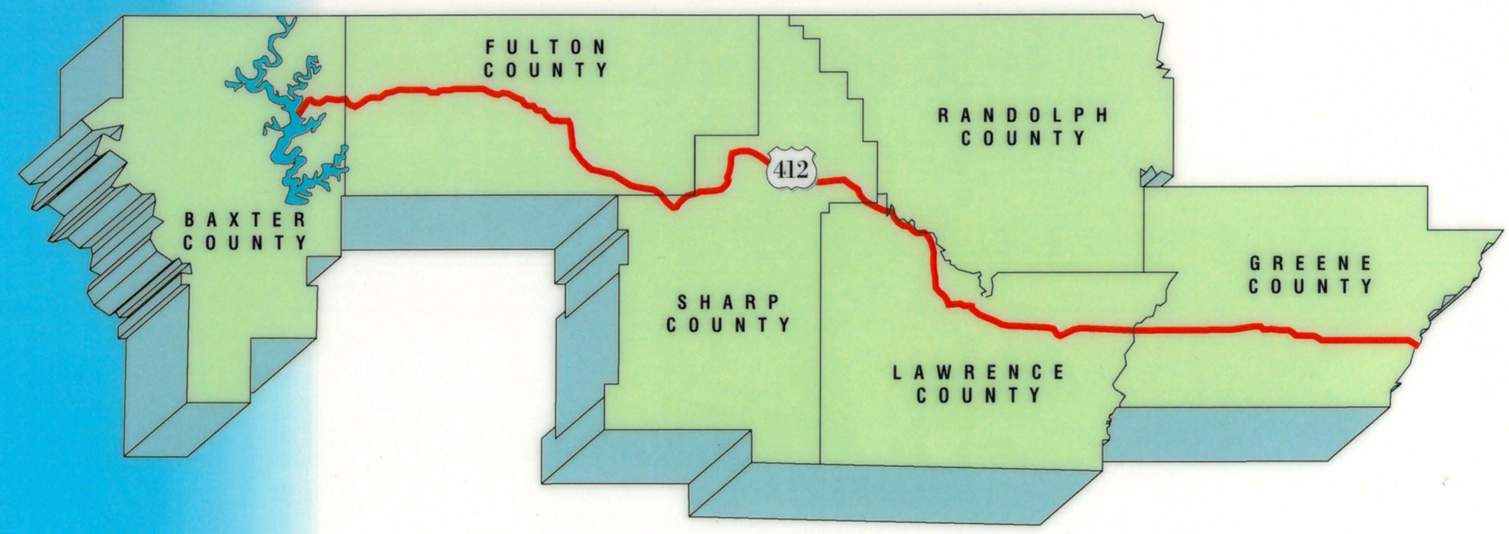
US 412
Corridor Planning Study

412

Final Report
December 1997



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ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

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10. ABSTRACT

The US 412 Corridor is the main east-west corridor in northern Arkansas. It was designated as a "High Priority Corridor" by Congress in the 1991 ISTEA Legislation from Tulsa, Oklahoma to Nashville, Tennessee through northern Arkansas. This study covers the eastern half of US 412 in the State of Arkansas. Travel demands in the corridor have exceeded available capacity at selected locations. The resulting congestion is inhibiting the safe and efficient movement of goods and people through northern Arkansas.

Five Proposed Alternatives were defined, analyzed and evaluated in detail. These are:
*1) **Base Case** -* Is the alternative against which the other alternatives were compared. It includes the existing facility plus all committed improvements and a continued maintenance program.
*2) **Improved Two-Lane Rural Arterial** -* Consists of localized improvements to the existing two-lane, two-way section.
*3) **Multi-Lane Rural Undivided Highway** -* Proposes to widen the existing roadway to a four-lane undivided section with unlimited access.
*4) **Four-Lane Divided Rural Highway** -* This Proposed Alternative would convert the existing two-lane, two-way roadway to a one-way roadway and build a parallel two-lane, one-way road with unlimited access.
*5) **Four-Lane Freeway** -* Consists of a full access controlled, grade separated freeway to Interstate Standards.

A comprehensive alternative analysis was performed evaluating the four project goals: ***improve mobility, project constructability, environment preservation*** and ***economic development***. All of the Proposed Alternatives were found feasible from the perspective of benefit/cost ratio. However, the improved two-lane rural arterial alternative fails to meet the minimum level-of-service criteria. The four-lane divided rural highway yields the highest "balanced" ratings on all the project goals, and is a good investment of public funds. Therefore, the Engineer recommends that AHTD implement this alternative when funds become available.

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F Glossary of Terms

Chapter 1

PURPOSE AND NEED

1.1 BACKGROUND

As early as 1974, the multi-state "Highway Corridor Study, Brunswick, Georgia to Kansas City, Missouri" under the direction of the Tennessee Department of Transportation identified the need for a major east/west freeway connection in northern Arkansas.

In 1988, the Northwest Arkansas Economic Development District, Inc., in cooperation with the Arkansas State Highway and Transportation Department (AHTD) conducted the "US 412 North Arkansas East/West Corridor Transportation Study." As a preferred design alternative, they concluded on the need to develop a continuously designated four-lane undivided, unlimited access highway along northern Arkansas with the intent of connecting Tulsa, Oklahoma with Nashville, Tennessee.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) provided funding for states to conduct feasibility studies for highway improvements along high priority corridors on the National Highway System. Section 1105 of ISTEA contained specific provisions for such studies for the east-west Transamerica corridor [§ 1105 (c)(3)], which includes the geographic area of northern Arkansas and the Mountain Home to Paragould area. The US 412 east-west Corridor from Tulsa, Oklahoma, through Arkansas to Nashville, Tennessee, is similarly defined in the legislation [§ 1105 (c)(8)] as a high priority corridor.

To accomplish the intent of the ISTEA legislation, AHTD has engaged the engineering firm, Lockwood, Andrews & Newnam, Inc. (LAN) to perform a planning study for a 216 km (134-mile) corridor on US 412 (US62/US63/US412) from Norfork Lake (east of Mountain Home) to the Missouri state line (east of Paragould).

1.2 PROJECT ISSUES

US 412 exists mostly as a two-lane facility between Lake Norfork and the Missouri state line. For most portions of the route, US 412 has a joint designation with US 62 or US 63. The eastern limit of the planning study at the Missouri state line will be coordinated with a companion study being proposed by the Missouri Department of Transportation. The existing terrain from Paragould to the Missouri border is level. The Crowley's Ridge range crosses the route west of Paragould, with the transition from the ridge to flat land occurring in Paragould. Within the City of Paragould, the existing route is primarily a four-lane curb and gutter roadway with major commercial development throughout the city. Any major improvements to improve capacity of the roadway in Paragould would require significant Right-of-Way (ROW) acquisition and relocation of commercial development. Thus, the most feasible alternative in this area might be a bypass to divert the through traffic around the city. Currently, a study is being done by AHTD to analyze this alternative.

Approximately 13 km (8 miles) west of Paragould, the route departs the Crowley's Ridge and returns to a river delta terrain. This terrain continues for the next 40.2 km (25 miles) to the Black River, between Black Rock and Portia.

The major features of the route between Paragould and Portia are the crossing of the Cache River, the intersection with US 67 at Walnut Ridge and the intersection of US 63 and US 412 near Portia. A new bridge crossing the Cache River has recently been completed, with a four-lane roadway section existing on the new bridge. At Walnut Ridge-Hoxie, a bypass is partially under construction. Widening of the roadway between Portia and Paragould, except the Walnut Ridge bypass, appears to be a feasible option, given the straight alignment and level terrain. The property adjacent to the roadway is primarily agricultural, thus ROW acquisition should be simplified.

The intersection of US 412/63 near Portia is problematic, as the intersection is also adjacent to a railroad track, which US 412 presently crosses at-grade. At the small community of Portia, alternatives for widening the roadway at the existing location as compared to a bypass will be studied.

As US 412 leaves Portia heading west, it crosses the Black River on a bridge that is approximately three-fourths of a mile in length. The bridge is constructed on a steel deck truss (truss below roadway) main span and steel girder approach spans. Widening of the roadway at this location would likely require a parallel structure.

After crossing the Black River the route passes on the south side of the village of Black Rock. As previously noted, the level terrain abruptly changes to rolling at the Black River. Widening the roadway through the town may be feasible as additional ROW acquisition appears possible, and most of the development in Black Rock is to the north of the existing roadway. However, the marginal condition of the existing bridge structure over the Black River, as well as the congestion related to the close proximity of the Black Rock and Portia communities, may make a bypass around both communities a viable option.

At the community of Imboden, US 62 and US 412 merge to form a common corridor to Mountain Home. Due to existing development in Imboden, a bypass to the south appears to be a practical alternative, if justified. The Spring River runs parallel to US 412 at Imboden and is located on the north side of town, thus making a bypass alignment to the north appear impractical. From Imboden to Hardy, the route of US 412 generally runs parallel to Spring River and the Burlington Northern Railroad and passes through Ravenden and near the Ozark Acres development. At Hardy, US 63 departs the corridor and goes north to Missouri. A large volume of truck traffic is observed on the portion of US 412 through Hardy east to Jonesboro and southwest to Ash Flat. The truck route out of southern Missouri through Hardy combined with the existing narrow ROW through downtown Hardy, makes a bypass an alternative to study, however terrain and development around Hardy will complicate any alternative. A major crossing of the Spring River at Hardy will also require special study. Also, a curve with a design speed of 48 km/h (30 mph) east of Hardy will require studies to determine if improvement is practical.

From Hardy to Ash Flat, approximately 16 km (10 miles) of US 412 has recently been widened to four lanes, few sections with curb and gutter and others with shoulders. This section along the route is mostly lined with commercial development, as the large Cherokee Village retirement community exists to the west of the route.

Just north of Ash Flat, a major intersection of US 412/62 and US 167 occurs. The intersection is controlled by stop signs for the US 412/62 eastbound approach. The traffic volumes and intersection configuration will require an analysis of this location for a potential interchange configuration.

From Ash Flat to Mountain Home the route passes through mountainous terrain with numerous reverse curves with a design speed of 72 km/h (45 mph). Widening of portions of the roadway in this area will be difficult due to the terrain. In addition, two small towns, Salem and Viola are present. These towns will be analyzed for widening and bypass possibilities.

About 15.3 km (9.5 miles) northeast of Mountain Home, US 412 crosses Norfork Lake (at the western project limit). The existing 13.4 m (44 ft.) wide bridge, constructed in the late 1980's, accomodates two lanes with shoulders on both sides.

1.3 OBJECTIVE

The main objective of this study is to identify alternatives and recommend a preferred alternative for improving US 412, including feasible interim improvements. This objective will be accomplished through the following study elements:

Public Involvement - The public involvement will be conducted in order to adequately identify public concerns and issues.

Economic Justification - The economic justification will be based on two general components: a) An analysis of benefits and costs of the proposed alternatives over the lifetime of the facilities; and b) Non-monetary considerations such as the improvement of access to important educational, medical, industrial, or recreation facilities.

Environmental and Social Considerations - A preliminary review will be conducted to determine the degree of preference of an alternative from an environmental and social perspective.

1.4 REVIEW OF PREVIOUS STUDIES

The study team performed an in-depth review of a number of previous transportation and planning studies which either included the entire US 412 study corridor, or selected portions of it. The studies included regional, corridor, bypass, and economic studies. Table 1-1 summarizes the previous study documents reviewed (listed in chronological order).

The following sections will summarize the improvement options previously identified and recommended in the listed studies.

A Corridor Study; US 62 Harrison to Hardy, AHTD Planning Division, August, 1981: This study included the section of US 412 from Norfork Lake to Hardy, representing approximately 86.6 km (53.8 miles), or about 40% of the study corridor. The study focused mainly on the section of US 62 west of Norfork lake. Included in the study were proposed bypass routes at Flippin and Cotter. The proposed Mountain Home bypass is also referenced. From Norfork Lake to Hardy, the report cites construction of eight-foot shoulders (completed Fall '81). The report forecasts that US 62 east of Salem and west of Ash flat will reach capacity by 1990, and that volumes in Salem and on the section of US 62 between Ash Flat and SH 175 (east leg) will reach capacity by the year 2000. Table 1-2 summarizes the recommended improvements and their current status.

Table 1-1: PREVIOUS STUDIES REVIEWED

Title of Study	Type of Study	Date
1. A Corridor Study; US 62 Harrison to Hardy	Corridor	81-Aug
2. Economic Study of the Arkansas Counties along the Northeast US 67 Corridor	Economics	85-April
3. US 67 Intermediate Improvement Needs; Walnut Ridge-Hoxie	Site Specific	87-Aug
4. North Arkansas East/West Corridor Study	Corridor	88-April
5. Northeast AR Arterial Highway Study; US 67	Corridor	88-Sept
6. Walnut Ridge/Hoxie Bypass Study	Site Specific	91-April
7. US 63 Corridor Study; Jonesboro to Mammoth Spring	Corridor	91-Sept
8. Impacts/benefits of improving the Regional Highway System in the Arkansas Delta Region	Regional	93-Jan
9. Final EIS: Newport - Highway 63, US Highway 67	Corridor	94-March
10. White River Overall Economic Development Program; FY 1996 Report	Regional	96-Jun

Table 1-2: RECOMMENDED IMPROVEMENTS FROM "A CORRIDOR STUDY; US 62 HARRISON TO HARDY" STUDY

Recommendation	1997 Status
1. Norfork Lake to Hardy: Construct climbing lanes at 8 locations	Complete
2. West of Hardy to Hardy City Limit: Widen roadway and straighten curves	Complete
3. Sections of US 62 east of Salem and west of Ash Flat: Consideration needed by 1990	Misc. improv.
4. Between Ash Flat and the east leg of SH 175 near Hardy: Consideration needed by 2000	Four-lane undiv. completed in 1996

Economic Study of the Arkansas Counties along the Northeast US 67 Corridor, AHTD Planning Division, Finance & Economics Section, April, 1985: This study presented socioeconomic data from seven counties along US 67 in northeast Arkansas. The counties included Greene and Lawrence counties, both of which contain the US 412 corridor, as well as several counties adjacent to the corridor. No discussion of transportation facility improvements was undertaken in this study.

US 67 Intermediate Improvement Needs; Walnut Ridge-Hoxie, AHTD Planning Division, August 1987: This study presented an operational analysis of US 67 through Walnut Ridge and Hoxie. The study acknowledged a bypass of Walnut Ridge/Hoxie as the preferred long-term solution, but recommended several "interim" measures to improve operations until the bypass is implemented as shown in Table 1-3.

Table 1-3: RECOMMENDED IMPROVEMENTS FROM "US 67 INTERMEDIATE IMPROVEMENT NEEDS; WALNUT RIDGE-HOXIE" STUDY

Recommendation	1997 Status
1. Widen US 67 between US 63 and US 412 to provide continuous two-way left turn lane	No Action
2. Repair and retime two traffic signals: US 412 at US 67, and US 412 just west of US 67	No Action

North Arkansas East/West Corridor Study, Northwest Economic Development District, Northwest Arkansas Regional Planning Commission, White River Planning and Development District and East Arkansas Planning and Development District; February, 1987; amended April 1988: This study reviewed options for a high type east-west corridor through north Arkansas to ultimately provide a continuous facility from Tulsa, Oklahoma to Nashville, Tennessee. The 22-county study area included fourteen "hill" counties and eight "delta" counties. A total of nine route alternatives were analyzed, with the presently designated US 412 route selected as the preferred route. The study recommended a four-lane undivided, unlimited access roadway along the 468 km (291 mile) route. The cost was estimated to range between $320 to $495 million (1987 dollars). Also 31 interim improvements were identified. These improvements were estimated to cost $99.4 million.

As stated in the executive summary of the report, the route ". . . could become a major alternative route for east/west travel if improvements are made which reduce congestion, increase passing opportunities, increase passing opportunities and improve roadway & shoulder conditions." The study included an origin/destination survey conducted in the summer of 1986. That study confirmed that virtually no interstate travel across north Arkansas from border to border used the available US highway facilities within the study area. The study concluded that travelers used I-40 to travel across the state. Though it was four miles longer than the US 412 route, the travel time was 18% faster.

The general conclusions and recommendations of the study are summarized as follows (see Table 1-4):

- Designate the preferred route with a common numbering system - "US 412"
- Improvements which will enhance flow of traffic through all terrain conditions across the study area
- Construction of facilities which will lessen traffic congestion within the communities located in the study area

Table 1-4: RECOMMENDED IMPROVEMENTS FROM "NORTH ARKANSAS EAST/WEST CORRIDOR STUDY"

County	Route	Limits	Priority
Greene	68	Paragould: Major widening by the addition of two lanes	High
Sharp	62	Ash Flat to Hardy: Major widening, addition of turn lanes	High
Sharp	62/63	Hardy Bypass	Medium
Lawrence	412	Walnut Ridge: Major widening by the addition of two lanes	Medium
Sharp	62/63	Hardy to Lawrence County: Shoulder width, resurface, and climbing lanes	Medium
Greene	412	Lawrence Co. to Paragould: Resurface, selected shoulder improvements, passing lanes	Medium
Fulton	62	Baxter County to Salem: Passing lanes	Medium
Lawrence	412	Walnut Ridge to Greene County: Resurfacing and selected shoulder width	Medium

Northeast AR Arterial Highway Study; US 67, AHTD Planning Division in cooperation with Federal Highway Administration (FHWA), September, 1988: This study focused on the US 67 corridor in a seven-county study area in northeast Arkansas. While the study area included Greene and Lawrence counties, both of which include the US 412 corridor, the report made no recommendations for improvements to US 412. Instead, the study focused on identifying four alternative alignments for a freeway facility between Newport and Walnut Ridge.

Walnut Ridge/Hoxie Bypass Study, AHTD Planning Division in cooperation with FHWA, April 1991: This study investigated the feasibility of constructing a bypass around the towns of Walnut Ridge and Hoxie in Lawrence County. The study included an origin-destination survey done in the summer of 1990, a travel time survey done in 1990 and a review of accident history. A total of four alternatives were identified. The selected alternative is shown schematically in dashed lines in Appendix A, Corridor Layout Sheet 08. The recommended section for this alternative was a four-lane divided highway with full control of access from US 412/63 (west of Hoxie) to US 67 (north of Hoxie). The total length is 19.2 km (11.91 miles). The study recommended a phased approach, with a two-lane facility to be constructed initially at an estimated cost of $18.5 million. The cost for the ultimate four-lane divided section was estimated at $31.4 million. All components of the bypass are included on the current AHTD Highway Improvement Program ("HIP"). The south bypass section connecting US 412/63 west of Hoxie to US 63 east of Hoxie (AHTD Jobs R00102 and R00103) is currently under construction. In addition, the section connecting Highway 34 and US 67 north of Hoxie (Job R00107 let in 4/97) is under construction. The US 412 to US 63 connection, west of Hoxie (Jobs R00105 and R00106), is programmed. The final component is the US 67/63 interchange southeast of Hoxie (Job R00104).

US 63 Corridor Study; Jonesboro to Mammoth Spring, AHTD Planning Division, September 1991: This study evaluated existing roadway conditions along US 63 from Mammoth Springs to Jonesboro, including the 76.7 km (47.67 miles) section along the US 412 study corridor from Hardy to Hoxie, and recommended both long-term and interim improvements. The recommendations are outlined in Table 1-5.

Table 1-5: RECOMMENDED IMPROVEMENTS FROM "US 63 CORRIDOR STUDY; JONESBORO TO MAMMOTH SPRING"

Recommended Improvements	Est. Cost	Priority
Long Term		
1. Widen US 412/63 to a four-lane divided section; Hardy to Hoxie		
• Hardy to Imboden - 32 km (19.88 miles)	$21.9	Low
• Imboden to Black Rock - 12.75 km (7.92 miles)	$8.7	Med.
• Black Rock to Hoxie - 12.73 km (7.91 miles)	$5.9	Med.
2. Hardy Bypass (to north); new location, 3.6 m (12 ft.) lanes/2.4 m (8 ft.) shoulders, intersections at grade	$4.2	Med.
Interim		
3. Shoulder improvements to 2.4 m (8 ft.) width: at Portia, Black Rock to Hardy	not listed	not listed

Impacts/Benefits of improving the Regional Highway System in the Arkansas Delta Region, AHTD Planning Division, January 1993: This report summarized the impacts/benefits of improving the transportation infrastructure in the 42 county "delta" region which includes the entire eastern side of the state. The report included the following recommendation: Widen US 412 to four lanes from Boone County line (west of Mountain Home) to Missouri state line. The report also contained a review of the literature. The following list summarizes previous reports containing recommendations for improvements to US 412:

- *The Delta Initiatives*, Lower Mississippi Delta Development Commission, 1990: Recommended the widening of US 412 to four lanes from Tulsa, Oklahoma, through northern Arkansas to connect with I-40 in Tennessee.
- *An examination of Arkansas Highway Infrastructure and Economic Development*, Transportation Management Program, Arkansas State University, May 1988: Recommended "Development of the North Arkansas 412 Corridor from Tennessee to Oklahoma" (one of the seven recommended highway improvements). The report identified that a key benefit would be that such a route would

tie together the grain production in east Arkansas and the poultry industry in northwest Arkansas. Also, this would strengthen the Delta region's access to other markets and help boost the region's growing retirement and tourism industry.

- *AHTD Arkansas Highway Improvement Program*: Recommended specific improvements on US 412 at: (1) east of Paragould, and (2) Hardy to Salem.

Final EIS: Newport - Highway 63, US Highway 67, FHWA & AHTD, March, 1994: This report describes the selected alternative for a new location four-lane divided highway, built to interstate standards, from Newport to Walnut Ridge/Hoxie. The report contains no recommendations for the US 412 corridor. A small portion of the Walnut Ridge/Hoxie Bypass (between US 63 east and US 412 east) will carry both US 67 and US 412 traffic.

White River Overall Economic Development Program; FY 1996 Report, White River Planning & Development District, June 1996: This report summarizes the economic and physical condition of the ten county districts which include Sharp and Fulton counties, both containing the US 412 corridor. With respect to US 412, the report contains the following recommendations:

- Encourage development of an east-west transportation network corridor through north Arkansas.
- Promote the expansion of four-lane highways within the region for easier accessibility.

1.5 PUBLIC INVOLVEMENT PLAN

The proposed study of the feasibility of various improvements to US 412 between Norfork Lake and the Missouri state line is a project that draws a great deal of public attention from the area residences and businesses along the route.

The local population is sensitive to any proposed improvements of US 412 that would affect their quality of life, tourism and economic base or disturb historical, religious sites. The need for early citizen participation in the planning of the US 412 project was necessary. From the beginning, emphasis was placed upon early involvement of citizens in the planning process. A total of two "open house" meetings were held; one on May 9, 1997, in Paragould and the other on May 10, 1997, in Hardy.

The objectives of the meetings included the following:

1. Inform all parties of the study and related activities;
2. Gather comments and opinions from the area residents;
3. Identify potentially controversial issues associated with the proposed alternatives for US 412;
4. Provide opportunity for attention and support; and
5. Provide a neutral forum in which to express "grass roots" concerns.

Throughout the public involvement process, the team recognized the importance of conveying to those involved that the study in no way guaranteed the construction, development or improvements along US 412.

The public involvement process included the following:

- General Preparation
  - A strategy meeting with the AHTD was held in January, 1997 to discuss the issues that needed to be addressed based on the improvements being considered.
  - Determine the objective to be achieved when the public meetings are completed.
  - Determine what type of a deliverable AHTD will want from the public relations consultant after the meetings — a general overview report listing concerns, etc.
  - Develop a comprehensive mailing list of individuals directly impacted by the alignments along the corridor:
    * Local landowners
    * Businesses in the area

* Environmental interest groups
* Local elected officials
* Professional groups
* Chambers of Commerce

- Communications
  - Develop meeting notices and distribute to public places.
  - Arrange for publication of the notices in corridor's major papers from Mountain Home to Paragould.
  - Approach landowners and businesses that will be directly affected either through a notice, a phone call or a visit asking them to send a representative to the meeting.
  - Contact quasi-governmental units such as the economic development associations, visitors and tourism associations, chambers, business leaders.
  - Send a formal request to the major and other public figures to attend.
  - Contact the media.

- Physical Preparation
  - Develop a news release to be given to the press to explain the project and its objectives.
  - Arrange for meeting location.
  - Provide sign-in sheets.
  - Arrange for individual at sign-in table.
  - Arrange for the room to be set up with tables, easels, chairs.
  - Layout and print one-page information sheets to be handed out at the public meetings giving a brief overview of the different topics under consideration, and the purpose of the public meeting.
  - Provide questionnaires for the attendee opinion survey.

- Deliverables
  - Provide a report outlining the public and private concerns on the suggested alignment alternatives.

A detailed discussion of the public involvement process for the US 412 project, including findings and conclusions, is given in Chapter 5.

1.6 STUDY MANAGEMENT PROCESS

For purposes of managing the study, the twelve tasks identified in the original scope of work were incorporated into the following six study steps:

1. Project Initiation
2. Define Needs
3. Identify and Screen Alternatives
4. Evaluate Alternatives
5. Prioritize Projects
6. Prepare Report

These steps were incorporated into a study management matrix which is shown schematically in Exhibit 1-1.

1.6.1 Project Management and Coordination

LAN, in coordination with the AHTD contract manager, was responsible for directing and coordinating all activities associated with the US 412 study (hereinafter referred to as "study").

Exhibit 1-1: US 412 STUDY MANAGEMENT MATRIX

ACTIVITIES	Project Initiation *January*	Define Needs *February*	Identify and Screen Alternatives *March*	Evaluate Alternatives *April/May*	Prioritize Projects *June*	Prepare Report *July*
Engineering *Lockwood, Andrews & Newnam, Inc.* *Cromwell A/E, Inc.* *Isbell Engineering* *AMI Engineering, Inc.*	Define Study Area and Prepare Base Maps	Analyze exist. transp. facilities. Prepare Existing Conditions Report and identify deficiencies (Cromwell). Evaluate proposed alternatives identified in previous studies (LAN). Define design criteria, eval. criteria and screening metholodogy (LAN).	Identify proposed alternatives & relief routes using existing alignment as much as possible (LAN). Estimate costs for each proposed alternative (Cromwell/LAN)	Evaluate proposed alternatives and prepare improvement plan. (LAN)	Prepare draft improvement plan by Segment (LAN)	Prepare Final Report to include: - executive summary - study process - management of study - types/methods of analysis - results/conclusions => submit to AHTD for review/appr.
Planning/Traffic *Barton-Aschman, Inc.*	Define Study Network and LOS Requirements	Develop future traffic volumes using historical traffic growth rates.	Forecast travel demand. Forecast LOS's and analyze safety improvements.	Identify both "long range" and "short range" (interim) improvements (LAN). Identify proposed localized improvements.	Prepare draft Travel Forecast (B/A) Prepare Alternative Evaluation technical memorandum (LAN)	Prepare Travel Demand as Chapter in final report.
Geotechnical *Grubbs, Garner, Hoskyn, Inc.*	Obtain available geotechnical data.	Map geological constraints. Determine geotechnical considerations for bridges, retaining walls, etc.	Design conceptual pavement sections for cost estimating purposes	Identify areas for future additional geotechnical investigations.	Prepare draft technical memorandum summarizing findings.	Prepare Geotechnical Section in final report.
Environmental *ETC Engineers, Inc.*	Contact local/state/Fed agencies. Identify natural, economic, hazardous material, and cultural issues.	Map potential environmental constraints	Minimize potential environmental impacts.	Identify environmental issues for future evaluation.	Prepare draft environmental technical memorandum.	Prepare Environmental Chapter in final report.
Economic Justification *Barton-Aschman, Inc.* *(unless noted otherwise)*	Review AHTD TIP (committed and programmed projects)(LAN). Define "Base Case" facility = exist. + committed (LAN, Cromwell)	Forecast economic development, population trends, land use, & socioeconomic changes to region. Summarize economic eval. procedures (definitions, economic methodology, & definition of economic impact areas).	Identify economic benefits of each alternative taking into account delay, fuel/road user costs, LOS, & accidents. Identify other benefits including travel & tourism, improved access to med., etc.	Determine life-cycle costs, eval. travel efficiency, eval. economic impacts, prepare cost/benefit analysis.	Prepare preliminary economic evaluation report for AHTD review summarizes economic assessment and its conclusion).	Prepare Chapter on Economic Justification in final report.
Public Involvement *Vesta Rea & Assoc.*	Prepare Public Involvement Plan	Distribute Press Release announcing project.	Organize & conduct "open house" public meetings to gather local input (concerns/desires) of public.	Summarize comments rec'd from "open house" meetings.	Prepare report outlining public/private concerns.	Prepare Public Involvement chapter in final report
Decision Making *AHTD & LAN*	Approve Study Concept, Problem Statement, Goals, & Objectives. →	Approve design criteria, evaluation criteria, and screening methodology. →	Select feasible alternatives and justify need. →	Select recommended Alternative →	Recommend candidate projects and prioritize by Segment. →	Include selected projects in future AHTD TIP programming.

1.6.2 Study Management Plan

A study management plan was prepared to identify organization and responsibilities, coordination and communication procedures, team meetings, document format, report format, technical memorandum format, graphic production standards and other important operational information pertaining to the overall team activities. The contract scope of services formed the "backbone" of the study management plan.

1.6.3 Study Progress Reports, Invoices and Billings

LAN's project manager continuously monitored the progress on all tasks and sub-tasks to ensure that major project milestones were achieved as planned. Monthly progress reports were prepared for review by the AHTD contract manager. Invoices for all work completed by LAN and the subconsultants were submitted monthly to AHTD in the required format. Monthly progress reports included:

- One page narrative of activities completed during the reporting period
- Gannt Chart prepared using Microsoft Project, identifying each task and sub-task and showing percent complete for each task and sub-task

1.6.4 Study Coordination/Administration

The development and maintenance of effective communication among the study team, AHTD and other entities was one of the key factors in achieving the successful completion of the study. LAN actively managed the team's efforts during execution of the task work and preparation of the study document as follows:

Study Coordination - All correspondence and coordination was handled through and with the concurrence of the AHTD contract manager.

Lines of Communication - All communications between the study team and AHTD were routed between LAN's project manager and AHTD's contract manager. In a few instances, deviations from this protocol were appropriate. In those instances, approval from AHTD was received prior to the contact, and AHTD was promptly notified in writing via a contact memorandum. Mr. Brock E. Miller, P.E., a registered professional engineer in Arkansas and Texas, was designated as LAN's project manager. Mr. Joe Nelson, AHTD, was designated as AHTD's acting contract manager. Mr. Robert L. Walters, P.E., was designated as AHTD's contract manager for billing and contract items.

Study Administration - LAN managed all study activities including: meetings, direction of team and staff, correspondence with AHTD and assisted AHTD in the preparation of responses to inquiries from the public.

Coordination Meetings - At various times during the course of the project, meetings and/or contacts were made with regional, local, state and federal agencies, property owners, utility owners, railroad companies, other consulting firms, etc., as needed or required to complete study tasks. Prior to meetings, LAN discussed the agenda for the meetings with the AHTD contract manager, to ensure that the released information was appropriate and correct. Data collected during the study was not released to any agency or to the public without prior approval of the AHTD contract manager. The engineer documented all meetings and forwarded copies of meeting minutes to the AHTD contract manager.

Correspondence - LAN submitted all written materials (letters, transmittals, etc.) used to solicit information or collect data for the study to the AHTD contract manager for review and acceptance before its use or distribution. Copies of all outgoing and incoming correspondence were provided to the AHTD contract manager.

Communication with Other Agencies - Communication with other agencies regarding this study were handled after concurrence from AHTD was received.

Release of Information - AHTD approval was obtained on all information released during the study.

Document Printing and Distribution - LAN was responsible for printing copies of all draft and final documents, reports, newsletters, etc., produced for the study. LAN provided 25 copies of the report for preliminary review, 25 copies for final review, and 50 copies of the final report document.

Project Closeout - Upon study completion, the Engineer will transmit all original study files to AHTD who will retain ownership. Copies of the transmitted materials will be retained by LAN.

1.6.5 Study Control/Scheduling

A detailed study schedule was prepared by LAN showing tasks, sub-tasks, critical dates, milestones, deliverables and AHTD review requirements. The study schedule was prepared using Microsoft Project, and was formatted to illustrate the interdependence of the various tasks, sub-tasks, milestones, and deliverables for each task identified herein. Progress was reviewed with AHTD at bi-monthly coordination meetings.

1.6.6 Subconsultant Management

In addition to LAN's role as the designated "prime" consultant, the study team included the following subconsultants:

- Barton-Aschman Associates, Inc. *Ft. Worth, TX* — Traffic Engineering & Economic Studies
- Cromwell Architects/Engineers, Inc. *Little Rock, AR* — Existing Conditions Analysis, Cost Estimates
- ETC Engineers, Inc. *Little Rock, AR* — Environmental Studies
- Grubbs, Garner, & Hoskyn, Inc. *Little Rock, AR* — Geotechnical Services
- Isbell Engineering & Surveying, Inc. *Mountain Home, AR* — Right of Way Studies
- AMI Engineering *Little Rock, AR* — Mapping
- Vesta Rea & Associates *Houston, TX* — Public Involvement

LAN prepared subcontracts for subconsultants, monitored subconsultant activities (staff and schedule), and reviewed and recommended approval of subconsultant invoices. Subconsultant progress reports and invoices were incorporated into a monthly study progress report and invoice described in sub-task 1.6.3.

1.6.7 Quality Assurance/Quality Control

LAN continually performed quality control reviews during the study to appraise both technical and business performance and provide direction for study activities. In addition, comprehensive quality assurance/quality control reviews were performed prior to submittal of interim review documents to AHTD.

EXISTING CONDITIONS

2.1 EXISTING CONDITIONS

Definition of Segments and Project Stationing. This chapter describes the existing conditions of the study area. These conditions serve to identify potential points of focus for improvements. Table 2-1 defines the segments of the study area based on the stationing developed for this project. Exhibit 2-1 shows the segment limits and the different existing road types. A photographic log of selected portions of the corridor from west to east is provided in Appendix B.

Table 2-1: SEGMENT DEFINITION

Segment	From (km)	To (km)	Location	Length (km)	Geological Classification
1	10.0*	40.0	Viola	30.0	Cotter Dolomite
2	40.0	58.0	Salem	18.0	Cotter Dolomite
3	58.0	85.0	Ash Flat	27.0	Cotter Dolomite
4	85.0	100.0	Hardy	15.0	Cotter Dolomite
5	100.0	133.0	Imboden	33.0	Powel Dolomite
6	133.0	152.4	Black Rock	19.4	Mississippi Embayment
7	152.4	164.0	Walnut Ridge	11.6	Mississippi Embayment
8	164.0	192.0	Crowley's Ridge	28.0	Mississippi Embayment
9	192.0	208.5	Paragould	16.5	Mississippi Embayment
10	208.5	217.3	Missouri State Line	8.8	Mississippi Embayment

* A 10 km buffer zone was established preceding the study area to accommodate any work that may be required on or west of the bridge over Lake Norfork.

2.2 GEOMETRIC CONDITIONS (Horizontal & Vertical Alignments and Pavement Conditions)

The study corridor area geometric conditions were analyzed from: ROW/record drawings, site visits, from AHTD's US 412 Highway Inventory Videotape, and from AHTD's Highway Needs Inventory Database. Table 2-2 summarizes the comparisons between the existing conditions and design criteria for a two-lane/two-way rural arterial as defined in Table 3-3. Vertical curves have been evaluated using Figure III-40, Figure III-42 of the 1994 AASHTO's "A Policy on Geometric Design of Highways and Streets" and Table 3-3 of this report. Pavement rates have been evaluated on the basis of ratings defined by the "Highway Needs Inventory Form" provided by AHTD.

Table 2-2: EXISTING GEOMETRIC CONDITIONS

Segment	Length (km)	Percent Length Horizontal Curves*	Percent Horizontal Curves Do Not Meet Criteria	Maximum Grade	Percent Grade Do Not Meet Criteria
1	30	40%	6%	7.0%	0.3%
2	18	40%	0%	N/A	N/A
3	27	19%	1%	N/A	N/A
4	15	32%	3%	N/A	N/A
5	33	33%	2%	6.0%	0.9%
6	19.4	25%	0%	N/A	N/A
7	11.6	8%	1%	N/A	N/A
8	28	8%	0%	7.1%	3.2%
9	16.5	N/A	N/A	N/A	N/A
10	8.8	4%	0%	N/A	N/A

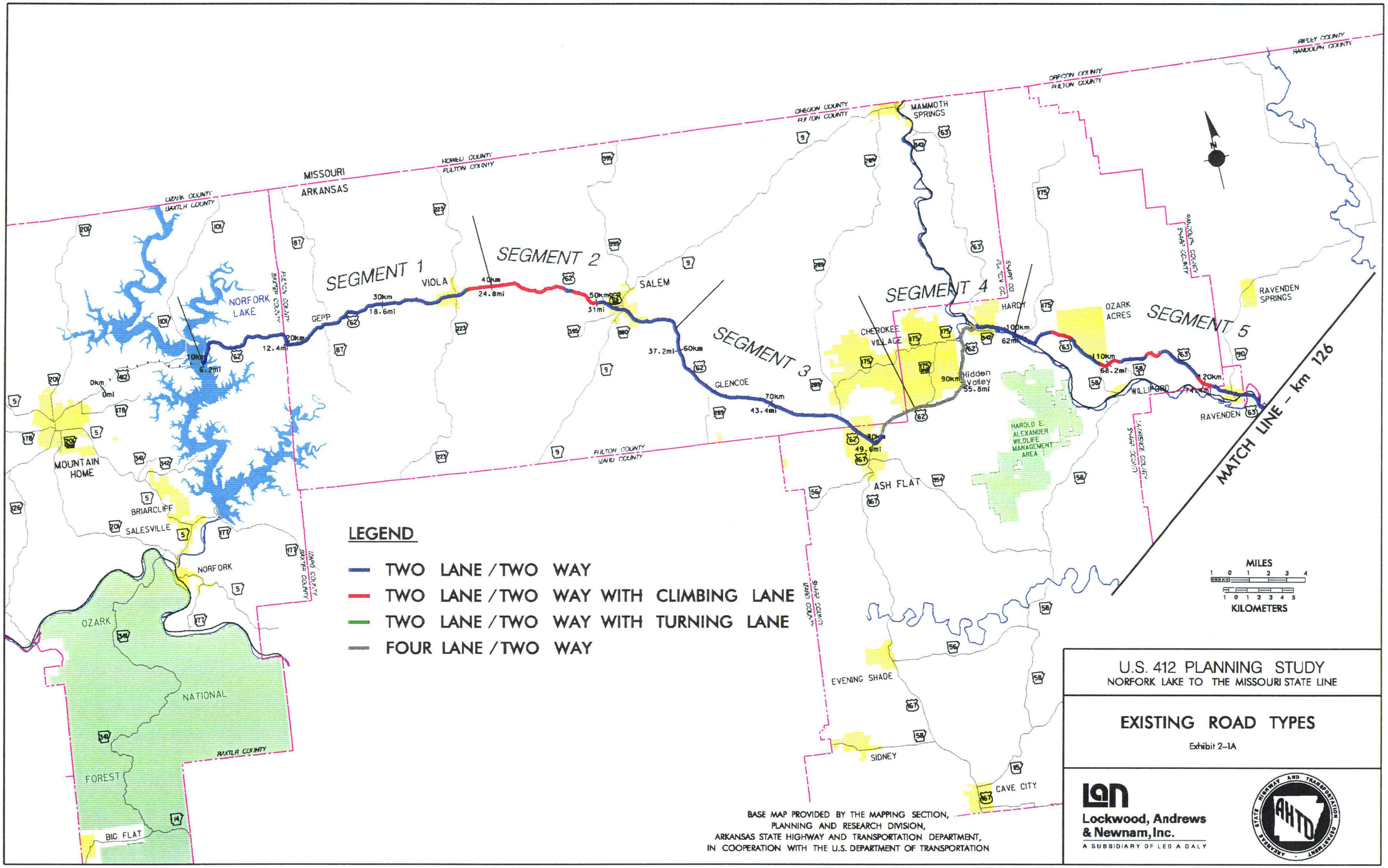
* Limited information was available on vertical curves.
N/A = Not available

2.2.1 Segment 1. Along US 62 from Norfork Lake (km 10) to east of Viola (km 40)

This segment is 30 km (18.6 miles) long and consists of a two-lane/two-way undivided road type. Eleven percent of the lane widths and 97% of the shoulders along the segment do not meet the design criteria. Truck climbing lanes exist along a 2.1 km (1.3 miles) section from km 37.9 to km 40.0. The pavement ratings of this segment are 100% within the "good" (4.0-3.1) classification.

2.2.2 Segment 2. Along US 62 from east of Viola (km 40) to east of Salem (km 58)

This segment is 18 km (11.2 miles) long and consists of a two-lane/two-way undivided road type. Sixty-nine percent of the lane widths and 96% of the shoulders along the segment do not meet the design criteria. Truck climbing lanes exist along a 6.8 km (4.2 miles) section of this segment from km 40.0 to km 46.8 and a 2.6 km section from km 47.5 to km 50.1. The pavement ratings of this



BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

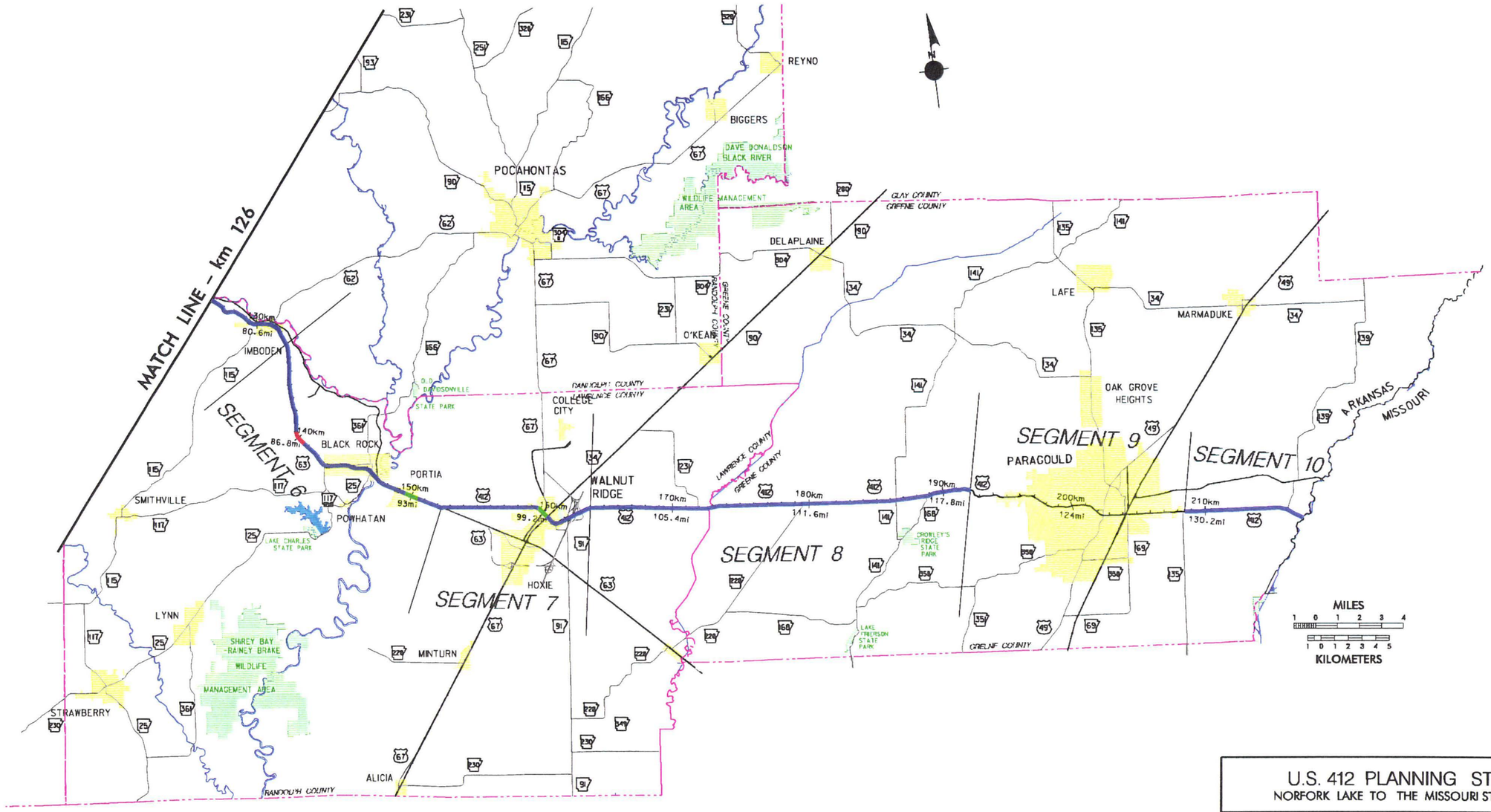
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING ROAD TYPES

Exhibit 2-1A

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
AHTD



LEGEND

- TWO LANE / TWO WAY
- TWO LANE / TWO WAY WITH CLIMBING LANE
- TWO LANE / TWO WAY WITH TURNING LANE
- FOUR LANE / TWO WAY

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U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING ROAD TYPES

Exhibit 2-1B

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY

segment are 39% within the "very good" (5.0-4.1) classification and 61% within the "good" (4.0-3.1) classification.

2.2.3 Segment 3. Along US 62 from east of Salem (km 58) to the intersection with US 63 (km 80) and then along US 63 to east of Ash Flat (km 85)

This segment is 27 km (16.8 miles) long and consists of a 22.1 km section of two-lane/two-way undivided road type from km 58.0 to km 81.1 and a 4.9 km section of four-lane/two-way undivided road type from km 81.1 to km 85.0. Eighty-two percent of the shoulders along the segment do not meet the design criteria. The pavement ratings of this segment are 90% within the "very good" (5.0-4.1) classification and 10% within the "good" (4.0-3.1) classification.

2.2.4 Segment 4. Along US 63 from east of Ash Flat (km 85) to east of Hardy (km 100)

This segment is 15 km (9.3 miles) long and consists of a 12.9 km section of four-lane/two-way undivided road type from km 85.0 to km 97.9 and a 2.1 km section of two-lane/two-way undivided road type from km 97.9 to km 100.0. Five percent of the lane widths and 70% of the shoulders along the segment do not meet the design criteria. The pavement ratings of this segment are 70% within the "very good" (5.0-4.1) classification and 30% within the "good" (4.0-3.1) classification.

2.2.5 Segment 5. Along US 63 from east of Hardy (km 100) to east of Imboden (km 133)

This segment is 33 km (20.5 miles) long and consists of a two-lane/two-way undivided road type. Thirty-four percent of the lane widths and 98% of the shoulders along the segment do not meet the design criteria. Truck climbing lanes exist along a 2.0 km section from km 103.7 to km 105.7, a 2.0 km section from km 109.1 to km 111.1, a 1.5 km section from km 113.5 to km 115.0, and a 1.5 km section from km 119.2 to km 120.7. The pavement ratings of this segment are 86% within the "good" (4.0-3.1) classification and 14% within the "fair" (3.0-2.1) classification.

2.2.6 Segment 6. Along US 63 from east of Imboden (km 133) to east of Portia (km 152.4) at the intersection of US 412

This segment is 19.4 km (12.1 miles) long and consists of a two-lane/two-way undivided road type. Five percent of the lane widths and 54% of the shoulders along the segment do not meet the design criteria. Truck climbing lanes exist along a 1.3 km section from km 139.4 to km 140.7, and a continuous left-turn lane exists along a 1.0 km section from km 149.5 to km 150.5. The pavement ratings of this segment are 100% within the "good" (4.0-3.1) classification.

2.2.7 Segment 7. Along US 412 from east of Portia (km 152.4) at the intersection of US 63 to east of Walnut Ridge (km 164)

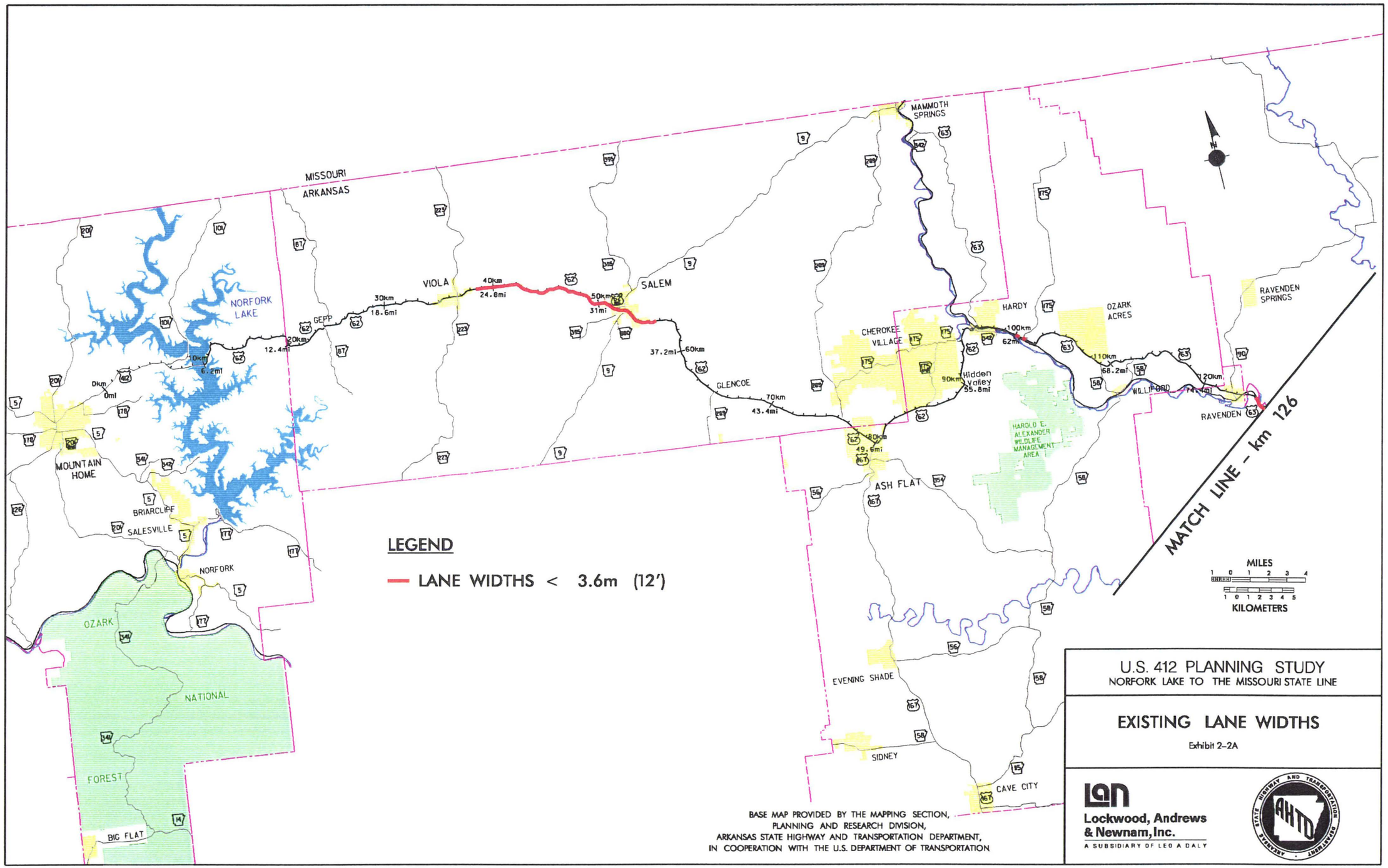
This segment is 11.6 km (7.2 miles) long and consists of a two-lane/two-way undivided road type. Thirteen percent of the lane widths and 13% of the shoulders along the segment do not meet the design criteria. A continuous left-turn lane exists along a 1.1 km section from km 159.6 to km 160.7. The pavement ratings of this segment are 100% within the "good" (4.0-3.1) classification.

2.2.8 Segment 8. Along US 412 from east of Walnut Ridge (km 164) to west of Paragould (km 192)

This segment is 28.0 km (17.4 miles) long and consists of a two-lane/two-way undivided road type. Five percent of the shoulders along the segment do not meet the design criteria. The pavement ratings of this segment are 95% within the "good" (4.0-3.1) classification and 5% within the "fair" (3.0-2.1) classification.

2.2.9 Segment 9. Along US 412 from west of Paragould (km 192) to east of Paragould (km 208.5)

Since AHTD is currently evaluating the feasibility of a bypass around Paragould, this segment has not been analyzed in detail as part of this report.


MISSOURI
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MOUNTAIN HOME
BRIARCLIFF
SALESVILLE
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VIOLA
SALEM
GLENCOE
CHEROKEE VILLAGE
MAMMOTH SPRINGS
HARDY
Hidden Valley
OZARK ACRES
WILLIFORD
RAVENDEN
RAVENDEN SPRINGS
HAROLD E. ALEXANDER WILDLIFE MANAGEMENT AREA
ASH FLAT
EVENING SHADE
SIDNEY
CAVE CITY
0km
0mi
10km
6.2mi
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30km
18.6mi
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50km
31mi
60km
37.2mi
70km
43.4mi
80km
49.6mi
90km
55.8mi
100km
62mi
110km
68.2mi
120km
74.4mi
MATCH LINE - km 126
LEGEND
LANE WIDTHS < 3.6m (12')
MILES
KILOMETERS
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
EXISTING LANE WIDTHS
Exhibit 2-2A
Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY
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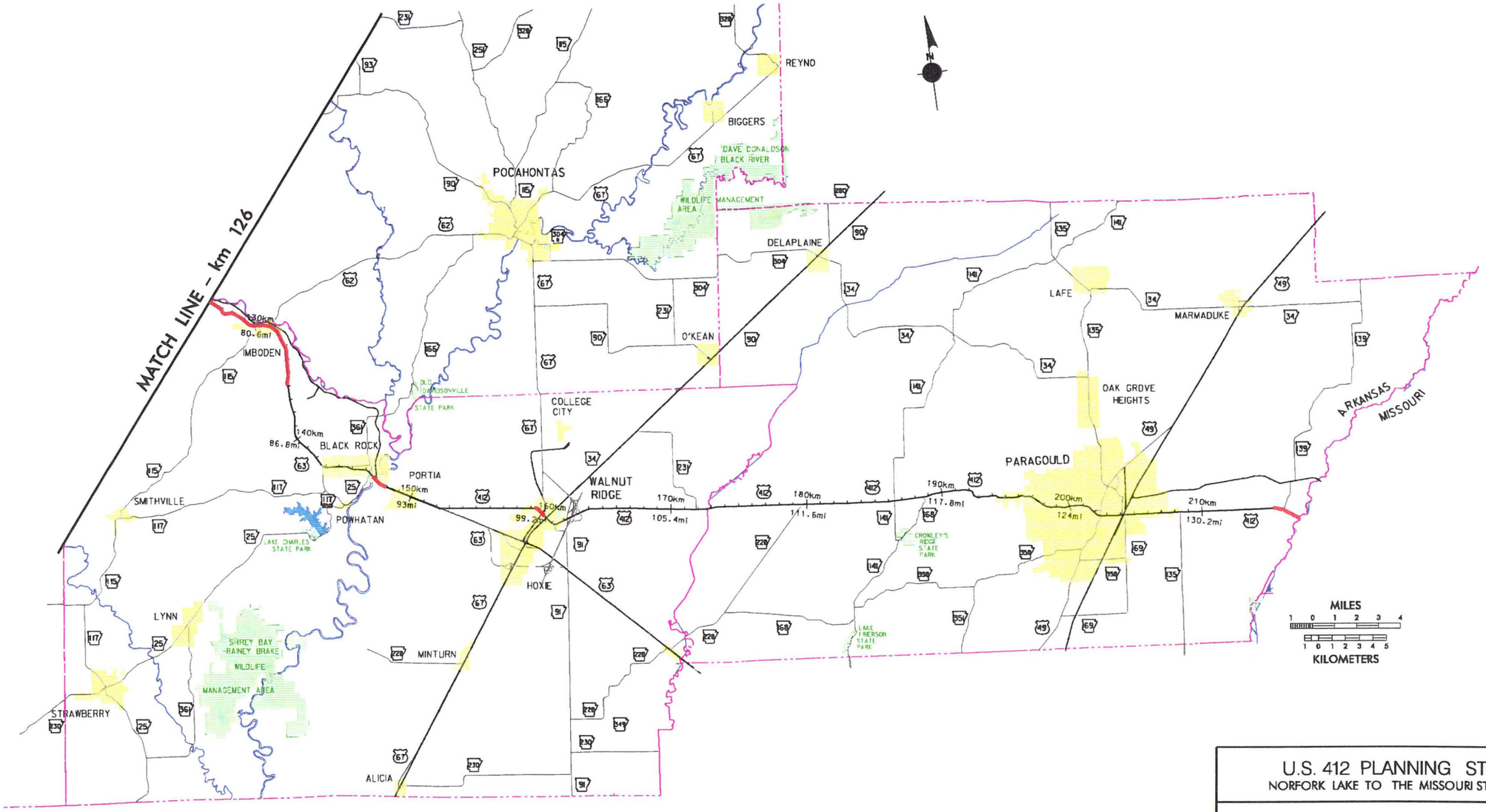

LEGEND

— LANE WIDTHS < 3.6m (12')

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U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING LANE WIDTHS

Exhibit 2-2B

Lockwood, Andrews & Newnam, Inc.
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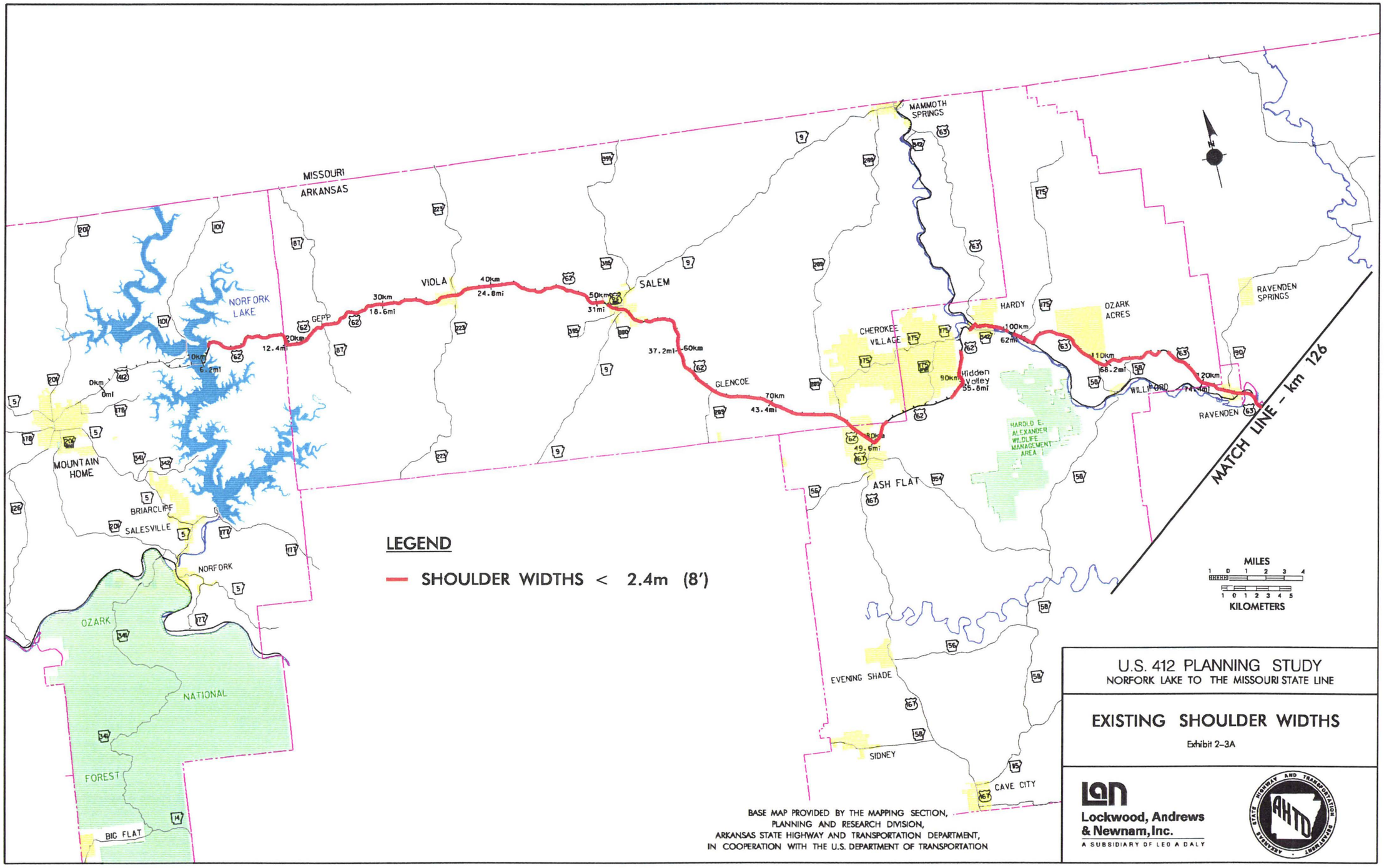
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BRIARCLIFF
SALESVILLE
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GEPP
VIOLA
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GLENCOE
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RAVENDEN
RAVENDEN SPRINGS
MAMMOTH SPRINGS
HAROLD E. ALEXANDER WILDLIFE MANAGEMENT AREA
MATCH LINE - km 126
LEGEND
SHOULDER WIDTHS < 2.4m (8')
MILES
KILOMETERS
BASE MAP PROVIDED BY THE MAPPING SECTION,
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U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
EXISTING SHOULDER WIDTHS
Exhibit 2-3A
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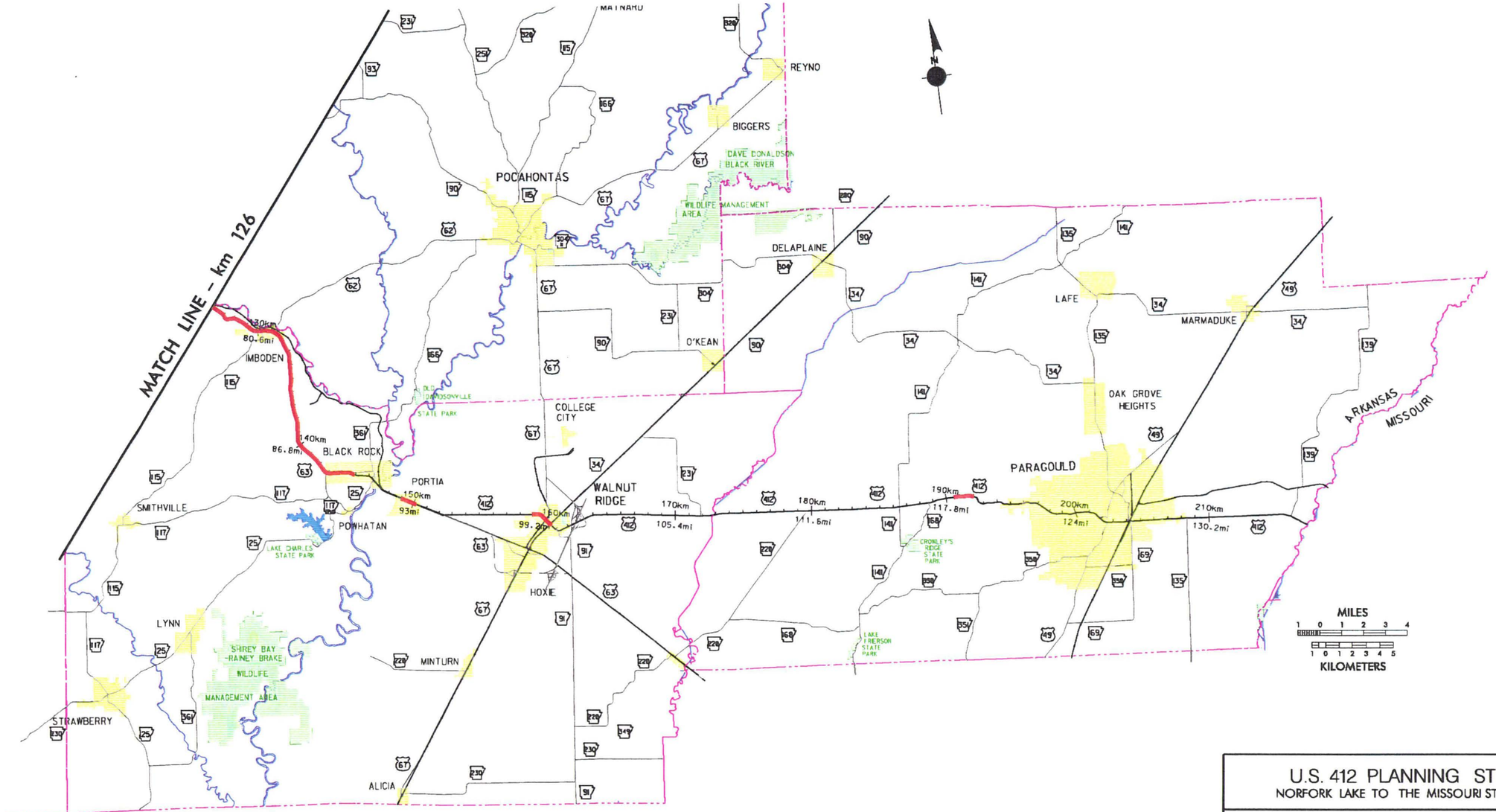

LEGEND

— SHOULDER WIDTHS < 2.4m (8')

BASE MAP PROVIDED BY THE MAPPING SECTION,
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U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING SHOULDER WIDTHS

Exhibit 2-3B

Lockwood, Andrews & Newnam, Inc.
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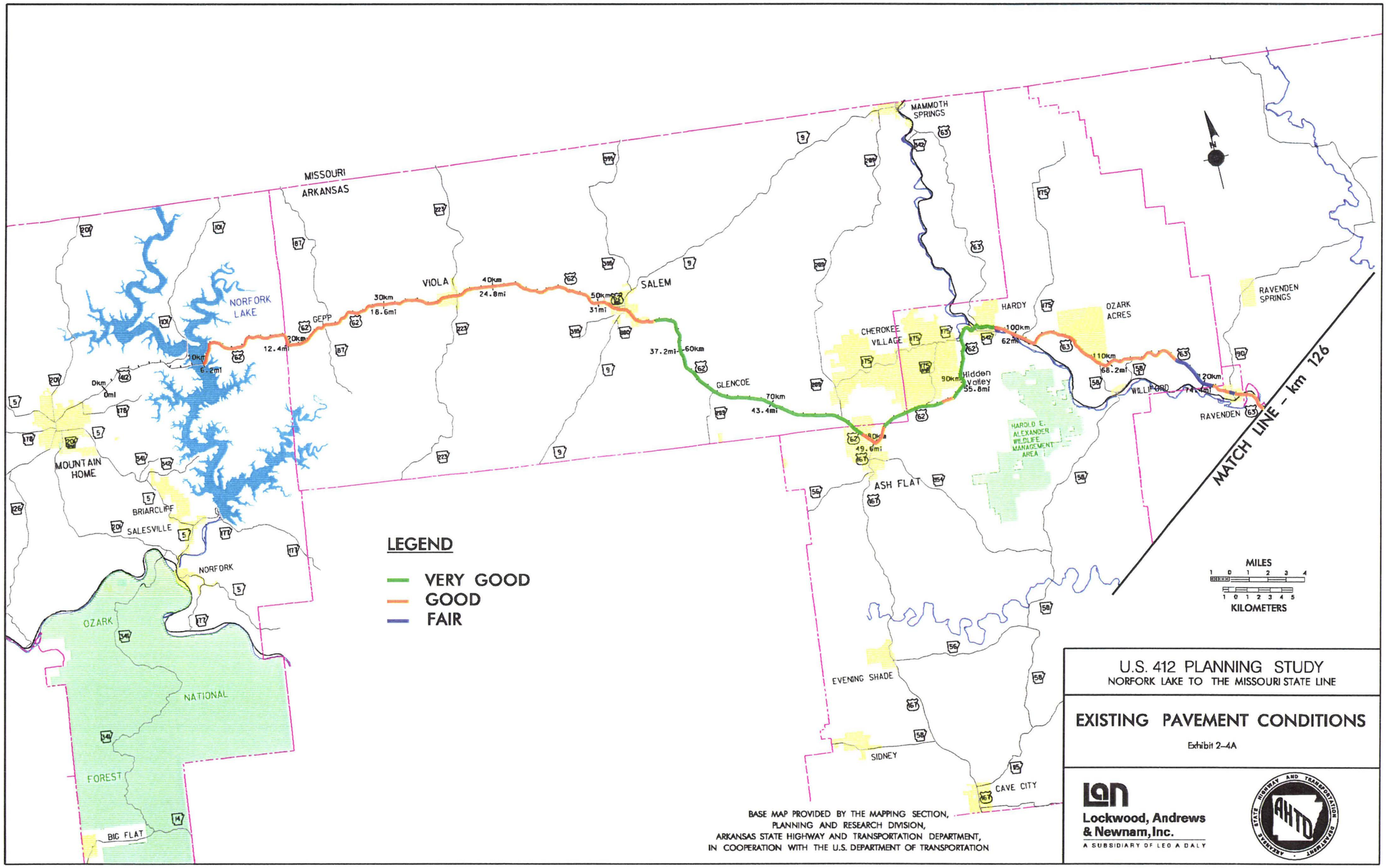
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT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ASH FLAT
EVENING SHADE
SIDNEY
CAVE CITY
MATCH LINE - km 126
0km 0mi
10km 6.2mi
20km 12.4mi
30km 18.6mi
40km 24.8mi
50km 31mi
60km 37.2mi
70km 43.4mi
80km 49.6mi
90km 55.8mi
100km 62mi
110km 68.2mi
120km 74.4mi
LEGEND
VERY GOOD
GOOD
FAIR
MILES
KILOMETERS
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
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U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
EXISTING PAVEMENT CONDITIONS
Exhibit 2-4A
Lockwood, Andrews & Newnam, Inc.
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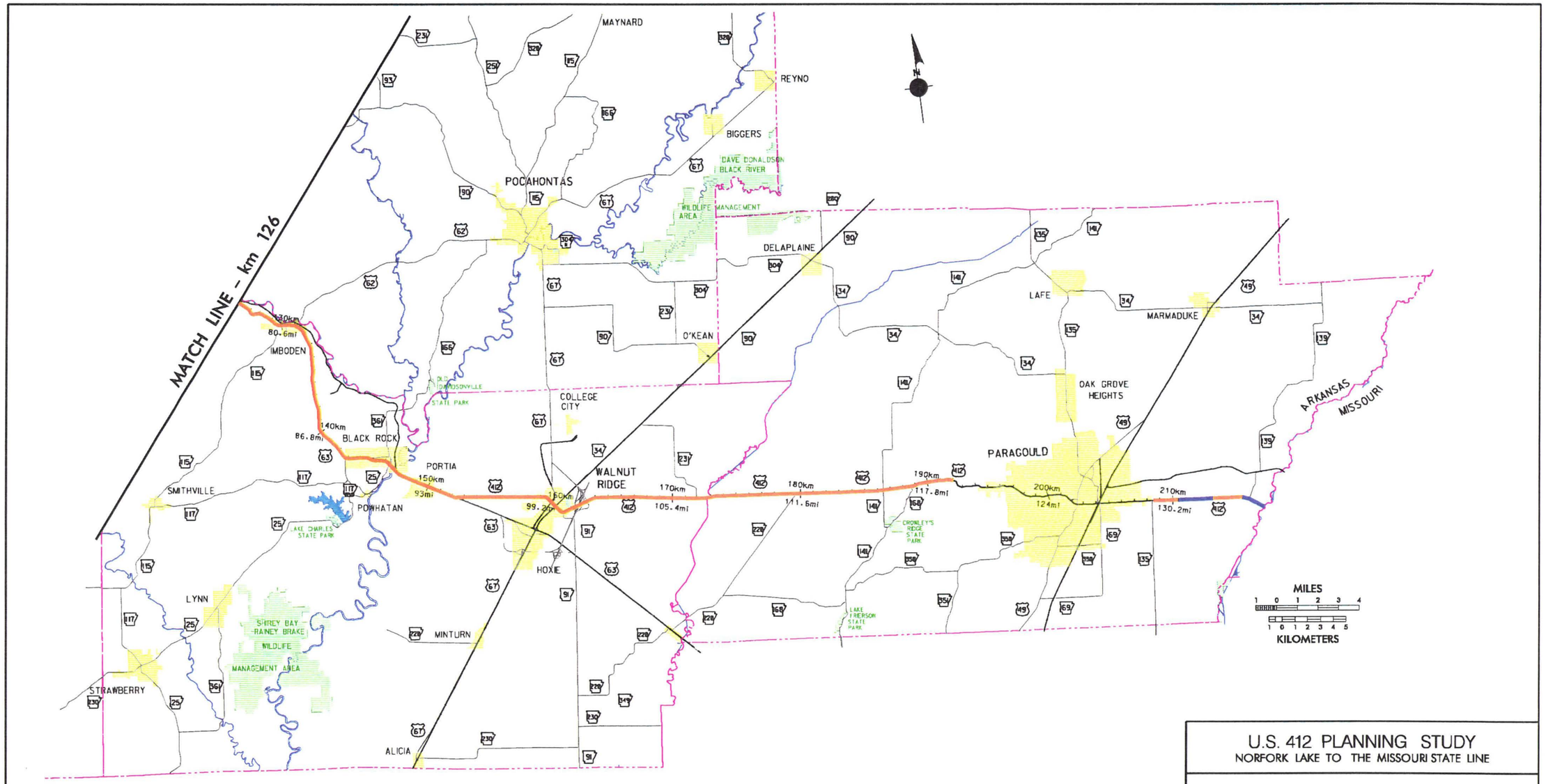
AHTD



LEGEND

- VERY GOOD
- GOOD
- FAIR

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U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING PAVEMENT CONDITIONS

Exhibit 2-4B

Lockwood, Andrews & Newnam, Inc.
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2.2.10 Segment 10. Along US 412 from east of Paragould (km 208.5) to the Missouri state line (km 217.3)

This segment is 8.8 km (5.5 miles) long and consists of a two-lane/two-way undivided road type. Nineteen percent of the lane widths do not satisfy the design criteria. The pavement ratings of this segment are 49% within the "good" (4.0-3.1) classification and 51% within the "fair" (3.0-2.1) classification.

2.3 ACCIDENT HISTORY

The study corridor area accidents were analyzed from data provided by AHTD for the years 1993, 1994 and 1995. Table 2-3 summarizes the three years of accident data and Table 2-4 summarizes the statewide accident rate averages over the three-year study period.

Table 2-3: SUMMARY OF 3-YEAR ACCIDENT HISTORY

Segment		Total Accidents		Fatal Accidents		Injury Accidents		Annual Accident Rate*		Annual Fatal Accident Rate**	
		Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
1		91	N/A	2	N/A	53	N/A	1.60	N/A	3.52	N/A
2		38	0	3	0	24	0	0.93	0.00	7.30	0.00
3	Two-Lane	55	0	0	N/A	46	N/A	0.80	N/A	0	N/A
	Four-Lane	43	0	0	N/A	24	N/A	1.59	N/A	0.00	N/A
4	Two-Lane	7	14	0	0	5	7	1.15	1.75	0	0.00
	Four-Lane	58	116	0	0	22	60	2.30	3.53	0.00	0.00
5		188	N/A	8	N/A	79	N/A	1.68	N/A	7.15	N/A
6		104	N/A	2	N/A	62	N/A	1.12	N/A	2.16	N/A
7		91	30	1	0	24	13	3.49	12.98	3.84	0.00
8		52	N/A	4	N/A	28	N/A	0.89	N/A	6.84	N/A
10		34	N/A	1	N/A	20	N/A	0.8	N/A	2.35	N/A

* Annual accident rate is defined as the number of accidents per one million vehicle miles traveled in one year on one segment of a highway.
** Annual fatal accident rate is defined as the number of fatalities per 100 million vehicle miles traveled in one year on one segment of a highway.
N/A = Not applicable

Table 2-4: 1993-1995 ARKANSAS STATEWIDE ACCIDENT RATE AVERAGES*

Road Type	Total Accidents		Fatal Accidents		Average Daily Vehicle Miles		Annual Accident Rate		Annual Fatal Accident Rate	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Two-Lane	42,603	25,060	926	81	78,803,678	13,058,399	1.46	5.26	3.21	1.7
Four-Lane	1,905	35,232	17	69	2,759,674	12,128,838	1.89	7.97	1.69	1.56

* For undivided highways with no control of access.

Exhibit 2-5 shows the high accident locations within the corridor for each segment. Exhibit 2-6 shows the accident rate for each one km section of the study area. Exhibits 2-7 and 2-8 show the accident rates and the fatal accident rates, respectively, as compared to statewide averages for each segment in the study area.

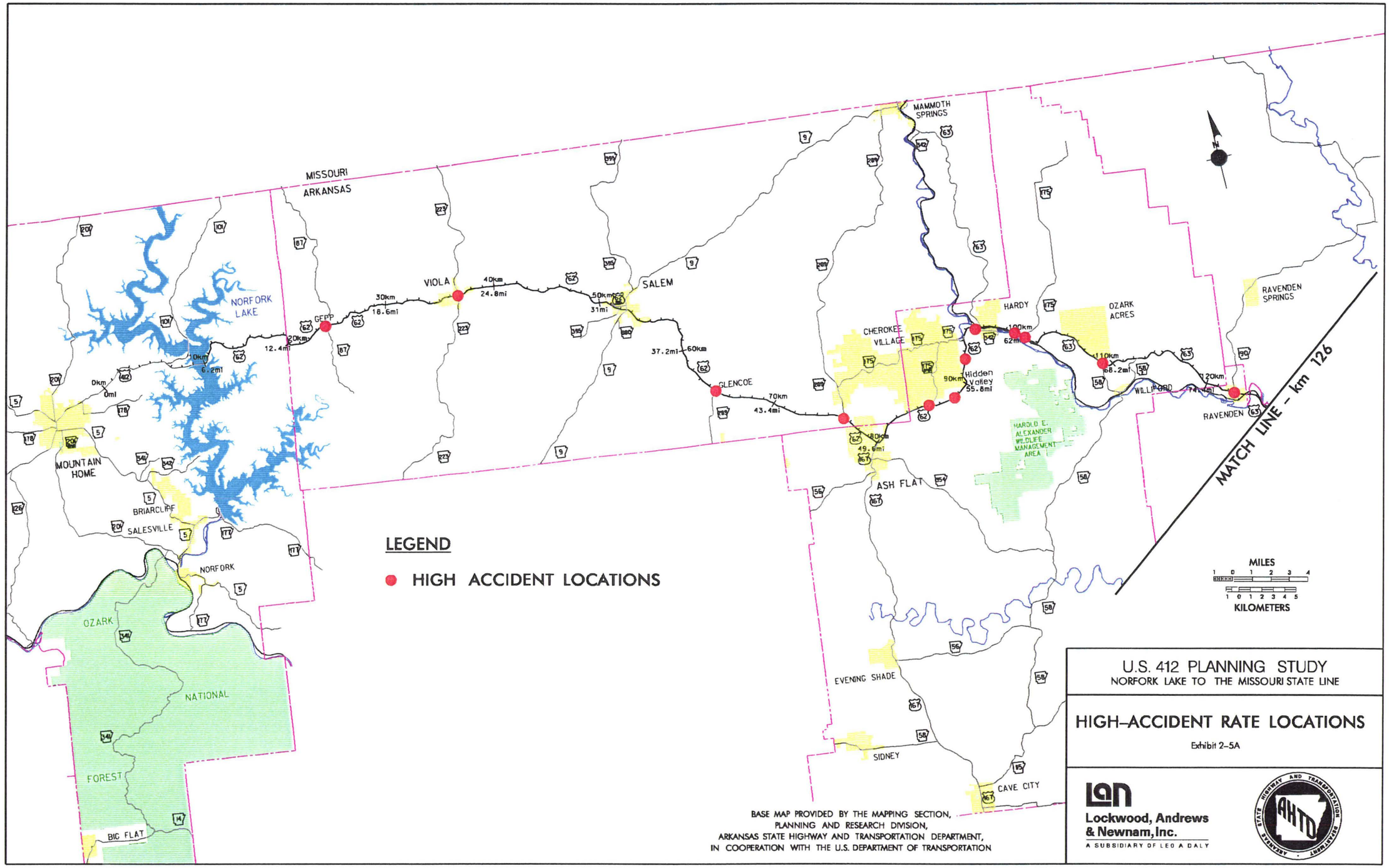
2.3.1 Segment 1. Along US 62 from Norfork Lake (km 10) to east of Viola (km 40)

The accident rate for this segment is 8% above the statewide rural average, while the fatal accident rate is 10% above the statewide average. The sections of roadway that run through Henderson (km 10 - km 14) and Viola (km 35 - km 39) have higher accident rates due to urban conditions. Two peak locations of accidents by number of accidents in this segment can be identified as follows:

- Intersection with SH 87 (km 23.82) with six accidents over the three-year study period.
- Intersection with SH 223 (km 36.60) with six accidents over the three-year study period.

