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

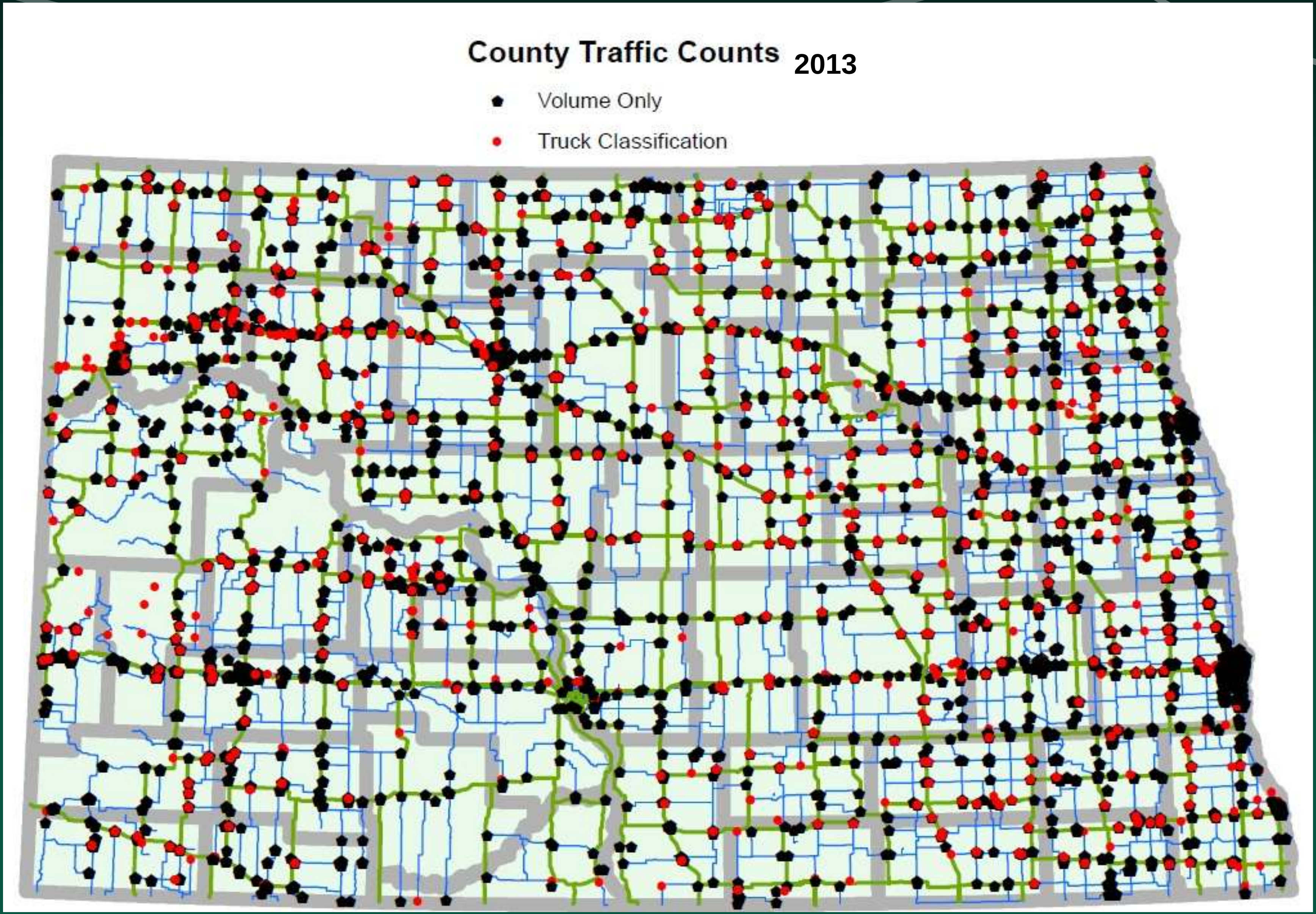
- Updated road GIS network representing 75,000+ miles
- Connected bridges to road segments
- Implemented models in CUBE Software
  - Better estimation of automobile and general cargo traffic
  - Advanced calibration methods
- Updated investment models for paved roads and bridges

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:
  - Joint collection - NDDOT staff and NDSU students
  - Number of counts taken - 1000+
  - Number of classification counts – 670


