A Case Study of Pavement Rehabilitation and Cost Effective Alternatives for Sections of I-15 and I-86 in Southeastern Idaho

Presented by

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PARSONS BRINCKERHOFF

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Acknowledgements

- Client – Idaho Transportation Department (ITD)
- Co-authors – Michelle D. Cline of PB
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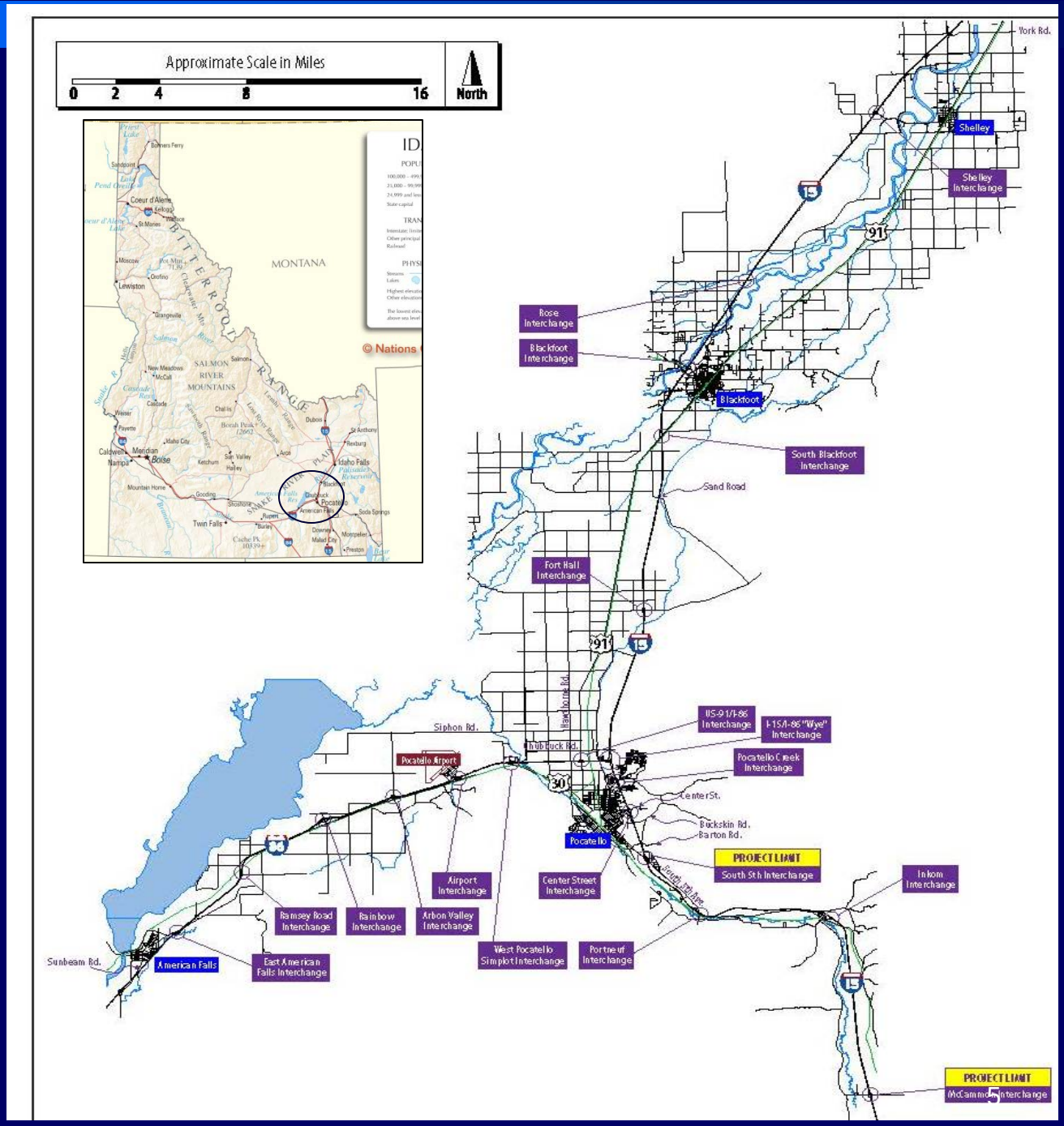
Outline

- Project Introduction
- Pavement Rehab/Evaluation Program
- Existing Pavement Condition
- Approach
- Conclusion
- Q&A