2.3.2 Segment 2. Along US 62 from east of Viola (km 40) to east of Salem (km 58)

The accident rate for this segment is below the statewide rural average; however, the fatal accident rate is 127% above the statewide rural average. There is no peak location of accidents in this segment.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HARDY
Hidden Valley
OZARK ACRES
WILLIFORD
RAVENDEN
RAVENDEN SPRINGS
HAROLD E. ALEXANDER WILDLIFE MANAGEMENT AREA
ASH FLAT
EVENING SHADE
SIDNEY
CAVE CITY
MATCH LINE - km 126
0km 0mi
10km 6.2mi
20km 12.4mi
30km 18.6mi
40km 24.8mi
50km 31mi
60km 37.2mi
70km 43.4mi
80km 49.6mi
90km 55.8mi
100km 62mi
110km 68.2mi
120km 74.4mi
LEGEND
HIGH ACCIDENT LOCATIONS
MILES
KILOMETERS
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
HIGH-ACCIDENT RATE LOCATIONS
Exhibit 2-5A
Lockwood, Andrews & Newnam, Inc.
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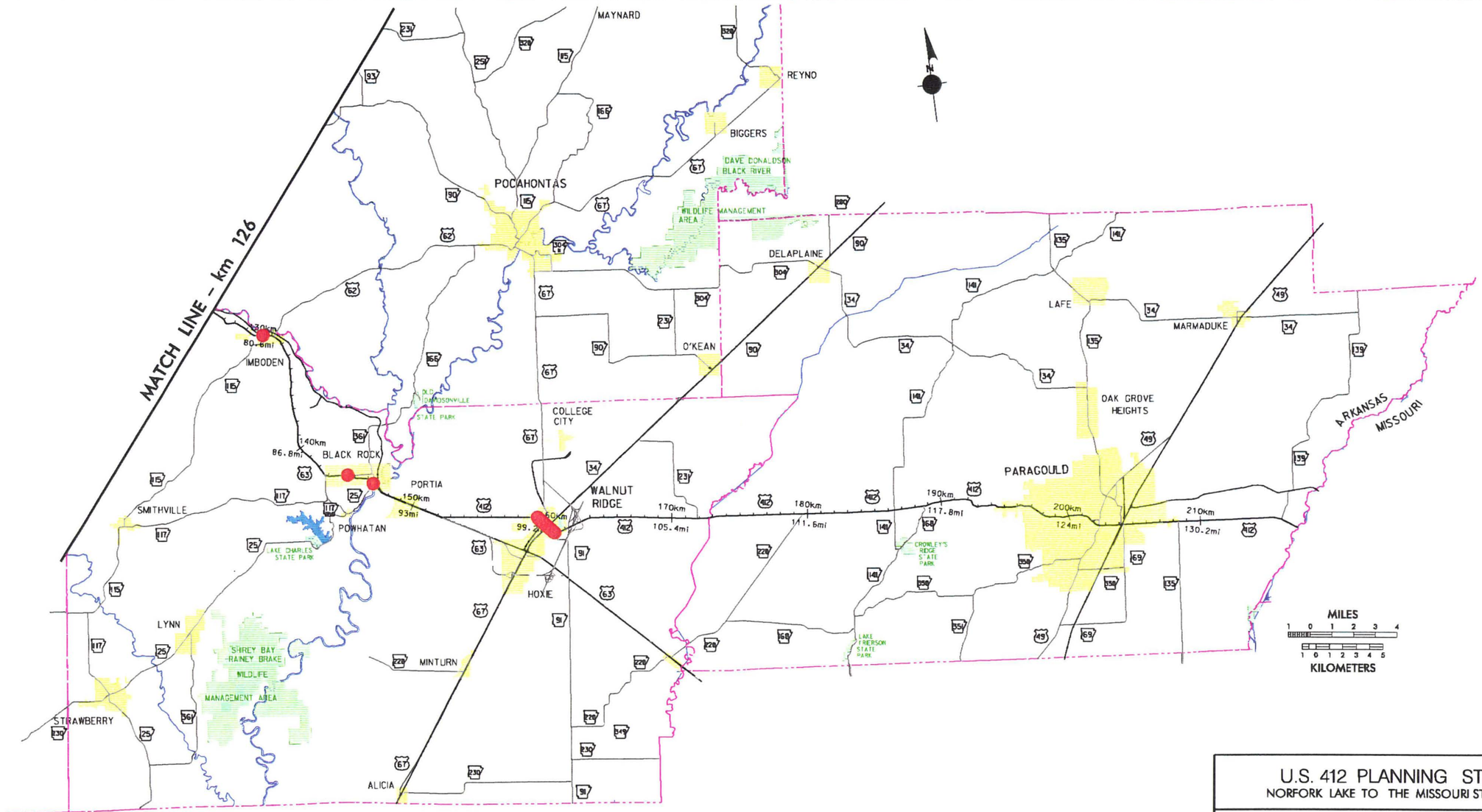

LEGEND

● HIGH ACCIDENT LOCATIONS

BASE MAP PROVIDED BY THE MAPPING SECTION,
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U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

HIGH-ACCIDENT RATE LOCATIONS

Exhibit 2-5B

Lockwood, Andrews & Newnam, Inc.
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Exhibit 2-6: ACCIDENT RATE PER KM

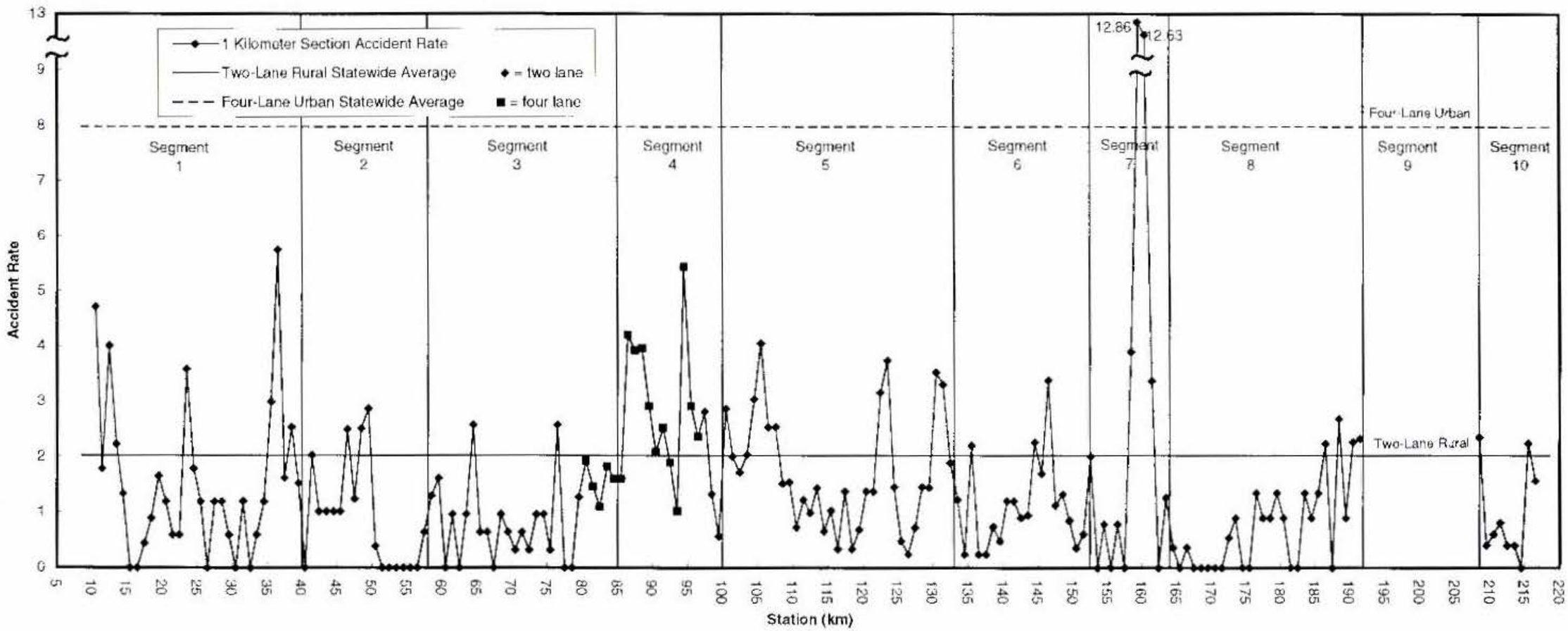


Exhibit 2-7
Accident Rate by Segment

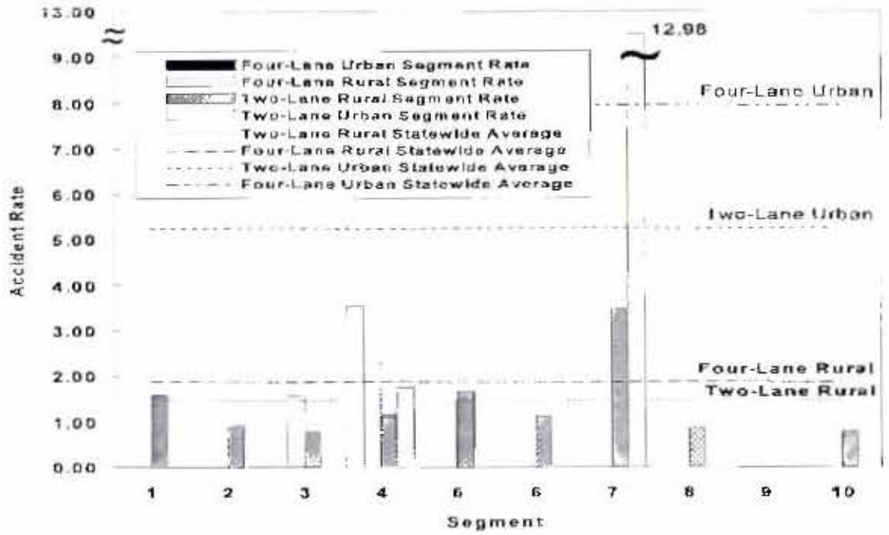
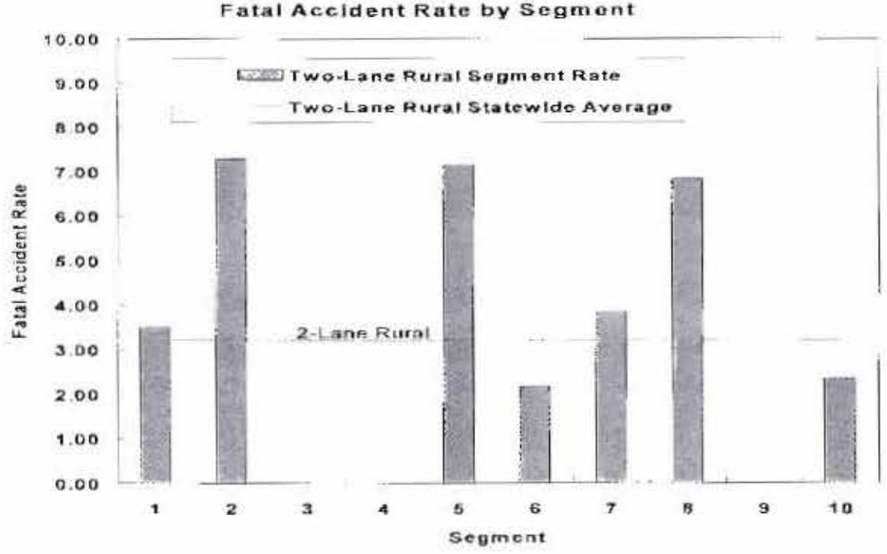


Exhibit 2-8
Fatal Accident Rate by Segment



2.3.3 Segment 3. Along US 62 from east of Salem (km 58) to the intersection with US 63 (km 80) and then along US 63 to east of Ash Flat (km 85)

The accident rates and the fatal accident rates for this segment are below the statewide average. Two peak locations of accidents by number of accidents in this segment can be identified as follows:

- Intersection with SH 289 (km 64.75) with six accidents over the three-year study period.
- Intersection with SH 289 (km 76.34) with six accidents over the three-year study period.

2.3.4 Segment 4. Along US 63 from east of Ash Flat (km 85) to east of Hardy (km 100)

The accident rate for the four-lane rural portion of this segment is 22% above the statewide average, while the remaining portion of the segment is below the statewide average. The fatal accident rate for this segment is below the statewide average. Six peak locations of accidents by number of accidents in this segment can be identified as follows:

- Intersection with SH 175 Spur (km 86.37) with ten accidents over the three-year study period.
- Intersection with County Road 59 (km 88.35) with seven accidents over the three-year study period.
- Intersection with Pontiac Drive (km 92.35) with four accidents over the three-year study period.
- Intersection with SH 175 (km 94.31) with twenty accidents over the three-year study period.
- Intersection with US 63 (km 96.63) with five accidents over the three-year study period.
- Intersection with Spring Street (km 99.56) with five accidents over the three-year study period.

2.3.5 Segment 5. Along US 63 from east of Hardy (km 100) to east of Imboden (km 133)

The accident rate for this segment is 14% above the statewide rural average, while the fatal accident rate is 123% above the statewide rural average. The sections of roadway that run through Ozark Acres (km 104 - km 108), Ravenden (km 122 - km 124), and Imboden (km 130 - km 132) have higher accident rates due to urban conditions. Four peak locations of accidents by number of accidents in this segment can be identified as follows:

- Intersection with SH 175 (km 100.90) with eight accidents over the three-year study period.
- Intersection with SH 58 (km 109.00) with five accidents over the three-year study period.
- Intersection with SH 90 (km 122.90) with ten accidents over the three-year study period.
- Intersection with SH 115 (km 130.63) with five accidents over the three-year study period.

2.3.6 Segment 6. Along US 63 from east of Imboden (km 133) to east of Portia (km 152.4) at the intersection of US 412

The accident rate and the fatal accident rate for this segment are below the statewide average. Two peak locations of accidents by number of accidents in this segment can be identified as follows:

- Intersection with SH 117 (km 144.68) with seven accidents over the three-year study period.
- Bridge 2112 (km 146.65) over the Black River with ten accidents over the three-year study period.

2.3.7 Segment 7. Along US 412 from east of Portia (km 152.4) at the intersection of US 63 to east of Walnut Ridge (km 164)

The accident rate for this segment is 136% above the statewide rural average and 147% above the statewide urban average, while the rural fatal accident rate is 20% above the statewide average. There are no urban fatal accidents in this segment. The section of roadway that runs through Walnut Ridge (km 158 - km 162) has higher accident rates due to urban conditions. Nine peak locations of accidents by number of accidents in this segment can be identified as follows:

- Intersection with Free Street (km 159.36) with thirteen accidents over the three-year study period.
- Intersection with A Avenue (km 159.59) with six accidents over the three-year study period.
- Intersection with Old Pocahontas Road (km 159.75) with six accidents over the three-year study period.
- Intersection with 6th Street (km 160.10) with six accidents over the three-year study period.
- Intersection with US 67/R.R. Crossing (km 160.31) with twenty accidents over the three-year study period.
- Intersection with 2nd Street (km 160.47) with nine accidents over the three-year study period.
- Intersection with 3rd Street (km 160.58) with eight accidents over the three-year study period.
- Intersection with 4th Street (km 160.70) with five accidents over the three-year study period.
- Intersection with SH 91 (km 160.91) with four accidents over the three-year study period.

2.3.8 Segment 8. Along US 412 from east of Walnut Ridge (km 164) to west of Paragould (km 192)

The accident rate for this segment is below the statewide average; however, the fatal accident rate is 113% above the statewide average. There is no peak location of accidents in this section.

2.3.9 Segment 9. Along US 412 from west of Paragould (km 192) to east of Paragould (km 208.5)

Since AHTD is currently evaluating the feasibility of a bypass around Paragould, this segment has not been analyzed as part of this report.

2.3.10 Segment 10. Along US 412 from east of Paragould (km 208.5) to the Missouri state line (km 217.3)

The accident rate and the fatal accident rate for this segment is below the statewide average. There is no peak location of accidents in this segment.

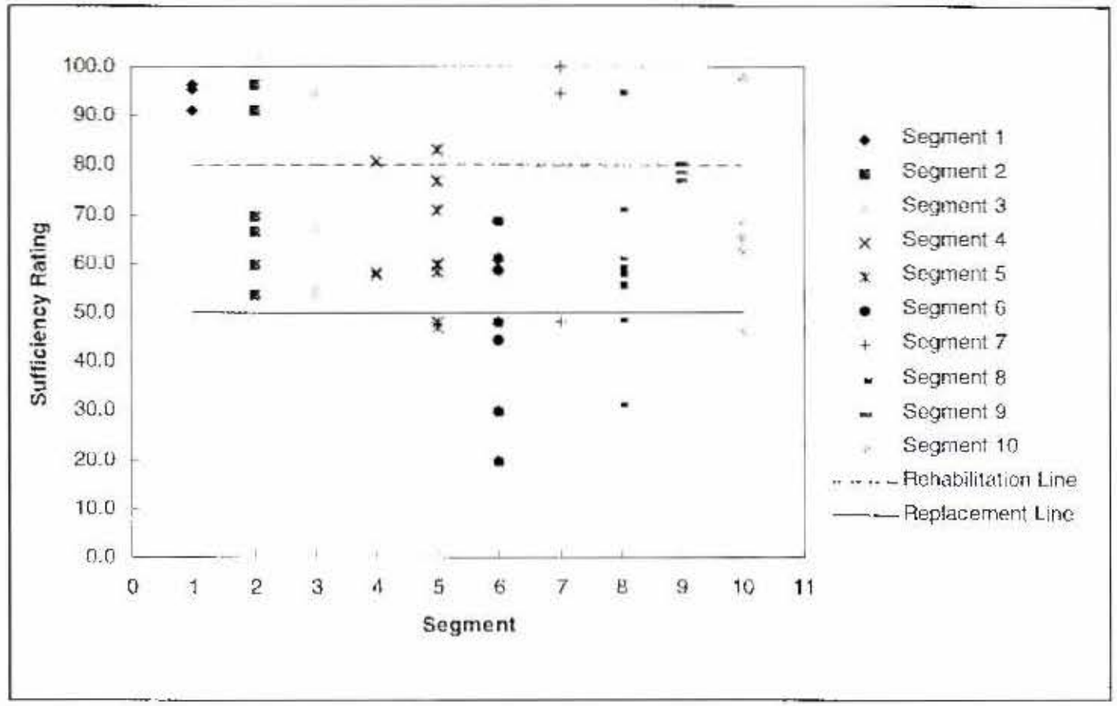
2.4 BRIDGE CONDITIONS

Exhibits 2-9 and 2-10 show the sufficiency ratings of the bridges in the study corridor per data received from AHTD. All bridges with a sufficiency rating between 80.0 and 50.0 inclusive are eligible for rehabilitation with Highway Bridge Replacement & Rehabilitation Program (HBRRP) funds. All bridges with a sufficiency rating less than 50.0 are eligible to use HBRRP funds for replacement. Existing bridge widths have been evaluated using the design criteria defined in Table 3-3. Table 2-5 describes the bridges in the design corridor.

2.4.1 Segment 1. Along US 62 from Norfork Lake (km 10) to east of Viola (km 40)

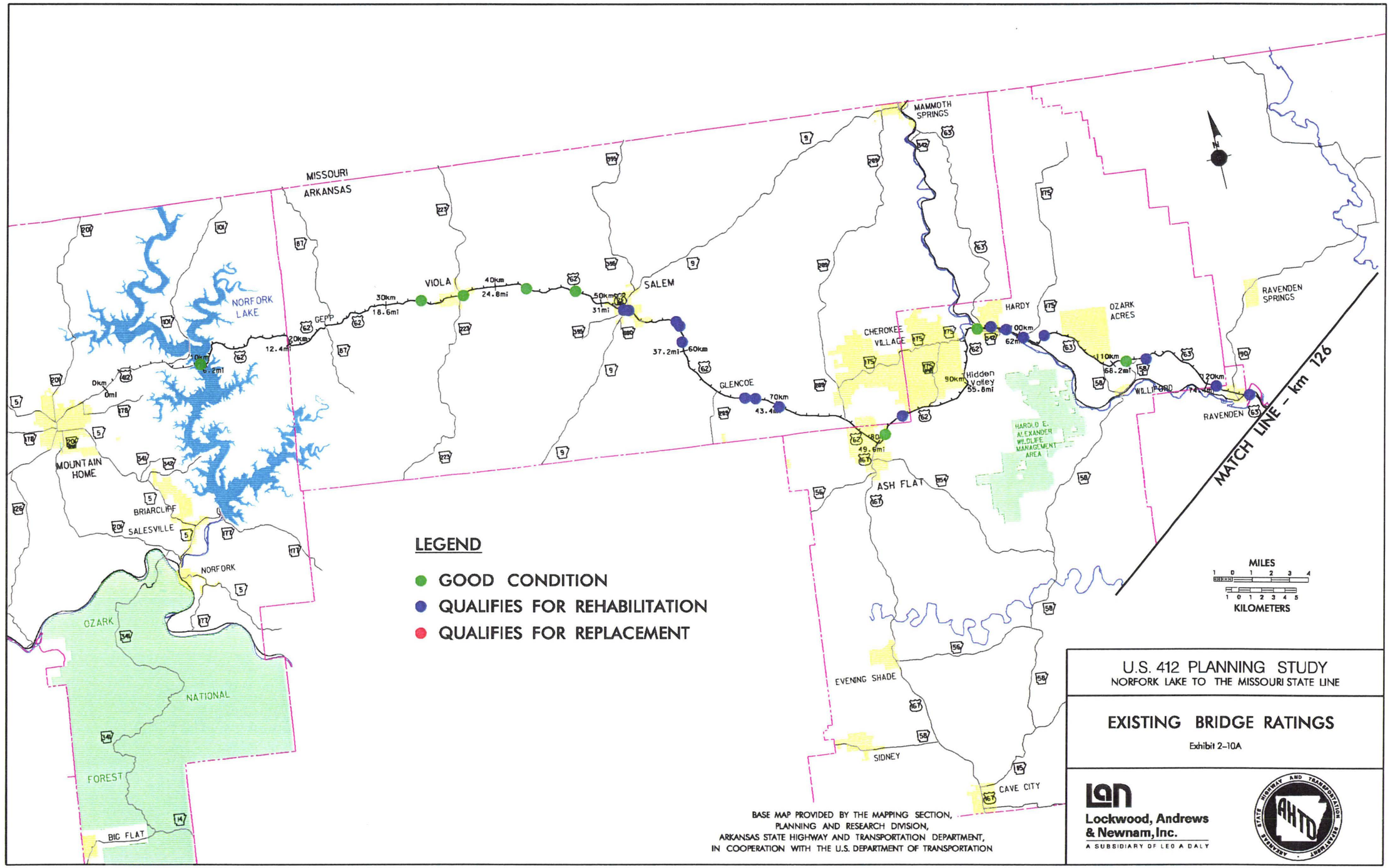
This segment has two bridges and is immediately preceded by the bridge over Norfork Lake (Bridge 05770). Both bridges in this segment (Bridge 01927 and Bridge 01831) have a sufficiency rating of 85.0 or higher, but do not meet design criteria of any of the four road types under consideration. The bridge over Norfork Lake has a sufficiency rating of over 85.0, but a width adequate for a two-lane rural arterial road type only.

Exhibit 2-9: EXISTING BRIDGE CONDITIONS



2.4.2 Segment 2. Along US 62 from east of Viola (km 40) to east of Salem (km 58)

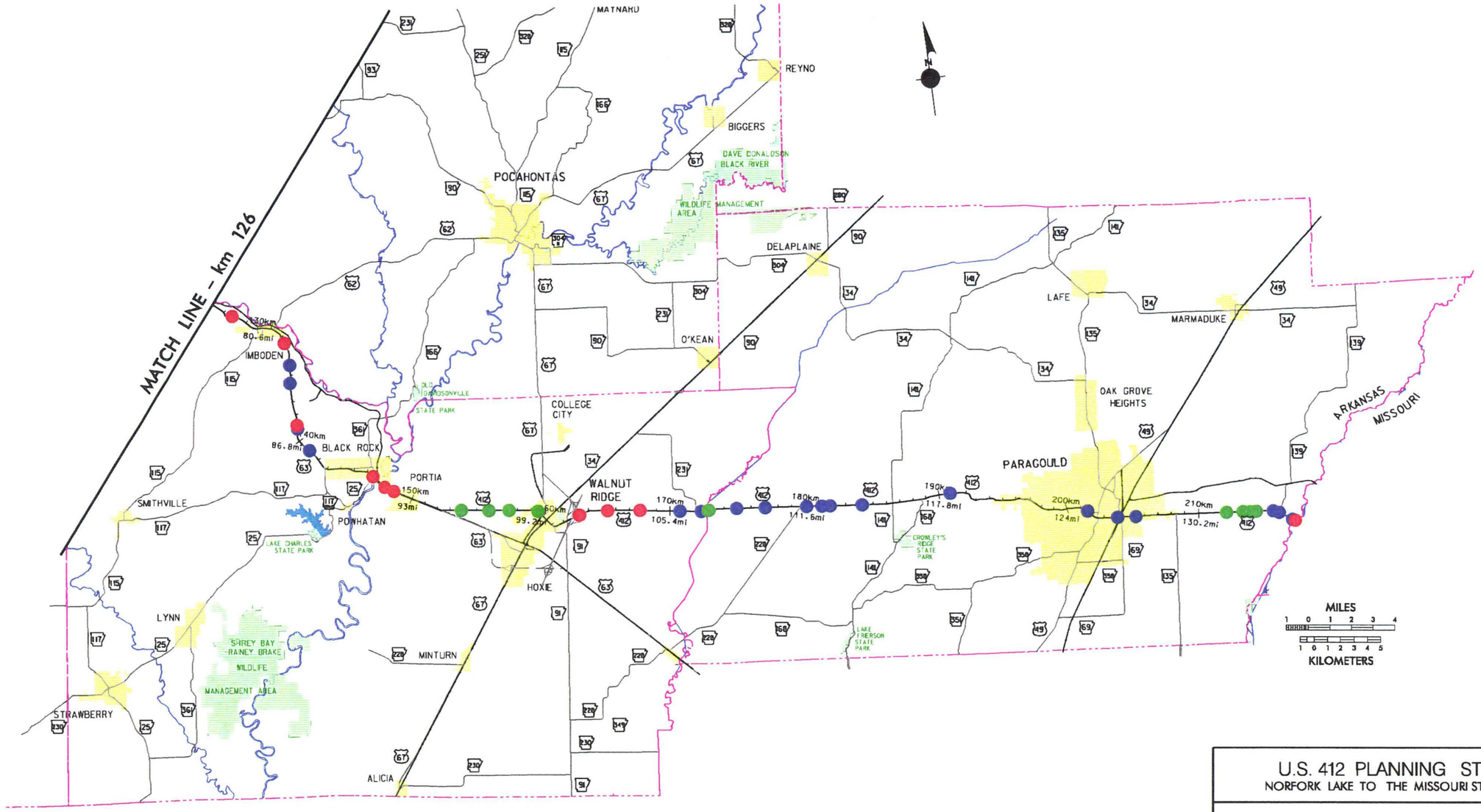
This segment has five bridges and one box culvert. Two of the bridges have a sufficiency rating of 85.0 or higher. Three of the bridges have a sufficiency rating between 80.0 and 55.0: Town Creek (Bridge 02968), South Fork Town Creek (Bridge A1532) and Wolf Creek (Bridge A1533). The box culvert has a sufficiency rating between 55.0 and 50.0: an unnamed creek (Bridge M1119). Two bridges have been declared functionally obsolete: Town Creek (Bridge 02968) and South Fork Town Creek (Bridge A1532). Four bridges in this segment do not meet design criteria of any of the four road types under consideration. The bridge over Davenport Creek (Bridge 01832) has a width adequate for a two-lane rural arterial road type only.



U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING BRIDGE RATINGS

Exhibit 2-10A



LEGEND

- GOOD CONDITION
- QUALIFIES FOR REHABILITATION
- QUALIFIES FOR REPLACEMENT

BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING BRIDGE RATINGS

Exhibit 2-10B

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2.4.3 Segment 3. Along US 62 from east of Salem (km 58) to the intersection with US 63 (km 80) and then along US 63 to east of Ash Flat (km 85)

This section has six bridges. One bridge has a sufficiency rating of 85.0 or higher. Another bridge has a sufficiency rating between 80.0 and 55.0 exclusive: Worthington Creek (Bridge X0871). Four bridges have a sufficiency rating between 55.0 and 50.0 inclusive: Miller Creek (Bridge M1120), Lick Creek (Bridge M1121), Lick Creek (Bridge M1122) and Wild Horse Creek (Bridge M1123).

2.4.4 Segment 4. Along US 63 from east of Ash Flat (km 85) to east of Hardy (km 100)

This section has three bridges. One bridge has a sufficiency rating between 85.0 and 80.0: Spring River (Bridge 02056). Two bridges have a sufficiency rating between 80.0 and 55.0: Forty Island Creek (Bridge A1135) and Flat Creek (Bridge A1136). One bridge has been declared functionally obsolete: Flat Creek (Bridge A1136).

2.4.5 Segment 5. Along US 63 from east of Hardy (km 100) to east of Imboden (km 133)

This section has eight bridges. One bridge has a sufficiency rating between 85.0 and 80.0: Humphrey Creek (Bridge 02555). Five bridges have a sufficiency rating between 80.0 and 55.0: Cabin Creek (Bridge A1137), Sugar Creek (Bridge A1138), Martin Creek (Bridge 03406), Browns Creek (Bridge 02554) and Spring River (Bridge 02540). Two bridges have a sufficiency rating of less than 50.0: an unnamed creek (Bridge M1128) and Harding Creek (Bridge A0650). Four bridges have been declared functionally obsolete: Cabin Creek (Bridge A1137), Sugar Creek (Bridge A1138), Spring River (Bridge 02540) and Harding Creek (Bridge A0650).

2.4.6 Segment 6. Along US 63 from east of Imboden (km 133) to east of Portia (km 152.4) at the intersection of US 412

This section has eight bridges. Four bridges have a sufficiency rating between 80.0 and 55.0: an unnamed creek (Bridge A0651), Chaplin Creek (Bridge A0652), an unnamed creek (Bridge X0888), and Stinnit Creek (Bridge A0655). Four bridges have a sufficiency rating of less than 50.0: Brushy Creek (Bridge A0653), Black River (Bridge 02112), an unnamed slough (Bridge 02190), and Black River Relief (Bridge 02189). Five of the bridges eight bridges have also been declared functionally obsolete: an unnamed creek (Bridge A0651), Chaplin Creek (Bridge A0652), Brushy Creek (Bridge A0653), Stinnit Creek (Bridge A0655) and an unnamed slough (Bridge 02190).

2.4.7 Segment 7. Along US 412 from east of Portia (km 152.4) at the intersection of US 63 to east of Walnut Ridge (km 164)

Four of the five bridges in this section have a sufficiency rating of 85.0 or higher. One bridge has a sufficiency rating less than 50.0: White Oak Slough (Bridge 01888).

2.4.8 Segment 8. Along US 412 from east of Walnut Ridge (km 164) to west of Paragould (km 192)

This section has twelve bridges. One bridge has a sufficiency rating of 85.0 or higher. Nine bridges have a sufficiency rating between 80.0 and 55.0: Flat Board Road Slough (Bridge 01891), an unnamed slough (Bridge M0620), Cache Relief (Bridge 01909), Lateral No. 3 (Bridge 01913), Grassy Slough (Bridge 01914), Overcup Slough (Bridge 01974), Main Lateral Drain Ditch (Bridge 01915), Caney Slough (Bridge 01916) and Sugar Creek (Bridge M0621). Two bridges have a sufficiency rating of less than 50.0: Kellow Canal (Bridge 01889) and an unnamed canal (Bridge 01890). Two bridges have been declared functionally obsolete: an unnamed canal (Bridge 01890) and Sugar Creek (Bridge M0621).

2.4.9 Segment 9. Along US 412 from west of Paragould (km 192) to east of Paragould (km 208.5)

All three bridges in this section have a sufficiency rating between 80.0 and 55.0 inclusive: Eight Mile Creek (Bridge 06289), 2nd Street and SLSW RR (Bridge 06087), and Eight Mile Creek (Bridge 05266).

Table 2-5: SUMMARY OF BRIDGES

Segment	Station (km)	Feature	Str Length	Width C/C	Proposed Width*	Suff Rate	Qualifying Code**	Bridge Number
0	8.94	Norfork Lake	3460	44	40	95.4	NQ	05770
1	33.01	Shipman Creek	44	34	40	96.4	NQ	01927
1	36.92	Big Creek	104	34	40	91.1	NQ	01831
2	42.68	Davenport Creek	62	44	40	96.2	NQ	01832
2	47.05	Pine Hill Creek	46	34	40	91.1	NQ	01833
2	51.99	Town Creek	150	26	40	66.6	FO	02968
2	52.5	South Fork Town Creek	100	26	40	59.5	FO	A1532
2	57.1	Wolf Creek	100	26	40	69.7	NQ	A1533
2	57.5	Creek	37	0	40	53.8	NQ	M1119
3	59.11	Miller Creek	33	0	40	53.8	NQ	M1120
3	67.21	Lick Creek	32	0	40	55	NQ	M1121
3	68.13	Lick Creek	21	0	40	55	NQ	M1122
3	70.36	Wild Horse Creek	32	0	40	55	NQ	M1123
3	81.17	Hackney Creek	105	68	40	94.7	NQ	06498
3	83.51	Worthington Creek	35	0	40	67.2	NQ	X0871
4	96.03	Spring River	1078	50	40	80.7	NQ	02056
4	97.66	Forty Island Creek	104	28	40	57.6	NQ	A1135
4	98.96	Flat Creek	82	26	40	58.2	FO	A1136
5	100.65	Cabin Creek	42	26	40	58.2	FO	A1137
5	102.95	Sugar Creek	82	26	40	59.9	FO	A1138
5	111.37	Humphrey Creek	58	38	40	83.2	NQ	02555
5	113.27	Martin Creek	227	28	40	70.7	NQ	03406
5	121.2	Browns Creek	66	38	40	76.8	NQ	02554
5	124.11	Spring River	528	26	40	59.6	FO	02540
5	128.1	Creek	30	0	40	47	NQ	M1128
5	132.8	Harding Creek	71	26	40	48.1	FO	A0650
6	134.5	No Name Creek	31	26	40	60.8	FO	A0651
6	135.87	Chaplin Creek	51	26	40	60.8	FO	A0652
6	139.06	Brushy Creek	36	26	40	48.1	FO	A0653
6	139.3	Creek	22	0	40	68.7	NQ	X0888
6	141.25	Stinnit Creek	142	26	40	58.5	FO	A0655
6	146.64	SH 25, Black River	2608	26	40	29.8	SD	02112
6	147.96	Slough	194	26	40	44.5	FO	02190
6	148.72	Black River Relief	290	26	40	19.5	SD	02189
7	154.08	Running Water Creek	105	40	40	94.7	NQ	05725
7	156.16	Swan Pond Ditch	75	40	40	94.7	NQ	05726
7	157.66	Coon Creek	99	40	40	94.7	NQ	05727
7	159.75	Village Creek	105	40	40	99.9	NQ	05728
7	163.19	White Oak Slough	46	27.2	40	48.1	NQ	01888
8	165.25	Kellow Canal	46	27.2	40	48.2	NQ	01889
8	167.71	Canal	46	27.2	40	31.1	FO	01890
8	170.63	Flat Board Road Slough	102	24	40	60.8	SD	01891
8	172.3	Slough	26	0	40	55.8	NQ	M0620
8	172.65	Cache River	384	70	40	94.6	NQ	06565
8	174.81	Cache Relief	47	27	40	70.8	NQ	01909
8	176.95	Lateral No. 3	92	24.2	40	58.7	NQ	01913
8	179.96	Grassy Slough	61	27	40	59.3	NQ	01914
8	181.2	Overcup Slough	62	27	40	59.3	NQ	01974
8	181.68	Main Lateral Drain Ditch	71	24	40	58.5	NQ	01915
8	184.04	Caney Slough	71	24	40	57.7	NQ	01916
8	190.66	Sugar Creek	76	23.7	40	55.4	FO	M0621
9	201.41	Eight Mile Creek	140	52	40	76.8	NQ	06289
9	203.94	2nd St. And SLSW RR	546	50	40	80	NQ	06087
9	205.18	Eight Mile Creek	132	50	40	78.4	NQ	05266
10	211.82	Johnson Creek	75	43	40	97.4	NQ	05267
10	212.72	Locust Creek Relief	75	43	40	97.4	NQ	05301
10	213.03	Locust Creek	132	43	40	97.4	NQ	05268
10	213.58	Mud Slough	75	43	40	97.4	NQ	05269
10	215.25	Big Slough	462	26	40	65.3	NQ	01664
10	215.67	Gate Ditch	26	0	40	68.4	NQ	M0622
10	216.15	St. Francis River Relief	450	26	40	62.8	FO	03037
10	216.86	St. Francis River	1941	26	40	45.9	FO	02877

* For a two-lane rural arterial.
** NQ: Not Qualified; FO: Functionally Obsolete; SD: Structurally Deficient.

2.4.10 Segment 10. Along US 412 from east of Paragould (km 208.5) to the Missouri state line (km 217.3)

Out of eight bridges in this section, four bridges have a sufficiency rating of 85.0 or higher. Three of the bridges have a sufficiency rating between 80.0 and 55.0: Big Slough (Bridge 01664), Gate Ditch (Bridge M0622) and St. Francis River Relief (Bridge 03037). One bridge has a sufficiency rating of

less than 50.0: St. Francis River (Bridge 02877). Two bridges have been declared functionally obsolete: St. Francis River Relief (Bridge 03037) and St. Francis River (Bridge 02877).

2.5 MULTIMODAL TRANSPORTATION SYSTEM

Transportation in the study area is not limited to automobile and truck traffic. Railroads, airports, waterways and pipelines exist in this area. This diversity not only provides competition in the transport of goods and people but also creates a network of systems that complement one another in serving the needs of north Arkansas. Exhibit 2-11 shows the location of the transportation systems in the study corridor area.

2.5.1 Railroads

Five railroad lines affect the study corridor. St. Louis Southern Railroad operates a north-south line with 15 trains per day through Paragould. Union Pacific Railroad operates a north-south line with 31 trains per day through Walnut Ridge. A second Union Pacific Railroad line handles 5 trains per day southeast-northwest from Newport to Norfork. Burlington Northern Railroad operates a north-south line through Walnut Ridge with no regular traffic. Another Burlington Northern Railroad line handles 30 trains per day southeast-northwest from Hoxie to Hardy parallel to the study corridor.

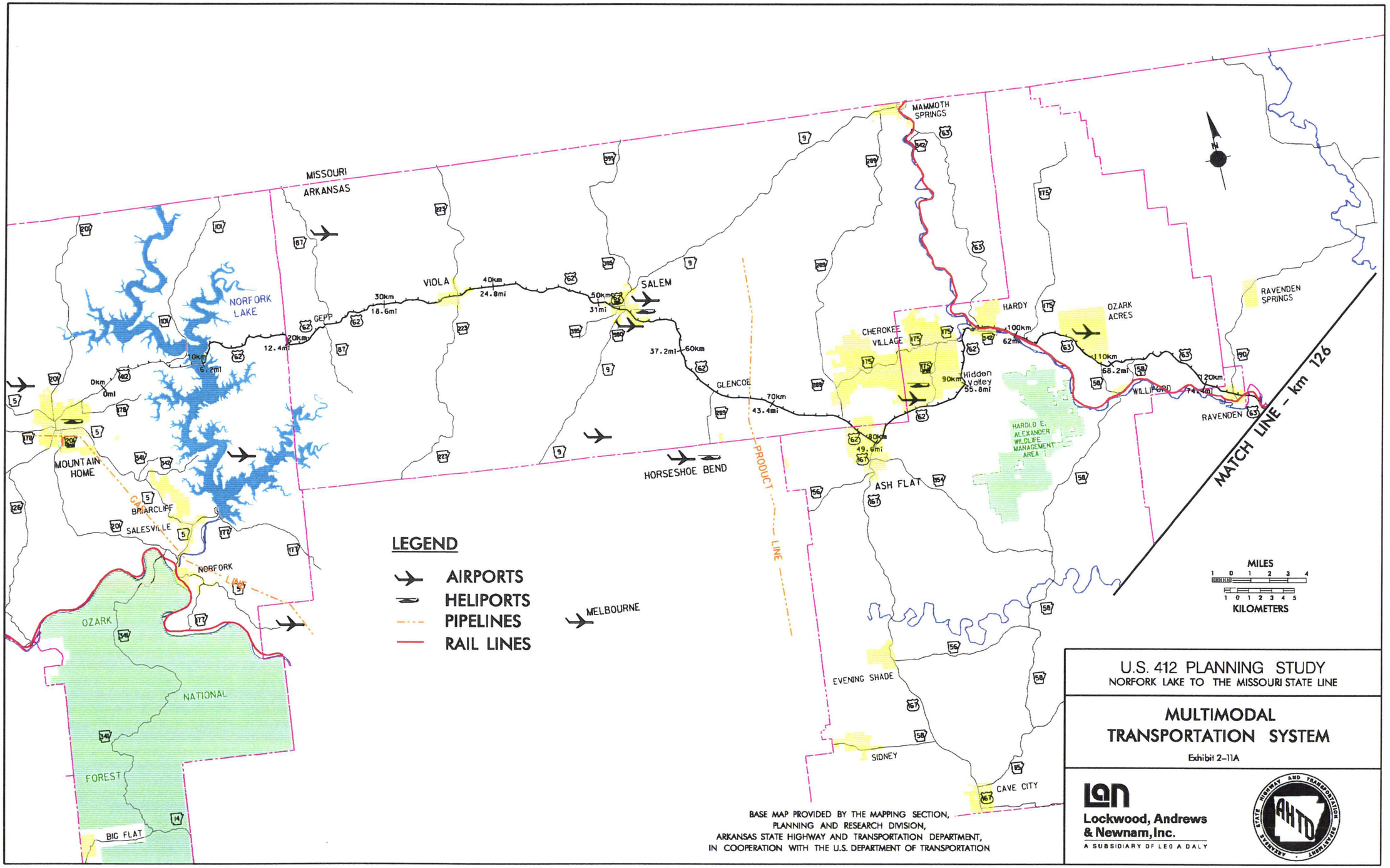
The railroad lines discussed above connect to metropolitan areas such as Memphis, Tennessee; Little Rock, Arkansas; St. Louis, Missouri; and Springfield, Missouri. These railroad lines transport industrial products, coal, agricultural products and even passengers to and from the study corridor. The railroad is a direct competitor with the trucks that use the study corridor; however, the trains are very restricted in where they can load and unload. This restriction provides opportunities for trucks to work with the railroad to transport products between their origin/destination and the trains.

Union Pacific Railroad is in the construction phase of a new intermodal yard in Ebony, Arkansas. This yard will move the current operation in Memphis, Tennessee across the river into Arkansas. The intermodal yard provides a location for the transfer of freight from other transportation systems to trains: truck trailers and barge crates loaded onto flat cars, for example. The new yard will increase train traffic in the study corridor as well as add to the transportation system serving the corridor.

2.5.2 Airports

Information provided by AHTD shows 30 airports in the study corridor. Two airports near the corridor offer commercial service: Jonesboro Municipal and Baxter County Regional (Mountain Home). Fourteen airports in the area are designated as public use - general aviation airports: Gaston's White River Resort (Lakeview), Calico Rock/Izard County, Salem, Horseshoe Bend, John Miller Field (Melbourne), Cherokee Village (Ash Flat), Nick Wilson Field (Pocahontas), Walnut Ridge Regional, Nolan (Jonesboro), Kirk Field (Paragould), Rector Municipal, Manila Municipal, Arkansas International (Blytheville), and Blytheville Municipal. Six airports in the area are designated as private use - general aviation airports: The Bluffs (Henderson), White River (Melbourne), John Parker Strip (Jonesboro), Caldwell Field (Walcott), Quinn Field (Paragould) and Randal Field (Gosnell). Eight heliports are located near the study corridor: Baxter County Regional Hospital (Mountain Home), Fulton County Hospital (Salem), Horseshoe Bend Municipal Airport, Cherokee Village Airport (Ash Flat), Randolph County Medical Center (Pocahontas), Lawrence Memorial (Walnut Ridge), Methodist Hospital of Jonesboro and Mississippi County Hospital (Blytheville). No military airfields are located in the study corridor.

The air travel in the area provides another form of competition to the highway system in the corridor. The air travel can also complement the highway system by establishing a means to import and export products into the region quickly and from anywhere in the world. The air traffic is limited to the air terminals and requires automobile traffic to transport people and goods to other locations. Heliport locations also provide emergency service to the corridor.


MISSOURI
ARKANSAS
NORFORK LAKE
MOUNTAIN HOME
BRIARCLIFF
SALESVILLE
NORFORK
GAS LINE
OZARK
NATIONAL
FOREST
BIG FLAT
GEPP
VIOLA
SALEM
GLENCOE
HORSESHOE BEND
MELBOURNE
PRODUCT LINE
MAMMOTH SPRINGS
CHEROKEE VILLAGE
HARDY
Hidden Valley
ASH FLAT
HAROLD E. ALEXANDER WILDLIFE MANAGEMENT AREA
OZARK ACRES
WILLIFORD
RAVENDEN
RAVENDEN SPRINGS
EVENING SHADE
SIDNEY
CAVE CITY
MATCH LINE - km 126
0km 0mi
10km 6.2mi
20km 12.4mi
30km 18.6mi
40km 24.8mi
50km 31mi
60km 37.2mi
70km 43.4mi
80km 49.6mi
90km 55.8mi
100km 62mi
110km 68.2mi
120km 74.4mi
LEGEND
AIRPORTS
HELIPORTS
PIPELINES
RAIL LINES
MILES
KILOMETERS
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
MULTIMODAL TRANSPORTATION SYSTEM
Exhibit 2-11A
Lockwood, Andrews & Newnam, Inc.
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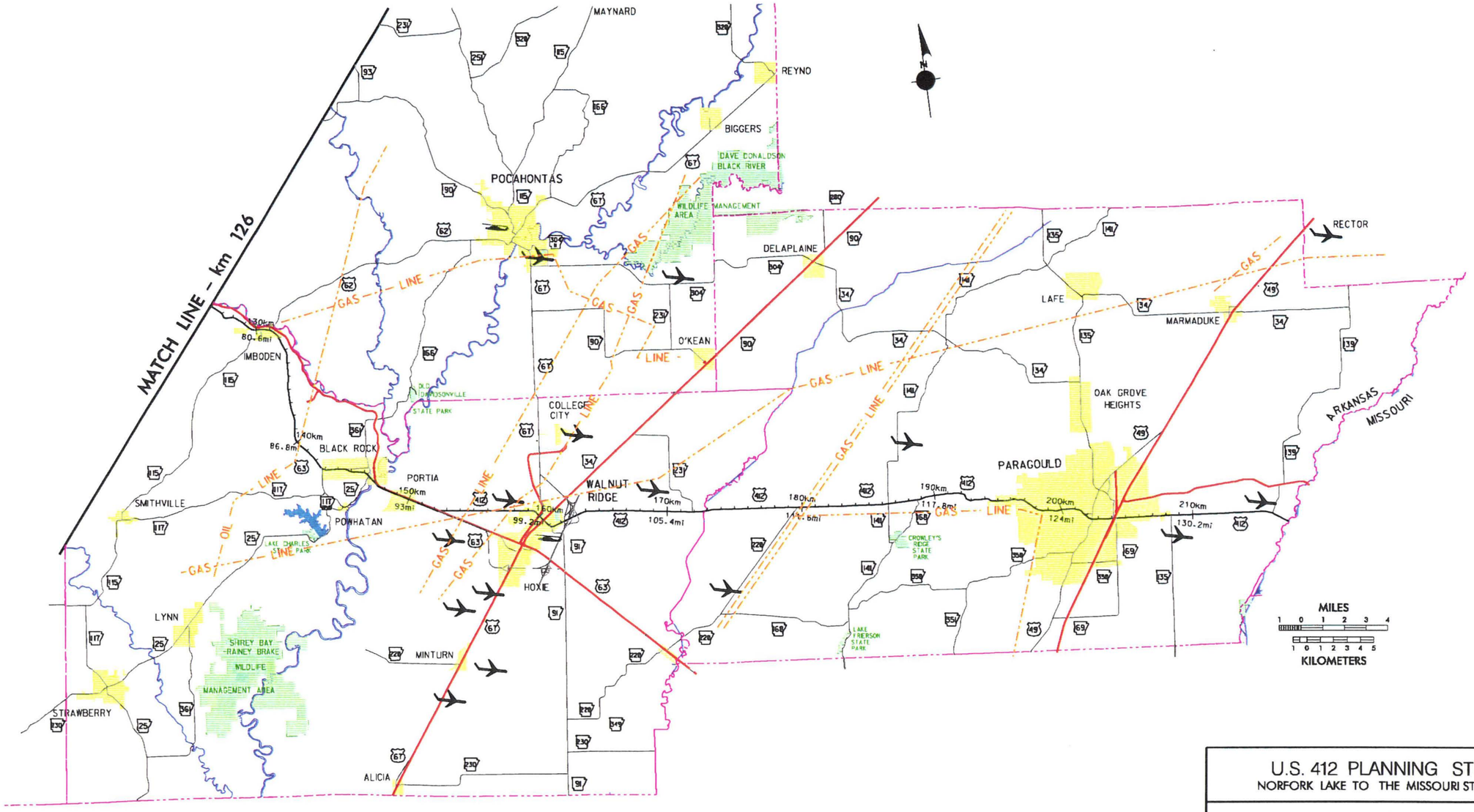
AHTD



LEGEND

- AIRPORTS
- HELIPORTS
- PIPELINES
- RAIL LINES

BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

MULTIMODAL TRANSPORTATION SYSTEM

Sheet 2-11B

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2.5.3 Waterways

Six rivers are located in or near the study corridor. Five of the these rivers are not navigable by barges through the corridor: White River (including Norfork Lake), Spring River, Black River, Cache River and St. Francis River. These rivers are primarily used for recreational and water supply purposes and not freight transport. The Mississippi River is the nearest navigable river to the area and serves as a complement to the transportation system in the area.

2.5.4 Pipelines

The study corridor is crossed by ten pipeline systems. These pipelines transport many products such as oil and natural gas to the study corridor. Most of the lines run perpendicular to the corridor and are no competition to the highway system. As with the other transportation systems, the pipeline system is restricted in locations of extracting the products and therefore provides opportunities for the highway system to transport the products to their final destination.

PROPOSED ALTERNATIVES

3.1 GENERAL

This chapter describes the Proposed Alternatives developed in this study to serve the projected traffic volumes as potential improvements to US 412. These alternatives will provide the Measures of Effectiveness (MOE's) for use in the comparison process. The Proposed Alternatives are five different improvement strategies for US 412. Each Proposed Alternative has a different typical cross section, serves a different traffic volume, and has a different construction cost. The evaluation process in Chapter 9 will compare the benefits and costs of each alternative in order to select a recommended alternative.

3.2 DEFINITION

Five Proposed Alternatives will be used in this study. These include:

Base Case - The base case is the alternative against which all other alternatives will be compared. The base case assumes that all Committed Improvements will be in place by design year 2017. This Proposed Alternative does not propose any additional capacity improvements and assumes a continued maintenance program.

Improved Two-Lane Rural Arterial - This alternative consists of localized improvements to the existing two-lane/two-way section. Some of the localized improvements include: providing full continuous shoulders on both sides, climbing lanes where necessary and bypasses around urban areas where necessary. Typically, it is recommended for design year AADTs of less than 7,000 vehicles.

Multilane Undivided Rural Highway - This alternative proposes to widen the existing roadway to a four-lane undivided section with unlimited access. A left turning lane will be provided through urban areas as necessary. Typically, it is recommended for AADTs of less than 12,000 vehicles in the design year.

Four-Lane Divided Rural Highway - This alternative proposes to convert the existing two-lane/two-way roadway to a one-way roadway and build a parallel two-lane/one-way road divided by a grassed median. This roadway would have unlimited access. Typically, it is recommended for design year AADTs between 7,000 and 20,000 vehicles. Due to geometric design requirements the existing roadway would have to be improved at selected locations.

Four-Lane Freeway - It is proposed to build a median divided, full access controlled, full grade separated freeway to Interstate Standards. Due to the proposed geometric criteria, it would be necessary to relocate the alignment for most of the project's length. The existing roadway would be used for access at selected locations. Typically, it is recommended for design year AADTs of up to 40,000 vehicles. This Proposed Alternative assumes that a freeway of such characteristics will be in place by the design year 2017 from Tulsa, Oklahoma to Nashville, Tennessee as defined by ISTEA as Corridor 8.

3.3 TERRAIN

Three different terrain conditions are defined by the AASHTO based on the terrain's geometric characteristics:

Level Terrain - is that condition where highway sight distances, as governed by both horizontal and vertical restrictions, are generally long or could be made to be so without construction difficulty or major expense.

Rolling Terrain - is that condition where the natural slopes consistently rise above and fall below the road or street grade and where occasional steep slopes offer some restriction to normal horizontal and vertical roadway alignment.

Mountainous Terrain - is that condition where longitudinal and transverse changes in the elevation of the ground with respect to the road or street are abrupt and where benching and side hill excavation are frequently required to obtain acceptable horizontal and vertical alignment.

All three terrain conditions exist along the corridor: mountainous and rolling from Norfork Lake to Walnut Ridge and through Crowley's Ridge west of Paragould, and level from Walnut Ridge to Crowley's Ridge and from Paragould to the Missouri state line.

3.4 DESIGN CRITERIA

The design criteria was developed in accordance to AASHTO's 1994 "A Policy on Geometric Design of Highways and Streets." Table 3-1 shows the criteria for the fill slope rates which applies for all Proposed Alternatives.

Table 3-1: FILL SLOPE RATES

Height of Fill meters (ft)	Fill Slope Rate
0 -1.5 (0 -4.9)	1:6
1.5 - 3.0 (4.9-9.8)	1:4
3.0 - 4.5 (9.8-14.8)	1:4
> 4.5 (> 14.8)	Subject to Stability Requirements

3.4.1 Two-Lane Rural Arterial Climbing Lane

Should be used when traveling speeds drop by 15 km/h (9.32 mph) with an inadequate Level-of-Service (LOS).

3.4.2 Left Turn Lane

Table 3-2: LEFT TURN LANE

	Left Turn Lane		
Turning ADT, vpd	300	500	750
Minimum Storage Length m (ft.)	30 (98.4)	50 (164.0)	75 (246.1)
Taper Length in m (ft.)	Flat	100 (328.7)	
	Rolling	85 (278.9)	

Table 3-3 shows the different geometric criteria for design and evaluation of the existing roadway for the different terrain types and proposed roadway sections. Exhibits 3-1 through 3-4 show the typical cross sections for the Proposed Alternatives: two-lane rural arterial, multilane undivided rural highway, four-lane divided rural highway and four-lane freeway, respectively. Exhibit 3-5 depicts a typical railroad overpass.

3.4.3 Railroad Grade Separations

A railroad grade separation should be built when a railroad crossing has more than 75,000-100,000 exposures for rural and urban areas, respectively. Exposures are the product of the AADT by the number of train crossings per day.

3.4.4 Four-Lane Freeway Vertical Curve Length

It is a function of the grade difference of the approach tangents, and should be calculated according to Figures III-40 and III-42 (Design controls for crest and sag vertical curves, on pages 286 and 290, respectively) of AASHTO's 1994 "A Policy on Geometric Design of Highways and Streets."

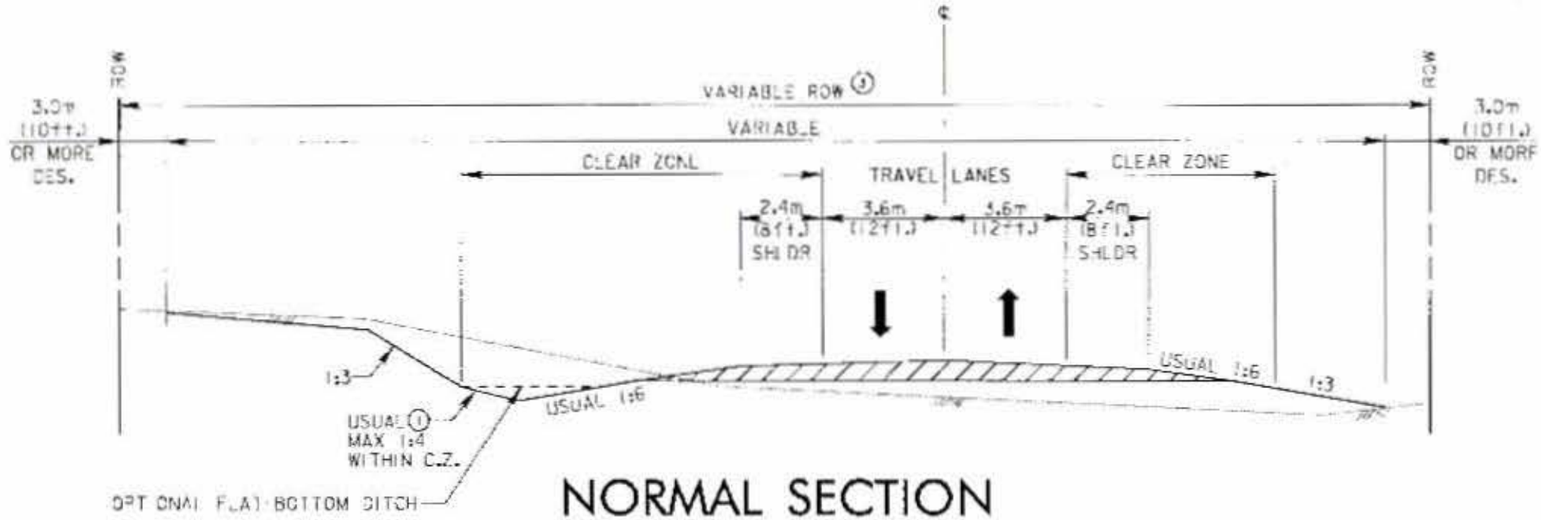
Table 3-3: GEOMETRIC DESIGN CRITERIA

	Two-Lane Rural Arterial			Multilane Rural Undivided Highway			Four-Lane Divided Rural Highway			Four-Lane Freeway		
	Level	Rolling	Mountainous	Level	Rolling	Mountainous	Level	Rolling	Mountainous	Level	Rolling	Mountainous
Design Speed	90 km/h (55 mph)	80 km/h (50 mph)	60 km/h (40 mph)	100 km/h (60 mph)	90 km/h (55 mph)	70 km/h (45 mph)	110 km/h (70 mph)	100 km/h (60 mph)	80 km/h (50 mph)	120 km/h (75 mph)	110 km/h (70 mph)	90 km/h (55 mph)
Max. Superelevation Rate (e_{max})	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Minimum Radius of Curve	275 m (902')	210 m (689')	115 m (377')	360 m (1181')	275 m (902')	160 m (525')	455 m (1493')	300 m (1181')	210 m (689')	595 m (1952')	455 m (1493')	275 m (902')
Maximum Grade	4%	5%	8%	3%	5%	7%	3%	4%	7%	3%	4%	6%
Minimum Stopping Sight Distance	160 m (525')	130 m (427')	85 m (279')	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Minimum Passing Sight Distance	610 m K=390 (2001') [a]	550 m K=310 (1804') [a]	410 m K=180 (1345') [a]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lane Width	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')
Median Width	N/A	N/A	N/A	Paint 1.8 m (6') [b]	Paint 1.8 m (6') [b]	Paint 1.8 m (6') [b]	5.4 m - 18.0 m (18' - 60') [b]	5.4 m - 18.0 m (18' - 60') [b]	5.4 m - 18.0 m (18' - 60') [b]	18.0 m (60')	18.0 m (60')	18.0 m (60')
Left Turning Lane Width	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	3.6 m (12')	N/A	N/A	N/A
Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A	N/A	1.8 m (6')	1.8 m (6')	1.8 m (6')	1.8 m (6')	1.8 m (6')	1.8 m (6')
Outside Shoulder Width	2.4 m (8')	2.4 m (8')	2.4 m (8')	2.4 m (8')	2.4 m (8')	2.4 m (8')	2.4 m (8')	2.4 m (8')	2.4 m (8')	3.0 m (10')	3.0 m (10')	3.0 m (10')
Bridge Width	12.0 m (40')	12.0 m (40')	12.0 m (40')	21.0 m (70')	21.0 m (70')	21.0 m (70')	24.6 m-11.4 m (82' - 38') [b]	24.6 m-11.4 m (82' - 38') [b]	24.6 m-11.4 m (82' - 38') [b]	12.0 m x 2 (40 x 2)	12.0 m x 2 (40' x 2)	12.0 m x 2 (40 x 2)
Horizontal Clearance	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')	9.0 m (30')
Vertical Clearance	N/A (At-grade)	N/A (At-grade)	N/A (At grade)	N/A (At-grade)	N/A (At-grade)	N/A (At-grade)	N/A (At-grade)	N/A (At-grade)	N/A (At-grade)	5.0 m (16.4')	5.0 m (16.4')	5.0 m (16.4')
Pavement Cross Slope	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Railroad Overpass Vertical Clearance	N/A	N/A	N/A	7.0 m (23')	7.0 m (23')	7.0 m (23')	7.0 m (23')	7.0 m (23')	7.0 m (23')	7.0 m (23')	7.0 m (23')	7.0 m (23')

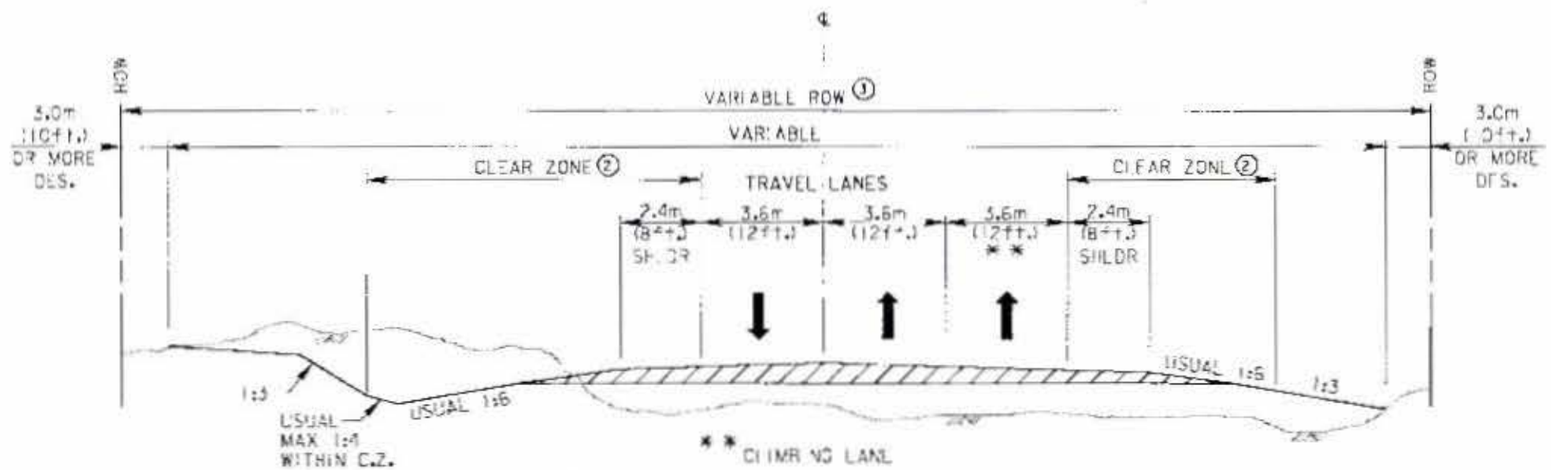
NOTES:

[a] Based on eye height of 1,070 mm and object height of 1,300 mm.
[b] Narrow Surfaced Median - Depressed Median
N/A – Not Applicable

$$K = \frac{\text{Length of Crest Vertical Curve}}{\text{Algebraic Difference in Grades}}$$



NORMAL SECTION



CLIMBING LANE SECTION

NOTES:

① SLOPE MAY BE EXCEEDED IN ROCK CUTS; FOR RESTRICTED RIGHT OF-WAY; DEEP CUT CONDITIONS; OR, WHERE DITCH IS NOT WITHIN CLEAR ZONE.

② WHERE FILL SLOPE RATE IS STEEPER THAN 1:6, AN OBSTRUCTION FREE AREA PREFERABLY SHOULD BE PROVIDED AT THE TOE OF SLOPE

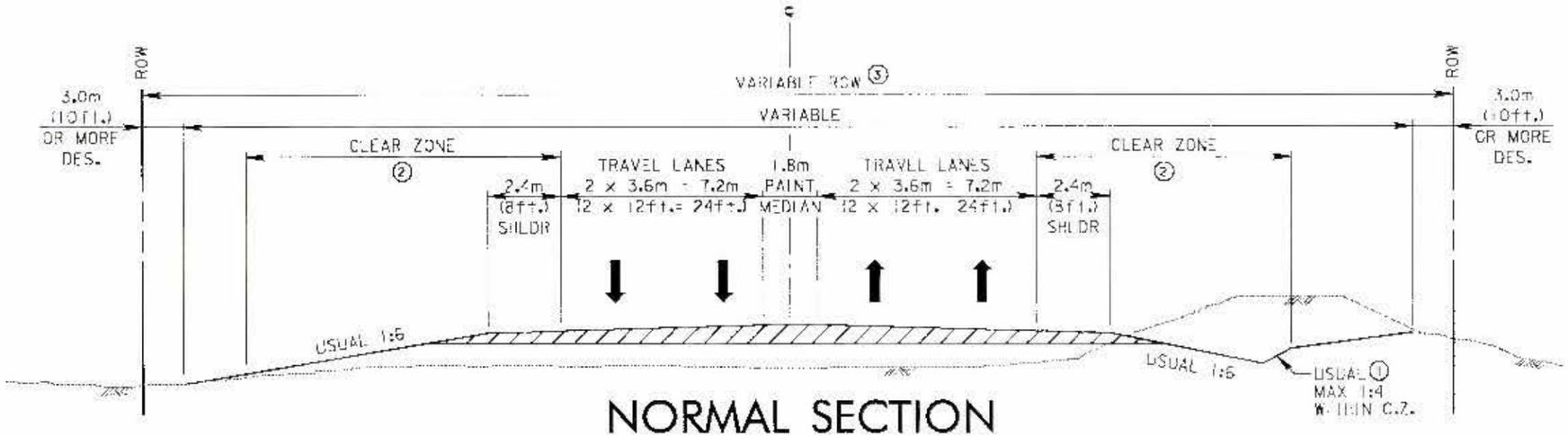
③ ROW WIDTH BASED ON SUM OF INDIVIDUAL CROSS SECTION ELEMENTS FOR SPECIFIC TRAFFIC VOLUME, SLOPE OBSTRUCTION CLEARANCE, AND TERRAIN CONDITIONS.

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

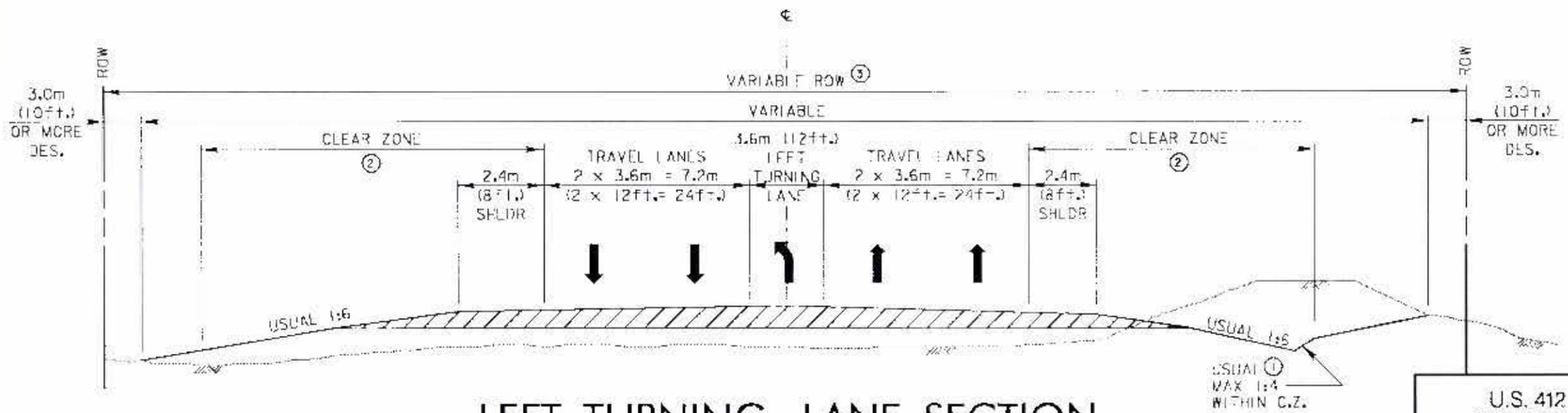
TWO-LANE RURAL ARTERIAL

Exhibit 3-1

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LTV HALY



NORMAL SECTION



LEFT TURNING LANE SECTION

NOTES:

① SLOPE MAY BE EXCEEDED IN ROCK CUTS; FOR RESTRICTIVE RIGHT OF WAY; DEEP CUT CONDITIONS; WHERE DITCH IS LOCATED AT OR BEYOND APPLICABLE CLEARANCE.

② 9.0m (30ft.) USUAL MINIMUM FOR S - 1:6 TO EDGE OF CLEAR ZONE.

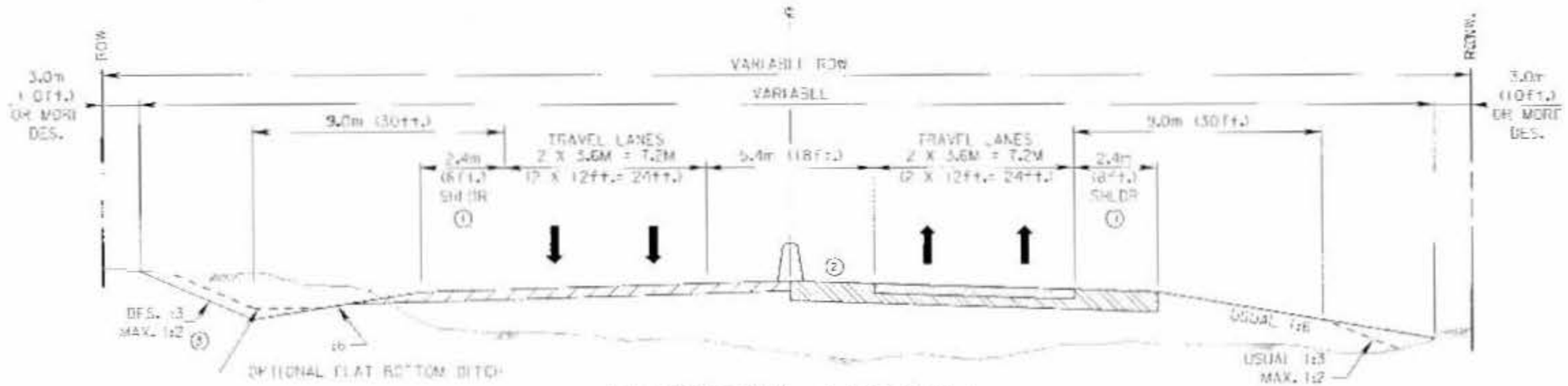
③ SHOULDERS FULLY SURFACED.

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

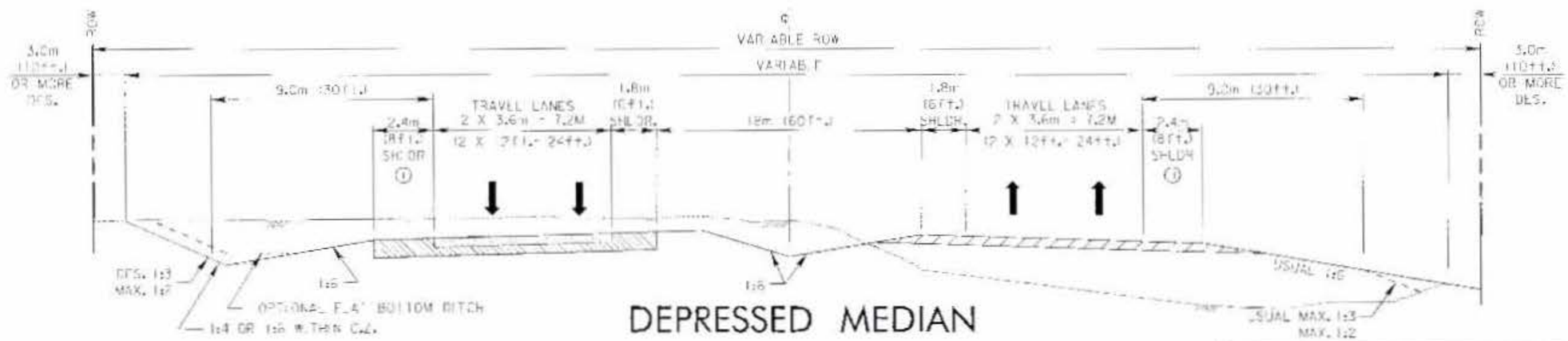
MULTI-LANE UNDIVIDED RURAL HIGHWAY

Exhibit 3.2

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY



NARROW MEDIAN



DEPRESSED MEDIAN

NOTES:

1. SHOULDER FULLY SURFACED
2. MEDIAN PAVED
3. SLOPE MAY BE EXCLUDED ON ROCK CUTS

ASPHALT CONCRETE PAVEMENT

PORTLAND CEMENT CONCRETE PAVEMENT

LIME STABILIZED SUBGRADE

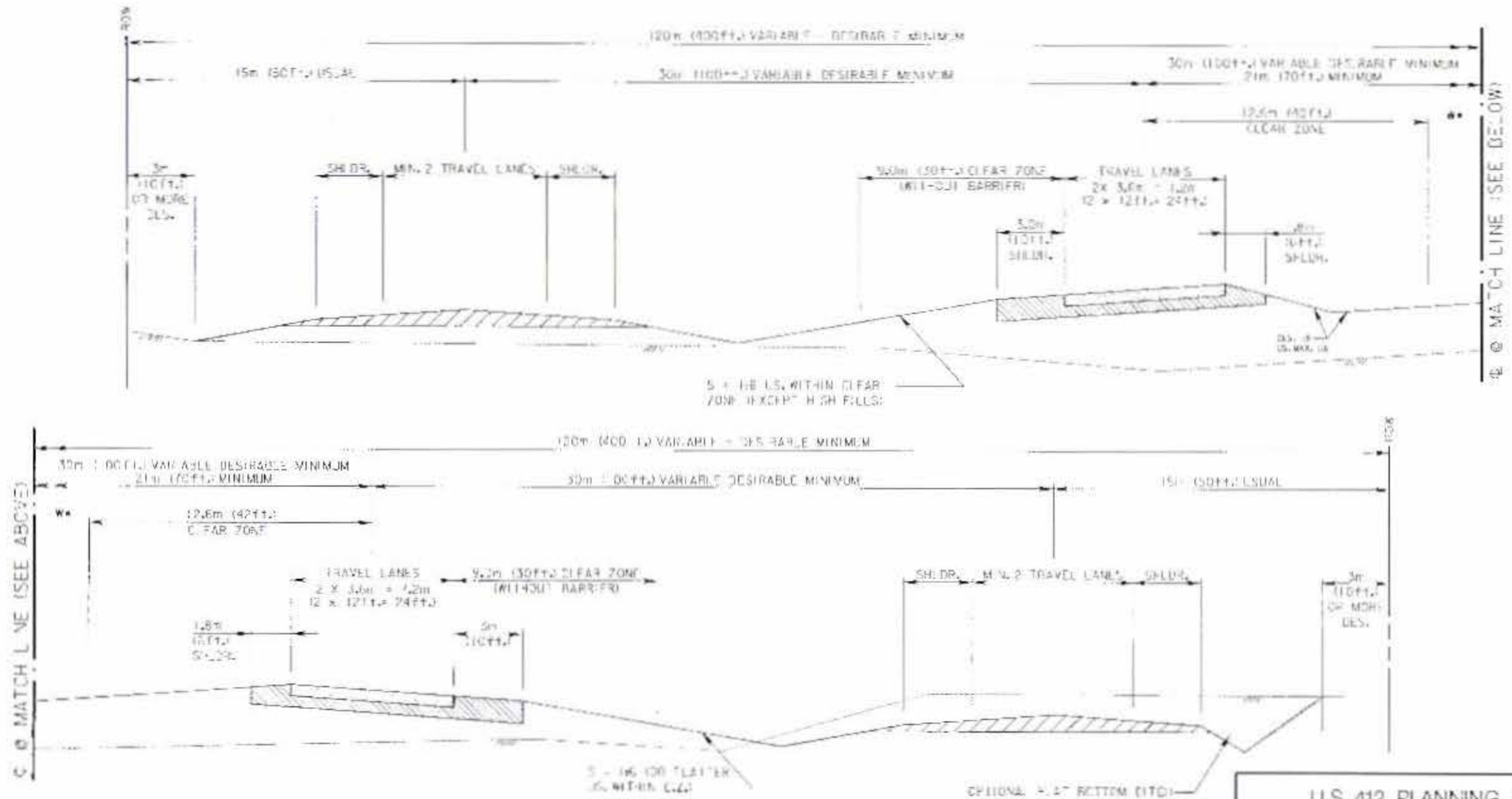
PAVEMENT TYPE TO BE DETERMINED BY OTHERS

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

FOUR LANE DIVIDED
RURAL HIGHWAY

Exhibit 3

Lockwood, Andrews
& Newnam, Inc.



NOTES:

① FOR MINIMUM 9.0m (29.53ft) CLEARANCE TO OBSTRUCTION IN MEDIANS, WIDTH ℄ TO ℄ OF 25.2m (82.7ft) + W* IS REQUIRED.

② BACKSLOPE IN CUTS MAY BE EXCLUDED IN ROCK.

③ ADDITIONAL WIDTH REQUIRED IN INTERCHANGE AREAS.

W* IS WIDTH OF DISTRUCTION.

ASPHALT CONCRETE PAVEMENT

PORTLAND CEMENT CONCRETE PAVEMENT

LIME STABILIZED SUBGRADE

PAVEMENT TYPE TO BE DETERMINED BY OTHERS

U.S. 412 PLANNING STUDY

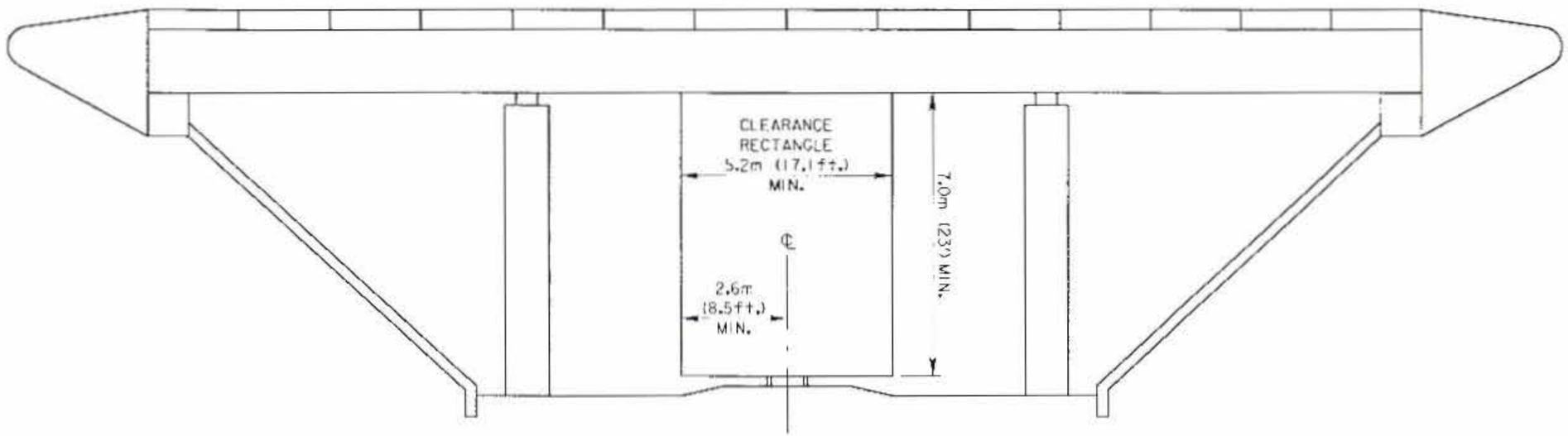
NORFORK LAKE TO THE MISSOURI STATE LINE

FOUR-LANE FREEWAY

Exhibit 4

Lockwood, Andrews & Newnam, Inc.

A SUBSIDIARY OF LCA-ANI



HORIZONTAL CLEARANCE

(℄ TRACK TO FACE OF PIER)
2.6 m (8.5ft.) - REQ'D. MINIMUM
3.6m (12ft.) - DES. MINIMUM
7.6m (25ft.) OR LESS - CRASH WALL MAY BE REQUIRED

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

RAILROAD OVERPASS

Exhibit 3-5

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LTV AMERICA

3.4.5 Existing Conditions vs. Design Criteria

Tables 3-4 through 3-6 summarize the comparisons between the existing conditions and design criteria of the Proposed Alternatives as defined in Table 3-3. These comparisons will be instrumental in determining the extent of the existing roadway that can be salvaged when any of the Proposed Alternatives is implemented. These values will be considered in developing the cost estimates in Chapter 7.

Table 3-4: EXISTING GEOMETRIC CONDITIONS - MULTILANE RURAL UNDIVIDED HIGHWAY

Segment	Length (km)	Percent Length Horizontal Curves	Percent Substandard Horizontal Curves	Maximum Grade	Percent Substandard Grade
1	30	40%	14%	7.0%	0.3%
2	18	40%	1%	N/A	N/A
3	27	19%	1%	N/A	N/A
4	15	32%	9%	N/A	N/A
5	33	33%	2%	6.0%	0.9%
6	19.4	25%	0%	N/A	N/A
7	11.6	8%	2%	N/A	N/A
8	28	8%	0%	7.1%	3.2%
9	16.5	N/A	N/A	N/A	N/A
10	8.8	4%	0%	N/A	N/A

N/A: Not available

Table 3-5: EXISTING GEOMETRIC CONDITIONS - FOUR-LANE DIVIDED RURAL HIGHWAY

Segment	Length (km)	Percent Length Horizontal Curves	Percent Substandard Horizontal Curves	Maximum Grade	Percent Substandard Grade
1	30	40%	23%	7.0%	0.3%
2	18	40%	8%	N/A	N/A
3	27	19%	3%	N/A	N/A
4	15	32%	12%	N/A	N/A
5	33	33%	6%	6.0%	0.9%
6	19.4	25%	0%	N/A	N/A
7	11.6	8%	6%	N/A	N/A
8	28	8%	0.4%	7.1%	3.2%
9	16.5	N/A	N/A	N/A	N/A
10	8.8	4%	0%	N/A	N/A

N/A: Not available

Table 3-6: EXISTING GEOMETRIC CONDITIONS - FOUR-LANE FREEWAY

Segment	Length (km)	Percent Length Horizontal Curves	Percent Substandard Horizontal Curves	Maximum Grade	Percent Substandard Grade
1	30	40%	28%	7.0%	0.3%
2	18	40%	18%	N/A	N/A
3	27	19%	9%	N/A	N/A
4	15	32%	18%	N/A	N/A
5	33	33%	8%	6.0%	0.9%
6	19.4	25%	1%	N/A	N/A
7	11.6	8%	8%	N/A	N/A
8	28	8%	3%	7.1%	3.2%
9	16.5	N/A	N/A	N/A	N/A
10	8.8	4%	3%	N/A	N/A

N/A: Not available

3.5 PAVEMENT SECTIONS

This information is intended for preliminary use in preparation of estimates related to the US 412 Corridor Planning Study. Final pavement design should be deferred until the required geotechnical studies have been completed.

The projected traffic data consists of projected 20-year (Year 2017) traffic, for all of the Proposed Alternatives. The traffic data includes average daily traffic, in vehicles per day (vpd), and percent trucks.

Specific design 18-kip equivalent single axle load (E-18) values were not available. E-18 values for use in preliminary design were determined utilizing AASHTO equivalency factors and a model truck traffic stream developed by the Asphalt Institute for rural interstate traffic. A directional split of 0.5 and a design lane factor of 0.8 were used, in accordance with AHTD criteria, to develop the traffic values for the 20-year design period. Traffic distribution and design E-18 values for all the cases are presented in Table 3-7.

Two generalized subgrade conditions were assumed, coinciding with the two major physiographic regions traversed by the alignment: the Ozarks Highland Region, west of Black Rock and the Mississippi Embayment, east of Black Rock. A representative subgrade Resilient Modulus (M_R) value was chosen for each of the regions, and this value was used in conjunction with a Loss of Support (LS) value of two to develop a design modulus of subgrade reaction (k) value for preliminary pavement designs. Segment 6 traverses both the Ozark Highland and Mississippi Embayment regions and sections were determined for each regional case.

Section thicknesses were determined in inches based on AASHTO's 1986 "Guide for Design of Pavement Structures." A conversion to metric units was then made and rounded-up to the nearest 10 mm. The preliminary pavement thickness (inches in parentheses) is presented in Table 3-7. These pavement thicknesses were utilized in developing the construction cost estimates presented in Chapter 7.

Table 3-7: PRELIMINARY PAVEMENT THICKNESS

	Base Case	Improved Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Segment 1	240 (9.32)	240 (9.46)	250 (9.79)	260 (9.96)	260 (10.11)
Segment 2	260 (9.99)	260 (10.10)	270 (10.36)	270 (10.49)	270 (10.61)
Segment 3	270 (10.64)	280 (10.71)	280 (10.90)	280 (11.00)	290 (11.09)
Segment 4	290 (11.27)	290 (11.33)	300 (11.51)	300 (11.60)	300 (11.69)
Segment 5	300 (11.54)	300 (11.63)	310 (11.84)	310 (11.96)	310 (12.07)
Segment 6a	310 (12.05)	310 (12.12)	320 (12.29)	320 (12.39)	320 (12.47)
Segment 6b	310 (12.12)	310 (12.19)	320 (12.34)	320 (12.44)	320 (12.54)
Segment 7	290 (11.21)	290 (11.33)	300 (11.64)	310 (11.84)	310 (11.94)
Segment 8	280 (10.95)	290 (11.10)	300 (11.46)	300 (11.64)	310 (11.86)
Segment 10	320 (12.39)	320 (12.46)	330 (12.64)	330 (12.75)	330 (12.84)

3.6 BYPASSES

The following potential bypasses are suggested for further study and analysis based on a qualitative review of the traffic volumes projected in Chapter 6, site visits, public involvement and on the existing constrained ROW along populated areas within the study corridor:

1) Salem
2) Viola
3) Ash Flat
4) Hardy
5) Imboden
6) Black Rock/Portia
7) Portia.

A bypass around Hoxie-Walnut Ridge is currently under construction and is considered as a committed improvement to be in place by the design year 2017. A separate study concurrent to this one is being conducted by the AHTD for the location and feasibility of a bypass at Paragould. The preliminary results from that study are being coordinated with the US 412 Corridor Planning Study.

These routes are conceptual in nature and do not depict calculated alignments. Furthermore, detailed route and schematic studies will be required in order to determine their feasibility and to select their ideal location. However, for purposes of performing the analysis of alternatives, general alignments have been selected to be used as a basis for the overall corridor cost estimate. The potential impacts and benefits of each proposed alternative can then be assessed. The potential locations of these bypasses can be seen in Appendix A, Corridor Layouts. The installation of traffic signals has been assumed as part of the Proposed Alternatives. It is recommended that warrant studies be performed as outlined in the Manual on Uniform Traffic Control Devices (MUTCD) to confirm applicability of these signal installations.

The Hardy bypass was a special concern to the public. The attendants to the public meeting expressed a concern of removing tourist traffic from the existing alignment since this would have a negative impact on their incomes. Meanwhile, a desire to remove trucks from the existing alignment was expressed due to safety and, again, economic impacts by discouraging tourists to stop in town. The proposed bypass, as illustrated in Appendix A, is located to the north side of town, south of Rainbow Lake connecting with US 63 at the north side of town. This alignment partially follows a previous AHTD recommendation in the "US 63 Corridor Study." Proposed improvements include installation of two fully-actuated traffic signals at the junctions of the proposed bypass with the existing alignments. A flashing signal is proposed on US 63 north of the bypass junction. The new alignment would be designated as US 63 and would handle the north-south truck movements outside the Hardy urbanized area. The east-west traffic (mostly tourist based) would remain on the existing alignment through town. In addition, due to safety reasons a fully-actuated signal is proposed at the existing US 63/US 62 junction east of the Spring River. These signal installations require further study to ensure that all applicable MUTCD warrants are satisfied.

3.7 INTERIM IMPROVEMENTS

In recognition of the fact that the funds required to incorporate proposed improvements in their entirety will be substantial, a program of interim improvements has been developed. "Interim improvements" are defined in this study to include those capacity (LOS E or F) or safety improvements that are needed under existing (Year 1994) conditions, including replacement of structurally obsolete bridges. The improvements are prioritized as "High," "Medium" or "Low" priority.

The following interim improvements are suggested based on the traffic volumes, existing level of service as calculated in Chapter 6, site visits, public involvement, constrained existing ROW along populated areas within the study corridor and on the existing accident rates as defined in Chapter 2 of this report. All proposed signal installations should be confirmed through appropriate MUTCD warrant studies.

