DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

INTERDEPARTMENT CORRESPONDENCE

FILE: NH-IM-85-2(165), (166), (167), (168), NH-IM-85-2(169), (170), (171), (172), (173), (174) & (175)
Gwinnett, Barrow, Jackson, Banks, Franklin and Hart
P.I. Nos. 110610, 110620, 110630, 110640, 110650, 110660, 110670, 110680, 110690, 110700, & 110710
I-85 Widening/Reconstruction

OFFICE: Engineering Services

DATE: May 15, 2007

FROM: Brian K. Summers, PE, Project Review Engineer

TO: Babs Abubakari, PE, State Program Delivery and Consultant Design Engineer

SUBJECT: **IMPLEMENTATION OF VALUE ENGINEERING STUDY ALTERNATIVES**

Recommendations for implementation of Value Engineering Study Alternatives are indicated in the table below. Incorporate the VE alternatives recommended for implementation to the extent reasonable in the design of the project.

ALT #	Description	Potential Savings/LCC	Implement	Comments
PAVEMENT				
A-1	Revise Typical Section and use asphalt widening and overlay	Note: See attached revised Life Cycle Cost Analysis which includes more current Asphalt prices.	No	A Life Cycle Cost Analysis has been done to reflect current material costs and the Pavement Design Committee has recommended a CRC Pavement typical section on these projects.
A-2	Mill asphalt down to existing concrete and use a bonded concrete overlay	Note: See attached revised Life Cycle Cost Analysis which includes more current Asphalt prices.	No	A Life Cycle Cost Analysis has been done to reflect current material costs and the Pavement Design Committee has recommended a CRC Pavement typical section on these projects.

ALT #	Description	Potential Savings/LCC	Implement	Comments
MULBERRY RIVER BRIDGE – P.I. No. 110620				
B-1	Jack the existing deck and widen the existing bridge	$7900 (revised costs submitted by PBS & J which takes into account the bridge rehabilitation work)	No	The Bridge Maintenance Office has determined that the existing bridges will require extensive corrective/rehabilitative work and has recommended that the existing bridges be replaced.
BRIDGE JACKING				
C-1	Revise the profile grades by milling the existing asphalt	$2,670,642	No	A Life Cycle Cost Analysis has been done to reflect current material costs and the Pavement Design Committee has recommended a CRC Pavement typical section on these projects.
MEDIAN BARRIER				
D-1	Use Double Face Guardrail with swale in the median	$67,485,729	No	The staging on these projects requires the median to be closed out in order to accommodate traffic flow while the existing pavement is being removed and replaced with a CRC Pavement Section.
D-2	Use Cable Median Barrier with a swale in the median	$73,838,220	No	The staging on these projects requires the median to be closed out in order to accommodate traffic flow while the existing pavement is being removed and replaced with a CRC Pavement Section.

ALT #	Description	Potential Savings/LCC	Implement	Comments
		FENCING		
E-1	Utilize and repair the existing fence	$2,680,818	No	This does not apply any more. The scope of the project does not include replacement of fencing which would require easements.
		PROFILE		
F-1	Mill the existing pavement to achieve the corrected "K" value	$475,365	No	A Life Cycle Cost Analysis has been done to reflect current material costs and the Pavement Design Committee has recommended a CRC Pavement typical section on these projects.

A meeting was held on March 28, 2007 to discuss the above recommendations. George Merritt with FHWA, Ron Morris and Mickey Michalski with PBS & J, Joe Wheeler and Stanley Hill of Consultant Design, and Brian Summers, Lisa Myers, and Ron Wishon of Engineering Services were in attendance.

Additional information was provided by the Office of Consultant Design on April 4, 2007.

The results above reflect the consensus of those in attendance and those who provided input.

Approved: [signature] **Date:** 5/19/07
David E. Studstill, Jr., P. E., Chief Engineer

Approved: for [signature] **Date:** 11/14/07
Rodney Barry, P.E., FHWA Division Administrator

BKS/REW

Attachments

c: Gus Shanine, FHWA
George Merritt, FHWA
Brent Story
Jason McCook
Sandy Moore
Stanley Hill
Brad McManus
Tim Matthews
Joe Wheeler
Randy Hart
Gail D'Avino
Ken Werho
Lisa Myers

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

INTERDEPARTMENT CORRESPONDENCE

FILE NH-IM-85-2(165), (166), (167), (168), (169), (170), (171), (172), (173), (174), (175)
Gwinnett, Barrow, Jackson, Banks, Franklin, and Hart Counties
P.I. Nos. 110610, 110620, 110630, 110640, 110650, 110660, 110670, 110680, 110690, 110700, and 110710
I-85 Widening (Northern Corridor)

OFFICE Atlanta, Georgia

DATE April 4, 2007

Stanley Hill

FROM For Mohammed (Babs) Abubakari, P. E., State Consultant Design Engineer

TO Brian Summers, P. E., Project Review Engineer

SUBJECT **Response to Value Engineering Study – Final Report**

Reference is made to the recommendations that were contained in the Value Engineering Study – Final Report dated March 15, 2005 for the above referenced projects. Our responses to the recommendations are as follows:

A. PAVEMENT

Value Engineering Alternative No. 1 – Revise typical section and use asphalt widening and overlay
Approval of the VE Alternative No. 1 is not recommended. The asphalt overlay will overlay an existing concrete pavement that has been deteriorating for 40+ years (it was overlaid with asphalt concrete in the 1980's), creating a pavement structure that has at its base a failing foundation.

The Department's Office of Materials and Research performed a life cycle cost analysis for several types of pavement, including asphalt. Based on their recommendations and with concurrence from Department management and FHWA, the Pavement Design Committee has approved use of a full depth Continuously Reinforced Concrete (CRC) section to replace the existing concrete pavement.

Value Engineering Alternative No. 2 – Mill existing asphalt down to existing concrete and use a bonded concrete overlay
Approval of the VE Alternative No. 2 is not recommended. As stated above, with concurrence from Department management and FHWA, the Pavement Design Committee has approved use of a full depth section of CRC to replace the existing pavement.

B. MULBERRY RIVER BRIDGE

Value Engineering Alternative – Jack the existing deck and widen the existing bridge
Approval of the VE Alternative is not recommended. A cost comparison that was prepared in September 2004 by Post Buckley Schuh & Jernigan (PBS&J) showed that a total replacement of the bridge would cost only approximately

$7,900 more that widening and rehabilitation of the existing steel bridge. Further, the Department's bridge condition survey of September 24, 2004 (copy attached) stated "There has been a significant amount of scour and drift accumulation around the substructure that has had to be repaired. There has also been progressive movement between the steel beams and the deck on the northbound bridge. Although hydrodemolition and overlay has been performed on this bridge in the past, extensive transverse cracking is present on the bottom portions of the decks on both bridges and is beginning to reflect up through the overlay. It has also been recommended that the cross slope on the bridges be increased to meet current standards. This will require deck hydrodemolition/deck replacement or jacking. There are also issues of section loss in both the steel beams and the piles in Bent 4."

A March 30, 2006 e-mail from Ben Rabun (the State Bridge Maintenance Engineer) noted that Bent #3 (located in the river channel) has a history of drift accumulation and scour which undermined the footing. Although that damage was repaired, the current (at the time) inspection listed minor undermining of the footing. Mr. Rabun went on to state that the cracking of the deck would, at a minimum, require complete replacement of the bridge deck, the cost of which is often the same or more than the cost of a complete bridge of equivalent square footage.

It is the recommendation of the Preconstruction Division to replace the bridge over the Mulberry River. Further, a revised concept report to replace the bridge was approved by the Department and FHWA in correspondence dated January 8, 2007.

C. BRIDGE JACKING

Value Engineering Alternative – Revise profile grade by milling existing pavement
Approval of the VE Alternative is not recommended. The approved design of using a full depth replacement with CRC precludes milling of the existing pavement. Therefore this alternative is not necessary and the Preconstruction Division recommends full depth with Portland cement concrete.

D. MEDIAN BARRIER

Value Engineering Alternative No. 1 – Double face guardrail with swale
Approval of the VE Alternative is not recommended. The staging of the project requires that the median must be closed out. The use of double faced guardrail would be possible only in those areas where the median is greater than 64 feet.

Value Engineering Alternative No. 2 – Cable barrier with swale
Approval of the VE Alternative is not recommended. The staging of the project requires that the median must be closed out. The use of cable barrier would be possible only in those areas where the median is greater than 64 feet.

E. FENCING

Value Engineering Alternative – Utilize and/or repair existing fencing
Approval of the VE Alternative is not recommended. The scope of the projects does not include replacement and/or repair of the existing fence. Replacement of the fence would require additional easement or right of way. There is very little right of way money designated for these projects. It is suggested that the

Department's Office of Maintenance investigate the condition of the existing fence and make a recommendation to replace or repair the fence under a separate project.

F. PROFILE

Value Engineering Alternative – Mill existing pavement to achieve corrected K value

Approval of the VE Alternative is not recommended. As previously stated, the Pavement Design Committee, with concurrence from Department management and FHWA, has approved use of a full depth section of CRC to replace the existing pavement. The profile grade for the new pavement will be adjusted as necessary to meet the required K value.

If you have any questions please contact Joe Wheeler at (404)657-9759.

