

Innovative Infrastructure Designs to Accommodate High-Loads and Over-Dimensional Loads through the Fort McMurray Area

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ABSTRACT

The Alberta Oil Sands (Oil Sands), located north of Fort McMurray are a major contributing factor in Alberta's economy, with billions of dollars spent each year on constructing facilities to extract bitumen from the Oil Sands. Many of the key components of bitumen are manufactured off site and hauled to various locations using Alberta's highways. Numerous loads are transported each day along Highway 63, which is a high-load (or over-dimensional) corridor, through Fort McMurray to the various Oil Sands plant sites to the north.

Objectives: Alberta Transportation (AT) must provide a high-load corridor that safely accommodates the general public, as well as, the transportation of oversized loads moved using transport vehicle combination units from the Nisku areas along Highway 63 through the Fort McMurray area, and to the various Oil Sands plant sites to the north.

Methodology: AT has undertaken a number of initiatives to make sure its infrastructure is designed to accommodate the oversized vehicles, including:

- Highway 63 is currently being designed as a twinned highway. Consideration is being given to widening the right travel lane to accommodate the wider trailers carrying the larger loads. This will promote the safety of all users and maintain a reasonable level of service when sharing the highway.
- Presently, in Fort McMurray from Morrison Street to Confederation Way, the existing four-lane divided rural highway is undergoing a staged construction of upgrades to develop a multi-lane freeway with collector-distributor lanes and core lanes. This includes 10 lanes crossing over the Athabasca River, high-load bypasses around Thickwood Boulevard Interchange and Confederation Way Interchange, and a removable interlocking median Vulcan gate barrier system (on wheels) that can be moved in a matter of minutes.
- A high-load bypass was constructed at Thickwood Boulevard Interchange using a tiered wall design that accommodates the current oversized design vehicle.

Conclusions: The high-loads or over-dimensional loads have increased substantially over the past number of years. AT's highway system has many elements which impose limitations and new construction must consider this unique demand.

Background

The Oil Sands north of Fort McMurray are a major driver of Alberta's economy, with billions of dollars spent each year on constructing facilities to extract bitumen from the Oil Sands. Manufacturing of the components for these facilities is completed offsite and hauled to various locations using Alberta's highways. Alberta has several dedicated high-load corridor routes throughout the province, including one from the Nisku area south of Edmonton along Highway 63 through the Fort McMurray area, and to the various Oil Sands plant sites to the north. The oversized loads must follow the high-load corridor route. Refer to **Figure 1 – High-Load Corridor Map** and **Figure 2 – Key Map** located in the **Figures Section**.

This paper focuses mainly on design challenges in the Fort McMurray area and the design measures implemented to address the safe movement of these oversized loads.

The oversized loads are comprised mainly of construction equipment, vessels, coker drums and pipes, and they vary in size and weight. As the cost for items such as fuel, royalties and environmental levies increase, loads are strategically becoming larger to reduce the number of trips required to move them. Loads are currently limited by maximum width, height and weight. The volume of oversized loads can vary significantly depending on the construction projects active in the Oil Sands sites. In 2010, there were a total of 1042 oversized loads issued permits to travel to the Fort McMurray area, and the monthly volumes ranged from a low of 49 loads to a high of 136 loads. These monthly volumes were taken at a period when development activities were relatively low at the Oil Sand sites.

In Fort McMurray specifically, the numerous constraints which have been encountered along the high-load corridor route are as follows:

- **Utilities** such as the major pipelines that follow Highway 63.
- **Existing geotechnical factors** such as unstable valley slopes.
- The **Athabasca River** crossing.
- **Road improvements** such as interchanges that are required to address high volumes of traffic from existing developments along the Highway 63 corridor as well as future developments.

Objectives for Transportation System Improvements

During the design of roadway improvements along Highway 63 for AT, the designers aim to provide high-load corridor improvements that would accommodate the following as cost-effectively as possible:

- Design the roadway to approved standards, while still designing the road to be as safe as possible.
- Develop designs for the safe and efficient movement of oversized loads being transported along Highway 63 through the Fort McMurray area, to the various Oil Sands plant sites to the north.
- Current and future traffic volumes for industry and municipal growth, based on long range planning data.

Transport Vehicle

An average highway truck-trailer is 4.1 m high and 2.6 m wide. The design vehicle will normally include one or two pull trucks (Tractors), one or two push trucks (Tractors), and four combination trailers (two at front and two at rear) that will be accompanied by a pilot vehicle in front and at the rear. The largest load recorded to date is:

- 102 m length / 11.8 m width / 13.0 m height
- Double Wide 10 Line Trailer width
- Double Wide 10 Line Road Style Scheuerle Transporter Trailer
- The truck and trailer maximum configurations for loads going to Kearn Lake was 334,568 lbs (about 167 tons), 64 m long, 7.3 m wide and 9.1 m high.

To receive a permit for the oversized loads, the transport company must prepare drawings indicating dimension and weight details. Refer to **Figure 3** – Typical Engineered Drawing by Transport Company.

When preparing to do a design that accommodates the oversized loads, the design criteria must meet the minimum requirements to accommodate high/oversized loads. The criteria was based on loads that have already been transported in Alberta. In addition, the design criterion was developed with input from the transport company. For the Thickwood Interchange, the design criterion included:

- Minimum 18 m of drivable road surface throughout the arc (R=82.8 m) where there is an abutment to the inside of the arc.
- Minimum 10 m drivable road surface in a straight away where an abutment to the inside (left side) of the load.
- Minimum 8 m drivable road surface where there is no abutment or any lateral restrictions.