High Priority:

A) Widen to four lanes undivided from Black Rock to Hardy by connecting the existing truck climbing lanes.

B) Install a fully-actuated traffic signal in Hardy at the intersection of US 62 with US 63.

C) Install a semi-actuated traffic signal in Viola at the intersection of US 62 with SH 223.

D) Construct a four-lane divided partial access control bypass around Hardy.

E) Construct a four-lane divided partial access bypass around Black Rock-Portia or realign road and reconstruct approaches and reconstruct the "SH 25, Black River," and the "Black River Relief" bridges. (Bridge numbers 02112 and 02189, respectively).

Medium Priority:

A) Widen to four lanes undivided section from west of Paragould to SH 168.

B) Construct a four-lane divided partial access control bypass around Imboden, or/and install a semi-actuated traffic light in Imboden at the intersection of US 63 with US 62.

C) Construct a left turn bay and install a fully-actuated traffic light in Cherokee Village at the intersection of US 63 with SH 175 Spur.

Low Priority:

A) Widen lanes and shoulders to 3.6 m (12') and 2.4 m (8') respectively, from Salem to Viola.

B) Rehabilitate the "Flat Board Road Slough" bridge (Bridge 01891), which is located near the Lawrence/Greene county line.

C) Install semi-actuated traffic lights at the following locations:

- In Gepp, at the intersection of US 62 with SH 87.
- In Glencoe, at the intersection of US 62 with SH 289 southbound.
- West of Ash Flat, at the intersection of US 62 with SH 289 northbound.
- East of Hardy, at the intersection of US 63 with SH 175 northbound.
- In Ravenden, at the intersection of US 63 with SH 90 northbound.

3.8 CONNECTION AT THE MISSOURI STATE LINE

Currently US 412 exists as a two-lane/two-way facility in most parts of the study corridor in the State of Missouri. However, the Missouri Department of Transportation (MoDOT) is moving forward with plans to improve US 412 from Kennett to Hayti, Missouri. The preferred alternative for US 412 is a four-lane divided expressway with at-grade intersections except at intersections with I-55 at the Hayti end of the project and at US 412 south/Missouri state highway (MO) 25 north near the Kennett end of the project. Mostly, the project involves adding two lanes north of the existing roadway in Pemiscot County and adding two lanes south of the existing roadway in Dunklin County. However, for approximately 5.5 miles, the existing roadway would be left in place as an outer road and four lanes would be constructed to the north of the existing roadway. Also, as part of the preferred alternative, MO 25 and US 412 would be moved to the east of Kennett. The draft environmental assessment was submitted to FHWA on April 8, 1997. The final environmental assessment is scheduled to be submitted by the end of 1997. The first construction project is tentatively scheduled to be let by the year 1999 or 2000.

The section of US 412 from south of Kennett to the Arkansas state line has not been studied at this time, and no specific plans exist for its immediate improvement. Any such improvements will be a function of improvements being planned as considered in Arkansas. MoDOT is currently the lead agency in a study to improve the St. Francis River Bridge, which is located over the St. Francis River at the Arkansas-Missouri state line and is the eastern terminus of this study.

Chapter 4

AFFECTED ENVIRONMENT

This chapter describes the existing environmental conditions and the impact of the Proposed Alternatives on it. The impacts of the Proposed Alternatives provide a basis for comparison between the different alternatives and for the feasibility evaluation of these alternatives.

4.1 LAND USE

4.1.1 Agricultural Land

Any land area that is cultivated or has been cleared for pasture is considered agricultural land. Pasture adapted plant species include Bermuda grass, lovegrass, fescue and lespedeza. The western and eastern portions of Greene County are primarily used for agriculture. The primary crops in the eastern portion are rice, soybean, cotton, corn, small grain and grain sorghum. The crops of choice grown in the western portion of the county include cotton, soybean and small grain. In the eastern part of Lawrence County most of the acreage is cultivated. Crops that are grown include rice, soybeans and grain sorghum. Some farmsteads and dwellings are located within this area while most farmsteads and dwellings are located in the central portion of the county. In the west-central portion, areas along the Black River and the extreme northwest portion of the county have been cleared and are primarily used as pasture lands. Some sections of land located in Sharp County are utilized for pasture use. Areas located within Fulton County that have gently sloping soils have, for the most part, been cleared for pasture. The extent and quantity of agricultural land affected by the alternatives has to be assessed in the next phase of the project.

4.1.2 Forest Land

Forested areas primarily consist of low-grade hardwood and cedar. The variety of tree species found in the forested areas includes southern red oak, eastern red cedar, short leaf pine, loblolly pine and black walnut. In the northwest portion of Lawrence County most of the area is wooded. Some pastures and a few farmsteads are along narrow creek bottom lands and adjacent foot slopes or on gently sloping or moderately sloping ridges. Within Sharp County, wooded areas are located along the Spring River. The majority of the area along the highway route in Sharp County is mainly used as woodland, consisting of low-grade hardwoods and cedars and as habitat for wildlife. Areas within Fulton County that have moderately steep sloping soils primarily consist of low-grade upland hardwood timber. The only portion of Baxter County that is of concern is the eastern portion. This portion consists of low-grade hardwoods and cedar. The central portion of Greene County is primarily wooded. The only wooded areas that occur in the western portion of the county are areas along stream channels and bayous. The exact area of forest land along the corridor affected by the alternatives needs to be determined in the next phase of the project.

4.1.3 Residential Land

Residential land along the corridor is primarily located in small community clusters. There are a few scattered residential properties along the corridor. The exact extent of the properties and acquisition for additional ROW should be further investigated in future phases of the project.

4.1.4 Commercial Land

The commercial lands are within small communities and towns and are mostly owned by local businesses. No major industrial establishments were found along the corridor which would require relocation.

4.1.5 Water Areas

The major waterways along the corridor are listed below (from west to east):

Shipman Creek	Sugar Creek	Clear Creek
Davenport Creek	Humphrey Creek	Brushy Creek
Miller Creek	Martin Creek	Stennitt Creek
Lick Creek	Browns Creek	Black River
Wild Horse Creek	Spring River	Cache River
Spring River	Harding Creek	Old Sugar Creek
Flat Creek	Wayland Creek	St. Francis River
Cabin Creek	Lawson Creek	

4.1.6 Wetlands

The alternatives studied are located in the current US 412 corridor from the east side of Norfork Lake to the Missouri state line. From the north-central part of the state to the northeast corner, the corridor passes through parts of Baxter, Fulton, Sharp, Lawrence and Greene Counties.

The intent of the Preliminary Wetland Assessment (PWA) is to make preliminary determinations and linear distance estimates of probable wetland areas along the referenced route, and to characterize those areas based on probable soil and hydrological attributes of the locale in which they may occur. The PWA is being undertaken using limited resources: site base (route) maps, U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS), county soil surveys and aerial photos supplied by AHTD. This process will reveal probable wetland areas but cannot be counted on to reveal all wetland areas which may exist along the corridor. Likewise, linear distance estimates are just that, estimates. Field verification of all suspected wetland areas and official delineations using the 1987 Corps of Engineers (COE) Wetland Delineation Manual should be conducted prior to any construction work. Also, besides COE jurisdictional wetlands compliance requirements under the Clean Water Act (CWA), the possibility exists that "farmed wetlands" and/or "prior converted wetlands" may be present along the highway corridor. Such wetlands are primarily under the authority of the USDA/NRCS, under compliance requirements of the Food Security Act (FSA) of 1975. Differentiation between those wetland types (based on regulatory jurisdiction or vegetation) cannot be positively accomplished using only the resources available for this PWA. Wetlands can also generally be considered to fall into one of four basic types based on vegetation: (1) farmed wetlands, (2) herbaceous wetlands, (3) scrub-shrub wetlands and (4) forested wetlands. For purposes of this PWA, a most likely wetland type will be proposed for each probable wetland area encountered, with full realization that ground-proofing will be required at a later date.

Working Definitions

The following working definitions will be utilized throughout this report as necessary:

Wetlands: Areas that are inundated or saturated by surface or groundwater for a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

Farmed Wetlands: Wetlands occurring on lands intensively used for the production of food fiber to the extent that the natural vegetation has been removed and therefore does not provide reliable indicators of wetland vegetation. Areas which meet this definition may include intensively used and managed cropland, hayland, pasture land, orchards, vineyards and areas that support wetland crops such as rice. Converted to cropland prior to December 23, 1985, farmed wetlands are mainly located along the drainage ways on agricultural lands that have not been effectively drained. Large tracts of this wetland type occur around rivers in the delta physiographic region. Small farmed wetlands can occur on undulating soils where they have been created from the ponding of local runoff. The NRCS is responsible for identification of these wetlands.

Prior Converted Wetlands: Wetlands converted to cropland prior to December 23, 1985, but have been out of production for five years and either wetland hydrology or vegetation has been altered. The NRCS is responsible for identification of these wetlands.

Herbaceous Wetlands: Generally a temporary vegetation type indicative of highly disturbed areas such as abandoned agricultural land (prior converted) or perhaps modified hydrology due to beaver activities. These wetlands vary in age from recently abandoned, totally herbaceous with sedges, rushes and the like, to herbaceous with an abundance of woody vegetation such as buttonbush (*Cephalanthus occidentalis*) and black willow (*Salix nigra*). NRCS or COE may be responsible for determination, dependent upon other factors such as prior use and wetland age.

Scrub-Shrub Wetlands: Successional area in transition from herbaceous wetlands to wooded wetlands or perhaps persisting under frequent disturbance. Buttonbush and black willow are usually

dominant. These wetlands typically occur on land that was cleared years ago for agricultural use, but was too wet in reality, so was abandoned. They vary in age and diversity and may be mixed with herbaceous wetlands. These wetlands, mostly under COE jurisdiction, are typically dominated by buttonbush and black willow.

Wooded (Forested) Wetlands: Wetlands which exhibit forest communities. Several types of wooded wetlands exist. Types likely to be encountered during this project are: Bald Cypress - Water Tupelo, Overcup Oak - Water Hickory, Red Maple, Willow Oak - Nuttall Oak, Mesic Oak - Hickory and Mixed Hardwoods. These wetlands, which are under COE jurisdiction, are most likely situated in association with the larger drainages or in isolated wooded areas that were never cleared.

Physiographic Regions

Ozark Highlands: The corridor will pass through the Ozark highland physiographic region from the starting point near Henderson (Baxter County) eastward through Fulton and Sharp Counties to Black Rock in Lawrence County. This region is characterized by gently sloping to rolling uplands in the western and central parts of the corridor (Salem Plateau) to deep hollows and high ridges in Sharp and western Lawrence Counties. Soils are primarily residuum of sedimentary rock consisting of limestone, chert, siltstone, sandstone and alluvium. Rivers, creeks and intermittent drainage ways generally have steep to fairly steep sides, with narrow floodplains. Wetlands are rare in this region, primarily herbaceous and associated with floodplains, though some perched wetlands may exist.

Delta: Starting at the Black River crossing at Black Rock and eastward all the way to Crowley Ridge at the SH 141 intersection near Walcott (Lawrence and Greene Counties) and from the east side of the ridge at Paragould to the Arkansas/Missouri state line, the corridor will be passing through the northwestern portion of the delta physiographic region. The undulating to level topography of this broad alluvial flat, or loessal plain, consisting primarily of soils formed in alluvial and eolian sediments on floodplains covered with a silt-laden layer of windblown sediments, has caused wetlands to be prevalent in this area. At the SH 141 intersection near Walcott the loessal plain of the delta region is interrupted by Crowley Ridge, a distinct and separate physiographic region. East of Crowley Ridge at Paragould, the loessal plain resumes, similar in nature to the western loessal plains. Bottomlands bound the loessal plains on both the west (Black River bottoms) and the east (St. Francis River bottoms).

Significant streams, rivers and waterbodies encountered along the corridor in this region are the Black River, Portia Bay, Cache River, Big Slough Ditch and the St. Francis River. Any or all of these areas may contain high-quality herbaceous, scrub-shrub or wooded wetlands.

Crowley Ridge: Crowley Ridge extends in a southwest-northeast direction across the central part of Greene County. It rises abruptly from the plains and its boundaries are distinct. The corridor crosses the ridge between the SH 141 intersection near Walcott and Paragould, where it is approximately 14.5 km (9 miles) wide. The ridge proper is well-drained to moderately well-drained, with much of the area being wooded and highly eroded. Streams within the ridge are fast-flowing. Thus, the soils on their floodplains consist of mixed silty and sandy material which range from somewhat poorly-drained to moderately well-drained. Any wetlands which may occur would most likely be limited to herbaceous or scrub-shrub type of small area in association with stream floodplains.

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Baxter County: Soils of the Arkana-Moko and Doniphan complexes dominate the US 412 corridor in this county. These soils are not hydric nor are they known to bear inclusions of hydric soils. There are no permanent stream crossings along the route. No wetlands are likely to be found along the route in Baxter County.

Fulton County: One small [<0.16 km (0.1 mile) length] area of Sturkie silt loam, frequently flooded, in the Shipman Creek bottoms, 1.6 km (1 mile) west of Viola. Hydric inclusions are possible, but the area should not present a problem.

Somewhat broader area of Sturkie silt loam along Town Branch in Salem, approximately 0.8 km (0.5 mile) in length. Part of this area, along the southern boundary of the corridor, appears to be wooded. This should be considered a possible problem area requiring a site visit.

The corridor crosses several intermittent stream beds which are comprised of soils from the Secesh and Elsah group. These areas are characterized by frequent flooding; they are generally quite narrow, appear to be in pasture and should not present a wetland problem. However, they should be checked by a wetlands expert.

Sharp County: Several intermittent stream beds will be crossed, exhibiting soils from the Razort loam and Sturkie silt loam groups. These crossings should not present a problem but should be checked out.

The Spring River crossing [an approximate distance of 0.32 km (0.2 mile)] at Hardy needs to be investigated. Section 10 and Section 404 permits may be required.

Lawrence County: Along the corridor, there are several intermittent creek beds and first order named creek beds that are frequently flooded, containing Captina silt loam or Hontas soils. These areas should not present a problem but need to be checked out.

The Spring River floodplain crossing at the Lawrence/Randolph county line consists of Healing silt loam, frequently flooded. This area [an approximate distance of 0.4 km (0.25 mile)] should be investigated further as it appears to be in pasture (possibly farmed wetlands) and likely will not present a problem.

Adjacent to the Spring River and 1.6 km (1 mile) east of the Spring River crossing lies another area of Healing silt loam. This area [an approximate distance of 0.8 km (0.5 mile)] appears to be partially wooded and should be investigated further.

Just east of Imboden, at the confluence of Wayland (Chaplin) Creek and the Spring River, lies another area [an approximate distance of 1.2 km (0.75 mile)] of Healing silt loam which needs to be checked out.

From Black Rock to the Cache River (county line), the entire corridor passes through farmland, primarily rice, cotton and soybeans, with the major exceptions of the Black & Cache River Bottoms and the Portia Bay area. These exception areas are likely to include high-quality wooded, herbaceous or scrub-shrub wetlands which may require Section 404 and 410 permits, including official wetlands delineations. Total corridor distance requiring further investigation in these areas is estimated at approximately 2 km (1.25 miles).

Greene County: From the Cache River to the SH 141 intersection near Walcott, on the western edge of Crowley Ridge, and from the eastern side of the ridge at Paragould to the Arkansas/Missouri state line, the corridor again passes primarily through croplands much like those encountered in eastern Lawrence County. The major exceptions along this portion of the corridor are the Cache River bottoms in the west [an approximate distance of 0.64 km (0.4 mile)] and the area from Big Slough Ditch to and including the St. Francis River bottoms in the east [an approximate distance of 3.2 km (2.0 miles)]. Like other major waterbodies encountered in eastern Lawrence County, these areas are very likely to include high-quality wooded, scrub-shrub or herbaceous wetlands which may require Section 404 and 410 permits, including official wetlands delineations. In the Crowley Ridge portion of the county there are several intermittent creek beds and first order named creek beds consisting of soils which may bear hydric soil inclusions. Of particular interest are Sugar and Eight-Mile Creeks, on either side of the ridge. These areas are by no means prime areas for wetlands to occur but should

nonetheless be checked out [total distance approximately 1.6 km (1.0 mile)]. Also, several drainage ditches which should be investigated are crossed by the corridor.

Summary

This section lists by county the estimated linear distance along the US 412 corridor which may require further investigation, COE Permits or wetland delineations (refer to Table 4-1). Also noted were other corridor features which may require further investigation, but were not of significant linear distance along the corridor to assign an approximate distance. Field verification will be necessary in all instances. All potential wetland areas have been mapped and included in Appendix A.

Table 4-1: WETLAND AREAS

County	Estimated Wetland Linear Distance	Likely Wetland Types	Other Areas to Investigate
Baxter	0	NA	None
Fulton	1 km (0.6 mile)	Herbaceous scrub-shrub wooded	Intermittent streams
Sharp	0.3 km (0.2 mile)	Herbaceous wooded	Intermittent streams
Lawrence	4.4 km (2.75 miles)	Herbaceous scrub-shrub wooded	Intermittent and perennial streams
Greene	5.4 km (3.4 miles)	Herbaceous scrub-shrub wooded	Drainage ditches

Tables 4-2 and 4-3 show the associated costs with delineation/mitigation of the wetlands for all alternatives.

Exhibits 4-1 and 4-2 show the potential wetland area in the vicinity of the Black and Cache Rivers, respectively.

Exhibit 4-1: TYPICAL WETLANDS AT BLACK RIVER (NORTH VIEW)

Exhibit 4-2: TYPICAL WETLANDS AT CACHE RIVER (NORTHEAST VIEW)

Table 4-2: WETLAND DELINEATION COST*

County	Log Kilometers (km)		Estimated Wetland Linear Distance (meters)	Base Case		Two-Lane Rural Arterial		Multi-Lane Rural Highway		Four-Lane Divided Rural Highway		Four-Lane Freeway	
	From	To		Add. ROW (meters)	Cost	Add. ROW (meters)	Cost	Add. ROW (meters)	Cost	Add. ROW (meters)	Cost	Add. ROW (meters)	Cost
Baxter	0	0	0	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00
Fulton	33.15	33.31	160.00	0	$0.00	6.8	$220.00	18.0	$570.00	21.6	$680.00	92.0	$2,910.00
Fulton	52.15	52.95	800.00	0	$0.00	6.8	$1,080.00	18.0	$2,850.00	21.6	$3,420.00	92.0	$14,550.00
Sharp	95.6	95.92	320.00	0	$0.00	3.8	$240.00	15.0	$950.00	18.6	$1,180.00	89.0	$5,630.00
Lawrence	122.4	123.2	800.00	0	$0.00	8.8	$1,390.00	20.0	$3,160.00	23.6	$3,730.00	94.0	$14,870.00
Lawrence	124	124.4	400.00	0	$0.00	8.8	$700.00	20.0	$1,580.00	23.6	$1,870.00	94.0	$7,430.00
Lawrence	132	133.2	1,200.00	0	$0.00	8.8	$2,090.00	20.0	$4,740.00	23.6	$5,600.00	94.0	$22,230.00
Lawrence	171	173	2,000.00	0	$0.00	8.8	$3,480.00	20.0	$7,910.00	23.6	$9,330.00	94.0	$37,160.00
Greene	173	173.64	640.00	0	$0.00	10.8	$1,370.00	22.0	$2,780.00	25.6	$3,240.00	96.0	$12,150.00
Greene	191.7	192.5	800.00	0	$0.00	10.8	$1,710.00	22.0	$3,480.00	25.6	$4,050.00	96.0	$15,180.00
Greene	201	201.8	800.00	0	$0.00	10.8	$1,710.00	22.0	$3,480.00	25.6	$4,050.00	96.0	$15,180.00
Greene	213	216.2	3,200.00	0	$0.00	10.8	$6,830.00	22.0	$13,920.00	25.6	$16,190.00	96.0	$60,730.00
TOTAL COST:					**$0.00**		**$20,820.00**		**$45,420.00**		**$53,340.00**		**$208,020.00**

* Note: Assumed $800.00 per acre is worst case scenario.

Table 4-3: WETLAND MITIGATION COST**

County	Log Kilometers (km)		Estimated Wetland Linear Distance (meters)	Base Case		Two-Lane Rural Arterial		Multi-Lane Rural Highway		Four-Lane Divided Rural Highway		Four-Lane Freeway	
	From	To		Add. ROW (meters)	Cost	Add. ROW (meters)	Cost	Add. ROW (meters)	Cost	Add. ROW (meters)	Cost	Add. ROW (meters)	Cost
Baxter	0	0	0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00	0	$0.00
Fulton	33.15	33.31	160.00	0	$0.00	6.8	$1,080.00	18.0	$2,850.00	21.6	$3,420.00	92.0	$14,550.00
Fulton	52.15	52.95	800.00	0	$0.00	6.8	$5,380.00	18.0	$14,230.00	21.6	$17,080.00	92.0	$72,750.00
Sharp	95.6	95.92	320.00	0	$0.00	3.8	$1,200.00	15.0	$4,740.00	18.6	$5,880.00	89.0	$28,150.00
Lawrence	122.4	123.2	800.00	0	$0.00	8.8	$6,960.00	20.0	$15,820.00	23.6	$18,660.00	94.0	$74,330.00
Lawrence	124	124.4	400.00	0	$0.00	8.8	$3,480.00	20.0	$7,910.00	23.6	$9,330.00	94.0	$37,160.00
Lawrence	132	133.2	1,200.00	0	$0.00	8.8	$10,440.00	20.0	$23,720.00	23.6	$27,990.00	94.0	$111,500.00
Lawrence	171	173	2,000.00	0	$0.00	8.8	$17,400.00	20.0	$39,540.00	23.6	$46,650.00	94.0	$185,820.00
Greene	173	173.64	640.00	0	$0.00	10.8	$6,830.00	22.0	$13,920.00	25.6	$16,190.00	96.0	$60,730.00
Greene	191.7	192.5	800.00	0	$0.00	10.8	$8,540.00	22.0	$17,400.00	25.6	$20,240.00	96.0	$75,910.00
Greene	201	201.8	800.00	0	$0.00	10.8	$8,540.00	22.0	$17,400.00	25.6	$20,240.00	96.0	$75,910.00
Greene	213	216.2	3,200.00	0	$0.00	10.8	$34,160.00	22.0	$69,580.00	25.6	$80,970.00	96.0	$303,640.00
TOTAL COST:					**$0.00**		**$104,010.00**		**$227,110.00**		**$266,650.00**		**$1,040,450.00**

** Note: Assumed $4,000 per acre in worst case scenario.

4.1.7 Park Land

Park lands along the existing corridor were found within the city limits. However, none of these parks will be affected due to the fact that all alternatives require a bypass.

4.1.8 Cemeteries

A visual inspection was conducted along the study area to determine the locations of all the cemeteries in the study area. Table 4-4 lists all cemetery locations and the cost associated with relocation.

4.1.9 Floodplains

Flood Insurance Rate Maps (FIRM), published by the Federal Emergency Management Agency (FEMA), were reviewed to determine if any flood-prone areas were located in the study area. It was concluded that the flood-prone areas were limited to the following: Lake Norfork, Hackney Creek, Flat Creek, Cabin Creek, Sugar Creek, Humphrey Creek, Martins Creek, Browns Creek, Wayland Creek, Lawson Creek, Clear Creek, Brushy Creek, Stennitt Creek, Portia Bay, Black River, Cache River and the St. Francis River. All results obtained from the FIRM maps are shown in Table 4-5.

The FIRM zone designations are explained as follows:

Zone A: Base flood elevations and flood hazard factors not determined for 100-year flood.
Zone AE: Base flood elevations and flood hazard factors determined for 100-year flood.

Table 4-4: CEMETERY LOCATIONS

County	Cemetery Name	Log Kilometers (km)		Estimated Cemetery Linear Distance (meters)	Base Case		Two-Lane Rural Arterial			Multi-Lane Rural Highway			Four-Lane Divided Rural Highway			Four-Lane Freeway		
		From	To		Add. ROW (meters)	Cost	Add. ROW (meters)	No. of Plots	Cost	Add. ROW (meters)	No. of Plots	Cost	Add. ROW (meters)	No. of Plots	Cost	Add. ROW (meters)	No. of Plots	Cost
Fulton	Agnos Church of Christ	71.0	71.2	150.00	0	$0.00	6.8	10	$100,000.00	18.0	27	$270,000.00	21.6	32	$320,000.00	92.0	138	$1,380,000.00
Sharp	Highland	88.5	88.6	150.00	0	$0.00	3.8	6	$60,000.00	15.0	23	$230,000.00	18.6	28	$280,000.00	89.0	134	$1,340,000.00
Sharp	Old Hardy	99.5	99.7	150.00	0	$0.00	3.8	6	$60,000.00	15.0	23	$230,000.00	18.6	28	$280,000.00	89.0	134	$1,340,000.00
Sharp	Church of Jesus Christ of Latter Day Saints	100.7	100.9	150.00	0	$0.00	3.8	6	$60,000.00	15.0	23	$230,000.00	18.6	28	$280,000.00	89.0	134	$1,340,000.00
TOTAL COST*:						$0.00			$280,000.00			$960,000.00			$1,160,000.00			$5,400,000.00

* Note: Assume $10,000.00 per plot is worst case scenario
Assume 100 square meters per plot

Table 4-5: FIRM ZONE DESIGNATIONS

Creek or Area	Zone Designation
Lake Norfork by Panther Bay	A
Hackney Creek	A
Flat Creek	A
Cabin Creek	A
Sugar Creek	A
Humphrey Creek	A
Martins Creek	A
Browns Creek	A
Wayland Creek	AE
Lawson Creek	A
Clear Creek	A
Brushy Creek	A
Stennitt Creek	A
Portia Bay	A
Black River	A
Cache River	A
St. Francis River	A

The areas with substantial impacts are Portia Bay, Black River, Cache River and St. Francis River. All these areas do not have elevation associated with the flood level; however, cursory review of topographic maps and comparison with flood maps indicated that the St. Francis River may require up to 3 m (10 ft.) fill. Field verification/study are required to assess the extent of the actual fill required in every instance. All potential floodplain areas have been mapped and included in Appendix A. The following Exhibit 4- 3 shows a typical flood occurrence at Cache River Crossing.

4.2 WATER QUALITY

4.2.1 Surface Water

The study area lies within the White River Basin and the St. Francis River Basin. For water quality monitoring purposes, the White River Basin has been divided into eleven stream segments and the St. Francis River Basin is divided into four segments. The following segments of the White River

Exhibit 4-3: TYPICAL FLOOD OCCURRENCE AT CACHE RIVER CROSSING (NORTHWEST VIEW)

Basin traverses the study area: Bayou DeView and tributaries (segment 4B); Cache River and tributaries (segment 4C); White River from the mouth of the Black River to the mouth of the Buffalo River (segment 4F); Black River, Strawberry River and tributaries (segment 4G); Spring River, South Fork Spring River and Eleven Point River (segment 4H). St. Francis River (segment 5C) of the St. Francis River Basin also traverses the study area. Based upon the 1996 Arkansas Water Quality Inventory Report, Table 4-6 illustrates the number of permitted outfalls occurring in each stream segment per basin.

All previously mentioned stream segments are designated for propagation of fish and wildlife, primary ("swimmable") and secondary contact recreation, domestic, agricultural and industrial water supplies. Stream segment 4F includes Baxter and Fulton Counties. Outstanding state or national resource waters make up 30.8 km (19.1 miles) within the segment. There were no active monitoring stations

located within the vicinity of the proposed construction site. It is assumed that surrounding waterbodies meet their designated uses.

Table 4-6: PERMITTED OUTFALLS OCCURRING PER SEGMENT

Stream Segment	Number of NPDES Permits
White River Basin	
4B	15
4C	29
4F	32
4G	18
4H	9
St. Francis River Basin	
5C	40

In stream segment 4B there are no streams that are being monitored by the Arkansas Department of Pollution Control & Ecology (ADPC&E). The only stream being monitored in this segment is Bayou DeView. There are tributaries that flow into this stream that may be affected by any construction; therefore, the water quality of Bayou DeView should be considered. The upper portion of this stream is not meeting the aquatic life use due to high turbidity and nutrient values. Both point and non-point sources are believed to be responsible for this situation. Occasionally elevated bacteria levels have been identified that partially impair the primary contact use in the majority of the upper reaches of Bayou DeView. Downstream reaches were assessed as having partially impaired aquatic life uses from the same causes; however, the lowest approximately 32 km (20 miles) of this stream appear to be meeting all designated uses. Table 4-7 provides a summary of the water quality information for Bayou DeView.

Stream segment 4C includes portions of Greene and Lawrence Counties. The only body of water not meeting the designated use requirement is the Cache River. An assessment indicated that the aquatic life uses were not met and that this use was only partially supported in the mid and upper reaches of this waterbody. Siltation and excessive turbidity values from agriculture runoff was the cause. Additionally, 40.3 km (25 miles) of these waters are designated as extraordinary resource waters. Stream segment 4B also contains a portion of Greene County. None of the waterbodies contained in this segment were designated as outstanding state or national resource waters. A summary of water quality information for Cache River and tributaries is shown in Table 4-8.

Table 4-7: WATER QUALITY INFORMATION FOR SEGMENT 4B - BAYOU DeVIEW AND TRIBUTARIES

Parameter	Mean	Number of Samples	Maximum Observed	Minimum Observed	Standard Deviation
Dissolved Oxygen (mg/L)	8.53	23	12.10	4.20	2.28
BOD_5/Day (mg/L)	2.88	24	6.70	0.90	1.46
pH	7.88	23	8.80	7.09	0.44
TSS (mg/L)	104.71	24	936.00	3.00	200.93
$NO_2 + NO_3$-N (mg/L)	0.97	23	2.79	0.05	0.77
Tot. Phos. (mg/L)	1.21	20	4.14	0.23	1
Tot. Org. Carbon (mg/L)	9.94	23	21.20	6.00	4.36
T. Hardness (mg/L)	81.90	25	311.00	20.00	72
Chloride (mg/L)	17.07	24	46.00	3.00	13.1
Sulfate (mg/L)	14.40	24	26.00	8.00	4.93
TDS (mg/L)	189.15	24	331.00	107.00	67.65
Turbidity NTU	109.96	25	760.00	8.00	155.43

Stream segment 4G contains sections of Sharp and Lawrence Counties. There are 180.7 km (112.2 miles) of streams designated as outstanding state or national resource waters. Several smaller tributary streams in this segment frequently show elevated bacteria levels, which are probably due to runoff from pasture land. Over 117 km (73 miles) of extraordinary resource waters in this segment were assessed with partial aquatic life impairment due to excessive turbidity levels.

Stream segment 4H contains sections of Fulton and Sharp Counties. About 74% of the waters contained within this segment are designated as outstanding state or national resource waters. The lower reaches of the Spring River, classified as extraordinary resource, indicate aquatic life impacts from occasionally very high turbidity levels. These levels seem to be associated with major storm events and are likely caused by land clearing to the edge of stream for pasture. The South Fork of the Spring River, which in the past has contributed high bacteria levels and excessive turbidity to the Spring River, did not demonstrate these excessive levels over the past two years. Jane Creek water quality appears to be near pristine levels.

Table 4-8: WATER QUALITY INFORMATION FOR SEGMENT 4C - CACHE RIVER AND TRIBUTARIES

Parameter	Mean	Number of Samples	Maximum Observed	Minimum Observed	Standard Deviation
Dissolved Oxygen (mg/L)	8.87	18	10.90	6.50	1.3
BOD_5/Day (mg/L)	0.79	23	1.30	0.20	0.33
pH	7.61	25	8.19	6.70	0.33
TSS (mg/L)	27.00	24	86.00	6.00	16.4
$NO_2 + NO_3$-N (mg/L)	0.27	24	0.44	0.10	0.09
Tot. Phos. (mg/L)	0.07	21	0.12	0.04	0
Tot. Org. Carbon (mg/L)	3.72	24	10.10	1.70	1.8
T. Hardness (mg/L)	144.59	24	196.00	115.00	18.82
Chloride (mg/L)	3.78	25	5.00	3.00	0.73
Sulfate (mg/L)	6.54	24	10.00	3.00	1.53
TDS (mg/L)	156.33	24	188.00	127.00	14.84
Turbidity NTU	15.50	25	65.00	3.70	13.33

Stream segment 5C contains the St. Francis River and its tributaries. Some notable tributaries that may be affected by construction include Eight Mile Creek, Eight Mile Ditch and Village Creek. Monitoring stations along the St. Francis River indicated that all water segments had aquatic life uses that were partially impaired or unsupportive to aquatic life use. This is due to excessive turbidity and silt load carried to the streams from row crop agricultural activities. These conditions were encouraged by the drainage of lowland areas by ditching and channelization of streams to facilitate the runoff. The continuation of such activities and the continuous maintenance dredging of the ditches and streams aggravates and further deteriorates the conditions.

The surface runoff from the construction improvements, regardless of the proposed alternative, has to be carefully conveyed to prevent deposition of sediment into receiving creeks, streams or tributaries. Sediment control measurement, such as fences, hay bales, etc., should be incorporated into the work.

4.2.2 Groundwater

According to the 1996 Arkansas Water Quality Inventory Report, groundwater protection programs are in varying stages of development by the State. The Arkansas Department of Health enacted the Wellhead Protection Program (WHPP) in 1991. Accomplishments of the program include development of WHPP for about 100 public water systems, delineations of wellhead protection areas for more than 300 wells, and outreach and technical aid programs. The Arkansas Soil & Water Conservation Commission (AS&WCC) has utilized funds from Section 106 of the Clean Water Act to identify areas of the state which may be vulnerable to contamination from nonpoint source pollution, especially through the use of pesticides.

Groundwater protection authority within the Water Division of ADPC&E is provided within Act 472, Arkansas Water and Air Pollution Control Act. The Act states that no waste shall be placed in any way such that it contaminates the "Waters of the State." Since the "Waters of the State" include subsurface or ground waters, ADPC&E is responsible for protecting groundwater from sources which are not regulated by other federal and state programs. A Storm Water Pollution Prevention Plan (SWPPP) is required under the National Pollution Discharge Elimination System (NPDES) general permit for discharge of storm water.

Since there is an absence of groundwater standards except for those covered in the federal primary drinking water standards, the Water Division uses these federal standards as action levels for the prevention and cleanup of groundwater contamination. According to the 1996 Water Quality Inventory Report, most of the contamination cases handled by the Water division are in regard to releases from waste storage lagoons, aboveground storage tanks and a myriad of other sources. Due to the lack of groundwater quality standards, only the groundwater quality monitoring will be investigated to indicate the existing conditions of the aquifers located in the area of the proposed site construction.

ADPC&E has established an ambient groundwater quality monitoring program in order to assess the background groundwater quality data from various aquifers on a statewide basis. At the same time, it evaluates water quality in areas of specific interests. Samples have been collected every three years for general water quality indicators, metals, petroleum hydrocarbons and pesticides. Currently, there are nine active monitoring sites at various locations in the state. Only two monitoring sites have been considered in this assessment due to their close proximity to the proposed construction site.

The first is the Jonesboro, Craighead County site. It is located within the Gulf Coastal plain province region. The aquifers located in this region are part of a thick sequence of semi-consolidated sediments consisting of sands, shales and clays with sand representing the larger fraction. Local relief at this site can be as much as 61 m (200 ft.) within the metropolitan area. There is a lack of an extensive confining layer separating the alluvial aquifer from the underlying Memphis aquifer, thereby increasing the susceptibility of the deeper aquifer to contamination moving through the shallow aquifer. The Memphis aquifer is the source for the four public water supply fields that supply drinking water to Jonesboro.

A total of eighteen wells were sampled during June of 1995. Fourteen wells were located in the alluvial aquifer and four wells in the Memphis aquifer. According to the 1996 Arkansas Water Quality Inventory Report, there were elevated nitrate concentrations in the alluvial aquifer in two wells (11.3 and 1.9 mg/L) and one in the Memphis aquifer well (1.69 mg/L). The Secondary Maximum Contaminate Level (SMCL) established by the Environmental Protection Agency (EPA) for iron was exceeded in eight alluvial wells. The SMCL for manganese was exceeded in nine of the alluvial wells. One alluvial well, with a TDS concentration of 703 mg/L, exceeded the SMCL (500 mg/L). All wells were analyzed for Volatile Organic Compounds (VOC's) with no detection.

The second monitoring site is located in Omaha, Boone County. This monitoring site is part of the Ozark region located in the northern half of the state. Two of the most important aquifers in northern Arkansas are the Roubidoux formation and the Gunter Sandstone. The landscape exhibits moderate relief with elevations ranging from 213 m (700 ft.) above sea level in the northeastern portion of the area to 488 m (1,600 ft.) near the center of the area. The geology of the area consists of cherty limestones of the Boone formation occupying the central portion of the area with the Cotter dolomite exposed to the northwest and northeast in the major stream tributaries. This site is located near an area of increased animal production and near a wood treatment, Superfund site contaminated with wood preservatives. The chief sources of pollution are service stations, septic tanks, poultry and livestock farms and an abandoned wood treatment plant.

The thickness of the Boone formation ranges from zero to 61 m (200 ft.), and the Cotter dolomite may be as thick as 152 m (500 ft.) thick. The presence of pentachlorophenol in Cricket Springs indicates that there is still an impact from wood preservatives. It was noted that one spring exceeded the SMCL for iron and two springs exceeded the SMCL for manganese. According to the United States Geological Survey (USGS) the major sources of groundwater contamination include poultry and livestock operations, septic tanks, sewage lagoons and wastewater treatment plants.

It is not believed that the proposed highway construction will adversely affect the quality of groundwater in the associated regions; however, occasionally construction activities may provide conduits between the ground surface and aquifer zones which may lead to contamination of the aquifer. This should be studied in more detail during further design development stages.

4.3 HAZARDOUS MATERIAL SITES

A regulatory database search of potentially hazardous sites located within the study area was performed. Database information utilized in the evaluation of potentially hazardous sites located within the study are summarized in Table 4-9. This database information may not reflect unregistered regulatory sites or sites which were not mappable based on regulatory agency information. Sites registered or reported to federal, state or local regulatory agencies after the preparation of this report will not be included. Additionally, the extent of the migration of contaminants, if any, into and within the study area, including project ROW's, cannot be determined by this regulatory search.

Table 4-9: REGULATORY DATABASES REVIEWED WITHIN THE STUDY AREA

Database	No. of Sites
Permit Compliance System (PCS)	4
Airs Facility System (AFS-Airs)	6
Section Seven Tracking System (SSTS)	0
National Compliance Data Base (NCDB)	0
Enforcement Docket System (Docket)	0
Federal Facility Information System (FFIS)	0
Chemicals in Commerce Information System (CICIS)	0
PCB Handler Activity Data System (PADS)	1
Toxic Chemical Release Inventory (TRI) System	0
RCRIS (5 counties requested) (RCRIS)	3
Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS)	0

A summary of each regulatory database reviewed during this investigation is defined in the following paragraphs.

4.3.1 Federal Databases

Resource Conservation and Recovery Information System (RCRIS); Treatment, Storage, and Disposal Facilities (RCRIS-TSD)

The RCRIS-TSD report contains information pertaining to facilities which either treat, store or dispose of hazardous waste. Information pertaining to the status of facilities tracked by the Resource Conservation and Recovery Act (RCRA) Administrative Action Tracking System (RAATS, dated 03/03/95) is included in the RCRIS-TSD Report.

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)

The CERCLIS database is a comprehensive listing of known or suspected uncontrolled or abandoned hazardous waste sites. These sites have either been investigated or are currently under investigation by the EPA for the release, or threatened release, of hazardous substances. Once a site is placed in CERCLIS, it may be subjected to several levels of review and evaluation and ultimately placed on the National Priorities List. As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned (NFRAP)" have been removed from the CERCLIS database.

Resource Conservation and Recovery Information System; Large Quantity Generators (RCRIS-LG)

The RCRIS-LG report contains information pertaining to facilities which either generate more than 1,000 kilograms (kg) of hazardous waste per month or meet other applicable requirements of the Resource Conservation and Recovery Act (RCRA). Information pertaining to the status of facilities tracked by the RCRA Administrative Action Tracking System (RAATS, dated 03/03/95) is included in the RCRIS-LG Report.

Resource Conservation and Recovery Information System; Small Quantity Generators (RCRIS-SG)

The RCRIS-SG report contains information pertaining to facilities which either generate between 100 kg and 1,000 kg (220 lbs to 2,200 lbs) of hazardous waste per month or meet other applicable requirements of the RCRA. Information pertaining to the status of facilities tracked by the RCRA Administrative Action Tracking System (RAATS, dated 03/03/95) is included in the RCRIS-SG Report.

Civil Enforcement Docket

The Civil Enforcement Docket is the EPA's system for tracking Civil Judicial Cases filed on the EPA's behalf by the Department of Justice. This report contains information on cases from 1972 to date.

Toxic chemical Release Inventory (TRI) System of 1992

The TRI report contains information on the industrial release and/or transfer of toxic chemicals as reported under Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III).

Tables 4-10 through 4-13 show the sites identified within the study area by the regulatory research.

Table 4-10: PERMIT COMPLIANCE SYSTEM

Facility EPA ID	Facility Name	Facility Address	City	Zip
AR0000565209	Imboden, Town of	Off US 63, 1.6 km (1 mile) E of City	Imboden	72434
AR0000537787	Highland Square Coin Operated	US 62 BT Hardy and Ash Flat	Cherokee Village	72525
AR00001603760	Bowers Stone Co.	US 63, 3.2 km (2 miles) E of city	Hardy	N/A
AR0001719731	Busy Bee Car Wash - Ash Flat	US 62	Ash Flat	72513

Table 4-11: AEROMETRIC INFORMATION RETRIEVAL SYSTEM (AIRS) FACILITIES

Facility EPA ID	Facility Name	Facility Address	City	Zip
ARD983283904	Stanleys Thriftway	US 62	Salem	72526
ARD983270414	Black Rock Sand and Gravel	US 63 West	Black Rock	72415
ARD983270414	Black Rock Crushing Plant	US 63 North	Black Rock	72415-0206
ARD053144234	Hogan Ben M. Co. #802	US 63	Black Rock	72415
ARD983270414	Black Rock Crushing Plant	US 63 North	Black Rock	72415-0206
ARD983270414	Black Rock Sand and Gravel	US 63 West	Black Rock	72415

Table 4-12: RCRIS

Type of Generator	Facility EPA ID	Facility Name	Facility Address	City	Zip	County
Small Quantity	ARD983286	Southern Ford	US 62, 167, 412	Hardy	72542	Sharp
Exempt	ARD983287	Dr. Pepper Bottling Co. of Paragou'd	US 412 & Court St.	Paragould	72451	Greene
Exempt	ARD981147	American Polishing Inc.	US 62 W & Viola Rd.	Salem	72576	Fulton

The impact of any site on the alternatives require more in depth study in future phases of the project. However, the effect of sites listed in RCRIS Database on the alternatives are minimal to none. This is due to the fact that all the sites listed in the database are located within the city limits of Hardy, Salem and Paragould. All these cities are proposed to be bypassed.

Table 4-13: PCB HANDLER ACTIVITY DATA SYSTEM

Facility EPA ID	Facility Name	Facility Address	City	Zip
ARD983269226	North Arkansas Electric Company	Jct. of US 62 & US 9	Salem	72576

4.3.2 State Databases

Regulated Storage Tanks (RST): This database is a compilation of all Underground Storage Tanks (UST) and Aboveground Storage Tanks (AST) since 1974. The database revealed a total of 72 RST/UST's along the corridor. Table 4-14 provides an estimate of the RST/UST's affected by each alternative. All others within the city limits will be bypassed. The typical cost of UST removal and replacement is estimated at $25,000.00.

Leaking Underground Storage Tank Database (LUST): The Leaking Underground Storage Tank (LUST) database is a State-operated database. LUST is a computerized database utilized to obtain specific locations of leaking underground storage tanks. The database has been in operation since 1988. When a spill or leak is reported to the Regulated Storage Tank Division of ADPC&E, a LUST number and facility number are issued for the reporting facility depending upon the county in which the facility is located. Table 4-15 contains specific information that includes the LUST number, date and time of leak, facility name, facility's address and city.

Table 4-14: REGULATED STORAGE TANKS (RST)

Alternates	Estimated Percentage of RST/UST Affected	Estimate of RST/UST Affected
Base Case	0%	0
Two-Lane Rural Arterial	5%	1
Multi-Lane Rural Highway	40%	6
Four-Lane Divided Rural Highway	60%	8
Four-Lane Freeway	90%	13

Table 4-15: LEAKING UNDERGROUND STORAGE TANK DATABASE (LUST)

LUST No.	Date	Time	Location	Address	City
03-006	9/10/91	13:45	Kay's Grocery and Gas	US 62 East	Henderson
68-001	10/6/89	11:05	Spring River Mini Mart	US 62/63	Hardy
68-002	12/21/89	11:00	Red Mule Service Station	Rt. 2 US 62/412	Hardy

4.4 NOISE ANALYSIS

A noise analysis was performed for the US 412 project in which current noise levels generated by the automobile and truck traffic on the road were calculated for several different typical residential locations along the proposed route. Noise level projections based on future conditions were also determined. The measured and projected levels were then compared to Noise Abatement Criteria (NAC) to evaluate its impact on the residents.

4.4.1 Noise Abatement Criteria (NAC)

The unit of noise measurement in community noise assessment is usually the A-weighted decibel, dBA. The dBA is the most common way of measuring noise for its impact on human activities such as speech interference, sleep disturbance and general annoyance. Table 4-16 gives examples of approximate sound levels in dBA associated with common activities and noise sources for reference. Since the sound level fluctuates greatly at most locations from one moment to the next, it is common to use an indication of the maximum levels to assess noise impact on a community. The L10(h) is defined as the dBA (noise level) within one hour which is equaled or exceeded for at least 10% of the time. The FHWA and other U.S. Department of Transportation agencies have developed NAC for certain land use criteria based on the L10(h) values for the noisiest hour of the day.

These criteria, listed in Table 4-17, provide a basis for quantifying noise impacts and evaluating the need for noise abatement treatment. For this project, Land Use Category B, which specifies a noise abatement criterion value of L10(h) equal to 70 dBA, is appropriate for the residences along the highway. Therefore, if the value of L10(h) caused by the project approaches or exceeds 70 dBA, it is considered to be a noise impact on the community.

In addition to the absolute criteria presented in Table 4-17, another way of assessing impact is evaluation of the increase in L10(h) caused by the project. An increase of 10 dBA, representing a doubling of the perceived loudness of a sound, is usually considered a substantial increase and an indication of noise impact.

Table 4-16: COMMON INDOOR AND OUTDOOR SOUND LEVELS (dBA)

Outdoor Noise Sources	
Jet flyover at 305m (1000 ft.)	100-105 dBA
Gasoline lawnmower at 1m (3 ft.)	90-95
Diesel truck at 15m (50 ft.)	80-90
Noisy urban daytime	75-80
Gasoline lawnmower at 31m (100 ft.)	70-75
Quiet urban daytime	45-50
Quiet urban nighttime	40-45
Quiet suburban nighttime	35-40
Quiet rural nighttime	25-30
Indoor Noise Sources	
Rock band	105-115 dBA
Textile weaving plant	90-95
Food blender at 1m (3 ft.)	85-90
Garbage disposal at 1m (3 ft.)	75-80
Normal speech at 1m (3 ft.)	60-65
Large business office	55-60
Soft whisper at 1m (3 ft.)	35-40
Bedroom at nighttime	25-30

4.4.2 Noise Calculations

To evaluate the expected noise impact of the project, a computer model developed by the FHWA (STAMINA 2) was used to predict the expected noise due to the highway traffic. The expected noise level at a location near a roadway depends on many factors which make the noise exposure unique at each location. The most important of the factors are:

- Distance from the roadway
- Number of vehicles per hour (vph)

Table 4-17: NOISE ABATEMENT CRITERIA
HOURLY A-WEIGHTED SOUND LEVEL IN DECIBELS (dBA)

Activity Category	L10(h)	Category Description
A	60 (exterior)	Tracts of land in which serenity and (exterior) quiet are of extraordinary significance and serve important public needs and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks, or open spaces which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	70 (exterior)	Residences, motels, hotels, public (exterior) activities not included in categories A and B above.
C	75 (exterior)	Developed lands, properties or (exterior) activities not included in categories A and B above.
D	—	Undeveloped lands
E	55 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums.

- Speed of the vehicles
- Mixture of vehicle types (automobiles, medium and heavy trucks)
- Curvature of the highway
- Grade (slope) of the highway
- Type of terrain between the receiver location and the highway
- Any barriers between the highway and the receiver

For the calculations of the US 412 study area, a number of simplifying assumptions were made to enable a projection of likely noise impact to be made. The highway was assumed to be straight with a change in elevation of 7.6 m (25 ft.) per 305 m (1000 ft.) of distance, the ground between the highway and any residence was assumed to be grassy or brush covered, and there were assumed to be no substantial barriers between the highway and the residence. The latter two assumptions are thought to represent typical conditions and the assumption of straightness will on an average be correct, since a residence on the inside of a curve will have slightly greater noise exposure and one

on the curve's outside will have slightly less noise exposure. The assumption of a slight grade gives a noise exposure prediction about 0.5 dBA greater than that for a flat highway, but about 1.5 dBA less than that for a severe grade.

In addition to the above assumptions, information about the traffic count, speed and type of vehicle was obtained from the project "travel demand forecasts," which provided detailed information for the sixty-three sections of the highway. The most recent (Year 1995) vehicle counts range from approximately 2,200 to 16,000 vpd, depending on the location, and the projected (Year 2017) vehicle counts ranged from about 3,800 to 24,000 vpd. This is an increase of about 75% for most areas, except around Paragould, where the increase is projected to be about 50%. In all areas, the peak hourly traffic was assumed to be 11% of the daily total. Truck traffic was stated to be about 10% of the total for the part of the project west of the intersection of US 412 and 63 (about 40% of the corridor) and 24% for the remaining eastern portion. For the noise exposure calculation, the truck traffic was assumed to be half medium and half heavy trucks.

The traffic study also provided the average vehicle speeds for the various sections, ranging from 15 to 100 km/h (10 to 60 mph). Since the noise exposure depends significantly on the vehicle speed, separate calculations were run at speeds of 30, 60 and 100 km/h (20, 40 and 60 mph) to indicate the noise impact in low, moderate and high speed areas.

Another major factor in noise exposure is the distance of the residence from the highway. In order to allow estimation of noise impact for residences at all distances, the following ranges from the highway centerline were used in the calculations:

Near [15 to 30 m (50 to 100 ft.)]
Medium [30 to 60 m (100 to 200 ft.)]
Far [60 to 120 m (200 to 400 ft.)]
Distant [120 to 240 m (400 to 800 ft.)]

Although no counts of residences classified by their distance from the highway is available, a brief field survey of several small towns along the corridor was conducted to estimate the number of residences potentially affected. The number of residences ranged from 4 per kilometer (Agnos) up to 43 per kilometer (Imboden), with an average of 16 residences per kilometer for the seven towns surveyed. In the rural areas between towns, the number would obviously be much lower.

4.4.3 Noise Exposure Calculation Results

The results of the calculated L10(h) noise exposures are shown in Table 4-18, with the L10(h) value shaded for those cases in which it approaches or exceeds the NAC of 70 dBA (69 dBA or more). For the nearest residences [15 to 31 m (50 to 100 ft.)], nearly all would be expected to approach or exceed the NAC, regardless of the traffic volume, speed or truck percentage, under both current and projected traffic situations. The only exceptions are those residences in Section 12C on US 62 where the speeds and volumes are the least. The same is true for the medium distance residences [31 to 61 m (100 to 200 ft.)] east of Walnut Ridge, due to the increased traffic volume and higher truck percentages. On this section of the highway, even many of the residences 61 to 122 m (200 to 400 ft.) from the highway will approach or exceed the NAC. Those residences greater than 122 m (400 ft.) from the highway are not expected to approach or exceed the NAC under either current or projected conditions.

In addition to the calculation of the value of L10(h) for various conditions, it may be more useful to determine the increase in noise exposure expected to be caused by the increased traffic volume expected by the year 2017 and the possible speed increase allowed by roadway improvements. Three conditions were considered: a 50% traffic volume increase (projected for the Paragould area), a 75% increase projected for most of the corridor, and a 100% increase to show the effect of greater than normal growth in some areas. A difference in sound level of about 3 dBA is the minimum that is usually noticeable and an increase of 10 dBA is generally considered to be a cause for doubling the perceived loudness.

Table 4-18: CALCULATED NOISE EXPOSURE VALUES [L10(h)]

	Seg.	Kilometer From	Kilometer To	2017 AADT	Speed (kmph)	Near (15-30m) No. of Houses	Near (15-30m) Noise Exposure	Medium (30-60m) No. of Houses	Medium (30-60m) Noise Exposure	Far (60-120m) No. of Houses	Far (60-120m) Noise Exposure	Distant (120-240m) No. of Houses	Distant (120-240m) Noise Exposure
Base Case	1	10.0	40.0	7,235	60	120	72.1	180	69.0	120	65.7	60	62.0
	2	40.0	58.0	10,103	60	72	74.4	108	71.2	72	67.7	36	63.9
	3	58.0	85.0	18,145	60	108	75.8	162	72.5	108	68.9	54	65.1
	4	85.0	100.0	15,644	60	60	76.0	90	72.8	60	69.2	30	65.4
	5	100.0	133.0	12,701	60	132	75.9	198	72.7	132	69.2	66	65.3
	6	133.0	152.4	18,544	60	78	77.9	116	74.6	78	70.9	39	67.0
	7	152.4	164.0	9,809	60	46	74.6	70	68.2	46	68.1	23	64.3
	8	164.0	192.0	5,576	60	112	74.6	168	68.2	112	68.1	56	64.3
	10	208.5	217.3	12,354	60	35	76.8	53	73.6	35	70.0	18	66.1
Two-Lane Rural Arterial	1	68.2	40.0	7,731	80	150	74.3	150	71.2	120	67.9	60	64.1
	2	40.0	58.0	10,599	80	90	74.4	90	71.2	72	67.7	36	63.9
	3	58.0	85.0	18,641	80	135	78.0	135	74.7	108	71.1	54	67.3
	4	85.0	100.0	16,140	80	75	78.3	75	75.0	60	71.4	30	67.5
	5	100.0	133.0	13,197	80	165	78.5	165	72.7	132	69.2	66	65.3
	6	133.0	152.4	19,040	80	97	78.3	97	76.2	78	72.6	39	68.8
	7	152.4	164.0	10,305	90	58	76.2	58	75.1	46	71.6	23	67.8
	8	164.0	192.0	6,072	90	140	80.8	140	73.0	112	69.9	56	65.9
	10	208.5	217.3	12,850	90	44	78.46	44	75.1	35	71.6	18	67.8
Multi-Lane Rural Highway	1	10.0	40.0	9,117	90	180	74.3	150	71.2	90	67.9	60	64.1
	2	40.0	58.0	11,985	70	108	74.4	90	71.2	54	67.7	36	63.9
	3	58.0	85.0	20,027	90	162	79.1	135	75.7	81	72.1	54	68.2
	4	85.0	100.0	17,526	90	90	78.3	75	75.0	45	71.4	30	67.5
	5	100.0	133.0	14,583	70	198	75.9	165	72.7	99	69.2	66	65.3
	6	133.0	152.4	20,426	90	116	80.2	97	76.8	58	73.2	39	69.1
	7	152.4	164.0	11,691	100	70	78.4	58	75.1	35	71.6	23	67.8
	8	164.0	192.0	7,458	100	168	76.2	140	73.0	84	69.6	56	65.9
	10	208.5	217.3	14,236	100	53	78.4	44	75.1	26	71.6	18	67.8
Four-Lane Divided Highway	1	10.0	40.0	9,911	100	210	74.3	150	71.2	90	67.9	30	64.1
	2	40.0	58.0	12,779	80	126	76.6	90	73.4	54	69.9	18	66.1
	3	58.0	85.0	20,821	100	189	79.1	135	75.7	81	72.1	27	68.2
	4	85.0	100.0	18,320	100	105	78.3	75	75.0	45	71.4	15	67.5
	5	100.0	133.0	15,377	80	231	79.6	165	76.2	99	72.6	33	67.6
	6	133.0	152.4	21,220	100	136	80.2	97	78.0	58	73.2	19	68.7
	7	152.4	164.0	12,485	110	81	78.4	58	75.1	35	71.6	12	67.8
	8	164.0	192.0	8,252	110	196	76.2	140	73.0	84	69.6	28	65.9
	10	208.5	217.3	15,030	110	62	80.5	44	77.1	26	71.6	9	67.8
Four-Lane Freeway	1	10.0	40.0	10,704	110	240	76.6	120	73.4	90	69.9	30	66.1
	2	40.0	58.0	13,572	90	144	76.6	72	73.4	54	69.9	18	66.1
	3	58.0	85.0	21,614	110	216	79.1	108	75.7	81	72.1	27	68.2
	4	85.0	100.0	19,113	110	120	78.3	60	75.0	45	71.4	15	67.5
	5	100.0	133.0	16,170	90	264	79.6	132	76.2	99	72.6	33	67.6
	6	133.0	152.4	22,013	110	155	80.2	78	76.8	58	73.2	19	68.7
	7	152.4	164.0	13,278	120	93	78.4	46	75.1	35	71.6	12	67.8
	8	164.0	192.0	9,045	120	224	76.2	112	73.0	84	69.6	28	65.9
	10	208.5	217.3	15,823	120	70	80.5	35	77.1	26	73.5	9	69.6

Note: Shaded cells are those in which the calculated L10(h) value approaches or exceeds the Noise Abatement Criterion of 70 dBA.

The projected increases in L10(h) in decibels are shown in Table 4-19:

Table 4-19: PROJECTED L10(h) INCREASE

	No speed change	15 km/h (10 mph) increase	30 km/h (20 mph) increase
50% growth	+1.8	+3.1	+4.4
75% growth	+2.5	+3.8	+5.1
100% growth	+3.0	+4.3	+5.6

4.4.4 Conclusions

Based on the computer model of the projected noise exposure increase by the year 2017 of only about 2 to 5 dBA from current conditions, the project should not have substantial impact in regard to noise increase, since 3 dBA is about the smallest increase that people will normally be able to notice, and an increase of 10 dBA is associated with a substantial impact.

However, there are many areas where the NAC of 70 dBA is already approached or exceeded for residences that are within 61 m (200 ft.) of the highway and in some areas out to a distance of 122 m (400 ft.). The increased traffic volume and speeds will mean that some additional residences will be expected to approach or exceed the NAC of 70 dBA. The typical increase of 3 dBA will approximately double the range at which the noise exceeds the NAC. For instance, if currently the homes in a 61 m (200 ft.) radius are in the 70 dBA range, then by the year 2017, the houses that will be in the 70 dBA range will increase to 122 m (400 ft.).

In addition to the noise increases expected at residences along the current highway route, noise increases will be expected along any bypasses which may be built as part of the project. The distances at which the NAC can be predicted depends on the traffic volume and design speed. Also, the current noise level along the proposed bypass routes is likely to be much less than along the present highway route, so substantial increases of 10 dBA or more may be anticipated if and when the bypass is constructed.

4.5 EMISSIONS IMPACTS

4.5.1 Area Emissions

All five counties in the proposed study area are currently unclassified or in attainment of the National Ambient Air Quality Standard (NAAQS) for all six criteria air pollutants. The six criteria air pollutants include nitrogen dioxide (NO_x), sulfur dioxide (SO_x), carbon monoxide (CO), particulate matter less than 10 microns in diameter (PM_{10}), lead and ozone. Attainment means that the ambient air concentrations of these pollutants are lower than the NAAQS. Therefore, little restriction exists for the dispersion of air pollutants within the study area.

The EPA AP-42 factors for Mobile Sources (Table 4-20) were used to calculate the exhaust emission. Furthermore, projected year 2017 Average Daily Traffic (ADT) volume (plus latent traffic) for each Proposed Alternative was used in each segment along the corridor. The results are shown in Table 4-21. The hydrocarbons emission rate (in metric tons) is computed by the multiplication of the hydrocarbon emission factor with the number of annual vehicle kilometers of travel.

Table 4-20: EXHAUST EMISSIONS FACTORS FROM MOBILE SOURCES

Pollutant	Emission Factor	
	grams/km	grams/mile
Hydrocarbons (HC)	0.588	0.946
Carbon Monoxide (CO)	6.666	10.728
Nitrogen Oxide (NOx)	0.674	1.085

Table 4-21: EXHAUST EMISSIONS FROM MOBILE SOURCES

	Segment	Log Kilometer		2017 ADT w/o Latent Demand (vpd)	Base Case			Improved Two-Lane Rural Arterial			Multilane Rural Highway			Four-Lane Divided Highway			Four-Lane Freeway		
		From (km)	To (km)		Latent Demand (vpd)	Emission Rate (metric ton/yr)	Emission Rate (ton/yr)	Latent Demand (vpd)	Emission Rate (metric ton/yr)	Emission Rate (ton/yr)	Latent Demand (vpd)	Emission Rate (metric ton/yr)	Emission Rate (ton/yr)	Latent Demand (vpd)	Emission Rate (metric ton/yr)	Emission Rate (ton/yr)	Latent Demand (vpd)	Emission Rate (metric ton/yr)	Emission Rate (ton/yr)
HYDROCARBONS	1	10.0	40.0	7,235	0	46.57	51.23	496	49.76	54.74	1,882	58.69	64.55	2,676	63.80	70.18	3,469	68.90	75.79
	2	40.0	58.0	10,103	0	39.02	42.92	496	40.93	45.03	1,882	46.29	50.92	2,676	49.35	54.29	3,469	52.42	57.66
	3	58.0	85.0	18,145	0	105.12	115.63	496	107.99	118.79	1,882	116.02	127.62	2,676	120.62	132.68	3,469	125.21	137.74
	4	85.0	100.0	15,644	0	50.35	55.38	496	51.95	57.14	1,882	56.41	62.05	2,676	58.96	64.86	3,469	61.51	67.67
	5	100.0	133.0	12,701	0	89.93	98.92	496	93.44	102.79	1,882	103.26	113.58	2,676	108.88	119.77	3,469	114.49	125.94
	6	133.0	152.4	18,544	0	77.19	84.91	496	79.25	87.18	1,882	85.02	93.53	2,676	88.33	97.16	3,469	91.63	100.79
	7	152.4	164.0	9,809	0	24.41	26.86	496	25.65	28.21	1,882	29.10	32.01	2,676	31.07	34.18	3,469	33.05	36.35
	8	164.0	192.0	5,576	0	33.50	36.85	496	36.48	40.13	1,882	44.81	49.29	2,676	49.58	54.53	3,469	54.34	59.77
	9	192.0	208.5	27,836	0	98.55	108.40	496	100.30	110.33	1,882	105.21	115.73	2,676	108.02	118.82	3,469	110.83	121.91
	10	208.5	217.3	12,354	0	23.33	25.66	496	24.26	26.69	1,882	26.88	29.57	2,676	28.38	31.22	3,469	29.88	32.86
	Total					587.97	646.76		610.01	671.03		671.69	738.85		706.99	777.69		742.26	816.48
CARBON MONOXIDE	1	10.0	40.0	7,235	0	528.13	580.95	496	564.34	620.77	1,882	665.51	732.06	2,676	723.47	795.82	3,469	781.36	859.49
	2	40.0	58.0	10,103	0	442.49	486.74	496	464.22	510.64	1,882	524.92	577.41	2,676	559.70	615.67	3,469	594.43	653.87
	3	58.0	85.0	18,145	0	1,192.08	1,311.28	496	1,224.66	1,347.13	1,882	1,315.72	1,447.29	2,676	1,367.88	1,504.67	3,469	1,419.98	1,561.98
	4	85.0	100.0	15,644	0	570.98	628.08	496	589.08	647.99	1,882	639.67	703.64	2,676	668.65	735.52	3,469	697.59	767.35
	5	100.0	133.0	12,701	0	1,019.85	1,121.83	496	1,059.67	1,165.64	1,882	1,170.96	1,288.06	2,676	1,234.72	1,358.19	3,469	1,298.40	1,428.23
	6	133.0	152.4	18,544	0	875.36	962.90	496	898.78	988.65	1,882	964.20	1,060.62	2,676	1,001.68	1,101.85	3,469	1,039.12	1,143.03
	7	152.4	164.0	9,809	0	276.88	304.55	496	290.86	319.95	1,882	329.98	362.98	2,676	352.39	387.63	3,469	374.78	412.26
	8	164.0	192.0	5,576	0	379.90	417.88	496	413.69	455.06	1,882	508.12	558.93	2,676	562.21	618.43	3,469	616.24	677.86
	9	192.0	208.5	27,836	0	1,117.57	1,229.32	496	1,137.48	1,251.23	1,882	1,193.13	1,312.44	2,676	1,225.00	1,347.50	3,469	1,256.84	1,382.53
	10	208.5	217.3	12,354	0	264.53	290.98	496	275.15	302.66	1,882	304.83	335.31	2,676	321.83	354.01	3,469	338.81	372.69
	Total					6,667.75	7,334.51		6,917.93	7,609.72		7,617.04	8,378.74		8,017.53	8,819.29		8,417.55	9,259.29
NITROGEN OXIDE	1	10.0	40.0	7,235	0	53.41	58.76	496	57.08	62.78	1,882	67.31	74.04	2,676	73.17	80.49	3,469	79.02	86.93
	2	40.0	58.0	10,103	0	44.75	49.23	496	46.95	51.64	1,882	53.09	58.40	2,676	56.61	62.27	3,469	60.12	66.13
	3	58.0	85.0	18,145	0	120.56	132.62	496	123.86	136.24	1,882	133.07	146.37	2,676	138.34	152.18	3,469	143.61	157.97
	4	85.0	100.0	15,644	0	57.75	63.52	496	59.58	65.54	1,882	64.69	71.16	2,676	67.63	74.39	3,469	70.55	77.61
	5	100.0	133.0	12,701	0	103.14	113.46	496	107.17	117.89	1,882	118.43	130.27	2,676	124.88	137.38	3,469	131.32	144.45
	6	133.0	152.4	18,544	0	88.53	97.38	496	90.90	99.99	1,882	97.52	107.27	2,676	101.31	111.44	3,469	105.09	115.60
	7	152.4	164.0	9,809	0	28.00	30.80	496	29.42	32.36	1,882	33.37	36.71	2,676	35.64	39.20	3,469	37.90	41.69
	8	164.0	192.0	5,576	0	38.42	42.26	496	41.84	46.02	1,882	51.39	56.53	2,676	56.86	62.55	3,469	62.32	68.56
	9	192.0	208.5	27,836	0	113.03	124.33	496	115.04	126.55	1,882	120.67	132.74	2,676	123.89	136.28	3,469	127.11	139.82
	10	208.5	217.3	12,354	0	26.75	29.43	496	27.83	30.61	1,882	30.83	33.91	2,676	32.55	35.80	3,469	34.27	37.69
	Total					674.34	741.79		699.07	769.02		770.37	847.40		810.88	891.96		851.31	936.45

4.6 FUEL CONSUMPTION

Energy consumption can be determined by analyzing the fuel consumption within the study area. Fuel consumption can be calculated using the worst case scenario of each road segment. Table 4-22 shows the fuel consumption values.

The fuel consumption is computed by multiplying the annual vehicle kilometers of travel with the fuel efficiency rate of 6.98 vkt/L (16.41 miles/g) as per FHWA 1992. The cost is computed using the average cost of 31 cents/L ($1.16 per gallon) based on the EPA average fuel rate.

Table 4-22: ANNUAL FUEL CONSUMPTION FOR MOBILE SOURCES

	Log Kilometer		Base Case		Improved Two-Lane Rural Arterial		Multilane Rural Highway		Four-Lane Divided Highway		Four-Lane Freeway	
Segment	From (km)	To (km)	Liters	$	Liters	$	Liters	$	Liters	$	Liters	$
1	10	40.0	3,120,166	956,138	3,441,975	1,054,752	4,347,842	1,332,344	4,882,867	1,496,297	5,382,393	1,649,370
2	40	58.0	4,310,339	1,320,852	4,583,446	1,404,542	5,349,908	1,639,416	5,804,169	1,778,619	6,225,943	1,907,866
3	58	85.0	7,701,514	2,360,037	8,119,859	2,488,234	9,293,924	2,848,012	9,989,760	3,061,243	10,635,833	3,259,225
4	85	100.0	1,970,958	603,977	2,046,245	627,048	2,257,527	691,792	2,382,756	730,168	2,499,028	765,797
5	100	133.0	2,066,606	633,287	2,158,144	661,337	2,415,041	740,061	2,567,297	786,718	2,708,660	830,037
6	133	152.4	3,709,145	1,136,623	3,848,314	1,179,270	4,238,885	1,298,956	4,470,652	1,369,978	4,685,292	1,435,752
7	152.4	164.0	1,253,244	384,042	1,354,230	414,988	1,637,641	501,836	1,805,611	553,308	1,961,569	601,100
8	164	192.0	4,264,285	1,306,739	4,636,672	1,426,982	5,757,885	1,764,435	6,410,544	1,964,435	7,016,528	2,150,131
10	208.5	217.3	1,357,150	415,882	1,411,138	432,426	1,562,653	478,856	1,652,451	506,374	1,735,828	531,924
Latent Demand			22,413,435	6,868,331	19,204,199	5,884,898	10,238,825	3,137,566	4,482,687	1,373,666	0	0
Total			52,166,842	15,985,908	50,804,222	15,574,477	47,100,131	14,433,274	44,448,794	13,620,806	42,851,074	13,131,202
Change from Base Case			0	0	-1,362,620	-411,431	-5,066,711	-1,552,634	-7,718,048	-2,365,102	-9,315,768	-2,854,706

@ 6.98 vkt/liter (16.41 miles/gallon fuel efficiency value as per FHWA 1992).
@ $0.31/l ($1.16/gal) EPA average price per gallon.

4.7 HISTORICAL SITES

The staff of the Arkansas Historic Preservation Program has reviewed the records that pertain to the project area. The staff has reported that one National Historic District (the Hardy Downtown Historic District), seven individually listed National Register properties (six structures and one bridge), two potentially eligible structures, and twelve historic cemeteries are located in or adjacent to the construction area. Therefore, in order to determine if these sites and any unknown sites will be impacted, it is recommended that a cultural resources survey be conducted in the EIS phase of the project. Table 4-23 illustrates the site designation numbers and approximate locations. The mitigation cost of historical sites is shown in Table 4-24.

Table 4-23: HISTORICAL SITES

Historical Site Designation	Site Location
LW0037	305 m (1,000 ft.) inside Walnut Ridge city limits, east of western portion of city limit; 15 m (50 ft.)
LW0064	427 m (1400 ft.) inside Walnut Ridge city limits, east of western portion of city limits; 30 m (100 ft.) north of US 412
LW0067	550 m (1800 ft.) inside Walnut Ridge city limits, east of western portion of city limits; 15 m (50 ft.) north of US 412
LW0040	11189.0 m (36,700 ft.) east of Walnut Ridge city limits; located on US 412
*LW0039	10092 m (33,100 ft.) east of Walnut Ridge city limits; 92 m (300 ft.) south of US 63
LW0065	Within Imboden; 61 m (200 ft.) north of US 63 & 61 m (200 ft.) northwest of US 62
LW00665	Located within Havenden, 10 m (25 ft.) north of US 63, 92 m (300 ft.) west of US 90
SH0073	Southeastern portion of Hardy; 61 m (200 ft.) north of US 62
SH0042	Located within Hardy, 10 m (25 ft.) south of US 62
SH0042	Located within Hardy, 10 m (25 ft.) south of US 62
FU0001	2317 m (7600 ft.) east of Agnos; 30 m (100 ft.) north of US 62
FU0002	3050 m (10000 ft.) west of Agnos; 610 m (2000 ft.) north of US 62
Custer-Herron Cemetery	4600 m (15000 ft.) east of Lake Norfork; 0. m south of US 62
Gobbler Trot Cemetery	2150 m (7000 ft.) east of Gepp, 0. m north of US 62
Hickory Grove Cemetery	7317 m (24000 ft.) east of Agnos; 61 m (200 ft.) east of US 62
Wiles Cemetery	7950 m (26000 ft.) east of Agnos; 0. m (0 ft.) northeast of US 62
Cemetery	7650 m (25000 ft.) west of Ravenden; 7 m (25 ft.) north of US 62
Kelley Cemetery	5182 m (17000 ft.) southwest of Imboden; 0 m (0 ft.) east of US 62
Cemetery	Located 61 m (200 ft.) north of US 62 and 61 m (200 ft.) east of US 466 at Hardy
Cemetery	Located 350 m (1100 ft.) south of US 62 at Salem
Graves Cemetery	7325 m (24000 ft.) west of Ravenden, 150 m (125 ft.) north of US 62
Hope Cemetery	625 m (2000 ft.) south of US 62 at Imboden
Oak Forest Cemetery	Northwestern portion of Black rock 450 m (1400 ft.) north of US 63

Table 4-24: HISTORICAL SITES MITIGATION COST*

	Base Case	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Number of sites affected	0	11	11	11	21
Cost	$0.00	$605,000	$605,000	$605,000	$1,155,000

*Note: Cost of testing is assumed as $5,000.00 per site.
Depending upon test results, the actual mitigation cost may be as much as $100,000.00 per site.
An average assumption of $50,000.00 per site was used.

4.8 THREATENED AND ENDANGERED SPECIES

The Arkansas Game and Fish Commission has provided information on threatened, endangered and candidate species of animals, as well as species of concern, located within the study area.

Habitat Summaries For Endangered Species

Gray Bat (Myotis Grisescens): The gray bat is nocturnal and navigates by uttering a continuous series of high-pitched cries that return as echoes when the sounds bounce off solid objects. It roosts in the daytime in caves, mines or deep rock crevices. Gray bats feed almost exclusively on night-flying aquatic insects, including mosquitoes. Colonies migrate between established maternity and hibernation caves. Bats mate between September and early October upon arrival at the hibernation cave. After mating, the females go into hibernation. Males will feed for several additional weeks. Females give birth to a single young in May or early June. After emerging from hibernation, the bats congregate in maternity caves. Gray bats primarily roost in caves carved out of limestone formations. In the winter they seek deep, vertical caves with narrow entrances. Summer roosts and maternity caves are usually located near rivers or reservoirs where insects are abundant. Adult gray bats feed over water, along rivers or reservoir edges. Since the gray bat population is restricted to these few hibernation caves, they are particularly vulnerable to human disturbance. Deforestation and brush clearing near cave entrances favor predators such as the screech owl, which are able to capture bats more successfully in open habitat. Deforestation can also deprive bats of safe migration routes. The gray bat is found in Baxter and Sharp Counties.

The potential impact of any proposed alternative seems negligent due to gray bat habitats and the fact that no deviation from existing alignment is anticipated. However, upon final determination of bypasses, the subject should be studied further.

Curtis' Pearly Mussel (Epioblasma Florentina Curtisi): The Curtis' pearly mussel is found in transitional zones between swift-flowing stream headwaters and the more leisurely currents of lowland meanders. It buries itself in substrates of sand and gravel or among cobbles or boulders, particularly

in shallow water at depths of up to 76 cm (30 in.). Its eggs are fertilized in fall and larvae are released in spring. Populations require clear, unsilted water. Impoundments created by damming rivers and streams can drastically reduce water flows resulting in stagnant bottom waters and accumulation of silt. Stream channelization and gravel dredging have reduced substrate stability. Poor land management practices have further intensified problems of siltation and chemical runoff. The mussel is found in the Spring River located in Fulton and Lawrence Counties.

Pink Mucket Mussel (Lampsilis Abrupta): The pink mucket mussel is found in the Current, Spring, and Black Rivers located in Randolph and Lawrence Counties. It is a long-term breeder. Males release sperm into the water in late summer or autumn. Females take in sperm but hatch larvae over winter in gill pouches and release them during the following spring. The pink mucket mussel inhabits shallow riffles and shoals of major rivers and tributaries. It is found in rubble, gravel or sand substrates which have been swept free from silt by the current. The mussel is unable to adapt to reduced and sporadic flows, altered water temperatures and seasonal oxygen deficiencies. Siltation smothers mussel beds or decreases the abundance of fish hosts, which are necessary to complete the mussel's life cycle. The impact of the construction across the Current, Spring and Black Rivers which are the subjects' habitat should be investigated further.

4.9 GEOTECHNICAL OVERVIEW

This section summarizes the general geotechnical conditions along the US 412 corridor in northeastern Arkansas. The area of study extends from the east side of Lake Norfork in Baxter County at the west to the Missouri state line located east of Paragould at the east. The length of the current alignment is approximately 216 km (134 miles).

The scope of the geotechnical investigations task included the following subtasks:

- Obtain available geotechnical and geologic data
- Determine location of faults, outcroppings, etc.
- Determine geotechnical considerations for bridges and retaining walls
- Recommend locations for additional geotechnical investigations in subsequent phases of project development

4.9.1 Overview of Physiographic Regions

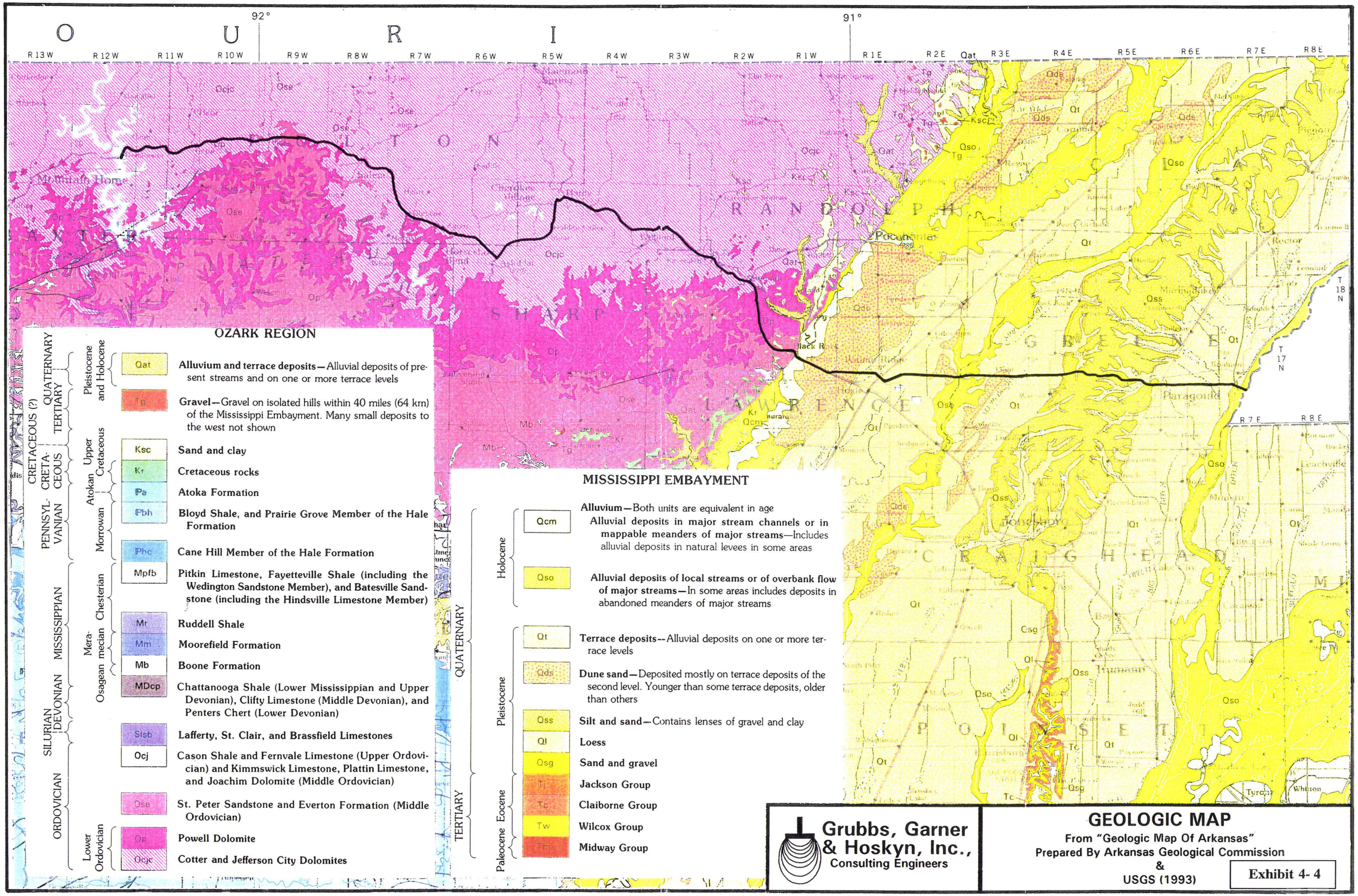
The existing alignment of US 412 crosses two major physiographic regions. The western portion of the alignment is within the Ozark Highlands region. The eastern portion from Black Rock to the Missouri state line is within the Mississippi Embayment.

The Ozark Dome is a broad asymmetrical structure. The Paleozoic beds dip away in all directions from the center of the dome located in the St. Francois Mountains of Missouri. In Arkansas, the beds dip generally southward toward the Arkansas valley. The dip is gentle near the Missouri state line but increases toward the south.

The rocks of the Ozark Highlands include beds of limestone, dolomite, shale, sandstone, chert and conglomerate. These beds range in age from Ordovician to Pennsylvanian.

The eastern portion of the alignment crosses the Mississippi Embayment physiographic region. The Mississippi Embayment is a structural trough whose axis trends along the Mississippi River. This region began subsiding in late Cretaceous time and probably continued until at least the beginning of the Holocene. Most of the embayment is blanketed with Quaternary alluvium. This alluvium is underlain by up to several hundred meters of Tertiary and late Mesozoic marine and non-marine deposits.

A geologic map of the area is presented in Exhibit 4-4. In addition, photos of geologic features along the study corridor are provided in Exhibits 4-5 through 4-14.



GEOLOGIC MAP

From "Geologic Map Of Arkansas"
Prepared By Arkansas Geological Commission
&
USGS (1993)

Exhibit 4- 4

Exhibit 4-5: RED SILTY CLAY WITH DOLOMITE EXPOSED AT BOTTOM OF SLOPE - 1.6 KM WEST OF US 412/SH 395

Exhibit 4-6: RED SILTY CLAY WITH DOLOMITE FLOAT - 2.4 KM WEST OF US412/SH 395

Exhibit 4-7: QUARRY AND KING REDI-MIX NORTH OF US 62/412, 6.4 KM WEST OF US 412/SH 289

Exhibit 4-8: DOLOMITE NEAR HARDY AND CHEROKEE VILLAGE

Exhibit 4-9: RED CHERTY CLAY WITH BOULDER FLOAT IN HARDY

Exhibit 4-10: DIFFERENTIAL WEATHERING NEAR SPRING RIVER

Exhibit 4-11: DIFFERENTIAL WEATHERING 4.8 KM WEST OF IMBODEN

Exhibit 4-12: DIFFERENTIAL WEATHERING 4.8 KM WEST OF IMBODEN

Exhibit 4-13: NEW HIGHWAY CONSTRUCTION 4 KM EAST OF IMBODEN

Exhibit 4-14: TYPICAL DIFFERENTIAL WEATHERING 4 KM EAST OF IMBODEN

4.9.2 Lake Norfork to Black Rock - Ozark Highlands

The highway alignment between Lake Norfork and Black Rock is underlain by Ordivician deposits of the Salem Plateau. These Ordovician deposits are of three principal formations:

1. ***Cotter and Jefferson City Dolomites:*** The Cotter dolomite consists largely of dolomite rock, but it includes shale, chert and sandstone. The beds are made up of two principal types of rock. One type is a massive, medium-grained gray rock, which becomes dark on exposure. The other type is a fine-grained, white to buff rock, known as "cotton rock". These two types are interbedded with each other and with thinner layers of sandstone, shale and chert.

   The Jefferson City dolomite consists of gray, crystalline dolomite with considerable chert content interbedded with thin-bedded, fine-grained, lighter dolomite without chert. This formation also includes thin beds of sandstone, shale, and oolite.

2. ***Powell Dolomite:*** The Powell formation is about 60 m (200 ft.) thick and consists of a dolomite or magnesia limestone interbedded with calcareous shale and some conglomerate. Some white chert is distributed through parts of the formation as concentrically banded nodules, but is not abundant.

3. ***St. Peter Sandstone and Everton Formation:*** The Everton formation consists of three divisions. The lower division is a hard, sandy, compact magnesia limestone. The middle division is a white, massive, finely laminated sandstone composed of medium-sized and transparent quartz grains. The upper division is massive, compact, blue-gray limestone interbedded with some sandstone. The St. Peter formation consists of well-rounded, medium-sized and transparent quartz grains. The cementation is calcium carbonate. The sandstone is massive and friable and porous where weathered. The thickness ranges from a feather edge to over 50 m (175 ft.).

The Cotter dolomite is the primary formation from Lake Norfork to Imboden. There is an area near Viola that crosses the Everton formation. South of Imboden, the existing alignment crosses the Powell Dolomite and the Everton formation. The "Fall Line" (the boundary between the Ozark Region and the Mississippi Embayment) is located just east of Black Rock.