JDW

MBA:JDW

Attachment

HAROLD E. LINNENKOHL
COMMISSIONER
(404) 656-5206

PAUL V. MULLINS
CHIEF ENGINEER
(404) 656-5277

Department of Transportation
State of Georgia

RECEIVED
SEP 27 2004

LARRY E. DENT
DEPUTY COMMISSIONER
(404) 656-5212

EARL MAHFUZ
TREASURER
(404) 656-5224

INTERDEPARTMENT CORRESPONDENCE

September 24, 2004

FROM: Bryant Poole, State Maintenance Engineer

TO: Brent Story, P.E., State Consultant Design Engineer
Attn: Joe Wheeler

SUBJECT: Bridge Condition Survey
NH-IM-85-2(166) / Barrow/Jackson
P.I. No. 110620

As requested, a condition survey has been completed on each of the bridges in this project. Following are location specific recommendations.

Structure ID 013-0022-0, 013-0023-0
Location ID 013-00403D-127.19N, 013-00403D-127.20N
I-85 NB & SB over Mulberry River

This bridges were built in 1964, widened in 1985, and consists of concrete bents, steel beam superstructure, and a concrete deck. The original design load capacity is HS-20 and the current load rating is HS-20. The sufficiency ratings on the structures are 93.9. The bridge is in fair condition and has had two maintenance rehabilitation projects.

There are still several issues that would have to be dealt with in widening this structure. There has been a significant amount of scour and drift accumulation around the substructure in the past 10 years that has had to be repaired. There has also been progressive movement between the steel beams and the deck on the northbound bridge. Although hydrodemolition and overlay has been performed on this bridge in the past, extensive transverse cracking is present on the bottom portions of the decks on both bridges and is beginning to reflect up through the overlay. It has been recommended that the cross slope on the bridges will have to be increased to meet current standards. This will require deck hydrodemolition /deck replacement or jacking. There are also issues of section loss in both the steel beams and the piles in Bent 4.

According to the estimate provided by PBS&J, it will be almost as expensive to repair and widen as it will be to replace the bridges. In addition, the life cycle costs for a steel structure are significantly higher that for a concrete structure. Based on the cost analysis and the higher life cycle costs, it is recommended that these bridges be replaced.

If further information is required, please contact Brian Summers at (404) 635-8179.

BP/BKS

Wheeler, Joe

From: Rabun, Ben
Sent: Thursday, March 30, 2006 3:45 PM
To: Wheeler, Joe
Subject: Fw: I-85 over Mulberry River

-----Original Message-----
From: Rabun, Ben
To: Abubakari, Babs
Sent: Mon Mar 13 17:05:14 2006
Subject: RE: I-85 over Mulberry River

Babs,
I have looked at the Sufficiency Ratings for these structures and the numbers appear to be correct. I have attached the current inspection reports which list a number of deficiencies. These structures have structural capacities equal to current design loadings (HS-20) and the condition evaluations of the deck, super and sub of 5 or 6. Based on a desk-review of the inspection reports, these ratings are appropriate and within the federal guidelines. The condition codes for 013-0023-0 might could be lowered to match 013-0022-0 with a new field inspection. This would result only in the sufficiency ratings for both being approx. 81.2

As discussed with Brian this morning, Bent #3 is located in the channel and has a history of drift accumulation and scour which undermined the footing at this location. This damage was repaired, however, the current inspection lists minor undermining of the footing.

The deck is another area of concern. The deck is moving independently of the superstructure and has resulted in or aggravated the cracking in the deck and possibly the problems in the edgebeams and back walls. A complete replacement of the deck will be required at a minimum. Many times the cost of this work is the same or more than the cost of a complete bridge of equivalent square footage.

The superstructure is steel beams. With steel prices currently at an all time high, there will be a cost difference to widen with steel over PSC beams.

Based on all of these conditions, a replacement structure, which moves the substructure units out of the waterway, is the most prudent solution.

<<013-0023-0.pdf>> <<013-0022-0.pdf>>

Ben Rabun, P.E.
GA D.O.T.
State Bridge Maintenance Engineer
Transportation Management Center
935 E. Confederate Avenue
Building 24, Room 410
Atlanta, GA 30316-2531
(404) 635-8179
(404) 635-8579 FAX

From: Abubakari, Babs
Sent: Thursday, March 09, 2006 8:10 AM
To: Rabun, Ben
Cc: Wheeler, Joe
Subject: FW: I-85 over Mulberry River

Importance: High

Ben:
Please review these reports for the bridge attached and confirm the sufficiency ratings. My guess is the ratings appear to be too high.

From: Wheeler, Joe
Sent: Monday, February 27, 2006 2:19 PM
To: Abubakari, Babs
Cc: Gratton, Buddy
Subject: RE: I-85 over Mulberry River

<< File: SBL Report.pdf >> << File: NBL Report.pdf >> The current inspection report for the NBL and SBL are attached.

Joe Wheeler
Georgia Department of Transportation
Office of Consultant Design
2 Capitol Square, S.W.
Atlanta, GA 30334-1002
Phone: (404)657-9759
FAX: (404)463-6136
e-mail: joe.wheeler@dot.state.ga.us

From: Abubakari, Babs
Sent: Monday, February 27, 2006 2:14 PM
To: Merritt_George
Cc: Gratton, Buddy; Wheeler, Joe
Subject: RE: I-85 over Mulberry River
Importance: High

George call me to discuss if you have any concerns. I think it is pretty obvious now why we replacing the bridge with a 3-span bridge. I am also going to ask our bridge maintenance staff to revisit the sufficiency rating for this bridge. I will get back with you as soon I hear back from them.

From: Wheeler, Joe
Sent: Monday, February 27, 2006 2:10 PM
To: Merritt_George
Cc: Abubakari, Babs; Gratton, Buddy
Subject: I-85 over Mulberry River

<< File: PBL.pdf >> << File: Debris Photo.pdf >> George,
Per our discussion this morning regarding the preliminary layout for I-85 over the Mulberry River, I have attached pdf files of the preliminary layout and a photo showing existing debris in the river.

Please note that the existing pile and bent locations have been screened on the preliminary bridge layout. The piles that are currently in the stream are being removed. Although the length of the bridge remains the same, it will be 3 spans instead of 4.

Joe Wheeler
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FAX: (404)463-6136
e-mail: joe.wheeler@dot.state.ga.us

DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

Interdepartmental Correspondence

FILE NH-IM-85-2 (All Units)
P.I. No. 110620-110710
Life Cycle Cost Analysis and
Pavement Type Recommendation
For Widening of I-85

OFFICE Materials & Research
Forest Park, Georgia

DATE March 31, 2006

FROM Georgene M. Geary, P.E., State Materials and Research Engineer

TO Babs Abubakari, P.E., State Consultant Design & Program Delivery Engineer
ATTN: Joe Wheeler, Design Group Manager

SUBJECT **Life Cycle Cost Analysis and Pavement Type Recommendation**
Widening of I-85 from Gwinnett County to South Carolina State Line

The Office of Materials and Research (OMR) has revised the Life Cycle Cost Analysis (LCCA) and Pavement Type Recommendation for the above referenced project. Additional pavement alternatives were included in the LCCA and in the pavement type selection process. These additional pavement alternatives included pavement designs for Hot Mix Asphalt (HMA). However, the recommendation for pavement type did not change.

Project Location & Description
This project is to add capacity by widening I-85 / SR 403 from two lanes in each direction to three lanes in each direction. This project starts in Gwinnett County and ends at the South Carolina Stateline in Hart County. The total length of this project is approximately 58.35 miles.

Pavement Type Recommendation
OMR recommends the following:

- Remove the existing pavement structure.
- Construct a 120-foot wide full depth pavement structure consisting of Continuously Reinforced Concrete (CRC),
    - Use Asphalt as an interlayer between the Grade Aggregate Base and the new CRC pavement,
    - This pavement structure will serve as six 12 foot wide travel lanes,
    - This pavement structure will serve as two 14 foot wide outside shoulders,
    - This pavement structure will serve as two 10 foot wide inside shoulders.

This pavement type recommendation is referenced as Alternative 3 in Table 1: Pavement Design Alternatives

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MAR 30 2006
OFFICE OF CONSULTANT DESIGN

Pavement Design Alternatives Considered

Six (6) alternative pavement designs were analyzed for life cycle costs. The alternates are listed in Table 1 below and are as follows:

Table 1: Pavement Design Alternatives

	Profile		Surface	Top	Intermediate	Base	SubBase	% Steel	Steel Bar Diameter	Steel Depth
Alternate 1 CRC Unbonded Overlay	**Mainline** *Overlay 10 feet wide*	Unbond Overlay CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Existing Pavement	0.8	0.750"	4.00"
	Full Depth 26 feet wide	Full Depth CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Graded Aggregate Base (12.00")	0.8	0.750"	4.00"
Full Depth Replace @ Overhead Bridges	**Inside Shoulders**	Full Depth CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Graded Aggregate Base (12.00")	0.8	0.750"	4.00"
	Outside Shoulders	Unbond Overlay CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Existing Pavement	0.8	0.750"	4.00"
Alternate 2 CRC Unbonded Overlay	**Mainline** *Overlay 10 feet wide*	Unbond Overlay CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Existing Pavement	0.8	0.750"	4.00"
	Full Depth 26 feet wide	Full Depth CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Graded Aggregate Base (12.00")	0.8	0.750"	4.00"
Raising Overhead Bridges & Ramp Replace	**Inside Shoulders**	Full Depth CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Graded Aggregate Base (12.00")	0.8	0.750"	4.00"
	Outside Shoulders	Unbond Overlay CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Existing Pavement	0.8	0.750"	4.00"
Alternate 3 CRC Full Depth Replace	**Mainline** *Full Depth 36 feet wide*	Full Depth CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Graded Aggregate Base (12.00")	0.8	0.750"	4.00"
	Inside Shoulders	Full Depth CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Graded Aggregate Base (12.00")	0.8	0.750"	4.00"
Remove Existing Pavement Structure	**Outside Shoulders**	Full Depth CRC	CRC (12.0")	---	19 mm Superpave (3.00")	---	Graded Aggregate Base (12.00")	0.8	0.750"	4.00"

