



Case Study

Climate Change Infrastructure Vulnerability Assessment for

The Quesnell Bridge - Edmonton, Alberta

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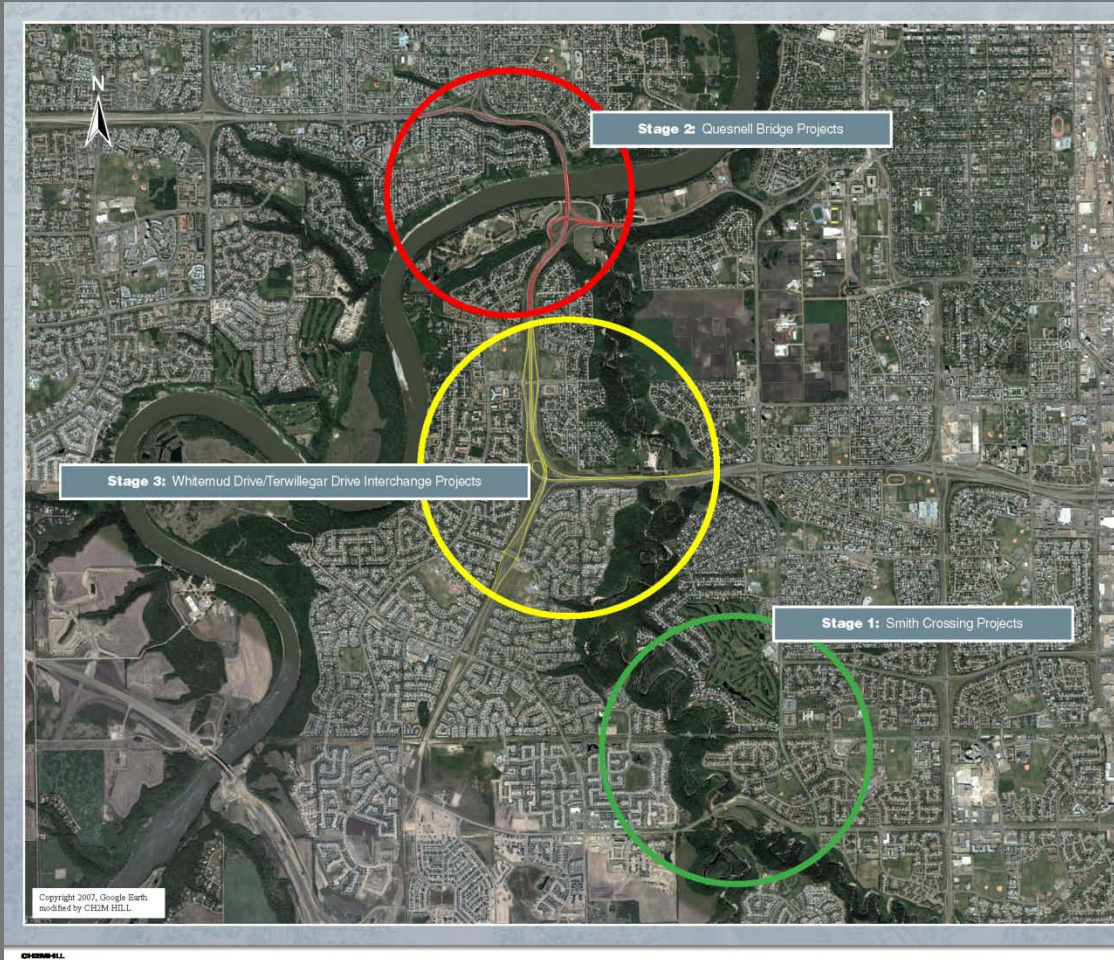
Case Study Infrastructure

- Host City: City of Edmonton
- Infrastructure category:
 - Roads and Associated Infrastructure
- Infrastructure owner: City of Edmonton
- Consultant: CH2M HILL Canada Ltd.