In summary, most of the alignment between Lake Norfork and Black Rock should be within the Cotter and Powell dolomites. These dolomites are typically hard and competent, and often require drilling and blasting within mass excavations. Within the competent rock, near vertical excavation slopes should be appropriate.

In the Black Rock area, the Everton formation should be encountered. A sandy limestone with some sandstone interbedding is anticipated. This rock is also relatively hard and competent. The requirement for drilling and blasting can be anticipated. Near vertical excavation slopes should also be appropriate within the competent rock.

Weathering of the dolomite and limestone bedrocks typically produces a reddish brown silty clay, sandy clay, or clay overburden. The overburden commonly contains a weathered chert "float". The amount of chert is related to the chert content of the parent formation. The thickness of the overburden soils can be highly variable, ranging from a few centimeters to over 10 m (30 ft.) over relatively short distances. Exhibit 4-10 illustrates differential physical weathering and solutioning (chemical weathering) results in the development of "pinnacles" and "valleys" and large detached boulders or "float". In other words, the upper surface of the bedrock is often highly irregular, particularly in the limestone units. Portions of a road cut may be entirely within hard rock and other nearby portions may be entirely with the residual overburden (see Exhibits 4-12 and 4-13).

Generally, the overburden soils may be excavated with normal, heavy-duty excavating equipment and techniques. Some of the more broken and highly weathered bedrock may be excavated by ripping or with a large truck-mounted excavator. Excavation in the competent and highly weathered bedrock will require drilling and blasting (see Exhibits 4-12 and 4-13).

As noted previously, excavations walls of near vertical should be appropriate within the competent bedrock. Within the overburden soils, cut slopes of about 1-vertical on 2.5-horizontal should be appropriate for excavation depths of 6 m (20 ft.) or less. Within deeper cuts, flatter slopes and/or benches may be warranted.

Both the dolomite and limestone units are subject to solutioning. Formation of sinkholes, however, is not common. Generally, the solutioning is most extensive near the soil/bedrock interface. This interface is often the zone of conduit-type groundwater flow.

Caverns have developed in both the dolomite and limestone units. The limestone is generally more soluble, and the presence of sandstone interbedding enhances development. For these reasons, there is apparently a greater occurrence of caverns within the Everton formation than within the Powell or Cotter formations. Many of these caverns have been mapped.

Structure foundations would generally be supported within the bedrock. Spread footings should be appropriate over most of the alignment between Lake Norfork and Black Rock. Within areas of deeper overburden soils, drilled shafts or end-bearing piles would be appropriate.

4.9.3 Black Rock to the Missouri State Line - Mississippi Embayment

The portion of the alignment between Black Rock and the Missouri State line crosses a broad alluvial plain. The plain has little surface relief except at boundaries of stream floodplains and terraces, locally occurring sandhills, and at Crowley's Ridge. These deposits are of two principal groups:

1. ***Quaternary Alluvium:*** Quaternary alluvium denotes the relatively thick sequence of fluvial deposits which blanket most of this portion of the alignment. This alluvium is part of the extensive deposits of the Arkansas and Mississippi River and their tributaries.

   The alluvium may be divided into two parts. The lower part includes sand and gravel with minor amounts of silt and clay. The upper part consists of silt and clay with minor amounts of sand. The alluvium thickness typically ranges from 30 to 60 m (100 to 200 ft.). The average thickness is about 30 m (100 ft.).

   The surficial alluvium may be divided into several types of floodplain deposits based on the mode of deposition. These deposits include natural levee, backswamp, point-bar, swale, and channel-fill deposits. Typically, the point bar and natural levee deposits are more sandy, and the backswamp and channel-fill deposits are more clayey.

2. ***Crowley's Ridge:*** Crowley's Ridge is located in an area of higher and rolling terrain west of Paragould. This ridge is an erosional remnant of Eocene clay, silt, sand and lignite capped by Pliocene sand and gravel. Crowley's Ridge is a divide formed during the Pleistocene as ancestors of the Mississippi River to the west and the Ohio River to the east eroded coastal plain sediments. The upper deposits consist largely of sand and silt but contain lenses of gravel and clay. These soils were apparently placed by stream deposition during Pliocene time.

   In certain areas, outcrops of the Tertiary Wilcox Group are present. These outcrops are principally located along the western edge of the ridge. These older deposits underlie the Pliocene sands and silts and consist of interbedded sand, silt, clay and some lignite.

East of Black Rock, the alignment crosses the geologically recent alluvium of the Black River floodplain. After crossing this relatively narrow floodplain [about 3 km (2 miles) wide], the terrain rises to an alluvial terrace level that is blanketed with dune sand. Some other areas of dune sand are also encountered east of Walnut Ridge. Further to the east, the dune sands disappear and the Quaternary terrace deposits are exposed. The alignment crosses the narrow floodplain of Calico River between Walnut Ridge and Crowley's Ridge.

Crowley's Ridge is located west of Paragould and about 30 km (18 miles) east of Walnut Ridge. This area should be underlain by mostly sands and silts with some clays and gravels.

Within and east of Paragould, the alignment crosses Quaternary terrace deposits. The final approximately 1.5 km (1 mile) of the alignment crosses the geologically recent alluvium of the St. Francis River floodplain.

In summary, most of the alignment between Black Rock and the Missouri State line crosses Quaternary terrace deposits. These deposits typically consist of 6 to 9 m (20 to 30 ft.) of firm to very stiff silty clay, clay, and clayey silt overlying about 20 m (70 ft.) or more of medium dense to dense sand with gravel. The more recent alluvial deposits within the active floodplains are similar in composition but are generally of lower shear strength.

Excavations may generally be accomplished using normal heavy-duty equipment and techniques. Dewatering or special procedures would be required in excavations extending into water-bearing sands. The potential for encountering shallow groundwater would be greatest in the active floodplains. In most areas, excavation slopes of 1-vertical on 2.5-horizontal should be appropriate for cut heights of 6 m (20 ft.) or less. Slopes of 1-vertical on 3-horizontal would be preferred to reduce erosion potential, particularly on Crowley's Ridge. Seismic conditions may dictate slopes of 1-vertical on 3-horizontal or flatter.

Driven, precast concrete piles would be the preferred foundation type for structures founded within the Quaternary alluvium. Pile lengths of about 15 to 20 m (50 to 60 ft.) would typically be required for

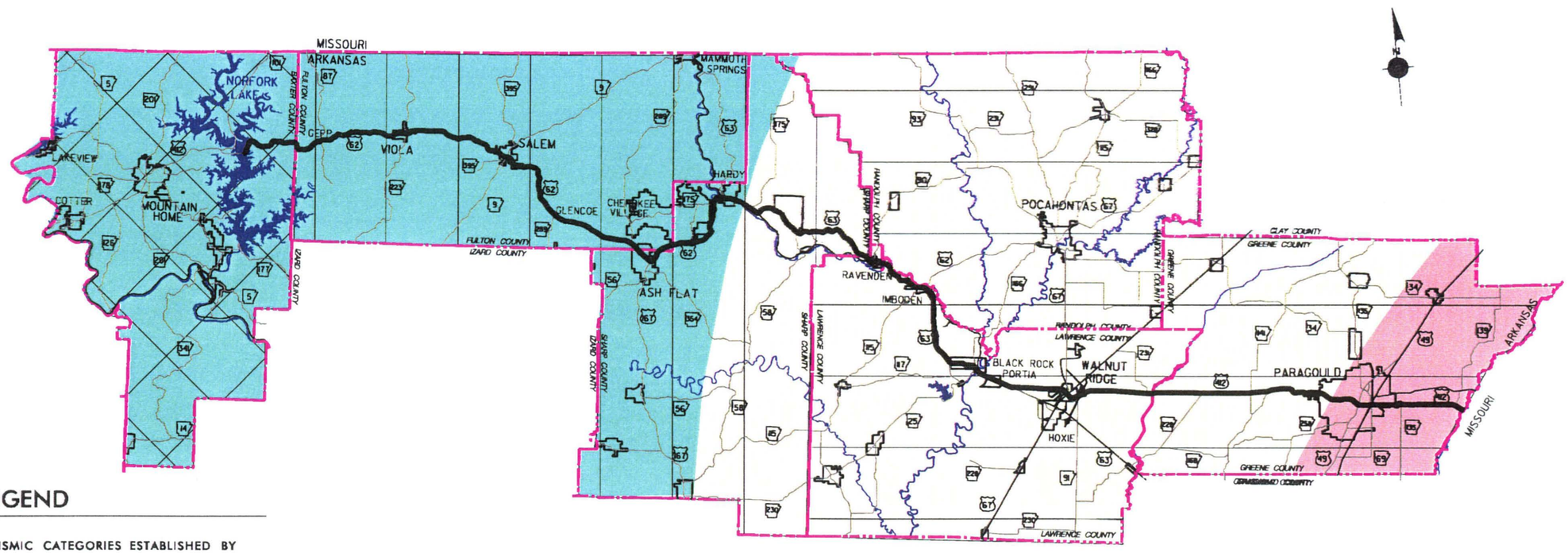
60-ton piles. Increased pile lengths could be required in the more recent alluvium. The use of spread footings may be feasible on portions of Crowley's Ridge.

4.9.4 Seismic Design

The alignment between Lake Norfork and the Missouri state line extends from Seismic Zone 1 at the west to Zone 3 at the east. Zone 1 represents an area of low anticipated seismic damage; whereas, Zone 3 represents an area of greatest seismic damage as defined in section 12-80-103 of the "1995 Laws & Rules of the Board Applying to Engineering & Land Surveying Registration" by the Arkansas State Board of Registration for Professional Engineers and Land Surveyors. AASHTO's Standard Specifications for Seismic Design of Highway Bridges (1991) defines seismic performance categories (SPC's) for geographic areas throughout the United States. The corridor study area includes seismic performance categories "A" from the western project limit to just east of Hardy, category "B" from this point to Paragould, and category "C" from Paragould to the eastern project limit. Exhibit 4-15 illustrates both the zonal boundaries and SPC's along the corridor study area.

The succession of earthquakes known as the New Madrid earthquakes (of 1811-1812) caused widespread liquefaction in an area of the northern Mississippi Embayment, including northeastern Arkansas. Liquefaction occurs when ground vibrations induce pore pressure buildup, and sand develops a liquefied state. These earthquakes caused multitudes of fissures and sand blows over a large region. Sand blows are small, dome-like accumulations of mostly sand at the ground surface. They are formed by groundwater temporarily under artesian pressure as a consequence of earthquake shaking. On the basis of available studies, the alluvium located east of Paragould underwent liquefaction.

In summary, we anticipate a low potential for seismic damage on the Ozark Plateau located west of Black Rock. On the alluvial plain, however, substantial damage associated with liquefaction could occur. The greatest potential for damage would likely be with the St. Francis River floodplain. The summary of geotechnical findings is presented as Table 4-25.



LEGEND

SEISMIC CATEGORIES ESTABLISHED BY ARKANSAS STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS AND LAND SURVEYORS:

ZONE 1
Area of low anticipated seismic damage.

ZONE 2
Area of moderate anticipated seismic damage.

ZONE 3
Area of greatest anticipated seismic damage.

AASHTO SEISMIC PERFORMANCE CATEGORY

A — Area of lower seismic exposure

B — Area of moderate seismic exposure

C — Area of higher seismic exposure

MILES
2 1 0 2 4 6 8
2 1 0 2 4 6 8 10
KILOMETERS

BASE MAP PROVIDED BY THE MAPPING SECTION, PLANNING AND RESEARCH DIVISION, ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT, IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

SEISMIC CLASSIFICATIONS

Exhibit 4–15

Lockwood, Andrews & Newnam, Inc.
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Table 4-25: SUMMARY OF GEOTECHNICAL FINDINGS

Segment	Physiographic Region	Geologic Formation	Mass Excavations			Solutioning Possible?	Caverns Likely?	Preferred Structural Footing Type	Seismic Zone
			Drilling/Blasting Req'd? (see Note 1)	Probability of Encountering Groundwater	Max. side slopes(H:V) (see note 2)				
1	Ozark Highlands	Cotter Dolomite/Everton Formation	Yes	Low	Nearly Vertical	Yes	Yes	Spread	1 & 2
2	Ozark Highlands	Cotter Dolomite	Yes	Low	Nearly Vertical	Yes	Yes	Spread	2
3	Ozark Highlands	Cotter Dolomite	Yes	Low	Nearly Vertical	Yes	Yes	Spread	2
4	Ozark Highlands	Cotter Dolomite	Yes	Low	Nearly Vertical	Yes	Yes	Spread	2
5	Ozark Highlands	Cotter Dolomite	Yes	Low	Nearly Vertical	Yes	Yes	Spread	2 & 3
6	Ozark Highlands	Powell Dolomite/Everton Formation	Yes	Low	Nearly Vertical	Yes	Yes	Spread	3
7	Mississippi Embayment	Black River Alluvium/Quaternary Terrace Deposits	No	High	2.5: 1	No	No	Driven Precast Conc. Piles (see note 3)	3
8	Mississippi Embayment	Quaternary Terrace Deposits	No	Medium	2.5: 1	No	No	Driven Precast Conc. Piles (see note 3)	3
9	Mississippi Embayment	Crowley's Ridge	No	Medium	2.5: 1	No	No	Driven Precast Conc. Piles (see note 3)	3
10	Mississippi Embayment	St. Francis River Alluvium/Quaternary Terrace Deposits	No	High	2.5: 1	No	No	Driven Precast Conc. Piles (see note 3)	3

Notes:
1. Where overburden soils are encountered, they may be excavated using normal heavy duty excavating equipment and techniques. Maximum cut slopes of 2.5:1 for excavation depths less than or equal to 6 m (20 ft.). Greater excavation depths may require flatter slopes and/or benching.
2. Cut slopes of 1:3 are preferred. Seismic design requirements may dictate flatter slopes.
3. Where overburden soil is encountered in lieu of competent rock, drilled shafts or end bearing piles would be anticipated. (Precast concrete piles are not used in performance categories).

Chapter 5

PUBLIC INVOLVEMENT

5.1 BACKGROUND

The public involvement process was developed to educate, inform and update the public on activities associated with the US 412 Corridor Planning Study. The process developed for this project focused on informing the public while gathering valuable local input.

The consultant team worked closely with AHTD to outline a successful public involvement plan and schedule. The plan developed included the following tasks:

- Develop a comprehensive mailing list database of project contacts
- Construct meeting notices and press releases
- Develop public meeting format
- Establish project handout materials
- Conduct two open houses (informal public meetings) within the corridor
- Design and implement public opinion surveys
- Provide media relations

5.2 PUBLIC INVOLVEMENT METHODOLOGY

The consultant team proposed the public involvement process for this project to be conducted in an informal open house format. The open house format used in this study was developed through prior experience. The open house format provides a comfortable setting for the public and the consultant team to exchange communications. The informal open house methodology implemented for this project established a sense of involvement from the communities along the US 412 study corridor.

5.2.1 Database

The consultant team developed a comprehensive database of interested parties impacted by the project. The database listing was updated throughout the duration of the project and included the following:

- Media contacts
- City, county, state and federal elected officials
- Local landowners
- Business within the corridor
- Special interest groups
- Chambers of commerce
- Concerned citizens
- Consultant team members

A comprehensive mailing list was developed from this database. The mailing list was used for project correspondence, which included open house announcements and press releases.

5.2.2 Logo Development

The consultant team developed a simple, easily recognizable project logo to be included on all press releases and public involvement correspondence. The logo was developed to be included on all correspondence regarding the public.

5.2.3 Press Releases

The press releases developed for the US 412 Corridor Planning Study were developed and written by the consultant team, in close coordination with AHTD. After review and approval of the press releases by AHTD, they were distributed to individuals in the mailing list database.

Three press releases were developed for this project. The first release was a general announcement of the project explaining who, what, why and where the project was being conducted. The second press release was an announcement of the open houses. The final press release contained a summary of the project's conclusions and recommendations.

5.2.4 Public Involvement Correspondence

The consultant team prepared and distributed several announcements and invitations during the course of the study including the following:

- General open house announcement
- Paragould open house announcement
- Hardy open house announcement
- Open house invitations to elected officials

The open house announcements were printed on highly visible colored paper and were posted strategically in highly visible areas in both Paragould and Hardy prior to the meeting.

5.2.5 Handout Materials

All materials required for the conduct of the public involvement process were developed by the consultant team. These materials were reader-friendly and written in such a manner so as to be easily understood by everyone in attendance. The consultant team developed handout materials to be distributed to all the open house attendees. The handout sheets produced for the open houses include the following materials:

- Open house stations
- Terms and abbreviations
- Project overview
- Study process flowchart
- Traffic analysis information
- Environmental and cultural constraints
- Goals and objectives

5.2.6 Exhibits and Displays

Each station in the open house had several colorful, simple graphics to illustrate the focus of the particular station. Each station was clearly marked with colorful street signs mounted on poles identifying the station name. The displays indicated the preliminary findings. These findings sparked an open discussion between the public and the consultant team. All exhibits and displays were provided by the consultant team.

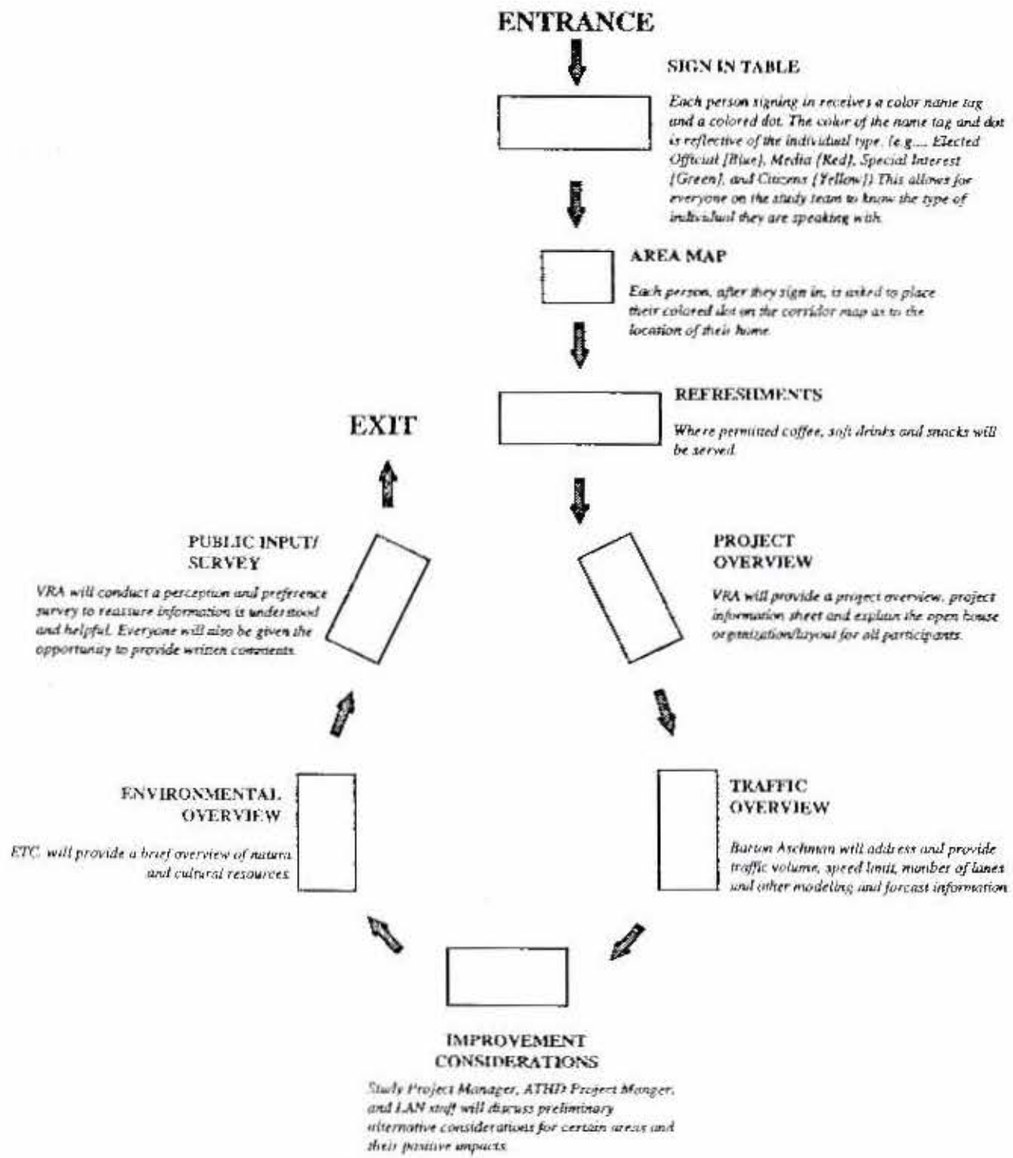
5.3 OPEN HOUSE FORMAT

The open houses were set up to easily guide the general public through a series of information stations. The flowchart in Exhibit 5-1 illustrates the open house setup and flow procedures. The information stations provided allowed for elements of the project to be separated. This separation allowed for participants to focus on the specific areas of the project they were interested in while given the opportunity to talk, one-on-one, with members of the consultant team. It also allowed for the public to participate at their own pace. The open house stations were laid out as follows:

- Welcome/sign-In
- Project overview
- Environmental concerns
- Traffic issues
- Alternative considerations
- Public input
- Refreshments

Exhibit 5-1

OPEN HOUSE FLOWCHART



5.3.1 Welcome/Sign-In Station

As participants in the public involvement process entered the open house they were greeted by a member of the consultant team and asked to sign-in. The sign-in sheet obtained general contact information including person's name, mailing address, telephone and fax numbers. The sign-in sheets were divided into the following four categories:

- Elected officials
- Special interest groups
- Media
- Citizens

The elected official sign-in sheets were printed on red paper and were for individuals holding an elected position whether city, county, state or federal (i.e. mayors, sheriffs, judges, state representatives, state senators, U.S. representatives and U.S. senators, etc.). The yellow special interest group sign-in sheets were completed by any individual representing a special group of more than one person excluding their family (coalitions, business owners, Chambers of Commerce directors, church ministers, etc.). Newspaper, television and radio station representatives signed the blue media sign-in sheets and citizens filled out the white sign-in sheets.

As each person signed in, they were given a color-coded name tag representative of the sign-in completed. Therefore, while visiting each project station consultant team members were able to identify the affiliation of the person with whom they were talking. Consultant team members present wore special name tags distinguishing them from other individuals.

A colored dot also representative of the sign-in sheet was given to each person and they were asked to place the dot on a corridor map in the general location of their home. This was a fun hands-on experience that allowed the public to interact with the consultant team while familiarizing them with the study area and the mapping to be used throughout the open house.

An informational packet was then handed to each participant. The packet contained an explanation of the open house stations and a list of transportation terms and abbreviation definitions. The participant was then directed to the project overview station.

5.3.2 Project Overview

The project overview station was manned by two consultant team representatives. The consultant team at this station explained the overall goals and objectives of the project. Exhibits illustrated the study area and the study limits of the project. The consultant team also explained how the consultant team was comprised, why the study was being conducted, the funding break-down for the project and the project schedule.

Information sheets were handed out that explained the purpose and goals of the study. A flowchart explaining the project flow process was also given out. General questions and concerns were also answered.

Consultant team members then funneled participants into the specialist project stations. Everyone was encouraged to visit and provide input to every station at their own pace. Once they completed their data gathering, they were requested to visit the public input station and provide the consultant team with written comments regarding specific areas of the project.

5.3.3 Traffic Station

The consultant team's traffic specialist provided exhibits and answered questions relating to traffic issues. Participants provided and received information about traffic volumes, accident locations, levels of service (LOS) and traffic operational patterns. Displays were provided to illustrate LOS and existing and future traffic volumes.

5.3.4 Environmental Station

At the environmental concerns station the consultant team's environmental and cultural expert highlighted environmental concerns throughout the study area. The location of historical sites, cemeteries, endangered species and other sensitive environmental or cultural areas within the study area were graphically represented on exhibits. Photographs were also provided to illustrate these concerns.

5.3.5 Alternative Consideration Station

The alternative consideration station explained the alternative considerations being studied throughout the corridor. This station was the focus of the open house and was manned by the consultant team's Project Manager and the AHTD Contract Manager. Displays opened discussions on short and long term improvements. The improvements discussed included building passing lanes, widening sections to four lanes and constructing bypasses around some towns. All attendees had the opportunity to provide input on the preliminary alternatives for both long and short term improvements.

5.3.6 Public Input/Survey Station

The final station in the open house was the public input station. All open house participants were given a survey form to be completed with their written opinions. The survey form provided a forum for citizens to provide the consultant team with their opinions on improvement alternatives for relieving congestion through problem areas along the corridor. Also, questions related to the number of travel lanes along each segment of the corridor were asked. The survey also provided the opportunity for input on environmental and cultural issues, general traffic concerns and any other issues that the participant felt needed to be studied by the consultant team.

After completing the survey, attendees were asked to complete a short three-question survey related to the open house format. Everyone who visited the public input station was given an Arkansas state highway map, courtesy of the AHTD Public Relations Department.

5.4 PUBLIC INVOLVEMENT IMPLEMENTATION

A total of two open house meetings were held during the course of the study. The first open house was held in Paragould, Arkansas on April 9, 1997. The second was held in Hardy, Arkansas, on April 10, 1997.

Exhibit 5-2 shows the location of the meeting attendees' homes by category type. The open houses held in Paragould and Hardy provided good representation from the central and eastern ends of the corridor. Both locations were within an hour's drive for 90% of the corridor population.

5.4.1 Paragould Open House

The open house in Paragould was held on Wednesday, April 9, 1997, in the Paragould Community Center between the hours of 4:00 pm and 8:00 pm. Prior to the meeting, the consultant team sent notices to state, city and county elected officials, local media and special interest groups. Representatives from AHTD were also invited by the consultant team through personal invitations. Citizens were notified of the meetings through fliers placed in storefronts and public service notices placed in area newspapers by the consultant team.

5.4.2 Hardy Open House

The open house in Hardy was conducted in the Old City Gym between the hours of 4:00 pm and 8:00 pm on Thursday, April 10, 1997. As with the Paragould open house, the consultant team invited all state, city and county elected officials, local media and special interest groups. Representatives from AHTD were also invited by the consultant team through personal invitations. Citizens were notified of the meetings through fliers placed in storefronts and public service notices placed in area newspapers by the consultant team.

There were 140 people in attendance at the open house in Hardy. There were seven (5%) elected officials, six (4.3%) media representatives, sixteen (11.4%) representing special interest groups, and 111 (79.3%) citizens.

The attendance at both the Paragould and Hardy open house meetings is summarized in Table 5-1.

Table 5-1: ATTENDANCE AT OPEN HOUSE MEETINGS

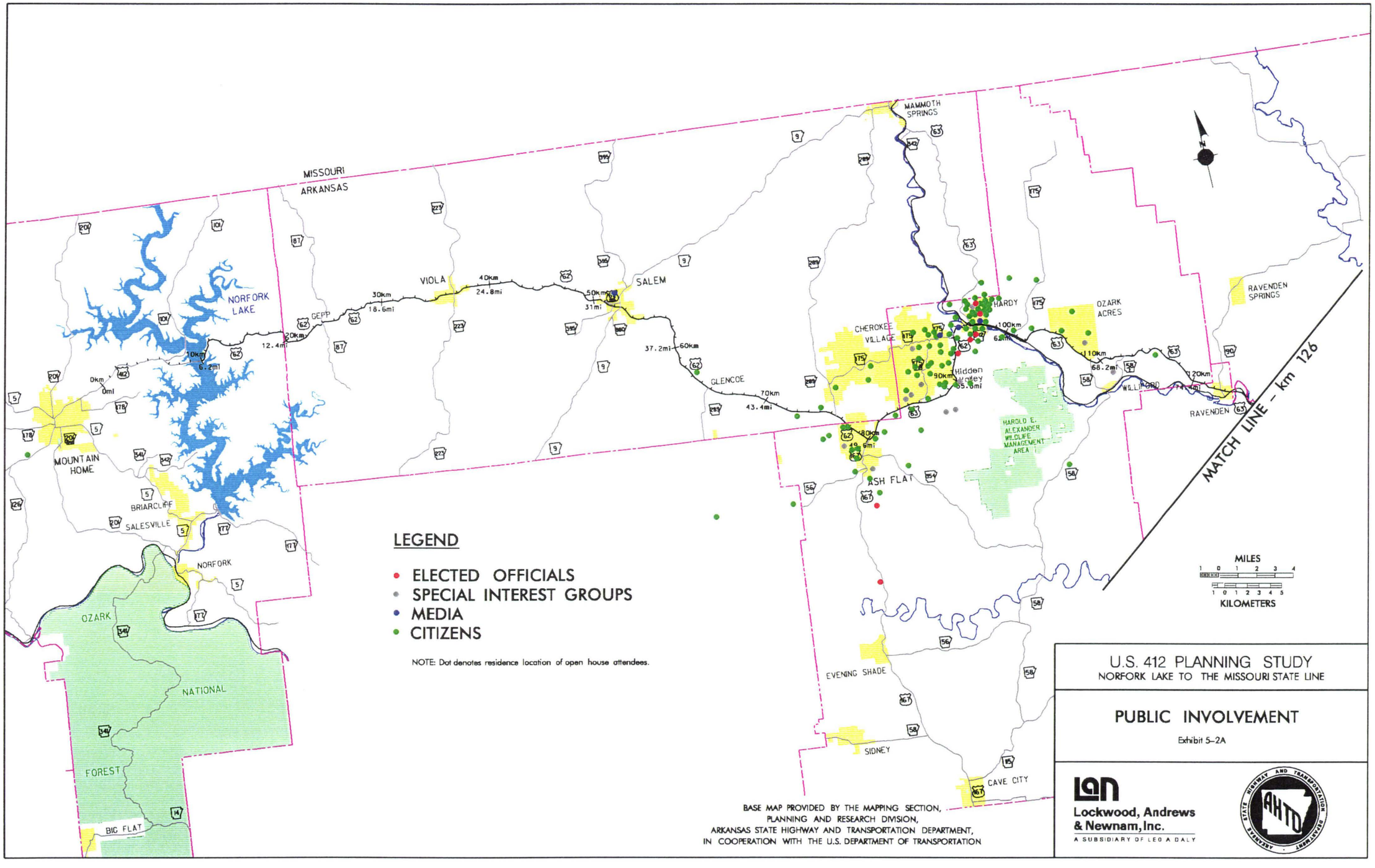
	Paragould April 9, 1997		Hardy April 10, 1997	
Elected Officials	7	(12.1%)	7	(5%)
Media	2	(3.4%)	6	(4.3%)
Special Interest	16	(27.6%)	16	(11.4%)
Citizens	33	(56.9%)	111	(79.3%)
Total	**58**	**(100%)**	**140**	**(100%)**

5.5 SUMMARY OF PUBLIC INPUT

As previously mentioned, the objective of the public involvement process was to educate, inform and update the public on the status of the US 412 Corridor Planning Study. The public involvement process also provided the consultant team with a means to obtain local perceptions and concerns. The consultant team, through the evaluation forms, was able to gather information directly from those who would be affected by the short and long term improvement plan recommended.

5.5.1 Evaluation Forms

The public input/survey evaluation form contained eighteen questions related to various study elements of the corridor. Exhibit 5-3 shows a copy of the evaluation form used at the open houses to obtain public comments. Questions 1 through 9 asked participants their views on improving traffic conditions in and around the towns of Paragould, Hardy, Walnut Ridge, Viola, Ash Flat, Salem, Portia, Black Rock and Ravenden. Questions 10 through 15 relate to improvement needs to be considered for the following roadway segments:


MISSOURI
ARKANSAS
NORFORK LAKE
MOUNTAIN HOME
BRIARCLIFF
SALESVILLE
NORFORK
OZARK
NATIONAL
FOREST
BIG FLAT
GEPP
VIOLA
SALEM
GLENCOE
ASH FLAT
MAMMOTH SPRINGS
CHEROKEE VILLAGE
HARDY
OZARK ACRES
RAVENDEN SPRINGS
RAVENDEN
WILLFORD
HAROLD E. ALEXANDER WILDLIFE MANAGEMENT AREA
EVENING SHADE
SIDNEY
CAVE CITY
MATCH LINE - km 126
0km 0mi
10km 6.2mi
20km 12.4mi
30km 18.6mi
40km 24.8mi
50km 31mi
60km 37.2mi
70km 43.4mi
80km 49.6mi
90km 55.8mi
100km 62mi
110km 68.2mi
120km 74.4mi
MILES
KILOMETERS
LEGEND
ELECTED OFFICIALS
SPECIAL INTEREST GROUPS
MEDIA
CITIZENS
NOTE: Dot denotes residence location of open house attendees.
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
PUBLIC INVOLVEMENT
Exhibit 5-2A
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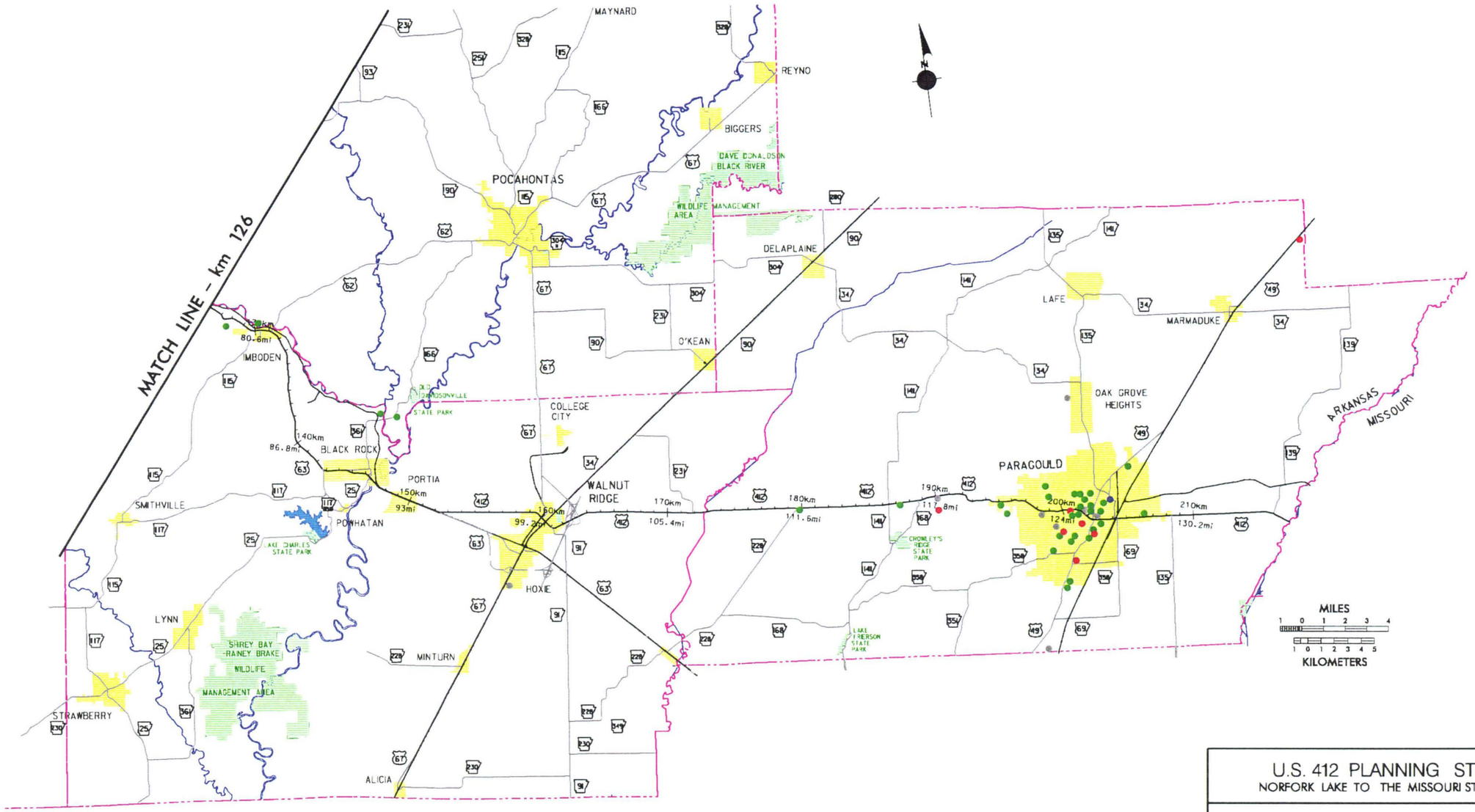
AHTD



LEGEND

- ELECTED OFFICIALS
- SPECIAL INTEREST GROUPS
- MEDIA
- CITIZENS

NOTE: Dot denotes residence location of open house attendees.

JONESBORO

BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

PUBLIC INVOLVEMENT

Exhibit 5-2B

Lockwood, Andrews & Newnam, Inc.
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412 62 63

US 412/62/63

Corridor Planning Study

Evaluation Form

Thank you for participating in tonight's US 412/62/63 Corridor Planning Study Open House. To help determine the corridor improvement options, we need your feedback.

Question 1
What is your recommendation for improving traffic conditions in and around **PARAGOULD?**

A. No improvements are needed
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 2
What is your recommendation for improving traffic conditions in and around **HARDY?**

A. No improvements are needed.
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 3
What is your recommendation for improving traffic conditions in and around **WALNUT RIDGE?**

A. No improvements are needed.
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 4
What is your recommendation for improving traffic conditions in and around **VIOLA?**

A. No improvements are needed.
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 5
What is your recommendation for improving traffic conditions in and around **ASH FLAT?**

A. No improvements are needed.
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 6
What is your recommendation for improving traffic conditions in and around **SALEM?**

A. No improvements are needed.
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 7
What is your recommendation for improving traffic conditions in and around **PORTIA?**

A. No improvements are needed.
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Exhibit 5-3: PUBLIC INPUT/EVALUATION FORM

Question 8
What is your recommendation for improving traffic conditions in and around **BLACK ROCK?**

A. No improvements are needed.
B. Build By-pass North of town from _____ to _____
C. Build By-pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 9
What is your recommendation for improving traffic conditions in and around **RAVENDEN?**

A. No improvements are needed
B. Build By-pass North of town from _____ to _____
C. Build By pass South of town from _____ to _____
D. Add additional lanes through town if space is available
E. No Opinion/Not Interested
F. Other (please explain) _____

Question 10
What roadway improvements need to be considered.

MOUNTAIN HOME TO SALEM
A. No improvements are needed.
B. Add passing lanes throughout
C. Widen to 4 lanes
D. No Opinion/Not Interested
E. Other (please explain) _____

Question 11
What roadway improvements need to be considered.

SALEM TO ASH FLAT
A. No improvements are needed.
B. Add passing lanes throughout
C. Widen to 4 lanes
D. No Opinion/Not Interested
E. Other (please explain) _____

Question 12
What roadway improvements need to be considered.

ASH FLAT TO HARDY
A. No improvements are needed
B. Add passing lanes throughout
C. Widen to 4 lanes
D. No Opinion/Not Interested
E. Other (please explain) _____

Question 13
What roadway improvements need to be considered.

HARDY TO WALNUT RIDGE
A. No improvements are needed
B. Add passing lanes throughout
C. Widen to 4 lanes
D. No Opinion/Not Interested
E. Other (please explain) _____

Question 14
What roadway improvements need to be considered.

WALNUT RIDGE TO PARAGOULD
A. No improvements are needed.
B. Add passing lanes throughout
C. Widen to 4 lanes
D. No Opinion/Not Interested
E. Other (please explain) _____

Question 15
What roadway improvements need to be considered.

PARAGOULD TO THE MISSOURI STATE LINE
A. No improvements are needed.
B. Add passing lanes throughout
C. Widen to 4 lanes
D. No Opinion/Not Interested
E. Other (please explain) _____

Exhibit 5-3: PUBLIC INPUT/EVALUATION FORM (Cont'd)

Question 16
What are your major concerns regarding TRAFFIC?

Question 17
What are your major ENVIRONMENTAL/CULTURAL concerns?

Question 18
Please provide any additional comments or concerns you have.

THANK YOU FOR YOUR HELP!

412 62 63

US 412/62/63

Corridor Planning Study

Questionnaire

Please answer the following questions to help us to continue improving the public participation process for the US 412/62/63 Corridor Planning Study.

Question 1
How did you hear about the Open House?

- o Newspaper
- o Radio
- o TV
- o Flyers
- o Word of Mouth
- o Other (please specify) _____

Question 2
Do you have any suggestions or comments about the format of this open house?

Question 3
Do you have any suggestions or comments about how to improve the way the public is being kept informed about this study?

Exhibit 5-3: PUBLIC INPUT/EVALUATION FORM (Cont'd)

- Mountain Home to Salem
- Salem to Ash Flat
- Ash Flat to Hardy
- Hardy to Walnut Ridge
- Walnut Ridge to Paragould
- Paragould to the Missouri state line

The last three questions were open responses from the public to provide their concerns on traffic, environmental/cultural and any other general comments. The evaluation forms were collected and summarized by location, and as a combined total.

5.5.2 Paragould Evaluation Form Results

The results are summarized in Table 5-3. The majority of the respondents from the Paragould open house, 59%, favored a bypass south of Paragould while 32% preferred a northern bypass. A northern bypass at Hardy was preferred by 40% while 33% of the respondents favored a northern bypass at Walnut Ridge. For the remaining areas, approximately 50% of the respondents felt additional lanes were required through the towns if right-of-way was available, while on an average approximately 20% had no opinion or were not interested in these areas. On an average for respondents from the Paragould open house, 38% responded to the need for additional lanes, while 27% had no opinions or were not interested. Only 5% of the attendees felt no improvements were needed for the corridor.

Of the participants in the open house, over 74% recommended additional lanes throughout the corridor. Over 91% thought US 412 between Paragould and the Missouri state line needed to be widened to four lanes and another 84% felt the same way for the segment between Paragould and Walnut Ridge. Public perception is that a four-lane facility will improve traffic conditions throughout the corridor.

Motorist safety was the major traffic concern from attendees at the Paragould open house. The most frequently cited issue was the mixture of high-speed through traffic and low-speed local traffic. When questioned about environmental and cultural concerns, only six responses were recorded. All favored environmental preservation as much as possible.

5.5.3 Hardy Evaluation Form Results

The results are summarized in Table 5-3. Attendees from the Hardy open house were very concerned and focused on removing truck traffic from the main street of Hardy (US 412/63). Close to 80% of the respondents felt a bypass north of Hardy was needed to remove congestion. The northern bypass of Hardy has a lot of support because of positive articles published in the Hardy newspaper recently. The mayor of Hardy has outlined a route and has been selling it to the public. When asked about improvements in and around other towns along the corridor, people at the Hardy open house had no opinion or were not interested.

Approximately 54% of the public surveyed at the Hardy open house felt that US 412 should be widened to four lanes throughout the corridor. Evaluation form results did not favor any particular segment. Public opinions in the Hardy area stated roadway improvements were needed for the entire corridor. However, another 33.6% had no opinion or were not interested in improving roadway conditions.

The most frequent responses to Question 16 - "What are your major concerns regarding traffic" were:

- Commercial vehicles traveling through town on the narrow roadways cause several accidents each week in town
- Truck mirrors are continuously hitting each other
- There are no passing opportunities throughout the town

An additional concern cited in the survey responses was the frequent flooding of Spring River.

Table 5-2: PUBLIC RECOMMENDATIONS FOR IMPROVING TRAFFIC CONDITIONS
PARAGOULD OPEN HOUSE

Question		No Improvements Are Needed		Build Bypass North of Town		Build Bypass South of Town		Add Additional Lanes in Town		No Opinion Not Interested		TOTAL	
		Response	Percent	Response	Percent	Response	Percent	Response	Percent	Response	Percent	Response	Percent
1	Paragould	0	0%	7	32%	13	59%	1	5%	1	5%	22	100%
2	Hardy	2	10%	8	40%	3	15%	3	15%	4	20%	20	100%
3	Walnut Ridge	1	6%	6	33%	4	22%	3	17%	4	22%	18	100%
4	Viola	1	5%	1	5%	2	9%	11	50%	7	32%	22	100%
5	Ash Flat	2	9%	4	18%	1	5%	10	46%	5	23%	22	100%
6	Salem	1	5%	1	5%	2	9%	10	46%	8	36%	22	100%
7	Portia	2	9%	1	5%	1	5%	11	50%	7	32%	22	100%
8	Black Rock	0	0%	2	9%	2	9%	11	50%	7	32%	22	100%
9	Ravenden	0	0%	1	5%	1	5%	12	55%	8	36%	22	100%
TOTAL		9	5%	31	16%	29	15%	72	38%	51	27%	192	100%

Question		No Improvements Are Needed		Add Passing Lanes Throughout		Widen to Four Lanes		No Opinion Not Interested		TOTAL	
		Response	Percent	Response	Percent	Response	Percent	Response	Percent	Response	Percent
10	Mountain Home to Salem	0	0%	2	9%	16	70%	5	22%	23	100%
11	Salem to Ash Flat	0	0%	2	9%	16	70%	5	22%	23	100%
12	Ash Flat to Hardy	2	8%	3	13%	14	58%	5	21%	24	100%
13	Hardy to Walnut Ridge	0	0%	2	8%	18	72%	5	20%	25	100%
14	Walnut Ridge to Paragould	1	4%	0	0%	21	84%	3	12%	25	100%
15	Paragould to Missouri state line	0	0%	0	0%	21	91%	2	9%	23	100%
TOTAL		3	2%	9	6%	106	74%	25	18%	143	100%

Table 5-3: PUBLIC RECOMMENDATIONS FOR IMPROVING TRAFFIC CONDITIONS
HARDY OPEN HOUSE

Question		No Improvements Are Needed		Build Bypass North of Town		Build Bypass South of Town		Add Additional Lanes in Town		No Opinion Not Interested		TOTAL	
		Response	Percent	Response	Percent	Response	Percent	Response	Percent	Response	Percent	Response	Percent
1	Paragould	2	2%	5	5%	7	7%	12	11%	81	76%	107	100%
2	Hardy	0	0%	71	79%	10	11%	7	8%	2	2%	90	100%
3	Walnut Ridge	1	1%	10	10%	7	7%	14	13%	73	70%	105	100%
4	Viola	3	3%	2	2%	1	1%	32	30%	69	65%	107	100%
5	Ash Flat	5	5%	12	12%	3	3%	40	40%	41	41%	101	100%
6	Salem	4	4%	2	2%	8	8%	36	34%	57	53%	107	100%
7	Portia	3	3%	3	3%	3	3%	36	33%	64	59%	109	100%
8	Black Rock	3	3%	3	3%	23	26%	4	5%	56	63%	89	100%
9	Ravenden	1	1%	0	0%	44	41%	4	4%	59	55%	108	100%
TOTAL		22	2%	108	12%	106	12%	185	20%	502	54%	923	100%

Question		No Improvements Are Needed		Add Passing Lanes Throughout		Widen to Four Lanes		No Opinion Not Interested		TOTAL	
		Response	Percent	Response	Percent	Response	Percent	Response	Percent	Response	Percent
10	Mountain Home to Salem	3	3%	11	10%	63	57%	34	31%	111	100%
11	Salem to Ash Flat	3	3%	10	9%	66	60%	31	28%	110	100%
12	Ash Flat to Hardy	3	7%	2	5%	21	49%	17	40%	43	100%
13	Hardy to Walnut Ridge	2	2%	14	13%	73	67%	20	18%	109	100%
14	Walnut Ridge to Paragould	4	4%	7	6%	51	46%	49	44%	111	100%
15	Paragould to Missouri state line	1	1%	14	12%	53	44%	52	43%	120	100%
TOTAL		16	3%	58	10%	327	54%	203	34%	604	100%

5.6 QUESTIONNAIRES

Meeting attendees were asked to fill out a three-question questionnaire relating to how they were informed of the open house, the format and how the public could be better informed of the project status. Word of mouth and the newspaper were the most popular means of spreading news of the open house. Radio public service announcements and fliers passed out by the consultant team were also two effective ways of generating interest in the open houses.

The open house format was rated by over 85% of the attendees as being very informative. There were only a few negative comments and these ranged from not enough media coverage to not enough information provided. Several comments were made to the lack of media coverage and others were concerned that AHTD was not keeping the public informed of all the happenings.

For ways to improve on keeping the public informed, several people expressed concerns for more media coverage and advertising. The public was also interested as to when results of the US 412 Corridor Planning Study would be available and presented to the public.

5.7 MEDIA RELATIONS

The media relations provided for the US 412 Corridor Planning Study included the interaction by the consultant team with the following media types:

- Newspapers
- Community journals
- Radio stations
- Television stations

The successful utilization of the media allowed for the consultant to positively reach a majority of the public. The media served as a timely means of informing the general public of the US 412 Corridor Planning Study. A relationship was established with media personnel to aid in the dissemination of project updates and future events. Several newspaper articles were written about the project.

Chapter 6

TRAVEL DEMAND FORECASTS

6.1 BACKGROUND

6.1.1 Issues

US 412 exists primarily as a two-lane rural highway across northern Arkansas. Regionally, it connects Tulsa, Oklahoma and Nashville, Tennessee. However, terrain and highway deficiencies preclude its use as a major east-west traffic carrier. It functions primarily to handle local trips for work and recreation, as well as providing a connecting link between major north-south crossing highways. Recent sustained economic growth, in the region including the tourism, agriculture and manufacturing sectors, accents the need for the improvement of this arterial. The Intermodal Transportation Efficiency Act of 1991 (ISTEA) recognized the importance of this corridor by designating US 412 as a "high priority corridor." The act authorized funding for feasibility and planning studies.

Urban congestion is often experienced in the corridor's small cities at or near major intersections with crossing highways. Heavy truck volumes are a consideration in some of these major crossing corridors. Truck traffic is also a concern in the mountainous areas where the terrain influences traveler delays.

Determining appropriate growth rates and dealing with the major crossings are necessary to establish accurate travel demand forecasts. It is also important to understand and incorporate available bypass and route study findings for the significant urban centers within the study limits.

6.1.2 Task Objectives

The task of travel demand forecasting includes the following objective elements:

- Review of available traffic volume data
- Development of future volume projections using historical traffic growth rates
- Analysis and forecasting of travel demands

Available traffic volume data will be examined on a section-by-section basis to identify critical sections and to relate physical conditions with peak demands. Future volume projections will then be established using historical count data and the corresponding growth rates. The growth rates will be evaluated in light of other study data and area socioeconomic growth potential. Next, existing and future projections will be analyzed in light of existing roadway conditions to determine the corresponding Levels of Service (LOS). Growth rates will be adjusted, if appropriate, and travel demands will be forecasted by section for the design year (Year 2017). Travel demand forecasts will be used to establish and test the Proposed Alternatives.

6.2 CORRIDOR CONDITIONS

6.2.1 Character of US 412

US 412 is the major east/west highway system between Norfork Lake and the Arkansas/Missouri state line, with concurrent sections of US 62 and US 63 between Norfork Lake and Walnut Ridge. US 412 follows a path of least resistance throughout most of northern Arkansas, which is primarily dictated by rolling and mountainous terrain.

Roadway inventory data for US 412 was provided by the AHTD. The inventory data dealt with the physical and operational characteristics of each section of roadway and were used to evaluate the existing and future travel demands. More than fifty descriptive items, ranging from lane width to percent no passing zones to truck traffic percent, were included in the data set. A summary of selected items from this inventory can be found in Appendix C.

Of the 216 km (134 miles) of US 412 included in this study, approximately 169 km (105 miles), or more than 78% of the existing highway, is two-lane. The remaining segments are four-lane. Approximately 90% of the total length has shoulders of eight feet or less, with 15% of the total having shoulders less

than four feet, and 10% having no shoulders. Over 90% of the route was in good pavement condition, while 9.1% was fair and none was rated poor.

Safe passing sight distance is available on approximately 47% of the corridor, yet truck climbing lanes have been provided on six sections of US 412. Heavy trucks account for much of the daily traffic in this region. The percent truck traffic is considerably high (approximately 20%) for the segments of US 412/63 between Hardy and Walnut Ridge. West of Hardy, the percent truck traffic decreases considerably and accounts for only 10% of the daily traffic. Unfortunately, both sections pass through some rolling and mountainous terrain which compounds the effect of truck traffic on other traffic. The segment of US 412 between Walnut Ridge and the Missouri state line had the highest percentage of truck traffic at 24%. Higher truck volumes in this region are less of a problem because of the relatively level terrain.

6.2.2 Existing Traffic Volumes

Existing (Year 1994) annual average daily traffic (AADT) volumes were obtained from AHTD and reviewed for each section along the US 412 corridor. Peak hour factors (K-factor) and directional splits (D-factor) were also obtained and verified. These factors were applied to the AADT's to determine a peak hour directional volume for each section. These volumes were then used to identify capacity deficiencies in the existing corridor. A summary of the traffic counts and peak hour factors is included in Table 6-1.

6.2.3 Accident History

Another important factor to consider when examining possible improvements to an existing route is the accident history. Accident data for the corridor from the years 1993, 1994 and 1995 was obtained from AHTD and reviewed for completeness. A summary of the accident data has been presented in Chapter 2 of this report. In addition, several studies conducted within the past several years have examined accident history for select segments of road along the US 412 corridor. Each study was reviewed for its content relevance to this study and summarized below.

Northeast Arkansas Arterial Highway Study

Accident rates for the three-year period 1984-1986 were examined for the state highway network (by roadway type) and the high accident locations in the study area (seven-county area of Clay, Craighead, Greene, Jackson, Lawrence, Poinsett and Randolph). Very little information was provided for sections along the US 412 corridor. The City of Paragould was cited as having a higher than normal accident rate (approximately 1.1 to 2 times higher than the state average). One would expect Paragould to have a slightly higher accident since it is an urban center for the region. Higher traffic volumes usually promote higher accident rates. In general, this study recommended the construction of a four-lane, full-access-controlled facility throughout the portion of the US 412 corridor that was studied.

US 63 Corridor Study: Jonesboro to Mammoth Spring

Accident data were studied along the US 63 corridor from Jonesboro to Mammoth Spring over an eight-year period (January 1981 to December 1988). An eight-year average of accident rates was computed for the various study sections. Lawrence County reported the highest average accident rate per million vehicle miles. Twelve accidents occurred at the intersection of US 63 and US 62 in Hardy during the eight-year evaluation period.

Walnut Ridge/Hoxie Bypass Study

Accident rates were examined for the routes in and through the Walnut Ridge and Hoxie area over a three-year period. Again, these rates were compared to the state average rate at that time (1.74 accidents per million vehicle miles). All of the sections along US 412 reported accidents rates well above the state average. The majority of these accidents were non-intersection related and could be attributed to the high density of commercial development along US 412.

Table 6-1: EXISTING (YEAR 1994) PEAK HOUR VOLUMES

SEGMENT	AHTD DISTRICT	COUNTY	LOG KILOMETERS (km) BEGINNING	LOG KILOMETERS (km) ENDING	EXIST. ADT	% TRUCKS	K FACTOR	DIRECTIONAL FACTOR	EXIST. PEAK HR. VOL.
1	9	Baxter	10.0	10.9	4,100	8	11	60/40	271
1	9	Baxter	10.9	19.2	3,300	8	11	60/40	218
1	5	Fulton	19.2	36.6	2,460	10	11	60/40	162
1	5	Fulton	36.6	37.9	2,710	10	11	60/40	179
1	5	Fulton	37.9	40.0	2,900	10	11	60/40	191
2	5	Fulton	40.0	46.8	2,900	10	11	60/40	191
2	5	Fulton	46.8	47.5	3,100	10	11	60/40	205
2	5	Fulton	47.5	50.1	4,100	10	11	60/40	271
2	5	Fulton	50.1	50.8	4,100	10	11	60/40	271
2	5	Fulton	50.8	52.5	3,635	10	11	60/40	240
2	5	Fulton	52.5	54.1	5,200	10	11	60/40	343
2	5	Fulton	54.1	58.0	4,570	10	11	60/40	302
3	5	Fulton	58.0	77.5	4,570	10	11	60/40	302
3	5	Sharp	77.5	80.1	4,630	10	11	60/40	306
3	5	Sharp	80.1	82.3	8,080	8	11	60/40	533
3	5	Sharp	82.3	84.3	8,080	8	11	60/40	533
3	5	Sharp	84.3	85.0	8,360	8	11	60/40	552
4	5	Sharp	85.0	85.9	8,360	8	11	60/40	552
4	5	Sharp	85.9	87.1	7,700	8	11	60/40	508
4	5	Sharp	87.1	90.7	7,060	8	11	60/40	466
4	5	Sharp	90.7	93.6	7,000	8	11	60/40	462
4	5	Sharp	93.6	96.7	7,570	8	11	60/40	500
4	5	Sharp	96.7	96.8	6,420	24	11	60/40	424
4	5	Sharp	96.8	97.1	7,310	24	11	60/40	482
4	5	Sharp	97.1	97.6	7,310	24	11	60/40	482
4	5	Sharp	97.6	98.3	7,310	24	11	60/40	482
4	5	Sharp	98.3	100.0	5,130	24	11	60/40	339
5	5	Sharp	100.0	103.7	5,130	24	11	60/40	339
5	5	Sharp	103.7	105.7	5,550	18	11	60/40	366
5	5	Sharp	105.7	109.2	5,550	18	11	60/40	366
5	5	Sharp	109.2	111.2	6,030	18	11	60/40	398
5	5	Sharp	111.2	112.8	6,010	18	11	60/40	397
5	5	Sharp	112.8	113.6	5,840	18	11	60/40	385
5	5	Sharp	113.6	115.1	4,484	18	11	60/40	296
5	5	Sharp	115.1	119.3	4,290	18	11	60/40	283
5	5	Sharp	119.3	120.8	4,290	18	11	60/40	283
5	5	Sharp	120.8	121.3	4,290	18	11	60/40	283

SEGMENT	AHTD DISTRICT	COUNTY	LOG KILOMETERS (km) BEGINNING	LOG KILOMETERS (km) ENDING	EXIST. ADT	% TRUCKS	K FACTOR	DIRECTIONAL FACTOR	EXIST. PEAK HR. VOL.
5	1	Lawrence	121.3	122.3	4,290	19	11	60/40	283
5	10	Lawrence	122.3	123.8	5,305	19	11	60/40	350
5	10	Lawrence	123.8	130.0	6,080	19	11	60/40	401
5	10	Lawrence	130.0	132.4	6,670	19	11	60/40	440
5	10	Lawrence	132.4	133.0	6,000	19	11	60/40	396
6	10	Lawrence	133.0	139.5	6,000	19	11	60/40	396
6	10	Lawrence	139.5	140.7	6,140	19	11	60/40	405
6	10	Lawrence	140.7	142.9	6,140	19	11	60/40	405
6	10	Lawrence	142.9	149.6	7,815	19	11	60/40	516
6	10	Lawrence	149.6	150.5	9,630	19	11	60/40	636
6	10	Lawrence	150.5	152.4	7,280	19	11	60/40	480
7	10	Lawrence	152.4	152.7	7,280	19	11	60/40	480
7	10	Lawrence	152.7	157.9	3,770	24	12	60/40	271
7	10	Lawrence	157.9	159.4	3,770	24	12	60/40	271
7	10	Lawrence	159.4	159.9	3,770	24	12	60/40	271
7	10	Lawrence	159.9	160.3	3,770	24	12	60/40	271
7	10	Lawrence	160.3	160.6	9,650	24	12	60/40	695
7	10	Lawrence	160.6	161.0	8,680	24	12	60/40	625
7	10	Lawrence	161.0	162.4	2,180	24	12	60/40	157
7	10	Lawrence	162.4	164.0	2,330	24	11	60/40	154
8	10	Lawrence	164.0	172.7	2,330	24	11	60/40	154
8	10	Greene	172.7	190.8	3,290	24	11	60/40	217
8	10	Greene	190.8	192.0	5,070	24	11	60/40	335
9	10	Greene	192.0	194.7	5,070	24	11	60/40	335
9	10	Greene	194.7	196.6	8,610	24	12	60/40	620
9	10	Greene	196.6	200.6	13,090	24	12	60/40	942
9	10	Greene	200.6	202.4	12,910	24	12	60/40	930
9	10	Greene	202.4	203.9	16,025	24	12	60/40	1,154
9	10	Greene	203.9	204.2	15,480	24	12	60/40	1,115
9	10	Greene	204.2	207.2	12,810	24	12	60/40	922
9	10	Greene	207.2	208.3	11,910	24	12	60/40	858
9	10	Greene	208.3	208.5	7,290	24	11	60/40	481
10	10	Greene	704.5	208.53	7,290	24	11	60/40	481
10	10	Greene	208.53	210.6	7,290	24	11	60/40	481
10	10	Greene	210.6	213.2	7,290	24	11	60/40	481
10	10	Greene	213.2	215.4	7,290	24	11	60/40	481
10	10	Greene	215.4	217.7	7,150	24	11	60/40	472

6.2.4 Proposed Corridor Alternatives

As discussed in Chapter 3 of this report, five different improvement strategies have been considered for the future US 412 corridor. The five alternatives are: *Base Case, Improved Two-Lane Rural Arterial, Four-Lane Undivided Rural Highway, Four-Lane Divided Rural Highway and Four-Lane Freeway.* Each of these cross sections will serve a different traffic volume for the same design year. Issues such as available capacity, improved travel time, latent travel demand and special growth along the corridor will have a significant influence on the relative difference. The analyses presented in the following sections will compare and contrast each alternative based on the anticipated growth in the corridor.

6.3 TRAFFIC GROWTH IN THE CORRIDOR

6.3.1 Historical Growth Rates

Traditionally, projected traffic volumes are developed by using past trends and extrapolating into the future. AHTD provided average annual daily traffic (AADT) volumes between the years 1986 and 1995 for most of the corridor sections. A historical growth rate was calculated for each section over the ten-year period. For those sections of US 412 without historical data, growth rates were supplied by AHTD. A summary of the growth rates are presented in Table 6-2.

6.3.2 Projected Traffic Volumes

Projected (Year 2017) annual average daily traffic (AADT) volumes for each section along the US 412 corridor were then calculated using these historical growth rates. The resulting projected (Year 2017) traffic volumes are presented in Table 6-2.

6.3.3 Bypass Considerations

Recent studies have investigated the feasibility of constructing highway bypasses around several of the urban centers in northeast Arkansas. Three projects have been identified along the US 412 corridor: the Hardy Bypass, the Walnut Ridge/Hoxie Bypass, and the Paragould Bypass. All of these projects, if and when completed, will have a dramatic effect on the percentage of through and truck traffic within these cities. The following is a synopsis of these studies.

Hardy Bypass

Hardy is a small retirement community in the Ozark Mountains of north-central Arkansas. US 63 through Hardy is a two-lane highway with parking on both sides of the street. Approximately 58% of the traffic traveling on US 63 is through traffic. Like many other towns along US 63, there is a high volume of truck traffic. Right-of-way constraints within the downtown area do not allow widening the existing route. As an alternative, a bypass for the City of Hardy was recommended. Construction of a bypass around Hardy should eliminate the vast majority of through traffic in the area. Projected traffic volumes for the year 2017 along this section of US 412/US 63 were adjusted in this study to reflect these changes.

Walnut Ridge/Hoxie Bypass

The two adjacent communities of Walnut Ridge and Hoxie are located at the intersection of US 67, US 63 and US 412. Traffic surveys conducted for the bypass study indicated that the two cities had a large amount of through and truck traffic. Construction of a bypass along the southern and eastern limits of the city should assist in reducing through traffic in this area. Results of the traffic surveys indicate that over 500 vehicles will be diverted during the peak hour from US 412 (between SH 90 and SH 91) to the proposed southeastern section of the bypass. Projected traffic volumes for the year 2017 along US 412 were adjusted in this study to reflect these changes.

Paragould Bypass

Paragould is the largest urban center within the US 412 study area. The city is located at the intersection of US 412 and US 49. A traffic survey conducted in the year 1993 as part of a proposed bypass feasibility study indicates that Paragould has a large amount of through and heavy truck traffic. Construction of a bypass should assist in reducing area through traffic. Preliminary results from the study were considered in the analysis of traffic patterns around the city.

Table 6-2: HISTORICAL GROWTH RATES AND PROJECTED YEAR 2017 AADT (w/o LATENT TRAVEL DEMAND)

SEGMENT	AHTD DISTRICT	COUNTY	LOG KILOMETERS (km) BEGINNING	LOG KILOMETERS (km) ENDING	GROWTH RATES (%)	YEAR 2017 AADT W/O LATENT TRAVEL DEMAND
1	9	Baxter	10.0	10.9	2.5	7,235
1	9	Baxter	10.9	19.2	2.96	6,455
1	5	Fulton	19.2	36.6	2.53	4,370
1	5	Fulton	36.6	37.9	2.24	4,511
1	5	Fulton	37.9	40.0	2.24	4,827
2	5	Fulton	40.0	46.8	2.24	4,827
2	5	Fulton	46.8	47.5	2.24	5,160
2	5	Fulton	47.5	50.1	2.63	7,449
2	5	Fulton	50.1	50.8	2.63	7,449
2	5	Fulton	50.8	52.5	2.63	6,604
2	5	Fulton	52.5	54.1	2.93	10,103
2	5	Fulton	54.1	58.0	2.93	8,879
3	5	Fulton	58.0	77.5	2.93	8,879
3	5	Sharp	77.5	80.1	3.06	9,261
3	5	Sharp	80.1	82.3	3.58	18,145
3	5	Sharp	82.3	84.3	3.58	18,145
3	5	Sharp	84.3	85.0	3.13	16,985
4	5	Sharp	85.0	85.9	3.13	16,985
4	5	Sharp	85.9	87.1	3.13	15,644
4	5	Sharp	87.1	90.7	3.13	14,344
4	5	Sharp	90.7	93.6	2.54	12,464
4	5	Sharp	93.6	96.7	2.75	14,128
4	5	Sharp	96.7	96.8	2.56	11,482
4	5	Sharp	96.8	97.1	2.56	6,700
4	5	Sharp	97.1	97.6	3.58	6,700
4	5	Sharp	97.6	98.3	3.58	6,700
4	5	Sharp	98.3	100.0	3.58	11,520
5	5	Sharp	100.0	103.7	3.58	11,520
5	5	Sharp	103.7	105.7	3.55	12,381
5	5	Sharp	105.7	109.2	3.55	12,381
5	5	Sharp	109.2	111.2	3.09	12,142
5	5	Sharp	111.2	112.8	3.09	12,102
5	5	Sharp	112.8	113.6	3.09	11,760
5	5	Sharp	113.6	115.1	3.21	9,274
5	5	Sharp	115.1	119.3	3.21	8,873
5	5	Sharp	119.3	120.8	3.21	8,873
5	5	Sharp	120.8	121.3	3.21	8,873
5	10	Lawrence	121.3	122.3	3.21	8,873
5	10	Lawrence	122.3	123.8	3.21	10,972
5	10	Lawrence	123.8	130.0	2.84	11,578
5	10	Lawrence	130.0	132.4	2.84	12,701
5	10	Lawrence	132.4	133.0	2.28	10,077
6	10	Lawrence	133.0	139.5	2.28	10,077
6	10	Lawrence	139.5	140.7	3.45	13,396
6	10	Lawrence	140.7	142.9	3.45	13,396
6	10	Lawrence	142.9	149.6	3.27	16,381
6	10	Lawrence	149.6	150.5	2.89	18,544
6	10	Lawrence	150.5	152.4	2.89	14,019
7	10	Lawrence	152.4	152.7	2.89	14,019
7	10	Lawrence	152.7	157.9	2.41	6,520
7	10	Lawrence	157.9	159.4	2.41	6,520
7	10	Lawrence	159.4	159.9	2.41	6,520
7	10	Lawrence	159.9	160.3	2.41	6,520
7	10	Lawrence	160.3	160.6	2.88	9,809
7	10	Lawrence	160.6	161.0	2.88	8,102
7	10	Lawrence	161.0	162.4	2.88	4,189
7	10	Lawrence	162.4	164.0	3.05	4,650
8	10	Lawrence	164.0	172.7	3.05	4,650
8	10	Greene	172.7	190.8	2.32	5,576
8	10	Greene	190.8	192.0	2.32	8,592
9	10	Greene	192.0	194.7	2.32	8,592
9	10	Greene	194.7	196.6	2.32	14,591
9	10	Greene	196.6	200.6	2.41	19,611
9	10	Greene	200.6	202.4	2.41	19,299
9	10	Greene	202.4	203.9	2.75	27,368
9	10	Greene	203.9	204.2	3.39	27,836
9	10	Greene	204.2	207.2	2.75	23,907
9	10	Greene	207.2	208.3	2.75	22,228
9	10	Greene	208.3	208.5	2.32	12,354
10	10	Greene	204.5	208.53	2.32	12,354
10	10	Greene	208.53	210.6	2.32	12,354
10	10	Greene	210.6	213.2	2.32	12,354
10	10	Greene	213.2	215.4	2.32	12,354
10	10	Greene	215.4	217.7	2.32	12,117

6.3.4 Latent Travel Demand

A significant factor affecting the design year 2017 projected traffic volumes is that of latent travel demand. Latent travel demand is defined as additional traffic that desires to use an existing facility, but is discouraged from doing so because of inadequate facilities or high levels of congestion. As a facility is improved, it is assumed that some traffic will divert from their current travel on a parallel route to the improved facility. In addition, new trips will be generated due to the improved facility. The prime motivator in causing this type of motorist behavior is improved travel time. Travel time will vary depending on the type of facility constructed. If we consider the proposed alternatives for US 412, the base case alternative should have the highest travel time and the freeway alternative should have the lowest travel time. We would then expect the freeway alternative to experience the most latent travel demand.

To estimate latent travel demand, corridor travel times are needed for the five proposed alternatives. Capacity analyses were performed using the initial projected AADT's for the five alternative cross sections. Average section speed (a by-product of the capacity analyses) was recorded and then used to calculate section travel time based on section length. Total travel time for the corridor was determined based on the sum of the individual section travel times. This process was repeated for the five proposed alternatives and is summarized in Table 6-3.

Based on the travel times presented, the freeway section should experience more latent travel demand than the other alternatives. Freeway latent travel demand was determined based on AADT volumes on pertinent parallel roadways within the study corridor such as I-40 to the south and I-44 and US 60 to the north. It was assumed that approximately 2,200 vehicles per day (vpd) would divert from their current route if the freeway alternative were built today. This value was projected out to the year 2017 assuming a conservative 2% growth rate. The resulting freeway latent travel demand is 3,469 vpd. Estimates for the remaining alternatives were assumed to be a percentage of this number based on the corresponding percent reduction in travel time. These values are also presented in Table 6-3.

Table 6-3: Proposed Alternative Corridor Travel Times and Latent Travel Demand

Proposed Alternative	Travel Time (min)	Percent Reduction in Travel Time (%)	Percent Latent Demand (%)	2017 Latent Demand (vpd) *
Base Case	178.85	0	0	0
Improved Two-Lane Rural Arterial	170.42	5	14	496
Multi-Lane Rural Highway	145.87	19	54	1882
Four-Lane Divided Rural Highway	130.95	27	77	2676
Four-Lane Freeway	117.32	35	100	3469

** Based on 1994 latent travel demand value of 2200 vpd.*

6.3.5 Special Growth Considerations

Some portions of the study area involve special issues that should be noted. The US 412 corridor is crossed by or runs concurrent with significant traffic flows that utilize a portion of the corridor before departing for destinations outside the corridor. US 63 carries heavy truck volumes between Missouri and Jonesboro, and shares a location with US 412 from Hardy to Imboden. US 63 also allows truck traffic to travel between Missouri and Batesville using US 167; this route is concurrent with US 412 between Hardy and Ash Flat. These heavy truck routes present a particular problem as they travel through downtown Hardy. The incompatible traffic mix causes congestion and safety concerns. Hardy relies on tourism that is particularly focused in the downtown area during the four or five festivals that are held at different times of the year. During these periods, traffic congestion is significant with the downtown area serving as a bottleneck for through traffic.

West of Hardy, the continued growth of Cherokee Village and Ash Flat may require special traffic solutions as concentrated traffic access points warrant special control or left turn provisions. Similar considerations will probably also be necessary in the rolling terrain just west of Paragould as this area develops. Expansion of US 412 facilities in Missouri and improvements to the St. Francis River bridge will facilitate travel to the east; compatible design treatments should be achieved.

6.4 TRAFFIC DEMAND REQUIREMENTS

6.4.1 Analysis Methodology

Capacity analyses were conducted for each section along the US 412 corridor using methodologies outlined in the *1994 Highway Capacity Manual*. Due to the different area types within the study area, two-lane highway, multi-lane highway and urban arterial analyses were performed to determine the existing (Year 1994) and projected (Year 2017) LOS for each section in the corridor. Capacity analyses were performed in two parts, first by examining 1994 traffic counts and then by examining the projected year 2017 traffic volumes (adjusted to include the latent travel demand values presented in Table 6-3) for the five proposed alternatives. Existing directional splits and peak hour factors were assumed for projected year 2017 analyses. All additional input data required for the analyses were obtained from AHTD and verified.

6.4.2 LOS Evaluation Criteria

Two-Lane Rural Highways

LOS criteria for two-lane highways address both mobility and accessibility concerns. The primary measure of service quality is percent time delay, with speed and capacity utilization used as secondary measures.

Multi-Lane Rural Highways

LOS criteria for multi-lane highways are defined in terms of density. Density is a measure that quantifies the proximity of vehicles to each other within the traffic stream and indicates the degree of maneuverability within the traffic stream.

Urban Arterials

Arterial LOS is defined in terms of average speed of all through vehicles on the arterial. It is strongly influenced by the number of signals per mile and the average intersection delay.

Freeways

Freeway LOS is also defined in terms of density (see Multi-Lane Rural Highways).

6.4.3 Level of Service Findings

The results of the LOS analysis for existing (Year 1994) traffic volumes on the existing facility and projected (Year 2017) traffic volumes for all proposed alternatives are shown in Table 6-4. The results are shown graphically in Exhibits 6-1A and 6-1B (existing), 6-2A and 6-2B (projected; base case alternative). The LOS were calculated according to the 1994 Highway Capacity Manual Tables 3-1, 7-1, and 8-1 for basic freeway sections, multi-lane highways and two-lane highways, respectively.

Existing (Year 1994) Levels of Service

The majority of the corridor currently operates at LOS D or worse. Only 45.3% of the study area operates at LOS C or better, which includes approximately 30 km (18 miles) of four-lane highway. The following major sections of the corridor were currently operating at or near capacity conditions (i.e., LOS D or worse):

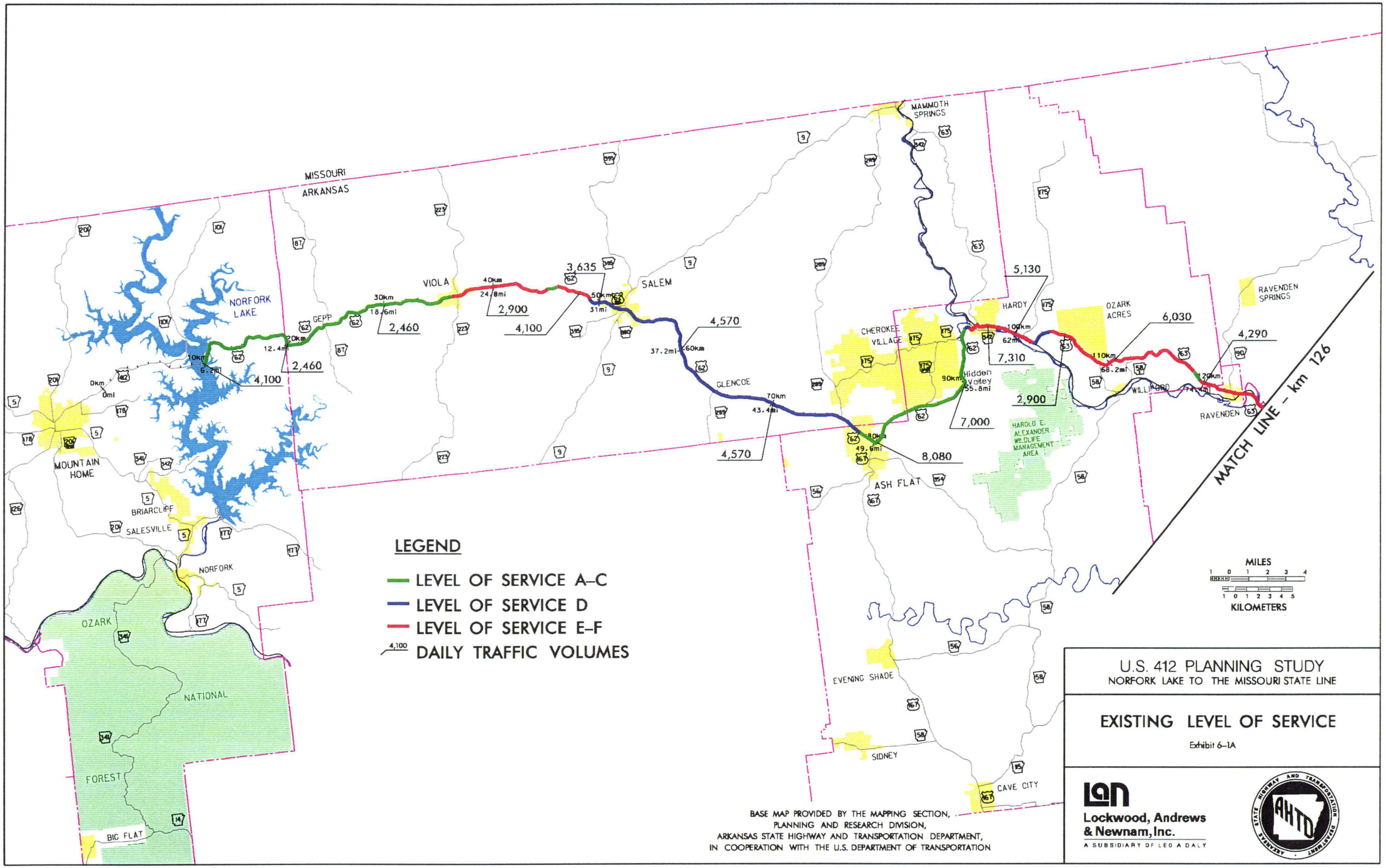
- US 62 between Viola and Ash Flat
- US 63 between Hardy and Walnut Ridge/Hoxie
- US 412 between US 67 and SH 91 in Walnut Ridge/Hoxie
- US 412 to the east and west of Paragould

Viola to Ash Flat - Conditions along US 412/US 62 between Viola and Ash Flat are less than desirable due to the mountainous terrain, high percentage of truck traffic and relatively few opportunities to pass. Contributing to the severe operational conditions is the fact that this portion of the study area is a common segment for all the route alternatives for east/west travel through the corridor.