County Traffic Counts
2013
Volume Only
Truck Classification

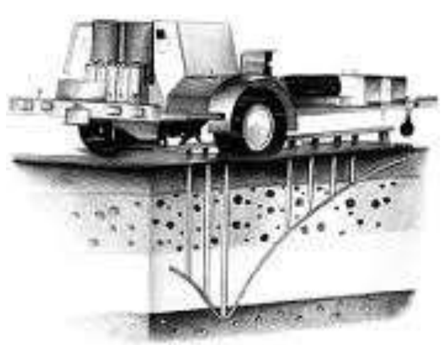
Pavement Data Collection

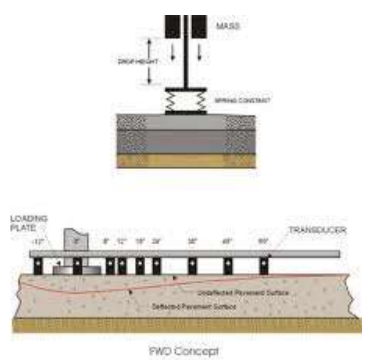
Objective – collect pavement distress, ride , strength and geometric information on paved county roads to determine remaining life and projected construction costs

- 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

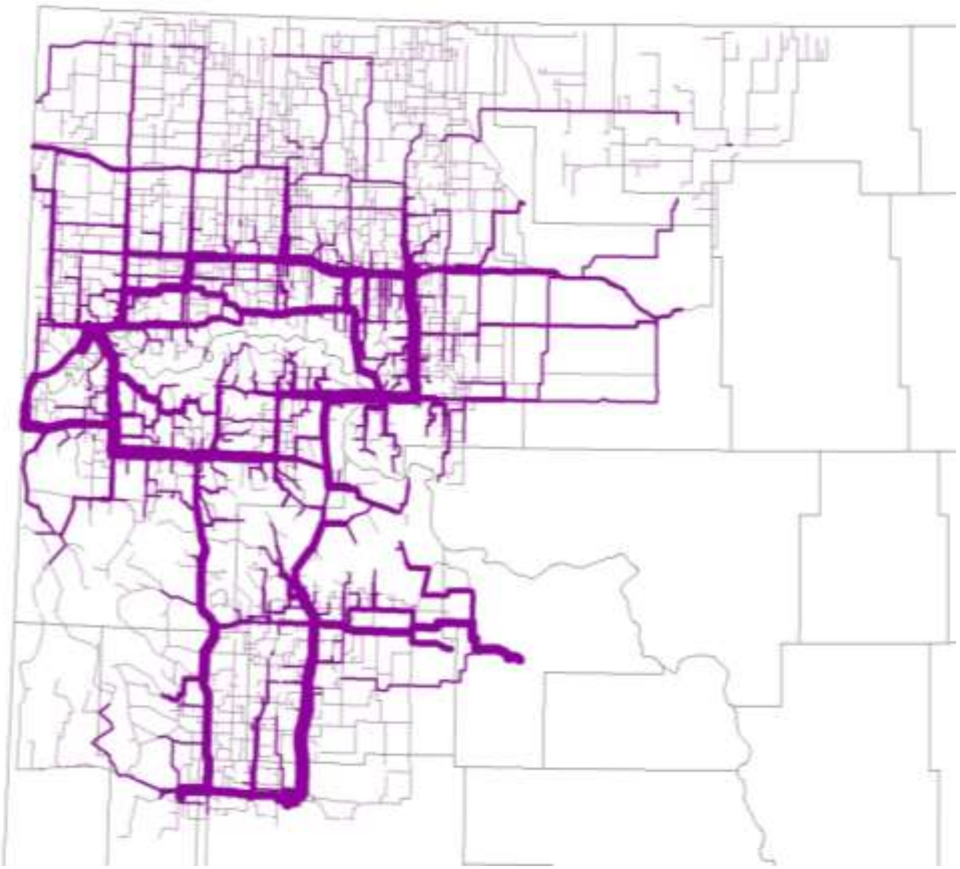
- Gravel costs & production techniques
- Placement costs
- Transportation & placement costs
- Dust suppressant costs
- Intermediate practices
  - Stabilization armor coat
  - Double chip seal/armor coat
  - Others

Traffic Projections

- Oil
  - Multiple discussions with Oil & Gas Division
  - Well sites, sand locations, & transload facilities
- Agriculture
  - Statewide grain elevator shipment data
  - Forecasts of crop types and yields
- Passenger
- Manufacturing
- Through traffic

