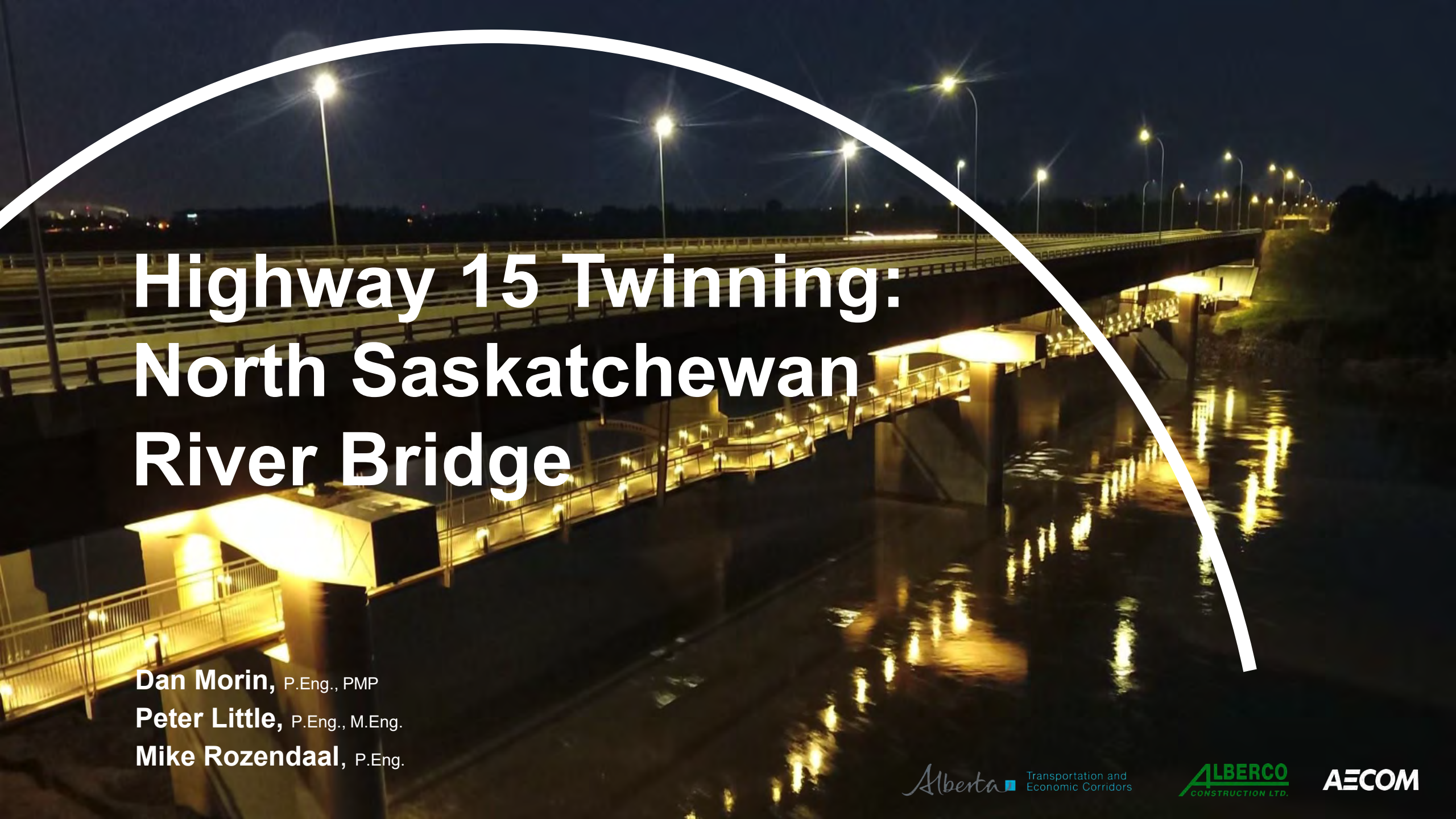

Highway 15 Twinning: North Saskatchewan River Bridge

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Agenda

1. **Design Phase**
   - Project Background and Description
   - Technical Design Considerations
   - Managing Project Risks
2. **Construction Phase**
   - River Berms
   - Pier Construction
   - Girder Erection
   - Deck Construction
   - Underslung Pedestrian Bridge
3. **Timelapse Video**
4. **Questions**