Table 6-4: EXISTING AND FUTURE LOS EVALUATION

SEG-MENT	AHTD DISTRICT	LOG km		1994		PROJECTED YEAR 2017 ADT/LOS (w/ LATENT DEMAND)									
		BEGIN	END			Base Case		Improved Two-Lane Arterial		Multi-Lane Rural Undivided Highway		Four-Lane Divided Rural Highway		Four-Lane Freeway	
				ADT	LOS	ADT	LOS	ADT	LOS	ADT	LOS	ADT	LOS	ADT	LOS
1	9	10.0	10.9	4,100	C	7,235	E	7,731	E	9,123	A	9,948	A	10,714	A
1	9	10.9	19.2	3,300	C	6,455	D	6,951	D	8,343	A	9,168	A	9,934	A
1	5	19.2	36.6	2,460	C	4,370	D	4,666	C	6,258	A	7,083	A	7,849	A
1	5	36.6	37.9	2,710	C	4,511	D	5,007	D	6,399	A	7,224	A	7,990	A
1	5	37.9	40.0	2,900	E	4,827	E	5,323	E	6,715	A	7,540	A	8,306	A
2	5	40.0	46.8	2,900	E	4,827	E	5,323	E	6,715	A	7,540	A	8,306	A
2	5	46.8	47.5	3,100	C	5,160	D	5,656	D	7,048	A	7,873	A	8,639	A
2	5	47.5	50.1	4,100	E	7,449	E	7,945	E	9,337	B	10,162	A	10,928	A
2	5	50.1	50.8	4,100	E	7,449	F	7,945	E	9,337	B	10,162	A	10,928	A
2	5	50.8	52.5	3,635	D	6,604	E	7,100	E	8,492	A	9,317	A	10,083	A
2	5	52.5	54.1	5,200	D	10,103	E	10,599	E	11,991	A	12,816	A	13,582	A
2	5	54.1	58.0	4,570	D	8,879	E	9,375	E	10,767	A	11,592	A	12,358	A
3	5	58.0	77.5	4,570	D	8,879	E	9,375	E	10,767	A	11,592	A	12,358	A
3	5	77.5	80.1	4,630	D	9,261	E	9,757	E	11,149	B	11,974	A	12,740	A
3	5	80.1	82.3	8,080	A	18,145	B	18,641	B	20,033	B	20,858	D	21,624	B
3	5	82.3	84.3	8,080	A	18,145	A	18,641	A	20,033	B	20,858	B	21,624	B
3	5	84.3	85.0	8,360	A	16,985	B	17,481	B	18,873	A	19,698	B	20,464	B
4	5	85.0	85.9	8,360	A	16,985	B	17,481	B	18,873	A	19,698	B	20,464	B
4	5	85.9	87.1	7,700	A	15,644	B	16,140	A	17,532	A	18,357	A	19,123	A
4	5	87.1	90.7	7,060	A	14,344	A	14,840	A	16,232	A	17,057	A	17,823	A
4	5	90.7	93.6	7,000	A	12,464	A	12,960	A	14,352	B	15,177	A	15,943	A
4	5	93.6	96.7	7,570	A	14,128	A	14,624	A	16,016	B	16,841	A	17,607	A
4	5	96.7	96.8	6,420	E	11,482	F	11,978	E	13,370	B	14,195	A	14,961	A
4	5	96.8	97.1	7,310	D	6,700	D	7,196	E	8,588	A	9,413	A	10,179	A
4	5	97.1	97.6	7,310	D	6,700	D	7,196	E	8,588	A	9,413	A	10,179	A
4	5	97.6	98.3	7,310	E	6,700	E	7,196	E	8,588	A	9,413	A	10,179	A
4	5	98.3	100.0	5,130	E	11,520	F	12,016	E	13,408	B	14,233	B	14,999	A
5	5	100.0	103.7	5,130	E	11,520	F	12,016	E	13,408	B	14,233	B	14,999	A
5	5	103.7	105.7	5,550	D	12,381	F	12,877	D	14,269	C	15,094	C	15,860	A
5	5	105.7	109.2	5,550	E	12,381	F	12,877	E	14,269	C	15,094	C	15,860	A
5	5	109.2	111.2	6,030	F	12,142	F	12,638	F	14,030	C	14,855	C	15,621	A
5	5	111.2	112.8	6,010	F	12,102	F	12,598	F	13,990	C	14,815	C	15,581	B
5	5	112.8	113.6	5,640	F	11,760	F	12,256	F	13,648	C	14,473	C	15,239	B
5	5	113.6	115.1	4,484	E	9,274	E	9,770	E	11,162	B	11,987	B	12,753	B
5	5	115.1	119.3	4,290	E	8,873	F	9,369	F	10,761	B	11,586	B	12,352	B
5	5	119.3	120.8	4,290	E	8,873	F	9,369	E	10,761	B	11,586	B	12,352	B
5	5	120.8	121.3	4,290	C	8,673	D	9,369	D	10,761	A	11,586	A	12,352	A

SEG-MENT	AHTD DISTRICT	LOG km		1994		PROJECTED YEAR 2017 ADT/LOS (w/ LATENT DEMAND)									
		BEGIN	END			Base Case		Improved Two-Lane Arterial		Multi-Lane Rural Undivided Highway		Four-Lane Divided Rural Highway		Four-Lane Freeway	
				ADT	LOS	ADT	LOS	ADT	LOS	ADT	LOS	ADT	LOS	ADT	LOS
5	10	121.3	122.3	4,290	E	8,873	E	9,369	E	10,761	A	11,586	A	12,352	A
5	10	122.3	123.8	5,305	E	10,972	F	11,468	E	12,860	A	13,685	A	14,451	A
5	10	123.8	130.0	6,080	E	11,578	F	12,074	E	13,466	B	14,291	A	15,057	A
5	10	130.0	132.4	6,670	E	12,701	F	13,197	F	14,589	B	15,414	B	16,180	A
5	10	132.4	133.0	6,000	E	10,077	E	10,573	E	11,965	A	12,790	A	13,556	A
6	10	133.0	139.5	6,000	E	10,077	E	10,573	E	11,965	A	12,790	A	13,556	A
6	10	139.5	140.7	6,140	E	13,396	E	13,892	E	15,284	B	16,109	B	16,875	B
6	10	140.7	142.9	6,140	E	13,396	F	13,892	E	15,284	B	16,109	B	16,875	B
6	10	142.9	149.6	7,815	E	16,381	F	16,877	F	18,269	B	19,094	B	19,860	B
6	10	149.6	150.5	9,630	E	18,544	F	19,040	E	20,432	B	21,257	B	22,023	A
6	10	150.5	152.4	7,280	D	14,019	E	14,515	E	15,907	A	16,732	A	17,498	A
7	10	152.4	152.7	7,280	D	14,019	E	14,515	E	15,907	A	16,732	A	17,498	A
7	10	152.7	157.9	3,770	C	6,520	D	7,016	D	8,408	A	9,233	A	9,999	A
7	10	157.9	159.4	3,770	C	6,520	D	7,016	C	8,408	A	9,233	A	9,999	A
7	10	159.4	159.9	3,770	C	6,520	D	7,016	D	8,408	A	9,233	A	9,999	A
7	10	159.9	160.3	3,770	C	6,520	D	7,016	D	8,408	A	9,233	A	9,999	A
7	10	160.3	160.6	9,650	E	9,809	E	10,305	E	11,697	A	12,522	A	13,288	A
7	10	160.6	161.0	8,080	E	8,102	E	8,598	E	9,990	A	10,815	A	11,581	A
7	10	161.0	162.4	2,180	C	4,189	D	4,685	C	6,077	A	6,902	A	7,668	A
7	10	162.4	164.0	2,330	C	4,650	D	5,146	C	6,538	A	7,363	A	8,129	A
8	10	164.0	172.7	2,330	C	4,650	D	5,146	C	6,538	A	7,363	A	8,129	A
8	10	172.7	190.8	3,290	C	5,576	D	6,072	C	7,464	A	8,289	A	9,055	A
8	10	190.8	192.0	5,070	E	8,592	E	9,088	E	10,480	A	11,305	A	12,071	A
9	10	192.0	194.7	5,070	E	8,592	E	9,088	E	10,480	A	11,305	A	12,071	A
9	10	194.7	196.6	8,610	F	14,591	F	15,087	F	16,479	B	17,304	A	18,070	A
9	10	196.6	200.6	13,090	C	19,611	D	20,107	C	21,499	C	22,324	C	23,090	C
9	10	200.6	202.4	12,910	C	19,290	E	19,795	D	21,187	B	22,012	B	22,778	B
9	10	202.4	203.9	16,025	D	27,388	F	27,884	D	29,276	C	30,101	B	30,867	B
9	10	203.9	204.2	15,480	D	27,836	F	28,332	D	29,724	C	30,549	B	31,315	B
9	10	204.2	207.2	12,810	C	23,907	F	24,403	D	25,795	B	26,620	B	27,386	B
9	10	207.2	208.3	11,910	D	22,228	D	22,724	C	24,116	B	24,941	B	25,707	B
9	10	208.3	208.5	7,290	C	12,354	D	12,850	B	14,242	A	15,067	A	15,833	A
10	10	204.5	208.53	7,290	C	12,354	D	12,850	B	14,242	A	15,067	A	15,833	A
10	10	208.53	210.6	7,290	D	12,354	E	12,850	E	14,242	A	15,067	A	15,833	A
10	10	210.6	213.2	7,290	D	12,354	E	12,850	E	14,242	A	15,067	A	15,833	A
10	10	213.2	215.4	7,290	D	12,354	E	12,850	E	14,242	A	15,067	A	15,833	A
10	10	215.4	217.7	7,150	D	12,117	E	12,613	E	14,005	A	14,830	A	15,596	A

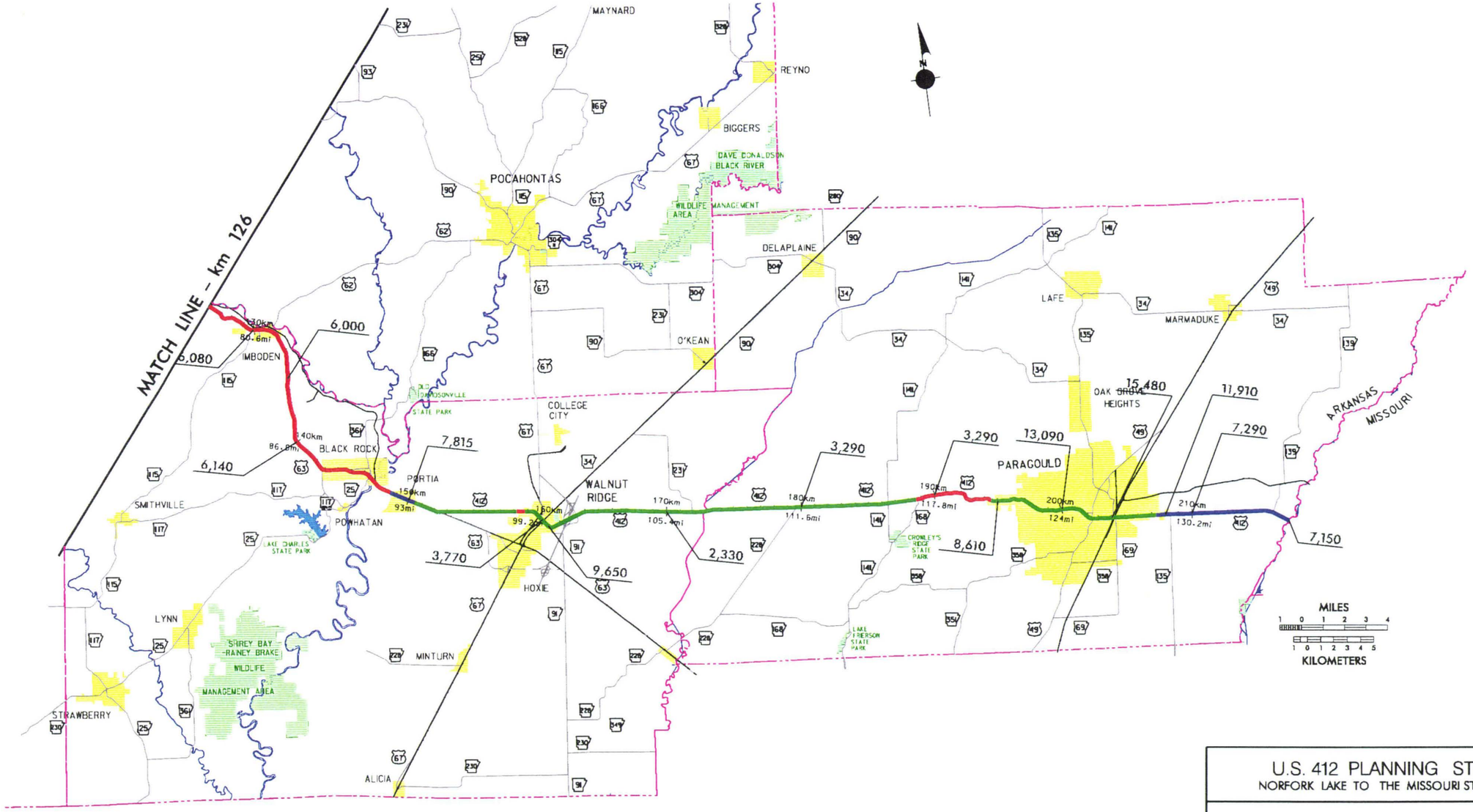


U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING LEVEL OF SERVICE

Exhibit 6–1A

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY



LEGEND

- LEVEL OF SERVICE A–C
- LEVEL OF SERVICE D
- LEVEL OF SERVICE E–F
- 4,100 DAILY TRAFFIC VOLUMES

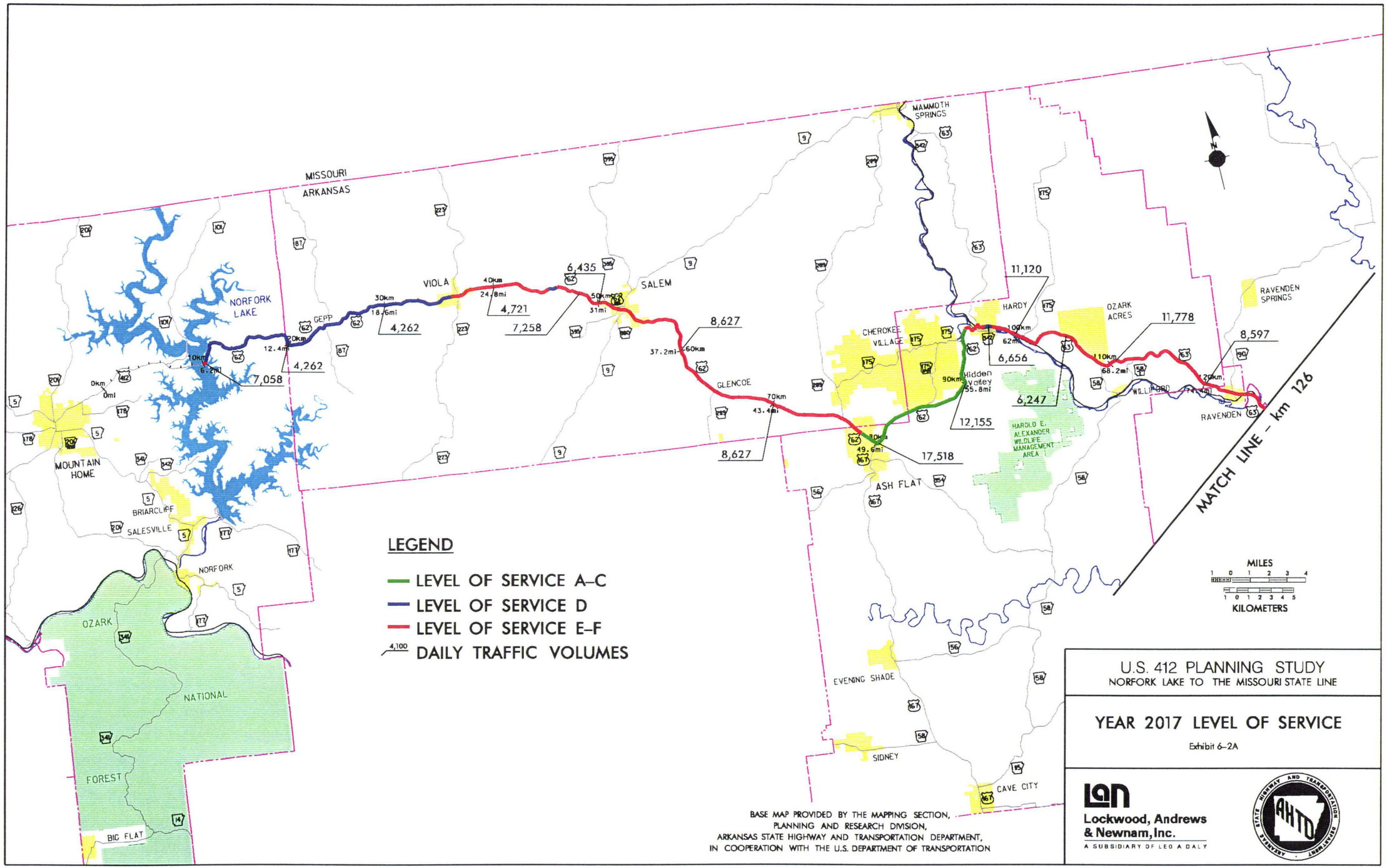
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

EXISTING LEVEL OF SERVICE

Exhibit 6–1B

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY


MISSOURI
ARKANSAS
NORFORK LAKE
MOUNTAIN HOME
BRIARCLIFF
SALESVILLE
NORFORK
OZARK
NATIONAL
FOREST
BIG FLAT
GEPP
VIOLA
SALEM
GLENCOE
CHEROKEE VILLAGE
MAMMOTH SPRINGS
HARDY
OZARK ACRES
WILLFORD
RAVENDEN
RAVENDEN SPRINGS
Hidden Valley
HAROLD E. ALEXANDER WILDLIFE MANAGEMENT AREA
ASH FLAT
EVENING SHADE
SIDNEY
CAVE CITY
0km 0mi
10km 6.2mi
20km 12.4mi
30km 18.6mi
40km 24.8mi
50km 31mi
60km 37.2mi
70km 43.4mi
80km 49.6mi
90km 55.8mi
100km 62mi
110km 68.2mi
120km 74.4mi
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4,721
7,258
6,435
8,627
8,627
17,518
12,155
6,656
6,247
11,120
11,778
8,597
MATCH LINE - km 126
LEGEND
LEVEL OF SERVICE A–C
LEVEL OF SERVICE D
LEVEL OF SERVICE E–F
4,100 DAILY TRAFFIC VOLUMES
MILES
KILOMETERS
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
YEAR 2017 LEVEL OF SERVICE
Exhibit 6–2A
Lockwood, Andrews & Newnam, Inc.
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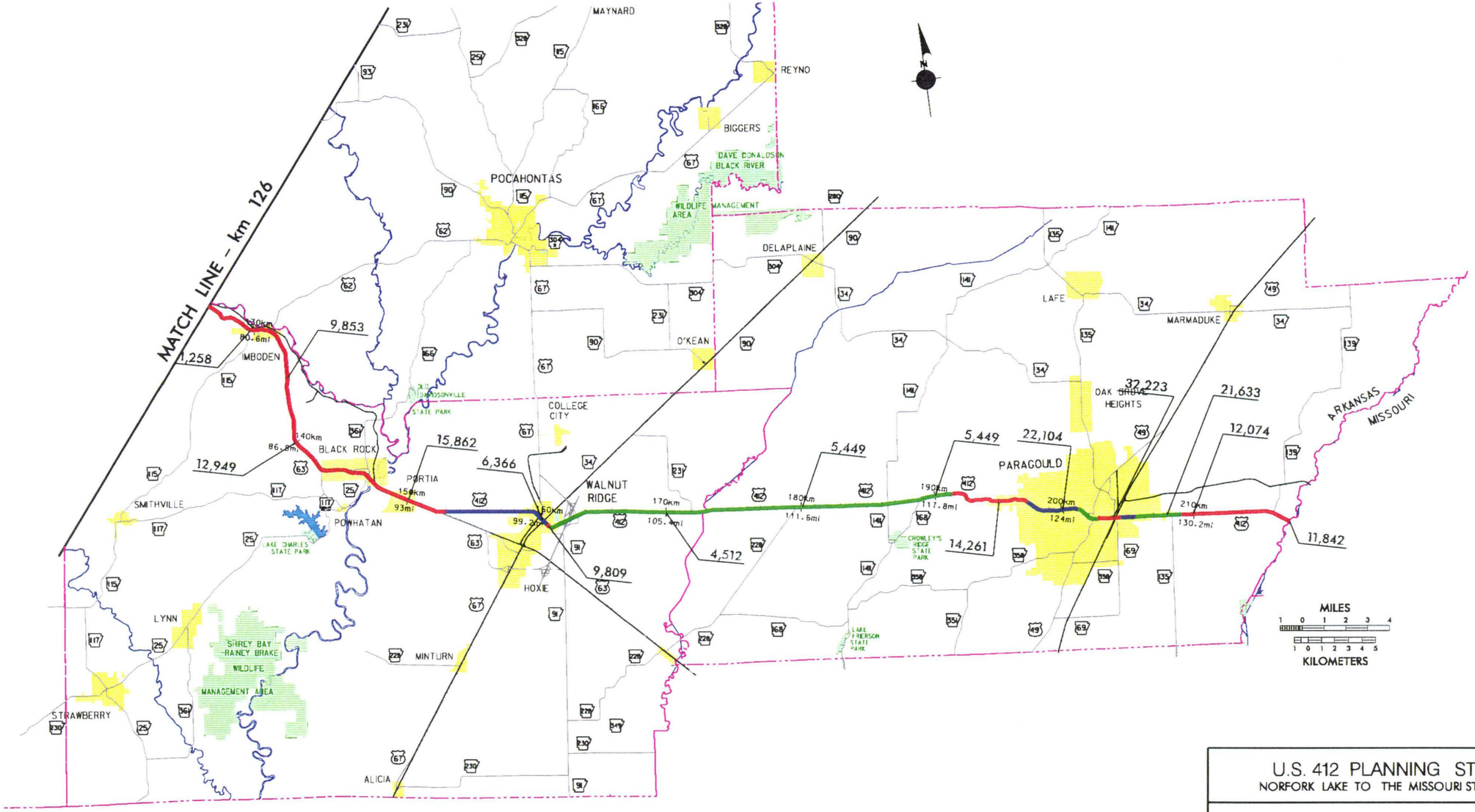
AHTD



LEGEND

- LEVEL OF SERVICE A–C
- LEVEL OF SERVICE D
- LEVEL OF SERVICE E–F
- 4,100 DAILY TRAFFIC VOLUMES

BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

YEAR 2017 LEVEL OF SERVICE

Exhibit 6–2B

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY

Hardy to Walnut Ridge - The combination of rolling and mountainous terrain and a high percentage of truck traffic along US 412/63 between Hardy and Walnut Ridge/Hoxie can cause severe traffic problems and poor LOS. Although this route is not as heavily traveled as the other segments, this section is a primary tourist and commercial truck route between Missouri and Tennessee.

Walnut Ridge/Hoxie - Conditions along US 412 between US 67 and SH 91 in Walnut Ridge/Hoxie are similar to many of the other urban centers along the study corridor. Within the town center, US 412 functions as the main street for the community. This section of US 412 is used by two primary through movements: Newport to Paragould and Hardy to Paragould. The construction of the outer loop around Walnut Ridge/Hoxie will help to alleviate future congestion along US 412 within the city limits.

Paragould Area - US 412 near Paragould has some of the highest daily traffic volumes in the study area. The poor LOS can be attributed to an insufficient number of lanes to accommodate these volumes.

Projected Levels of Service for Proposed Alternatives

Base Case Alternative - The results indicate that in the year 2017, almost 80% of the study area will operate at or near capacity (i.e., LOS D or worse). The section of US 412 between US 67 and SH 91 in Walnut Ridge/Hoxie reported LOS E, with or without the proposed bypass in place.

Improved Two-Lane Rural Highway - The results suggest that in the year 2017, almost 65% of the study area will operate at LOS D or worse, with more than 80% of these sections at LOS E or F. The only sections shown to operate at acceptable LOS were the existing four-lane sections and those affected by the proposed bypasses, excluding Walnut Ridge.

Multi-Lane Alternatives (Multi-Lane Undivided Highway, Four-Lane Divided Rural Highway, and Four-Lane Freeway) - The results indicate that in the year 2017 the study area will operate at an acceptable LOS (LOS C or better) with any of the proposed four-lane alternatives.

6.5 MEASURES OF EFFECTIVENESS FOR IMPROVED MOBILITY

The following measures of effectiveness (MOEs) were prepared to evaluate the proposed alternatives based on the evaluation criterion, *improve mobility*. The MOEs were derived based on the results of the travel demand study for Design Year 2017. The following are definitions of the MOEs used in this study:

Average Daily Trips - Measures the number of average daily trips per segment. The calculated values for all the Proposed Alternatives are presented in Table 6-5.

Table 6-5: 2017 AVERAGE DAILY TRIPS (VEHICLES PER DAY)

Segment	Base Case	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	5,044	5,541	6,935	7,761	8,528
2	7,222	7,719	9,113	9,939	10,706
3	11,024	11,520	12,913	13,738	14,505
4	12,366	12,858	14,241	15,060	15,820
5	11,073	11,567	12,954	13,776	14,539
6	13,528	14,023	15,413	16,236	17,001
7	6,487	6,977	8,352	9,167	9,923
8	5,336	5,831	7,220	8,043	8,807
10	12,337	12,822	14,184	14,991	15,741
Total	84,417	88,858	101,325	108,711	115,570
Change from Base Case	0	4,441	16,908	24,294	31,153

Peak Hour Person Capacity - Measures the carrying capacity during the peak hour, in person trips for a specific segment along the study corridor. It is determined by multiplying the segment peak hour volume by the statewide average occupancy rate of 1.7 persons per vehicle. The calculated values for all the alternatives are presented in Table 6-6.

Table 6-6: 2017 PEAK HOUR PERSON CAPACITY (PERSONS PER HOUR)

Segment	Base Case	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	569	625	783	876	962
2	815	871	1,028	1,122	1,208
3	1,244	1,300	1,457	1,550	1,637
4	1,396	1,451	1,607	1,700	1,785
5	1,250	1,305	1,462	1,555	1,641
6	1,527	1,583	1,739	1,832	1,919
7	787	846	1,013	1,113	1,205
8	602	658	815	908	994
10	1,399	1,454	1,608	1,699	1,784
Total	9,589	10,093	11,512	12,355	13,135
Change from Base Case	0	504	1,923	2,766	3,546

Peak Hour Volume/Capacity Ratio - Measures the ratio between the estimated future annual average weekday peak hour traffic and the projected roadway capacity for the proposed alternatives. The calculated values for all the alternatives are presented in Table 6-7.

Table 6-7: 2017 PEAK HOUR VOLUME/CAPACITY RATIO

Segment	Base Case	Improved 2-Lane Arterial	Multi-Lane Rural Undivided Highway	4-Lane Divided Rural Highway	4-Lane Freeway
1	0.36	0.35	0.18	0.17	0.16
2	0.56	0.55	0.22	0.22	0.21
3	0.54	0.57	0.26	0.25	0.22
4	0.47	0.43	0.29	0.29	0.25
5	0.97	0.74	0.40	0.38	0.32
6	0.94	0.88	0.34	0.34	0.29
7	0.68	0.42	0.16	0.15	0.14
8	0.43	0.28	0.15	0.13	0.13
10	0.68	0.68	0.25	0.25	0.20
Total	0.57	0.49	0.25	0.25	0.20

Peak Hour Level of Service - Quantitatively measures the proposed alternative's weighted peak hour LOS based on the projected year 2017 average daily traffic on a 0 to 5 scale for LOS F to A, respectively. The calculated values for the various alternatives are presented in Table 6-8.

Table 6-8: PEAK HOUR LEVEL OF SERVICE

Segment	Base Case		Improved Two-Lane Arterial		Multi-Lane Rural Undivided Highway		Four-Lane Divided Rural Highway		Four-Lane Freeway	
1	1.90	E	2.48	D	5.00	A	5.00	A	5.00	A
2	1.00	E	1.04	E	4.82	B	5.00	A	5.00	A
3	1.62	E	1.62	E	4.75	B	4.82	B	4.72	B
4	3.91	C	4.06	B	4.48	B	4.83	B	5.00	A
5	0.13	F	0.76	F	3.88	C	4.07	B	4.80	B
6	0.49	F	0.65	F	4.43	B	4.43	B	4.48	B
7	1.91	E	2.30	D	5.00	A	5.00	A	5.00	A
8	1.96	E	1.98	E	5.00	A	5.00	A	5.00	A
10	1.31	E	1.92	E	5.00	A	5.00	A	5.00	A
Total	1.47	E	1.76	E	4.67	B	4.75	B	4.88	B
Change from Base Case	0		0.29		3.20		3.28		3.41	

Accident Cost Reduction - Quantifies the savings obtained from reducing the accident rates. Existing Property Damage Only (PDO), injury, and fatal accident rates for the base case alternative were calculated based on historical data. The existing calculated accident rates were used to estimate year 2017 accidents for the base case alternative. For the remaining alternatives, the statewide average accident rates were used to estimate year 2017 accidents and fatalities. PDO and injury rates were a function of accidents per million vehicle miles of travel each year (MVM); whereas, fatality rates were a function of fatalities per 100 million vehicle miles of travel each year (100 MVM). The number of PDO, injury and fatal accidents were then calculated by multiplying their respective rates by segment ADTs for each alternative (converted to MVM and 100 MVM, respectively). To estimate total accidents per alternative, each PDO, injury and fatality was multiplied by its associated cost (PDO and injury - $7,765 per accident; and fatality - $2,200,000 per person based on FHWA's Technical Advisory 7570.2 dated October 31, 1994). The estimated annual accident cost reduction for each alternative was compared with the base case alternative. The estimated number of accidents reduced for each alternative is shown in Table 6-9. The calculated values for accident cost savings for all the proposed alternatives are presented in Table 6-10.

Table 6-9: 2017 ANNUAL ACCIDENT REDUCTION

Segment	Improved Two-Lane Arterial		Multi-Lane Rural Undivided Highway		Four-Lane Divided Rural Highway		Four-Lane Freeway	
	Fatalities	Non-fatal Accidents	Fatalities	Non-fatal Accidents	Fatalities	Non-fatal Accidents	Fatalities	Non-fatal Accidents
1	0.00	1.00	-0.08	-14.49	0.02	7.15	0.34	13.78
2	0.53	-2.22	0.47	-20.05	0.61	8.73	1.00	17.48
3	1.03	-3.79	0.95	-31.99	1.21	15.76	1.88	29.96
4	0.08	1.70	0.06	-16.24	0.04	14.33	0.21	25.69
5	0.34	0.40	0.33	-6.62	0.40	5.88	0.57	9.58
6	0.03	-0.06	0.01	-11.99	0.14	10.07	0.44	16.56
7	0.00	10.33	-0.02	4.68	0.02	13.19	0.14	15.79
8	0.51	-3.10	0.41	-22.98	0.55	5.87	0.97	14.66
10	0.01	-0.41	0.00	-5.31	0.04	3.54	0.16	6.20
Total	2.53	3.85	2.13	-126.99	3.03	84.52	5.71	149.70

Table 6-10: 2017 ANNUAL ACCIDENT COST REDUCTION

Segment	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	$ 7,765.00	$ -288,515.00	$ 99,520.00	$ 855,002.00
2	$ 1,148,762.00	$ 878,312.00	$ 1,409,788.00	$ 2,335,732.00
3	$ 2,236,571.00	$ 1,841,598.00	$ 2,784,376.00	$ 4,368,639.00
4	$ 189,201.00	$ -9,634.00	$ 199,272.00	$ 661,483.00
5	$ 751,106.00	$ 674,596.00	$ 925,658.00	$ 1,328,389.00
6	$ 65,534.00	$ -71,102.00	$ 386,194.00	$ 1,096,588.00
7	$ 80,212.00	$ -7,660.00	$ 146,420.00	$ 430,609.00
8	$ 1,097,929.00	$ 723,560.00	$ 1,255,581.00	$ 2,247,835.00
10	$ 18,816.00	$ -41,232.00	$ 115,488.00	$ 400,143.00
Total	$ 5,595,896.00	$ 3,699,923.00	$ 7,322,297.00	$13,724,420.00

Trip Time - Measures the total travel time required to traverse each corridor segment for an average loaded truck. Trip time is computed by multiplying the segment length by the average vehicle speed for each segment determined from capacity analyses. The calculated values for all the Proposed Alternatives are presented in Table 6-11.

Table 6-11: AVERAGE TRUCK TRAVEL TIME (MINUTES)

Segment	Base Case	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	24.2	23.5	22.6	20.3	17.8
2	15.7	14.4	14.4	12.8	11.1
3	20.8	20.1	18.6	16.7	14.8
4	11.9	11.6	10.0	8.9	8.0
5	33.6	31.3	26.0	23.0	20.0
6	20.0	18.2	13.2	11.9	10.6
7	8.5	8.3	7.1	6.5	6.1
8	21.4	19.1	17.4	15.8	14.9
10	6.7	6.7	5.4	4.9	4.6
Total	162.8	153.2	134.7	120.8	107.9
Change from Base Case	0	-9.6	-28.1	-42.0	-54.9

Vehicle Hours Traveled - Measures the vehicle hours traveled per segment for each proposed alternative. It is computed by dividing vehicle kilometers traveled per segment at the average segment speed. The average segment speed for the base case and improved two-lane alternatives was determined from capacity analyses. For the remaining multi-lane alternatives, the average segment speed was assumed to be equal to the design speed. The calculated values for all the alternatives are presented in Table 6-12.

Table 6-12: ANNUAL VEHICLE HOURS TRAVELED (VEHICLE-HOURS)

Segment	Base Case	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	275,946	306,164	345,944	348,656	328,867
2	410,314	417,701	438,813	426,145	413,691
3	704,658	703,368	720,542	697,068	674,703
4	181,560	167,338	169,162	161,222	154,137
5	245,036	211,595	207,268	195,958	186,198
6	455,017	314,097	309,976	295,974	283,383
7	107,240	105,028	114,307	114,574	114,098
8	381,757	397,546	437,664	439,262	437,692
10	122,823	109,442	109,073	104,856	100,967
Latent Demand	1,738,286	1,489,392	794,078	347,657	0
Total	4,622,637	4,221,671	3,646,827	3,131,372	2,693,736
Change from Base Case	0	-400,966	-975,810	-1,491,265	-1,928,901

Annual Travel Time Savings - Quantifies the annual travel time savings obtained from reducing the travel time along each segment when compared with the base case. Travel time savings were based on year 1996 average hourly cost rates for both trucks ($19.00 per hour per commercial truck as per the National Trucking Association) and automobiles ($6.63 per hour per automobile based on average wages and vehicle occupancy for the study area). The calculated values for all the proposed alternatives are presented in Table 6-13.

Table 6-13: 2017 ANNUAL TRAVEL TIME SAVINGS (IN YEAR 1996 THOUSAND DOLLARS)

Segment	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	$ -235.43	$ -545.36	$ -566.49	$ -412.31
2	$ -58.11	$ -224.20	$ -124.54	$ -26.57
3	$ 10.09	$ -124.25	$ 59.37	$ 234.31
4	$ 114.56	$ 99.87	$ 163.82	$ 220.89
5	$ 300.42	$ 339.30	$ 440.90	$ 528.58
6	$ 1,265.50	$ 1,302.51	$ 1,428.25	$ 1,541.32
7	$ 21.20	$ -67.72	$ -70.28	$ -65.72
8	$ -151.56	$ -536.64	$ -551.98	$ -536.91
10	$ 128.44	$ 131.98	$ 172.46	$ 209.79
Latent Demand	$ 2,162.58	$ 8,204.00	$ 12,082.85	$ 15,103.56
Total	$ 3,557.69	$ 8,579.49	$ 13,034.36	$ 16,796.94

Note: Positive values denote savings.
Negative values denote additional costs.

Vehicle Kilometers Traveled - Measures the vehicle kilometers traveled per segment for each proposed alternative and is computed by multiplying the number of average weekday trips by the segment length. The calculated values for all the alternatives are presented in Table 6-14.

Table 6-14: 2017 ANNUAL VEHICLE KILOMETERS TRAVELED

Segment	Base Case	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	21,778,759	24,024,984	30,347,937	34,082,414	37,569,105
2	30,086,164	31,992,452	37,342,358	40,513,099	43,457,085
3	53,756,567	56,676,615	64,871,589	69,728,524	74,238,114
4	13,757,290	14,282,792	15,757,535	16,631,655	17,443,215
5	14,424,908	15,063,843	16,856,985	17,919,731	18,906,444
6	25,889,830	26,861,230	29,587,417	31,205,152	32,703,338
7	8,747,644	9,452,524	11,430,736	12,603,168	13,691,754
8	29,764,711	32,503,568	40,190,038	44,745,597	48,975,364
10	9,472,904	9,849,741	10,907,315	11,534,110	12,116,080
Latent Demand	156,445,775	134,045,309	71,466,998	31,289,156	0
Total	364,124,552	354,753,058	328,758,908	310,252,606	299,100,499
Change from Base Case	0	-9,371,494	-35,365,644	-53,871,946	-65,024,053

Vehicle Operating Costs - Computed by multiplying the vehicle kilometers traveled by the internal Revenue Service's (IRS) standard $0.19 per kilometer ($0.31 per mile) for 1996 vehicle operating costs. The calculated values for all the Proposed Alternatives are presented in Table 6-15.

Table 6-15: 2017 ANNUAL VEHICLE OPERATING COSTS

Segment	Base Case	Improved Two-Lane Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1	$ 4,195,119	$ 4,628,760	$ 5,845,752	$ 6,567,029	$ 7,236,724
2	$ 5,795,328	$ 6,162,525	$ 7,193,047	$ 7,803,809	$ 8,370,893
3	$ 10,354,824	$ 10,917,296	$ 12,495,848	$ 13,431,450	$ 14,300,069
4	$ 2,649,989	$ 2,751,214	$ 3,035,295	$ 3,203,662	$ 3,359,988
5	$ 2,778,589	$ 2,901,663	$ 3,247,066	$ 3,451,777	$ 3,641,847
6	$ 4,987,012	$ 5,174,127	$ 5,699,257	$ 6,010,487	$ 6,299,459
7	$ 1,685,009	$ 1,820,786	$ 2,201,838	$ 2,427,677	$ 2,637,365
8	$ 5,733,408	$ 6,260,979	$ 7,741,580	$ 8,619,092	$ 9,433,848
10	$ 1,824,712	$ 1,897,300	$ 2,101,014	$ 2,221,750	$ 2,333,852
Latent Demand	$ 30,135,266	$ 25,820,391	$ 13,766,284	$ 6,027,053	$ 0
Total	$ 70,139,256	$ 68,335,041	$ 63,326,981	$ 59,763,786	$ 57,614,045
Change from Base Case	$ 0	$ -1,804,215	$ -6,812,275	$ -10,375,470	$ -12,525,211

Through Trips - Assumed to equal latent travel demand for the proposed alternatives (see Section 6.3.4 for discussion of latent travel demand). See Table 6-3, page 6-6.

COST

This chapter describes the costing methodology used to estimate the capital costs for the proposed alternatives. These cost estimates provide the basis for comparison between the different proposed alternatives and for the feasibility evaluation of such proposed alternatives.

7.1 UNIT COSTS

The unit costs used are based on the 1996 Weighted Average Unit Prices provided by AHTD as shown in Appendix D. All cost estimates are expressed in constant 1996 U.S. dollars. The general cost estimates were derived using the "as-built" plans, the proposed typical cross sections, the design criteria presented in Chapter 3, and the Standard Specifications for Highway Construction of the AHTD.

7.1.1 Roadways

The roadway quantities include all construction items necessary to build the proposed alternatives as defined in Chapter 3.

7.1.2 Structures

The base case includes the replacement or rehabilitation of bridges with existing sufficiency ratings under 50 and 80, respectively. The following unit costs were derived based on the unit costs presented in Appendix D: \$570/m^2 (\$53/sf) for new bridge construction, \$375/m^2 (\$35/sf) for bridge widening (based on the final width of the structure), \$320/m^2 (\$30/sf) for bridge rehabilitation and \$55/m^2 (\$5/sf) for the removal of deficient structures. These unit costs per square meter (square foot) include costs for all bridge structural components and striping and signing, assuming support by concrete piles.

7.1.3 Earthwork

Earthwork quantities include preparing right-of-way, clearing and grubbing, grading, excavation, embankment, sodding, fertilizing and watering. Average cut and construction of embankment quantities were estimated for the different terrain conditions (level, rolling and mountainous). Unclassified excavation (a weighted average of common excavation and rock excavation) was used according to the Geological Classification defined in Chapter 4.

7.1.4 Legal, Management and Design

Legal, management and design costs were assumed to be 10% of the construction costs and include: legal fees, state administration costs, plan specifications and estimates, material testing and construction inspection.

7.1.5 Utilities Relocation

The costs to move or adjust existing utilities during construction were assumed to be a typical 5% of the overall construction costs. Some utilities will be moved/relocated at the expense of the utility owner. Those costs are not included in this cost estimate.

7.1.6 Mobilization

Mobilization costs were assumed to be 5%. This item includes all preparatory work and operations for the movement of personnel, equipment, supplies and incidentals to the project site.

7.1.7 Contingencies

Planning level contingency costs were assumed to be a typical 20% of the overall construction costs.

7.1.8 Miscellaneous

Other construction costs included in the estimates were striping, signing, installation of traffic signals and obliteration of abandoned roadway. The costs for the first two items were estimated using the length of the proposed segments for the appropriate alternatives. The cost of the traffic signals were calculated based on the unit costs in Appendix D. Costs for obliteration of abandoned roadway were estimated by determining the length of existing roadway to be removed at the proposed new bypass connections.

7.2 O&M COSTS

The Operations and Maintenance (O&M) costs are based on statewide annual (Year 1996) highway maintenance costs of $709 per lane-km ($2,282 per two-lane mile) as provided by the Maintenance Division of AHTD. Bridge rehabilitation and replacement costs, based on AHTD's bridge sufficiency rating inventory (see Chapter 2), are included in the capital cost estimates of the proposed alternatives. A detailed cost estimate of O&M costs by segment for each Proposed Alternative can be found in Appendix E.

Table 7-1: OPERATIONS AND MAINTENANCE COSTS (in 1996 dollars)

	Unit Cost	Unit	Quantity	First Year
Base Case	709	lane-km	473.18	$335,500
Improved Two-Lane Rural Arterial	709	lane-km	477.58	$338,600
Multi-Lane Undivided Rural Highway	709	lane-km	785.4	$556,800
Four-Lane Divided Rural Highway	709	lane-km	785.40	$556,800
Four-Lane Freeway	709	lane-km	785.40	$685,461

7.3 RIGHT-OF-WAY (ROW) COSTS

ROW acquisition costs include purchase, relocation, sale of improvements, and a typical 15% markup over acquisition costs to account for appraisal, surveying, salaries and title insurance.

7.3.1 Approach

To develop the ROW costs the following approach was used:

Land Cost - The courthouses of each county (Baxter, Fulton, Sharp, Lawrence and Greene) were visited and sample assessed values determined. Where available, a copy of the assessor's formula was obtained. Recent land documents were also gathered.

Land Classification - The entire length of the route was driven and the properties were classified. The classifications are forest, agriculture, residential, commercial and barren. Notation of the relative land value was also observed. For each residential property, a "frontage" length of 46 m (150 feet) along the existing US 412 ROW was assumed. For each commercial property, a frontage length of 61 m (200 feet) was assumed. Percentages of the remaining property were assigned to either forest, agriculture or barren land.

Property Values - Combining the above information on a spreadsheet determined the value of the properties that fronted on the proposed improvements.

Damages - Using a comparison between recent purchases by AHTD and other land sales determined the amount of damages that might be expected. The damages were applied to either the land costs or lump summed to the properties.

Four-Lane Freeway - For this alternative it was assumed that the route would be relocated utilizing the existing roadway for access at selected locations. The result of this assumption is that the amount of land needed for ROW increased while the value and damages were reduced. No credit was taken for the existing ROW.

Guidance and review of ROW cost estimates was provided by AHTD's Appraisal Section of the ROW Division.

Table 7-2 shows the ROW cost estimates in 1996 dollars for the proposed alternatives. Appendix E shows the detailed ROW takings per land use and the detailed ROW acquisition cost estimates.

Table 7-2: ROW COST ESTIMATE (in 1996 dollars)

Base Case	No new ROW required
Improved Two-Lane Rural Arterial	$7,245,830
Multi-Lane Rural Highway	$9,115,005
Four-Lane Divided Rural Highway	$15,678,284
Four-Lane Freeway	$16,303,625

7.4 CAPACITY IMPROVEMENT COSTS

Base Case

This alternative includes the costs for rehabilitating and replacing the bridge structures as per their existing sufficiency rating. The Base Case Detailed Cost Estimate is shown in Appendix E.

Improved Two-Lane Rural Arterial

This alternative includes the costs for improving the existing facility and the construction of the proposed bypasses to meet the design criteria of a two-lane rural arterial as established in Chapter 3. The Two-Lane Rural Arterial Detailed Cost Estimate is shown in Appendix E.

Multi-Lane Rural Undivided Highway

This alternative includes the costs for improving the existing facility and the construction of the proposed bypasses to meet the design criteria of a multi-lane rural undivided highway as established in Chapter 3. The Multi-Lane Rural Undivided Highway Detailed Cost Estimate is shown in Appendix E.

Four-Lane Divided Rural Highway

This alternative includes the costs for improving the existing facility and the construction of the proposed bypasses to meet the design criteria of a four-lane divided rural highway as established in Chapter 3. The Four-Lane Divided Rural Highway Detailed Cost Estimate is shown in Appendix E.

Four-Lane Freeway

This alternative includes the costs for improving the existing facility and the construction of the proposed bypasses to meet the design criteria of a four-lane freeway as established in Chapter 3. The Four-Lane Freeway Detailed Cost Estimate is shown in Appendix E.

Table 7-3 shows the construction cost estimates for the proposed alternatives.

Table 7-3: CONSTRUCTION COST ESTIMATES (in 1996 dollars)

Base Case	$13,093,732
Improved Two-Lane Rural Arterial	$111,307,854
Multi-Lane Rural Highway	$408,816,676
Four-Lane Divided Rural Highway	$459,287,873
Four-Lane Freeway	$850,299,459

7.5 MITIGATION COSTS

Based on values developed in the environmental impacts chapter (Chapter 4) of this report, Table 7-4 shows the estimated mitigation costs per Proposed Alternative. Mitigation costs include wetland delineation, wetland site remediation, underground storage tank removal and replacement (USTR), cemetery site remediation (plot relocation), and historical site testing and mitigation. The Base Case alternative does not incur mitigation costs.

Table 7-4: MITIGATION COSTS

	Wetlands	USTR	Cemeteries	Historical Sites	Total
Two-Lane Rural Arterial	$124,830	$25,000	$280,000	$605,000	$1,034,830
Multi-Lane Rural Highway	$272,530	$150,000	$460,000	$605,000	$1,987,530
Four-Lane Divided Rural Highway	$319,990	$200,000	$1,160,000	$605,000	$2,284,990
Four-Lane Freeway	$1,248,470	$325,000	$5,400,000	$1,155,000	$8,128,470

7.6 RESIDUAL VALUES

Residual value is defined as the value of the facility after its design life. The project's design life is 30 years since concrete pavement was assumed as the design pavement surface. Table 7-5 shows the design life for the different project components.

Table 7-5: DESIGN LIFE

	Design Life	Residual Value
ROW	100 years	70%
Roadway[1]	50 years	40%
Pavement	30 years	0%
Bridges	60 years	50%
Traffic Installations	35 years	15%

[1] Roadway construction items other than pavement.

Based on these percentages, estimated residual values of 20.9%, 13.6%, 19.8% and 23.1% were calculated for the two-lane rural arterial, multi-lane rural highway, four-lane divided rural highway and four-lane freeway, respectively.

7.7 INTERIM IMPROVEMENTS

In case funds do not become available to implement the recommended alternative, a series of interim improvements (as defined in Chapter 3) are proposed as the minimum improvements to be done in the corridor. Detailed cost estimates for these improvements can be found in Appendix E, page E-11. The interim improvements vary from $29,000 for a flashing signal to $72,189,000 to widen US 412 to a four-lane undivided section from Black Rock to Hardy.

ECONOMIC JUSTIFICATION STUDIES

8.1 INTRODUCTION

8.1.1 Overview

This report examines the costs and benefits of major new highway construction across north-central Arkansas, providing a link from Oklahoma and western Arkansas to Missouri and Tennessee. The study evaluated four alternative levels of improvement for US 412, from improving the existing two-lane rural arterial to a full access controlled freeway.

A major motivation for considering the proposed highway improvements has been the belief, promoted by some community and business leaders, that a high-quality four-lane highway connecting cities across the corridor could significantly enhance economic growth in the region. It is in response to a concern that unless highway improvements to the corridor are evaluated in terms of economic development potential, the benefits of major corridor improvements will be underestimated.

At the state level, there is also interest in using transportation investments to promote economic development objectives. However, the state must carefully consider the cost of all such investments and where they occur and explicitly examine the tradeoff between maximizing total statewide benefits and the benefits to specific sub-state areas. Here, AHTD recognized the need to move beyond its traditional means of evaluating highway improvements. Accordingly, AHTD commissioned this study to include an assessment of the potential long-term economic development benefits of improving US 412, in terms of benefits to the corridor and areas within the corridor.

8.1.2 Highway Corridor

The focus of this study is a broad band of northern Arkansas from the recreational area of Mountain Home to the Missouri state line. It links the cities of Mountain Home, Salem, Ash Flat, Hardy, Walnut Ridge/Hoxie and Paragould. The planning study area extends from Norfork Lake (east of Mountain Home) to the Missouri state line (east of Paragould). Currently, this stretch of US 412 and US 62 and US 63 is a 216 km (134 miles) corridor, mostly two-lane. Several of the cities along the corridor have been studied for possible bypasses. The most notable improvement to the roadway is the 16 km (10 miles) between Hardy and Ash Flat which has been widened to four lanes.

8.1.3 Types of Economic Development Benefits

One of the basic benefits from highway improvements is the improvement in travel times and reduced transportation costs. These are direct benefits to highway travelers ("user benefits") which are traditional benefits of highway improvements. These types of benefits can translate into real dollar savings for businesses that ship by truck.

Highway improvements can have significant impacts on the corridor over and above the user benefits. Reducing truck shipping costs can provide a real cost savings for the shipping company, the business shipping out the product and business receiving the product. These lower production costs can make local businesses more competitive and better able to expand. In addition to lower production costs, highway improvements extend the market area for local business as well as the access to suppliers. They make customers more easily accessible and expand the distances from which the company can compete with out-of-state companies. These travel range impacts can provide opportunities for significant expansion and attraction of manufacturing and distribution industries.

There can be additional impacts on the attraction of new businesses. Some types of businesses would find northern Arkansas to be an attractive location if it were not for its lack of a four-lane east-west highway link. This is especially true if the area is served by a four-lane freeway providing fast and reliable transportation links to the national highway network, regional population centers and specific buyers or suppliers.

In summary, the development effects of highway improvements do not end with "direct effects" on business expansion and attraction. There are also highly significant spill-over effects on the rest of

the area economy. The direct effect on business expansion and attraction leads to "indirect effects" in terms of additional orders for materials and equipment from other businesses. For instance, expansion of the food processing industry leads to expanded orders for plastic packaging and cardboard boxes. In addition, there are "induced effects" that result when new and expanding businesses hire more workers, who then spend more on consumer products and services.

8.1.4 Measuring Economic Development Benefits

All of the direct benefits of a highway, and therefore improvements to the highway, flow from using it for transportation. There are two types of benefits described below: travel efficiency gains and economic development impacts. Travel efficiency gains are key to economic feasibility analysis. Economic development impacts are changes in the relative competitiveness of the area affected by the improvement brought about by these transportation cost savings.

In the benefit/cost calculation, benefits of a transportation improvement are compared with the relevant costs. These costs are incremental costs that would arise if the improvements were made. They include capital costs and operation & maintenance costs.

8.1.5 Methodology

The evaluation of economic benefits involved use of a regional impact model to quantify the effects of reduced transportation costs.

IMPLAN Software

Creating regional economic models requires a tremendous amount of data. The costs of surveying industries within each region to derive a list of commodity purchases (production functions) is prohibitive. IMPLAN (IMpact Analysis for PLANning) was developed as a cost-effective means to develop regional input-output models. IMPLAN was originally developed by the USDA Forest Service in cooperation with FEMA and the USDA Bureau of Land Management to assist the Forest Service in land and resource management planning. The IMPLAN accounts closely follow the accounting conventions used in the "Input-Output Study of the US Economy" by the Bureau of Economic Analysis (1980) and the rectangular format recommended by the United Nations.

IMPLAN software was designed to serve three functions: 1) data retrieval, 2) data reduction and model development and 3) impact analysis. Comprehensive and detailed data coverage of the entire United States by county, and the ability to incorporate user-supplied data at each state of the model building process, provides a high degree of flexibility both in terms of geographic coverage and model formulation.

The IMPLAN database, created by Minnesota IMPLAN Group, Inc. (MIG), consists of two major parts: 1) A national-level technology matrix and 2) Estimates of sectorial activity for final demand, final payments, industry output and employment for each county in the US along with state and national totals. Data is available for years 1977, 1982, 1985, 1990, 1991 and 1992 for county level economic activity for 528 sectors. New databases are continually being developed by MIG, Inc.

IMPLAN easily allows the user to do the following:

- Develop project specific multiplier tables
- Change any component of the system, production functions, trade flows or database
- Create custom impact analysis by entering final demand changes
- Obtain any report in the system to examine the models' assumptions and calculations

There are two components to the IMPLAN system – the database and the software. The databases provide all information to create regional IMPLAN models. The software performs the calculations and provides an interface for the user to make final demand changes.

8.1.6 Key Assumptions

Input-output modeling is based on several assumptions:

- Constant returns to scale
- No supply constraints
- Fixed commodity input structure
- Homogeneous sector output
- Industry technology assumption

The first assumption is that the production functions (an industry's list of expenditures) are assumed to have constant returns to scale. *Constant returns to scale* means the production functions are considered linear; if additional input is required, all inputs increase proportionately. *No supply constraints* means supplies are unlimited; an industry has unlimited access to raw materials and its output is limited only by the demand for its products. A *fixed commodity input structure* implies that price changes do not cause a firm to buy substitute goods. A fixed commodity input structure assumes that changes in the economy will affect the industry's output but not the mix of commodities and services it requires to make its products. The fourth assumption is that there is *homogeneous sector output*. In other words, the proportions of all the commodities produced by that industry remain the same, regardless of total output. An industry will not increase the output of one product without proportionately increasing the output of all its other products. The *industry technology assumption* comes into play when data is collected on an industry-by-commodity basis and then converted to industry-by-industry matrices. It assumes that an industry uses the same technology to produce all its products. In other words, an industry has a primary or main product and all other products are by-products of the primary product.

8.1.7 Impact Analysis: A Definition

Economic impact analysis involves applying a final demand change to a predictive economic input-output model, and then analyzing the resulting changes in the economy. A concise definition of impact analysis is:

> An assessment of change in overall economic activity as a result of some change in one or several economic activities.

In practice, economic impact analysis can mean many different things. It might measure the impacts of a new factory moving into an area. It might involve estimating the local impacts of a professional football team moving into an area or the effects of tourist spending. Governments use impact analysis for policy decisions and planning. Researchers use impact analysis to study relationships of different elements in an economy. An impact analysis begins by converting a topic of concern (or *project*) to a set of economic issues and factors. For example, our project is the construction of a new highway. This might translate to the economic issues: availability of natural resources for economic development, encouragement of recreational and educational uses of the land and the development of an administrative structure to enhance economic development.

Once the issues have been identified, the factors involved can be identified and their actions converted to a set of expenditures. These expenditures are the initial changes that stimulate further economic activity. The actions and the economic activity they stimulate are the impact. As we prepare to run our initial changes resulting from the new roadway through the predictive model, we will need to know whether the expenditures are made in purchaser or producer prices and the year(s) of the expenditures. *Producer prices* are those paid at the factory door. This is the money an industry receives for its output. Input-output models such as IMPLAN are concerned with the effects on industries and values are in producer prices. *Purchaser prices* are those paid at the retail level. A purchaser price actually includes a mix of producer elements. For instance, the price of a roll of film from a retail outlet includes the retail markup, wholesale markup, transportation costs from the producer to the retailer and the price at the factory door.

If an impact analysis involves purchaser prices, the values need to be subdivided to work with the producer-priced input-output model. This is done using *margins*. *Margins* represent the difference between producer and purchaser prices. Margining assigns direct expenditures to the correct sector

multipliers. It splits a purchaser price into the appropriate producer values, each value impacting a specific industry. A deflator needs to be applied to the cost estimates to equate them to the model's base year's data. *Deflators* account for the changes in actual value of the dollar over the years. Price changes need to be accounted for; otherwise, the impacts will be estimated incorrectly.

8.2 ECONOMIC BASELINE

8.2.1 Overview of the Study Area

Regional highway improvements have greater impact on certain types of businesses and on certain parts of the study area. The nature of economic benefits thus depends upon the mix of the current business activity and that which is forecasted for the future. Understanding the area's economy provides a basis for understanding the relationship between proposed highway improvements and economic development. This section summarizes key aspects of the economy of the study area and specific zones within the study area. Socioeconomic data used in the IMPLAN model are shown in Table 8-1.

Table 8-1: Socioeconomic Data

	Baxter County	Fulton County	Sharp County	Lawrence County	Greene County	Total
Population	34,600	10,400	15,800	17,400	34,000	112,200
Employment	17,306	3,591	6,588	8,193	16,235	51,913
Households	14,533	4,519	7,114	7,185	12,375	45,726
Area (sq. miles)	554	618	604	587	578	2,941
No. of Industries	144	83	100	116	140	583
Income per Household	$39,975	$26,248	$28,430	$32,320	$39,919	$36,916
Total Income	$580,957,000	$118,615,000	$202,251,000	$232,219,000	$493,998,000	$1,688,040,000

The counties and cities, following an east to west direction, are listed below:

County	Cities
Baxter	Anderson, Mountain Home
Fulton	Salem, Viola
Sharp	Ash Flat, Hardy
Lawrence	Walnut Ridge/Hoxie
Greene	Paragould

The industrial activity within the study area has primarily occurred in Paragould. Other growth centers located south of the study area are Jonesboro, Batesville, Newport and Searcy. While the size of the urban centers varies, each of the cities/towns play a special role.

Population characteristics of the region provide an insight into the many problems and economic trends experienced by this region of the state. During the forties, fifties and sixties the region experienced consistent loss of population. The out-migration was due largely to a changed economic base (previously agrarian) which no longer supported the number of residents in the area. Until the year 1980 the area population did not surpass the population figure of the year 1940.

According to a study released by the University of Arkansas titled "Rural Profile of Arkansas 1993," the rural areas of the state contain proportionately more children and more elderly people than the urban areas. The study states that the rural areas of the state carry the heavier burden of caring for "dependent" population, which will affect education and health care.

Several counties, including Fulton and Sharp, have been designated as long-term economically deteriorated. The U.S. Department of Commerce, Economic Development Administration, under the Public Works and Economic Development Act of 1965, as amended, officially designated the counties as redevelopment areas based on a number of qualifications, such as substantial and persistent

unemployment, low median family income, unusual and abrupt rise in unemployment resulting from the loss of a major employment source and decline in per capita employment.

As the study area is relatively isolated geographically, large size industrial development has been confined to Paragould, Jonesboro, Batesville, Newport and Searcy, which are south of the study area, have experienced growth due to their access to the railway system and a better road network. A transport system to industry complements large industrial development.

A part of the region has turned to the service and retail components of the local economies for new opportunities. The most significant of new opportunities is the emergence of tourism as a factor in the regional economy. Many tourist activities are related to Ozark folk culture, local heritage and the area's natural beauty throughout the study area. The Mountain Home area has particularly benefitted from tourism.

Agricultural activity has declined in the past years to a point where it no longer supports the area's economy. Family farms, which traditionally have been the backbone of Arkansas and the nation, are decreasing. Large-scale farming operations dominate the countryside in Arkansas. The costs of production, equipment and supplies have risen dramatically.

As farm population decreases, other rural economic activity decreases. The elimination of small farms and the out-migration of farm population decrease demand for a variety of retail and personal services, causing further out-migration and unemployment.

8.3 BUSINESS GROWTH IMPACTS

8.3.1 Issues

Improvements to US 412 can reduce travel time on the highway providing cost savings for existing trucking companies and businesses shipping and receiving products. Those savings result in lower product costs which in turn makes local area businesses more competitive, therefore more profitable with greater ability to expand.

In addition to lowering transportation costs, highway improvements benefit businesses in several ways. By reducing travel times on the highways, they effectively extend both the area that businesses serve and the area from which they can access suppliers. Local businesses also benefit from the expanded area over which they can successfully compete with their counterparts in nearby states.

8.3.2 Methodology

A highway improvement causes economic value which accrues to both users and non-users of that highway. The first impact is the construction of the highway. The estimated construction, ROW and mitigation costs developed in Chapter 7 were used as input data to the IMPLAN model. This model shows the direct impact of construction on wages in each county as well as the induced and indirect impacts caused by the construction. A second area of cost savings is in direct travel cost savings. These benefits are calculated and discussed in Chapter 6 of this report.

8.4 ECONOMIC DEVELOPMENT IMPACTS

Impacts to the five-county study area were analyzed using the IMPLAN predictive model. The proposed alternatives were defined as the improvements to be considered.

8.4.1 Defining Input-Output Analysis

Input-Output Analysis is a means of examining relationships within an economy both between businesses and between business and final consumers. It captures all monetary market transactions for consumption in a given time period. The resulting mathematical formulae allow one to examine the effects of a change in one or several economic activities on an entire economy (impact analysis). A *primary input-output* study is based on data collected directly from industries. An example is the United States Benchmark Study of Input-Output Accounts (the data is actually based on economic census collected directly from firms). Other countries have done primary national level input-output

studies as well. Primary state or local level input-output studies are not common due to the high cost of data collection. *Secondary input-output* studies rely on data collected from other sources to construct accounts. The inter-industry transaction information usually comes from some other primary study. IMPLAN is an example of a secondary input-output modeling system.

There are two phases in input/output analysis:

- Descriptive modeling
- Predictive modeling

A *Descriptive Model* includes information about local economic interactions known as regional economic accounts. These tables describe a local economy in terms of the flow of dollars from purchasers to producers within the region. *Trade Flows* are also part of the descriptive model. They describe the movement of goods and services between a region and the outside world (regional imports and exports). The initial IMPLAN data details all purchases including imported goods and services. When regional economic accounts are created, imports to the region are removed from the initial data, allowing local inter-industry transactions and final purchases to be examined. By adding *Social Accounting* data, an analyst can examine non-industrial transactions such as payment of taxes by businesses and households. Social accounting data includes tax collection by governments and payments to households and businesses. Input-output accounting describes the flow of commodities from producers to intermediate and final consumers. Social Accounting Matrices (SAM's) show the flow of money between institutions. Both are part of the descriptive model.

The regional economic accounts are used to construct local level *multipliers*. Multipliers describe the response of the economy to a stimulus (a change in demand or production). The multipliers are the *Predictive Model*. Purchases for final use (final demand) drive an input-output model. Industries producing goods and services for consumption purchase goods and services from other producers. These other producers, in turn, purchase goods and services. These indirect purchases (or indirect effects) continue until leakages from the region (imports, wages, profits, etc.) stop the cycle. The indirect effects and the effects of increased household spending (induced effects) can be mathematically derived as sets of multipliers. The derivation is called the "Leontief inverse." The resulting sets of multipliers describe the change of output for each industry caused by a one dollar change in final demand for any given industry.

8.4.2 Business Benefits

Input-output models are driven by final consumption (or final demand). Industries respond to meet demands directly or indirectly (by supplying goods and services to industries responding directly). Each industry that produces goods and service generates demands for other goods and services and so on, round by round. The impact of a new highway on economic activity in the study area is divided into three components:

Direct Benefits are the changes resulting from the expenditure of highway construction dollars on goods, services and labor in the project area.

Indirect Benefits are the changes in inter-industry purchases as they respond to the new demands of the directly affected industries: those industries supporting highway construction.

Induced Benefits reflect changes in spending from households with increased income due to changes in production.

The direct benefit of the new highway is not the total construction cost. This is because some of the material and labor for the new highway will come from outside the study area. The IMPLAN model includes a formula for calculating the percentage of the new highway costs which will be spent in the local area. Table 8-2 shows the direct, indirect and induced benefits of the four construction alternatives. Table 8-3 shows the same three benefits for Operation & Maintenance (O&M).

Table 8-2: Economic Benefits - Construction

Alternative	Direct	Indirect	Induced	Total
Base Case	$12,578,201	$2,355,752	$2,967,369	$17,901,322
Improved Two-Lane Rural Arterial	$87,771,581	$21,929,136	$25,764,911	$135,465,628
Multi-lane Rural Undivided Highway	$308,890,471	$77,149,328	$95,154,332	$481,194,131
Four-Lane Divided Rural Highway	$347,332,975	$86,759,401	$105,800,369	$539,892,745
Four-Lane Freeway	$633,845,727	$158,307,394	$195,785,627	$987,938,748

Table 8-3: Economic Benefits - O&M

Alternative	Direct	Indirect	Induced	Total
Base Case	$322,387	$60,387	$76,560	$458,830
Improved Two-Lane Rural Arterial	$325,269	$60,919	$76,735	$462,923
Multi-lane Rural Undivided Highway	$534,879	$100,177	$126,185	$761,241
Four-Lane Divided Rural Highway	$534,879	$100,177	$126,185	$761,241
Four-Lane Freeway	$658,512	$123,332	$155,352	$937,196

8.4.3 Opportunities to Enhance Business Development

Many local and regional agencies are actively involved in economic development. This includes encouraging new businesses to move to the study area as well as assisting existing businesses to expand. These types of activities are vital to the continued development of the region. Economic development activities must continue even if a new highway is constructed. The benefits described in this section are based on a number of assumptions including continued economic development.

8.5 TOURISM

8.5.1 Identification of Tourism Benefits

Tourism will benefit from highway improvements because recreation and visitor attractions become more accessible to visitors from other parts of Arkansas and surrounding states. The tourism industry serves both business travel and recreational trips. Highway improvements lessen travel time, reduce safety hazards and make travel more enjoyable for trips to various destinations and recreational attractions in Arkansas. Businesses servicing the tourism trade are primarily hotels & lodging places, eating & drinking establishments, amusement & recreational services as well as retail trade and service businesses.

8.5.2 Assessment of Benefits

The methodology for evaluating the benefits of proposed highway improvements on tourism included two key steps. The first part of the tourism benefit analysis was to determine baseline tourism activity in the study area. The second part of the analysis was to determine the potential benefit on visitor activity resulting from the proposed highway improvement alternatives.

8.5.3 Economic Baseline

The tourism baseline was developed based on conversations with the Arkansas Department of Parks and Tourism. Table 8-4 shows year 1994 travel benefits for the five-county study area. The major tourist attraction in the study area is Mountain Home. Baxter County is the primary county encompassing the Mountain Home recreational area and consequently has the largest travel expenditures in the study area.

Table 8-4: Annual Benefit of Travel on Arkansas Counties - 1994

County	Total Travel Expenditures (Dollars)	Travel Generated Payroll (Dollars)	Travel Generated Employment (Jobs)	State Tax Receipts (Dollars)	Local Tax Receipts (Dollars)	Visitors (Person Trips)
Greene	$11,870,000	$2,080,000	210	$610,000	$230,000	79,331
Lawrence	$9,360,000	$1,360,000	130	$490,000	$190,000	61,191
Sharp	$24,480,000	$3,510,000	320	$1,250,000	$640,000	148,801
Fulton	$12,790,000	$2,090,000	200	$660,000	$310,000	80,853
Baxter	$97,600,000	$16,430,000	1,610	$4,950,000	$1,800,000	645,377
Study Area	$156,100,000	$25,470,000	2,470	$7,960,000	$3,170,000	1,015,553
State	$2,929,710,000	$502,860,000	46,450	$130,760,000	$55,680,000	17,818,000

Source: Arkansas Department of Parks and Tourism
US Travel Data Center County Travel Economic Impact Model (CTEIM)

8.5.4 Requirements for Tourism Attractions

The benefits of an improved highway were determined through an informal survey of highway officials and tourism personnel. They predicted a 20-30% increase in tourism from the implementation of a freeway. A 20% growth rate in tourism and 5% inflation (Year 1994 to 1996) was assumed. The growth was then prorated for the remaining proposed alternatives. This is based on the assumption that a four-lane freeway would have the most beneficial impact on tourism. The remaining alternatives would have less of a benefit with the improved two-lane rural arterial having the least benefit. The prorated figures are based on the latent demand calculations discussed in Chapter 6 of this report. Table 8-5 shows the benefit of the proposed alternatives on tourism.

Table 8-5: Annual Benefit of Proposed Alternatives on Tourism, Compared to Base Case - 1996

Alternative	Total Travel Expenditures (Dollars)	Travel Generated Payroll (Dollars)	Travel Generated Employment (Jobs)	State Tax Receipts (Dollars)	Local Tax Receipts (Dollars)	Visitors (Person Trips)
Improved Two-Lane Rural Arterial	$4,589,340	$748,818	73	$234,024	$93,198	29,857
Multi-Lane Rural Highway	$17,701,740	$2,888,298	280	$902,664	$359,478	115,164
Four-Lane Divided	$25,241,370	$4,118,499	399	$1,287,132	$512,589	164,215
Four-Lane Freeway	$32,781,000	$5,348,700	519	$1,671,600	$665,700	213,266

8.6 BENEFITS

In the preceding sections of Chapter 8, the economic benefit of the highway improvement alternatives in terms of travel efficiency and construction and O&M have been discussed. The benefits are greater than costs for all construction alternatives. The following paragraphs describe the economic benefits.

8.6.1 Seven Indicators of Economic Development

The US 412 improvements could yield many different forms of benefit to local economies. In order to recognize these diverse impacts in a consistent fashion, a single set of "indicators of impact" and a single set of definitions were used throughout the economic benefit calculations. These are summarized in Tables 8-6 and 8-7. Construction and O&M have been evaluated separately because construction is a one-time cost and O&M is on an annual basis. The economic benefits are expressed in terms of seven "indicators of economic development":

Project Expenditures - Defined as "direct benefit," it is the value of the final demand created by the highway improvements within the project area.

Industry Sales - This is the "indirect benefit" or the sum of all the intermediate goods and services needed to produce the final demand, the industry-to-industry sales.

Household Expenditures - Defined as "induced benefit," this is increased household consumption resulting from highway construction and use.

Jobs - Total new jobs attributable to the highway improvement due to road construction and road use, plus the share of those that are employed in sectors that directly support the construction process.

Wages - This measure consists of the total increases in payroll costs (wages, salaries and benefits) paid by local industries due to the improved highway, plus income from self-employment, other property income (interest and corporate profit) and transfer payments.

Value Added - The value of the corridor's firms' output minus the value of the inputs they purchase from other firms. In the corridor study, it is the value added by firms located in the defined corridor impact areas, including employee compensation, proprietary income, indirect business taxes and other property income.

Increased Taxes - These are the taxes which result from the companies participating in highway construction as well as increased employment and wages.

Table 8-6: Evaluation Criteria - Economic Development (in 1996 dollars) (Construction, Mitigation & ROW)

	Base Case	Two-Lane Rural Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Project Expenditures	$12,578,201	$87,771,581	$308,890,471	$347,332,975	$633,845,727
Industry Sales	$2,355,752	$21,929,136	$77,149,328	$86,759,401	$158,307,394
Household Expenditure	$2,967,369	$25,764,911	$95,154,332	$105,800,369	$195,785,627
Jobs Created	285	2,548	9,211	10,279	18,936
Wages Added	$5,379,818	$47,160,523	$172,513,591	$191,815,357	$354,957,968
Value Added	$8,247,399	$76,074,945	$269,218,653	$302,229,637	$552,657,389
Increased Taxes	$394,209	$4,222,027	$13,605,022	$15,713,501	$27,733,992

Table 8-7: Evaluation Criteria - Economic Development (in 1996 dollars) (Operations & Maintenance)

	Base Case	Two-Lane Rural Arterial	Multi-Lane Rural Undivided Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Project Expenditures	$322,387	$325,260	$534,879	$54,879	$58,512
Industry Sales	$60,387	$60,919	$100,177	$100,177	$123,332
Household Expenditure	$76,056	$76,735	$126,185	$126,185	$155,352
Jobs Created	7	7	12	12	15
Wages Added	$137,888	$139,121	$228,773	$228,773	$281,652
Value Added	$211,386	$231,276	$350,715	$350,715	$431,779
Increased Taxes	$10,104	$10,194	$16,763	$16,763	$20,638

8.6.2 Four Economic Development Causes

By improving travel conditions in the US 412 corridor, the highway improvements, through reduced travel times and costs to the residents and businesses in the area, could create additional economic development benefits to the primary impact area and state economies. These additional benefits are categorized into four types:

Act of Highway Construction/Increased Maintenance - The act of spending money in the primary impact area to build the improved highway will be of immediate economic benefit to the corridor area. The construction impacts are temporary in nature, since they exist only during the construction period and terminate when the road construction is complete.

Roadside Expenditures - A more efficient US 412 in northern Arkansas will attract more traffic into the corridor resulting in greater traffic volumes on US 412. Increased travel on US 412 will create increased sales for roadside businesses (motels, restaurants, gasoline stations, tourist visitation places and others who cater to highway users). These increased roadside expenditures are net benefits to the corridor region.

Competitive Position - An improved highway reduces the cost of transportation. Reductions in transportation time and cost lead to reduced costs of production, which in turn lead to marginally reduced prices and/or increased profits. These can lead to increased production that generates economic value. These competitive position benefits are created by the increased travel efficiency of the highway improvement and are benefits to both the corridor region and the State of Arkansas.

Non-Business - An improved highway also creates travel efficiency benefits for non-business travelers. These non-business travelers receive time savings benefits, operating cost savings as well as reduced number of accidents similar to trucks and business travelers. These non-business benefits are valuable to the highway user but are not translated into economic development. They are treated as direct benefits.

8.6.3 Benefit/Cost Analysis

Comparison of the full set of economic benefits and costs associated with each of the proposed alternatives provides a basis for selecting the most effective alternative. *Cost Effectiveness* is defined as the relative ratio of benefit to cost. The costs are developed and defined in Chapter 7 of this report. They include construction, mitigation, ROW and O&M. Benefits result from expenditures within the study area for construction, support industries and household activities. In addition there are travel related savings for projected traffic levels on the Proposed Alternatives.

Table 8-8 summarizes the costs and benefits as well as calculates the benefit/cost ratio. Benefits are divided by costs to obtain the benefit cost ratio. A ratio greater than 1.0 means that benefits are greater than costs and the project is justified.

The construction, mitigation and ROW costs are one-time costs; but since their benefits will be obtained through an extended time frame, these costs have been annualized assuming a 7% discount rate over a 30-year period.

8.6.4 Conclusion

All of the Proposed Alternatives will improve the five-county study area. The improvements to US 412 will bring a much needed boost to the local economy through direct, indirect, and induced benefits. Improved travel related costs will benefit those using the roadway. Finally, tourism will increase due to the reduction in travel time to recreational facilities. The improvement of US 412 will be a good use of state resources.

As can be seen, the improved two-lane rural arterial proposed alternative yields the highest benefit cost ratio of all the alternatives, thus being the most efficient proposed alternative. However, this alternative fails to meet the LOS criteria established as one of the mobility goals. Chapter 9 will evaluate the Proposed Alternatives from the perspective of all the project goals and will select a recommended alternative.

Table 8-8: Benefit Cost Ratio (Values in Year 1996 Million Dollars)

	Benefits												Costs						Ratio
	Travel				Economic														
	Accident Cost Reduction	Travel Time Savings	Vehicle Operating Cost Savings	Fuel Consumption Savings	Tourism Impacts	Project Expenditure	Industrial Sales	Household Expenditure	Value Added	Wages Added to Payroll	Increased Taxes	Total Benefits	Operations & Maintenance	Construction Costs*	ROW Costs*	Mitigation Costs*	Emissions Impacts	Total Costs	Benefit/ Cost Ratio
Two-Lane Rural Arterial	5.60	3.56	1.80	0.41	4.59	6.01	1.56	1.82	5.43	3.3	0.31	34.43	0.003	7.84	0.58	0.08	1.97	10.48	3.29
Multi-Lane Rural Undivided Highway	3.70	8.58	6.81	1.55	17.70	23.87	6.01	7.41	20.97	13.4	1.06	111.11	0.22	31.59	0.73	0.16	7.48	40.19	2.76
Four-Lane Divided Rural Highway	7.32	13.03	10.38	2.37	25.24	26.94	6.78	8.26	23.61	15.0	1.23	140.13	0.22	35.62	1.25	0.18	10.64	47.92	2.92
Four-Lane Freeway	13.72	16.8	12.53	2.85	32.78	49.94	12.51	15.47	43.68	28.1	2.19	230.53	0.35	66.84	1.30	0.65	13.80	82.94	2.78

* These values have been annualized assuming a 7% discount rate over a 30-year period.

Does not meet LOS criteria.

Chapter 9

PROPOSED ALTERNATIVES EVALUATION

9.1 GENERAL

The purpose of the evaluation is to compare the Proposed Alternatives against the base case in order to select the alternative that best meets the following goals:

Improve Mobility - The Proposed Alternatives should improve person throughput capacity, reduce travel time, reduce accident rates, improve access, and facilitate through trips (minimum peak hour LOS: D).

Project Constructability - The Proposed Alternatives should be feasible from a construction perspective.

Environment Preservation - The Proposed Alternatives should preserve and enhance the existing environment and minimize possible environmental impacts.

Economic Development - The Proposed Alternatives should promote economic development in the communities served and be feasible from a public investment standpoint.

9.2 DEFINITIONS

The following are definitions of the MOE's that will be used in this study:

IMPROVE MOBILITY

Average Daily Trips - Measures the number of new average daily trips when compared to the base case alternative.

Peak Hour Person Capacity - Measures the carrying capacity during the peak hour, in person trips for a specific location in the study corridor.

Peak Hour Volume/Capacity Ratio - Measures the ratio between the estimated future AADT and the projected roadway vehicle capacity for the Proposed Alternatives.

Peak Hour Level of Service - Estimates the average peak hour LOS in the study corridor.

Safety Improvements (Fatalities Avoided, Non-fatal Accidents Avoided) - Estimates the fatalities and non-fatal accidents (injury and property damage only) avoided due to the improved geometrics of the Proposed Alternatives when compared to the base case.

Accident Cost Reduction - Quantifies the savings realized from the estimated reduction in accident rates attributed to improved geometrics of the Proposed Alternatives when compared to the base case.

Average Truck Trip Time Reduction - Measures the total travel time required to traverse the corridor for an average loaded truck, in minutes, for each Proposed Alternative when compared to the base case.

Vehicle Hours Traveled - Measures the change in vehicle hours traveled for each Proposed Alternative as compared to the base case.

Travel Time Savings - Monetizes the savings obtained from the reduction of vehicle hours traveled for each Proposed Alternative as compared to the base case.

Vehicle Kilometers Traveled (VKT) - Measures the change in vehicle kilometers traveled for each Proposed Alternative as compared to the base case.

Vehicle Operating Costs - Quantifies the dollar savings obtained from the reduction in VKT by multiplying the VKT for each Proposed Alternative by the IRS's standard $0.31 per mile ($0.19 per kilometer) for 1996 vehicle operating costs.

Through Trips Gained - Measures the number of through trips gained in the corridor as compared to the base case.

PROJECT CONSTRUCTABILITY

Constructability - Measures qualitatively the relative degree of construction difficulty and complexity for each Proposed Alternative.

Construction Time - Estimates the time required to complete the Proposed Alternatives.

Differential Operations & Maintenance Costs - Measures the increase in annual O&M costs for each Proposed Alternative as compared to the base case, based on per lane-kilometer historical costs for similar facilities in the State of Arkansas.

Construction Costs - Estimates in detail the construction capital investment required to complete the Proposed Alternatives based on AHTD's 1996 weighted unit bid prices.

Right-of-Way Costs - Estimates in detail the capital investment required to acquire all the new ROW for the Proposed Alternatives based on district appraisal figures for agricultural, forest, barren land, residential and commercial areas per hectare.

Mitigation Costs - Estimates the costs to alleviate any environmental impacts caused by the construction process. It includes wetland delineation and remediation, removal of UST, relocation of cemeteries, historical & archeological testing and site remediation.

Total Annualized Costs - The sum total of annualized construction, ROW and mitigation costs (based on a 7% discount rate over a 30-year period) and the annual O&M costs.

Costs per Vehicle Kilometer Traveled - Is obtained by dividing the total annualized cost by the total annual vehicle kilometers traveled per Proposed Alternative. It gives a measure of costs relative to mobility.

Costs per Kilometer - Is obtained by dividing the total annualized cost by the length of the corridor.

ENVIRONMENT PRESERVATION

Land Impacts - Measures the area (in hectares) impacted as a consequence of the development of the Proposed Alternatives, categorized by land use (wetlands, aquifers, forest and agricultural land).

Dwellings and Businesses Relocated - Estimates the number of dwellings and businesses that would need to be relocated as a result of implementing the Proposed Alternatives, measured by area (in hectares) of residential and commercial land impacted.

Cemeteries - Quantifies the number of cemetery plots affected by the construction of the Proposed Alternatives.

Hazardous Material Sites - Quantifies the number of identified hazardous material sites affected by each Proposed Alternative.

Noise Impacts - Estimates noise exposure changes for each Proposed Alternative when compared to the base case, measured in decibels at sensitive receptor areas. Sensitive receptors include houses along the corridor.

Emissions Impacts - According to FTA, it is "...the value of the forecast change in criteria pollutant emissions and in greenhouse gas emissions, ascribable to the proposed new investment, discounted and levelized, expressed in absolute and regional percentage change terms." It will be measured in terms of tons/year of volatile organic compounds (VOC) and nitrous oxide (NO_x) and their monetary value (based on an EPA recommended value of $7,500 per ton of VOC and $4,000 per ton of NO_x).

Endangered Species - Measures the potential impacts of the Proposed Alternatives on federally listed endangered species and other lists.

Fuel Consumption - Quantifies the liters consumed and their dollar value for each Proposed Alternative by dividing the VKT by an EPA average kilometers per liter for automobiles, then multiplies by the EPA average price per liter of $0.31.

Historical and Archeological Sites Impacted - Estimates the potential number of historical and archeological sites affected by the Proposed Alternatives.

ECONOMIC DEVELOPMENT

Discounted Benefit/Cost Ratio - Measures the relationship between the benefit's present value and the cost's present value based on an assumed 7% discount rate (as recommended by the US Office of Management and Budget) for each Proposed Alternative over a 30-year design period.

Net Present Value - The arithmetic difference between the discounted costs and the discounted benefits for each proposed alternative.

Internal Rate of Return - The discount rate at which the net present value difference between costs and benefits is zero.

Residual Value - The percentage of the capital investment that will remain beyond the 30-year design life.

Tourism Impacts - Estimates the benefits that will be obtained by the local tourism industry due to improved mobility. It is measured both in terms of total expenditure gained in the study area and number of new visitors.

Jobs Created - Estimates the potential number of one-year jobs created by each Proposed Alternative.

Project Expenditures, Industry Sales and Household Expenditures - These measures are derived from the construction of the Proposed Alternatives.

Value Added to Goods Produced, Wages Added to Payrolls and Increased Taxes - These measures are derived from the regional economic growth gained from the construction and improved mobility of the Proposed Alternatives.

Table 9-1 shows the Measures of Effectiveness (MOE's) that will be used to evaluate the Proposed Alternatives based on the project goals. The MOE's will be derived from traffic, environmental and engineering studies.

Table 9-1: EVALUATION CRITERIA

Improve Mobility	Project Constructability	Environment Preservation	Economic Development
Average Daily Trips	Constructability	Land Impacts	Discounted Benefit/Cost Ratio
Peak Hour Person Capacity	Construction Time	Dwellings and Business Relocated	Net Present Value
Peak Hour Volume/Capacity Ratio	Operations & Maintenance Costs	Cemeteries Impacted	Internal Rate of Return
Peak Hour Level-of-Service	Construction Costs	Hazardous Material Sites	Residual Value
Safety Improvements	ROW Costs	Noise Impacts	Tourism Impacts
Accident Cost Reduction	Mitigation Costs	Emissions Impacts	Jobs Created
Average Truck Trip Time Reduction	Annualized Costs	Endangered Species	Project Expenditures
Vehicle Hours Traveled	Cost per Vehicle Kilometer Traveled	Fuel Consumption Savings	Industry Sales
Travel Time Savings	Cost per Kilometer	Historical and Archeological Sites Impacted	Household Expenditure
Vehicle Kilometers Traveled			Value Added to Goods Produced
Vehicle Operating Costs			Wages Added to Payroll
Through Trips Gained			Increased Taxes

9.3 METHODOLOGY

Each Proposed Alternative will be evaluated based on the four objectives set forth at the beginning of this chapter. The MOE's that will be used include both quantitative and qualitative measures. An evaluation matrix will reveal the goals & MOE's that provide significant differences between the Proposed Alternatives. An assessment of their relative performance will be documented in the form of a narrative. The evaluation process is presented in six steps:

1) ***Raw Values*** - Presents all the data calculated for this study in their original units and quantities. Some of these may be qualitative measures.
2) ***Percentile Values*** - Assigns, for each MOE, the highest value as 100%, and all others as a percentage of the highest MOE.
3) ***Ranked Values*** - Ranking of the MOE's on a scale of 1 to 5, the most desirable value being 5 and least desirable being 1 (it recognizes that for some MOE's a high value is better, and for other MOE's a low value is better), and all others as a pro-rated value in between.
4) ***MOE's Combinations*** - Based on the project goals and objectives and other combination measures, the ranked values are grouped together and the resulting summation of the rankings for the Proposed Alternatives is given.
5) ***Ranked Combinations*** - Uses the same 1 to 5 ranking methodology described in step 3 for the MOE's combinations.
6) ***Summary Results*** -Presents the results of the six-step analysis. Re-ranks the Proposed Alternatives based on all the combinations.

Finally, a recommended alternative is selected by the Engineer based on the results of the evaluation process. The recommended alternative will then be presented to AHTD for their consideration. In comparing the raw values for the Proposed Alternatives, one should keep in mind that for some MOE's the lowest value is more desirable, while for other MOE's the highest value is more desirable. For example, it is desirable to have a high benefit/cost ratio. Conversely, it is desirable to keep the capital cost low. The ranking matrix eliminates this difficulty by assigning a value of 5 to the most desirable value, a value of 1 to the least desirable value, and pro-rating all others.

9.4 IMPROVE MOBILITY

Travel demand forecasts for the Proposed Alternatives were analyzed in Chapter 6. This section presents a summary of their mobility impacts. As expected, the higher classification roadways yield higher mobility benefits to the corridor. The only noticeable exemption to this trend is the high non-fatal accidents of the multi-lane rural highway Proposed Alternative. Table 9-2 shows their annualized mobility impacts when compared to the base case.

The ratings for the Proposed Alternatives based on the improved mobility goal are:

Improved Two-Lane Rural Arterial	1.0	Least desirable
Multi-Lane Rural Highway	2.5	
Four-Lane Divided Rural Highway	3.7	
Four-Lane Freeway	5.0	Most desirable

There is a significant difference between the different Proposed Alternatives in the mobility impacts over the study area.

Table 9-2: MOBILITY IMPACTS

	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Average Daily Trips	4,441	16,908	24,294	31,153
Peak Hour Person Capacity	504	1,923	2,766	3,546
Peak Hour Volume/Capacity Ratio	0.49	0.25	0.25	0.2
Peak Hour LOS	0.29 E	3.20 B	3.28 B	3.41 B
Fatalities Saved	2.53	2.13	3.03	5.71
Non-Fatal Accidents Saved	3.85	-126.99	84.52	149.20
Accident Cost Reduction (millions)	$5.60	$3.7	$7.32	$13.72
Trip Time Reduction (min.)	9.6	28.1	42.0	54.9
Saved Vehicle Hours Traveled (thousands)	401	976	1,491	1,929
Travel Time Cost Savings (millions)	$3.56	$8.58	$13.03	$16.80
Saved Vehicle Kilometers Traveled (millions)	9.37	35.37	53.86	65.02
Vehicle Operating Cost Savings (millions)	$1.80	$6.81	$10.38	$12.53
Through Trips	496	1,882	2,676	3,469

9.5 PROJECT CONSTRUCTABILITY

This section evaluates the constructability of the Proposed Alternatives from both qualitative and quantitative perspectives.

Constructability - This is a qualitative measure based on engineering analysis of the construction complexity of the Proposed Alternatives. As shown in Table 9-3, the Proposed Alternatives were ranked from 1 to 5, with 5 being the easiest alternative to implement and 1 the most complex.

Clearly, the freeway alternative would be the most complex to construct due to the grade separations and the relatively high percentage of roadway that would need to be located on new alignment to meet the proposed geometric design criteria. Second in complexity is the multi-lane rural highway alternative since this alternative would require widening of the existing facility with a high amount of traffic handling. Next is the four-lane divided rural highway. Traffic control for this alternative is simplified by maintaining traffic on the existing facility while the new parallel roadway is constructed. Traffic is then switched to the new facility while the existing facility is reconstructed to conform with current design criteria. The least complex alternative to implement would be the improved two-lane rural arterial. This alternative slightly widens lanes and shoulders to meet the proposed design criteria. The new construction would be limited and concentrated on bridge replacement and on the bypasses located on new alignment away from existing traffic.

Construction Time - This measure is an estimate of the construction time required to implement the Proposed Alternatives as defined in Chapter 3, assuming multiple, concurrent contracts were possible (e.g. simultaneous work at the different bypass locations, etc.). Table 9-3 shows the estimated construction time for the Proposed Alternatives.

Construction, O&M and ROW cost estimates for the Proposed Alternatives were presented in detail in Chapter 7. Mitigation costs were discussed in Chapter 4.

Table 9-3: CONSTRUCTABILITY AND CONSTRUCTION TIME

	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Constructability	5	2	4	1
Construction Time (months)	10	24	18	30

Table 9-4 shows the annualized costs for the Proposed Alternatives.

Table 9-4: COSTS

	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Differential O&M costs (thousands)	$3.1	$221.4	$221.4	$350.0
Construction costs (thousands)*	$7,841	$31,593	$35,622	$66,839
ROW costs (thousands)*	$579	$728	$1,252	$1,302
Mitigation costs (thousands)*	$83	$159	$182	$649
Total Costs (thousands)*	$8,505	$32,701	$37,278	$69,140
$/VKT	$0.02	$0.10	$0.12	$0.23
$/km	$41,029	$157,747	$179,826	$333,526

*Annualized at a 7% discount rate over a 30-year design life.

As expected, the higher classification roadways incur higher costs for their implementation. The O&M costs are a function of the total lane-kilometers for each Proposed Alternative. The basic guideline in developing the Proposed Alternatives was to utilize the existing alignment as much as possible. The change from the base case to the improved two-lane rural arterial reflects the additional length on the route added by the bypasses. All four-lane alternatives reflect twice as many lane-kilometers as the improved two-lane rural arterial. In addition, the freeway alternative reflects ramps and access roads.

The ratings for the Proposed Alternatives based on the constructability goal are:

Improved Two-Lane Rural Arterial	5.0	Most desirable
Multi-Lane Rural Highway	3.2	
Four-Lane Divided Rural Highway	3.1	
Four-Lane Freeway	1.0	Least desirable

As expected, the lower cost Proposed Alternatives have a higher rating from the point of view of the constructability goal. Note that there is no significant difference between the multi-lane rural highway and the four-lane divided rural highway Proposed Alternatives.