Oil – Drilling Process	Trucks per Well	Inbound or Outbound
Sand	100	Inbound
Water (fresh)	450	Inbound
Water (waste)	225	Outbound
Fracturing tanks	115	Both
Rig equipment	65	Both
Drilling mud	50	Inbound
Chemical	5	Inbound
Cement	20	Inbound
Pipe	15	Inbound
Scoria/gravel	80	Inbound
Fuel trucks	7	Inbound
Frac/cement pumper trucks	15	Inbound
Workover rigs	3	Both
Total trucks	2,300	

Oil Exploration Traffic Projections



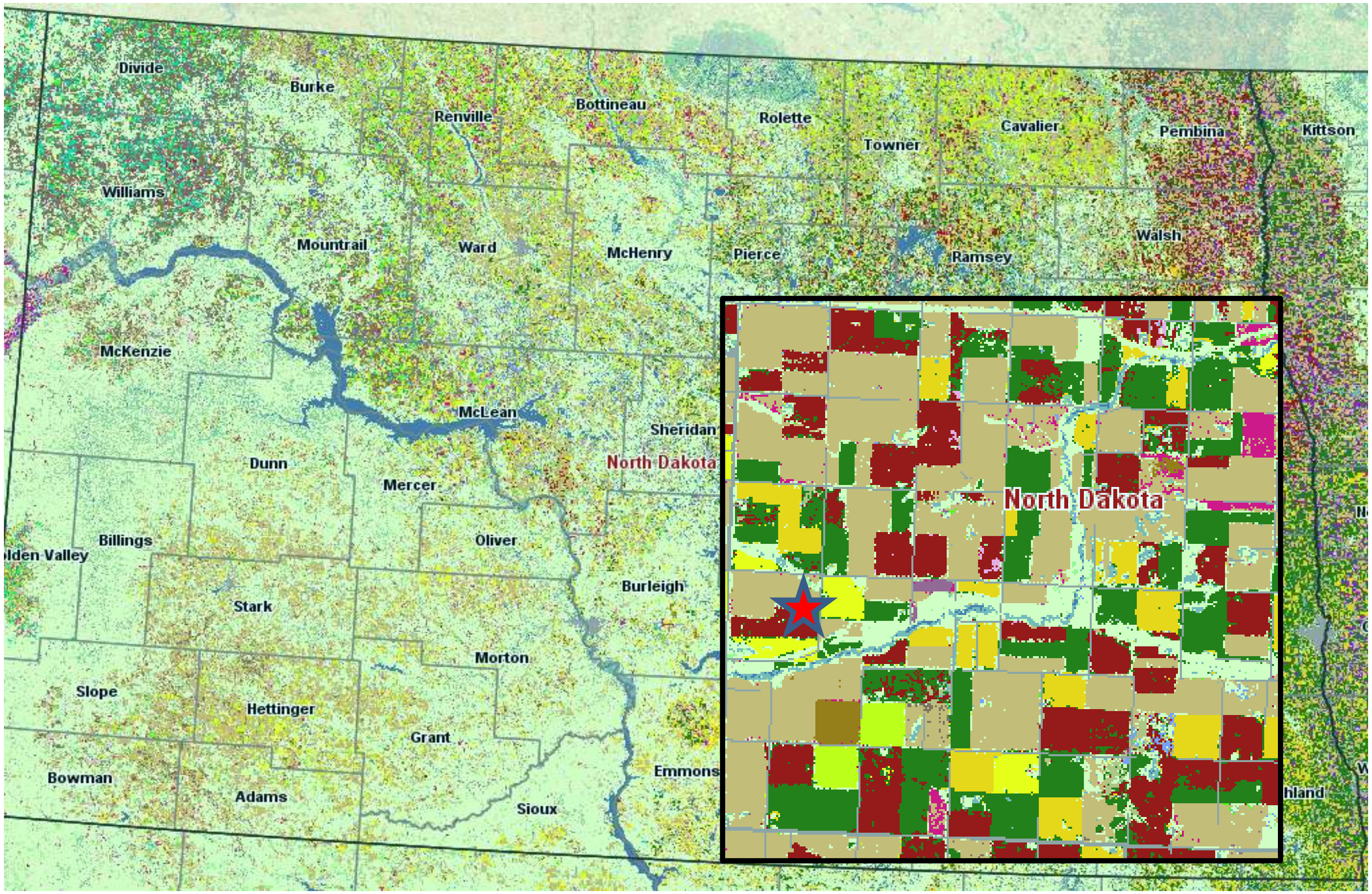
Example of predicted traffic flows over road network

