Welcome

Joshua Laipply, PE (Bridge Branch Manager)

- ABC and CDOT
- Politics of ABC

  Tim Harris, PE (Chief Engineer)
- Overview
  - Forms and Decision assistance
  - Region 4
  - Region 2
  - Region 6
  - FHWA

Implementing ABC at CDOT

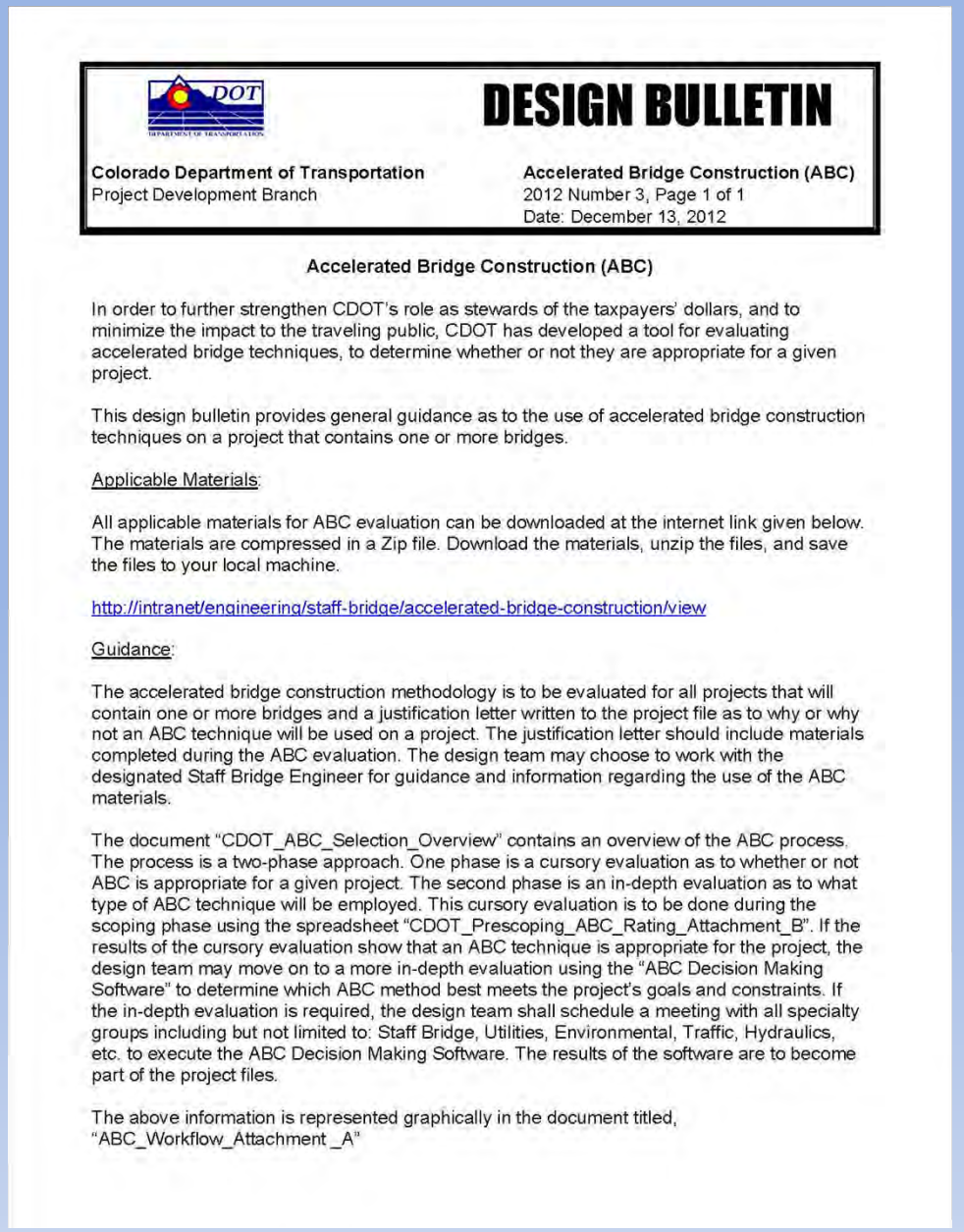
Behrooz Far, PE
Preeda Chomsrimake, PE

R3 Design and Construction
&
Fabrication Inspection
Staff Bridge

CDOT's ABC Method

- Goal
  - CDOT specific ABC decision –making tool to aid transportation professionals in making educated decisions on using ABC techniques on Colorado transportation projects and other off system projects.
  - The Right ABC method for the Right Project
- Tools
  - Workflow
  - Pre-Scoping Rating
  - AHP Software

ABC
Design Bulletin
Dec 13, 2012



DESIGN BULLETIN

Colorado Department of Transportation
Project Development Branch

Accelerated Bridge Construction (ABC)
2012 Number 3, Page 1 of 1
Date: December 13, 2012

Accelerated Bridge Construction (ABC)

In order to further strengthen CDOT's role as stewards of the taxpayers' dollars, and to minimize the impact to the traveling public, CDOT has developed a tool for evaluating accelerated bridge techniques, to determine whether or not they are appropriate for a given project.

This design bulletin provides general guidance as to the use of accelerated bridge construction techniques on a project that contains one or more bridges.

Applicable Materials:

All applicable materials for ABC evaluation can be downloaded at the internet link given below. The materials are compressed in a Zip file. Download the materials, unzip the files, and save the files to your local machine.

http://intranet/engineering/staff-bridge/accelerated-bridge-construction/view

Guidance:

The accelerated bridge construction methodology is to be evaluated for all projects that will contain one or more bridges and a justification letter written to the project file as to why or why not an ABC technique will be used on a project. The justification letter should include materials completed during the ABC evaluation. The design team may choose to work with the designated Staff Bridge Engineer for guidance and information regarding the use of the ABC materials.

The document "CDOT_ABC_Selection_Overview" contains an overview of the ABC process. The process is a two-phase approach. One phase is a cursory evaluation as to whether or not ABC is appropriate for a given project. The second phase is an in-depth evaluation as to what type of ABC technique will be employed. This cursory evaluation is to be done during the scoping phase using the spreadsheet "CDOT_Prescoping_ABC_Rating_Attachment_B". If the results of the cursory evaluation show that an ABC technique is appropriate for the project, the design team may move on to a more in-depth evaluation using the "ABC Decision Making Software" to determine which ABC method best meets the project's goals and constraints. If the in-depth evaluation is required, the design team shall schedule a meeting with all specialty groups including but not limited to: Staff Bridge, Utilities, Environmental, Traffic, Hydraulics, etc. to execute the ABC Decision Making Software. The results of the software are to become part of the project files.

The above information is represented graphically in the document titled, "ABC_Workflow_Attachment _A"

External CDOT Website Location

ABC documents on the
Design & Construction Project Support

http://www.coloradodot.info/business/designsupport

http://www.coloradodot.info/business/designsupport/abc-documents

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BOOKMARK

Quick Links

- Design and Construction Project Support
- American Recovery and Reinvestment Act
- Accelerated Bridge Construction Documents
- Construction Specifications
- Bulletins and Manuals
- Misc. Design Documents
- Other Specifications
- Policy Memos
- M&S Standard Plans
- CADD, Engineering Design Processes, and ProjectWise
- Innovative Contracting and Design - Build
- CDOT & Local Agency
- Software / Software Support
- Water Quality Control

Design and Construction Project Support

The Design & Construction Support Site has changed. It still contains the same information. Please use our search function if you cannot locate the document you are looking for.

The Design and Construction Project Support Section contains information about Standards and Specifications used during the design and construction of CDOT projects. There are also design aids, Construction Bulletins, Special Provisions, and Support Software.

Please reference the Quick Links located to the left to navigate. Below is a brief outline indicating what information can be found within those links listed in alphabetical order.

- **American Recovery and Reinvestment Act:** (ARRA) Related Documents.
- **Accelerated Bridge Construction Documents**
- **Construction Specifications:** This area contains standard specifications appropriate for use on CDOT construction Projects and revisions thereto. The 2005 Standard Specifications are now available and should be used on all projects advertised on or after October 13, 2005.
- **Bulletins and Manuals:** Links to various Design Manuals & Guides, Construction Bulletins.
- **Miscellaneous Design Documents:** Library of CDOT Sample Sheets, Safety Selection Guide and other documents not related to any of the above categories.
- **Other Specifications:** ITS, FIPI, Material Specificiations Checklist, Pilot Project Special Provisions.
- **Policy Memos:** Various Policy Memos as well as Americans with Disabilities Act (ADA) Accessibility Requirements in CDOT Transportation Projects.
- **M&S Standard Plans:** The M Standard Plans and the S Standard Plans.
- **CADD & Engineering Processes:** All CADD and ProjectWise Related Documents, Training, Manuals, Library, Tips.
- **Innovative Contracting and Design - Build:** A process of systematic decision-making, risk identification and allocation, identification of goals and objectives, identification and development of strategies, and creation of a competitive procurement environment.

Contact Information

Questions about the use of Design & Construction Support should be directed to CDOT's Standards and Specifications Unit:
Larry Brinck
(303) 757-9474
larry.brinck@state.co.us

Working with Local Government

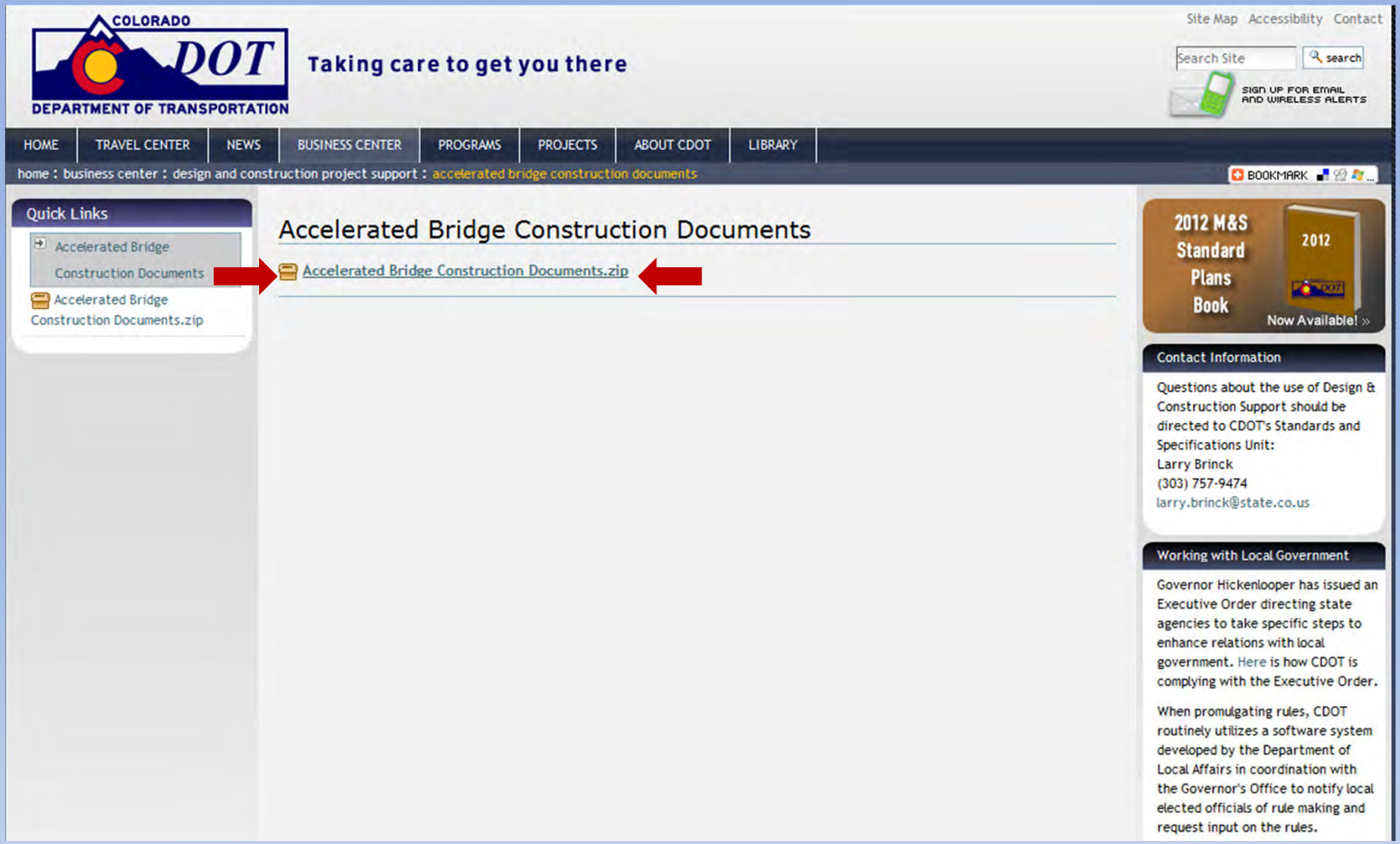
Governor Hickenlooper has issued an Executive Order directing state agencies to take specific steps to enhance relations with local government. Here is how CDOT is complying with the Executive Order.

When promulgating rules, CDOT routinely utilizes a software system developed by the Department of Local Affairs in coordination with the Governor's Office to notify local elected officials of rule making and request input on the rules.

CDOT Financials

In accordance with House Bill 11-1002, CDOT has created an online database for the Colorado

DOT DEPARTMENT OF TRANSPORTATION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2012 M&S Standard Plans Book
2012
Now Available! »
Contact Information
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Working with Local Government
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DEPARTMENT OF TRANSPORTATION

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  - Bridge Data
  - Bridge Policies
  - Revision History
  - Org Chart
  - Staff Bridge Phone Directory
  - Accelerated Bridge Construction

You are here: Home › Engineering › Staff Bridge

Staff Bridge

by Nord, Mark — last modified Apr 27, 2012 05:18 PM

External Links

- Bridge Field Log of Structures
- Bridge Design Manual
- Bridge Detail Manual
- Metric Bridge Geometry
- Bridge Rating Manual
- Pontis Coding Guide
- Structural Worksheets
- Project Special Provisions
- Technical Memorandums
- External Bridge Site
- External Bridge Enterprise Site
- Bridge Enterprise SharePoint Team Site
- Bridge Data SharePoint Partnernet Site
- Bridge Design & Rating Software

Contact Information

Contact Information
Staff Bridge Branch
4201 E Arkansas Ave Room 107
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Branch Manager

Mac Hasan, P.E.
Bridge Policy and Standards

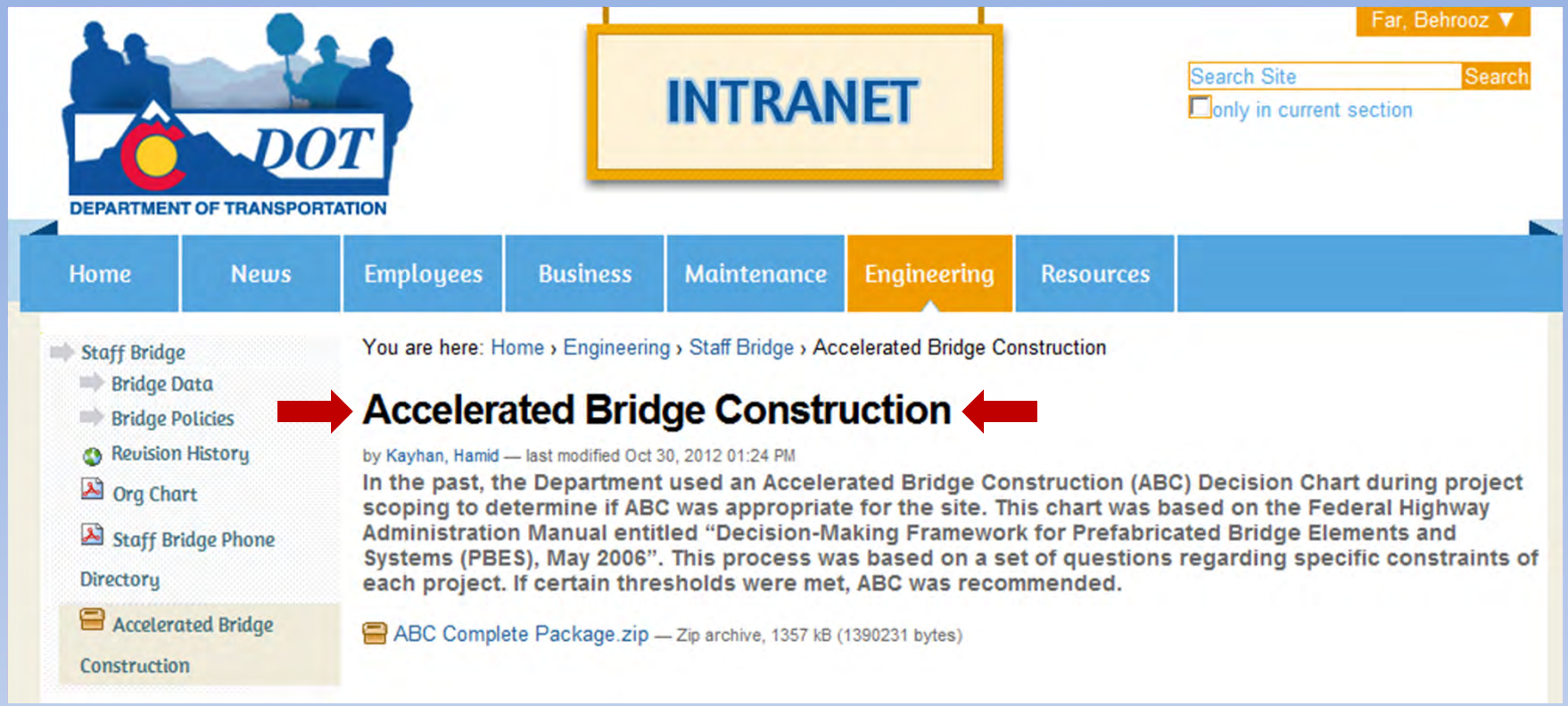
Lynn Croswell, P.E.
Bridge Inspection Program

Behrooz Far, P.E.
Bridge Fabrication Inspection

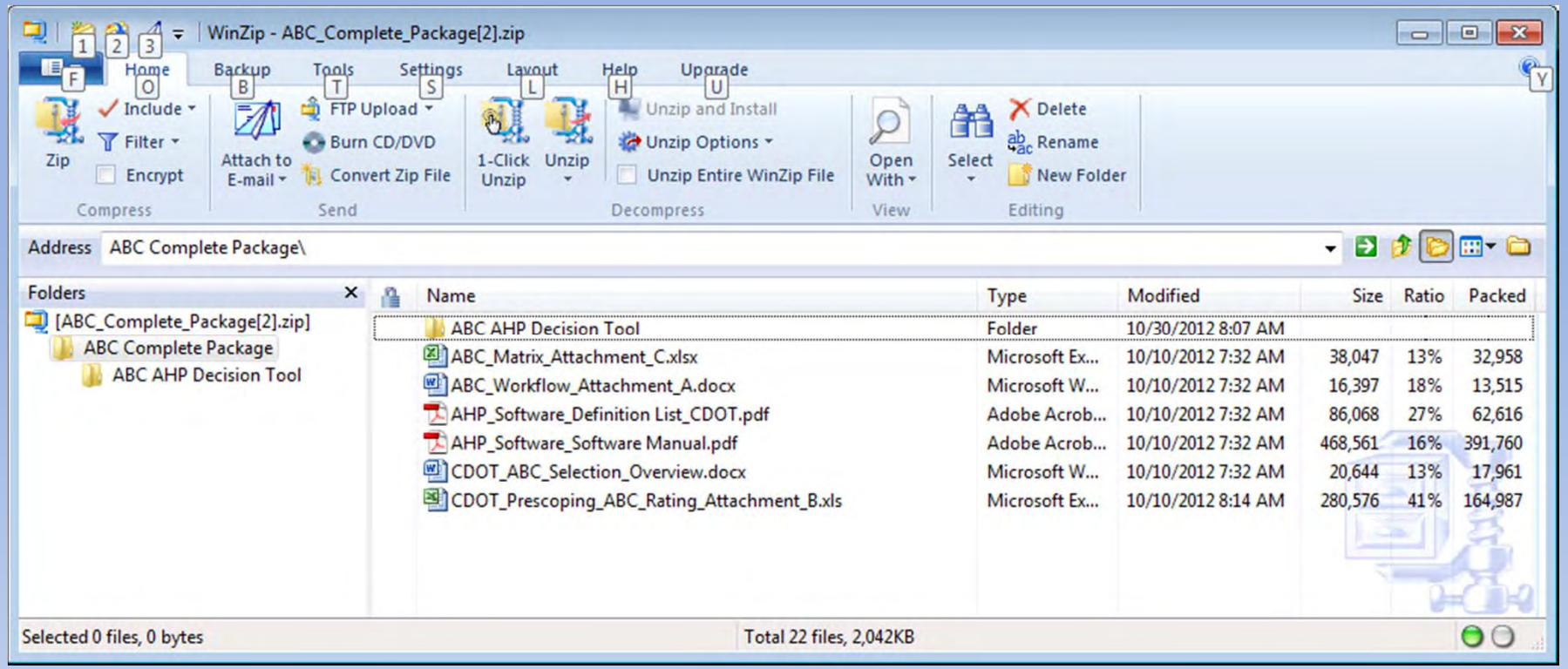
Mark Nord, P.E.
Bridge Asset Management and Records

DEPARTMENT OF TRANSPORTATION

CDOT INTERNAL SITE



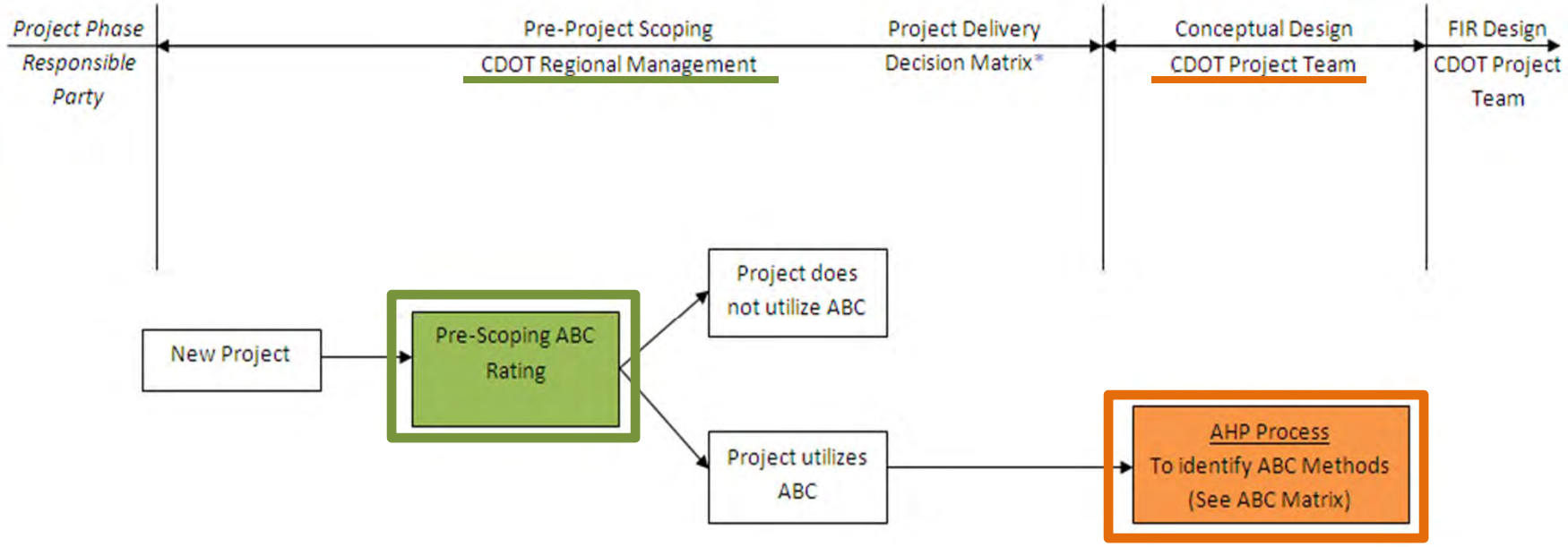
Material for ABC Evaluation



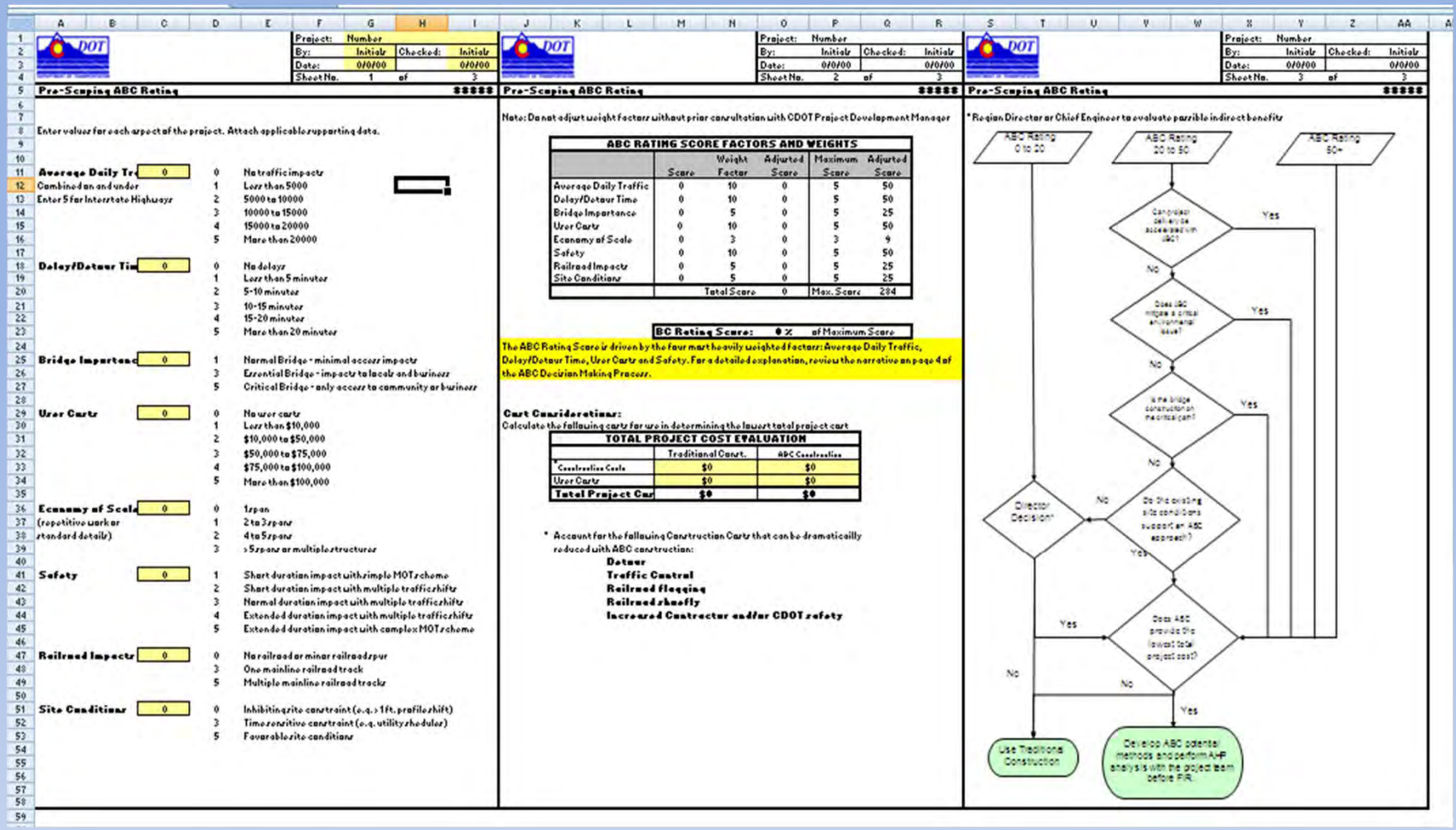
Workflow (Top Section)

Attachment A

ABC Evaluation and Decision Matrix Workflow



Pre-Scoping Rating



Pre-Scoping ABC Rating

Enter values for each aspect of the project. Attach applicable supporting data.

Average Daily Tr	0	0	No traffic impacts
Combined on and under		1	Less than 5000
Enter 5 for Interstate Highways		2	5000 to 10000
		3	10000 to 15000
		4	15000 to 20000
		5	More than 20000
Delay/Detour Tim	0	0	No delays
		1	Less than 5 minutes
		2	5-10 minutes
		3	10-15 minutes
		4	15-20 minutes
		5	More than 20 minutes
Bridge Importanc	0	1	Normal Bridge - minimal access impacts
		3	Essential Bridge - impacts to locals and business
		5	Critical Bridge - only access to community or business
User Costs	0	0	No user costs
		1	Less than $10,000
		2	$10,000 to $50,000
		3	$50,000 to $75,000
		4	$75,000 to $100,000
		5	More than $100,000
Economy of Scale	0	0	1 span
(repetitive work or		1	2 to 3 spans
standard details)		2	4 to 5 spans
		3	> 5 spans or multiple structures
Safety	0	1	Short duration impact with simple MOT scheme
		2	Short duration impact with multiple traffic shifts
		3	Normal duration impact with multiple traffic shifts
		4	Extended duration impact with multiple traffic shifts
		5	Extended duration impact with complex MOT scheme
Railroad Impacts	0	0	No railroad or minor railroad spur
		3	One mainline railroad track
		5	Multiple mainline railroad tracks
Site Conditions	0	0	Inhibiting site constraint (e.g. > 1ft. profile shift)
		3	Time sensitive constraint (e.g. utility schedules)
		5	Favorable site conditions

Pre-Scoping ABC Rating

Note: Do not adjust weight factors without prior consultation with CDOT Project Development Manager

ABC RATING SCORE FACTORS AND WEIGHTS

	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Daily Traffic	0	10	0	5	50
Delay/Detour Time	0	10	0	5	50
Bridge Importance	0	5	0	5	25
User Costs	0	10	0	5	50
Economy of Scale	0	3	0	3	9
Safety	0	10	0	5	50
Railroad Impacts	0	5	0	5	25
Site Conditions	0	5	0	5	25
		Total Score	0	Max. Score	284

ABC Rating Score: 0 % of Maximum Score

The ABC Rating Score is driven by the four most heavily weighted factors: Average Daily Traffic, Delay/Detour Time, User Costs and Safety. For a detailed explanation, review the narrative on page 4 of the ABC Decision Making Process.