- Infrastructure: Quesnell Bridge over the North Saskatchewan River



Infrastructure Site



Whitemud Drive & Quesnell Bridge Project Edmonton, AB



West/Southwest Project Groups

Stage 1: Smith Crossing Projects
Twinning of 23 Avenue from 119 Street to Hodgson Way, and twinning of 119 Street from 34 Avenue to 23 Avenue

Stage 2: Quesnell Bridge Projects
Rehabilitation and widening of Quesnell Bridge, Fox Drive Overpass and Whitemud Drive

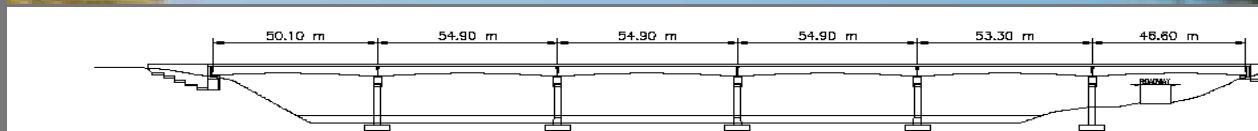
Stage 3: Whitemud Drive/Terwillegar Drive Interchange Projects
Reconfiguration and reconstruction of the interchange, and completion of the interchange at 40 Avenue and Terwillegar Drive





Quesnell Bridge

- Links Whitemud Dr. and access road to Fort Edmonton Park
- Constructed in 1968
- 315 m long
- 6-span over North Saskatchewan River
- 3 lanes each direction
- 114,000 vehicles per day
- Parabolic pre-cast concrete girders, with cast-in-place deck



Quesnell Bridge – Current Situation

- functionally obsolete due to increased traffic volumes
 - currently undergoing rehab and widening
 - constructed 1968
 - girders & substructure in good condition
 - deck exhibiting deterioration/corrosion
 - drainage needs improvement
 - possible use of RWIS & automatic chemical de-icing
 - mandate for rehab: extend life by 50 years
-
- Time frame for this assessment: 50 years



Quesnell Bridge



Deviations from PIEVC Protocol



- The assessment was substantially compliant with the PIEVC Protocol
- Step 3 minor modification: Prioritization category threshold for “No vulnerability identified” changed to $P_c \leq 16$

Climate Factors

- Edmonton:
 - northern continental climate
 - extreme seasonal temperatures
 - fairly dry
 - frequent thunderstorms, occasionally severe
 - tornadoes, hail storms, etc
- Historical events
 - 1915 flood
 - tornadoes/storms increasing
 - extreme events
 - sequenced events



In Edmonton: A number of extreme climatic events have been recorded since the 1900s



Year	Incident	Cost/Impact
1901	Thunderstorm: Hail the size of pigeons	N/A
1915	Flood: North Sask. River	2,000 Homeless
'42, '57, '64, '72	Blizzard/Snowstorm	4 dead (1964)
'44, '52, '53	Flood	N/A
1949	Tornado: Outskirts of Edmonton	N/A
'53, '72, '78, '86	Flood: 1978 – high local rainstorm	\$4-8M
'87, '89	Tornado: 1989 most severe	\$665M, 27 dead
'79, '82, '89, '97	Blizzard/Snowstorm: '82 severe	\$1.7M, 2 dead
'92, '93, '95, '04	Hailstorm: 2004 most severe	\$21-\$74M

Climate Baseline

- **Wind Pressure Load** – 600 locations, 1990 latest update
- **Temperature (Daily Max and Min)** – 30 years of record up to 1970
- **Relative Humidity (Annual Mean)** – 10 years of data, 1957 to 1966 inclusive
- **Ice Load** – based on a 1976 update to the 1974 edition of the NBC

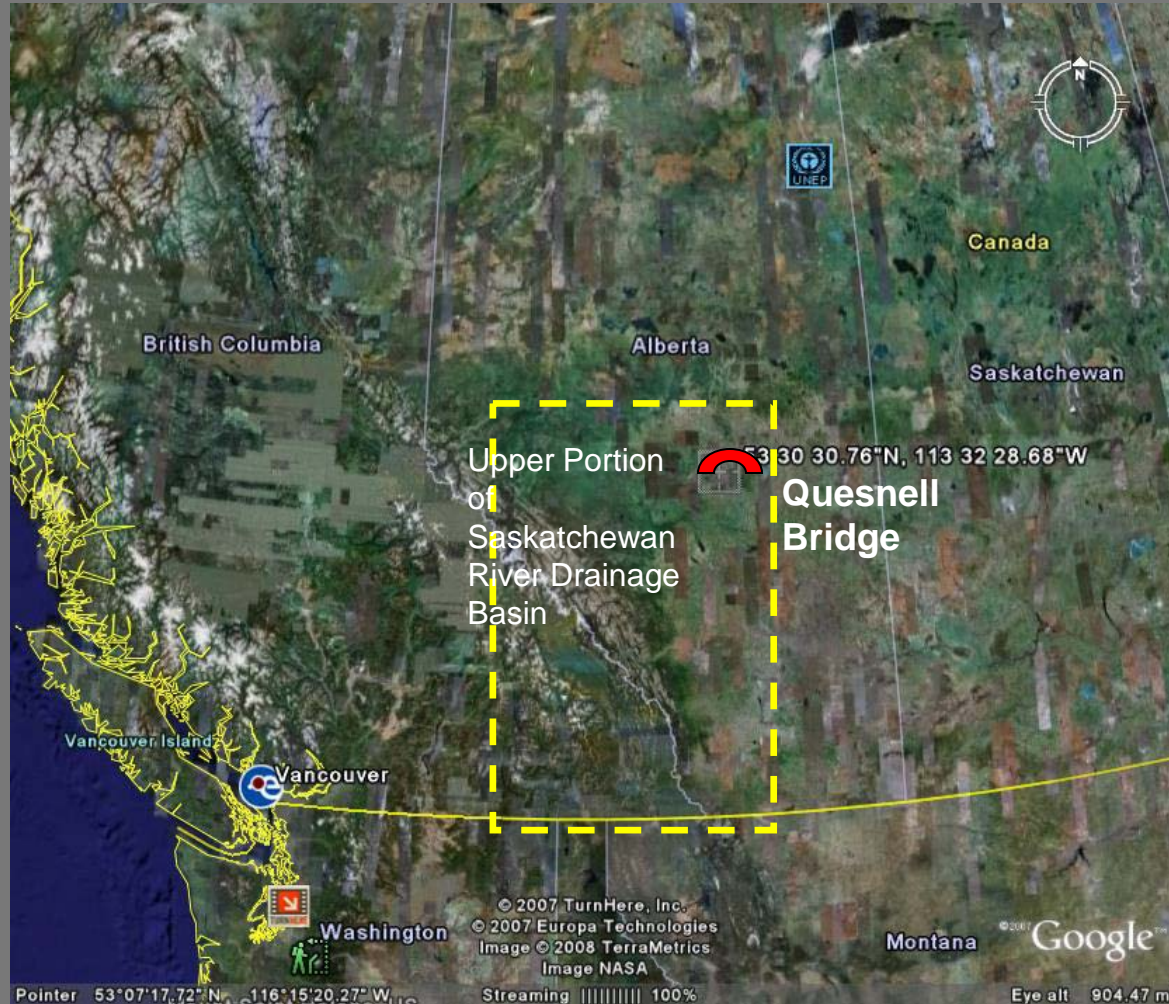


Modelling Approach for Quesnell Bridge Study

- Global Climate Model (GCM)
 - Topography of Upper Saskatchewan River Basin
 - Available historical meteorological data
- Supplemental Data
- Regional Climate Model (RCM)
- Forecast horizon 2050
- Data available from 9 weather stations in region



Upper Saskatchewan Drainage Basin



Climate Factors

- Relevant climate factors for climate change forecasting
 - temperature (high, low, range)
 - rainfall (frequency, intensity)
 - snow (frequency, intensity)
 - freeze/thaw cycles
 - ice accretion
 - ice build up
 - extreme wind/storm/tornado
 - hydrological (incl. river ice)
 - combination & sequenced events



Climate Factors

Uncertainty in projections for small scale / localized weather events:

- Wind
 - hurricanes, tornadoes, thunderstorms, wind gusts, rainfall
- Ice
 - ice build-up, ice accretion, freezing rain
- Snow
 - rapid melt events



Quesnell Bridge - Conclusions



- Structure generally robust
- Bridge has responded well to extreme events to date
- Combination or sequencing events pose greatest risk
- Potential vulnerabilities in:
 - wearing surface
 - water proofing membrane
 - deck drainage system
 - retention pond
- Potential performance response vulnerabilities:
 - operation/maintenance (e.g. snow clearing)
 - serviceability, safety (e.g. road flooding, icing)



Quesnell Bridge - Recommendations Related to Climate Change Impact

- Review base climate data used in design
- Consider sensitivity analysis for climate change in current rehab design

Cross Cutting Issues

- Climate design factors in S6 should be reviewed and updated
- Owners should regularly review local design guidelines and operations procedures
- Bridge structures
 - unlikely to be structurally deficient
 - scour may be a concern in certain locations
- Further study to consider
 - combination or sequencing of events
 - impact of land use planning



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