Critical Issues/Design Considerations

Some of the issues and considerations taken into account when designing the corridor are as follows:

1. Oversized loads are typically slow moving and are wider than the lane they travel in and the faster traveling passenger vehicles tend to stack up behind the slower moving oversized loads. The Highway 63 high-load corridor route consists mainly of two-lane undivided rural roadway standard having 3.7 m travel lanes and 1.5m shoulders. There are limited opportunities for passing due to the terrain, and the oversized loads and pilot vehicles often obscure oncoming vehicles. Impatient passenger vehicle drivers often take undue risks, which can result in serious collisions.
2. Necessary infrastructure in place to accommodate movement of loads from origin to destination and back to origin.
3. Geotechnical challenges throughout Fort McMurray, especially along Highway 63 corridor, include unstable slopes between the west side of Highway 63 and the Athabasca River, from the north bank of the Athabasca River north to Confederation Way.
4. The major oil pipelines belonging to Suncor and Enbridge and Athabasca River along the east side of Highway 63 had to be avoided or relocated while maintaining continuous operation.

5. Inadequate land constraints for the development of interchanges to accommodate traffic demand. In conjunction, bypass facilities also had to be developed accommodate the oversized vehicles.
6. Cost sharing negotiations between Alberta Government and Oil Sands developers to modify and construct more complex infrastructure to accommodate the oversized loads has resulted in the need to evaluate a variety of alternatives in an effort to optimize the balance between capital costs and performance of the new facilities.

Methodology to Provide Infrastructure for Oversized Vehicles

AT has undertaken a number of initiatives to prove its infrastructure is designed to accommodate the oversized vehicles. In the rural areas, Highway 63 is planned to be twinned as a four-lane divided rural highway between Highway 55 to the Fort McMurray city limit. The design generally includes a widening of the right travel lane to 4.5 m to accommodate the wider trailers carrying the larger loads. The additional roadway width maintains a reasonable level of service and improved safety where the oversized loads and passenger vehicles are sharing the highway.

Potential Solutions:

1. The high-load corridor route will achieve improved traffic flow when the right travel lane is widened to allow for passing. In urban centers, an alternative would be to provide dedicated routes for high-loads to separate the oversized vehicles from the local traffic. In Fort McMurray, AT is exploring the alternative of an installation of separate collector-distributor roadways next to the highway corridor to improve traffic flow and minimize the disruption caused by the oversized vehicles passing through during the night.
2. In Fort McMurray, from Morrison Street to Confederation Way, the existing four-lane divided rural highway is going through a staged construction of upgrades to develop a multi-lane freeway with collector-distributor lanes and core lanes. Work includes development of 10 lanes crossing over the Athabasca River, using three separate structures to allow staged construction. Refer to **Figure 4** - Rendering of Highway 63 upgrade from Morrison Street (South of Athabasca River) to Thickwood Boulevard.
3. Dedicated high-load bypasses around Thickwood Boulevard Interchange and Confederation Way Interchange have been designed. Refer to **Figure 5** - Rendering of Thickwood Boulevard Interchange and Confederation Way Interchange.
4. A 60 m removable interlocking median Vulcan gate barrier system (on wheels) installed between the median concrete barrier that can be moved in a matter of minutes has been implemented. Refer to **Figure 6** - Photo of Typical Vulcan Gate Barrier System.
5. High-load warning system has been installed at King Street Interchange to use the interchange ramp to re-route over height vehicles around the interchange bridge to exit on the interchange ramp and not damage the new interchange bridge. The oversized vehicles then are routed up the ramps of the diamond Interchange at Hospital Street using clear signage.
6. Rotatable traffic signals have been installed on at-grade intersections so the signals can be temporarily moved out of the path of the oversized vehicles. Traffic signals using rotatable bases

at at-grade signalized have been implemented at the intersections along Highway 63 at MacKenzie Boulevard, Gregoire Drive, Hardin Street, and Morrison Street.

Applications and Solutions

Currently, the Thickwood Boulevard Intersection at Highway 63 is an at-grade intersection involving a triple bay left turn slot for northbound (NB) to westbound (WB) traffic and double right for eastbound (EB) to southbound (SB) traffic. As a result of the very high traffic volumes, AT made the decision to construct an interchange at this location. The site however, is constrained by a steep and somewhat unstable hillside on the east, the Athabasca River to the west, Conn Creek to the north, as well as Enbridge and Suncor Pipelines running through or next to the interchange site.

AT had completed several functional planning studies. Originally, the plan was to construct a traditional diamond interchange; however, the high traffic volumes resulted in the configuration being changed to a Parclo B/half-diamond with a double lane loop (with an R70) for the NB to WB traffic. The high-load bypass ramp was designed to merge with EB-NB traffic

The Regional Municipality of Wood Buffalo (RMWB) provided their input into the highway corridor Functional Planning Study so that it would accommodate planned local growth. RMWB requested AT to split local and non-local Highway 63 traffic, by having through traffic accommodated by the highway and a CD road each side to handle the local traffic.

When AT reviewed the functional design they requested a R90 loop radius be used on the double lane ramp to handle higher speed traffic approaching the loop ramp. The larger radius pushed the high-load bypass closer to the river and projected the fill sideslopes out into the flood plain of the Athabasca River. Refer to **Figure 7** - Geometric Layout of Thickwood Boulevard Interchange.

To minimize impacts on the river and environmentally sensitive areas, the design proposed to retain sideslope fills outside of floodplain through the use of retaining walls however walls extended 12m in height posed a global stability problem. As the interchange moved closer to the river, existing ground was at a downgrade. A tiered wall at 6 m increments (upper wall & lower wall) provided improved stability. EB-NB traffic access was located along the upper wall and high-load bypass was developed between the upper and lower MSE wall. Refer to **Figure 8** – Thickwood Boulevard Interchange Cross-Section. Refer to **Figures 9** – Construction Photos.

The transport company was contacted to review the design and they provided the previously noted design requirements based on accommodating largest loads they had hauled up to that date. Further discussions with the transport company revealed that a wider path would be needed to allow larger loads to navigate around the outside the edge of the wall.

When the transport company suggested increasing the design vehicle criteria AT requested that a second option be examined. This alternative included an elevated ramp to tie in with the EB to NB ramp which would situate the bypass 12 m in fill height. Following a cost benefit analysis this alternative was ruled out.

