North Dakota County Roads - Pavement Network Structural Assessment: Integration of GPR and FWD Data

by

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Background

- ND State Legislature Commissioned Study
- Assess 20-year transportation Infrastructure Needs
  - County, townships, tribal roads
- Motivated by
  - Oil related traffic
  - Agricultural related traffic

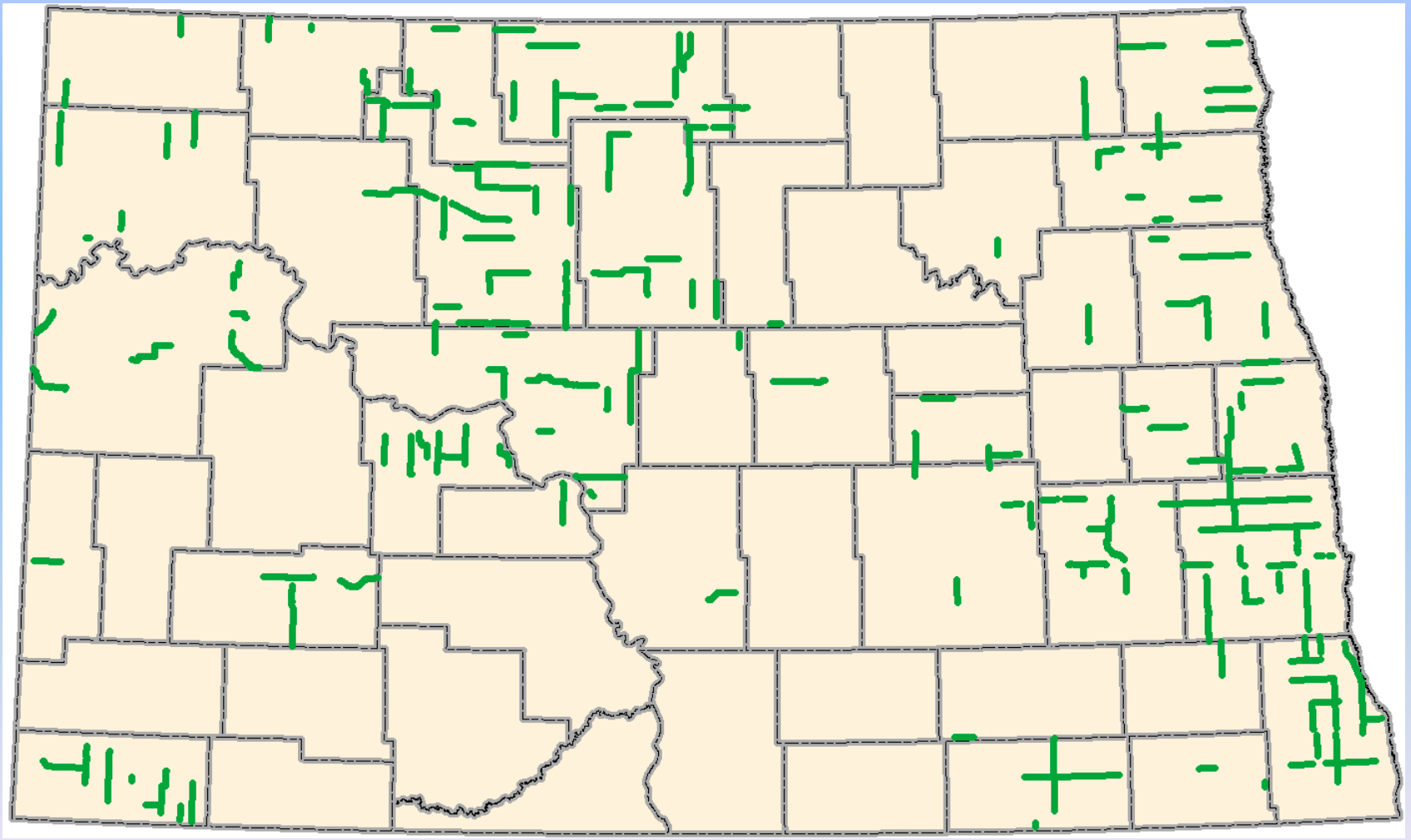
Background

- 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
- Current study: updated estimates based on higher forecasts (e.g., 60,000 new wells)

