minimal effect on the deck overhang as shown in **Drawing 8.7.1.1**.

The approach span girders have typical K-frame or X-frame cross bracing comprised of angles spaced at a maximum spacing of 8 m. Additional cross bracing would be required on either side of a kink location should this option be selected. The lateral bracing will be located in one exterior bay only, and will likely be comprised of WT sections at half the spacing of the cross bracing. **Figure 8.7.1.1** shows the approach span superstructure. A catwalk could be installed between the middle girders if required, allowing for partial inspection of the soffit and access to the south side sewer pipe.



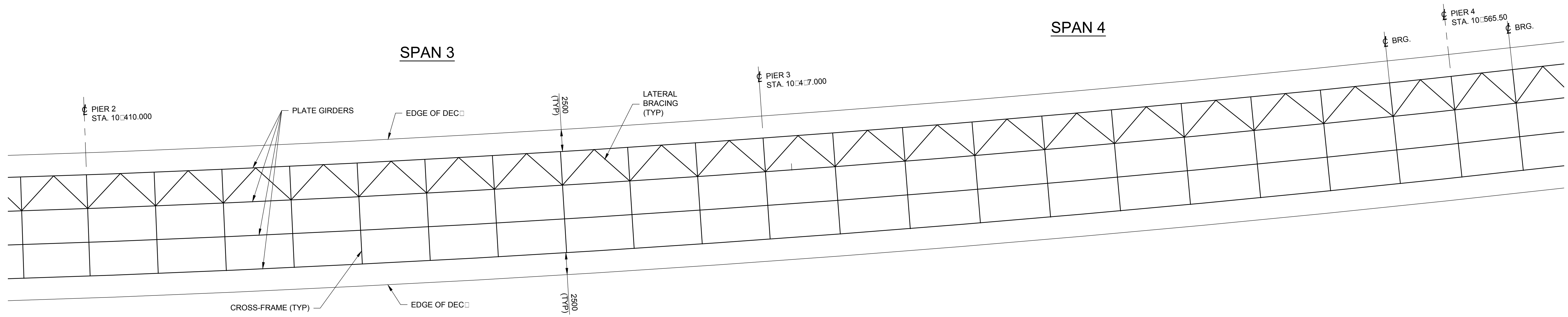
DEC□ OVERHANG - CURVED GIRDERS

1:50



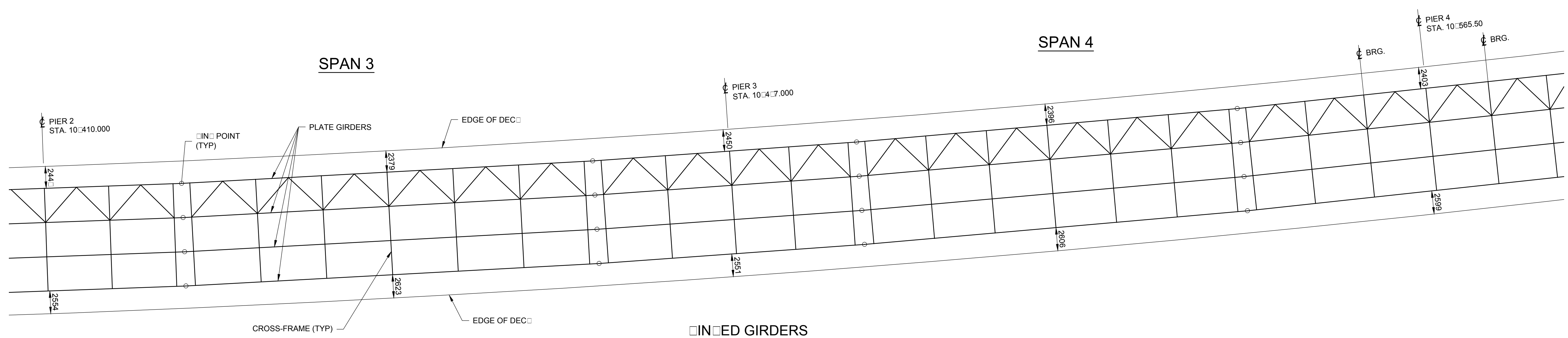
DEC□ OVERHANG - □IN□ED GIRDERS

1:50



CURVED GIRDERS

1:250



□IN□ED GIRDERS

1:250

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

□IN□ED vs CURVED PLATE GIRDERS

KINGSTON

Mark Van Buren, P.Eng. — *Director of Engineering & Deputy Commissioner*

Dan Franco, P.Eng. — *Project Engineer*

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	□7.1.1
Sheet No.:	-- of ---
Des: JJA	Chk'd: RO
Dwn: □RS	Chk'd: JJA
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Last Saved: Saturday, April 29, 2017 2:27:4□ PM Plot Date: 5/1/2017 □:33:31 AM

Consultant's Information: C:\pw_working\ontario\p004544\d\mdms0135\□7.1.1.dwg

Figure 8.7.1.1: Rendering of Approach Span Superstructure

Consideration should be given to a five-plate girder option as opposed to a four-plate girder option during detailed design as shown in **Figure 8.7.1.2**. Having five girders can reduce the width of the concrete cantilever to 1.65 m instead of 2.5 m. Cast-in-place concrete overhangs are costly to form as they require extensive temporary brackets to support the wet concrete and the exterior girders will have to be modified to account for the loading during concrete placement depending on the spacing and detailing of the overhang brackets. With the five-plate girder option, the girders would be shallower and the additional steel fabrication and erection cost would be offset by the reduction in the number of overhang supports required and the labour associated with their installation.

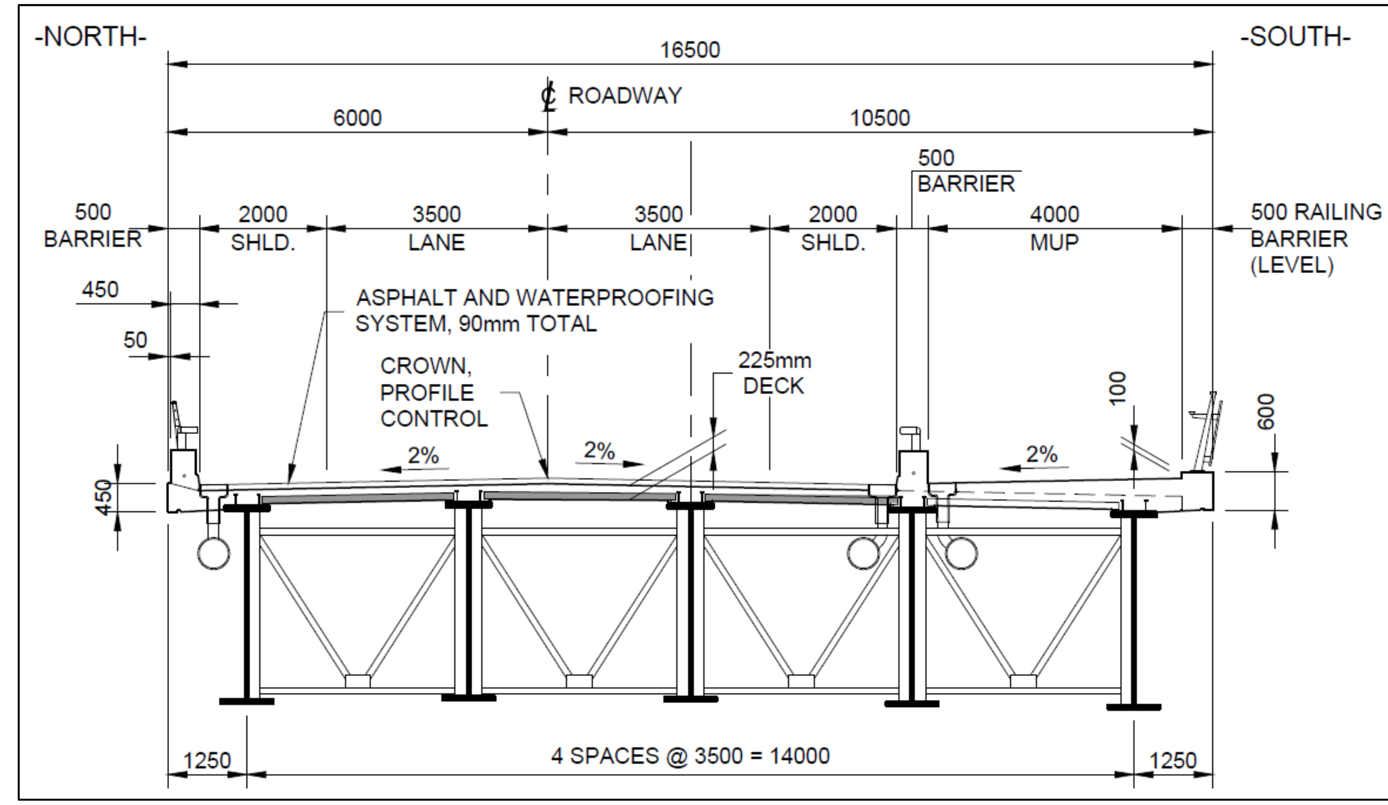


Figure 8.7.1.2: Cross-Section with Five Plate Girders

8.7.2 Arch

The arch is a tied arch, with 10° inclined outwards arch ribs, vertical cables, and five braces as shown in **Figure 8.7.2**. Although the arch is on a curved horizontal alignment, the arch is designed so that the arch ties are parallel and wide enough apart to support the widened deck due to the mild alignment curvature. The tied arch is supported on the v-piers.

As the bottom chord of the arch is in tension, the structural steel ties will be fracture critical members and will require some form of redundancy. This can be achieved either: using built-up members for the tie, thereby creating an internal redundancy or by internal post-tensioning to ensure that the tie is consistently in compression even under service loads.

Each arch will have 32 hangers that are connected to the transverse floorbeams, which will be built-up steel sections supporting the bridge deck. The multi-strand cables will be compromised of 7 to 14 seven wire strands with a diameter of 15.7 mm. Consideration should be given for additional strands for corrosion and service life monitoring in some of the hangers. The hanger system will be designed to withstand the loss of one stay cable without any effect on the overall structural integrity. The cables can be replaced by reducing the live load in the area that is supported by the cable. The anchorages of the cables will consist of an upper pin connection at the arch rib and a lower fixed connection at the floor beams. The tension in the cables will be able to be adjusted using anchorages with an adjustment nut at the floorbeams.

The transverse floorbeams will extend past the south side tie to support the cantilevered lookout zone. Five stringers will run perpendicular to and frame into the floorbeams to make the grillage system, which will support the concrete deck. A major diaphragm will be located at each end to stabilize the arch transversely. The arch bracing will be a built-up box section which flare at the connections to the arch.

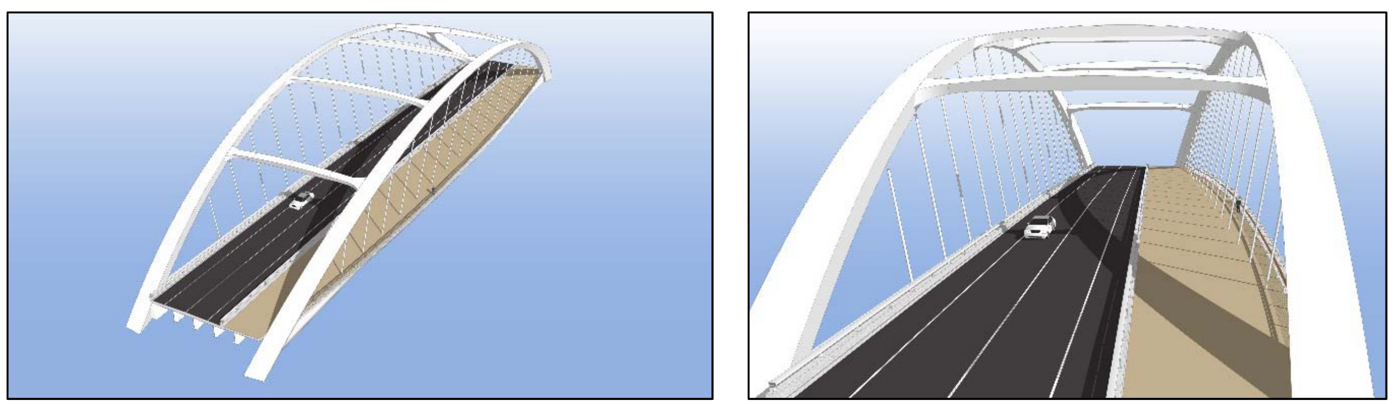


Figure 8.7.2: Design Concept for Arch

8.7.3 Joints and Bearings

Expansion joints are required at four different locations on the bridge: at both abutments and at the ends of the arch span. Due to the length of the west approach spans, modular joints will be required at the west abutment and the west end of the arch. At the arch east support and at the east abutment, strip seal expansion joints will be used.

The joints will be designed such that they can be easily inspected and replaced without permanent modifications to any load carrying component other than the concrete deck. The expansion joints at the arches shall include a secondary seal, gutter and/or trough to prevent any water infiltration, leading to deterioration over the v-piers which are not easily accessible for rehabilitation. The expansion joints shall be designed to be safe for both cyclists and pedestrians on the multi-use pathway and on the roadway as well as be designed to withstand snow plow wear.

The bearings will be designed to account for large movements due to the continuous arrangement of the west approach while supporting large vertical loads due to the length of the spans. Guided pot bearings will be considered for the approach spans and the arch. A bearing will be required at each girder for each pier and one bearing at the end of the rib / tie connection on the arch span. Different pot bearings are expected for the multi-directional bearings; uni-directional guided bearings; fixed bearings; and the bearings supporting the short jump span directly adjacent to the arch would require uplift restraints.

Uni-directional transversely fixed bearings will be used under one girder at all support locations, except for Pier 8 and Pier 17 to fix the bridge in the transverse direction. Pier 8 and Pier 17 will have a fixed bearing for one girder and uni-directional longitudinally fixed bearings for the remaining girders as that bearing location is at approximately the mid-point of the west side and east side, respectively. Multi-directional bearings will be used for the remaining approach span support locations. A fixed bearing will be used at west end of the arch span (Pier 15), along with a longitudinally fixed uni-directional bearing at the same end. The opposite end will have a transversely fixed uni-directional bearing and a multi-directional bearing.

The piers and bearings will be designed such that the bearings can be easily accessed for inspection and replacement without modifications to the pier cap and steel girders. The piers will be designed with the provision for future jacking for the replacement of the bearings without need for temporary falsework. The bearing pads will be designed to provide active drainage such that water does not pond against the bearings.

8.7.4 Barriers

A low wall concrete barrier with steel railing (Minnesota Combination Barrier) is recommended for the roadway section of the bridge so that it can provide unimpeded views for drivers. A similar barrier system was used for the Vimy Memorial Bridge in Ottawa over the Rideau Canal and is shown below in **Figure 8.7.4.1**.

Figure 8.7.4.1: Low Wall Concrete Barrier with Steel Railing (Vimy Memorial Bridge)

The barriers and railings on the bridge will be designed in accordance with CHBDC for a posted speed of 60 km/hr. It was determined that a TL-4 barrier would be required for the roadway based on the roadway being a Highway Class A with a design speed of 70 km/hr. All barriers except for the center barrier will have a minimum overall height of 1.37 m to accommodate a cyclist railing. The center barrier between the roadway and the multi-use path will not have any cyclist specific railings on top to ensure that cyclists have free movement over the barrier during a collision in accordance with the TAC Guide to Bridge Traffic and Combination Barriers, except at locations where there are benches or light standards on the multi-use path.

For the barrier on the south side for the multi-use pathway, open railings will be used to maximize the viewing opportunities from the bridge. A small concrete curb will be at the base of the south barrier to allow snow plows to ride against it without damaging the railing system as well as prevent salt-laden water from flowing down the fascia. Utility ducts for street lighting and telecommunications will be located within the barrier between the roadway and the multi-use pathway to allow for maintenance. Spare ducts can be provided in the north barrier.

As discussed later in this Report, a noise barrier is required on the south side of the bridge which will extend 117 m west from the east abutment. The noise barrier on the bridge is required to be 1.5 m tall as measured from the asphalt surface and will be placed on the south side of the center barrier. As the noise barrier will be placed adjacent to traffic, a crash tested noise barrier system is recommended. Consideration will be given to noise barrier systems that do not hinder views and are bird friendly. It is optimal to have the noise barrier closer to the roadway to further diminish the noise as shown in **Figure 8.7.4.2**.

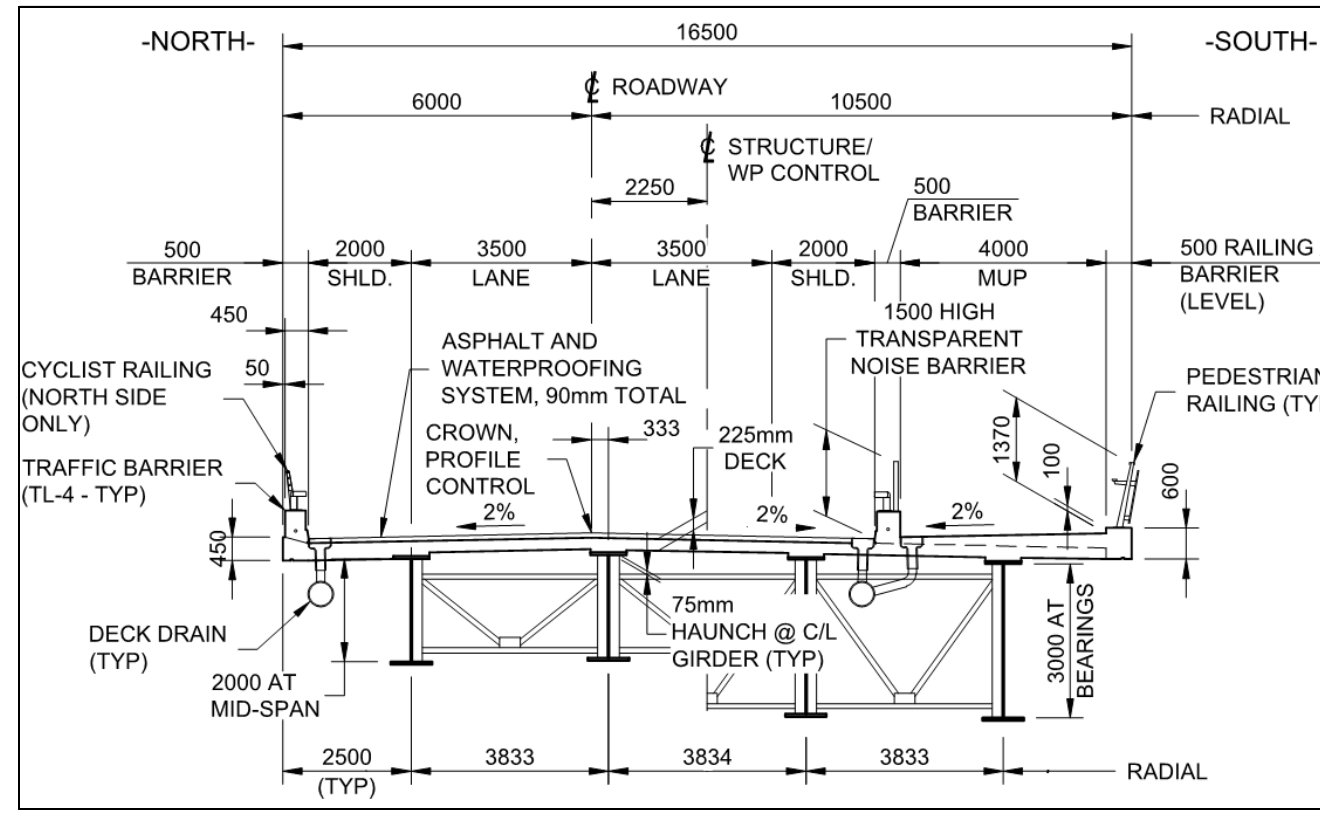


Figure 8.7.4.2: Cross-Section of Bridge East of the Arch with Noise Barrier

8.7.5 Deck

A conventional 225 mm concrete deck will be required for both the approach spans and the arch span. The concrete will be protected using a hot applied asphalt waterproofing system and protection boards and two layers of asphalt for a total thickness of 90 mm. Galvanized/ GFRP and/or stainless steel rebar will be used in corrosion prone areas. No utilities will be located within the concrete deck to enhance the deck's durability and to prevent concrete deck damage. The wearing surface for the multi-use path portion of the deck will be a concrete surface protected by a sealant coating.

The concrete deck can either be cast-in-place or precast or a combination of both. The precast panels can either be partial depth as shown in **Figure 8.7.5.1** with a cast-in-place concrete overlay or they can be full depth with closure pieces in between.

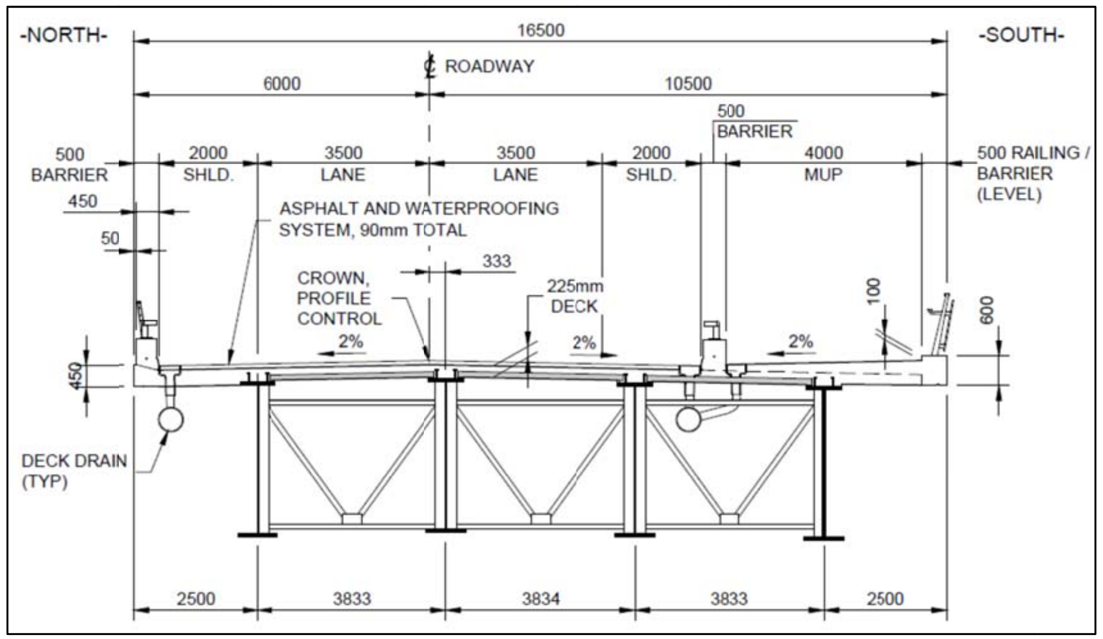


Figure 8.7.5.1: Cross-Section with Partial Precast Panels

8.7.6 Future Conversion into Additional Vehicle Lane

The bridge was analyzed to see the effects of converting the multi-use pathway into an additional traffic lane by removing the center barrier. It was determined that the substructure and approach span structural steel would not require any major modifications to account for the additional loads as the weight of the barrier and the additional concrete on the sidewalk that would be removed offsets the live loading from the additional lane. The cost of the arch span would increase by approximately 10% as it would require larger hangers and tie-beams.

8.8 Substructure

8.8.1 V-Piers at Arch

The piers at the arches will be concrete v–piers with a 26 m long jump span. The v–piers will be situated on eight-2100 mm diameter caissons rock socketed in the bedrock. The caissons will support a 2.5 m deep footing which supports the v-pier legs. The top of footing will be at an elevation of 74.0 m which is lower than the low water datum, therefore the footing will always be beneath the water. A portion of the riverbed will be excavated to construct the footing. This will either be done by using cofferdams or placement of a precast concrete shell.

The v-piers will be inclined at an angle of 43˚ from the horizon to match the shape of the arch. The interior radius of the v-pier is situated at approximately an elevation of 77.1 m which is 0.8 m above the regulatory water level so that the v-piers will always have a distinguishable V-shape. The v-piers will have different geometry on the arch and on the approach side to properly support the arch and the plate girders as shown in **Figure 8.8.1.1**. The approach side legs will have two separate legs with a 10˚ inclination on both sides to match the approach span piers and the inclination of the arch. Each pier leg will support two lines of girders based on the four-plate girder option. The arch side will consist of two wider legs in order to support the arch bearings that will be connected by a header beam at the top of the pier. There will be six bearings on the arch side leg, four for the plate girders and two for the arch. The arch pier legs and the approach pier legs are required to be tied together for stability. The ties are envisaged as post-tensioned precast concrete elements. For aesthetic reasons, the tie-beam would be hidden between the plate girders so that they are not visible in elevation. A portion of the arch legs will be formed to have a recessed texture appearance to match the geometry of the approach side pier legs. On the arch legs, there will be a ledge on the interior face where the approach span girders can be jacked to facilitate bearing replacement in the future. The use of post-tensioning strands within the v-pier legs would help to minimize the tensile stresses in the pier legs and prevent cracks from developing.

The arch pier footing will be fitted with a pier nosing composed of either granite or steel which will act as an ice breaker to minimize the ice loading placed on the pier. The pier nosing will be inclined so that as the ice moves, it will be lifted and break apart. A further study will be required to refine the forces that will be developed by the ice movement.

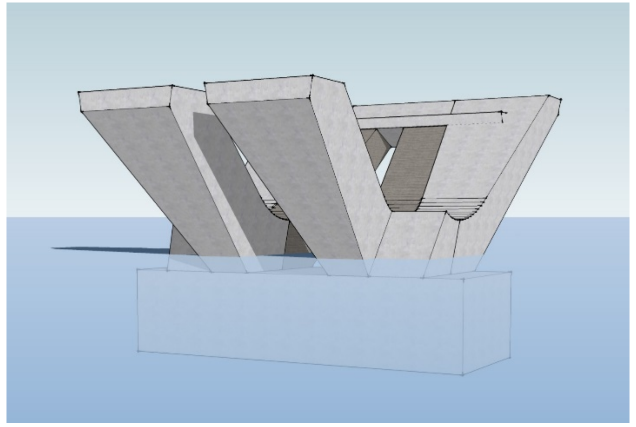



Figure 8.8.1.1: Rendering of V-Piers at Arch

8.8.2 Inverted U-Frame Piers

The bridge will have 16 inverted u-frame piers: 14 piers to the west of the arch and 2 piers to the east of the arch. The inverted u-frame piers will support the four plate girders for the approach spans. The piers will be founded on two-1800 mm diameter caissons which will be rock-socketed into the bedrock. The caissons will have a steel casing which will have a coating system applied to the top portion and for a length that will accommodate the varying water level to further protect the caissons. On top of the caissons, the pier will transition from a circular caisson to a square pier leg over a height of 1500 mm. The pier legs will be inclined outwards 10˚ to match the inclination of the v-piers and the arch. The pier legs can be cast separately from the pier cap to simplify the concrete placement. The pier caps will have a uniform shape and size for all piers, 13.5 m wide, 1.8 m long and 2 m deep to facilitate construction. The pier cap will be designed to provide jacking points on either side of the bearings to allow for jacking of the girders directly to replace the bearings. Pier leg heights will vary from 0 m tall to 4.2 m tall and the spacing of the caissons will range from 7.7 m to 11 m as shown in **Drawing 8.8.2** to maintain the constant pier cap dimensions.

8.8.3 Abutments

The abutments will be reinforced concrete founded on fourteen-600 mm diameter caissons rock socketed into bedrock. The west abutment will require minimal excavation for the construction of the abutment and the east abutment will be in a fill condition, requiring the construction of the approach embankments to achieve finished grade levels. Both abutments will have conventional concrete wingwalls. Rock protection will be used on the front and side slopes of the embankments to prevent any erosion and loss of embankment material.

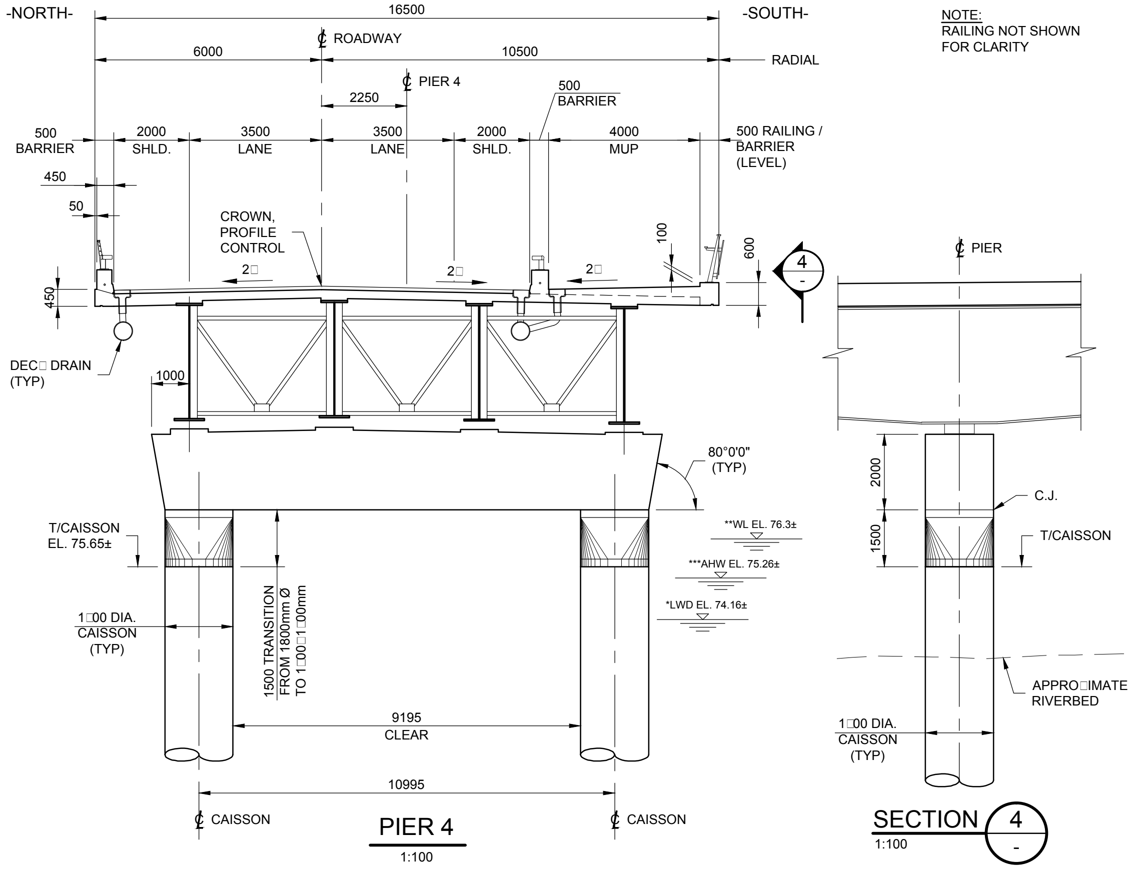
8.9 Deck Drainage

As noted earlier, the key criteria for the deck drainage is the 2 m flow spread based on the 10 year design for the traffic lanes, a 1.5 m allowable flow spread based on a five year storm event for the bike friendly traffic lanes and 1.5 m flow spread for a 10 year design storm for the multi-use pathway. For the 0.75% longitudinal grade associated with the lower profile, the design would require 15 deck drains (OPSD 3340.150) west of the arch and 3 deck drains east of the arch. For the multi-use path, the key criterion for the drainage is that a minimum of 2.5 m remains clear of flooding during a 10-year design storm. This results in 13 deck drains to the west of the arch and 3 deck drains to the east. The deck drains will be required along the inside face of the north barrier and both sides of the south intermediate barrier. A 525 mm diameter storm sewer pipe will be required on the south side of the bridge and a 375 mm diameter sewer pipe will be required on the north side. There will be a sleeve through the abutment walls to allow the sewer pipes to go through and connect to the storm system on the approaches.

8.10 Approach Roadway Layout

The conceptual west approach arrangement was shown earlier on **Drawing 5.5.1** and includes two intersections with associated turning lanes in each direction. Vehicular lanes are 3.5 m in width and a cycling lane is provided near each curb with a 1.5 m width. The Montreal Street intersection will require an upgraded lane arrangement in all directions as part of a reconfiguration that accommodates the lanes approaching the bridge.

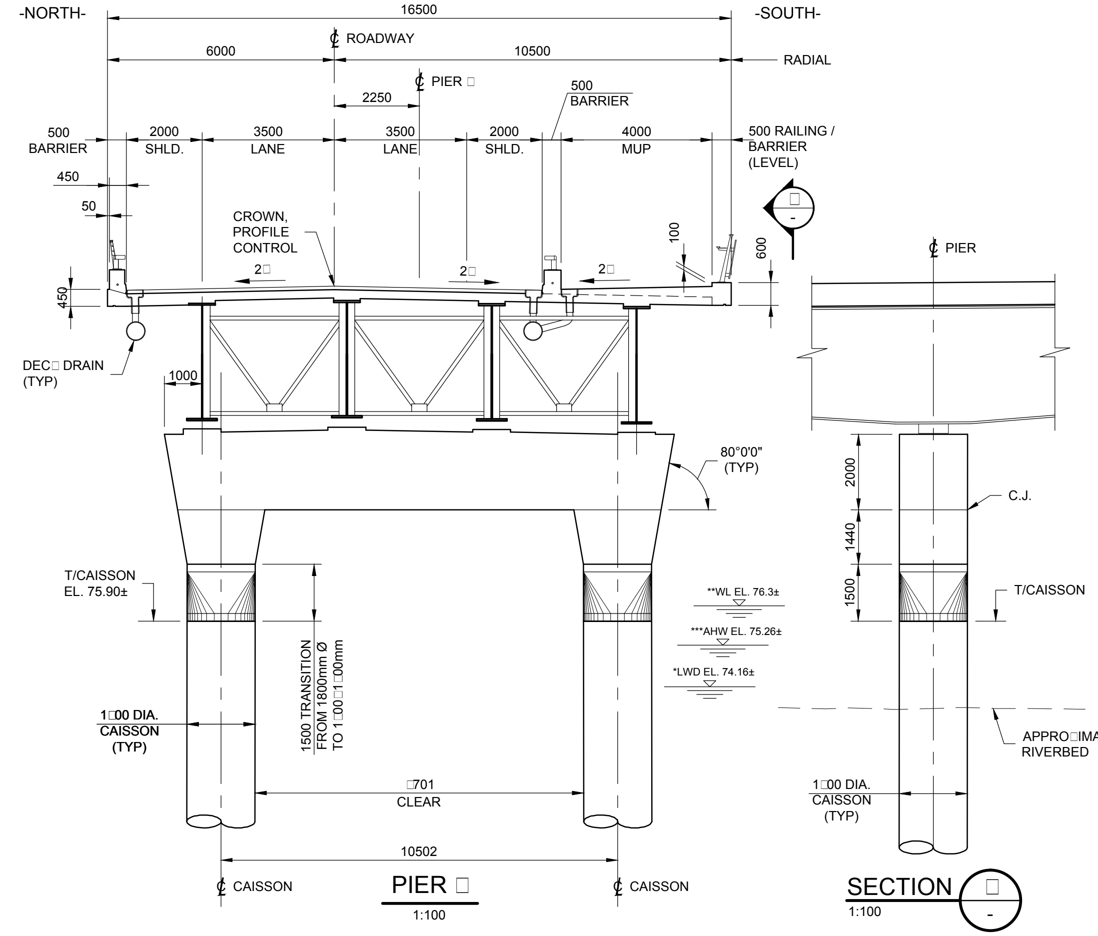
The conceptual east approach arrangement was shown on **Drawing 5.5.3** and also includes two intersections with associated turning lanes in each direction. Vehicular lanes are 3.5 m in width and a cycling lane is provided near each curb with a 1.5 m width, similar to the west approach. A key modification to the east approach involves the re-alignment of the Gore Road Library entrance with Point St. Mark Drive, and the signalization of this intersection. This will enable pedestrians to cross Gore Road safely. Since the Library entrance will be located further west, the longer laneway will also provide additional queuing length at the intersection and layby parking along the sides.



PIER 4
1:100

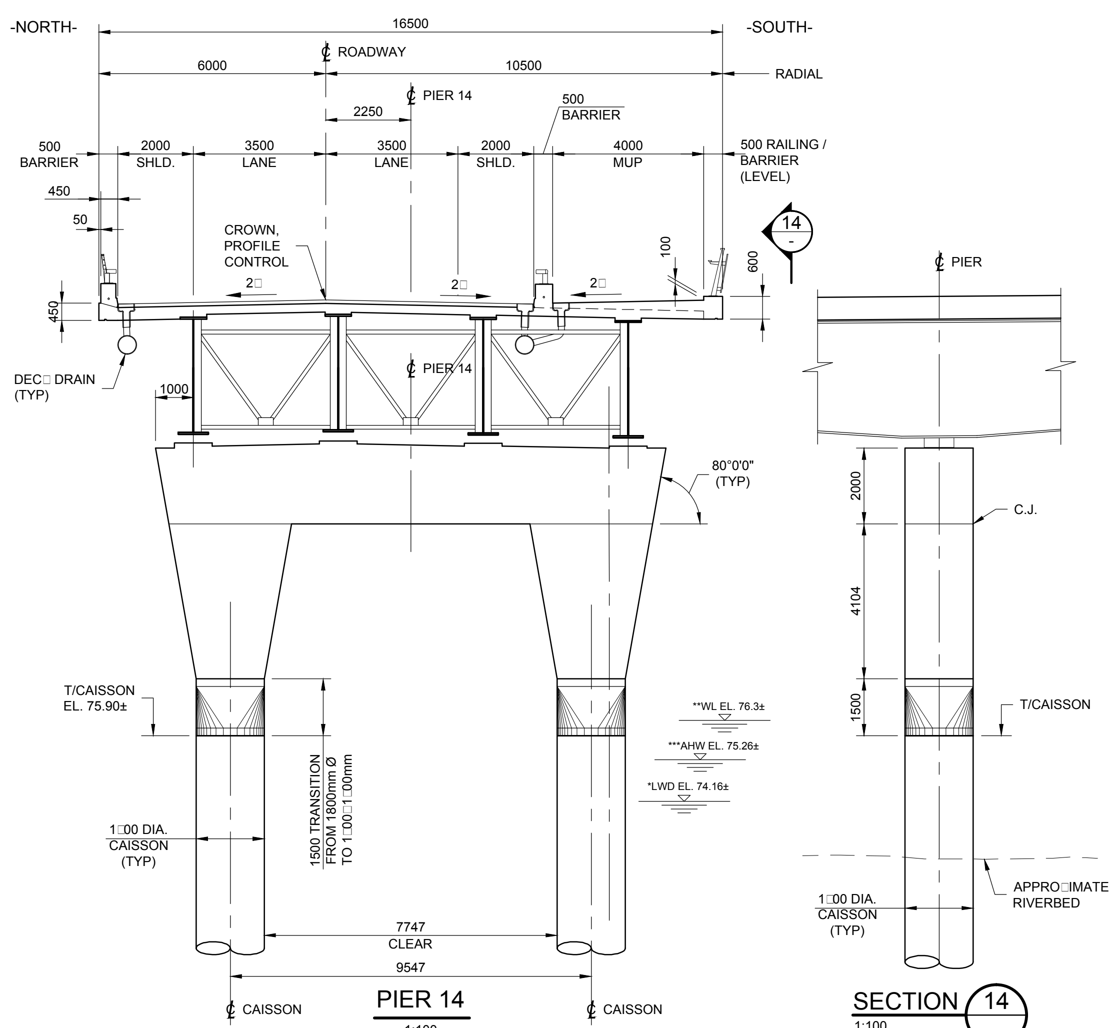
SECTION 4
1:100

NOTE:
RAILING NOT SHOWN FOR CLARITY



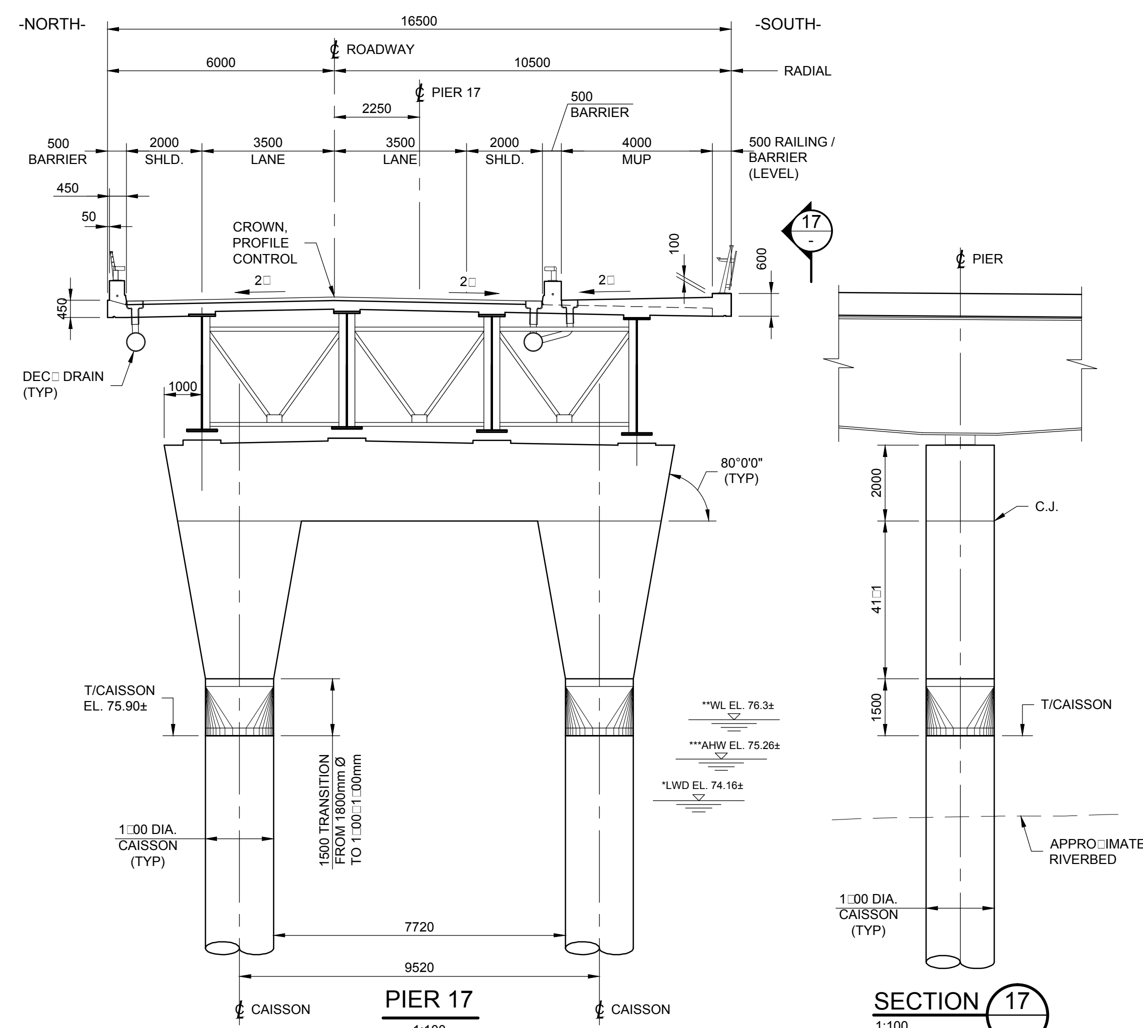
PIER
1:100

SECTION
1:100



PIER 14
1:100

SECTION 14
1:100



PIER 17
1:100

SECTION 17
1:100

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

INVERTED U-FRAME PIERS

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	2
Sheet No.:	-- of --
Des: JJA	Chk'd: RO
Dwn: RS	Chk'd: JJA
Scale:	AS NOTED
Utility Circ. No.	------
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Plot Date: 5/2/2017 1:27:32 PM
Last Saved: Monday, May 01, 2017 :37:55 AM
Consultant's Information: C:\pw_working\ontario\p004544\dms01335\2.dwg

Both east and west approach roadways will adopt a conventional road cross section with raised curb and gutter along the edge of pavement. Catchbasins required for stormwater management will include cycle friendly grating or side-inlets. Sidewalks and multi-use pathways are located adjacent to, or offset from, the roadway.

Integration of cycling infrastructure, pedestrian and multi-use path into the arrangement of the approach corridors is an important consideration. Over the bridge, cyclists will be encouraged to use the multi-use pathway. In order to manage the transition from roadside cycling lanes to the multi-use pathway, enhanced crossing movements may be integrated near intersections such as at Montreal Street and the reconfigured Gore Road Library-Point St. Mark Drive Entrance. As discussed earlier, at Ascot Lane, there is soft merit for including signalization at this intersection where cyclists, pedestrians and multi-use pathway users can safely cross John Counter Boulevard. The intersection has been laid out to accept signalization at a future date.

8.11 Traffic Management

A transportation assessment has been completed to confirm the turning lane requirements at three intersections along the east and west approaches to the bridge:

1. John Counter Boulevard-Montreal Street.
2. John Counter Boulevard-Ascot Lane.
3. Gore Road-Point St. Mark Drive.
4. Gore Road-Highway 15 (confirmed by others as part of the Highway 15 Class EA).

As noted earlier, the ESR presented projected volumes for a 4-lane crossing. Since the completion of the ESR, the recommended bridge cross-section has been reduced to two vehicle lanes as per the 2015 KTMP and subsequent direction by City Council (Report No. 15-268). The City has also recently updated their Travel Demand Model for the Third Crossing to account for new mode share targets that were established since the completion of the 2015 KTMP.

The performance of the three intersections within the approach areas was analyzed under the projected 2034 volumes, including the assumption that other conditions such as the widening of Highway 15 to four lanes between Gore Road and Highway 2 and a list of Development Charge Projects planned for implementation by 2019 are in place. For the purposes of this analysis and consistent with the ESR, it has been assumed that all intersections would be signalized, with the exception of the John Counter Boulevard-Ascot Lane (which would be two-way stop controlled).

The analysis was completed using the software package Synchro 8, based on the Level of Service (LOS) criteria established by the Highway Capacity Manual for signalized and un-signalized intersections. The intersection lane arrangement, signal control type, signal timing, and cycle length were optimized for each intersection in order to achieve an acceptable LOS for all approaches where possible.

Turn lane requirements were identified for each intersection based on the 2034 PM peak hour volumes. A signal warrant analysis was also completed for the following two minor intersections:

1. John Counter Boulevard-Ascot Lane.
2. Gore Road-Point St. Mark Drive.

The warrant analysis was completed using Book 12 of the Ontario Traffic Manual (OTM). Justification 7 was evaluated using the projected 2034 PM peak hour volumes. Based on these volumes, the warrants for the installation of new traffic signals were not met. Although the installation of traffic signals was deemed not to be warranted based on the OTM analysis, other factors should be considered such as the need for a protected crossing for pedestrian and cyclists at these locations.

A Class EA is currently underway for the widening of Highway 15. As part of the Third Crossing Preliminary Design project, lane arrangements selected for the Gore Road-Highway 15 intersection have been co-ordinated with the Highway 15 Class EA work to ensure a cohesive design for this intersection.

Preliminary PHM-125 drawings (which are used to plan signalized intersection layouts) have been developed for the three intersections within the project corridor (excluding the Gore Road-Highway 15 intersection, which is being determined under separate study), as shown in **Drawing 8.11.1** to **Drawing 8.11.3**. This includes the John Counter Boulevard-Ascot Lane intersection for consideration of signalization at a future date.

Several alternative traffic calming measures aimed at preventing ‘short-cutting’ of traffic through the Point St. Mark neighbourhood following the construction of the bridge are available. Traffic calming in this neighbourhood is possible and feedback obtained through public consultation at the first Open House indicated a desire to implement applicable measures.

'Short-cutting' is the use of local or collector streets through a residential area by roadway users to avoid congestion and/or delays on the regularly travelled arterial roadway system. In this instance, it is understood that PM peak hour vehicles moving eastbound along the bridge could turn right at Point St. Mark Drive to avoid delays at the Highway 15-Gore Road intersection. Similarly, vehicles moving northbound during the AM period on Highway 15 could turn left at Point St. Mark Drive to avoid congestion at the same intersection. Although the first priority for reducing short-cutting should be to address congestion and delays at the Highway 15-Gore Road Intersection, alternative measures are available.

Four alternative traffic calming measures from least intrusive to most intrusive are (1) signed turn prohibition during peak hour, (2) curb extensions within the neighbourhood, (3) speed humps within the neighbourhood, and (4) directional closure at entrances. Consideration could be given to implementing the options in a progressive manner, which would be dependent on the results of a monitoring program. Conversely, directional closure could be implemented immediately at the intersection of Point St. Mark Drive and Gore Road in order to eliminate the short-cutting possibility from the onset, as shown in **Figure 8.11.1**.

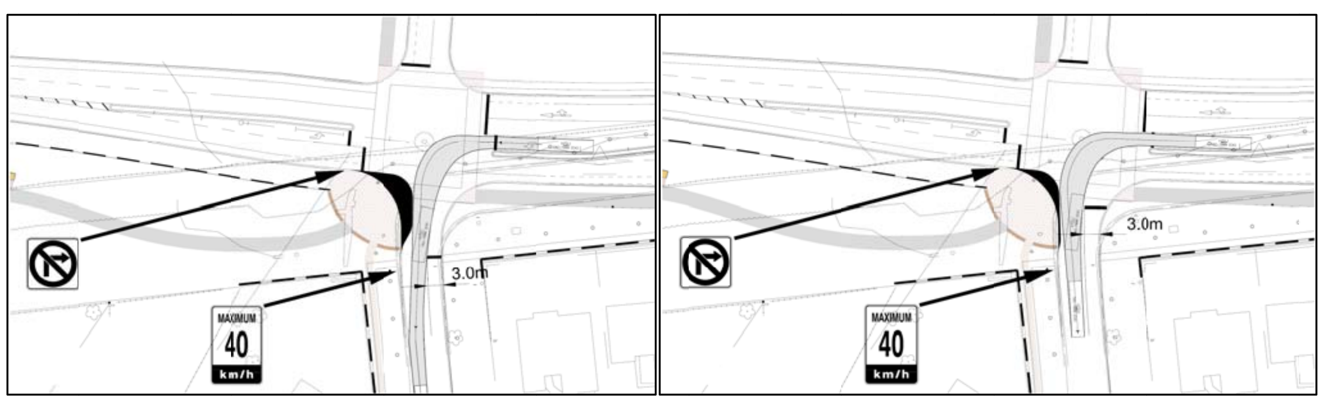


Figure 8.11.1: Full and Partial Curb Extension Traffic Calming Options

Complete closure of this entrance into the Point St. Mark neighbourhood has been suggested as an additional alternative, leaving only one entrance onto Highway 15 for residents. Generally, this alternative is not advisable if emergency vehicles cannot be accommodated. However, a closure that involves prohibiting regular cars but allowing access by emergency vehicles could be considered by designers, with consultation from emergency services personnel.