Project Introduction

- ~73.5 mile pavement rehabilitation project in District 5 of ITD
- I-15 and I-86 corridors
- Originally constructed in 1950s through 1960s
- ITD's new pavement management system in 2012
  - To estimate rehabilitation costs for funding
  - To evaluate and design as per ITDs recent standards
- Preliminary design ongoing - 5 out of 11 project segments complete to date

Project Vicinity Map



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Project Section Limits and Locations

Project Segment No.	Route	Project Location	Begin Mile Post	End Mile Post	Project Length (miles)
2	I-15	IC 40 to IC 47	39.8	46.7	6.9
3	I-15	IC No. 47 to IC No. 67 Bannock Co	47.5	66.8	19.3
4	I-15	Chubbuck Rd to MP 76.01	72.6	76.0	3.4
5	I-15	MP 76.01 to Burns Rd	76.0	81.9	5.9
6	I-15	Sand Road to S. Blackfoot	85.6	89.3	3.7
7	I-15	S Blackfoot IC 89 to W Blackfoot IC 93	89.3	92.5	3.2
8	I-15	W Blackfoot IC 93 to Lava Bed Crossover	92.5	100.4	7.9
9	I-15	Lava Bed Crossover to Baseline Rd	100.4	106.7	6.3
10	I-15	Baseline Rd to Bingham County Line	106.7	111.9	5.2
11	I-86	IGO IC to Arbon Valley IC 52	45.5	52.8	7.3
12	I-86	Arbon Valley IC 52 to W. Poc IC 58	53.8	58.1	4.3
				TOTAL	**73.4 miles**

Pavement Rehab / Evaluation Program

- Review of previous data and design records
- “Windshield” pavement visual distress survey
- Field exploration
- Evaluation and analysis of Falling Weight Deflectometer (FWD) data files
- Traffic data analysis
- Structural design of pavement (flexible and rigid)
- Life Cycle Cost Analysis (LCCA)
- Reporting (findings, analysis and recommendations)

Review of Existing Data

- Pavement condition and records
- ITD deficiency thresholds
- Traffic data

ITD Deficiency Thresholds

Pavement Condition	Cracking Index (CI)	Roughness Index (RI)	Rutting (R)
Good	CI > 3.0	RI > 3.0	0” – 0.24”
Fair	2.5 ≤ CI ≤ 3.0	2.5 ≤ RI ≤ 3.0	0.25” – 0.49”
Poor	2.0 ≤ CI < 2.5	2.0 ≤ RI < 2.5	0.50” – 0.74”
Very Poor	CI < 2.0	RI < 2.0	≥0.75”