Pavement Data Collection

- Ride and Distress Data – 4786 miles
- Falling Weight Deflectometer (FWD) and Ground Penetrating Radar (GPR) – 1519 miles
  - Western ND (785 mi)
  - Eastern ND (734 mi)

Nondestructive Testing - Statewide



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FWD/GPR Testing Equipment

Dynatest Model 8002 FWD

GSSI 1-GHz Horn Antenna GPR System

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FWD/GPR Testing

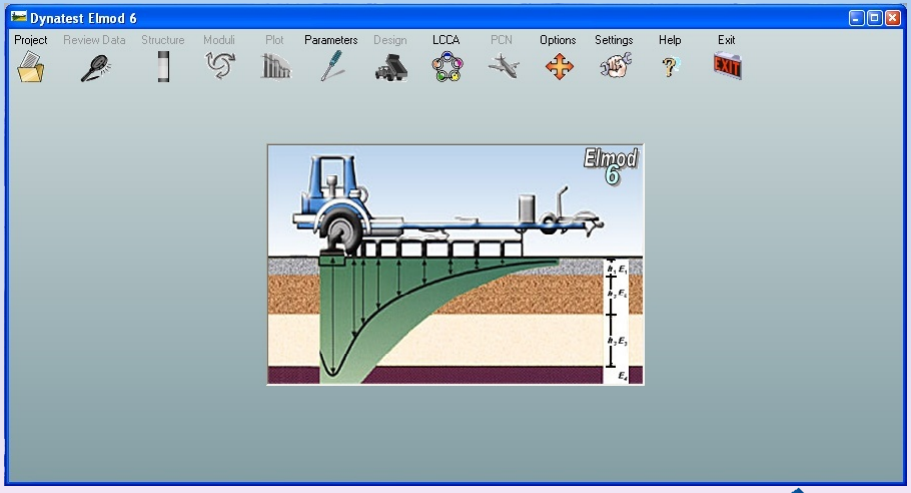
- Testing period: 08/05 through 9/21/2013
- GPR/FWD collected independently
  - Coordinated using GPS
- Numbers:
  - Number of segments: 169
  - GPR data collected continuously at 1 foot intervals
  - Number of FWD test locations: 6,259
  - FWD used two load levels and two replicates
  - 21,560 deflection basins collected

Sample GPR Output

Segment	station	lat	lon	L1Thk	L2Thk	L1Type	L2Type	Inline	Crossline
3924	0	46.3114167	-96.72965	6.90	18.35	ac	base	0.00	0.76
3924	1320	46.3114367	-96.724423	7.80	16.96	ac	base	0.31	0.24
3924	2640	46.3114633	-96.719187	7.25	17.47	ac	base	0.54	-1.18
3924	3960	46.3114817	-96.713955	7.59	19.23	ac	base	0.31	-0.05
3924	5280	46.3114933	-96.70872	7.62	15.41	ac	base	0.31	0.87
3924	6600	46.311505	-96.703482	7.58	18.34	ac	base	0.00	-0.43
3924	7920	46.3115133	-96.698255	7.92	14.92	ac	base	0.44	-0.86
3924	9240	46.3115233	-96.69302	8.36	18.25	ac	base	0.44	-1.31
3924	10560	46.3115317	-96.687787	8.81	18.65	ac	base	0.31	1.05
3924	11880	46.3115283	-96.68255	7.96	14.74	ac	base	0.00	1.44
3924	13200	46.311505	-96.677317	7.82	16.98	ac	base	0.00	-0.85
3924	14520	46.311485	-96.672082	8.01	17.12	ac	base	-0.44	0.20
3924	15840	46.31147	-96.666847	7.11	14.94	ac	base	-0.44	0.03
3924	17160	46.311455	-96.661617	8.17	11.95	ac	base	0.54	-0.13
3924	18480	46.3114233	-96.656375	10.58	10.22	ac	base	0.44	-0.36
3924	19800	46.3114317	-96.651147	10.47	12.35	ac	base	-0.31	1.23
3924	21120	46.31145	-96.645912	10.45	10.89	ac	base	0.00	1.65
3924	22440	46.31146	-96.640683	10.45	11.85	ac	base	0.00	0.67
3924	23760	46.311475	-96.635445	9.94	13.15	ac	base	-0.31	0.82
3924	24456.96	46.3114767	-96.632685	8.80	11.34	ac	base	-1.32	0.50

