Needs Study of North Dakota Roads and Bridges

Status Report

Interim Energy Development and Transmission Committee

February 11, 2014

Upper Great Plains Transportation Institute
North Dakota State University
Background

• 2010 study: UGPTI estimated road investment needs for the 2011 session
  – Based on 21,500 new wells
• 2012 study: updated road investment needs for the 2013 session
  – Based on 46,000 new wells
  – Initial bridge study
• Current study: updated estimates based on higher forecasts (e.g., 60,000 new wells)
Why an Updated Study is Needed

• To reflect current economic forecasts
  – Changing/higher production forecasts for oil
  – Changes in agricultural production/densities
  – Growth in manufacturing/service industries

• To expand/improve initial bridge study

• To improve the accuracy of investment forecasts with detailed traffic, road substructure, and condition data; implement modeling improvements
Study Coordination

• NDDOT
• North Dakota Association of Counties
• North Dakota Township Officers Association
• Industrial Commission - Oil & Gas Division
• North Dakota Petroleum Council
• North Dakota Ag. Commodity Groups
• Kadrmas, Lee & Jackson Energy Study
• However, UGPTI estimates are independent
Status Report

• **Outputs/results**: What to expect and when

• **Analysis process**: How the study is being conducted (methods and data sources)

• **Data collection**
  – Field data (traffic, road condition, etc.)
  – Surveys

• **Timeline**
Results/Outputs

- Projected investment needs for county, township, tribal, and city roads
  - Entire state, by county
  - Next 20 years, by biennium
  - Paved and unpaved roads
- Projected investment needs: county bridges
- GIS maps
  - Improvements by type (e.g., recon., resurface)
  - Bridge location
Analysis Process: Major Steps

- Forecast annual production at spacing unit or township level (≈ 22,000 zones)
- Forecast inputs and products
- Convert quantities to truck trips
- Route trips to and from zones to minimize costs and meet demands
- Sum annual trucks trip on each road segment/convert to ADT
- Estimate equivalent single axle loads (ESALS)
Analysis Process: Additional Steps

• Calibrate model
  – Compare predicted trips in 2013 to observed trips
  – Adjust predictions (as necessary)
• Use engineering/economic methods and current construction costs to estimate the types of improvements needed, costs, and timing
• Sensitivity/scenario analysis
Model Improvements

• Updated road GIS network representing 75,000+ miles
• Connected bridges to road segments
• Implemented models in CUBE Software
  – Better estimation of automobile and general cargo traffic
  – Advanced calibration methods
• Updated investment models for paved roads and bridges
Primary Data Collection (completed)

- Methods: (1) surveys, (2) field collection
- Surveys: county & township costs and practices; city needs
- Field data
  - Traffic: volume counts & vehicle types
  - Paved road condition: Pathways van
  - Road geometry (e.g., width)
  - Structural pavement data: falling weight deflectometer (FWD) and ground penetrating radar (GPR)
Data Collection – Traffic Counts

• Traffic counts – volume and classification data on county and township roads for travel demand models and ESAL (equivalent single axle load) calculations:
  o Joint collection - NDDOT staff and NDSU students
  o Number of counts taken - 1000+
  o Number of classification counts – 670
County Traffic Counts 2013

- Volume Only
- Truck Classification
Pavement Data Collection

Objective – collect pavement distress, ride, strength and geometric information on paved county roads to determine remaining life and projected construction costs

• **Condition Data Collection**
  - Collect data with NDDOT pathway van
  - 5,600 miles of paved county roads
  - Van provides consistent pavement distress and ride information
  - Collection completed in summer/fall 2013

• **Pavement and shoulder width data**
Pavement Data Collection

- Non-Destructive Testing - verify prior estimates on subgrade strength
  - Falling Weight Deflectometer (FWD) and Ground Penetrating Radar (GPR)
  - Western ND – all pavements not recently improved
  - Eastern ND – selected based on agricultural production facilities and other major traffic generators
  - FWD will done first; GPR will be done on sites thumped with FWD
Data Collection – Cost Projections

- Gravel costs & production techniques
- Placement costs
- Transportation & placement costs
- Dust suppressant costs
- Intermediate practices
  - Stabilization armor coat
  - Double chip seal/armor coat
  - Others
Traffic Projections

• Oil
  o Multiple discussions with Oil & Gas Division
  o Well sites, sand locations, & transload facilities

• Agriculture
  o Statewide grain elevator shipment data
  o Forecasts of crop types and yields

• Passenger
• Manufacturing
• Through traffic
<table>
<thead>
<tr>
<th>Oil – Drilling Process</th>
<th>Trucks per Well</th>
<th>Inbound or Outbound</th>
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<tbody>
<tr>
<td>Sand</td>
<td>100</td>
<td>Inbound</td>
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<tr>
<td>Water (fresh)</td>
<td>450</td>
<td>Inbound</td>
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<tr>
<td>Water (waste)</td>
<td>225</td>
<td>Outbound</td>
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<tr>
<td>Fracturing tanks</td>
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<td>Both</td>
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<tr>
<td>Rig equipment</td>
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<td>Both</td>
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<tr>
<td>Drilling mud</td>
<td>50</td>
<td>Inbound</td>
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<tr>
<td>Chemical</td>
<td>5</td>
<td>Inbound</td>
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<tr>
<td>Cement</td>
<td>20</td>
<td>Inbound</td>
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<tr>
<td>Pipe</td>
<td>15</td>
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<tr>
<td>Scoria/gravel</td>
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<td>Inbound</td>
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<td>Fuel trucks</td>
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<tr>
<td>Frac/cement pumper trucks</td>
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<td>Inbound</td>
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<tr>
<td>Workover rigs</td>
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<td>Both</td>
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<tr>
<td>Total trucks</td>
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</table>
Oil Exploration Traffic Projections

Example of predicted traffic flows over road network

Preliminary estimates
Agricultural Shipment Projections

- **Known**: Crop production
- **Predict**: Truck trips and routes
- **Known**: Elevator & plant demands
- **Estimate**: Segment specific traffic
Crop Production and Location
Crop Movement Projections - Canola

Illustration based on preliminary work. Not final.
Modeling: Unpaved Road Maintenance

- Life-cycle cost analysis - graveling and blading
  - Normal levels (regraveling every 5 years, blade 1/month)
  - Increased levels (regraveling every 3-4 years, blade 2/month)
  - High levels (regraveling every 2-3 years, blade 1/week)
  - Usage of dust suppressant on impacted roads
Gravel Road Improvements

• Intermediate improvements
  o Graveling and base stabilization
  o Graveling and base stabilization with armor coat
  o Others as reported at the county level

• Asphalt surfacing: potentially at higher traffic levels
Pavement Performance and Traffic

AASHTO. AASHTO Guide for Design of Pavement Structures, 1993. Figure 1-2
Effects of Heavy Traffic on Paved Roads

Reduced Pavement Life Cycle (Hypothetical)

- New
- Traditional Traffic
- Oil Traffic

Time (Years)
ND Highway 68 (Real World Example)

Pavement Analysis Process

- Forecast annual ESALs
- Estimate remaining life given current condition and traffic levels
  - Detailed data on layer thickness and subgrade strength
  - Apply traffic projections and present serviceability rating
- Determine recommended improvements and costs based on width, starting condition, and future traffic estimates
ESAL Factors: Single Axle

- Single Axle Load in Thousand Pounds: 16, 18, 20, 22, 24
- ESALs: 0.645, 1, 1.47, 2.09, 2.89
Bridge Analysis & Projections

- 2,593 bridges on county/local system
  - 45% (1,167) more than 50 years old (theoretical design life)
  - 20% (519) more than 70 years old
Bridge Analysis & Projections

• Condition/appraisal data from National Bridge Inventory
  - 568 (22%) structurally deficient – one or more components rated in “poor” condition (not inherently unsafe, but needing attention)
  - 196 (8%) functionally obsolete – not designed to carry modern traffic volume, speed, size or weight
Bridge Analysis & Projections

• Current Needs
  o Criteria for rehabilitation/replacement based upon FHWA criteria and discussions with NDDOT personnel
  o Short span bridges to be replaced by box culverts
  o Replacement unit cost based upon recent county bridge projects
Bridge Analysis & Projections

• Future Needs
  o Apply deterioration models to forecast deck/superstructure/substructure condition
  o Forecast year of rehabilitation/replacement
  o Short span bridges to be replaced by box culverts
    o Near term bridge needs numbers must include comments of what can be built in a period/biennium
Bridge Impact Factors

- Structurally deficient bridges (current and projected)
- Weight limits
- Obsolescence
- Total number of trips affected
- Detour distance (additional VMT) attributable to bridge condition
- Costs: replacement and maintenance
## Study Timeline

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<thead>
<tr>
<th>Task</th>
<th>Start Date</th>
<th>Completion Date</th>
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<tr>
<td>Assumptions data collection</td>
<td>August 2013</td>
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<td>Jurisdictional data collection</td>
<td>June 2013</td>
<td>September 2013</td>
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<td>Traffic counts</td>
<td>June 2013</td>
<td>October 2013</td>
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<td>Cost &amp; practices survey</td>
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<td>Roadway &amp; bridge analysis, modeling, &amp; projections</td>
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<td>May 2014</td>
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<td>Draft report</td>
<td>July 1 2014</td>
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Study Outputs

• Needs – by biennium for next 20 years
  o Roads
    – Statewide
    – By county
    – By surface type
  o Bridges
    – Statewide
    – By county
Questions?

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Updates and background posted at
www.ugpti.org/