Project Background and Timelines

November 2017 → **January 2019**

QBS Procurement: RFP Scope and Fee Negotiations

Dec. 2017 – March 2018

Limited Planning Study: To determine side of Highway Twinning

Feb. – June 2018

Conceptual/ Preliminary Design: Select River Bridge, Optimize Rdwy Alignments, CN Bridge Modifications

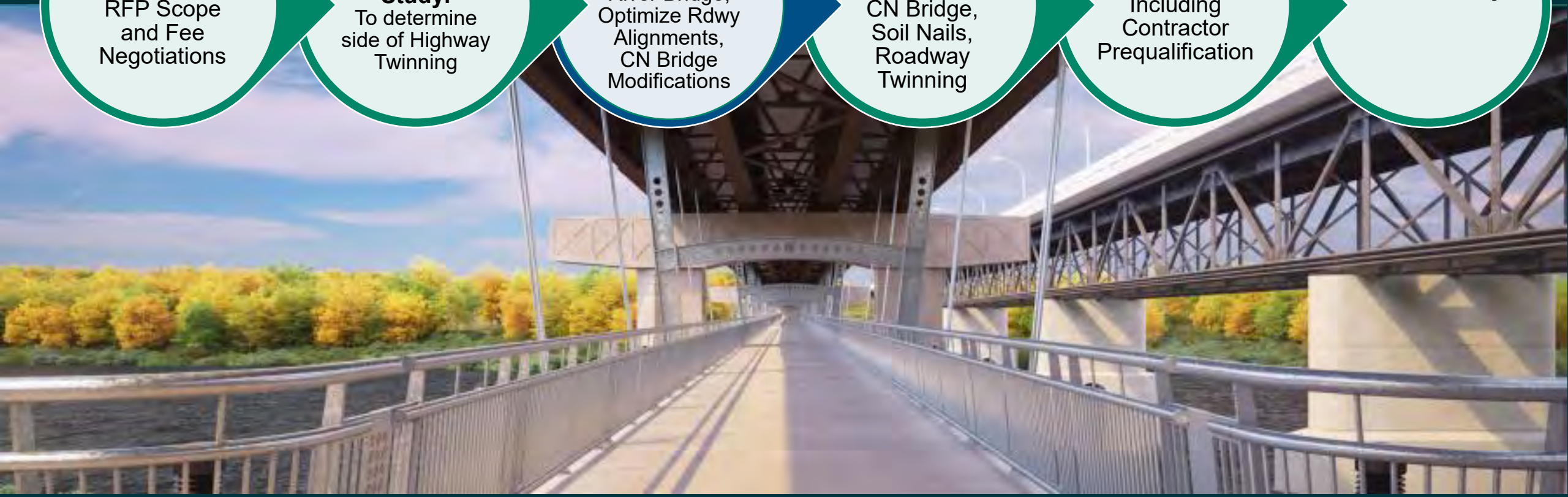
April – Dec. 2018

Detailed Design: River Bridge, CN Bridge, Soil Nails, Roadway Twinning

Sept. – Dec. 2018

Tender Preparation: Including Contractor Prequalification

Tender Ready



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Project Scope and Description