Backcalculation

- Software: ELMOD (Dynatest)
- Assumptions:
  - Linear elastic moduli for HMA and unbound base layers
  - Non-linear elastic modulus for subgrade
  - Thicknesses from GPR
  - All structures were limited to max 3 layers



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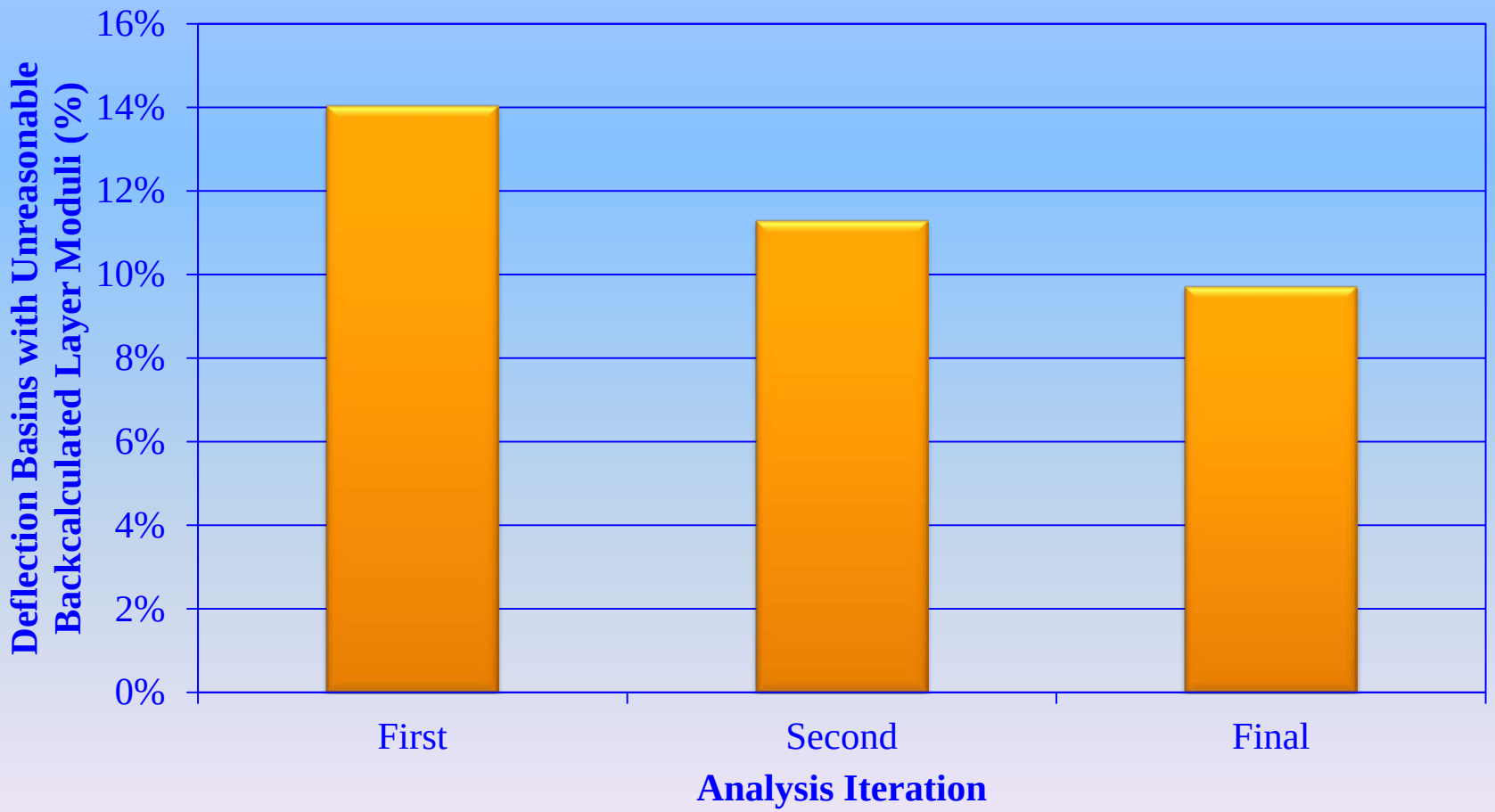
Iterative FWD and GPR analysis