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

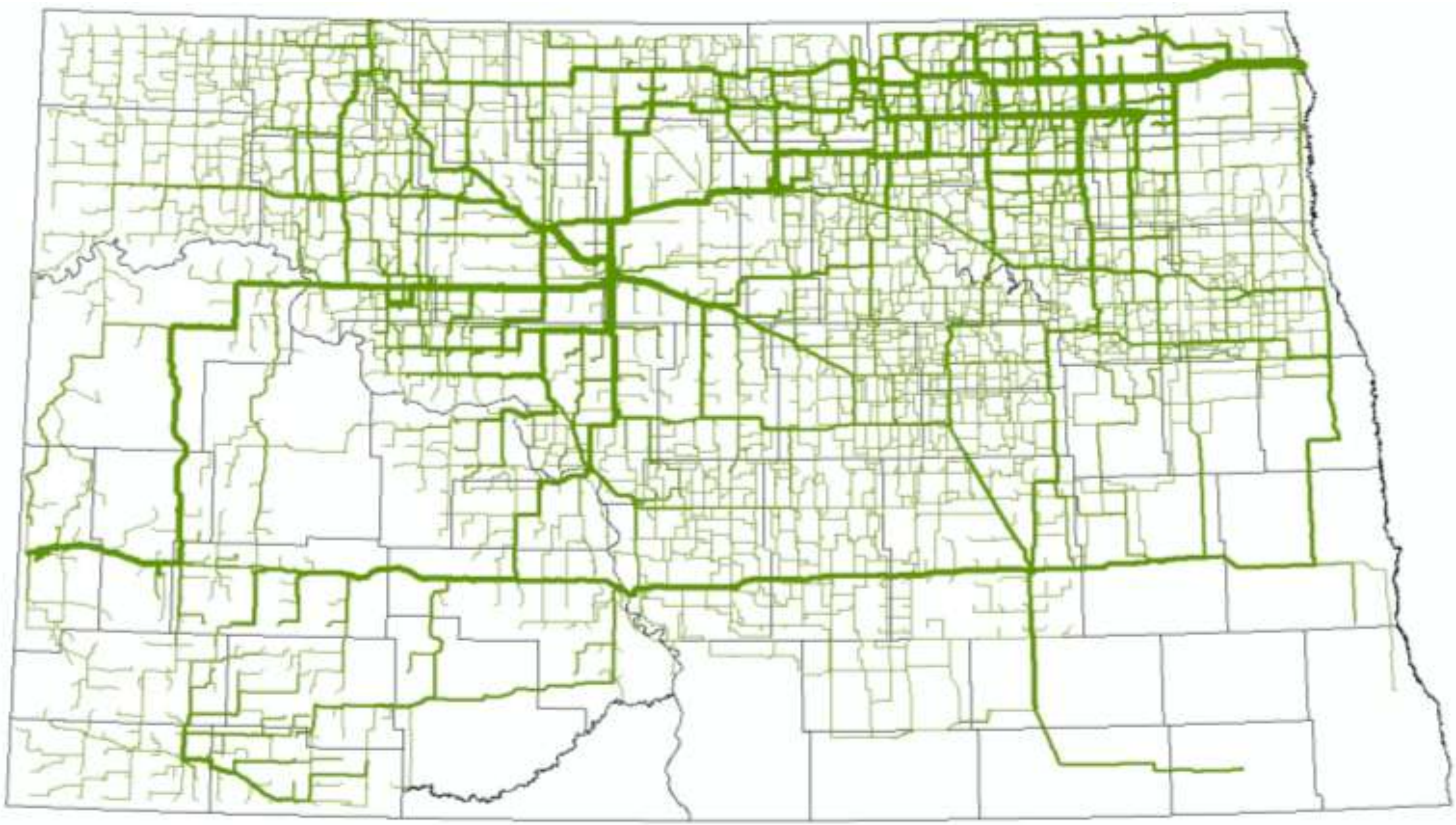


Illustration based on preliminary work. Not final.