Table 1: Pavement Design Alternatives (continued)

	Profile		Surface	Top	Intermediate	Base	SubBase	% Steel	Steel Bar Diameter	Steel Depth
Alternate 4	**Mainline** *Overlay 10 feet wide*	HMA Overlay	12.5 mm PEM (1.25")	12.5 mm SMA (1.50")	19 mm Superpave (6.00")	---	Existing Pavement	---	---	---
HMA Overlay	*Full Depth 26 feet wide*	Full Depth HMA	12.5 mm PEM (1.25")	12.5 mm SMA (1.50")	19 mm Superpave (2.00")	25 mm Superpave (13.00")	Graded Aggregate Base (12.00")	---	---	---
Full Depth Replace @ Overhead Bridges	**Inside Shoulders**	Full Depth HMA	*12.5 mm PEM * (1.25")*	12.5 mm Superpave (1.50")	19 mm Superpave (2.00")	25 mm Superpave (13.00")	Graded Aggregate Base (12.00")	---	---	---
	Outside Shoulders	HMA Overlay	*12.5 mm PEM * (1.25")*	12.5 mm Superpave (1.50")	19 mm Superpave (6.00")	---	Existing Pavement	---	---	---
Alternate 5	**Mainline** *Overlay 10 feet wide*	HMA Overlay	12.5 mm PEM (1.25")	12.5 mm SMA (1.50")	19 mm Superpave (6.00")	---	Existing Pavement	---	---	---
HMA Overlay	*Full Depth 26 feet wide*	Full Depth HMA	12.5 mm PEM (1.25")	12.5 mm SMA (1.50")	19 mm Superpave (2.00")	25 mm Superpave (13.00")	Graded Aggregate Base (12.00")	---	---	---
Raising Overhead Bridges & Ramp Replace	**Inside Shoulders**	Full Depth HMA	*12.5 mm PEM * (1.25")*	12.5 mm Superpave (1.50")	19 mm Superpave (2.00")	25 mm Superpave (13.00")	Graded Aggregate Base (12.00")	---	---	---
	Outside Shoulders	HMA Overlay	*12.5 mm PEM * (1.25")*	12.5 mm Superpave (1.50")	19 mm Superpave (6.00")	---	Existing Pavement	---	---	---
Alternate 6 HMA Full Depth Replace	**Mainline** *Full Depth 36 feet wide*	Full Depth HMA	12.5 mm PEM (1.25")	12.5 mm SMA (1.50")	19 mm Superpave (2.00")	25 mm Superpave (13.00")	Graded Aggregate Base (12.00")	---	---	---
	Inside Shoulders	Full Depth HMA	*12.5 mm PEM * (1.25")*	12.5 mm Superpave (1.50")	19 mm Superpave (2.00")	25 mm Superpave (13.00")	Graded Aggregate Base (12.00")	---	---	---
Remove Existing Pavement Structure	**Outside Shoulders**	Full Depth HMA	*12.5 mm PEM * (1.25")*	12.5 mm Superpave (1.50")	19 mm Superpave (2.00")	25 mm Superpave (13.00")	Graded Aggregate Base (12.00")	---	---	4.00"

** 12.5 mm PEM extends for 18 inches (1 ½ feet) into both inside and outside shoulders from the mainline pavement.*

Table 2 below summarizes life cycle costs for 30 year and 40 year analysis periods. The amounts displayed are the Annualized Agency Costs per mile per both directions.

Table 2 : Annualized Agency Costs

ALTERNATIVE DESIGNS	30 YEAR ANNUALIZED AGENCY COST *per mile per both directions*	40 YEAR ANNUALIZED AGENCY COST *per mile per both directions*
Alternative 1 *CRC Unbonded Overlay (CRC Full Depth Reconstruction @ Overhead Bridges)*	$ 432,219	$ 377,086
Alternative 2 *CRC Unbonded Overlay (Raise Overhead Bridge & Ramp Reconstruction)*	$ 435,689	$ 374,093
Alternative 3 *CRC Full Depth Reconstruction (Remove Existing Pavement Structure)*	$ 461,088	$ 395,010
Alternative 4 *HMA Overlay (HMA Full Depth Reconstruction @ Overhead Bridges)*	$ 479,020	$ 454,801
Alternative 5 *HMA Overlay (Raise Overhead Bridge & Ramp Reconstruction)*	$ 499,612	$ 472,262
Alternative 6 *HMA Full Depth Reconstruction (Remove Existing Pavement Structure)*	$ 544,324	$ 499,032

Table 3 below summarizes the Total Scores and Rankings from the Decision Matrix. The scores were determined from the LCCA using a 40 year Analysis Period.

Table 3 : Ranking of Alternative Pavement Designs

ALTERNATIVE DESIGNS	RANK	TOTAL SCORE
Alternative 3 *CRC Full Depth Reconstruction* *(Remove Existing Pavement Structure)*	1	83.5
Alternative 2 *CRC Unbonded Overlay* *(Raise Overhead Bridge & Ramp Reconstruction)*	2	78.8
Alternative 1 *CRC Unbonded Overlay* *(CRC Full Depth Reconstruction @ Overhead Bridges)*	3	78.5
Alternative 4 *HMA Unbonded Overlay* *(CRC Full Depth Reconstruction @ Overhead Bridges)*	4	64.0
Alternative 5 *HMA Unbonded Overlay* *(Raise Overhead Bridge & Ramp Reconstruction)*	5	60.7
Alternative 6 *HMA Full Depth Reconstruction* *(Remove Existing Pavement Structure)*	6	55.0

The LCCA is based on the following:

- Staging costs were *not* considered
  - Durations for staging were not considered.
- Costs to raise overhead bridge were considered
- A Discount Rate of 3 % was used
- Two analysis periods were used
  - 30 years, and
  - 40 years
- Recommendations are based on the 40 year analysis
- The service life prior to first major maintenance activities were as follows:
  - 25 years for Full Depth Reconstruction of Continuously Reinforced Concrete Pavements (CRCP)
  - 20 years for CRCP Unbonded Overlay
  - 10 years for Full Depth Reconstruction of Hot Mix Asphalt (HMA) pavements
  - 8 years for HMA Overlay pavements.
- Deterministic approach to LCCA is based on the guidelines in the following document:
  - Federal Highway Administration Publication No. FHWA-SA-98-079, Life-Cycle Cost Analysis in Pavement Design
- Production rates: Average production rates were determined from historical project information within the Georgia Department of Transportation. Those are:
  - Ready Mix Concrete Plant: 6000 square yards per day
    - The average of 4000 linear feet of paving for a 12 foot wide lane and 2500 linear feet of paving for a 24 foot wide lane
  - Asphalt Concrete Plant: 200 tons per hour.

The detailed analysis is on file and can be requested from The Office of Materials and Research. Please contact Moussa Issa at (404) 636-7581 if you should have any further questions.

GMG: JTR: AJJ: JHT

Attachments (2)
(a) LCCA Summary Report
(b) Summary of Initial Costs

SUMMARY of INITIAL COSTS

ALTERNATIVE 1

Travel Lane Pavement Type CRC
Travel Lane Pavement Method Unbonded Overlay
More Description Overlay -Full Replacement @ Overpass Bridges

ROADWAY PAVEMENT		
ITEM		**ITEM TOTAL COST**
CRC	$	243,893,760.00
PCC	$	-
RCC	$	-
12.5 mm PEM	$	-
12.5 mm SMA	$	-
12.5 mm Superpave	$	-
19 mm Superpave	$	41,583,886.08
19 mm SMA	$	-
25 mm Superpave	$	-
Graded Aggregate Base	$	41,656,665.60
TOTAL ROADWAY PAVEMENT COSTS	$	327,134,311.68

OTHER & PREPARATORY WORK		
ITEM		**ITEM TOTAL COST**
Traffic Control	$	17,322,000.00
Staging	$	-
Roadway Bridges	$	11,876,040.00
Raise Bridge	$	-
New Ramp Construction	$	-
Grading	$	11,952,180.00
Waterproofing Joints & Cracks	$	1,715,792.60
Remove Roadway Slab	$	-
Remove Roadway Slab (Exceptions)	$	14,002,560.00
Remove Existing Concrete prior to Overlay	$	1,332,320.00
Full Depth Slab Replacement prior to Overlay	$	5,995,440.00
Mill Asphalt	$	19,308,256.00
Less excavation / grading than Alt. #3	$	(1,332,320.00)
Additional Shoulder Embankment than Alt. #3	$	2,498,100.00
Joint Reinforcement Fabric	$	-
Bituminous Tack Coat	$	-
Vegetation Removal	$	11,548,000.00
Barrier Wall	$	19,169,680.00
Striping / Signage	$	4,619,200.00
Longitudinal Drainage	$	5,831,740.00
Misc: (Guardrail, Soundwalls, EC, etc)	$	20,209,000.00
TOTAL OTHER & PREPARATORY COSTS	$	146,047,988.60