- GPR layer interpretation checks done through the backcalculation
- Modulus reasonable checks applied
- Layer type interpretation updated iteratively
- Result improve the overall quality and accuracy of both analyzes

Impact of Iterative Technique



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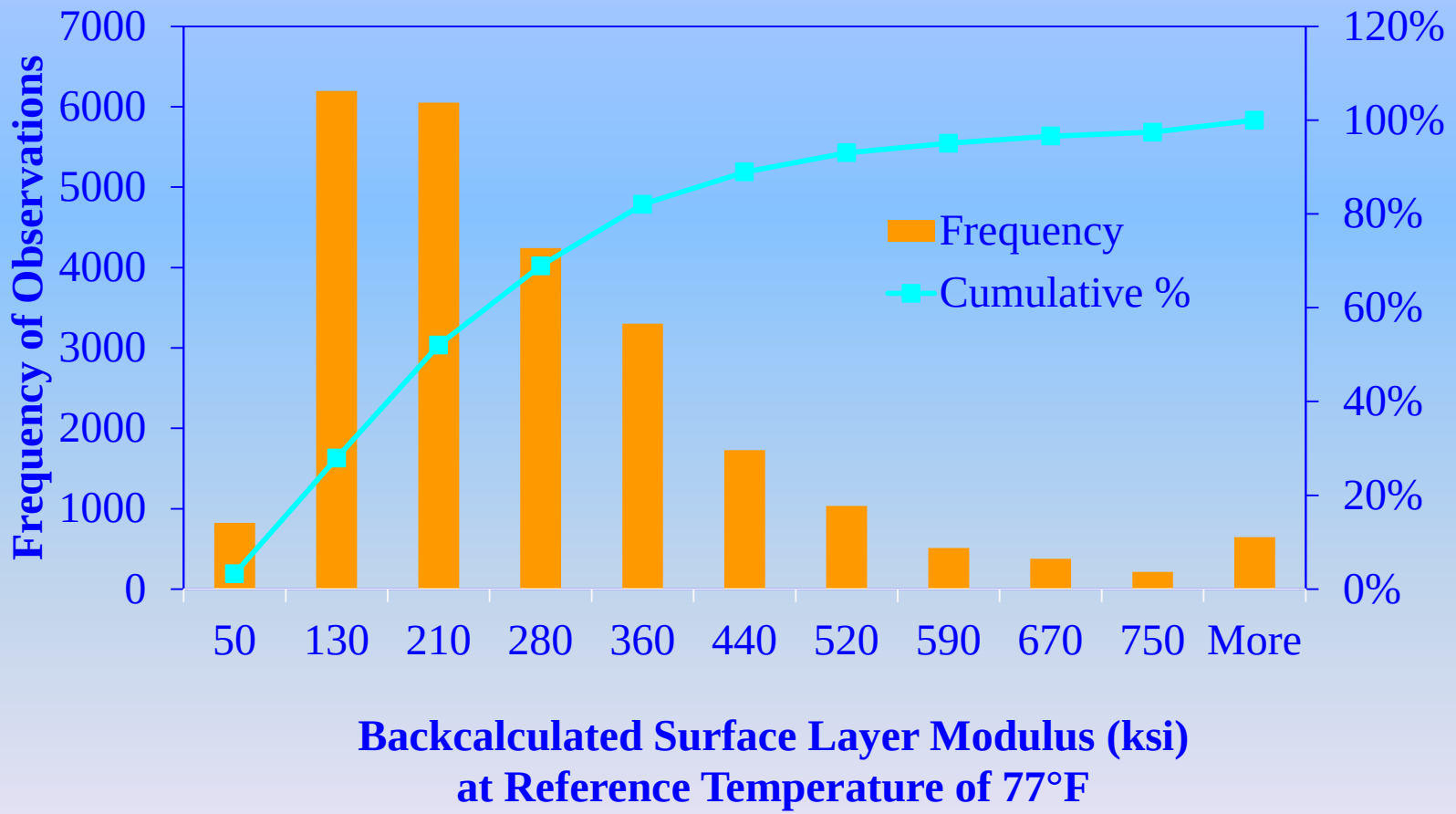
Results - HMA