Cost Considerations:

Calculate the following costs for use in determining the lowest total project cost

TOTAL PROJECT COST EVALUATION

	Traditional Const.	ABC Construction
* Construction Costs	$0	$0
User Costs	$0	$0
Total Project Cos	$0	$0

* Account for the following Construction Costs that can be dramatically reduced with ABC construction:

Detour
Traffic Control
Railroad flagging
Railroad shuttle
Increased Contractor and/or CDOT safety

* Region Director or Chief Engineer to evaluate possible indirect benefits

DEPARTMENT OF TRANSPORTATION

Example for US 6 over Garrison

Sufficiency Rating = 31.6 SD

US 6 over Garrison
Pre-Scoping Meeting

- Information Needed
  - Average Daily Traffic
  - Delay/Detour Time
  - Bridge Importance
  - User Costs
  - Economy of Scale
  - Safety
  - Railroad Impacts
  - Site Conditions

ROAD USER COST CALCULATIONS

Subaccount: | Project Name: US 6 over Garrison | Highway No.: 006G

Construction Year ADT: 102000 | % Trucks: 2

NON-CONSTRUCTION CONDITIONS

Posted Speed = 65 | Length

Travel Time = Mileage ÷ (Posted Spee

CONSTRUCTION CONDITIONS

Total Construction Length including Detours:

	*Length	Con
Segment 1:	0.5	M ÷
Segment 2:	0.6	M ÷
Segment 3:	0.5	M ÷
Segment 4:		M ÷	x 60 = 0.00

*Segment Length Total: 1.6 | Total Travel Time =

*Segment mileage should add up to Total Construction Length.

TRAVEL TIME COSTS:

Delay Cost Factors:

Passenger Cars: 12.16 $ / veh-hr of delay

Multi-Unit Trucks: 24.18 $ / veh-hr of delay

	[%]		[ADT]		[COST FACT]		
Passenger Car Component:	0.98	X	1E+05	X	12.16	÷ 60 min/hr =	
Truck Component:	0.02	X	1E+05	X	24.18	÷ 60 min/hr =	

Total Daily Cost per Minute of Delay =

ROAD USER COSTS

Construction Delay = Construction Travel Time - Non-Construction Travel Time = 0.41 Minutes

Total Resultant Delay Costs = 0.41 X $21,081 = $8,727 per day

USE

Detour Length 19:	0.6 mi
Toll Facility 20:	3
Custodian 21:	1
Owner 22:	1
Functional Class 26:	12
Year Built 27:	1964
Lanes on 28A:	6
Lanes Under 28B:	4
ADT 29:	102,000
Year of ADT 30:	2008

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Pre-Scoping Meeting

		Project:	Number		
		By:	Initials	Checked:	Initials
		Date:	0/0/00		0/0/00
		Sheet No.	1	of	3

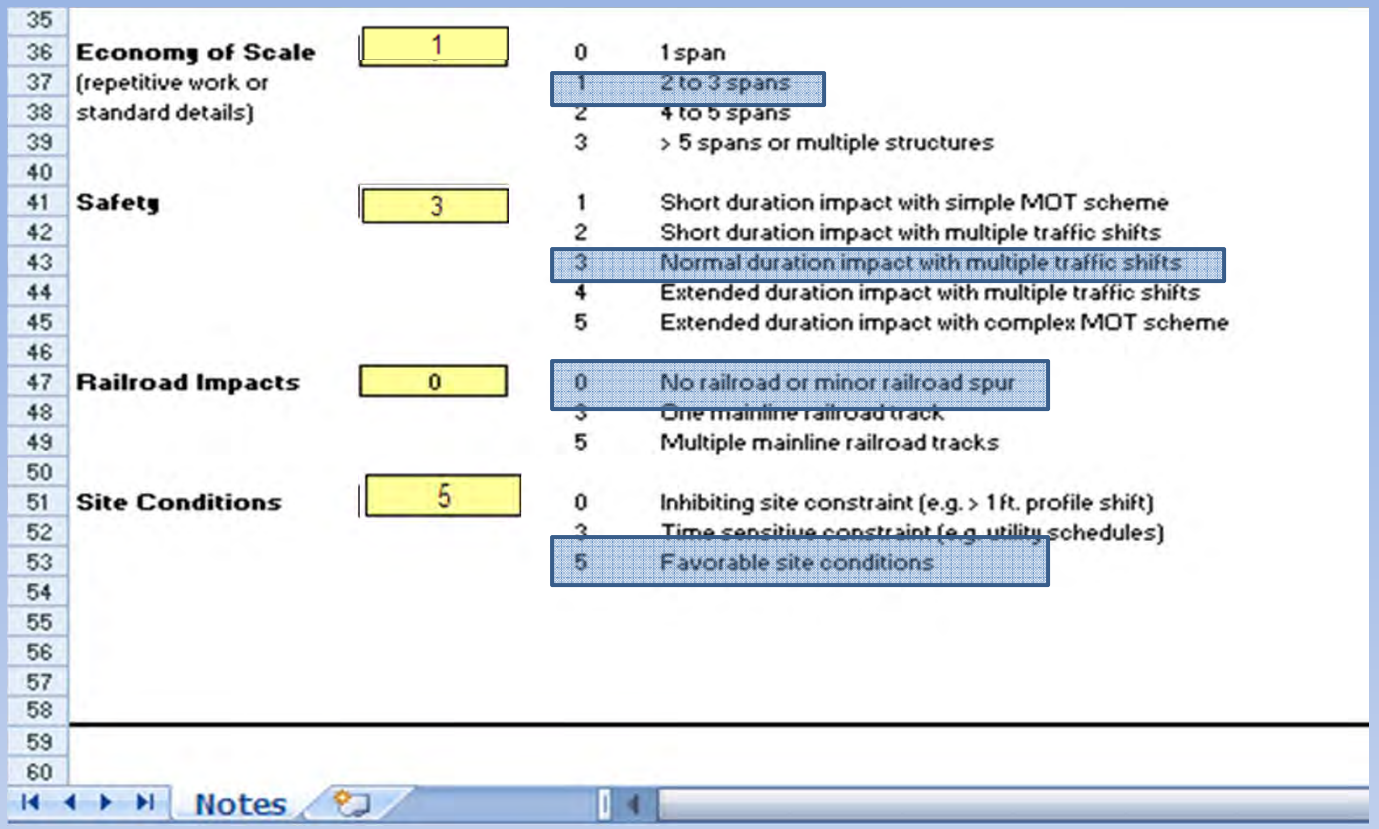
Pre-Scoping ABC Rating **May 2012**

Enter values for each aspect of the project. Attach applicable supporting data.

Average Daily Traffic	5	0	No traffic impacts
Combined on and under		1	Less than 5000
Enter 5 for Interstate Highways		2	5001 to 10000
		3	10001 to 15000
		4	15001 to 20000
		5	More than 20000
Delay/Detour Time	1	0	No delays
		1	Less than 5 minutes
		2	5-10 minutes
		3	10-15 minutes
		4	15-20 minutes
		5	More than 20 minutes
Bridge Importance	3	1	Normal Bridge - minimal access impacts
		3	Essential Bridge - impacts to locals and business
		5	Critical Bridge - only access to community or business
User Costs	1	0	No user costs
(per day)		1	Less than $10,000
		2	$10,000 to $50,000
		3	$50,000 to $75,000
		4	$75,000 to $100,000
		5	More than $100,000

ADT = 102,000

Pre-Scoping Meeting



Economy of Scale (repetitive work or standard details)	1	0	1 span
		1	2 to 3 spans
		2	4 to 5 spans
		3	> 5 spans or multiple structures
Safety	3	1	Short duration impact with simple MOT scheme
		2	Short duration impact with multiple traffic shifts
		3	Normal duration impact with multiple traffic shifts
		4	Extended duration impact with multiple traffic shifts
		5	Extended duration impact with complex MOT scheme
Railroad Impacts	0	0	No railroad or minor railroad spur
		3	One mainline railroad track
		5	Multiple mainline railroad tracks
Site Conditions	5	0	Inhibiting site constraint (e.g. > 1 ft. profile shift)
		3	Time sensitive constraint (e.g. utility schedules)
		5	Favorable site conditions

Notes

Pre-Scoping Worksheet
Page 2

Project:	Number		
By:	Initials	Checked:	Initials
Date:	0/0/00		0/0/00
Sheet No.	2	of	3

May 2012

Project:	F-16-ER US 6 over Garrison		
By:	LEB	Checked:	BMF
Date:	2/21/2013		3/6/2013
Sheet No.	2	of	3

Pre-Scoping ABC Rating **May 2012**

Note: Do not adjust weight factors without prior consultation with CDOT Project Development Manager

ABC RATING SCORE FACTORS AND WEIGHTS

	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Daily Traffic	5	10	50	5	50
Delay/Detour Time	1	10	10	5	50
Bridge Importance	3	5	15	5	25
User Costs	1	10	10	5	50
Economy of Scale	1	3	3	3	9
Safety	3	10	30	5	50
Railroad Impacts	0	5	0	5	25
Site Conditions	5	5	1	5	25
		Total Score	118	Max. Score	284

ABC Rating Score: 42 % of Maximum Score

The ABC Rating Score is driven by the four most heavily weighted factors: Average Daily Traffic, Delay/Detour Time, User Costs and Safety. For a detailed explanation, review the narrative on page 4 of the ABC Decision Making Process.

Cost Considerations:

Calculate the following costs for use in determining the lowest total project cost. (Completed at FIR level)

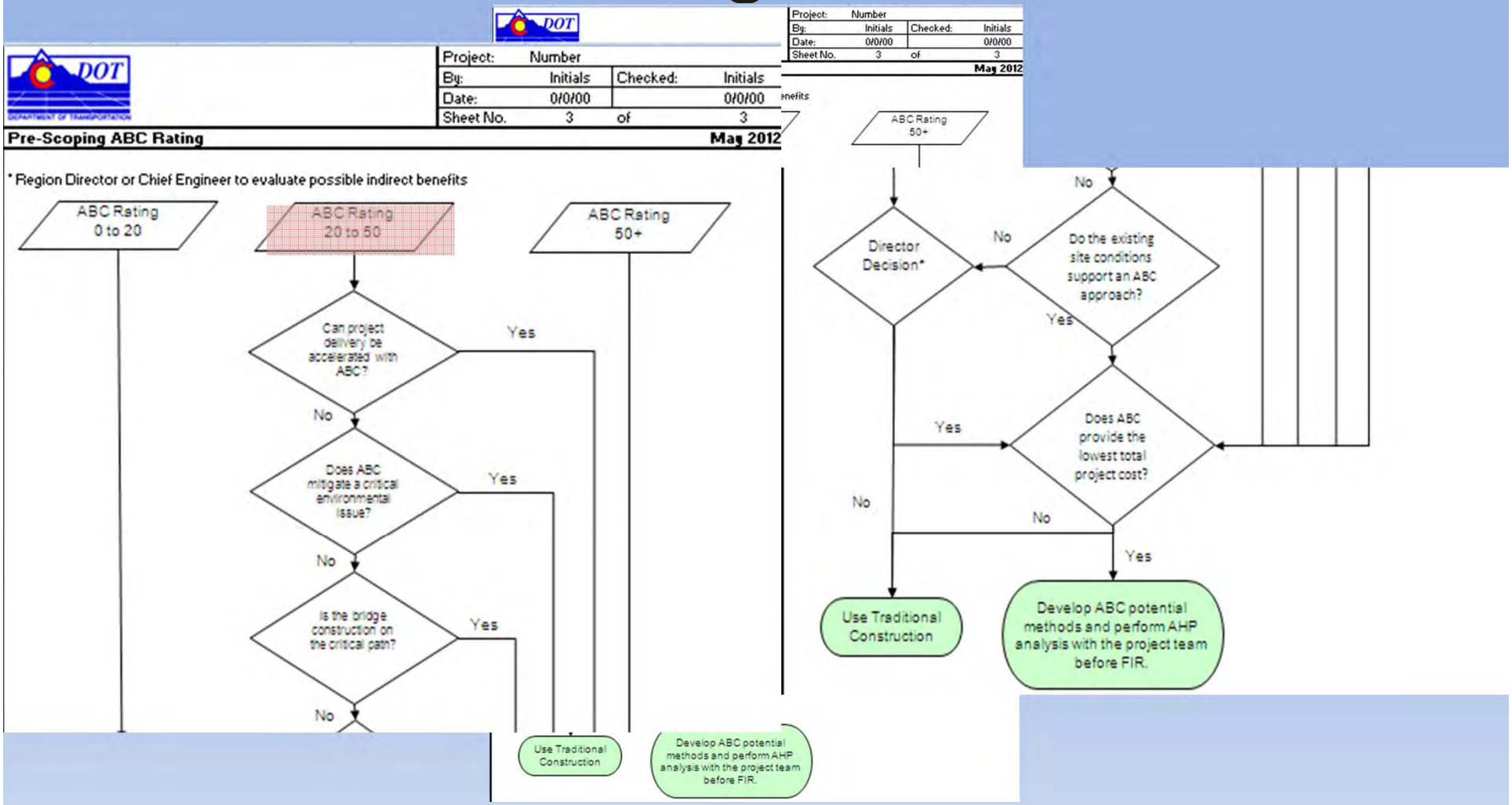
TOTAL PROJECT COST EVALUATION

	Traditional Const.	ABC Construction
*Construction Costs	$0	$0
User Costs	$0	$0
Total Project Cost	**$0**	**$0**

* Account for the following Construction Costs that can be dramatically reduced with ABC construction:

Detour
Traffic Control
Railroad flagging
Railroad shoefly
Increased Contractor and/or CDOT safety

Pre-Scoping Worksheet
Page 3



ABC Matrix

Attachment C

Accelerated Bridge Construction Matrix

This matrix is to provide suggestions and previously utilized methods for accelerated bridge construction, it is not all inclusive nor intended to dictate any particular method.

PROJECT COMPLEXITY

Substructure	Approach, Embankment & Backfill	Superstructure	Super Structure placement
	Pre-fabricated approach slabs	Adjacent Girders[2]	
	Flowfill	Precast Deck Panels (partial depth)[2]	
Pre-fabricated Pier Caps	Expanded Polystyrene (EPS) Geofoam	Pre-fabricated pedestrian bridge[2]	
Pre-fabricated columns		Pre-fabricated box culvert[2]	
Pre-fabricated foundations		Precast Deck Panels (full depth)[2]	
Geosynthetic Reinforced Soil (GRS) Abutment[1]		Modular Girder and Deck elements[2]	
Pre-fabricated wingwalls/backwalls[2]		Post-tensioned concrete through beams[2]	Heavy Lift Cranes
Continuous Flight Auger Piles (CFA)		Pre-fabricated truss or arch span[2]	Skid or Slide In
			Longitudinal Bridge Launch
			Self Propelled Modular Transport (SPMT)

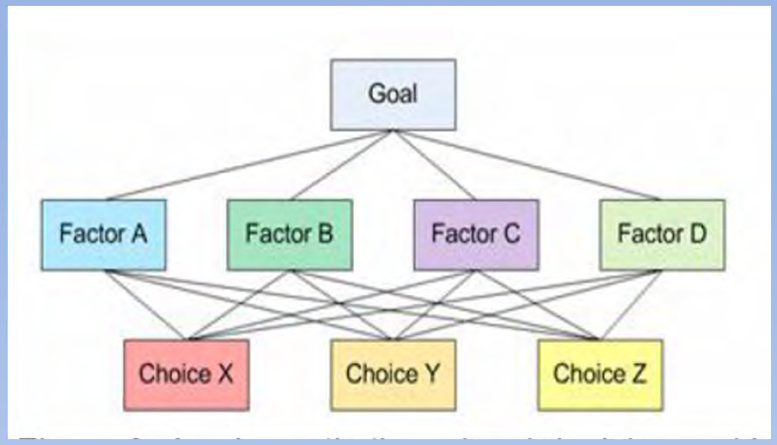
[1] FHWA Every Day Counts Initiatives

[2] Prefabricated Bridge Elements and Systems (PBES)

ABC Costs *ABC method construction costs generally increase with project complexity. However many methods of ABC may reduce the over all project cost. Specifically where ABC methods can eliminate or reduce detours, or traffic control.*

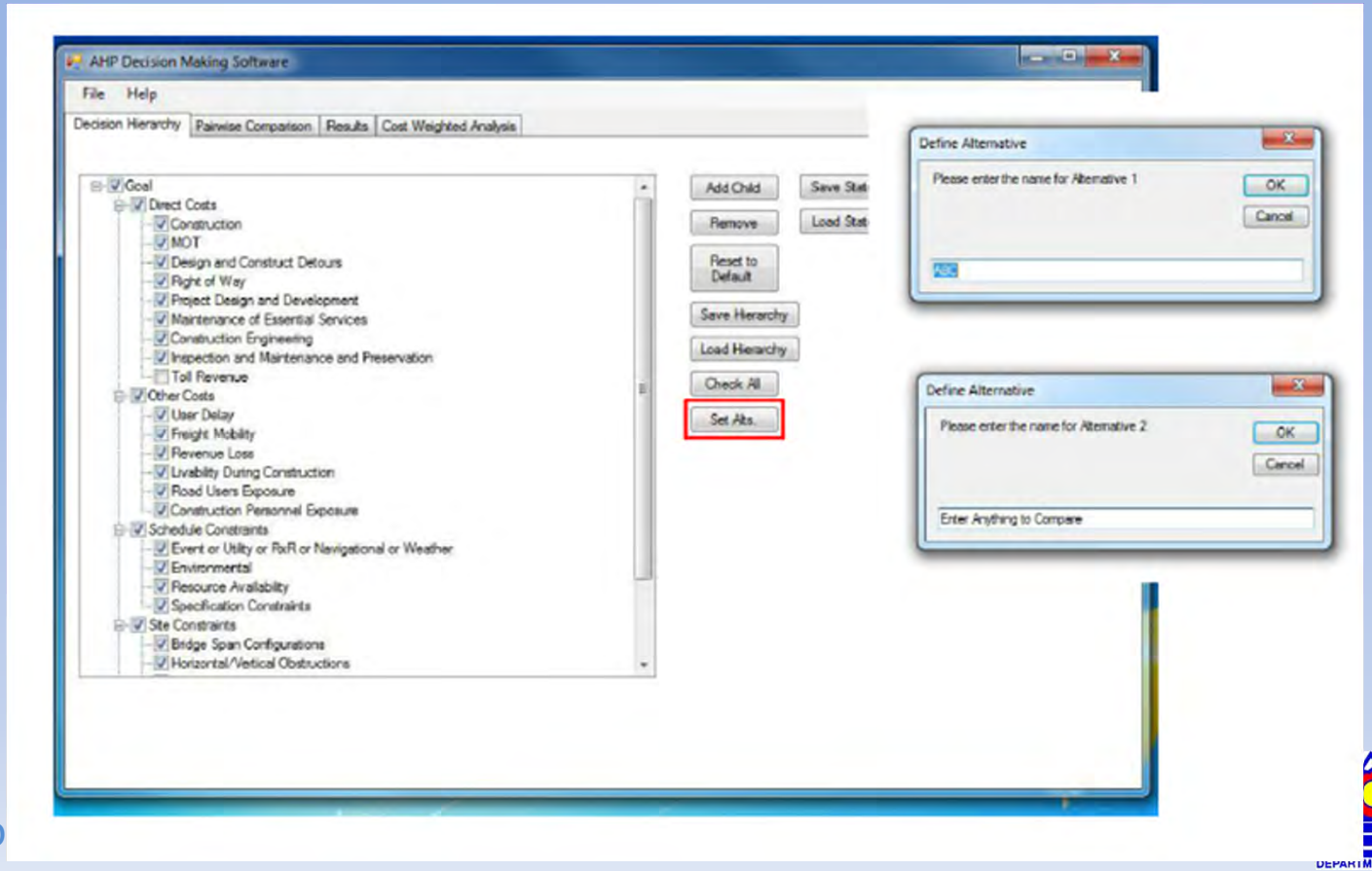
Analytic Hierarchy Process

- Decision making process
  - Simplifies numerous factors into pair-wise comparisons
- Project specific weight factors
- Compares ABC alternatives

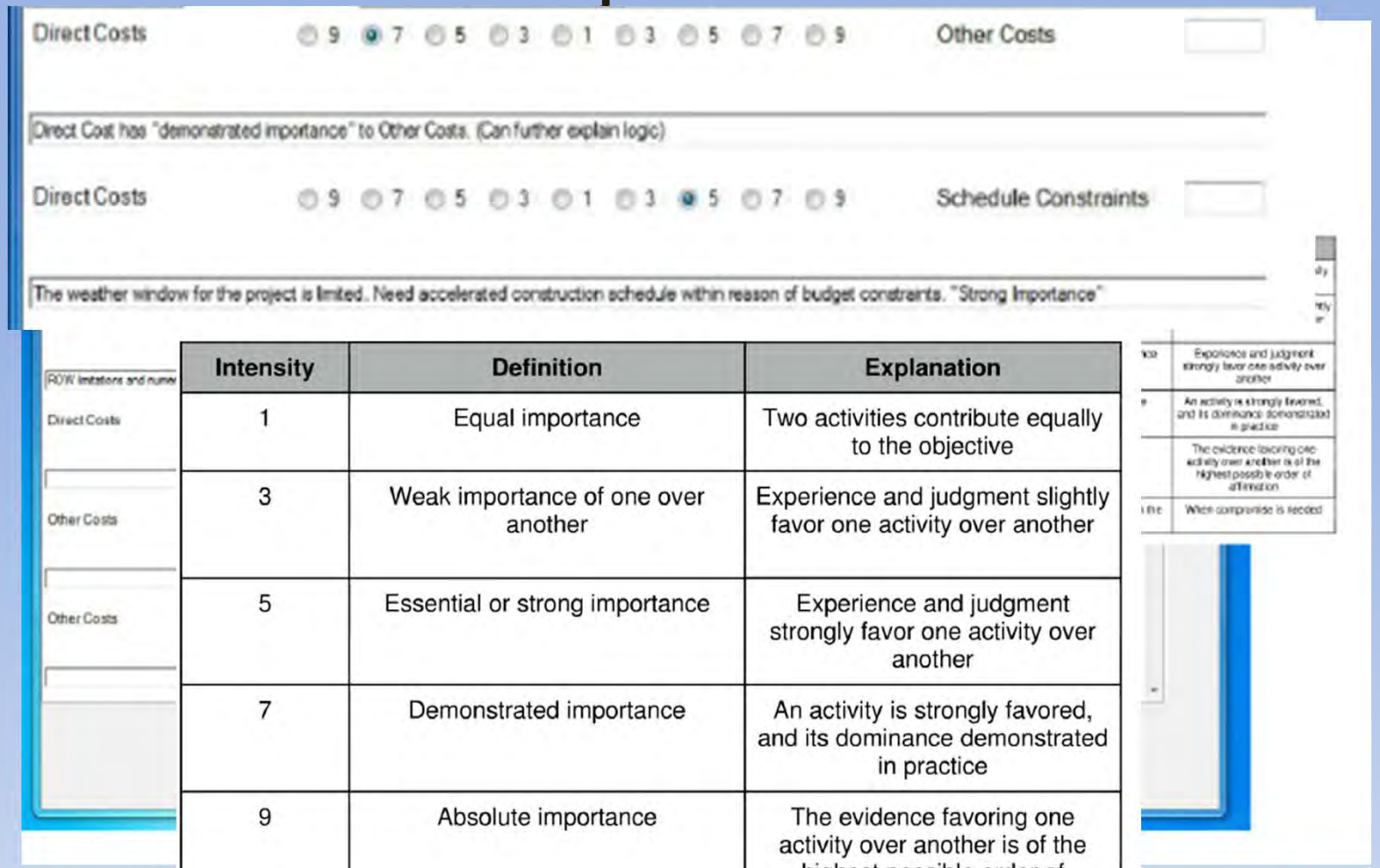


Step 1: Develop Hierarchy and Set Alternatives

- Select those that apply to your project
- Set Alternatives



Step 2: Complete Pairwise Comparisons

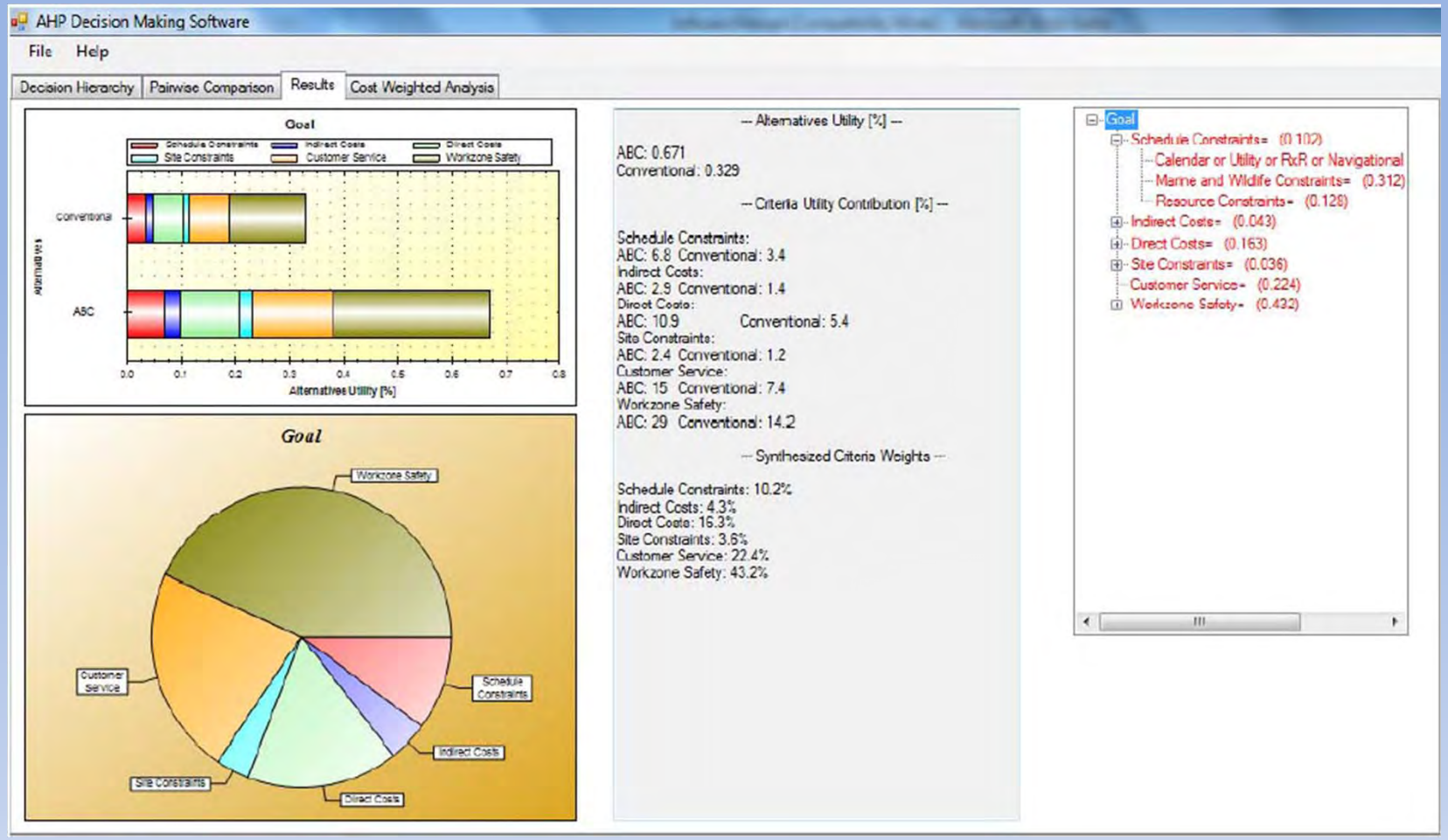


Intensity	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored, and its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

Step 3: Apply to Alternatives

Intensity	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored, and its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

Step 4: Analyze Results



AHP Software

- Project specific
- Documentation of thought process
- Tool to facilitate discussion and come to conclusion for best fit ABC alternative

Subject Matter Expert Contact Information

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303-757-9193
BEHROOZ.FAR@STATE.CO.US

Or

Preeda Chomsrimake
303-757-9194
PREEDA.CHOMSRIMAKE@STATE.CO.US

Thank you

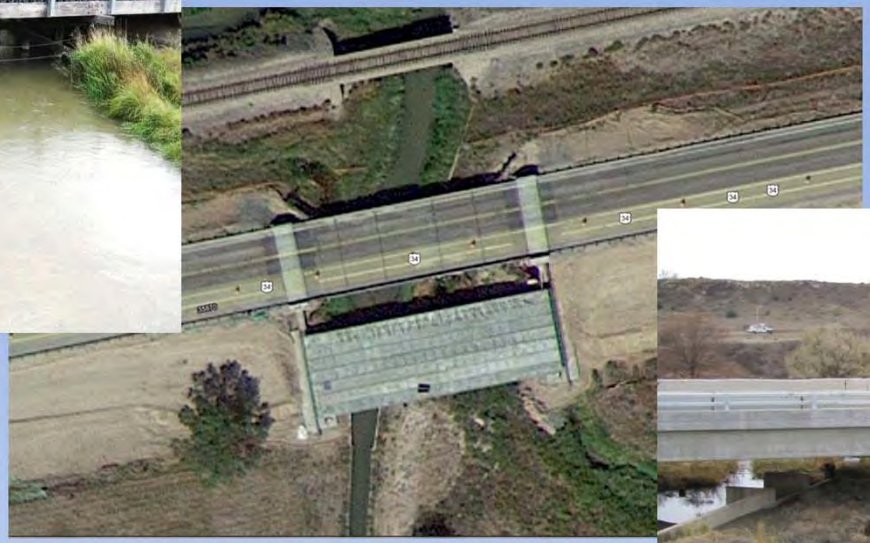
Questions

Region 4 Bridge Slides

TSIOUVARAS SIMMONS HOLDERNESS
CONSULTING ENGINEERS

US 34 BRIDGE REPLACEMENT EAST OF WRAY

Before



During

72 Hours Later

DOT
DEPARTMENT OF TRANSPORTATION

TSIOUVARAS SIMMONS HOLDERNESS
CONSULTING ENGINEERS

CDOT Management Team

- Keith Sheaffer, R4 South Program Engineer
- Brett Locke, Sterling Resident Engineer
- Craig Schumacher, Sterling Project Engineer

TSIOUVARAS SIMMONS HOLDERNESS
CONSULTING ENGINEERS

CDOT/TSH Blended Design Team

- Tsiouvaras Simmons Holderness Engineering: Structure Design
  - Jeff Simmons
  - Treena Fulton
  - Andy Pelster
- Project Engineer (Roadway Design): Craig Schumacher CDOT
- Hydraulic Engineer: Steve Griffin CDOT
- Staff Bridge: Richard Osmun CDOT
- Environmental: Patrick Hickey, Jennifer Gorek, Jennifer Klaetsch CDOT
- Traffic: Daniel Thomas CDOT
- Utilities: Rudy Sipnefski CDOT
- Survey: Lee Groves CDOT
- Right of Way: Dan Michna CDOT
- Materials: Rick Chapman CDOT