SUMMARY of INITIAL COSTS

ALTERNATIVE 2

Pavement Type CRC
Pavement Method Unbonded Overlay
More Description Overlay - Raise Bridges

ROADWAY PAVEMENT		
ITEM		**ITEM TOTAL COST**
CRC	$	243,893,760.00
PCC	$	-
RCC	$	-
12.5 mm PEM	$	-
12.5 mm SMA	$	-
12.5 mm Superpave	$	-
19 mm Superpave	$	41,583,886.08
19 mm SMA	$	-
25 mm Superpave	$	-
Graded Aggregate Base	$	34,248,428.54
TOTAL ROADWAY PAVEMENT COSTS	$	319,726,074.62

OTHER & PREPARATORY WORK		
ITEM		**ITEM TOTAL COST**
Traffic Control	$	17,322,000.00
Staging	$	-
Roadway Bridges	$	11,876,040.00
Raise Bridge	$	8,633,593.62
New Ramp Construction	$	3,862,983.11
Grading	$	11,952,180.00
Waterproofing Joints & Cracks	$	1,715,792.60
Remove Roadway Slab	$	-
Remove Roadway Slab (Exceptions)	$	668,800.00
Remove Existing Concrete prior to Overlay	$	1,999,008.00
Full Depth Slab Replacement prior to Overlay	$	8,995,536.00
Mill Asphalt	$	19,308,256.00
Less excavation / grading than Alt. #3	$	(1,999,008.00)
Additional Shoulder Embankment than Alt. #3	$	3,748,140.00
Joint Reinforcement Fabric	$	-
Bituminous Tack Coat	$	-
Vegetation Removal	$	11,548,000.00
Barrier Wall	$	19,169,680.00
Striping / Signage	$	4,619,200.00
Longitudinal Drainage	$	5,831,740.00
Misc: (Guardrail, Soundwalls, EC, etc)	$	20,209,000.00
TOTAL OTHER & PREPARATORY COSTS	$	149,460,941.33

SUMMARY of INITIAL COSTS

ALTERNATIVE 3

Pavement Type CRC
Pavement Method Full Depth
More Description

ROADWAY PAVEMENT		
ITEM		ITEM TOTAL COST
CRC	$	243,893,760.00
PCC	$	-
RCC	$	-
12.5 mm PEM	$	-
12.5 mm SMA	$	-
12.5 mm Superpave	$	-
19 mm Superpave	$	41,583,886.08
19 mm SMA	$	-
25 mm Superpave	$	-
Graded Aggregate Base	$	56,461,405.44
TOTAL ROADWAY PAVEMENT COSTS	$	341,939,051.52

OTHER & PREPARATORY WORK		
ITEM		ITEM TOTAL COST
Traffic Control	$	17,322,000.00
Staging	$	-
Roadway Bridges	$	11,876,040.00
Raise Bridge	$	-
New Ramp Construction	$	-
Grading	$	11,952,180.00
Waterproofing Joints & Cracks		
Remove Roadway Slab	$	40,648,960.00
Remove Roadway Slab (Exceptions)	$	-
Remove Existing Concrete prior to Overlay	$	-
Full Depth Slab Replacement prior to Overlay	$	-
Mill Asphalt	$	19,308,256.00
Less excavation / grading than Alt. #3	$	-
Additional Shoulder Embankment than Alt. #3	$	-
Joint Reinforcement Fabric	$	-
Bituminous Tack Coat	$	-
Vegetation Removal	$	11,548,000.00
Barrier Wall	$	19,169,680.00
Striping / Signage	$	4,619,200.00
Longitudinal Drainage	$	5,831,740.00
Misc: (Guardrail, Soundwalls, EC, etc)	$	20,209,000.00
TOTAL OTHER & PREPARATORY COSTS	$	162,485,056.00

SUMMARY of INITIAL COSTS

ALTERNATIVE 4

Pavement Type HMA
Pavement Method HMA Overlay PCC
More Description Overlay - Full Replacement @ Overpass Bridges

ROADWAY PAVEMENT		
ITEM		**ITEM TOTAL COST**
CRC		
PCC	$	-
RCC	$	-
12.5 mm PEM	$	13,078,802.88
12.5 mm SMA	$	18,109,111.68
12.5 mm Superpave	$	5,643,335.77
19 mm Superpave	$	42,260,866.56
19 mm SMA	$	-
25 mm Superpave	$	124,370,188.80
Graded Aggregate Base	$	41,625,723.12
TOTAL ROADWAY PAVEMENT COSTS	$	245,088,028.81

OTHER & PREPARATORY WORK		
ITEM		**ITEM TOTAL COST**
Traffic Control	$	17,322,000.00
Staging	$	-
Roadway Bridges	$	11,876,040.00
Raise Bridge	$	-
New Ramp Construction	$	-
Grading	$	11,952,180.00
Waterproofing Joints & Cracks	$	1,715,792.60
Remove Roadway Slab	$	-
Remove Roadway Slab (Exceptions)	$	14,002,560.00
Remove Existing Concrete prior to Overlay	$	1,332,320.00
Full Depth Slab Replacement prior to Overlay	$	5,995,440.00
Mill Asphalt	$	19,308,256.00
Additional excavation / grading over Alt. #3	$	666,160.00
Shoulder Embankment	$	1,078,725.00
Joint Reinforcement Fabric	$	1,958,510.40
Bituminous Tack Coat	$	541,557.35
Vegetation Removal	$	11,548,000.00
Barrier Wall	$	19,169,680.00
Striping / Signage	$	4,619,200.00
Longitudinal Drainage	$	5,831,740.00
Misc. (Guardrail, Soundwalls, EC, etc)	$	20,209,000.00
TOTAL OTHER & PREPARATORY COSTS	$	149,127,161.35

SUMMARY of INITIAL COSTS

ALTERNATIVE 5

Pavement Type HMA
Pavement Method HMA Overlay PCC
More Description Overlay - Raise Bridges

ROADWAY PAVEMENT		
ITEM		**ITEM TOTAL COST**
CRC		
PCC	$	-
RCC	$	-
12.5 mm PEM	$	13,078,802.88
12.5 mm SMA	$	18,109,111.68
12.5 mm Superpave	$	5,643,335.77
19 mm Superpave	$	49,535,766.02
19 mm SMA	$	-
25 mm Superpave	$	102,252,147.71
Graded Aggregate Base	$	34,246,950.65
TOTAL ROADWAY PAVEMENT COSTS	$	222,866,114.70

OTHER & PREPARATORY WORK		
ITEM		**ITEM TOTAL COST**
Traffic Control	$	17,322,000.00
Staging	$	-
Roadway Bridges	$	11,876,040.00
Raise Bridge	$	8,633,593.62
New Ramp Construction	$	3,862,983.11
Grading	$	11,952,180.00
Waterproofing Joints & Cracks	$	1,715,792.60
Remove Roadway Slab	$	-
Remove Roadway Slab (Exceptions)	$	668,800.00
Remove Existing Concrete prior to Overlay	$	1,999,008.00
Full Depth Slab Replacement prior to Overlay	$	8,995,536.00
Mill Asphalt	$	19,308,256.00
Additional excavation / grading over Alt. #3	$	3,166,610.40
Shoulder Embankment	$	612,044.00
Joint Reinforcement Fabric	$	2,938,541.76
Bituminous Tack Coat	$	490,355.71
Vegetation Removal	$	11,548,000.00
Barrier Wall	$	19,169,680.00
Striping / Signage	$	4,619,200.00
Longitudinal Drainage	$	5,831,740.00
Misc: (Guardrail, Soundwalls, EC, etc)	$	20,209,000.00
TOTAL OTHER & PREPARATORY COSTS	$	154,919,361.20

SUMMARY of INITIAL COSTS

ALTERNATIVE 6

Pavement Type HMA
Pavement Method Full Depth
More Description

ROADWAY PAVEMENT		
ITEM		**ITEM TOTAL COST**
CRC		
PCC	$	-
RCC	$	-
12.5 mm PEM	$	13,078,802.88
12.5 mm SMA	$	18,109,111.68
12.5 mm Superpave	$	5,643,335.77
19 mm Superpave	$	27,722,590.72
19 mm SMA	$	-
25 mm Superpave	$	168,571,237.12
Graded Aggregate Base	$	56,461,405.44
TOTAL ROADWAY PAVEMENT COSTS	$	289,586,483.61

OTHER & PREPARATORY WORK		
ITEM		**ITEM TOTAL COST**
Traffic Control	$	17,322,000.00
Staging	$	-
Roadway Bridges	$	11,876,040.00
Raise Bridge	$	-
New Ramp Construction	$	-
Grading	$	11,952,180.00
Waterproofing Joints & Cracks		
Remove Roadway Slab	$	40,648,960.00
Remove Roadway Slab (Exceptions)	$	-
Remove Existing Concrete prior to Overlay	$	-
Full Depth Slab Replacement prior to Overlay	$	-
Mill Asphalt	$	19,308,256.00
Additional excavation / grading over Alt. #3	$	5,369,820.00
Shoulder Embankment	$	-
Joint Reinforcement Fabric	$	-
Bituminous Tack Coat	$	1,073,132.54
Vegetation Removal	$	11,548,000.00
Barrier Wall	$	19,169,680.00
Striping / Signage	$	4,619,200.00
Longitudinal Drainage	$	5,831,740.00
Misc. (Guardrail, Soundwalls, EC, etc)	$	20,209,000.00
TOTAL OTHER & PREPARATORY COSTS	$	168,928,008.54

LCCA SUMMARY REPORT

Project Number: NH-IM-85-2 (All Units)
P.I. Number: 110620 ~ 110710
Widenig of I-85 / SR 403 from Gwinnett County to South Carolina
Gwinnett, Barrow, Jackson, Banks, Franklin & Hart County, Georgia

I. PROJECT AGENCY COSTS

Values in this section represent Agency Costs only. All values are calculated on per mile per *both* directions basis. Below are the Total Present Value Costs for a 30-year Analysis Period and a 40-year Analysis Period for each alternative. The values represent costs per mile.