8.12 Lighting, Electrical and Communications

8.12.1 Lighting

Illumination of the bridge can be provided for a number of elements, resulting from a need to meet certain legal or municipal obligations, a desire to highlight certain aspects of the bridge from an aesthetic perspective and/or an overall desire to provide reasonable but not overly dramatic illumination of the spaces. There are, in essence, five elements of the bridge and its approaches that need to be considered.

1. **Roadway Illumination:** The City has developed Roadway Illumination guidelines (Technical Standards and Specifications, City of Kingston, Technical Schedule 2, Appendix 2F: Design Standards – Streetlighting Guidelines) that ensures safe, effective illumination for all its roadways. As an Undivided Urban Arterial, the recommended illumination design levels along the project corridor should have an average, maintained, horizontal illuminance level of 17 lux with an average to minimum ratio of 3:1. These levels can be achieved with 13 m poles mounted 40 m apart in the median throughout the length of the bridge and its approaches from both Highway 15 along Gore Road on the east side to Montreal Street along John Counter Boulevard on the west side.

2. **Multi-Use Pathway Illumination (on the bridge):** The City's Pathways Study (2003) as well as the IESNA guidelines have been referenced for guidance on pathway illumination. Recommended illumination design levels for walkways distant from roadways (or independent of roadways) should have an average, maintained, horizontal illuminance level of 5 lux. These levels can be achieved with a smaller wattage luminaire on the same 13 m pole mounted 40 m apart throughout the length of the project corridor as noted above.

3. **Bridge Structure Illumination:** Independent of the roadway and walkway illumination requirements, the bridge illumination is strictly an aesthetic consideration, and is currently being considered. The conceptual basis for aesthetic illumination of the bridge will be to provide illumination of the arch span, including the arch v-piers.

FORM PH-M-125 – Revised 1990 AutoCAD ver 12

COLLISION DIAGRAM

NUMBER OF ANGLE COLLISIONS

Year	Nº
— —	— —
— —	— —
— —	— —
TOTAL	— — —
AVERAGE PER YEAR	— —

MINIMUM REQUIREMENTS FOR INSTALLATION OF TRAFFIC SIGNALS
(WARRANT ANALYSIS FORMS SHOULD BE ATTACHED)

LOCATION: JOHN COUNTER BLVD AT MONTREAL STREET
MUNICIPALITY: KINGSTON, ONTARIO DATE OF SURVEY: ______

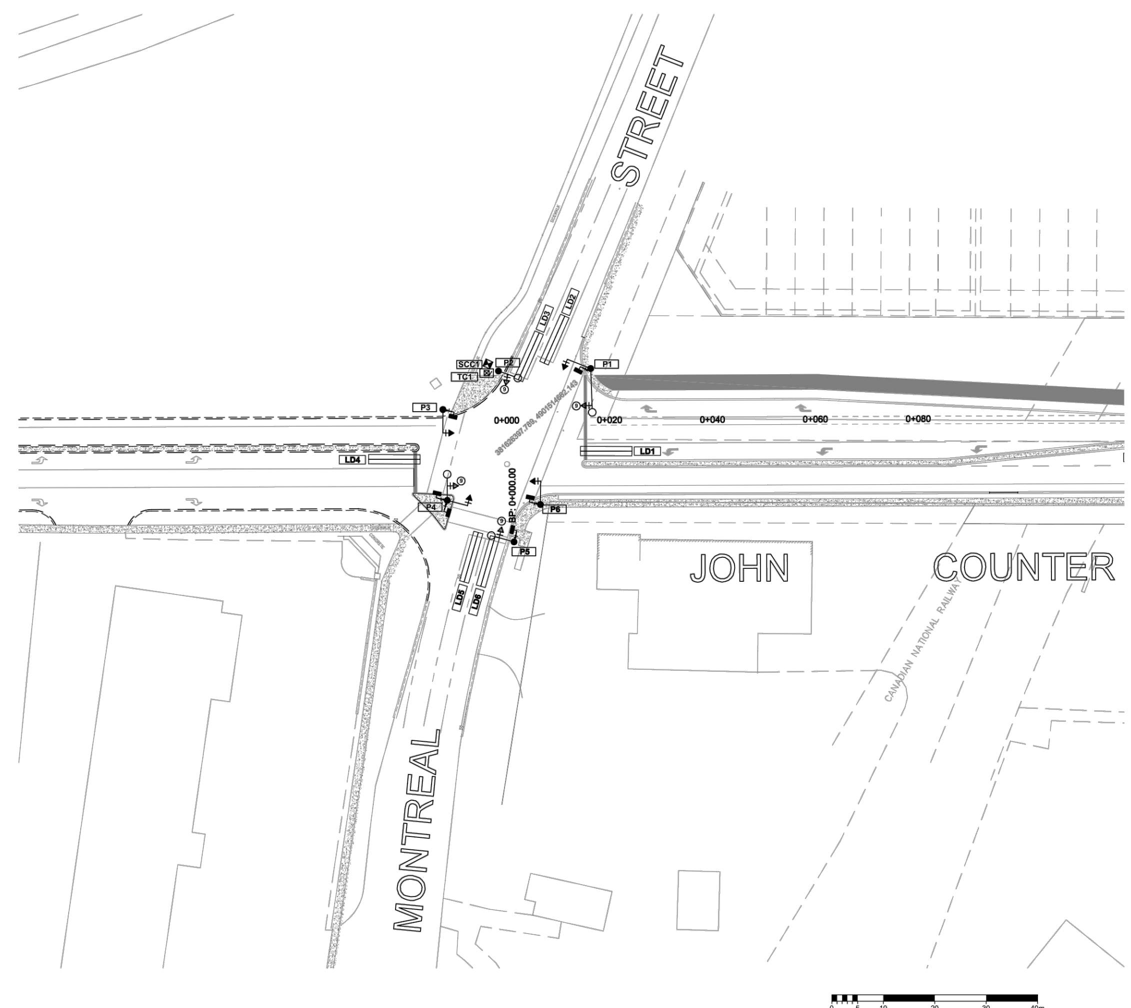
	WARRANT	DESCRIPTION	MINIMUM REQUIREMENT FOR TWO-LANE ROADWAYS: FREE FLOW – OPERATING SPEED GREATER THAN OR EQUAL TO 70 km/h	RESTRICTED FLOW – OPERATING SPEED LESS THAN 70 km/h	COMPLIANCE: SECTIONAL %	③ ENTIRE %
INTERSECTION	1. MINIMUM VEHICULAR VOLUME	①A Vehicle Volume, All Approaches for Each of the Heaviest 8 hours of an Average Day, and	480	720		
		④B Vehicle Volume, Along Minor Streets for Each of the Same 8 hours	120	170		
	2. DELAY TO CROSS TRAFFIC	①A Vehicle Volume, Along Major Street for Each of the Heaviest 8 Hours of an Average Day, and	480	720		
		②B Combined Vehicle and Pedestrian Volume Crossing the Major Street for Each of the Same 8 hours	50	75		
	3. ACCIDENT HAZARD	A Total Reported Accidents of Types Susceptible to Correction by a Traffic Signal, per 12 Month Period Averaged Over a 36 Month Period, and	5			
		B Adequate Trial of Less Restrictive Remedies, Where Satisfactory Observance and Enforcement Have Failed to Reduce the Number of Accidents, and	Yes ☐ No ☐			
		C Fulfilment of Either of the Above Warrants (Minimum Vehicular Volume or Delay to Cross Traffic) to the Extent of 80% or More.	Yes ☐ No ☐			
	4. COMBINATION WARRANT	Two or More of the Above Warrants (1, 2, or 3) Satisfied to the Extent of 80% or More.	Yes ☐ No ☐			
MID-BLOCK	5. ⑤ MINIMUM PEDESTRIAN VOLUME	A Pedestrian Volume Crossing the Major Street Average per Hour for the Heaviest 8 Hours of an Average Day, and	120	240		
		①B Vehicle Volume Along Major Street Average Per Hour for the Same 8 Hours.	290	575		

NOTES:
① Vehicle Volume Warrants (1A), (2A) and (5B) for Roadways Having Two or More Moving Lanes in one Direction Should Be 25% Higher Than Values Given Above.
② For Definition of Crossing Volume Refer to Note ④ on the Signal Warrant Analysis Form B2.03.08
③ The Lowest Sectional Percentage Governs the Entire Warrant.
④ For 'T' Intersections the Values for Warrant (1B) Should Be Increased by 50%
⑤ Pedestrian Mid Block Signals may also be warranted based on a Pedestrian cross over warrant

LEGEND

- HIGHWAY SIGNAL HEAD (30 cm. Red) WITH BACKBOARD AND MAST ARM
- HIGHWAY SIGNAL HEAD (30 cm. Red) WITH BACKBOARD AND OVERHEAD CABLE
- HIGHWAY SIGNAL HEAD WITH BACKBOARD AND MAST ARM (ALL 30 cm. LENSES)
- SPECIAL HEAD WITH ARROW INDICATION AND BACKBOARD (Example shows Type ② Head)
- SPECIAL HEAD WITH BACKBOARD AND ONE OR MORE PROGRAMMABLE LENSES (Example shows Type ② Head)
- STANDARD SIGNAL HEAD WITH BACKBOARD AND MAST ARM (ALL 20 cm. LENSES)
- STANDARD SIGNAL HEAD WITH MAST ARM, WITHOUT BACKBOARD
- PEDESTRIAN SIGNAL HEAD
- PEDESTRIAN PUSH BUTTON
- VEHICLE PASSAGE LOOP DETECTOR
- VEHICLE LOOP DETECTOR
- DUPLEX LOOP DETECTOR
- DIAMOND LOOP DETECTOR
- MICRO-LOOP DETECTOR
- EMERGENCY VEHICLE PRE-EMPTION DETECTOR
- MICRO-WAVE DETECTOR
- MAGNETIC VEHICLE DETECTOR
- TRAFFIC CONTROLLER
- TRAFFIC SIGN
- TRAFFIC SIGN WITH FLASHING BEACON
- ILLUMINATED TRAFFIC SIGN

	DATE	ANALYST	DESCRIPTION OF REVISIONS	RECOMMENDED BY
REVISIONS				



CLASSIFICATION OF ROADWAY		TRAFFIC SIGNAL HEADS: TYPE	SIZE	BACKBOARD	LOCATION: MOUNTING HT.	OFFSET FROM POLE
ROADWAY: JOHN COUNTER BLVD		PRIMARY	HIGHWAY	YES	5.0m	TBD
		SECONDARY	HIGHWAY	YES	5.0m	TBD
MULTILANE ☐		AUXILIARY				
TWO-LANE ☒	SEPARATE LT.TURN ARROWS	PRIMARY				
		SECONDARY				
ROADWAY: MONTREAL STREET		PRIMARY	HIGHWAY	YES	5.0m	TBD
		SECONDARY	HIGHWAY	YES	5.0m	TBD
MULTILANE ☐		AUXILIARY				
TWO-LANE ☒	SEPARATE LT.TURN ARROWS	PRIMARY				
		SECONDARY				

TYPES OF SPECIAL ARROW HEADS WITH BACKBOARD
ALL 30 cm LENSES, EXCEPT AS NOTED

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪

⑧ ⑨ AMBER ARROW MUST BE USED IN A PROTECTED/PERMISSIVE SIMULTANEOUS LEFT TURN OPERATION.

NOTE: FOR SPECIAL ARROW HEADS ⑧, ⑨, ⑩ AND ⑪, 20 cm AMBER BALL AND 20 cm GREEN BALL LENSES SHOULD BE USED

TRAFFIC DRAWING: E102

MUNICIPALITY: KINGSTON, ONTARIO	MINISTRY OF TRANSPORTATION, ONTARIO
INTERSECTION: JOHN COUNTER BLVD & MONTREAL STREET	SIGNALS WARRANTED: REPLACING EXISTING
	SIGNAL DESIGN RECOMMENDED FOR APPROVAL:
DATE: APRIL 2017 SCALE: 1:500	SIGNAL INSTALLATION APPROVED AS PER SECTION 144 (31.1) H.TA.;
RECOMMENDED BY: ______ MUNICIPAL OFFICIAL (MUNICIPAL INSTALLATION) REGIONAL TRAFFIC REPRESENTATIVE (MINISTRY INSTALLATION)	APPROVAL DATE:

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

TRAFFIC DRAWING
MONTREAL STREET AND
JOHN COUNTRE BOULEVARD

Mark Van Buren, P.Eng.
Director of Engineering and Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

Project No.:	27143
Drawing No.:	□11.1
Sheet No.:	
Des:	Chk'd:
Dwn:	Chk'd:
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS	No.	Description	By	Date (dd/mm/yy)
	1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

THIS "PRELIMINARY" PH-M-125 DRAWING IS PROVIDED IN THE REPORT FOR INFORMATION PURPOSES ONLY. REFER TO THE PRELIMINARY DESIGN DRAWING SET FOR FULL SI□E DRAWING TO SCALE.

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

TRAFFIC DRAWING
ASCOT LANE AND
JOHN COUNTRE BOULEVARD

Mark Van Buren, P.Eng.
Director of Engineering and Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

KINGSTON

Project No.:	27143
Drawing No.:	□11.2
Sheet No.:	
Des:	Chk'd:
Dwn:	Chk'd:
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

FORM PH-M-125 – Revised 1990 AutoCAD ver 12

REVISIONS

DATE	ANALYST	DESCRIPTION OF REVISIONS	RECOMMENDED BY

COLLISION DIAGRAM NUMBER OF ANGLE COLLISIONS

Year	№
— —	— —
— —	— —
— —	— —

TOTAL — — —
AVERAGE PER YEAR — —

MINIMUM REQUIREMENTS FOR INSTALLATION OF TRAFFIC SIGNALS
(WARRANT ANALYSIS FORMS SHOULD BE ATTACHED)

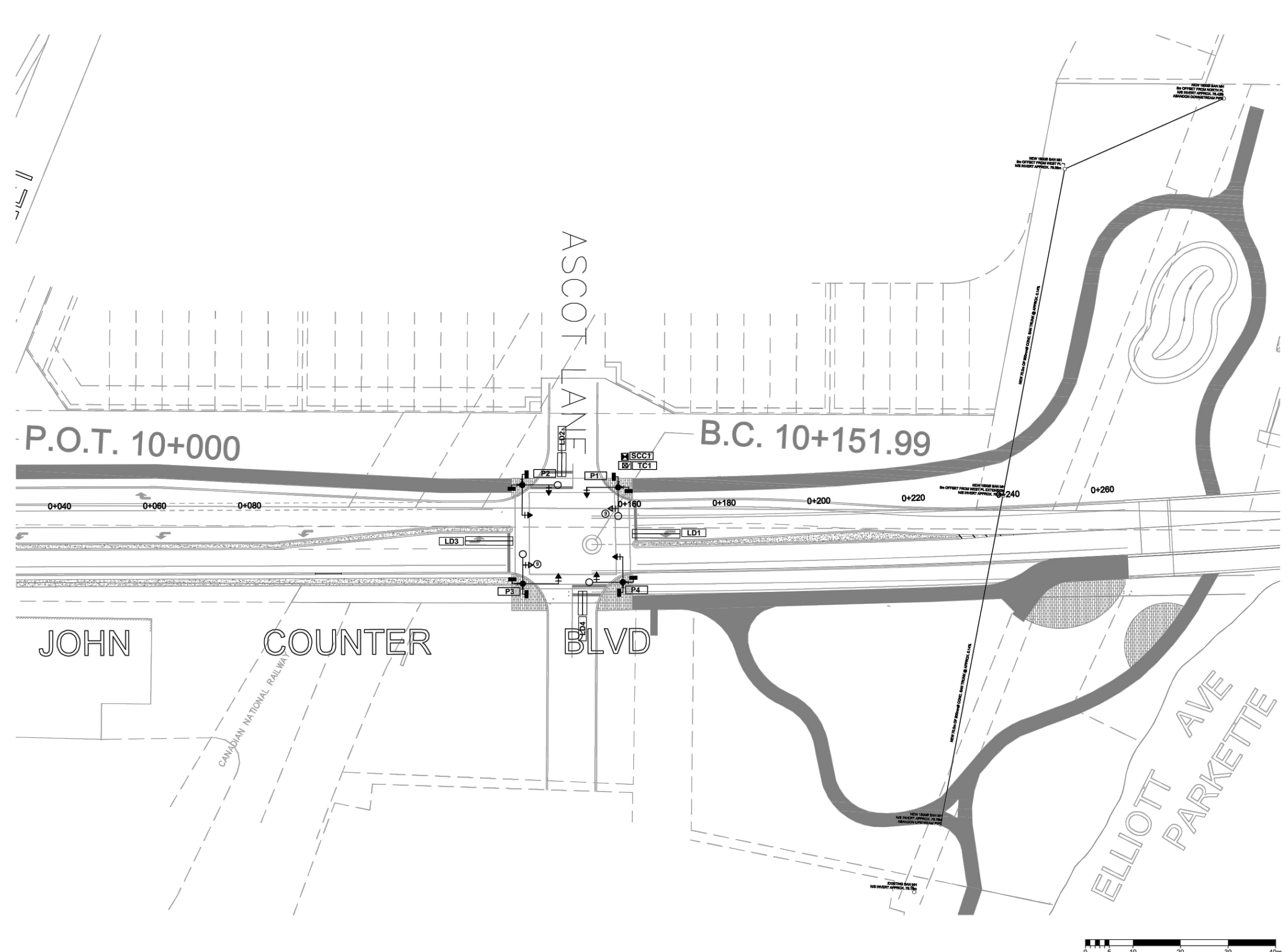
LOCATION: JOHN COUNTER BLVD AT ASCOT LANE
MUNICIPALITY: KINGSTON, ONTARIO DATE OF SURVEY: ________

	WARRANT	DESCRIPTION	MINIMUM REQUIREMENT FOR TWO-LANE ROADWAYS: FREE FLOW – OPERATING SPEED GREATER THAN OR EQUAL TO 70 km/h	RESTRICTED FLOW – OPERATING SPEED LESS THAN 70 km/h	COMPLIANCE: SECTIONAL %	③ ENTIRE %
INTERSECTION	1. MINIMUM VEHICULAR VOLUME	①A Vehicle Volume, All Approaches for Each of the Heaviest 8 hours of an Average Day, and	480	720		
		④B Vehicle Volume, Along Minor Streets for Each of the Same 8 hours	120	170		
	2. DELAY TO CROSS TRAFFIC	①A Vehicle Volume, Along Major Street for Each of the Heaviest 8 Hours of an Average Day, and	480	720		
		②B Combined Vehicle and Pedestrian Volume Crossing the Major Street for Each of the Same 8 hours	50	75		
	3. ACCIDENT HAZARD	A Total Reported Accidents of Types Susceptible to Correction by a Traffic Signal, per 12 Month Period Averaged Over a 36 Month Period, and	5			
		B Adequate Trial of Less Restrictive Remedies, Where Satisfactory Observance and Enforcement Have Failed to Reduce the Number of Accidents, and	Yes ☐ No ☐			
		C Fulfilment of Either of the Above Warrants (Minimum Vehicular Volume or Delay to Cross Traffic) to the Extent of 80% or More.	Yes ☐ No ☐			
	4. COMBINATION WARRANT	Two or More of the Above Warrants (1, 2, or 3) Satisfied to the Extent of 80% or More.	Yes ☐ No ☐			
MID-BLOCK	5. ⑤ MINIMUM PEDESTRIAN VOLUME	A Pedestrian Volume Crossing the Major Street Average per Hour for the Heaviest 8 Hours of an Average Day, and	120	240		
		① B Vehicle Volume Along Major Street Average Per Hour for the Same 8 Hours.	290	575		

NOTES:
① Vehicle Volume Warrants (1A), (2A) and (5B) for Roadways Having Two or More Moving Lanes in one Direction Should Be 25% Higher Than Values Given Above.
② For Definition of Crossing Volume Refer to Note ④ on the Signal Warrant Analysis Form B2.03.08
③ The Lowest Sectional Percentage Governs the Entire Warrant.
④ For 'T' Intersections the Values for Warrant (1B) Should Be Increased by 50%
⑤ Pedestrian Mid Block Signals may also be warranted based on a Pedestrian cross over warrant

LEGEND

- HIGHWAY SIGNAL HEAD (30 cm. Red) WITH BACKBOARD AND MAST ARM
- HIGHWAY SIGNAL HEAD (30 cm. Red) WITH BACKBOARD AND OVERHEAD CABLE
- HIGHWAY SIGNAL HEAD WITH BACKBOARD AND MAST ARM (ALL 30 cm. LENSES)
- SPECIAL HEAD WITH ARROW INDICATION AND BACKBOARD (Example shows Type ② Head)
- SPECIAL HEAD WITH BACKBOARD AND ONE OR MORE PROGRAMMABLE LENSES (Example shows Type ② Head)
- STANDARD SIGNAL HEAD WITH BACKBOARD AND MAST ARM (ALL 20 cm. LENSES)
- STANDARD SIGNAL HEAD WITH MAST ARM, WITHOUT BACKBOARD
- PEDESTRIAN SIGNAL HEAD
- PEDESTRIAN PUSH BUTTON
- VEHICLE PASSAGE LOOP DETECTOR
- VEHICLE LOOP DETECTOR
- DUPLEX LOOP DETECTOR
- DIAMOND LOOP DETECTOR
- MICRO-LOOP DETECTOR
- EMERGENCY VEHICLE PRE-EMPTION DETECTOR
- MICRO-WAVE DETECTOR
- MAGNETIC VEHICLE DETECTOR
- TRAFFIC CONTROLLER
- TRAFFIC SIGN
- TRAFFIC SIGN WITH FLASHING BEACON
- ILLUMINATED TRAFFIC SIGN



CLASSIFICATION OF ROADWAY		TRAFFIC SIGNAL HEADS: TYPE	SIZE	BACKBOARD	LOCATION: MOUNTING HT.	OFFSET FROM POLE
ROADWAY: JOHN COUNTER BLVD		PRIMARY	HIGHWAY	YES	5.0m	TBD
		SECONDARY	HIGHWAY	YES	5.0m	TBD
MULTILANE ☐		AUXILIARY				
TWO-LANE ☒	SEPARATE LT.TURN ARROWS	PRIMARY				
		SECONDARY				
ROADWAY: ASCOT LANE		PRIMARY	HIGHWAY	YES	5.0m	TBD
		SECONDARY	HIGHWAY	YES	5.0m	TBD
MULTILANE ☐		AUXILIARY				
TWO-LANE ☒	SEPARATE LT.TURN ARROWS	PRIMARY				
		SECONDARY				

TYPES OF SPECIAL ARROW HEADS WITH BACKBOARD
ALL 30 cm LENSES, EXCEPT AS NOTED

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪

⑧ ⑨ AMBER ARROW MUST BE USED IN A PROTECTED/PERMISSIVE SIMULTANEOUS LEFT TURN OPERATION.

NOTE: FOR SPECIAL ARROW HEADS ⑧, ⑨, ⑩ AND ⑪, 20 cm AMBER BALL AND 20 cm GREEN BALL LENSES SHOULD BE USED

TRAFFIC DRAWING: E103

MUNICIPALITY: KINGSTON, ONTARIO
INTERSECTION: JOHN COUNTER BLVD & ASCOT LANE
DATE: APRIL 2017 SCALE: 1:500
RECOMMENDED BY: ________
MUNICIPAL OFFICIAL (MUNICIPAL INSTALLATION)
REGIONAL TRAFFIC REPRESENTATIVE (MINISTRY INSTALLATION)

MINISTRY OF TRANSPORTATION, ONTARIO
SIGNALS WARRANTED: NEW INTERSECTION
SIGNAL DESIGN RECOMMENDED FOR APPROVAL:
SIGNAL INSTALLATION APPROVED AS PER SECTION 144 (31.1) H.TA.;
APPROVAL DATE:

THIS "PRELIMINARY" PH-M-125 DRAWING IS PROVIDED IN THE REPORT FOR INFORMATION PURPOSES ONLY. REFER TO THE PRELIMINARY DESIGN DRAWING SET FOR FULL SI□E DRAWING TO SCALE.

Plot Date: 5/2/2017 4:19:03 PM
Last Saved: May 2, 2017 4:18:06 PM
Consultant's Information: K:\27000\27143 - Third Crossing Pre-Design\JLR DWG\Civil\PDR Figures\DWG\PDR - 8.11.1 TO 8.11.3.dwg

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

TRAFFIC DRAWING
POINT ST MAR□ DRIVE
AND GORE ROAD

Mark Van Buren, P.Eng.
Director of Engineering and Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS·ARCHITECTS·PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	□11.3
Sheet No.:	
Des:	Chk'd:
Dwn:	Chk'd:
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

FORM PH-M-125 – Revised 1990 AutoCAD ver 12

REVISIONS

DATE	ANALYST	DESCRIPTION OF REVISIONS	RECOMMENDED BY

COLLISION DIAGRAM

NUMBER OF ANGLE COLLISIONS

Year	№
— —	— —
— —	— —
— —	— —

TOTAL — — —

AVERAGE PER YEAR — —

MINIMUM REQUIREMENTS FOR INSTALLATION OF TRAFFIC SIGNALS
(WARRANT ANALYSIS FORMS SHOULD BE ATTACHED)

LOCATION: GORE ROAD AT ST MARK DRIVE

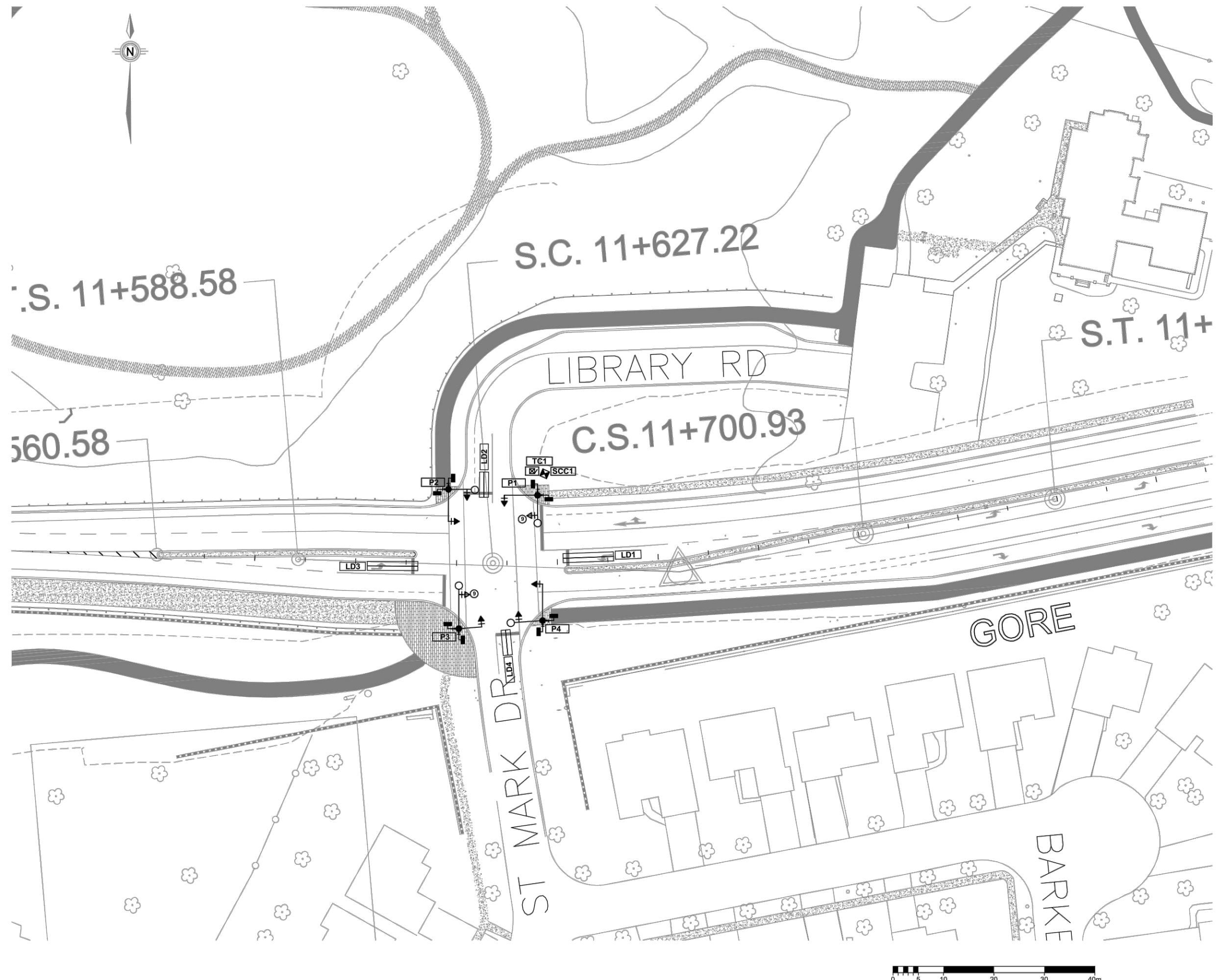
MUNICIPALITY: KINGSTON, ONTARIO DATE OF SURVEY: ______

	WARRANT	DESCRIPTION	MINIMUM REQUIREMENT FOR TWO-LANE ROADWAYS: FREE FLOW – OPERATING SPEED GREATER THAN OR EQUAL TO 70 km/h	RESTRICTED FLOW – OPERATING SPEED LESS THAN 70 km/h	COMPLIANCE: SECTIONAL %	③ ENTIRE %
INTERSECTION	1. MINIMUM VEHICULAR VOLUME	①A Vehicle Volume, All Approaches for Each of the Heaviest 8 hours of an Average Day, and	480	720		
		④B Vehicle Volume, Along Minor Streets for Each of the Same 8 hours	120	170		
	2. DELAY TO CROSS TRAFFIC	①A Vehicle Volume, Along Major Street for Each of the Heaviest 8 Hours of an Average Day, and	480	720		
		②B Combined Vehicle and Pedestrian Volume Crossing the Major Street for Each of the Same 8 hours	50	75		
	3. ACCIDENT HAZARD	A Total Reported Accidents of Types Susceptible to Correction by a Traffic Signal, per 12 Month Period Averaged Over a 36 Month Period, and	5			
		B Adequate Trial of Less Restrictive Remedies, Where Satisfactory Observance and Enforcement Have Failed to Reduce the Number of Accidents, and	Yes ☐ No ☐			
		C Fulfilment of Either of the Above Warrants (Minimum Vehicular Volume or Delay to Cross Traffic) to the Extent of 80% or More.	Yes ☐ No ☐			
	4. COMBINATION WARRANT	Two or More of the Above Warrants (1, 2, or 3) Satisfied to the Extent of 80% or More.	Yes ☐ No ☐			
MID-BLOCK	5. ⑤ MINIMUM PEDESTRIAN VOLUME	A Pedestrian Volume Crossing the Major Street Average per Hour for the Heaviest 8 Hours of an Average Day, and	120	240		
		①B Vehicle Volume Along Major Street Average Per Hour for the Same 8 Hours.	290	575		

NOTES:
① Vehicle Volume Warrants (1A), (2A) and (5B) for Roadways Having Two or More Moving Lanes in one Direction Should Be 25% Higher Than Values Given Above.
② For Definition of Crossing Volume Refer to Note ④ on the Signal Warrant Analysis Form B2.03.08
③ The Lowest Sectional Percentage Governs the Entire Warrant.
④ For 'T' Intersections the Values for Warrant (1B) Should Be Increased by 50%
⑤ Pedestrian Mid Block Signals may also be warranted based on a Pedestrian cross over warrant

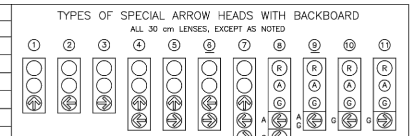
LEGEND

- HIGHWAY SIGNAL HEAD (30 cm. Red) WITH BACKBOARD AND MAST ARM
- HIGHWAY SIGNAL HEAD (30 cm. Red) WITH BACKBOARD AND OVERHEAD CABLE
- HIGHWAY SIGNAL HEAD WITH BACKBOARD AND MAST ARM (ALL 30 cm. LENSES)
- SPECIAL HEAD WITH ARROW INDICATION AND BACKBOARD (Example shows Type ② Head)
- SPECIAL HEAD WITH BACKBOARD AND ONE OR MORE PROGRAMMABLE LENSES (Example shows Type ② Head)
- STANDARD SIGNAL HEAD WITH BACKBOARD AND MAST ARM (ALL 20 cm. LENSES)
- STANDARD SIGNAL HEAD WITH MAST ARM, WITHOUT BACKBOARD
- PEDESTRIAN SIGNAL HEAD
- PEDESTRIAN PUSH BUTTON
- VEHICLE PASSAGE LOOP DETECTOR
- VEHICLE LOOP DETECTOR
- DUPLEX LOOP DETECTOR
- DIAMOND LOOP DETECTOR
- MICRO-LOOP DETECTOR
- EMERGENCY VEHICLE PRE-EMPTION DETECTOR
- MICRO-WAVE DETECTOR
- MAGNETIC VEHICLE DETECTOR
- TRAFFIC CONTROLLER
- TRAFFIC SIGN
- TRAFFIC SIGN WITH FLASHING BEACON
- ILLUMINATED TRAFFIC SIGN



CLASSIFICATION OF ROADWAY	TRAFFIC SIGNAL HEADS: TYPE		SIZE	BACKBOARD	LOCATION: MOUNTING HT.	OFFSET FROM POLE
ROADWAY: GORE ROAD		PRIMARY	HIGHWAY	YES	5.0m	TBD
		SECONDARY	HIGHWAY	YES	5.0m	TBD
		AUXILIARY				
MULTILANE ☐	SEPARATE LT.TURN ARROWS	PRIMARY				
TWO-LANE ☒		SECONDARY				
ROADWAY: ST MARK DRIVE		PRIMARY	HIGHWAY	YES	5.0m	TBD
		SECONDARY	HIGHWAY	YES	5.0m	TBD
		AUXILIARY				
MULTILANE ☐	SEPARATE LT.TURN ARROWS	PRIMARY				
TWO-LANE ☒		SECONDARY				

TYPES OF SPECIAL ARROW HEADS WITH BACKBOARD
ALL 30 cm LENSES, EXCEPT AS NOTED



⑧ ⑨ AMBER ARROW MUST BE USED IN A PROTECTED/PERMISSIVE SIMULTANEOUS LEFT TURN OPERATION.

NOTE: FOR SPECIAL ARROW HEADS ⑧, ⑨, ⑩ AND ⑪, 20 cm AMBER BALL AND 20 cm GREEN BALL LENSES SHOULD BE USED

TRAFFIC DRAWING: E104

MUNICIPALITY: KINGSTON, ONTARIO	MINISTRY OF TRANSPORTATION, ONTARIO
INTERSECTION: GORE ROAD & ST. MARK DRIVE	SIGNALS WARRANTED: NEW INTERSECTION
DATE: APRIL 2017 SCALE: 1:500	SIGNAL DESIGN RECOMMENDED FOR APPROVAL:
RECOMMENDED BY: ______ MUNICIPAL OFFICIAL (MUNICIPAL INSTALLATION) REGIONAL TRAFFIC REPRESENTATIVE (MINISTRY INSTALLATION)	SIGNAL INSTALLATION APPROVED AS PER SECTION 144 (31.1) H.TA.;
	APPROVAL DATE:

THIS "PRELIMINARY" PH-M-125 DRAWING IS PROVIDED IN THE REPORT FOR INFORMATION PURPOSES ONLY. REFER TO THE PRELIMINARY DESIGN DRAWING SET FOR FULL SI□E DRAWING TO SCALE.

4. **Intersection Illumination:** The intersection of illuminated roadways, whether signalized or not, require additional illumination levels. It is proposed that all intersections related to the bridge and its intersections with other roadways will be provided with 50% more illumination. These intersections will include Highway 15 and the Point St. Mark Drive-Library access on the east side, and Ascot Lane and Montreal Street on the west side.

5. **Park Illumination:** Park areas are planned for both the east and west sides of the bridge with the intention of connecting the pathways and walkways of these areas with the multi-use pathway on the bridge. It is intended that these park and pathway areas will be fitted with decorative luminaires located at strategic points to blend in with the surrounding landscape. Illumination may not be required on pathways that are not adjacent or immediately offset from the roadway [as per the City Pathways Study (2003)]. However, illumination on pathways near the bridge and under the bridge near abutments will be required.

Consideration of light fixtures that prevent light pollution both to the sky and over the side of the bridge to the river must be considered. Lighting must be focused on the roadways and multi-use pathways.

Bridge navigational safety lighting is also anticipated. The base of the arch v-piers will require navigational lighting and/or warning lights near the surface of the water. Preliminary lighting arrangement and power supply is shown in **Drawing 8.12.2.1**.

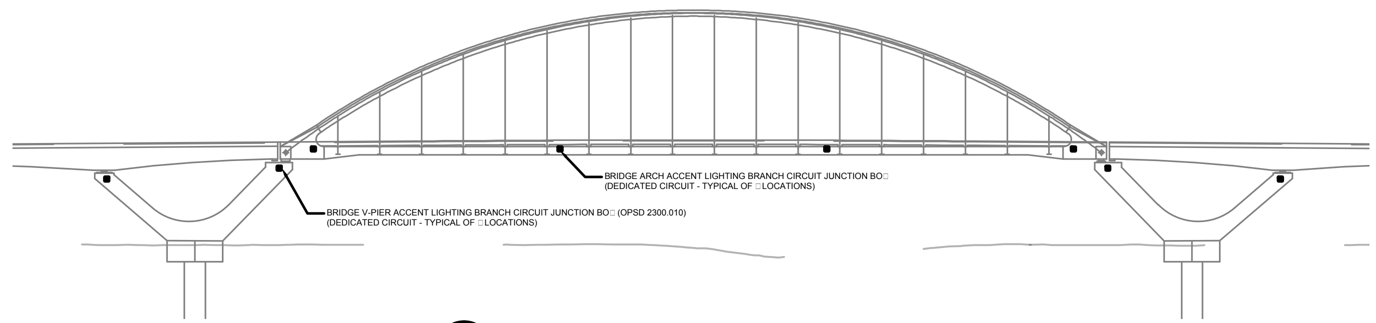
8.12.2 Electrical and Communications

The illumination of the areas noted previously requires service points to deliver electrical power. Furthermore, there is the potential for future requests for electrical power and/or security elements to the areas. Due to the length of the roadway and bridge structure, it is intended to provide three separate supply points located at strategic points along the bridge. The catwalk proposed for the bridge will provide the ideal location and conduit pathways for both power and any communications requirements design. It is anticipated that three supply points [Supply Control Cabinets (SCCs)] will provide satisfactory coverage of the electrical requirements. Electrical supply for the bridge is anticipated to be from Kingston Hydro sources on the west side of the bridge.

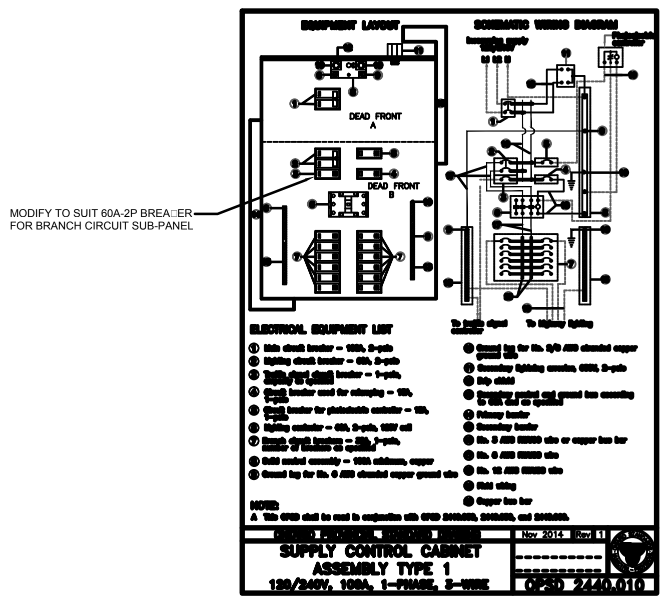
The furthest SCC will be located near the west side of the arch, approximately 300 m from the east abutment, and will supply electricity to the arch and locations on the bridge east of the arch. The remaining two SCCs (one located equidistant from the west abutment and the second located near the mid-point of the bridge), will service the west side of the bridge. These three SCCs will provide all the lighting and electrical requirements for the bridge structure, including the roadways, the multi-use pathway, bridge illumination and navigation safety lighting as well as auxiliary power receptacles. The remaining intersection and park illumination requirements will be serviced by local SCCs with power available from sources on either approach.

Penetrations through the bridge deck at any location are to be minimized. It is therefore intended that branch circuit wiring between luminaires will be restricted to the concrete barrier separating the roadway from the multi-use pathway. This will ensure that the deck penetrations for the roadway and multi-use illumination occur where the service point feeds the first luminaire in a string of ten luminaires.

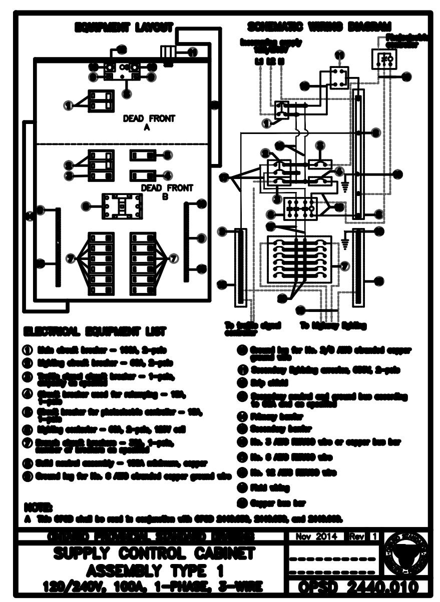
In addition to electrical services, communications services on the bridge will be installed via a communications raceway system located under the bridge with access on the proposed catwalk. Communications services will provide the option of providing emergency call button, closed circuit video monitoring, weather monitoring, bridge health monitoring or other real-time system.



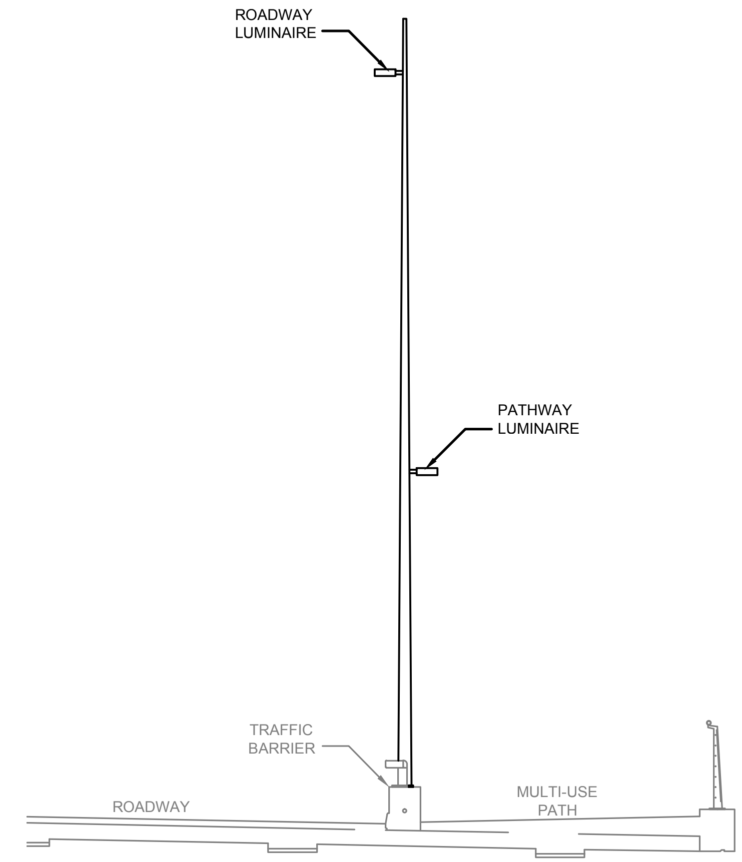
1 ES□-01 ACCENT LIGHTING BRANCH CIRCUIT PROVISIONS
SCALE: N/A



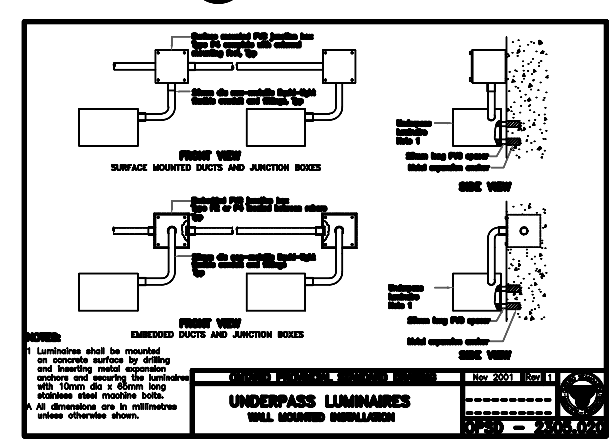
3 ES□-01 PANELBOARD "P2", "P3", "P4"
SCALE: N/A

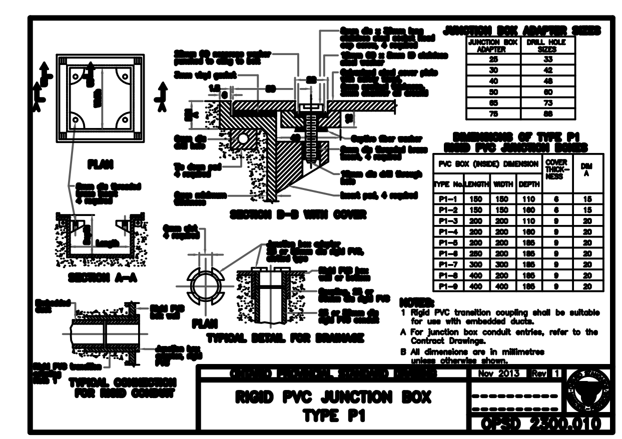


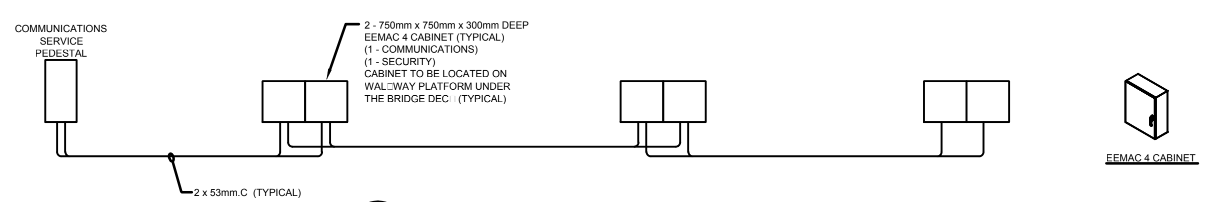
4 ES□-01 PANELBOARD "P1", P5"
SCALE: N/A



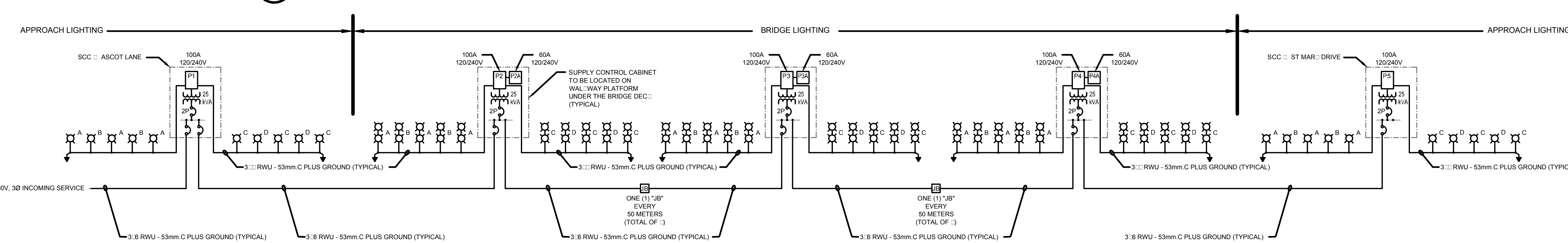
2 ES□-01 ROADWAY / MUP LUMINAIRE ASSEMBLY
SCALE: N/A







4 ES□-01 COMMUNICATIONS RACEWAY SYSTEM
SCALE: N/A



5 ES□-01 SINGLE LINE DIAGRAM
SCALE: N/A

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ELECTRICAL AND COMMUNICATIONS SINGLE LINE DIAGRAM AND DETAILS

Mark Van Buren, P.Eng.
Director, Infrastructure Services

Dan Franco, P.Eng.
Manager, Construction Services - West

KINGSTON

J.L.Richards
ENGINEERS·ARCHITECTS·PLANNERS

PARSONS

Project No.: 27143
Drawing No.: □12.2.1
Sheet No.:
Des: | Chk'd:
Dwn: | Chk'd:
Scale: AS NOTED
Utility Circ. No.
Code:
Load:

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
01	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	SS	03/05/17

Consultant's Information: ...\27000\27143 - Third Crossing Pre-Design\JLR DWG\Civil\PDR Figures\DWG\PDR - 12.1.dwg
Last Saved: April 29, 2017 11:24:57 AM
Plot Date: 4/29/2017 11:26:32 AM

8.13 Utility Accommodations

As discussed below, certain utility relocations will be required due to widened road approaches leading up to the bridge on both east and west shores; bridge abutments; stormwater management facilities; and other related infrastructure. In addition, the ESR presented a landscape concept of the project corridor that was free of overhead utilities on the west approach (similar to existing conditions on the east approach):

1. **Hydro One:** Relocation of the existing Hydro One owned 44kV lines located on poles on John Counter Boulevard west of the Cataraqui River will be required. Overhead lines will be relocated to two sets of 44kV underground duct banks from west of Montreal Street to the submarine cables. Underground services may be located under the 3 m wide pathway on the north side of John Counter Boulevard between the bridge and Montreal Street. A duct containing six conduits (3H:2V) will accommodate the power cabling.

   Relocation of underground transmission lines on Gore Road near Highway 15 (due to road widening as well as area of bridge approach fill) may also be required in addition to relocation of poles near the Highway 15 intersection. Relocation (raising) of overhead utilities on poles alongside Highway 15 near the existing dog park is similarly expected to accommodate a future bridge construction access road at this location. Temporary power lines to future bridge construction staging areas on the east shore can be also anticipated.

2. **Kingston Hydro:** Relocation of Kingston Hydro's distribution voltage currently located overhead on John Counter Boulevard to underground from west of Montreal Street to the bridge abutment (to service future bridge electrical requirements) will be required. Underground services have been requested by Kingston Hydro, separated from the Hydro One services within their own three conduit duct bank. A pad mount transformer located adjacent to the west bridge abutment will be necessary to service the power requirements of the bridge.

3. **Utilities Kingston Sanitary:** Relocation of the Rideau Heights trunk sanitary main along the west shoreline will be required to permit additional room for staging and laydown during construction as well as stormwater management facility(s). Given its age, the sanitary trunk sewer must also be moved away from the west bridge abutment and renewed in order to ensure vital infrastructure does not underlay new infrastructure.

   In addition, regarding the sanitary forcemain on the east shore within the Gore Road allowance, relocation will not be required. However, protection from excessive fill associated with embankment construction will be required.

4. **Utilities Kingston Water:** The existing underground watermains within the project corridor are not expected to require relocation.