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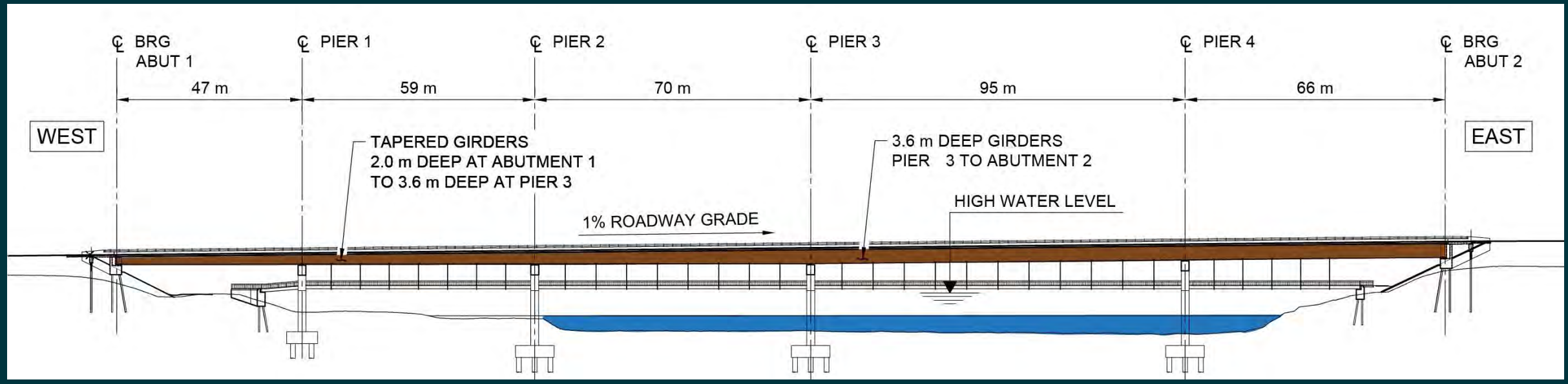
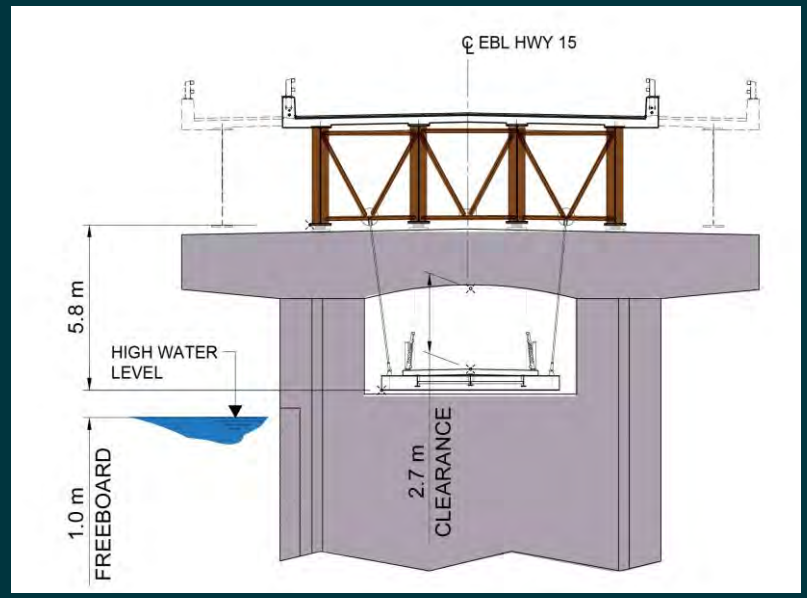
Span Arrangement



Reasons for tapered girders and span arrangement:

- 2 m maximum girder depth at west end of bridge due to various design constraints:
  - 1% roadway grade on bridge.
  - Highway 15 passes under CN Bridge to west and pedestrian bridge to east.
  - Underslung pedestrian bridge (5.8 m added structure depth).
- Undesirable to have a 6 or 7 span bridge with 2 m deep girders.
- Tapered girders resulted in just 2 piers in the main river channel.