Net Present Value / Total Present Value Costs:

Net Present Value (NPV) is the discounted monetary value of Present Value benefits minus Present Value costs ($PV_{benefits} - PV_{costs}$). Because the benefits of keeping the roadway above some pre-established terminal service ability level are the same for all design alternatives, the benefits component of above equation is negated thus the analysis is based solely on the costs.

Below are the Total Present Value Costs for a 30-year Analysis Period and a 40-year Analysis Period for each alternative. The values represent costs per mile.

	30-Year Analysis Period	40-Year Analysis Period
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay - Full Replacement @ Overpass Bridges	$8,608,890	$8,716,259
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	$8,539,696	$8,647,065
ALTERNATIVE 3-CRC Full Depth Mainline	$9,037,523	$9,130,566
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	$9,388,998	$10,512,622
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	$9,792,613	$10,916,238
ALTERNATIVE 6-HMA Full Depth Mainline	$10,668,990	$11,535,013

Annualized Costs:

Annualized Costs represents the Net Present Value (NPV) of all discounted cost and benefits of an alternative as if they were to occur uniformly throughout the analysis period.

Below are the Annualized Costs for a 30-year analysis period and a 40-year analysis period for each alternative. The values represent costs per mile.

	30-Year Analysis Period	40-Year Analysis Period
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay - Full Replacement @ Overpass Bridges	$439,219	$377,086
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	$435,689	$374,093
ALTERNATIVE 3-CRC Full Depth Mainline	$461,088	$395,010
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	$479,020	$454,801
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	$499,612	$472,262
ALTERNATIVE 6-HMA Full Depth Mainline	$544,324	$499,032

Total Agency Costs Calculations:

Total Agency Costs were based on the quantities of materials, labor and time required for Initial Construction and Maintenance.

Below are the Total Agency Costs per alternative per construction event. The costs are shown in both constant and nominal US dollars. The nominal costs are discounted at 3 %. The nominal dollar costs are italicized.

	Year 2006 (Initial Construction)	Year 2014 (Rehabiliation)	Year 2016 (Rehabiliation)	Year 2022 (Rehabiliation)	Year 2026 (Rehabiliation)	Year 2030 (Rehabiliation)
ALTERNATIVE 1- CRC Unbonded	$473,182,300 *$473,182,300*				$54,351,616 *$30,094,490*	
ALTERNATIVE 2- CRC Unbonded	$469,187,016 *$469,187,016*				$54,351,616 *$30,094,490*	
ALTERNATIVE 3- CRC Full Depth	$504,424,108 *$504,424,108*					
ALTERNATIVE 4- HMA HMA Overlay	$352,487,698 *$352,487,698*	$111,004,498 *$87,626,951*		$111,004,498 *$69,178,003*		$111,004,498 *$54,603,113*
ALTERNATIVE 5- HMA HMA Overlay PCC Mainline	$375,792,458 *$375,792,458*	$111,004,498 *$87,626,951*		$111,004,498 *$69,178,003*		$111,004,498 *$54,603,113*
ALTERNATIVE 6- HMA Full Depth Mainline	$458,514,492 *$458,514,492*		$121,369,255 *$90,310,863*		$121,369,255 *$67,202,156*	

Initial Construction Costs:

The initial construction costs and the maintenance costs were determined by grouping calculated item costs appropriately. The GDOT Item Mean Summary for January 1, 2002 through December 01, 2002 and current market prices were the basis for the calculations.

Initial costs were calculated based primarily on pavement designs but other items such as Bituminous Tack Coat and Rumble Strips were also considered. Listed below are the alternatives with their corresponding initial costs. The costs are not discounted because they are based on the most current market prices and are associated with initial construction.

	Cost per mile	Total Cost
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay - Full Replacement @ Overpass Bridges	$8,195,052	$473,182,300
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	$8,125,858	$469,187,016
ALTERNATIVE 3-CRC Full Depth Mainline	$8,736,129	$504,424,108
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	$6,104,740	$352,487,698
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	$6,508,356	$375,792,458
ALTERNATIVE 6-HMA Full Depth Mainline	$7,941,020	$458,514,492

Maintenance Costs:

For Full Depth Reconstruction of CRC pavements, an initial service life of 25 years was used with maintenance assumed to occur in 25 year intervals after its initial service life. For pavements overlaid with CRC, an initial service life of 20 years was used with maintenance assumed to occur in 20 year intervals after its initial service life. For Full Depth Reconstruction of JPC pavements, an initial service life of 20 years was used with maintenance assumed to occur in 20 year intervals after its initial service life. For pavements overlaid with JPC, an initial service life of 16 years was used with maintenance assumed to occur in 16 year intervals after its initial service life. For Full Depth Reconstruction of HMA pavements, an initial service life of 10 years was used with maintenance assumed to occur in 10 year intervals after its initial service life. For pavements overlaid with HMA, an initial service life of 8 years was used with maintenance assumed to occur in 8 year intervals after its initial service life.

Listed below are the net present maintenance costs for a 30-year analysis period and a 40-year analysis period for each alternative. These costs were discounted at the rate of 3 %. The costs are per mile per *both* directions.

	30-Year Analysis Period	40-Year Analysis Period
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay - Full Replacement @ Overpass Bridges	$521,207	$521,207
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	$521,207	$521,207
ALTERNATIVE 3-CRC Full Depth Mainline	$449,573	$449,573
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	$3,661,380	$4,407,882
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	$3,661,380	$4,407,882
ALTERNATIVE 6-HMA Full Depth Mainline	$2,727,971	$3,593,993

Salvage Value:

Salvage Value represents the value of an investment alternative at the end of the analysis period. The two fundamental components associated with Salvage Value are Residual Value and Serviceable Life Value.

Residual Value refers to the net value from recycling the pavement. This component is negligible effect on LCCA results when discounted over a 30-year or 40-year analysis period. Serviceable Life Value refers to the value based on the remaining life in a pavement alternative at the end of the analysis period.

Below are the Salvage Values for a 30-year analysis period and a 40-year analysis period for each alternative. The values are costs per mile and are *not* discounted.

	30-Year Analysis Period	40-Year Analysis Period
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay - Full Replacement @ Overpass Bridges	$260,603	$0
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	$260,603	$0
ALTERNATIVE 3-CRC Full Depth Mainline	$359,658	$179,829
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	$915,345	$0
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	$915,345	$0
ALTERNATIVE 6-HMA Full Depth Mainline	$0	$0

II. PROJECT USER COSTS

User Costs are the delay costs and vehicle operating costs (VOC) incurred by users of a roadway resulting from construction, maintenance or rehabilitation. They are directly related to the traffic demand, roadway capacity and timing of work periods.

Net Present Value / Total Present Value User Costs:

Below are the Total Present Value User Costs for a 30-year Analysis Period and a 40-year Analysis Period for each alternative. These values represent costs per mile.

	30-Year Analysis Period	40-Year Analysis Period
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay - Full Replacement @ Overpass Bridges	$74,573,732	$74,573,732
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	$74,573,732	$74,573,732
ALTERNATIVE 3-CRC Full Depth Mainline	$80,904,277	$80,904,277
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	$121,437,474	$366,589,204
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	$121,437,474	$366,589,204
ALTERNATIVE 6-HMA Full Depth Mainline	$116,824,068	$280,433,771

Annualized User Costs:

Below are the Annualized User Costs for a 30-year analysis period and a 40-year analysis period for each alternative. The values represent costs per mile.

	30-Year Analysis Period	40-Year Analysis Period
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay - Full Replacement @ Overpass Bridges	$3,804,697	$3,226,237
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	$3,804,697	$3,226,237
ALTERNATIVE 3-CRC Full Depth Mainline	$4,127,676	$3,500,111
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	$6,195,650	$15,859,521
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	$6,195,650	$15,859,521
ALTERNATIVE 6-HMA Full Depth Mainline	$5,960,277	$12,132,232

User Cost Components:

There are seven (7) conditions that make up the daily user costs for a particular construction event.

I. DELAY COST (Speed reduced due to Speed Limit *inside* Work Zone)
II. DELAY COST (Speed Change due to Conditions/Speed Limit just prior and just after Work Zone)*
III. VEHICLE OPERATING COST (Speed Change due to Conditions/Speed Limit just prior and just after Work Zone)*
IV. DELAY COST (Stopping due to Queue)
V. VEHICLE OPERATING COST (Stopping due to Queue)
VI. DELAY COST (Idle – Speed reduced due to Queue)
VII. VEHICLE OPERATING COST (Idle – Speed reduced due to Queue)

* *NOTE: User Components II and III occur before and after Work Zone while User Component I occurs inside the physical Work Zone.*

Total User Costs Calculations:

Total User Costs were based on the Daily User Costs which were estimated from analysis of the Annual Average Daily Traffic (AADT). Other factors in determining Total User Costs are Production Rates, Quantities and Project Duration.