5. **Storm Sewers:** The storm sewers on Gore Road are not expected to require relocation. However, enhancements and integrations to the existing stormwater management infrastructure on both approaches will be required.

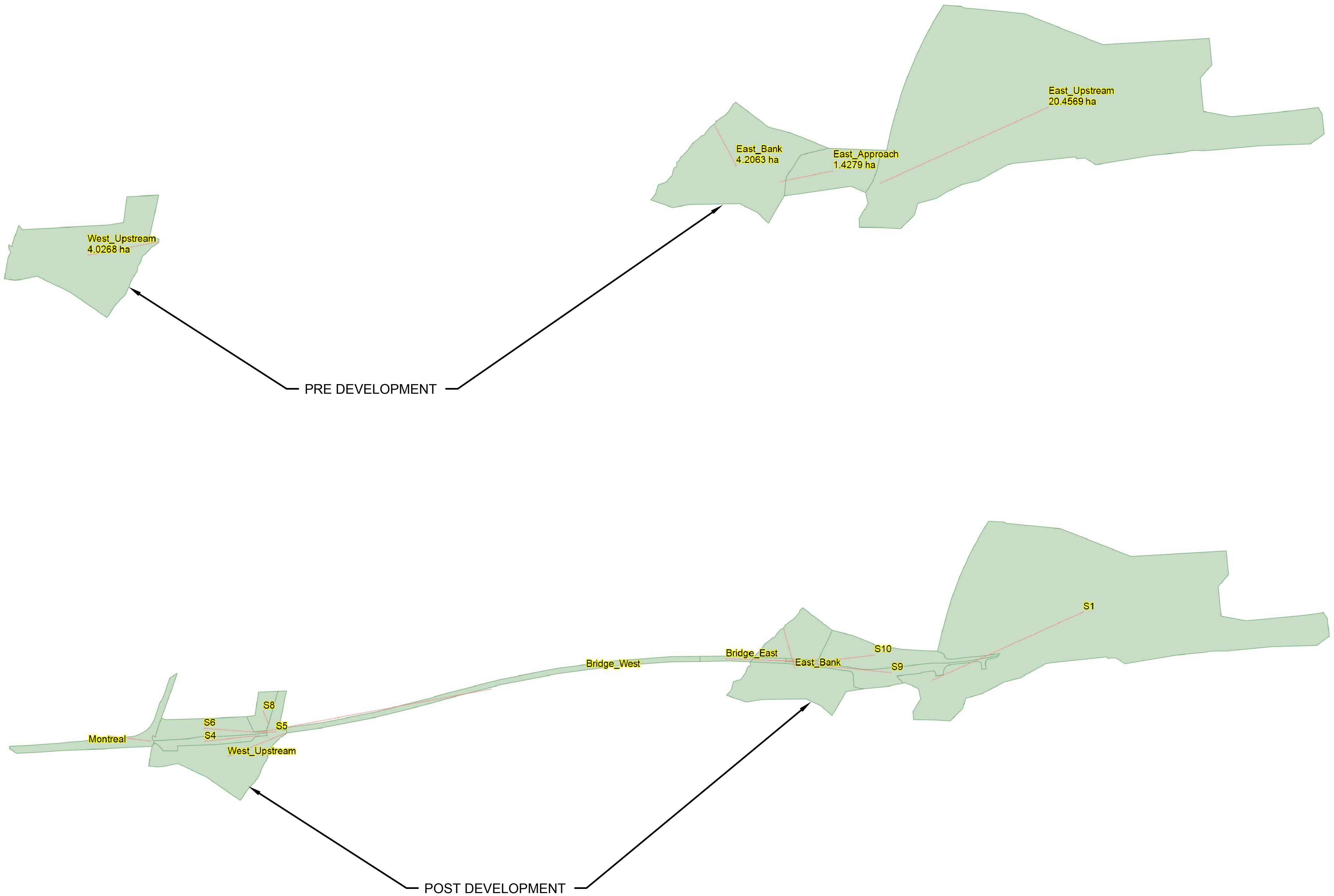
6. **Bell Canada:** Relocation will be required to ensure services are out of the future paved areas. Relocation (raising) of overhead utilities on poles alongside Highway 15 near the existing dog park is anticipated to accommodate the future bridge construction access road.

7. **Cogeco Cable:** Relocation will be required to ensure services are out of the future paved areas. Relocation (raising) of overhead utilities on poles alongside Highway 15 near the existing dog park is anticipated to accommodate the future bridge construction access road. In addition, Cogeco Cable has requested future accommodation within the bridge structure for a fibre-optic cable.

8.14 Approach Drainage and Stormwater Management

Stormwater management provisions are required for lands modified as part of the bridge. In particular, the approach roadways (where low permeability / higher runoff volumes are expected) generally require formalized stormwater management where stormwater quantity and quality is sufficiently managed. Bridge runoff will be directed to shore as well. Where both flows converge, techniques for quantity and quality control are also required. The supporting report is included in **Appendix J.**

The accepted practice for stormwater management involves a comparison of pre-development to post-development flows to demonstrate that flows are adequately managed. Factors to be considered include identification of major (overland) and minor (underground) drainage pathways, sizing and type of treatment facilities, and discharge method at both shorelines. **Drawing 8.14.1** shows a comparison of stormwater catchment areas within the project corridor (pre-development and post-development conditions):



THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

STORMWATER CATCHMENT AREAS

Mark Van Buren, P.Eng.	Dan Franco, P.Eng.
Director of Engineering and Deputy Commissioner	Project Engineer

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

KINGSTON

Project No.:	27143
Drawing No.:	14.1
Sheet No.:	
Des:	Chk'd:
Dwn:	Chk'd:
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

Plot Date: 4/28/2017 3:36:31 PM

Last Saved: April 28, 2017 3:36:21 PM

Consultant's Information: K:\27000\27143 - Third Crossing Pre-Design\JLR DWG\Civil\PDR Figures\DWG\PDR - 8.14.1.dwg

1. On the west approach:

   a) The Pre-Development condition has no piped storm system east of Montreal Street. There is an informal ditch system along north side of John Counter Boulevard, no formal drainage along south side of John Counter Boulevard (overland flow is east towards Cataraqui River) and no current formal outlet on the west bank (runoff enters the river as sheet flow).

   b) The Post-Development condition, as shown on **Drawing 8.14.2**, includes:

      i. the upgraded and widened Montreal Street intersection, which is disconnected from Montreal Street (south) and diverted to John Counter Boulevard (east), where stormwater is diverted from the additional lanes at this location;

      ii. a dry pond facility on the west bank for quantity control and stormwater treatment unit for quality control;

      iii. a new minor system of stormwater piping (1:10 year event via to low point on the approach road) using a 450 mm diameter pipe;

      iv. from the low point, the minor system is piped to the dry pond facility whereas major event flows will flow overland to the dry pond facility; and

      v. bridge drainage joins the approach drainage also at the low point.

   c) The Post-Development condition, as shown on **Drawing 8.14.2**, includes:

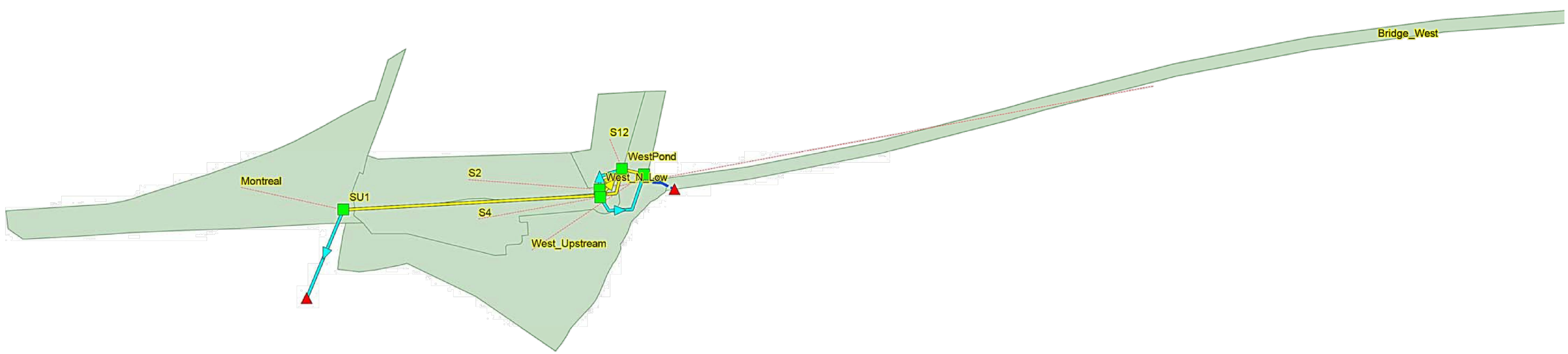
      i. the upgraded and widened Montreal Street intersection, which is disconnected from Montreal Street (south) and diverted to John Counter Boulevard (east), where stormwater is diverted from the additional lanes at this location;

      ii. a dry pond facility on the west bank for quantity control and stormwater treatment unit for quality control;

      iii. a new minor system of stormwater piping (1:10 year event via to low point on the approach road) using a 450 mm diameter pipe;

      iv. from the low point, the minor system is piped to the dry pond facility whereas major event flows will flow overland to the dry pond facility; and

      v. bridge drainage joins the approach drainage also at the low point.



THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

POST DEVELOPMENT WEST CATCHMENT AREA

Mark Van Buren, P.Eng.	Dan Franco, P.Eng.
Director of Engineering and Deputy Commissioner	Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.: 27143	
Drawing No.: □14.2	
Sheet No.:	
Des:	Chk'd:
Dwn:	Chk'd:
Scale: N.T.S.	
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

Consultant's Information: K:\27000\27143 - Third Crossing Pre-Design\JLR DWG\Civil\PDR Figures\DWG\PDR - 8.14.2.dwg

Last Saved: April 28, 2017 3:38:45 PM

Plot Date: 4/28/2017 3:39:02 PM

2. On the east approach:

   a) The Pre-Development condition includes an existing 600 mm diameter sewer on Gore Road which captures an area east of Highway 15 and the existing catchbasins on Gore Road. Flows are discharged into natural springs which then transitions to small creek flow discharge into the Cataraqui River. Overland flow that is not captured by the creek flow enters the river as overland sheet flow.

   b) The Post-Development condition, as shown on **Drawing 8.14.3**, includes:

      i. continued maintenance of the existing minor system that drains directly to the river;

      ii. a dry pond facility on the east bank for quantity control and stormwater treatment unit for quality control;

      iii. a new minor system of stormwater piping (1:10 year event via to low point on the approach road) using a 375 mm diameter pipe into the dry pond facility;

      iv. accommodation of bridge drainage and overland flows from major events into the dry pond facility; and

      v. a new minor system on the north side of Gore Road to capture the road widenings, including west of Point St. Mark Drive.

Stormwater Treatment Units for quality control (Oil-grit separator units such as 'Stormceptors') will be used ahead of the dry pond facilities. Dry ponds on both shores are anticipated to include a 4:1 length to width ratio, with an active storage depth of less than 1 m and side slopes of 4:1. Conceptual water quality release rates and pond sizing (area and volume) are shown in **Table 8.14.1** through **Table 8.14.3**.

Table 8.14.1: Water Quantity Release Rates

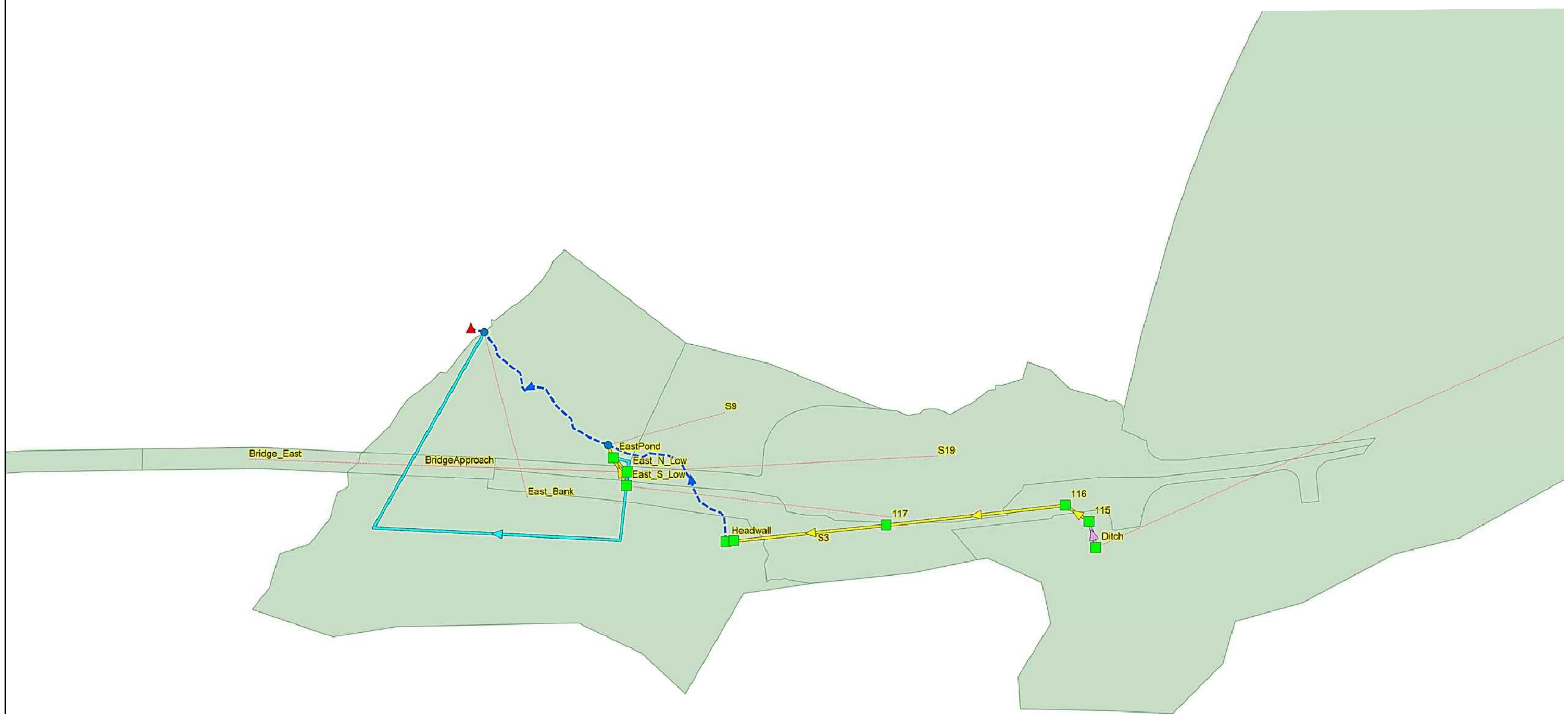
	West Pond (m^3/s)	East Pond (m^3/s)
Pre-development maximum flow to river	0.43	1.29
Maximum runoff from bridge surface	0.25	0.05
Target flow: pre-development plus bridge runoff	0.68	1.33
Post-development: maximum flow to river	0.60	1.32

Table 8.14.2: West Pond Stage Storage Relationship

West Pond	Elevation (m)	Area (m x m)	Volume (m^3/s)
Base of Pond	76.3	102	0
Maximum Water Level	77.3	344	218
Top of Pond	77.6	439	331

Table 8.14.3: East Pond Stage Storage Relationship

West Pond	Elevation (m)	Area (m x m)	Volume (m^3/s)
Base of Pond	76.3	181	0
Maximum Water Level	77.2	456	285
Top of Pond	77.6	560	458



THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

POST DEVELOPMENT EAST CATCHMENT AREA

Mark Van Buren, P.Eng.	Dan Franco, P.Eng.
Director of Engineering and Deputy Commissioner	*Project Engineer*

KINGSTON

J.L.Richards ENGINEERS·ARCHITECTS·PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	□14.3
Sheet No.:	
Des:	Chk'd:
Dwn:	Chk'd:
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

Plot Date: 4/28/2017 3:45:07 PM

Last Saved: April 28, 2017 3:45:00 PM

Consultant's Information: K:\27000\27143 - Third Crossing Pre-Design\JLR DWG\Civil\PDR Figures\DWG\PDR - 8.14.3.dwg

Pond outlets will include orifice and spillways to manage outlet flow. Orifices will be connected to 450 mm pipes. A level spreader that is approximately 50 m long will reduce discharge velocities to less than 0.9 m/s along the west shoreline.

8.15 Project Corridor Restoration and Enhancement

The Natural Heritage Protection and Enhancement Plan (NHPEP) provided in **Appendix K** includes best management practices and design measures to both protect and enhance the cultural and natural heritage landscape within the project corridor. The recommended best management practices to protect the landscape during the construction and operation phases of the project are discussed later in this Report. This section of the Report focuses on design measures which will restore and enhance the landscape as part of and following the construction phase.

Firstly, the intent of the preferred bridge concept is to provide a world-class signature design that is appropriate to its context, and is balanced with structural feasibility, constructability, and cost-effectiveness. This is achieved through the following aesthetic expression:

1. A 1.2 km bridge configured in a subtle s-curve that provides:
    a) An elegant overall visual effect.
    b) An organic reflection of the bridge within the context of its 'transitional' location between the natural character of the waterway to the north and the more urbanized environment of the City to the south, east and west.
    c) An expanded viewscape experience for bridge users, in that open views would be provided of the natural character of the waterway to the north and the more urbanized environment of the City to the south, east and west.
2. A feature tilted arch span over the navigable channel and adjacent rowing lanes using v-piers that acts as a focal and destination point of the whole composition.
3. A series of inverted U-frame piers having an outside face angle that both matches and gradually increases in height toward the tilted arch span, and which provides a cohesive overall rhythm towards the arch span as the focal point of the bridge.
4. The bridge clearance above the water, which accommodates existing topographic conditions on both shorelines, exceeds the Rideau Canal's Federally regulated navigable requirement, and mitigates visual impacts, in that its silhouette would be below the tree line when viewed from on-water and on-land.
5. Girders placed at a maximum setback from the edge of the bridge deck and at a minimum depth to emphasize visual lightness.
6. The design of noise attenuation barriers which mitigate noise impacts from the bridge on nearby sensitive receptors and also maintain lightness and transparency along the affected portion of the bridge.
7. The design of barriers and railings to maximize public safety as well as visual lightness, transparency and views to the river setting.
8. Enhanced pedestrian experiences crossing the bridge through such means as:
    a) Universally accessible provisions, including:
        i. the 4 m wide multi-use pathway, which increases to 9.5 m under the arch span to provide a look-out over the navigation channel and adjacent rowing lanes;
        ii. rest areas incorporated into the south side of the barrier separating the roadway and multi-use pathway;
        iii. a pedestrian railing along the south side of the bridge deck;
        iv. contemporary lighting of the multi-use pathway that provides safe access as well as comfortable and evenly distributed light in accordance with IESNA Standards; and
        v. deck drains that are not located within the multi-use pathway, but rather along the north side of the barrier separating the roadway and the multi-use pathway.
    b) Interpretive panels along the south side of the bridge deck that respond to special aspects of the area context, such as the Canal, Belle Island, and the Greater Cataraqui Marsh.

9. Materials and finishes that are durable, high quality, and aesthetically pleasing, especially when experienced up close.

10. Roadway lighting that is functional, low maintenance, and contemporary in appearance.

11. Accent lighting that highlights the feature arch span and V-piers in a subtle manner that provides a pleasing aesthetic effect by night.

Secondly, the landscape concept developed for the east and west side lands, as shown on **Drawing 8.15.1** and **Drawing 8.15.2**, respectively, further informs the opportunities to restore and enhance the natural and cultural heritage values of the project corridor. Cross-section and elevation schematic plans taken at certain reference points on the landscape concepts are shown on **Drawing 8.15.3**.

The main components of the landscape concepts are as follows:

1. The constant gradual s-curve of the bridge, which lands north of the Point St. Mark residential neighbourhood, and offers opportunities for:
   a) Reduced potential noise and visual impacts on Point St. Mark.
   b) ‘Softer landscaping’ along the Gore Road right-of-way.

2. Grounding the bridge structure dramatically and distinctively at each abutment using materials and proportions that reference and enhance the cultural landscape without overt imitation of heritage architecture.

3. The use of native plant materials to provide landscape variety and hardiness.

4. The incorporation of observation look-out / interpretive areas in order to:
   a) Bring attention to the waterfront trail system at an appropriate scale with the bridge and gateway elements.
   b) Provide a natural destination point, resting place or rendezvous.
   c) Accentuate the public realm by accommodating interpretive panels about the Canal, Belle Island and the Greater Cataraqui Marsh, public art installations and site furniture.

5. The incorporation of active travel and commuter cycling provisions to connect with existing non-automotive networks on both sides of the Cataraqui River.

6. Accessible multi-use pathways in terms of: width (i.e. 3 m); running slope (i.e. 4% or less); cross slope (i.e. 2% or less); and lighting (i.e. contemporary, comfortable and evenly distributed, and compliant with IESNA Standards). Note that the accessible route to the east waterfront area will be from the pathway on Kenwoods Circle, as shown in **Drawing 8.15.1**.

7. Restoration of the natural shorelines and forest and the installation of natural vegetation buffers around the bridge approaches following construction.

LEGEND:

EXISTING WOODLOT

EXISTING TREES

PROPOSED TREES
Specimen tree planting at 3m to 4.5m height (2m conifers).
Typical native tree species:
Shagbark Hickory, Red Oak, Pin Oak, Red Maple, Sugar Maple, Hackberry, Serviceberry, White Pine, White Spruce, Blue Spruce

SHRUB PLANTING
Native shrub species appropriate to each location.
Typical species: Fragrant Sumac, Staghorn Sumac, Elderberry, Bush Honeysuckle, Serviceberry, Dogwood, Chokecherry, Ninebark, Whitch Hazel, Juniper

REFORESTATION PLANTING
Mixed deciduous woodland planting, native tree and shrub mix with species as above.

RIPARIAN PLANTING
Mix of riparian shrubs, native grasses and forbs such as Speckled Alder, Black Cherry Chokeberry, Dogwood, Elderberry, Nannyberry, Bebb's Willow, Pussy Willow, Soft Rush, Cattail, and Sedges.

WILDFLOWER MEADOW
Mix of native grasses and perennials such as Big Bluestem, Canada Wild Rye, Switch Grass, Indian Grass, Little Bluestem, Prairie Dropseed, Azure Aster, Butterfly Weed, Common Mountain Mint, Golden Alexander, Giant Hyssop, Pearly Everlasting, Wild Columbine, Swamp Milkweed, Purple Coneflower, Joe Pye Weed, Yellow Coneflower, Black Eyed Susan

NOISE ATTENUATION BARRIER

LIMESTONE BLOCK WALL

SPECIALITY PAVING

GENERAL LOCATION FOR WILDLIFE MICRO-HABITAT

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

LANDSCAPE LAYOUT - EAST

Mark Van Buren, P.Eng.
Director of Engineering and Deputy Commissioner

Dan Franco, P. Eng.
Project Engineer

KINGSTON

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

CSW

Project No.:	27143
Drawing No.:	8.15.1
Sheet No.:	
Des: SE	Chk'd: ML
Dwn: SE	Chk'd: ML
Scale:	1:1500
Utility Circ. No.	111222333
Code:	CAN/CSA-S6-06
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
01	ISSUED FOR PRELIMINARY DESIGN REPORT	SE	3 MAY 2017

Plot Date: 5/2/2017 2:13:52 PM
Last Saved: Tuesday, May 02, 2017 2:03:03 PM
Consultant's Information: C:\Projects\1705-01 Cataraqui Crossing\Drawings\Drawings - Design Development\1705-01 Cataraqui Crossing - Landscape Layout 18.dwg

LEGEND:

EXISTING WOODLOT

EXISTING TREES

PROPOSED TREES
Specimen tree planting at 3m to 4.5m height (2m conifers).
Typical native tree species:
Shagbark Hickory, Red Oak, Pin Oak, Red Maple, Sugar Maple, Hackberry, Serviceberry, White Pine, White Spruce, Blue Spruce

SHRUB PLANTING
Native shrub species appropriate to each location.
Typical species: Fragrant Sumac, Staghorn Sumac, Elderberry, Bush Honeysuckle, Serviceberry, Dogwood, Chokecherry, Ninebark, Whitch Hazel, Juniper

REFORESTATION PLANTING
Mixed deciduous woodland planting, native tree and shrub mix with species as above.

RIPARIAN PLANTING
Mix of riparian shrubs, native grasses and forbs such as Speckled Alder, Black Cherry Chokeberry, Dogwood, Elderberry, Nannyberry, Bebb's Willow, Pussy Willow, Soft Rush, Cattail, and Sedges.

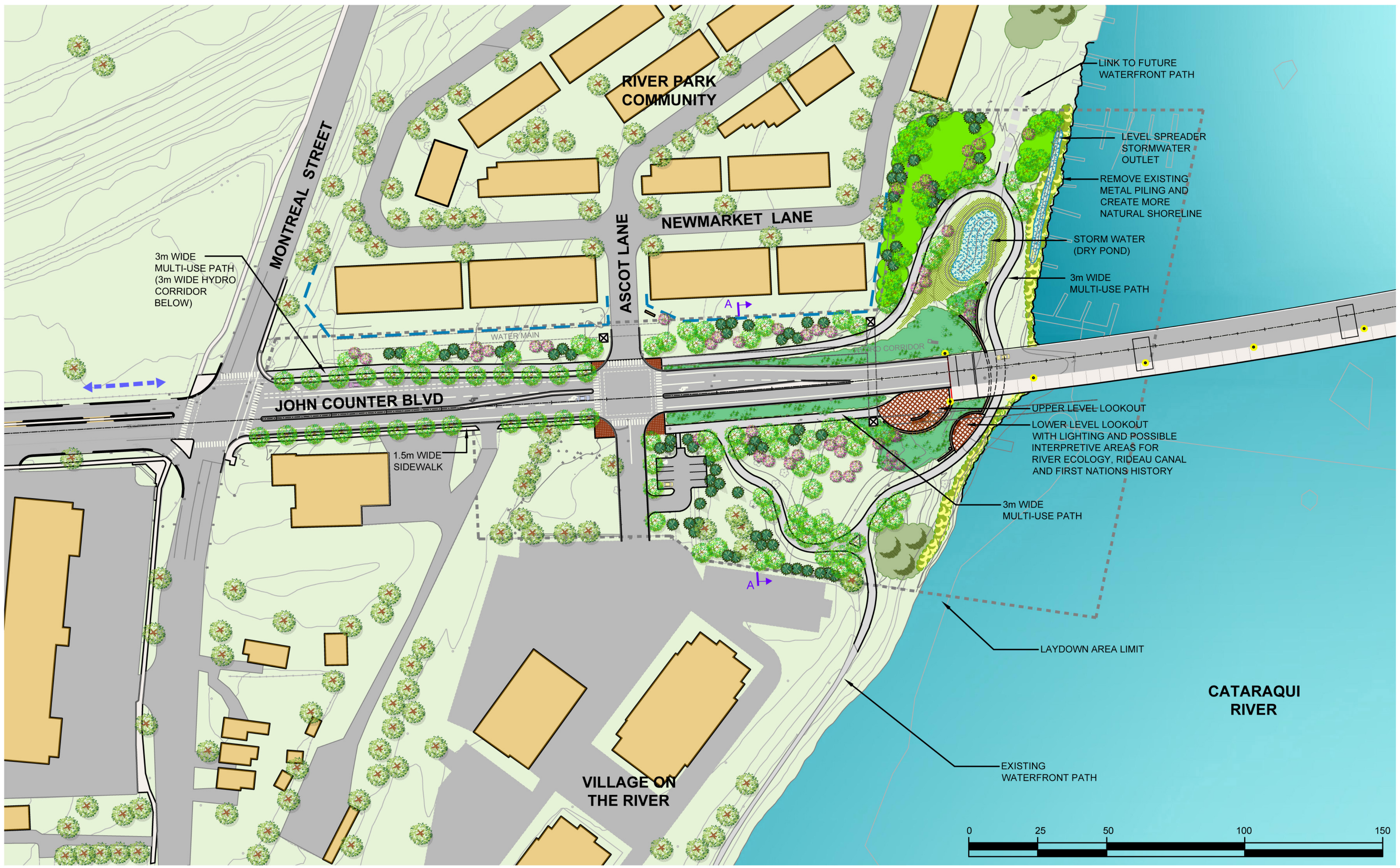
WILDFLOWER MEADOW
Mix of native grasses and perennials such as Big Bluestem, Canada Wild Rye, Switch Grass, Indian Grass, Little Bluestem, Prairie Dropseed, Azure Aster, Butterfly Weed, Common Mountain Mint, Golden Alexander, Giant Hyssop, Pearly Everlasting, Wild Columbine, Swamp Milkweed, Purple Coneflower, Joe Pye Weed, Yellow Coneflower, Black Eyed Susan

NOISE ATTENUATION BARRIER

LIMESTONE BLOCK WALL

SPECIALITY PAVING

GENERAL LOCATION FOR WILDLIFE MICRO-HABITAT



THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

LANDSCAPE LAYOUT - WEST

Mark Van Buren, P.Eng.
Director of Engineering and Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

CSW

Project No.:	27143
Drawing No.:	8.15.2
Sheet No.:	
Des: SE	Chk'd: ML
Dwn: SE	Chk'd: ML
Scale:	1:1500
Utility Circ. No.	111222333
Code:	CAN/CSA-S6-06
Load:	CL625ONT

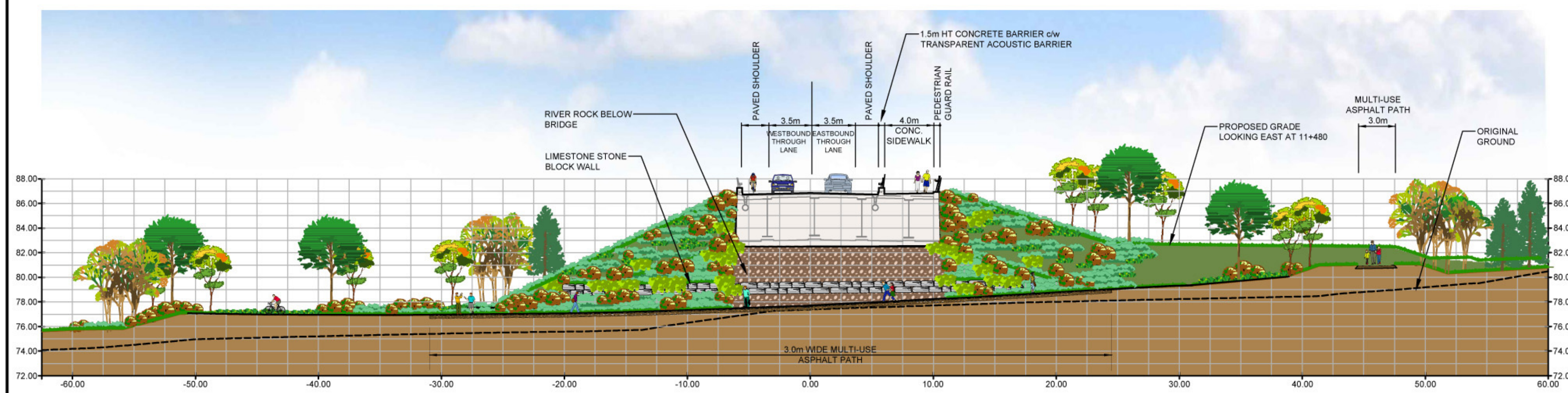
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

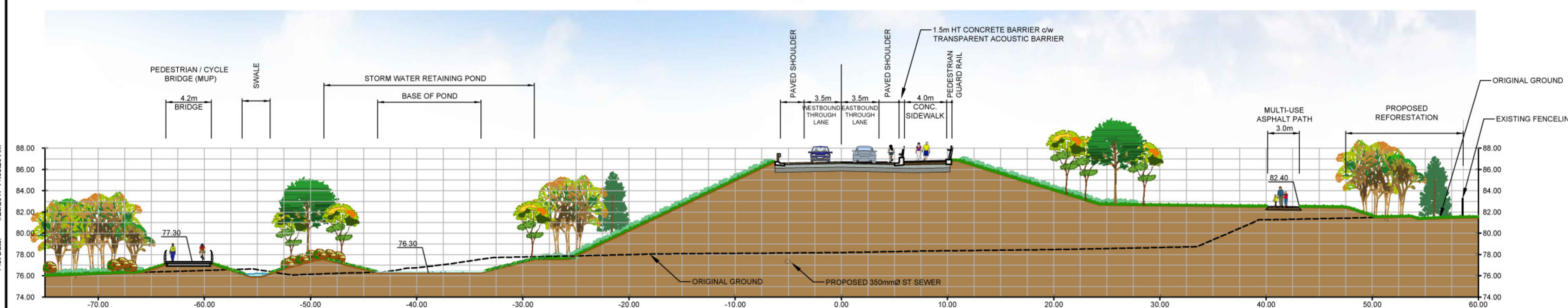
No.	Description	By	Date (dd/mm/yy)
01	ISSUED FOR PRELIMINARY DESIGN REPORT	SE	3 MAY 2017

Plot Date: 4/28/2017 11:18:34 AM
Last Saved: Tuesday, April 25, 2017 10:29:32 AM
Consultant's Information: C:\Projects\1705-01 Cataraqui Crossing\Drawings\Drawings - Design Development\1705-01 Cataraqui Crossing - Landscape Layout 18.dwg

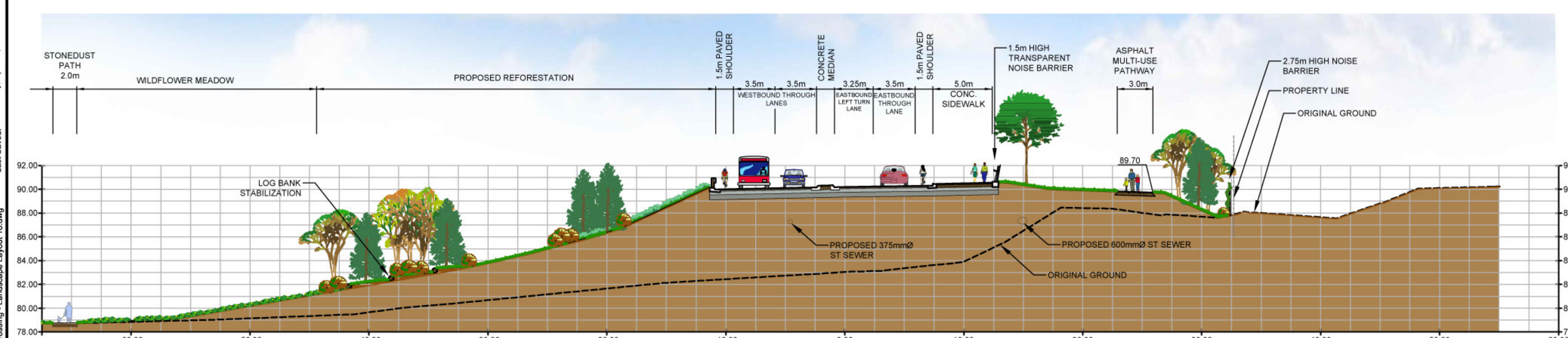
EAST APPROACH - LANDSCAPE CROSS SECTIONS AND ELEVATION



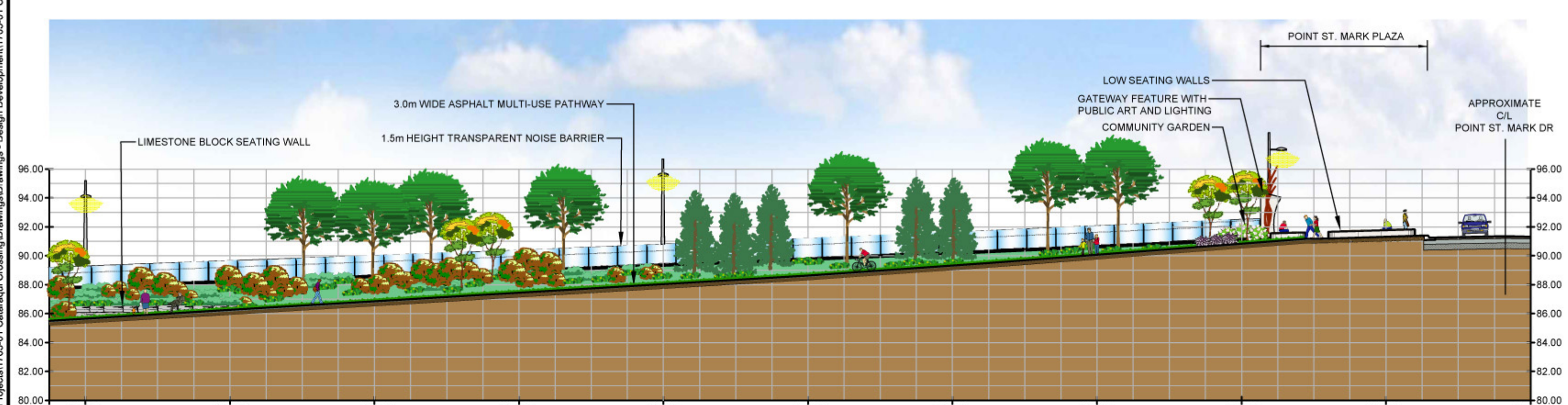
SECTION / VIEW A-A 11+430



CROSS SECTION B-B 11+480

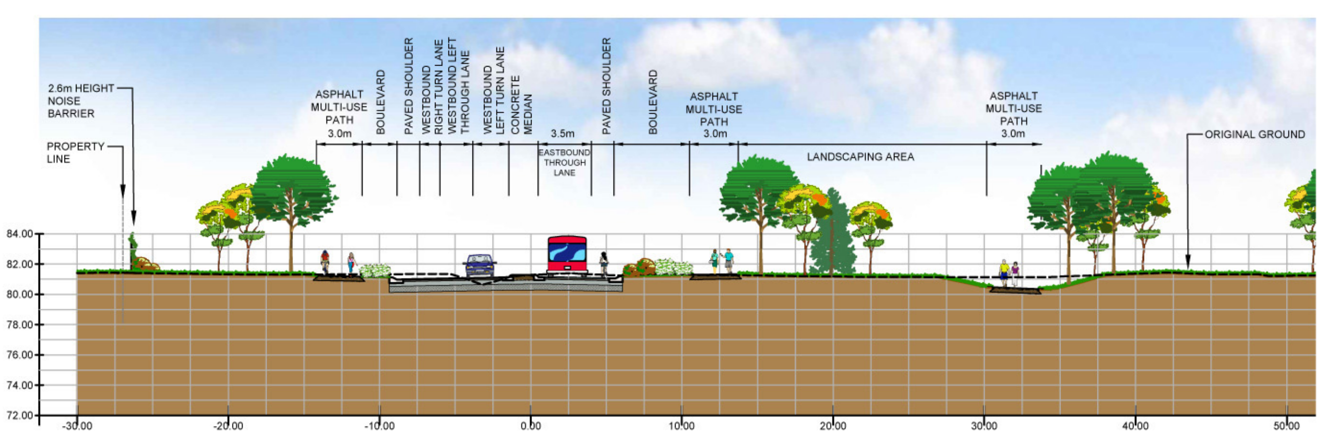


CROSS SECTION C-C 11+600



ELEVATION - POINT ST. MARK DRIVE PLAZA - DD

WEST APPROACH - LANDSCAPE CROSS SECTION



CROSS SECTION A-A 10+190

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

LANDSCAPE CROSS SECTIONS

Mark Van Buren, P.Eng.
Director of Engineering and Deputy Commissioner

Dan Franco, P. Eng.
Project Engineer

KINGSTON

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

CSW

Project No.:	27143
Drawing No.:	8.15.3
Sheet No.:	
Des: SE	Chk'd: ML
Dwn: SE	Chk'd: ML
Scale:	1:500
Utility Circ. No.	111222333
Code:	CAN/CSA-S6-06
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
01	ISSUED FOR PRELIMINARY DESIGN REPORT	SE	3 MAY 2017

Plot Date: 4/28/2017 11:35:20 AM
Last Saved: Tuesday, April 25, 2017 10:29:32 AM
Consultant's Information: C:\Projects\1705-01 Cataraqui Crossing\Drawings\Drawings - Design Development\1705-01 Cataraqui Crossing - Landscape Layout 18.dwg

More specific design provisions on the east side lands include:

1. An urban landscape theme with avenue tree plantings to serve as a buffer from the Gore Road / Highway 15 intersection area to a plaza space at the Gore Road / Point St. Mark Drive / Gore Road Library intersection where a more natural landscape theme then takes over closer to the bridge and shoreline. This includes meandering rock walls in order to:
    a) Break up the grade change and thereby provide a more natural approach.
    b) Maximize the usable ‘meadow’ space for future park development.
2. Selected plant materials are based on the list of vascular plants observed on the east side lands as well as native and non-invasive plant species suitable to the area, and which are resilient to environmental stresses. More specifically:
    a) Reforestation planting will include predominantly mixed deciduous trees and shrub species.
    b) Shrub planting will include a mix of deciduous and coniferous shrubs as well as a large variety of fruiting species to provide a food source for wildlife.
    c) The meadow area will be re-established using existing topsoil (stockpiled during construction) with seed sources from the existing seed bank as well as a seed mix of native grasses and perennials.
    d) The river’s edge will be restored using hydric soils (stockpiled during construction) containing local seed and root stock as well as riparian shrub planting.
3. In regards to multi-use pathway provisions:
    a) A circular 3 m wide multi-use pathway (asphalt) from the Gore Road Library parking lot to the shoreline and observation look-out / interpretive area (complete with two pedestrian bridges over the existing watercourses and a secondary stone dust path connection). The network of pathways follow existing established trails as well as the same route through the woodlot as the proposed future construction access road (discussed later in this Report).
    b) A 3 m wide multi-use pathway and 1.5 m wide sidewalk arrangement with the sidewalk only on the north side of Gore Road and the multi-use pathway link along the south side of Gore Road with a proposed crosswalk / cross-ride at the Gore Road-Point St. Mark Drive-Gore Road Library intersection.
4. A realigned portion of the dry stone wall and reinstated dog park on the Gore Road Library property.
5. A dry stormwater pond, also on the Gore Road Library property.
6. The provision of wildlife micro-habitat such as bat boxes, areas suitable for turtle nesting, duck boxes and snake hibernacula. The use of limestone block walls, which will minimize the extent of grading needed for the bridge and associated infrastructure, will also provide habitat for certain species of bats, snakes and insects. Log piles will also be retained to provide cover for wildlife.

More specific design provisions on the west side lands include:

1. The removal of existing metal piling and the reinstatement of a more natural shore line with hydric soils (stockpiled during construction), riparian shrub planting, native grasses and forbs.
2. Avenue street tree planting with native, drought tolerant species as well as clusters of specimen tree planting, including both deciduous and coniferous species, to provide screening to adjacent properties.
3. An area of reforestation planting to the north of the bridge to extend the existing corridor of woodland vegetation along the western shore of the river.
4. A 3 m wide multi-use pathway on the north side of John Counter Boulevard, to the west of Ascot Lane, in order to allow:
    a) A potential future connection to the multi-use pathway route north of John Counter Boulevard.
    b) a connection with the existing Elliott Avenue Parkette to the south by a multi-use pathway under the bridge at elevation 75.78 m (note that though the flood plain

elevation is at 76.3 m, based on consultation with the CRCA, the multi-use path can be located within 0.8 m below the flood plain elevation).

5. The extension of the multi-use pathway to the east of Ascot Lane on the south side of John Counter Boulevard, which:

    a) Connects with the existing Elliott Avenue Parkette and proposed observation look-out / interpretive area.

    b) Provides an alternate route for pedestrians and cyclists, in addition to the multi-use pathway under the bridge.

6. A buried utility corridor along the north side of John Counter Boulevard.

7. A dry stormwater pond and outlets, also on the north side of John Counter Boulevard, near the west shoreline.

8. A parking area for ten vehicles on the southeast corner of the John Counter Boulevard / Ascot Lane intersection.

9. The use of noise attenuation which would include landscape elements such as climbers to soften their appearance.

Thirdly, as discussed later in this Report, in-water construction of the bridge will be facilitated by a temporary work bridge. The temporary work bridge will be approximately 11 m wide, and supported on piles every 10 to 12 m. It will be advanced incrementally in conjunction with the construction of the permanent bridge from shore to the navigable channel on both sides. It would take up to three months to remove the temporary work bridge following construction of the permanent bridge. The temporary piles could either be removed completely or cut below the top of the riverbed and left in place.

Discussions with Parks Canada have confirmed that restoration of the Greater Cataraqui Marsh PSW areas disturbed by the temporary work bridge piles would not be required, due to their small footprint and anticipated ability to rebound faster post-disturbance. However, compensation for PSW areas permanently lost due to the footprint of the permanent bridge, estimated to be up to 5000 m^2, should be implemented.

As shown in **Figure 8.15.1**, the goal of the proposed in-water works is to apply a 1:1 compensation ratio to restoring the wetland structure and function of an area near-shore on the west side of the project corridor following the project construction phase. This area has sustained various impacts related to the former marina operation, and includes three wetland plant communities that were documented during the Class EA, namely:

1. Submerged Vegetation (SuW1).

2. Submerged Vegetation: Floating-leaved Plants (SuW2).

3. Robust Emergents: Narrow-leaved Emergents (reM3).

Restoration activities will include the following:

1. Sedimentation and soil erosion control measures installed during the construction phase will be maintained, and removed only after the restoration work is complete and the exposed substrates are stabilized by vegetation.

2. The bottom substrate could be contoured to desired elevations (optional).

3. Wildlife habitat enhancement structures, such as reptile basking structures as well as submerged and emergent stumps or logs will be installed in areas that complement other desired recreational access and usage of the Cataraqui River.

4. Re-vegetation of the area using dominant wetland species in each of the three affected wetland plant communities will be accomplished by seeding (i.e. broadcasting above the water level or seed mixed with clay pellets below the water level), plugs or live shoots / stakes, depending on water depth, turbidity and anticipated wave energy:

5. The restored area will be periodically reviewed by a qualified wetland scientist.

Preventative actions that could be implemented to avoid disturbance to the restored area include:

1. Signs or buoys to discourage vessel traffic in the area.

2. Vessel speed / wake restrictions.

3. Public awareness initiatives to educate the general public and stakeholders on the restoration works and associated behaviours to facilitate success of the program.

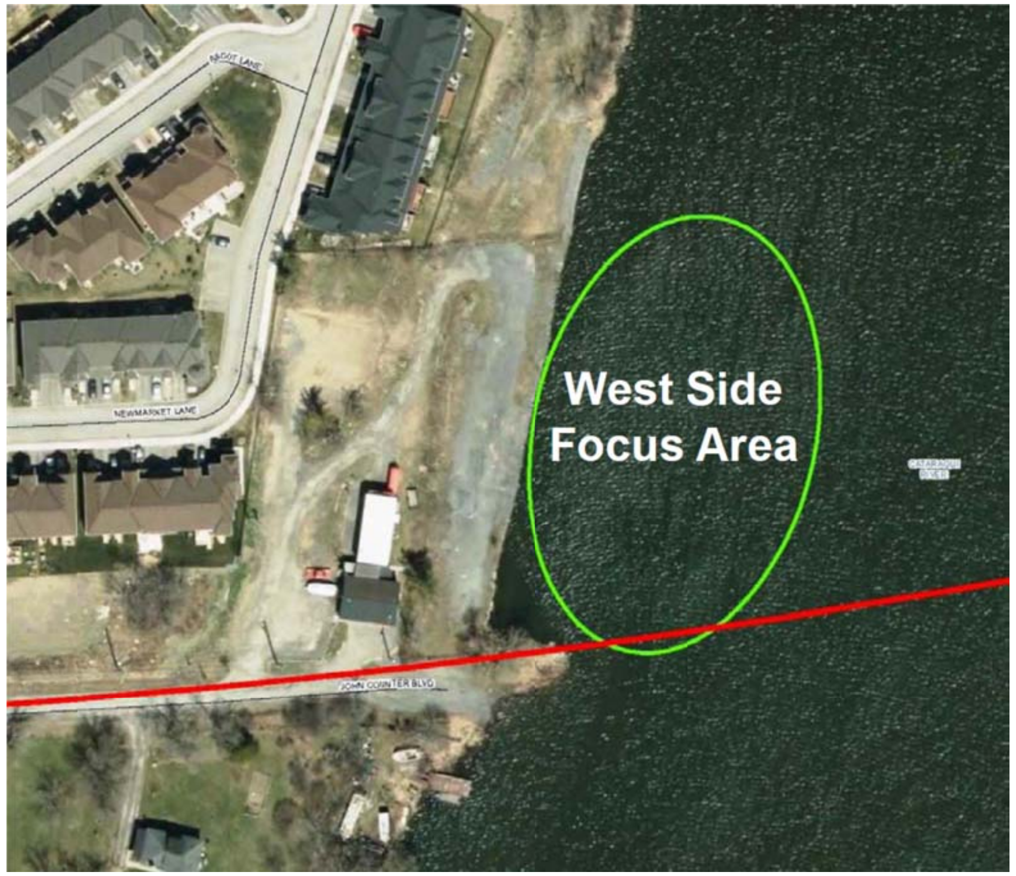


Figure 8.15.1: In-Water Compensation

8.16 Construction Strategies

8.16.1 Site Access and Staging

Staging for bridge and road construction may be undertaken in different forms depending on Contractor preferences and equipment availability. Generally, the bridge could be constructed from a combination of work bridge, barges (where allowed/applicable), the immediate west shore at the current limit of John Counter Boulevard and the immediate east shore at the end of the road allowance of Gore Road. Availability of other remote locations in Kingston is limited. Access routes to the project corridor are shown in **Figure 8.16.1.**

Due to its location, construction of the bridge must mitigate impacts to the navigable channel and adjacent rowing lanes. Boat traffic along the Rideau Canal occurs from mid-May through mid-October. Active rowing begins soon after the ice melts in the spring and extends through the Fall.

Access to the project corridor via water could be accomplished from Lake Ontario or the St. Lawrence River through the LaSalle Causeway. The width and height of the bascule lift bridge needs to be considered by Contractors, should marine equipment be brought by water to the project corridor. The bridge has limited operating hours during the open season and is generally closed in the winter. The Bridge Master on-site should be contacted to confirm capacity and timing of bridge operations, as well as confirming other special accommodations that the Contractor may require. In between the LaSalle Causeway and the project corridor, the navigable channel also has a finite width that may limit certain vessel sizes. In addition, the draft of the navigable channel is limited in most locations and, without dredging access may be difficult.

As discussed earlier, construction of a temporary work-bridge is the preferred method of construction based on on-going discussions with Parks Canada in order to minimize potential impacts and required mitigation measures.

On the west shore, approaching from the intersection of Montreal Street and John Counter Boulevard, construction access will be available to the Contractor in order to launch materials and equipment onto the bridge. There is limited area in this location to manoeuver materials due to the narrow access; however, launching of longitudinal pieces (such as girders) may be possible. Water access on the west shore is limited. Access on the west approach is shown in **Figure 8.16.2** which also highlights property acquisition and/or easement requirements to facilitate construction access along the west shore and south of the John Counter Boulevard right-of-way.