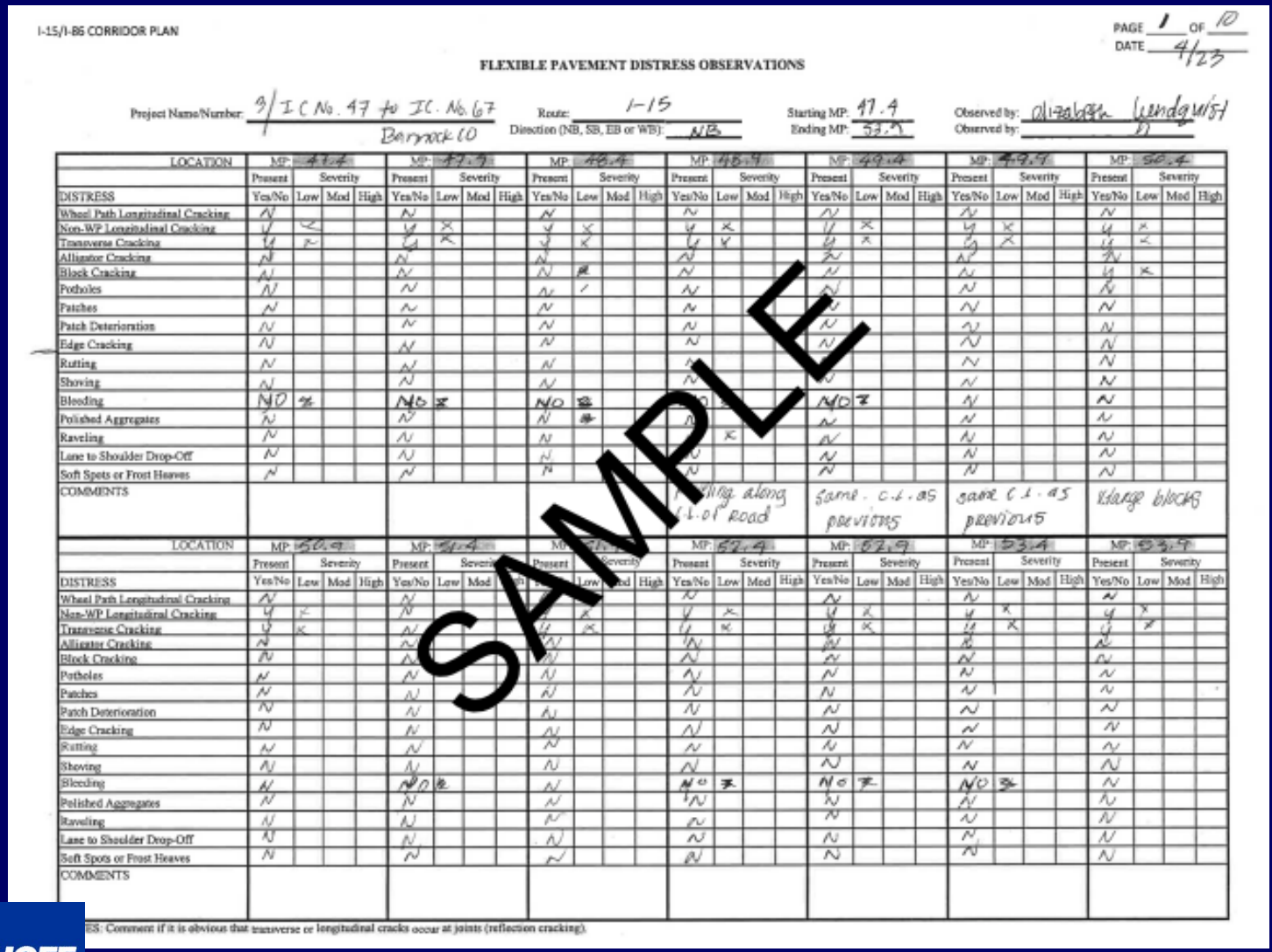
Traffic and Existing Pavement Section Data from ITD

Project No.	Traffic Data (AADT)				Approximate Pavement Section provided by ITD	
	2010	2017	2037	Commercial Vehicles (%)	AC (ft)	Base/ Subbase (ft)
2	9548	11551	17275	7.8	0.4	0.4-1.6
3	15344	18555	27727	7.8	0.4	0.4-1.3
4	22000	26427	39078	7.7	0.4	0.4-1.1
5	21661	26029	38510	7.7	0.4	0.4-1.1
6	20880	24473	36549	7.7	0.4	0.7-0.9
7	19500	23490	34890	7.7	0.4	0.4
8	20172	24279	36015	7.7	0.4	0.4-1.5
9	20500	24665	36565	7.7	0.4	0.4-0.8
10	20500	24665	36565	7.7	0.4	0.8
11	10520	12728	19638	7.8	0.8	0.2
12	11475	13859	20671	7.8	0.4	0.6

“Windshield” Pavement Visual Distress Survey

- Low speed “windshield” survey
- Intervals – 0.1 mile in urban areas and
  0.5 mile rural areas in both directions
- Distress type and severity

“Windshield” Pavement Visual Distress Survey



I-15/I-86 CORRIDOR PLAN

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FLEXIBLE PAVEMENT DISTRESS OBSERVATIONS

Project Name/Number: 9/I C No. 47 to IC. No. 67 Barrock CO
Route: I-15
Direction (NB, SB, EB or WB): NB
Starting MP: 47.4
Ending MP: 53.9
Observed by: [illegible] Lundquist
Observed by:

LOCATION	MP: 47.4				MP: 47.9				MP: 48.4				MP: 48.9				MP: 49.4				MP: 49.9				MP: 50.4			
	Present	Severity			Present	Severity			Present	Severity			Present	Severity			Present	Severity			Present	Severity			Present	Severity		
DISTRESS	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High
Wheel Path Longitudinal Cracking	N				N				N				N				N				N				N			
Non-WP Longitudinal Cracking	Y	L			Y	X			Y	X			Y	X			Y	X			Y	X			Y	X		
Transverse Cracking	Y	L			Y	X			Y	X			Y	X			Y	X			Y	X			Y	L		
Alligator Cracking	N				N				N				N				N				N				N			
Block Cracking	N				N				N	M			N				N				N				Y	X		
Potholes	N				N				N	I			N				N				N				N			
Patches	N				N				N				N				N				N				N			
Patch Deterioration	N				N				N				N				N				N				N			
Edge Cracking	N				N				N				N				N				N				N			
Rutting	N				N				N				N				N				N				N			
Shoving	N				N				N				N				N				N				N			
Bleeding	NO	%			NO	%			NO	%			NO				NO	%			N				N			
Polished Aggregates	N				N				N	M			N				N				N				N			
Raveling	N				N				N				N	X			N				N				N			
Lane to Shoulder Drop-Off	N				N				N				N				N				N				N			
Soft Spots or Frost Heaves	N				N				N				N				N				N				N			
COMMENTS									Cracking along L.L. of road								same. C.L. as previous				same C.L. as previous				Large blocks			

LOCATION	MP: 50.4				MP: 50.9				MP: 51.4				MP: 51.9				MP: 52.4				MP: 52.9				MP: 53.4				MP: 53.9			
	Present	Severity			Present	Severity			Present	Severity			Present	Severity			Present	Severity			Present	Severity			Present	Severity			Present	Severity		
DISTRESS	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High	Yes/No	Low	Mod	High
Wheel Path Longitudinal Cracking	N				N				N				N				N				N				N				N			
Non-WP Longitudinal Cracking	Y	L			N				Y	X			Y	X			Y	X			Y	L			Y	X			Y	X		
Transverse Cracking	Y	X			N				Y	X			Y	X			Y	X			Y	X			Y	X			Y	X		
Alligator Cracking	N				N				N				N				N				N				N				N			
Block Cracking	N				N				N				N				N				N				N				N			
Potholes	N				N				N				N				N				N				N				N			
Patches	N				N				N				N				N				N				N				N			
Patch Deterioration	N				N				N				N				N				N				N				N			
Edge Cracking	N				N				N				N				N				N				N				N			
Rutting	N				N				N				N				N				N				N				N			
Shoving	N				N				N				N				N				N				N				N			
Bleeding	N				N	%			N				N				N				N				N				N			
Polished Aggregates	N				N				N				N				N				N				N				N			
Raveling	N				N				N				N				N				N				N				N			
Lane to Shoulder Drop-Off	N				N				N				N				N				N				N				N			
Soft Spots or Frost Heaves	N				N				N				N				N				N				N				N			
COMMENTS																																

SAMPLE

ES: Comment if it is obvious that transverse or longitudinal cracks occur at joints (reflection cracking).

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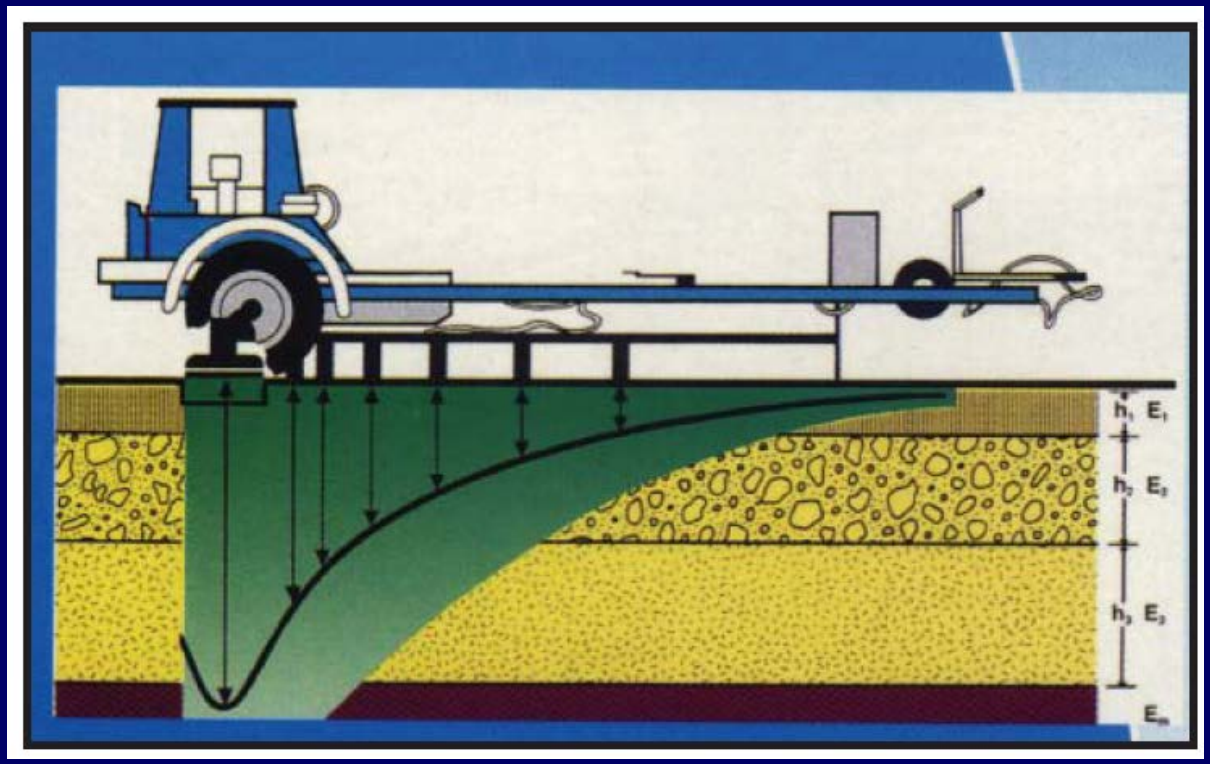
Field Exploration & Laboratory Testing