9.6 ENVIRONMENT PRESERVATION

This section evaluates the relative impacts on the environment resulting from the construction and operation of the Proposed Alternatives. For purposes of evaluation, the environmental MOE's were grouped in two categories:

1. Environmentally Sensitive Areas (8 MOE's)
   - Wetlands impacted
   - Aquifers impacted
   - Forest impacted
   - Agricultural land impacted
   - Commercial land impacted
   - Residential land impacted
   - Cemetery plots impacted
   - Archeological & Historical sites impacted

2. Overall Environmental Preservation MOE's (11 MOE's)
   - All MOE's listed above
   - Noise impacts
   - Emissions impacts
   - Fuel consumption savings

9.6.1 Environmentally Sensitive Areas

For this grouping, information from a variety of sources was gathered and analyzed. The wetlands impacted were estimated utilizing site base maps, USDA, NRCS, county soil surveys and aerial

photos. Land use was categorized based on field investigations. Environmental impacts were then estimated for each land use type based on estimated ROW takings for each Proposed Alternative. The impacts on aquifers were estimated by calculating the area of bridge construction. The cemetery and the historical sites impacts were estimated using data bases and field surveys. The results are summarized in Table 9-5.

Table 9-5: ENVIRONMENTALLY SENSITIVE AREAS IMPACTED

Alternative	Land Impacts (hectares)				Displacements (hectares)			
	Wetlands Impacted	Aquifers Impacted	Forest Impacted	Agricultural Land Impacted	Commercial Land Impacted	Residential Land Impacted	Cemetery Plots Relocated	Historical Sites Impacted
Improved Two-Lane Rural Arterial	10.52	2.05	51.63	127.64	26.44	39.18	28	11
Multi-Lane Rural Highway	22.98	5.43	91.63	216.95	65.14	76.65	96	11
Four-Lane Divided Rural Highway	26.99	6.32	2121.31	410.55	111.72	120.24	116	11
Four-Lane Freeway	105.26	11.21	950.67	1295.81	75.33	220.72	540	21

The ratings for the Proposed Alternatives based on environmentally sensitive areas impacted (8 MOE's) are:

Improved Two-Lane Rural Arterial	5.0	Most desirable
Multi-Lane Rural Highway	4.2	
Four-Lane Divided Rural Highway	3.0	
Four-Lane Freeway	1.0	Least desirable

Since the lower grade roadways require a narrower ROW, the land impacts are lower. Of particular note is the large gap between the four-lane freeway and the four-lane divided rural highway.

9.6.2 Overall Environmental Preservation

The additional MOE's considered in this grouping were calculated for each Proposed Alternative. The results are summarized in Table 9-6.

Table 9-6: ENVIRONMENTAL PRESERVATION MOE'S

Alternative	Noise Impacts	Emissions Impacts			Fuel Consumption Savings	
		Volatile Organic Compounds (VOC) (metric tons)	Nitrogen Dioxide (NO_x) (metric tons)	Millions	Million Liters	Millions
Two-Lane Rural Arterial	5,518	251	23	$1.97	1.36	$0.41
Multi-Lane Rural Highway	6,185	951	88	$7.48	5.07	$1.55
Four-Lane Divided Rural Highway	9,335	1,352	126	$10.64	7.72	$2.37
Four-Lane Freeway	12,381	1,753	163	$13.80	9.32	$2.85

Note: Figures represent the relative difference between the Proposed Alternative and the base case.

The overall environmental preservation ratings (11 MOE's) follow the same trend as for the impacts on environmentally sensitive areas:

Improved Two-Lane Rural Arterial	5.0	Most desirable
Multi-Lane Rural Highway	4.0	
Four-Lane Divided Rural Highway	2.8	
Four-Lane Freeway	1.0	Least desirable

Two additional MOE's, *hazardous materials* and *endangered species*, were identified early on and were researched during the course of the study. For the hazardous materials MOE, several federal and state databases were investigated. However, as no hazardous materials sites were found to be potentially impacted, this MOE was removed from the evaluation process. For the endangered

species MOE, three threatened/endangered species were identified within the study area: the Gray Bat (*Myotis Grisescens*), the Curtis' Pearly Mussel (*Epioblasma Florentina curtisi*) and the Pink Mucket Mussel (*Lampsilis Abrupta*). It is estimated that none of the Proposed Alternatives will destroy any caves occupied by Gray bat. In addition, it was not possible to accurately estimate potential damage to the mussels which might be caused by construction of the proposed alternatives. Due to these factors, this MOE was removed from the evaluation process.

9.7 ECONOMIC DEVELOPMENT

Chapter 8 of this report presents in detail the economic analysis performed. This section summarizes its results. Residual values are presented in Chapter 7. Table 9-7 presents the economic MOE's developed.

The ratings for the Proposed Alternatives based on the economic development goal are:

Improved Two-Lane Rural Arterial	1.0	Least desirable
Multi-Lane Rural Highway	1.8	
Four-Lane Divided Rural Highway	3.0	
Four-Lane Freeway	5.0	Most desirable

Since many of the economic indicators are driven by the total capital investment, the alternatives with the largest cost yield a higher rating from the economic development perspective. A noticeable exception is the benefit/cost ratio. This trend is also true with the internal rate of return. Due to the much needed mobility improvements, the high potential economic gain due to tourism and the relatively low cost of the improved two-lane rural arterial alternative yields the highest benefit/cost ratio. This alternative is followed by the four-lane divided rural highway, the multi-lane rural highway and the four-lane freeway.

Table 9-7: ECONOMIC DEVELOPMENT

	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Discounted Benefit/Cost Ratio	3.29	2.76	2.92	2.78
Net Present Value	$23.95	$70.92	$92.21	$147.60
Internal Rate of Return	26.22%	22.04%	23.32%	22.16%
Residual Value	20.9%	13.6%	19.8%	23.1%
Annual Tourism Benefits (millions)	$4.59	$17.70	$25.24	$32.78
Annual Visitors Gained	30	115	164	213
Permanent Jobs	73	285	404	527
One-Year Jobs	2,263	8,926	9,994	18,651
Project Expenditures (millions)*	$6.01	$23.87	$26.94	$49.94
Industry Sales (millions)*	$1.56	$6.01	$6.78	$12.51
Household Expenditures (millions)*	$1.82	$7.41	$8.26	$15.47
Value Added (millions)*	$5.43	$20.97	$23.61	$43.68
Wages Added (millions)*	$3.3	$13.4	$15.0	$28.1
Increased Taxes (thousands)*	$306	$1,061	$1,230	$2,193

*Annualized at 7% discount rate over a 30-year design life.

9.8 OVERALL EVALUATION

Table 9-8 shows the evaluation matrices in the six steps as outlined in the methodology section (section 9.3). The different characteristics of each alternative yield contrasting results. For example, while the freeway is the most desirable alternative from the mobility and economic development standpoints, it is the least desirable on the other two project goals. The opposite is true with the improved two-lane rural arterial which is the most desirable alternative from the constructability and environment preservation, and has the highest rate of return, while it yields the lowest rating for mobility benefits and economic development. It is also important to note that this alternative fails to have a satisfactory LOS for significant portions of its length.

Table 9-8: COMPARISON OF PROPOSED ALTERNATIVES

RAW VALUES

Item	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1. IMPROVE MOBILITY				
a. Average Daily Trips	4,441	16,998	24,294	31,153
b. Peak Hour Person Capacity	504	1,923	2,760	3,546
c. Peak Hour Volume/Capacity Ratio*	0.49	0.25	0.25	0.20
d. Peak Hour Level-of-Service	0.29	3.20	3.28	3.41
e. Fatalities Saved	2.53	2.13	3.03	5.71
f. Non-fatal Accidents Saved	3.85	(126.99)	84.52	149.20
g. Accident Cost Reduction (millions)	$5.60	$3.70	$7.32	$13.72
h. Trip Time Reduction (min.)	9.6	28.1	42.0	54.9
i. Saved Vehicle Hours Traveled (thousands)	400.97	975.81	1,491.27	1,928.90
j. Travel Time Cost Savings (millions)	$3.56	$8.58	$13.03	$16.80
k. Saved Vehicle Kilometers Traveled (millions)	9.37	35.37	53.86	65.02
l. Vehicle Operating Costs Savings (millions)	$1.80	$6.81	$10.38	$12.53
m. Through Trips	496	1,882	2,676	3,469
2. PROJECT CONSTRUCTABILITY				
a. Constructability	5.0	2.0	4.0	1.0
b. Construction Time (months)*	10	24	18	30
c. Dif. O&M Costs (x1,000)*	$3.1	$221.4	$221.4	$350.0
d. Annualized Construction Costs (x1,000)*	$7,841	$31,593	$35,622	$66,839
e. Annualized Right-of-Way Costs (x1,000)*	$579	$728	$1,252	$1,302
f. Annualized Mitigation Costs (x1,000)*	$83	$159	$182	$649
g. Total Annualized Costs (x1,000)*	$8,505.2	$32,700.9	$37,278.0	$69,140.0
h. Total Cost/VKT*	$0.02	$0.10	$0.12	$0.23
i. Annualized Cost/km*	$41,029	$157,747	$179,826	$333,526
3. ENVIRONMENT PRESERVATION				
a. Wetlands Impacted (hectares)*	10.52	22.98	26.99	105.26
b. Aquifers Impacted (hectares)*	2.05	5.43	6.32	11.21
c. Forest Impacted (hectares)*	51.63	91.63	2,121.31	950.67
d. Agricultural Land Impacted (hectares)*	127.64	216.95	410.55	1,295.81
e. Cemeteries Impacted (plots)*	28	96	116	540
f. Noise Impacts*	5,518	6,185	9,335	12,381
g. VOL Emissions (tons)*	251	951	1,352	1,753
h. NO Emissions (tons)*	23	88	126	163
i. Emissions Impacts (millions)*	$1.97	$7.48	$10.64	$13.80
j. Commercial Land Impacted (hectares)*	26.44	65.14	111.72	75.33
k. Residential Land Impacted (hectares)*	39.18	76.65	120.24	220.72
l. Fuel Consumption Savings (million liters)*	1.36	5.07	7.72	9.32
m. Fuel Consumption Savings (millions)*	$0.41	$1.55	$2.37	$2.85
n. Archeological and Historical Sites Impacted*	11	11	11	21
4. ECONOMIC DEVELOPMENT				
a. Discounted Benefit/Cost Ratio	3.29	2.76	2.92	2.78
b. Net Present Value (millions)	$23.95	$70.92	$92.21	$147.60
c. Internal Rate of Return	26.22%	22.04%	23.32%	22.16%
d. Residual Value	20.9%	13.6%	19.8%	23.1%
e. Tourism Impacts (millions)	$4.59	$17.70	$25.24	$32.78
f. Visitors Gained (x1,000)	30	115	164	213
g. Permanent Jobs Created	73	285	404	527
h. One-Year Jobs Created	2,263	8,926	9,994	18,651
i. Annualized Project Expenditures (millions)	$6.01	$23.87	$26.94	$49.94
j. Annualized Industry Sales (millions)	$1.56	$6.01	$6.78	$12.51
k. Annualized Household Expenditure (millions)	$1.82	$7.41	$8.26	$15.47
l. Value Added to Goods Produced (millions)	$5.43	$20.97	$23.61	$43.68
m. Wages Added to Payroll (millions)	$3.3	$13.4	$15.0	$28.1
n. Increased Taxes (x1,000)	$306	$1,061	$1,230	$2,193

PERCENTILE VALUES

Item	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1. IMPROVE MOBILITY				
a. Average Daily Trips	14%	54%	78%	100%
b. Peak Hour Person Capacity	14%	54%	78%	100%
c. Peak Hour Volume/Capacity Ratio*	100%	51%	51%	41%
d. Peak Hour Level-of-Service	9%	94%	96%	100%
e. Fatalities Saved	44%	37%	53%	100%
f. Non-fatal Accidents Saved	3%	-85%	57%	100%
g. Accident Cost Reduction (millions)	41%	27%	53%	100%
h. Trip Time Reduction (min.)	17%	51%	77%	100%
i. Saved Vehicle Hours Traveled (thousands)	21%	51%	77%	100%
j. Travel Time Cost Savings (millions)	21%	51%	78%	100%
k. Saved Vehicle Kilometers Traveled (millions)	14%	54%	83%	100%
l. Vehicle Operating Costs Savings (millions)	14%	54%	83%	100%
m. Through Trips	14%	54%	77%	100%
2. PROJECT CONSTRUCTABILITY				
a. Constructability	100%	40%	80%	20%
b. Construction Time (months)*	33%	80%	60%	100%
c. Dif. O&M Costs (x1,000)*	1%	63%	63%	100%
d. Annualized Construction Costs (x1,000)*	12%	47%	53%	100%
e. Annualized Right-of-Way Costs (x1,000)*	44%	56%	96%	100%
f. Annualized Mitigation Costs (x1,000)*	13%	24%	28%	100%
g. Total Annualized Costs (x1,000)*	12%	47%	54%	100%
h. Total Cost/VKT*	10%	43%	52%	100%
i. Annualized Cost/km*	12%	47%	54%	100%
3. ENVIRONMENT PRESERVATION				
a. Wetlands Impacted (hectares)*	10%	22%	26%	100%
b. Aquifers Impacted (hectares)*	18%	48%	56%	100%
c. Forest Impacted (hectares)*	2%	4%	100%	45%
d. Agricultural Land Impacted (hectares)*	10%	17%	32%	100%
e. Cemeteries Impacted (plots)*	5%	18%	21%	100%
f. Noise Impacts*	45%	50%	75%	100%
g. VOL Emissions (tons)*	14%	54%	77%	100%
h. NO Emissions (tons)*	14%	54%	77%	100%
i. Emissions Impacts (millions)*	14%	54%	77%	100%
j. Commercial Land Impacted (hectares)*	24%	58%	100%	67%
k. Residential Land Impacted (hectares)*	18%	35%	54%	100%
l. Fuel Consumption Savings (million liters)*	15%	54%	83%	100%
m. Fuel Consumption Savings (millions)*	14%	54%	83%	100%
n. Archeological and Historical Sites Impacted*	52%	52%	52%	100%
4. ECONOMIC DEVELOPMENT				
a. Discounted Benefit/Cost Ratio	100%	84%	89%	85%
b. Net Present Value (millions)	16%	48%	62%	100%
c. Internal Rate of Return	100%	84%	89%	85%
d. Residual Value	90%	59%	86%	100%
e. Tourism Impacts (millions)	14%	54%	77%	100%
f. Visitors Gained (x1,000)	14%	54%	77%	100%
g. Permanent Jobs Created	14%	54%	77%	100%
h. One-Year Jobs Created	12%	48%	54%	100%
i. Annualized Project Expenditures (millions)	12%	48%	54%	100%
j. Annualized Industry Sales (millions)	12%	48%	54%	100%
k. Annualized Household Expenditure (millions)	12%	48%	53%	100%
l. Value Added to Goods Produced (millions)	12%	48%	54%	100%
m. Wages Added to Payroll (millions)	12%	48%	53%	100%
n. Increased Taxes (x1,000)	14%	48%	56%	100%

*NOTE: These measures are best minimized; others are best maximized.

Table 9-8: COMPARISON OF PROPOSED ALTERNATIVES (Cont'd)

RANKED VALUES: 5=MOST DESIRABLE, 1=LEAST DESIRABLE

Item	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
1. IMPROVE MOBILITY				
a. Average Daily Trips	1.0	2.9	4.0	5.0
b. Peak Hour Person Capacity	1.0	2.9	4.0	5.0
c. Peak Hour Volume/Capacity Ratio*	1.0	4.3	4.3	5.0
d. Peak Hour Level-of-Service	1.0	4.7	4.8	5.0
e. Fatalities Saved	1.4	1.0	2.0	5.0
f. Non-fatal Accidents Saved	2.9	1.0	4.1	5.0
g. Accident Cost Reduction (millions)	1.8	1.0	2.4	5.0
h. Trip Time Reduction (min.)	1.0	2.6	3.9	5.0
i. Saved Vehicle Hours Traveled (thousands)	1.0	2.5	3.9	5.0
j. Travel Time Cost Savings (millions)	1.0	2.5	3.9	5.0
k. Saved Vehicle Kilometers Traveled (millions)	1.0	2.9	4.2	5.0
l. Vehicle Operating Costs Savings (millions)	1.0	2.9	4.2	5.0
m. Through Trips	1.0	2.9	3.9	5.0
2. PROJECT CONSTRUCTABILITY				
a. Constructability	5.0	2.0	4.0	1.0
b. Construction Time (months)*	5.0	2.2	3.4	1.0
c. Dif. O&M Costs (x1,000)*	5.0	2.5	2.5	1.0
d. Annualized Construction Costs (x1,000)*	5.0	3.4	3.1	1.0
e. Annualized Right-of-Way Costs (x1,000)*	5.0	4.2	1.3	1.0
f. Annualized Mitigation Costs (x1,000)*	5.0	4.5	4.3	1.0
g. Total Annualized Costs (x1,000)*	5.0	3.4	3.1	1.0
h. Total Cost/VKT*	5.0	3.5	3.1	1.0
i. Annualized Cost/km*	5.0	3.4	3.1	1.0
3. ENVIRONMENT PRESERVATION				
a. Wetlands Impacted (hectares)*	5.0	4.5	4.3	1.0
b. Aquifers Impacted (hectares)*	5.0	3.5	3.1	1.0
c. Forest Impacted (hectares)*	5.0	4.9	1.0	3.3
d. Agricultural Land Impacted (hectares)*	5.0	4.7	4.0	1.0
e. Cemeteries Impacted (plots)*	5.0	4.5	4.3	1.0
f. Noise Impacts*	5.0	4.6	2.8	1.0
g. VOL Emissions (tons)*	5.0	3.1	2.1	1.0
h. NO Emissions (tons)*	5.0	3.1	2.1	1.0
i. Emissions Impacts (millions)*	5.0	3.1	2.1	1.0
j. Commercial Land Impacted (hectares)*	5.0	3.2	1.0	2.7
k. Residential Land Impacted (hectares)*	5.0	4.2	3.2	1.0
l. Fuel Consumption Savings (million liters)*	5.0	3.1	1.8	1.0
m. Fuel Consumption Savings (millions)*	5.0	3.1	1.8	1.0
n. Archeological and Historical Sites Impacted*	5.0	5.0	5.0	1.0
4. ECONOMIC DEVELOPMENT				
a. Discounted Benefit/Cost Ratio	5.0	1.0	2.2	1.1
b. Net Present Value (millions)	1.0	2.5	3.2	5.0
c. Internal Rate of Return	5.0	1.0	2.2	1.1
d. Residual Value	4.1	1.0	3.6	5.0
e. Tourism Impacts (millions)	1.0	2.9	3.9	5.0
f. Visitors Gained (x1,000)	1.0	2.9	3.9	5.0
g. Permanent Jobs Created	1.0	2.9	3.9	5.0
h. One-Year Jobs Created	1.0	2.6	2.9	5.0
i. Annualized Project Expenditures (millions)	1.0	2.6	2.9	5.0
j. Annualized Industry Sales (millions)	1.0	2.6	2.9	5.0
k. Annualized Household Expenditure (millions)	1.0	2.6	2.9	5.0
l. Value Added to Goods Produced (millions)	1.0	2.6	2.9	5.0
m. Wages Added to Payroll (millions)	1.0	2.6	2.9	5.0
n. Increased Taxes (x1,000)	1.0	2.6	3.0	5.0

MOE's COMBINATIONS

Combination Group	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
A All Factors, Equal Weight (50 MOE's)	156.2	150.3	159.4	154.2
B Improve Mobility (13 MOE's)	16.1	34.0	49.5	65.0
C Improve Mobility (9 MOE's)	11.3	25.0	35.1	45.0
D Level-of-Service (2 MOE's)	2.0	9.0	9.1	10.0
E Project Constructability (9 MOE's)	45.0	29.1	27.9	9.0
F Environment Preservation (11 MOE's)	55.0	45.3	32.6	15.0
G Environmentally Sensitive Areas (8 MOE's)	40.0	34.4	26.0	12.0
H Economic Development (14 MOE's)	25.1	32.5	43.4	62.2
I Construction Cost	5.0	3.4	3.1	1.0
J Benefit/Cost (16 MOE's)	44.8	43.9	45.2	52.1
K Benefit/Cost Ratio	5.0	1.0	2.2	1.1
L Jobs Gained (2 MOE's)	2.0	5.5	6.8	10.0
M Travel Time	3.0	7.7	11.6	15.0
N Travel Time + Cost/VKT	8.0	11.2	14.7	16.0
O All MOE's with Cost Double Weight	161.2	153.6	162.5	155.2
P All MOE's with Env. Double Weight	211.2	195.5	192.0	169.2
Sum of Above Weighted Combinations	790.8	781.7	821.3	792.0

RANKED COMBINATIONS: 5=MOST DESIRABLE, 1=LEAST DESIRABLE

Combination Group	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
A All Factors, Equal Weight (50 MOE's)	3.6	1.0	5.0	2.7
B Improve Mobility (13 MOE's)	1.0	2.5	3.7	5.0
C Improve Mobility (9 MOE's)	1.0	2.6	3.8	5.0
D Level-of-Service (2 MOE's)	1.0	4.5	4.6	5.0
E Project Constructability (9 MOE's)	5.0	3.2	3.1	1.0
F Environment Preservation (11 MOE's)	5.0	4.0	2.8	1.0
G Environmentally Sensitive Areas (8 MOE's)	5.0	4.2	3.0	1.0
H Economic Development (14 MOE's)	1.0	1.8	3.0	5.0
I Construction Cost	5.0	3.4	3.1	1.0
J Benefit/Cost (16 MOE's)	1.4	1.0	1.6	5.0
K Benefit/Cost Ratio	5.0	1.0	2.2	1.1
L Jobs Gained (2 MOE's)	1.0	2.7	3.4	5.0
M Travel Time	1.0	2.6	3.9	5.0
N Travel Time + Cost/VKT	1.0	2.6	4.4	5.0
O All MOE's with Cost Double Weight	4.4	1.0	5.0	1.7
P All MOE's with Env. Double Weight	5.0	3.5	3.2	1.0
Sum of Above Ranked Combinations	46.4	41.7	55.7	50.5

SUMMARY RESULTS

	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Average Ranking	2.90	2.61	3.48	3.16
Re-ranked, 1 to 5 (based on all MOE's)	1.92	1	5	2.04
Re-ranked (based on all Combinations)	2.34	1	5	3.51
Number times ranked 5 "most desirable"	6	0	2	8
Number times ranked 1 "least desirable"	7	4	0	5

The ratings for the Proposed Alternatives based on all the MOE's combinations are:

Improved Two-Lane Rural Arterial	2.34	
Multi-Lane Rural Highway	1.00	Least desirable
Four-Lane Divided Rural Highway	5.00	Most desirable
Four-Lane Freeway	3.51	

9.9 RECOMMENDED ALTERNATIVE

Based on the detailed analysis and findings presented in both this chapter and previous chapters, the four-lane divided rural highway is the most viable alternative and is selected as the recommended alternative. It provides the best balance in terms of satisfying the project goals of *improved mobility, constructability, environmental preservation* and *economic development*. Other factors noted in the selection of this alternative include:

- Provides a high level of improved mobility
- Provides a high benefit/cost ratio
- Meets/exceeds minimum LOS criteria along all segments
- Yields the second highest economic development rating
- Rated highest based on average of all MOE's (see Table 9-8)
- Rated highest based on evaluation of all MOE combinations (see Table 9-8)

9.10 SEGMENT PRIORITIZATION

An evaluation process similar to the one utilized to select the recommended alternative was performed for the nine segments studied for the four-lane divided highway Proposed Alternative. The purpose of this evaluation was to prioritize improvements by segment. The ratings for the nine corridor segments based on all combinations are given in Table 9-9.

Table 9-9: SEGMENT PRIORITIZATION

Segment	Limits	Rate	Priority		
			Low	Medium	High
1	East of Lake Norfork to east of Viola	4.1			●
2	East of Viola to east of Salem	3.4		●	
3	East of Salem to east of Ash Flat	3.6		●	
4	East of Ash Flat to east of Hardy	2.7		●	
5	East of Hardy to east of Imboden	1.0	●		
6	East of Imboden to the US63/US412 junction	4.0			●
7	Connections to Walnut Ridge/Hoxie Bypass	5.0			●
8	East of Walnut Ridge/Hoxie to west of Paragould	3.0		●	
10	East of Paragould to the Missoury state line	4.4			●

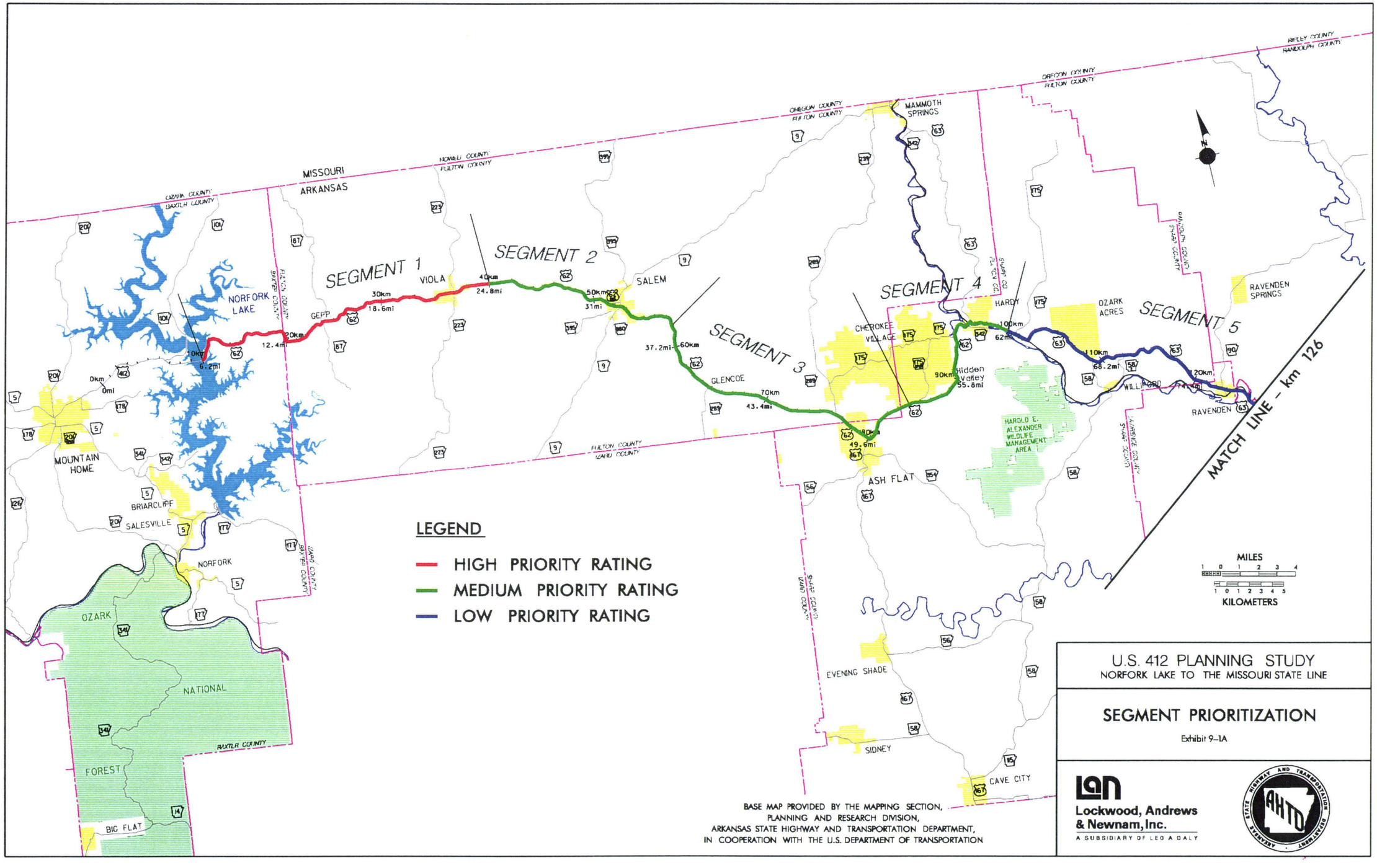
Note: Segment 9 (Paragould area) not included in this study.

The priority ranking of these segments is shown graphically in Exhibits 9-1A and 9-1B. The evaluation matrices are shown in Table 9-10.

An important footnote in the foregoing priority ranking exercise is that:

- Full benefits will be realized only when all segments have been improved
- Incremental implementation of improvements will not yield proportional benefits

In other words, if one segment is improved, the resultant benefits will be less than the expected pro-rata share of total estimated benefits. The reason lies mainly in the fact that the expected benefits are dependent upon a latent demand being diverted to US 412 from a parallel facility which has become relatively less attractive to the user. The real or perceived attractiveness of the overall US 412 facility will increase at an increasing rate as more segments are improved over time.

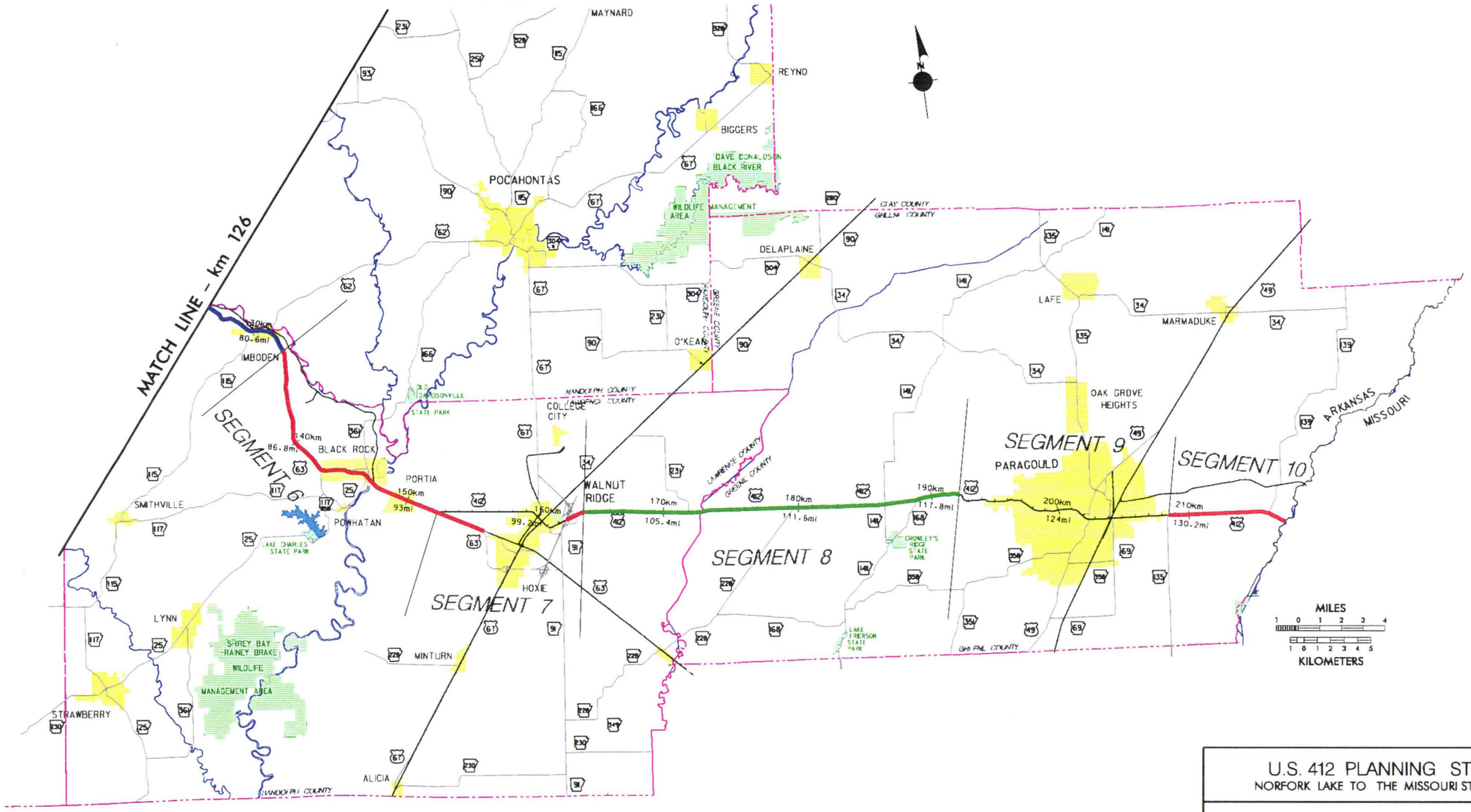


U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

SEGMENT PRIORITIZATION

Exhibit 9-1A

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY



LEGEND

- HIGH PRIORITY RATING
- MEDIUM PRIORITY RATING
- LOW PRIORITY RATING

BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

SEGMENT PRIORITIZATION

Exhibit 9-1B

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY

Table 9-10: SEGMENT EVALUATION

RAW VALUES

Item	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10
1. IMPROVE MOBILITY									
a. Average Daily Trips	7,761	9,939	13,738	15,060	13,776	16,236	9,167	8,043	14,991
b. Peak Hour Person Capacity	876	1,122	1,550	1,700	1,555	1,832	1,113	906	1,699
c. Peak Hour Volume/Capacity Ratio*	0.17	0.22	0.25	0.29	0.38	0.34	0.15	0.13	0.25
d. Peak Hour Level-of-Service	5.00	5.00	4.82	4.83	4.07	4.43	5.00	5.00	5.00
e. Fatalities Saved	0.02	0.61	1.21	0.04	0.40	0.14	0.02	0.55	0.04
f. Non-fatal Accidents Saved	7.15	8.73	15.76	14.33	5.88	10.07	13.19	5.87	3.54
g. Accident Cost Reduction (millions)	$0.10	$1.41	$2.78	$0.20	$0.93	$0.39	$0.15	$1.26	$0.12
h. Trip Time Reduction (min.)	3.9	2.9	4.1	3.0	10.6	8.1	2.0	5.6	1.8
i. Saved Vehicle Hours Traveled (thousands)	146.22	115.60	204.56	129.92	280.85	300.57	77.35	144.98	82.21
j. Travel Time Savings (millions)	$1.14	$0.91	$1.60	$1.05	$2.60	$2.70	$0.74	$1.39	$0.79
k. Saved Vehicle Kilometers Traveled (millions)	7.39	1.40	1.75	6.99	18.18	7.42	3.77	3.24	3.72
l. Vehicle Operating Costs Savings (millions)	$1.42	$0.27	$0.34	$1.35	$3.50	$1.43	$0.73	$0.62	$0.72
2. PROJECT CONSTRUCTABILITY									
a. Constructability	2.9	2.9	3.5	1.0	3.0	3.2	4.6	4.3	5.0
b. Construction Time (months)*	12	16	10	18	18	16	4	10	6
c. Dif. O&M Costs (x1,000)*	$41.4	$19.6	$25.0	$8.9	$43.2	$26.8	$4.2	$39.7	$12.5
d. Annualized Construction Costs (x1,000)*	$5,523	$3,479	$4,764	$3,360	$7,463	$5,632	$466	$4,068	$1,914
e. Annualized Right-of-Way Costs (x1,000)*	$262	$157	$188	$285	$193	$99	$23	$36	$9
f. Annualized Mitigation Costs (x1,000)*	$11	$4	$30	$58	$45	$0	$9	$12	$14
g. Total Annualized Costs (x1,000)*	$5,837.0	$3,658.9	$5,006.7	$3,711.5	$7,743.7	$5,757.9	$502.2	$4,156.1	$1,949.1
h. Total Cost/VKT*	$0.03	$0.02	$0.02	$0.02	$0.03	$0.03	$0.00	$0.02	$0.01
i. Annualized Cost/km*	$28,157	$17,650	$24,152	$17,904	$37,355	$27,776	$2,422	$20,049	$9,402
3. ENVIRONMENT PRESERVATION									
a. Wetlands Impacted (hectares)*	0.35	1.73	0.00	0.60	5.66	0.00	0.00	6.41	10.24
b. Aquifers Impacted (hectares)*	0.16	0.38	0.27	1.04	1.12	2.44	0.25	0.77	1.73
c. Forest Impacted (hectares)*	36.08	20.87	15.56	3.12	92.42	36.75	0.00	0.00	0.00
d. Agricultural Land Impacted (hectares)*	55.90	35.25	106.46	1.69	62.70	63.02	0.00	72.20	11.34
e. Cemeteries Impacted (plots)*	0	0	32	56	28	0	0	0	0
f. Noise Impacts*	-1779	1002	1964	847	2521	1151	1208	1805	616
g. VOL Emissions (tons)*	213	128	191	106	234	137	82	198	62
h. NO Emissions (tons)*	20	12	18	10	22	13	8	18	6
i. Emissions Impacts (millions)*	$1.67	$1.00	$1.51	$0.84	$1.84	$1.08	$0.65	$1.56	$0.49
j. Commercial Land Impacted (hectares)*	13.75	19.53	16.42	23.51	26.75	20.16	0.00	2.96	2.39
k. Residential Land Impacted (hectares)*	30.97	16.80	9.03	20.92	16.40	13.27	10.66	10.98	1.86
l. Fuel Consumption Savings (million liters)*	1.06	0.20	0.25	1.00	2.60	1.00	0.54	0.46	0.53
m. Fuel Consumption Savings (millions)*	$0.32	$0.06	$0.08	$0.31	$0.80	$0.33	$0.17	$0.14	$0.16
n. Archeological and Historical Sites Impacted*	2	0	1	1	3	0	2	1	1
4. ECONOMIC DEVELOPMENT									
a. Discounted Benefit/Cost Ratio	4.25	2.37	2.52	2.73	2.82	2.60	2.58	2.43	2.68
b. Net Present Value (millions)	$24.38	$6.37	$9.89	$7.89	$17.45	$10.97	$1.81	$8.19	$4.11
c. Internal Rate of Return	33.90%	18.82%	20.06%	21.79%	22.40%	20.74%	20.51%	19.36%	21.40%
d. Residual Value	20.4%	20.9%	19.7%	26.5%	20.5%	17.6%	21.3%	12.4%	22.5%
e. Tourism Impacts (millions)	$16.44	$0.57	$0.92	$1.61	$2.68	$0.68	$0.11	$1.62	$0.61
f. Visitors Gained	108,541	3,620	5,792	9,807	16,468	4,423	707	10,812	4,046
g. Permanent Jobs Created	271	9	15	22	36	10	2	28	11
h. One-Year Jobs Created	1,522	954	1,306	968	2,019	1,501	131	1,084	508
i. Annualized Project Expenditures (millions)	$4.10	$2.57	$3.52	$2.61	$5.44	$4.05	$0.35	$2.92	$1.37
j. Annualized Industry Sales (millions)	$1.03	$0.65	$0.89	$0.66	$1.37	$1.02	$0.09	$0.74	$0.34
k. Annualized Household Expenditure (millions)	$1.26	$0.79	$1.08	$0.80	$1.67	$1.24	$0.11	$0.90	$0.42
l. Value Added to Goods Produced (millions)	$3.60	$2.25	$3.06	$2.29	$4.77	$3.55	$0.31	$2.56	$1.20
m. Wages Added to Payroll (millions)	$2.3	$1.4	$2.0	$1.5	$3.0	$2.2	$0.2	$1.6	$0.8
n. Increased Taxes (x1,000)	$167	$117	$161	$119	$248	$185	$16	$133	$63

PERCENTILE VALUES

Item	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10
1. IMPROVE MOBILITY									
a. Average Daily Trips	48%	61%	85%	93%	85%	100%	56%	50%	92%
b. Peak Hour Person Capacity	48%	61%	85%	93%	85%	100%	61%	50%	93%
c. Peak Hour Volume/Capacity Ratio*	45%	58%	66%	76%	100%	89%	39%	34%	66%
d. Peak Hour Level-of-Service	100%	100%	96%	97%	81%	89%	100%	100%	100%
e. Fatalities Saved	2%	50%	100%	3%	33%	12%	2%	45%	3%
f. Non-fatal Accidents Saved	45%	55%	100%	91%	37%	64%	84%	37%	22%
g. Accident Cost Reduction (millions)	4%	51%	100%	7%	33%	14%	5%	45%	4%
h. Trip Time Reduction (min.)	37%	27%	39%	28%	100%	76%	19%	53%	17%
i. Saved Vehicle Hours Traveled (thousands)	49%	38%	68%	43%	96%	100%	26%	48%	27%
j. Travel Time Savings (millions)	42%	34%	59%	39%	96%	100%	27%	52%	29%
k. Saved Vehicle Kilometers Traveled (millions)	41%	8%	10%	38%	100%	41%	21%	18%	20%
l. Vehicle Operating Costs Savings (millions)	41%	8%	10%	38%	100%	41%	21%	18%	20%
2. PROJECT CONSTRUCTABILITY									
a. Constructability	58%	58%	70%	20%	60%	64%	96%	86%	100%
b. Construction Time (months)*	67%	69%	56%	100%	100%	89%	22%	56%	33%
c. Dif. O&M Costs (x1,000)*	96%	45%	58%	21%	100%	62%	10%	92%	29%
d. Annualized Construction Costs (x1,000)*	74%	47%	64%	45%	100%	75%	6%	55%	26%
e. Annualized Right-of-Way Costs (x1,000)*	92%	55%	66%	100%	68%	35%	8%	13%	3%
f. Annualized Mitigation Costs (x1,000)*	19%	6%	52%	100%	78%	0%	15%	21%	24%
g. Total Annualized Costs (x1,000)*	75%	47%	65%	48%	100%	74%	6%	54%	25%
h. Total Cost/VKT*	79%	51%	70%	50%	100%	78%	7%	57%	27%
i. Annualized Cost/km*	75%	47%	65%	48%	100%	74%	6%	54%	25%
3. ENVIRONMENT PRESERVATION									
a. Wetlands Impacted (hectares)*	3%	17%	0%	6%	55%	0%	0%	82%	100%
b. Aquifers Impacted (hectares)*	7%	16%	11%	43%	46%	100%	10%	32%	71%
c. Forest Impacted (hectares)*	39%	23%	17%	3%	100%	40%	0%	0%	0%
d. Agricultural Land Impacted (hectares)*	52%	33%	100%	2%	58%	58%	0%	67%	10%
e. Cemeteries Impacted (plots)*	0%	0%	57%	100%	50%	0%	0%	0%	0%
f. Noise Impacts*	-71%	40%	78%	34%	100%	46%	48%	72%	24%
g. VOL Emissions (tons)*	91%	55%	82%	45%	100%	59%	35%	85%	27%
h. NO Emissions (tons)*	91%	55%	82%	45%	100%	59%	35%	85%	27%
i. Emissions Impacts (millions)*	91%	55%	82%	45%	100%	59%	35%	85%	27%
j. Commercial Land Impacted (hectares)*	51%	73%	61%	88%	100%	75%	0%	11%	9%
k. Residential Land Impacted (hectares)*	100%	54%	29%	68%	53%	43%	34%	35%	6%
l. Fuel Consumption Savings (million liters)*	41%	8%	10%	38%	100%	41%	21%	18%	20%
m. Fuel Consumption Savings (millions)*	41%	8%	10%	38%	100%	41%	21%	18%	20%
n. Archeological and Historical Sites Impacted*	67%	0%	33%	33%	100%	0%	67%	33%	33%
4. ECONOMIC DEVELOPMENT									
a. Discounted Benefit/Cost Ratio	100%	56%	59%	64%	66%	61%	61%	57%	63%
b. Net Present Value (millions)	100%	26%	41%	32%	72%	45%	7%	34%	17%
c. Internal Rate of Return	100%	56%	59%	64%	66%	61%	61%	57%	63%
d. Residual Value	77%	79%	74%	100%	77%	66%	80%	47%	85%
e. Tourism Impacts (millions)	100%	3%	6%	10%	16%	4%	1%	10%	4%
f. Visitors Gained	100%	3%	5%	9%	15%	4%	1%	10%	4%
g. Permanent Jobs Created	100%	3%	6%	8%	13%	4%	1%	10%	4%
h. One-Year Jobs Created	75%	47%	65%	48%	100%	74%	6%	54%	25%
i. Annualized Project Expenditures (millions)	75%	47%	65%	48%	100%	74%	6%	54%	25%
j. Annualized Industry Sales (millions)	75%	47%	65%	48%	100%	74%	6%	54%	25%
k. Annualized Household Expenditure (millions)	75%	47%	65%	48%	100%	74%	6%	54%	25%
l. Value Added to Goods Produced (millions)	75%	47%	65%	48%	100%	74%	6%	54%	25%
m. Wages Added to Payroll (millions)	75%	47%	65%	48%	100%	74%	6%	54%	25%
n. Increased Taxes (x1,000)	75%	47%	65%	48%	100%	74%	6%	54%	25%

*NOTE: These measures are best minimized; others are best maximized.

Table 9-10: SEGMENT EVALUATION (Cont'd)

RANKED VALUES: 5=BEST, 1=LEAST

Item	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10
1. IMPROVE MOBILITY									
a. Average Daily Trips	1.0	2.0	3.8	4.4	3.8	5.0	1.7	1.1	4.4
b. Peak Hour Person Capacity	1.0	2.0	3.8	4.4	3.8	5.0	2.0	1.1	4.4
c. Peak Hour Volume/Capacity Ratio*	4.4	3.6	3.1	2.4	1.0	1.6	4.7	5.0	3.1
d. Peak Hour Level-of-Service	5.0	5.0	4.2	4.3	1.0	2.5	5.0	5.0	5.0
e. Fatalities Saved	1.0	3.0	5.0	1.1	2.3	1.4	1.0	2.8	1.1
f. Non-fatal Accidents Saved	2.2	2.7	5.0	4.5	1.6	3.1	4.2	1.8	1.0
g. Accident Cost Reduction (millions)	1.0	3.0	5.0	1.1	2.2	1.4	1.1	2.7	1.0
h. Trip Time Reduction (min.)	2.0	1.5	2.0	1.5	5.0	3.9	1.1	2.7	1.0
i. Saved Vehicle Hours Traveled (thousands)	2.2	1.7	3.3	1.9	4.6	5.0	1.0	2.2	1.1
j. Travel Time Savings (millions)	1.6	1.3	2.8	1.6	4.6	5.0	1.0	2.3	1.1
k. Saved Vehicle Kilometers Traveled (millions)	2.4	1.0	1.1	2.3	5.0	2.4	1.6	1.4	1.6
l. Vehicle Operating Costs Savings (millions)	2.4	1.0	1.1	2.3	5.0	2.4	1.6	1.4	1.6
2. PROJECT CONSTRUCTABILITY									
a. Constructability	2.9	2.9	3.5	1.0	3.0	3.2	4.8	4.3	5.0
b. Construction Time (months)*	2.7	1.6	3.3	1.0	1.0	1.6	5.0	3.3	4.4
c. Dif. O&M Costs (x1,000)*	1.2	3.4	2.9	4.5	1.0	2.7	5.0	1.4	4.1
d. Annualized Construction Costs (x1,000)*	2.1	3.3	2.5	3.3	1.0	2.0	5.0	2.9	4.2
e. Annualized Right-of-Way Costs (x1,000)*	1.3	2.9	2.4	1.0	2.3	3.7	4.8	4.6	5.0
f. Annualized Mitigation Costs (x1,000)*	4.2	4.7	2.9	1.0	1.9	5.0	4.4	4.1	4.0
g. Total Annualized Costs (x1,000)*	2.1	3.3	2.5	3.2	1.0	2.1	5.0	3.0	4.2
h. Total Cost/VKT*	1.9	3.1	2.3	3.1	1.0	1.9	5.0	2.8	4.1
i. Annualized Cost/km*	2.1	3.3	2.5	3.2	1.0	2.1	5.0	3.0	4.2
3. ENVIRONMENT PRESERVATION									
a. Wetlands Impacted (hectares)*	4.9	4.3	5.0	4.8	2.8	5.0	5.0	1.7	1.0
b. Aquifers Impacted (hectares)*	5.0	4.6	4.8	3.5	3.3	1.0	4.9	3.9	2.2
c. Forest Impacted (hectares)*	3.4	4.1	4.3	4.9	1.0	3.4	5.0	5.0	5.0
d. Agricultural Land Impacted (hectares)*	2.9	3.7	1.0	4.9	2.7	2.7	5.0	2.3	4.0
e. Cemeteries Impacted (plots)*	5.0	5.0	2.7	1.0	3.0	5.0	5.0	5.0	5.0
f. Noise Impacts*	5.0	2.4	1.5	2.6	1.0	2.3	2.2	1.7	2.6
g. VOL Emissions (tons)*	1.5	3.5	2.0	4.0	1.0	3.2	4.5	1.8	5.0
h. NO Emissions (tons)*	1.5	3.5	2.0	4.0	1.0	3.2	4.5	1.8	5.0
i. Emissions Impacts (millions)*	1.5	3.5	2.0	4.0	1.0	3.2	4.5	1.8	5.0
j. Commercial Land Impacted (hectares)*	2.9	2.1	2.5	1.5	1.0	2.0	5.0	4.6	4.6
k. Residential Land Impacted (hectares)*	1.0	2.9	4.0	2.4	3.0	3.4	3.8	3.7	5.0
l. Fuel Consumption Savings (million liters)*	3.6	5.0	4.9	3.7	1.0	3.6	4.4	4.6	4.4
m. Fuel Consumption Savings (millions)*	3.6	5.0	4.9	3.7	1.0	3.6	4.4	4.6	4.4
n. Archeological and Historical Sites Impacted*	2.3	5.0	3.7	3.7	1.0	5.0	2.3	3.7	3.7
4. ECONOMIC DEVELOPMENT									
a. Discounted Benefit/Cost Ratio	5.0	1.0	1.3	1.8	2.0	1.5	1.4	1.1	1.7
b. Net Present Value (millions)	5.0	1.8	2.4	2.1	3.8	2.0	1.0	2.1	1.4
c. Internal Rate of Return	5.0	1.0	1.3	1.8	2.0	1.5	1.4	1.1	1.7
d. Residual Value	3.3	3.4	3.1	5.0	3.3	2.5	3.5	1.0	3.9
e. Tourism Impacts (millions)	5.0	1.1	1.2	1.4	1.6	1.1	1.0	1.4	1.1
f. Visitors Gained	5.0	1.1	1.2	1.3	1.6	1.1	1.0	1.4	1.1
g. Permanent Jobs Created	5.0	1.1	1.2	1.3	1.6	1.1	1.0	1.4	1.1
h. One-Year Jobs Created	3.9	2.7	3.5	2.8	5.0	3.9	1.0	3.0	1.8
i. Annualized Project Expenditures (millions)	3.9	2.7	3.5	2.8	5.0	3.9	1.0	3.0	1.8
j. Annualized Industry Sales (millions)	3.9	2.7	3.5	2.8	5.0	3.9	1.0	3.0	1.8
k. Annualized Household Expenditure (millions)	3.9	2.7	3.5	2.8	5.0	3.9	1.0	3.0	1.8
l. Value Added to Goods Produced (millions)	3.9	2.7	3.5	2.8	5.0	3.9	1.0	3.0	1.8
m. Wages Added to Payroll (millions)	3.9	2.7	3.5	2.8	5.0	3.9	1.0	3.0	1.8
n. Increased Taxes (x1,000)	3.9	2.7	3.5	2.8	5.0	3.9	1.0	3.0	1.8

MOE'S COMBINATIONS

Combination Group	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10
A. All Factors, Equal Weight (44 MOE's)	151.9	140.6	146.6	136.0	128.3	148.7	147.9	136.0	148.0
B. Improve Mobility (9 MOE's)	19.2	21.0	29.3	25.5	23.5	26.2	21.1	20.5	21.6
C. Level of Service	5.0	5.0	4.2	4.3	1.0	2.5	5.0	5.0	5.0
D. Project Constructability (10 MOE's)	20.5	28.4	24.8	21.4	13.2	24.3	44.0	29.4	39.3
E. Environment Preservation (14 MOE's)	44.1	54.6	45.4	48.4	23.8	46.6	60.7	46.2	57.8
F. Economic Development (8 MOE's)	60.9	29.8	36.2	34.1	50.7	38.8	17.4	30.7	24.0
G. Cost (5 MOE's)	10.9	17.6	13.2	13.1	7.2	15.5	24.2	16.0	21.5
H. Discounted Benefit/Cost Ratio	5.0	1.0	1.3	1.8	2.0	1.5	1.4	1.1	1.7
I. Feasibility (8 MOE's)	31.2	21.6	20.7	19.7	14.7	17.1	28.4	24.5	26.2
J. Environmentally Sensitive Areas Impacted	23.6	26.7	21.5	22.7	13.0	22.1	27.0	21.6	21.5
K. Travel Time	6.0	4.5	8.1	5.1	14.6	13.9	3.1	7.3	3.2
L. Travel Time + Cost/VKT	7.9	7.6	10.4	8.2	15.6	15.8	8.1	10.1	7.3
M. Total Cost/VKT	1.9	3.1	2.3	3.1	1.0	1.9	5.0	2.8	4.1
N. All MOE's with Cost Double Weight	162.8	158.1	159.9	149.1	135.5	164.2	172.0	152.0	169.6
O. All MOE's with Cost Triple Weight	173.7	175.7	173.1	162.2	142.6	179.7	196.2	168.1	191.1
P. All MOE's with Env. Double Weight	195.1	195.2	192.0	184.4	152.1	195.4	208.5	182.2	205.8
Sum of Above Weighted Combinations	921	890	899	839	740	914	970	854	949

RANKED COMBINATIONS: 5=BEST, 1=LEAST

Combination Group	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10
A. All Factors, Equal Weight (44 MOE's)	5.0	3.1	4.1	2.3	1.0	4.5	4.0	2.3	4.3
B. Improve Mobility (9 MOE's)	1.0	1.7	5.0	3.5	2.7	3.8	1.7	1.5	2.0
C. Level of Service	5.0	5.0	4.2	4.3	1.0	2.5	5.0	5.0	5.0
D. Project Constructability (10 MOE's)	1.9	3.0	2.5	2.1	1.0	2.4	5.0	3.1	4.4
E. Environment Preservation (14 MOE's)	3.2	4.3	3.3	3.7	1.0	3.5	5.0	3.4	4.7
F. Economic Development (8 MOE's)	5.0	2.1	2.7	2.5	4.1	3.0	1.0	2.2	1.7
G. Cost (5 MOE's)	1.9	3.4	2.4	2.4	1.0	3.0	5.0	3.1	4.4
H. Discounted Benefit/Cost Ratio	5.0	1.0	1.3	1.6	2.0	1.5	1.4	1.1	1.7
I. Feasibility (8 MOE's)	5.0	2.7	2.5	2.2	1.0	1.6	4.3	3.4	3.8
J. Environmentally Sensitive Areas Impacted	3.9	4.9	3.3	3.7	1.0	3.5	5.0	3.3	3.3
K. Travel Time	2.0	1.5	2.7	1.7	5.0	4.7	1.0	2.5	1.0
L. Travel Time + Cost/VKT	1.3	1.1	2.4	1.4	4.9	5.0	1.4	2.3	1.0
M. Total Cost/VKT	1.9	3.1	2.3	3.1	1.0	1.9	5.0	2.8	4.1
N. All MOE's with Cost Double Weight	4.0	3.5	3.7	2.5	1.0	4.1	5.0	2.8	4.7
O. All MOE's with Cost Triple Weight	3.3	3.5	3.3	2.5	1.0	3.8	5.0	2.9	4.6
P. All MOE's with Env. Double Weight	4.1	4.1	3.8	3.3	1.0	4.1	5.0	3.1	4.8
Sum of Above Ranked Combinations	54	48	50	43	30	53	60	45	56

SUMMARY RESULTS

	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10
Average Ranking	3.3	3.0	3.1	2.7	1.9	3.3	3.8	2.8	3.5
Re-ranked, 1 to 5 (based on all measures)	4.1	3.6	3.6	2.7	1.0	4.0	5.0	3.0	4.6
Re-ranked (based on all combinations)	4.1	3.4	3.6	2.7	1.0	4.0	5.0	3.0	4.4
Number times ranked "5"	5	5	5	5	5	5	5	5	5
Number times ranked "1"	1	1	1	1	1	1	1	1	1

Realization of the full latent demand (and resultant fully valued benefits) will be realized only when all of the segments of US 412 have been improved.

Segment 7 was rated with the highest value. Due to its relatively short length and its direct connection with the Walnut Ridge/Hoxie bypass currently under construction, the construction of this segment could be done immediately after completion of the bypass. It would be a logical extension to the west. As the local population has grown accustomed to the local roadway construction, local community concerns regarding disruption should be minimal.

The second highest rated segment is Segment 10 to the east of Paragould. This segment could be built immediately after the construction of the Paragould bypass. It should include the replacement of the St. Francis river bridge, a proposal currently under consideration by a bi-state committee led by the Missouri Department of Transportation (MoDOT). The construction of this segment will also serve as an impetus for MoDOT to complete the four-lane widening of US 412 through Missouri.

Segments 1 and 6 are also rated as high. Segment 1 shows a high rating mainly due to the tourist benefits obtained in Baxter County, a major tourist destination within the study area. Theimplementation of improvements on Segment 6 would extend the four-lane section through the rolling-mountainous area all the way to Imboden.

The medium priority ratings group includes Segments 2, 3, 4 and 8. Segments 2 and 3 connect Baxter County to the already four-lane segment at Ash Flat through rolling-mountainous terrain. While Segment 8 connects the two bypasses currently committed, it is rated as medium priority since it is located in flat terrain, and therefore can provide a higher LOS under the current conditions. Segment 4 has a medium priority since it is a four-lane undivided section.

Segment 5 is rated as the lowest of all the segments. It joins Hardy and Imboden through rolling-mountainous terrain. Even though it is rated as the lowest, it has a benefit/cost ratio well above one and is still a good investment of public funds. In relative terms, the high need for improvements in the other segments results in a lower priority rating for this segment.

It is important to re-emphasize that the full corridor needs to be improved in order to achieve the full benefits in attracting latent demand. Furthermore, all segments should be improved in order to provide lane continuity.

Chapter 10

CONCLUSIONS AND RECOMMENDATIONS

10.1 INTRODUCTION

The US Congress through the 1991 ISTEA legislation defined US 412 as a high-priority corridor and provided funds to conduct a feasibility study of this corridor. In order to accomplish the intent of the legislation, AHTD engaged the engineering firm of Lockwood, Andrews & Newnam, Inc. (LAN) to perform a corridor planning study on the eastern portion of US 412 within the State of Arkansas. This report presents the work and conclusions of this study.

10.2 EXISTING CONDITIONS

A thorough analysis of the existing transportation system was performed. It was found that while US 412 is the only east-west corridor in northern Arkansas, it is seldom used to traverse the state and is mostly used for local trips. This situation is the result of mobility constraints imposed by the mostly rolling to mountainous terrain and the fact that the existing roadway is a two-lane two-way road with a geometric alignment that follows closely the terrain. Travel times through the corridor were found to be greater than those obtained by using parallel routes even though these are located outside the study area.

Existing traffic volumes are currently approaching capacity levels. The projected volumes from local trips alone greatly exceed capacity. The tourism industry represents a significant source of revenue for the study area. The limited accessibility to the tourist resorts located in the study area inhibits potential future economic growth.

10.3 PUBLIC INVOLVEMENT

The local population supports the improvements to the overall route, based on input gathered during the public involvement program. Concerns expressed by the public focused primarily on site-specific local safety issues and on bypass issues.

10.4 DEVELOPMENT OF THE PROPOSED ALTERNATIVES

Five Proposed Alternatives to serve the corridor were developed and analyzed in detail. They include:

- Base Case
- Improved Two-Lane Rural Arterial
- Multi-Lane Rural Highway
- Four-Lane Divided Rural Highway
- Four-Lane Freeway

The base case is defined as the benchmark against which all other alternatives are compared. It includes the minimum improvements that must be done to the corridor to maintain its functionality.

Construction, mitigation, O&M and ROW cost estimates were developed for each of the Proposed Alternatives. Table 10-1 shows the cost estimates per alternative.

Table 10-1: COST ESTIMATES FOR PROPOSED ALTERNATIVES

	Construction	ROW	Mitigation	O&M (for one year)	Totals
Base Case	$13,093,732	$0.00	$0.00	$335,485	$13,429,217
Two-Lane Rural Arterial	$111,307,854	$7,245,830	$1,034,830	$338,604	$119,927,118
Multi-Lane Rural Highway	$408,816,676	$9,115,005	$1,987,530	$556,849	$420,476,060
Four-Lane Divided Rural Highway	$459,287,873	$15,678,284	$2,284,990	$556,849	$477,807,996
Four-Lane Freeway	$850,299,459	$16,303,625	$8,128,470	$685,461	$875,417,018

10.5 GOALS

Four project goals were identified to evaluate the Proposed Alternatives. An overriding requirement was that a minimum acceptable LOS C should be achieved in the design year. The goals are: 1) Improve Mobility (including a minimum LOS C), 2) Constructability, 3) Environment Preservation and 4) Economic Development (including a benefit/cost ratio).

Improve Mobility

As expected, the freeway alternative provides the highest level of mobility; the other alternatives are evenly separated. The improved two-lane rural arterial proposed alternative does not meet the minimum acceptable LOS criteria over significant lengths of the corridor.

Constructability

From this perspective, the improved two-lane rural arterial is the most desirable alternative and the freeway the least. As opposed to the mobility goal, no significant difference was found between the multi-lane rural highway and the four-lane divided rural highway.

Environment Preservation

The environmental impacts are directly related to the amount of new ROW required. In addition, the latent demand attracted by the improved design speeds impacts the corridor with greater noise and emissions.

Economic Development

As a large portion of the local economy is tourism based, this industry would benefit substantially from the implementation of the proposed improvements to US 412. The economic benefits are expenditure driven; therefore, the higher cost alternatives generally yield higher returns. However, the two-lane rural arterial alternative actually yields the highest benefit/cost ratio and the highest internal rate of return. This is due to the moderate benefits gained relative to its low cost. This alternative fails to meet the minimum acceptable LOS requirement of C.

10.6 FEASIBILITY

All of the Proposed Alternatives were found to be feasible from the perspective of benefit/cost ratio. Therefore, they are all a good investment of public funds. However, the improved two-lane rural arterial Proposed Alternative fails to meet the desired minimum LOS. Table 10-2 shows the benefit/cost ratio and the average peak-hour LOS for the Proposed Alternatives.

Table 10-2: BENEFIT/COST RATIO AND 2017 LOS FOR PROPOSED ALTERNATIVES

	Two-Lane Rural Arterial*	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Benefit/Cost Ratio	3.29	2.76	2.92	2.78
Year 2017 LOS	E	B	B	B

* Does not meet LOS criteria.

10.7 EVALUATION

A series of MOE's was developed to measure each project goal. A comprehensive evaluation procedure was established to assess the ability of each of the Proposed Alternatives to meet those goals. The evaluation process identified the Proposed Alternative with the highest benefit/cost ratio subject to the minimum acceptable design year LOS which must be obtained in order to make the project feasible and address the mobility requirements. The final objective of the evaluation process was to choose a "balanced" solution that would attain all the specified project goals. The most desirable option was identified by assessing the ability of each of the Proposed Alternatives to meet a combination of the project goals. Table 10-3 shows the average ratings for all the Proposed Alternatives.

Table 10-3: RATINGS OF PROPOSED ALTERNATIVES

	Two-Lane Rural Arterial	Multi-Lane Rural Highway	Four-Lane Divided Rural Highway	Four-Lane Freeway
Rating based on all MOE's	1.97	1.00	5.00	2.09
Rating based on all Combinations	2.37	1.00	5.00	3.54

10.8 RECOMMENDED ALTERNATIVE

The four-lane divided rural highway alternative is selected as the recommended alternative. This alternative yields the highest rating while considering all the evaluated MOE's with equal weight, and also while considering all the "combinations" of MOE's. It yields a high mobility rating, an average constructability rating, an average environmental preservation rating and a high economic development rating. It has the second highest benefit/cost ratio and internal rate of return, and at the same time satisfies the required LOS criteria with an average peak hour LOS "C". It is the most desirable alternative since it provides the best "balance" for all the project goals.

10.9 PRIORITIZATION

For the purpose of project analysis, the project was divided in ten segments. Of these, segment nine (Paragould) was not considered in this study. A separate study by AHTD addresses this segment. The remaining nine study segments were compared to each other utilizing the same MOE's developed for the analysis of the proposed alternatives. Table 10-4 shows the segment priority ratings and categories segment prioritization as "low," "medium" or "high."

10.10 INTERIM IMPROVEMENTS

In recognition of the fact that funding may not be immediately available to implement the Proposed Alternative, a program of interim improvements was developed. These improvements primarily address safety issues and capacity improvements to the segments with the highest existing congestion in the corridor. The interim improvements are prioritized as "High," "Medium" or "Low" priority.

Table 10-4: SEGMENT PRIORITIZATION

Segment	Limits	Rate	Priority		
			Low	Medium	High
1	East of Lake Norfork to east of Viola	4.1			●
2	East of Viola to east of Salem	3.4		●	
3	East of Salem to east of Ash Flat	3.6		●	
4	East of Ash Flat to east of Hardy	2.7		●	
5	East of Hardy to east of Imboden	1.0	●		
6	East of Imboden to the US63/US412 junction	4.0			●
7	Connections to Walnut Ridge/Hoxie Bypass	5.0			●
8	East of Walnut Ridge/Hoxie to west of Paragould	3.0		●	
10	East of Paragould to the Missoury state line	4.4			●

Notes:
(1) Segment 9 (Paragould area) not included in this study.
(2) See Exhibits 9-1A and 9-1B for graphical depiction of segment priority rankings.

The following interim improvements are suggested based on the traffic volumes, existing level of service as calculated in Chapter 6, site visits, public involvement, constrained existing ROW along populated areas within the study corridor and on the existing accident rates as defined in Chapter 2 of this report. All proposed signal installations should be confirmed through appropriate MUTCD warrant studies.

High Priority:

A) Widen to four lanes undivided from Black Rock to Hardy by connecting the existing truck climbing lanes.

B) Install a fully-actuated traffic signal in Hardy at the intersection of US 62 with US 63.

C) Install a semi-actuated traffic signal in Viola at the intersection of US 62 with SH 223.

D) Construct a four-lane divided partial access control bypass around Hardy.

E) Construct a four-lane divided partial access bypass around Black Rock-Portia or realign road and reconstruct approaches and reconstruct the "SH 25, Black River," and the "Black River Relief" bridges. (Bridge numbers 02112 and 02189, respectively).

Medium Priority:

A) Widen to four lanes undivided section from west of Paragould to SH 168.

B) Construct a four-lane divided partial access control bypass around Imboden, or/and install a semi-actuated traffic light in Imboden at the intersection of US 63 with US 62.

C) Construct a left turn bay and install a fully-actuated traffic light in Cherokee Village at the intersection of US 63 with SH 175 Spur.

Low Priority:

A) Widen lanes and shoulders to 3.6 m (12') and 2.4 m (8') respectively, from Salem to Viola.

B) Rehabilitate the "Flat Board Road Slough" bridge (Bridge 01891), which is located near the Lawrence/Greene county line.

C) Install semi-actuated traffic lights at the following locations:

- In Gepp, at the intersection of US 62 with SH 87.
- In Glencoe, at the intersection of US 62 with SH 289 southbound.
- West of Ash Flat, at the intersection of US 62 with SH 289 northbound.
- East of Hardy, at the intersection of US 63 with SH 175 northbound.
- In Ravenden, at the intersection of US 63 with SH 90 northbound.

Appendix A

Corridor Layout Sheets

- STATE BOUNDARY
- COUNTY BOUNDARY
- U.S. LAND TOWNSHIP LINE
- SECTION LINE
- NATIONAL FOREST BOUNDARY
- PARK OR RESERVATION BOUNDARY
- PAVED STATE OR U.S. HIGHWAY
- UNPAVED STATE OR U.S. HIGHWAY
- PROJECTED ROAD
- 62 U.S. NUMBERED HIGHWAY
- 5 STATE HIGHWAY
- PAVED LOCAL ROAD
- GRAVEL LOCAL ROAD
- GRADED & DRAINED LOCAL ROAD
- UNIMPROVE LOCAL ROAD
- RAILROAD (ANY NUMBER OF TRACKS USED BY A SINGLE OPERATING COMPANY)
- RAILROAD STATION
- GRADE CROSSING
- OVERPASS
- UNDERPASS
- TUNNEL
- HIGHWAY BRIDGE (20 FEET OR MORE IN LENGTH)
- PAVED FORD OR LOW WATER BRIDGE
- LEVEE OR DIKE
- * 0.6 * MILEAGE BETWEEN POINTS
- LAKE, RESERVOIR OR POND
- LAKE, RESERVOIR OR POND WITH DAM
- WIDE RIVER OR STREAM
- DOCK, PIER OR LANDING
- N/. INTERMITTENT NAVIGATION
- MARSH OR SWAMP
- W HEAD OF NAVIGATION (WAR DEPARTMENT DESIGNATION)
- SMALL STREAM
- DRAINAGE DITCH
- CORPORATE LIMITS AND ROADS THROUGH TOWN
- LIMITS OF UNINCORPORATED DEVELOPMENT
- LIMITS OF UNINCORPORATED DEVELOPMENT
- FAP FEDERAL AID PRIMARY ROUTE
- FAS FEDERAL AID SECONDARY ROUTE
- LOCAL ROAD
- F.F. FREE FERRY

- COUNTY SEAT
- OTHER CITIES AND TOWNS
- MUNICIPAL AIRPORT
- PRIVATE AIRFIELD
- FARM UNIT OR DWELLING
- GROUP OF CLOSELY SPACED DWELLINGS (5, IF NO FIGURE SHOWN)
- 10 1 2 3 GROUP OF CLOSELY SPACED MIXED CULTURAL FEATURES (NUMBER OF UNITS SHOWN REGARDLESS OF ORDER)
- APARTMENT COMPLEX (A) OR MOTEL (M)
- CHURCH OR OTHER RELIGIOUS INSTITUTION
- HOSPITAL OR ANIMAL CLINIC (V)
- SCHOOL
- POST OFFICE POST OFFICE AND BUSINESS
- CEMETERY
- CHURCH WITH CEMETERY ADJACENT
- BUSINESS ESTABLISHMENT
- FACTORY OR INDUSTRIAL PLANT-COTTON GIN (G)
- SAWMILL
- GRAVEL PIT QUARRY
- NURSERY
- TOWN OR COMMUNITY HALL
- POWER PLANT
- KARK RADIO OR TELEVISION STATION AND CALL LETTERS
- A.H.T.D. GARAGE OR COUNTY GARAGE (C)
- U.S. U.S. CORPS OF ENGINEERS HEADQUARTERS
- FIRE ENGINE HOUSE
- GAUGING OR PUMPING STATION
- NURSING OR REST HOME
- POWER SUBSTATION
- TRAILER PARK
- FISH HATCHERY
- PUMPING STATION, OIL OR GAS
- OBSERVATION OR LOOKOUT TOWER
- CAMP OR LODGE
- C GOLF COURSE OR COUNTRY CLUB
- A ATHLETIC FIELD OR AMUSEMENT PARK
- R RODEO ARENA
- SP SMALL PARK (SP-STATE, CP-COUNTY, MP-MUNICIPAL, WP-WAYSIDE)
- W WATER SUPPLY STANDPIPE OR TANK
- S SEWAGE DISPOSAL PLANT
- D GARBAGE DUMP OR SANITARY LANDFILL
- A AUTO SALVAGE YARD
- CHICKEN HOUSE OR OTHER LIVESTOCK
- POWER SUBSTATION

- RV RECREATIONAL VEHICLE CAMP
- ANTENNA MAST
- FAIRGROUND, RACE COURSE OR SPEEDWAY
- HISTORICAL MONUMENT, PUBLIC USE OR RECREATION AREA
- GRAIN ELEVATOR
- V ANIMAL CLINIC
- ABANDONED SCHOOL
- FOREST RANGER STATION
- MINE, SHAFT OR DRIFT ORE MILL OR REPRODUCTION PLANT
- BOUNDARY OF MINING AREA
- PUBLIC USE OR RECREATION AREA
- RV RECREATIONAL VEHICLE CAMP

LAND USE

- Urban
- Forest
- Wetlands
- Floodplains
- Water

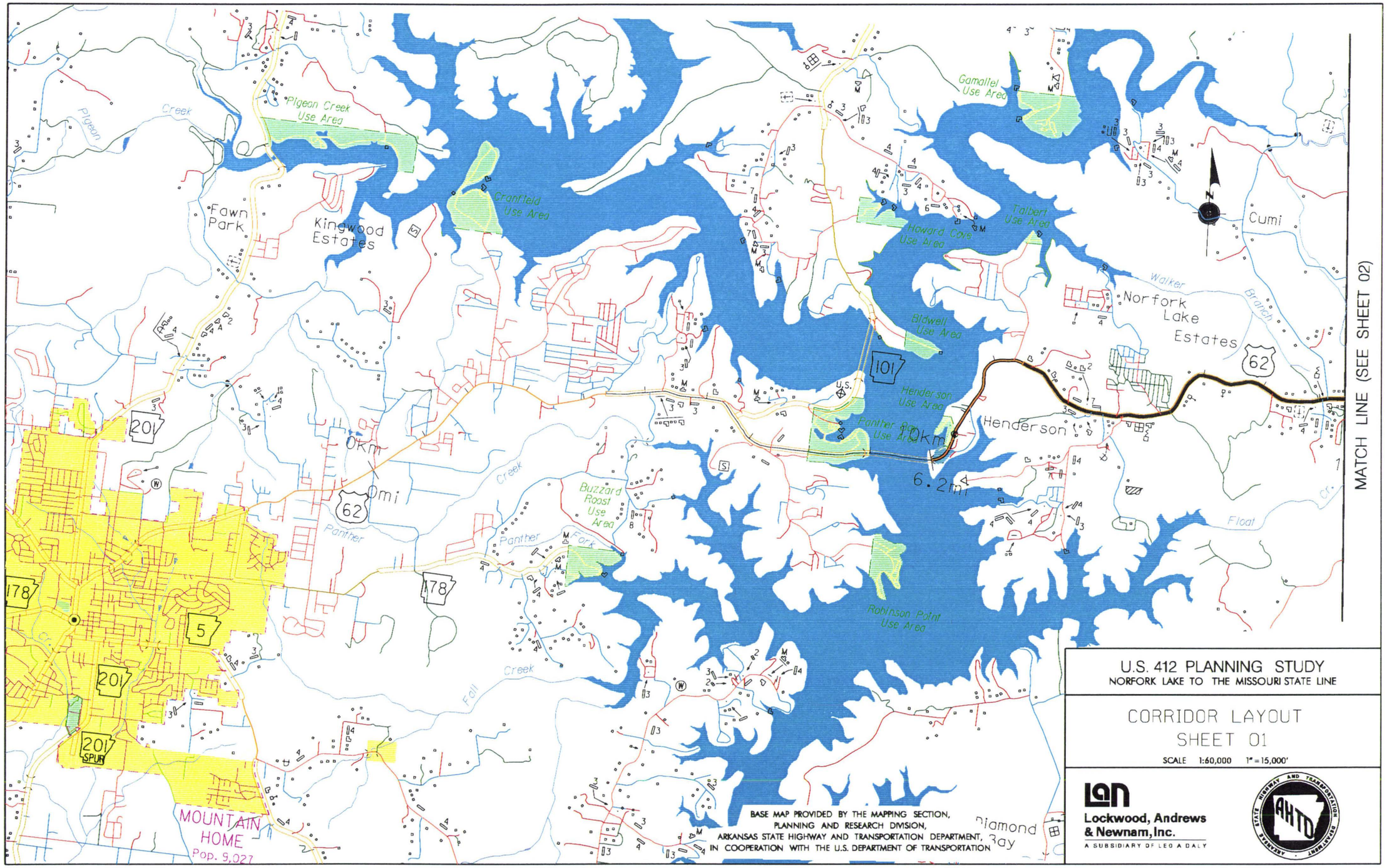
PROJECT LOCATION

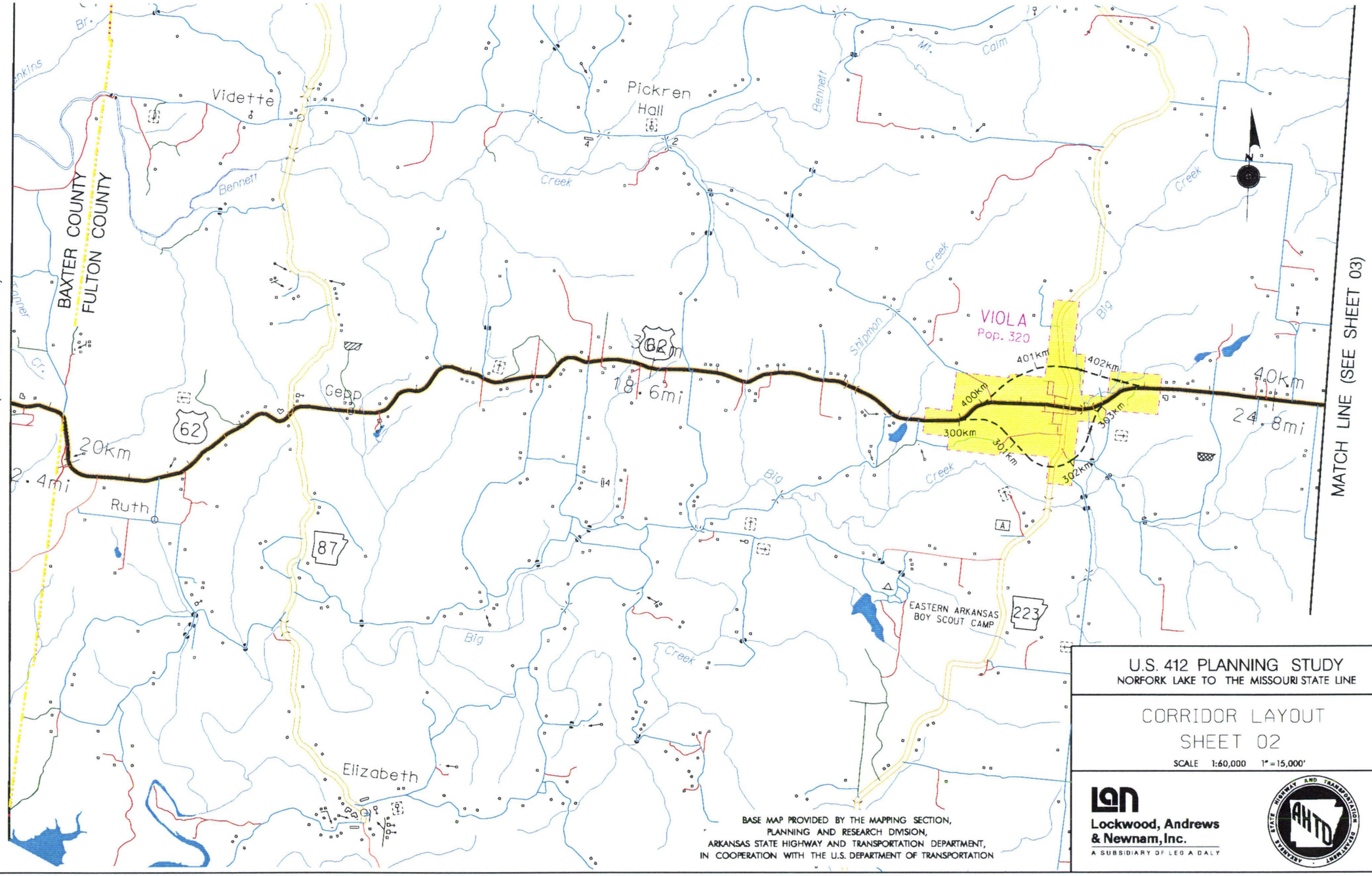
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

LEGEND

Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT AHTD


Pigeon Creek
Pigeon Creek Use Area
Fawn Park
Kingwood Estates
Granfield Use Area
Gamaliel Use Area
Talbert Use Area
Howard Cove Use Area
Bidwell Use Area
Henderson Use Area
Panther Cove Use Area
Buzzard Roost Use Area
Robinson Point Use Area
Cumi
Norfork Lake Estates
Walker Branch
Henderson
Float Cr.
Panther Creek
Panther Fork
Fall Creek
Cr.
MOUNTAIN HOME
Pop. 9,027
Diamond Bay
0km
6.2mi
MATCH LINE (SEE SHEET 02)
BASE MAP PROVIDED BY THE MAPPING SECTION, PLANNING AND RESEARCH DIVISION, ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT, IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
CORRIDOR LAYOUT
SHEET 01
SCALE 1:60,000 1" = 15,000'
Lockwood, Andrews & Newnam, Inc.
A SUBSIDIARY OF LEO A DALY
AHTD



BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY

NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT
SHEET 02

SCALE 1:60,000 1" = 15,000'

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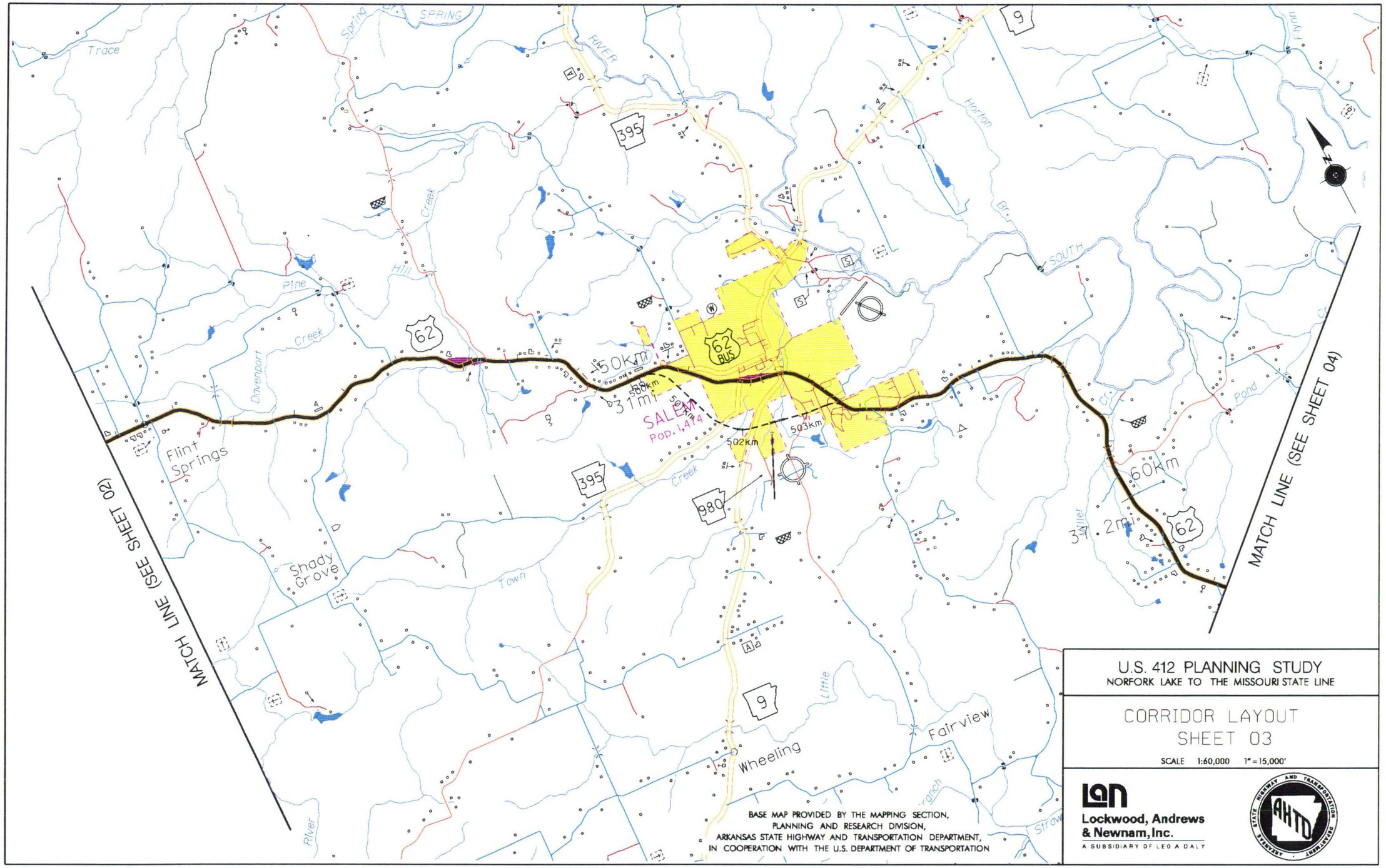

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT
SHEET 03

SCALE 1:60,000 1" = 15,000'