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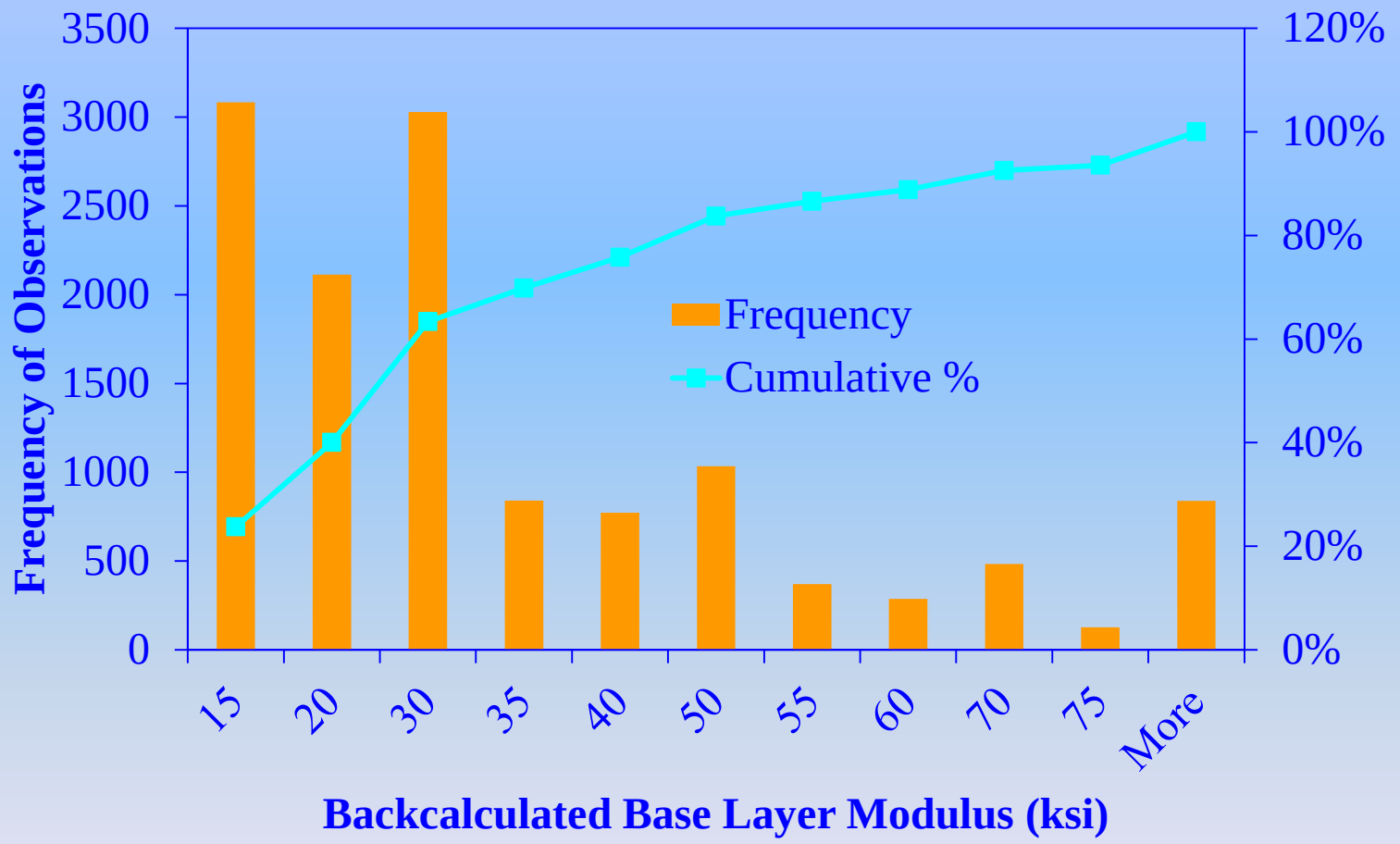