A high-load bypass is being developed around the east side of **Confederation Way Interchange**. This interchange utilizes a trumpet interchange configuration, and the bypass was incorporated into the standard interchange due to limited right-of-way. To implement this design, a major pipeline relocation was required.

Removeable median barrier (using Vulcan Gate System) to accommodate high-loads to cross traffic and access the southbound lanes through the interchanges. The path followed southbound on-ramp of Thickwood Boulevard Interchange, cross Thickwood Boulevard, access southbound off-ramp, remain on southbound auxiliary lane, access southbound on-ramp of Confederation Way, cross Confederation Way, access southbound off-ramp, head to nearest at-grade intersection. A future median cross-over will be provided when the existing at-grade intersection is removed and a systems interchange is constructed 3.2km north of Confederation Way. **Refer to Figures 10a-c** for High-load Bypass Route. The Route is shown in “blue” and the alternate high-load bypass route is shown in “Red” (should largest load not be accommodated around loop ramp).

Design Development Example for the King Street Interchange High-Load Bypass

At the **King Street Interchange**, the high-load bypass was designed utilizing the northbound ramp along the east side of King Street Interchange. Prior to this interchange being constructed there was minimal separation between the at-grade intersection at Highway 63 and a T-intersection at King Street and Tolen Drive. Left turn movement from SB-EB and WB-SB became unsafe due to increased traffic along Highway 63, as well as, increased traffic along King Street. With the new interchange, a five-legged intersection needed to be constructed very close to Highway 63 in the proximity of the Hanging Stone River. This was identified as an ideal location for a roundabout. The interchange was constructed with a half diamond on the west side, however in order to accommodate high-loads, the roundabout was moved further east to allow half-diamond ramps for north bound traffic. It was set up so high-loads could access ramps to exit/enter Highway 63. Refer to **Figure 11** - Photos of King Street Interchange

Design Development Example for the Highway 63 and Highway 69 Intersection High-Load Bypass

A Functional Design plan involving a roundabout at Highway 63 and Highway 69 has been developed to allow removal of at-grade traffic signals. This plan will allow free flow traffic movements for south bound vehicles. The roundabout has been configured so the over sized loads can pass through the center of the roundabout using two gated openings in the central island to accommodate the super high-loads. Measures include a mountable apron that can act as an extension of the travel lane, allowing the use of both circulating lanes on the multi-lane roundabout. The two openings for the oversized vehicles are aligned with Highway 63 north and southbound approaches. These openings will be 7.4 m

wide and will be gated on both approaches to prohibit regular traffic from utilizing these openings. Refer to **Figure 12** - Conceptual design of roundabout at intersection of Highway 63 and Highway 69.

Conclusions

The size and number of high-loads or over-dimensional loads have increased substantially over the past few years. Alberta Transportation's highway system has many elements that impose limitations and new construction must consider this unique demand. Engaging the Alberta Oil Sands early in the project phase will be important in order to carefully assess the immediate impacts, constraints, costs and possible land acquisition to accommodate the complex roadway geometry. This will promote for better opportunities for partnering to alleviate some of the issues and enable innovative solutions. It will also be important to understand the long term goals of the Alberta Oil Sands and assess how it coincides with Alberta Transportation's goals. A common goal must be achieved.

With the increase in traffic demand in the Fort McMurray area, infrastructure will become more complex and challenging for the designer. Various design ideas done elsewhere in the world can be implemented in Fort McMurray. The Alberta Oil Sands may want to consider the possibility of other means of transport such as rail, air, or water for loads that exceed the highway limitations.