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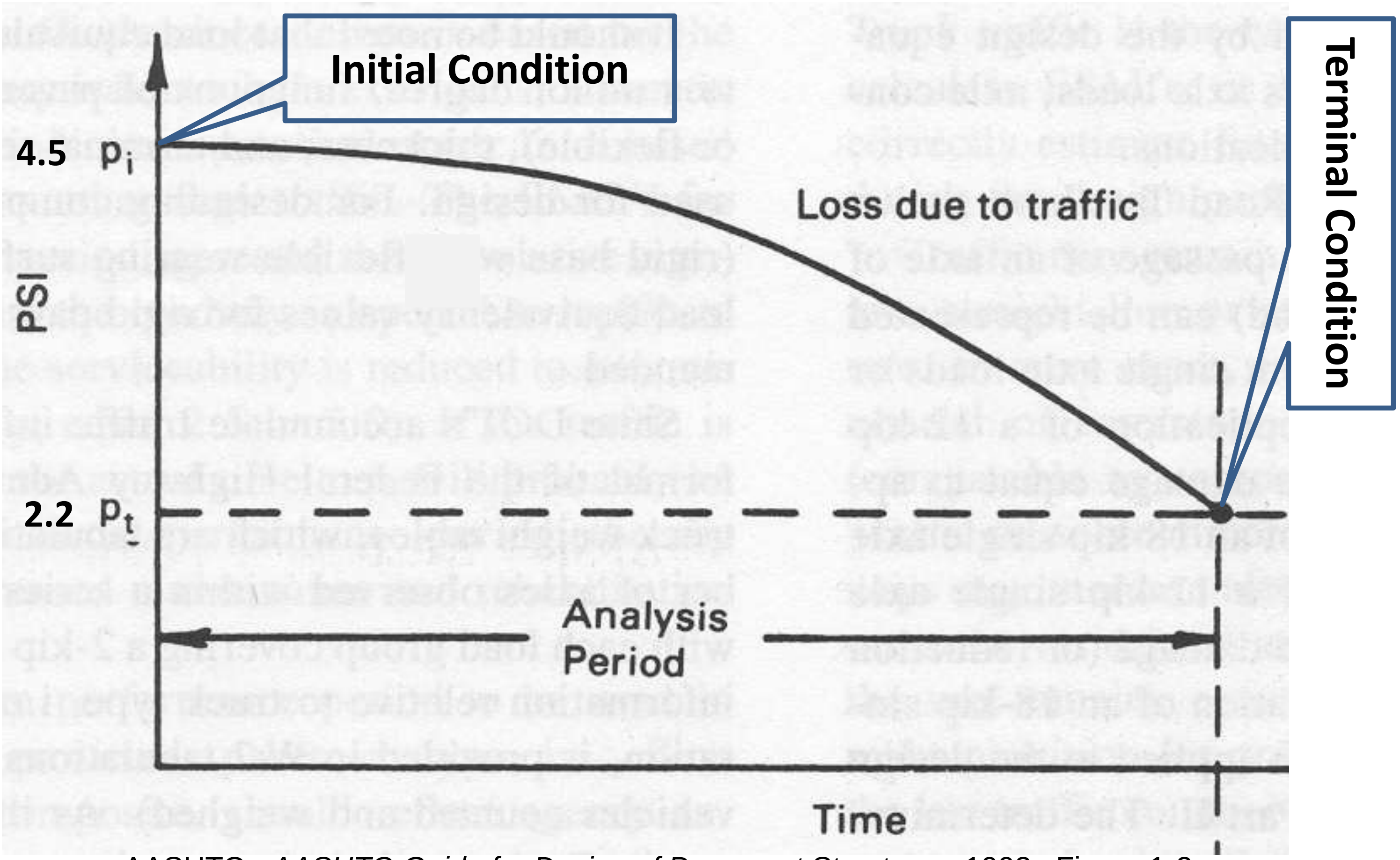
Modeling: Unpaved Road Maintenance

- 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
  - Graveling and base stabilization
  - Graveling and base stabilization with armor coat
  - Others as reported at the county level
- Asphalt surfacing: potentially at higher traffic levels