Figure 8.16.1: Construction Access Locations

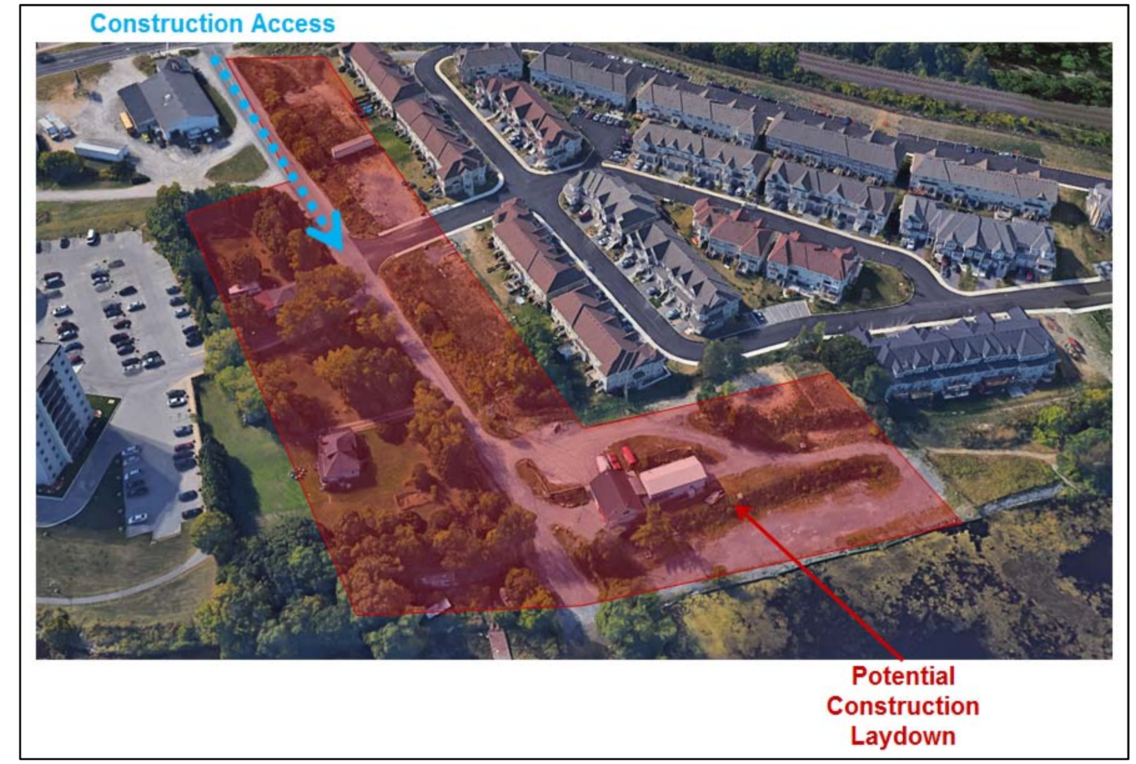


Figure 8.16.2: Construction Access (West)

On the east shore, site access is from Highway 15. City owned lands include the area surrounding the Gore Road Library from the dog park located at the north end of the property, to the east bank of the Cataraqui River, south to the extension of Gore Road in the road allowance. Access to this property is from Highway 15 near the dog park and along Gore Road. A looped access road is envisioned which will assist with traffic management of trucks that are required to transport fill to create the bridge approach embankments. Using a circular movement, trucks will be able to arrive from the north on Highway 15, turn into the site, loop down through a meadow near the water and return to Gore Road to exit the site. This movement is shown conceptually in **Figure 8.16.3**.

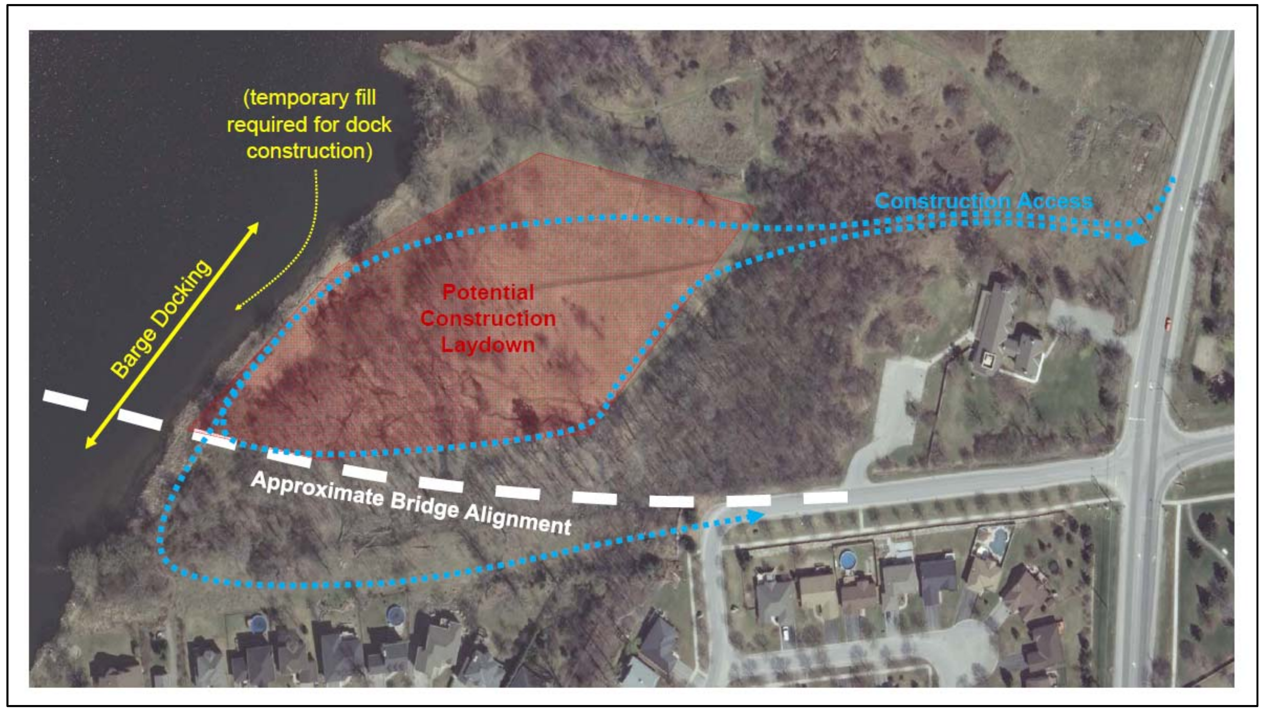


Figure 8.16.3: Construction Access (East)

Examples of construction staging techniques that can be utilized include:

1. Clearing lands on both shores, providing sufficient water access dockage and dredging along the north side of the bridge alignment and at pier locations for barge access.
2. Installing temporary construction roads through the laydown locations.
3. Constructing the bridge components in laydown areas on-shore and subsequent transfer into position.
4. Installing the substructure components (this is typically advanced from the foundations, through to the piers and into the above water substructures).
5. Installing the superstructure and deck components (these may be either lifted into place or moved laterally into place from shore, depending on the Contractor's means and methods).
6. Constructing the arch component, which can be constructed in a separate location, brought into position and raised to bridge deck height depending on the Contractor's means and methods. Bridges in other locations that utilize arches have successfully used this technique for erection.

Ensuring sufficient flexibility in staging and laydown accommodation to the Contractor promotes creative, innovative, and cost effective bridge and road construction methods. Providing as much land area and waterfront access in close proximity to the construction site will be a priority. Nevertheless, for environmental considerations, incentive should be provided to the Contractor to minimize impact to vegetated staging areas. Since construction of the bridge and approach roadways is expected to take up to three years, various staging configurations within the available lands is possible.

8.16.2 Temporary Facilities

Clearing of lands within laydown area lands on both shores, and providing sufficient access to the bridge alignment and at pier locations for via the temporary work bridge will be the first activities on site. In addition, construction roads and temporary electrical and communications service to the site will be required.

Temporary construction roads are anticipated within the Gore Road Library property on the east shore and are envisioned to enter the site near the existing dog park and loop south of the bridge abutment and exiting on Gore Road near Point St. Mark Drive. Relocation (raising) of overhead utilities will be required near the existing dog park where a construction entrance is envisioned. Temporary relocation of the dog park to an off-site location during construction will be required.

Since construction access roads will be required in an existing park-like area, existing open cut pathways should be used to minimize tree removal that would otherwise be required. There is opportunity to re-use the construction roads and modify them into formalized multi-use pathways post-construction.

Electrical and communication services to site trailers as well as on-shore work areas may be anticipated for the duration of the project. Temporary overhead servicing via temporary utility poles may be required.

At the conclusion of the project, site restoration activities will include removing excess fill that was placed for construction roads and temporary utility services.

8.16.3 Laydown Areas

The land adjacent to the future bridge approaches was identified as the most accessible and appropriate. In particular, the City-owned Gore Road Library property on the east shore was viewed as valuable for construction laydown activities. Sufficient land exists at this location for several uses including storage of materials, equipment, site trailers and off-site assembly of bridge components. Three laydown areas have been identified that include: (1) the meadow, (2) dog park, and (3) Library entrance. Each of these areas is shown in **Drawing 8.16.1**.

Due to the proximity of the Point St. Mark neighbourhood on the south side of Gore Road, erection of sound barrier walls prior to construction is anticipated. Relocation (raising) of overhead utilities will be required near the existing dog park where a construction entrance is envisioned. Temporary relocation of the dog park to an off-site location during construction will also be required. Significant vegetation/tree clearing along the bridge and approach alignment is anticipated, as well as along the shore on the north and south sides of the alignment. Additional vegetation/tree clearing will be required on the north side of the bridge alignment to facilitate water access for transfer of materials.

On the west shore, land on the north side of John Counter Boulevard as well as waterfrontage near the former Music Marina is available for construction staging and material laydown. Certain lands on the south side of John Counter Boulevard are expected to become available with future City acquisition of these properties.

Due to the proximity of the Ascot Lane Townhouse complex on the north side of John Counter Boulevard, erection of sound barrier walls prior to construction is anticipated. Contractors will need to review the stability of existing sheet-piling near the former Music Marina should significant staging and laydown occur close to shore. Each of these areas is shown in **Drawing 8.16.2**.

8.16.4 Property Impacts

Property considerations are necessary in three locations with respect to the bridge and approach roadways: the east approach (on land); the bridge span (over water); and the west approach (on land).

The east side of the bridge corridor utilizes an unopened road allowance at the west end of Gore Road (north of the Point St. Mark neighbourhood) and the City-owned Gore Road Library property at the northwest corner of Highway 15 and Gore Road. All east side lands required for the construction and operation of the approach roadway, active transportation provisions and landscape works, embankment leading to the bridge abutment, bridge footprint and stormwater management areas will be contained within City-owned property.

The Cataraqui River bed is owned by the Federal government and managed by Parks Canada. As such, it will be necessary to recognize the footprint of the bridge both within and over the river as well as the construction and operation of the bridge through a future land lease and construction agreement(s) with Parks Canada.

The west side of the bridge corridor predominantly uses an existing unopened road allowance at the west end of John Counter Boulevard. The City has already purchased the former Music Marina property on the north side of the road allowance near-shore, up to the River Park Subdivision. This property will partially accommodate construction staging and laydown area requirements as well as future stormwater management provisions. Additional lands will also be required:

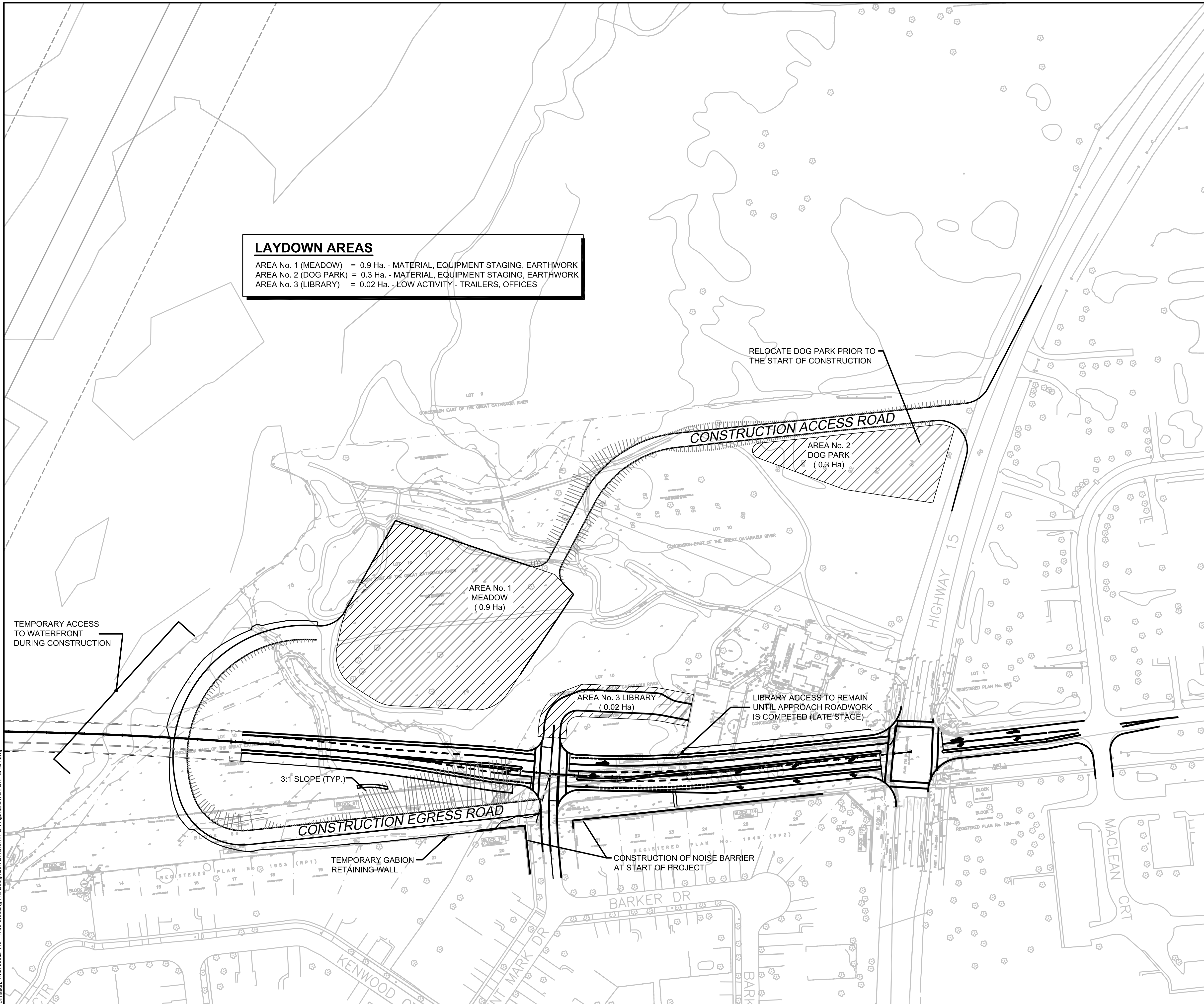
1. On the south side of the road allowance to accommodate construction staging and laydown areas, the re-located John Counter-Boulevard-Ascot Lane intersection as well as active transportation and landscape works.
2. At the John Counter Boulevard-Montreal Street intersection for widening John Counter Boulevard to accommodate eastbound turning and through lanes.

Construction activities (which include site preparation, construction, and site restoration and rehabilitation) on the affected properties within the staging and laydown areas will include the following tasks (and potentially others depending on Contractor means and methods):

1. Contractor mobilization to site (equipment, site trailers and materials begin to arrive at site).
2. Installation of environmental controls (e.g. erosion and sedimentation control measures, perimeter silt fences).
3. Construction of noise attenuation barriers.
4. Designation of low, medium, high impact areas (i.e. parking, offices, material storage, active material assembly / construction).
5. Relocation of the dog park on the Gore Road Library property to a temporary off-site facility.

6. Site vegetation and earth stripping as well as rough grading.
7. Relocation of utilities (above ground and below ground) and the installation of temporary utilities for construction uses.
8. Installation of temporary traffic controls and signalization (where necessary).
9. Construction of stormwater management facilities.
10. Construction of temporary access and egress haul roads for bringing earthen fill and bridge materials to site as well as temporary truck turning areas.
11. Construction of the temporary work bridge along with related on-shore access provisions.
12. Placement of the approach road embankments.
13. Bridge material staging and assembly (assembly of long girders).
14. Staging for construction of the bridge components in-place.
15. Road building, landscaping, pathway installation and site restoration (including shoreline enhancements).
16. Demobilization activities (e.g. site cleanup, trailer and material removals, temporary utility / facility removals).
17. Removal of temporary erosion and sediment control measures after the terrestrial vegetation is re-established as part of the landscape improvement works.

It should also be noted that the assembly and staging of materials for bridge construction will require space on-land that is not available on the temporary work bridge. For example, the assembly of the bridge structures (e.g. girder pairs, formwork, reinforcement steel cages) would likely take place on-land within the staging and laydown areas, and then transported via the temporary work bridge and subsequently placed into position. This could be the case for the long approach spans as well as the arch. In particular, assembly of the arch (which would likely take place on the east shore) will require significant on-land space. Given the limited available lands both on the east and west shores, it is anticipated that the Contractor will make use of all available lands within the staging and laydown areas, subject to the best management practices and mitigation measures that will be in place to either reduce or eliminate the potential negative effects of specific construction activities.



THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

STAGING AND LAYDOWN ACCESS / EGRESS EAST

Mark Van Buren, P.Eng. — Director of Engineering and Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer

KINGSTON

J.L.Richards — ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

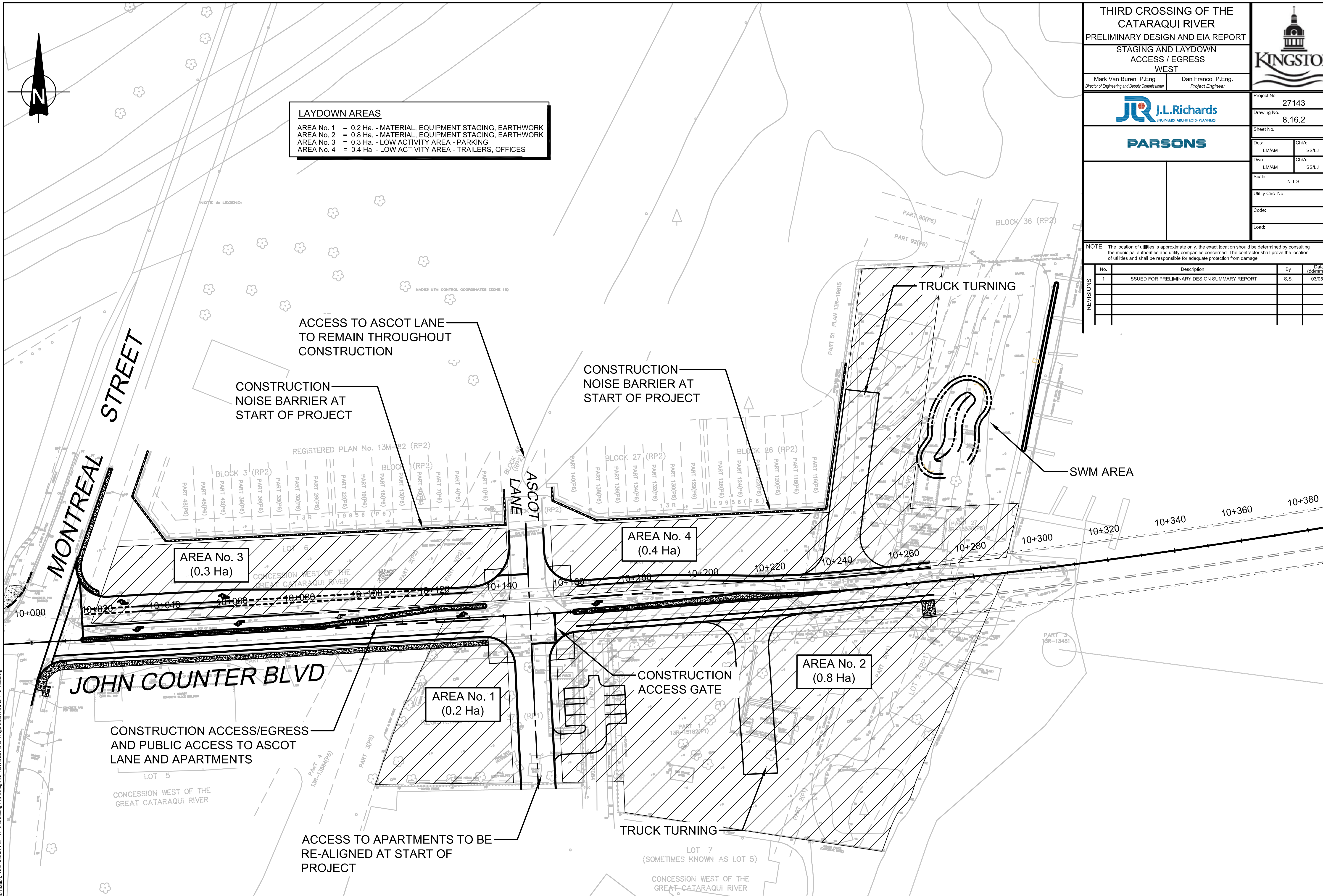
Project No.:	27143
Drawing No.:	8.16.1
Sheet No.:	
Des: LM/AM	Chk'd: SS/LJ
Dwn: LM/AM	Chk'd: SS/LJ
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

Plot Date: 5/3/2017 1:54:54 PM
Last Saved: May 3, 2017 1:54:49 PM
Consultant's Information: K:\27000\27143 - Third Crossing Pre-Design\JLR DWG\Civil\PDR Figures\DWG\PDR - 8.16.1.dwg



THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

STAGING AND LAYDOWN ACCESS / EGRESS WEST

Mark Van Buren, P.Eng — Director of Engineering and Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer

KINGSTON

J.L.Richards — ENGINEERS · ARCHITECTS · PLANNERS
PARSONS

Project No.:	27143
Drawing No.:	8.16.2
Sheet No.:	
Des: LM/AM	Chk'd: SS/LJ
Dwn: LM/AM	Chk'd: SS/LJ
Scale:	N.T.S.
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	S.S.	03/05/17

Plot Date: 5/3/2017 10:05:13 AM
Last Saved: May 3, 2017 10:05:05 AM
Consultant's Information: K:\27000\27143 - Third Crossing Pre-Design\JLR DWG\Civil\PDR Figures\DWG\PDR - 8.16.2.dwg

8.16.5 Substructure

Foundations can be constructed from the temporary work bridge and will require driving the caisson liners through the overburden and seating them firmly into bedrock using a crane situated on the work bridge. For caissons, this will be followed by excavating the native material from within the casing then drilling rock sockets into competent bedrock. A reinforcing steel cage will be lowered using cranes into the caissons and tremie concrete will be poured into the caisson from a concrete pump on the work bridge. Minimal dewatering is anticipated for this operation if the caisson liner is extended above the high-water level.

For the inverted u-frame piers, following the installation of the caissons, a custom transition form will be placed on top of the caisson to convert the circular caisson into a rectangular shape over a height of 1500 mm. Standard steel/ timber formwork can be used to form the rest of the pier legs. The piers will consist of two separate concrete pours: one for the pier legs (above the caissons) and another for the pier caps.

For the arch v-piers, a concrete footing will be supported on the caissons and will require localized dredging of the river bed. The dredged material will be shipped off site for proper disposal. Cofferdams will be required for the construction of the footings and may include a concrete shell that will be lowered over the caissons and form part of the permanent footing or sheet piles driven into the riverbed. Once the v-pier footing has been poured, the v-pier legs will be formed and temporary supports will be used to support the legs. The temporary supports can either be off of the temporary work bridge or be separate piles driven into the riverbed. The v-piers legs should be poured simultaneously to balance the load. Temporary ties will be required between both legs to provide stability. Once the legs are constructed they will be post-tensioned. The use of precast box sections for the v-pier legs is a viable option which can be explored by the Contractor. The tie can be formed off the pier legs and poured in place or can be precast and post-tensioned. Once the tie has been placed the tie will be post-tensioned prior to the removal of the temporary supports.

The bracing and diaphragm of the girders in the vicinity of the v-piers will be designed to avoid conflict at the tie location. The use of cross-frames and/or wide flanged deep beams should be considered at the tie-beam locations.

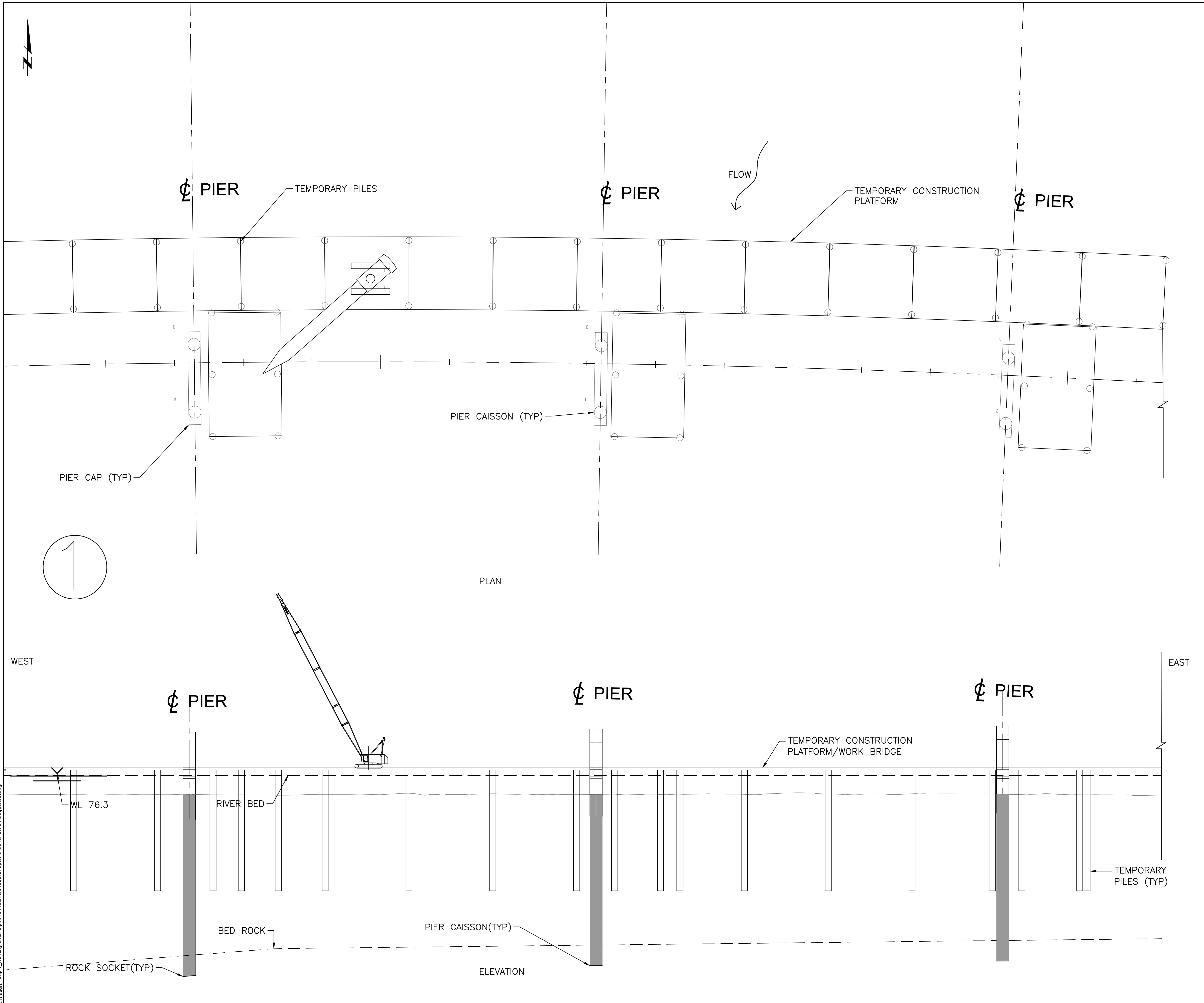
The abutments will be founded 14 – 600 mm caissons founded on bedrock. Earth excavation will be required at the west abutment for the perched abutment and at the east abutment the embankment will be backfilled with engineered fill to the base of the abutment.

8.16.6 Superstructure

The steel plate girders for the approach spans can be assembled on the approaches and can either be lifted into place by means of cranes from the temporary work bridge or can be launched from the approaches. The use of inverted u-frame piers instead of v-piers throughout facilitates launching the plate girders from the approaches as there will be no interference between the girder bracing and the v-pier ties. The plate girders can either be kinked or curved in plan to facilitate the Contractor’s means and methods. With the curved plated girders, the concrete overhangs will be constant but the girders will be more difficult to fabricate and transport. For the kinked plate girders, the concrete overhangs will vary but the girders will be easier to fabricate and transport.

If the approach span girders are lifted into place from the temporary work bridge, the following construction sequence would likely occur, as shown in **Drawing 8.16.6.1** to **Drawing 8.16.6.4**:

1. Assemble the girders into pairs by connecting cross-bracing.
2. Transport the girder pairs onto the work bridge.
3. Lift, install, and stabilize the girder pair segments over the pier **(Drawing 8.16.6.2)**.
4. Lift, install, and stabilize the girder pair segments over the adjacent pier **(Drawing 8.16.6.2)**.
5. Lift the girder pair segments over the drop-in spans (in between piers) and field splice to the erected girder segments (over piers) **(Drawing 8.16.6.3)**.
6. Complete the installation of cross bracing and lateral bracing.
7. Repeat the above steps for the next span(s).



STEP 1

- TRESTLE AND SUBSTRUCTURE WORK IS COMPLETED

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

SPAN CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards ENGINEERS·ARCHITECTS·PLANNERS

PARSONS

KINGSTON

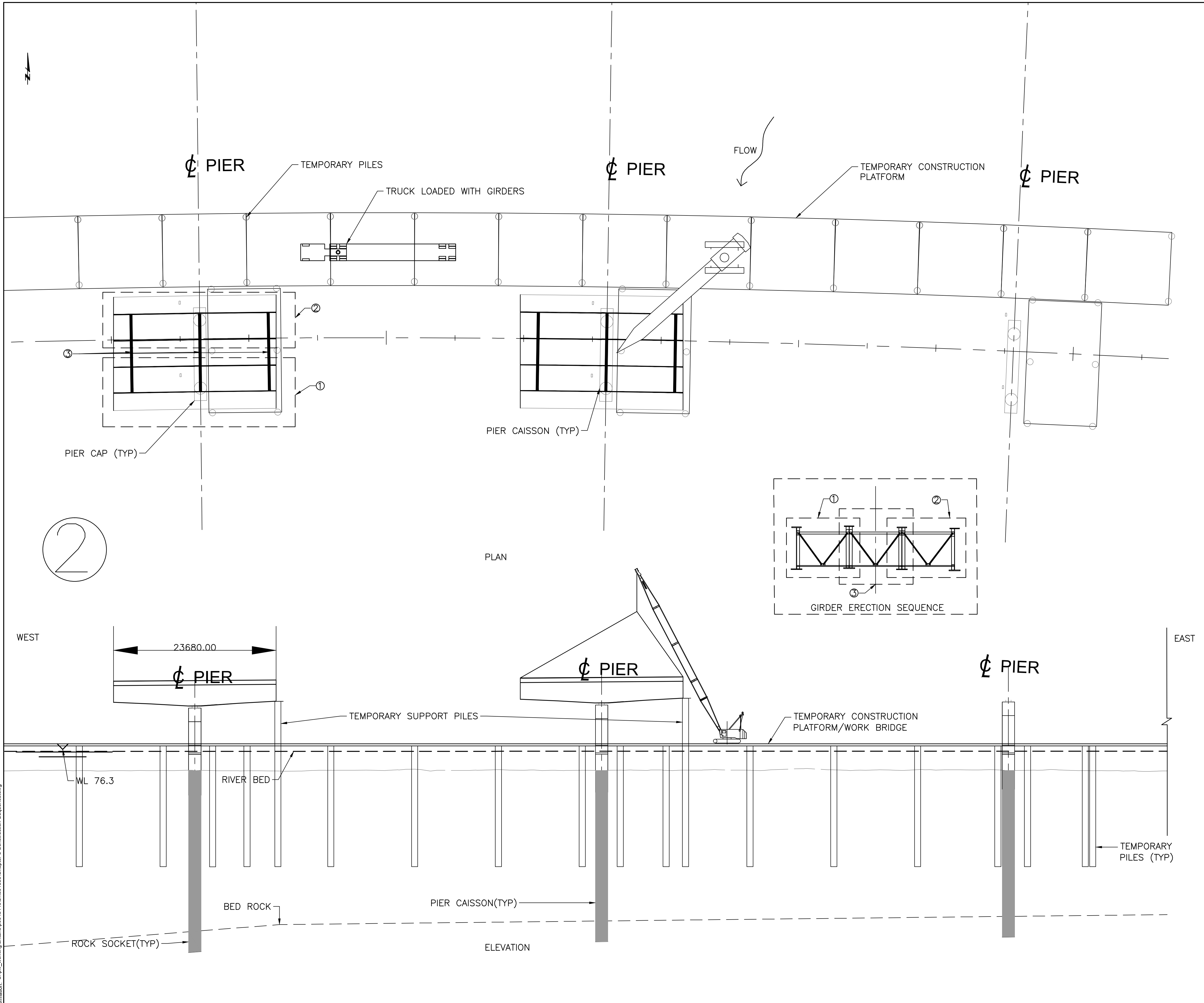
Project No.:	27143
Drawing No.:	□.16.6.1
Sheet No.:	17 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	------
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Plot Date: 5/2/2017 11:28:55 AM
Last Saved: Tuesday, May 02, 2017 10:42:47 AM
Consultant's Information: C:\pw_working\ontario\p004544\d\ms01353\Chapter 8 Construction Sequence.dwg



STEP 2

- ERECT PIER GIRDERS AT TWO ADJACENT PIERS
- PROVIDE SUPPORT FOR GIRDER SEGMENTS UTILIZING TRESTLE PILES

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

SPAN CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

KINGSTON

Project No.:	27143
Drawing No.:	□.16.6.2
Sheet No.:	1□ of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

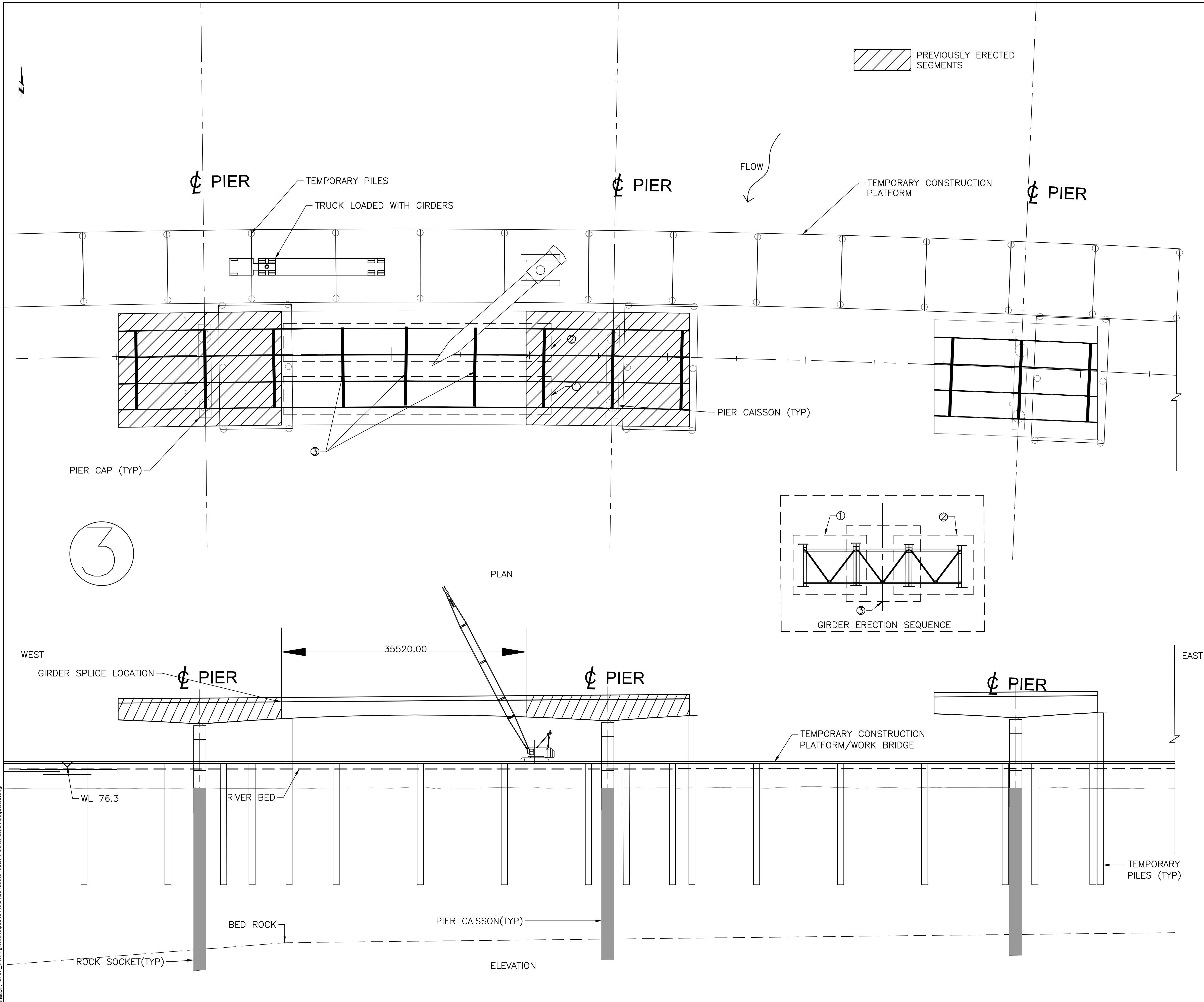
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Last Saved: Tuesday, May 02, 2017 10:42:47 AM Plot Date: 5/2/2017 11:30:19 AM

Consultant's Information: C:\pw_working\ontario\p004544\dms01353\Chapter 8 Construction Sequence.dwg



STEP 3

- ERECT DROP IN GIRDERS MID-SPAN
- ERECT THE NEXT PIER GIRDER

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

SPAN CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng. — Director of Engineering & Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

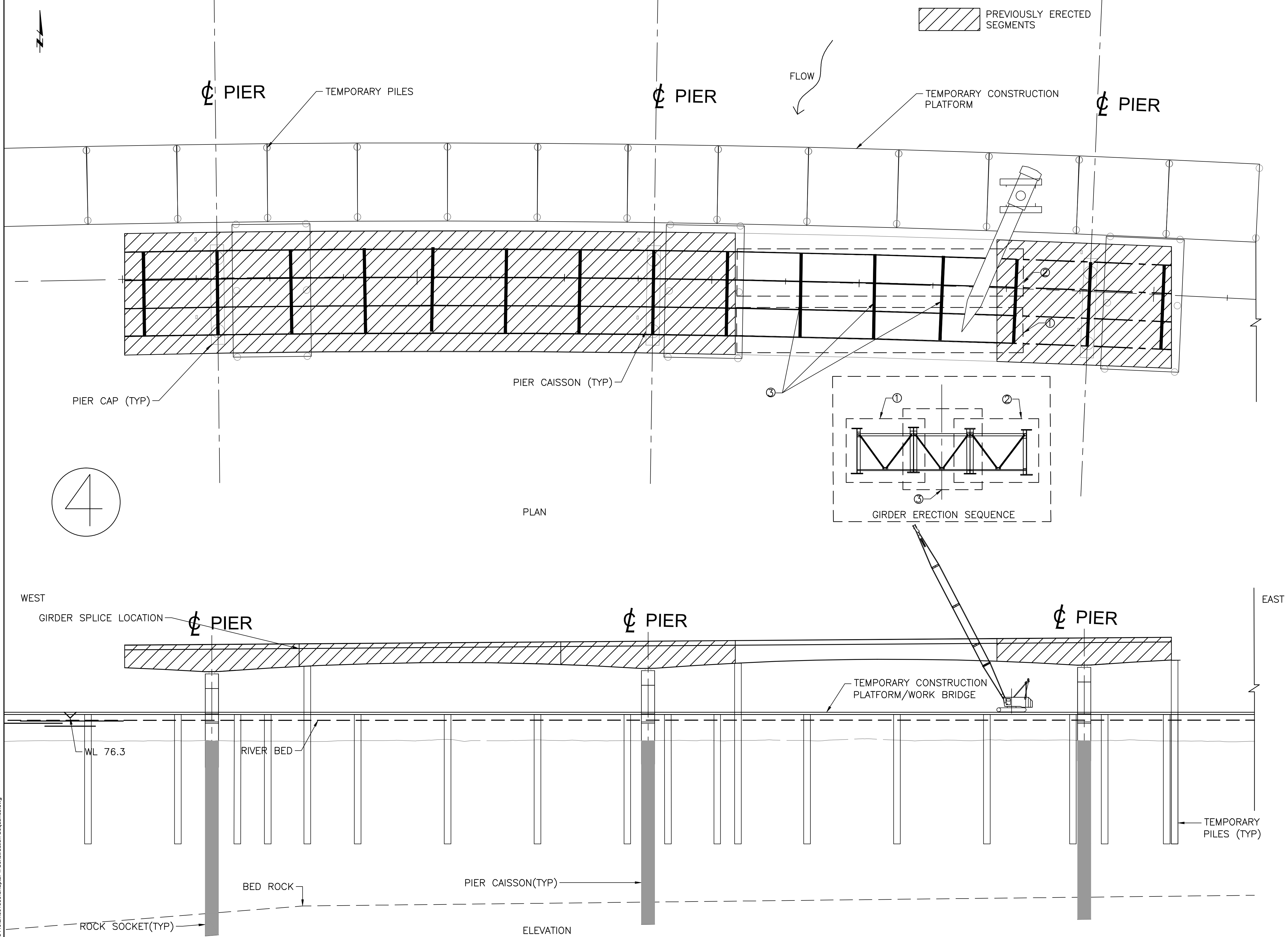
Project No.:	27143
Drawing No.:	16.6.3
Sheet No.:	19 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Plot Date: 5/2/2017 11:31:23 AM
Last Saved: Tuesday, May 02, 2017 10:42:47 AM
Consultant's Information: C:\pw_working\ontario\p004544\d\ms01353\Chapter 8 Construction Sequence.dwg



STEP 4

- ERECT THE MID–SPAN DROP IN GIRDERS

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

SPAN CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng. *Director of Engineering & Deputy Commissioner*	Dan Franco, P.Eng. *Project Engineer*

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	□.16.6.4
Sheet No.:	20 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Consultant's Information C:\pw_working\ontario\p004544\dms01353\Chapter □ Construction Sequence.dwg
Last Saved: Tuesday, May 02, 2017 10:42:47 AM Plot Date: 5/2/2017 11:32:29 AM

The erection of the plate girders between the v-pier legs will be more complex than the other spans due to the presence of the v-pier ties. The v-pier tie will be erected prior to the erection of the structural steel. The girder sections will have to be erected singly instead of in pairs as the cross-bracing will be designed to go around the v-pier ties and will not be erected until after the v-pier is in place. Alternatively, the interior pair of girders can be erected together followed by the exterior girders.

The arch can be assembled on the approach and launched into position from the east shore; the arch can be assembled on the work bridge and lifted into position; or the arch can be erected in place while accommodating the navigation channel and rowing requirements and constraints. The arch construction will follow the following sequence, as shown in **Drawing 8.16.6.5** to **Drawing 8.16.6.20**:

1. Install the temporary supports, install the ends of the bottom chord to beyond the first transverse brace and install the structural steel grillage system between the bottom chords **(Drawing 8.16.6.5).**

2. Build up the second temporary support to support the arch rib and install the temporary compressive struts and the first sets of hangers **(Drawing 8.16.6.6).**

3. Install the temporary supports for the next segment of bottom chord and grillage system to beyond the second transverse brace **(Drawing 8.16.6.7)**.

4. Install the second portion of the arch rib, the second temporary compressive strut and the second set of hangers **(Drawing 8.16.6.8)**.

5. Complete the installation of the bottom chord and deck grillage system **(Drawing 8.16.6.9)**.

6. Complete the installation of the arch rib and installation of the hangers **(Drawing 8.16.6.10)**.

7. Transfer the arch from the temporary supports to a movable platform with jacking towers **(Drawing 8.16.6.16)**.

8. Slide the arch into position along the south side of the bridge via a temporary trestle **(Drawing 8.16.6.17)**.

9. Remove the temporary compressive struts and lift the bridge to its proper elevation **(Drawing 8.16.6.18)**.

10. Slide the bridge onto the v-piers and complete the arch erection **(Drawing 8.16.6.19)**.

The arch can either be moved using Self-Propelled Modular Transporters (SPMT) as shown in **Figure 8.16.6.1**, strand jacks or Hilman style rollers. SPMT's are generally the most expensive option but provide the greatest maneuverability and are the faster option. The Hillman style roller is the most economical, but has limitations to the flexibility of movements during transport.

Figure 8.16.6.1: Erection of Hastings Bridge Using SPMT

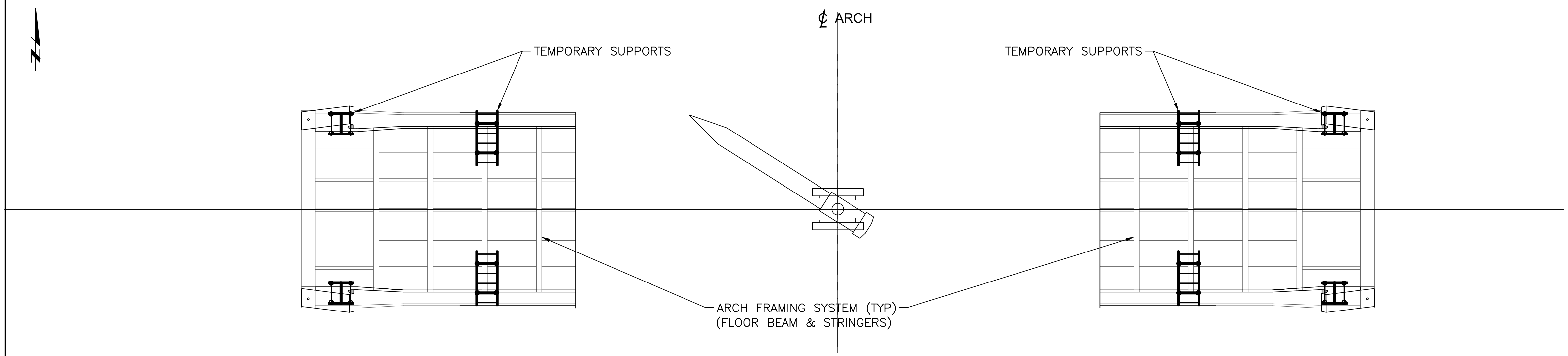
The approach span and arch structural steel will require a special oversize/overweight hauling permit to be transported by highway carrier on Provincial highways and municipal roads. Any prefabricated component that exceeds any of the following limitations (including the transportation vehicle) will require a permit:

1. Length = 19 m.

2. Width = 3.5 m.

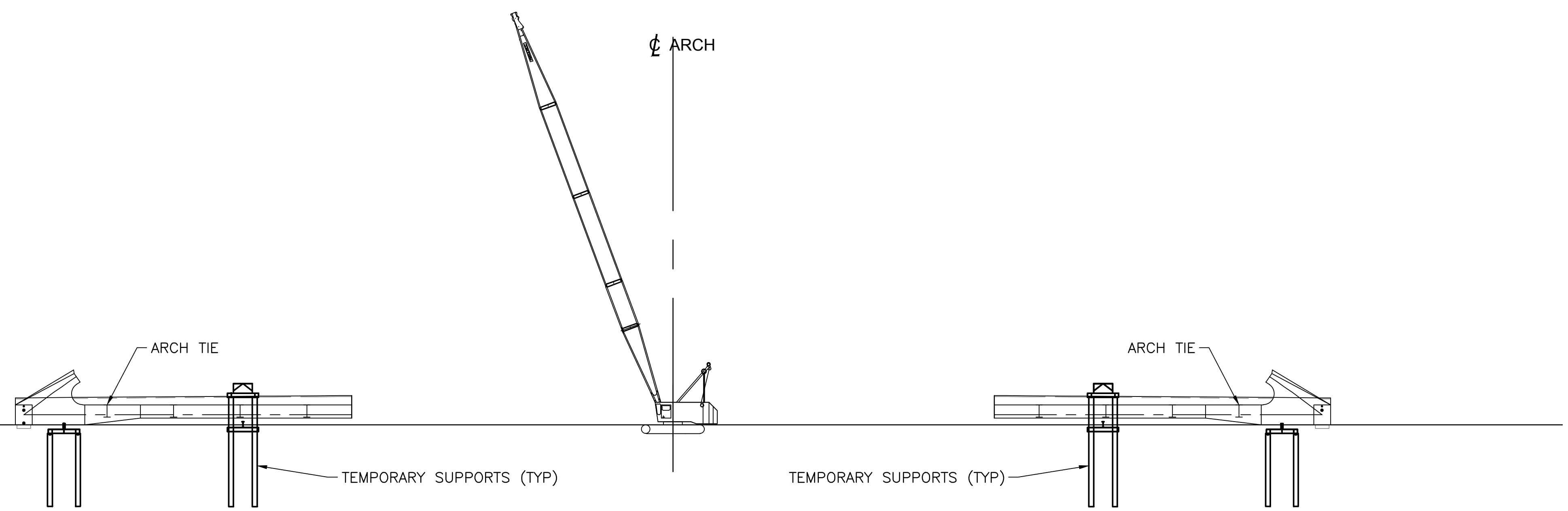
3. Height = 2.6 m.