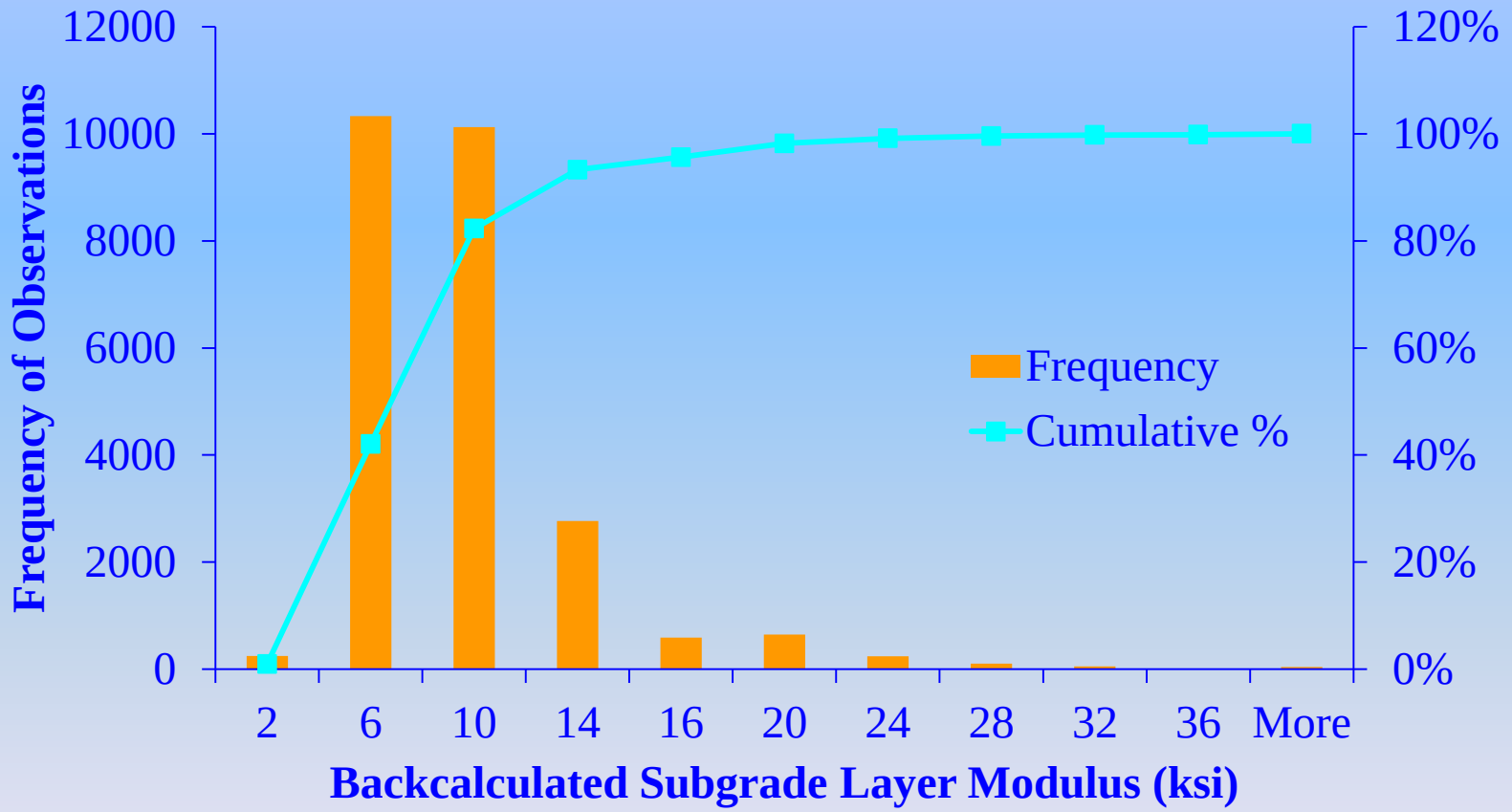
Results – Unbound Base Layer