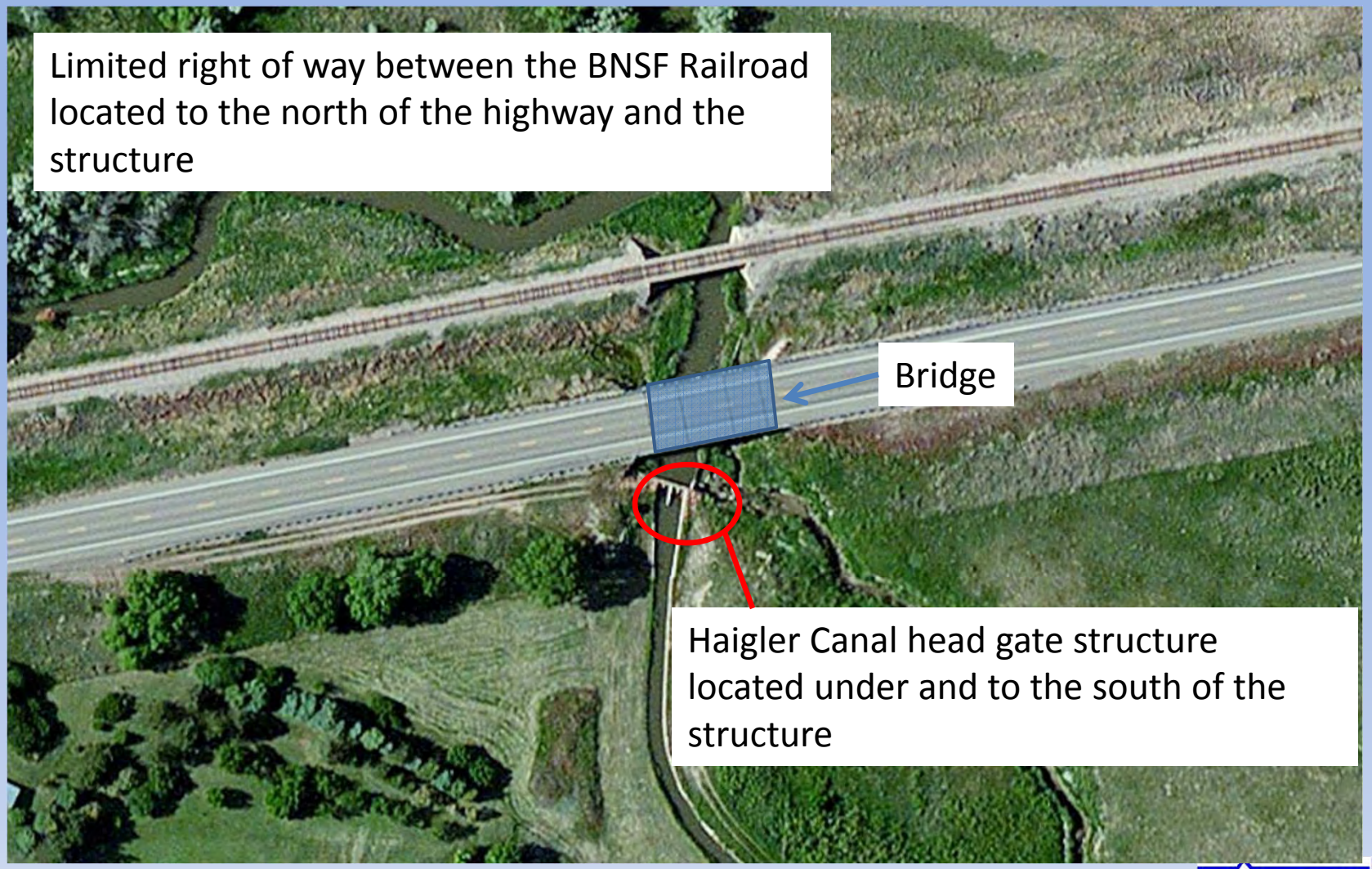
TSIOUVARAS SIMMONS HOLDERNESS
CONSULTING ENGINEERS

Project Construction Team

- CDOT Resident Engineer: Brett Locke
- CDOT Project Engineer: Craig Schumacher
- CDOT Inspector: Carlos Gomez
- CDOT Tester: Andrew Muller
- Tsiouvaras Simmons Holderness: Engineering Review
- Consultant Inspector: Richard McKay
- Construction Contractor: Lawrence Construction
- Project Manager: Anne Lawrence
- Superintendent: Lee Adams
- Foreman: Jose Diaz

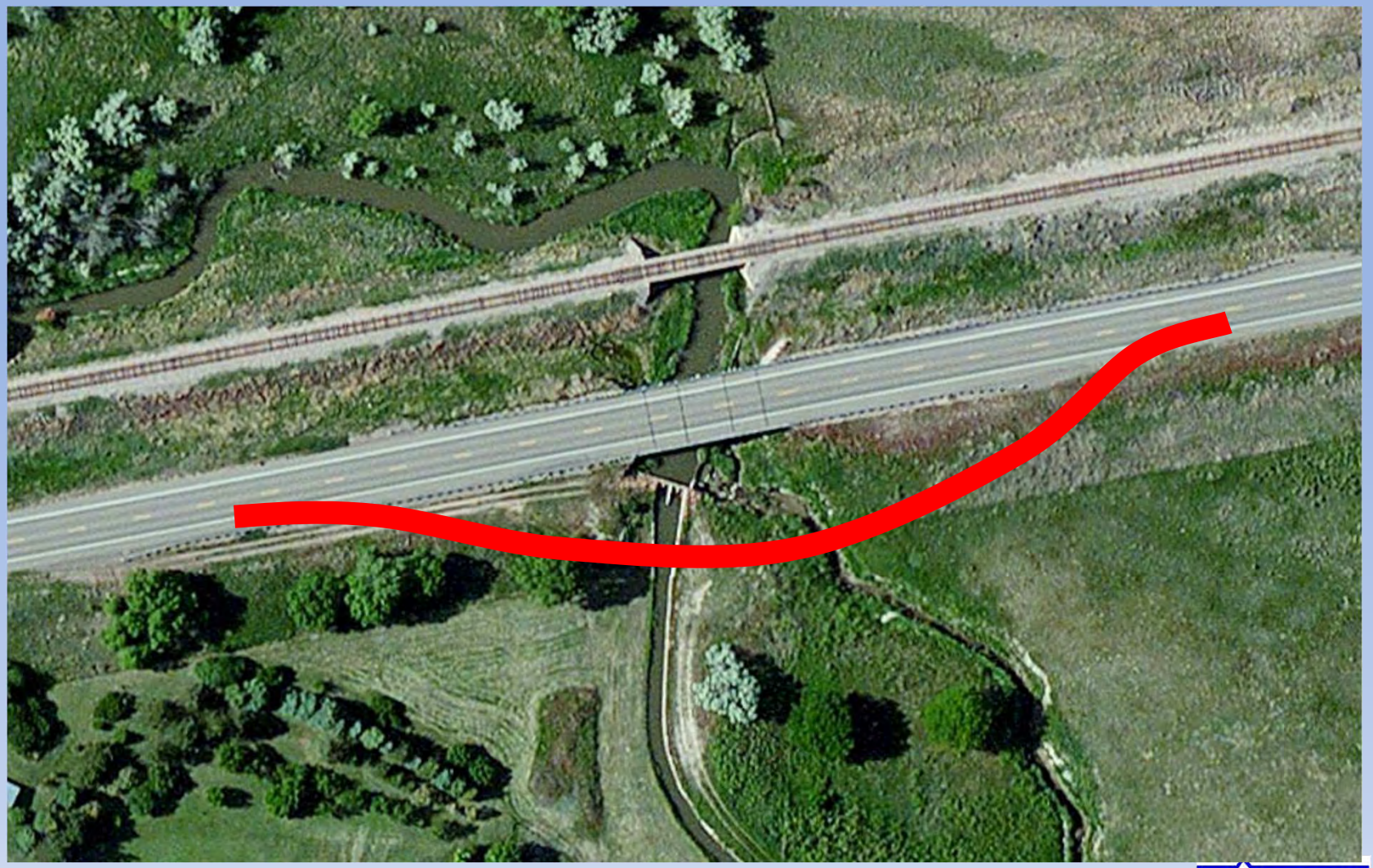
TSIOUVARAS SIMMONS HOLDERNESS
CONSULTING ENGINEERS

Site Challenges



TSIOUVARAS SIMMONS HOLDERNESS
CONSULTING ENGINEERS

On Site Detour



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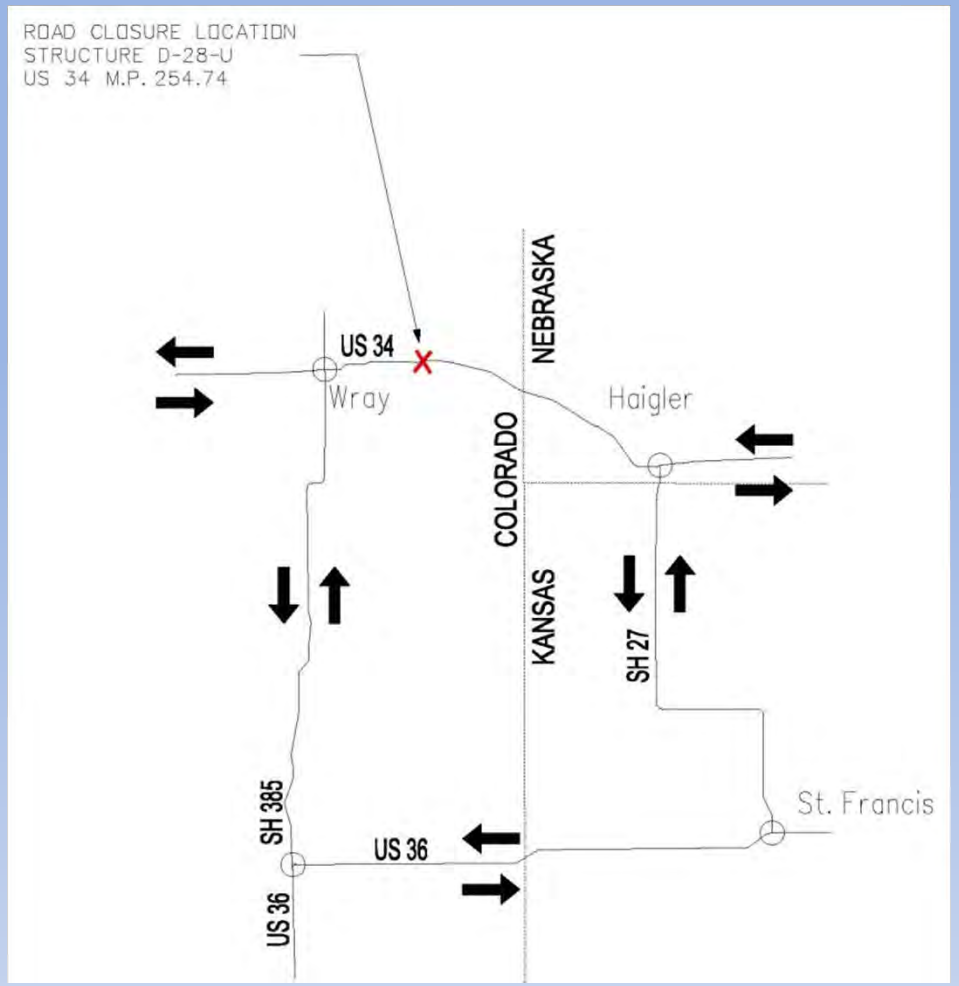
Off Site Detour

- Shortest paved detour route was 69 miles long with a calculated user cost at $48,000 per day.



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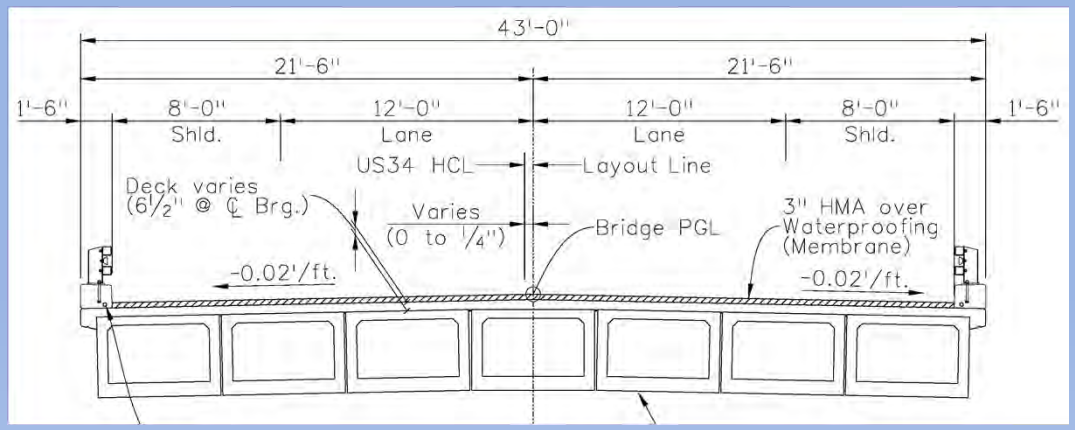
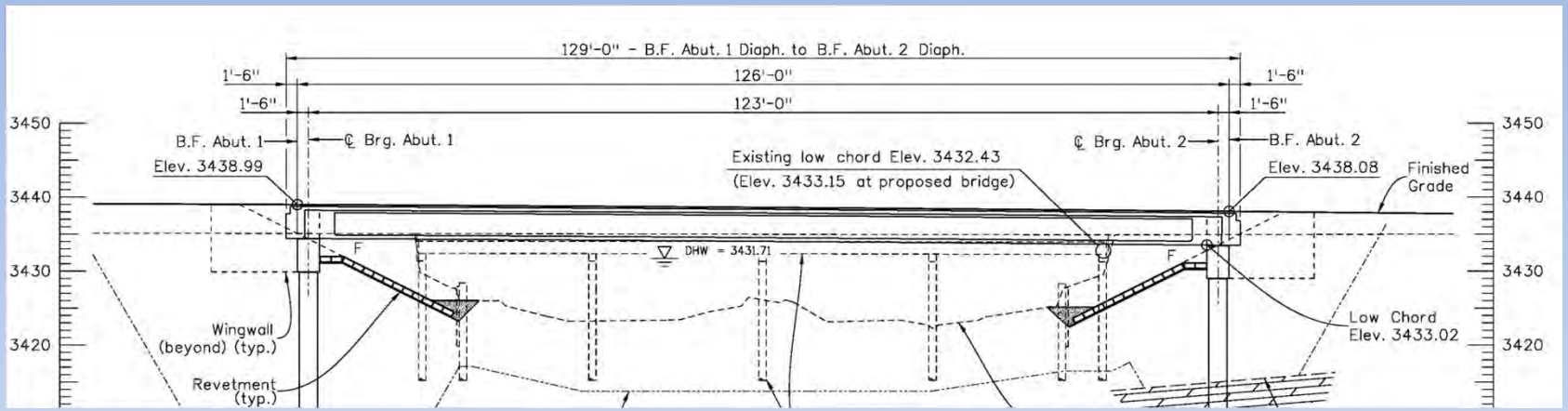
Bridge Section and Layout





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Alternatives Considered

Construction Method	Engineer Estimate	User Costs	Total Cost
Complete Closure - Off Site Detour	$ 2,111,031	$ 4,320,000	$ 6,431,031
Complete Closure - On Site Detour to South	$ 2,629,011	$ -	$ 2,629,011
2 Phase construction - One Lane Traffic Open During Construction	$ 2,382,539	$ -	$ 2,382,539
Complete Closure - Lateral Roll-In	$ 2,323,735	$ 96,000	$ 2,419,735
Complete Closure - In Place Accelerated Bridge Construction	$ 2,335,517	$ 672,000	$ 3,007,517

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Design Decisions

- Design two alternatives for contractors to bid.
- Alt 1 = Build in Place Utilizing Accelerated Bridge Construction
- Alt 2 = Slide-In
- Utilize A+B Cost Plus Time Bidding. The B portion being the number of days needed to close US 34 to traffic with a maximum number of days set at 16.
- The Slide-In would involve building the foundations under live traffic, building the bridge superstructure to the south of the existing bridge, and sliding it in to its final position.

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Bid Results

- 7 Bidders
  - 4 Bids for the Roll in Option
  - 3 Bids for Rapid In Place Construction

Contractor Name	(Section A)	(Section A + B)	Days
Lawrence Construction Co.	$ 2,316,105	$ 2,508,105	4
SEMA Construction, Inc.	$ 2,359,949	$ 2,791,949	9
Concrete Express, Inc.	$ 2,486,341	$ 2,870,341	8
Edward Kraemer & Sons, Inc.	$ 2,800,440	$ 3,040,440	5
TLM Constructors, Inc.	$ 2,448,000	$ 3,216,000	16
American Civil Constructors, Inc.	$ 3,039,318	$ 3,327,318	6
Dondlinger & Sons Construction	$ 3,540,127	$ 3,924,127	8

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Bid Results

Contractor Name	(Section A)	(Section A + B)	Days
Engineer's Estimate	$ 2,394,382	$ 3,162,382	16
Lawrence Construction Co.	$ 2,316,105	$ 2,508,105	4
SEMA Construction, Inc.	$ 2,359,949	$ 2,791,949	9
Diffrence between #1 and #2	$ 43,844	$ 283,844	5
% of Low Bid	2%	11%	

Bridge Cost = $795,258 / $143 per sq foot
Bridge Move Pay Item = $73,908 / 9% of Bridge Cost

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Key ABC Components

- Offline prefabrication of the complete bridge superstructure
- Construction of substructure in precast shoring vaults
- Demolition of existing bridge, channel improvements, and slide-in of new superstructure completed during 3 day full closure



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Offline Superstructure Construction

- Temporary foundation, girder support beam, and track system

- Precast side-by-side box girders erected on temporary beam

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Offline Superstructure Construction

- Deck, diaphragm, and bridge rail

- Superstructure complete except wearing surface

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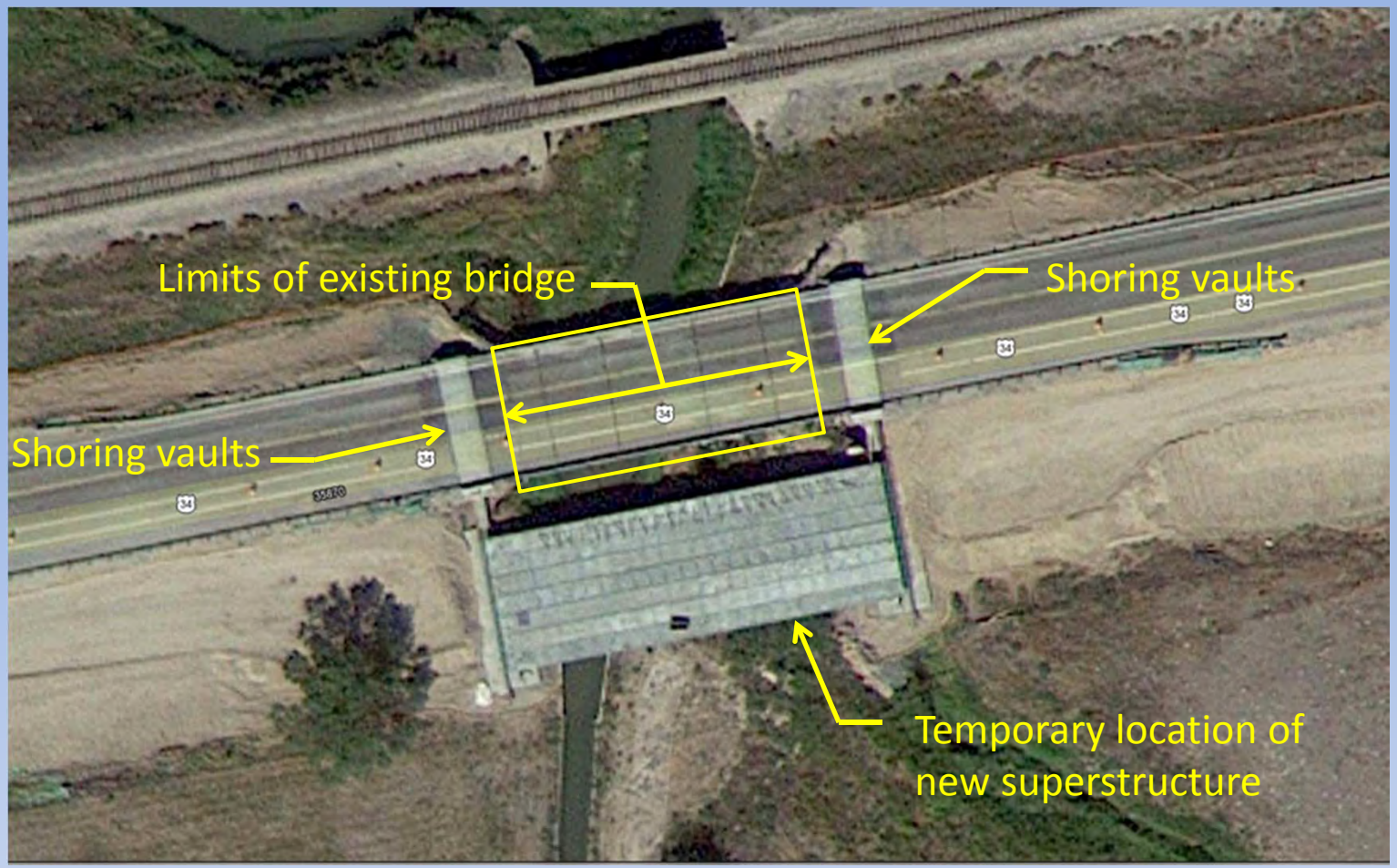
Precast Shoring Vaults



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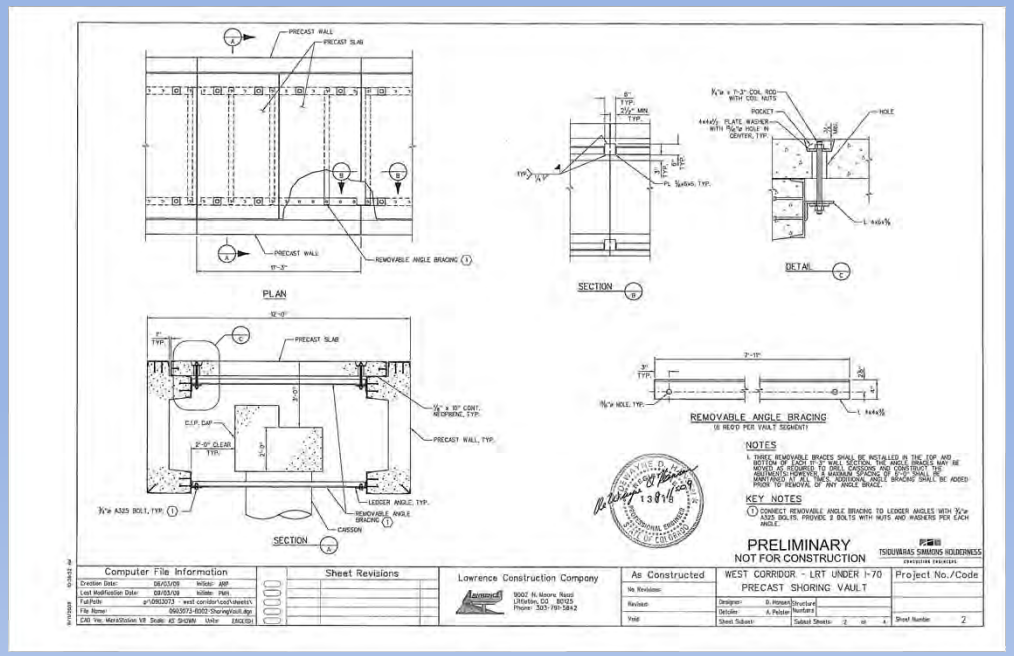
Precast Shoring Vaults



- Shoring vaults precast off site
- Assembled vaults installed under traffic

- Lids removable for access
- Adaptable to multiple site configurations

- Caisson construction completed under traffic

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Precast Shoring Vaults

- Abutment cap construction completed under live traffic

- Large enough to accommodate full construction of abutment cap and slide-in system track

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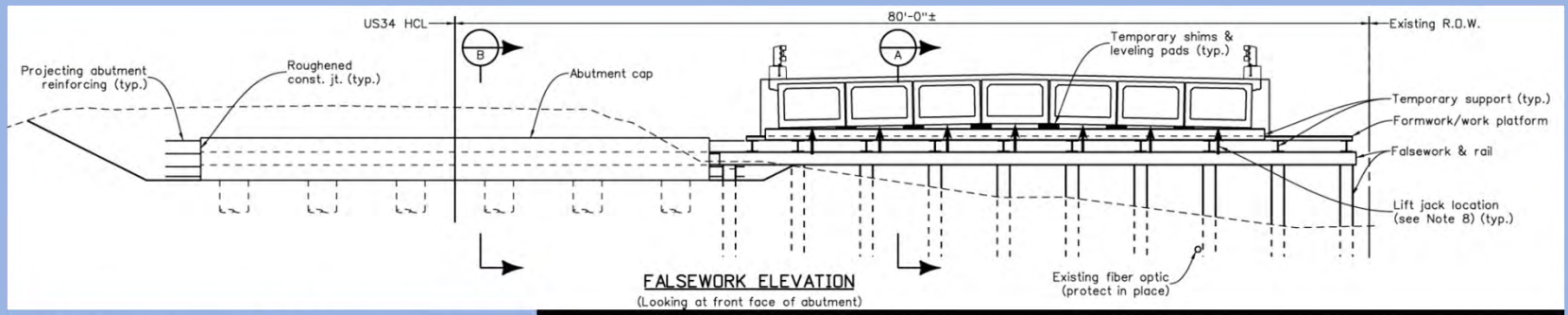
Slide-in Operation

50 feet in 90 minutes



- Lift bridge off falsework
- Lower bridge onto rollers
- Incremental move along continuous track to final position
- Lift bridge off rollers
- Adjust bearing shims and lower bridge onto bearings

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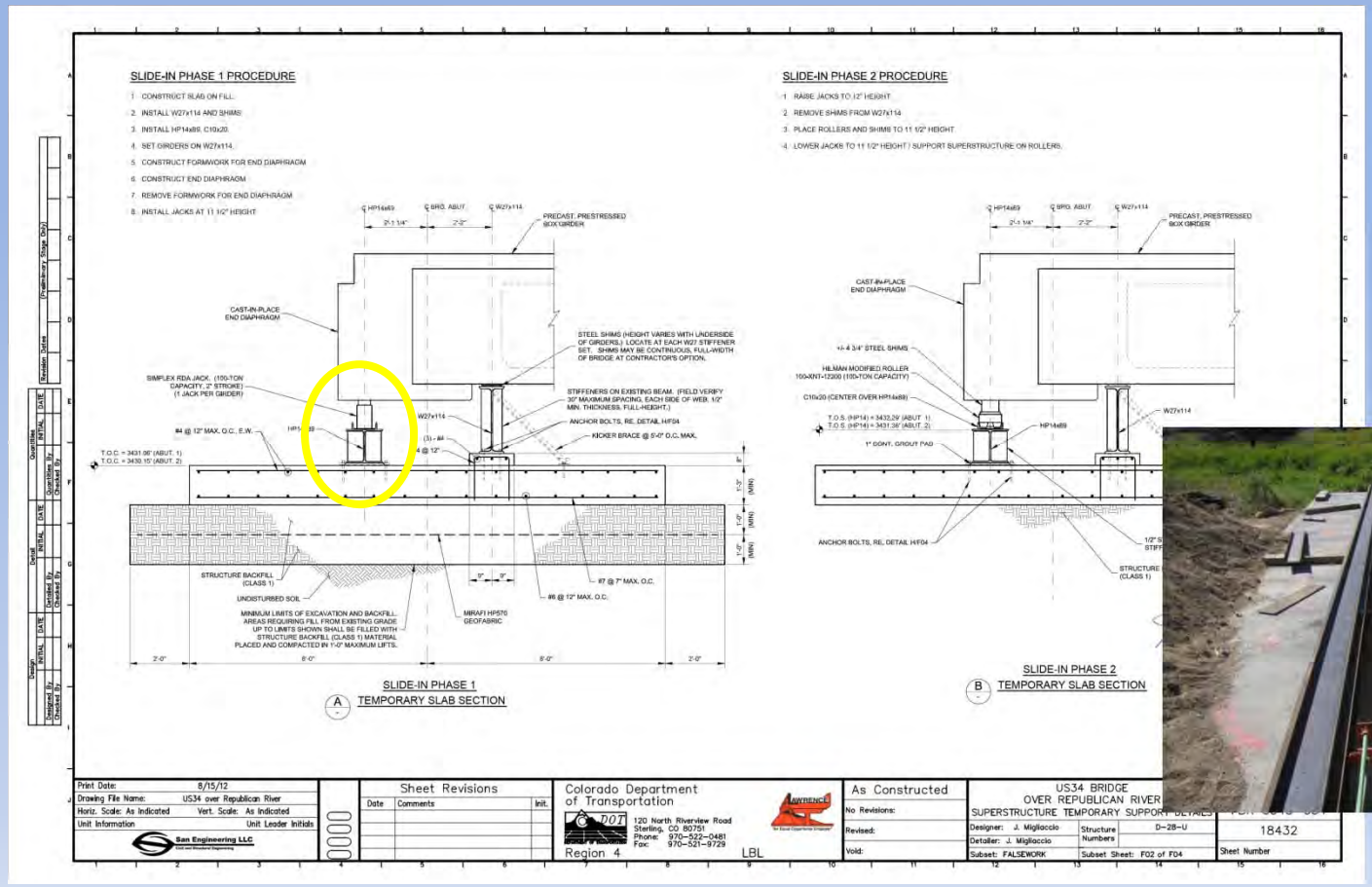
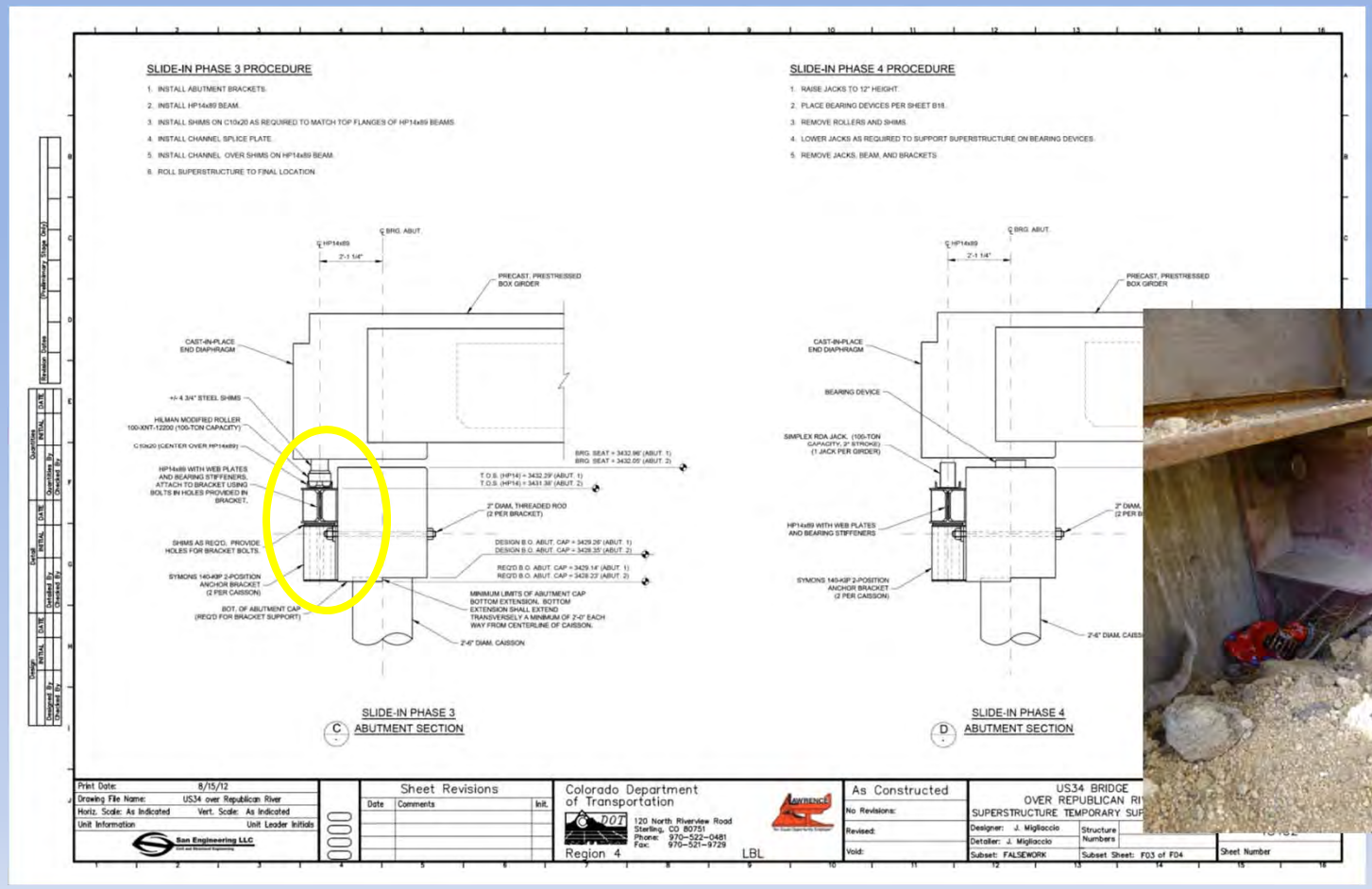
Track on Temporary Foundation