- Shallow borings and sampling – 47 total
- Pavement coring
- Index property testing
- No CBR/R-value tests were performed (Client's request)
- Boring logs
- Core photographs and visual inspections

Falling Weight Deflectometer (FWD) Testing

- Pavement section response (deflection) to applied loading



Approach

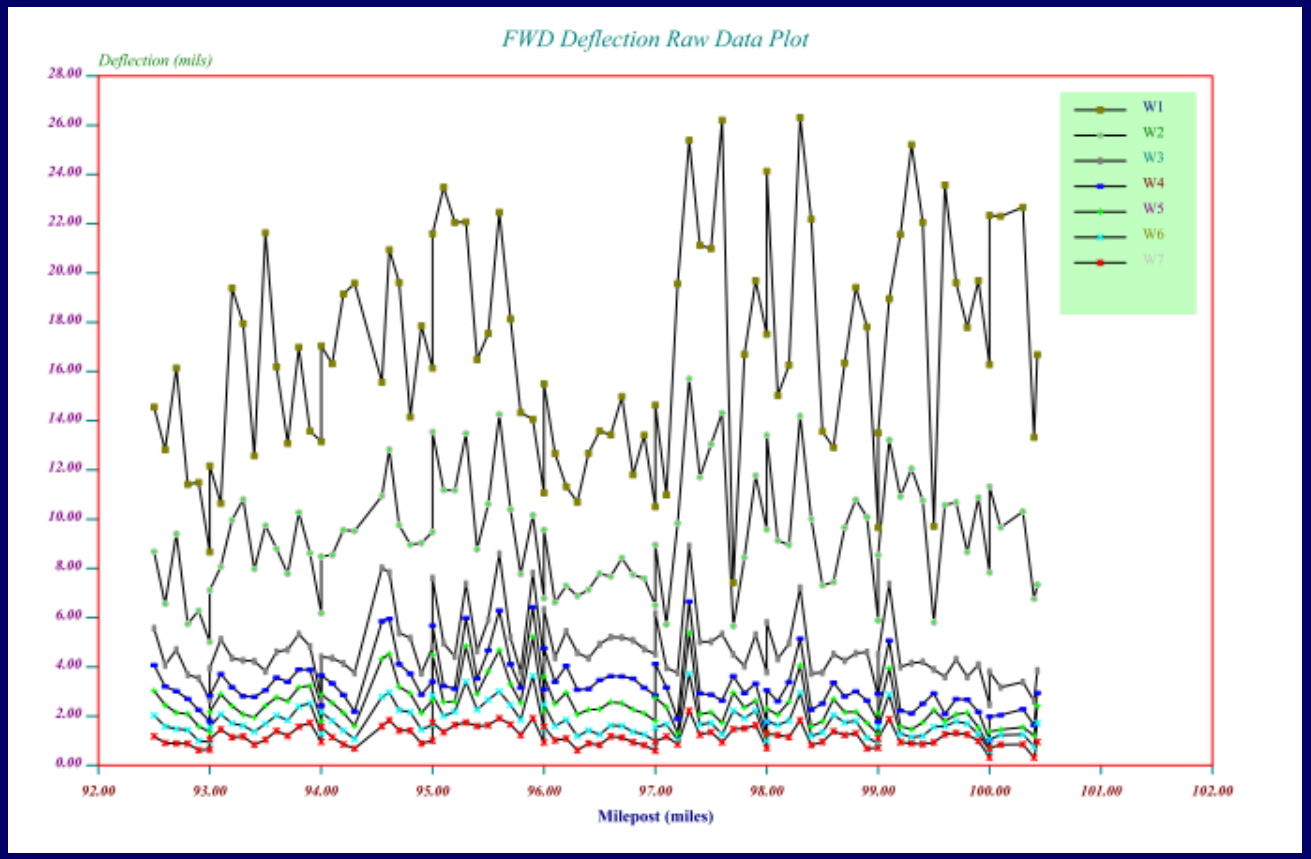
- Evaluation of FWD data – Modulus 6.0 software
- Statistical analysis for layer modulus
- Flexible pavement design – Winflex 2006 software
- Rigid pavement design – WinPAS 2009 software
- Cement-Recycled Aggregate Base Stabilization (CRABS)
- “Whitetopping”
- LCCA – ITD LCCA spreadsheet 2010
- Pavement design alternative