Results - Subgrade



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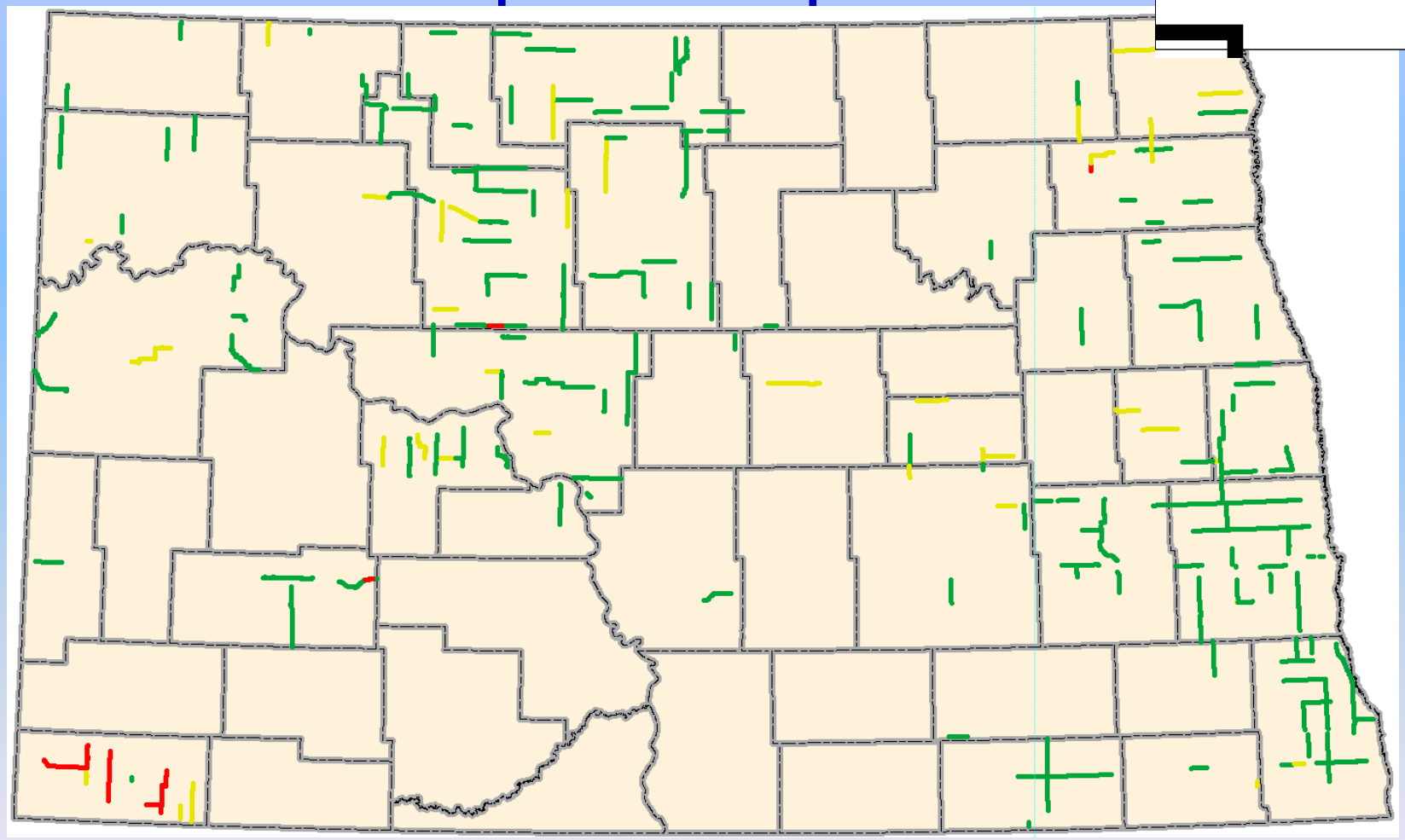
GPR Asphalt Depth