- Reinforced cast-in-place concrete footing on reinforced fill
- HP 14x89 support beam bolted to temporary footing
- C 10x20 continuous guide channel welded to support beam



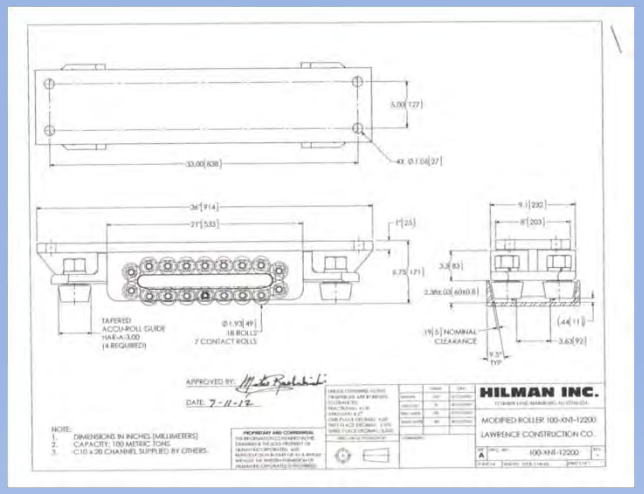
Track on Abutment

- 2 ~ 140 kip brackets bolted through abutment cap at each caisson (12 per abutment)
- Support beam with guide channel bolted to brackets
- Support beam and guide channel field spliced



Jacks and Rollers

- 7 ~ 100 ton jacks at each diaphragm



- 7 ~ 100 ton rollers at each diaphragm
- 2 guided rollers
- 5 unguided rollers

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Ram System

•Bracket bolted to diaphragm

•Pair of hydraulic cylinders at each diaphragm
•30 inch stroke

•Bracket attached to track with removable pins

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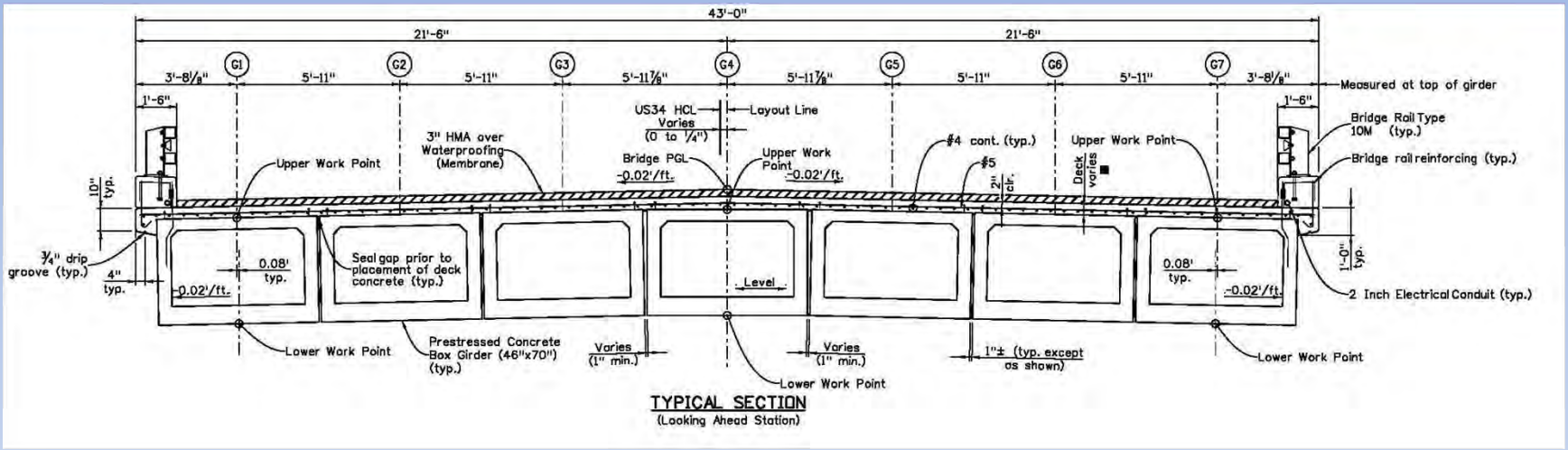
Design Considerations

- In-place vs. Slide-in
  - In-place
    - Precast, pre-stressed superstructure
    - Integral abutments
    - Caisson foundation
  - Slide-in
    - Precast, pre-stressed superstructure
    - Elastomeric bearing pads
    - Caisson foundation
- Two bridge designs
  - Two sets of plans

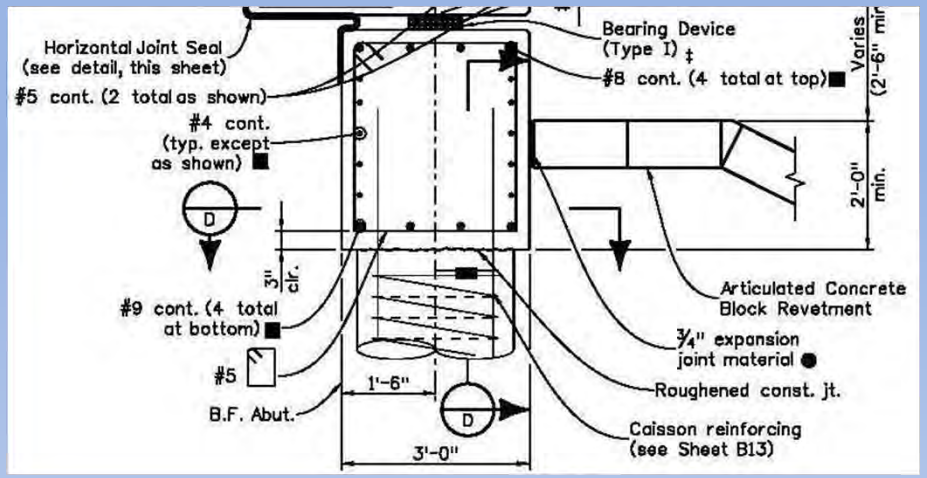
Superstructure

- One design – two bridges
- Designed as conventional bridge
- Constructed as conventional bridge



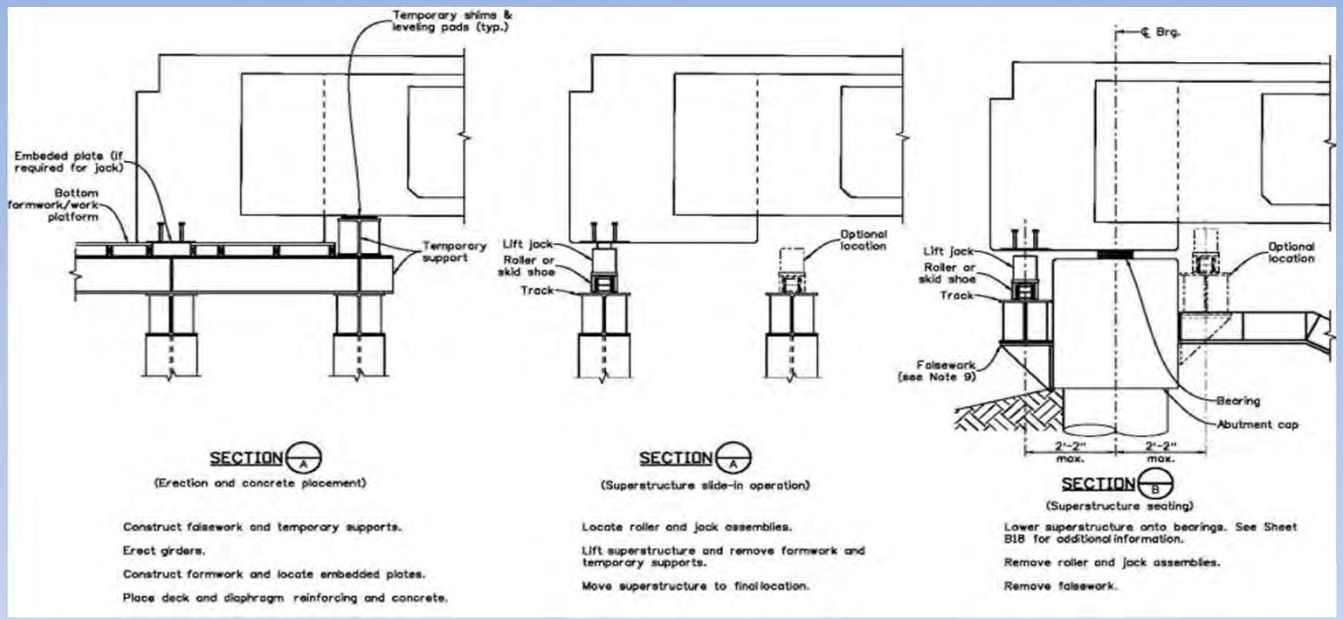
Abutment Cap and Caissons

- Abutment cap design
- Support at each caisson
  - Load path to caissons
- Caisson design cases
  - Final configuration
  - Eccentric load from slide
  - Horizontal force from slide



End Diaphragms

- Added length for slide-in supports
- Slide-in considerations
  - Jacking locations



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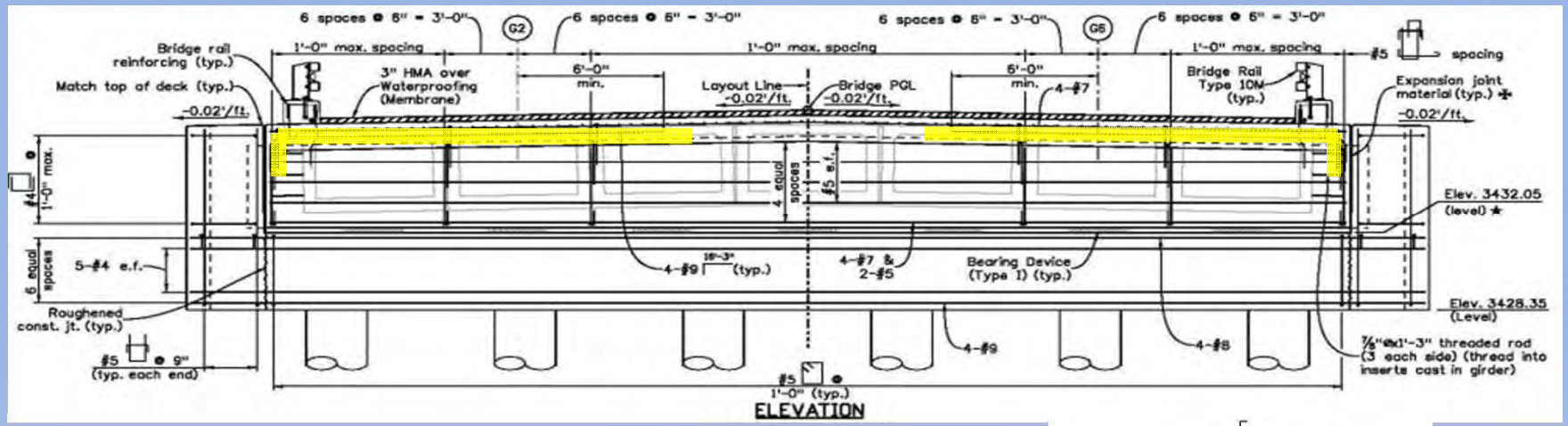
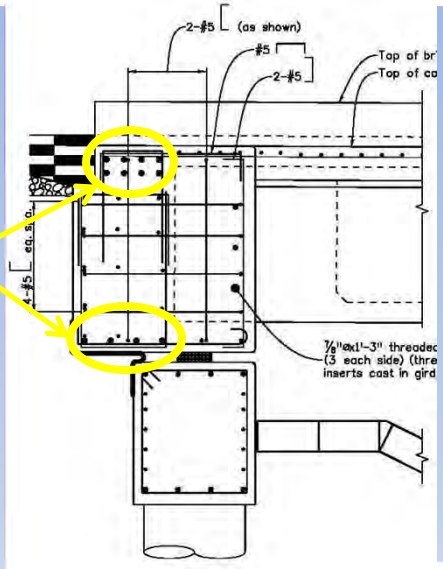
Diaphragms Cont.



- Roller locations
- Loss of roller(s) during slide

Additional Reinforcing



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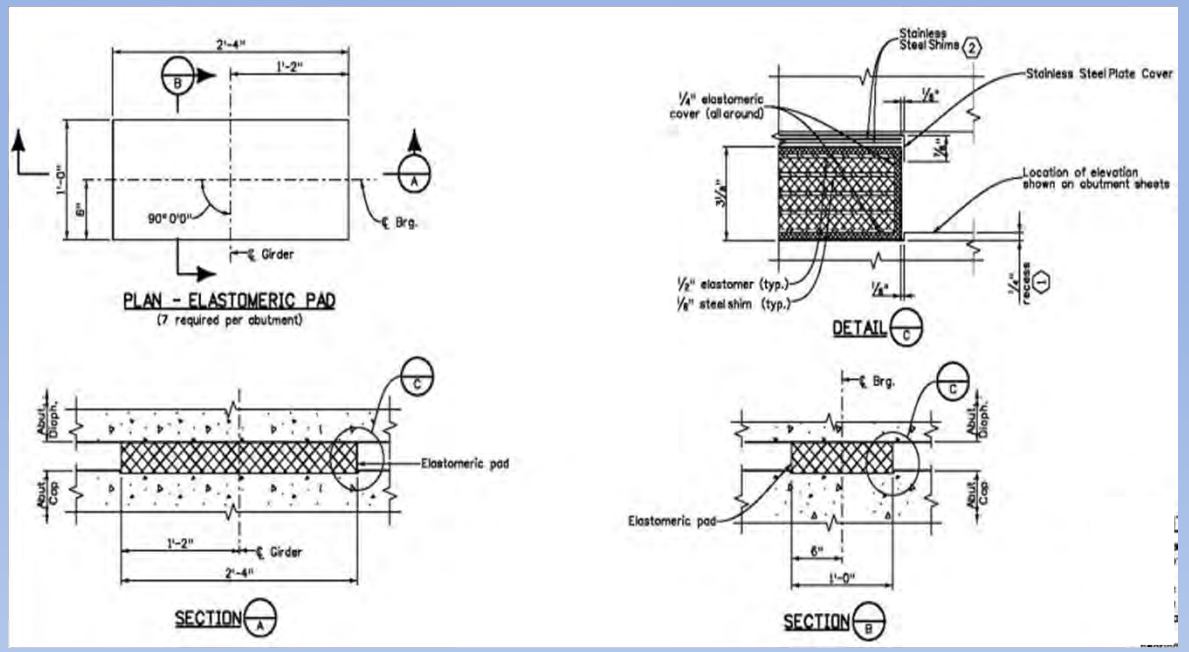
Bearing Design

- Design forces
  - Vertical
  - Horizontal
  - Rotation
- Slide-in considerations
  - Uneven loading
  - Additional load



Bearings Cont.

- Cover plate
- Loading process
  - Position superstructure
  - Evaluate gap
  - Place shims
  - Place cover plate
  - Lower superstructure

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Questions?

Region 2 Bridge Slides

Jeffrey Dobmeier, PE, SE

Jacobs Engineering

Presentation Outline

- Project overview and timeline
- ABC motivation
- Slide and roll concepts
- What went well
- Details to improve upon

Two Acronyms

- ABC = Accelerated Bridge Construction
- CM/GC = Construction Manager / General Contractor
  - Allows contractor input during design phase
  - Real world advice on means and methods
  - More owner control over product than DB

CM/GC Project Team = CDOT + Kiewit + Jacobs

Project Overview

Project Overview

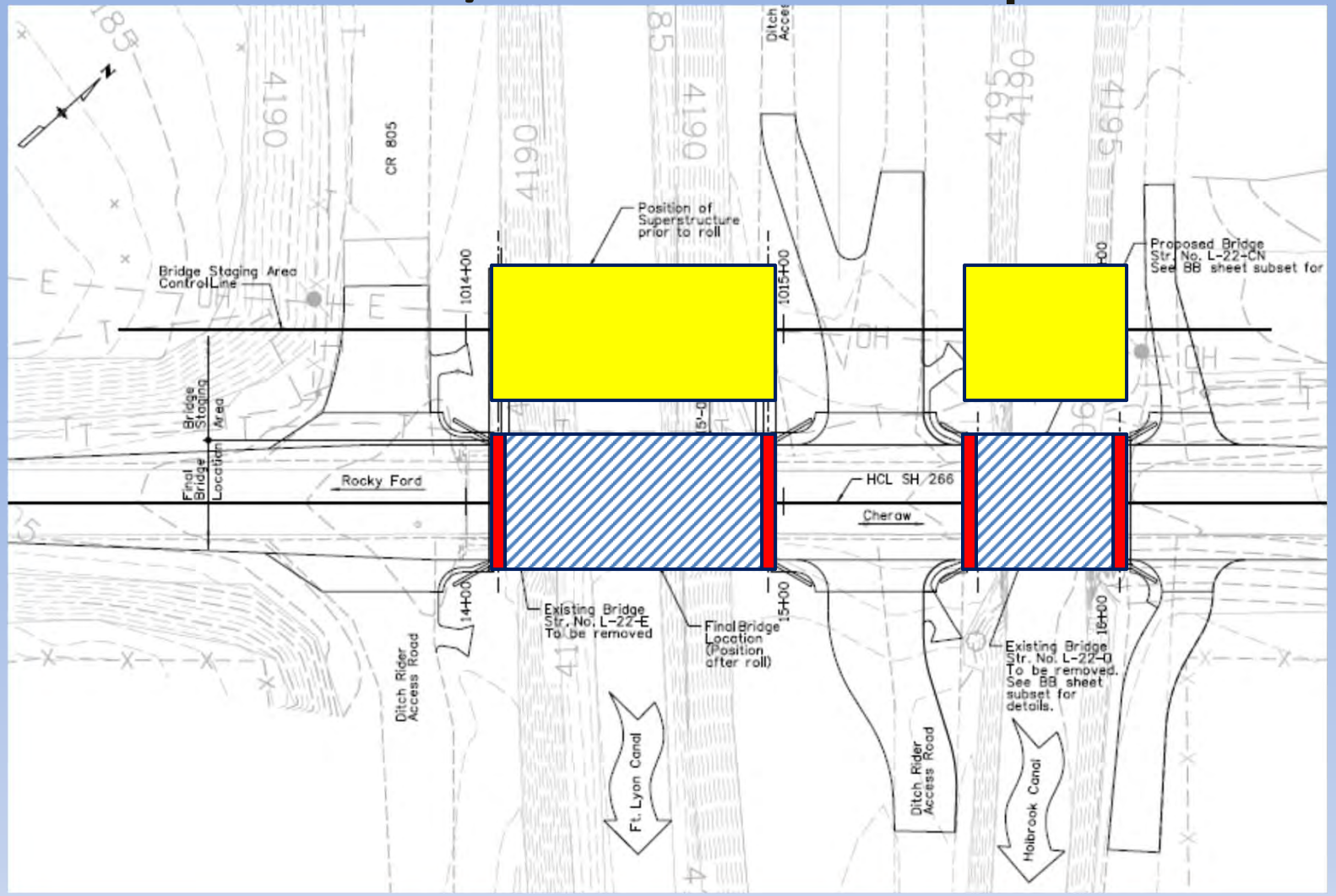
Project Timeline

Nov 2010	Contracted for Preliminary Design
April 2011	ABC and CM/GC first discussed
June 2011	ABC and CM/GC selected
Sept– Nov 2011	Solicitation of contractor for pre-construction services
Jan – May 2012	Final design
June – July 2012	GMP Negotiation and FHWA approval
August 2012	NTP
February 2013	Substantial Completion

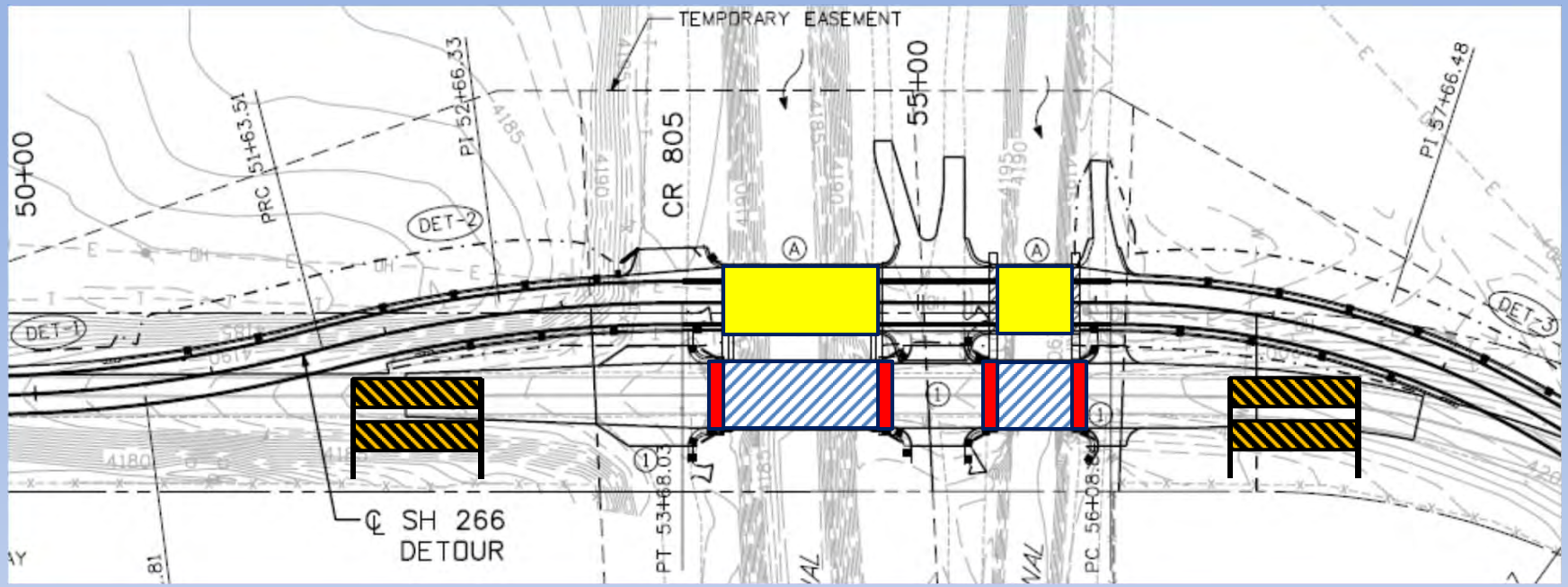
ABC Motivation

- Detour challenges
  - Lengthy detours on existing roadways
  - Expensive on-site detours
- Less impacts to public
- Proving ground for future work

Slide / Roll - Concept



Slide / Roll – As Implemented

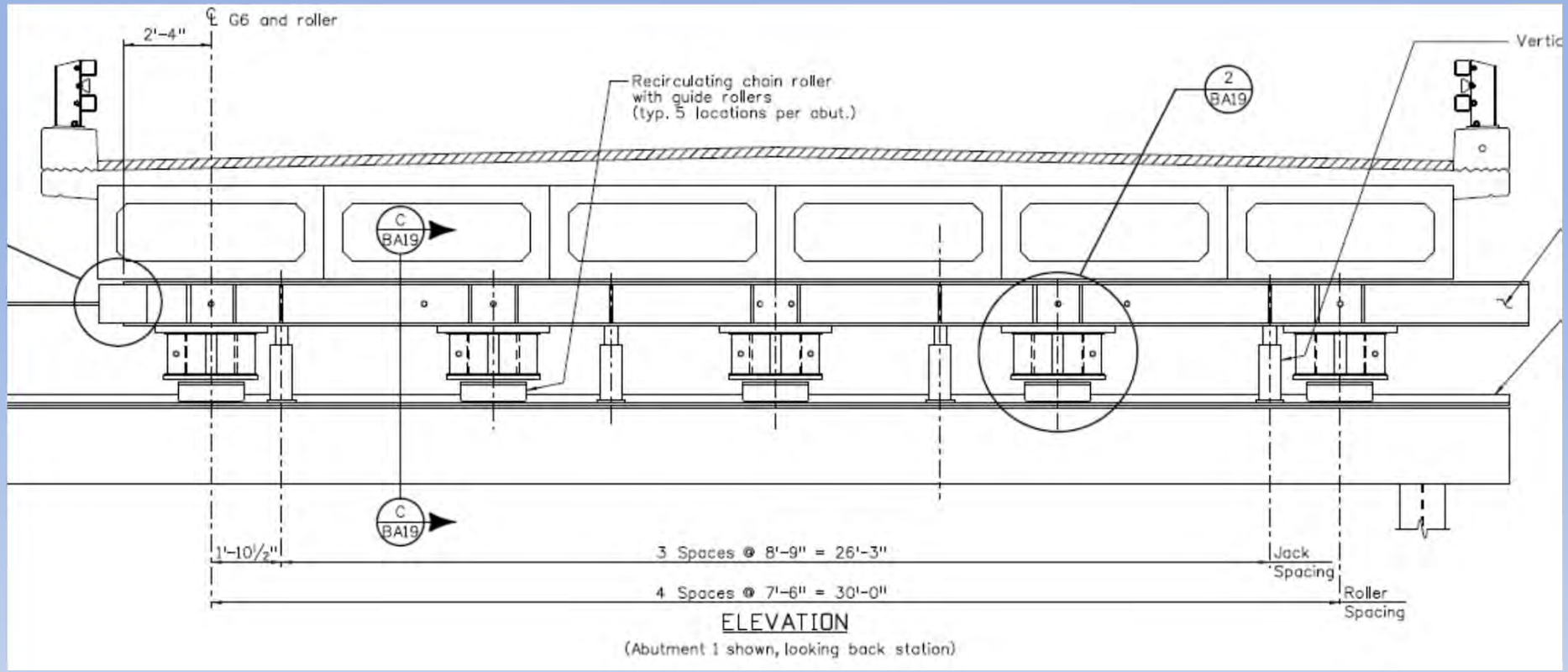


Slide / Roll – As Implemented

- Regular meetings with contractor and CDOT
  - Brainstorming and vetting concepts
  - Broad ideas down to finer details

Ft. Lyon Canal Bridge	Holbrook Canal Bridge
– Prestressed box beams	– Steel girders
– Cast-in-place topping	– Traditional concrete deck
– Integral abutments	– Integral abutments
– Heavy-duty rollers	– PTFE sliding elements
– Pull with jacks	– Push with jacks