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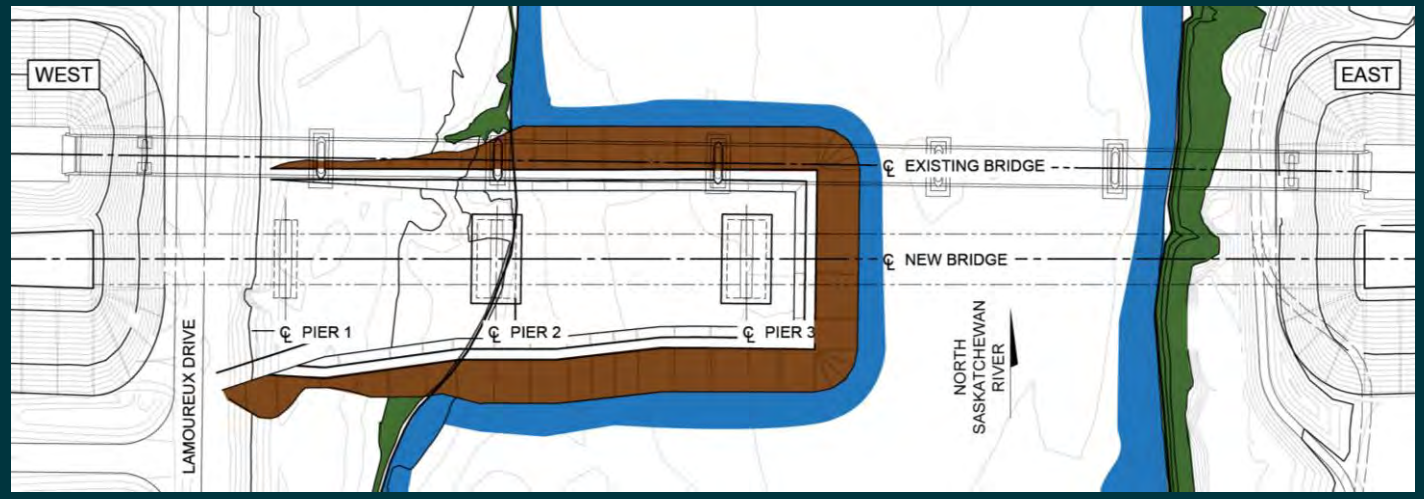
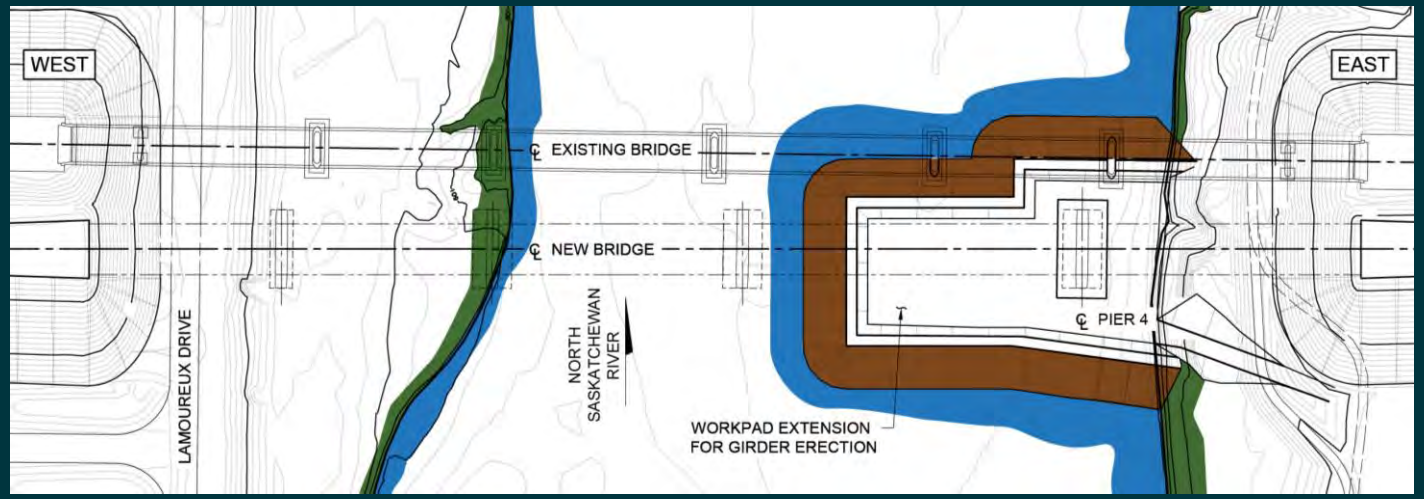
Benefits of tapered girders and 5-span layout

- No compromise on roadway profile design.
- Schedule and environmental benefits with less in-stream work.
- Lower scour risk to existing bridge foundations due to in-stream berms.
- No significant cost difference between the 5-span bridge ($47.8M) and a 6-span bridge ($47.4M)*