Total User Costs were calculated by determining the number of work days it would take to perform a particular construction event. The number of days was determined using Production Rates for the particular pavement type of each alternative. The number of days was then multiplied by the Daily User Costs to get the Total User Cost.

Below are the Total User Costs per alternative per construction event. The costs are shown in both constant and nominal US dollars. The nominal costs are discounted at 3 %. The nominal dollar costs are italicized.

	Year 2006 (Initial Construction)	**Year 2014** (Rehabiliation)	**Year 2016** (Rehabiliation)	**Year 2022** (Rehabiliation)	**Year 2026** (Rehabiliation)	**Year 2030** (Rehabiliation)
ALTERNATIVE 1- CRC Unbonded	$3,235,219,309 ***$3,235,219,309***				$1,933,660,801 ***$1,070,667,986***	
ALTERNATIVE 2- CRC Unbonded	$3,235,219,309 ***$3,235,219,309***				$1,933,660,801 ***$1,070,667,986***	
ALTERNATIVE 3- CRC Full Depth	$3,235,219,309 ***$3,235,219,309***					
ALTERNATIVE 4- HMA HMA Overlay	$2,526,975,265 ***$2,526,975,265***	$1,333,485,133 ***$1,052,653,164***		$2,295,763,171 ***$1,430,719,608***		$4,068,818,277 ***$2,001,451,710***
ALTERNATIVE 5- HMA HMA Overlay	$2,526,975,265 ***$2,526,975,265***	$1,333,485,133 ***$1,052,653,164***		$2,295,763,171 ***$1,430,719,608***		$4,068,818,277 ***$2,001,451,710***
ALTERNATIVE 6- HMA Full Depth	$3,188,332,073 ***$3,188,332,073***		$1,946,241,239 ***$1,448,198,106***		$3,808,725,821 ***$2,108,891,487***	

Daily User Costs Calculations:

Daily User Costs were broken down into seven (7) components. Calculations were computed by using Delay Cost Rates and Vehicle Operating Cost Rates.

Below are the Daily User Costs calculations for anticipated construction years. The Daily User Costs shown below are in constant US dollars.

Year 2006 (Initial Construction)	--------------------	$42,739 per mile
Year 2014 (Rehabiliaion)	--------------------	$224,220 per mile
Year 2016 (Rehabiliation)	--------------------	$259,284 per mile
Year 2022 (Rehabiliation)	--------------------	$386,023 per mile
Year 2026 (Rehabiliation)	--------------------	$507,411 per mile
Year 2030 (Rehabiliation)	--------------------	$684,155 per mile

III. CONSTRUCTION

Production Rates:

Production rates were determined from historical information from various projects within the Georgia Department of Transportation. The average of the production rates from statewide projects were calculated and are as follows. For Concrete, the production rate was determined to be approximately 6,000 square yards per day (250 square yards per hour). This figure was based on an average of 4,000 linear feet of pavement for a 12 foot wide pavement being placed in a day. For Asphalt, the production rate was determined to be approximately 200 tons per hour.

Quantities:

Quantities were calculated using the pavement designs for each alternative. The following table illustrates the amount of Asphalt and Concrete for each alternative.

		Asphalt (tons)	Concrete (square yards)
ALTERNATIVE 1 Unbonded Overlay CRC	**TOTAL**	**670,708**	**4,064,896**
	Travel lanes	*134,142*	*812,979*
	Shoulders (In - Out)	*111,785 156,498*	*677,483 948,476*
	Overlaid Sections	*268,283*	*1,625,958*
ALTERNATIVE 2 Unbonded Overlay CRC	**TOTAL**	**670,708**	**4,064,896**
	Travel lanes	*134,142*	*812,979*
	Shoulders (In - Out)	*111,785 156,498*	*677,483 948,476*
	Overlaid Sections	*268,283*	*1,625,958*
ALTERNATIVE 3 Full Depth CRC	**TOTAL**	**670,708**	**4,064,896**
	Travel lanes	*402,425*	*2,438,938*
	Shoulders (In - Out)	*111,785 156,498*	*677,483 948,476*
	Overlaid Sections		
ALTERNATIVE 4 HMA Overlay PCC HMA	**TOTAL**	**3,065,694**	
	Travel lanes	*793,671*	
	Shoulders (In - Out)	*621,802 867,728*	
	Overlaid Sections	*782,492*	
ALTERNATIVE 5 HMA Overlay PCC HMA	**TOTAL**	**3,065,694**	
	Travel lanes	*793,671*	
	Shoulders (In - Out)	*621,802 867,728*	
	Overlaid Sections	*782,492*	
ALTERNATIVE 6 Full Depth HMA	**TOTAL**	**3,870,543**	
	Travel lanes	*2,381,013*	
	Shoulders (In - Out)	*621,802 867,728*	
	Overlaid Sections		

Project Durations

Initial Construction:

Based upon the calculated quantities and their corresponding production rates, the duration for initial construction was estimated. The following list illustrates the duration of initial construction for each alternative

ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay -Full Replacement @ Overpass Bridges	.... 1311 days
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	.... 1311 days
ALTERNATIVE 3-CRC Full Depth Mainline	.... 1311 days
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	.... 1024 days
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	.... 1024 days
ALTERNATIVE 6-HMA Full Depth Mainline	.... 1292 days

Rehabilitations:

The duration for rehabilitations was based upon the calculated duration for initial construction which was established from the total construction area and production rates. The duration of rehabilitations was also based on the percentage of full depth replacement which was established from total construction area and the pavement types. Therefore, it was assumed that the duration of rehabilitation would minimally take the percentage of full depth replacement times the total duration of initial construction. In essence, the duration for rehabilitations were calculated by doubling the percentage of full depth replacement, in order to take in account for pavement removal and other activities, and then multiplying that percentage by the calculated duration of initial construction.

Rehabilitation events for Asphalt included Full Depth Asphalt Patching, Milling and Overlaying. The duration for asphalt pavements was assumed to be 10% of the duration for its initial construction (5% Full Depth Asphalt Patching + 5% for Milling and Overlaying).

Rehabilitation events for JPC pavements included Full Depth Slab Replacement, Grinding, and Resealing Joints and Cracks. The duration for JPC pavements was assumed to be 10% of the duration for its initial construction (5% for the Full Depth Slab Replacement + 5% for the Grinding, Resealing and Removal)

Rehabilitation events for CRC pavements included Punchout Repair and Grinding. The duration for CRC pavements was assumed to be 5% of the duration for its initial construction (2.5% for Punchout Repair + 2.5 % for Grinding and Removal).

The following list illustrates the duration of rehabilitations for each alternative.

ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay -Full Replacement @ Overpass Bridges	.... 66 days
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay - Raise Bridges	.... 66 days
ALTERNATIVE 3-CRC Full Depth Mainline	.... 66 days
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	.... 103 days
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	.... 103 days
ALTERNATIVE 6-HMA Full Depth Mainline	.... 130 days

AADT Calculations:

Annual Average Daily Traffic (AADT) calculations for anticipated construction years are as follows:

Year 2006 (Initial Construction)	--------------------	68,500
Year 2014 (Rehabiliation)	--------------------	84,127
Year 2016 (Rehabiliation)	--------------------	88,562
Year 2022 (Rehabiliation)	--------------------	103,320
Year 2026 (Rehabiliation)	--------------------	114,500
Year 2030 (Rehabiliation)	--------------------	126,890

Calculations for AADT and Daily User Costs were based on the following assumptions.

- Traffic Growth Rate
  - 2.60% for Passenger Cars
  - 2.60% for Single-Unit and Multi-Unit Trucks
- 24 hour Truck Percentages were broken down into
  - 20 % of 24 hour Truck Percentage as Multi-Unit Trucks
  - 10 % of 24 hour Truck Percentage as Single-Unit Trucks
- MicroBENCOST Default Directional Hourly Distribution for Rural roadways used for traffic analysis
- Speed Limit ...70 mph (normal), 55 mph (work zone)
- Queue Dissipation Rate – 1,818 vplph
- Length of work zone is two (2) miles.
- Work Period is 15 hours per day.

IV. PAVEMENT SELECTION

Pavement Selection is a process of analyzing pavement alternatives and of determining the Pavement Alternative which best addresses the requirements of a roadway construction project. Many factors are to be considered in the Pavement Selection process. These factors are called *Decision Factors*. While any pavement alternative may be an acceptable solution to the roadway construction project, the Pavement Selection process provides validity to the selection of a particular pavement alternative.

Decision Matrix:

As an aid to the pavement selection process, the *Decision Matrix* was adapted by the Pavement Management Branch. The *Decision Matrix* is based upon the aforementioned Decision Factors.

Each Decision Factor is given a weight based upon its relative importance to the project. This weight is called *Decision Worth*. For every Pavement Alternative, a division is created per Decision Factor called the *Matrix Element*. The Matrix Element can be viewed as a Pavement Alternative per Decision Factor. Each Matrix Element is given a value called the *Element Value*. The Element Value is based on LCCA calculations or the experiences of OMR. From the Element Value, a ratio is calculated called the *Spread Factor*. The *Element Score* is then calculated. The Element Score is the product of the Decision Worth and the Spread Factor. The *Total Score* for an alternative is the sum of its Element Scores.

Below are the Total Scores and Rankings from the Decision Matrix. The scores were determined for the LCCA with 40-year Analysis Period.