MODULUS 6.0

- FWD from ITD
- Backcalculation method
- Data processing - error and outliner elimination
- Statistical approach for layer moduli determination

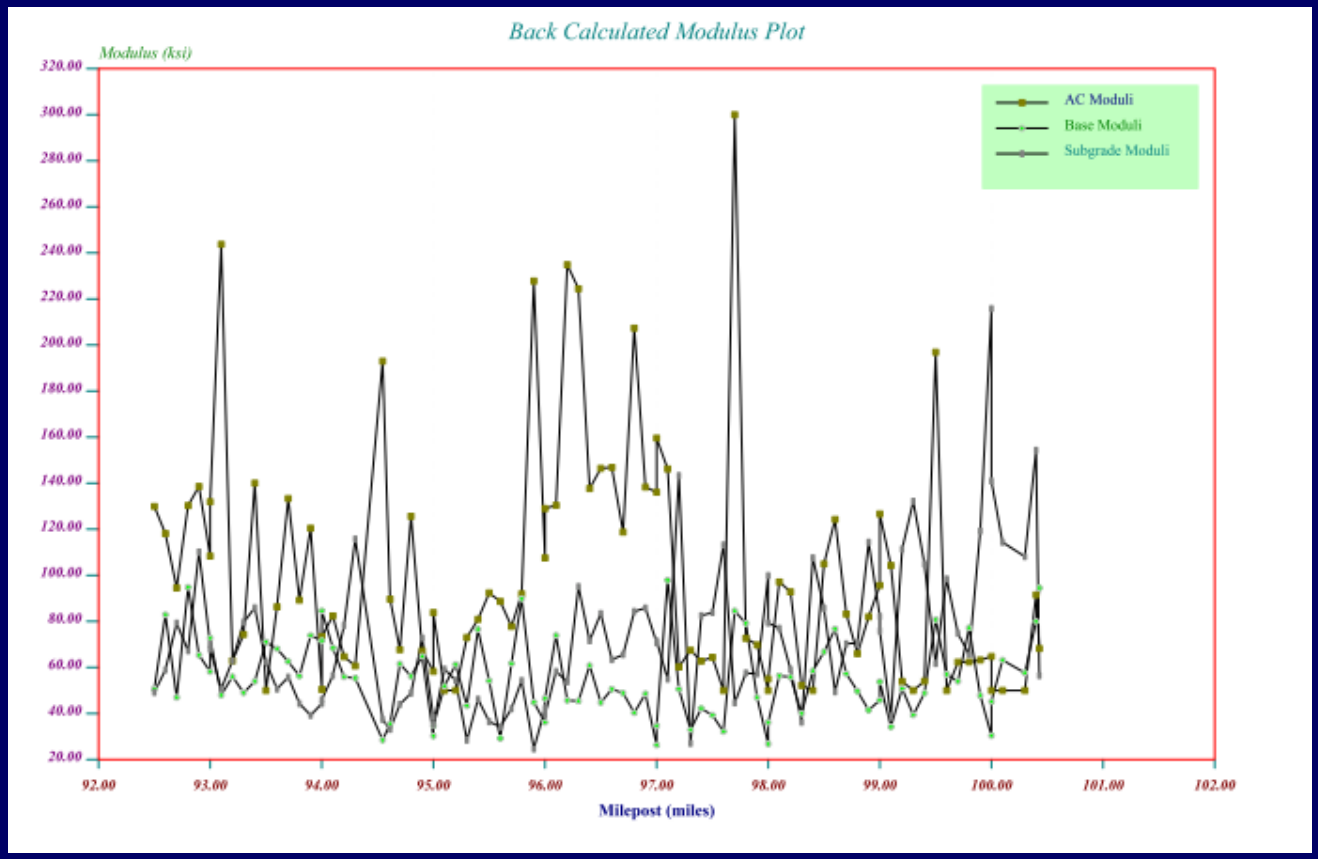
MODULUS 6.0 (Cont.)