4. Weight = 30,000 kg.



PLAN

1



ARCH TIE BEAMS AND FLOOR BEAMS ARE SUPPORTED ON TEMPORARY PILES

ELEVATION

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng. — *Director of Engineering & Deputy Commissioner*
Dan Franco, P.Eng. — *Project Engineer*

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

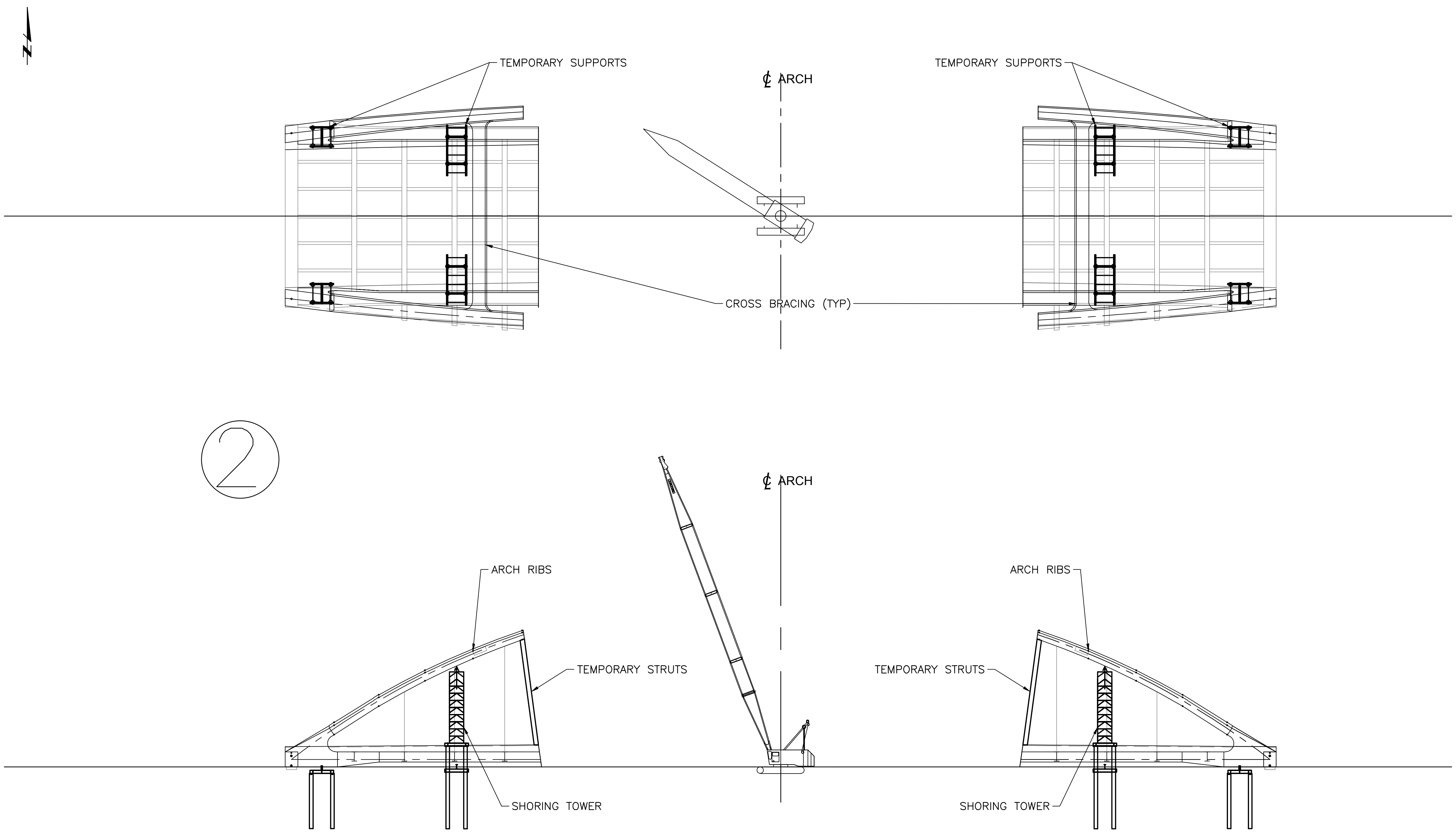
Project No.: 27143
Drawing No.: □.16.6.5
Sheet No.: 1 of 20
Des: MLC
Chk'd: MLC
Dwn: TT
Chk'd: MLC
Scale: AS NOTED
Utility Circ. No. -----
Code: CAN/CSA-S6-14
Load: CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Last Saved: Tuesday, May 02, 2017 10:42:47 AM
Plot Date: 5/2/2017 11:09:27 AM
Consultant's Information: C:\pw_working\ontario\p004544\d\ms01353\Chapter 6 Construction Sequence.dwg



ARCH RIB SUPPORTED BY SHORING TOWERS, BRACING, AND TEMPORARY STRUT

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	□.16.6.6
Sheet No.:	2 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

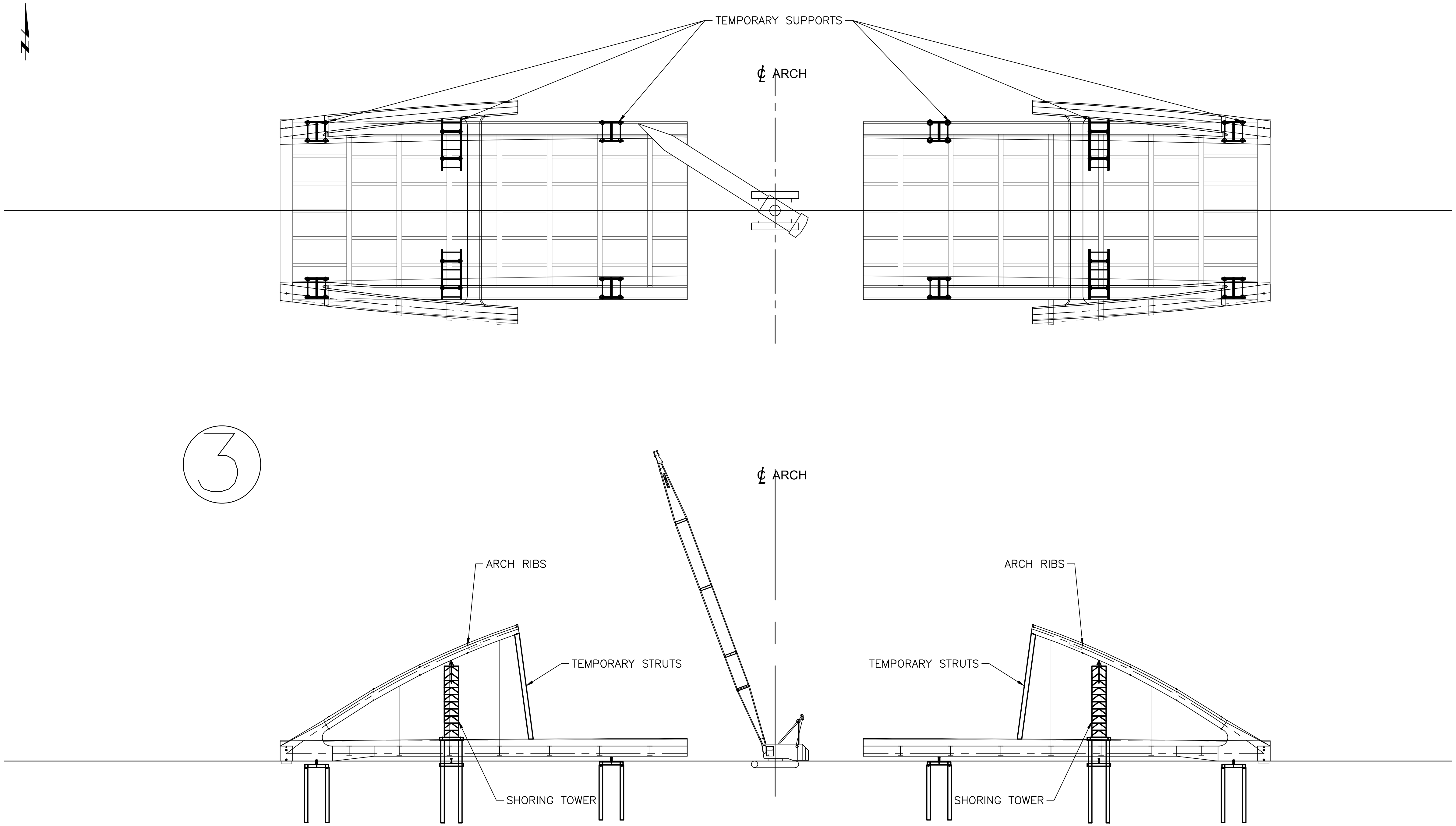
No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

SUGGESTED CONSTRUCTION SEQUENCE

Plot Date: 5/2/2017 11:10:46 AM

Last Saved: Tuesday, May 02, 2017 10:42:47 AM

Consultant's Information: C:\pw_working\ontario\p004544\dms01353\Chapter 8 Construction Sequence.dwg



TIE SECTION ADDED

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT
ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	□.16.6.7
Sheet No.:	3 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

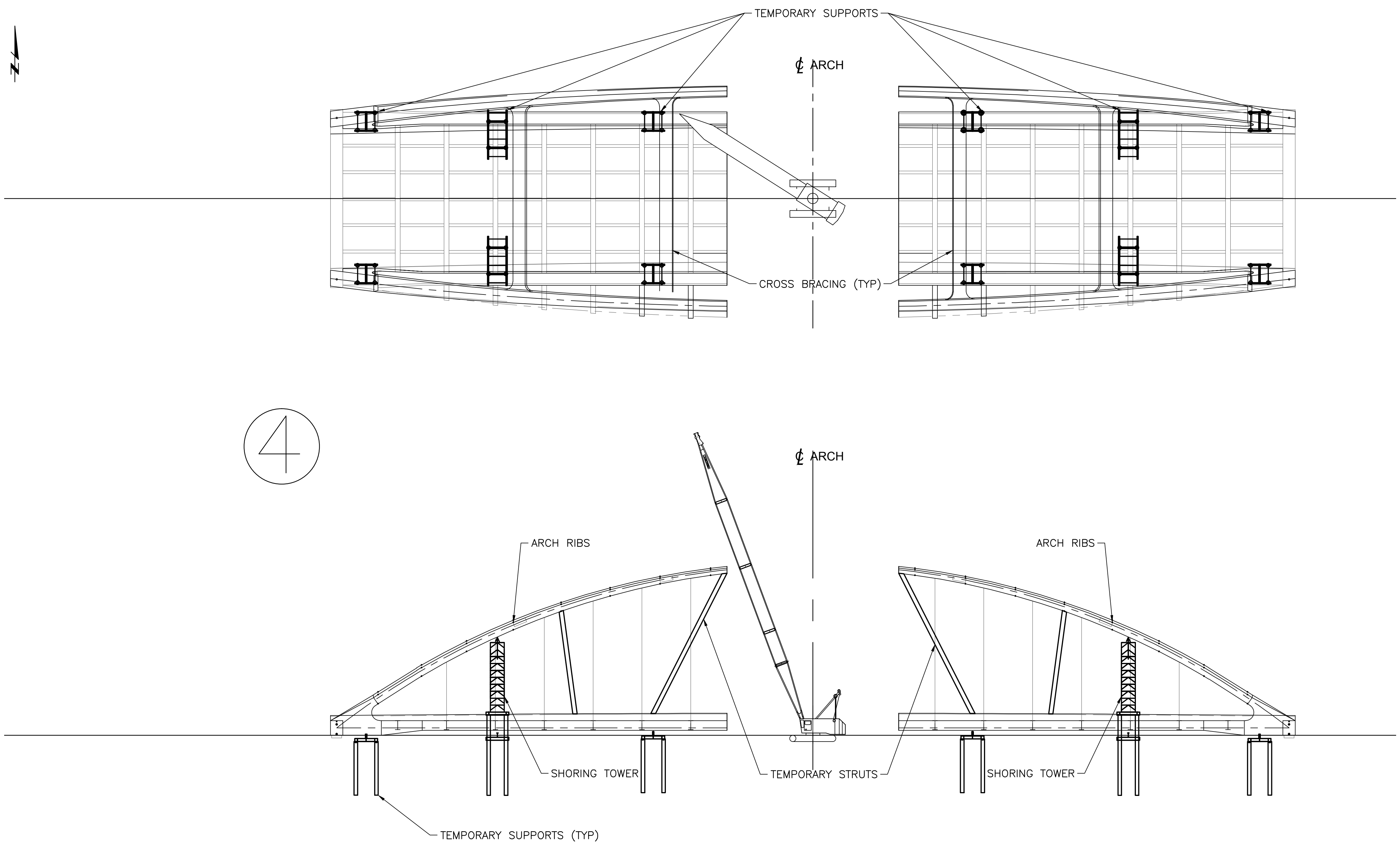
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

SUGGESTED CONSTRUCTION SEQUENCE

Last Saved: Tuesday, May 02, 2017 10:42:47 AM Plot Date: 5/2/2017 11:11:50 AM
Consultant's Information: C:\pw_working\ontario\p004544c\d\ms01353\Chapter 8 Construction Sequence.dwg



RIB SECTION AND TEMPORARY STRUTS ADDED

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

KINGSTON

Project No.:	27143
Drawing No.:	□.16.6.□
Sheet No.:	4 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

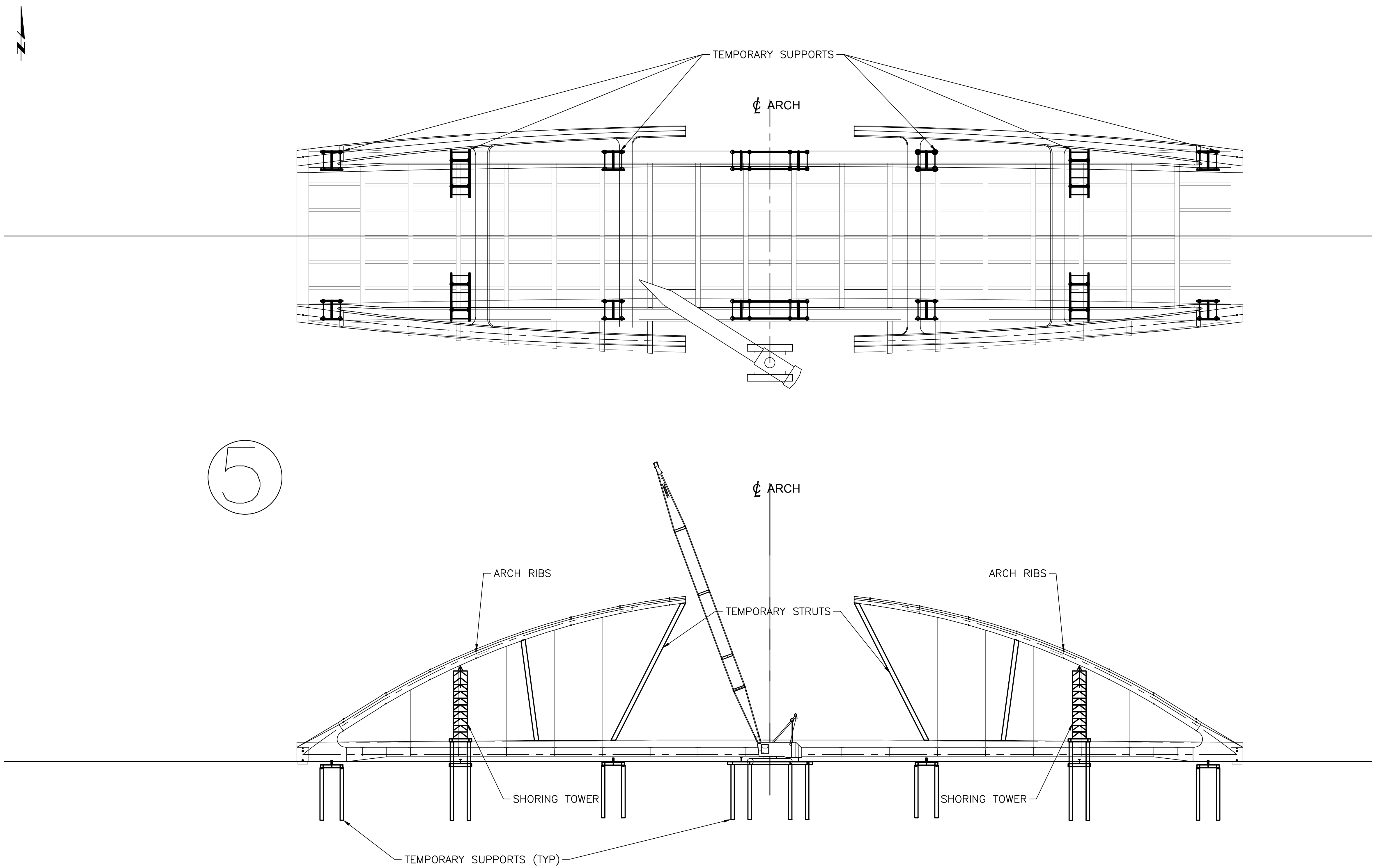
REVISIONS

No.	Description	By	Date (dd/mm/yy)

SUGGESTED CONSTRUCTION SEQUENCE

Last Saved: Tuesday, May 02, 2017 10:42:47 AM Plot Date: 5/2/2017 11:13:03 AM

Consultant's Information: C:\pw_working\ontario\p004544\dms01353\Chapter 8 Construction Sequence.dwg



COMPLETE TIE INSTALLATION

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

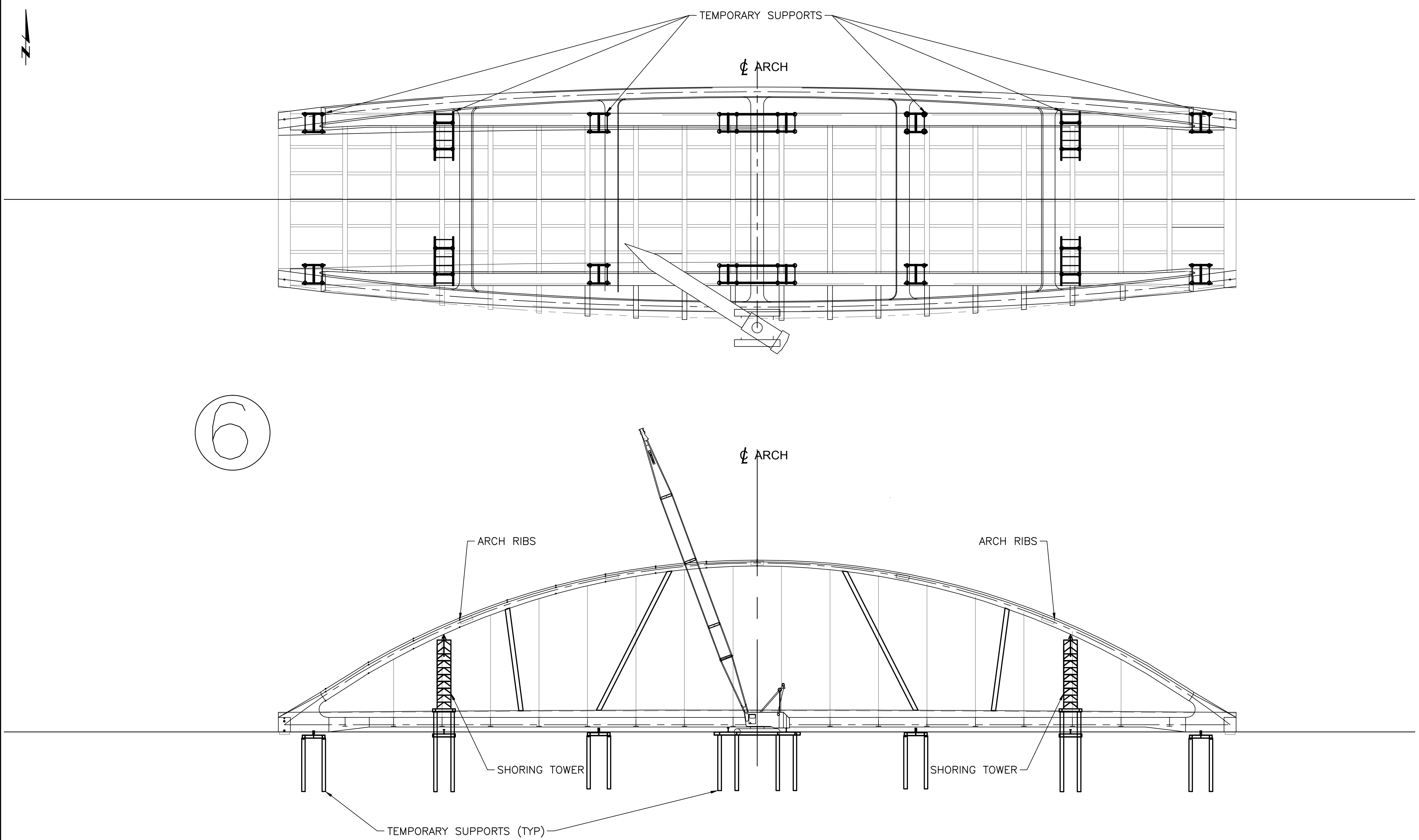
KINGSTON

Project No.:	27143
Drawing No.:	16.6.9
Sheet No.:	5 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



INSTALL SECONDARY MULTI–STRAND TIE WITH STEEL TIE AND COMPLETE THE ARCH INCLUDING TENSIONING THE MULTI–STRAND HANGERS

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng. — *Director of Engineering & Deputy Commissioner*

Dan Franco, P.Eng. — *Project Engineer*

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

KINGSTON

Project No.:	27143
Drawing No.:	16.6.10
Sheet No.:	6 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

SUGGESTED CONSTRUCTION SEQUENCE

Consultant's Information: C:\pw_working\ontario\p004544\d\ms01353\Chapter 8 Construction Sequence.dwg

Last Saved: Tuesday, May 02, 2017 10:42:47 AM

Plot Date: 5/2/2017 11:15:14 AM

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

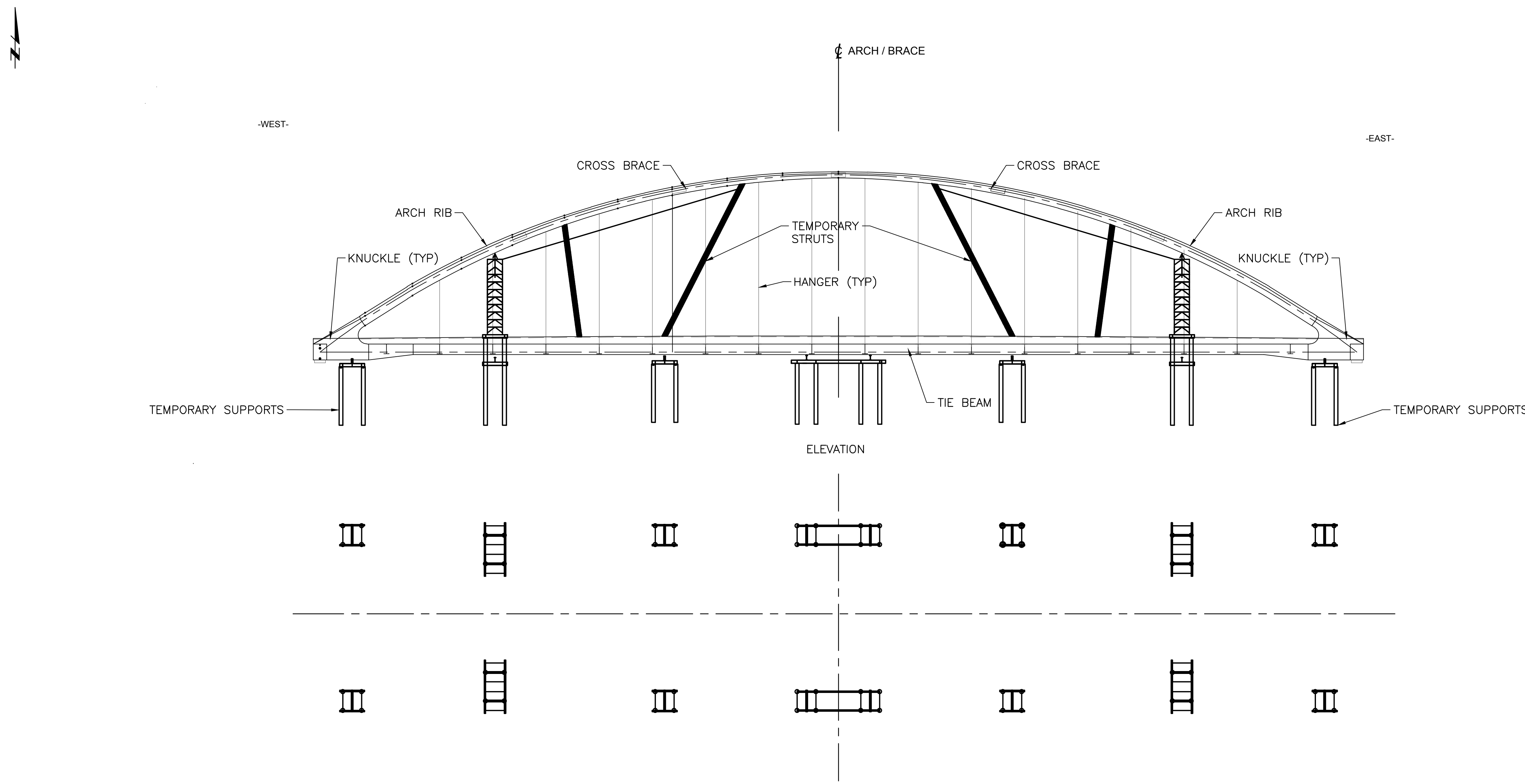
PARSONS

Project No.:	27143
Drawing No.:	16.6.11
Sheet No.:	7 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



ARCH TIE BEAMS AND FLOOR BEAMS ARE SUPPORTED ON TEMPORARY PILES

PLAN

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng. *Director of Engineering & Deputy Commissioner*	Dan Franco, P.Eng. *Project Engineer*

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

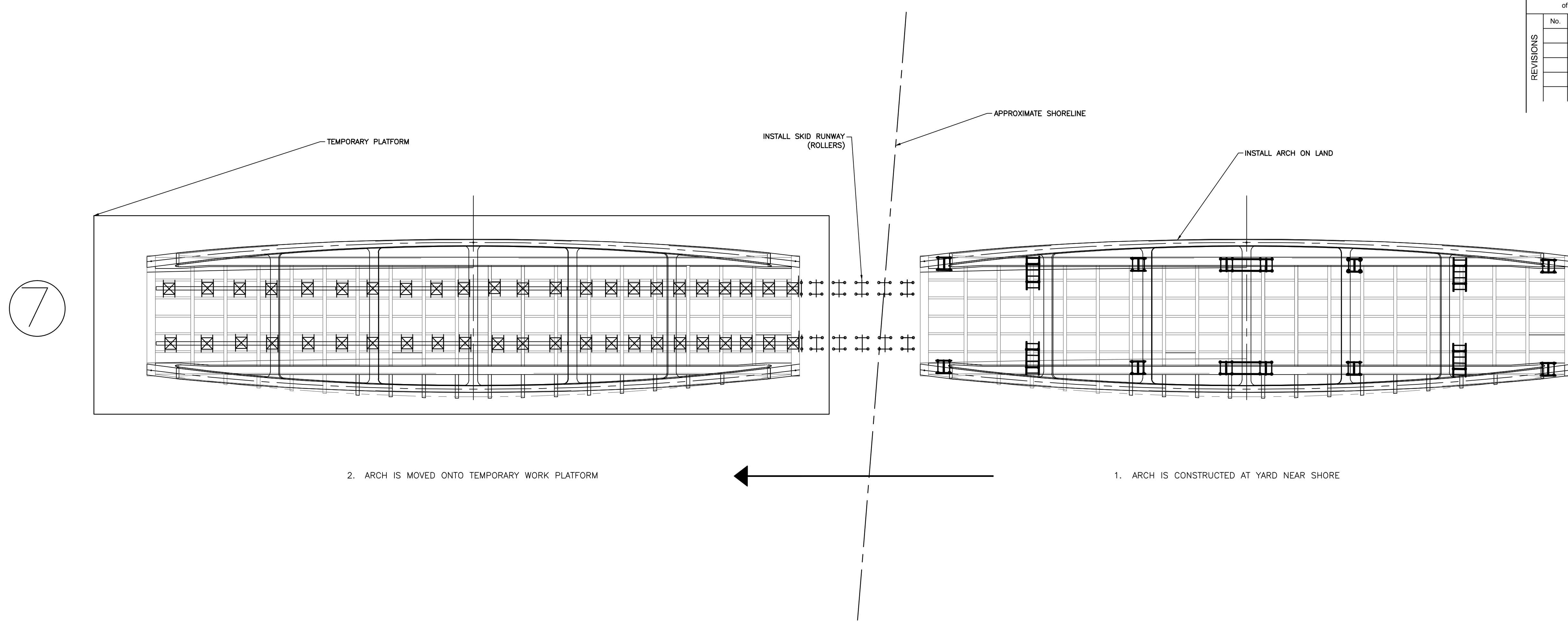
KINGSTON

Project No.:	27143
Drawing No.:	16.6.12
Sheet No.:	of 100
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



ARCH MOVED ONTO TEMPORARY WORK PLATFORM

SUGGESTED CONSTRUCTION SEQUENCE

Last Saved: Tuesday, May 02, 2017 10:42:47 AM Plot Date: 5/2/2017 11:17:44 AM

Consultant's Information: C:\pw_working\ontario\p004544\dms01353\Chapter 6 Construction Sequence.dwg

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

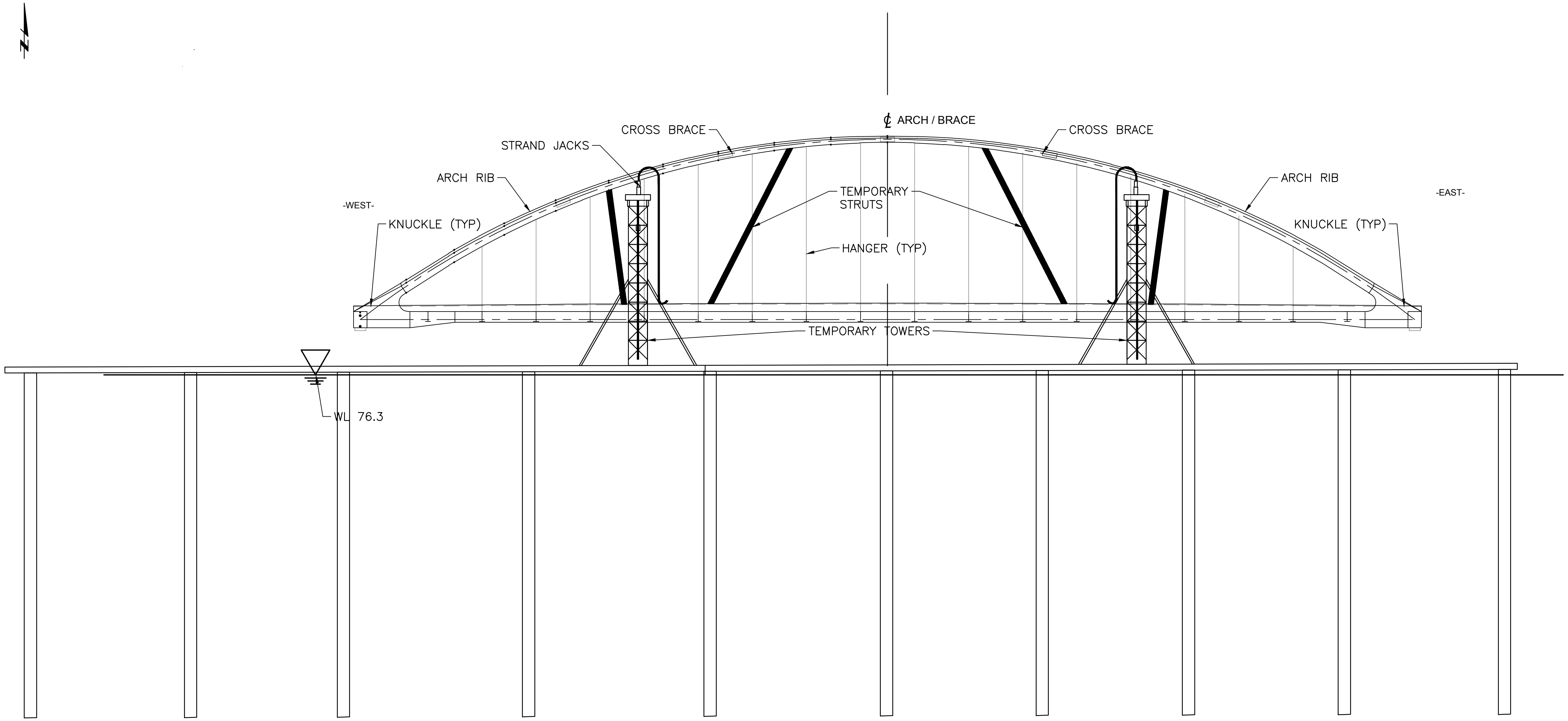
PARSONS

Project No.:	27143
Drawing No.:	16.6.13
Sheet No.:	9 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

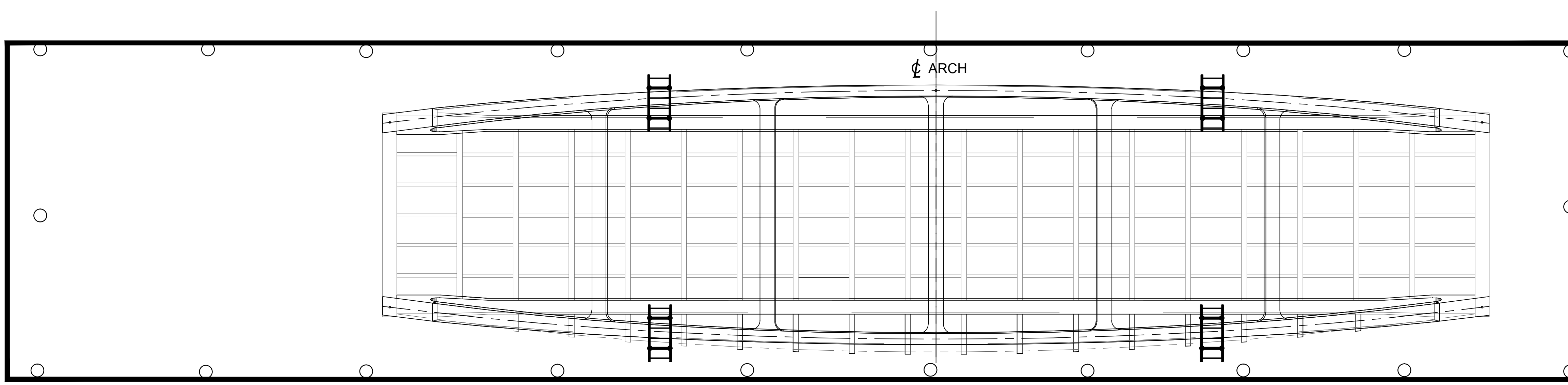
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



ELEVATION



PLAN

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH CONSTRUCTION SEQUENCE

Mark Van Buren, P.Eng. — Director of Engineering & Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer

KINGSTON

J.L.Richards — ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

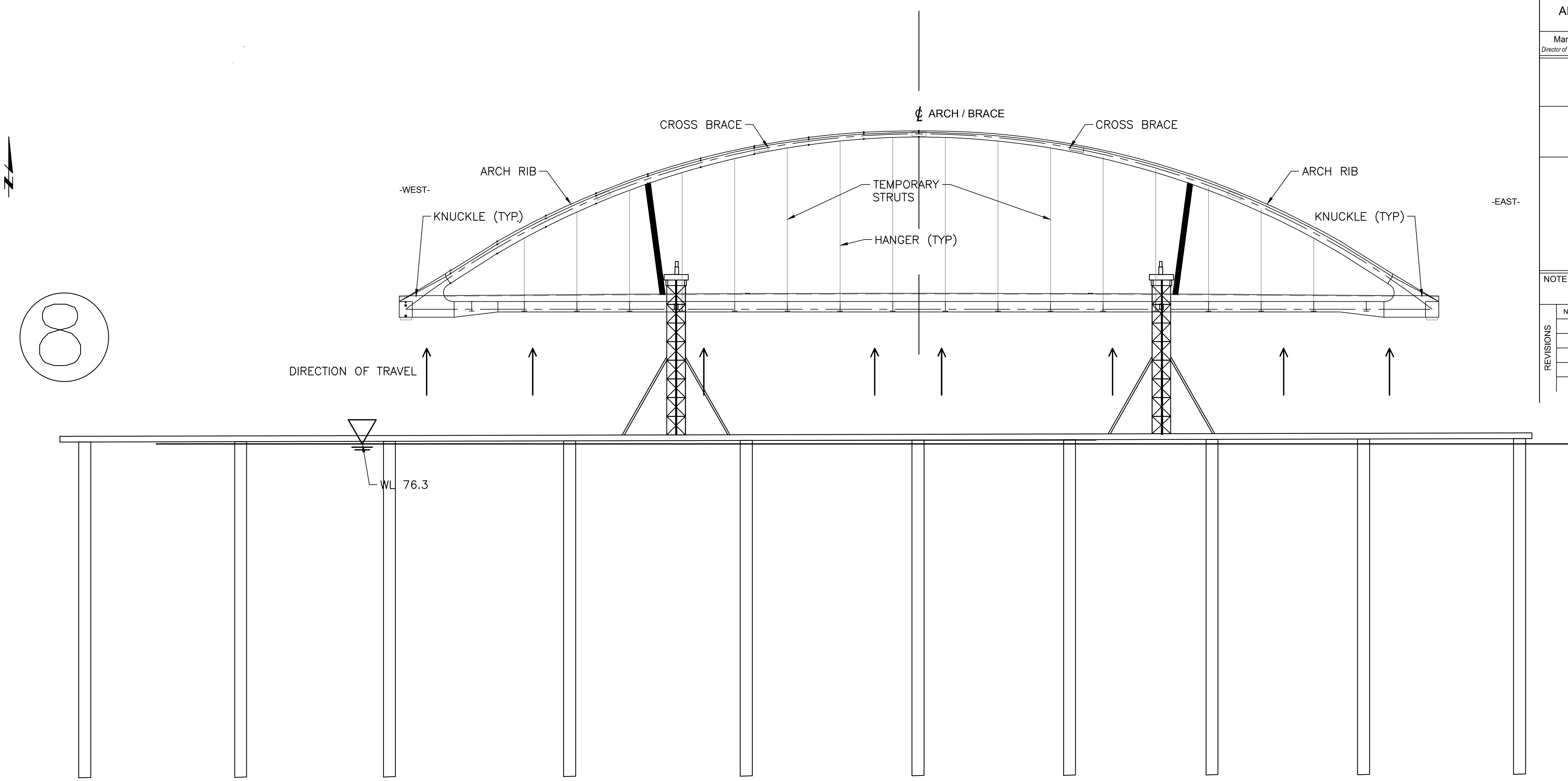
Project No.:	27143
Drawing No.:	16.6.14
Sheet No.:	10 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

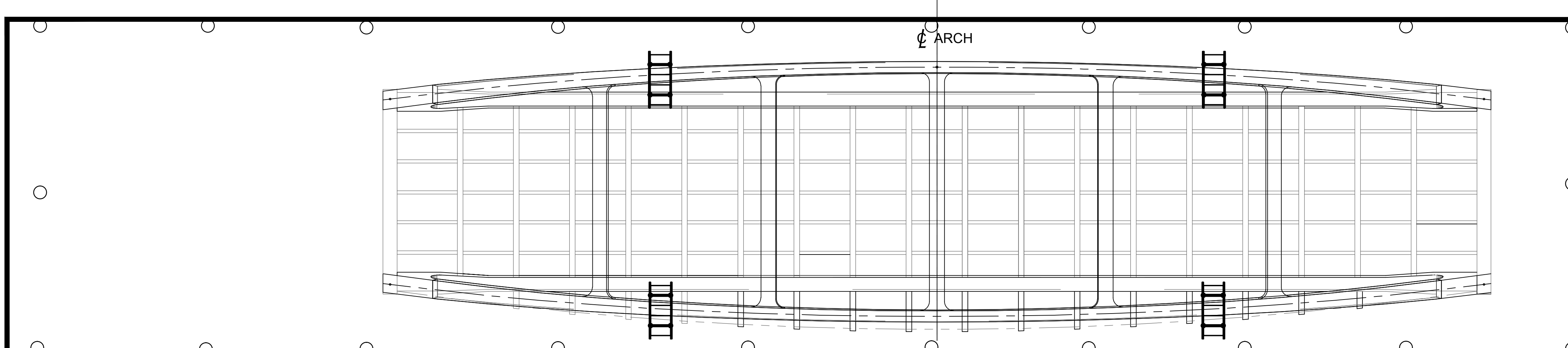
REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

8



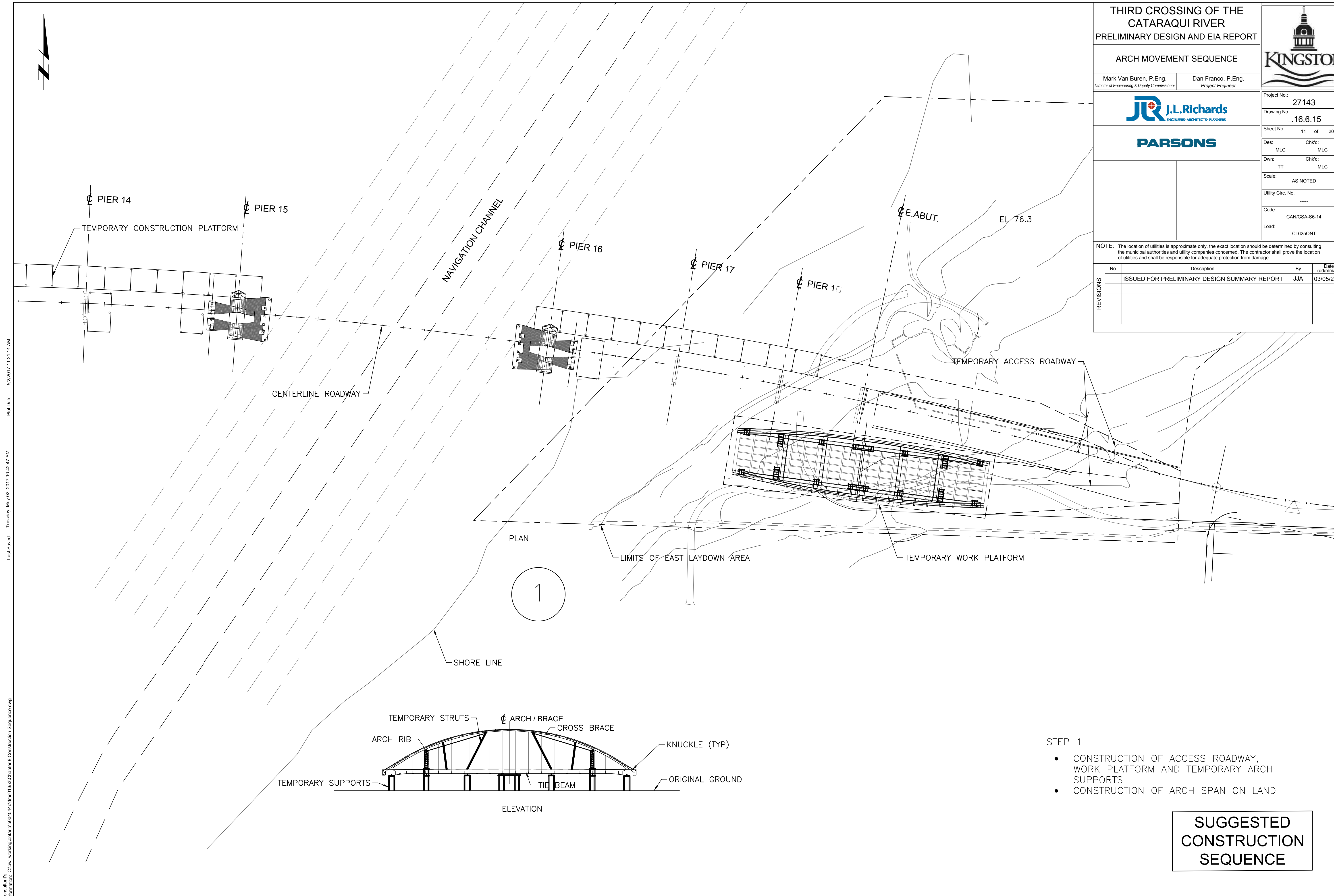
ELEVATION



RAISE THE ARCH UPWARDS IN THE PREPARATION FOR LONGITUDINAL SLIDE TOWARDS NAVIGATION CHANNEL

PLAN

SUGGESTED CONSTRUCTION SEQUENCE



STEP 1

- CONSTRUCTION OF ACCESS ROADWAY, WORK PLATFORM AND TEMPORARY ARCH SUPPORTS
- CONSTRUCTION OF ARCH SPAN ON LAND

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH MOVEMENT SEQUENCE

Mark Van Buren, P.Eng. — Director of Engineering & Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer

KINGSTON

J.L.Richards — ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	16.6.15
Sheet No.:	11 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

Consultant's Information: C:\pw_working\ontario\p004544\dms01353\Chapter 8 Construction Sequence.dwg
Last Saved: Tuesday, May 02, 2017 10:42:47 AM
Plot Date: 5/2/2017 11:21:14 AM

THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

ARCH MOVEMENT SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

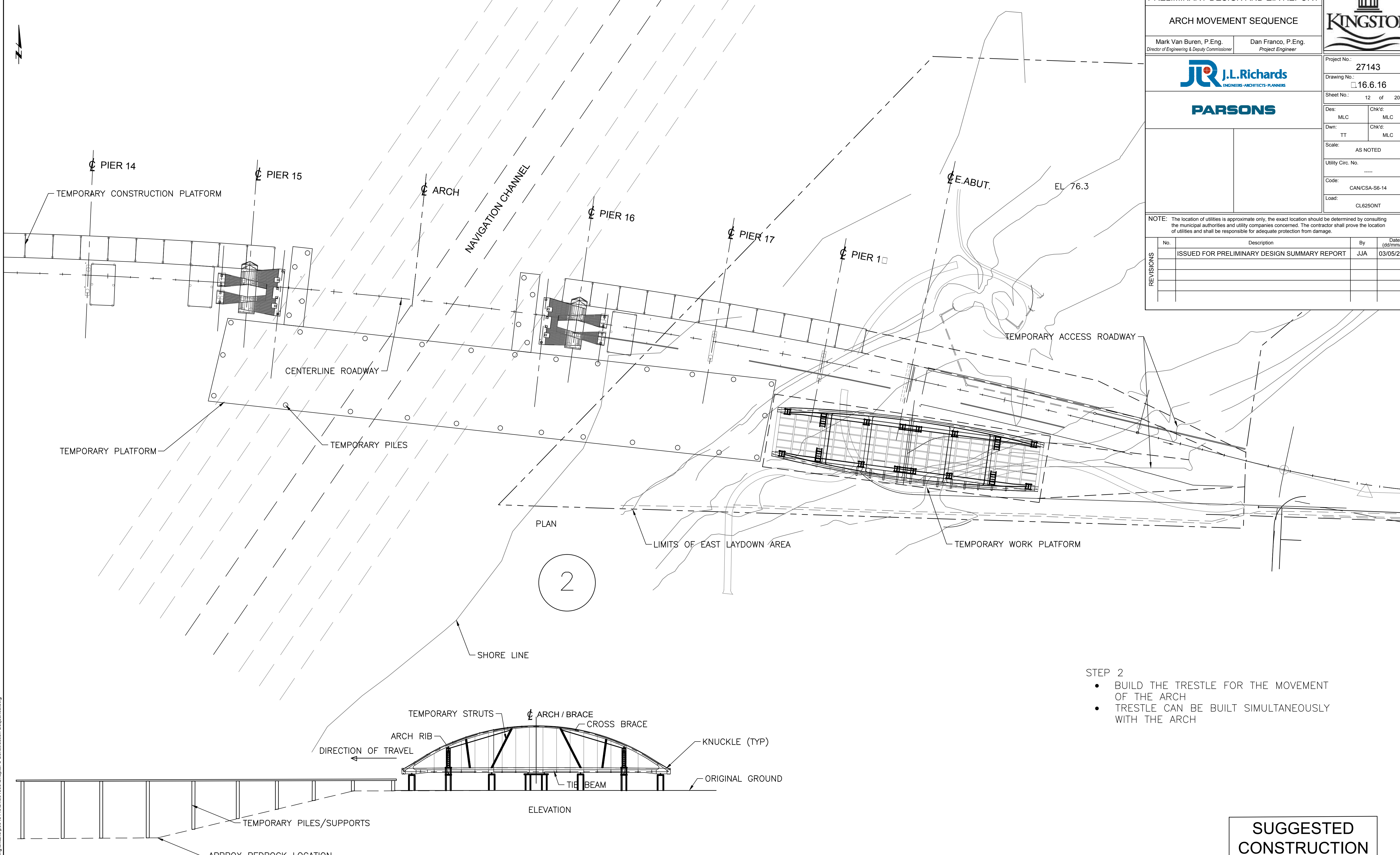
KINGSTON

Project No.:	27143
Drawing No.:	16.6.16
Sheet No.:	12 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



STEP 2

- BUILD THE TRESTLE FOR THE MOVEMENT OF THE ARCH
- TRESTLE CAN BE BUILT SIMULTANEOUSLY WITH THE ARCH

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH MOVEMENT SEQUENCE

Mark Van Buren, P.Eng. — Director of Engineering & Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

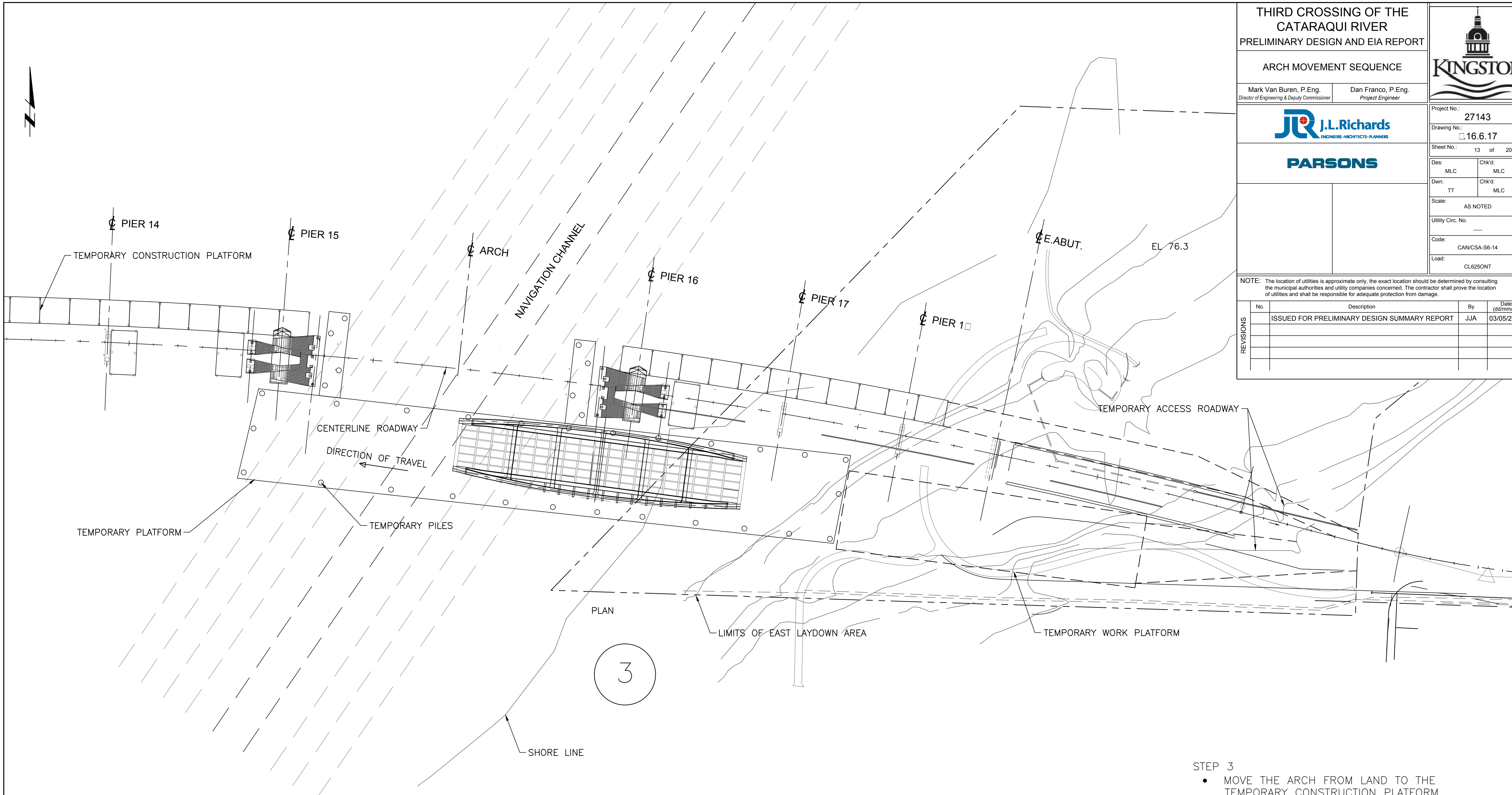
PARSONS

Project No.:	27143
Drawing No.:	16.6.17
Sheet No.:	13 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