	RANK	TOTAL SCORE
ALTERNATIVE 3-CRC Full Depth Mainline	1	83.5
ALTERNATIVE 2-CRC Unbonded Overlay Mainline Overlay Raise Bridges	2	78.8
ALTERNATIVE 1-CRC Unbonded Overlay Mainline Overlay Full Replacement @ Overpass Bridges	3	78.5
ALTERNATIVE 4-HMA HMA Overlay PCC Mainline Overlay - Full Replacement @ Overpass Bridges	4	64.0
ALTERNATIVE 5-HMA HMA Overlay PCC Mainline Overlay - Raise Bridges	5	60.7
ALTERNATIVE 6-HMA Full Depth Mainline	6	55.0

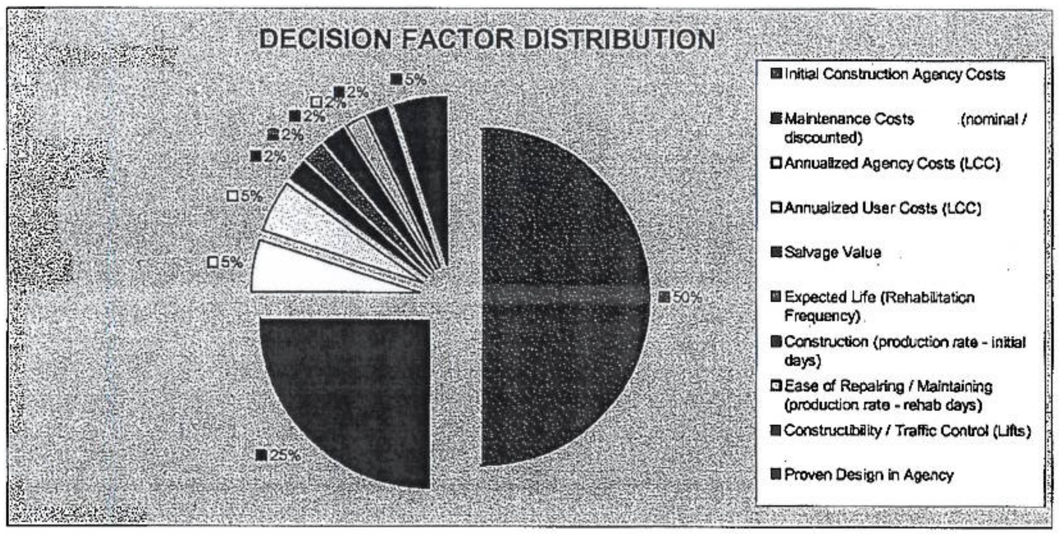
Decision Factors:

Decision Factors play an important role in the Pavement Selection process. They may have varying importance depending on a specific project.

Below are the Decision Factors and their relative importance in this project.

Decision Factors	Relative Importance
Initial Construction Agency Costs	50%
Maintenance Costs (nominal / discounted)	25%
Annualized Agency Costs (LCC)	5%
Annualized User Costs (LCC)	5%
Salvage Value	2%
Expected Life (Rehabilitation Frequency)	2%
Construction (production rate - initial days)	2%
Ease of Repairing / Maintaining (production rate - rehab days)	2%
Constructibility / Traffic Control (Lifts)	2%
Proven Design in Agency	5%

*The Decision Factor, Proven Design in Agency, is not calculated from the general LCCA computations. Rather, it is calculated from the experiences and observations of OMR for the pavement type associated with the particular pavement alternative. Those experiences take into account the past performance of the pavement type, the frequency of use of the pavement type, and the functional class of the roadway to the pavement type.



Element Values:

The values of each Pavement Alternative per Decision Factor are determined based upon calculations from the LCCA. The exception is the value of the Decision Factor for Proven Design in Agency. The value for Proven Design in Agency is more subjective. It is determined by the experiences and observations of OMR with the pavement type associated with the pavement alternative. These values per Pavement Alternative per Decision Factor are called *Element Values*.

Below are the *Element Values* used in the Decision Matrix. These *Element Values* represent the 40-year Analysis Period LCCA

	Initial Construction Agency Costs	Maintenance Costs (nominal / discounted)	Annualized Agency Costs (LCC)	Annualized User Costs (LCC)	Salvage Value
Unbonded Overlay Mainline Overlay -Full	8,195,052	521,207	377,086	3,226,237	0
Unbonded Overlay Mainline Overlay - Raise	8,125,858	521,207	374,093	3,226,237	0
ALTERNATIVE 3-CRC Full Depth Mainline	8,736,129	449,573	395,010	3,500,111	179,829
HMA Overlay PCC Mainline Overlay - Full	6,104,740	4,407,882	454,801	15,859,521	0
HMA Overlay PCC Mainline Overlay - Raise	6,508,356	4,407,882	472,262	15,859,521	0
ALTERNATIVE 6-HMA Full Depth Mainline	7,941,020	3,593,993	499,032	12,132,232	0

	Expected Life (Rehabilitation Frequency)	Construction (production rate - initial days)	Maintaining (production rate - rehab days)	Constructibility / Traffic Control (Lifts)	Proven Design in Agency
Unbonded Overlay Mainline Overlay -Full	20	1,311	66	10	269
Unbonded Overlay Mainline Overlay - Raise	20	1,311	66	10	266
ALTERNATIVE 3-CRC Full Depth Mainline	25	1,311	66	12	533
HMA Overlay PCC Mainline Overlay - Full	8	1,024	412	25	269
HMA Overlay PCC Mainline Overlay - Raise	8	1,024	412	25	266
ALTERNATIVE 6-HMA Full Depth Mainline	10	1,292	390	30	533

The Spread Factor:

The *Spread Factor* is a ratio that measures distributional differences in Element Values. The *Spread Factor* ranges from 0.00 to 1.00. The *Spread Factor* is based on the optimum value for each Decision Factor.
The optimum value can be either the minimum or maximum value depending on the Decision Factor. As an example, for a Decision Factor illustrating cost, the optimum value of the Decision Factor will be the minimum cost value. Furthermore, for a Decision Factor illustrating pavement life, the optimum value of the Decision Factor will be the maximum life value.

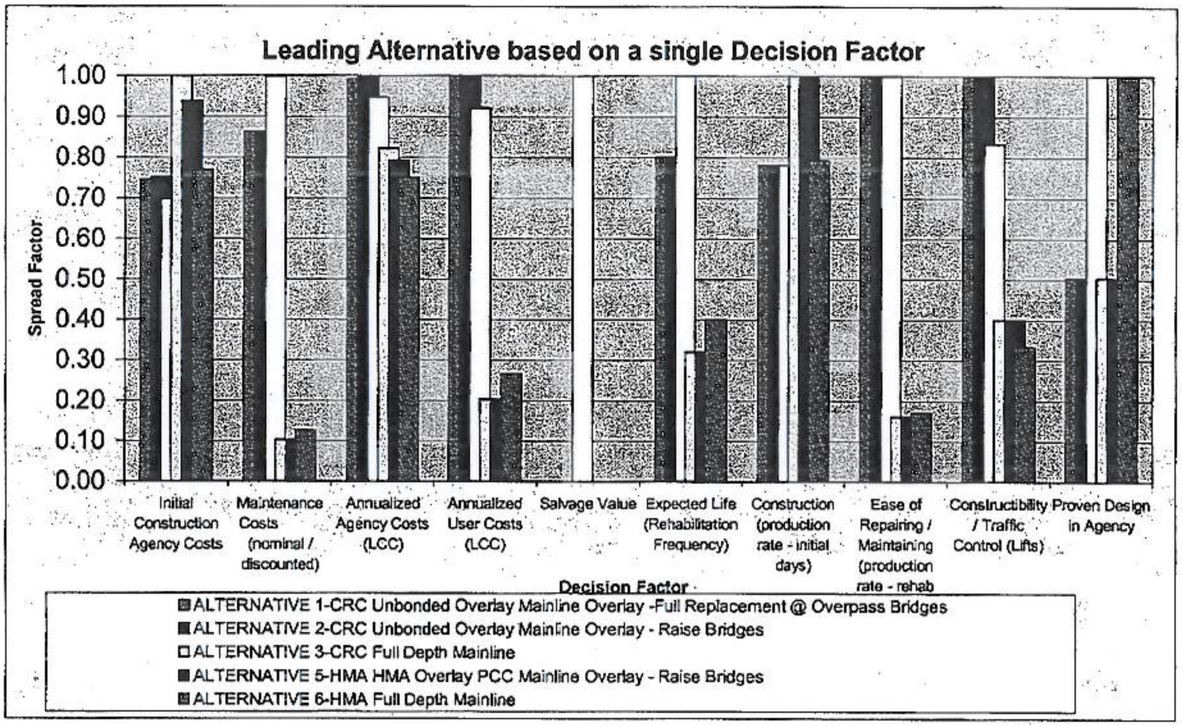
The *Spread Factor* for each Element Value is calculated as a ratio. This ratio is based upon the optimum value per Decision Factor. Thus, the pavement alternative with the optimum value will have the *Spread Factor* of 1.00. All other pavement alternatives will have a *Spread Factor* which will be proportioned based on its particular value to the optimum value and will be lower than 1.00.

Below are the *Spread Factors* used in the Decision Matrix. These *Spread Factors* are based on calculations from the 40-year Analysis Period LCCA.