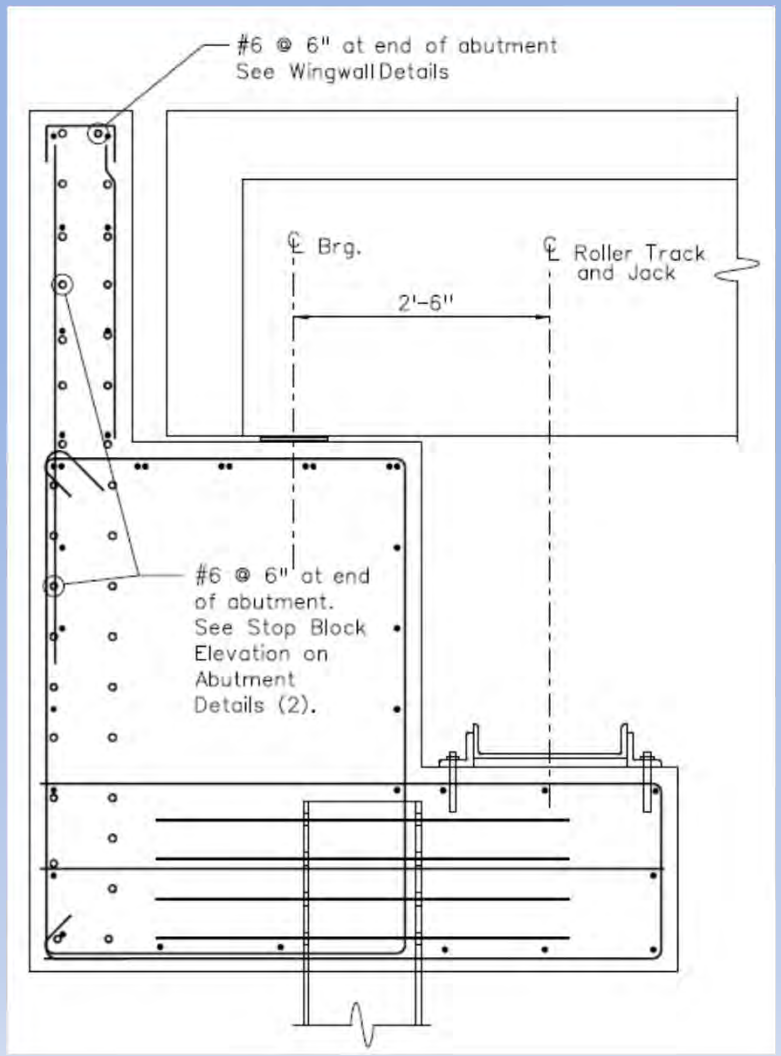
Ft. Lyon Canal Bridge – Roll



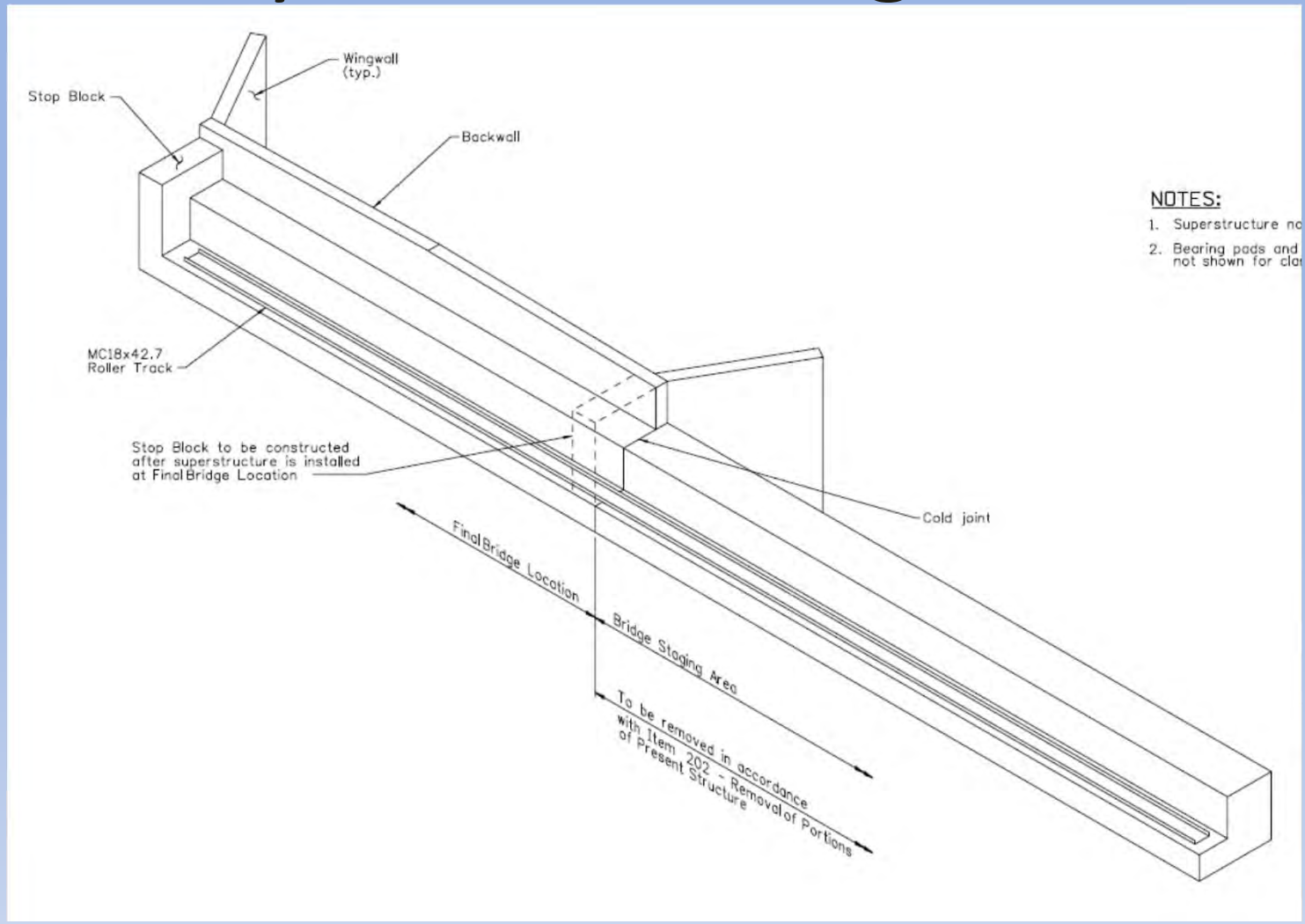
Ft. Lyon Canal Bridge – Roll

Ft. Lyon Canal Bridge – Roll

Ft. Lyon Canal Bridge – Roll

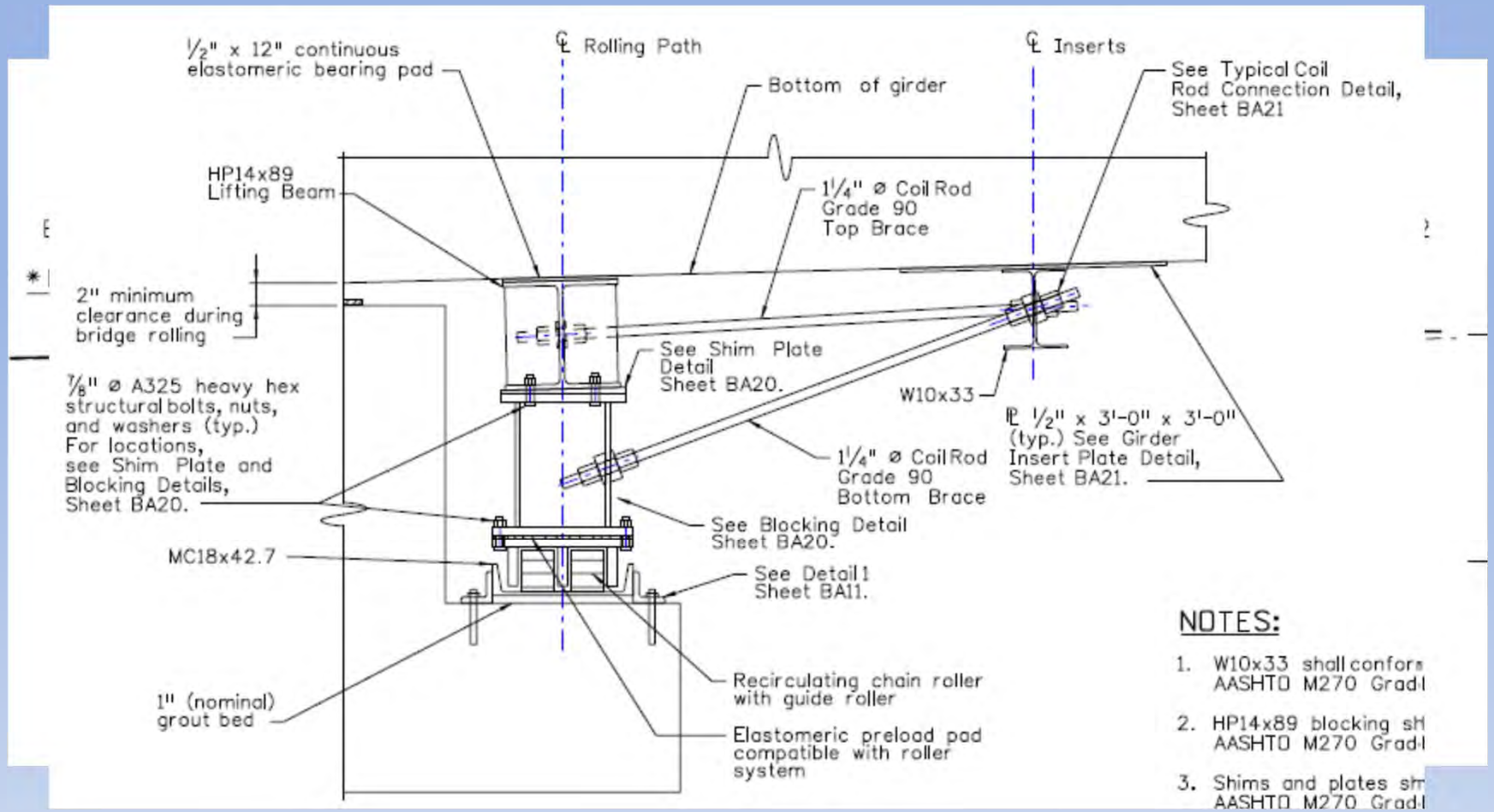


Ft. Lyon Canal Bridge – Roll



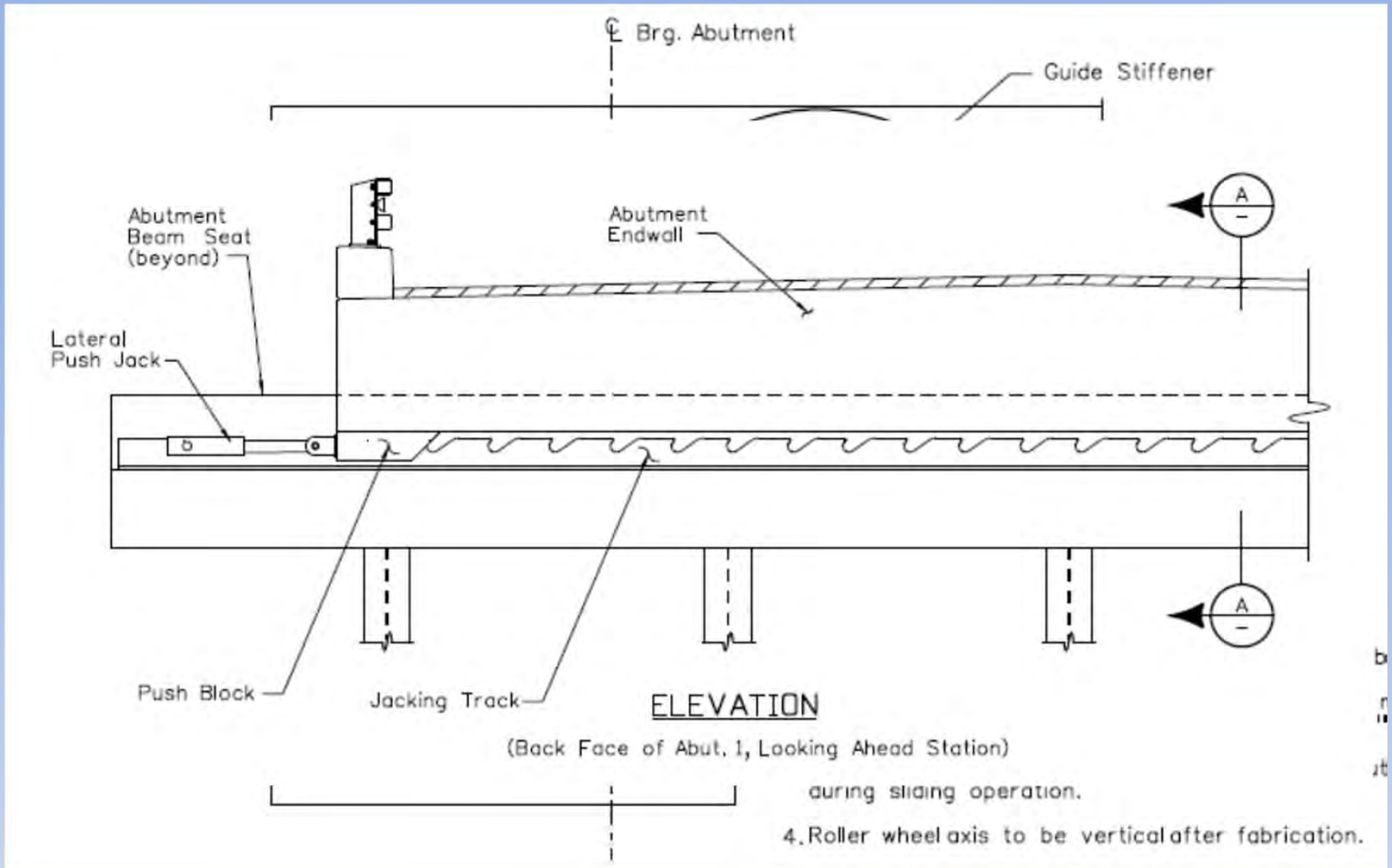
Ft. Lyon Canal Bridge – Roll

Ft. Lyon Canal Bridge – Roll



Ft. Lyon Canal Bridge – Roll

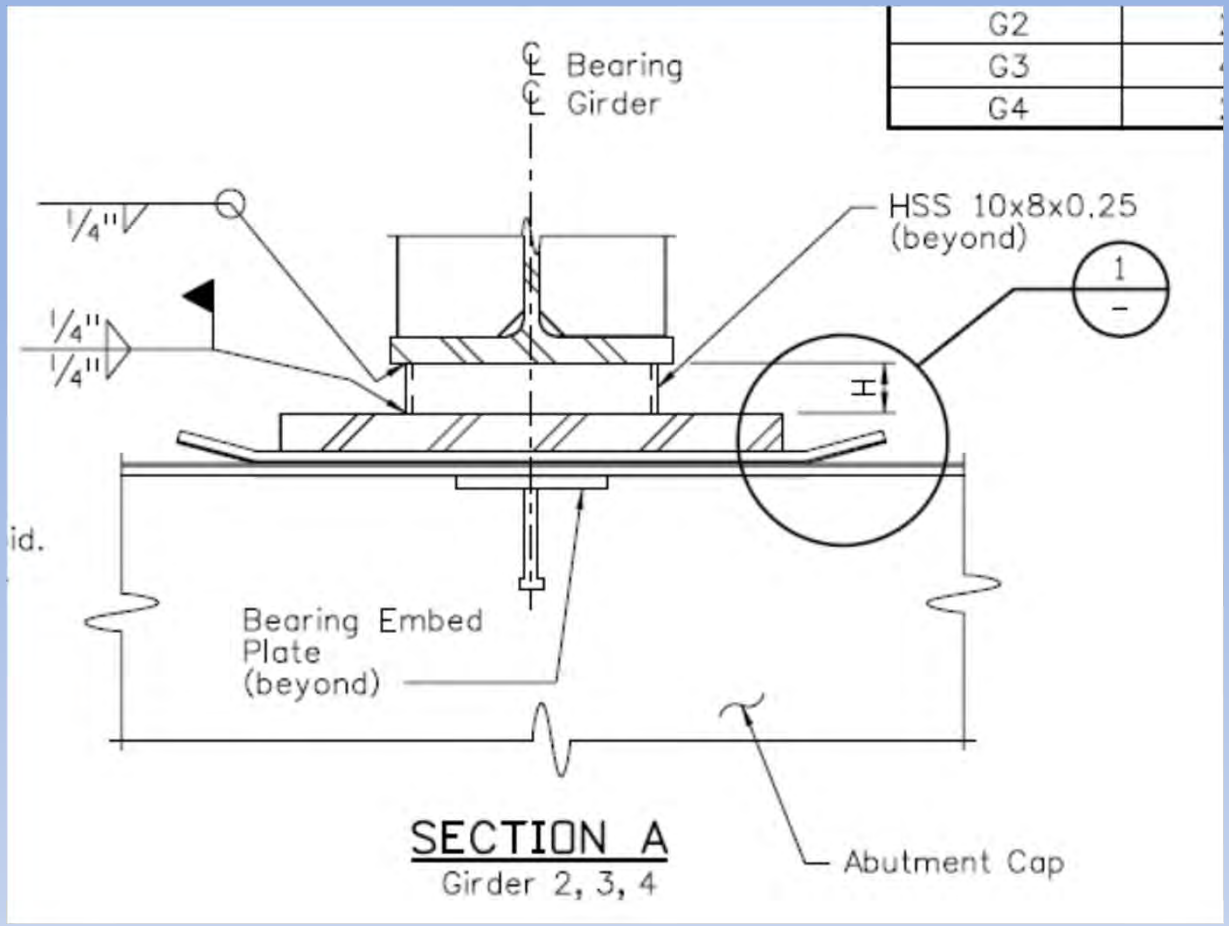
Holbrook Canal Bridge – Slide



Holbrook Canal Bridge – Slide

Holbrook Canal Bridge – Slide

Holbrook Canal Bridge – Slide



Holbrook Canal Bridge – Slide

Holbrook Canal Bridge – Slide

When/Why to use this technology

- Expensive or lengthy detour routes
- High user costs
- Improve work zone safety
- Waterway crossings

What went well

- Successfully moved two bridges!!!
  - 45 min for slide
  - 100 min for lift & roll
- Geometry adjustments in the field
  - Surveying as-built geometry at staging area
  - Tweaking permanent features to match

What went well

- Double backwall (Roll)

What went well

- Guidance Rollers (Slide)

What went well

- Jacking Track (Slide)

Details to improve upon

- Attachment of lower PTFE plate (Slide)

Details to improve upon

- Closure mechanism (Slide)

Details to improve upon

- Fit-interference at backwalls (Roll)

Positive Experience?

- Absolutely
- Great team of CDOT, Kiewit, and Jacobs
- Sharing knowledge with industry

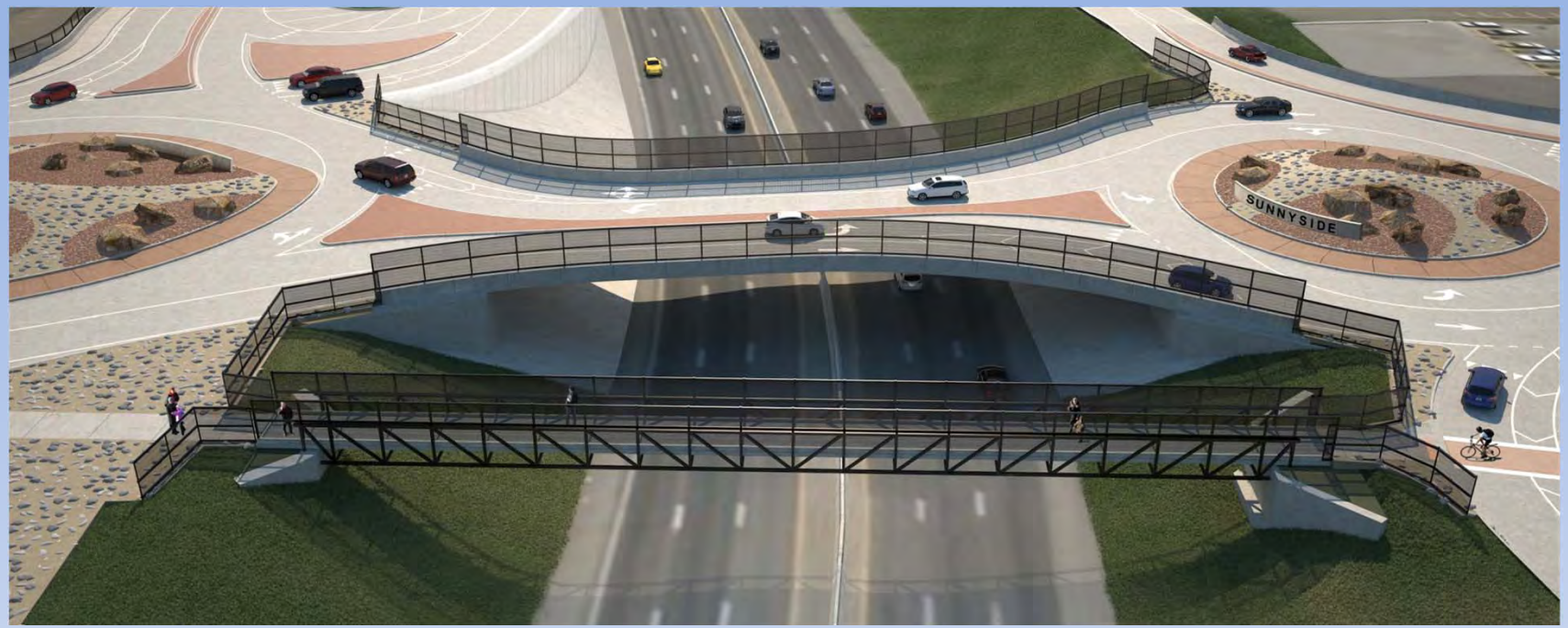
Questions?

Break – 10 Minutes

or

Pecos Street over I-70
Replacement of Str. E-16-EW

Using Accelerated Bridge Construction (ABC)



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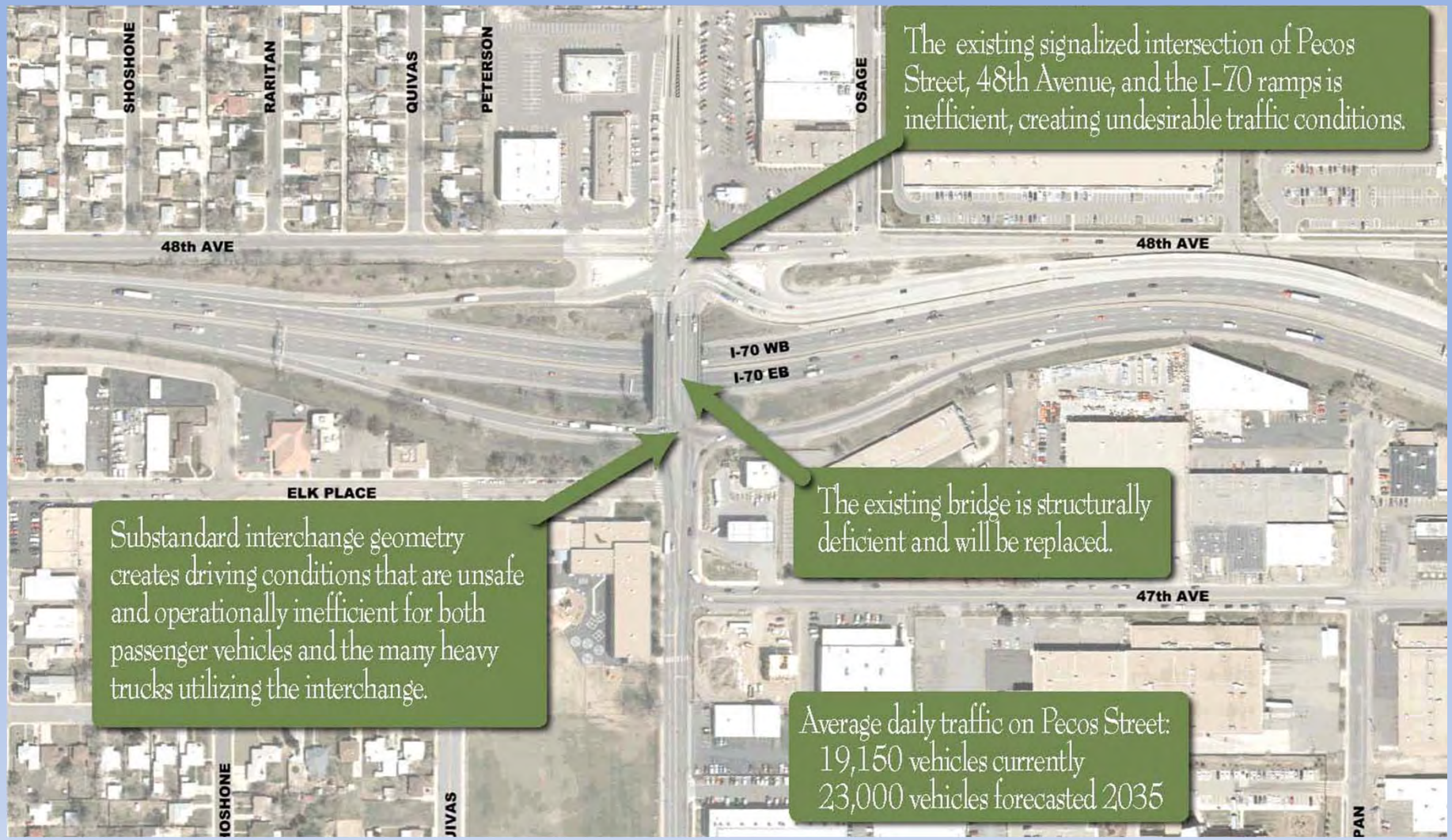
Pecos/I-70 Project Team

- Owner – CDOT
  - CDOT PM: Tamera Hunter-Maurer
- Consultant – Wilson & Company
  - Project Manager: Jim Brady
- CM/GC Contractor – Kiewit Infrastructure
  - Project Manager: Dave Paris

Existing Interchange



Existing Bridge

Proposed Interchange

Proposed Bridges

Project Goals

1. Advance knowledge, experience & cost efficiency of the CDOT construction program and the construction industry in ABC and CM/GC project delivery
2. Provide a well publicized, highly successful ABC project
3. Replace the poor structure, and improve traffic operations and safety within the project budget
4. Accelerate delivery of construction schedule & complete by October 1, 2013

Project Goals (cont.)

5. Minimize inconvenience to traveling public, & maximize safety of workers & traveling public
6. Facilitate a collaborative partnership with all of the members of the project team and stakeholders
7. Provide a high quality design and construction

CM/GC Delivery Method

Benefits

- Allows input from Contractor for project elements unique to ABC methods
- Permanent structure can be designed and detailed for specific ABC method selected
- Costs of ABC will be more accurate with Contractor pricing
- Contractor has advantage to pick the best Bridge Staging location early in process

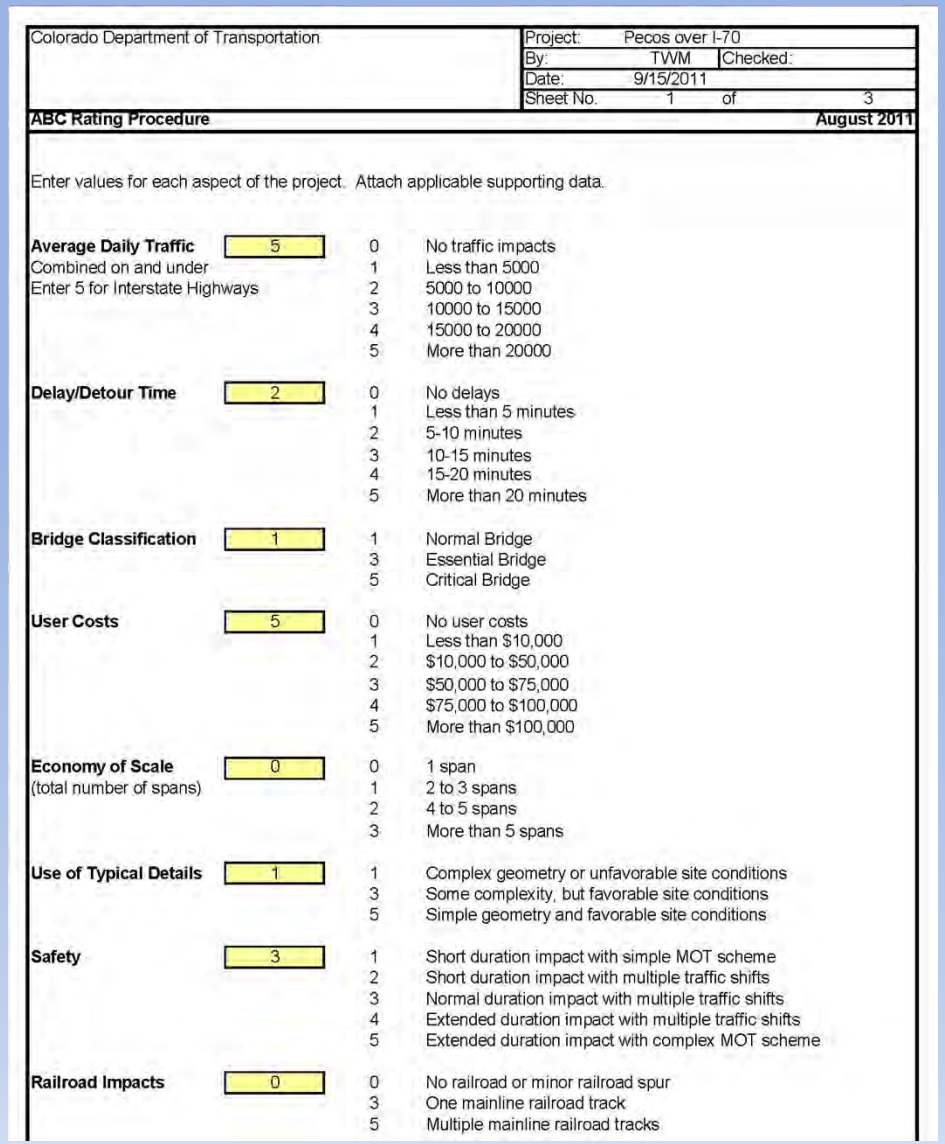
Why ABC for this Project?

- Reduced construction schedule (preferred by local businesses)
- Reduced road user costs and delays
- Improved safety (work zone & road user)
- Strong public support for ABC approach
- Meets project goal to expand ABC construction knowledge in Colorado for Contractor and Owner

ABC Decision Making Process

- Used UDOT's ABC Rating Procedure for Pecos
- Based on FHWA "Decision-Matrix Framework for PBES", May 2006
- Rating procedure is easy to use
- 8 evaluation measures for decision making
- Road User Delays/Costs - major consideration
- CDOT Report CDOT-2010-2 confirms road user delay/costs can be significant
- Favorable site conditions must be satisfied

Evaluation Measures



Colorado Department of Transportation		Project: Pecos over I-70		
		By: TWM	Checked:	
		Date: 9/15/2011		
		Sheet No. 1 of 3		
ABC Rating Procedure				**August 2011**
Enter values for each aspect of the project. Attach applicable supporting data.				
Average Daily Traffic Combined on and under Enter 5 for Interstate Highways	5	0 1 2 3 4 5	No traffic impacts Less than 5000 5000 to 10000 10000 to 15000 15000 to 20000 More than 20000	
Delay/Detour Time	2	0 1 2 3 4 5	No delays Less than 5 minutes 5-10 minutes 10-15 minutes 15-20 minutes More than 20 minutes	
Bridge Classification	1	1 3 5	Normal Bridge Essential Bridge Critical Bridge	
User Costs	5	0 1 2 3 4 5	No user costs Less than $10,000 $10,000 to $50,000 $50,000 to $75,000 $75,000 to $100,000 More than $100,000	
Economy of Scale (total number of spans)	0	0 1 2 3	1 span 2 to 3 spans 4 to 5 spans More than 5 spans	
Use of Typical Details	1	1 3 5	Complex geometry or unfavorable site conditions Some complexity, but favorable site conditions Simple geometry and favorable site conditions	
Safety	3	1 2 3 4 5	Short duration impact with simple MOT scheme Short duration impact with multiple traffic shifts Normal duration impact with multiple traffic shifts Extended duration impact with multiple traffic shifts Extended duration impact with complex MOT scheme	
Railroad Impacts	0	0 3 5	No railroad or minor railroad spur One mainline railroad track Multiple mainline railroad tracks	

1. **Average Daily Traffic**
2. **Delay/Detour Time**
3. Bridge Classification
4. **User Costs**
5. Economy of Scale
6. Use of typical details
7. **Safety**
8. Railroad impact

Scoring and Costs

Colorado Department of Transportation	Project:	Pecos over I-70		
	By:	TWM	Checked:	
	Date:	9/15/2011		
	Sheet No.	2	of	3

ABC Rating Procedure **August 2011**

Note: Do not adjust weight factors without prior consultation with Project Team.