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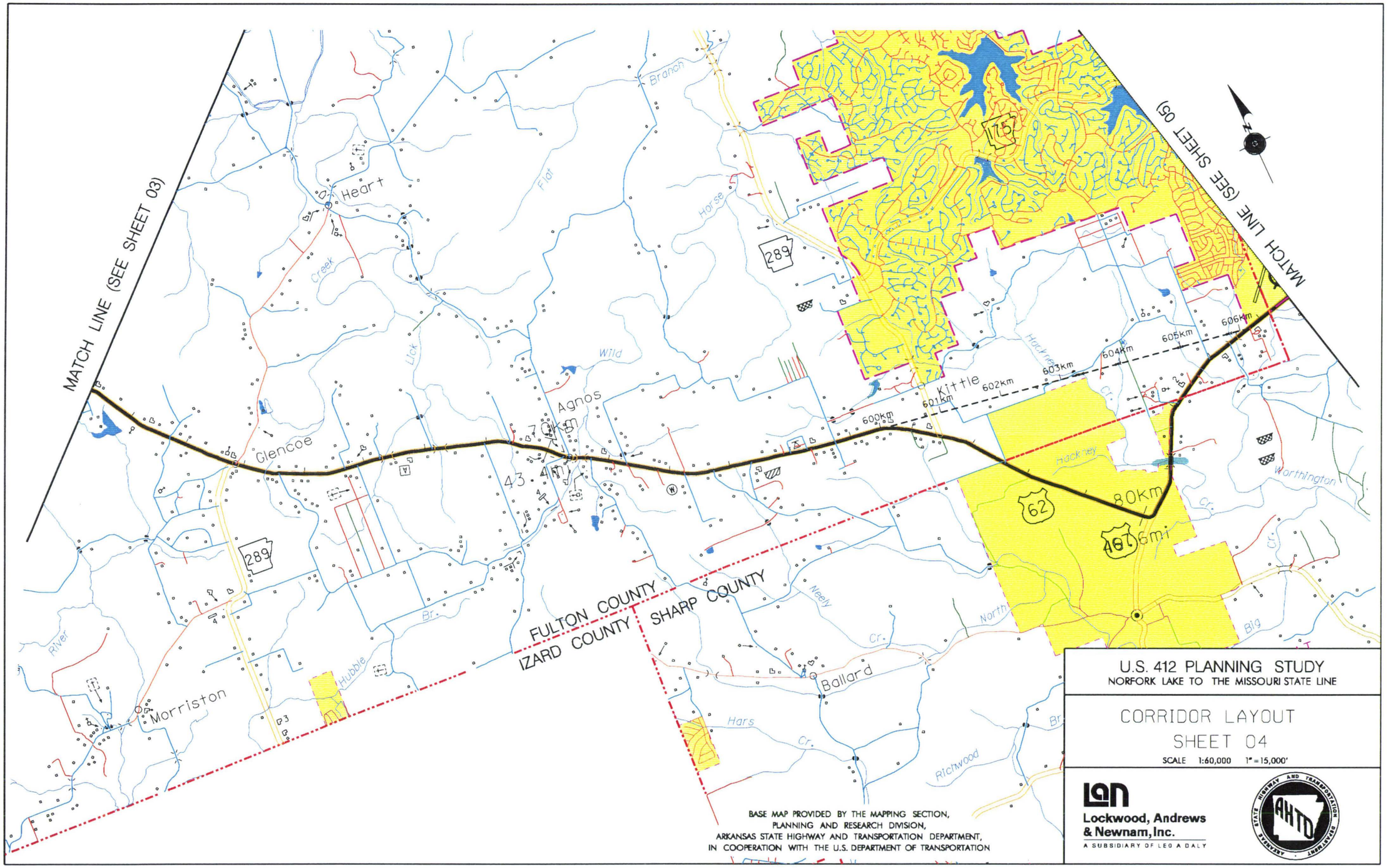

BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT
SHEET 04

SCALE 1:60,000 1" = 15,000'

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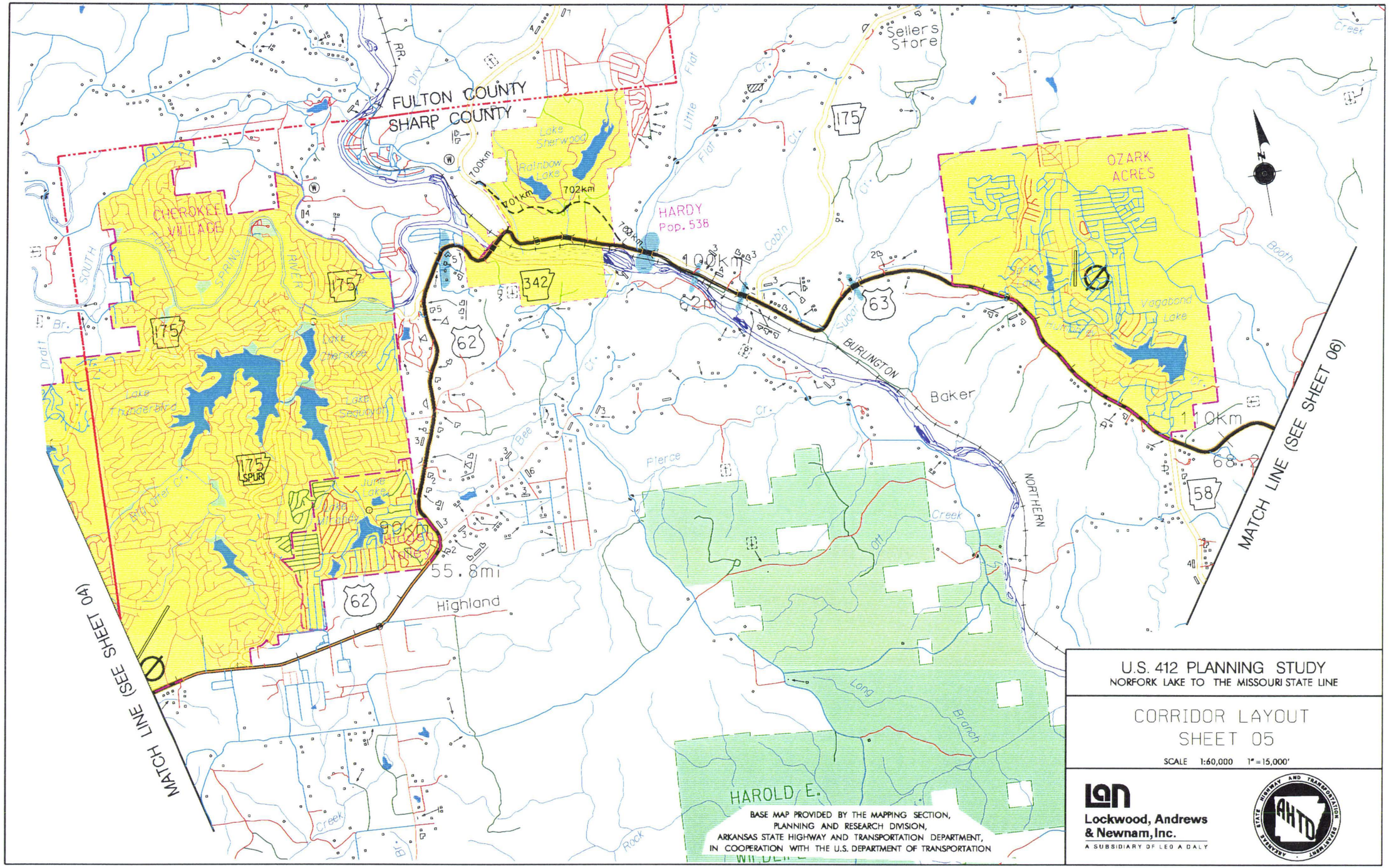

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT
SHEET 05

SCALE 1:60,000 1" = 15,000'

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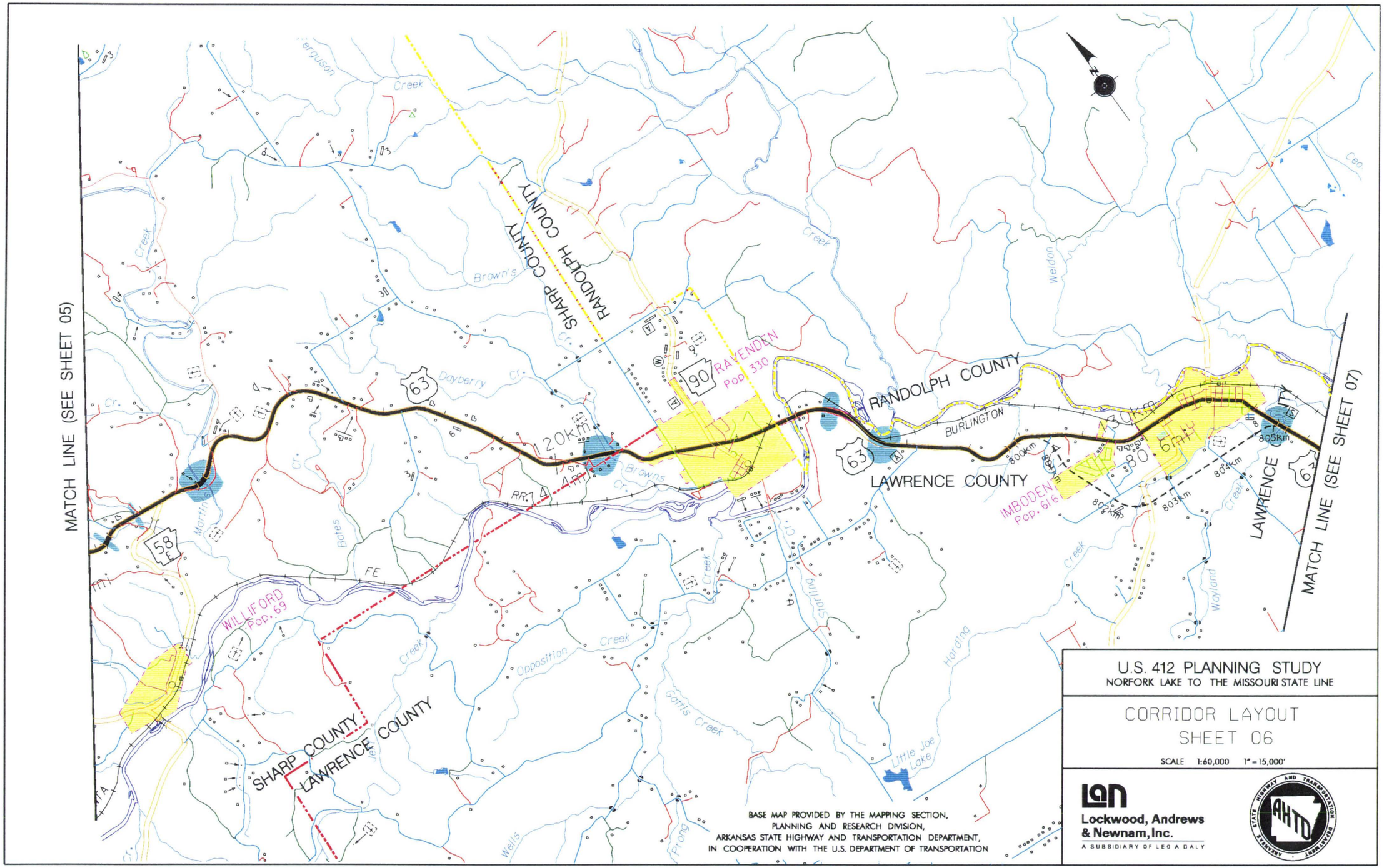

U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT
SHEET 06

SCALE 1:60,000 1" = 15,000'

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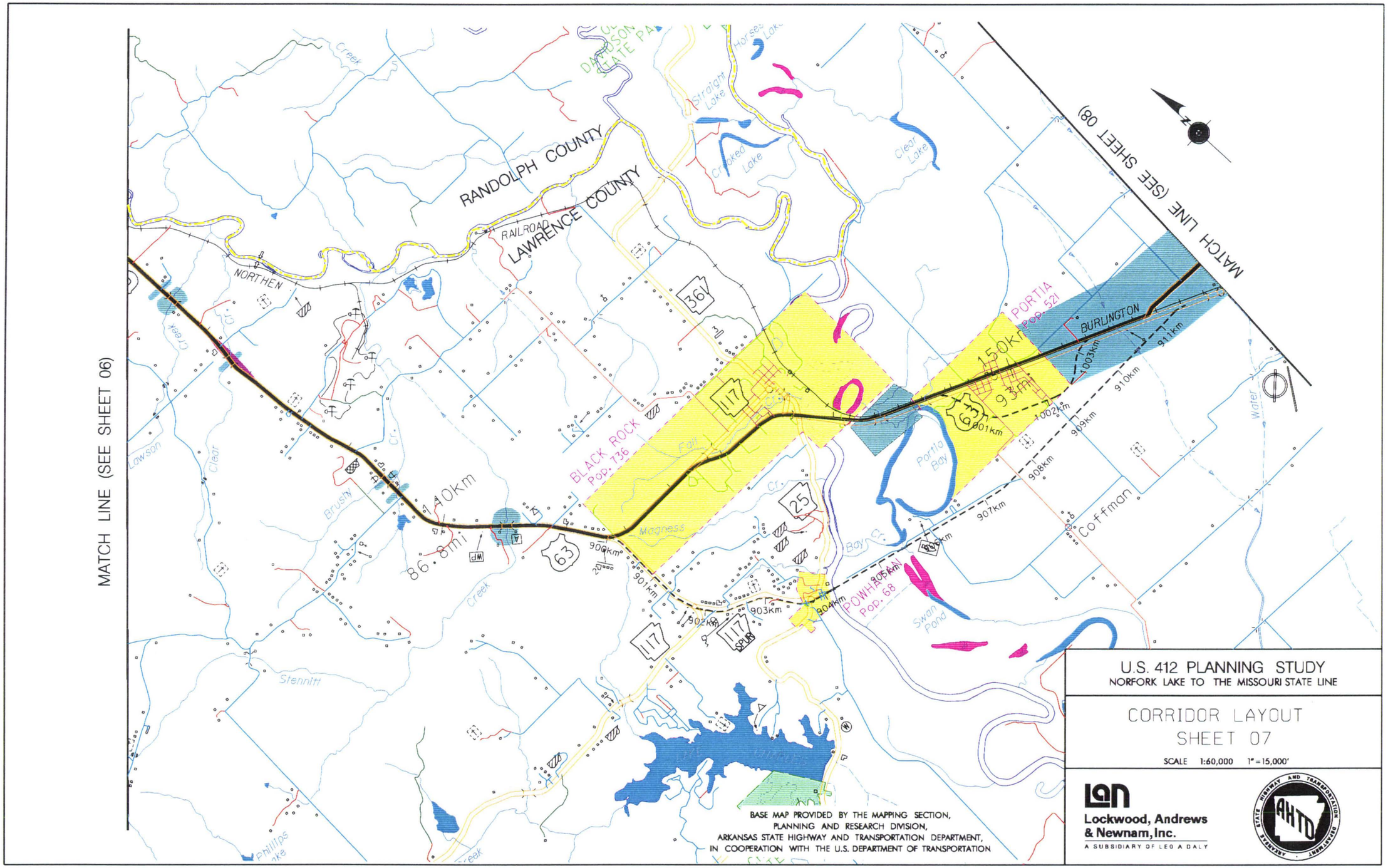

U.S. 412 PLANNING STUDY

NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT

SHEET 07

SCALE 1:60,000 1" = 15,000'

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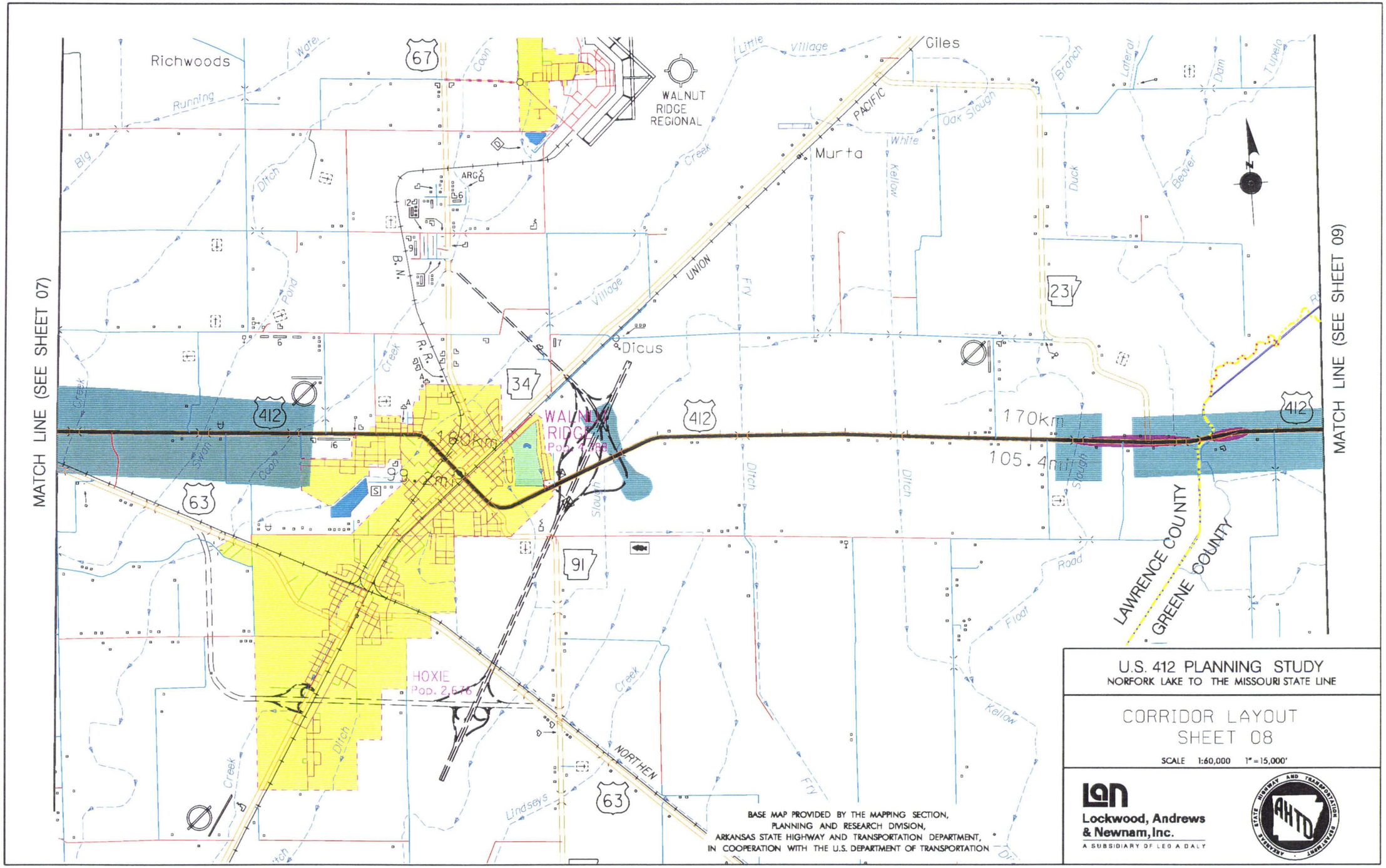
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT



U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT
SHEET 08

SCALE 1:60,000 1" = 15,000'

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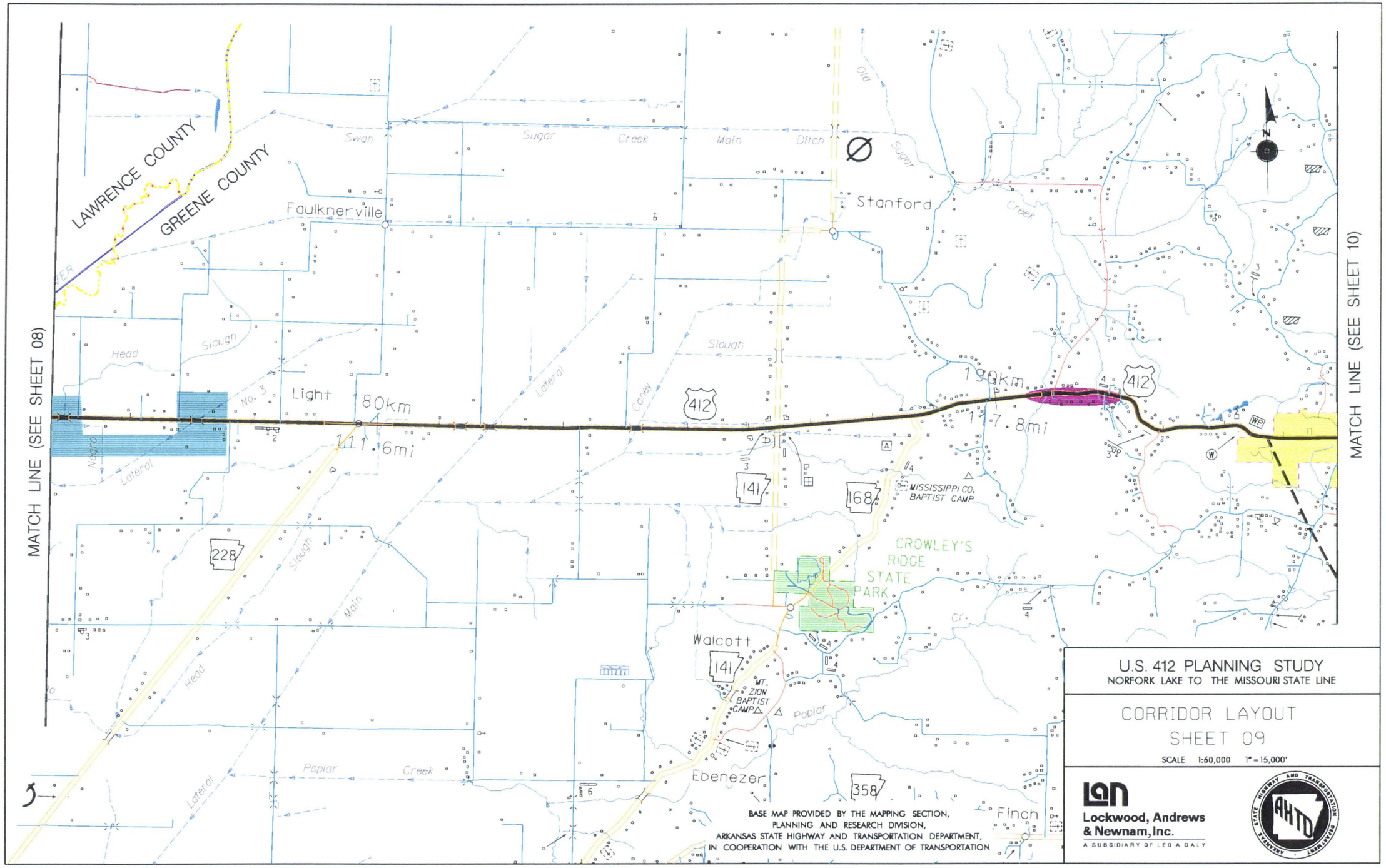

U.S. 412 PLANNING STUDY

NORFORK LAKE TO THE MISSOURI STATE LINE

CORRIDOR LAYOUT

SHEET 09

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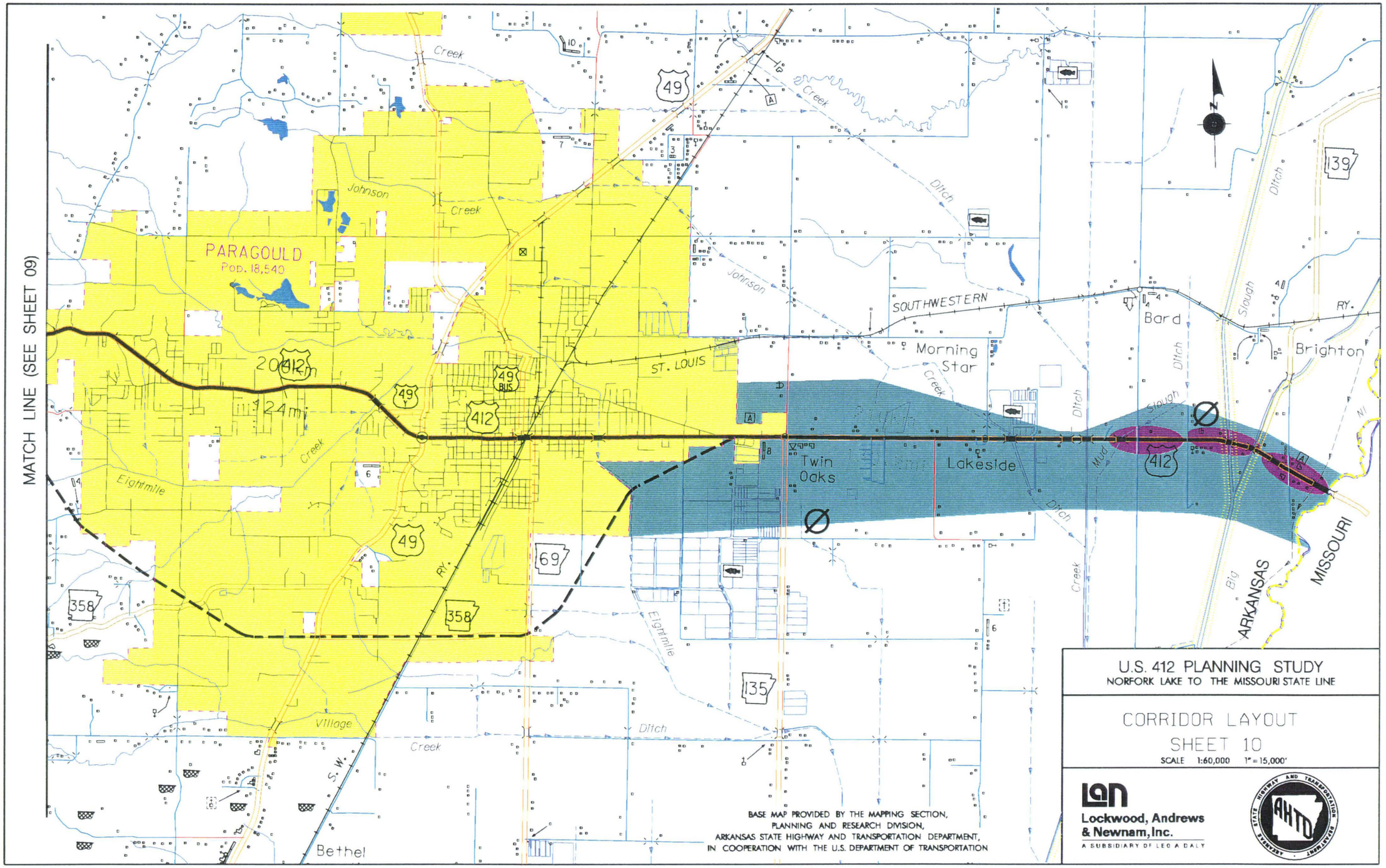
MATCH LINE (SEE SHEET 09)
PARAGOULD
POP. 18,540
Johnson Creek
Eightmile Creek
Village Creek
Eightmile Ditch
Mud Creek
Big Slough
Ditch
Slough
SOUTHWESTERN
ST. LOUIS
S. W.
RY.
Morning Star
Twin Oaks
Lakeside
Bard
Brighton
Bethel
ARKANSAS
MISSOURI
2.0 mi
1.24 mi
49
49 BUS
412
69
358
135
139
BASE MAP PROVIDED BY THE MAPPING SECTION,
PLANNING AND RESEARCH DIVISION,
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT,
IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
U.S. 412 PLANNING STUDY
NORFORK LAKE TO THE MISSOURI STATE LINE
CORRIDOR LAYOUT
SHEET 10
SCALE 1:60,000 1" = 15,000'
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Appendix B

Photo Log

BEGINNING OF THE STUDY AREA EAST OF NORFORK LAKE

LOOKING EAST AT "GEPP"

LOOKING EAST AT "VIOLA"

LOOKING WEST AT NORFORK LAKE BRIDGE

LOOKING WEST AT NORFORK LAKE

LOOKING EAST IN HENDERSON

LOOKING WEST, EAST OF "GEPP"

LOOKING EAST, 1.6 KM WEST OF "VIOLA"

LOOKING WEST, 1.6 KM WEST OF "VIOLA"

LOOKING EAST AT "VIOLA"

LOOKING EAST, OUTSIDE (EAST) OF "VIOLA"

LOOKING WEST AT INTERSECTION OF SH 9 AND US 62 "SALEM"

LOOKING EAST AT EASTERN OUTSKIRTS OF "SALEM"

LOOKING WEST, AT EASTERN EDGE OF "SALEM"

LOOKING EAST AT "SALEM"

LOOKING WEST AT BLACK RIVER BRIDGE NEAR BLACKROCK

LOOKING EAST AT SPRING RIVER BRIDGE NEAR HARDY

LOOKING WEST FROM WEST OF ASH FLAT

LOOKING WEST AT INTERSECTION OF US 62 & 167 NEAR ASH FLAT

LOOKING EAST, EAST OF INTERSECTION OF US 62 & 167 NEAR ASH FLAT

LOOKING WEST AT INTERSECTION OF US 62 & 167 NEAR ASH FLAT

LOOKING WEST, FROM EAST OF "ASH FLAT"

LOOKING SOUTHWEST AT INTERSECTION OF US 62, 63 & 412

LOOKING SOUTHWEST AT THE INTERSECTION OF US 62, 63 & 412

LOOKING EAST, NEAR "RAVENDEN"

LOOKING WEST, AT DOWNTOWN HARDY

LOOKING EAST, FROM EAST OF DOWNTOWN HARDY

PANORAMIC VIEW OF DOWNTOWN HARDY

LOOKING EAST, NEAR "IMBODEN"

LOOKING WEST NEAR "IMBODEN"

LOOKING EAST, WEST OF "IMBODEN"

LOOKING WEST, WEST OF "IMBODEN"

LOOKING EAST NEAR "PORTIA"
(NOTE RAILROAD TO THE NORTH)

TWO-LANE BRIDGE AT BLACK RIVER RELIEF

LOOKING EAST, WEST OF "WALNUT RIDGE"

LOOKING WEST, WEST OF "WALNUT RIDGE"

LOOKING WEST AT THE INTERSECTION OF US 412 & 63

LOOKING EAST, FROM EAST OF CACHE RIVER BRIDGE

LOOKING WEST, FROM EAST OF CACHE RIVER BRIDGE

LOOKING WEST, FROM EAST OF WALNUT RIDGE COMMUNITY

LOOKING EAST, FROM 13 KM WEST OF "PARAGOULD"

LOOKING WEST, 13 KM WEST OF "PARAGOULD"

LOOKING WEST, FROM EAST OF US 412 & SH 228

LOOKING EAST, NEAR "CROWLEY'S RIDGE"

LOOKING WEST, NEAR "CROWLEY'S RIDGE"

LOOKING EAST, 6 KM WEST OF "PARAGOULD"
(BEGIN SHOULDERS)

LOOKING WEST, 6 KM WEST OF "PARAGOULD"

LOOKING WEST, AT ST. FRANCIS BRIDGE
(VIEW FROM MISSOURI SIDE OF THE BRIDGE)

LOOKING WEST, AT ST. FRANCIS BRIDGE

LOOKING EAST, AT ST. FRANCIS RIVER BRIDGE
(VIEW FROM ARKANSAS SIDE OF THE BRIDGE)

Appendix C

Roadway Inventory

Segment	District	County Name	Log km Begin	Log km End	Section Length (km)	Highway Type (code)	No. of Through Lanes	Pavement Type	Lane Width (Feet)	Shoulder Type	Shoulder Width (Feet)	Shoulder Condition	Median Type	Existing ROW Width (Feet)	Area Type	Speed Limit (mph)	Truck Climbing Lanes?	Terrain Type	Passing Zone (%)	Average Hwy. Speed (mph)	Continuous LT Lanes? (Yes/No)	Pavement Rating	Pavement Width (Feet)
1	9	Baxter	10.00	10.37	0.37	1	2	Flexible	12	Surfaced	10	Good	None	100	Rural	55	No	Rolling	60	50	No	Good	44
1	9	Baxter	10.37	10.93	0.56	1	2	Flexible	12	Surfaced	10	Good	None	80	Rural - Dense	45	No	Rolling	0	45	No	Good	44
1	9	Baxter	10.93	19.24	8.30	1	2	Flexible	12	Surfaced	5	Fair	None	80	Rural - Dense	55	No	Rolling	10	60	No	Good	34
1	5	Fulton	19.24	36.62	17.38	1	2	Flexible	12	Surfaced	5	Good	None	80	Rural	55	No	Rolling	10	60	No	Good	34
1	5	Fulton	36.62	37.89	1.27	1	2	Flexible	11	Surfaced	6	Good	None	80	Rural - Dense	45	No	Rolling	0	45	No	Good	34
1	5	Fulton	37.89	40.00	2.11	1	2	Flexible	11	Surfaced	3	Good	None	80	Rural	55	Yes	Mount.	0	55	No	Good	40
2	5	Fulton	40.00	46.76	6.76	1	2	Flexible	11	Surfaced	3	Good	None	80	Rural	55	Yes	Mount.	0	55	No	Good	40
2	5	Fulton	46.76	47.53	0.77	1	2	Flexible	11	Surfaced	6	Good	None	80	Rural	55	No	Rolling	0	55	No	Good	34
2	5	Fulton	47.53	50.14	2.61	1	2	Flexible	11	Surfaced	3	Good	None	80	Rural	55	Yes	Mount.	0	55	No	Good	40
2	5	Fulton	50.14	50.78	0.64	1	2	Flexible	11	Surfaced	6	Good	None	80	Rural	45	No	Mount.	0	45	No	Good	38
2	5	Fulton	50.78	52.47	1.69	1	2	Flexible	11	Surfaced	5	Good	None	80	Rural - Dense	45	No	Rolling	20	40	No	Very Good	33
2	5	Fulton	52.47	54.08	1.61	1	2	Flexible	12	Surfaced	5	Good	None	80	Outlying Business	45	No	Rolling	30	45	No	Good	34
2	5	Fulton	54.08	58.01	3.93	1	2	Flexible	12	Surfaced	5	Good	None	100	Rural	55	No	Rolling	30	55	No	Very Good	34
2	5	Fulton	58.01	77.46	19.46	1	2	Flexible	12	Surfaced	5	Good	None	100	Rural	55	No	Rolling	30	55	No	Very Good	34
3	5	Sharp	77.46	80.14	2.67	1	2	Flexible	12	Surfaced	5	Good	None	100	Rural - Dense	55	No	Rolling	20	55	No	Good	34
3	5	Sharp	80.14	82.26	2.12	2	4	Flexible	12	Surfaced	8	Good	Unprotected	100	Rural	55	No	Rolling	0	50	No	Very Good	64
3	5	Sharp	82.26	84.27	2.01	2	4	Flexible	12	Surfaced	8	Good	Unprotected	100	Rural	55	No	Rolling	0	60	No	Very Good	80
3	5	Sharp	84.27	85.00	0.73	2	4	Flexible	12	Surfaced	8	Good	Unprotected	100	Rural - Dense	45	No	Rolling	0	55	No	Very Good	64
4	5	Sharp	85.00	85.88	0.89	2	4	Flexible	12	Surfaced	8	Good	Unprotected	100	Rural - Dense	45	No	Rolling	0	55	No	Very Good	64
4	5	Sharp	85.88	87.09	1.21	2	4	Flexible	12	4	0	Good	None	100	Rural - Dense	45	No	Flat	0	55	No	Good	48
4	5	Sharp	87.09	90.66	3.57	2	4	Flexible	12	4	0	Good	None	100	Outlying Business	45	No	Flat	0	50	No	Very Good	48
4	5	Sharp	90.66	93.61	2.95	2	4	Flexible	12	Surfaced	12	Good	Unprotected	100	Rural - Dense	45	No	Rolling	0	55	No	Very Good	72
4	5	Sharp	93.61	96.65	3.04	2	4	Flexible	12	4	0	Good	None	100	Outlying Business	45	No	Rolling	0	55	No	Very Good	48
4	5	Sharp	96.65	96.81	0.16	1	2	Flexible	11	Surfaced	8	Good	None	60	Rural - Dense	35	No	Rolling	0	30	No	Good	36
4	5	Sharp	96.81	97.05	0.24	1	2	Flexible	12	Surfaced	6	Fair	None	40	Rural - Dense	30	No	Flat	0	25	No	Good	36
4	5	Sharp	97.05	97.61	0.56	1	2	Flexible	10	Surfaced	8	Good	None	42	CBD	20	No	Flat	0	10	No	Good	36
4	5	Sharp	97.61	98.26	0.64	1	2	Flexible	12	Surfaced	2	Fair	None	100	Outlying Business	35	No	Rolling	0	35	No	Good	28
4	5	Sharp	98.26	100.00	1.74	1	2	Flexible	12	Surfaced	2	Fair	None	80	Rural	55	No	Rolling	30	55	No	Good	26
5	5	Sharp	100.00	103.73	3.73	1	2	Flexible	12	Surfaced	2	Good	None	80	Rural	55	No	Rolling	30	55	No	Good	28
5	5	Sharp	103.73	105.71	1.98	1	2	Flexible	12	Surfaced	4	Good	None	100	Rural	55	Yes	Mount.	100	50	No	Good	44
5	5	Sharp	105.71	109.18	3.48	1	2	Flexible	12	Surfaced	2	Fair	None	100	Rural	55	No	Mount.	20	50	No	Good	26
5	5	Sharp	109.18	111.18	2.00	1	2	Flexible	12	Surfaced	4	Good	None	100	Rural	55	Yes	Mount.	0	50	No	Good	44
5	5	Sharp	111.18	112.81	1.63	1	2	Flexible	12	Surfaced	2	Good	None	100	Rural	55	No	Mount.	30	50	No	Good	28
5	5	Sharp	112.81	113.55	0.74	1	2	Flexible	12	Surfaced	8	Fair	None	100	Rural	55	No	Mount.	0	55	No	Good	40
5	5	Sharp	113.55	115.09	1.54	1	2	Flexible	12	Surfaced	4	Good	None	100	Rural	55	Yes	Mount.	100	55	No	Good	44
5	5	Sharp	115.09	119.29	4.20	1	2	Flexible	12	Surfaced	2	Fair	None	100	Rural	55	No	Mount.	20	50	No	Fair	28
5	5	Sharp	119.29	120.76	1.46	1	2	Flexible	12	Surfaced	4	Fair	None	100	Rural	55	Yes	Mount.	20	50	No	Good	44
5	5	Sharp	120.76	121.29	0.53	1	2	Flexible	12	Surfaced	2	Fair	None	100	Rural	55	No	Flat	0	60	No	Fair	28
5	10	Lawrence	121.29	122.26	0.97	1	2	Flexible	11	Surfaced	4	Good	None	80	Rural	55	No	Rolling	0	50	No	Good	30

Segment	District	County Name	Log km Begin	Log km End	Section Length (km)	Highway Type (code)	No. of Through Lanes	Pavement Type	Lane Width (Feet)	Shoulder Type	Shoulder Width (Feet)	Shoulder Condition	Median Type	Existing ROW Width (Feet)	Area Type	Speed Limit (mph)	Truck Climbing Lanes?	Terrain Type	Passing Zone (%)	Average Hwy. Speed (mph)	Continuous LT Lanes? (Yes/No)	Pavement Rating	Pavement Width (Feet)
5	10	Lawrence	122.25	123.81	1.56	1	2	Flexible	11	Surfaced	6	Good	None	100	Rural - Dense	40	No	Rolling	20	40	No	Good	34
5	10	Lawrence	123.81	130.01	6.20	1	2	Flexible	11	Surfaced	6	Good	None	100	Rural	55	No	Rolling	30	55	No	Good	34
5	10	Lawrence	130.01	132.39	2.38	1	2	Flexible	11	Stabilized	4	Poor	None	40	Rural - Dense	35	No	Rolling	10	35	No	Good	22
5	10	Lawrence	132.39	133.00	0.61	1	2	Flexible	12	Surfaced	4	Poor	None	100	Rural	55	No	Rolling	30	55	No	Good	25
6	10	Lawrence	133.00	139.46	6.45	1	2	Flexible	12	Stabilized	4	Poor	None	100	Rural	55	No	Rolling	30	55	No	Good	25
6	10	Lawrence	139.46	140.73	1.27	1	2	Flexible	12	Stabilized	4	Poor	None	100	Rural	55	Yes	Rolling	100	50	No	Good	40
6	10	Lawrence	140.73	142.85	2.12	1	2	Flexible	12	Stabilized	4	Poor	None	100	Rural	55	No	Rolling	40	50	No	Good	25
6	10	Lawrence	142.85	149.61	6.76	1	2	Flexible	12	Surfaced	8	Good	None	100	Rural	55	No	Rolling	40	55	No	Good	41
6	10	Lawrence	149.61	150.54	0.93	1	2	Flexible	11	Surfaced	4	Good	None	80	Rural - Dense	35	No	Flat	0	35	Yes	Good	41
6	10	Lawrence	150.54	152.40	1.86	1	2	Flexible	12	Surfaced	8	Good	None	100	Rural	55	No	Flat	80	55	No	Good	41
7	10	Lawrence	152.40	152.67	0.27	1	2	Flexible	12	Surfaced	8	Good	None	100	Rural	55	No	Flat	80	55	No	Good	41
7	10	Lawrence	152.67	157.93	5.26	1	2	Flexible	12	Surfaced	8	Good	None	80	Rural	55	No	Flat	70	55	No	Good	40
7	10	Lawrence	157.93	159.43	1.50	1	2	Flexible	12	Surfaced	8	Fair	None	60	Rural - Dense	40	No	Flat	100	40	No	Good	40
7	10	Lawrence	159.43	159.85	0.42	1	2	Flexible	11	Surfaced	4	Fair	None	60	Outlying Business	30	No	Flat	0	30	No	Good	30
7	10	Lawrence	159.85	160.33	0.48	1	2	Flexible	11	Surfaced	3	Fair	None	60	Fringe of CBD	30	No	Flat	0	30	Yes	Good	40
7	10	Lawrence	160.33	160.60	0.27	1	2	Flexible	10	Surfaced	6	Good	None	60	Rural - Dense	30	No	Flat	0	30	Yes	Good	42
7	10	Lawrence	160.60	160.97	0.37	1	2	Flexible	10	Surfaced	2	Fair	None	60	Rural - Dense	30	No	Flat	0	30	Yes	Good	40
7	10	Lawrence	160.97	162.42	1.45	1	2	Flexible	12	Surfaced	8	Good	None	100	Rural	55	No	Flat	90	60	No	Good	40
7	10	Lawrence	162.42	164.00	1.58	1	2	Flexible	12	Surfaced	8	Good	None	100	Rural	55	No	Flat	90	60	No	Good	40
8	10	Lawrence	164.00	172.67	8.67	1	2	Flexible	12	Surfaced	8	Good	None	100	Rural	55	No	Flat	90	60	No	Good	40
8	10	Greene	172.67	190.75	18.07	1	2	Flexible	12	Surfaced	8	Fair	None	80	Rural	55	No	Flat	70	55	No	Good	40
8	10	Greene	190.75	192.00	1.25	1	2	Flexible	12	Stabilized	4	Poor	None	80	Rural - Dense	55	No	Rolling	10	50	No	Fair	25
9	10	Greene	192.00	194.74	2.74	1	2	Flexible	12	Stabilized	4	Poor	None	80	Rural - Dense	55	No	Rolling	10	50	No	Fair	25
9	10	Greene	194.74	196.62	1.88	1	2	Flexible	12	Stabilized	4	Poor	None	80	Rural - Dense	55	No	Rolling	10	50	No	Fair	25
9	10	Greene	196.62	200.55	3.93	2	4	Flexible	12	Curbed	0	Good	None	80	Rural - Dense	45	No	Rolling	0	45	No	Very Good	49
9	10	Greene	200.55	202.37	1.82	2	4	Flexible	12	Curbed	0	Good	None	80	Outlying Business	45	No	Flat	0	45	No	Good	45
9	10	Greene	202.37	203.86	1.50	2	4	Flexible	12	Curbed	0	Good	None	60	Fringe of CBD	35	No	Flat	0	35	No	Good	49
9	10	Greene	203.86	204.15	0.29	2	4	Flexible	12	Curbed	0	Good	None	60	Fringe of CBD	35	No	Flat	0	35	No	Very Good	49
9	10	Greene	204.15	207.21	3.06	2	4	Flexible	12	Curbed	0	Good	None	60	Outlying Business	35	No	Flat	0	35	No	Fair	49
9	10	Greene	207.21	208.26	1.05	2	4	Flexible	12	Surfaced	10	Good	None	100	Outlying Business	45	No	Flat	0	45	No	Good	68
9	10	Greene	208.26	208.50	0.24	2	4	Flexible	12	Surfaced	10	Good	None	100	Outlying Business	45	No	Flat	0	45	No	Good	68
10	10	Greene	208.50	208.53	0.03	2	4	Flexible	12	Surfaced	10	Good	None	100	Outlying Business	45	No	Flat	0	45	No	Good	68
10	10	Greene	208.53	210.64	2.11	1	2	Flexible	12	Surfaced	10	Good	None	100	Rural	55	No	Flat	90	50	No	Good	44
10	10	Greene	210.64	213.20	2.56	1	2	Flexible	12	Surfaced	10	Good	None	150	Rural	55	No	Flat	100	55	No	Fair	44
10	10	Greene	213.20	215.42	2.22	1	2	Flexible	12	Surfaced	10	Good	None	150	Rural	55	No	Flat	80	55	No	Good	44
10	10	Greene	215.42	217.42	2.00	1	2	Rigid	11	Surfaced	8	Good	None	150	Rural	55	No	Flat	70	55	No	Fair	38

Code:
1. 2 or 3 lane
2. Multilane Undivided without access control

Appendix D

Unit Costs

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
PROGRAMS AND CONTRACTS DIVISION
WEIGHTED AVERAGE UNIT PRICES
AUGUST 1, 1996 - DECEMBER 31, 1996
(ITEMS UNDER STANDARD SPECIFICATIONS - EDITION OF 1996)

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
201	Clearing	ACRE	0.55	7000.00	7000.00	7000.00*
201M	Clearing	HA	29.52	500.00	500.00	500.00*
201	Clearing	STA	1436.00	966.00	200.00	402.91
201M	Clearing	MSTA	179.00	5100.00	500.00	1585.75
201	Grubbing	ACRE	1263.10	17000.00	47.00	377.18
201M	Grubbing	HA	29.52	500.00	500.00	500.00*
201M	Grubbing	MSTA	179.00	5100.00	575.00	1590.97
201	Grubbing	STA	173.00	500.00	200.00	298.84
201	Clearing and Grubbing Trees	EACH	33.00	365.00	200.00	291.82
201	R&D of Curb	LF	4486.00	20.00	2.00	2.14
202	R&D Curb and Gutter	LF	3045.00	7.50	1.26	2.35
202M	R&D of Curb and Gutter	M	95.00	12.00	12.00	12.00*
202	R&D of Fence	LF	137907.00	2.00	0.30	0.53
202M	R&D of Fence	M	8458.00	4.00	1.50	1.92
202	R&D of Brick Posts	EACH	5.00	90.00	90.00	90.00*
202	R&D of Walls	LF	684.00	7.00	7.00	7.00*
202	R&D of Retaining Walls	LF	270.00	24.00	24.00	24.00*
202M	R&D of Retaining Walls	M	43.00	20.00	20.00	20.00*
202	R&D of Concrete Pavement	SQYD	20577.00	10.00	3.20	3.42
202	R&D Asph. Pvmt. & Base Crs.	SQYD	10333.00	0.63	0.63	0.63*
202	R&D of Concrete Islands	SQYD	487.00	8.30	4.00	7.88
202M	R&D of Concrete Islands	SQ M	62.00	18.00	8.00	13.00
202	R&D of Concrete Driveways	SQYD	2921.00	7.00	4.50	6.00
202M	R&D of Concrete Driveways	SQ M	1825.00	8.00	8.00	8.00*
202	R&D of Walks	SQYD	515.00	20.00	5.06	7.19
202M	R&D of Walks	SQ M	12.00	8.00	8.00	8.00*
202	R&D of Concrete Slabs	SQYD	84.00	3.79	3.79	3.79*
202M	R&D of Foundations	SQ M	28.00	40.00	40.00	40.00*
202	R&D of Concrete Foundation	SQYD	4200.00	1.15	1.15	1.15*
202	R&D of Pole Foundation	EACH	1.00	474.04	474.04	474.04*
202	R&D of House Foundation	LF	1777.00	6.00	2.00	4.42
202	R&D of Junction Boxes	EACH	1.00	1850.00	1850.00	1850.00*
202	R&D of Drop Inlets	EACH	9.00	475.00	475.00	475.00*
202	R&D of Catch Basins	EACH	3.00	575.00	575.00	575.00*
202	R&D of Pipe Culverts	EACH	450.00	2000.00	100.00	234.10

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
202	R&D of Box Culverts	EACH	41.00	7000.00	300.00	1084.39
202	R&D of Headwalls	EACH	25.00	1264.10	500.00	670.56
202	R&D of Low Water Slab	SQYD	35.00	10.00	10.00	10.00*
202	R&D of Ditch Paving	SQYD	157.00	8.30	8.30	8.30*
202M	R&D of Ditch Paving	SQ M	125.00	12.50	12.50	12.50*
202	R&D of Guard Rail	LF	15854.00	3.53	1.00	2.09
202M	R&D of Guard Rail	M	43.50	15.50	10.50	14.64
202	R&D Impact Atten. Barrier	EACH	1.00	2022.46	2022.46	2022.46*
202	R&D of Luminaire Foundations	EACH	2.00	474.04	474.04	474.04*
202	R&D Traf. Signal Fnd.	EACH	4.00	316.02	316.02	316.02*
202	R&D Antenna Found.	EACH	1.00	316.02	316.02	316.02*
202	R&D of Septic Tank	EACH	4.00	1000.00	632.05	908.01
202	R&D of Water Well	EACH	1.00	1000.00	1000.00	1000.00*
202	R&D of Buildings	EACH	2.00	5000.00	3000.00	4000.00
202	R&D Weigh Scales & Pits	EACH	2.00	2528.20	2528.20	2528.20*
202	R&D Rubbish	CUYD	500.00	4.80	4.80	4.80*
202	R&D Concrete Med. Barrier	LF	8396.00	29.81	29.81	29.81*
205	Remv. Exist. Br. Str. (Site 1)	L.S.	23.00	200000.00	1500.00	15484.59
206	Flowable Select Material	CUYD	322.00	200.00	53.00	82.55
206M	Flowable Select Material	CU M	20.74	132.00	132.00	132.00*
207	Stone Backfill	TON	10700.00	20.00	8.00	13.38
207M	Stone Backfill	MTON	38500.00	25.00	0.10	10.46
208	Fence Remv. & Reconstructed	LF	1470.00	12.00	3.50	6.34
208M	Fence Remv. & Reconstructed	M	615.00	45.10	45.10	45.10*
208	Gates Remv. & Reconstructed	EACH	27.00	495.00	200.00	266.85
210	Unclassified Excavation	CUYD	5038198.00	27.97	0.01	1.98
210M	Unclassified Excavation	CU M	292726.00	10.00	2.00	4.13
210	Borrow	CUYD	837115.00	6.40	3.00	4.70
210M	Borrow	CU M	27859.00	6.46	6.46	6.46*
210	Granular Borrow	CUYD	114318.00	0.01	0.01	0.01*
210	Presplitting	SQYD	500.00	10.00	10.00	10.00*
210M	Presplitting	SQ M	95542.00	0.10	0.10	0.10*
210	Compacted Embankment	CUYD	572588.00	41.00	1.00	3.32
210M	Compacted Embankment	CU M	665341.00	22.00	4.00	4.87
210M	Sep. Fabric for Pvmt. Reinf.	SQ M	21230.00	1.50	1.50	1.50*

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
210M	Geogrid for Pvmt. Reinf.	SQ M	21230.00	2.70	2.70	2.70*
215	Trenching and Shoulder Prep.	STA	988.00	142.00	142.00	142.00*
301	Process Lime Treated Subgrade	SQYD	286571.00	1.25	1.25	1.25*
301	Quicklime (Dry) Trtd. Subgr.	TON	3668.00	81.00	81.00	81.00*
303	Aggr. Base Course (Class 5)	TON	5514.00	32.40	11.67	14.29
303	Aggr. Base Course (Class 7)	TON	304351.40	37.74	7.95	13.05
303M	Aggr. Base Course (Class 7)	MTON	98551.00	25.50	15.87	18.90
303	Aggr. Surf. Course (CL-D2)	TON	164.00	27.46	27.46	27.46*
305	Reconstructed Base Course	STA	158.90	430.00	125.00	190.37
307	Process. Cmnt. Trtd. Bs. Crse-6"	SQYD	56487.00	1.50	1.50	1.50*
307	Cement in Stabilized Base Crse	TON	955.00	116.52	116.52	116.52*
309	P.C. Concrete Base-10"	SQYD	1808.00	51.92	51.92	51.92*
401	Prime Coat	GAL	156755.00	1.95	0.90	1.20
401	Tack Coat	GAL	148940.00	1.52	0.01	0.74
401M	Tack Coat	L	115269.00	1.20	0.26	0.31
402	Mineral Aggr. in A.S.T. (CL1)	TON	5597.00	19.00	19.00	19.00*
402	Mineral Aggr. in A.S.T. (CL4)	TON	876.00	26.50	26.50	26.50*
402	Mineral Aggr. in A.S.T.S (CL5)	TON	575.00	31.75	31.75	31.75*
402	Asphalt in Surface Treatment	GAL	14638.00	1.50	1.50	1.50*
402	Poly. Mod. Cat. Emuls. Asph (CRS2P)	GAL	167819.00	1.65	1.23	1.30
405	M.A. in ACHM Stabilized Base	TON	55044.00	31.96	20.00	26.28
405M	M.A. in ACHM Stabilized Base	MTON	38679.00	52.06	27.40	30.04
405	M.A. in ACHM Superpave Base	TON	102202.00	26.00	15.87	23.27
405	A.B. (PG 64-22) ACHM Stab. Base	TON	2326.00	166.00	120.00	144.47
405M	A.B. (PG 64-22) ACHM Stab. Base	MTON	1846.00	203.50	120.00	176.33
405	A.B. (PG 70-22) ACHM Stab. Base	TON	100.00	259.10	259.10	259.10*
405	A.B. (PG 64-22) ACHM Superp. Base	TON	4890.00	150.00	150.00	150.00
406	M.A. ACHM Binder Course (TY1)	TON	29559.00	35.00	20.00	24.10
406M	M.A. ACHM Binder Course (TY1)	MTON	11332.00	48.94	31.00	36.16
406	M.A. ACHM Binder Course (TY2)	TON	11783.00	48.00	22.50	25.23
406M	M.A. ACHM Binder Course (TY2)	MTON	10668.00	32.95	31.77	32.43
406	M.A. in ACHM Superpave Binder	TON	71805.00	26.50	15.00	22.93
406	A.B. (PG 64-22) ACHM Bind.-T1	TON	1250.00	200.00	120.00	144.24
406M	A.B. (PG 64-22) ACHM Bind.-T1	MTON	515.00	221.00	120.00	183.13
406	A.B. (PG 64-22) ACHM Bind.-T2	TON	542.00	175.00	150.00	157.49
406M	A.B. (PG 64-22) ACHM Bind.-T2	MTON	481.00	209.00	175.00	194.37
406	A.B. (PG 70-22) ACHM Bind.-T1	TON	65.00	258.88	258.88	258.88*
406	A.B. (PG 64-22) ACHM Superp. Binder	TON	3232.00	150.00	150.00	150.00
407	M.A. ACHM Surface Course-T1	TON	86291.00	51.20	20.00	24.73
407M	M.A. ACHM Surface Course-T1	MTON	14683.00	47.35	33.70	37.89
407	M.A. ACHM Surface Course-T2	TON	133002.20	100.00	16.45	23.53
407M	M.A. ACHM Surface Course-T2	MTON	29711.00	57.20	29.30	31.15
407	M.A. ACHM Surface Course-T3	TON	1692.00	25.45	25.45	25.45*
407	M.A. in ACHM Superpave Surface	TON	73839.00	27.00	18.17	22.53

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
407	A.B. (PG 64-22) ACHM Superp. Surface	TON	4091.00	150.00	150.00	150.00
407	A.B. (PG 64-22) ACHM Surf. T1	TON	4531.00	221.22	120.00	156.13
407M	A.B. (PG 64-22) ACHM Surf. T1	MTON	796.00	221.00	120.00	161.64
407	A.B. (PG 64-22) ACHM Surf. T2	TON	7943.30	1000.00	140.00	157.70
407M	A.B. (PG 64-22) ACHM Surf. T2	MTON	1764.00	226.60	150.00	183.08
407	A.B. (PG 64-22) ACHM Surf. T3	TON	108.00	185.00	185.00	185.00*
407	A.B. (PG 70-22) ACHM Surf. T1	TON	320.00	256.17	256.17	256.17*
408	M.A. ACHM Binder Course-HT	TON	4626.00	37.50	37.50	37.50*
408	M.A. ACHM Surface Course-HT	TON	3623.00	37.70	37.70	37.70*
408	A.B. (PG 76-22) ACHM Binder-HT	Ton	213.00	313.00	313.00	313.00*
408	A.B. (PG 76-22) ACHM Surface-HT	TON	199.00	318.00	318.00	318.00*
412	Cold Milling Asphalt Pavement	SQYD	98870.00	10.00	0.83	1.15
414	Asph. Conc. Patch-Maint. of Trfc.	TON	914.00	200.00	35.00	72.08
414M	Asph. Conc. Patch-Maint. of Trfc.	MTON	477.00	125.00	58.41	83.40
415	ACHM Patch. Exist. Asphalt Rdwy.	TON	600.00	60.00	31.50	44.92
415M	ACHM Patch. Exist. Asphalt Rdwy.	MTON	1796.00	100.00	88.00	89.26
415	Spot Location Patching	SQYD	500.00	10.00	10.00	10.00*
501	P.C.C. Pavement-10"	SQYD	3000.00	68.48	68.48	68.48*
501	Sep. Fabric for Pvmt. Reinf.	SQYD	39369.00	0.85	0.85	0.85*
501	Geogrid for Pvmt. Reinf.	SQYD	39369.00	2.00	2.00	2.00*
504	Approach Slabs	CUYD	413.26	250.00	215.00	220.81
504	Approach Gutters (Type A)	CUYD	12.64	400.00	360.00	380.00
504	Approach Gutters (Type B)	CUYD	35.52	350.00	330.00	343.33
504M	Approach Gutters (Type B1)	CU M	9.08	530.00	530.00	530.00*
504M	Approach Gutters (Type B2)	CU M	28.92	328.11	328.11	328.11*
504	Approach Gutters (Type C)	CUYD	36.72	250.00	250.00	250.00*
504	Approach Gutters (Type D)	CUYD	5.96	350.00	350.00	350.00*
504	Approach Gutters (Ty Special)	CUYD	73.56	300.00	300.00	300.00*
505	P.C. Concrete Driveway	SQYD	2577.22	25.40	25.00	25.34
505M	P.C. Concrete Driveway	SQ M	2042.43	27.50	27.50	27.50*
506	P.C. Concrete Corrugation	SQYD	108.00	9.15	9.15	9.15*
507	R&D Concrete Pvmt. for Patch	SQYD	2096.00	26.25	26.25	26.25*
507	P.C.C.P. Patch-10"	SQYD	2096.00	70.35	70.35	70.35*
509	Saw. & Seal. Jts. Conc. Pvmt. Patch	LF	7290.00	2.89	2.89	2.89*
509	Stress Relief Jt. Exst. Conc. Pvm	LF	1080.00	15.00	15.00	15.00*
512	Long. Jt. Seal (Shld)	LF	98630.00	0.50	0.50	0.50*
601	Mobilization	L.S.	73.00	465000.00	100.00	45396.54
602	Furnishing Field Office	EACH	17.00	9000.00	1000.00	4123.53
602	Furnishing Field Laboratory	EACH	12.00	15000.00	2000.00	5606.25
603	Maintenance of Traffic	L.S.	62.00	112500.00	100.00	13434.43
603	Traffic Control Supervisor	L.S.	1.00	68626.36	68626.36	68626.36*
603	Maintenance of Traffic	L.S.	7.00	110900.00	4000.00	38095.24
603M	300 mm Temporary Culvert	M	180.00	23.25	23.25	23.25*
603	18" Temporary Culvert	LF	905.00	23.00	14.00	14.84

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
603M	450 mm Temporary Culvert	M	8.00	95.00	95.00	95.00*
603	24" Temporary Culvert	LF	552.00	28.00	18.00	25.69
603M	600 mm Temporary Culvert	M	13.10	220.00	105.00	149.77
603	30" Temporary Culvert	LF	60.00	20.00	20.00	20.00*
603M	750 mm Temporary Culvert	M	16.00	100.00	100.00	100.00*
603	36" Temporary Culvert	LF	690.00	25.00	25.00	25.00
603M	900 mm Temporary Culvert	M	3.60	250.00	250.00	250.00*
603M	1050 mm Temporary Culvert	M	40.00	94.99	94.99	94.99*
603M	1200 mm Temporary Culvert	M	107.00	96.60	96.60	96.60*
603	54" Temporary Culvert	LF	180.00	40.00	40.00	40.00*
603M	1350 mm Temporary Culvert	M	66.00	136.55	136.55	136.55*
603	60" Temporary Culvert	LF	26.00	31.00	31.00	31.00*
603M	1650 mm Temporary Culvert	M	60.00	145.06	145.06	145.06*
603M	885 mm x 610 mm Temp. Culvert	M	3.50	250.00	250.00	250.00*
603M	1440 mm x 970 mm Temp. Culvert	M	3.00	380.00	380.00	380.00*
603	64" x 43" Temporary Culvert	LF	18.00	82.00	82.00	82.00*
603M	1620 mm x 1100 mm Temp. Culvert	M	8.00	210.00	210.00	210.00*
603M	Temp. Br. Structure (6.0m Rdwy.)	M	21.00	1690.50	1690.50	1690.50*
604	Signs	SQFT	18180.50	20.00	0.50	10.08
604M	Signs	SQ M	504.51	140.00	101.08	122.83
604	Signs Left in Place	SQFT	60.00	14.00	14.00	14.00*
604	Barricades	LF	3383.00	40.00	20.00	24.71
604M	Barricades	M	297.00	105.00	60.00	79.57
604	Barricades Left in Place	LF	144.00	26.00	26.00	26.00*
604	Traffic Drums	EACH	4605.00	114.38	1.00	64.27
604	Furn. & Instl. Precast Conc. Barr.	LF	11436.00	40.33	18.00	30.62
604M	Furn. & Instl. Precast Conc. Barr.	M	768.60	150.00	88.00	101.16
604	Relo. Precast Concrete Barrier	LF	4610.00	9.00	7.40	8.03
604M	Relo. Precast Concrete Barrier	M	918.60	37.00	22.00	24.56
604	Const. Pavement Markings	LF	473537.00	0.80	0.12	0.18
604M	Const. Pavement Markings	M	86722.00	1.85	0.45	0.57
604	Const. Pavement Markings-R.R.	EACH	4.00	280.00	280.00	280.00*
604	Removable Const. Pavement Mark.	LF	5110.00	2.00	2.00	2.00
604	Removal Const. Pavement Mark.	LF	126306.00	0.85	0.25	0.51
604M	Removal Const. Pavement Mark.	M	13887.00	2.10	0.85	1.28
604	Removal Perm. Pavement Markings	LF	41401.00	1.53	0.40	0.79
604M	Removal Perm. Pavement Markings	M	6674.00	4.00	1.25	3.00
604	Advance Warning Arrow Panel	DAY	1395.00	33.00	10.50	24.34
604	Port. Changeable Message Sign	DAY	860.00	88.00	70.00	75.23
604	Vertical Panels	EACH	413.00	44.24	20.00	26.29
604	Modular Glare Shield	LF	4426.00	35.23	35.23	35.23*
605	Concrete Ditch Paving (Type A)	SQYD	13062.00	28.50	23.00	23.56
605M	Concrete Ditch Paving (Type A)	SQ M	1065.00	1.00	1.00	1.00*
605	Concrete Ditch Paving (Type B)	SQYD	7033.00	40.00	22.00	26.61

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
605M	Concrete Ditch Paving (Type B)	SQ M	4215.00	31.20	31.00	31.09
606	18" R.C. Pipe Culverts (CL.3)	LF	7653.00	56.19	22.40	25.48
606M	450 mm R.C. Pipe Culverts (CL.3)	M	97.00	114.00	114.00	114.00*
606	24" R.C. Pipe Culverts (CL.3)	LF	4693.00	38.00	30.90	34.56
606M	600 mm R.C. Pipe Culverts (CL.3)	M	285.20	600.00	108.00	185.09
606	24" R.C. Pipe Culverts (CL.5)	LF	80.00	190.00	190.00	190.00*
606	30" R.C. Pipe Culverts (CL.3)	LF	1265.00	50.75	39.00	43.97
606M	750 mm R.C. Pipe Culverts (CL.3)	M	162.80	275.00	160.00	202.12
606	30" R.C. Pipe Culverts (CL.5)	LF	100.00	240.00	240.00	240.00*
606	36" R.C. Pipe Culverts (CL.3)	LF	1533.00	70.00	54.00	58.17
606M	900 mm R.C. Pipe Culverts (CL.3)	M	101.40	375.00	375.00	375.00*
606	42" R.C. Pipe Culverts (CL.3)	LF	679.00	105.00	71.80	78.21
606M	1050 mm R.C. Pipe Culverts (CL.3)	M	5.00	381.00	381.00	381.00*
606	42" R.C. Pipe Culverts (CL.4)	LF	216.00	80.50	80.50	80.50*
606	48" R.C. Pipe Culverts (CL.3)	LF	1131.00	100.14	86.60	88.97
606M	1200 mm R.C. Pipe Culverts (CL.3)	M	31.80	559.00	350.00	389.43
606	48" R.C. Pipe Culverts (CL.4)	LF	727.00	124.00	124.00	124.00*
606	48" R.C. Pipe Culverts (CL.5)	LF	809.00	149.00	149.00	149.00*
606	54" R.C. Pipe Culverts (CL.3)	LF	539.00	123.00	106.00	115.35
606	54" R.C. Pipe Culverts (CL.5)	LF	301.00	158.00	158.00	158.00*
606M	1350 mm R.C. Pipe Culverts (CL.5)	M	129.00	460.00	460.00	460.00*
606	60" R.C. Pipe Culverts (CL.5)	LF	178.00	170.35	170.35	170.35*
606	72" R.C. Pipe Culverts (CL.3)	LF	193.00	190.00	180.00	184.92
606	18" ZC (Galv) C.S. Pipe Clvt.	LF	16.00	23.00	23.00	23.00*
606	18" Asph. C.C. Steel Pipe Clvt.	LF	162.00	20.00	20.00	20.00*
606	24" Asph. C.C. St. Pipe Clvt.	LF	164.00	26.00	26.00	26.00*
606	30" ZC (Galv) C.S. Pipe Clvt.	LF	34.00	40.00	40.00	40.00*
606	30" Asph. C.C. Steel Pipe Clvt.	LF	162.00	30.00	30.00	30.00*
606	36" Asph. C.C. Steel Pipe Clvt.	LF	66.00	40.00	40.00	40.00*
606	18" Al. C.C. St. Pipe Clvt.	LF	44.00	22.00	22.00	22.00*
606	24" Al. C.C. St. Pipe Clvt.	LF	896.00	33.00	22.00	24.75
606	30" Al. C.C. St. Pipe Clvt.	LF	496.00	40.00	32.00	32.68
606	36" Al. C.C. St. Pipe Clvt.	LF	207.00	42.00	42.00	42.00*
606	42" Al. C.C. St. Pipe Clvt.	LF	126.00	47.00	47.00	47.00*
606	48" Al. C.C. St. Pipe Clvt.	LF	50.00	53.00	53.00	53.00*
606M	1200 mm Al. C.C. St. Pipe Clvt.	M	74.70	195.48	195.48	195.48*
606	54" Al. C.C. St. Pipe Clvt.	LF	128.00	56.00	56.00	56.00*
606	66" Al. C.C. St. Pipe Clvt.	LF	20.00	170.00	170.00	170.00*
606M	600 mm P.P.M.C.C. St. Pipe Clvt.	M	65.00	78.00	78.00	78.00*
606M	750 mm P.P.M.C.C. St. Pipe Clvt.	M	24.00	97.50	97.50	97.50*
606M	900 mm P.P.M.C.C. St. Pipe Clvt.	M	19.00	136.00	136.00	136.00*
606M	900 mm P.P.M.C.S. Pipe Clvt.	M	123.00	136.00	136.00	136.00*
606M	1050 mm P.P.M.C.C. St. Pipe Clvt.	M	103.00	156.50	156.50	156.50*
606	48" P.P.M.C.C.S. Pipe Clvt.-10G	LF	1940.00	113.00	113.00	113.00*

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
606M	1350 mm P.P.M.C.C. St. Pipe Clvt.	M	220.00	221.00	221.00	221.00*
606M	450 mm Polyethylene Pipe Clvt.	M	728.00	45.50	45.50	45.50*
606M	600 mm Polyethylene Pipe Clvt.	M	408.00	96.70	96.70	96.70*
606M	1050 mm Polyethylene Pipe Clvt.	M	150.00	202.00	202.00	202.00*
606M	900 mm x 575 mm RC Arch Pipe	M	107.00	245.00	227.00	235.07
606	44" x 27" RC Arch Pipe	LF	204.00	100.00	100.00	100.00*
606	59" x 36" RC Arch Pipe	LF	251.00	109.80	109.80	109.80*
606	65" x 40" RC Arch Pipe	LF	110.00	164.50	164.50	164.50*
606M	1440x970 Al. C.C.S. Arch Pipe	M	74.00	208.00	208.00	208.00*
606M	1800x1200 Al. C.C.S. Arch Pipe	M	69.00	345.00	345.00	345.00*
606	12" Side Drain	LF	375.00	19.45	19.45	19.45*
606M	300 mm Side Drain	M	164.00	40.00	40.00	40.00*
606	18" Side Drain	LF	4204.00	25.00	14.00	17.91
606M	450 mm Side Drain	M	850.50	185.00	42.00	60.94
606	24" Side Drain	LF	2232.00	25.50	16.75	21.42
606M	600 mm Side Drain	M	196.50	230.00	52.00	89.76
606	30" Side Drain	LF	776.00	35.25	25.00	25.93
606M	750 mm Side Drain	M	133.50	105.00	60.00	81.73
606M	900 mm Side Drain	M	9.00	163.00	163.00	163.00*
606M	1050 mm Side Drain	M	11.90	440.00	440.00	440.00*
606M	1200 mm Side Drain	M	9.50	450.00	450.00	450.00*
606	54" Side Drain	LF	200.00	55.00	55.00	55.00*
606	72" Side Drain	LF	176.00	100.00	100.00	100.00*
606	21" x 15" Side Drain	LF	220.00	16.20	16.20	16.20*
606	28" x 20" Side Drain	LF	192.00	29.00	29.00	29.00*
606	42" x 29" Side Drain	LF	28.00	30.00	30.00	30.00*
606M	1440 mm x 970 mm Side Drain	M	90.00	186.00	186.00	186.00*
606M	1800 mm x 1200 mm Side Drain	M	36.00	314.00	314.00	314.00*
606	18" Safety E.S. C.D.-1	EACH	100.00	520.00	520.00	520.00*
606	24" Safety E.S. C.D.-1	EACH	1.00	550.00	550.00	550.00*
606	30" Safety E.S. C.D.-1	EACH	2.00	850.00	850.00	850.00*
606	42 x 29 Safety E.S. C.D.-1	EACH	3.00	2000.00	2000.00	2000.00*
606	18" FES RC Pipe Clvt.	EACH	31.00	880.00	400.00	758.06
606M	450 mm FES RC Pipe Clvt.	EACH	8.00	860.00	860.00	860.00*
606	18" FES CS Pipe Clvt.	EACH	1.00	450.00	450.00	450.00*
606	24" FES RC Pipe Clvt.	EACH	54.00	1100.00	459.00	707.00
606M	600 mm FES RC Pipe Clvt.	EACH	25.00	1300.00	500.00	810.80
606	24" FES CS Pipe Clvt.	EACH	21.00	228.00	228.00	228.00*
606M	600 mm FES CS Pipe Clvt.	EACH	4.00	250.00	250.00	250.00*
606	30" FES RC Pipe Clvt.	EACH	9.00	880.00	556.00	790.22
606M	750 mm FES RC Pipe Clvt.	EACH	11.00	1600.00	710.00	1115.45
606	30" FES CS Pipe Clvt.	EACH	16.00	500.00	328.00	349.50
606M	750 mm FES CS Pipe Clvt.	EACH	2.00	285.00	285.00	285.00*
606	36" FES RC Pipe Clvt.	EACH	9.00	1550.00	1200.00	1372.22

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
606M	900 mm FES RC Pipe Clvt.	EACH	16.00	1800.00	400.00	1275.00
606	36" FES CS Pipe Clvt.	EACH	7.00	420.00	420.00	420.00*
606	42" FES RC Pipe Clvt.	EACH	4.00	1600.00	1500.00	1550.00
606M	1050 mm FES RC Pipe Clvt.	EACH	2.00	2880.00	2880.00	2880.00*
606	42" FES CS Pipe Clvt.	EACH	5.00	600.00	600.00	600.00*
606M	1050 mm FES CS Pipe Clvt.	EACH	6.00	2000.00	700.00	1133.33
606	48" FES RC Pipe Clvt.	EACH	11.00	1920.00	1375.00	1804.55
606M	1200 mm FES RC Pipe Clvt.	EACH	3.00	3500.00	1625.00	2250.00
606	48" FES CS Pipe Clvt.	EACH	7.00	1930.00	720.00	1584.29
606M	1200 mm FES CS Pipe Clvt.	EACH	6.00	753.26	753.26	753.26*
606	54" FES RC Pipe Clvt.	EACH	7.00	2650.00	2000.00	2144.29
606M	1350 mm FES RC Pipe Clvt.	EACH	2.00	2000.00	2000.00	2000.00*
606	54" FES CS Pipe Clvt.	EACH	4.00	800.00	800.00	800.00*
606M	1350 mm FES CS Pipe Clvt.	EACH	8.00	900.00	900.00	900.00*
606	60" FES RC Pipe Clvt.	EACH	1.00	3300.00	3300.00	3300.00*
606	66" FES CS Pipe Clvt.	EACH	2.00	2000.00	2000.00	2000.00*
606	72" FES RC Pipe Clvt.	EACH	4.00	3400.00	3050.00	3225.00
606M	900x575 FES RC Arch Pipe Clvt.	EACH	10.00	2475.00	750.00	1785.00
606	44x27 FES RC Arch Pipe Clvt.	EACH	3.00	1500.00	1500.00	1500.00*
606M	1440x970 FES CS Arch Pipe Clvt.	EACH	4.00	1120.00	1120.00	1120.00*
606	65x40 FES RC Arch Pipe Clvt.	EACH	2.00	2500.00	2500.00	2500.00*
606M	1800x1200 FES CS Arch Pipe	EACH	6.00	1550.00	1550.00	1550.00*
606M	1800x1200 Safety E.S. S.D.-1	EACH	1.00	4200.00	4200.00	4200.00*
606	Selected Pipe Bedding	CUYD	2338.00	36.00	5.00	15.84
606M	Selected Pipe Bedding	CU M	2318.00	70.00	1.00	19.92
606	Selected Pipe Backfill	CUYD	2894.00	25.00	4.00	15.98
606M	Selected Pipe Backfill	CU M	3108.00	44.00	1.00	15.84
607	E.P. Box Clvt. (3' x 3')	EACH	1.00	5500.00	5500.00	5500.00*
607	E.P. Box Clvt. (4' x 4')	EACH	3.00	5500.00	5500.00	5500.00*
607	E.P. Box Clvt. (5' x 2')	EACH	2.00	5000.00	5000.00	5000.00*
607	E.P. Box Clvt. (5' x 5')	EACH	1.00	5100.00	5100.00	5100.00*
607	E.P. Box Clvt. (D5' x 2')	EACH	1.00	4600.00	4600.00	4600.00*
607	E.P. Box Clvt. (6' x 3')	EACH	2.00	5500.00	5500.00	5500.00*
607	E.P. Box Clvt. (6' x 4')	EACH	1.00	6500.00	6500.00	6500.00*
607	E.P. Box Clvt. (6' x 6')	EACH	1.00	5200.00	5200.00	5200.00*
607	E.P. Box Clvt. (D6' x 4')	EACH	1.00	10500.00	10500.00	10500.00*
607	Precast R.C. Box Clvt.	LF	60.00	550.00	550.00	550.00*
609	Drop Inlets (Type C)	EACH	11.00	3300.00	2650.00	3063.64
609	Drop Inlets (Type E)	EACH	4.00	4955.27	2400.00	4027.64
609	Drop Inlets (Type N1)	EACH	15.00	2100.00	2100.00	2100.00*
609	Drop Inlets (Type MO)	EACH	119.00	2000.00	1675.00	1778.36
609	Drop Inlets (Type RM)	EACH	26.00	2600.00	2400.00	2500.00
609	Drop Inlets (Type TM)	EACH	2.00	2600.00	2600.00	2600.00*
609	Modifying Drop Inlets	EACH	3.00	5000.00	1250.00	3750.00

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
609	Junction Boxes (Type E)	EACH	4.00	2650.00	2260.00	2357.50
609	Junction Boxes (Type ST)	EACH	2.00	2075.00	1700.00	1887.50
609	Drop Inlet Extensions (4')	EACH	20.00	430.00	430.00	430.00*
609M	Drop Inlet Extensions (1200 mm)	EACH	15.00	750.00	750.00	750.00*
609	Drop Inlet Extensions (8')	EACH	39.00	875.00	780.00	792.18
609M	Drop Inlet Extensions (2400 mm)	EACH	22.00	950.00	950.00	950.00*
609	Yard Drain	EACH	21.00	1050.00	1000.00	1014.29
609	Energy Dissipator (Size A)	EACH	2.00	9500.00	9500.00	9500.00*
609	Energy Dissipator (Size B)	EACH	8.00	17000.00	17000.00	17000.00*
609	Energy Dissipator (Size C)	EACH	1.00	19000.00	19000.00	19000.00*
611	Underdrain Outlet Protectors	EACH	239.00	500.00	125.00	250.17
611	4" Pipe Underdrains	LF	23130.00	13.00	0.01	6.20
611M	100 mm Pipe Underdrains	M	8350.00	16.40	8.00	13.55
611M	100 mm Pipe Underdrains	M	1080.00	20.00	20.00	20.00*
611	Underdrain Outlet Protector	EACH	72.00	225.00	225.00	225.00*
615	Pvmt. Repair O/Clvt. (Concrete)	CUYD	201.48	225.00	120.00	170.89
615M	Pvmt. Repair O/Clvt. (Concrete)	CU M	110.85	400.00	194.00	294.33
615	Pvmt. Repair O/Clvt. (Asphalt)	TON	302.00	56.20	56.20	56.20*
617	Guardrail (Type A)	LF	15720.00	20.00	12.75	14.14
617M	Guardrail (Type A)	M	1010.30	75.00	50.00	62.01
617	Guardrail (Type C)	LF	225.00	20.00	20.00	20.00*
617	Term. Anchor Posts (Type 1)	EACH	46.00	600.00	340.00	458.30
617	Bridge End Terminal-A	EACH	6.00	4396.78	4396.78	4396.78*
617	Guard Rail Terminal (Type 2)	EACH	113.00	3800.00	2950.00	3080.53
617	Guard Rail Mod. (Type BGR-1)	EACH	12.00	4800.00	4800.00	4800.00*
617	Guard Rail Mod. (Type BGR-3)	EACH	1.00	4800.00	4800.00	4800.00*
617	Guard Rail Mod. (Type BGR-4)	EACH	5.00	4800.00	4800.00	4800.00*
617	Guard Rail Mod. (Type BGR-6)	EACH	4.00	3000.00	3000.00	3000.00*
618	Guard Cable	LF	2600.00	5.25	5.25	5.25*
619	Wire Fence (Type A)	LF	123053.00	2.50	2.50	2.50
619M	Wire Fence (Type A)	M	1265.00	9.00	9.00	9.00*
619	Wire Fence (Type C)	LF	34260.00	3.50	2.00	2.73
619M	Wire Fence (Type C)	M	2998.00	10.50	7.45	8.35
619	Wire Fence (Type D)	LF	38702.00	4.00	1.85	2.24
619M	Wire Fence (Type D)	M	1625.00	11.70	6.46	7.50
619	Wire Fence (Type D-1)	LF	7657.00	2.85	2.10	2.41
619M	Wire Fence (Type D-1)	M	1785.00	9.02	7.74	7.93
619M	Wire Fence (Type D-2)	M	367.00	12.00	9.36	10.80
619	Wire Fence (Type A Special)	LF	4070.00	2.50	2.50	2.50*
619M	1200 mm Steel Chain Link Fence	M	154.00	22.86	22.86	22.86*
619	12' Steel Gates	EACH	44.00	250.00	175.00	206.82
619M	3650 mm Steel Gates	EACH	8.00	250.00	175.00	226.25
619	16' Steel Gates	EACH	27.00	300.00	225.00	272.22
619M	4900 mm Steel Gates	EACH	4.00	245.00	200.00	222.50

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
619	20' Steel Gates	EACH	1.00	425.00	425.00	425.00*
619M	4900 mm Steel Gates	EACH	3.00	300.00	300.00	300.00*
619	16' Aluminum Gates	EACH	5.00	225.00	225.00	225.00*
620	Lime	TON	1012.36	220.00	18.00	24.98
620M	Lime	MTON	330.69	110.00	20.00	43.56
620	Seeding	ACRE	478.51	10000.00	485.00	525.21
620M	Seeding	HA	73.24	3500.00	900.00	1444.33
620	Seeding (Special)	ACRE	17.77	1300.00	1300.00	1300.00*
620	Mulch Cover	ACRE	963.69	10000.00	525.00	646.31
620M	Mulch Cover	HA	139.38	4000.00	800.00	1718.43
620	Water	MGAL	116692.76	5.00	0.01	0.24
620M	Water	KL	155812.40	0.40	0.01	0.03
621	Temporary Seeding	ACRE	455.99	1500.00	225.00	308.10
621M	Temporary Seeding	HA	66.64	3500.00	433.00	821.46
621	Baled Straw Ditch Checks	BALE	3880.00	25.00	4.50	6.53
621	Silt Fence	LF	128574.00	5.00	2.00	2.35
621M	Silt Fence	M	19105.00	12.00	7.38	8.40
621	Sand Bag Ditch Checks	BAG	7240.00	11.00	2.75	5.05
621	Sacked Sand-Cement Ditch Check	CUYD	8.60	650.00	650.00	650.00*
621	Diversion Ditch	LF	46107.00	3.40	1.00	1.24
621M	Diversion Ditch	M	2279.00	9.84	1.00	6.47
621	Drop Inlet Silt Fence	LF	872.00	8.00	4.75	6.36
621M	Drop Inlet Silt Fence	M	450.00	36.00	18.50	18.58
621	Sediment Basin	CUYD	33646.00	10.00	2.65	2.83
621M	Sediment Basin	CU M	600.00	4.55	4.55	4.55*
621	Rock Filter for Sed. Basin	TON	125.00	30.00	18.00	19.15
621	Obliteration of Sed. Basin	CUYD	33646.00	10.00	2.80	2.97
621M	Obliteration of Sed. Basin	CU M	600.00	4.55	4.55	4.55*
621	Sediment Removal and Disposal	CUYD	7858.20	20.00	3.00	8.07
621M	Sediment Removal and Disposal	CU M	4225.00	20.00	6.00	10.17
621	Pipe for Slope Drains	LF	5797.00	23.00	5.00	9.97
621M	Pipe for Slope Drains	M	199.00	62.05	53.00	54.96
621	Rock Ditch Checks	CUYD	1275.00	25.00	18.00	19.16
621M	Rock Ditch Checks	CU M	130.00	52.00	35.00	44.15
621	Rock Ditch Checks	TON	1.40	46.00	46.00	46.00*
621	Rock Ditch Liner	TON	715.00	30.00	30.00	30.00*
622	Sod Mulch	CUYD	4787.00	16.70	16.70	16.70*
622	Overseeding Sod Mulch	ACRE	9.34	354.00	354.00	354.00*
623	Second Seeding Application	ACRE	455.03	5000.00	170.00	197.78
623M	Second Seeding Application	HA	72.41	2200.00	500.00	720.88
623	2nd Seeding Appl. (SP)	ACRE	17.70	1300.00	1300.00	1300.00*
624	Solid Sodding	SQYD	16676.50	17.50	2.95	4.80
624M	Solid Sodding	SQ M	16989.60	25.00	5.00	7.96
625M	Geotextile Fabric (Type 1)	SQ M	4850.00	4.00	4.00	4.00*