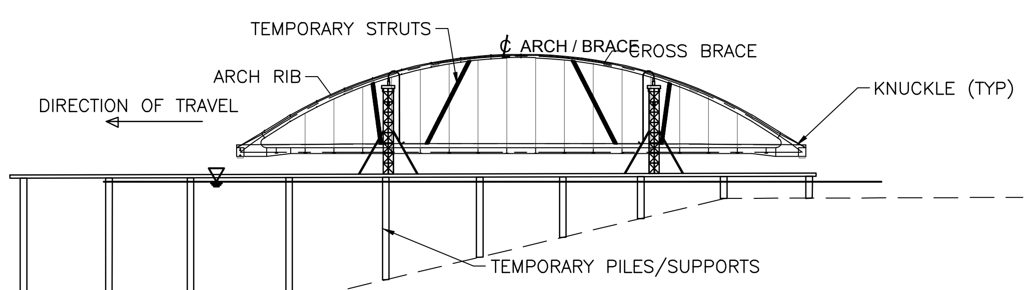
REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



PLAN

STEP 3
- MOVE THE ARCH FROM LAND TO THE TEMPORARY CONSTRUCTION PLATFORM



ELEVATION

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH MOVEMENT SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

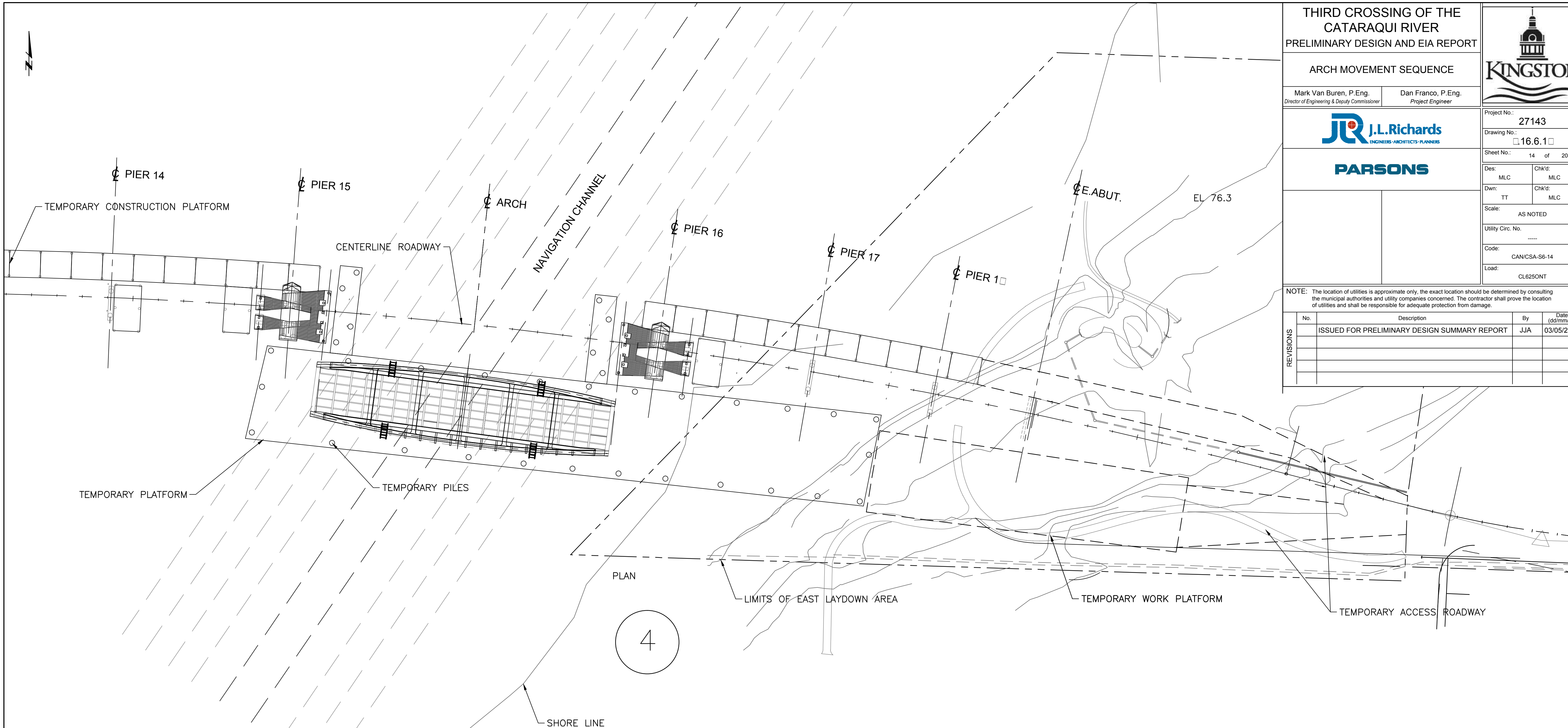
PARSONS

Project No.:	27143
Drawing No.:	16.6.1
Sheet No.:	14 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

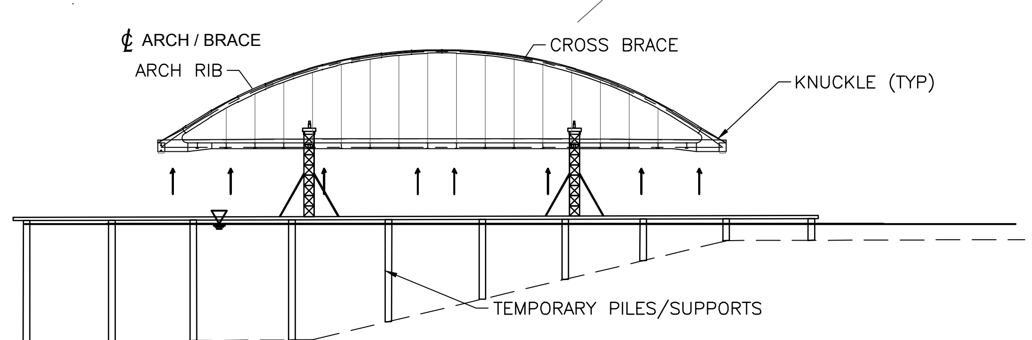
NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



PLAN



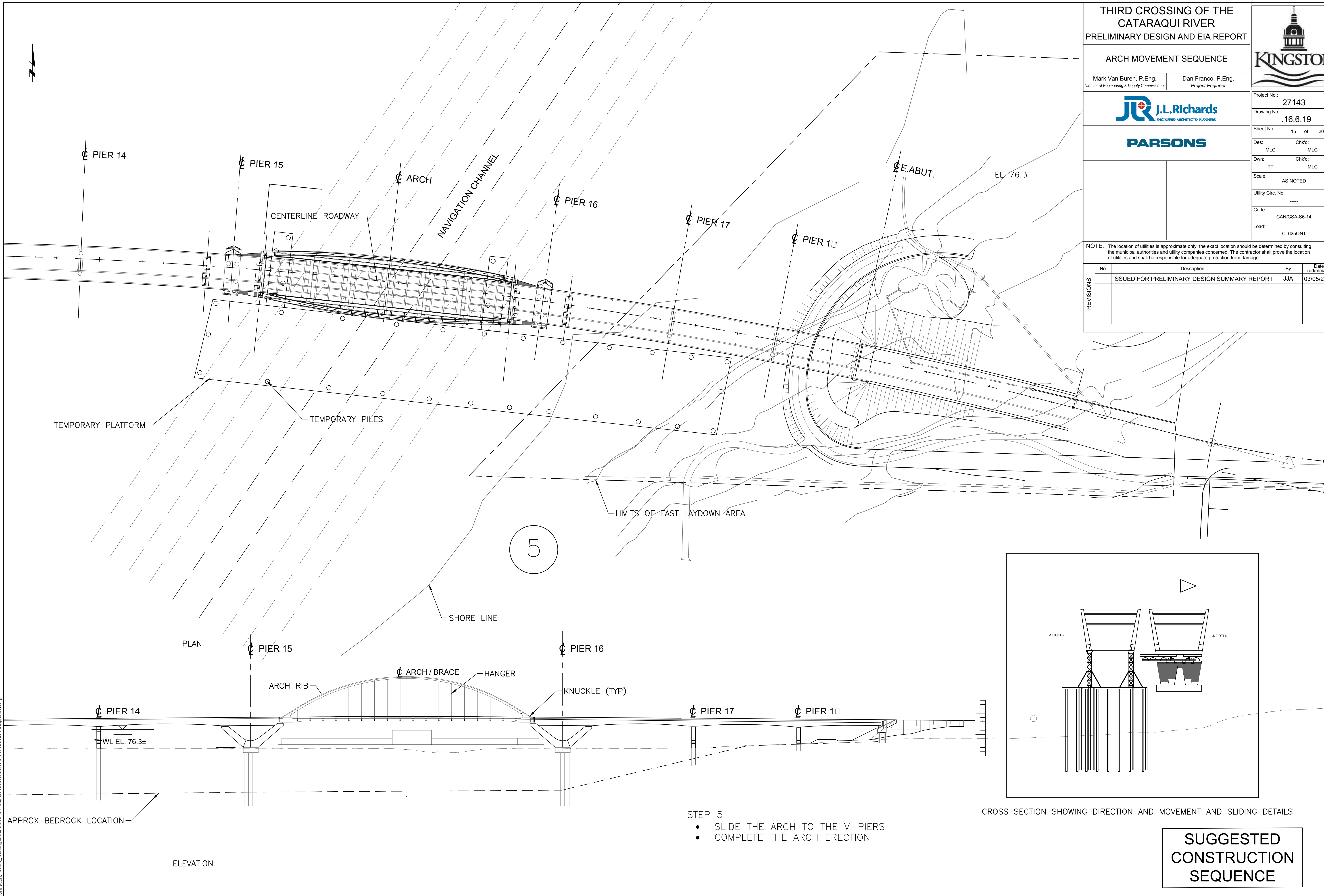
ELEVATION

STEP 4

- CONSTRUCT THE TEMPORARY JACKING TOWERS
- LIFT THE ARCH USING JACKING TOWERS

SUGGESTED CONSTRUCTION SEQUENCE

Plot Date: 5/2/2017 11:25:47 AM
Last Saved: Tuesday, May 02, 2017 10:42:47 AM
Consultant's Information: C:\pw_working\ontario\p004544\d\ms01353\Chapter 8 Construction Sequence.dwg



STEP 5
- SLIDE THE ARCH TO THE V–PIERS
- COMPLETE THE ARCH ERECTION

SUGGESTED CONSTRUCTION SEQUENCE

THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH MOVEMENT SEQUENCE

Mark Van Buren, P.Eng. — Director of Engineering & Deputy Commissioner
Dan Franco, P.Eng. — Project Engineer

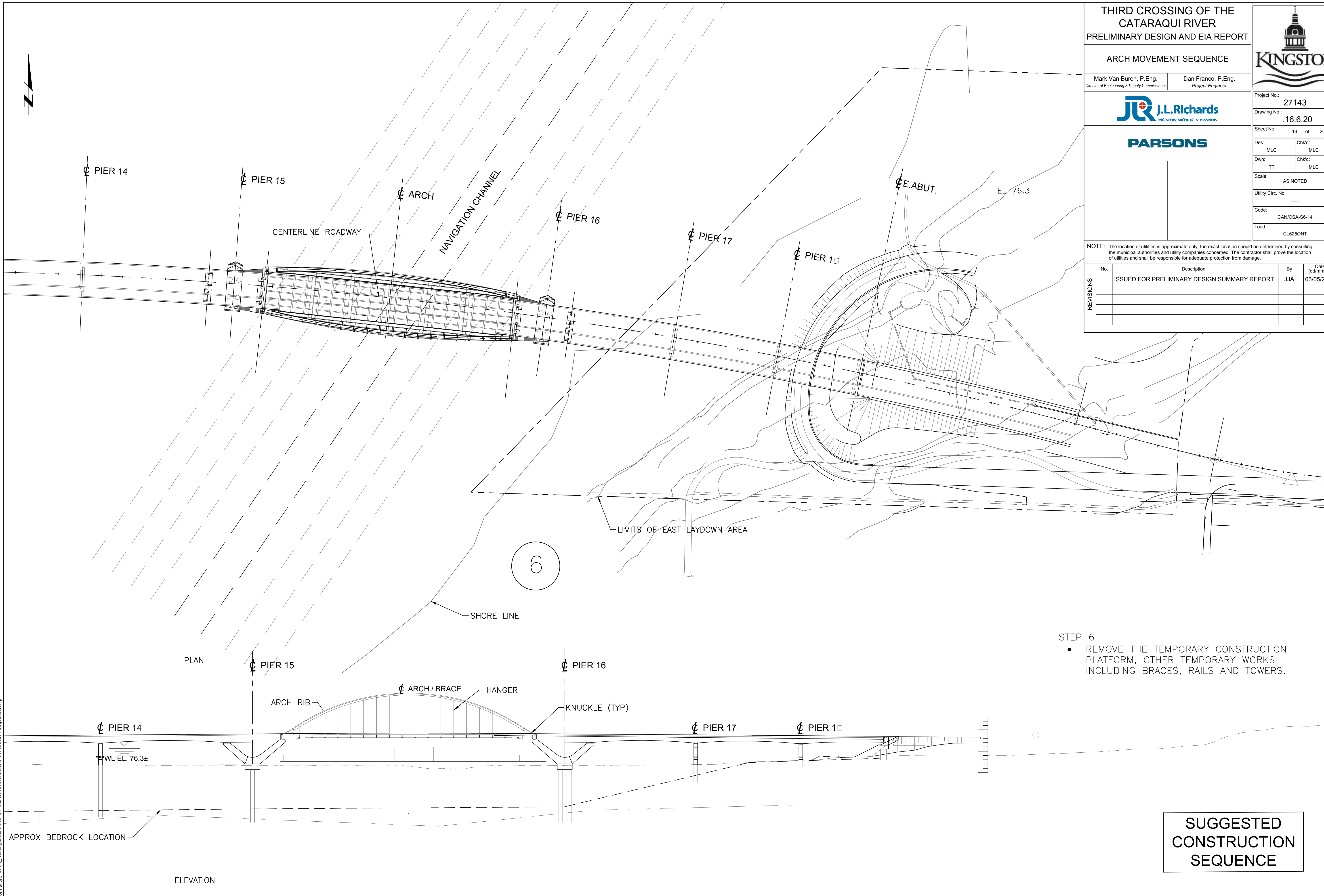
J.L.Richards — ENGINEERS • ARCHITECTS • PLANNERS
PARSONS
KINGSTON

Project No.:	27143
Drawing No.:	□16.6.19
Sheet No.:	15 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017



THIRD CROSSING OF THE CATARAQUI RIVER
PRELIMINARY DESIGN AND EIA REPORT

ARCH MOVEMENT SEQUENCE

Mark Van Buren, P.Eng.
Director of Engineering & Deputy Commissioner

Dan Franco, P.Eng.
Project Engineer

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Project No.:	27143
Drawing No.:	□16.6.20
Sheet No.:	16 of 20
Des: MLC	Chk'd: MLC
Dwn: TT	Chk'd: MLC
Scale:	AS NOTED
Utility Circ. No.	-----
Code:	CAN/CSA-S6-14
Load:	CL625ONT

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
	ISSUED FOR PRELIMINARY DESIGN SUMMARY REPORT	JJA	03/05/2017

STEP 6

- REMOVE THE TEMPORARY CONSTRUCTION PLATFORM, OTHER TEMPORARY WORKS INCLUDING BRACES, RAILS AND TOWERS.

SUGGESTED CONSTRUCTION SEQUENCE

Plot Date: 5/2/2017 11:27:52 AM

Last Saved: Tuesday, May 02, 2017 10:42:47 AM

Consultant's Information: C:\pw_working\ontario\p004544\dms01353\Chapter 8 Construction Sequence.dwg

There are two categories for oversize/overweight loads: Category A: Routine Oversize / Overweight Loads and Category B: Non-Routine Oversize / Overweight Loads. The approach span structural steel would require a Category A permit as the max depth of the girders are approximately 3 m which if laid on its side is less than the 4.3 m requirement for a Category B permit. The girders will have to be properly supported in order to not place excessive stress on the webs of the girders during construction. The transportation of the arch may require a Category A or B permit, depending on the locations of the splices which will be determined by the Contractor's construction engineer.

The deck can be either cast-in-place or precast depending on the design requirements. A precast deck would involve either: full depth precast in which precast panels will be supported on the girders with cast-in-place concrete poured at the joints or partial depth precast panels with a cast-in-place concrete overlay on top. Precast decks panels can be erected from shore or from the work bridge whereas a cast-in-place deck/overlay would require a concrete conveyance system from both shores. It is anticipated that the deck will be poured in segments as the steel superstructure erection advances. This will provide access so that the sidewalk, barrier, railings and remaining deck related work can be completed.

The v-pier leg formwork will be tied together and will have to be poured simultaneously to balance the load. For the v-piers, temporary supports will be required to support the formwork for the legs. The use of precast box sections will be investigated for the use for the v-pier legs. The tie can be formed off of the pier legs and poured in place or can be precast and post-tensioned. The use of post-tensioning strands can be used to accommodate the tensile stresses that will be placed on the concrete v-pier legs once the braced formwork is removed. Furthermore, post-tensioning of the v-pier legs is anticipated to minimize the tensile stresses in the pier legs and the associated cracks.

The bracing and diaphragm of the girders in the vicinity of the piers will be designed to avoid conflict at the tie location. The use of cross-frames and/or wide flanged deep beams will be investigated at the tie-beam locations.

8.16.7 Approaches and Utilities

Construction activities within the bridge approach areas will first require consideration of construction staging and laydown requirements as well as utility relocations. This can then be followed by rough grading and finished road construction near the end of the project construction period.

As discussed earlier, key utilities will require relocation, particularly on the west shore where high voltage power lines owned by Hydro One and located on Kingston Hydro Poles are required to be moved underground. These lines will also require positioning around the west bridge abutment. In addition to the high voltage lines, distribution voltage owned by Kingston Hydro, as well as other utilities such as Bell and Cogeco cable will require relocation.

On the west shore, the trunk sanitary sewer main is also recognized as significant existing buried infrastructure that requires relocation prior to bridge construction activities. The west bridge abutment and future stormwater management facility require that this infrastructure be moved. This also provides opportunity for renewal of the sewer pipe since it is significantly aged and ensures the new bridge approaches are not constructed on top of deteriorated piping that may require renewal itself within the lifespan of the bridge.

In the later stages of construction activities when staging areas for bridge materials are no longer required, rough grading of the abutment fill areas can be finalized (ensuring consolidation of materials) and fine grading, placement of curbs and paving can be completed.

Temporary utilities required for construction laydown as well as relocations to facilitate construction road access (e.g. construction road from Highway 15 near the dog park) will be required.

8.16.8 Permits and Approvals

As noted earlier, Parks Canada is responsible on behalf of the Federal government for managing and protecting the Canal as a National Historic Site and Canadian Heritage River. Parks Canada is also responsible on behalf of the UNESCO World Heritage Committee for protecting the Canal as a UNESCO World Heritage Site. The City and Project Team are currently working with Parks Canada on achieving an agreement-in-principle regarding the DIA as part of this current project phase.

Following the formal approval of the DIA during the future final design phase, the City will be required to enter into an agreement with the Government of Canada (represented by Parks Canada) to ultimately proceed to construct and subsequently operate the bridge for the duration of its life cycle, pursuant to the Federal Real Property and Federal Immovables Act.

In addition, there are also a number of permits and approvals that will be required from various regulatory authorities in support of the design work as it proceeds from the pre-design stage to the final design stage. Such approvals are related to various non-passive fieldwork activities in support of the design work (e.g. from MNRF, DFO, MOECC, CRCA), which could also include authorizations pursuant to:

1. The Endangered Species Act.
2. The Permit To Take Water requirements under the Ontario Water Resources Act.
3. Ontario Regulation 148/06, Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (administered through the CRCA).

8.16.9 Community Action Plan

As stated earlier, the purpose of the CAP is to establish protocols for use by the City for notifying the general public of any service interruptions and addressing public issues both prior to and during bridge construction activities as well as during the subsequent use and maintenance of the bridge. Recommended CAP provisions for the City are outlined below:

1. During the construction phase:
   a) Provide information on construction activities and advance notices on upcoming service interruptions (including their anticipated duration) through such means as a project website, various social media platforms and on-site signage.
   b) Ensure the Contractor has a Construction Liaison Officer whose specific role would be to liaise with – and address issues from – the general public and other stakeholders.
2. During the operations phase:
   a) Provide information (and advance notices) on upcoming service interruptions related to maintenance and public events (including their anticipated duration) through such means as a project website, various social media platforms and on-site signage.
   b) Retain a Bridge Liaison Officer whose specific role would be to:
      i. educate the general public and other stakeholders regarding restoration and enhancement works within the project corridor as well as associated preventative actions and appropriate behaviours to facilitate success of these works; and
      ii. liaise with – and address issues from – the general public and other stakeholders.
      iii. Prior to, and during construction, maintain intimate dialogue with the Kingston Rowing Club in order to maintain access to their facilities and provide safe passage to rowers.

8.16.10 Pre-Construction Scheduling

Following completion of the current project phase, there are a number of tasks that will ultimately lead up to construction of the bridge, as shown on **Table 8.16.10.1**.

Table 8.16.10.1: Pre-Construction Tasks

Tasks	Timeline (not sequential)
Obtain Permits and Approvals (Parks Canada)	6 - 24 months
Obtain Permits and Approvals (Other Regulators)	6 - 24 months
Finalize Project Delivery Method	0 - 12 months
Secure Project Funding	Unknown
Finalize Property Acquisition	6 - 24 months
Complete Detail Design (dependent on project delivery model)	12 months
Contractor Prequalification and Tendering (dependent on project delivery model)	3 months
Complete Pre-Construction Tasks	12 - 24 months

8.16.11 Construction Scheduling

Preliminary scheduling of the project has included a review of the order of construction operations for both on-land and on-water activities (and acknowledging that the Contractor may approach construction scheduling differently due to construction means and methods). It is understood that a number of activities will take place concurrently both on-land, on-water and off-site in a fabrication facility and, as such, these activities can be scheduled simultaneously. A draft schedule has been included in **Figure 8.16.11.1 and Figure 8.16.11.2** which show an approximate three year construction period. The schedule is a function of the Contractor operations including access means and methods and the availability of equipment and crews.

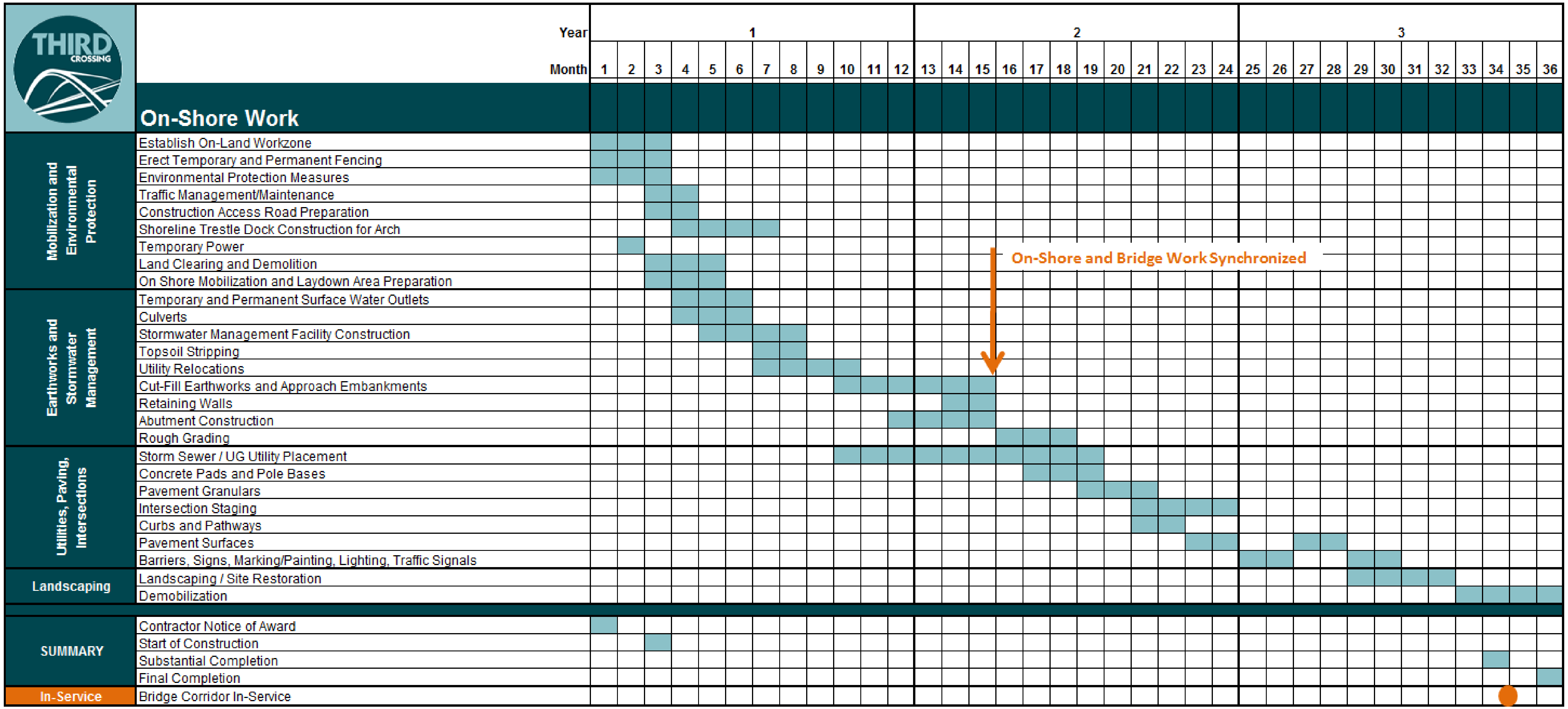


Figure 8.16.11.1: Conceptual Construction Schedule (On-Shore Work)

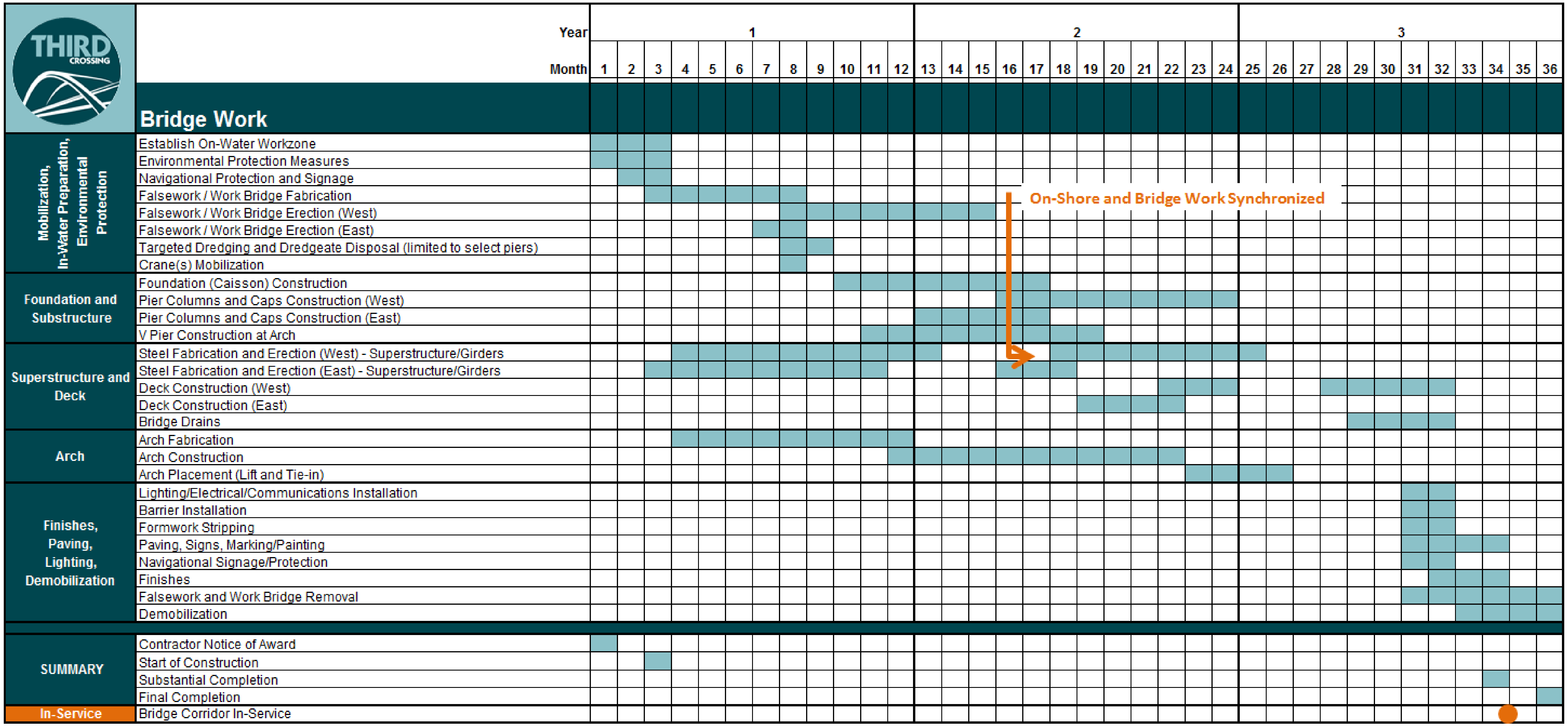


Figure 8.16.11.2: Conceptual Construction Schedule (Bridge Work)

On-shore work will generally follow an order of operations that includes:

1. Mobilization and C-NHPEP (protection) / CAP implementation
2. Earthworks and stormwater management
3. Utilities, paving and intersections
4. C-NHPEP (enhancement) implementation

Bridge construction work will generally follow an order of operations that includes:

1. Mobilization, C-NHPEP (protection) / CAP implementation
2. Steel superstructure (Girders and arch) Fabrication
3. In-water preparation
4. Foundation and substructure
5. Steel superstructure (Girders and arch) Erection
6. Concrete Deck
7. Utilities, paving and lighting
8. C-NHPEP (restoration / enhancement) implementation
9. Demobilization

Based on feedback received from the Rowing Club, construction activities should be planned so that are at least three southbound rowing lanes and one northbound rowing lane are available at all times during the training season (ice thaw to ice formation). All construction equipment in the vicinity to the rowing lanes must have lights as well as all obstructions and permanent elements.

Consideration should be given to installing the arch outside of the navigation season so that the channel can be used to erect the arch and to eliminate any potential disruptions of the navigation channel.

8.16.12 Decommissioning

The demolition of the bridge will follow the reverse sequencing of the construction. First, all of the additional dead loads will be removed from the bridge (e.g. barriers, railings, lighting, benches, asphalt, etc.). Then the concrete deck will be sawcut into small segments so that it can be easily lifted and removed. The girders will be lifted off of the piers and removed. The piers will be demolished and the caissons will be cut below the riverbed and will remain.

If the approach span structural steel was launched, it can be jacked and placed on rollers to be removed similar to how it was launched. The use of temporary towers and cables can be used to support the spans as they become unsupported by the piers.

The arch will be lifted off of the bearing and lowered in one piece like it was erected. Once it is lowered it will be moved to the approaches to be dismantled.

8.17 Operational Maintenance Considerations

To ensure the long term safety and viability of the new structure, operational maintenance will be taken into consideration during the pre-design. The following items were taken into consideration during the design concept phase:

1. **Winter Provisions:** Snow removal is key aspect to prolong the life of a structure as salt-laden snow will cause deterioration to the concrete if it is left in place for too long. In order to ensure that all snow will be removed from the bridge deck efficiently, there will be no obstructions on the roadway or multi-use pathway that will collect snow which cannot be removed by a snow plow vehicle. The lighting for the bridge will be on the roadway parapet wall and the lighting for the multi-use pathway will have benches around them which will taper back into the barrier wall to provide a smooth line. The multi-use pathway will be sloped towards the roadway such that the water from the snow will flow towards the deck drains.

   In some instances, heated bridge deck are proactive/preventative snow and ice removal alternatives that can be used on their own, or in addition to, traditional plowing and sanding operations (which are viewed as reactive snow and ice removal measures) or other anti-icing applications. These technologies are often seen as advantageous on bridges where icing conditions can be accelerated compared to surrounding roads, where traditional chloride-based road salts can have a detrimental effect on the environment, where salts cause corrosion issues with the bridge structure itself, and finally where sand and grit can clog bridge drains and stormwater management devices. Types of heated bridge deck options include hydronic piping and electrical resistant technologies. Many jurisdictions have invested in heated bridge deck technologies or pilot projects; however, due primarily to construction, operation and maintenance costs they have largely not been adopted as mainstream winter strategies. Introducing mechanical systems into a bridge does increase initial capital cost and ongoing maintenance costs. The Third Crossing will be a long and narrow bridge. This type of geometry does not lend well to integrated pavement systems due to the resources required to either maintain heated fluid or adequate power for a significant distance. To overcome these challenges, significant cost and the potential expense of architectural bridge elements would be a direct result. Therefore, it was found that the Third Crossing is not a good candidate for heated pavements.

Anti-icing is a pro-active approach to winter road maintenance, which involves the application of freezing-point depressants to prevent ice and snow from bonding to the roadway surface rather than applying chemicals to melt ice and snow after they have already formed. As opposed to being a replacement for snow removal operations, in particular in heavier snowfall conditions, anti-icing is a preventive measure that is often used in concert with other snow and ice control techniques. Various Fixed Anti-Icing System Technology (FAST) systems were reviewed and compared. In-deck piping running in the plane of the deck or electrical heating systems embedded in the cementitious wearing surface were not recommended due to excessive durability risk for the Third Crossing bridge deck. If a FAST system is implemented, it is recommended that the system requirements be structured such that: any embedded element shall have the same service life as the element into which they are embedded, replaceable elements have a minimum 20 year useful life and that any pressurized piping shall be located outside of box-girder sections and shall employ double-containment provisions.

2. **Expansion Joints:** Cleaning joints and replacing expansion joint seals is an ongoing maintenance and cost issue on all bridges. Minimizing the number of joints is important to reduce the amount of maintenance and operational cost in the future.

3. **Drainage System:** The inspection of the drainage system is important as leaks can cause corrosion of the structural steel if left unnoticed and unrepaired.

4. **Cables:** The replacement of arch cables can be a costly and complex procedure. The arch cables will be designed such that there is redundancy in the system so one cable can be replaced at a time without the need to provide any additional support to the arch.

5. **Structural Steel Coating:** The durability of the structural steel is of the upmost importance for the long-term service life of the bridge. A coating system that is suitable for the environment over the Cataraqui River will be chosen to ensure the durability of the structure. Alternatively, Atmospheric Corrosion Resistant (ACR) steel will be considered for the approach spans and this will minimize the long term coating maintenance cost.

6. **Bearings:** Although current bearing technology ensures maintenance free units for many decades, they have in the past been susceptible to seizing and general wear-and-tear due to their continual movement. Hence, regular inspection is required to ensure that unwanted forces are not imposed on the bridge due to malfunctioning bearings.

7. **Inspections:** Regular inspections is the best way to reduce rehabilitation costs in the future as ongoing maintenance can eliminate major repairs in the future. A catwalk will be placed under the bridge to facilitate the inspection of the structural steel, drainage systems, soffit, etc.

8. **Emergency Provisions:** In case of an emergency on the bridge, there is sufficient space to allow for both lanes of traffic to continue to flow if all vehicles are pulled over onto the shoulder of the bridge.

   In case of a full road closure on the bridge:

   a) There is ample room for passenger vehicles to turn around. The vehicles would then be detoured to either the Highway 401 crossing to the north or the LaSalle Causeway crossing to the south.

   b) The multi-use pathway will be subjected to pedestrian loading of up to 4.0 kPa; and/or Maintenance Vehicle gross loading of 80 kN, which at this time can accommodate an ambulance. A fire truck is much heavier, but can be added as a load case during the future detail design stage. Based on such provisions, it should then also be noted that removable bollards should be considered at both approaches to prevent non-emergency vehicle access onto the multi-use pathway.

9. **Other Provisions:** The Project Team understands that the weight of a typical army tank is in the range of 70 tonnes. This is comparable to the 63.7 tonne CL-625-ONT truck load used to design the bridge. If required, army tanks can be added as a load case during the future detail design stage. Nevertheless, it should be noted that the use of track-mounted army tanks directly on the bridge deck would damage the wearing surface. Army tanks are usually transported on trucks, which distribute the load on multiple axles.

8.18 Class 'B' Cost Estimate

As noted earlier, a preliminary opinion of probable capital cost was developed during the Class EA for the Arch With V-Piers bridge deck conceptual design scenarios (in 2011 dollars and excluding applicable taxes). The preliminary opinion of probable cost of a 2- lane bridge (in 2011 dollars and excluding applicable taxes) was $121M. As part of the pre-design work, an updated Class 'C' estimate was developed for the original v-pier design concept, based on its current status in February 2017 that included the preferred temporary work bridge construction option. The result was a significant capital cost escalation, in the range of $200M (2017 dollars).

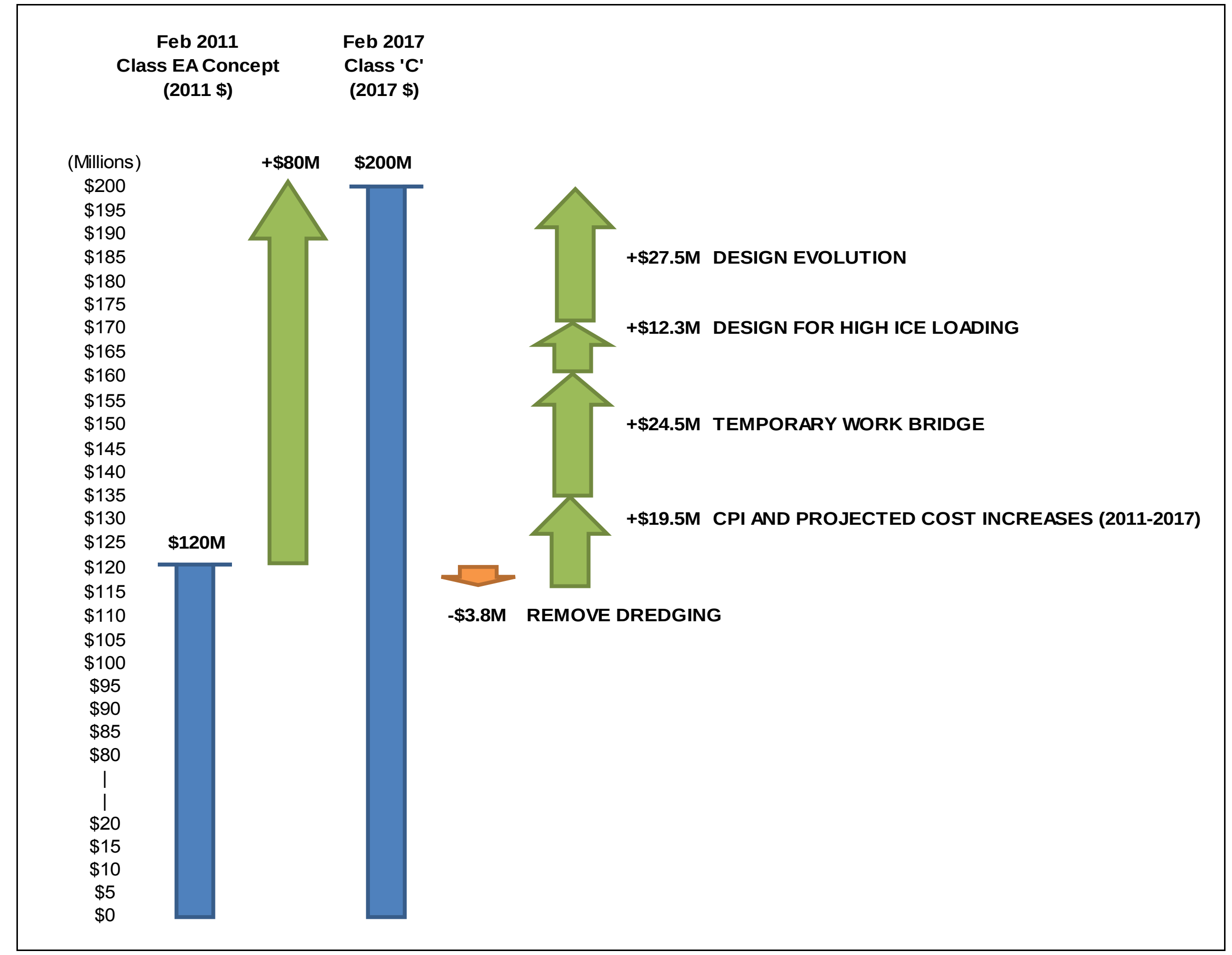


Figure 8.18.1: Capital Cost Escalation Considerations

As referenced earlier, the refined pier design offered an opportunity to reduce costs along with environmental impacts and retaining aesthetic design and user experiences. The design innovation associated with the inverted U-shape pier design allowed for considerable offsets to the increased costs associated with the temporary work bridge.

An updated Class 'B' estimate was prepared for the final preliminary design using HiCo, MTO's infrastructure costing system and knowledge of local construction pricing. The capital project cost including the refined pier design and temporary work bridge option amounted to $161M, a $40M decrease compared to the initial design. A summary is provided in **Table 8.18.1**.

Table 8.18.1: Class 'B' Cost Estimate	
Sub-Total for Structure Construction	$106,500,000
Sub-Total for Construction of Bridge Approaches	$11,500,000
Sub-Total for Landscaping	$3,400,000
Sub-Total for Construction Costs	**$121,400,00**
Mobilization (3%)	$3,600,00
Engineering and Contract Administration (12.5%)	15,200,000
Quality Management (3.0%, 2.5% Structural)	$3,100,000
Contingency (15%, 10% Landscape)	$18,000,000
Total Estimated Construction Cost	**$161,300,000**

Proportionate costs relative to construction costs (75%) and indirect costs (25%) are shown in **Figure 8.18.2**.

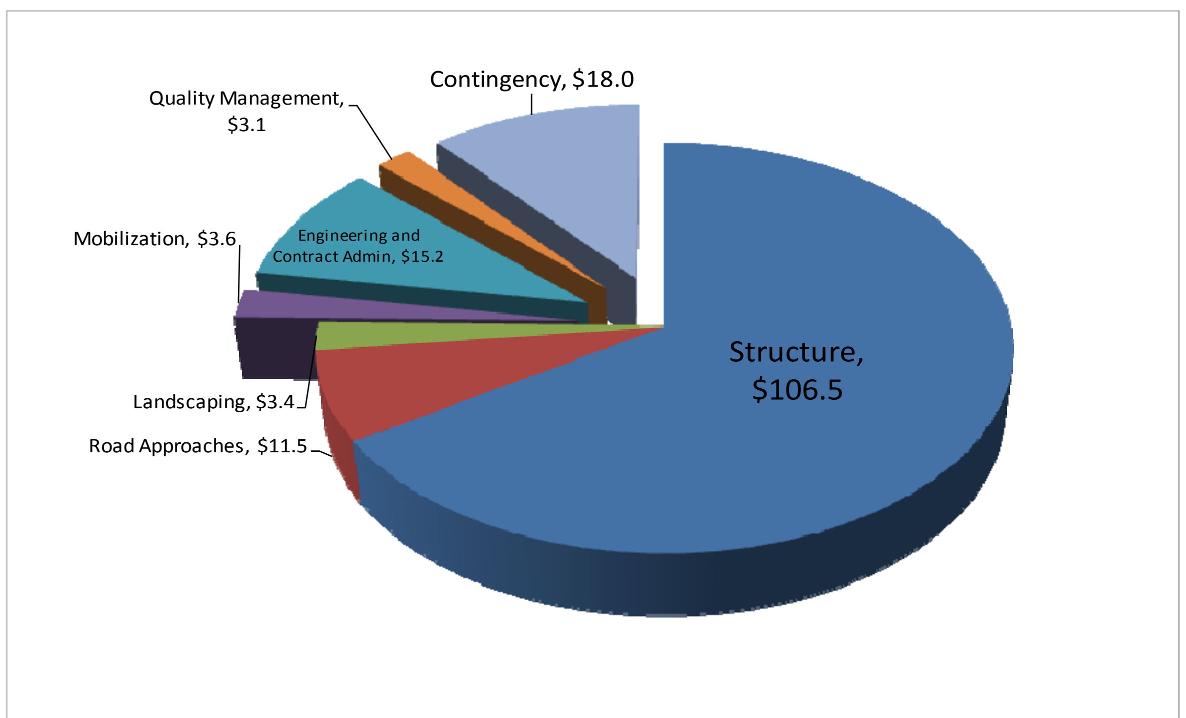


Figure 8.18.2: Proportionate Construction and Indirect Costs

Further perspective on the capital cost progression from the Arch with V-Piers design concept in the ESR to the current refined bridge design is shown in **Figure 8.18.2**.

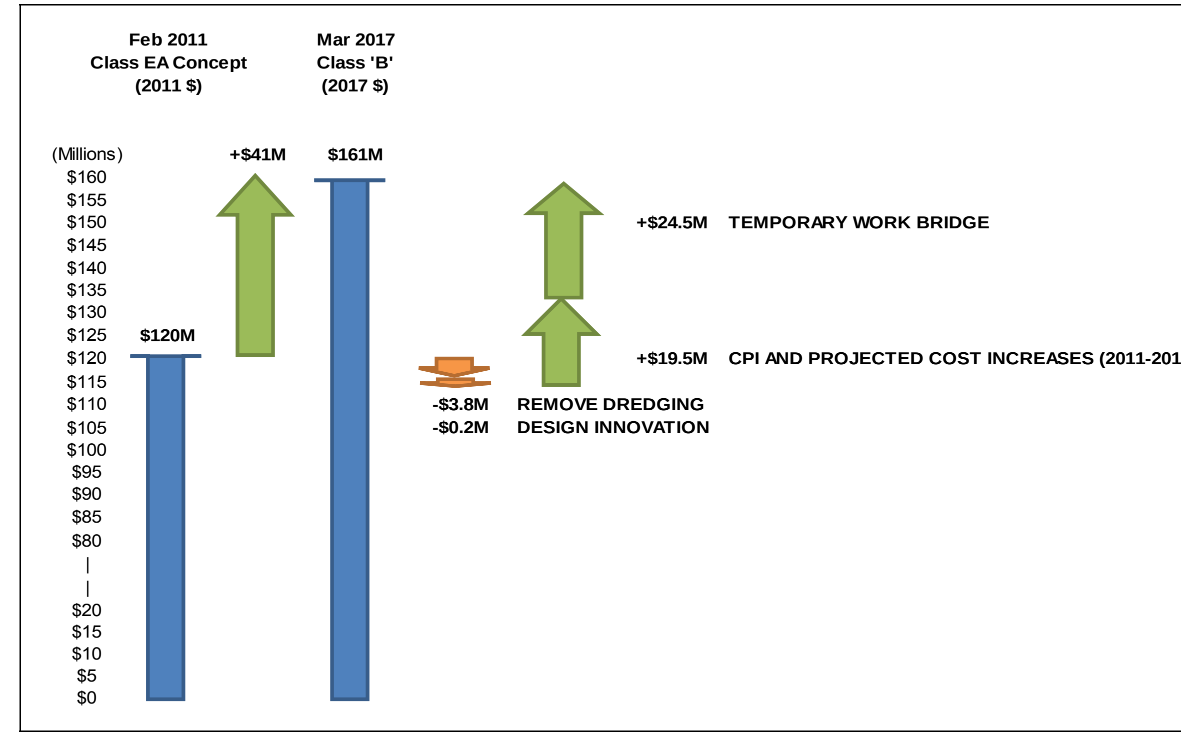


Figure 8.18.2: Class EA Capital Cost Progression

Through design innovation, the cost of the project (from 2011), other than inflation and the preferred temporary work bridge construction option, is expected to remain the same.

8.19 Life Cycle Cost Analysis

A life cycle cost analysis was undertaken for the Third Crossing bridge in accordance with the current MTO Financial Analysis Manual, to determine the future capital and maintenance costs for the bridge through its service life of 100 years. With regular maintenance, it is expected that the bridge can last more than 100 years. The life cycle cost includes the costs associated with bridge elements that have a design life less than the overall design life of the bridge which will be replaced and bridge elements which will require repairs to achieve the overall design life of the bridge. **Table 8.19.1** shows the service life of the different bridge elements and whether they will require replacement over the course of the bridge's service life.

The concrete deck is anticipated to have a 100-year design life with continuous maintenance of the waterproofing system as the deck will be reinforced with stainless steel reinforcement and have additional cover over traditional concrete decks. The life cycle cost analysis considers the annual maintenance and operation costs as well as inspections costs. Visual inspections will occur every 2 years and a comprehensive detailed and underwater inspection will occur every 2 years or so prior to a major rehabilitation to determine the scope of the rehabilitation work. The life cycle cost analysis does not account for any reconfiguration of the bridge in the future.

It is anticipated that a minor rehabilitation would be required every 15 years which would consist of: mill and paving of the asphalt deck surface, and replacement of the expansion joint seals.

A major rehabilitation would occur every 25 to 30 years, depending on the existing condition of the element, and would consist of: replacement of the waterproofing membrane and asphalt, replacement of the bearings, replacement of the modular and strip seal joints, replacement of the noise barriers, localized concrete repairs and re-coating of structural steel.

At 60 years, a major rehabilitation will occur which will include the items of the previous major rehabilitation and in addition will include: replacement of the drainage system and replacement of the traffic railings.

The future rehabilitation costs are presented in constant 2017 dollars and are separated into individual cost estimates for each element. Each rehabilitation option includes a mobilization and demobilization fee of approximately 2%. The costs are based on the assumption that each rehabilitation is completed separately and there may be cost savings with completing multiple rehabilitations simultaneously with regards to traffic control and access costs. The rehabilitation options have a 20% contingency and a 15% allowance for engineering services. The annual maintenance and operation cost has a 20% contingency. The inspection costs have a 5% contingency. These contingencies, as described earlier, account for variability of market forces in the future.