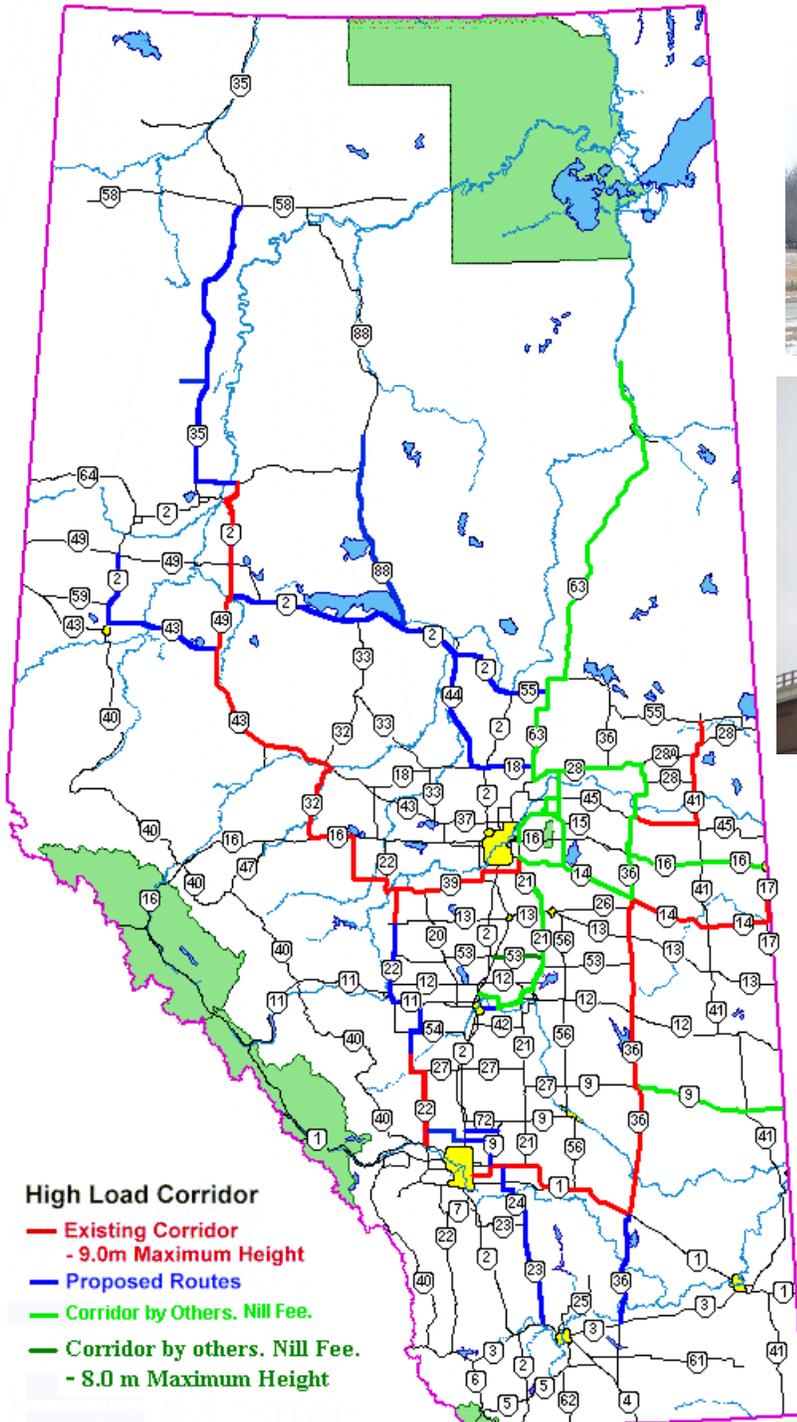
References

Government of Alberta Ministry of Transportation: High-Load Corridor. (n.d.). Government of Alberta Ministry of Transportation:. Retrieved June 30, 2011, from <http://www.transportation.alberta.ca/3192.htm>

Rahman, M. (2011, May 06). Statistics for High-loads or Over-Sized Vehicles using Hwy 63 [E-mail].