* preliminary “B” estimates, 2018 rates



Stage 1 Berm for construction of Pier 3



Stage 2 Berm for construction of Pier 4 and erection of Span 4 girders

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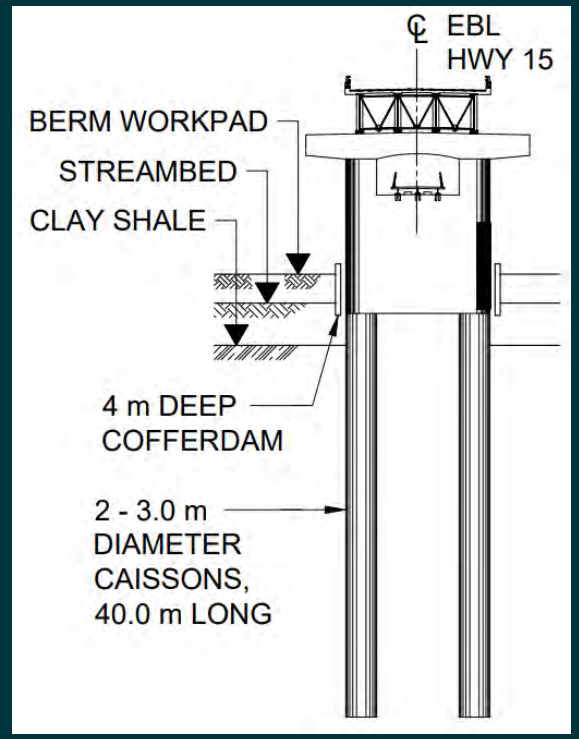
Pier Foundations

Option 1: Two 3.0 m diameter caissons

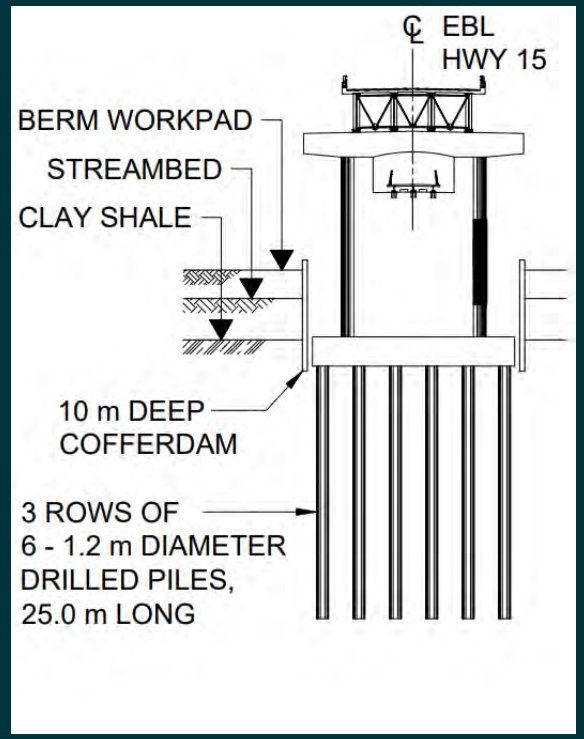
Notable examples: Northeast and Southwest Anthony Henday Drive bridges over the North Saskatchewan River.



- Lower estimated cost - approx. $1.5M total savings for 4 piers.
- Potentially shorter construction schedule.
- Less construction risks associated with shorter cofferdams.

Option 2: Pile cap with up to 18 - 1.2 m diameter drilled piles

*18 piles at Pier 3, 15 piles at Piers 2 and 4, 12 piles at Pier 1
Notable example: Hwy 2 Peace River Bridge (completed in 2020).

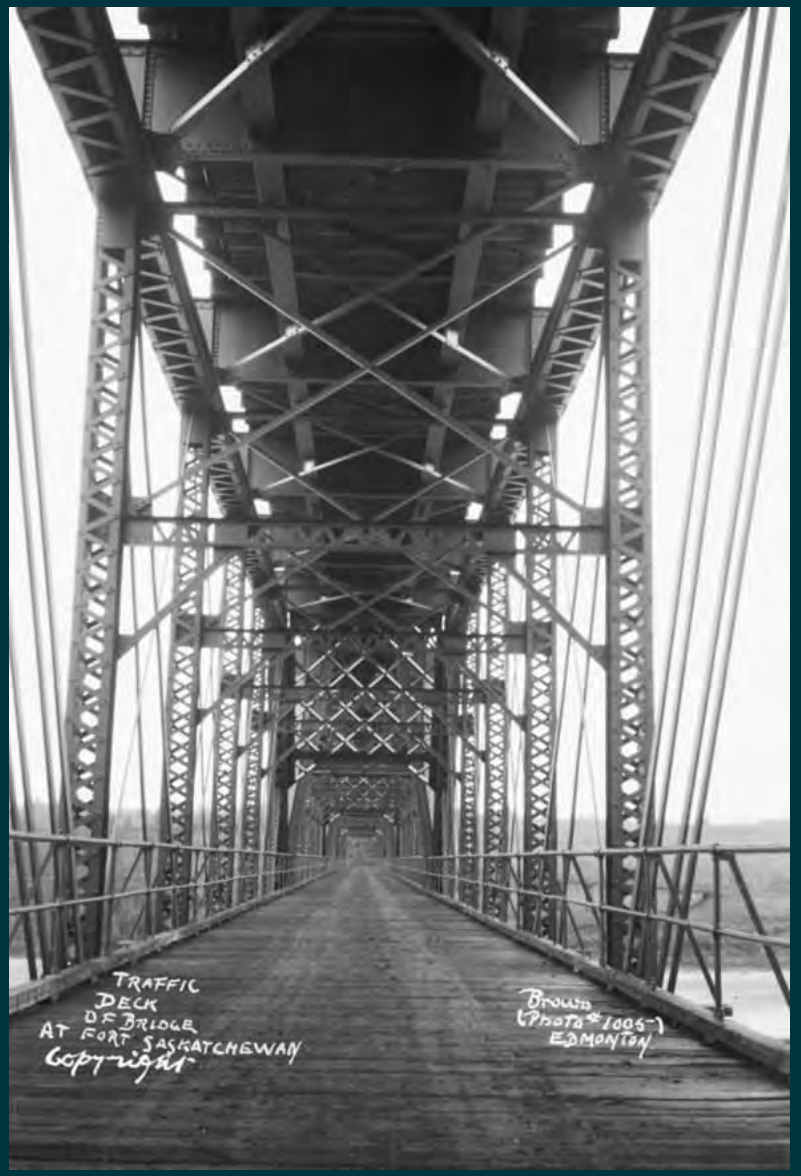


- Less potential for issues as piles can be drilled and rebar & concrete placed in one day.
- More redundancy with a pile cap and large number of piles to deal with construction issues.
- More local piling contractors with required piling equipment and expertise.

Pedestrian Bridge Structural Layout

Pedestrian Bridge Features – Pier Reveals

Looking upstream at the piers of the old CN bridge



Pedestrian Bridge Features - Medallions

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Pedestrian Bridge Features – Lookouts

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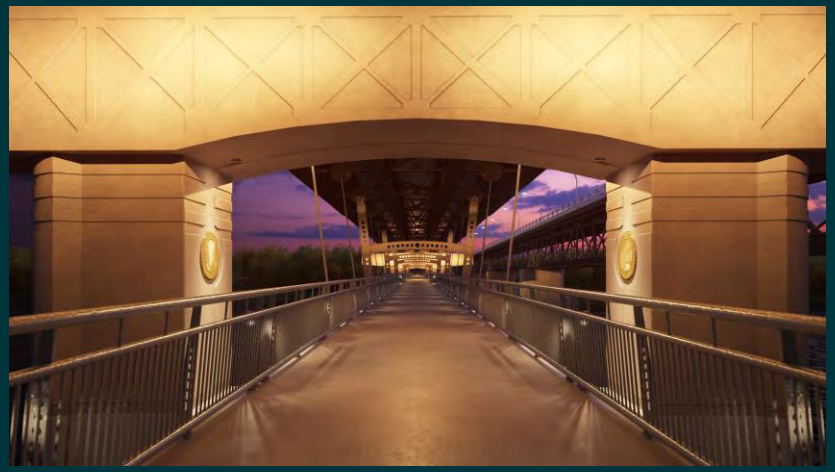

Pedestrian Bridge Features – Lighting

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Managing Project Risks

QBS Consultant Procurement:

- Awarded based on qualifications to ensure proponent had the necessary experience and skill set to undertake the design work.
- Allowed for detailed discussions on scope prior to setting fees.
- Allowed team to become knowledgeable with project prior to project kickoff, supporting a quick start.

Fast-track Decision Meetings:

- Allowed key actions and decisions to be made in a timely manner.
- Meetings included:
  - Technical presentations, followed by round table discussions, followed by a decision-making process by the main decision makers.
- Examples: selection of which side of the existing river bridge to twin Highway 15, bridge span arrangement, foundation type

Early Stakeholder Engagement = Buy-In:

- Early engagement of all stakeholders with regular communications resulted in early input and successful “buy-in” at the start of the project.
- CN Rail – face to face meetings secured buy-in on bridge modification design, followed by successful cost apportionment negotiations.
- RVA – Early presentations and input allowed the underslung pedestrian bridge architectural features to be agreed to between parties

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Sample Lessons Learned	Success / Challenge	Recommendation
Tremie Pile Concrete - specifying use of tremie concrete for drilled river piles - regardless if foundation hole is wet or dry.	Success	Use tremie concrete for river foundation piles. Benefits include contractor being able to bid Tremie at start of project and reduced onus for contractor and owner's inspector in determining dry vs. wet hole.
Mock-Ups - Various mock-ups and trials were required on complex, non-typical work prior to contractor performing the actual work. [medallions, architectural reveals, pedestrian benches, pedestrian railing fit-up, pedestrian deck pour]	Success	Mock-ups drew the Contractor's attention to challenging and unique aspects of the project and proved that they could complete the work before doing it, resulting in less re-work!
Existing Bridge Scour Considerations - Recognizing scour risks on the existing truss bridge spread footings during construction due to restricting the river with berms, was critical to manage safe operation of existing infrastructure.	Success	Risk mitigations included: • restricting instream works to times of the year with lower water levels (removal of berm before April); • adding a scour monitoring program; • specifying minimum berm extents to provide added protection to the existing truss bridge piers.
Anticipate Graffiti – Design included reveals on large concrete surfaces to help cover up future tagged locations as well as plates on girder ends to limit accessibility.	Success & Challenge	Consider how graffiti will be covered up / removed once in service. Precast benches were changed from colored concrete to pigmented sealer so graffiti could be covered if tagged.
Girder Transportation – Deep girders delivered to site horizontally sustained fatigue damage due to being improperly supported. Repairs were completed, fatigue life was restored.	Challenge	Girder transportation plan for deep girders that are shipped horizontally is very important to reduce risk of fatigue damage and associated repairs to restore fatigue life.

Construction Begins August 2019 – River Berm Access

- Two River Access Berms constructed for Pier Foundations & Structural Steel Erection
- River Access Window: Aug 1st – April 1st (8 months) of each year
- Stage 1 Berm - Aug 2019 – April 2020 / 25,000 m3 Berm / Pier 2, 3 / Girder Erection
- Stage 2 Berm – Sept 2020 – April 2021 / 27,000 m3 Berm / Pier 4 / Girder Erection

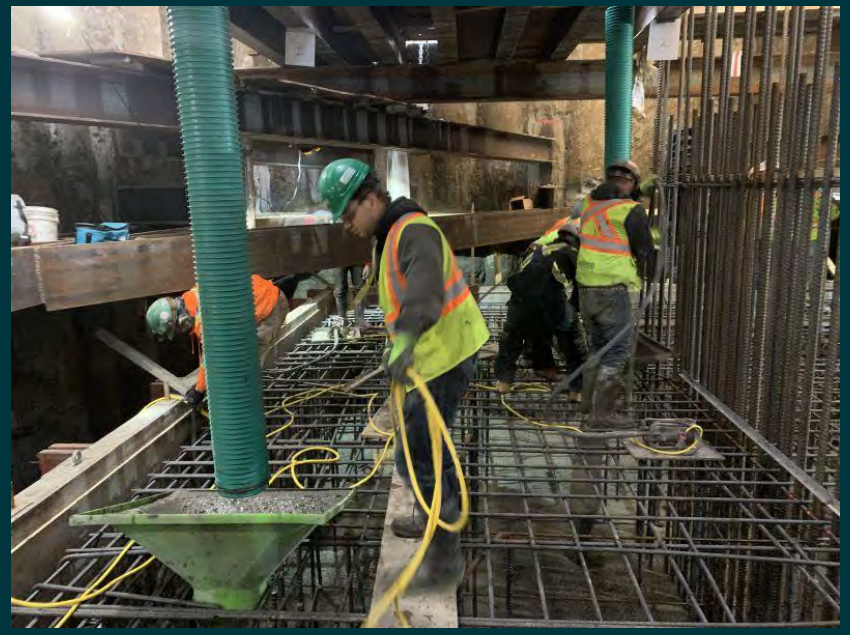
Pier Foundation Piles

- 4 river piers are supported on 60 – 1.2m dia concrete piles up to 32m in depth. Pier 4 required full segmental steel casing, tremie pour with SCC concrete & CSL testing.
- Total of 1,650 m3 30-MPa concrete placed 6m below berm surface.
- Pile productivity varied from 2 piles/ 10hrs at Pier 2 to 1 pile every 2-days at Pier 4. Typical pour day was 14-hrs.
- Sandstone core drilling required at Pier 4.

Secant Pile Cofferdams – Piers 2, 3, 4

- Due to a dense clay shale layer at 6 m below riverbed, Pier 2, 3, and 4 utilized rectangular Secant Pile Cofferdams, including internal steel bracing.
- 102 lean mix (3-MPa) secant piles per cofferdam with periodic vertical H-Piles vibrated into piles to provide structural support for steel bracing.
- Staged excavation and bracing installation.
- Water control with continuous pumping.
- H-Piles removed by vibro-hammer and secants drilled-out to top of pile cap elevation. Piles backfilled with native riverbed materials.

Pier Foundation – Pile Caps



- Pile Caps are 20m long x 9.2m wide by 3.0m deep – 552 m3/ ea.
- Mass pour element with winter heating & hoarding requirements.
- 2-pumps and RMC supplied 48-60 m3/hr.
- Pour chutes through suspended hoarding roof, including hoppers & elephant trunks used for placing concrete.

Pier 01, 02 & 03 Construction happened Concurrently – Sept 2019 to April 2020

- River Piers designed to accommodate future girder lines. Each pier average of 1,200 m3 TEC Class C 35-MPa Concrete. Pile Cap (550 m3), Pier Shaft & Columns (505 m3) and Pier Cap (145) m3.
- Pier Shafts/columns averaged 18m tall, poured in 3 sections. 2 Shaft sections followed by the column sections.
- Formwork design considered pour volumes, mass concrete procedure, heating, hoarding & curing requirements. Pier cap formwork supported on pier shaft to allow for concurrent removal of secant piles and pier shaft backfill.
- From Nov 2019 to April 2020, two river piers were constructed on Stage 1 Access Berm, placing a combine concrete volume for piles, secants & pier structures of 4,600m3 in 6-months.

Girder Erection

- Conventional “stick build” girder erection with shoring towers supported on river berms. Both hydraulic & conventional cranes used.
- Ped bridge erected from berm surfaces concurrent with girder erection.
- Access ramps, berm surface conditions, and clear runway south of south girder lines were construction considerations.
- Erection complete in winter/ spring conditions of each year which added site complexity. Stagged berm removal required for Stage 2 river berm to accommodate spring river flows.

Deck Construction – May 2021 to Aug 2022

- Bridge deck measures 14 m wide x 337 m long for a total deck area of 4,700 m2
- 1,580 m3 of AT 45 MPa High-Performance Concrete/ 232,000 kg SS Rebar.
- 9-Deck Sections varying from 27 m to 51 m long / Max deck pour 240 m3.
- 55-m pump including up to 120m line pumping/ Gomaco C-450 Finisher.
- 1,632 sheets plywood (41 lifts)/ 676 Knee Braces/ 507 Beams/ 7 km chamfer.

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Suspended Pedestrian Deck - Concrete Work May 2022 – July 2022

- 5.17 m wide x 277m long x 0.160m thick slab.
- 243 m3 of CIP 40 MPa Class C.
- 31 Deck panels including 2 Ped Plazas.
- Profile control using overlapping spin screeds.
- Trolley supported formwork platform.

Completed Pedestrian Deck – Sept 2022

- Architectural Features in all Pier and Abutment Surfaces.
- CAD Drawings / Pre-fabricated liner panels using Phenolic Plywood/ Custom site layout on each formwork element.

Bridge Complete – Open for both traffic & pedestrians October 2022

Construction Schedule: Aug 2019 – Oct 2022 (38 Months)

Total Concrete	Reinforcing Steel
10,184 m3	1,062,000 kg
Steel Girders	Deck ACP
1,665 t	885 t

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Highway 15 Twinning - Timelapse Video

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Thank you

Project Awards:

- **2020**
  CEA Showcase Award of Excellence in Transportation Structures
- **2022**
  Ministers Award of Excellence for Design Innovation
- **2024**
  ACI's Concrete Excellence Award in Bridges

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