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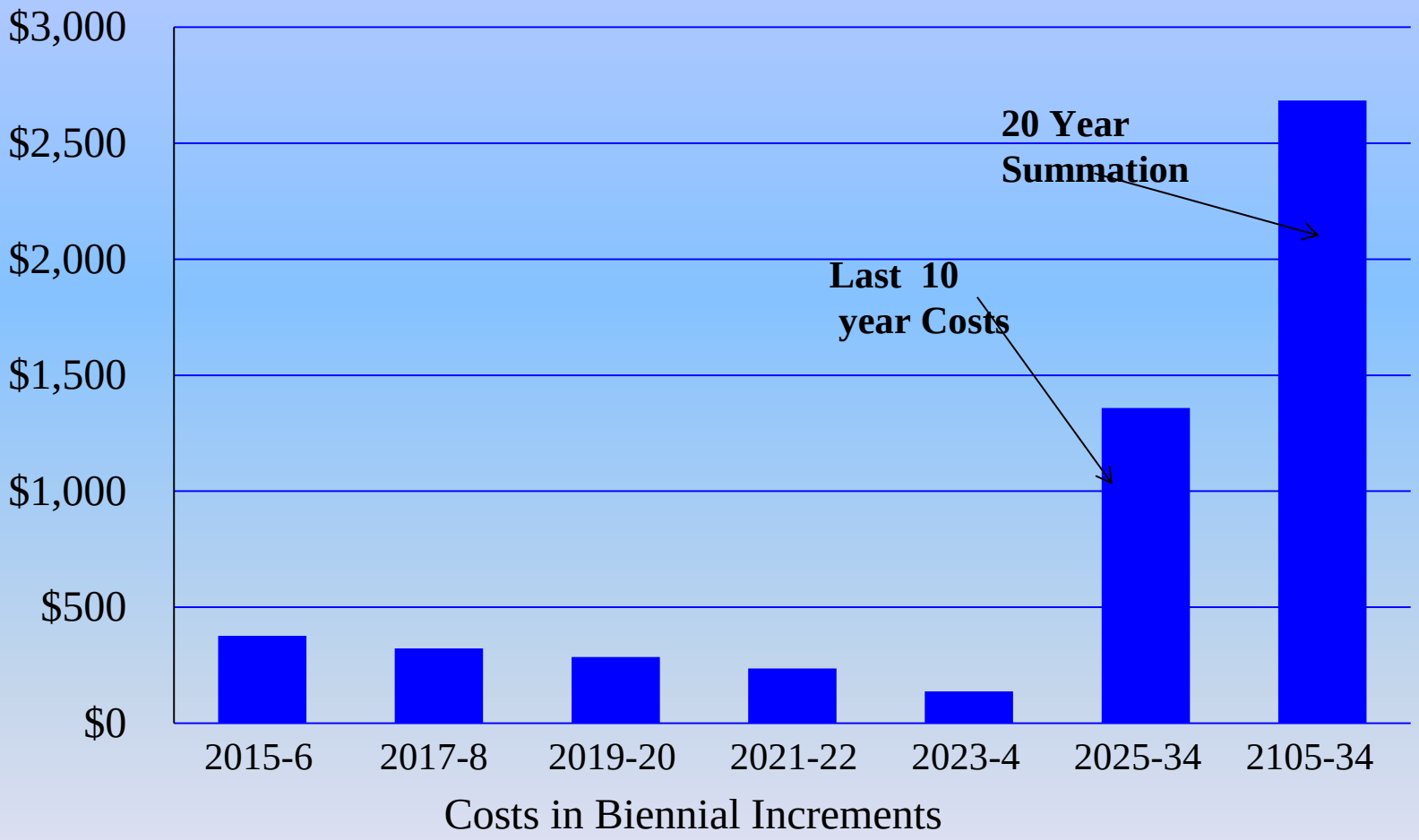
Analysis Steps & Review

- FWD/GPR Structure Information used with AASHTO 1993 Design Guide
- Year & type of improvement predicted.
- Improvement threshold: PSR < 2.5
- Year of improvement based on:
  - Existing structural capacity
  - Forecasted ESALs

Projected Expenditures



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Summary

- GPR/FWD combination effectively provides pavement structure data at network level
- Results can be used to predict remaining life and project required improvements
- North Dakota was able to use this approach to evaluate its 20 year transportation infrastructure needs.