ABC RATING SCORE FACTORS AND WEIGHTS

	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Daily Traffic	5	10	50	5	50
Delay/Detour Time	2	10	20	5	50
Bridge Classification	1	5	5	5	25
User Costs	5	10	50	5	50
Economy of Scale	0	3	0	3	9
Use of Typical Details	1	3	3	5	15
Safety	3	10	30	5	50
Railroad Impacts	0	5	0	5	25
		Total Score	158	Max. Score	274

ABC Rating Score: 58

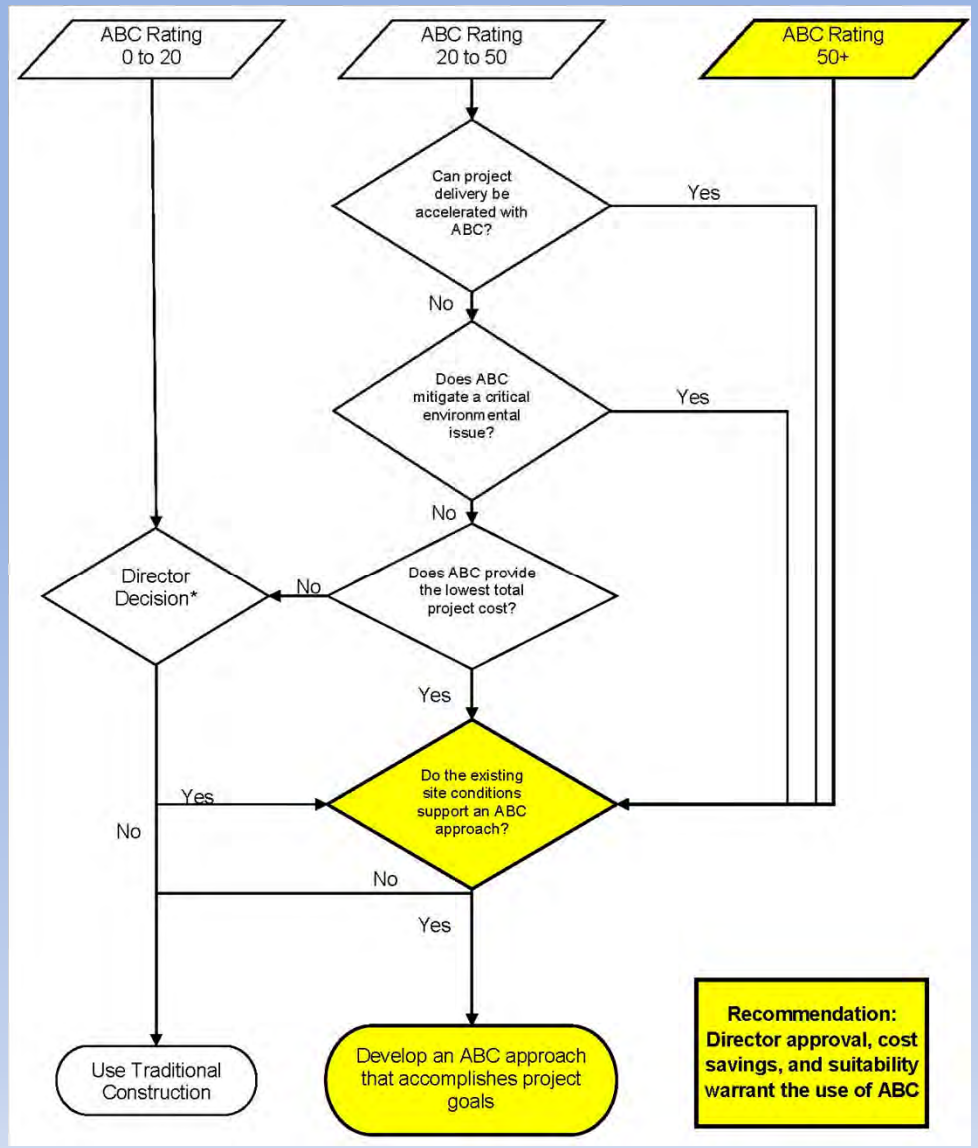
The ABC Rating Score is driven by the four most heavily weighted factors: Average Daily Traffic, Delay/Detour Time, User Costs and Safety. For a detailed explanation, review the narrative of the ABC Decision Making Process.

Cost Considerations:
Calculate the following costs for use in determining the lowest total project cost

TOTAL PROJECT COST EVALUATION

	Alt. 1: 3-phase Conv.	Alt. #2: ABC with SPMT	Alt. #3: ABC with slide-in
Bridge Const.Costs	$3,552,000	$3,552,000	$3,552,000
ABC costs or overbuild	$450,000	$800,000	$250,000
User Delay Costs	$3,543,000	$1,305,000	$1,452,500
Bridge Project Cost	**$7,545,000**	**$5,657,000**	**$5,254,500**
User costs/bridge costs	1.00	0.37	0.41

Final tests for using ABC

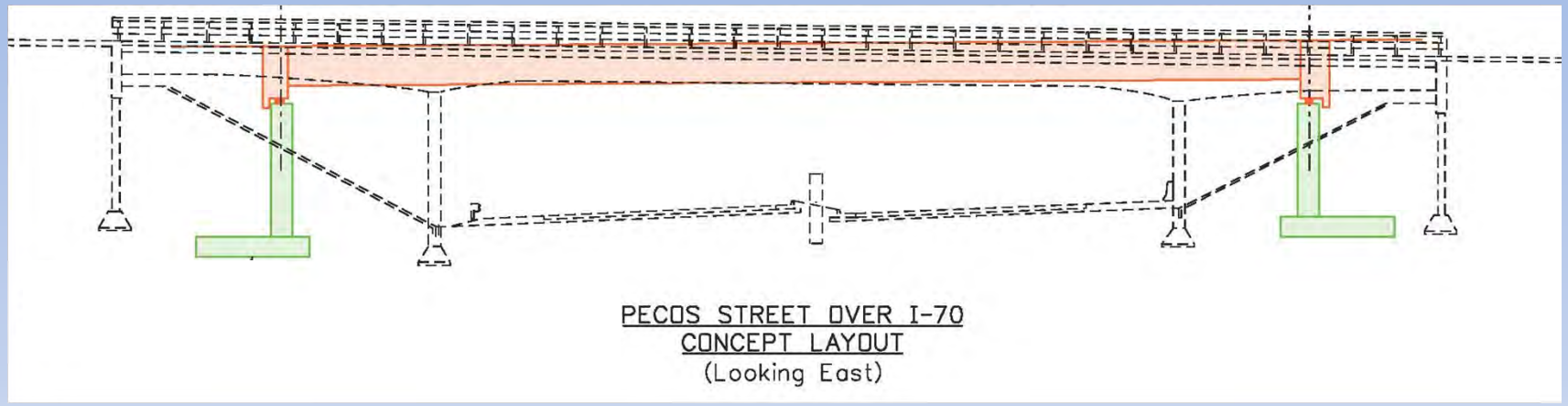


1. Can project be accelerated using ABC?
2. Does ABC mitigate a critical environmental issue?
3. Does ABC provide lowest total project cost?
4. **Do existing site conditions support an ABC approach?**

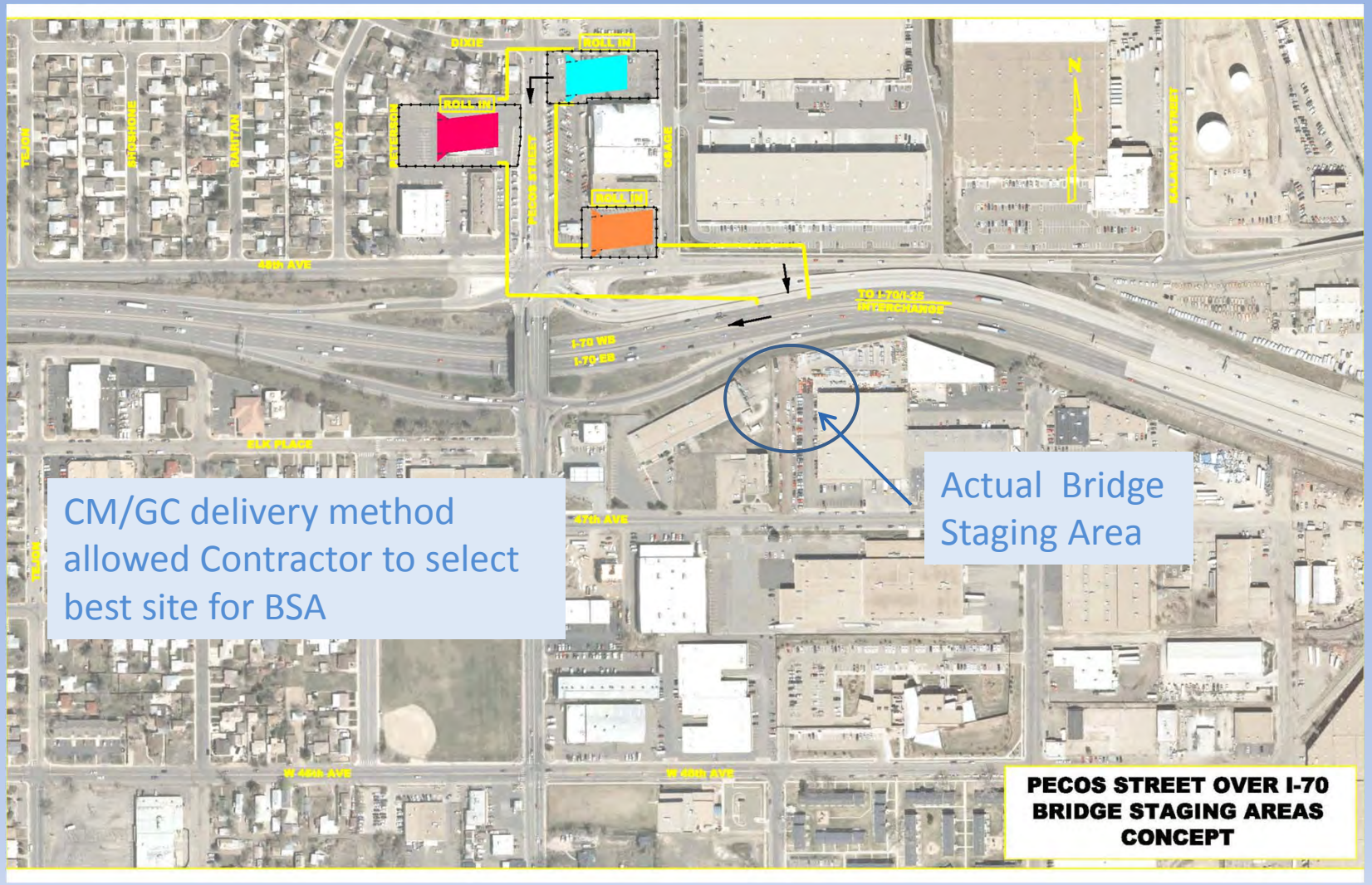
Do Site Conditions favor ABC?

Considerations

- Existing and proposed grades
- Room for substructure construction
- Room for maintaining traffic
- Size of Bridge Staging Area
- Suitability of Travel path



Do Site Conditions favor ABC?



Decisions made prior to CM/GC Contractor selection

- Interchange type and geometrics
- Project Goals
- ABC approach (using ABC Decision Process)
- Structure layout
- Structure type options

Decisions made with CM/GC Contractor

- Structure type
- Abutment foundation
- ABC method
- Bridge Staging Area (BSA) location
- Temporary supports at BSA
- Construction schedule

ABC: Roll-in Approach (selected)

- Construct superstructure in Bridge Staging Area
- Construct abutments behind existing piers
- No I-70 closures until bridge move
- Replace superstructure in 50-hour weekend closure of I-70

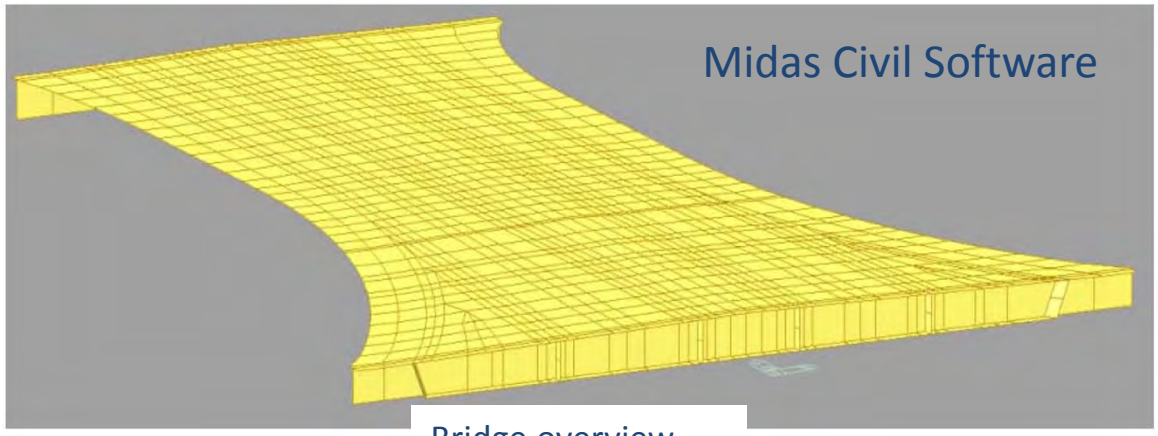
ABC: Slide-in Approach

- Construct superstructure adjacent to existing bridge over I-70
- Construct abutments behind existing piers
- **Requires several I-70 closures (more user costs)**
- Replace superstructure in 24-48 hour weekend closure
- Technique is not new to CDOT
- Reduced safety by constructing over I-70

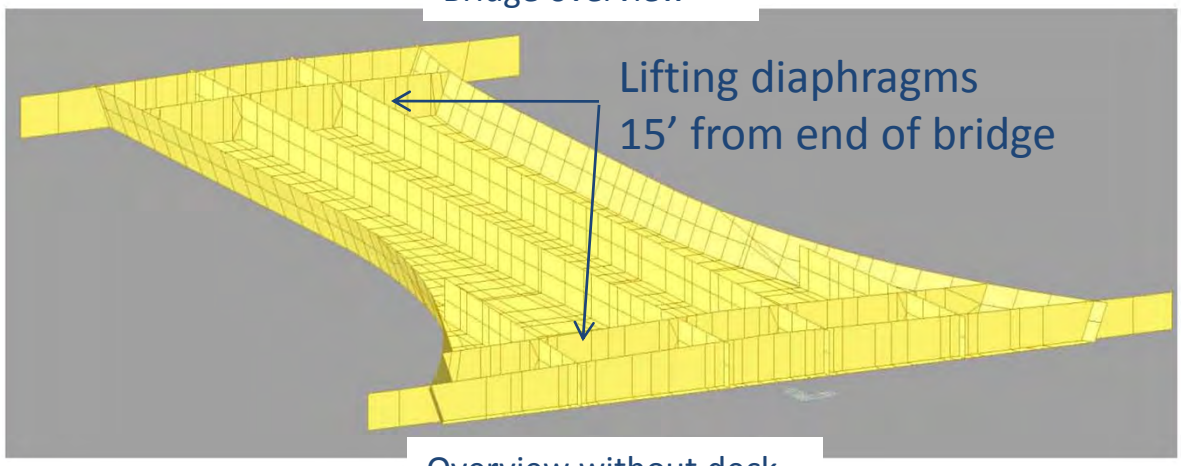
Costs associated with ABC

- Estimated about $1.5M for ABC approach using roll-in. Actual costs less than $2M
- Other elements not included in ABC costs:
  - Lifting Diaphragms
  - Wingwall tops placed after roll-in
  - Low overhead caisson rig for working under existing bridge

Design Overview



Bridge overview



Overview without deck

3D analysis required to determine permanent and temporary loads

- Selected plate element model
- Used to determine reactions in lifting diaphragms
- Used to develop acceptable distortion limits for bridge move

Lessons Learned

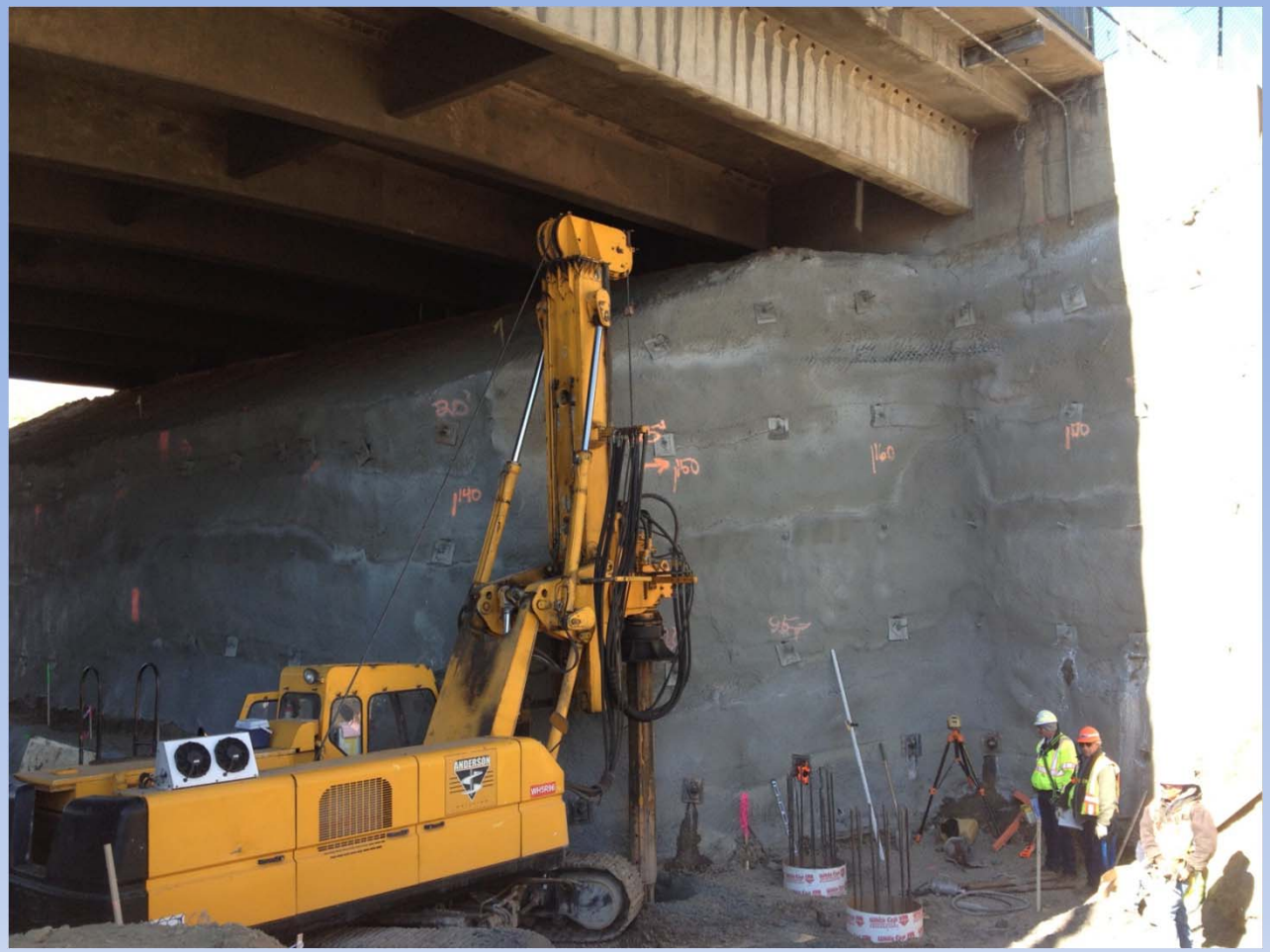
- Simplify geometry when possible
- Selection of bridge modeling is critical for handling all loading conditions
- More balanced loads at temporary supports helps simplify SPMT design
- Bearings – need better method for setting bearings to evenly distribute loads
- Deck PT – Type 7 barrier would be better than Type 10 for avoiding rebar conflicts with PT anchorages
- Lighter weight bridge reduces cost of SPMT (about $10,000 per axle for Pecos)

Pecos/I-70 - Fun Facts

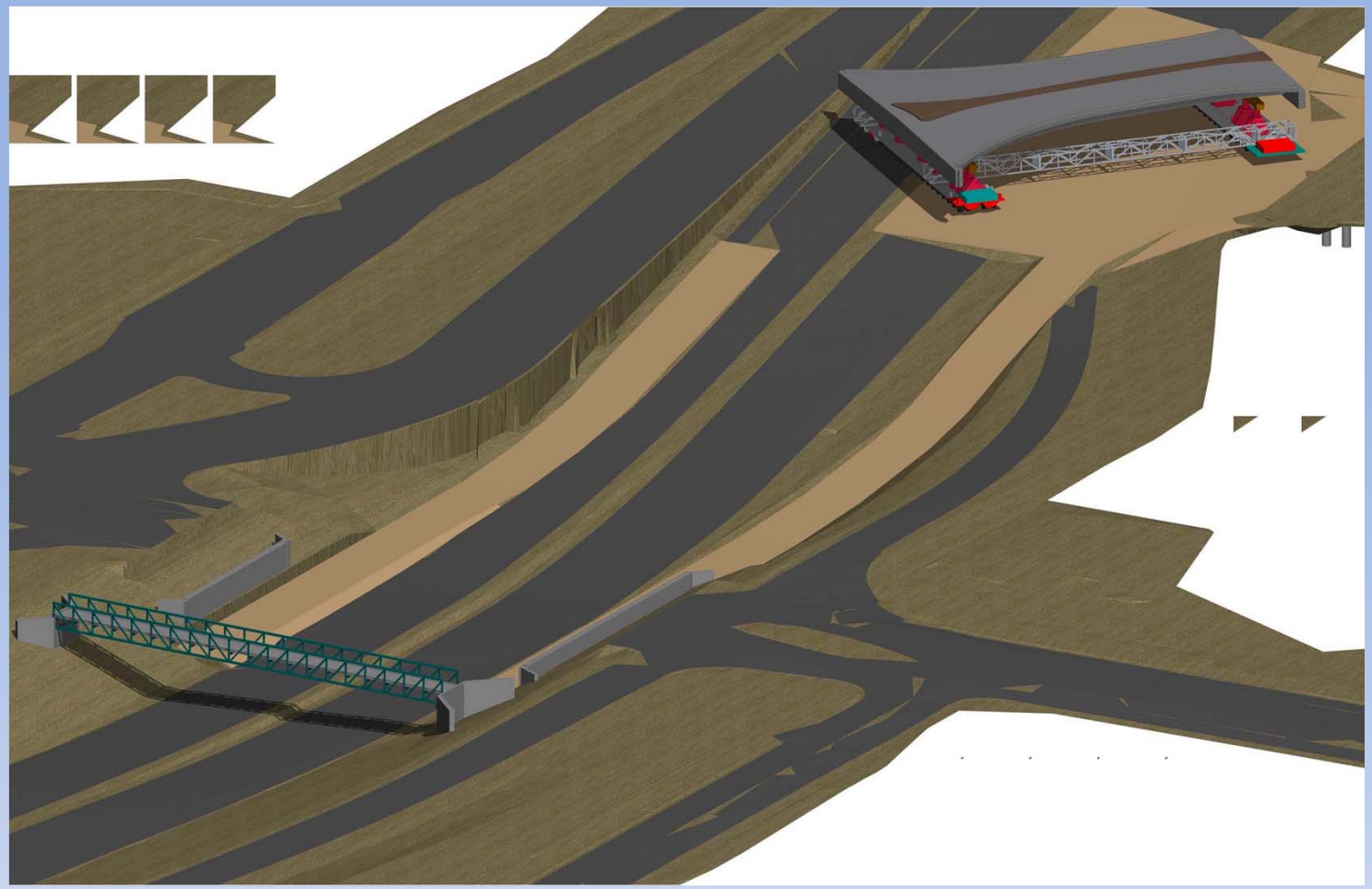
- 96 Self-Propelled Modular Transporters (SPMT) Axles
- Bridge weighs a total of 2,400 tons
  - 1,060 CY of concrete
  - 300,000 LBS Reinforcing Steel
- 7,200 feet, or 1.3 miles of Post Tensioning
- Traffic Counts per Day:
  - I-70 – 130,000
  - Pecos Street – 19,000

Construction - Bridge Staging Area

Construction – North Abutment



ABC Roll-in



Pecos/I-70 Project Schedule

- Winter 2013 – Bridge structure construction off-site, improvements to Pecos Street and building eastbound on- and off- ramps
- Spring 2013 – installation of pedestrian bridge and two-month closure of Pecos Street
- Summer 2013 – bridge roll-out
- Project completed summer 2013

Questions?

National Perspective On Accelerated Bridge Construction

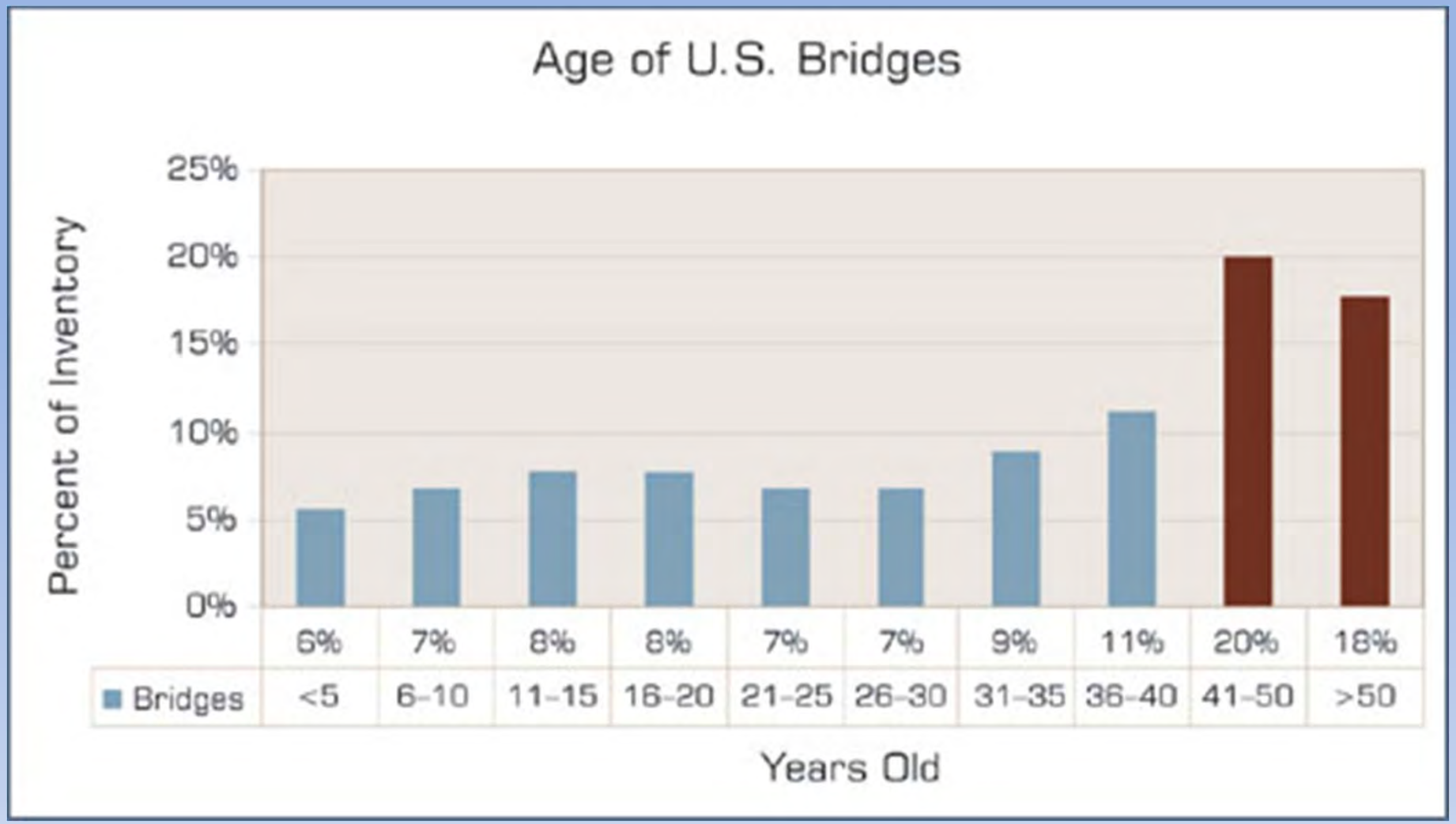
Jamal Elkaissi, PE,MS

Federal Highway Administration

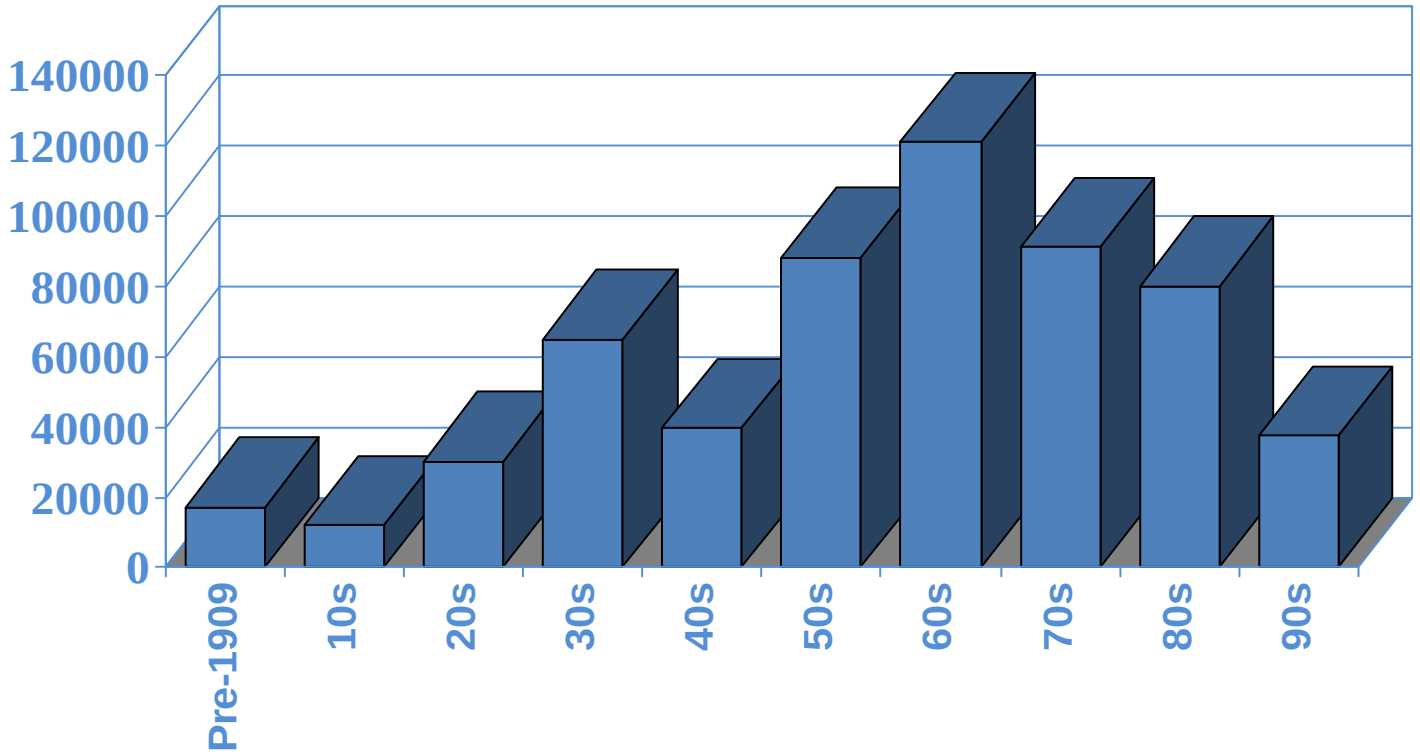
Presentation Outline

- Facts about ABC
- How the States Responding to ABC
- Nationwide Case Studies
- Lessons Learned & Best Practices
- Implement Standardization- Practice

Age of U.S. Bridges



U.S. Bridge Construction By Decade



Front burner priorities

- By 2020, 90% of Urban Interstate Highways are at or exceeding capacity
- 1/3 bridges – some 200,000 bridges – are structurally deficient or functionally obsolete
- Annual loss of 41,000 lives

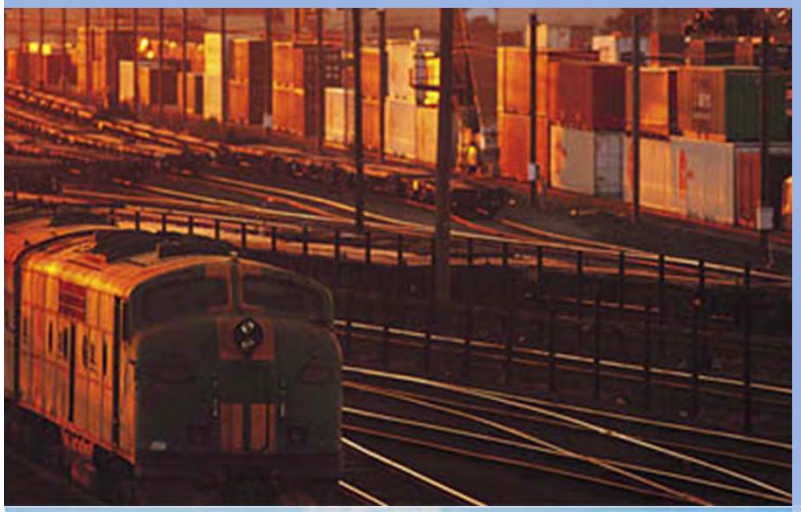
Conventional Construction Site

Congestion Impact

Congestion robs our nation of productivity and quality of life

- 4 billion hours/year time delay
- 2.7 billion gallons of wasted gas/year
- $73 billion in 75 urban areas

Cost of Congestion to U.S. Businesses



$500K/year for additional travel time for maintenance crews

Congestion at the Ambassador Bridge, cost users between $150M and $200M.