- FWD Deflection Plot



MODULUS 6.0 (Cont.)

- Layer Moduli Plot



Flexible Pavement Design

- WINFLEX 2006 software
- Mechanistic-Empirical overlay design procedure
  - Existing pavement section
  - Overlay data
  - Traffic data
  - Failure controlled by fatigue and rutting (Asphalt Institute model)
  - Temperature adjustment to Idaho climatic zones
  - Overlay thickness and damage ratio
- CRABS

Flexible Pavement Design Inputs

Input Parameter	Value
One-way ESALs over design period	(2037 ESALs minus 2017 ESALs)
Lane Distribution Factor	70%
Poisson's Ratio, CRABS	0.4
Poisson's Ratio, Base	0.4
Poisson's Ratio, Subgrade	0.45
Modulus, CRABS	100 ksi
Climatic Zone	2 or 3 (varied per segment)
Temperature at FWD test	60-100 deg F
Modulus, Overlay	400 ksi
Poisson's Ratio, Overlay	0.35

Rigid Pavement Design

- Modulus of subgrade reaction (k-value) determination (AASHTO 1993)
  - Subgrade modulus
  - Weighted average of existing AC/base/subbase
  - Relative damage
  - Corrected k-value after loss of support

Rigid Pavement Design (Cont.)

- Portland cement concrete pavement over existing asphalt (whitetopping)
- WINPAS v1.0.4 - American Concrete Pavement Association (ACPC) based software
- 1993 AASHTO guide for design of pavement structures
  - Rigid design inputs
  - Rigid pavement design/evaluation
  - Solving for PCC thickness

Rigid Pavement Design Inputs

Input Parameter	Value
One-way ESALs over design period	(2057 ESALs minus 2017 ESALs)
Lane distribution factor	70%
Reliability	90%
Standard Deviation	0.34
Modulus of Rupture	700 psi
Modulus of Elasticity	4,200,000 psi
Load Transfer Coefficient	2.9
Drainage Coefficient	1.0
Initial Serviceability	4.5
Terminal Serviceability	2.5
Modulus of Subgrade Reaction	700 -1,000 psi/in

Life Cycle Cost Analysis (LCCA)

- Based on ITD's LCCA spreadsheet (version 4_28_10, 2010)
  - Based on ITD Material Manual
  - 36 year design life
  - Standard unit costs, salvage values
  - Standard flexible maintenance – crack seal (6), sealcoat (4), mill and inlay (1), and major rehabilitation/reconstruction (1)
  - Standard rigid maintenance - joint seals (2) and combined rehabilitation/joint sealing (1)
  - Initial Cost
  - Net present worth @ 4% Interest (NPW)
  - Equivalent Uniform Annual Cost (EUAC)

3/12/2013

LIFE CYCLE COST ANALYSIS
I-15, S. Blackfoot IC to W. Blackfoot IC
22756B

CRABS Reconstruction

CRABS the existing pavement to a depth of 0.80 ft (full width) and overlay the roadway using 0.67 ft of PG Hot Mix Asphalt to a width of 76.22 ft. Roadway shoulders at 4:1 (L) and 4:1 (R) slopes.