Table 8.19.1: Service Life of Bridge Components

Bridge Element	Service Life (Years)
Permanent Elements:	
Foundations, including caissons/ footings	100
Piers	100
Abutments	100
Concrete Deck	100
Steel Superstructure and Arch	100
Arch Cables	100
Replaceable Elements:	
Bridge Bearings	30
Strip Seal Expansion Joint -- Neoprene Seals	15
Strip Seal Expansion Joints – Assemblies	30
Modular Expansion Joints – Assemblies	30
Deck Wearing Surface – Asphalt Top Lift	15
Deck Wearing Surface – Complete System	30
Deck Waterproofing	30
Traffic Railing	60
Coating System for Structural Steel	30
Noise Barriers	30
Drainage System	60
LED Luminaires	20
Light Standards and Brackets	50

For the concrete repairs task, it is estimated that there will be:

1. 100 m^2 of concrete repairs on the vertical piers and pier caps.
2. 50 m^2 on the two arch v-piers which is approximately 3% of the surface area.
3. 100 m^2 on the soffit which is approximately 0.5% of the surface area.
4. 50 m^2 on the barriers which is approximately 1% of the surface area.
5. 5 m^2 on the abutments and wingwalls which is approximately 5% of the surface area.

The life cycle cost analysis presents the cost of all future capital and maintenance costs as present net value (in 2017 dollars) for the item using economic principles and a discount rate. The effective discount rate used for the financial analysis was 3% with a sensitivity analysis of life cycle cost using discount rates of 5% and 7%. A summary of the life cycle cost analysis are shown in **Table 8.19.2**.

Table 8.19.2: Net Present Cost of Bridge Structure with Different Discount Rates

Discount Rate	Net Present Cost (2017)
3%	$156,500,000
5%	$137,900,000
7%	$126,500,000

In general, much of the road approach components will require repairs over the design life of the bridge as well. **Table 8.19.3** shows the service life of the different road approach elements and an estimated replacement schedule over the course of the bridge's service life.

Renewal of asphalt components as well as landscaping, stormwater facility maintenance, traffic light and overhead lighting is expected as with any road in the city. Underground utilities will require replacement/rehabilitation during the life of the adjacent bridge as well. Life cycle costing has considered the annual maintenance and operation costs of the road approaches including an allowance for winter maintenance.

Similar to the bridge structure, future rehabilitation costs are presented in constant 2017 dollars and are separated into individual cost estimates for each element. Each rehabilitation option includes a mobilization and demobilization fee, traffic control (where applicable) and contingency and engineering services allowances.

Table 8.19.3: Service Life of Road Approaches

Road Approach Element	Service Life (Years)
Surface Course Asphalt (1 lift)	15
Surface and Minor Base Asphalt (2 lifts)	30
Major Road Rehabilitation/Reconstruction incl. Storm Sewers and Structures, Granulars, Asphalt, Guide Rail, Storm Treatment Devices, Concrete Sidewalks	60
Granular Pathway Maintenance (Rehab)	15
Landscaping Renewal	25
Stormwater Management Pond Maintenance	25
Traffic Lights and Controllers	20
Noise Barriers / Fencing	30
LED Luminaires	15
Light Standards and Brackets	50

Table 8.19.2: Net Present Cost of Road Approaches with Different Discount Rates

Discount Rate	Net Present Cost (2017)
3%	$20,300,000
5%	$16,300,000
7%	$14,300,000

9.0 POTENTIAL PROJECT EFFECTS

As noted earlier, the intent of this Report is twofold, namely:

1. Refine the preferred bridge, roadway and landscape concept from the Class EA.
2. Review potential environmental interactions and proposed measures to mitigate potential adverse environmental effects associated with the construction and operation phases of the refined concept.

The proposed refinements to the preferred bridge, roadway and landscape concept further reinforce the potential of the project to provide an overall community benefit to the City:

1. The identified roadway improvement works should maintain the flow of traffic along this critical mid east-west arterial corridor at an acceptable LOS over the long-term. This analysis has also demonstrated that short-cutting of traffic through the Village On The River Apartments on the west side is not anticipated. Furthermore, additional traffic calming alternatives have been proposed at the reconfigured Point St. Mark Drive-Gore Road Intersection, which should prevent short-cutting of traffic through the Point St. Mark residential neighbourhood on the east side.
2. The purpose of the active transportation provisions on the bridge and on-land is to connect with, and thereby enhance, existing non-automotive networks on both sides of the Cataraqui River.
3. The intent of the preferred bridge concept, in conjunction with on-land design provisions in the C-NHPEP, is to enhance the cultural and natural heritage landscape within the project corridor and as part of the broader Canal context.

It is equally acknowledged however, that the C-NHPEP will be a critical piece of the broader package of mitigation measures required during the project construction and operation phases to either reduce or eliminate potential negative project impacts on the surrounding cultural and natural heritage landscape. These potential project effects are outlined below. In certain cases, specific DIA area conditions or project design mitigation considerations are discussed for ease of reference.

9.1 The West and East Side On-Land Effects

1. Potential Natural Heritage and Cultural Heritage Effects

The potential effects of the project on the on-land natural and cultural heritage features of the project corridor include:

1. Exhaust emissions and airborne dust from equipment traffic during construction and from the subsequent use and maintenance of the bridge could impact air quality (particulate matter).
2. Though the alignment would avoid Archaeological Site BbGc-127 and the stone survey marker on the south boundary of the Gore Road Library, both sites would still be affected by bridge construction activities.
3. As shown earlier on **Drawing 8.16.2**, it is anticipated that, due to a lack of available vacant land on the west side, certain privately owned properties (either in whole or in part) would be required for the road, stormwater management and C-NHPEP works, and as a bridge construction lay-down and staging area. Moreover, though visual examination of the west side lands suggests that virtually all lands within the existing road rights-of-way have been disturbed to the extent that any archaeological testing in those areas is almost certain to be futile, the private lands on either side of John Counter Boulevard do not appear to have been extensively disturbed and may contain areas where archaeological potential still remains.
4. As noted earlier, the bridge, by landing north of the Point St. Mark community, would impact the woodland, former fields, and recreational pathways on the lower plateau portion of the Gore Road Library. As shown earlier on **Drawing 8.16.1**, it is also anticipated that, due to a lack of available vacant land on the east side, a portion of the lower plateau would be required for stormwater management provisions and as a bridge construction lay-down and staging area.

   In addition, the widening of Gore Road would also require the removal of the formal gardens that extend along the southerly portion of the Gore Road Library property as well as the relocation of a 12 m portion of the dry stone wall that extends perpendicular from the Library into the Gore Road right–of-way on the upper plateau. These features are significant attributes of the Gore Road Library property that contribute to its heritage value and landmark status along Highway 15.

5. All peat, silty clay and clayey silt within the footprint on the west embankment (i.e. about 2.1 m) and east embankment (i.e. about 0.6 m) would need to be stripped, since these soils are compressible, and would be expected to settle under increased loads. As discussed earlier in this Report, there are a number of APECs on the west side lands. Site preparation and bridge construction activities could disturb potentially contaminated soils in these areas. Furthermore, the existing ground surface is within 1 m of the existing river level at the west embankment as well. If the west abutment is to be supported on spread footings bearing on the dolostone bedrock, the excavation work could be carried out in conjunction with the abutment footing construction. Otherwise, the excavation work would require some water-tight shoring to enable work below the river level.

6. As it is understood that the bridge approaches would match existing grades:

   a) Up to 4 m of fill would be required from the existing grade of John Counter Boulevard to the proposed west abutment.

   b) Up to 9 m of fill would be required from the existing grade of Gore Road to the proposed east abutment.

   The preferred use of suitable fill such as Select Subgrade Material or rock will need to confirmed during the detail design phase, including the need for appropriate erosion mitigation works of the embankment side slopes due to surface water runoff.

7. The bridge would impact existing faunal wildlife habitats and species on both sides of the Cataraqui River. As noted earlier, certain faunal species are also at some level of risk under the Provincial ESA and Federal SARA. Lands would be required for road, stormwater management and C-NHPEP works, and as a bridge construction lay-down and staging area. Such activities would involve:

   a) Riparian vegetation removal.
   b) Stripping and stockpiling of topsoil.
   c) Shoreland excavation works.
   d) Heavy equipment use and maintenance.
   e) Heavy material use and storage.
   f) Sanitary and construction waste management.
   g) Accidents and malfunctions.

   Without mitigation measures in place, these activities would lead to increased levels of sensory disturbance, loss of habitat, species mortalities, restricted species movement, shoreline erosion, sediment deposition and a subsequent decrease in surface water quality.

8. The bedrock on-shore could potentially be frost susceptible, as it is at relatively shallow depths of about 1.7 m and 3.1 m at the east and west banks, respectively.

It is equally important however, to reiterate the role of the C-NHPEP in restoring and enhancing the cultural and natural heritage landscape within the project corridor, relative to the fieldwork that was done during the Class EA and current project design phase:

1. There have neither been deer yards identified in the project corridor nor is there any identified moose late winter habitat.

2. There are no banks, rocky islands or peninsulas suitable for colonial bird nesting habitat.

3. Though the Cataraqui River and Greater Cataraqui Marsh PSW are known to provide support to waterfowl during migration times, no terrestrial stopover or staging habitat were observed.

4. The project corridor does not have areas of suitable shorebird foraging habitat. In addition, no concentrations of shorebirds or presence of the listed species were identified.

5. Given the relatively small size of terrestrial natural features within the project corridor and the urban context to the south, east and west, the project corridor is unlikely to provide suitable land-bird stopover areas.

6. Ideal raptor winter roosting areas are generally located in mature mixed or coniferous woodlands that abut windswept fields that do not get covered by deep snow. The project corridor does not provide such suitable areas.

7. Suitable habitat for wild turkey includes a mix of forest and open land such as natural grassland or agriculture. For wintering, wild turkeys tend to prefer large dense coniferous forests adjacent to open land and close to both a food source and groundwater seeps. The project corridor does not provide such suitable areas.

8. The project corridor is not large enough to meet the criteria for area-sensitive bird habitat breeding nor was any of the listed indicator species observed. Furthermore, there is no suitable marsh breeding bird habitat within the project corridor, although suitable habitats are present within the visible cattail portion of the Greater Cataraqui Marsh to the north.

9. The west side lands, in particular are dominated by urban land uses but no cultural heritage properties or ELC community types. As such, the C-NHPEP represents an opportunity for restoring the extensive environmental disturbance that has occurred, and enhancing the area as a naturalized landscape. This in turn could further serve to enhance both the ‘ribbon of life’ along the shoreline and visitor experience of the Canal.

10. The east side lands, in particular:

    a) Demonstrate anthropogenic-based disturbances, including: i) historic agricultural land uses; ii) the trails and off-leash dog park on the Gore Road Library property, which have fragmented the forest block; iii) non-native and some invasive plant species; and v) surrounding urban land uses.

    b) Generally lack the key characteristics of an old-growth forest, even though there are some very large mature trees. Moreover, none of the trees observed in publicly accessible areas are listed under the ESA or SARA, although it is recognized that Butternut Trees may be present on privately owned lands.

    As such, the significant functions of the forested block on the east side lands are restricted to the provision of shoreline and fish habitat protection as well as in forming part of the ‘ribbon of life’. Ultimately, the C-NHPEP represents an opportunity for ecological compensation following project construction by restoring and enhancing the naturalized landscape in this area. This in turn could also further serve to enhance both the ‘ribbon of life’ along the shoreline and visitor experience of the Canal.

2. Potential Noise Effects on Humans and Terrestrial Wildlife

The construction and operation of the bridge will generate environmental noise impacts on both humans and terrestrial wildlife. For this reason, noise assessments were conducted, focusing on:

1. Potential noise impacts on human receptors within the project corridor from (a) bridge construction; and (b) bridge operations (i.e. traffic).
2. Potential noise impacts on (a) birds and reptiles from bridge construction (i.e. impact pile driving); and (b) birds from bridge operations (i.e. traffic).

The supporting reports are included in **Appendix L** and **Appendix M**.

(A) Noise Impact Assessment on Human Receptors

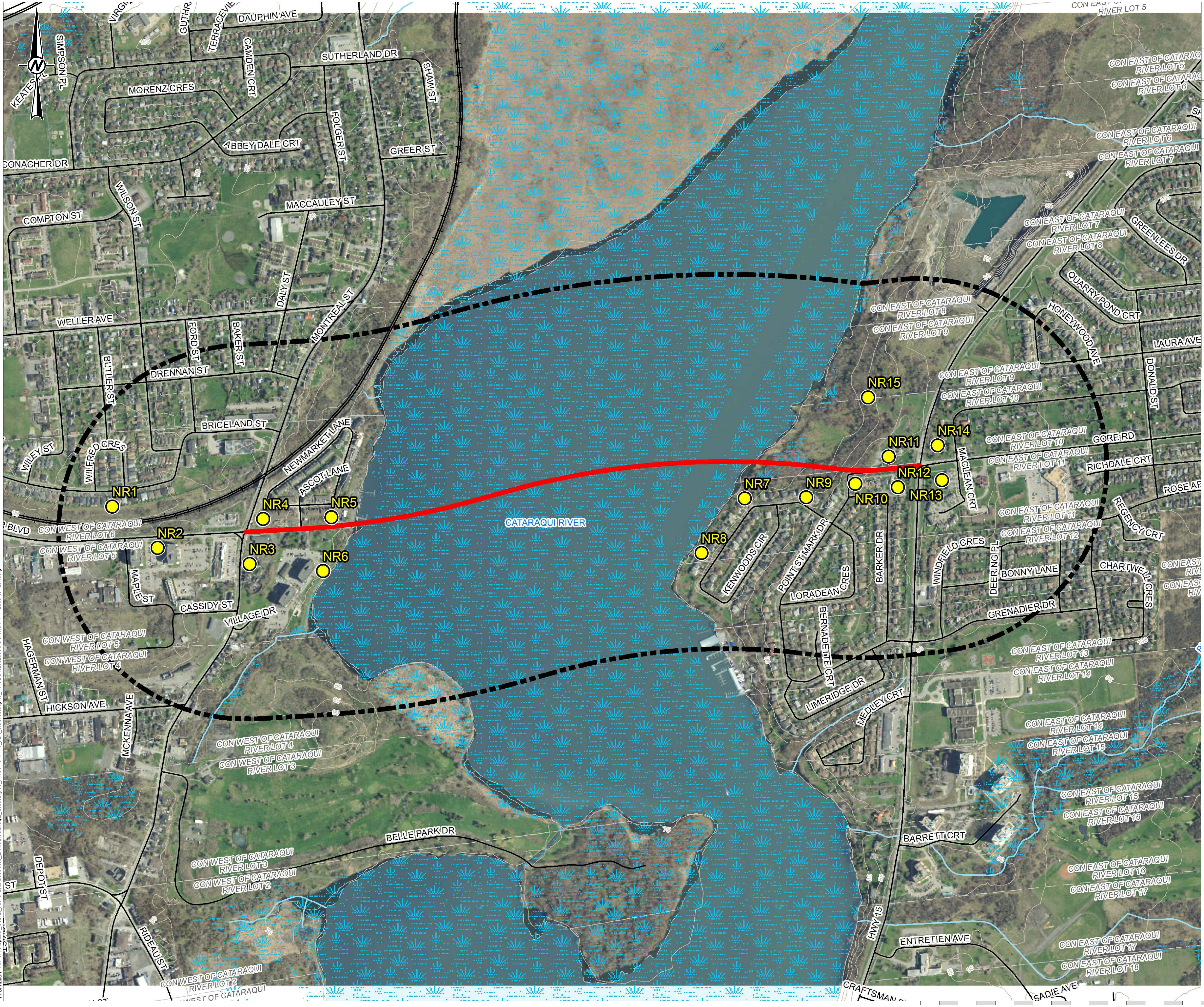
The MTO Noise Guide outlines requirements for noise assessments and mitigation relating to the construction of new or the expansion of existing Provincial highways, and is often referenced for municipal roadway projects. Mitigation is warranted when increases in sound levels over the future ‘no-build’ ambient sound levels are either 5 A-weighted decibels (dBA) or greater; or greater than 65 dBA at the Outdoor Living Areas (OLA) of Noise Sensitive Areas (NSA). Mitigation measures should achieve at least 5 dBA of attenuation, averaged over the first row of noise-sensitive receivers.

As shown on **Drawing 9.1.2.1**, 15 noise receptors represent the NSA within the project corridor, which is consistent with the NSA defined during the Class EA. There are approximately 324 NSA in the following general areas:

1. Six existing residential areas.
2. An existing day care centre on the south side of John Counter Boulevard just west of Montreal Street.
3. A vacant privately owned lot adjacent to the Gore Road Library property to the north that could potentially accommodate a future residential development.
4. The Gore Road Library, though it is not strictly considered a NSA by the MTO Noise Guide.

The noise assessment then compared future ‘build’ ambient sound levels (i.e. projected traffic volumes for the 2034 horizon year with the 2-lane bridge in place) versus the future ‘no-build’ ambient sound levels. Critical inputs in this analysis are as follows:

1. The OLA have been evaluated as per the MTO Noise Guide, but assessed at a more conservative height of 1.5 m (not 1.2 m), as per the MOECC Environmental Noise Guideline (NPC-300).



THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

NOISE SENSITIVE AREAS AND OUTDOOR LIVING AREAS ASSESSED

Mark Van Buren, P.Eng *Director of Engineering and Deputy Commissioner*	Dan Franco, P.Eng. *Project Engineer*

KINGSTON

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Golder Associates

Project No.:	27143
Drawing No.:	9.1.2.1
Sheet No.:	
Des: RT	Chk'd: JT
Dwn: JEM	Chk'd: BJV
Scale:	1:1,750
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)

LEGEND

- NOISE SENSITIVE AREA
- PROPOSED ALIGNMENT
- ROADWAY
- RAILWAY
- WATERCOURSE
- TOPOGRAPHIC CONTOUR, metres
- WETLAND
- LOT FABRIC
- AREA OF INVESTIGATION

2. The expected percentage of heavy vehicles is assumed to be split evenly between 'heavy trucks'[6] and 'medium trucks'[7].

3. The daytime and nighttime (D / N) breakdown of the traffic volume has assumed consistency with the Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT).

Table 8.1.2.1 summarizes the vehicle class and D / N breakdowns used in the analysis.

Table 9.1.2.1: Summary of Vehicle Class and D / N Breakdowns

Intersection	Automobile (A) / Medium Truck (M) / Heavy Truck (H)				D / N (%)
	Eastbound (%)	Westbound (%)	Northbound (%)	Southbound (%)	
John Counter / Montreal	A: 95.0 M: 2.5 H: 2.5	A: 92.5 M: 3.75 H: 3.75	A: 92.5 M: 3.75 H: 3.75	A: 92.5 M: 3.75 H: 3.75	D: 90.0 N: 10.0
John Counter / Ascot	A: 92.5 M: 3.75 H: 3.75	A: 92.5 M: 3.75 H: 3.75	A: 99.0 M: 1.0 H: 1.0	A: 99.0 M: 1.0 H: 1.0	D: 90.0 N: 10.0
Gore Road / Point St. Mark	A: 92.5 M: 3.75 H: 3.75	A: 92.5 M: 3.75 H: 3.75	A: 99.0 M: 1.0 H: 1.0	A: 99.0 M: 1.0 H: 1.0	D: 90.0 N: 10.0
Gore Road / Highway 15	A: 92.5 M: 3.75 H: 3.75	A: 95.0 M: 2.5 H: 2.5	A: 95.0 M: 2.5 H: 2.5	A: 95.0 M: 2.5 H: 2.5	D: 90.0 N: 10.0

[6] MTO defines 'heavy trucks' as all vehicles having 3 or more axles and designed for the transportation of cargo. Generally, the gross vehicle weight is greater than 12,000 kilograms (kg). Intercity buses are also included in this category.
[7] MTO defines 'medium trucks' as all vehicles having 2 axles and 6 wheels designed for the transportation of cargo. Generally, the gross vehicle weight is greater than 4,500 kg but less than 12,000 kg. City buses are also included in this category.

4. In addition:

a) Speed limits have been assumed at 60 km/hr within the project corridor (50 km/hr elsewhere) on proposed road elevations with a pavement type having 'average' acoustic absorption.

b) Traffic has been assumed to be predominantly free-flowing and has not considered the acoustic effects of vehicles accelerating or decelerating at flow control devices.

c) Regarding the future 'no-build' scenario, it should be noted that, in addition to the future 'build' scope of the enclosed Report, the majority of the project corridor extends over the Cataraqui River, where no major noise sources currently exist. As such, the analysis conservatively has assumed that the first-row NSA would all be subject to a minimum 5 dB increase under the future 'no-build' scenario.

With the above context in mind, **Table 8.1.2.2** shows the future 'build' versus future 'no-build' comparison.

Table 9.1.2.2: Projected 2034 Sound Levels (Unmitigated)

Receptor Location	NSA	Unmitigated Future 'No-Build' (dBA)	Unmitigated Change From Project (dB)	Unmitigated Future 'Build' (dBA)
NR1 (Briceland Street Residential)	25	45 – 50	≤ 5	50
NR2 (Day Care)	1	50 – 55	≤ 5	58
NR3 (Montreal Street Residential)	10	55 – 60	≤ 5	62
NR4 (River Park Subdivision West)	72	50 – 55	≥ 5	61
NR5 (River Park Subdivision East)	72	40 – 45	≥ 5	65
NR6 (Village On The River Apartment)	50	40 – 45	≥ 5	53
NR7 (Kenwood Crescent Residential)	15	40 – 45	≥ 5	56
NR8 (Kenwood Crescent Residential)	15	40 – 45	≥ 5	51

Table 9.1.2.2: Projected 2034 Sound Levels (Unmitigated)				
Receptor Location	**NSA**	**Unmitigated Future 'No-Build' (dBA)**	**Unmitigated Change From Project (dB)**	**Unmitigated Future 'Build' (dBA)**
NR9 (Kenwood Crescent Residential)	15	40 – 45	≥ 5	56
NR10 (Barker Drive Residential)	10	45 – 50	≥ 5	61
NR11 (Gore Road Library)	-	50 – 55	≥ 5	60
NR12 (Barker Drive Residential)	15	55 – 60	≤ 5	60
NR13 (McLean Court Residential)	12	50 – 55	≤ 5	55
NR14 (McLean Court Residential)	12	50 – 55	≤ 5	56
NR15 (Vacant Land-Potential Residential)	-	45 – 50	≤ 5	51

The results show that noise mitigation is required for certain NSA within the project corridor. Potential mitigation measures in this regard could include:

1. Changes to horizontal alignments: Horizontal changes in alignment can result in increases or decreases in sound levels at NSA by moving the roadway closer or further away. However, the changes that result are limited since the distance to the roadway must be doubled for a 3 dB to 5 dB decrease in sound level. This is not feasible at the project corridor as the alignment is constrained by the location and width of the existing rights-of-way, and by the proximate locations of the NSA.

2. Changes to vertical alignments: Vertical changes in alignment can affect sound levels at NSA by affecting the line-of-sight between the roadway sources and the receiver. Line-of-sight changes influence ground attenuation and barrier effects of the surrounding topography. For example, placing the roadway at the bottom of a shallow in-cut can create a natural barrier effect at the edge of the excavation. On the other hand, elevated roadways located on embankments or structures may also have reduced sound levels, as the structure can act as a barrier for ground level receptors, blocking the line-of-sight for roadway lanes on the 'far side' of the road from the receptor in question. However, these scenarios are not feasible at the project corridor as the alignment is constrained by the location and width of the existing rights-of-way, and by the proximate locations of the NSA.

3. Sound-reducing pavement: For vehicles travelling at highway speeds, the majority of the sound produced is due to interactions between the tires and pavement surface. Sound-reducing asphalts such as 'open-graded friction course' or 'stone mastic asphalt' may cost twice as much as conventional mixes, and by themselves, rarely achieve the required 5 dB reduction in sound level on their own.

4. Sound barriers: Barriers reduce sound levels at protected receptors by blocking the path of sound waves from the source towards the receiver, and by absorbing or reflecting the incident sound energy away. Therefore, a sound barrier must at least break the line-of-sight between the source (i.e. the roadway) and the NSA. Sound barriers, which can be formed of earthen berms, engineered walls, or a combination of the two, can achieve the required 5 dB reduction in sound level.

Based on the above and consistent with the Class EA, sound barriers are the preferred method of noise mitigation resulting from bridge use:

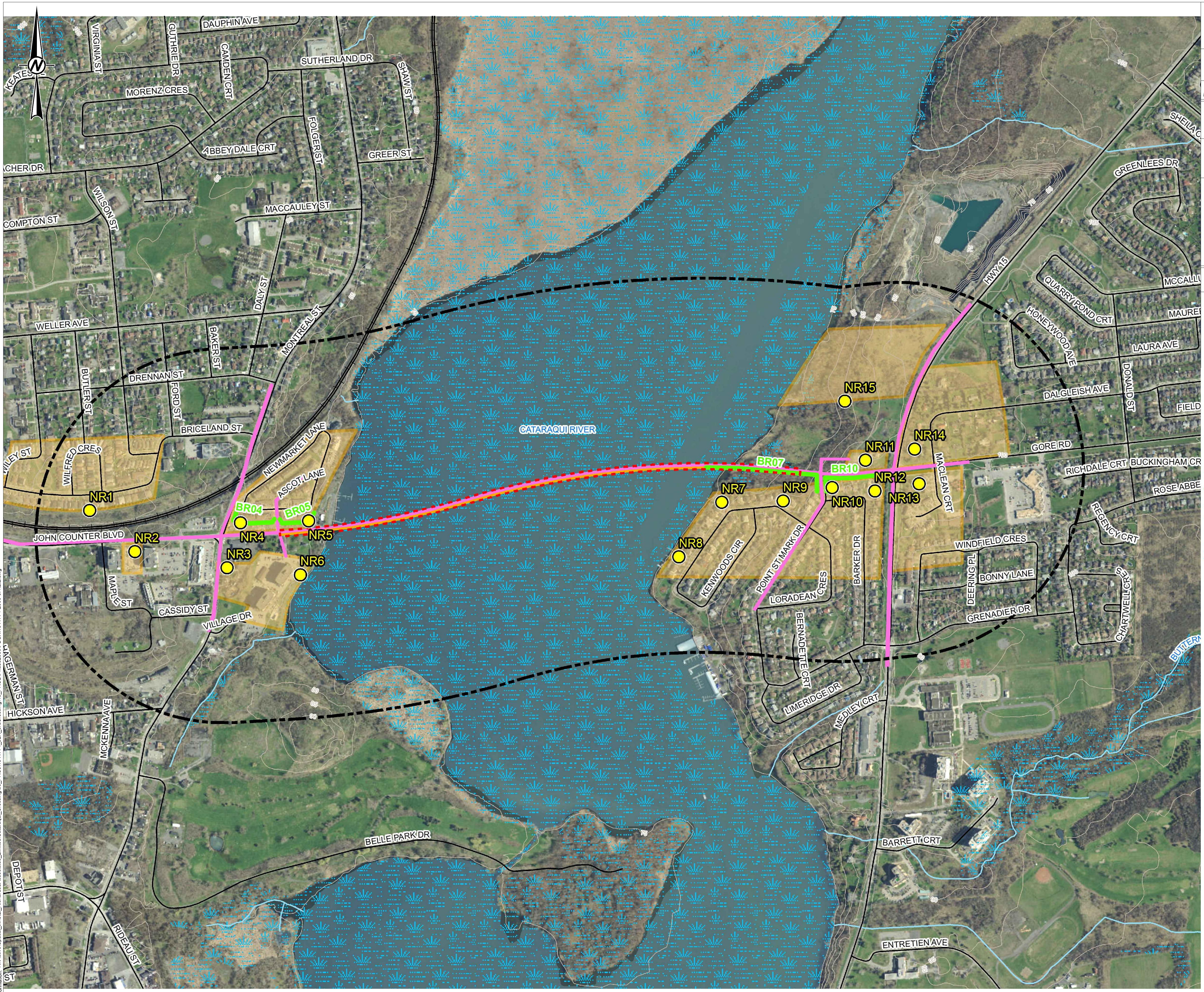
1. As shown on **Drawing 9.1.2.2**, regarding the use of sound barriers for the identified NSA on the west side lands:

   a) For Barrier BR04 (River Park Subdivision West) a 2.6 m high by 140 m long sound barrier wall, earthen berm or a combination is recommended on the north side of John Counter Boulevard up to Ascot Lane.

   b) For Barrier BR05 (River Park Subdivision East), a 2.6 m high by 113 m long sound barrier wall, earthen berm or a combination is recommended on the north side of John Counter Boulevard up to Ascot Lane.

2. As also shown on **Drawing 9.1.2.2**, regarding the use of sound barriers for the identified NSA on the east side lands:

   a) For Barrier BR07 (Kenwood Crescent Residential) a 1.5 m high by 340 m long sound barrier wall is recommended extending west from the south side of the Gore Road / Point St. Mark Drive intersection onto a portion of the bridge deck.



THIRD CROSSING OF THE CATARAQUI RIVER

PRELIMINARY DESIGN AND EIA REPORT

NOISE STUDY RESULTS (WITH BARRIERS)

Mark Van Buren, P.Eng *Director of Engineering and Deputy Commissioner*	Dan Franco, P.Eng. *Project Engineer*

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

PARSONS

Golder Associates

KINGSTON

Project No.:	27143
Drawing No.:	9.1.2.2
Sheet No.:	
Des: RT	Chk'd: JT
Dwn: JEM	Chk'd: BJV
Scale:	1:1,750
Utility Circ. No.	
Code:	
Load:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)

LEGEND

- NOISE SENSITIVE AREA
- ROADWAY
- RAILWAY
- WATERCOURSE
- TOPOGRAPHIC CONTOUR, metres
- FUTURE ASSESSED ROAD
- PROPOSED ACOUSTIC BARRIER
- MINNESOTA WALL 0.5 m
- WETLAND
- NOISE SENSITIVE AREA (NSA)
- PROJECT SITE (PROPOSED ALIGNMENT)
- AREA OF INVESTIGATION (500 m)

Plot Date: 4/28/2017 2:42:46 PM

b) For Barrier BR10 (Barker Drive Residential) a 2.75 m high by 205 m long sound barrier wall is recommended extending east from the south side of the Point St. Mark Drive / Gore Road intersection to Highway 15.

Generally, the sound barriers are limited to either within or along the boundary of the rights-of-way with limited return legs extending roughly perpendicular to the main lengths of the sound barriers beyond the right-of-way. As shown earlier on **Drawing 9.1.2.2**, a portion of Barrier BR07 on the east side lands is staggered, in that a portion of it is shifted from the north side of the multi-use path to the south side of the multi-use path ahead of the Gore Road / Point St. Mark Drive intersection. This layout, which should be further reviewed during the detail design phase, is recommended as part of the current project design phase for the following reasons:

1. It prevents an obstruction between the multi-use path and the Gore Road / Point St. Mark Drive intersection.

2. Typically, the boulevard on a road will slope from the property line to the road. If the sound barrier is placed on the south side, the design can maintain a standard drainage pattern from the barrier back to the curb. If the sound barrier is completely on the north side of the multi-use path, then the design would have to slope runoff south from the barrier down the slope. This is not ideal from a stormwater management perspective.

In addition, it is also anticipated that the bridge may serve as an emergency detour route for Highway 401, should an accident or event cause it to be closed in the vicinity of Kingston. In this instance, traffic volumes on the bridge can be expected to increase, likely to the point of causing congestion and reduced vehicle speed since the bridge would be exceeding its capacity. Such congestion events generally produce reduced sound levels from road traffic since wheel sound is largely limited by the reduced speed of the vehicles. Normally, wheel sound created by the interaction of tires with the road surface creates a large portion of traffic sound levels, which tends to increase with increasing speed. As a result, emergency detours over the bridge are expected to produce lower sound levels than under more free-flow conditions. This could also extend to emergency situations on the bridge itself, which are expected to result in decreased sound levels due to restricted traffic movements.

Finally, sound from bridge construction activities would also be generated at the project corridor, which will be temporary and vary temporally and spatially as construction progresses. Sound levels from construction at a given NSA will also vary over time as different activities take place and change location. Though construction sound would be largely unavoidable, the use of construction grade noise attenuation measures as well as adherence to guideline and Code of Practice requirements will be critical to minimize potential effects on NSA. In this latter regard, the City Noise By-Law (No. 2004-52), as amended, prohibits the following:

1. The operation of any item of construction equipment without an effective exhaust muffling device that is in good working order and in constant operation.

2. The operation of construction equipment or performing any action relating to construction between 1900 hours (7:00 PM) of one day to 0700 hours (7:00 AM) of the next day, with no construction on Sundays and statutory holidays.

However, it is also important to note that under Schedule 'C' to the City Noise By-Law, the operation of municipal and utility service vehicles and related equipment is exempt, which could apply to bridge construction activities. Despite this, a protocol has been put in place for other past major municipal infrastructure projects to notify the City in advance if the Contractor has deemed it necessary to perform construction works outside of the allowable time periods listed above. This protocol has given the City the opportunity to consider whether any conditions should be imposed on proposed works.

Furthermore:

1. As shown in **Table 9.1.2.3**, the MOECC Model Municipal Noise Control By-Law (NPC-115) stipulates the following sound emissions limits from individual items of construction equipment:

Table 9.1.2.3: Construction Equipment Sound Emission Levels

Type of Unit	Maximum Sound Level (dBA)	Distance From NSA (m)	Power Rating [kilowatt (kW)]
Excavation Equipment	83	15	less than 75 kW
	85	15	more than 75 kW
Pneumatic Equipment	85	7	not applicable
Portable Compressors	76	7	not applicable

2. The MOECC Publication NPC 119 on blasting also sets blast vibration limits, as shown below in **Table 8.1.2.4**:

Table 9.1.2.4: Maximum Blast Vibration Levels

Vibration Source	Cautionary (Unmonitored Blasts)	Peak (Monitored Blasts)
Concussion (air overpressure)	120 dB	128 dB
Ground-borne Vibration	1 centimetre / second (cm/s)	1.25 cm/s

(B) Noise Impact Assessment on Terrestrial Wildlife

Noise can negatively affect wildlife by: causing loss of hearing sensitivity, either temporarily or permanently; increasing stress levels by altering the production of stress hormones, causing negative physiological effects to cardio-vascular systems; masking important signals from predators or prey; and interfering with acoustic communications, which can further interfere with mating or how animals select foraging locations. Wildlife responses to noise is usually related to the type of noise, the sound level, the frequency structure of noise relative to the hearing ability of the animal, and the distance of the noise source from the animal.

Based on the fieldwork activities undertaken during the Class EA, 59 bird species and one snake species were identified as species of interest for the noise impact assessment on terrestrial wildlife[8]. Birds are a keystone species used to describe the effects of human-generated noise on wildlife. This is due to the fact that the inner structures of all vertebrate ears are similar; birds and humans share many of the same environments; and the hearing range of birds and humans is also similar. On the other hand, snakes have long been considered deaf or insensitive to sound because they lack outer ears. However, recent research has demonstrated that: snakes perceive sound as well as vibration through their skin cells (also known as somatic hearing) and inner ear; and bird and reptile hearing share a number of similarities.

With the above context in mind:

[8] The potential noise impacts on turtles are addressed later in this Report.

1. A similar approach has been used to guide the assessment of noise impacts from bridge construction on birds and snakes, namely:

   a) In-air acoustic sound propagation was calculated using JASCO's Impulse Noise Propagation Model (INPM)[9]. The INPM has conservatively assumed that bridge construction would be facilitated by impact pile driving activities, as this method generates more in-air noise than either vibratory pile driving or rock socket drilling.

   b) The modelling location within the project corridor was roughly centered between the west shore and the mid-point of the Cataraqui River, where the in-river sediment is thickest (and which could require more pile driver strikes), and the typical nesting and perching habitat associated with the visible cattail portion of the Greater Cataraqui Marsh north of John Counter Boulevard is most proximate.

The results indicate the following:

1. Overall, the risk of auditory injury to birds and snakes due to impact pile driving is low, but not negligible:

   a) Auditory injury in birds could occur at levels about 125 dBA, which corresponds to a location within 20 m of the pile driving location.

   b) Auditory impairment in birds could occur at levels greater than 93 dBA, which corresponds to a maximum distance of 113 m from the pile driving location.

   c) Auditory masking and behavioural disturbance could occur at levels greater than 55 dBA, which corresponds to a maximum distance of 2.3 km from the pile driving location.

   d) Auditory impairment in snakes could occur at levels greater than 104.5 dBA, which corresponds to a maximum distance of 37 m from the pile driving location (i.e. close to shore).

   Despite the above however, it is equally critical to note the following:

[9] The INPM computes acoustic fields by modelling transmission loss along evenly spaced radial traverses covering a 360 degree swath from the source.

a) The preferred method for pile installation is drilling, not impact pile driving, which generates noise emissions below established thresholds.

b) Additional proposed mitigation measures discussed later in this Report will either further reduce or eliminate potential negative effects.

2. The potential effects of traffic noise from bridge operations have only been considered for birds, since the available information on received sound levels was restricted to ambient-weighted metrics which, although applicable to birds, is not appropriate to assess the hearing sensitivity of snakes. With this in mind, the results indicate the following:

a) Similar to humans:

i. auditory injury to birds is not expected to result from traffic noise exposure since anticipated sound levels will not exceed levels that are considered high enough to cause injury even at very close distances from the sound sources; and

ii. although auditory impairment to birds could occur when received sound levels exceed 93 dBA, this level is unlikely to be reached anywhere within or near the project corridor.

b) Anticipated traffic noise is in frequencies that hearing for both birds and humans will be unaffected. Furthermore, the aforementioned proposed transportation noise mitigation measures which would lower the potential risk of noise impact on humans would similarly lower the potential risk of noise impact on birds.

3. Potential Viewscape Effects

The bridge represents a major piece of infrastructure at the project corridor. As such, its on-land visual impacts on the community and Canal would not be completely eliminated. Therefore, in light of the DIA scope and surrounding contextual landscape, it is critical that the project design not only accommodate existing topographic conditions on-shore, but also mitigate on-land visual impacts.

Based on the key viewshed limits at the project corridor and surrounding area:

1. As shown earlier on **Figure 4.4.1**, the project corridor is not visible from Highway 401.

2. **Figure 8.1.1**, which provides a bridge profile view from the Elliott Avenue Parkette on the west side of the Cataraqui River, shows the gradual rise in bridge clearance over the water west-to-east that remains at or below the tree line on the east side of the river.

3. **Figure 8.1.4**, which provides a bridge profile view from the Point St. Mark residential neighbourhood on the east side of the Cataraqui River during winter, shows the gradual descent in bridge clearance over the water east-to-west and its integration into the urban landscape on the west side of the river, with the Village On The River Apartments and John Counter Place noted prominently in the background. It should also be noted that the landscape improvements on the west side lands provide an opportunity for the bridge to be below the 'future' tree line in this area when viewed during non-winter periods from both the water and land on the east side.

9.2 The In-Water Effects

As discussed below, prior to mitigation, the project has the potential to negatively impact the natural and cultural heritage of the marine environment during the construction and operation phases. These potential project effects are outlined below. In certain cases, specific DIA area conditions or project design mitigation considerations are discussed for ease of reference.

1. Potential Effects on Marine Archaeological Resources

As noted earlier, no in-water cultural heritage materials were located as part of the fieldwork during the Class EA or current project design phase. The paleo-environment of the project corridor is a 'marsh environment', akin to its designation as the Greater Cataraqui Marsh PSW. As such, the project corridor exhibits a low archaeological potential for encountering either prehistoric or historic cultural remains. This should not be interpreted to mean however, that marine archaeological resources are not present within the project corridor, and will not be potentially encountered during the construction and operation phases of the project.

2. Potential Effects on River Hydrology

The installation of piers could change water levels and flows. This is due to the partial blockage of water flow from the in-water works which causes upstream water levels to increase to force the flow through the restricted openings and around the obstructions. Typically, hydraulic bridge design is based largely on the flow-generated conditions at the bridge location, as these conditions generate the largest local velocities. Though wind speed and water flow velocities vary within the watercourse over time, as previously noted, the lower Cataraqui River reach is not a typical reach, in that it is wide and flow-generated velocities, especially at the project corridor, are low, at roughly 0.4 m/s. As such, the physical characteristics of the lower Cataraqui River reach are similar to a lake-like setting.

Due to the reduced importance of the hydrologic conditions at the project corridor, six environmental forcing scenarios reflecting a range of temporal changes in water flow and wind speeds were modeled during the Class EA phase to assess potential project impacts from the v-piers on river hydrology. The scenario conditions are summarized in **Table 8.2.1**.

Table 9.2.1: Class EA Hydraulic Modelling Scenarios			
Scenario	**Water Flow (m^3/s)**	**Wind Speed (m/s)**	**Wind Direction**
High (100 Year) Condition	50	20	North
Moderate I Condition	50	4.5	North
Moderate II Condition	10	20	North
Moderate III Condition	10	4.5	North
Moderate IV Condition	4.5	20	South
Low Condition	0	4.5	North

The modelling results generally show that the worst case scenario is the 'High (100 Year) Condition' model. Under this scenario, the piers would generate the most impact on water levels and flow-generated velocities. But these impacts are considered minor and localized, especially in light of the current design optimizations in support of the inverted U-frame pier design, in that:

1. The highest increase in water levels was modeled to be only 4 mm in the vicinity of the v-piers, which was due to the resistance to flow generated by the piers and the increase in flow-generated velocity between the v-piers. In addition, the highest increase in flow-generated velocity was modeled to be only 0.035 m/s, which was found between the spans of each V-pier. It is anticipated that these minimal impacts will be reduced even further with the inverted U-frame pier design, given that the comparative in-water footprint has been reduced from 5,000 m^2 to 4,200 m^2 through design optimization.

2. The above-noted impacts would be under worst case conditions, which would not be expected to persist for any significant period of time. As such, flow-generated velocities and their related effects would be reduced even further under more normal conditions.

In addition, general and local scour estimates were prepared based on the hydraulic modelling and as per the CHBDC requirements with guidance from MTO's Drainage Management Manual. Given the width of the watercourse and limited flow-generated velocities at the project corridor, the general scour estimates are in the order of 2 N/SM, which is considered negligible. In terms of local scour, estimates suggest a local scour depth allowance of 7.5 m. This potential undermining of the pier footings would be prevented if the piles were socketed directly into the bedrock.

Finally, the potential for any of the bridge concepts to influence ice jamming on the Cataraqui River is also considered to be negligible. As stated earlier, the ice generally melts in place due to the limited flow-generated velocities. This is not expected to change with the construction of the bridge.

Floodplain compensation management is prescribed by the Cataraqui Conservation Authority (CRCA) and filling within the floodplain is not encouraged. Construction of the bridge will involve impacts in the floodplain due to installation of the piers as well as near shore activities. The modification of the pier structure from V-shape to inverted U-shape has reduced the footprint substantially, but the impacts on the floodplain cannot be completely eliminated. On land, there is a balance between accommodating existing near shore underground infrastructure, necessary new stormwater management features, maintaining similar public access to the waterfront, providing an accessible pathway networks with gentle slopes and placement of the bridge abutments. Infringing into the floodplain on land is necessary in a limited sense.

The CRCA has stated that the Cataraqui River floodplain elevation is recognized at the 76.3m elevation. In addition, the 100 year water level elevation is at 76.0 m and a 0.3 m wave uprush is recognized as the difference in between these two elevations. The CRCA has communicated that, within the Cataraqui River at the proposed location of the bridge, there is no floodplain compensation required above the 76.0 elevation.

Further discussions have identified that within the Cataraqui River floodplain and upstream of the proposed bridge corridor there are limited opportunities for floodplain compensation to make up for limited filling of the floodplain. However, in this area, the impact of limited filling is minimized by the types of natural and built environment that could potentially be affected. In essence, between the bridge location and Kingston Mills Locks, examples of areas that could be potentially affected would be the built up areas along the CN rail and Highway 401 corridors and the natural wetland vegetation found throughout this area.

Permanent bridge piers and associated rock scour protection that may be required will potentially amount to 3000-4000 m^2 of impacted floodplain area. On shore, within the current design, 1000-2000 m^2 of impacted floodplain is expected. With modifications to the design near the waterfront, it is possible that the total impact on east and west shorelines could be reduced to less than 1000 m^2. Therefore, in total, the impacted area is predicted to be less than 5000 m^2.

To establish the amount of impact, the CRCA has suggested that a reasonable exercise during ongoing design would be to undertake a minor Hydrology and Hydraulics review to demonstrate that the proportionately small 5000 m^2 impact area within a (greater than) 1.5 million m^2 upstream area is demonstrated to be during the infrequent flood event.

Lastly, fluctuating water levels in the Great Lakes and St. Lawrence River due to the adoption of Plan 2014 by the International Joint Commission, in comparison to the infrequent occurrence of impacted floodwaters caused by the limited infilling described above, may be expected to be of greater concern.

3. Potential Effects on Watercraft Navigation

As noted earlier, the bridge clearance above the water is 12 m over the navigable channel and adjacent rowing lanes. This exceeds the 6.7 m Federally regulated navigable requirement for the Canal. In addition, the 145.6 m arch span pier-to-pier over the navigable channel provides unencumbered through-navigation for the rowing course. However, proper advance safety mitigation measures, in conjunction with required regulatory approvals, will be required to protect the public in support of any bridge construction or subsequent maintenance activities that may need to occur over the navigable channel or adjacent rowing lanes during the navigation season.

4. Potential Effects on Geophysical Conditions

For seismic design purposes, Kingston is listed in Table A3.1.1 of the CHBDC and falls in an Acceleration-related seismic zone (‘Za’) of 2 and a Zonal acceleration ratio of 0.10. Assuming the bridge would be classified as a ‘Lifeline’ bridge, the seismic performance zone would be 3 based on the CHBDC. The Site Coefficient (‘S’) for the project corridor, also based on the CHBDC, may be taken as 1.5, which is consistent with Soil Type III, due to the deep clay deposit within the Cataraqui River.

Under the design earthquake condition, the silty clay soil and glacial till soil at the project corridor are not considered to be susceptible to liquefaction. This is because of their relatively high fines contents and plasticity. But the layer of organic soils below the river mudline is considered to be susceptible to liquefaction under the design earthquake condition. Provided the bridge structure is founded on bedrock, no adverse impact on the post-liquefaction capabilities of the bridge foundation is anticipated. Furthermore, provided that the approach embankment side slopes are maintained no steeper than 2H:1V, the embankments should have an adequate minimum required factor of safety of greater than 1.3 under static conditions and 1.1 under seismic loading conditions.

In addition, as discussed earlier, there are two possible in-water fault zones within the project corridor where low resistivity is observed within the bedrock beneath the river, centered at distances of 320 m and 970 m. These areas are most likely associated with the Frontenac Axis. The bedrock cores recovered from boreholes within these zones do not suggest that the boreholes were drilled through a historical fault. However, bridge foundation construction may encounter a fault or highly fractured bedrock within these zones or closer to the shorelines at a transition from the gneissic bedrock in the Cataraqui River to the limestone bedrock at the east shore and the dolostone bedrock at the west shore. At these locations, the design may require modification to accommodate a reduced axial geotechnical capacity, either with deeper rock sockets or through the use of post-grouting to improve the side wall shear resistance.

Finally, in regards to other bridge foundation design considerations, the potential geophysical effects are as follows:

1. In terms the in-water bridge foundations, due to the significant length of the caissons required to reach the bedrock and depth below the Cataraqui River, it may not be feasible

to dewater and clean the base of the caisson and, as such, full end-bearing support may not be developed. Thus:

a) The axial geotechnical resistance for rock socketed caissons would need to be based on the side-wall (shaft) resistance of the rock socket, rather than end-bearing.

b) The use of a liner or casing would also be required to advance the caissons through the overburden with minimal loss of ground. The casing should be extended so that it is seated a minimum of 300 mm into the bedrock.

c) Casing installation through the glacial till containing cobbles and boulders (where encountered) may be difficult. Churn drilling and possibly rock coring techniques would be required to advance the caissons through potential boulder deposits. Moreover, since the bedrock at the project corridor is strong-to-very-strong, the caisson sockets would likely have to be advanced by rock coring (and possibly supplemented with a down-hole hammer) and/or chisel drilling.

2. The in-water test holes put down as part of the current project design phase were advanced at selected pier locations based on the previous 14-span V-pier arrangement. As discussed earlier, the refined bridge arrangement maintains the same abutment locations and overall bridge length, but now comprises 19 inverted U-frame piers. As such, most of the test holes are no longer within the footprint of the inverted U-frame pier locations. Though the relevance and applicability of the geotechnical assessments to the refined bridge arrangement is re-confirmed, additional field investigations should be carried out during the detail design phase to confirm bedrock surface elevation and founding soil and bedrock conditions at the proposed U-frame pier locations.

5. Potential Effects on Substrate Disturbance

Should in-river sediment material be brought to land during construction, the portion taken at depths greater than 1.3 m below the top of the sediment does not meet MOECC Table 1 (R/P/I/I/C/C) standards for metals. Bridge construction activities will disturb this substrate. If proper mitigation measures are not in place, this disturbance could cause sediment re-suspension, the dispersion of associated contaminants, potential changes in sedimentation dynamics, and increased turbidity in the water column.

6. Potential Effects on Fish and Fish Habitat

In-water bridge construction activities could potentially lead to: i) restriction of fish movement; ii) species mortalities or avoidance of the area; iii) the loss of aquatic vegetation and fish habitat; iv) erosion along the shoreline; v) the spread of invasive species from vessels brought in from areas outside the Great Lakes system; and vi) accidents and malfunctions from equipment use. It is the cumulative effect of all of these potential impacts which can result in a 'Harmful Alteration Disruption or Destruction' (HADD) to fish and fish habitat.

The Class EA context in which dredging was recommended as the preferred in-water bridge construction option has subsequently evolved, as highlighted below:

1. UK confirmed an alternative route for the proposed watermain that was originally intended to be located within the dredged channel.

2. Based on more in-depth fieldwork activities, the composition of the dredgeate could lead to severe suspension and sloughing of in-river sediment during construction; and changes in sediment dynamics and increased turbidity in the water column after construction.

3. Critical outcomes from specific consultations with Parks Canada during the current project yielded the following:

a) The context of the bridge corridor within the Greater Cataraqui Marsh PSW ecosystem, particularly its role as a coastal wetland, and its status as one of Parks Canada's larger protected heritage areas.

b) The proposed 4.3 ha impact area from the dredging option, which is significantly larger than the proposed 0.6 ha impact area from the temporary work bridge option. Furthermore, the impact area from the temporary work bridge option would be a patchwork of small areas that cumulatively add up to 0.6 ha, as opposed to a large linear area. Targeted dredging will still be required at each pier location, but the overall impact footprint will still be significantly minimized. As such, these smaller patches would be anticipated to rebound faster post-disturbance, and will not pose a barrier to habitat access.

c) With minimal anticipated impacts on habitat fragmentation and no expected long term changes to sediment dynamics or turbidity, the lower risk concerning the potential long-term effects from the temporary work bridge option on the Cataraqui River substrate, vegetation, habitat and water quality.

Based on the above considerations as well as the aforementioned extensive bridge constructability assessments by the JLR Project Team in consultation with City staff, the current project is recommending the temporary work bridge as the preferred in-water bridge construction option, which as noted earlier, is supported by Parks Canada.