Intel has moved their shipment departure time up two hours

Work Zone Impacts

- 6,400 work zones (2003)
- 6,157 lane miles closed
- 20% capacity reduction
- Safety Issues

Construction Workers Injuries

- 44% of bridge construction workers injuries involve a vehicle traveling through a work zone (*OSHA Type 1622,1984-2010*)
- 2/3 are fatal
- 28% of worker injuries involve construction vehicles

WHY ABC

"Get In, Get Out, Stay Out!

ADVANTAGES :

- **Reduced onsite construction time**
- **Minimized traffic disruption – from months to days-User Costs**
- **Reduced Environmental impact**
- **Improved work zone safety –**
- **Lower First and Life-Cycle Costs**
- **Improved product quality – controlled environment**

What is ABC?

Paradigm Shift

- Innovative methods to decrease bridge construction time
- Build elements offsite/outside traffic area
- Transport to site and install rapidly

COMPONENTS OF ABC

- **Project Planning**

Decision Making Frame work

- **PBES**

Superstructure

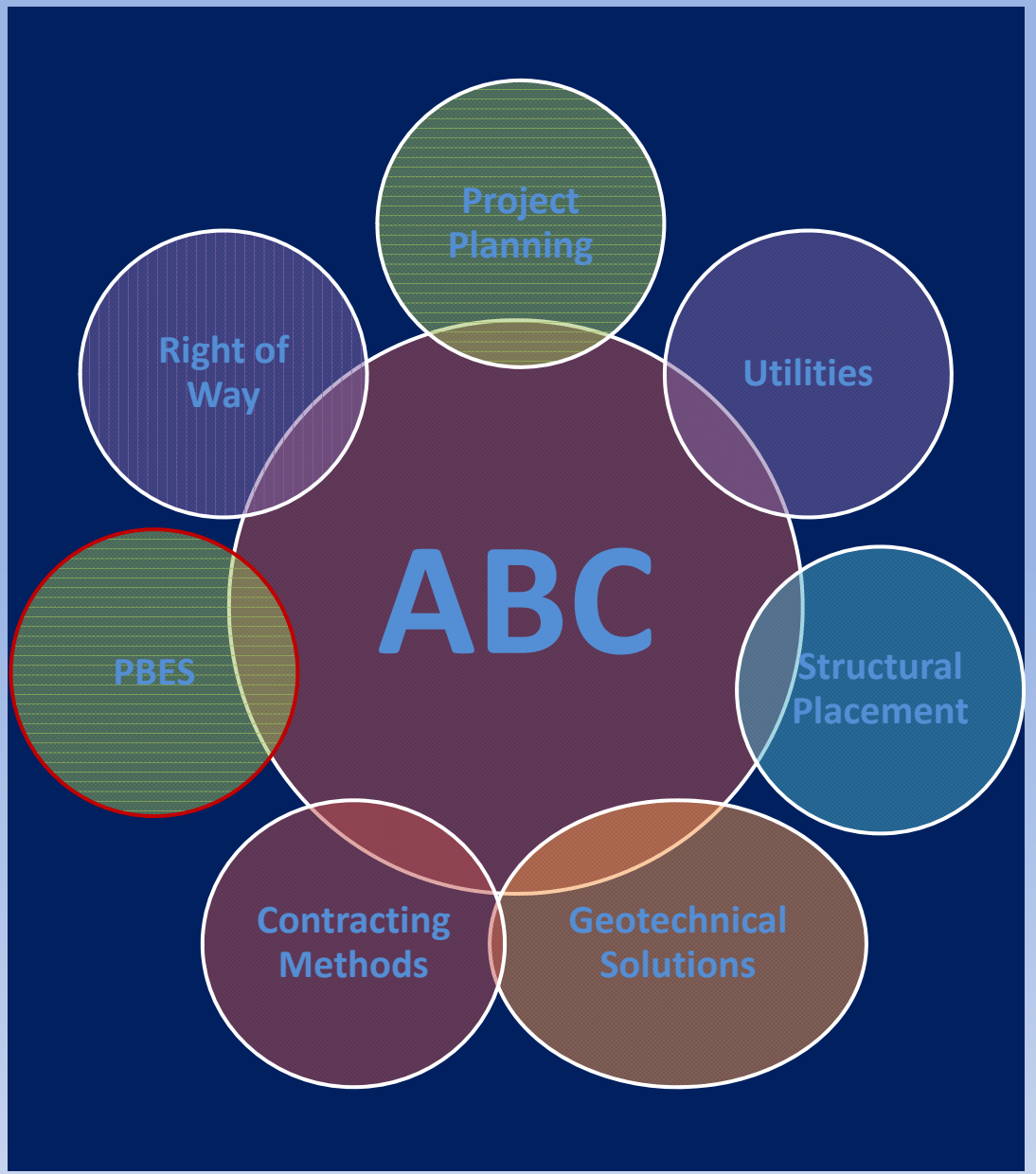
Precast Full Depth Deck Panels
Precast Straight and Curved Girders
Steel Girders, Straight and Curved
Fiber Reinforced Polymer (FRP) Panels
Precast Approach Slabs

Substructure

Precast Pier Caps
Precast Piers

- **Contracting Methods/Innovative**

Design/Built
Best Value
CMGC
A+B
A+B+C
Warranties
Incentives/Disincentives



COMPONENTS OF ABC

•Structural Placement Methods

Self-Propelled Modular Transporter (SPMTs)

Longitudinal Launching

Horizontal Sliding or Skidding

Conventional & Heavy Lifting Equipment & Methods

• Geotechnical Solutions

Geosynthetic Reinforced Soils (GRS) Integrated Bridge Systems(IBS)

Expanded Polystyrene (EPS) Geofoam.

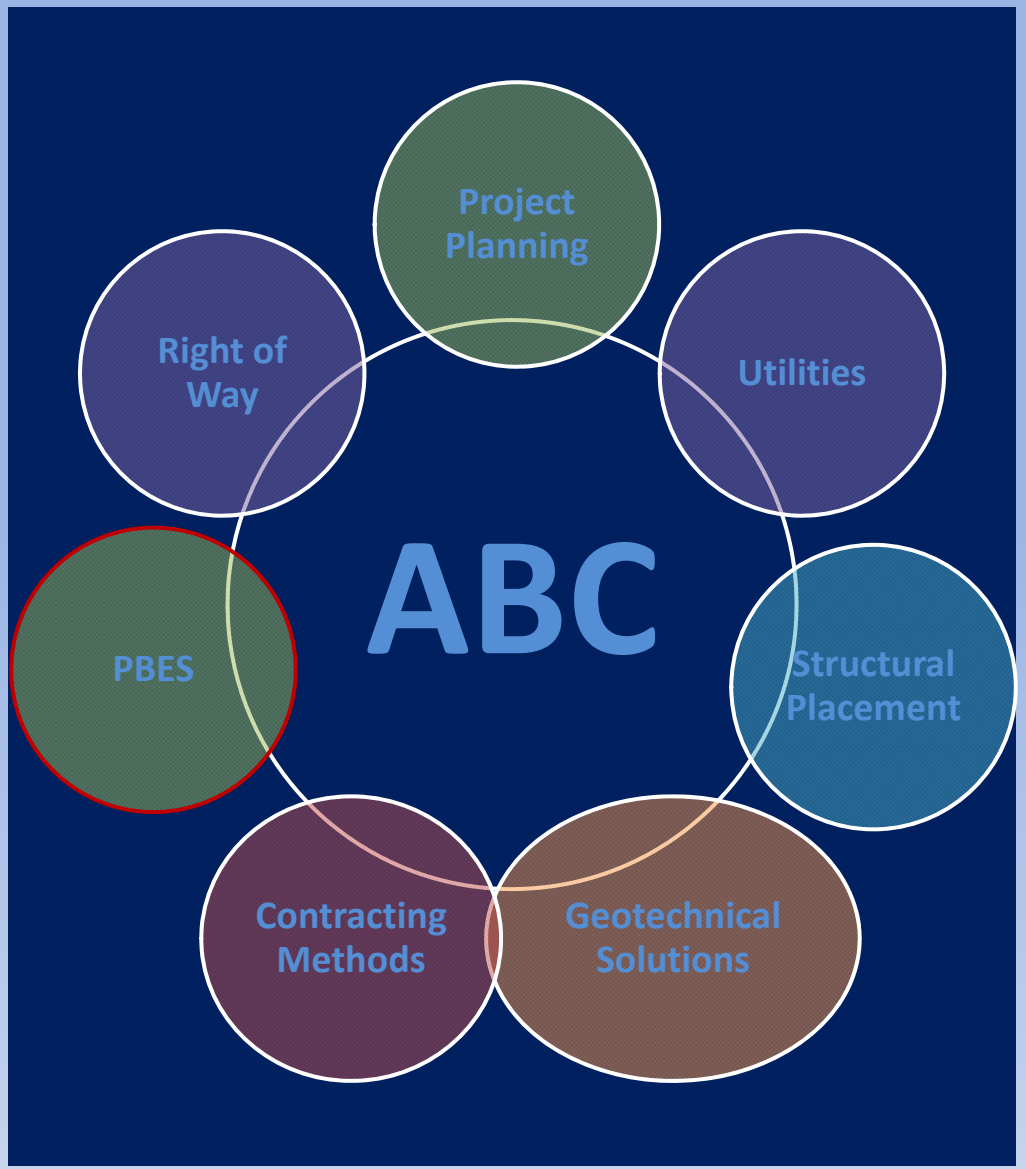
Self Compacting material

• Right Of Way

Flexibilities in Right –of-Way

• Utilities

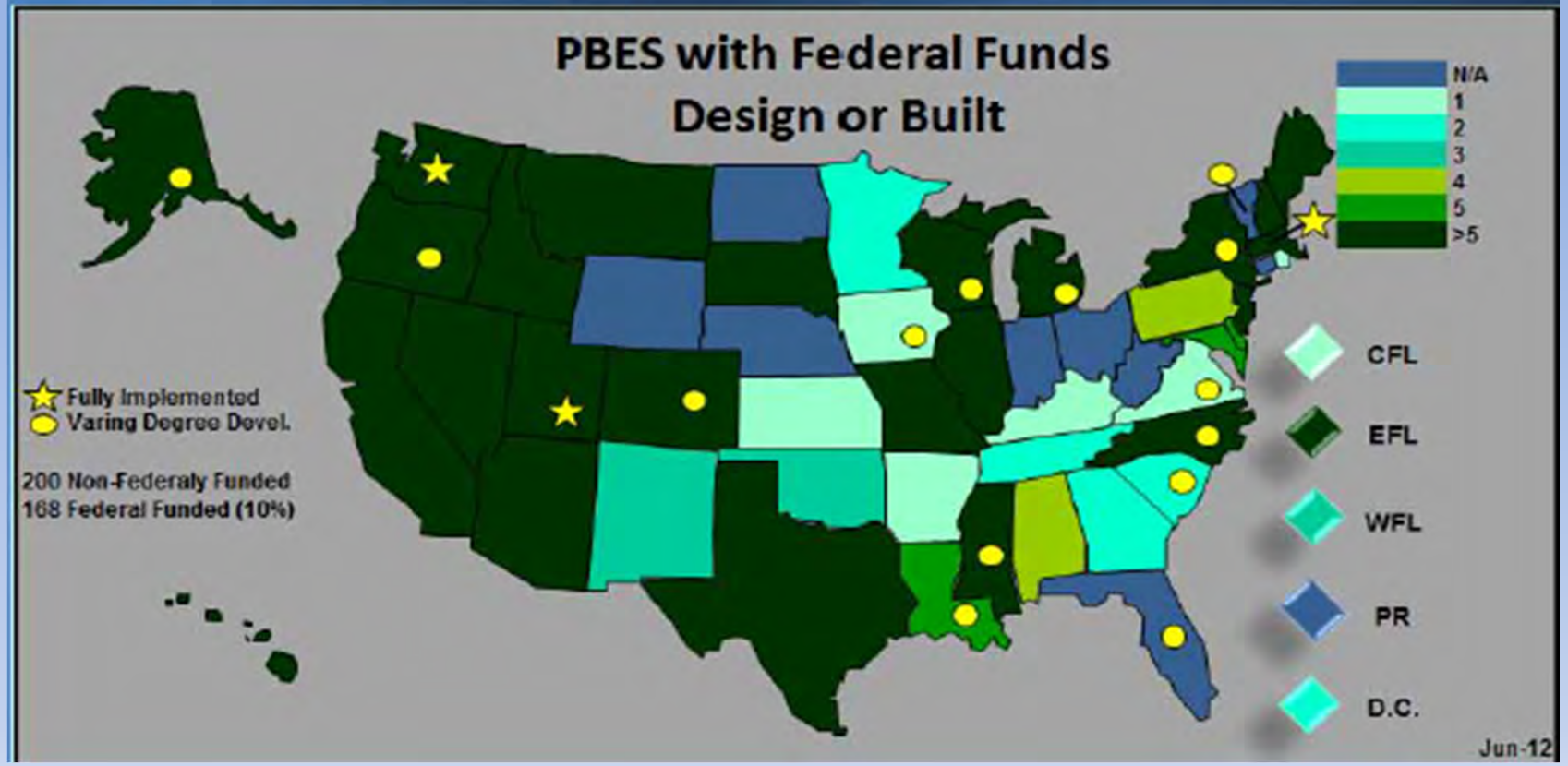
Flexibilities in Utility Accommodation and Relocation



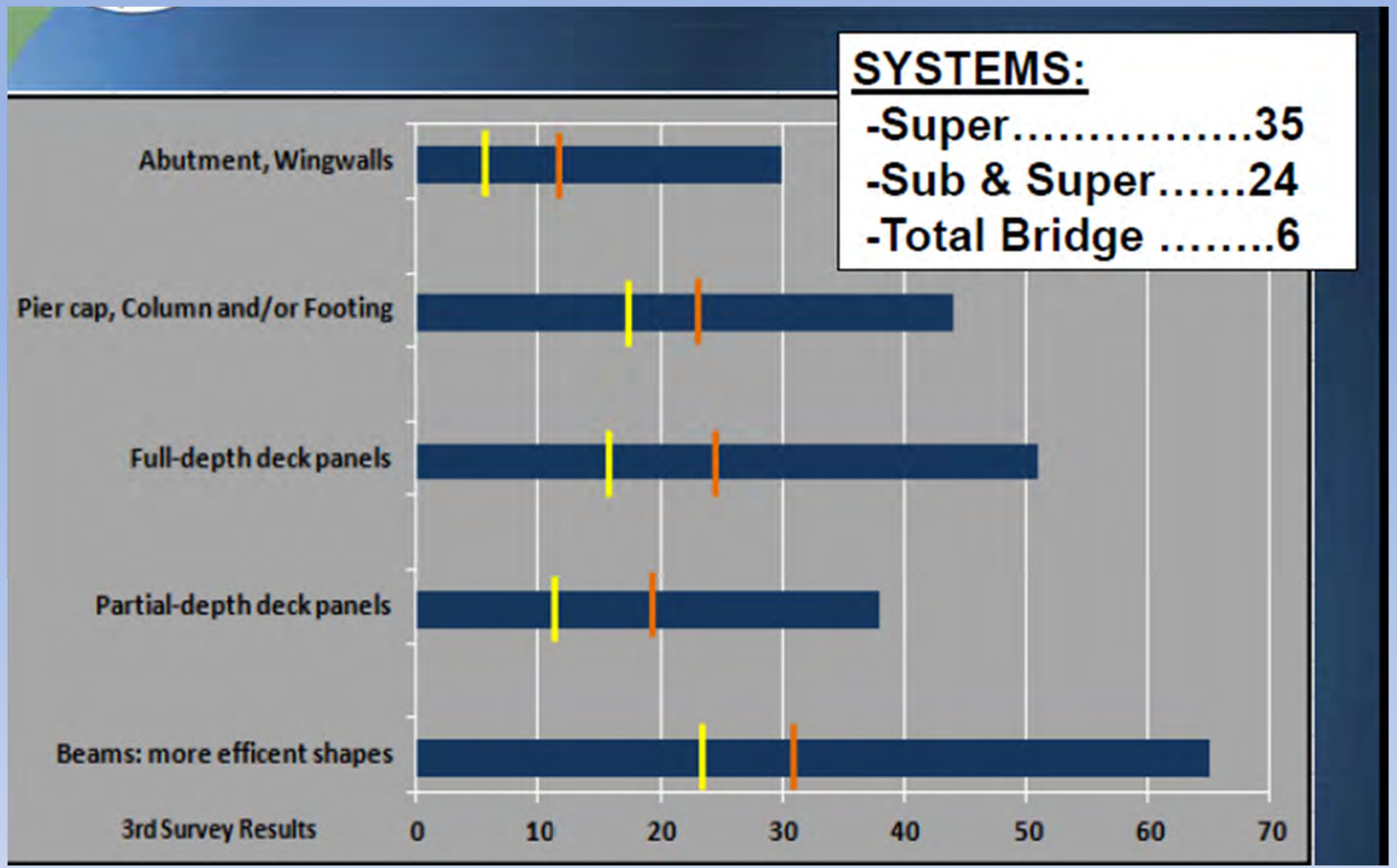
How the Nation Responding to ABC

	1st	2nd
Authorized Projects	1,200	1,600
PBES	143	200
PBES w/ Fed Aid	132	168

2010 to June 2012:
802 bridges
Elements



What Are They Selecting



Utah Case Studies

4500 South Bridge over I-215E, UT - 2007

4500 South over I-215

Construction Year:	2007
Total Construction Cost:	$7,700,000
ABC Construction Cost:	$900,000*
Facility User Cost Per Day:	$35,500
Estimated Days Saved:	120
User Savings:	$4,260,000
Cost Benefit Ratio:	5

* Project cost does not take into account for traffic control cost savings from traditional to ABC

Utah Case Studies

Full Superstructure I-215 East over 3760 South

- Full superstructure replacement deck precast on steel girders
- Lifted into place by cranes

Full Superstructure I-215 East over 3760 South

Construction Year:	2004
Total Construction Cost:	$2,690,965
ABC Construction Cost:	$600,000*
Facility User Cost Per Day:	$34,000
Estimated Days Saved:	30
User Savings:	$1,020,000
Cost Benefit Ratio:	2

* Project cost does not take into account for traffic control cost savings from traditional to ABC

Utah Case Studies

I-80 State Street to 1300 East Multiple Structures, UT - 2008

- I-80W over Highland Drive
- I-80W over 900 East Street
- I-80W over 700 East Street
- I-80W over 600 East Street
- I-80W over 500 East Street
- I-80W over 300 East Street
- I-80W 600 East Ramp Bridge

I-80 State Street to 1300 East

Utah Case Studies

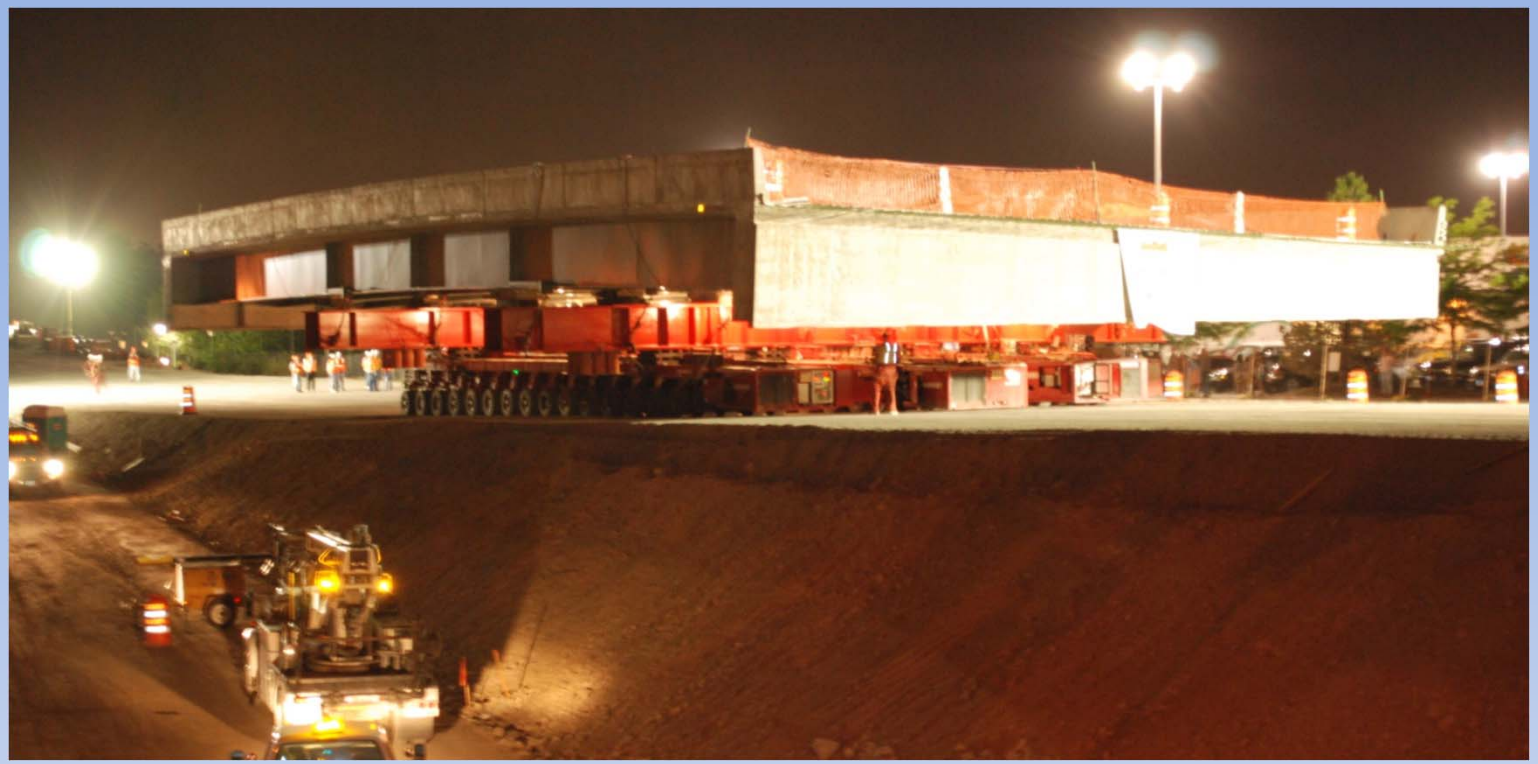
- Replacement of seven structures along I-80
- Moved to location using SPMTs
- Moved over final location using skid shoes
- Lowered to final location using climbing jacks

I-80 State Street to 1300 East

AB

I-80 State Street to 1300 East

I-80 State Street to 1300 East



I-80 State Street to 1300 East

I-80 State Street to 1300 East

Utah Case Studies

Rapid Deck at Wanship over I-80

- Deck replacements using precast deck panels

Rapid Deck at Wanship over I-80

Construction Year:	2004
Total Construction Cost:	$366,073
ABC Construction Cost:	$10,000*
Facility User Cost Per Day:	$4,000
Estimated Days Saved:	90
User Savings:	$360,000
Cost Benefit Ratio:	36

* Project cost does not take into account for traffic control cost savings from traditional to ABC

Utah Case Studies

Fort Lane/I-15 South Layton Interchange, UT – 2010

60

Utah Case Studies

Fort Lane/I-15 South Layton Interchange

UDOT Practice

Timeline and History

ABC Method / Element	Number of Bridges
Bridge Launch	2
Self Propelled Modular Transporters (SPMT)	23
Slide-in	5
Heavy Lift Cranes	2
Half Depth Precast Deck Panels	63
Full Depth Precast Deck Panels	31
Precast Voided Slabs	3
Approach Slab Panels	15
Precast Sleeper Slabs	14
Precast Abutments	6
Precast Bent Caps	3
Precast Columns	1
Prefabricated Pedestrian Bridge	5
Precast Box Culvert	44

Nevada Case Study

Slide-In Construction

Photos courtesy of Nevada DOT

27 Accelerated Bridge Construction

Weekend Bridge - Colorado

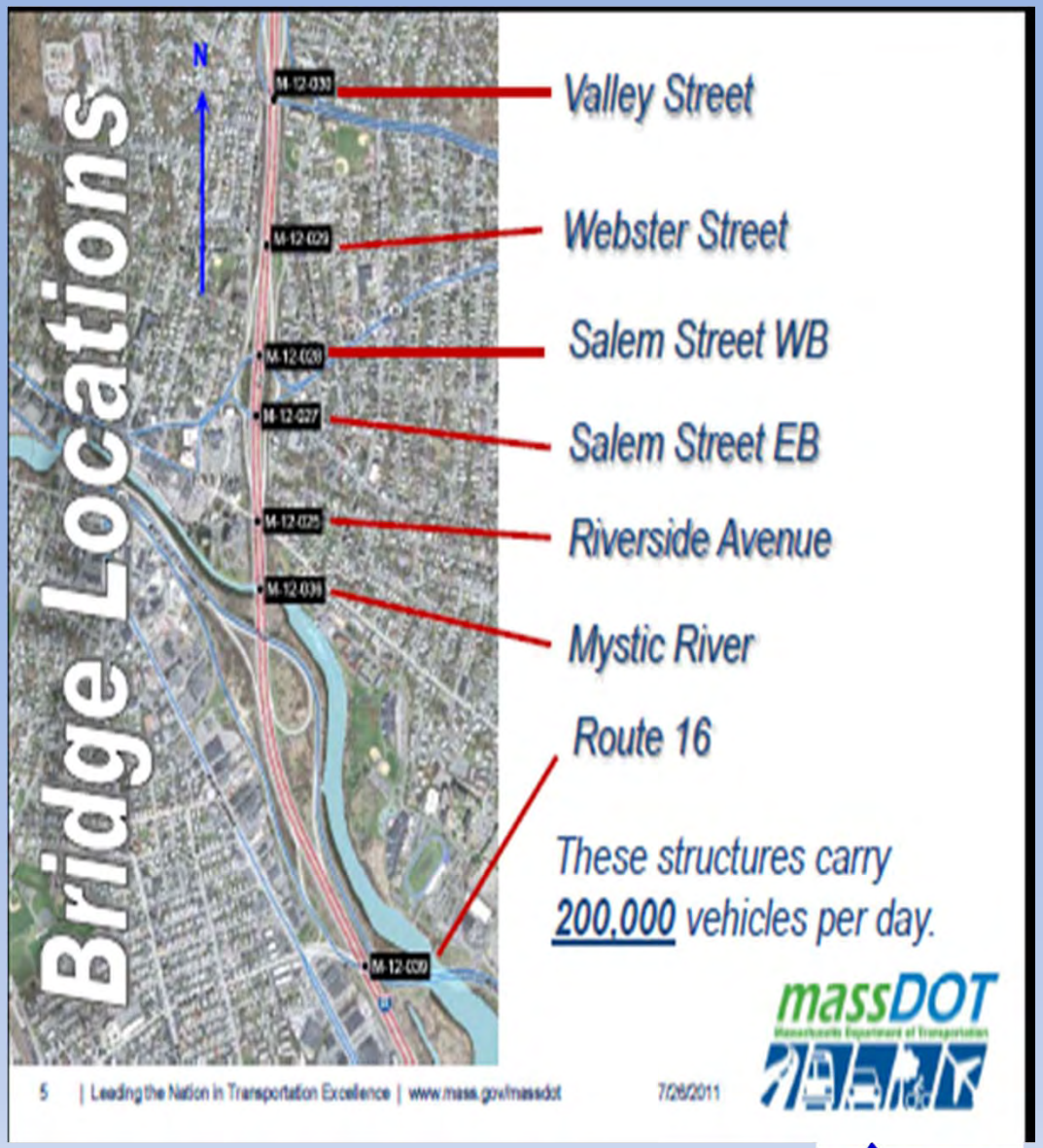
Mitchell Gulch Bridge

Bronco Arch Bridge –Colorado
Total Prefabricated elements
A Good Candidate for ABC