Figures

Figure 1 – High-Load Corridor Map



Alberta Transportation

Figure 2 – Key Map

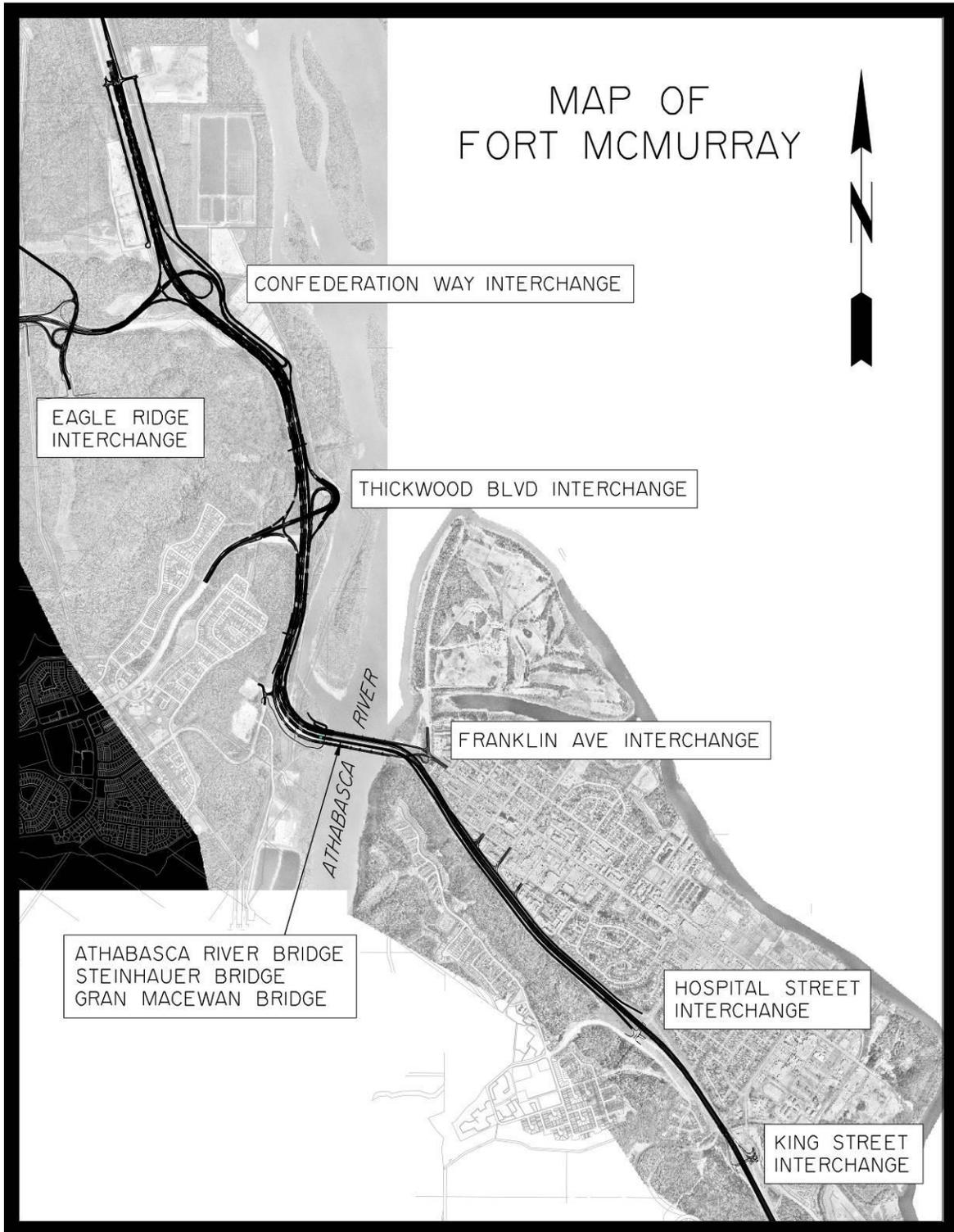


Figure 3 – Typical Engineered Drawing by Transport Company

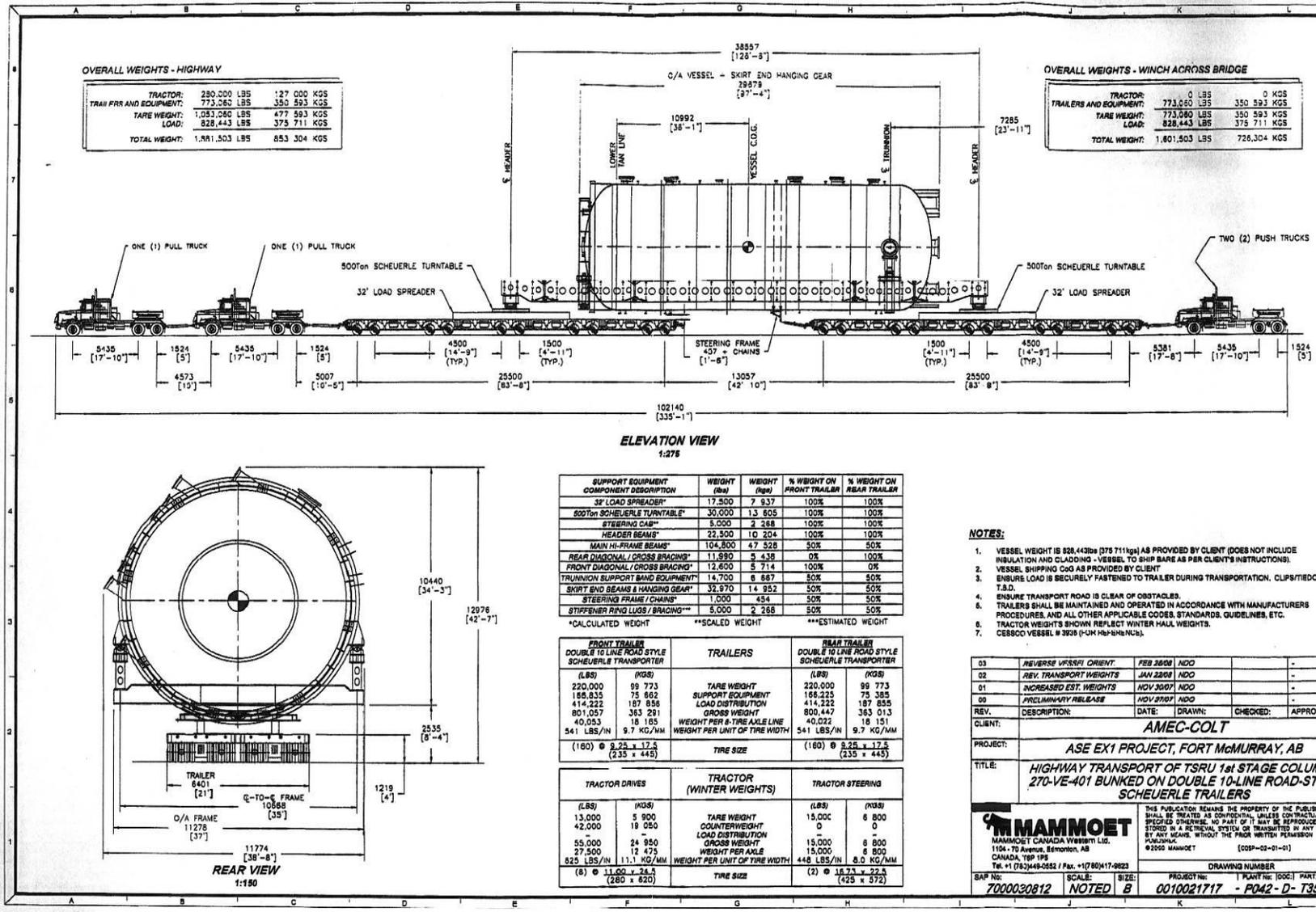


Figure 4 – Rendering of Highway 63 Upgrade from Morrison Street (South of Athabasca River) to Thickwood Boulevard



Figure 5 – Rendering of Thickwood Boulevard Interchange and Confederation Way Interchange