	Initial Construction Agency Costs	Maintenance Costs (nominal / discounted)	Annualized Agency Costs (ECC)	Annualized User Costs (ECC)	Salvage Value
ALTERNATIVE 1-CRC Unbonded Overlay	0.74	0.86	0.99	1.00	0.00
ALTERNATIVE 2-CRC Unbonded Overlay	0.75	0.86	1.00	1.00	0.00
ALTERNATIVE 3-CRC Full Depth Mainline	0.70	1.00	0.95	0.92	1.00
ALTERNATIVE 4-HMA HMA Overlay PCC	1.00	0.10	0.82	0.20	0.00
ALTERNATIVE 5-HMA HMA Overlay PCC	0.94	0.10	0.79	0.20	0.00
ALTERNATIVE 6-HMA Full Depth Mainline	0.77	0.13	0.75	0.27	0.00

	Expected Life (Rehabilitation Frequency)	Construction (production rate - initial days)	Ease of Repairing / Maintaining (production rate - rehab days)	Constructibility / Traffic Control (Lifts)	Proven Design in Agency
Unbonded Overlay Mainline Overlay -Full	0.80	0.78	1.00	1.00	0.50
Unbonded Overlay Mainline Overlay - Raise	0.80	0.78	1.00	1.00	0.50
ALTERNATIVE 3-CRC Full Depth Mainline	1.00	0.78	1.00	0.83	1.00
HMA Overlay PCC Mainline Overlay - Full	0.32	1.00	0.16	0.40	0.50
ALTERNATIVE 5-HMA HMA Overlay PCC	0.32	1.00	0.16	0.40	0.50
ALTERNATIVE 6-HMA Full Depth Mainline	0.40	0.79	0.17	0.33	1.00

The figure below represents a graphical representation of the advantages / disadvantages that each alternative has over each other per decision factor.



Element Score:

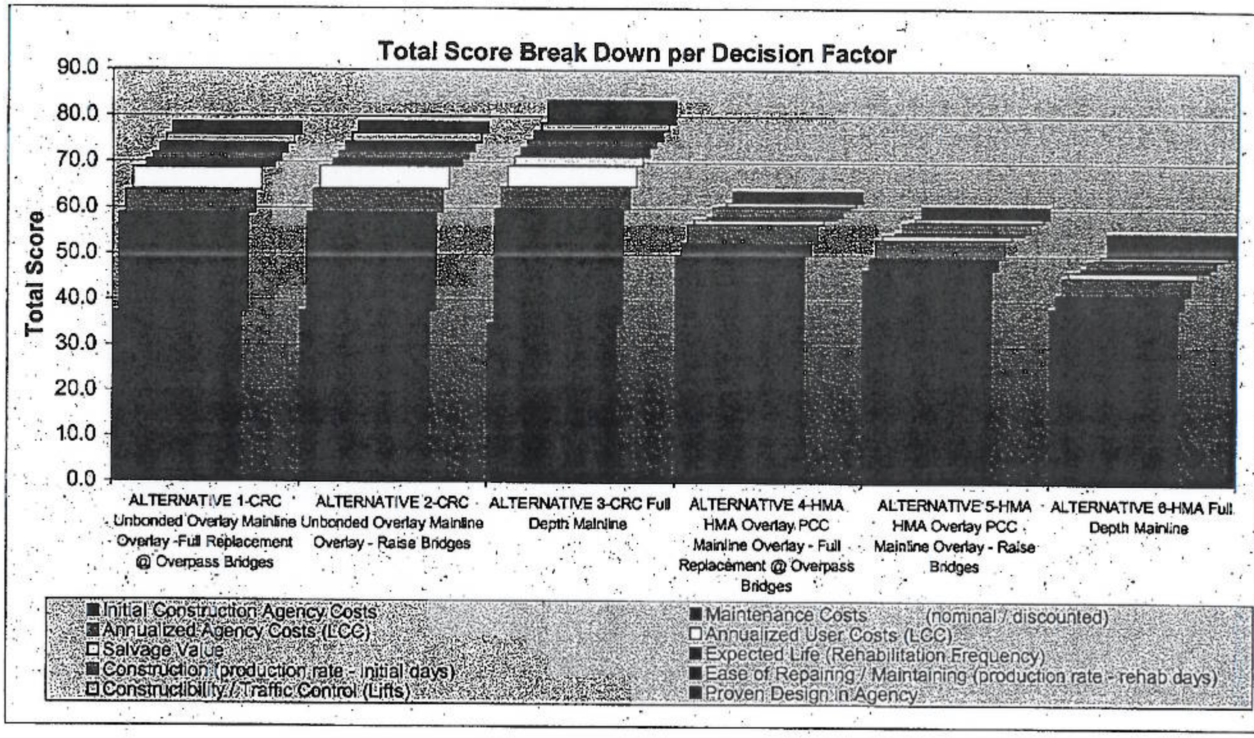
Element Score is the product of Decision Worth and the Spread Factor.

Below are the *Element Scores* used in the Decision Matrix. These *Element Scores* are based on calculations from the 40-year Analysis Period LCCA.

	Initial Construction Agency Costs	Maintenance Costs (nominal / discounted)	Annualized Agency Costs (LCC)	Annualized User Costs (LCC)	Salvage Value
Unbonded Overlay Mainline Overlay -Full	37.2	21.6	5.0	5.0	0.0
Unbonded Overlay Mainline Overlay - Raise	37.6	21.6	5.0	5.0	0.0
ALTERNATIVE 3-CRC Full Depth Mainline	34.9	25.0	4.7	4.6	2.0
HMA Overlay PCC Mainline Overlay - Full	50.0	2.5	4.1	1.0	0.0
HMA Overlay PCC Mainline Overlay - Raise	46.9	2.5	4.0	1.0	0.0
ALTERNATIVE 6-HMA Full Depth Mainline	38.4	3.1	3.7	1.3	0.0

	Expected Life (Rehabilitation Frequency)	Construction (production rate - initial days)	Ease of Repairing / Maintaining (production rate - rehab days)	Constructibility / Traffic Control (Lifts)	Proven Design in Agency
ALTERNATIVE 1-CRC Unbonded Overlay	1.6	1.6	2.0	2.0	2.5
ALTERNATIVE 2-CRC Unbonded Overlay	1.6	1.6	2.0	2.0	2.5
ALTERNATIVE 3-CRC Full Depth Mainline	2.0	1.6	2.0	1.7	5.0
ALTERNATIVE 4-HMA HMA Overlay	0.6	2.0	0.3	0.8	2.5
ALTERNATIVE 5-HMA HMA Overlay	0.6	2.0	0.3	0.8	2.5
ALTERNATIVE 6-HMA Full Depth	0.8	1.6	0.3	0.7	5.0

The figure below represents a graphical representation of the total score of each alternative. Furthermore, the figure illustrates the contribution of each decision factor to the total score of each alternative.



V. APPENDICES

APPENDIX A: Pavement Designs - Travel Lanes:

Pavement Designs were created for each alternative analyzed for life cycle costs. Below is each alternative with their corresponding pavement design for the travel lanes.

	FULL DEPTH SECTIONS	OVERLAID SECTIONS
ALTERNATIVE 1 **Unbonded Overlay** **CRC** 12 feet - Full Depth width 24 feet - Overlaid width	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---	12 inches --- CRC 3 inches --- 19 mm Superpave --- ---
ALTERNATIVE 2 **Unbonded Overlay** **CRC** 12 feet - Full Depth width 24 feet - Overlaid width	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---	12 inches --- CRC 3 inches --- 19 mm Superpave --- ---
ALTERNATIVE 3 **Full Depth CRC** 36 feet - Full Depth width	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---	--- --- --- ---
ALTERNATIVE 4 **HMA Overlay PCC** **HMA** 12 feet - Full Depth width 24 feet - Overlaid width	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm SMA 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm SMA 6 inches --- 19 mm Superpave 0 inches --- 25 mm Superpave
ALTERNATIVE 5 **HMA Overlay PCC** **HMA** 12 feet - Full Depth width 24 feet - Overlaid width	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm SMA 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm SMA 6 inches --- 19 mm Superpave 0 inches --- 25 mm Superpave
ALTERNATIVE 6 **Full Depth HMA** 36 feet - Full Depth width	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm SMA 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base	--- --- --- ---
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APPENDIX B: Pavement Designs - Shoulders:

Pavement Designs were created for each alternative analyzed for life cycle costs. Below is each alternative with their corresponding pavement design for the inside and outside shoulders.

	INSIDE SHOULDERS	OUTSIDE SHOULDERS
ALTERNATIVE 1 **Unbonded Overlay CRC** 10 feet - In. Shoulder width 14 feet - Out. Shoulder width	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---
ALTERNATIVE 2 **Unbonded Overlay CRC** 10 feet - In. Shoulder width 14 feet - Out. Shoulder width	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---
ALTERNATIVE 3 **Full Depth CRC** 10 feet - In. Shoulder width 14 feet - Out. Shoulder width	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---	12 inches --- CRC 3 inches --- 19 mm Superpave 12 inches --- Graded Aggregate Base --- ---
ALTERNATIVE 4 **HMA Overlay PCC HMA** 10 feet - In. Shoulder width 14 feet - Out. Shoulder width	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm Superpave 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm Superpave 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base
ALTERNATIVE 5 **HMA Overlay PCC HMA** 10 feet - In. Shoulder width 14 feet - Out. Shoulder width	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm Superpave 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm Superpave 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base
ALTERNATIVE 6 **Full Depth HMA** 10 feet - In. Shoulder width 14 feet - Out. Shoulder width	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm Superpave 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base	1.25 inches --- 12.5 mm PEM 1.5 inches --- 12.5 mm Superpave 2 inches --- 19 mm Superpave 13 inches --- 25 mm Superpave 12 inches --- Graded Aggregate Base
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