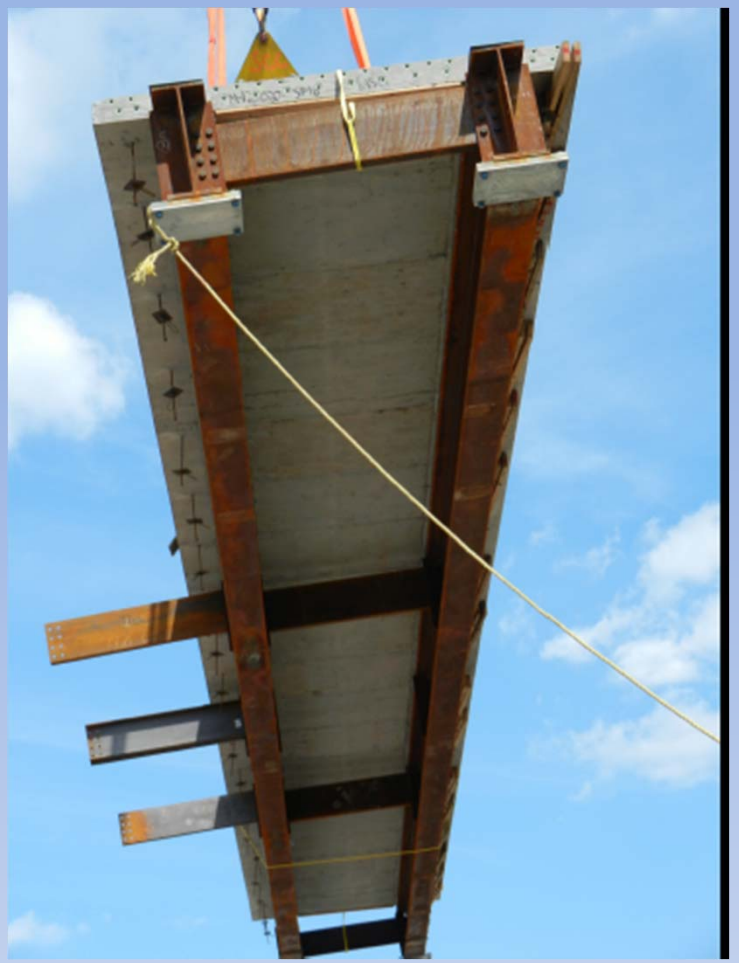
FAST 14 Project Mass Case Study

I93- Bridge Replacement

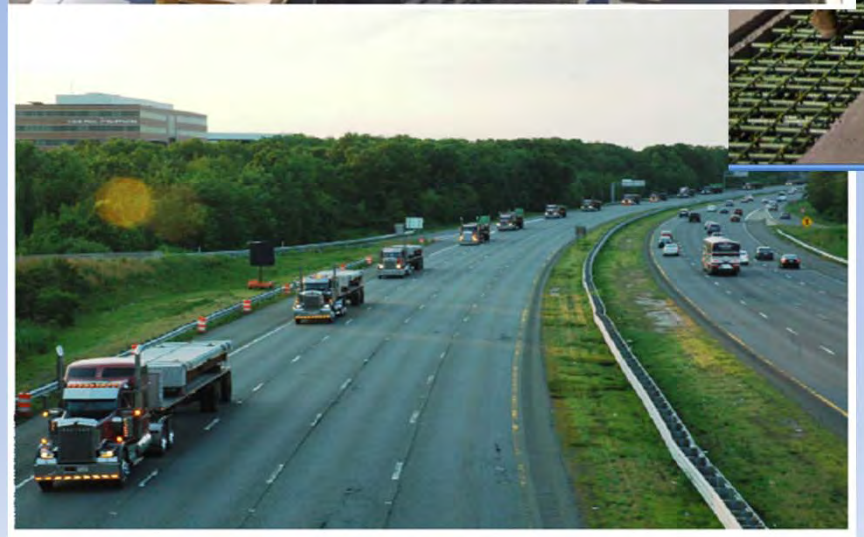
14 Bridges In 10 Weekends

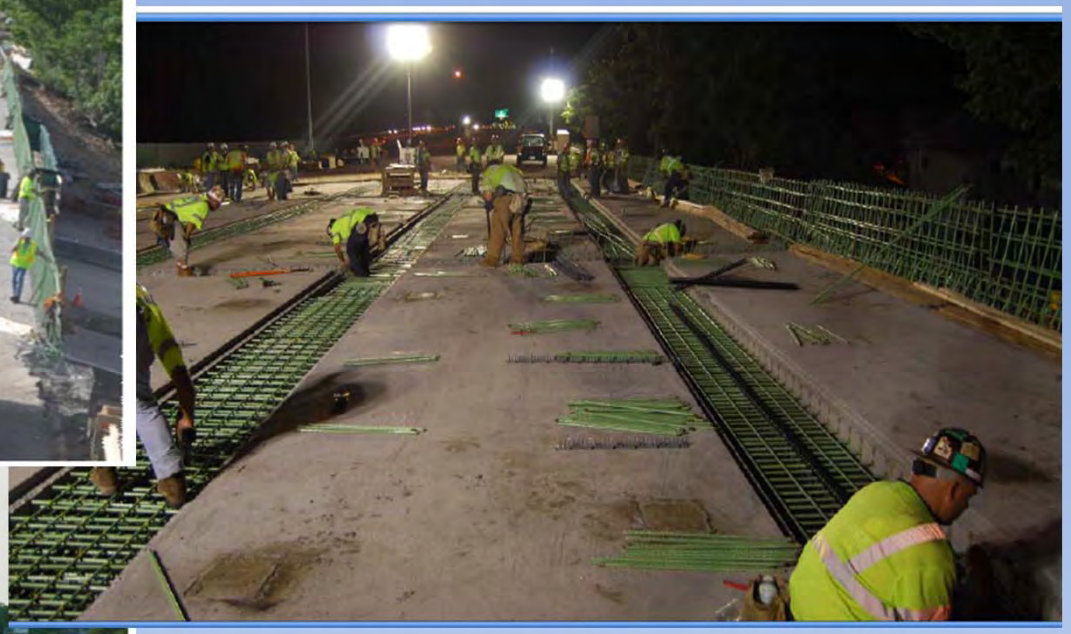


Superstructure Units



Massachusetts Case Study

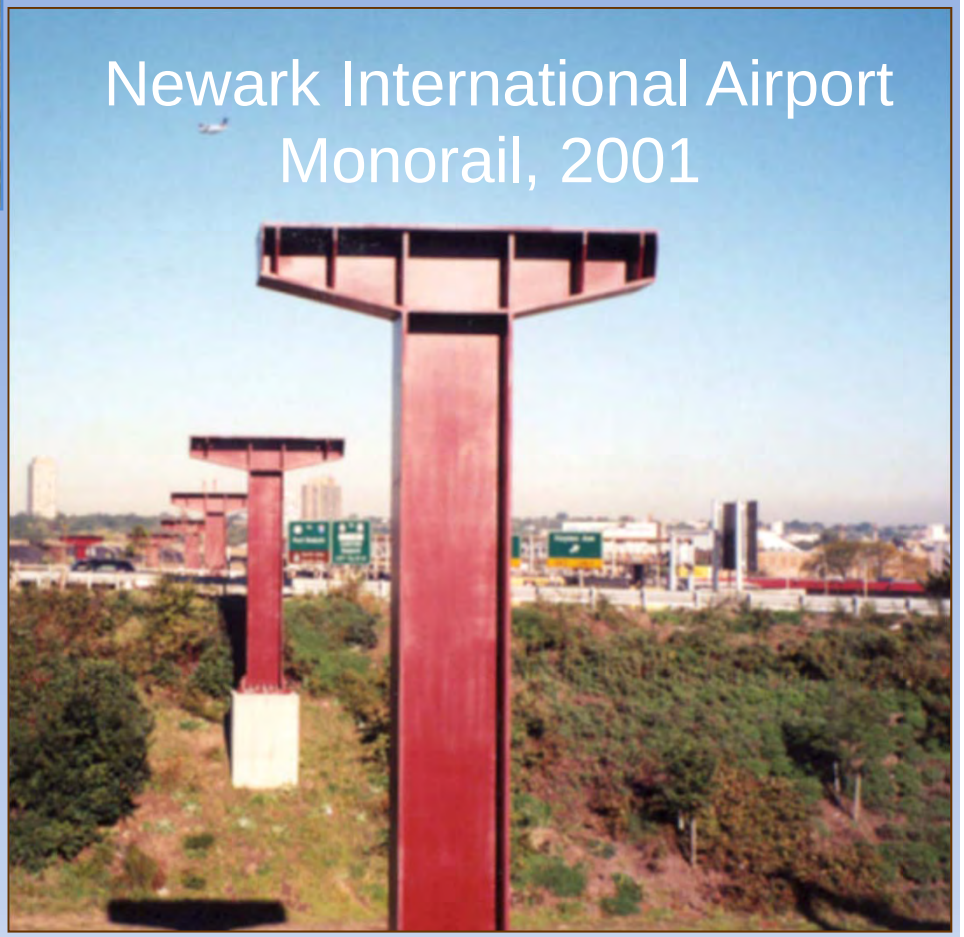




Prefabricated Substructures

Lake Ray Hubbard Bridge, 2002

Lake Belton Bridge, 2004



Newark International Airport Monorail, 2001

I-287 Cross Westchester Expressway, NY

Pier

DOT
DEPARTMENT OF TRANSPORTATION

Mill St. Bridge in Epping, NH

2.5 hours to set all elements, 15-30 mins per piece

Superstructure Units

Full Depth Precast Deck Panels

Folded Steel Plate Bridge

Folded Steel Plate Bridge

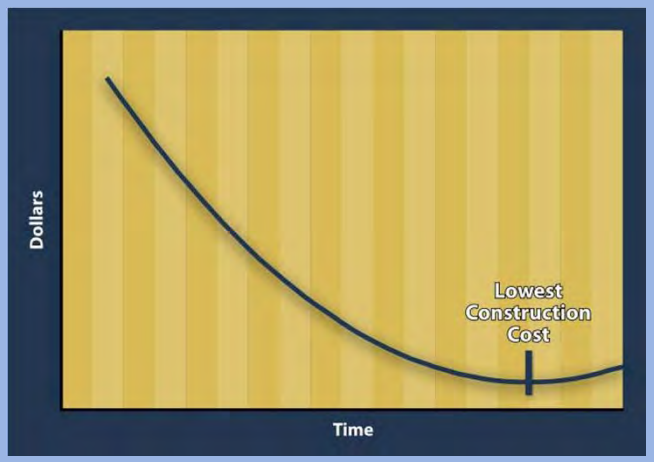
Folded Steel Plate Bridge

Embankment

Accelerated Geotechnical; Geofoam Embankment

Lessons Learned And Best Practices

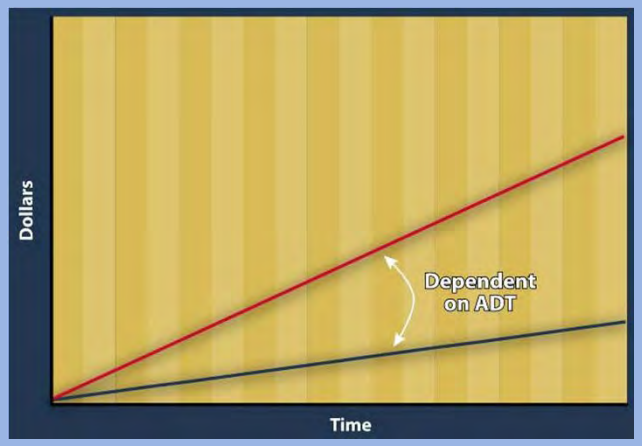
COST



Traditional Business Model

- Successful business model
- Existing interstate was constructed
- Competition determines the lowest construction cost
- Contractors select time and method

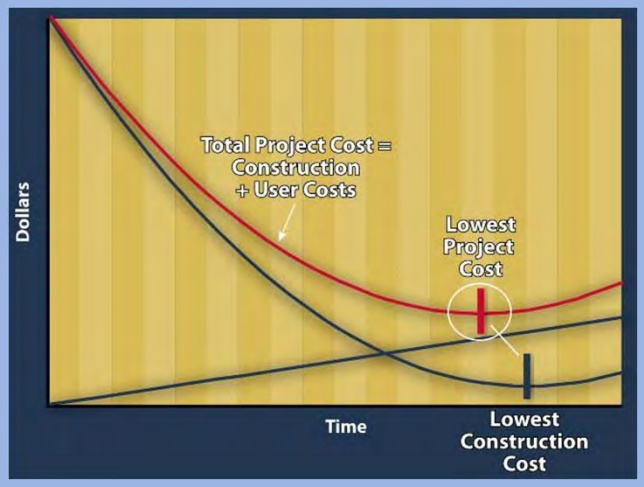
COST



societal Costs

- Linear relationship
- Cost depends on volume of traffic
- Longer construction duration ⇨ increase impacts to users

COST

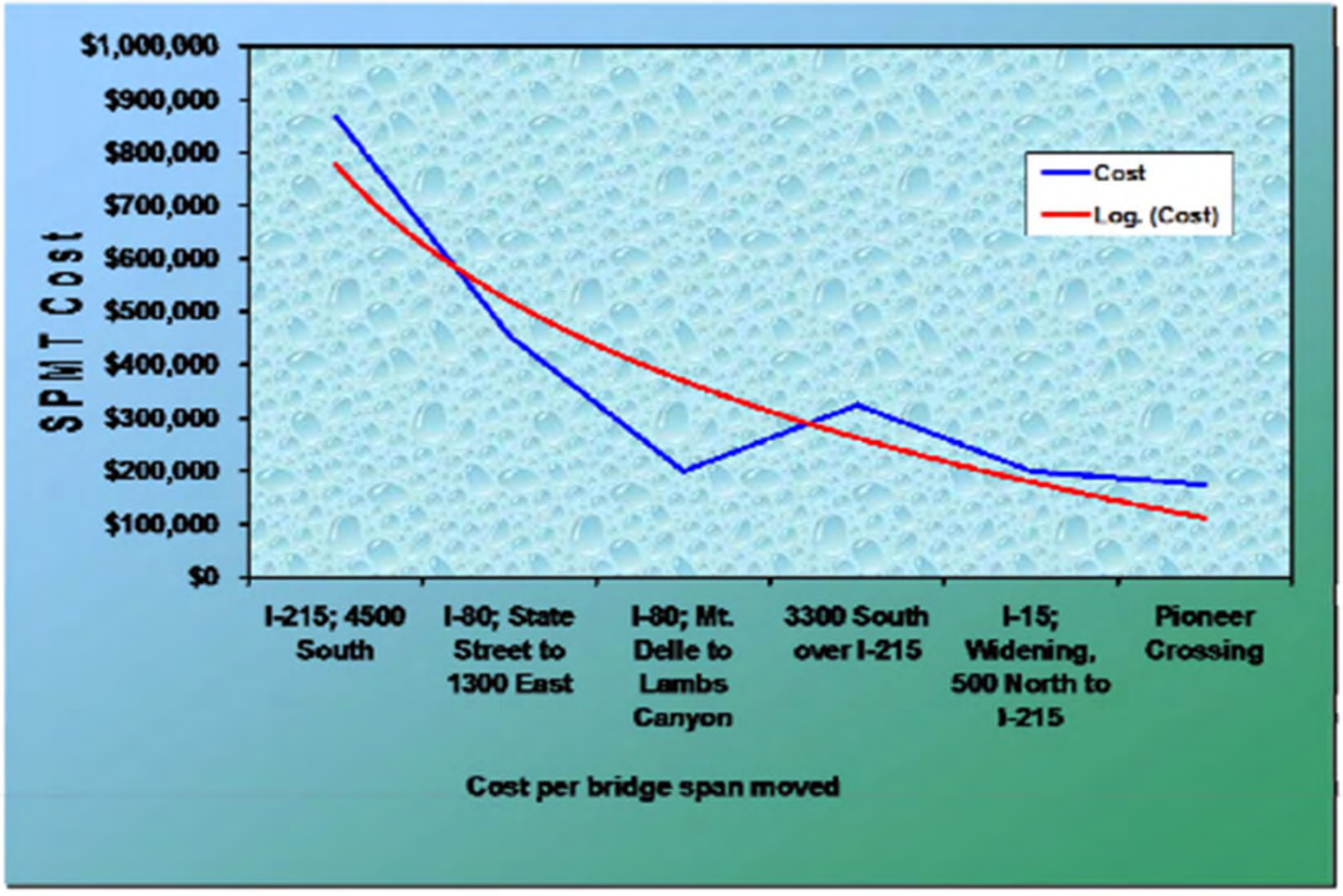


New Business Model

- New paradigm
- Lowest construction cost ⟹ lowest project cost
- Societal costs minimized
- Political capital
- Public praise

COST

SPMT Bridge Move Costs in Utah



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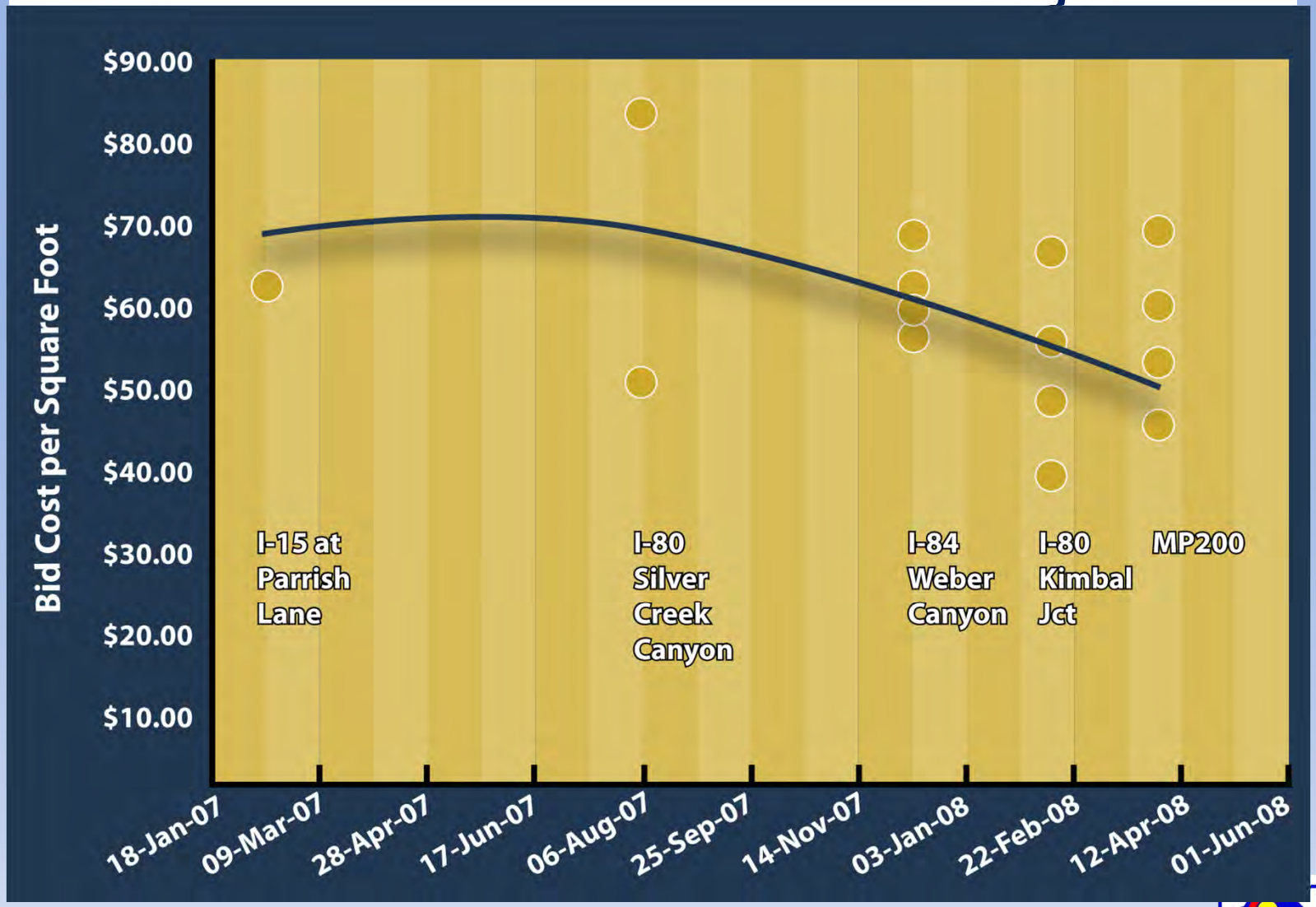
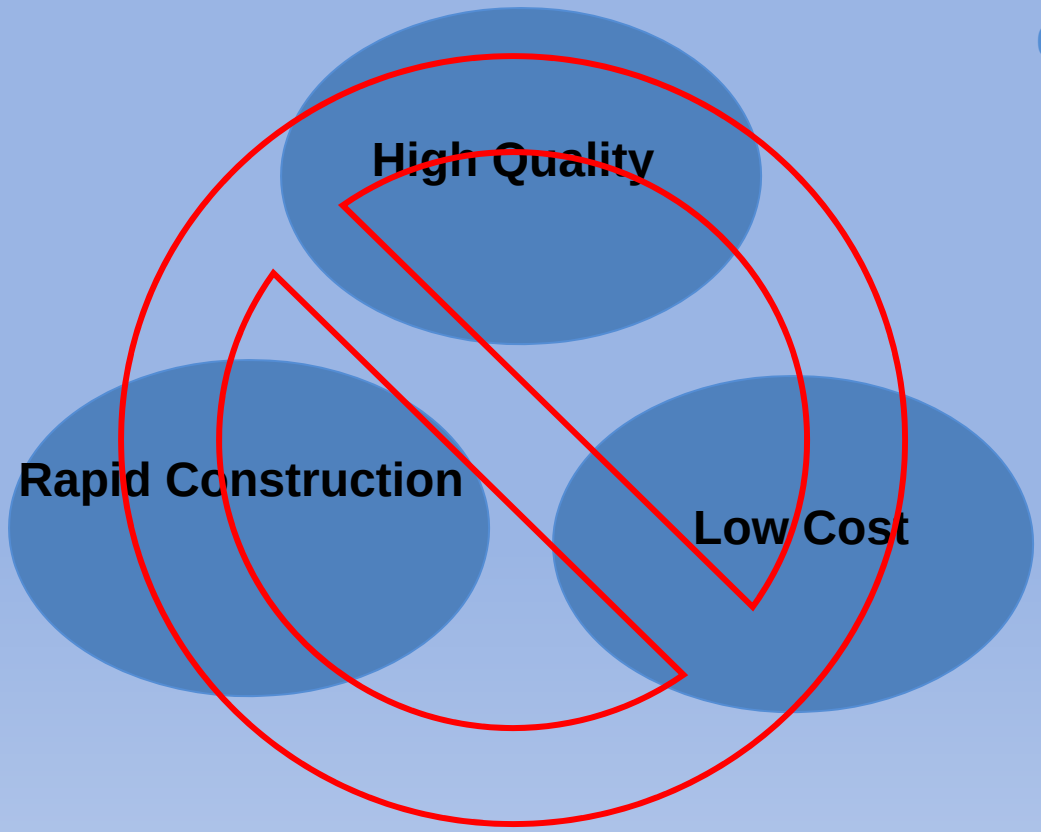
COST

Utah Precast Deck Panel Projects



Old Adage

You can only have any two

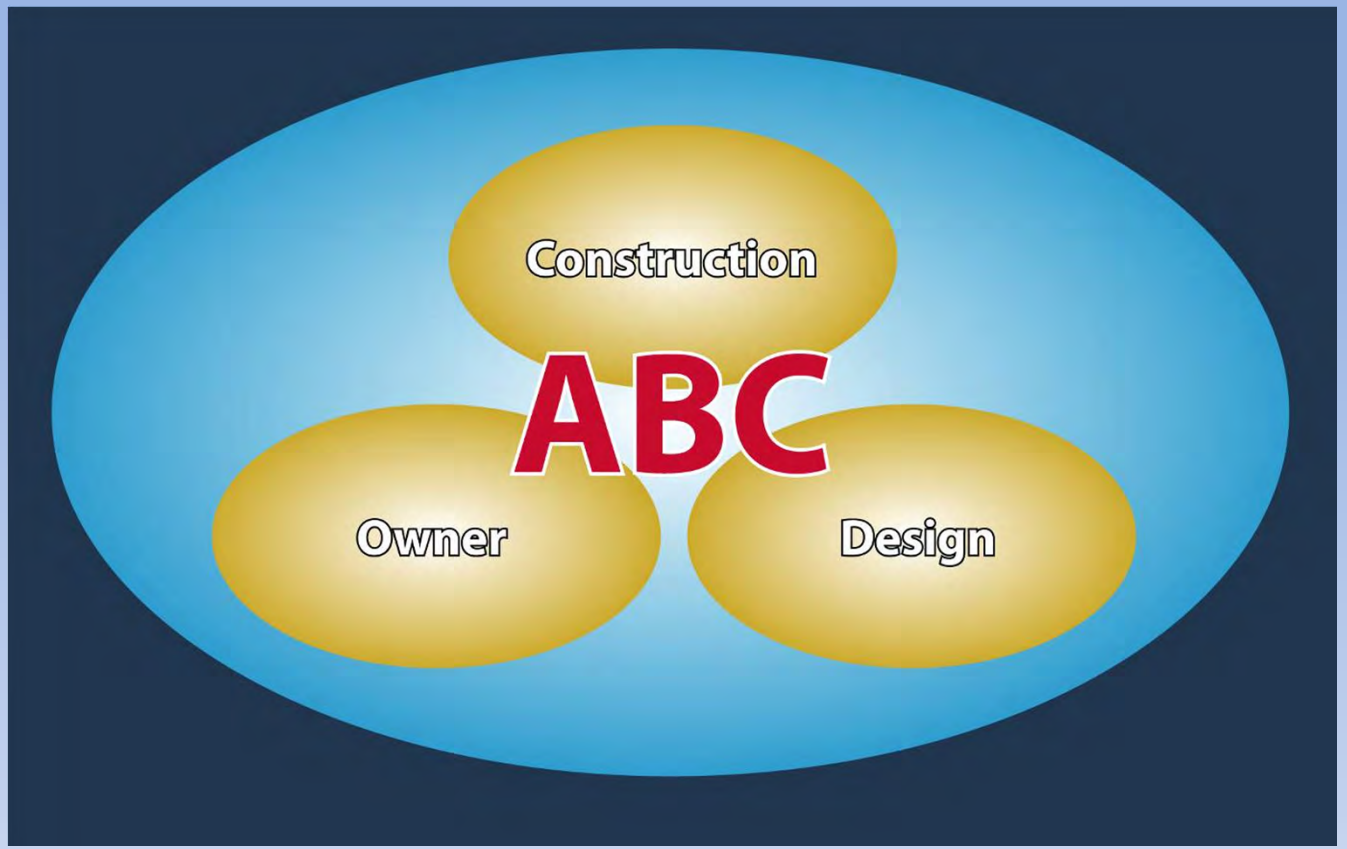


By elimination of temporary bridges or costly stage construction schemes,

you <u>CAN</u> have all three

Lessons Learned and Best Practices

- Engage the industry



Share or Define Risk

- Contractors perceived level of risk translates to dollars on bid day
- May prevent interest in the project
- Limit what's incidental, and what can’t be defined by specification or plans

Design Build

Planning NEPA ROW / Utilities Design / Construction

With DB project delivery, the designer-builder assumes responsibility for the majority of the design work and all construction activities. This provides the designer-builder with increased flexibility to be innovative, along with greater responsibility and risk.

Benefits:

- Considerable time savings over the traditional process of Design-Bid-Build (DBB)
- Allows design to be tailored to contractor's resources
- Allows quality evaluation factors and best-value selection criteria when selecting contractors

DEPARTMENT OF TRANSPORTATION

Construction Manager / General Contractor (CMGC)

Planning NEPA ROW / Utilities Design / Construction

CM/GC occupies the middle ground between the traditional (DBB) and (DB). CM/GC provides for project acceleration by allowing the owner to contract with a construction manager early in the design process and agree to a negotiated price for construction later before the design is complete.

Benefits:

- Reduces Costs
- No compromise on quality
- Enhances potential for creativity

Clean simple details

- Tend to:
  - Drive down costs
  - Be built to higher standards
  - Reduce inventories & speed replacements
  - Reduce overheads & distributed costs

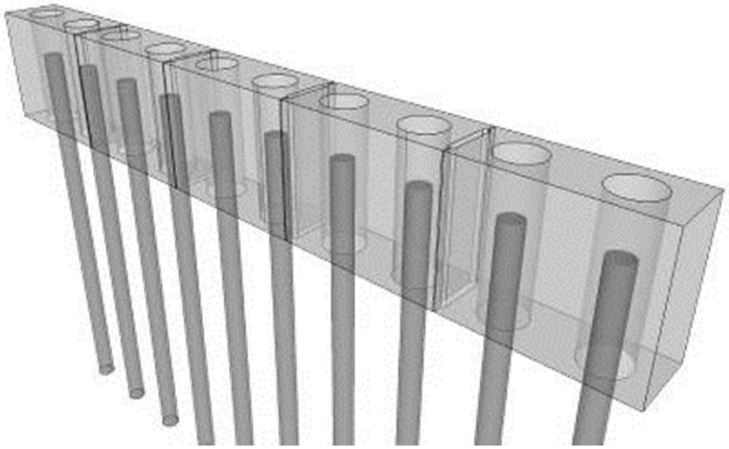
One of a kind designs

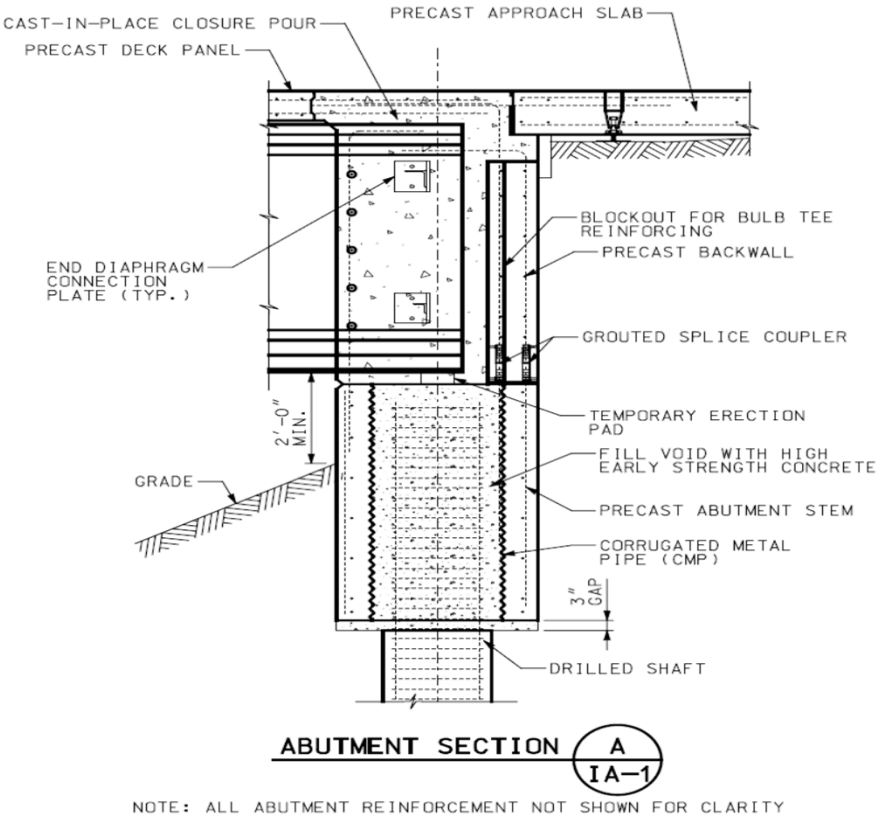
- Limits re-use of
  - Technology
  - Equipment, forms, yards
  - Cost history
  - Personnel

Design

Implement Standardization

- ABC Manual and Standard Drawings





Why ABC ?

- Minimizes Traffic delays
- The Public expects it!
- The Public demands it!
- Its' Good Engineering!

Malcolm T. Kerley, P.E.
Chief Engineer, VDOT
Chair, AASHTO Subcommittee on
Bridges and Structures

Thank you

Questions

Thanks for Attending

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