Figure 6 – Photo of Typical Vulcan Gate Barrier System

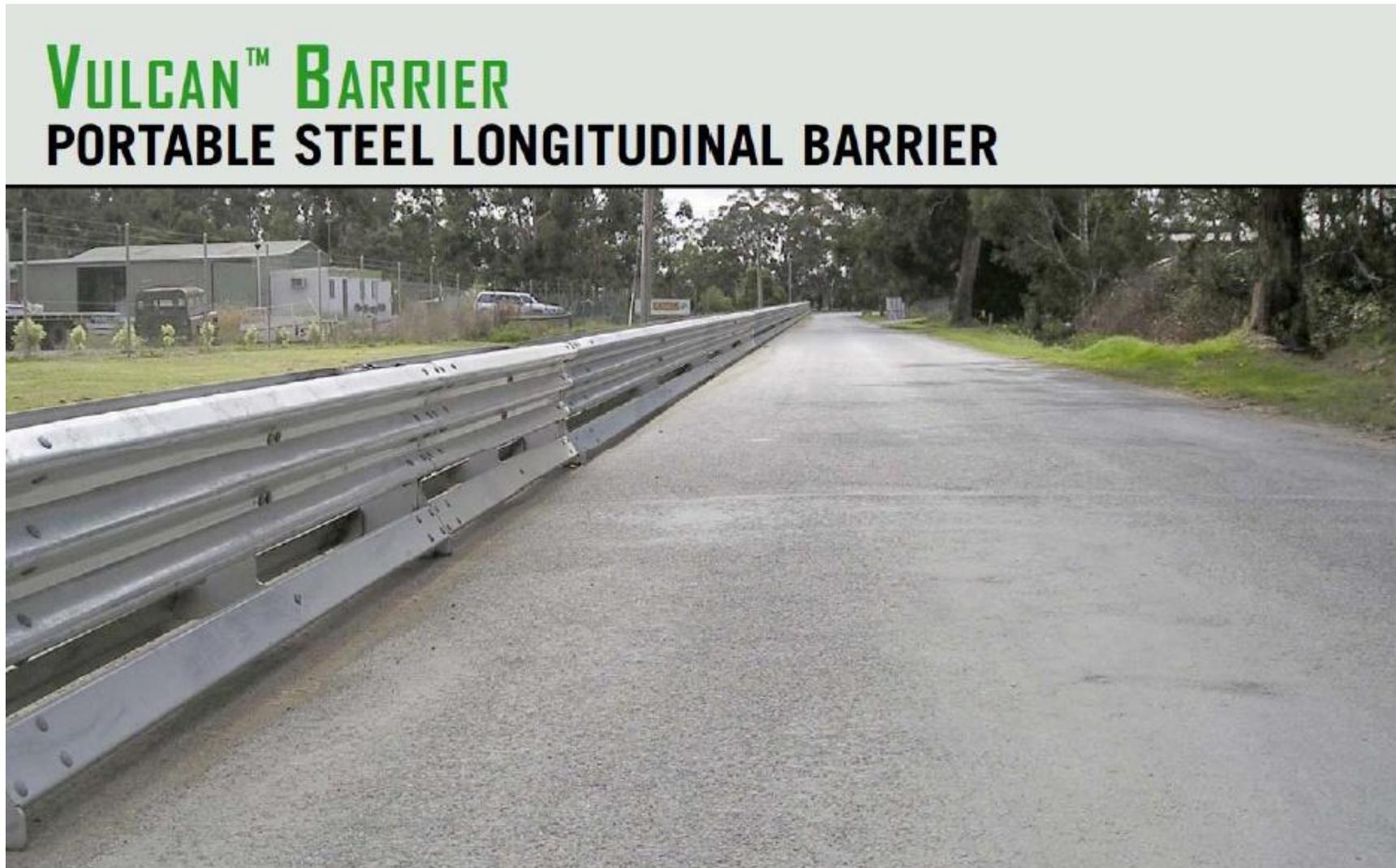
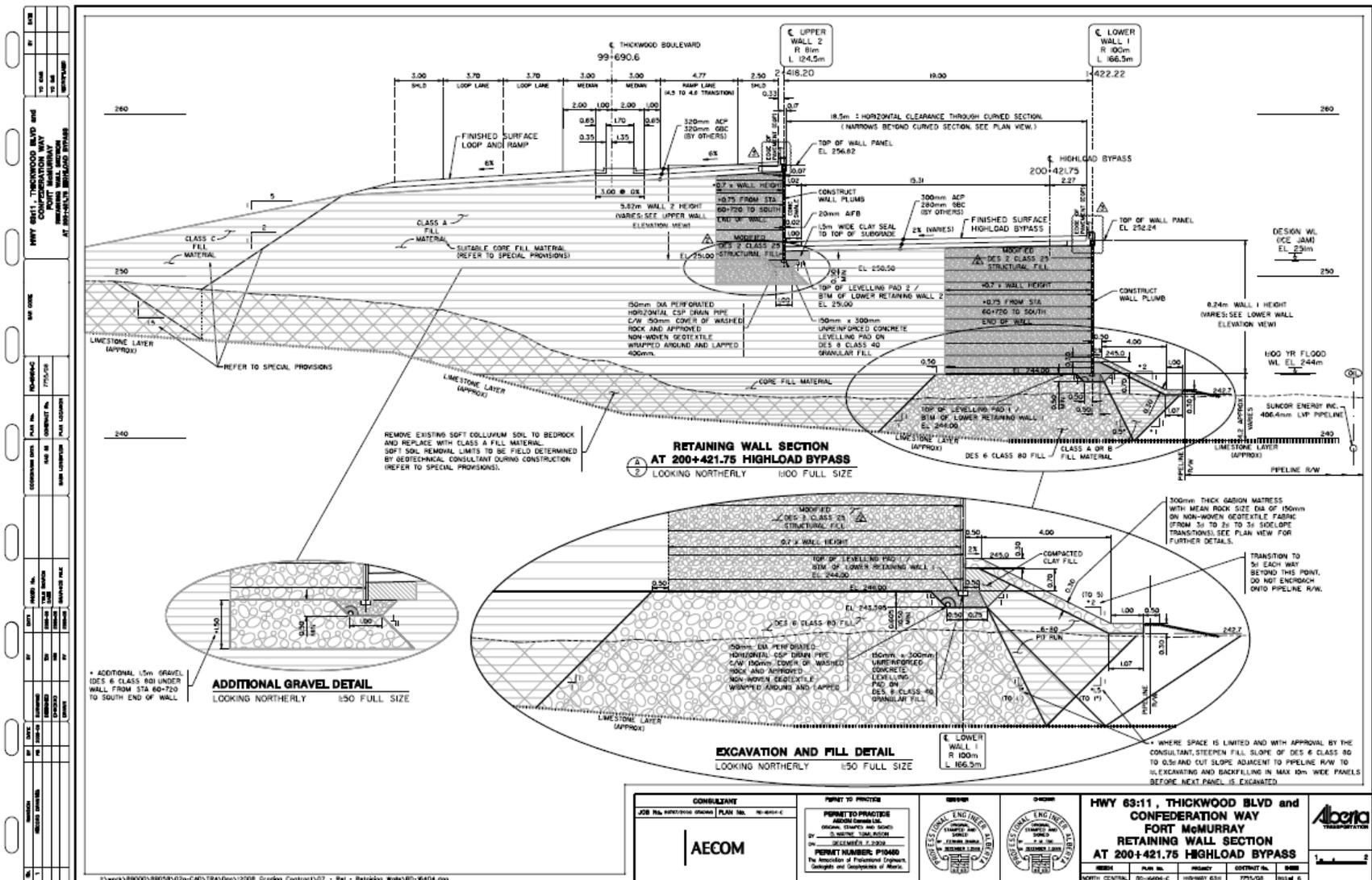


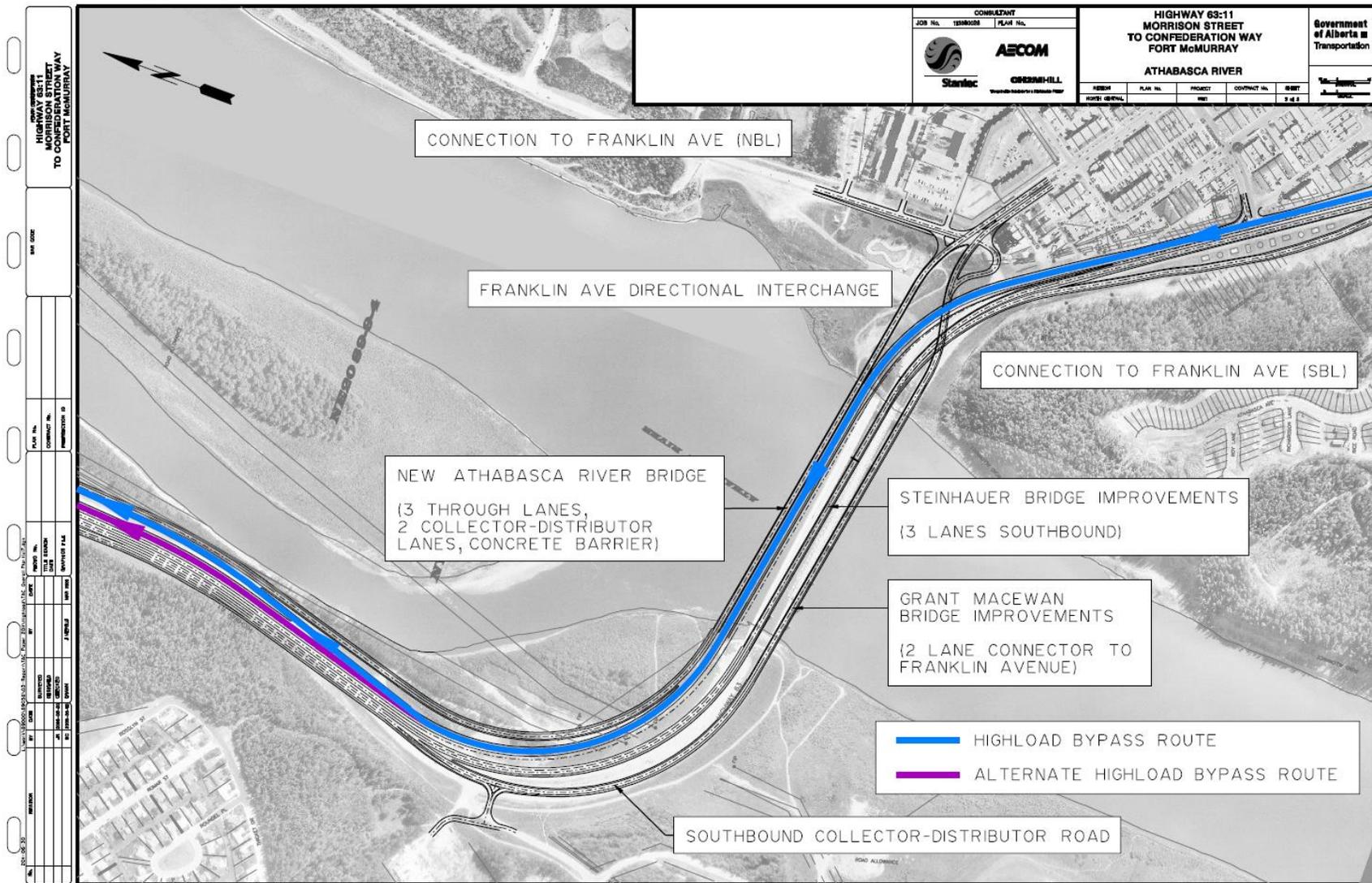
Figure 8 – Thickwood Boulevard Interchange Cross-section

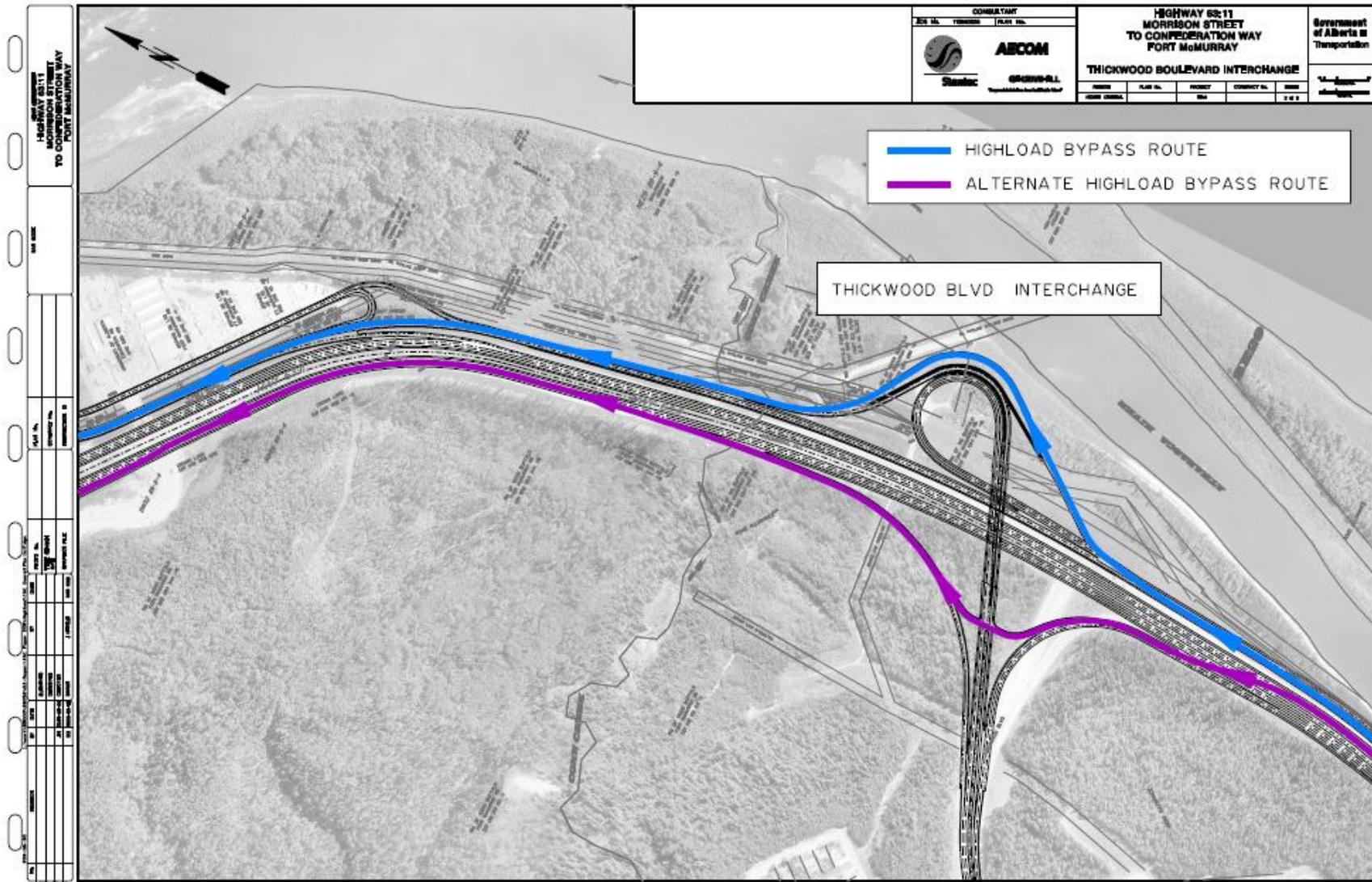


Figures 9 – Construction Photos



Figures 10a-c – High-Load Bypass Route





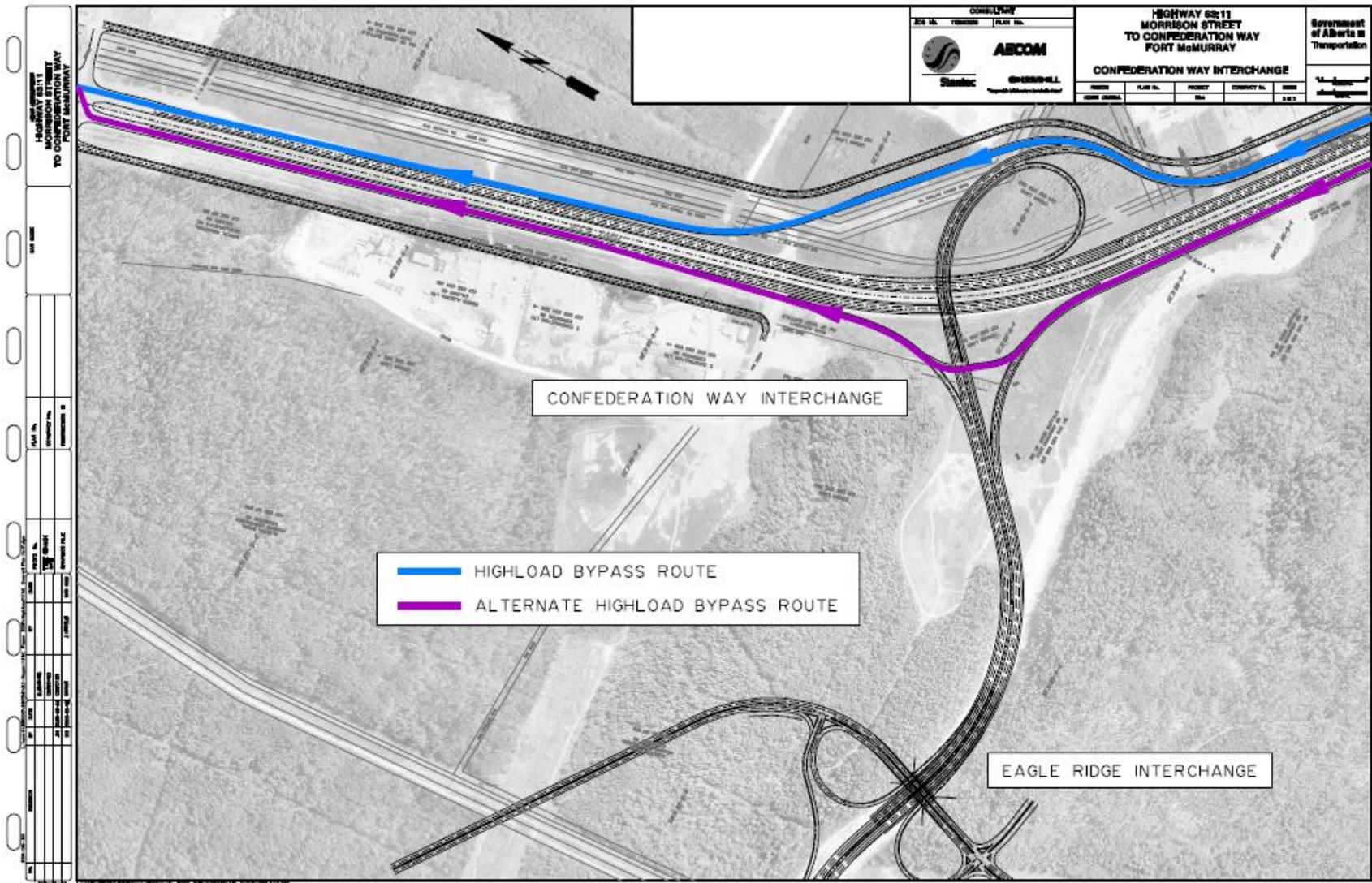


Figure 11 – Photos of King Street Interchange



Figure 12 - Conceptual Design of Roundabout at Intersection of Highway 63 and Highway 69