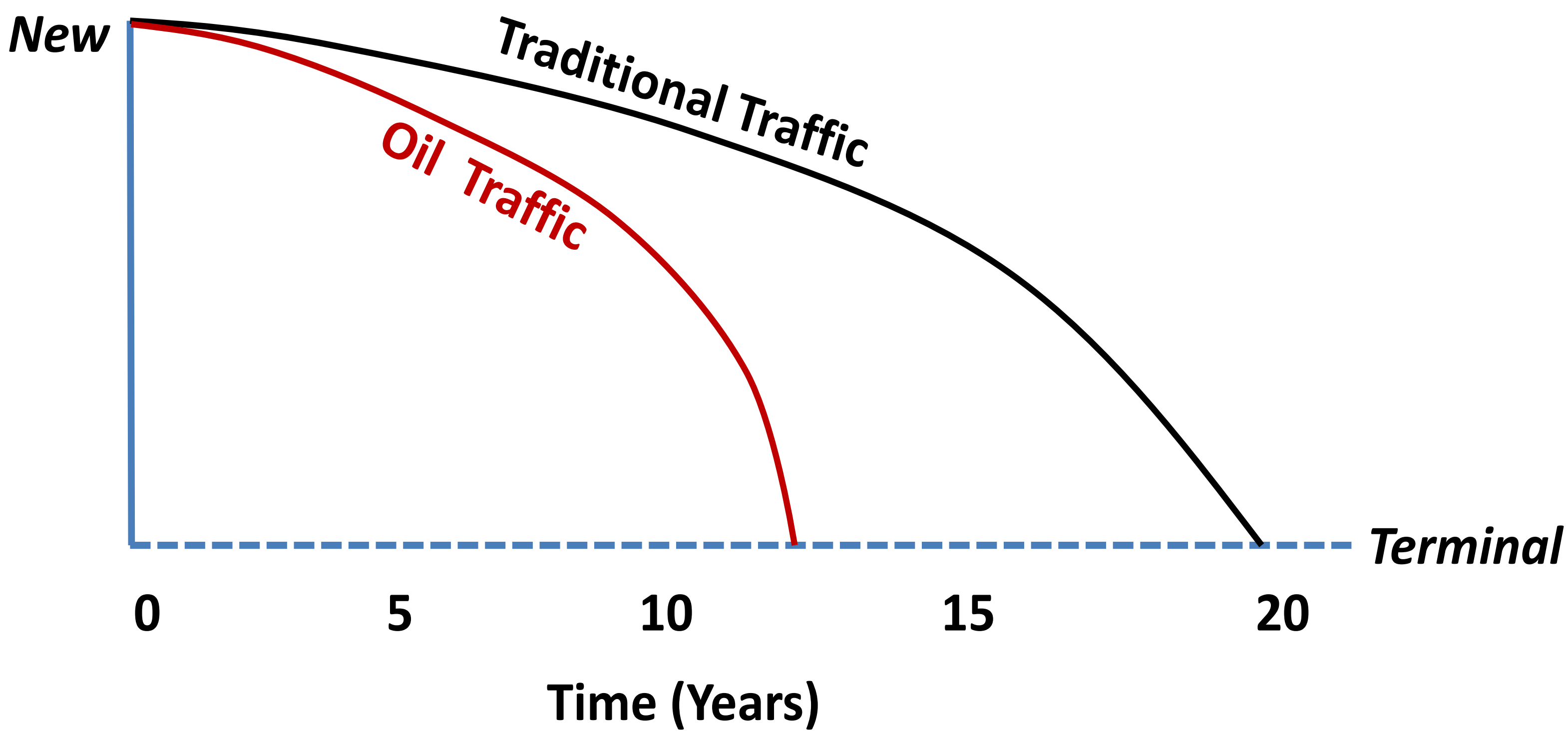
Pavement Performance and Traffic



AASHTO. *AASHTO Guide for Design of Pavement Structures*, 1993. Figure 1-2

Effects of Heavy Traffic on Paved Roads

Reduced Pavement Life Cycle (Hypothetical)



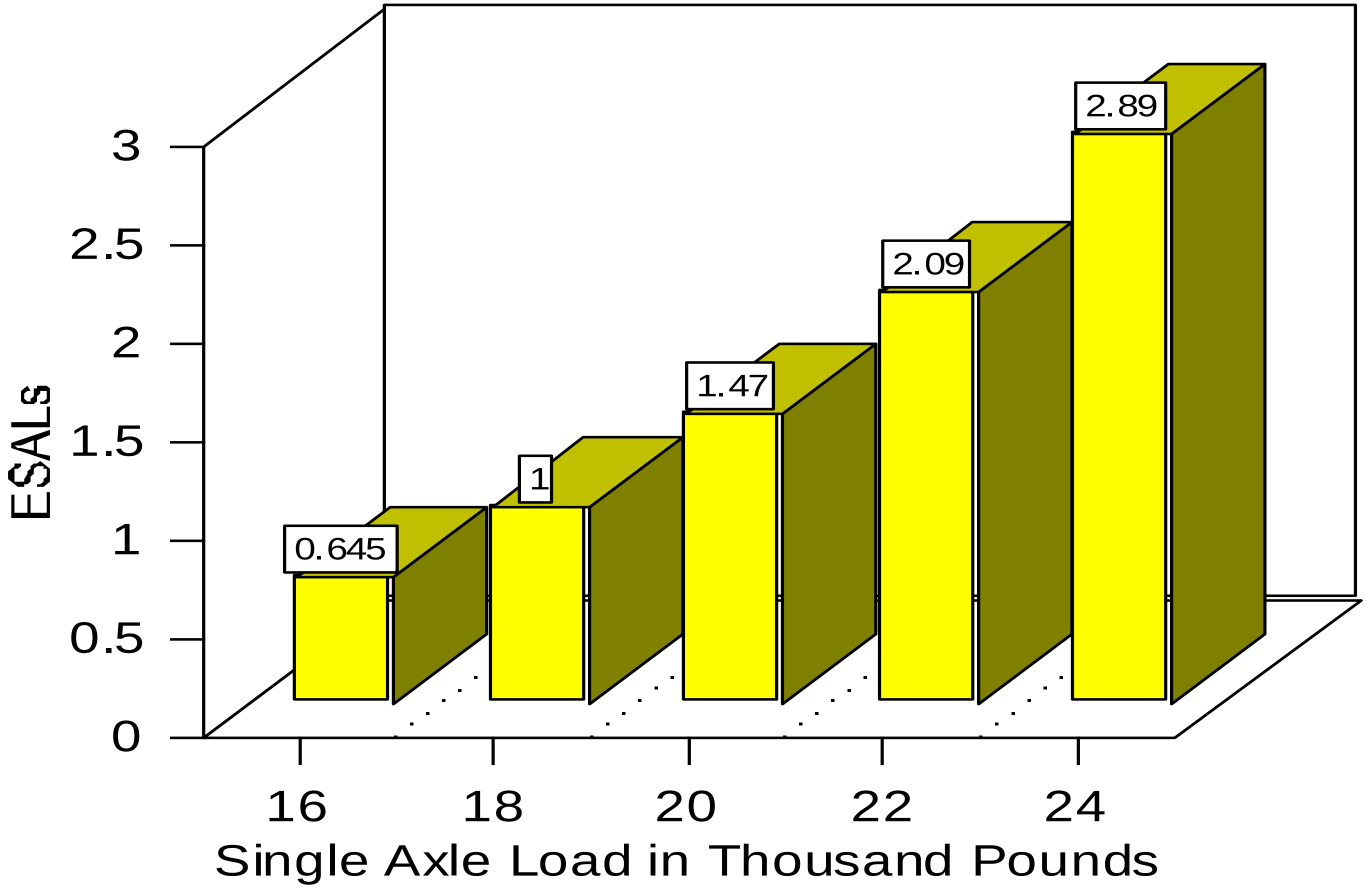
ND Highway 68 (Real World Example)

NDDOT. *Impact of Oil Development on State Highways*, May, 2006.

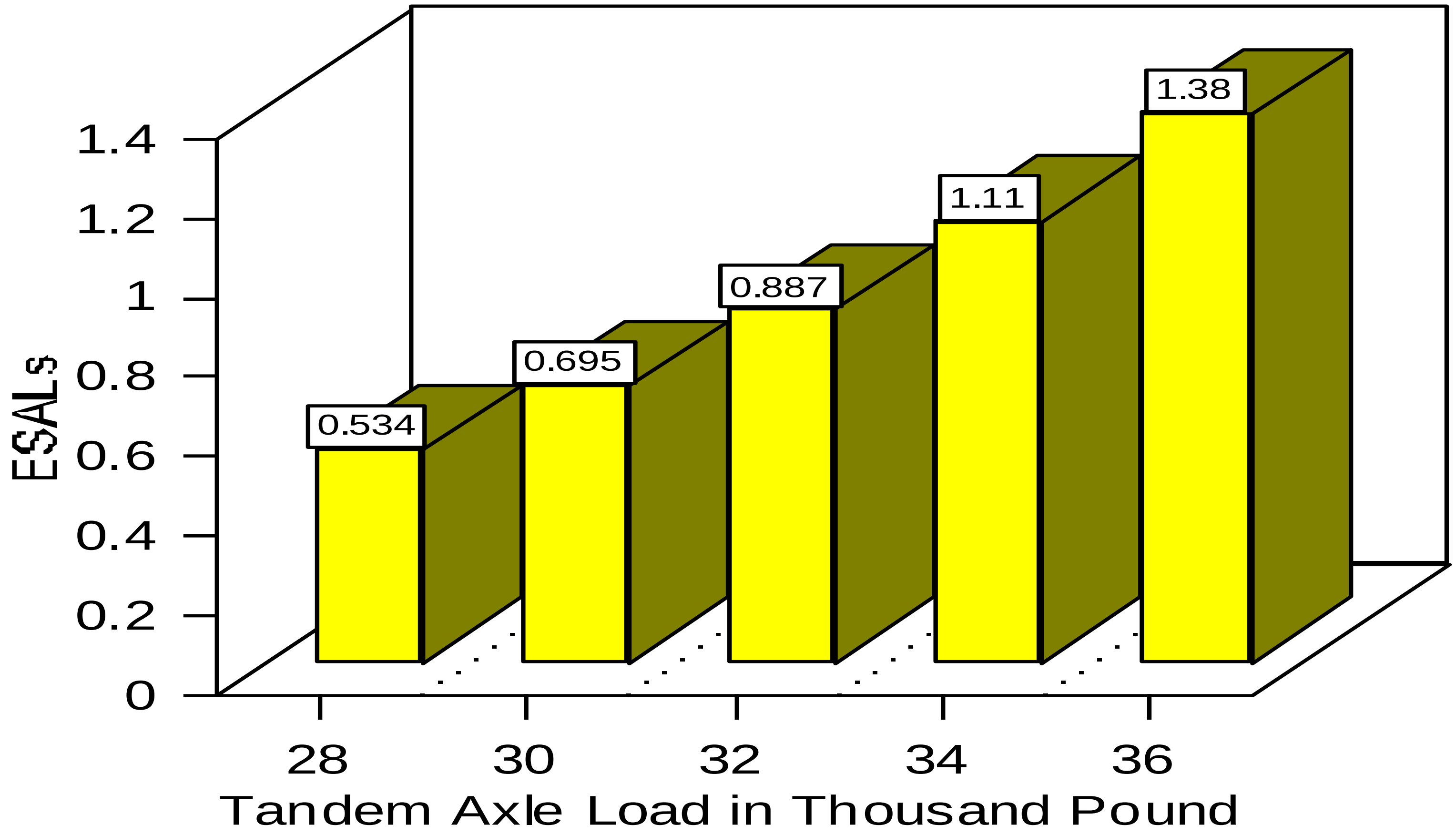
Pavement Analysis Process

- 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



ESAL Factors: Tandem Axle



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
  - Criteria for rehabilitation/replacement based upon FHWA criteria and discussions with NDDOT personnel
  - Short span bridges to be replaced by box culverts
  - Replacement unit cost based upon recent county bridge projects

Bridge Analysis & Projections

- Future Needs
  - Apply deterioration models to forecast deck/superstructure/substructure condition
  - Forecast year of rehabilitation/replacement
  - Short span bridges to be replaced by box culverts
    - 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

Task	Start Date	Completion Date
Assumptions data collection	August 2013	August 2013
Jurisdictional data collection	June 2013	September 2013
Road condition assessment	July 2013	September 2013
Traffic counts	June 2013	October 2013
Cost & practices survey	August 2013	October 2013
Non-destructive testing	July 2013	November 2013
Roadway & bridge analysis, modeling, & projections	Fall 2013	May 2014
Draft report		July 1 2014

Study Outputs

- Needs – by biennium for next 20 years
  - Roads
    - Statewide
    - By county
    - By surface type
  - Bridges
    - Statewide
    - By county

Questions?

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Updates and background posted at
www.ugpti.org/