In addition, regarding the permanent bridge:

1. Although the span arrangement would increase from 14-to-19-spans, the overall environmental footprint from the U-frame piers would still be lower compared to the initial V-pier design.

2. The bridge deck would ultimately have a total shore-to-shore area of approximately 20,000 m^2.(measured abutment to abutment) In addition to the use of the bridge, in order to ensure its long term safety and viability, operational maintenance will also be required. With these factors in mind, the potential direct impacts associated with bridge operations could include: i) the loss of aquatic vegetation and fish habitat due to shading from the bridge; and ii) accidents and malfunctions from bridge operations and maintenance. These impacts are considered minor relative to the following:

   a) The bridge clearance above the water, which as noted earlier, is approximately 4 m near its westerly portion and then gradually rises to over 11 m over the navigable channel and then descends to approximately 9 m at the east shore, should contribute only partial bridge deck shading on the marine environment.

   b) The proper safety mitigation measures that will be put in place by the City to address accidents and malfunctions from bridge operations and maintenance.

7. Potential Noise Effects on Marine Wildlife

The aforementioned negative effects of noise on terrestrial wildlife are equally applicable to the marine environment (i.e. loss of hearing sensitivity; increased stress levels by altering the production of stress hormones; masking important signals from predators or prey; and interfering with acoustic communications). As such, based on the fieldwork activities undertaken during the Class EA, 24 fish species and five turtle species were identified as species of interest for the noise impact assessment on marine wildlife. The goal of this assessment was to predict the extent of ensonification from pile driving and assess the potential effects on fish, turtles, fish eggs, and fish larvae from underwater noise, based on currently applied sound level thresholds for auditory injury and behavioural disturbance. The supporting report is included in **Appendix N**.

Fish are classified based on their hearing capabilities, which are typically determined by whether a swim bladder is present and, if it is, whether it is directly involved in hearing. All of the fish species present within the project corridor have swim bladders and many have additional adaptations that provide pressure sensitivity and extend the hearing frequency range. In addition, recent research on sea turtles suggested similar criteria and thresholds to fish. This Report acknowledges there are no sea turtles present within the project corridor, but no other criteria are available for turtles exposed to sound underwater.

With the above context in mind, a similar approach has been used to guide the assessment of noise impacts from bridge construction on birds and snakes, namely:

1. Acoustic sound propagation was calculated using JASCO's Pile Driving Source Model (PDSM)[10] and Full Waveform Range-dependent Acoustic Model (FWRAM)[11] to estimate sound levels that would be radiated into the environment by impact pile driving activities and the propagation of sound through the water column and riverbed.

2. The PDSM and FWRAM have conservatively assumed that bridge construction would be facilitated by impact pile driving activities, as this method generates more in-air noise than either vibratory pile driving or rock socket drilling.

3. The modelling location within the project corridor was roughly centered between the west shore and the mid-point of the Cataraqui River, where the in-river sediment is thickest (and which could require more pile driver strikes), and the typical nesting habitat associated with

[10] The PDSM is a physical model of pile vibration and near-field sound radiation which is used in conjunction with wave equation modelling to obtain an equivalent pile source signature consisting on a vertical array of discrete point sources.

[11] The FWRAM is a time-domain acoustic model that determines received levels as a function of depth, range and azimuth. It accepts as input a PDSM-generated array of point sources representing the pile and computes synthetic pressure waveforms via Fourier synthesis, from which several metrics – sound pressure level, peak pressure level and sound exposure level – can be obtained.

the visible cattail portion of the Greater Cataraqui Marsh north of John Counter Boulevard is most proximate.

The results indicate the following:

1. The peak pressure thresholds for mortal and recoverable acoustic injury to fish and for mortal injury to fish eggs, fish larvae and turtles occurred within 2 to 3 m of the source.
2. The sound-exposure-level-over-24-hour thresholds for mortal acoustic injury to fish (with a swim bladder), fish eggs, fish larvae and turtles occurred within 5 to 6 m of the source.
3. The sound-exposure-level-over-24-hour thresholds for recoverable acoustic injury to fish (with a swim bladder) occurred within 7 m of the source.
4. Turtles within tens of metres of the pile are at high risk of recoverable injury, and fish eggs and larvae are at moderate risk of recoverable injury within this range. The relative risk is low for distances of hundreds-to-thousands of metres.
5. Adult fish with a swim bladder (either involved or not involved in hearing) and turtles are at high risk of behavioural disruption within tens of metres of the pile.
6. Larval fish are at moderate risk of behavioural disruption within tens of metres of the pile.

Despite the above however, it is equally critical to note the following:

1. The preferred method for pile installation is drilling, not impact pile driving, which generates noise emissions below established thresholds. Additional proposed mitigation measures discussed later in this Report will either further reduce or eliminate potential negative effects.
2. The riverbed bathymetry and its compositional properties are the most important environmental factors governing propagation of sound from pile driving activities. A portion of the sound generated from the driven pile is radiated directly into the riverbed, and in such a shallow environment, there are multiple sound wave bottom interactions or ‘bounces’. Thus, sound transmission into deeper sediment and rock layers and attenuation within the riverbed becomes significant loss factors for waterborne energy. Since the top sediment layer at the riverbed surface is composed of fine, water-saturated sediments, it allows for a high penetration of acoustic energy, which provides effective noise attenuation.
3. Underwater vegetation is also present throughout the water column, which can play a role in both scattering and attenuating sound.

8. Potential Viewscape Effects

Similar to the potential on-land visual impacts from the bridge, the potential on-water visual impacts would also not be completely eliminated. Therefore, in light of the DIA scope and surrounding contextual landscape, it is equally critical that the project design not only accommodate Federally regulated navigable requirements, but also mitigate on-water visual impacts.

Based on the key viewshed limits at the project corridor and surrounding area:

1. As shown earlier on **Figure 4.4.1**, the project corridor is not visible from the water at or near Highway 401 and, as such, the visible cattail marsh, near continuous overhanging tree canopy and shrub understory would still dominate the natural landscape.
2. **Figure 8.1.2** shows that as boaters proceed southward at roughly 1 km north of the Inner Harbour entrance near Belle Island and enter the open vista of the Cataraqui River, the bridge would be in full view along with the City’s emerging urban landscape, but most of the rising silhouette of the bridge would be below the tree line along the north shore of Belle Island and Belle Park. Furthermore, **Figure 8.1.3** shows contemporary and elegant roadway lighting with accent lighting that highlights key bridge corridor components in a subtle, yet aesthetically pleasing effect at night.
3. As discussed earlier, views of the project corridor south of Belle Island are blocked by the tree line along the northern portion of Belle Park and Belle Island as well as by the extension of the eastern shoreline whereon the Gore Road Library, Point St. Mark residential neighbourhood and Rideau Marina are located. Views of the project corridor are similarly blocked by these features for boaters proceeding from the LaSalle Causeway northward. This includes the protected views related to Fort Henry and Kingston fortifications in the southern portion of the DIA area.

   Figure 8.1.6 shows that as boaters proceed northward from the LaSalle Causeway and round the tip of Belle Island at roughly 1 km south of the project site location, the sense of the urban-to-natural landscape transition begins with all but the east end of the bridge being visible (the east end is blocked from view by the Rideau Marina and shoreline) and its rising silhouette either at or below the tree line of the natural landscape that emerges in the background further north.

9.3 The Carbon Life Cycle Assessment

One of the main objectives of the Sustainability Charrette was to establish sustainability priorities for this project. This objective reflects the role of sustainable development in the City as a critical lens through which development in general, and this project in particular, must proceed.

The Project Team conducted a Carbon Life Cycle Assessment (LCA) focusing on mitigation measures resulting from anticipated energy use and greenhouse gas (GHG) emissions outputs from the construction phase of the project. Granted, it is acknowledged that a whole-project LCA would estimate carbon emissions caused by materials extraction and processing, transportation of materials to be used during construction and operation, and project maintenance and operation, including vehicle traffic. Although the boundary of this LCA is limited to the construction phase, its relationship to a whole project LCA has also been explored to demonstrate context and relationship of this analysis to the energy and carbon impacts that may be performed for other phases of the project.

The LCA is summarized below. The full LCA report is included in **Appendix O.**

The United States Federal Highway Administration (FHWA) Infrastructure Carbon Estimator (ICE) tool was selected for the LCA because it provides approximate energy use and emissions outputs for projects that have not progressed to more detailed levels of design and construction planning[12]. All available facility and project types in the ICE tool are shown in **Table 9.3.1**, with ones applicable to this project highlighted in green boxes.

Table 9.3.1: FHWA ICE Tool Facility and Project Types

Category	Facility Type	Project Type
Roadways	Rural interstates Rural principal arterials Rural minor arterials Rural collectors Urban interstates / expressways Urban principal arterials Urban minor arterials / collectors	Roadway construction: • New facility • Re-alignment Construct additional lane: • Lane widening • Shoulder improvement Roadway rehabilitation • Re-construct pavement • Resurface pavement
Parking	Surface parking Structured parking	New construction
Bridge Structures	Single-span Two-span Multi-span (over land) Multi-span (over water)	New construction Reconstruction Land addition
Rail	Light rail Heavy rail Rail station	New construction (underground) New construction (elevated) New construction (at grade) Convert / Upgrade existing facility
Bus Rapid Transit (BRT)	BRT lane or right-of-way BRT station	New construction Convert / Upgrade lane
Bicycle	Off-street paths On-street bicycle lanes	New construction Replacing Restriping (on-street)
Pedestrian	Off-street paths On-street sidewalks	New construction Replacing Restriping (off-street)

[12] FHWA's ICE tool is designed to allow users to create ballpark estimates of energy and greenhouse gas emissions using data collected from state transportation departments, a nationwide database of construction bid documents, and consultation with transportation engineers and lifecycle analysis experts. The calculation methodologies, including energy and emissions factors embedded in the tool are based on empirical data gathered from a broad sample of projects throughout the United States.

The LCA results are expressed with an upper and lower limit to the energy and emissions calculation. The upper limit (or Unmitigated) result represents the energy consumption and emissions associated with standard practice [i.e. the worst case scenario as informed by Ontario Province Standard Specifications (OPSS)]. The lower limit (or Mitigated) result represents the energy and emissions calculated when various mitigation strategies have been applied. None of the mitigation strategies pose a risk to the structural performance of the bridge.

The Unmitigated and Mitigated condition assumptions are described below and summarized in **Table 9.3.2**. **Table 9.3.2** also summarizes the ICE Threshold condition assumptions:

1. The OPSS do not address the use of hybrid or biofuel construction vehicles. Therefore, the Unmitigated condition assumes that 0% of construction vehicles will be hybrid, use B20 fuel, use B100 fuel, or be combined hybrid / alternative fuel vehicles. The Mitigated condition was assumed, conservatively, to be 10% use of each vehicle type.

2. At this current project design phase, it has not been determined how much cold-in place recycling or full-depth reclamation of existing roadway will be used. The Unmitigated condition was therefore assumed to be 0% and the Mitigated condition was assumed to be 50%.

3. Warm Mix Asphalt (WMA): The MTO specified 10% WMA on all of its contracts in 2011. For the Mitigated condition, it is assumed that in 2018 it will be possible to use at least 20% WMA.

4. The OPSS state that values up to a certain percentage of Reclaimed Asphalt Pavement (RAP), Recycled Concrete Material (RCM), and cementitious material substitutes are allowed, which means that the minimum amount of recycled and reclaimed materials that would be incorporated into a standard project is 0%. This was used as the Unmitigated condition, or the worst case energy and emissions scenario for the incorporation of recycled and reclaimed materials.

Table 9.3.2: Emissions Mitigation Practices

Strategy	Unmitigated	Mitigated	ICE Threshold
Alternative Fuels and Vehicle Hybridization:			
Hybrid construction vehicles and equipment – as a percentage of all construction vehicles/equipment	0%	25%	44%
Switch from diesel to B20 in construction vehicles and equipment – as a percentage of total fuel used by construction vehicles	0%	10%	100%
Switch from diesel to B100 in construction vehicles and equipment – as a percentage of total fuel used by construction vehicles	0%	10%	100%
Combined hybridization/B20 in construction vehicles and equipment – as a percentage of all construction vehicles/equipment	0%	10%	44%
In-Place Roadway Recycling:			
Cold In-place recycling – the percentage of total roadway resurfacing and BRT conversion lane miles that are resurfaced using cold in-place recycling	0%	50%	99%
Full depth reclamation – the percentage of total roadway resurfacing and BRT conversion lane miles that are reconstructed using full depth reclamation	0%	50%	99%
Warm Mix Asphalt:			
Warm Mix Asphalt – the percentage by mass of warm mix asphalt used in the project	0%	20%	100%
Recycled and Reclaimed Materials:			
Use recycled asphalt pavement as a substitute for virgin asphalt aggregate – the percentage by mass of recycled aggregates used in the project	0%	25%	25%
Use recycled asphalt pavement as a substitute for	0%	30%	40%

Table 9.3.2: Emissions Mitigation Practices

Strategy	Unmitigated	Mitigated	ICE Threshold
virgin asphalt bitumen – the percentage by mass of bitumen used that comes from recycled asphalt pavement			
Use industrial byproducts as substitutes for Portland cement – the percentage by mass of Portland cement substitutes are used (e.g. fly ash, blast furnace slag, silica fume)	0%	25%	33%
Use recycled concrete aggregate as a substitute for base stone – the percentage by mass of aggregate that comes from recycled concrete	0%	50%	100%

Energy use and greenhouse gas emissions were measured in millions of British Thermal Units (MMBTU) and metric tons of carbon dioxide [CO_2 equivalent (MT CO_2e)], respectively. The energy and emissions savings associated with each mitigation strategy were first evaluated separately and then a combined impact was calculated, as shown in the scenarios below:

1. Scenario 1: Unmitigated Baseline Performance
2. Scenario 2A: Mitigated (Alternative Fuels Only)
3. Scenario 2B: Mitigated (In-Place Roadway Recycling Only)
4. Scenario 2C: Mitigated (Warm Mix Asphalt Only)
5. Scenario 2D: Mitigated (Recycled and Reclaimed Materials Only)
6. Scenario 3: Mitigated (All Mitigations Combined)

The Unmitigated, or worst case scenario energy and GHG emissions outputs are summarized in **Table 9.3.3** and **Table 9.3.4**, respectively.

Table 9.3.3: Unmitigated Construction Phase Energy Use

Energy (MMBTU)	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total
Upstream: Materials	1,505	1,508	13,787	3,487	20,287
Direct: Construction Equipment	618	412	5,501	584	7,115
Total	2,123	1,920	19,288	4,071	27,402
Percent Contribution	7.7%	7.0%	70.4%	14.9%	-

Table 9.3.4: Unmitigated Construction Phase GHG Emissions

GHG Emissions (MT CO2E)	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total
Upstream: Materials	96	97	1,405	201	1,799
Direct: Construction Equipment	45	30	401	43	519
Total	141	127	1,806	244	2,318
Percent Contribution	6.1%	5.5%	77.9%	10.5%	-

A summary of the energy and GHG emissions outputs of the Unmitigated condition, each individual Mitigation category, and the impact of all Mitigations combined are summarized in **Table 9.3.5** and **Table 9.3.6**, respectively.

Table 9.3.5: Energy Use and Percentage Savings by Mitigation Scenario

Energy (MMBTU)	Unmitigated	Alternative Fuels	In-Place Road Recycling	Warm Mix Asphalt	Recycled / Reclaimed Materials	Combined Mitigations
Upstream: Materials	20,287	20,287	20,261	20,232	16,571	16,489
Direct: Construction Equipment	7,115	7,449	6,975	7,115	7,115	7,303
Total	27,402	27,736	27,236	27,347	23,686	23,792
Percent Savings	-	-1.2%	0.6%	0.2%	13.6%	13.2%

Table 9.3.6: GHG Emissions Outputs and Percentage Savings by Mitigation Scenario

GHG Emissions (MT CO2E)	Unmitigated	Alternative Fuels	In-Place Road Recycling	Warm Mix Asphalt	Recycled / Reclaimed Materials	Combined Mitigations
Upstream: Materials	1,799	1,799	1,797	1,794	1,519	1,512
Direct: Construction Equipment	519	452	509	519	519	443
Total	2,318	2,251	2,306	2,313	2,038	1,955
Percent Savings	-	2.9%	0.5%	0.2%	12.1%	15.7%

A summary of the energy and GHG emissions outputs by project component from all combined Mitigations combined are summarized in **Table 9.3.7** and **Table 9.3.8**, respectively.

The LCA results indicate the following:

1. Overall unmitigated energy use and emissions for the construction phase are dominated by the contribution of the bridge portion of the scope (70% and 78%, respectively). This is to be expected since the bridge comprises the largest portion of the scope of work and associated materials. As such, the mitigation measures that have a large impact on the bridge materials and transport greatly influence the overall energy and emissions outputs for the project. Ultimately, the combined mitigations for the bridge component comprise over 47% of the total energy savings and over 62% of the total emissions reduction.

2. Mitigation 2D (Recycled and Reclaimed Materials Only) has the most significant impact to energy use and emissions (13.6% and 12%, respectively). The decreased need for extraction and transport of virgin materials leads to this significant decrease in Upstream Materials energy and emissions for all project components.

3. Mitigation 2A (Alternative Fuels Only) also contributes 2.9% to overall emissions reduction (likely due to lower emissions factors for biofuels and electricity), which is significant because even though this mitigation only influences the Direct emissions from construction vehicles, it still has the second largest impact overall. Interestingly, the switch to alternative fuel vehicles appears to increase energy outputs marginally (possibly due to lower energy intensity of biofuel and electricity). When broken down by project component, all of the scenarios see this increase in energy consumption for Construction Equipment, except for Roadway Rehabilitation. This is attributable to significant energy use reduction resulting from Mitigation 2B (In-Place Roadway Recycling Only).

4. Mitigation 2B has a noticeable impact on the Direct (Construction Equipment) energy and emissions of the Roadway Rehabilitation portion of the project, but has comparatively little impact to reducing energy and emissions overall (0.6% and 0.5%, respectively).

5. Mitigation 2C (Warm Mix Asphalt Only) has the smallest contribution to energy and emissions reduction (0.2%, and 0.2%, respectively). It is important to note that a relatively small amount (20%) of warm mix asphalt was assumed for the Mitigated condition, compared to the maximum amount allowed by the ICE tool. However, even if this percentage were increased to 90%, the overall impact of this Mitigation on the project would still be less than 1%.

6. The use of recycled materials has an impact on energy use and emissions. The project specifications should encourage the use of these materials, without compromising structural performance, by providing specific percentage minima for such content.

Table 9.3.7: Energy Use and Percentage Savings by Project Component

Energy (MMBTU)	Combined Mitigations Energy Use (MMBTU)					Combined Mitigations (Percentage Savings by Category)				
	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total
Upstream: Materials	1,112	1,087	11,821	2,469	16,489	26.1%	27.9%	14.3%	29.2%	18.7%
Direct: Construction Equipment	647	285	5,760	611	7,303	-4.7%	30.8%	-4.7%	-4.6%	-2.6%
Total and Percentage Savings By Category	1,759	1,372	17,581	3,080	23,792	17.1%	28.5%	8.9%	24.3%	13.2%
Percentage Contribution to Overall Savings						10.1%	15.2%	47.3%	27.5%	-

Table 9.3.8: GHG Emissions Output and Percentage Savings by Project Component

GHG Emissions (MT CO2E)	Combined Mitigations GHG Emissions (MT CO2E)					Combined Mitigations (Percentage Savings by Category)				
	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total
Upstream: Materials	71	71	1,228	142	1,512	26.0%	26.8%	12.6%	29.4%	16.0%
Direct: Construction Equipment	39	17	350	37	443	13.3%	43.3%	12.7%	14.0%	14.6%
Total and Percentage Savings By Category	110	88	1,578	179	1,955	22.0%	30.7%	12.6%	26.6%	15.7%
Percentage Contribution to Overall Savings						8.5%	10.7%	62.8%	17.9%	-

7. Means of transportation, fuels used, and emissions factors influence emissions for material transport and construction equipment operation, even if the total energy consumption is not significantly reduced. As construction means and methods progress, the focus should be on minimizing distance travelled and using fuels with low emissions factors.

8. WMA and in-place roadway recycling have energy and emissions benefits, but the emissions for the project are not very sensitive to these practices, and can be emphasized less.

9. As part of the detail design phase, it is recommended that a more detailed LCA be performed based on estimates of material quantities, raw material source and manufacturing locations, use of recycled materials, transportation distances, and anticipated transportation modes, and likely construction means, methods, and equipment.

10.0 MITIGATION MEASURES

The assessment of the project and its potential effects is useful in further exploring the interactions of the project during each stage of its design life (i.e. construction, operation and decommissioning). This can assist in identifying best management practices and mitigation measures required to either reduce or eliminate the potential negative effects of specific project activities.

As discussed earlier, the Federal EIA process is part of the scope of this current project design phase, and shall continue into future project phases leading up to construction. Given the nature of the project and the sensitivity of the project area, Parks Canada's Director of Waterways has determined that the DIA framework is to be used for the Federal EIA. The DIA is the most comprehensive level of assessment, intended for complex projects that require applied analysis of project interactions with valued components that may affect a particularly sensitive environmental setting or threaten one or more sensitive valued components.

Parks Canada, in consultation with the City and Project Team, prepared a Scoping Document for the DIA, which is included in **Appendix B**. The Scoping Document provides guidance on the following phases of the project that shall be addressed in the DIA:

1. Site preparation.
2. Construction.
3. Site restoration and rehabilitation.
4. Operation.

It is acknowledged that decommissioning is discussed in this Report, but it is not part of the scope of the DIA, since it is anticipated that the bridge will have a life span of more than 100 years. If and when decommissioning and rehabilitation are required at the project corridor, it is anticipated that such works would be assessed as part of a Decommissioning Plan and regulatory impact assessment provisions current to that time.

Based on the above context, the DIA shall describe and assess potential interactions (including timing, frequency, duration, residual effects, cumulative effects and mitigation) between the phases of the project noted above and various environmental components, focused within the project corridor. The environmental components are categorized as:

1. Valued Components, which represent the main focus of the DIA based on Parks Canada's mandate.
2. Secondary Components, which represent the secondary focus of the DIA, but are also reflective of Parks Canada's mandate.

Highlights of the C-NHPEP to this point of the Report have focused on design measures which will restore and enhance the landscape following the construction phase, in accordance with the aforementioned Mission Statement, Vision and Values for the project. In addition, the CAP, which was also introduced earlier in this Report, establishes protocols for use by the City for notifying the general public of any service interruptions and addressing public issues both prior to and during bridge construction activities as well as during the subsequent use and maintenance of the bridge.

This Section of the Report further incorporates provisions in both the C-NHPEP and CAP by focusing on best management practices that will serve to protect the cultural and natural heritage landscape within the project corridor during the construction (which groups the DIA phases focusing on site preparation, construction, and site restoration and rehabilitation as noted and applicable below to minimize duplication), and operation phases of the project. These are outlined below.

1. As part of the construction phase:
   a) Continue to consult with Parks Canada and other applicable review agencies and stakeholders in further refining the C-NHPEP, CAP and LCA as part of the detail design phase for subsequent implementation during all construction sub-phases.
   b) Ensuring all equipment during all construction sub-phases:
      i. is maintained in good working condition through regular maintenance and inspections;
      ii. includes industry-standard emissions treatment and noise-suppression systems that meet applicable Provincial guidelines current at that time; and
      iii. operates and re-fuels only in designated areas.

c) Employing dust suppression techniques such as watering on project site access roads and sweeping at project site entrances during all construction sub-phases.

d) Employing detailed protocols are in place during all construction sub-phases for employees/contractors regarding equipment maintenance and inspections procedures for minimizing both the duration and severity of any accidents or malfunctions as well as emergency response procedures.

e) In advance of on-land excavation works during the site preparation sub-phase, installing sediment fencing along the riverbanks to prevent sediment movement and erosion outside of the work area for the duration of the construction phase.

f) Installing silt fencing for spoil stockpiling or fill materials during the site preparation sub-phase and maintaining it for the duration of the construction phase, and further ensuring that such areas are at least 30 m off-shore.

g) Ensuring during all construction sub-phases that spill kits are located on-site and storing construction materials and debris as well as fuel, lubricants and other hazardous materials in designated areas away from high-traffic areas and the Cataraqui River.

h) Suspending in-water activities during all construction sub-phases during periods of heavy rain and high wind events.

i) Unless otherwise necessary, undertaking activities during all construction sub-phases during daylight hours in accordance with the City's Noise By-Law and to avoid potential effects of noise and artificial night lighting on the natural environment.

j) Conducting advance inspections in affected areas during all construction sub-phases in order to assess the presence of sensitive vegetation and tree species as well as wildlife species and the feasibility of relocating affected species to other hospitable environments and/or establishing buffers to protect affected species and to restrict access.

k) Scheduling activities during all construction sub-phases:

i. to avoid confirmed or assumed habitats as well as breeding/spawning seasons and over-wintering periods for:

(a) American Eel and other fish from March 15 to July 15;

(b) Barn Swallow from May through the end of August;

(c) Common Nighthawk from the end of April through mid-October;

(d) Bats from early April through the start of September (maternity roosting) and October through April (hibernating);

(e) Spring and Fall for migratory waterfowl;

(f) Eastern Milk Snake from May to late September and the Fall-Winter months;

(g) Blanding's and other turtles from October through March (over-wintering) and late May through early July (nesting);

unless advance inspection and exclusion provisions, in conjunction with applicable permits and approvals being in place, have ensured that there will be no potential species impacts; and

ii. in consultation with Parks Canada, DFO, TC and the Kingston Rowing Club to ensure that either:

(a) the navigable channel and/or adjacent rowing lanes remain open during the site preparation and construction sub-phases and the arch span installation in particular occurs during when the navigable channel and/or adjacent rowing lanes are officially closed to watercraft; or

(b) proper advance safety mitigation measures, in conjunction with required regulatory approvals, are in place to protect the public in support of any activities that may need to occur during the site preparation and construction sub-phases over the navigable channel and/or adjacent rowing lanes during the navigation season.

l) In regards to the Gore Road Library property:

i. in advance of the site preparation sub-phase:

(a) documenting the condition of historic structures in advance of site preparation works and during construction activities to ensure that any adverse effects are promptly addressed;

(b) ensuring that the historic structures are protected from direct impact by vehicles during site preparation and construction activities;

(c) assessing the condition of trees and plantings along the southern boundary of the property and avoiding or relocating those specimens having historical significance to other suitable locations on the property, as feasible and appropriate;

(d) documenting the section of the dry stone wall to be relocated, both for historical purposes and to facilitate site reconstruction;

ii. during the site preparation sub-phase:

(a) relocating as little of the dry stone wall as possible in order to facilitate the widening of Gore Road and to meet safety and traffic requirements in road construction;

(b) ensuring the relocated section of the dry stone wall is reconstructed by a qualified heritage stonemason and that it is rebuilt as a continuation of the existing wall, but at right angles and heading eastward on a parallel to Gore Road (the latter as per the request of representatives of the Kingston Heritage Advisory Committee); and

(c) assessing the condition of the remaining dry stone wall by a qualified heritage stonemason; and

(d) preparing an interpretive plan that both documents and presents the known history of the Gore Road Library property in situ.

m) In advance of the site preparation sub-phase:

i. documenting and removing archeological site BbGc-127 through archaeological excavation in order to mitigate the risk of the site being damaged during the project construction phase; and

ii. documenting and temporarily removing the survey marker for subsequent reinstatement in situ during the site restoration and rehabilitation sub-phase.

n) Ensuring proper in situ conservation or excavation and removal measures as well as notification protocols are in place during all construction sub-phases regarding the discovery of previously undocumented cultural heritage and archaeological resources.

o) Sorting construction debris during all construction sub-phases for recycle or disposal for hauling off-site by licensed operators to approved facilities.

p) Using licensed personnel during all construction sub-phases to:

i. handle hazardous materials; and

ii. provide regular pump-out and haulage services of temporary on-site effluent holding tanks to an approved water pollution control plant for disposal and treatment.

q) Ensuring during all construction sub-phases that proper on-site construction signage and controls are installed for designated areas and traffic lanes to ensure safe and efficient circulation on-land and in-water.

r) Installing:

i. temporary ditches and permanent stormwater drainage and management facilities during the site preparation sub-phase to drain all temporary project site access roads to permanent on-land stormwater management facilities for treatment (sediment removal) and release in accordance with regulatory requirements; and

ii. permanent stormwater drainage facilities during the construction sub-phase to drain all roadway and bridge deck areas to on-land stormwater management facilities.

s) Conducting analyses of sediments in advance of and following all excavation activities both on-shore and in-water during the site preparation and construction sub-phases in order to:

i. determine sediment contamination levels; and

ii. further ensure appropriate protocols are in place for:

(a) control measures (work stoppage and agency notification); and

(b) excavated material disposal to an approved landfill facility in accordance with regulatory requirements.

t) Ensuring that during the site preparation and construction sub-phases:

i. on-land excavation works meet applicable Provincial blasting vibration guidelines current at that time;

ii. proper construction equipment noise ramp-up procedures are in place to enable wildlife to either adapt their behaviour to the affected area or avoid it entirely;

iii. multiple underwater noise generating activities are either minimized or sequenced to minimize their duration; and

iv. hydro-acoustic monitoring is in place to confirm that noise levels at close range to the in-water pile installation work in particular, are either below the injury threshold for fish and aquatic wildlife or that additional mitigation measures need to be considered.

u) Purging the ballasts of all in-water vessels during the site preparation and construction sub-phases, should they originate from outside the Great Lakes system, in order to minimize the risk of introducing invasive species into the Cataraqui River.

v) Minimizing the removal of shoreline and riparian vegetation during the site preparation and construction sub-phases and ensuring that permitting from the City is in place regarding the removal of any trees.

w) In advance of in-water removal of aquatic vegetation or substrate during the site preparation and construction sub-phases, installing silt curtains and/or turbidity barriers around in-water work areas and ensuring such measures remain in place until the sediments within the affected area have settled.

x) Regularly monitoring:

i. river water quality north and south of the project corridor during all construction sub-phases for turbidity, suspended soils, nutrients and contaminants; and

ii. shoreline erosion and sediment control measures and ensuring such measures are not removed until the terrestrial vegetation is re-established as part of the site restoration and rehabilitation sub-phase.

2. As part of the project operation phase:

a) Preparing and employing an Operations and Maintenance (O&M) Manual that contains detailed protocols for employees/contractors regarding the CAP, stormwater management system and maintenance equipment inspections and maintenance procedures for minimizing both the duration and severity of any accidents or malfunctions as well as emergency response procedures.

b) Ensuring all maintenance equipment is in good working condition through regular maintenance and inspections.

c) Continuing to regularly monitor:

i. shoreline erosion and sediment control measures and ensuring such measures are not removed until the terrestrial vegetation is re-established as part of the landscape improvement works; and

ii. Cataraqui River water quality north and south of the project site location for turbidity, suspended soils, nutrients and contaminants.

d) Maintaining and monitoring those works that are included in the C-NHPEP.

e) Implementing dust suppression measures as part of maintenance activities.

f) Using only non-chlorinated de-icing agents on the bridge deck.

g) Ensuring the stormwater drainage and management facilities are in good working condition through regular maintenance and inspections.

h) Suspending in-water maintenance activities during periods of heavy rain and high wind events.

i) Conducting advance inspections in areas slated for maintenance activities in order to assess the presence of sensitive vegetation and tree species as well as wildlife species and the feasibility of relocating affected species to other hospitable environments and/or establishing buffers to protect affected species and to restrict access.

j) Ensuring that the historic structures are protected from direct impact by maintenance equipment.

k) Scheduling maintenance activities:

i. to avoid confirmed or assumed habitats as well as breeding/spawning seasons and over-wintering periods for:

(a) American Eel and other fish from March 15 to July 15;

(b) Barn Swallow from May through the end of August;

(c) Common Nighthawk from the end of April through mid-October;

(d) Bats from early April through the start of September (maternity roosting) and October through April (hibernating);

(e) Spring and Fall for migratory waterfowl;

(f) Eastern Milk Snake from May to late September and the Fall-Winter months;

(g) Blanding's and other turtles from October through March (over-wintering) and late May through early July (nesting);

unless advance inspection and exclusion provisions, in conjunction with applicable permits and approvals being in place, have ensured that there will be no potential species impacts; and

ii. in consultation with Parks Canada, DFO, TC and the Kingston Rowing Club to ensure that either:

(a) the navigable channel and/or adjacent rowing lanes remain open during the operational phase; or

(b) proper advance safety mitigation measures, in conjunction with required regulatory approvals, are in place to protect the public in support of any maintenance activities that may need to occur over the navigable channel and/or adjacent rowing lanes during the navigation season.

l) Monitoring future traffic conditions by the City in order to further:

i. optimize the coordination of traffic signals to maximize efficient traffic flows; and

ii. address any issues of short-cutting through the Point St. Mark residential neighbourhood on the east side lands.

The project description and potential project effects, when read in conjunction with the proposed mitigation measures, provides further perspective on the effects of the project on the Valued and Secondary Components for the DIA. In order to avoid duplication, this is summarized for the construction and operations phases of the project in **Table 10.1** and **Table 10.2**, respectively. Note the significance of the residual effects on each Valued and Secondary Component is categorized as follows:

1. **Magnitude:** the typical effects of the impact i.e. low (L), medium (M) or high (H).
2. **Geographic Extent:** where the effect occurs i.e. immediate (I), local (L) or regional (R).
3. **Duration:** the duration of the effect i.e. short term (S) or long term (L).
4. **Frequency:** the frequency of the effect i.e. intermittent (I) or continuous (C).
5. **Reversibility / Irreversibility:** whether an effect can be reversed (R) or is irreversible (I).
6. **Ecological Context:** an estimate of the ecological value of the area in which the effect occurs i.e. low (L) or high (H).

Table 10.1: Project Effects on Valued and Secondary Components: Construction Phase

Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Greater Cataraqui Marsh PSW	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Waste Management Systems Malfunctions and Accidents	Loss of structure and function	L/M	I	S	I	R	H	The short-term residual environmental effect will be Low/Medium and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; and the proposed project design and mitigation measures.
Surface Water Quality and Quantity	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Waste Management Systems Malfunctions and Accidents	Soil erosion and sediment loading Accidental spills	H H	I I	S S	I I	R R	H H	The residual environmental effect will be Minimal given the proposed mitigation measures. The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Hydrologic Processes	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Changes to water flow	L/M	I	L	C	R	H	The short-term residual environmental effect will be Low/Medium and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Fish / Aquatic Habitat Quality	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Change in diversity Accidental spills	H H	L I	S S	I I	R R	H H	The short-term residual environmental effect will be Low and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; and the proposed project design and mitigation measures. The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.

Table 10.1: Project Effects on Valued and Secondary Components: Construction Phase

Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Fish / Aquatic Wildlife / SAR and Vegetation	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Sensory disturbance	L	I	S	I	R	H	The residual environmental effects will be Minimal given the proposed mitigation measures.
		Loss and fragmentation	L/M	I	S	I	R	H	The short-term residual environmental effect will be Low and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; and the proposed project design and mitigation measures.
		Mortality risk	L/M	I	S	I	R	H	The residual environmental effect will be Low to reflect 100 percent mortality avoidance is not possible in relation to the short-term duration of construction and the proposed mitigation measures.
		Accidental spills	H	I	S	I	R	H	The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Submerged Cultural Resources	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Loss and fragmentation of Archaeological Site BbGc-127 and the stone survey marker	H	I	L	I	R	H	The short-term residual environmental effect will be Low/Medium and the mid-to-long-term residual environmental effect will be Minimal to reflect: the short-term duration of construction; and the proposed project design and mitigation measures.
		Loss and fragmentation of previously undocumented resources	L	I	S	I	R	H	The residual environmental effect will be Minimal given: the characteristics of the project corridor; and the proposed mitigation measures.

Table 10.1: Project Effects on Valued and Secondary Components: Construction Phase

Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Surrounding Cultural Landscape Canal's Commemorative Integrity Canal's Outstanding Universal Value Visitor Experience and Recreation Aesthetic Values	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Loss and fragmentation	H	L	S	I	R	H	The short-term residual environmental effect will be Low and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; and the proposed project design and mitigation measures.
Navigation	Site Preparation Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Waste Management Systems Malfunctions and Accidents	Level of service Accidents	L/M H	I I	S S	I I	R R	H H	The short-term residual environmental effect will be Low and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Groundwater Quality and Quantity	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Waste Management Systems Malfunctions and Accidents	Groundwater should not be encountered	L	I	S	I	R	H	The residual environmental effect will be Minimal given: the characteristics of the project corridor; the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.

Table 10.1: Project Effects on Valued and Secondary Components: Construction Phase									
Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Terrain, Geology and Soils	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Waste Management Systems Malfunctions and Accidents	Soil erosion and sediment deposition	H	I	S	I	R	H	The residual environmental effect will be Minimal given: the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
		Uncover contaminated soils and accidental spills	H	I	S	I	R	H	
Terrestrial Wildlife / Migratory Birds / SAR	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Sensory disturbance	L	I	S	I	R	H	The residual environmental effects will be Minimal given the proposed mitigation measures.
		Loss and fragmentation	L/M	I	S	I	R	H	The short-term residual environmental effect will be Low and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; the characteristics of the project corridor; and the proposed project design and mitigation measures.
		Mortality risk	L/M	I	S	I	R	H	The residual environmental effect will be Low to reflect 100 percent mortality avoidance is not possible in relation to the short-term duration of construction and the proposed mitigation measures.
		Accidental spills	H	I	S	I	R	H	The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.

Table 10.1: Project Effects on Valued and Secondary Components: Construction Phase

Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Terrestrial Vegetation / Habitat	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Change in diversity	H	L	S	I	R	L	The short-term residual environmental effect will be Low and the mid-to-long-term residual environmental effect will be Positive to reflect: the short-term duration of construction; the characteristics of the existing vegetation; and the proposed project design and mitigation measures.
		Accidental spills	H	I	S	I	R	L	The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Air Quality and Climate Change	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Diesel exhaust emissions	M	I	S	I	R	H	The residual environmental effect will be Low to reflect: existing land uses in relation to weekday construction activities; the short-term duration of construction; the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
		Airborne dust	M	I	S	I	R	H	
		Noise emissions	M	I	S	I	R	H	
		High noise events	M	I	S	I	R	H	

Table 10.2: Project Effects on Valued and Secondary Components: Operations Phase

Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Greater Cataraqui Marsh PSW	Road / Water Use Maintenance Malfunctions and Accidents	Loss of structure and function	H	I	L	I	R	H	The residual environmental effect will be Positive to reflect the proposed project design and mitigation measures.
Surface Water Quality and Quantity	Road / Water Use Maintenance Malfunctions and Accidents	Soil erosion and sediment deposition	H	I	L	I	R	H	The residual environmental effect will be Minimal given: the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Hydrologic Processes	Road / Water Use Maintenance Malfunctions and Accidents	Changes to water flow	M	I	L	C	I	H	The will be Positive to reflect: the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Fish / Aquatic Habitat Quality	Road / Water Use Maintenance Malfunctions and Accidents	Change in diversity Accidental spills	M H	I I	L L	I I	R R	H H	The residual environmental effect will be Positive to reflect the proposed project design and mitigation measures. The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Fish / Aquatic Wildlife / SAR and Vegetation	Road / Water Use Maintenance Malfunctions and Accidents	Sensory disturbance Loss and fragmentation Mortality risk Accidental spills	M H	I I	L L	I I	R R	H H	The short-term residual environmental effect will be Positive to reflect the proposed project design and mitigation measures. The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Submerged Cultural Resources	Road / Water Use Maintenance Malfunctions and Accidents	Loss and fragmentation	H	I	L	I	I	H	The residual environmental effect will be Minimal to reflect: the characteristics of the project corridor; and the proposed project design and mitigation measures.

Table 10.2: Project Effects on Valued and Secondary Components: Operations Phase

Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Surrounding Cultural Landscape Canal's Commemorative Integrity Canal's Outstanding Universal Value Visitor Experience and Recreation Aesthetic Values	Site Preparation Temporary Facilities and Lay-Down Areas Superstructure Construction Bridge Deck Construction Utility Installations Site Restoration and Rehabilitation Malfunctions and Accidents	Loss and fragmentation	H	L	L	I	I	H	The residual environmental effect will be Positive to reflect the proposed project design and mitigation measures.
Navigation	Road / Water Use Maintenance Malfunctions and Accidents	Level of service Accidents	M H	I I	S S	I I	R R	H H	The residual environmental effect will be Positive to reflect: the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Groundwater Quality and Quantity	Road / Water Use Maintenance Malfunctions and Accidents	Groundwater should not be encountered	H	I	L	I	R	H	The residual environmental effect will be Minimal given: the characteristics of the project corridor; the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Terrain, Geology and Soils	Road / Water Use Maintenance Malfunctions and Accidents	Soil erosion and sediment deposition	H	I	L	I	R	H	The residual environmental effect will be Minimal given: the proposed project design and mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.

Table 10.2: Project Effects on Valued and Secondary Components: Operations Phase									
Component	Interaction	Potential Environmental Effect Before Mitigation	Residual Effects Evaluation Criteria						Significance of Residual Environmental Effects
			Magnitude	Geographic Extent	Duration	Frequency	Reversibility / Irreversibility	Ecological Context	
Terrestrial Wildlife / Migratory Birds / SAR	Road / Water Use Maintenance Malfunctions and Accidents	Sensory disturbance	M	I	L	I	R	H	The short-term residual environmental effect will be Positive to reflect the proposed project design and mitigation measures.
		Loss and fragmentation	M	I	L	I	R	H	The short-term residual environmental effect will be Positive to reflect the proposed project design and mitigation measures.
		Mortality risk	M	I	L	I	R	H	The short-term residual environmental effect will be Positive to reflect the proposed project design and mitigation measures.
		Accidental spills	H	I	L	I	R	H	The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Terrestrial Vegetation / Habitat	Road / Water Use Maintenance Malfunctions and Accidents	Change in diversity	M	I	L	I	R	H	The residual environmental effect will be Positive to reflect the proposed project design and mitigation measures.
		Accidental spills	H	I	L	I	R	H	The residual environmental effect will be Minimal given: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
Air Quality and Climate Change	Road / Water Use Maintenance Malfunctions and Accidents	Diesel exhaust emissions	L/M	I	L	C	I	H	The residual environmental effect will be Low to reflect: the proposed mitigation measures; and the projected infrequent occurrence of malfunctions and accidents.
		Airborne dust	L/M	I	L	C	I	H	
		Noise emissions	L/M	I	L	I	R	H	
		High noise events	L/M	I	L	I	R	H	

10.1 Effects of the Environment on the Project

This section of the Report outlines the effects of climatic fluctuations and extreme events on the project that could occur in the area.

1. Climatic Fluctuations

Climatic fluctuations cannot be accurately predicted. As such, it is considered highly unlikely that any fluctuations that affect long-term weather trends would significantly affect the project, particularly since the design features of the project will need to meet the CHBDC.

2. Extreme Events

Potential extreme weather events that could affect the project include wind, earthquake, lightning and fire. Firstly, an extreme wind event is defined as winds in the range of 100 km/hr to 140 km/hr. Extreme wind events are rare but have been known to occur in the area. Wind data from the Kingston Airport suggests that most of the winds are from the southwesterly quadrants. The largest contributions are from due south and due west, caused mainly by the effects of Lake Ontario. Probable hourly wind speeds aggregated annually suggest that high winds can be experienced from any direction. But 100 year wind speeds are roughly 20 m/s (or 72 km/hr), which falls well below the criteria for an extreme wind event.

Secondly, as also noted earlier, for seismic design purposes, Kingston is listed in Table A3.1.1 of the CHBDC and falls in an Acceleration-related seismic zone (‘Za’) of 2 and a Zonal acceleration ratio of 0.10. Assuming the bridge would be classified as a ‘Lifeline’ bridge, the seismic performance zone would be 3 based on the CHBDC. The Site Coefficient (‘S’) for the project corridor, also based on the CHBDC, may be taken as 1.5, which is consistent with Soil Type III, due to the deep clay deposit within the Cataraqui River. Under the design earthquake condition, the silty clay soil and glacial till soil at the project site location are not considered to be susceptible to liquefaction. This is because of their relatively high fines contents and plasticity. But the layer of organic soils below the river mudline is considered to be susceptible to liquefaction under the design earthquake condition. Provided the bridge structure is founded on bedrock, no adverse impact on the post-liquefaction capabilities of the bridge foundation is anticipated.

There are also two zones within the project site location where low resistivity is observed within the bedrock beneath the river, centred at distances of 320 m and 970 m along the alignment. These areas are most likely associated with the Frontenac Axis. As discussed earlier, the in-water test holes put down as part of the current project design phase were advanced at selected pier locations based on the previous 14-span V-pier arrangement. Although the refined bridge arrangement maintains the same abutment locations and overall bridge length, it now comprises 19 inverted U-frame piers. As such, most of the test holes are no longer within the footprint of the inverted U-frame pier locations. Though the relevance and applicability of the geotechnical assessments to the refined bridge arrangement is re-confirmed, additional field investigations should be carried out during the detail design phase to confirm bedrock surface elevation and founding soil and bedrock conditions at the proposed U-frame pier locations.

Thirdly, during the spring and summer seasons, thunderstorms and electrical storms can occur in the area. In the event of a lightning strike that hits the bridge, the built-in grounding system should prevent any severe damage and reduce the risk of fire.

Given the design features of the project, which will need to meet the CHBDC, a significant environmental effect due to extreme events is unlikely to occur.

10.2 Cumulative Effects

In addition to the impacts of the project on the Valued and Secondary Components, this Report must also consider the cumulative environmental effects of the project in conjunction with existing and future activities or projects. Cumulative effects are defined as effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out. Cumulative effects are limited to those effects that are likely and for which measureable or detectable residual effects are predicted. A measureable change is defined as a change that is real, observable and detectable compared with existing (baseline) conditions. A predicted change that is negligible or indistinguishable from background conditions is not considered to be measureable.

In addition, the proposed refinements to the preferred bridge, roadway and landscape concept further reinforce the potential of the project to provide an overall community benefit to the City:

1. The identified roadway improvement works should maintain the flow of traffic along this critical mid east-west arterial corridor at an acceptable LOS over the long-term. This analysis has also demonstrated that short-cutting of traffic through the Village On The River Apartments on the west side is not anticipated. Furthermore, additional traffic calming alternatives have been proposed at the reconfigured Point St. Mark Drive-Gore Road

Intersection, which should prevent short-cutting of traffic through the Point St. Mark residential neighbourhood on the east side.

2. The purpose of the active transportation provisions on the bridge and on-land is to connect with, and thereby enhance, existing non-automotive networks on both sides of the Cataraqui River.

3. The recommended best management practices in the C-NHPEP and CAP will protect the cultural and natural heritage landscape within the project corridor during the construction and operation phases of the project. This is considered a 'triple win', in that:

   a) The temporary work bridge is preferred over the dredged channel from an environmental impact and protection perspective with regards to construction methodology (first win).

   b) Although the span arrangement would increase from 14-to-19-spans, the overall environmental footprint from the U-frame piers would still be lower compared to the initial V-pier design. This alternative pier design, in conjunction with the temporary work bridge, also yields a more reasonable cost estimate that is commensurate with the City's current financial resources (second win).

   c) From functional and aesthetic perspectives, the functionality of the bridge would not be compromised due to the alternative pier design, and the bridge deck features would be retained to enhance user experiences along the Canal; and aesthetically, the inverted U-frame piers would still provide a cohesive overall rhythm towards the arch span as the focal point of the bridge (third win).

4. Further to the above, the intent of the preferred bridge concept, in conjunction with on-land and in-water design provisions in the C-NHPEP, is to enhance the cultural and natural heritage landscape within the project corridor and as part of the broader Canal context. As such, the overall project design satisfies the aforementioned:

   a) Statement of Outstanding Universal Values for the Rideau Canal UNESCO World Heritage Site (UNESCO).

   b) Commemorative Integrity Statement for the Canal (Parks Canada).

   c) Heritage Values and Guiding Principles for the Cataraqui River Sector of the Rideau Canal (Parks Canada).

   d) Bridge Design Guidelines (Parks Canada).

   e) DIA Scoping Document for the Federal EIA (Parks Canada) up to this current project phase.

   f) Mission Statement, Vision and Values for the project (City and Project Team).

11.0 NEXT STEPS

The following activities will remain from the completion of the current project to the start of construction:

1. Continue stakeholder and First Nations consultations.
2. Finalize the Federal EIA with Parks Canada.
3. Confirm the need to prepare addenda to the ESR in light of current bridge design and constructability refinements.
4. Determine the preferred project delivery model.
5. Determine project financing.
6. Prepare final design drawings and specifications for construction.
7. Prepare detailed construction phasing, scheduling and cost estimates.
8. Obtain all permits and approvals required for construction.
9. Execute the land lease and construction agreement(s) with Parks Canada.
10. Obtain property easements and acquisitions for the project.
11. Procure the project (Pre-qualification, Proposal / Tendering, Agreements).

Additional studies that should be conducted during the detailed design stage include, but are not limited to, the following:

1. **Geotechnical Investigation:** Performing a borehole investigation at each pier location is recommended as it reduces the risk of unforeseen conditions occurring during construction which can significantly delay construction. As the span arrangement was revised during the preliminary design, some of the boreholes that were taken during the preliminary design do not line up with revised pier locations.

2. **Scour Study:** An investigation should be completed to determine the effect of scour will have on the circular piers and the v-piers. The effects of scour can either be mitigated through design details or it can be mitigated by scour protection.

3. **Ice Study:** An investigation should be conducted on the effect that the ice will have on the v-pier footing and the optimal pier nosing / ice breaker design to reduce the ice loading.

4. **Hydrology and Hydraulics Review:** A desktop study to demonstrate that the proportionately limited floodplain impact area caused by the bridge piers and shoreline impacts will not negatively impact the greater floodplain area upstream of the bridge.




www.jlrichards.ca

Ottawa

864 Lady Ellen Place
Ottawa ON Canada
K1Z 5M2
Tel: 613 728-3571
E-mail: ottawa@jlrichards.ca

Kingston

203-863 Princess Street
Kingston ON Canada
K7L 5N4
Tel: 613 544-1424
E-mail: kingston@jlrichards.ca

Sudbury

314 Countryside Drive
Sudbury ON Canada
P3E 6G2
Tel: 705 522-8174
E-mail: sudbury@jlrichards.ca

Timmins

201-150 Algonquin Blvd. East
Timmins ON Canada
P4N 1A7
Tel: 705 360-1899
E-mail: timmins@jlrichards.ca

North Bay

200-175 Progress Road
North Bay ON Canada
P1A 0B8
Tel: 705 495-7597
E-mail: northbay@jlrichards.ca

Hawkesbury

326 Bertha Street
Hawkesbury ON Canada
K6A 2A8
Tel: 613 632-0287
E-mail: hawkesbury@jlrichards.ca

Guelph

107-450 Speedvale Ave W
Guelph ON Canada
N1H 7Y6
Tel: 519 763-0713
E-mail: guelph@jlrichards.ca

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS