Project Description

Updated January 2004

1. Introduction

The Deh Cho Bridge Corporation Ltd. of Fort Providence, NT has proposed to the GNWT to finance and construct a bridge across the Mackenzie River, at km 23, Yellowknife HWY #3. The estimated cost for construction of the bridge is in the range of $50 million, which will be raised through shareholders and bank loans. After construction, the bridge will be operated under an agreement with GNWT for a period of 35 years. For the duration of the agreement the bridge will be operated and maintained by the Deh Cho Bridge Corporation. On expiration of the agreement the ownership of the bridge will be transferred to the GNWT.

The proposed bridge will replace the existing ferry and ice bridge crossings, and will make the Yellowknife HWY an all-weather facility guaranteeing an uninterrupted link between the capital of the NT and the rest of Canada.

The proposed initiative, including the selected bridge site and bridge parameters were approved by the DOT, GNWT engineering personnel, and is fully supported by the local residents and the Municipal Authorities of Fort Providence. A Memorandum of Intent (MOI), between the GNWT and the Deh Cho Bridge Corporation Ltd., for proceeding with the final design and preparation for construction was signed on November 15, 2002.

The proposed bridge site and bridge parameters have been agreed to by the Northern Transportation Company Limited (NTCL), which are the major operator on the Mackenzie River Water Way

2. Bridge Location

The proposed site is located at the crossing of the Yellowknife HWY #3, NT and the Mackenzie River. It is located on the existing highway right-of-way, at km 23 HWY #3, near Fort Providence, NT.

1:5,000,000 NT Geographic Map *(Attachment #1).*

1:50,000 Topographic Map 85F/5 *(Attachment #2).*

1:25,000 Hydrographical Chart #6453 *(Attachment #3).*

Latitude: **61° 15' 45" N** Longitude: **117° 31' 30" W**

3. Selection of Bridge Site

It is proposed to construct the bridge at the existing ferry crossing. At this site the natural riverbed is approximately 1,560 m wide. For the purpose of the ferry operation, partial causeways were extended on the north and on the south shore, more than 30 years ago. The north causeway projects into the river 430 m, and the south one 165 m. Presently, the constricted river is 965 m wide at the ferry crossing. The proposed bridge is 1,045 m long and would allow an increase of the waterway to 995 m.

The proposed site was recommended in a Study named Preliminary Hydraulic Design, Mackenzie River Bridge, Liard River Bridge, Great Bear River Bridge prepared for PWC by NORTHWEST HYDRAULIC CONSULTANTS LTD (NHCL) of Edmonton, AB in 1975. The Study establishes that the waterway could be constricted to 3,000 feet (915 m) or less without serious hydraulic effects, and concludes that a design value of less than 3,000 feet would be acceptable from a river engineering viewpoint. The Study evaluated three potential sites for a bridge

crossing between Fort Providence Rapids and Beaver Lake *(Attachment#3),* and recommends the site at the existing ferry crossing for the following reasons:

- ✓ The bed of the river at the proposed site is highly stable and scour resistant with changes occurring only in geologic time scale.
- ✓ The direction of flow does not vary markedly from point to point across the section
- ✓ The structure is not located in a curve of the navigation channel
- ✓ The depth of the river at the proposed site is fairly uniform. The maximum depth is substantially less than the ones of the other locations.
- ✓ The bridge would use the existing highway approaches and would not interfere with lands along the shoreline that might be of interest to others.

The proposed site was confirmed by PWC and it was the basis for their Mackenzie River Bridge, Fort Providence, Yellowknife HWY #3, NT, Preliminary Design and Cost Estimate, dated December 1975.

4. Regime Analysis, Geotechnical, Bed Scour

The banks of the Mackenzie River in the vicinity of the proposed site are stable with no appreciable changes having occurred during a 50-year interval based on inspection of aerial photographs. A distinctive feature of the banks is numerous spur-like projections, some of which exceed 300 m in length. Although portions of them are submerged during high open water or ice jam high water, there is no sign of recent erosion.

The bed of Mackenzie River in the vicinity of the proposed crossing is comprised of hard dry clay-till overlain by 0.8 m to 1.2 m layer of alluvium. At the ferry crossing divers have reported that the bed was clay scattered with large, partially embedded boulders. The riverbed is considered stable, and general scour is not anticipated. However, local scour might be developed around the pier footings. Scour assessment study carried out by the Trillium Engineering of Edmonton, AB recommends placing of aprons of selected blasted rock around the piers for scour protection. Enclosed in Appendix "B" is a Geotechnical Report prepared by EBA Engineering of Yellowknife, NT

5. Ice Action

The bridge piers, abutments and the approaches projecting into the river are designed for the calculated ice forces, and according to the applicable chapters of the Canadian Bridge Code CSA-S6-00. The complicated mechanism of the break-up and the associated magnitude and direction of the ice forces were established by the specialised engineering firm Trillium Engineering of Edmonton, AB. Enclosed in Appendix "C" is their Ice Forces Assessment Report.

6. Components & Parameters

.1 The proposed bridge, consisting of nine spans, is 1,045 m long, and is configured as steel girders-concrete deck composite construction. The static scheme is a simple main span supported on the cantilevered ends of two opposing continuous four span approaches. Enclosed in Appendix "A" are Preliminary Design Drawings prepared by the bridge designer J.R. Spronken & Associates of Calgary, AB.

The superstructure is supported on eight piers constructed in the watercourse and two abutments constructed on the approach berms. Under the main span there is a navigation channel used by large tug-barges configurations. The main span, including the cantilevers, is 190 m long with a vertical clearance of 22.56 m at H.W.L. The main span is flanked by three 112.5 m spans and one at 90.0 m end span. In order to reduce the depth of the girder on the main span the design contemplates a system of portal and stays installed on the piers on both

sides of the main span. This allows for 9.0 m vertical clearance, and 10.5 m horizontal clearance on the bridge deck. It is anticipated that such clearances will not present limitation for oversize loads travelling between Alberta and the NWT.

The roadway width on the bridge deck is 10.50 m, allowing for two 3.75 m wide traffic lanes and two at 1.50 m shoulders. On each side of the deck there are 0.82 m high safety rails consisting of 0.25 m high concrete curbs and 0.57 m high steel rail. The maximum longitudinal grade on the bridge is 3.5%.

.2 The Design Live Load for the bridge is CL-750 (GVW of 750 kN) in accordance with the CSA-S6-00. There is a 40% dynamic allowance and additional 60% safety factor incorporated in the design. Additionally, the design allows for special, overload truck configurations as shown on the drawings.

.3 The superstructure is a composite construction of two WWF-Special steel girders with pre-cast concrete deck panels. The deck panels are pre-stressed transversely during fabrication, and post-tensioned longitudinally after installation.

.4 The abutments are cast in place concrete structure consisting of pile cap, back wall, and wing walls at 45 degree to the centre line of the bridge. The abutment construction involves production and placing of 650 cu m concrete.

The abutments are supported on heavy gage H piles, predrilled and driven to refusal into the underlying till.

.5 The substructure of the piers is cast-in place concrete flat footings and pedestals (appx 12,500 cu m). The pedestals are of conical shape. Aprons of granite Rip Rap will be paced around the pedestals for scour control (total of 5,000 cu m covering an area of appx. 6,000 sq m).

Prior to placing the footings the design contemplates construction of sheet pile cofferdams (appx 4,800 sq m), excavation of the riverbed to the design elevation (appx 6,100 cu m), placing of a tremie-concrete mud slabs (appx. 1,000 cu m) and dewatering of the cofferdams.

The substructure is designed to resist the impact of a colliding stray vessel. Friction and deformation of the colliding vessel will absorb the energy of the impact.

.6 The superstructure of the piers, or the pier bents are presented in concrete and steel options.

The concrete option consists of pre-cast and post-tensioned concrete sections involving 1,200 cu m pre-cast concrete and 1,100 cu m cast in place concrete.

The steel option consists of prefabricated steel elements assembled and bolted on site. The amount of steel required for the steel bents is 1,250 tonnes.

.7 The proposed road approaches are 12.0 m wide. Both approaches coincide with the existing causeways of the north and south ferry landings. The north approach projects into the river 350 m, and the south one 230 m. In order to avoid potential flooding and ice shove accumulations, the approaches are set at elevation not less than 2.0 m above the calculated ice jam. This elevation is the same as the one of the highway-winter road intersection on the north side of the bridge, which historically has never been flooded.

The footprints on the riverbed of the bridge approaches exceed the ones of the existing causeways. The required extension and widening of the footprints comprises placing of appx. 17,000 cu m clean limestone and appx. 5,000 cu m granite into the river. This rock will be placed to an elevation of 1.0 m above the Mean Water Level. The approach embankments above that elevation will be constructed of 90,000 cu m common backfill and will be dressed with 1 m thick layer of blasted rock rip rap.

The head-slopes of the approaches and their upstream shoulders exposed to ice action will be armoured with approx. 3,000 cu m large size granite rip-rap.

The roadway on the approaches will be paved. There is a standard highway guardrail installed on each side of the roadway.

.7 It is proposed to excavate and remove the backfill material from two areas within the limits of the watercourse. These areas are part of the Department of Transportation infrastructure associated with the existing ferryboat operation. It is possible that these areas are contaminated with hydrocarbons or other harmful to the fish habitat material. In order to establish if any contaminants are present in these areas the Department of Transportation has commissioned study with the environmental consultant Dillon. It is noted that it will be Department's liability should any contaminants are found.

The excavation and removal of backfill material will be completed to depths between 2.0 m and 4.0 m below the water level, to match the adjacent natural riverbed. These areas are depicted on *Attachment #4* and could be described as follows:

- ✓ Area "E" (4,300 sq. m) is part of the existing north ferry landing projected 80 m into the watercourse beyond the proposed bridge approach. The material to be removed from this area consists of 9,000 cu m granular backfill for embankment, 500 cu m blasted rock for rip rap, 80 cu m concrete for landing pad, and 30,000 kg structural steel for sheet-pile wall.
- ✓ Area "D" (9,500 sq. m) is part of the existing ferry haul-out on the south shore. It is located downstream, adjacent to the bridge approach. The material to be removed from this area consists of 11,000 cu m granular backfill and 90 cu m structural timber.

Most of the removed steel, concrete, and timber, will be disposed of in borrow pits that will be used for sources of common fill associated with the bridge approaches. The disposed of material will be covered with a layer of pit run. Some of the steel and timber might be salvaged. The excavated gravel will be tested for contaminants, and if found suitable may be used for road embankment widening. Alternatively it will be appropriately disposed of in the borrow pit. The armour rock will be salvaged and will be incorporated in the erosion protection of the bridge approaches.

.8 Accesses for public and commercial vehicles to both ferry landings and clear route for the ferryboat will be maintained, without interruption, for the duration of the bridge construction. Since sections of the existing access roads to the ferry landings and the bridge approaches overlap *(Attachment #7, Attachment #8*), it is proposed to construct detours as follows:

- ✓ South Approach: Construct approx. 250 m detour road and arrange for temporary south ferry landing 10 m downstream of the existing one. This involves minor road improvement works with no in-stream construction activities.
- ✓ North Approach: Construct approx. 450 m detour road 25 m downstream of the existing access. This involves placing approx. 6,000 cu m blasted rock into the watercourse, with corresponding 5800 sq m footprint on the riverbed. The road embankment above the water level will be built of gravel. After completion of the bridge construction the gravel and the blasted rock will be thoroughly recovered from the river, and will be incorporated in the bridge approach widening, and armouring correspondingly.

7. Construction Details and Schedule

.1 The construction methodology proposed for the bridge construction is based on sound engineering principals and advanced technology that have been tested, and proven to be successful in large number of similar projects in North America. The proposed construction schedule is based on minimum disruption of the fish habitat, and was developed in consideration of the migration and spawning patterns of the different fish population inhabiting the river.

The following description of the construction activities is not presented in chronological order, but rather by type of activities comprised in the bridge construction. Those activities could be defined as follows:

- ✓ Earthworks, including production and placing of rock and backfill material, and excavation-removal of material from the river
- ✓ Foundations including installation of pier footings and pedestals, and pile driving for abutments
- ✓ Pier shafts fabrication and installation
- ✓ Abutments construction
- ✓ Steel superstructure fabrication and installation
- ✓ Bridge deck fabrication and installation
- ✓ Completion works including paving, guard rail on the approaches, bridge signs, and landscaping

The proponent will be prepared to reasonably reschedule the in-stream construction activities, if this would minimise further the harm to fish habitat and population.

.2 Earthworks

- ✓ The sandstone required for widening of the bridge approaches and detour will be obtained from the quarry located at km 192, HWY #1, appx 28 km to the south of the bridge site. The rock will have to be blasted and screened for separation of the fines prior to placing into the water. The rock required for the north approach and detour will be transported across the river on the ice crossing between February and April 2004.

  The detour construction will be completed in April 2004 prior to opening of the ferry season. Widening of the approaches and extension of the causeway will take place in summer 2004 after completion of the pier foundation work.

  The armour rock will be obtained via blasting from the granite quarry located at km 231, HWY #3, appx 206 km to the north of the bridge site.

  Placing the rock for detour, for approaches, and for armouring is considered an in-stream activity and is subject to the conditions of the DFO permit. Construction equipment used for the placing of the rock includes dump trucks, bulldozers and excavators. None of this equipment will be deployed in the water for the purpose of this work.

- ✓ Common backfill for bridge approaches and detour embankment will be obtained from designated pits located within 1 km distance on both sides of the river. The common fill will be placed on top of the rock fill described in the previous paragraph. Equipment used for this work includes dump trucks, bulldozers, graders and compactors. The approach embankment will be constructed in two stages. First one, to the elevation of the abutment bearings, will be done in summer 2004 after completion of the concrete abutments. Second one, to the final roadway grade, in spring 2005 after installation of the bridge superstructure.

Common backfill for bridge approaches and detour embankment is not considered an in-stream activity.

- ✓ Removal of detour and excavation-removal of backfill from the areas described in article 6.7 is an in-stream activity. Equipment used for this activity includes excavators, loaders and dump trucks. Concrete-cutting and demolishing equipment might be used for the removal of the concrete landing. None of the above-specified equipment will be deployed in the water for the purpose of this work. The work will be completed in September 2005 and October 2005, after opening of the bridge for traffic and discontinuing the ferry operation.

.3 Pier Foundations

- ✓ Construction of the pier foundations is an in-stream activity and will be subject to the conditions of the DFO permit. Most of the work will take place in February – April 2004, deploying the equipment and manpower on the ice.
- ✓ The cofferdams for the pier foundations will consist of standard sheet piles driven to refusal in pre-drilled cased holes in the riverbed. Prior to commencement of the work, the natural ice cover of appx 1.1 m will be increased by flooding to appx 1.6 m required to support the construction equipment.
- ✓ After installation of the cofferdams the riverbed will be excavated to an elevation of not less than 3.5 m below the natural level. The excavated material, ranging from 500 cu m to 800 cu m per pier, will be stockpiled for several hours on the ice and after freezing will be trucked and disposed of in a nearby gravel pit. After removal of the excavated material the ice will be scraped clean.
- ✓ It is anticipated, the sheet piles driven in hard till will produce a watertight cofferdam cell. In such case, the cofferdam will be dewatered prior to the excavation of the riverbed.
- ✓ After completion of the excavation a 0.5 m levelling concrete or "mud-slab" will be placed on a "dry bottom". In case of leaks on the base of the cofferdam, the excavation will be carried out under water, and the mud-slab of tremie concrete will be placed to seal the base prior to dewatering.
- ✓ The water from the dewatering could contain a fair amount of suspended solid fraction. It is proposed this water to be pumped into a confined area on the river ice, and after freezing to be ripped and disposed of in a nearby gravel pit after freezing.
- ✓ Construction of the pier footings and pedestals involves installation of formwork and rebar and placing concrete. The work will be carried out under hoarding in heated environment to allow for properly setting and curing of the concrete. After completion of the footings and pedestals the sheet piles will be removed (extracted) from the riverbed using vibrating equipment.
- ✓ Concrete for the pier foundations will be produced in a concrete plant prepared to operate in sub-arctic winter conditions. The anticipated productivity of the concrete plant is not less than 60 cu m concrete per hour.
- ✓ In order to complete the pier foundations within the specified 11 weeks long winter construction season, the contractor may choose to mobilise as many as three sets of construction crews. It is anticipated that not less than five of the eight pier foundations

will be completed as winter operation. The remaining not more than three foundations will be completed in the 2004 open water season commencing by mid June.

- ✓ It is assumed that the uncompleted piers, if any, would be the ones closest to shore on both sides of the river. In order to access these piers, it maybe necessary to construct two temporary bridges projecting from shore to the corresponding sites. The bridges would be of multiple15.0 m spans supported on "H" piles driven into the riverbed. Installation of the pile supports and the spans will be completed by equipment deployed on the previously constructed ones. The temporary bridges will be removed by the end of the 2004 summer construction season, prior to freeze up. No heavy equipment will be deployed into the river for the purpose of construction and removal of the temporary bridges.

.4 Bridge abutments

- ✓ Installation of piles for abutments is not an in-stream activity. "H" piles will be driven in pre-drilled holes using diesel hammer, crane and air-track deployed on top of the sub-grade of the bridge approaches. The work will be completed in May - July 2004 after completion of the pier foundations and the extension and widening of the bridge approaches.
- ✓ The abutments will be constructed on top of the sub-grade of the bridge approaches. The design contemplates conventional formwork and cast in place reinforced concrete. The required 325 cu m concrete for each abutment will be placed in four pours not exceeding 100 u m each. This concrete will be produced in the established on shore concrete plant, will be delivered with mixer trucks, and will be placed with crane equipped with bucket. For delivery of the concrete to the shore opposite to the concrete plant the contractor may use his own barges, or negotiate with the GNWT using the ferry between midnight and 6:00 am.

.5 Pier bents

- ✓ For both, steel and concrete options, the elements for pier bents will be pre-fabricated in a specialized plant in southern Canada. The assembly and installation will take place in February-April 2005, in concert with the bridge launching operation. Equipment involved in the installation includes 80 t crane deployed on the ice, scaffolding, trucks etc. The estimated time for the assembly of each individual pier is not more than a week.
- ✓ If some of the pier foundations were to be constructed in summer 2004 using the temporary bridge, the same bridge will be used for the assembly/installation of the corresponding bents.

.6 Steel fabrication and installation

- ✓ Fabrication of the steel girders will likely be carried out in a specialized plant in southern Canada. The girders may be delivered by rail and/or by road to the bridge site. Each girder section will not exceed 22.5 m in length x 4.5 m in depth and weigh not more than 37.5 tonnes. The fabrication and delivery will be completed between March 2004 and January 2005.
- ✓ Installation of the steel for the bridge superstructure is an in-stream activity. It will be completed in Two Phases. The Phase One consists of launching the three intermediate spans and the end-span from each side of the river. This Phase will take place from February to April 2005. The Phase Two consists of installation of the main, or centre-span of the bridge, and will take place in June - July 2005.

Phase One:

The girder sections of the end spans will be pre-assembles and braced together on levelled areas along the bridge approaches on both sides of the river. These areas will have dimensions greater than 300 m by 20 m, sufficient to accommodate the pre-assembled sections and all launching mechanisms. Launching will commence simultaneously on both sides of the river. In order to achieve better deflection control on the cantilevered part during launching, there will be temporary piers installed midway between the permanent piers. Each of the temporary piers will consist of steel frame tower supported on the ice. Once the steel superstructure has been secured, the temporary piers will be removed. Launching of the four end-spans on each side of the river will be completed within eight weeks.

Phase Two:

The girders of the main span will be fully pre-assembled on a barge in the NTCL docks in Hay River, and will be towed to the bridge site. The approximate weight of the pre-assembled span is 900 tonnes. The span will be lifted in place with winches installed on the cantilevered ends of the already erected spans. The work will be completed within two weeks.

If the Phase One of the launching can be completed in time, the main span can be assembled on the ice and lifted in place in April 2005.

.7 Bridge Deck

- ✓ The bridge deck will be constructed of pre-cast and transversely pre-stressed concrete panels fabricated in a specialised concrete plant. Each panel will be 11.5 m long, 2.5 m wide, with 0.3 m thickness, weighing 21.5 tonnes. All panels will be trucked and stored on the bridge site prior to installation. Fabrication and delivery will be completed between June 2004 and June 2005.
- ✓ Installation of the deck panels will proceed from each end of the bridge towards the centre. The equipment involved in the installation will be deployed on previously placed panels. After installation, the panels will be, post-tensioned and anchored to the steel girders to provide composite action for traffic loading. Prefabricated concrete curbs will be installed on both sides of the finished deck. Handrails and bridge lights will follow in due course to present a finished structure. Installation of the bridge deck will commence in June 2005 and will be substantially completed in late August 2005.

.8 Paving and Completion works

- ✓ Installation of bridge lights and railing, paving of the approaches, landscaping of the construction site are conventional activities and will be completed in summer-fall 2005 prior to the opening the bridge for traffic.

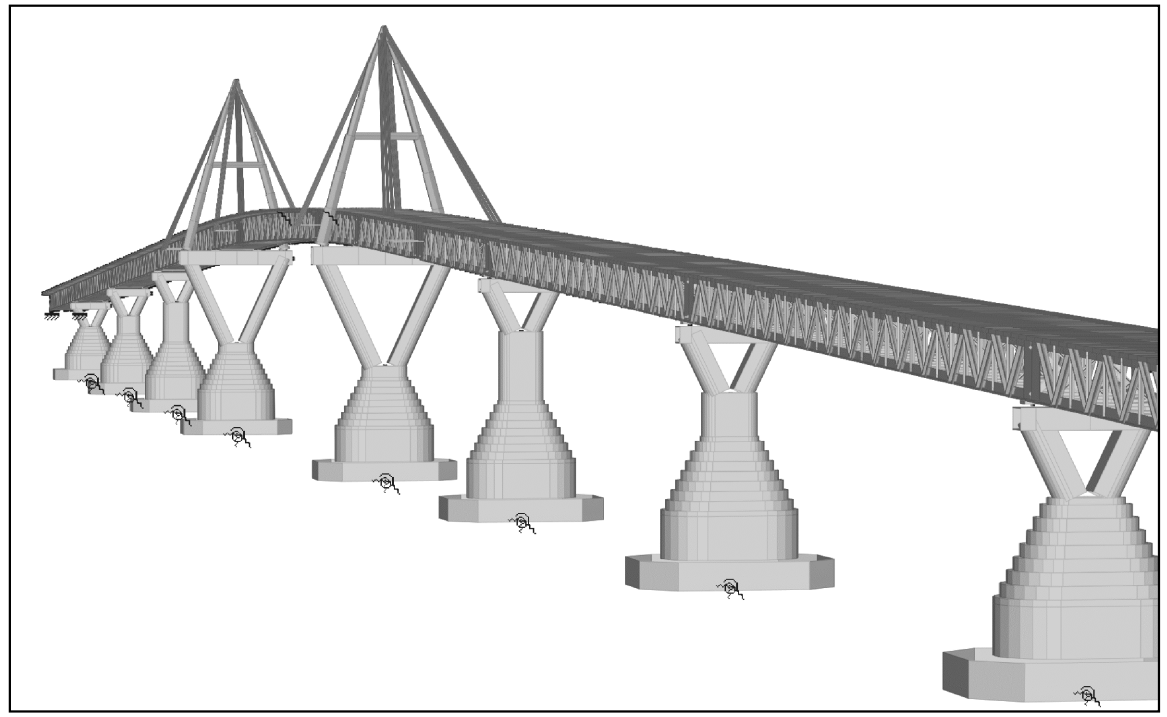
Prepared by:
Jivko Engineering
Jivko Jivkov, P. Eng.

January 02, 2004

DEH CHO BRIDGE

YELLOWKNIFE HWY#3 Km 23

ON MACKENZIE RIVER



Deh Cho Bridge Corporation

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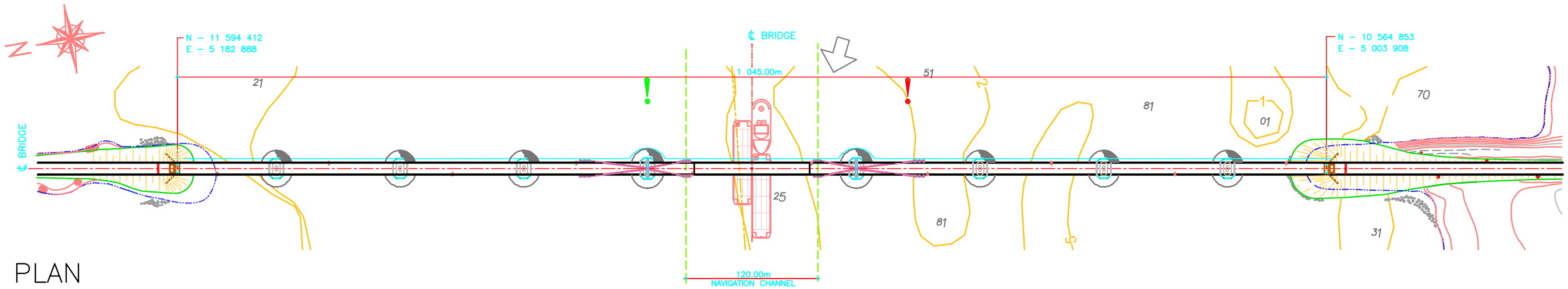
Drawing No. 02 152-001



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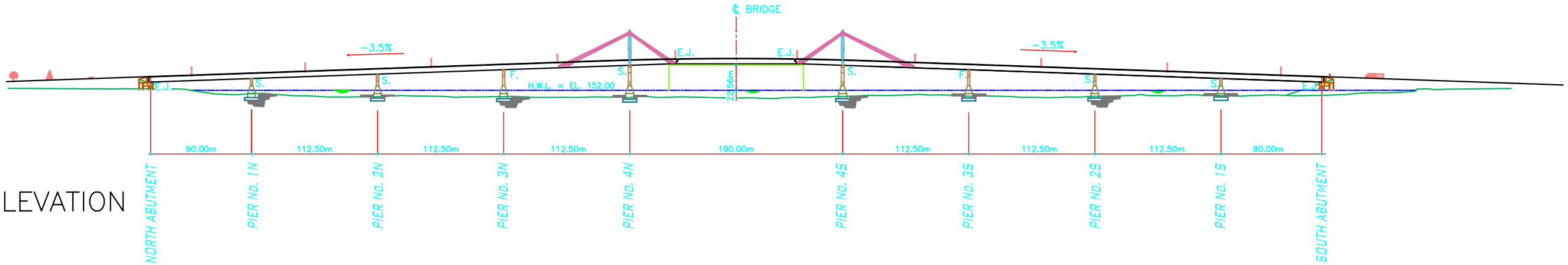
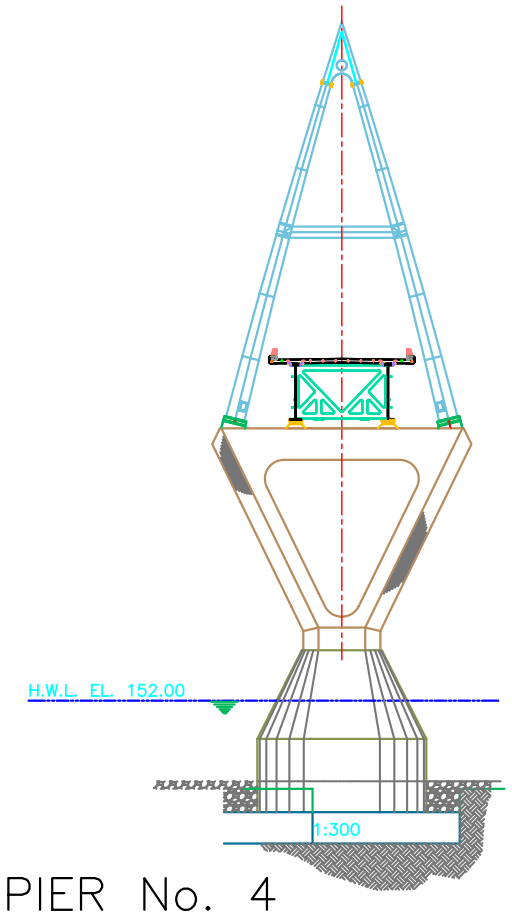


ELEVATION



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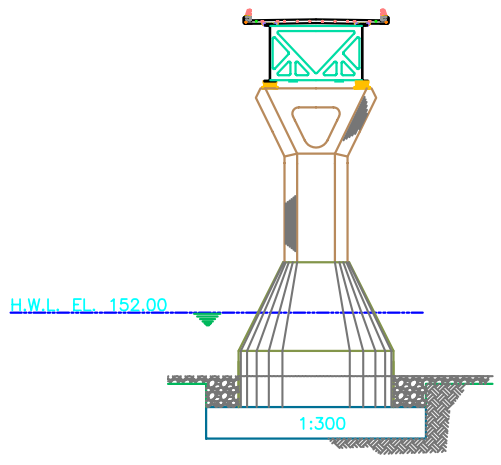
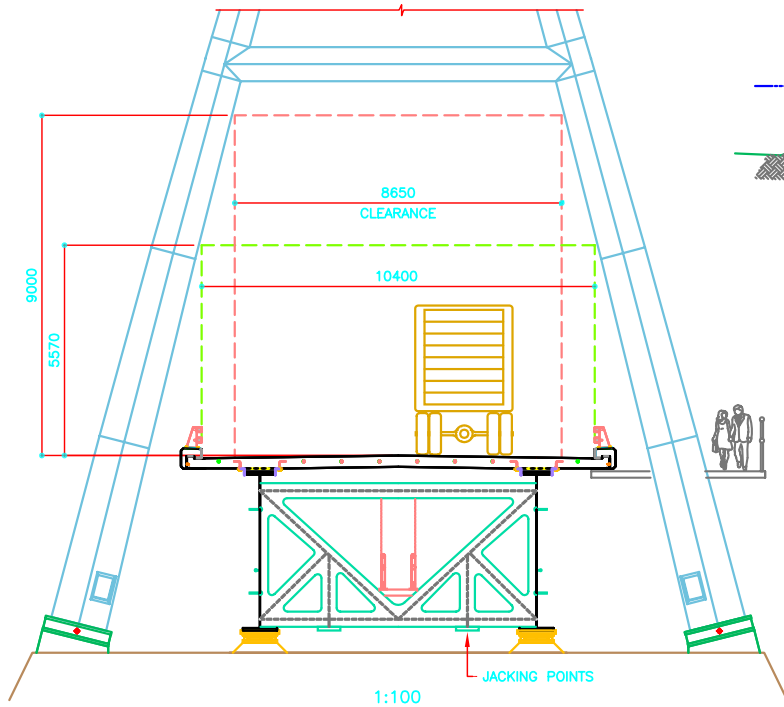


PIER's 1, 2 & 3



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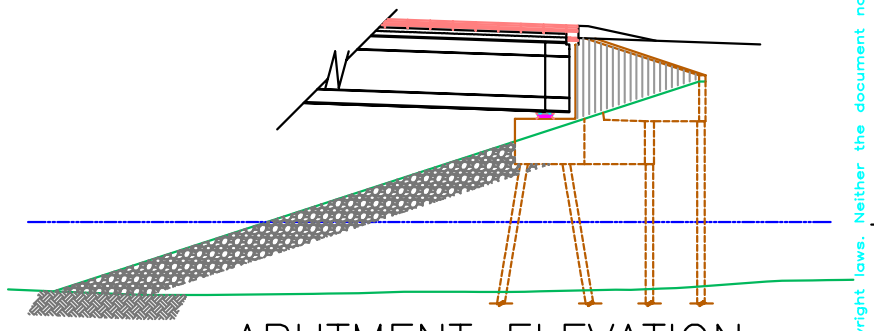
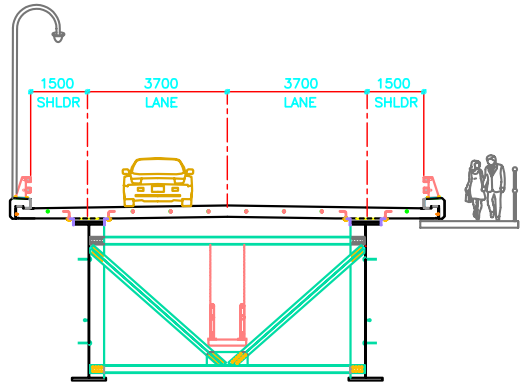


ABUTMENT ELEVATION



TYPICAL SECTION

Deh Cho Bridge Corporation

ALL DIMENSIONS & ELEVATIONS ARE APPROXIMATE & ARE SHOWN FOR REPRESENTATION ONLY

REV	DATE	DESCRIPTION

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Project

YELLOWKNIFE HWY#3 Km 23
DEH CHO BRIDGE
ON MACKENZIE RIVER

Title

PROPOSED
BRIDGE
PLAN & PROFILE

Scale 2000
Surveyed by
Drawn by R.Loeppky date : 04.01.29
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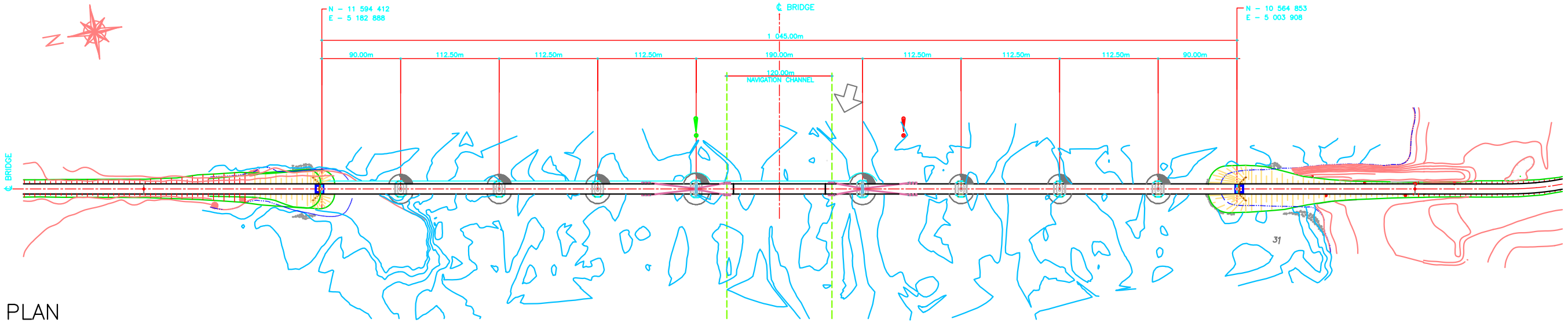
22x34 METRIC FILE NAME : DEH CHO – 000-a

PLOT DATE : 04.02.09



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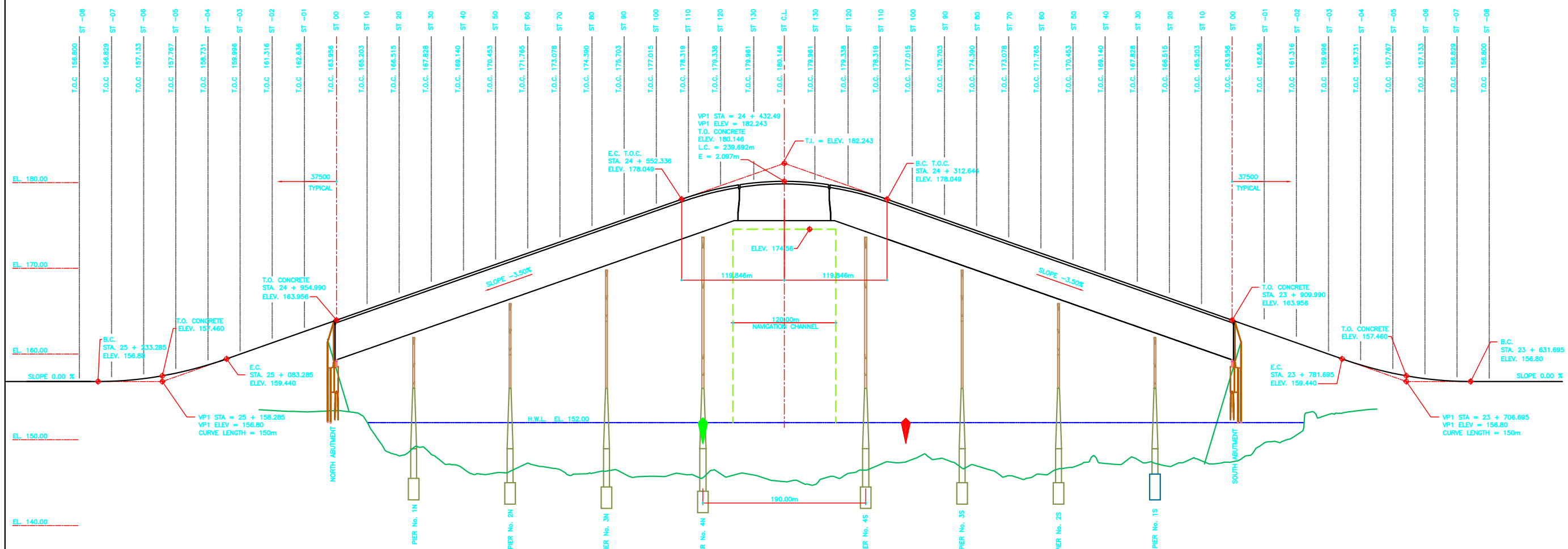

ELEVATION

HORIZ. SCALE 1:2500

VERT. SCALE 1:250

NOTE: ALL DIMENSIONS ARE BASED ON HORIZONTAL PROJECTIONS

Deh Cho Bridge Corporation

ALL DIMENSIONS & ELEVATIONS ARE APPROXIMATE & ARE SHOWN FOR REPRESENTATION ONLY

REV	DATE	DESCRIPTION

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Project

YELLOWKNIFE HWY#3 Km 23
DEH CHO BRIDGE
ON MACKENZIE RIVER

Title

PROPOSED
BRIDGE
PLAN & PROFILE

Scale 2500
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