24 Year Standard Remaining Life

COST PER MILE SUMMARY:

INITIAL CONSTRUCTION:	
Traffic Cross Overs	$0
Borrow	$0
Excavation	$0
Plant Mix	$1,883,300
CRABS	$179,900
TOTAL INITIAL	$2,063,200
Seal Coat Full Width	$81,600
Seal Driving Lanes	$51,600
Seal Cracks	$26,500
PRESERVATION AT 12 YEARS:	
Coldmill travel lanes	$68,300
Plant mix inlay (PG Mix)	$781,800
Seal coat full width	$81,600
Seal cracks	$26,500
TOTAL 12 YEAR PRESERVATION	$958,200
RECONSTRUCTION AT 24 YEARS:	$1,811,500
SALVAGE VALUE (79%)	($1,629,928)
TOTAL 36 YEAR LIFE CYCLE COST (from Time Line Chart)	$3,598,372
EQUIVALENT UNIFORM ANNUAL COST (euac)	$170,900
TOTAL NET PRESENT WORTH AT 4% INTREST	$2,606,200
CONSTRUCTION USER COST	$0

3/12/2013

LIFE CYCLE COST ANALYSIS
I-15, S. Blackfoot IC to W. Blackfoot IC
22756B

Rigid Pavement Reconstruction

Construct roadway using 13.13 in of Doweled & Jointed PCC Pavement on top of . Roadway shoulders at 4:1 (L) and 4:1 (R) slopes.

COST PER MILE SUMMARY:

INITIAL CONSTRUCTION:	
Traffic Cross Overs	$0
Rotomilling	$0
Additional Borrow	$0
Additional Excavation	$0
Doweled & Jointed PCC Pavement	$2,363,000
Cement Treated Base W/ Sep.	$0
ATPB Base	$0
Aggregate Base	$0
Rock Cap	$0
Granular Subbase	$0
Granular Borrow	$0
Edge Drains	$302,000
Subgrade Seperation Geotex	$0
TOTAL INITIAL	$2,665,000
REHABILITATION AT 9 YEA	
Seal Longitudinal Joints	$12,300
Seal Transvers	$14,200
TOTAL 9 YEAR REHABI TION	$26,500
REHABILITA ION YEARS:	
Slab Replacem at 2%	$8,100
Grinding Lanes	$100,800
Seal Longitudinal Joints	$12,300
Seal Transverse Joints	$14,200
TOTAL 18 YEAR REHABILITATION	$135,400
REHABILITATION AT 27 YEARS	
Seal Longitudinal Joints	$12,300
Seal Transverse Joints	$14,200
TOTAL 27 YEAR REHABILITATION	$26,500
TOTAL 36 YEAR LIFE CYCLE COST (from Time Line Chart)	$1,707,450
EQUIVALENT UNIFORM ANNUAL COST (euac)	$131,200
TOTAL NET PRESENT WORTH AT 4% INTREST	$2,480,600
SALVAGE VALUE	($1,145,960)
CONSTRUCTION USER COST	$0

LCCA Summary

Pavement Type	Cost	Project 2	Project 3	Project 5	Project 6	Project 7
Flexible Pavement Alternative (CRABS)	AC (in)	7.5	8.5	8.0	8.5	8.0
	CRABS (in)	8.4	9.6	9.6	9.6	9.6
	Initial Cost	$1,950,300	$2,176,000	$2,091,400	$2,176,000	$2,063,100
	NPW (4%)	$2,533,500	$2,679,900	$2,623,500	$2,679,900	$2,605,200
	EUAC	$166,200	$175,800	$172,100	$175,800	$170,900
Rigid Pavement Alternative	PCC (in)	12.0	13.0	13.2	13.0	13.1
	Initial Cost	$2,480,800	$2,643,800	$2,668,200	$2,643,800	$2,665,000
	NPW (4%)	$2,314,200	$2,461,700	$2,482,500	$2,461,700	$2,480,600
	EUAC	$122,400	$133,200	$131,300	$130,200	$131,200

LCCA Summary

- Based on preliminary results
  - Initial cost - rigid 20-30% greater than flexible
  - EUAC – flexible 28-32% greater than rigid
  - No construction/maintenance during construction costs were included

Conclusion

- Heavy traffic loading
- Fair to good existing pavement (asphalt) condition
- Rehab Alternatives
  - CRABS (7.5 to 8.5 inches)
  - PCC (13 to 14 inches)
- Better alternative – CRABS (in terms of sustainability, LCCA and construction schedule)

THANK YOU.

QUESTIONS?