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
625	Geotextile Fabric (Type 5)	SQYD	512.00	4.00	3.00	3.16
625	Geotextile Fabric (Type 8)	SQYD	19654.00	1.95	1.10	1.26
626	Erosion Control Matting-3	SQYD	10560.00	7.00	2.65	3.92
626M	Erosion Control Matting-3	SQ M	1962.00	9.00	7.20	7.33
628	Topsoil Furnished and Placed	CUYD	160443.00	11.38	2.30	3.34
630	Rock Buttress	CUYD	34214.00	25.00	25.00	25.00*
631	Conc. Barr. Wall (Med. Type Sp.)	LF	8237.00	49.72	49.72	49.72*
631	Conc. Barr. Wall (Parapet-TY.A)	LF	2689.00	36.45	36.45	36.45*
631	Conc. Barr. Wall (Med. Type A)	LF	6366.00	88.00	88.00	88.00*
631	Conc. Barr. Wall (Med. Type B)	LF	984.00	120.00	120.00	120.00*
631	Conc. Barr. Wall (Med. Type D)	LF	401.00	85.00	85.00	85.00*
631	Remod. Exist. Conc. Med. Barrier	LF	35.00	49.72	49.72	49.72*
632	Concrete Island	SQYD	3233.00	50.00	20.00	22.42
632M	Concrete Island	SQ M	86.00	40.00	33.60	37.08
633	Concrete Walks	SQYD	9681.00	50.00	18.65	22.51
633M	Concrete Walks	SQ M	252.00	35.00	35.00	35.00*
634	Asphalt Curb	LF	41.00	20.00	20.00	20.00*
634	CC Curb & Gutter-A (1'6")	LF	31434.00	35.00	8.50	9.64
634M	CC Curb & Gutter-A (450 mm)	M	3259.00	29.50	29.50	29.50*
634	CC Curb & Gutter-A (5')	LF	270.00	44.50	44.50	44.50*
635	Rdwy. Construction Control	L.S.	30.00	200000.00	1000.00	35737.33
636	Bridge Construction Control	L.S.	16.00	8000.00	2500.00	18647.50
637	Mailboxes	EACH	323.00	150.00	28.00	37.37
637	Mailbox Supports (Single)	EACH	263.00	100.00	50.00	75.07
637	Mailbox Supports (Double)	EACH	30.00	112.00	60.00	101.33
701	Actuated Controller (2 Phase)	EACH	2.00	7730.00	5928.00	6829.00
701	Actuated Controller (3 Phase)	EACH	1.00	7040.00	7040.00	7040.00*
701	Actuated Controller (5 Phase)	EACH	1.00	6465.00	6465.00	6465.00*
701	Actuated Controller (8 Phase)	EACH	4.00	8000.00	7100.00	7657.50
704	Vehicle Detector	EACH	59.00	230.00	135.00	174.6_
704	Motion Detector	EACH	7.00	880.00	775.00	820.__
704	Loop Wiring	LF	7790.00	4.50	2.40	2.72
704M	Loop Wiring	M	725.00	10.60	10.60	10.60*
704	___der Wire	LF	7410.00	1.25	0.65	0.76
704M	___der Wire	M	420.00	2.00	2.00	2.00*
704	Magnetic Loop Det. (1x2)	EACH	4.00	990.00	990.00	990.00*
704	Magnetic Loop Det. (4x2)	EACH	9.00	3500.00	3070.00	3165.56
705	Loop Wiring in Duct	LF	790.00	3.05	3.05	3.05*
706	Traffic Signal Head (3SEC/1WAY)	EACH	44.00	450.00	350.00	389.41
706	Traffic Signal Head (4SEC/1WAY)	EACH	2.00	475.00	475.00	475.00*
706	Traffic Signal Head (5SEC/1WAY)	EACH	12.00	710.00	575.00	649.83
706	Louvers	EACH	6.00	225.00	225.00	225.00*
707	Pedestrian Signal Head	EACH	28.00	500.00	405.00	422.50
708	Traffic Signal Cable (3C/14)	LF	430.00	1.30	0.56	0.96

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
708M	Traffic Signal Cable (3C/14)	M	115.00	2.00	2.00	2.00*
708	Traffic Signal Cable (5C/14)	LF	5015.00	1.45	0.65	0.88
708M	Traffic Signal Cable (5C/14)	M	120.00	2.50	2.50	2.50*
708	Traffic Signal Cable (7C/14)	LF	1123.00	1.50	0.71	1.06
708M	Traffic Signal Cable (7C/14)	M	35.00	2.85	2.85	2.85*
708	Traffic Signal Cable (12C/14)	LF	855.00	2.10	1.11	1.88
708M	Traffic Signal Cable (12C/14)	M	70.00	4.50	4.50	4.50*
708	Traffic Signal Cable (20C/14)	LF	1835.00	2.25	2.17	2.20
708M	Traffic Signal Cable (20C/14)	M	68.00	6.20	6.20	6.20*
708	Elect. Cond. for Luminaires	LF	265.00	2.05	2.05	2.05*
709	Galv. Steel Conduit (1")	LF	55.00	12.50	12.50	12.50*
709	Galv. Steel Conduit (2")	LF	25.00	14.70	14.70	14.70*
710	PVC Conduit (1")	LF	1525.00	7.10	4.00	5.97
710M	PVC Conduit (27 mm)	M	140.00	21.50	21.50	21.50*
710	PVC Conduit (2")	LF	955.00	12.12	11.00	12.05
710M	PVC Conduit (53 mm)	M	70.00	43.00	43.00	43.00*
710	PVC Conduit (3")	LF	1123.00	19.50	15.00	16.74
710M	PVC Conduit (78 mm)	M	30.00	60.00	60.00	60.00*
711	Concrete Pull Box (Type 1)	EACH	24.00	217.00	165.00	209.92
711	Concrete Pull Box (Type 2)	EACH	28.00	260.00	210.00	235.29
713	Span Wire Assembly	EACH	1.00	1050.00	1050.00	1050.00*
714	T.S.M. Arm & Pole w/End (24')	EACH	2.00	3485.00	3485.00	3485.00*
714	T.S.M. Arm & Pole w/End (28')	EACH	1.00	3750.00	3750.00	3750.00*
714	T.S.M. Arm & Pole w/End (32')	EACH	2.00	4075.00	3950.00	4012.50
714	T.S.M. Arm & Pole w/End (36')	EACH	1.00	4850.00	4850.00	4850.00*
714	T.S.M. Arm & Pole w/End (38')	EACH	2.00	5700.00	5700.00	5700.00*
714	T.S.M. Arm & Pole w/End (40')	EACH	4.00	5035.00	4750.00	4942.50
714	T.S.M. Arm & Pole w/End (42')	EACH	2.00	5525.00	4900.00	5212.50
714	T.S.M. Arm & Pole w/End (44')	EACH	1.00	5515.00	5515.00	5515.00*
714M	T.S.M. Arm & Pole w/End (9.5m)	EACH	1.00	4600.00	4600.00	4600.00*
714M	T.S.M. Arm & Pole w/End (10m)	EACH	2.00	4700.00	4700.00	4700.00*
714M	T.S.M. Arm & Pole w/End (11.5m)	EACH	1.00	5200.00	5200.00	5200.00*
714	Luminaire Assembly	EACH	2.00	325.00	325.00	325.00*
715	Traffic Sig. Ped. Pole w/End.	EACH	1.00	840.00	840.00	840.00*
715	Mod. of Traffic Signal Equip.	EACH	1.00	750.00	750.00	750.00*
715	Remvl. Traffic Sig. Equipment	L.S.	3.00	2075.00	250.00	1378.33
716	Treated Wood Pole (Class 3, 35)	EACH	696445.00	0.80	0.08	0.12
718M	Refl. Paint Pvmt. Mrk. WH-100	M	13776.00	3.90	0.35	0.51
718	Refl. Paint Pvmt. Mrk. WH (10")	LF	490.00	1.12	1.12	1.12*
718M	Refl. Paint Pvmt. Mrk. WH-300	M	45.00	11.00	8.80	9.76
718	Refl. Paint Pvmt. Mrk. WH (4")	LF	1221519.00	0.95	0.08	0.14
718M	Refl. Paint Pvmt. Mrk. YL-100	M	17604.00	3.90	0.51	0.59
718	Refl. Paint Pvmt. Mrk. - Arrow	EACH	7.00	116.00	116.00	116.00*
718	Refl. Paint Pvmt. Mrk. - RR.EMB.	EACH	8.00	275.00	240.00	251.25

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
719	Thermo. Pvmt. Mark. White (4")	LF	270702.00	1.10	0.32	0.38
719M	Thermo. Pvmt. Mark. White-100	M	27917.00	2.85	1.05	1.27
719	Thermo. Pvmt. Mark. White (8")	LF	3836.00	2.29	0.92	1.46
719M	Thermo. Pvmt. Mark. White-200	M	82.00	8.25	8.25	8.25*
719	Thermo. Pvmt. Mark. White (12")	LF	275.00	3.30	1.40	2.76
719	Thermo. Pvmt. Mark. White (24")	LF	1379.00	7.78	2.80	7.49
719M	Thermo. Pvmt. Mark. White-600	M	44.00	50.00	13.75	21.22
719	Thermo. Pvmt. Mark. Yellow (4")	LF	306208.00	1.14	0.32	0.39
719M	Thermo. Pvmt. Mark. Yellow-100	M	24755.00	2.85	1.05	1.24
719	Thermo. Pvmt. Mark. Yellow (12")	LF	70.00	2.67	2.67	2.67*
719	Thermo. Pvmt. Mark. Yellow (24")	LF	187.00	2.80	2.80	2.80*
719	Thermo. Pvmt. Marking (Words)	EACH	6.00	220.00	140.00	185.00
719	Thermo. Pvmt. Marking (Arrows)	EACH	15.00	167.00	75.00	111.40
719	Thermo. Pvmt. Mark. (RR EMB.)	EACH	4.00	750.00	750.00	750.00*
719	Durable Pvmt. Mrk WH-12"	LF	230.00	1.90	1.90	1.90*
720	Perm. Pvmnt. Mrkg. Tape (WH, 4, T3)	LF	16794.00	2.25	2.25	2.25*
720	Perm. Pvmnt. Mrkg. Tape (YL, 4, T3)	LF	16794.00	2.33	2.33	2.33*
721	Raised Pavement Markers-1	EACH	2368.00	11.00	6.00	6.63
721	Raised Pavement Markers-2	EACH	5574.00	13.20	6.00	7.13
722	Plowable Pavement Marker-1	EACH	1580.00	42.00	29.74	34.77
722	Plowable Pavement Marker-2	EACH	3448.00	42.00	29.74	33.03
724	Mod. Sign Struct. (_)	EACH	2.00	3458.00	3458.00	3458.00
725	G. Sign-Roadside Mount (Dmntbl)	SQFT	20208.80	18.20	18.20	18.20*
725	G. Sign-Roadside Mount (Demount)	SQFT	29642.50	20.43	20.43	20.43*
726	Standard Sign	SQFT	3803.72	20.00	11.00	13.79
726	Sign and Assembly Removal	EACH	5.00	334.72	334.72	334.72*
727	Exit No. Panel (Type A)	SQFT	2598.00	21.66	21.66	21.66*
727	Exit No. Panel (Type B)	SQFT	1953.00	21.66	21.66	21.66*
727	Exit No. Panel (Type C)	SQFT	134.00	21.66	21.66	21.66*
729	Channel Post Sign Support-A	EACH	69.00	100.00	30.00	48.90
729	Channel Post Sign Support-B	EACH	8.00	100.00	60.00	81.25
729	Channel Post Sign Support-C	EACH	56.00	65.00	25.00	35.93
730	Breakaway Sign Supp. (Type 1)	LB	9400.00	2.86	2.86	2.86*
730	Breakaway Sign Supp. (Type 2)	LB	20000.00	2.66	2.66	2.66*
730	Breakaway Sign Support (Ty G-1)	LB	104152.60	2.40	2.40	2.40*
730	Breakaway Sign Support (Ty G-2)	LB	26818.20	2.30	2.30	2.30*
801	Unclass. Excav. for Strs-BR	CUYD	6135.00	100.00	7.50	30.15
801M	Unclass. Excav. for Strs-BR	CU M	2071.00	35.00	21.00	21.28
801	Common Excav. for Strs-Bridge	CUYD	1686.00	20.00	12.90	13.97
801	Unclass. Excav. for Strs-Rdwy.	CUYD	5859.72	55.00	13.00	19.75
801M	Unclass. Excav. for Strs-Rdwy.	CU M	2281.00	85.00	7.25	17.75
802	Class S Concrete-Roadway	CUYD	7928.51	500.00	220.00	254.70
802M	Class S Concrete-Roadway	CU M	4935.57	609.50	225.00	273.49
802	Class S Concrete-Bridge	CUYD	4713.31	505.00	230.00	278.73

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
802M	Class S Concrete-Bridge	CU M	2144.50	510.00	300.00	313.62
802	Class S (AE) Concrete-Bridge	CUYD	5330.40	410.00	270.00	295.69
802M	Class S (AE) Concrete-Bridge	CU M	2870.40	585.00	333.05	343.05
802	Seal Concrete-Bridge	CUYD	574.00	100.00	100.00	100.00*
802	31' Precast Conc. Curb Units	EACH	12.00	2133.00	2133.00	2133.00*
802	31' Precast Conc. Inter. Units	EACH	30.00	1819.00	1819.00	1819.00*
802	31' Precast Parapet Rail Units	EACH	12.00	2513.00	2513.00	2513.00*
803	Class 1 Protect. Surf. Treatment	GAL	451.70	80.00	14.50	24.43
803M	Class 1 Protect. Surf. Treatment	L	1115.00	15.00	6.90	8.25
804	Reinf. Steel-Roadway (GR 60)	LB	1044889.00	1.00	0.42	0.50
804M	Reinf. Steel-Roadway (GR 400)	KG	334539.00	1.25	0.10	0.93
804	Reinf. Steel-Bridge (GR 60)	LB	840613.00	0.60	0.37	0.42
804M	Reinf. Steel-Bridge (GR 400)	KG	301047.00	1.22	1.00	1.07
804	Epoxy Coat. Reinf. Steel-GR 60	LB	1207080.00	0.58	0.50	0.54
804M	Epoxy Coat. Reinf. Steel-GR 400	KG	296050.00	1.37	1.37	1.37*
805	Steel Piling (HP 10x42)	LF	970.00	70.00	35.00	42.34
805	Augered Cast-in-Place Piles	LF	135.00	150.00	150.00	150.00*
805	Steel Shell Piling (18")	LF	6313.00	45.00	45.00	45.00*
805	Steel Shell Piling (24")	LF	4908.00	63.00	63.00	63.00*
805	Concrete Piling (14" Square)	LF	17780.00	26.50	26.50	26.50*
805	Concrete Piling (16" Square)	LF	1225.00	27.25	27.25	27.25*
805	Concrete Piling (18" Square)	LF	1539.00	33.50	33.50	33.50*
805M	Concrete Piling (455 mm Square)	M	998.50	195.00	116.09	129.37
805	Concrete Piling (16" Octagonal)	LF	555.00	45.00	45.00	45.00*
805M	Concrete Pile (405 Oct/355 Sq)	M	2877.20	130.00	90.00	92.59
805	Concrete Piling (16 Oct/16 Sq)	LF	1135.00	36.00	36.00	36.00*
805	Test Piles (14" Square)	LF	195.00	60.00	60.00	60.00*
805	Test Piles (16" Square)	LF	60.00	100.00	100.00	100.00*
805	Test Piles (18" Square)	LF	90.00	100.00	100.00	100.00*
805M	Test Piles (455 mm Square)	M	74.00	328.08	209.00	306.36
805	Test Piles (16" Octagonal)	LF	85.00	85.00	85.00	85.00*
805M	Test Piles (405 Oct/355 Sq.)	M	153.60	328.08	124.00	229.52
805	Test Piles (16" Oct/16" Sq.)	LF	95.00	100.00	100.00	100.00*
805	Pile Encasement	LF	450.00	40.00	40.00	40.00*
805	Dynamic Pile Load Test	EACH	8.00	2500.00	1750.00	2218.75
806M	Metal Bridge Railing (TY-GP)	M	21.30	70.00	70.00	70.00*
806	Pipe Railing	LF	200.00	29.00	29.00	29.00*
806	Handrail	LF	884.00	50.00	50.00	50.00*
806	Repair Exst. Br. Parapet Rail	CUFT	20.00	198.25	198.25	198.25*
807	Str. St. Beam Spans (M270-GR50W)	LB	1993390.00	1.10	0.77	0.83
807M	Str. St. Beam Spans (M270-GR345W)	KG	29495.00	2.65	2.65	2.65*
807	Str. St. Pl. Grd. Spn (M270-GR36)	LB	950670.00	1.00	1.00	1.00*
807	Str. St. Pl. Grd. Spn (M270-GR50)	LB	960580.00	1.00	1.00	1.00*
807	Str. St. Pl. Grd. Spn (M270-GR50W)	LB	387480.00	0.77	0.77	0.77*

Item No.	Item Description	Unit	Quantity	Contract Prices High	Contract Prices Low	Weighted Average
807M	Str. St. Pl. Grd. Spn (M270-GR345W)	KG	1274600.00	1.84	1.84	1.84*
807	Welded Steel Truss Spans	L.S.	1.00	302000.00	302000.00	302000.00*
807	Painting Structural Steel	TON	955.70	82.00	82.00	82.00*
808	Elastomeric Bearings	CUIN	119916.00	1.60	1.00	1.20
808M	Elastomeric Bearings	CUCM	1332080.00	0.07	0.07	0.07*
808	Sliding Elastomeric Bearings	CUIN	11440.00	4.70	4.70	4.70*
809	Preformed Joint Seal	LF	1186.00	50.00	20.00	28.54
809M	Preformed Joint Seal	M	22.50	75.00	75.00	75.00*
809	Arm. Jt w/Neoprene Strip Seal	LF	258.00	90.00	90.00	90.00*
810M	Closed Cell Joint Filler	M	108.40	132.00	132.00	132.00*
812	Bridge Name Plate (Type C)	EACH	20.00	500.00	100.00	190.25
816	Filter Blanket	SQYD	7480.00	3.00	1.10	2.15
816M	Filter Blanket	SQ M	1997.00	4.50	3.50	3.58
816	Dumped Riprap	CUYD	5428.00	54.00	12.00	26.83
816M	Dumped Riprap	CU M	1620.00	70.00	26.00	45.52
816	Dumped Riprap (Grouted)	CUYD	141.00	65.00	65.00	65.00*
816	Dumped Riprap (SP-1)	CUYD	2780.00	11.00	11.00	11.00*
816	Dumped Riprap (SP-2)	CUYD	15080.00	11.00	11.00	11.00*
816	Concrete Riprap	CUYD	1138.00	245.00	245.00	245.00*
816M	Concrete Riprap	CU M	373.00	265.00	265.00	265.00*
816	Foundation Protection Riprap	TON	555.00	22.85	22.85	22.85*
820	Cl & Paint Exst. Str. Steel-TY 2	TON	6524.00	290.00	249.50	260.51
820	Disp. of Haz. Waste-Site 1	LS	13.00	20000.00	300.00	3938.46
821	Mod. Existing Br. Str (BR_____)	L.S.	1.00	275.00	275.00	275.00*
822	Fill Holes Exist. Bridge Deck	L.S.	1.00	5000.00	5000.00	5000.00*
901	Remv. & Replacing Cattle Guard	EACH	1.00	3500.00	3500.00	3500.00*
903	Precst. Stonewall Planter	LF	520.00	18.97	18.97	18.97*
903	Irrigation System	L.S.	1.00	2117.37	2117.37	2117.37*
903	Dwarf Red Barberry	EACH	300.00	18.90	18.90	18.90*
903	Var. Procumben Juniper	EACH	300.00	18.90	18.90	18.90*
903	Japanese Holly	EACH	200.00	18.90	18.90	18.90*
903	Dwarf Crape Myrtle	EACH	12.00	87.22	87.22	87.22*
906	Rogers Frisco Trans. Depot	L.S.	1.00	343421.00	343421.00	343421.00*
906	Glenwood Rest Area	L.S.	1.00	212800.00	212800.00	212800.00*
998	Site Work	L.S.	1.00	15257.68	15257.68	15257.68*

* Item appeared in one job only.

Appendix E

O&M, Construction and ROW Cost Estimates

Operations & Maintenance Costs

ALTERNATIVE	UNIT	UNIT PRICE	QUANTITY										COSTS (IN THOUSANDS OF DOLLARS)									
			Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total
Length	km		30.10	18.25	24.75	17.10	33.50	21.10	14.75	28.00	8.80	196.35										
Base Case	lane-km	$709	62.10	45.40	63.80	55.80	73.00	46.48	53.00	56.00	17.60	473.18	$44.0	$32.2	$45.2	$39.6	$51.8	$33.0	$37.6	$39.7	$12.5	$335.5
Improved Two-Lane Rural Arterial	lane-km	$709	62.30	45.90	52.50	66.40	74.00	49.88	53.00	56.00	17.60	477.58	$44.2	$32.5	$37.2	$47.1	$52.5	$35.4	$37.6	$39.7	$12.5	$338.6
Multilane Rural Undivided Highway	lane-km	$709	120.40	73.00	99.00	68.40	134.00	84.40	59.00	112.00	35.20	785.40	$85.4	$51.8	$70.2	$48.5	$95.0	$59.8	$41.8	$79.4	$25.0	$556.8
Four-Lane Divided Rural Highway	lane-km	$709	120.40	73.00	99.00	68.40	134.00	84.40	59.00	112.00	35.20	785.40	$85.4	$51.8	$70.2	$48.5	$95.0	$59.8	$41.8	$79.4	$25.0	$556.8
Four-Lane Freeway	lane-km	$709	143.60	96.20	116.40	97.40	174.60	107.60	64.80	129.40	36.80	966.80	$101.8	$68.2	$82.5	$69.1	$123.8	$76.3	$45.9	$91.7	$26.1	$685.5

ROW Acquisition Cost Estimate for Two-Lane Rural Arterial

	Agricultural			Forest			Residential			Commercial			Barren Land					
	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	R-O-W Costs	Total Area (Acre)	Cost per Acre ($/Acre)
SEGMENT 1	47.21	1,041	47,267	25.11	990	24,858	22.08	21,685	478,801	9.27	17,893	165,804	9.34	13,462	125,738	844,358	103.67	8,144.98
SEGMENT 2	34.91	1,037	34,806	15.97	692	11,050	10.29	25,132	258,515	12.50	27,753	346,995	1.78	11,538	20,529	673,287	73.66	9,139.91
SEGMENT 3	66.02	1,779	112,959	5.14	768	3,947	6.03	5,795	34,918	8.24	27,996	230,564	3.56	7,692	27,372	386,905	85.42	4,529.38
SEGMENT 4	1.07	2,285	2,361	2.01	1,657	3,329	30.41	18,521	563,298	17.38	34,501	599,538	0.00	0	0	1,168,620	50.87	22,970.59
SEGMENT 5	29.89	1,417	40,713	41.47	832	34,507	7.48	8,667	64,841	15.93	21,240	338,410	6.23	9,615	59,875	539,974	94.77	5,697.56
SEGMENT 6	60.49	797	46,364	37.79	659	24,886	12.60	5,586	70,408	10.30	18,656	192,217	1.42	1,923	2,735	341,199	122.08	2,794.98
SEGMENT 7	0.00	0	0	0.00	0	0	3.50	2,885	10,096	0.00	0	0	0.00	0	0	10,096	3.50	2,884.62
SEGMENT 8	157.47	179	28,196	86.41	772	66,670	60.02	12,388	743,560	51.85	26,244	1,360,729	11.21	8,029	89,981	2,446,795	356.64	6,860.60
SEGMENT 10	0.27	865	233	0.00	0	0	0.06	2,404	137	0.05	95,087	5,156	0.00	0	0	5,527	0.38	14,512.66
TOTAL	397.33	787	312,898	213.90	791	169,248	152.47	14,590	2,224,573	125.52	25,808	3,239,412	33.53	9,728	326,230	6,416,761	891.00	7,201.75

	Agricultural			Forest			Residential			Commercial			Barren Land					
	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	R-O-W Costs ($)	Total Area (Hectare)	Cost per Hectare ($/Hectare)
SEGMENT 1	19.12	2,472	47,267	10.17	2,445	24,858	8.94	53,544	478,801	3.75	44,180	165,804	3.78	33,239	125,738	844,358	41.98	20,111.34
SEGMENT 2	14.14	2,462	34,806	6.47	1,709	11,050	4.17	62,056	258,515	5.06	68,527	346,995	0.72	28,490	20,529	673,287	29.83	22,567.98
SEGMENT 3	26.74	4,225	112,959	2.08	1,895	3,947	2.44	14,308	34,918	3.34	69,127	230,564	1.44	18,994	27,372	386,905	34.60	11,183.80
SEGMENT 4	0.44	5,426	2,361	0.81	4,090	3,329	12.32	45,732	563,298	7.04	85,190	599,538	0.00	0	0	1,168,620	20.60	56,718.28
SEGMENT 5	12.10	3,363	40,713	16.80	2,055	34,507	3.03	21,401	64,841	6.45	52,446	338,410	2.52	23,742	59,875	539,974	38.38	14,068.25
SEGMENT 6	24.50	1,893	46,364	15.30	1,626	24,886	5.10	13,793	70,408	4.17	46,064	192,217	0.58	4,748	2,735	341,199	49.44	6,901.28
SEGMENT 7	0.00	0	0	0.00	0	0	1.42	7,123	10,096	0.00	0	0	0.00	0	0	10,096	1.42	7,122.60
SEGMENT 8	30.50	962	29,324	0.00	0	0	1.74	2,924	5,077	0.36	3,336	1,192	0.00	0	0	2,446,795	32.59	75,076.84
SEGMENT 10	0.11	2,137	233	0.00	0	0	0.02	5,936	137	0.02	234,785	5,156	0.00	0	0	5,527	0.15	35,834.22
TOTAL	127.64	2,460.26	314,026	51.63	1,986.75	102,578	39.18	37,932.62	1,486,090	26.44	64,826	1,714,071	9.04	26,126.94	236,248	6,416,761	249.00	25,769.96

ROW Acquisition Cost Estimate for Multi-Lane Rural Undivided Highway

	Agricultural			Forest			Residential			Commercial			Barren Land					
	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	R-O-W Costs ($)	Total Area (Acre)	Cost per Acre ($/Acre)
SEGMENT 1	75.55	1,039	78,483	44.78	993	44,490	39.08	27,370	1,069,532	16.98	20,420	346,675	0.00	0	0	1,539,180	176.39	8,726.10
SEGMENT 2	51.15	1,036	53,011	27.07	674	18,239	18.73	15,719	294,419	24.97	23,775	593,653	0.00	0	0	959,323	121.92	7,868.29
SEGMENT 3	110.64	1,671	184,866	15.28	788	12,042	18.37	16,107	295,872	21.96	19,173	420,958	0.00	0	0	913,738	166.25	0.00
SEGMENT 4	2.84	2,469	7,001	4.98	1,852	9,229	43.60	22,185	967,153	45.61	33,969	1,549,374	0.00	0	0	2,532,757	97.03	26,103.84
SEGMENT 5	49.89	1,338	65,436	79.69	740	58,960	18.75	8,606	161,334	33.38	27,517	918,643	0.00	0	0	1,204,373	180.72	6,664.29
SEGMENT 6	86.21	802	69,173	54.43	644	35,040	18.91	5,415	102,376	27.95	19,657	549,510	4.13	1,923	7,949	771,997	190.08	0.00
SEGMENT 7	0.00	0	0	0.00	0	0	7.21	2,885	40,785	0.00	0	0	0.00	0	0	40,785	7.21	5,660.25
SEGMENT 8	63.49	962	61,051	0.00	0	0	9.67	3,493	33,772	2.53	13,205	33,361	0.00	0	0	128,184	75.69	1,693.62
SEGMENT 10	3.64	865	3,150	0.00	0	0	0.77	2,404	1,848	0.73	2,885	2,112	0.00	0	0	7,110	5.14	0.00
TOTAL	442.41	1,180	522,172	226.24	787	178,000	175.07	16,948	2,967,091	174.11	25,353	4,414,287	4.13	1,923	7,949	8,097,447	1,020.42	7,935.41

	Agricultural			Forest			Residential			Commercial			Barren Land					
	Area (Hectares)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectares)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectares)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectares)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectares)	Unit Cost ($/Hectare)	Total Cost ($)	R-O-W COSTS ($)	Total Area (Hectares)	Cost per Hectare ($/Hectare)
SEGMENT 1	30.60	2,565	78,483	18.14	2,453	44,490	15.83	67,580	1,069,532	6.88	50,421	346,675	0.00	0	0	1,539,180	71.44	21,546.23
SEGMENT 2	20.72	2,559	53,011	10.96	1,664	18,239	7.59	38,812	294,419	10.11	58,704	593,653	0.00	0	0	959,323	49.38	19,428.14
SEGMENT 3	44.81	4,126	184,866	6.19	1,945	12,042	7.44	39,770	295,872	8.89	47,342	420,958	0.00	0	0	913,738	67.33	13,571.28
SEGMENT 4	1.15	6,096	7,001	2.02	4,572	9,229	17.66	54,778	967,153	18.47	83,876	1,549,374	0.00	0	0	2,532,757	39.30	64,454.82
SEGMENT 5	19.80	3,305	65,436	32.28	1,827	58,960	7.59	21,249	161,334	13.52	67,944	918,643	0.00	0	0	1,204,373	73.19	16,455.27
SEGMENT 6	34.91	1,981	69,173	22.04	1,590	35,040	7.66	13,369	102,376	11.32	48,537	549,510	1.67	4,748	7,949	771,997	76.98	10,028.18
SEGMENT 7	0.00	0	0	0.00	0	0	2.92	13,976	40,785	0.00	0	0	0.00	0	0	40,785	2.92	13,976.11
SEGMENT 8	63.49	962	61,051	0.00	0	0	9.67	3,493	33,772	2.53	13,205	33,361	0.00	0	0	128,184	75.69	1,693.62
SEGMENT 10	1.47	2,137	3,150	0.00	0	0	0.31	5,936	1,848	0.30	7,123	2,112	0.00	0	0	7,110	2.08	3,414.76
TOTAL	216.95	2,406.84	522,172	91.63	1,942.65	178,000	76.65	38,707.53	2,967,091	65.14	62,443	4,067,612	1.67	4,748.40	7,949	8,097,447	458.30	17,668.51

ROW Acquisition Cost Estimate for Four-Lane Divided Rural Highway

	Agricultural			Forest			Residential			Commercial			Barren Land			R-O-W Costs	Total Area (Acre)	Cost per Acre ($/Acre)
	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)			
SEGMENT 1	138.03	1,037	143,138	89.08	1,001	89,135	76.47	25,690	1,964,541	33.94	21,190	719,192	0.00	0	0	2,916,006	336.52	969.64
SEGMENT 2	87.04	1,036	90,168	51.54	661	34,089	41.49	9,967	413,494	48.22	21,485	1,036,013	0.00	0	0	1,573,766	228.29	643.46
SEGMENT 3	267.81	1,639	439,069	38.42	726	27,911	22.29	22,105	492,650	40.56	24,841	1,007,445	0.00	0	0	1,967,074	369.08	5,329.72
SEGMENT 4	4.17	2,319	9,659	7.71	1,690	13,029	51.66	24,929	1,287,931	58.06	30,957	1,797,346	0.00	0	0	3,107,965	121.60	25,559.43
SEGMENT 5	154.81	1,390	215,134	228.19	793	180,856	40.51	8,556	346,565	66.05	22,773	1,504,269	0.00	0	0	2,246,824	489.56	1,126.79
SEGMENT 6	155.60	837	130,213	90.75	630	57,188	32.78	5,269	172,711	49.77	12,793	636,761	10.10	1,923	19,420	1,035,714	339.00	901.43
SEGMENT 7	0.00	0	0	0.00	0	0	26.33	2,885	275,956	0.00	0	0	0.00	0	0	275,956	26.33	10,480.09
SEGMENT 8	178.27	962	171,409	0.00	0	0	27.12	3,574	96,901	7.30	3,307	24,135	0.00	0	0	292,445	212.68	1,375.05
SEGMENT 10	27.99	865	24,222	0.00	0	0	4.59	2,303	10,576	5.89	3,007	17,728	0.00	0	0	52,526	38.48	1,365.09
TOTAL	1,013.71	1,206	1,223,014	505.70	795	402,208	323.23	15,659	5,061,326	309.80	21,766	6,742,888	10.10	1,923	19,420	13,468,276	2,161.53	6,230.89

	Agricultural			Forest			Residential			Commercial			Barren Land			R-O-W COSTS ($)	Total Area (Hectare)	Cost per Hectare ($/Hectare)
	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)			
SEGMENT 1	55.90	2,561	143,138	36.08	2,471	89,135	30.97	63,433	1,964,541	13.75	52,321	719,192	0.00	0	0	2,916,006	136.29	21,395.68
SEGMENT 2	35.25	2,558	90,168	20.87	1,633	34,089	16.80	24,611	413,494	19.53	53,051	1,036,013	0.00	0	0	1,573,766	92.46	17,021.71
SEGMENT 3	108.46	4,048	439,069	15.56	1,794	27,911	9.03	54,580	492,650	16.42	61,336	1,007,445	0.00	0	0	1,967,074	149.47	13,159.99
SEGMENT 4	1.69	5,725	9,659	3.12	4,173	13,029	20.92	61,553	1,287,931	23.51	76,439	1,797,346	0.00	0	0	3,107,965	49.25	63,110.56
SEGMENT 5	62.70	3,431	215,134	92.42	1,957	180,856	16.40	21,126	346,565	26.75	56,231	1,504,269	0.00	0	0	2,246,824	198.27	11,332.23
SEGMENT 6	63.02	2,066	130,213	36.75	1,556	57,188	13.27	13,011	172,711	20.16	31,588	636,761	4.09	4,748	19,420	1,035,714	137.29	7,543.81
SEGMENT 7	0.00	0	0	0.00	0	0	10.66	25,877	275,956	0.00	0	0	0.00	0	0	275,956	26.33	10,480.09
SEGMENT 8	72.20	2,374	171,409	0.00	0	0	10.98	8,824	96,901	2.96	8,165	24,135	0.00	0	0	292,445	86.13	3,395.23
SEGMENT 10	11.34	2,137	24,222	0.00	0		1.86	5,685	10,576	2.39	7,426	17,728	0.00	0	0	52,526	15.58	3,370.63
TOTAL	410.55	2,978.99	1,223,014	204.81	1,963.85	402,208	130.91	38,663.54	5,061,326	111.72	53,918	6,023,696	4.09	4,748.40	19,420	13,468,276	891.08	15,114.61

ROW Acquisition Cost Estimate for Four-Lane Freeway

	Agricultural			Forest			Residential			Commercial			Barren Land			R-O-W	Total	Cost
	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Area (Acre)	Unit Cost ($/Acre)	Total Cost ($)	Costs	Area (Acre)	per Acre ($/Acre)
SEGMENT 1	397.71	1,000	397,706	456.93	500	228,466	80.00	10,000	800,000	35.00	20,000	700,000	0.00	0	0	2,126,172	969.64	2,192.75
SEGMENT 2	245.34	1,000	245,343	313.12	500	156,558	60.00	10,000	600,000	25.00	20,000	500,000	0.00	0	0	1,501,901	643	2,334.10
SEGMENT 3	590.68	1,200	708,816	278.79	600	167,272	80.00	10,000	800,000	35.00	20,000	700,000	0.00	0	0	2,376,088	984	2,413.58
SEGMENT 4	214.69	1,000	214,689	252.03	500	126,017	50.00	15,000	750,000	20.00	25,000	500,000	0.00	0	0	1,590,707	537	2,963.73
SEGMENT 5	356.31	1,000	356,313	655.48	500	327,740	80.00	10,000	800,000	35.00	20,000	700,000	0.00	0	0	2,184,054	1,127	1,938.29
SEGMENT 6	450.71	1,000	450,714	321.68	500	160,838	90.00	10,000	900,000	30.00	20,000	600,000	9.04	200	1,808	2,113,360	901	2,344.46
SEGMENT 7	62.27	1,000	62,270	14.36	500	7,180	5.00	10,000	50,000	1.00	20,000	20,000	6.33	200	1,265	140,716	89	1,581.83
SEGMENT 8	695.91	1,000	695,915	19.35	500	9,673	80.00	10,000	800,000	35.00	20,000	700,000	0.00	0	0	2,205,587	830	2,656.50
SEGMENT 10	185.94	1,000	185,939	35.63	500	17,816	20.00	10,000	200,000	5.00	20,000	100,000	9.04	200	1,808	505,563	256	1,977.87
TOTAL	3,199.57	1,037	3,317,706	2,347.36	512	1,201,561	545.00	10,459	5,700,000	221.00	20,452	4,520,000	24.40	200	4,881	14,744,147	6,337	2,326.55

	Agricultural			Forest			Residential			Commercial			Barren Land			R-O-W	Total	Cost per
	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Area (Hectare)	Unit Cost ($/Hectare)	Total Cost ($)	Costs ($)	Area (Hectare)	Hectare ($/Hectare)
SEGMENT 1	161.07	2,469	397,706	185.05	1,235	228,466	32.40	24,692	800,000	14.17	49,383	700,000	0.00	0	0	2,126,172	393	5,414.27
SEGMENT 2	99.36	2,469	245,343	126.81	1,235	156,558	24.30	24,692	600,000	10.12	49,383	500,000	0.00	0	0	1,501,901	261	5,763.30
SEGMENT 3	239.22	2,963	708,816	112.91	1,482	167,272	32.40	24,692	800,000	14.17	49,383	700,000	0.00	0	0	2,376,088	399	5,959.54
SEGMENT 4	86.95	2,469	214,689	102.07	1,235	126,017	20.25	37,038	750,000	8.10	61,729	500,000	0.00	0	0	1,590,707	217	7,317.96
SEGMENT 5	144.30	2,469	356,313	265.47	1,235	327,740	32.40	24,692	800,000	14.17	49,383	700,000	0.00	0	0	2,184,054	456	4,785.97
SEGMENT 6	182.54	2,469	450,714	130.28	1,235	160,838	36.45	24,692	900,000	12.15	49,383	600,000	3.66	494	1,808	2,113,360	365	5,788.86
SEGMENT 7	25.22	2,469	62,270	5.82	1,235	7,180	2.02	24,692	50,000	0.40	49,383	20,000	2.56	494	1,265	140,716	36	3,905.81
SEGMENT 8	281.84	2,469	695,915	7.83	1,235	9,673	32.40	24,692	800,000	14.17	49,383	700,000	0.00	0	0	2,205,587	336	6,559.35
SEGMENT 10	75.30	2,469	185,939	14.43	1,235	17,816	8.10	24,692	200,000	2.02	49,383	100,000	3.66	494	1,808	505,563	104	4,883.70
TOTAL	1,295.81	2,560.34	3,317,706	950.67	1,263.91	1,201,561	220.72	25,824.34	5,700,000	75.33	60,003	4,520,000	9.88	493.83	4,881	14,744,147	2,567	5,744.65

Base Case Construction Costs

ITEM	ITEM NO.	UNIT	UNIT PRICE	QUANTITY Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total	COSTS (IN THOUSANDS OF DOLLARS) Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total
Clearing	201M	HA	$1,500.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Grubbing	201M	HA	$1,500.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Obliterate Abandoned Road	202M	SM	$4.50	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Remove Old Concrete (Pavement)	202M	SM	$4.50	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Remove Existing Bridge Structure	205M	SM	$55.00	0	0	0	0	188	7555	0	232	2345	10320	$0	$0	$0	$0	$10	$416	$0	$13	$129	$568
Compacted Embankment	210M	CM	$2.10	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Unclassified Excavation	210M	CM	$18.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subgrade Preparation	214M	MSTA	$480.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Process Lime Treated Subgrade	301M	SM	$1.65	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Aggregate Surface Course (Shoulder)	304M	SM	$6.10	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
P.C.C. Pavement	501M	CM	$320.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Water	602M	KL	$0.03	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Guard Rail (Type A)	617M	M	$65.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mulch Cover	620M	HA	$1,800.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Seeding	620M	HA	$1,450.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Concrete Barrier Wall (Type A)	631M	M	$150.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bridge (New Construction)		SM	$570.00	0	0	0	0	188	7555	0	232	2345	10320	$0	$0	$0	$0	$107	$4,306	$0	$132	$1,337	$5,882
Bridge (Rehabilitation)		SM	$320.00	0	866	85	469	2398	553	116	1359	2217	8063	$0	$277	$27	$150	$767	$177	$37	$435	$709	$2,580
Bridge (Widen)		SM	$375.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Flashing Signal		EA	$20,000.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Fully-Actuated Signal		EA	$90,000.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Railroad Grade Separations		SM	$570.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Semi-Actuated Signal		EA	$50,000.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Striping & Signing		KM	$13,000.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
												Subtotal		$0	$277	$27	$150	$865	$4,899	$37	$580	$2,175	$9,030
Legal, Administrative, & Engineering			10%											$0	$28	$3	$15	$88	$490	$4	$58	$218	$903
Utilities Relocation			5%											$0	$14	$1	$8	$44	$245	$2	$29	$109	$452
Right-of-Way														$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Traffic Handling			5%											$0	$14	$1	$8	$44	$245	$2	$29	$109	$452
Mobilization			5%											$0	$14	$1	$8	$44	$245	$2	$29	$109	$452
Contingencies			20%											$0	$55	$5	$30	$177	$980	$7	$116	$435	$1,806
												Total		$0	$402	$39	$218	$1,283	$7,103	$54	$841	$3,154	$13,093 /32
												Cost per Kilometer		$0	$22	$2	$12	$36	$337	$18	$30	$356	$71
												Cost per Mile		$0	$35	$3	$20	$89	$542	$29	$48	$577	$114
																						Grand Total =	$13,094

Two-Lane Rural Arterial Construction Costs

ITEM	ITEM NO.	UNIT	UNIT PRICE	QUANTITY Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10	Total	COSTS (IN THOUSANDS OF DOLLARS) Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10	Total
Clearing	201M	HA	$1,500.00	11.37	13.2	21.24	11.35	21.67	35.86	0	2.3	0	117.21	$17	$20	$32	$17	$33	$54	$0	$3	$0	$176
Grubbing	201M	HA	$1,500.00	11.37	13.2	21.24	11.35	21.67	35.86	0	2.3	0	117.21	$17	$20	$32	$17	$33	$54	$0	$3	$0	$176
Obliterate Abandoned Road	202M	SM	$4.50	8320	8800	13920	3400	6096	10000	0	0	0	50536	$37	$40	$63	$15	$27	$45	$0	$0	$0	$227
Remove Old Concrete (Pavement)	202M	SM	$4.50	20458	0	2280	4867	42566	0	360	33840	0	104391	$92	$0	$10	$22	$192	$0	$2	$152	$0	$470
Remove Existing Bridge Structure	205M	SM	$55.00	0	0	0	0	188	7555	0	232	2345	10320	$0	$0	$0	$0	$10	$416	$0	$13	$129	$568
Compacted Embankment	210M	CM	$2.10	66144	56760	93691	53127	131966	174064	454	42683	0	618909	$139	$119	$197	$112	$277	$366	$1	$90	$0	$1,300
Unclassified Excavation	210M	CM	$18.00	124467	105600	174311	98842	245555	104052	271	29406	0	882504	$2,240	$1,901	$3,138	$1,779	$4,420	$1,873	$5	$529	$0	$15,885
Subgrade Preparation	214M	MSTA	$480.00	44.2	37.5	61.9	35.1	87.2	115	0.3	28.2	0	409.4	$21	$18	$30	$17	$42	$55	$0	$14	$0	$197
Process Lime Treated Subgrade	301M	SM	$1.65	65635	101100	74280	42120	137640	138000	360	33840	9405	602380	$108	$167	$123	$69	$227	$228	$1	$56	$16	$994
Aggregate Surface Course (Shoulder)	304M	SM	$6.10	32208	66960	29712	16848	40656	55200	144	13536	8208	263472	$196	$408	$181	$103	$248	$337	$1	$83	$50	$1,607
P.C.C. Pavement	501M	CM	$320.00	9211	10416	12925	7834	22011	27324	67	6498	581	96867	$2,948	$3,333	$4,136	$2,507	$7,044	$8,744	$21	$2,079	$186	$30,997
Water	602M	KL	$0.03	10260	8700	14360	8140	20230	22080	60	5420	0	89250	$0	$0	$0	$0	$1	$1	$0	$0	$0	$3
Guard Rail (Type A)	617M	M	$65.00	109.67	182.83	207.33	59.51	120.17	1844.67	0	56	592	3172.18	$7	$12	$13	$4	$8	$120	$0	$4	$38	$206
Mulch Cover	620M	HA	$1,800.00	10.26	8.7	14.36	8.14	20.23	22.08	0.06	5.42	0	89.25	$18	$16	$26	$15	$36	$40	$0	$10	$0	$161
Seeding	620M	HA	$1,450.00	10.26	8.7	14.36	8.14	20.23	22.08	0.06	5.42	0	89.25	$15	$13	$21	$12	$29	$32	$0	$8	$0	$129
Concrete Barrier Wall (Type A)	631M	M	$150.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bridge (New Construction)		SM	$570.00	658	1097	1244	732	721	11068	0	336	3552	19408	$375	$625	$709	$417	$411	$6,309	$0	$192	$2,025	$11,063
Bridge (Rehabilitation)		SM	$320.00	0	263	66	198	2397	553	614	1358	2217	7666	$0	$84	$21	$63	$767	$177	$196	$435	$709	$2,453
Bridge (Widen)		SM	$375.00	161	556	88	300	3688	841	724	2151	3358	11847	$60	$209	$33	$113	$1,376	$315	$272	$807	$1,259	$4,443
Flashing Signal		EA	$20,000.00	0	0	0	1	0	0	0	0	0	1	$0	$0	$0	$20	$0	$0	$0	$0	$0	$20
Fully-Actuated Signal		EA	$90,000.00	0	0	0	1	0	0	0	0	0	1	$0	$0	$0	$90	$0	$0	$0	$0	$0	$90
Railroad Grade Separations		SM	$570.00	0	0	0	0	4650	0	0	0	0	4650	$0	$0	$0	$0	$2,651	$0	$0	$0	$0	$2,651
Semi-Actuated Signal		EA	$50,000.00	2	0	3	3	3	0	0	0	0	11	$100	$0	$150	$150	$150	$0	$0	$0	$0	$550
Striping & Signing		KM	$13,000.00	30.1	16.25	24.75	17.1	33.5	21.1	3.02	28	8.8	184.62	$391	$237	$322	$222	$436	$274	$39	$364	$114	$2,400
												Subtotal		$6,764	$7,221	$9,236	$5,764	$18,416	$19,436	$538	$4,840	$4,527	$76,764
Legal, Administrative, & Engineering			10%											$678	$722	$924	$576	$1,842	$1,944	$54	$484	$453	$7,676
Utilities Relocation			5%											$339	$361	$462	$288	$921	$972	$27	$242	$226	$3,838
Right-of-Way														$954	$756	$437	$1,312	$614	$390	$12	$2,765	$6	$7,246
Traffic Handling			5%											$339	$361	$462	$288	$921	$972	$27	$242	$226	$3,838
Mobilization			5%											$339	$361	$462	$288	$921	$972	$27	$242	$226	$3,838
Contingencies			20%											$1,357	$1,444	$1,847	$1,153	$3,683	$3,888	$108	$968	$905	$15,353
												Total		$10,791	$11,227	$13,830	$9,670	$27,318	$28,574	$792	$9,783	$6,570	$116,553,684
												Cost per Kilometer		$359	$615	$559	$566	$815	$1,354	$262	$349	$747	$642
												Cost per Mile		$577	$990	$899	$910	$1,312	$2,179	$422	$562	$1,201	$1,033

Grand Total = $118,554

Multi-lane Rural Undivided Highway Construction Costs

ITEM	ITEM NO	UNIT	UNIT PRICE	QUANTITY										COSTS (IN THOUSANDS OF DOLLARS)									
				Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10	Total	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7	Seg 8	Seg 10	Total
Clearing	201M	HA	$1,500.00	65.88	44.98	52.05	43.13	64.39	58.07	2.93	37.67	1.99	371.09	$99	$67	$78	$65	$97	$87	$4	$57	$3	$557
Grubbing	201M	HA	$1,500.00	65.88	44.98	52.05	43.13	64.39	58.07	2.93	37.67	1.99	371.09	$99	$67	$78	$65	$97	$87	$4	$57	$3	$557
Obliterate Abandoned Road	202M	SM	$4.50	8320	6800	13920	3400	6096	10000	0	0	0	50536	$37	$40	$63	$15	$27	$45	$0	$0	$0	$227
Remove Old Concrete (Pavement)	202M	SM	$4.50	44478	1575	2650	14250	30310	0	0	35540	0	128803	$200	$7	$12	$64	$136	$0	$0	$160	$0	$580
Remove Existing Bridge Structure	205M	SM	$55.00	0	0	0	0	188	7555	0	232	2345	10320	$0	$0	$0	$0	$10	$416	$0	$13	$129	$568
Compacted Embankment	210M	CM	$2.10	213430	193410	223820	146700	276870	10590	2410	15963	237510	1320703	$448	$406	$470	$308	$581	$22	$5	$34	$499	$2,774
Unclassified Excavation	210M	CM	$18.00	397060	359640	416400	273040	515120	402390	8730	129880	0	2502480	$7,147	$6,477	$7,495	$4,915	$9,272	$7,243	$157	$2,338	$0	$45,045
Subgrade Preparation	214M	MSTA	$480.00	600.6	361.8	492.2	333	703.2	402.6	60.2	553.4	163.8	3670.6	$288	$174	$236	$160	$338	$193	$29	$266	$79	$1,762
Process Lime Treated Subgrade	301M	SM	$1.65	378130	330740	381945	178280	524772	372344	41310	403240	0	2610761	$624	$546	$630	$294	$866	$614	$68	$665	$0	$4,308
Aggregate Surface Course (Shoulder)	304M	CM	$6.10	144150	86780	118130	79420	159170	96620	14450	132820	39310	870850	$879	$529	$721	$484	$971	$589	$88	$810	$240	$5,312
P.C.C. Pavement	501M	CM	$320.00	81903	52690	76490	35860	113270	88230	8286	81130	22113	559972	$26,209	$16,861	$24,477	$11,475	$36,246	$28,234	$2,652	$25,962	$7,076	$179,191
Water	602M	KL	$0.03	69670	41950	57100	38630	76930	42100	5780	54720	15720	402600	$2	$1	$2	$1	$2	$1	$0	$2	$0	$12
Guard Rail (Type A)	617M	M	$65.00	109.71	182.86	207.24	121.9	120.1	1844.7	0	56.10	591.9	3234.48	$7	$12	$13	$8	$8	$120	$0	$4	$38	$210
Mulch Cover	620M	HA	$1,800.00	69.67	41.95	57.1	38.63	76.93	42.1	5.78	54.72	15.72	402.6	$125	$76	$103	$70	$138	$76	$10	$98	$28	$725
Seeding	620M	HA	$1,450.00	69.67	41.95	57.1	38.63	76.93	42.1	5.78	54.72	15.72	402.6	$101	$61	$83	$56	$112	$61	$8	$79	$23	$584
Concrete Barrier Wall (Type A)	631M	M	$150.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bridge (New Construction)		SM	$570.00	1152	1920	2176	1280	1261	19369	0	589	6215	33962	$657	$1,094	$1,240	$730	$719	$11,040	$0	$336	$3,543	$19,358
Bridge (Rehabilitation)		SM	$320.00	0	263	66	198	2397	553	614	1358	2217	7666	$0	$84	$21	$63	$707	$177	$196	$435	$709	$2,453
Bridge (Widen)		SM	$375.00	282	1370	154	7425	6420	1472	1997	3763	8161	31044	$106	$514	$58	$2,784	$2,400	$552	$749	$1,411	$3,060	$11,642
Flashing Signal		EA	$20,000.00	0	0	0	1	0	0	0	0	0	1	$0	$0	$0	$20	$0	$0	$0	$0	$0	$20
Fully Actuated Signal		EA	$90,000.00	0	0	0	1	0	0	0	0	0	1	$0	$0	$0	$90	$0	$0	$0	$0	$0	$90
Railroad Grade Separations		SM	$570.00	0	0	0	0	4650	0	0	0	0	4650	$0	$0	$0	$0	$2,651	$0	$0	$0	$0	$2,651
Semi-Actuated Signal		EA	$50,000.00	2	0	3	3	3	0	0	0	0	11	$100	$0	$150	$150	$150	$0	$0	$0	$0	$550
Striping & Signing		KM	$15,000.00	30.1	18.25	24.75	17.1	33.5	21.1	3.02	28	8.8	184.52	$451	$274	$371	$257	$503	$317	$45	$420	$132	$2,769
												Subtotal		$37,581	$27,290	$36,331	$22,074	$55,698	$49,574	$4,017	$33,144	$15,503	$281,243
Engr., Administrative, & Engineering			10%											$3,758	$2,729	$3,630	$2,207	$5,610	$4,987	$402	$3,314	$1,556	$28,194
Utilities Relocation			5%											$1,879	$1,364	$1,815	$1,104	$2,805	$2,494	$201	$1,657	$778	$14,097
Right-of-Way														$1,729	$1,079	$1,032	$2,636	$1,361	$880	$42	$146	$8	$9,115
Traffic Handling			5%											$1,879	$1,364	$1,815	$1,104	$2,805	$2,494	$201	$1,657	$778	$14,097
Mobilization			5%											$1,879	$1,364	$1,815	$1,104	$2,805	$2,494	$201	$1,657	$778	$14,097
Contingencies			20%											$7,516	$5,458	$7,260	$4,415	$11,220	$9,976	$803	$6,629	$3,113	$56,389
												Total		$56,221	$40,649	$53,698	$34,645	$82,734	$73,197	$5,867	$48,206	$22,574	$417,931
												Cost per Kilometer		$1,868	$2,207	$2,188	$2,035	$2,459	$3,469	$1,943	$1,722	$2,565	$2,284
												Cost per Mile		$3,006	$3,585	$3,460	$3,279	$3,873	$5,583	$3,126	$2,771	$4,128	$3,643

Grand Total = $417,932

Four-Lane Divided Rural Highway Construction Costs

ITEM	ITEM NO	UNIT	UNIT PRICE	QUANTITY Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total
Clearing	201M	HA	$1,500.00	125.33	78.79	114.99	44.36	128.12	97.93	8.92	94.44	14.96	707.84
Grubbing	201M	HA	$1,500.00	125.33	78.79	114.99	44.36	128.12	97.93	8.92	94.44	14.96	707.84
Obliterate Abandoned Road	202M	SM	$4.50	8320	8800	13920	3400	6096	10000	0	0	0	50536
Remove Old Concrete (Pavement)	202M	SM	$4.50	78700	12600	7940	19000	62000	0	0	36700	0	216940
Remove Existing Bridge Structure	205M	SM	$55.00	0	0	0	0	188	7555	0	232	2345	10320
Compacted Embankment	210M	CM	$2.10	545500	316155	438890	243850	603300	173950	7224	77477	352170	2758516
Unclassified Excavation	210M	CM	$18.00	1E+06	588200	808530	453679	1E+06	421030	26187	310240	0	4745166
Subgrade Preparation	214M	MSTA	$480.00	600.6	361.6	492.2	333	663.2	402.6	60.2	553.4	0	3466.8
Process Lime Treated Subgrade	301M	SM	$1.65	459800	265400	357400	192100	511400	360600	34300	355250	0	2536250
Aggregate Surface Course (Shoulder)	304M	SM	$6.10	166490	96500	133960	75030	184150	132850	12640	130860	34400	966880
P.C.C. Pavement	501M	CM	$320.00	74200	46320	66602	36730	97860	75150	6720	71760	20090	495412
Water	602M	KL	$0.03	94900	57130	77770	41630	105790	59010	8310	76370	22600	543510
Guard Rail (Type A)	617M	M	$65.00	246.33	496.17	429.17	146.34	851.5	3829.5	190.17	704.83	1961.2	8855.1748
Mulch Cover	620M	HA	$1,800.00	94.9	57.13	77.77	41.63	105.79	59.01	8.31	76.37	22.6	543.51
Seeding	620M	HA	$1,450.00	94.9	57.13	77.77	41.63	105.79	59.01	8.31	76.37	22.6	543.51
Concrete Barrier Wall (Type A)	631M	M	$150.00	0	0	0	17100	0	0	0	0	0	17100
Bridge (New Construction)		SM	$570.00	1478	2977	7575	1800	5109	22977	1141	4229	11767	54053
Bridge (Rehabilitation)		SM	$320.00	0	263	66	198	2397	553	614	1358	2217	7666
Bridge (Widen)		SM	$375.00	161	556	88	8383	3668	841	724	2151	3358	19930
Flashing Signal		EA	$70,000.00	0	0	0	1	0	0	0	0	0	1
Fully-Actuated Signal		EA	$90,000.00	0	0	0	1	0	0	0	0	0	1
Railroad Grade Separations		SM	$570.00	0	0	0	0	4650	0	0	0	0	4650
Semi-Actuated Signal		EA	$50,000.00	2	0	3	3	3	0	0	0	0	11
Striping & Signing		KM	$13,000.00	30.1	18.25	24.75	17.1	33.5	21.1	3.02	28	8.8	184.62

ITEM	COSTS (IN THOUSANDS OF DOLLARS) Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total
Clearing	$188	$118	$172	$67	$192	$147	$13	$142	$22	$1,062
Grubbing	$188	$118	$172	$67	$192	$147	$13	$142	$22	$1,062
Obliterate Abandoned Road	$37	$40	$63	$15	$27	$45	$0	$0	$0	$227
Remove Old Concrete (Pavement)	$354	$57	$36	$86	$279	$0	$0	$165	$0	$976
Remove Existing Bridge Structure	$0	$0	$0	$0	$10	$416	$0	$13	$129	$568
Compacted Embankment	$1,146	$664	$922	$512	$1,267	$365	$15	$163	$740	$5,793
Unclassified Excavation	$18,268	$10,588	$14,554	$8,166	$20,203	$7,579	$471	$5,584	$0	$85,413
Subgrade Preparation	$288	$174	$236	$160	$318	$193	$29	$266	$0	$1,664
Process Lime Treated Subgrade	$759	$438	$590	$317	$844	$595	$57	$586	$0	$4,185
Aggregate Surface Course (Shoulder)	$1,016	$589	$817	$458	$1,123	$810	$77	$798	$210	$5,898
P.C.C. Pavement	$23,744	$14,822	$21,313	$11,754	$31,315	$24,048	$2,150	$22,970	$6,416	$158,532
Water	$3	$2	$2	$1	$3	$2	$0	$2	$1	$16
Guard Rail (Type A)	$16	$32	$28	$10	$55	$249	$12	$46	$127	$576
Mulch Cover	$171	$103	$140	$75	$190	$106	$15	$137	$41	$978
Seeding	$138	$83	$113	$60	$153	$86	$12	$111	$33	$788
Concrete Barrier Wall (Type A)	$0	$0	$0	$2,565	$0	$0	$0	$0	$0	$2,565
Bridge (New Construction)	$842	$1,697	$1,468	$1,026	$2,912	$13,097	$650	$2,411	$6,707	$30,810
Bridge (Rehabilitation)	$0	$84	$21	$63	$767	$177	$196	$435	$709	$2,453
Bridge (Widen)	$60	$209	$33	$3,144	$1,376	$315	$272	$807	$1,259	$7,474
Flashing Signal	$0	$0	$0	$20	$0	$0	$0	$0	$0	$20
Fully-Actuated Signal	$0	$0	$0	$90	$0	$0	$0	$0	$0	$90
Railroad Grade Separations	$0	$0	$0	$0	$2,651	$0	$0	$0	$0	$2,651
Semi-Actuated Signal	$100	$0	$150	$150	$150	$0	$0	$0	$0	$550
Striping & Signing	$391	$237	$322	$222	$436	$274	$39	$364	$114	$2,400
Subtotal	$47,709	$30,053	$41,151	$29,027	$64,469	$48,651	$4,024	$35,140	$16,531	$316,750
Legal, Administrative, & Engineering 10%	$4,771	$3,005	$4,115	$2,903	$6,446	$4,865	$402	$3,514	$1,653	$31,675
Utilities Relocation 5%	$2,385	$1,503	$2,058	$1,451	$3,223	$2,433	$201	$1,757	$827	$15,838
Right-of-Way	$3,277	$1,962	$2,355	$3,566	$2,418	$1,242	$294	$453	$111	$15,678
Traffic Handling 5%	$2,385	$1,503	$2,058	$1,451	$3,223	$2,433	$201	$1,757	$827	$15,838
Mobilization 5%	$2,385	$1,503	$2,058	$1,451	$3,223	$2,433	$201	$1,757	$827	$15,838
Contingencies 20%	$9,542	$6,011	$8,230	$5,805	$12,893	$9,730	$805	$7,028	$3,306	$63,350
Total	$72,455	$45,539	$67,024	$45,655	$95,892	$71,786	$6,128	$51,405	$24,081	$474,966.157
Cost per Kilometer	$2,407	$2,495	$3,506	$2,670	$2,802	$3,402	$2,029	$1,836	$2,737	$2,573
Cost per Mile	$3,874	$4,016	$4,033	$4,297	$4,607	$5,475	$3,266	$2,955	$4,404	$4,140

Grand Total = $474,966

Four-Lane Freeway Construction Costs

ITEM	ITEM NO.	UNIT	UNIT PRICE	QUANTITY Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total	COSTS (IN THOUSANDS OF DOLLARS) Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7	Seg. 8	Seg. 10	Total
Clearing	201M	HA	$1,500.00	337.97	212.31	261.42	186.69	379.69	239.52	33.68	288.32	79.77	2019.57	$507	$318	$392	$280	$570	$359	$51	$432	$120	$3,029
Grubbing	201M	HA	$1,500.00	337.97	212.31	261.42	186.69	379.69	239.52	33.68	288.32	79.77	2019.57	$507	$318	$392	$280	$570	$359	$51	$432	$120	$3,029
Obliterate Abandoned Road	202M	SM	$4.50	8320	8800	13920	3400	6096	10000	0	0	0	50536	$37	$40	$63	$15	$27	$45	$0	$0	$0	$227
Remove Old Concrete (Pavement)	202M	SM	$4.50	98482	29180	20160	29085	72315	1076	2880	50520	2953	306651	$443	$131	$91	$131	$325	$5	$13	$227	$13	$1,380
Remove Existing Bridge Structure	205M	SM	$55.00	0	0	0	0	155	7555	0	232	2345	10320	$0	$0	$0	$0	$10	$416	$0	$13	$129	$568
Compacted Embankment	210M	CM	$2.10	1377996	820176	1084944	745584	1492176	171288	17550	177876	352170	6239700	$2,894	$1,722	$2,278	$1,566	$3,134	$360	$37	$374	$740	$13,103
Unclassified Excavation	210M	CM	$18.00	[illegible]	1573104	2062336	1447056	2858544	773136	86580	870198	24960	12294858	$46,961	$28,316	$36,942	$26,047	$51,454	$13,916	$1,558	$15,664	$449	$221,307
Subgrade Preparation	214M	MSTA	$480.00	752.6	513.6	606.2	523	969.2	554.6	98.2	667.4	0	4684.8	$361	$247	$291	$251	$465	$266	$47	$320	$0	$2,249
Process Lime Treated Subgrade	301M	SY	$1.65	658195	505500	504840	461880	839700	537120	78120	499920	0	4085275	$1,086	$834	$833	$762	$1,386	$886	$129	$825	$0	$6,741
Aggregate Surface Course (Shoulder)	304M	CM	$6.10	[illegible]	204528	183792	154512	309168	190656	26200	181824	67920	1563840	$1,502	$1,248	$1,121	$943	$1,886	$1,163	$154	$1,109	$414	$9,539
P.C.C. Pavement	501M	CM	$320.00	107901	79627	88091	83978	159470	102927	14144	94121	35023	758282	$34,528	$25,481	$28,189	$26,873	$48,790	$32,937	$4,526	$30,119	$11,207	$242,650
Water	602M	KL	$0.03	213980	127750	170240	116510	232890	159940	18090	174140	47660	1261200	$6	$4	$5	$3	$7	$5	$1	$5	$1	$38
Guard Rail (Type A)	617M	M	$65.00	1318.3	1568.2	1233.2	2291.5	2727.5	4901.5	458.17	1508.8	2497.2	18504.33	$86	$102	$80	$149	$177	$319	$30	$98	$162	$1,203
Mulch Cover	620M	HA	$1,800.00	213.98	127.75	170.24	116.51	232.89	159.94	18.09	174.14	47.66	1261.2	$385	$230	$306	$210	$419	$288	$33	$313	$86	$2,270
Seeding	620M	HA	$1,450.00	213.98	127.75	170.24	116.51	232.89	159.94	18.09	174.14	47.66	1261.2	$310	$185	$247	$169	$338	$232	$26	$253	$69	$1,829
Concrete Barrier Wall (Type A)	631M	M	$150.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bridge (New Construction)		SM	$570.00	7910	9409	7399	13749	16365	29409	2749	9053	14983	111026	$4,509	$5,363	$4,217	$7,837	$9,328	$16,763	$1,567	$5,160	$8,540	$63,285
Bridge (Rehabilitation)		SM	$320.00	0	263	66	198	2397	553	614	1358	2217	7666	$0	$84	$21	$63	$767	$177	$196	$435	$709	$2,453
Bridge (Widen)		SM	$375.00	161	556	88	300	3668	841	724	2151	3358	11847	$60	$209	$33	$113	$1,376	$315	$272	$807	$1,259	$4,443
Flashing Signal		EA	$20,000.00	0	0	0	1	0	0	0	0	0	1	$0	$0	$0	$20	$0	$0	$0	$0	$0	$20
Fully-Actuated Signal		EA	$90,000.00	0	0	0	1	0	0	0	0	0	1	$0	$0	$0	$90	$0	$0	$0	$0	$0	$90
Railroad Grade Separations		SM	$570.00	0	0	0	0	4650	0	0	0	0	4650	$0	$0	$0	$0	$2,651	$0	$0	$0	$0	$2,651
Semi-Actuated Signal		EA	$50,000.00	2	0	3	3	3	0	0	0	0	11	$100	$0	$150	$150	$150	$0	$0	$0	$0	$550
Striping & Signing		KM	$15,000.00	38.1	26.25	30.75	27.1	47.5	29.1	5.02	34	12.8	250.62	$571	$394	$461	$407	$713	$437	$75	$510	$192	$3,759
												Subtotal		$94,855	$66,225	$76,114	$66,359	$124,541	$69,247	$8,764	$57,096	$24,212	$580,413
Legal, Administrative, & Engineering			10%											$9,485	$6,523	$7,611	$6,636	$12,454	$6,925	$876	$5,710	$2,421	$58,641
Utilities Relocation			5%											$4,743	$3,261	$3,806	$3,318	$6,227	$3,462	$438	$2,855	$1,211	$29,321
Right-of-Way														$2,351	$1,661	$2,627	$1,759	$2,415	$2,337	$156	$2,439	$559	$16,304
Traffic Handling			5%											$4,743	$3,261	$3,806	$3,318	$6,227	$3,462	$438	$2,855	$1,211	$29,321
Mobilization			5%											$4,743	$3,261	$3,806	$3,318	$6,227	$3,462	$438	$2,855	$1,211	$29,321
Contingencies			20%											$18,971	$13,045	$15,223	$13,272	$24,908	$13,849	$1,753	$11,419	$4,842	$117,283
												Total		$139,891	$96,238	$112,992	$97,979	$183,000	$102,746	$12,864	$85,228	$35,665	$866,603.084
												Cost per Kilometer		$3,672	$3,666	$3,675	$3,615	$3,853	$3,531	$2,563	$2,507	$2,785	$3,458
												Cost per Mile		$5,909	$5,900	$5,913	$5,818	$6,200	$5,682	$4,124	$4,034	$4,484	$5,565

Grand Total = $866,603

Interim Improvements Construction Costs

				QUANTITY										COSTS (IN THOUSANDS OF DOLLARS)									
ITEM	ITEM NO.	UNIT	UNIT PRICE	Four-Lane at Paragould	Four-Lane at Black Rock	Widen Lanes at Salem	Hardy Bypass	Black Rock Bypass	Imboden Bypass	Black Rock Bridges	Flat Board Bridge	Traffic Lights	Total	Four-Lane at Paragould	Four-Lane at Black Rock	Widen Lanes at Salem	Hardy Bypass	Black Rock Bypass	Imboden Bypass	Black Rock Bridges	Flat Board Bridge	Traffic Lights	Total
Clearing	201M	HA	$1,500.00	29.57	161.41	43.47	19.84	69	32.64	0	0	1.1	357.03	$44	$242	$65	$30	$104	$49	$0	$0	$2	$536
Grubbing	201M	HA	$1,500.00	29.57	161.41	43.47	19.84	69	32.64	0	0	1.1	357.03	$44	$242	$65	$30	$104	$49	$0	$0	$2	$536
Obliterate Abandoned Road	202M	SM	$4.50	0	0	0	3400	10000	0	0	0	0	13400	$0	$0	$0	$15	$45	$0	$0	$0	$0	$60
Remove Old Concrete (Pavement)	202M	SM	$4.50	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Remove Existing Bridge Structure	205M	SM	$55.00	0	0	0	0	0	0	7000	0	0	7000	$0	$0	$0	$0	$0	$0	$385	$0	$0	$385
Compacted Embankment	210M	CM	$2.10	8888	396900	41400	95232	66240	156672	0	0	0	765332	$19	$833	$87	$200	$139	$329	$0	$0	$0	$1,607
Unclassified Excavation	210M	CM	$18.00	52520	211680	77625	178560	257600	293760	0	0	0	1071745	$945	$3,810	$1,397	$3,214	$4,637	$5,288	$0	$0	$0	$19,291
Subgrade Preparation	214M	MSTA	$480.00	161.5	682	345	62	230	102	0	0	11	1793.6	$78	$423	$166	$30	$110	$49	$0	$0	$5	$861
Process Lime Treated Subgrade	301M	SM	$1.65	96960	529200	51750	74400	276000	122400	0	0	3960	1154670	$160	$873	$85	$123	$455	$202	$0	$0	$7	$1,905
Aggregate Surface Course (Shoulder)	304M	SM	$6.10	38784	211680	82800	29760	110400	48960	0	0	5280	527664	$237	$1,291	$505	$182	$673	$299	$0	$0	$32	$3,219
P.C.C. Pavement	501M	CM	$320.00	25452	123768	4312	13838	54848	22768	0	0	1102	245887	$8,145	$39,606	$1,380	$4,428	$17,487	$7,285	$0	$0	$353	$78,684
Water	602M	KL	$0.03	29570	161410	43470	19840	69000	32640	0	0	1100	357030	$1	$5	$1	$1	$2	$1	$0	$0	$0	$11
Guard Rail (Type A)	617M	M	$65.00	0	0	0	122	1646	73	1,167	0	0	3,008	$0	$0	$0	$8	$107	$5	$76	$0	$0	$196
Mulch Cover	620M	HA	$1,800.00	29.57	161.41	43.47	19.84	69	32.64	0	0	1.1	357.03	$53	$291	$78	$36	$124	$59	$0	$0	$2	$643
Seeding	620M	HA	$1,450.00	29.57	161.41	43.47	19.84	69	32.64	0	0	1.1	357.03	$43	$234	$63	$29	$100	$47	$0	$0	$2	$518
Concrete Barrier Wall (Type A)	631M	M	$150.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bridge (New Construction)		SM	$570.00	0	0	0	732	9876	439	7000	0	0	18047	$0	$0	$0	$417	$5,629	$250	$3,990	$0	$0	$10,287
Bridge (Rehabilitation)		SM	$320.00	0	0	0	0	0	0	0	227	0	227	$0	$0	$0	$0	$0	$0	$0	$73	$0	$73
Bridge (Widen)		SM	$375.00	486	3630	0	0	0	0	0	0	0	4116	$182	$1,361	$0	$0	$0	$0	$0	$0	$0	$1,544
Flashing Signal		EA	$20,000.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Fully-Actuated Signal		EA	$90,000.00	0	0	0	0	0	0	0	0	1	1	$0	$0	$0	$0	$0	$0	$0	$0	$90	$90
Railroad Grade Separations		SM	$570.00	0	0	0	0	0	0	0	0	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Semi-Actuated Signal		EA	$50,000.00	0	0	0	0	0	0	0	0	7	7	$0	$0	$0	$0	$0	$0	$0	$0	$350	$350
Striping & Signing		KM	$13,000.00	8.08	44.1	17.25	3.1	11.5	5.1	0	0	1.1	90.33	$105	$573	$224	$40	$150	$66	$0	$0	$14	$1,173
												Subtotal		$10,096	$49,785	$4,119	$8,782	$29,867	$13,976	$4,451	$73	$858	$121,996
Legal, Administrative, & Engineering			10%											$1,006	$4,979	$412	$878	$2,987	$1,398	$445	$7	$86	$12,197
Utilities Relocation			5%											$503	$2,489	$206	$439	$1,493	$699	$223	$4	$43	$6,098
Right-of-Way														$0	$0	$0	$724	$208	$82	$0	$0	$0	$1,014
Traffic Handling			5%											$503	$2,489	$206	$439	$1,493	$699	$223	$4	$43	$6,098
Mobilization			5%											$503	$2,489	$206	$439	$1,493	$699	$223	$4	$43	$6,098
Contingencies			20%											$2,011	$9,957	$824	$1,756	$5,973	$2,796	$890	$15	$172	$24,393
												Total		$14,581	$72,189	$5,971	$13,457	$43,015	$20,349	$6,454	$105	$1,244	$177,865
												Cost per Kilometer		$1,806	$1,637	$346	$4,341	$3,784	$3,990	N/A	N/A	N/A	$1,971
												Cost per Mile		$2,904	$2,634	$557	$6,986	$6,089	$6,421	N/A	N/A	N/A	$3,172
																						Grand Total	$177,865

Appendix F

Glossary of Terms

KEYWORDS

Alignment The route or path of an existing or proposed roadway.

At-grade Intersection The crossing of two roadways at normal street level.

Average Daily Trips A measure of the number of new average daily trips when compared to the base case alternative.

Base Case The alternative improvement concept against which all other alternatives are compared. The base case assumes that all Committed Improvements will be in place by the design year. This alternative proposes no additional capacity improvements and assumes only a continued maintenance program.

Bypass The re-routing of a roadway, typically around a community, to minimize impacts to the community while optimizing "through" traffic movements.

Capacity The maximum rate of flow at which vehicles can be reasonably expected to traverse a point or uniform segment of a lane or roadway during a specified time period under prevailing roadway, traffic, and control conditions, usually expressed as *vehicles per hour* (veh/hr).

Clear Zone The unobstructed, relatively flat area provided beyond the edge of the roadway shoulder for the recovery of errant vehicles. Roadway design criteria normally specifies a "clear zone" width which should be kept free of fixed objects.

Committed Improvements Planned roadway improvement projects in which funding has been allocated, but which have not yet been constructed.

Constructability Measures qualitatively the relative degree of construction difficulty and complexity for each Proposed Alternative.

Construction Time An estimate of the time required to complete the Proposed Alternatives.

Cost Effectiveness The relative ratio of benefit to cost.

Deflator A multiplier used in economic analysis to adjust cost estimates to the base year of the economic model. Deflators account for the changes in actual value of the dollar over time. Price changes need to be accounted for; otherwise, the impacts will be estimated incorrectly.

Density The number of vehicles occupying a given length of lane or roadway averaged over time, usually expressed as vehicles per mile or vehicles per mile per lane.

Descriptive Model The first phase of an input/output analysis. It includes information about local economic interactions.

Differential Operations & Maintenance Costs Measures the increase in annual O&M costs for each Proposed Alternative as compared to the base case, based on per lane-kilometer historical costs for similar facilities in the State of Arkansas.

Direct Benefits The value of the final demand created by the highway improvements within the project area.

Direct Effects The changes in the industries where a final demand was made.

Discounted Benefit Cost Ratio Measures the relationship between the benefit's present value and the cost's present value based on an assumed 7% discount rate (as recommended by the US Office of Management and Budget) for each Proposed Alternative over a 30-year design period.

Draft Environmental Assessment The preliminary document required by the Environmental Protection Agency for most major roadway projects to assess potential environmental impacts if the project is constructed.

East-West Transamerica Corridor A transportation corridor defined in the 1991 Intermodal Surface Transportation Act ("ISTEA") connecting the east and west coasts, and including the section of US 412 through northern Arkansas.

Expressway A partially or fully access controlled highway which may or may not be divided or have grade separations at intersections.

Final Environmental Assessment — The final document required by the Environmental Protection Agency ("EPA") for most major roadway projects to assess potential environmental impacts if the project is constructed.

Fixed Commodity Input Structure — An assumption in economic studies that price changes do not cause a firm to buy substitute goods. Assumes that changes in the economy will affect the industry's output but not the mix of commodities and services it requires to make its products

Four-Lane Freeway — This alternative proposes to convert the existing two-lane/two-way roadway to a one-way roadway and build a parallel two-lane/one-way road. The resulting roadway would have full control of access with higher design speeds than a two-lane road.

Four-Lane Divided Rural Highway — This alternative proposes to convert the existing two-lane/two-way roadway to a one-way roadway and build a parallel two-lane/one-way road. Due to geometric design requirements the existing roadway would have to be improved at selected locations. This proposed roadway would have unlimited access (no control of access).

Freeway — A highway devoted entirely to the task of traffic movement, with full control of access and egress, and on which all crossing conflicts are removed by grade separation.

Grade — Synonymous with "slope".

Grade Separated Freeway — A roadway facility that goes over or under an intersecting roadway, such that direct vehicular conflicts are completely avoided.

Hazardous Material Sites — Sites which may contain potentially hazardous materials and are reported and registered with federal, state, or local regulatory agencies.

Homogeneous Sector Output — An assumption in economic studies that the proportions of all the commodities produced by an industry remain the same, regardless of total output. An industry will not increase the output of one product without proportionately increasing the output of all its other products

Impact Analysis — An assessment of change in overall economic activity as a result of some change in one or several economic activities.

Improved Two-Lane Rural Arterial — This alternative consists of localized improvements to the existing two-lane/two-way section. Some of the localized improvements include: providing full continuous shoulders on both sides, climbing lanes where necessary and bypasses around urban areas where necessary.

Indirect Effects — The changes in inter-industry purchases as they respond to the new demands of the directly affected industries: those industries supporting highway construction.

Indirect Impact — The sum of all the intermediate goods and services needed to produce the final demand: the industry-to-industry sales.

Induced Effects — reflect changes in spending from households as income increases due to changes in production: a new highway.

Induced Impact — Increased household consumption resulting from highway construction and use.

Input/Output Analysis — A means of examining relationships within an economy both between businesses and between business and final consumers. It captures all monetary market transactions for consumption in a given time period. The resulting mathematical formulae allow one to examine the effects of a change in one or several economic activities on an entire economy (impact analysis).

Interim Improvements — Roadway improvements that are recommended as a *temporary* solution until full funding can be obtained for the Recommended Alternative improvements

Internal Rate of Return — The discount rate at which the net present value difference between costs and benefits is zero.

Interstate Standards — Roadway design standards established by the Federal Highway Administration for the design and construction of the Interstate system of highways constructed beginning in the 1950's.

Land Use — The categorization of land according to its primary function (e.g., farming, timber production, agricultural, etc.).

Leontief Inverse — The mathematical derivation of multipliers that reflect direct and indirect chain reaction effects of Industries producing goods and services for consumption, who must purchase goods and services from other producers, and so on.

Manual on Uniform Traffic Control Devices — A standard adopted by the by the U.S. Department of Transportation providing for the uniform application of traffic control devices including signs, signals, and pavement markings, on all highways open to public travel.

Margins — The difference between producer and purchaser prices

Mississippi Embayment Physiographic Region — A structural trough on the east side of Arkansas, with flat to rolling terrain and primarily comprised of alluvial soils underlain with marine and non-marine deposits.

Mitigation — The implementation of appropriate measures or strategies to minimize the effects of construction on existing resources such as environmental, cultural, archeological and historical, etc.

Net Present Value — The arithmetic difference between the discounted costs and the discountec benefits for each proposed alternative.

1994 Highway Capacity Manual — The latest revision of the document that is the accepted industry standard used by professional transportation engineers to assess the capacity and quality of service for key elements of transportation systems. The document is published by the Transportation Research Board ("TRB"), a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering.

Ozark Highlands — A physiographic region located west of the Mississippi Embayment, with steep to rolling topography and geologic conditions predominated by limestone, dolomite, chert, shale, and sandstone.

Peak Hour — The hour during the day at which the heaviest traffic volume is experienced.

Percentile Values — Assigns, for each MOE, the highest value as 100%, and all others as a percentage of the highest MOE.

Person Capacity — Measures the carrying capacity of a given facility in person trips for a specific location in the study corridor.

Physiographic Region — A region in which all parts are similar in geologic structure and climate and which has had a unified geomorphic history; relief features differ significantly from adjacent regions.

Predictive Model — Application of multipliers that describe the response of the economy to a stimulus (a change in demand or production).

Primary Input-Output Studies — Economic studies based on data collected directly from industries. An example is the United States Benchmark Study of Input-Output Accounts (the data is actually based on economic census collected directly from firms).

Producer Prices — The price paid for an industry's output or product at the factory door.

Proposed Alternatives — Roadway improvement options developed during the course of the Study which include elements such as capacity improvements (new construction), bypasses, traffic signals, and an ongoing operations and maintenance program.

Purchaser Prices — Price paid at the retail level. A purchaser price actually includes a mix of producer elements. For instance, the price of a roll of film from a retail outlet includes the retail markup, wholesale markup, transportation costs from the producer to the retailer and the price at the factory door.

Ranked Values — Ranking of the MOE's on a scale of 1 to 5, the most desirable value being 5 and least desirable being 1 (it recognizes that for some MOE's a high value is better, and for other MOE's a low value is better), and all others as a pro-rated value in between.

Raw Values — Presentation of the data calculated for this study in their original units and quantities. Some of these may be qualitative measures.

Residual Value — The percentage of the capital investment that will remain beyond the 30-year design life.

Secondary Input-Output Studies	Studies that rely on data collected from other sources to construct accounts. The inter-industry transaction information usually comes from some other primary study. IMPLAN is an example of a secondary input-output modeling system.
Social Accounting Data	Data used in a descriptive model which includes tax collection by governments and payments to households and businesses.
Study	US 412 Corridor Planning Study.
Supply Constraints	An assumption in economic studies that supplies are unlimited: an industry has unlimited access to raw materials and its output is limited only by the demand for its products
Trade Flows	The movement of goods and services between a region and the outside world (regional imports and exports).
Trip Time	The total travel time required to traverse each corridor segment for an average loaded truck. Computed by multiplying the segment length by the average vehicle speed for each segment determined from capacity analysis.
Vehicle Hours Travelled	Measures the change in vehicle hours traveled for each Proposed Alternative as compared to the base case.
Vehicle Operating Costs	Quantifies the dollar savings obtained from the reduction in VKT by multiplying the VKT for each Proposed Alternative by the IRS s standard $0.31 per mile ($0.19 per kilometer) for 1996 vehicle operating costs.
Volume	The number of vehicles passing a point on a lane, roadway, or other trafficway during some time interval, often taken to be 1 hour, expressed in vehicles.
Volume to Capacity (V/C) Ratio	The ratio of demand flow rate to capacity for a traffic facility.
Wetlands	A lowland area such as a marsh or swamp that is saturated with moisture and supports a natural wildlife habitat.

ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway & Transportation Officials
ADPC&E	Arkansas Department of Pollution Control & Ecology
ADT	Average Daily Traffic
AHTD	Arkansas State Highway and Transportation Department
AIRS	Aerometric Information Retrieval System
AS&WCC	Arkansas Soil and Water Conservation System
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
CICIS	Chemicals in Commerce Information System
CO	Carbon Monoxide
COE	Corps of Engineers
CTEIM	County Travel Economic Impact Model
CWA	Clean Water Act
dBA	A-weighted decibel
E-18	18-kip equivalent single axle load
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FFIS	Federal Facility Information System
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FSA	Flood Security Act
HIP	Highway Improvement Program
IMPLAN	Impact Analysis Model for Planning
IRS	Internal Revenue Service
ISTEA	Intermodal Surface Transportation Efficiency Act
k	Design Modulus of Subgrade Reaction
K-factor	The quotient of the length of crest vertical curve divided by the algebraic difference in grades of the two tangent sections.
Kg	Kilogram
LAN	Lockwood, Andrews & Newnam, Inc.
LOS	Level of Service
LS	Loss of Support
LUST	Leaking Underground Storage Tank
mg/l	milligrams per liter
MIG, Inc.	Minnesota IMPLAN Group, Inc.
MoDOT	Missouri Department of Transportation
MOE	Measure of Effectiveness
M_R	Resilient Modulus
MUTCD	Manual on Uniform Traffic Control Devices
MVM	Million vehicle miles
MVMT	Million Vehicles Miles Travelled
NAAQS	National Ambient Air Quality Standards
NAC	Noise Abatement Criteria
NCDB	National Compliance Database
NFRAP	No Further Remedial Action Planned
NO_x	Nitrous Oxide emissions
NPDES	National Pollution Discharge Elimination System
NRCS	National Resource Conservation Service
O&M	Operation & Maintenance
PADS	PCB Handler Activity Data System
PCS	Permit Compliance System
PDO	Property Damage Only accident
PM_{10}	Particulate Matter less than 10 Microns in Diameter
PWA	Preliminary Wetlands Assessment
RAATS	Resource Administrative Action Tracking System
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RCRIS-LG	Resource Conservation and Recovery Information System - Large Quantity Generators
RCRIS-TSC	Resource Conservation and Recovery Information System - Small Quantity Generators
RCRIS-TSD	Resource Conservation and Recovery Information System - Total Dissolved Solids
ROW	Right-of-Way
RST	Regulatory Storage Tanks
SAM	Social Accounting Matrix
SARA	Superfund Amendment and Reauthorization Act of 1986
SMCL	Secondary Maximum Contaminate Level
SO_x	Sulfur Oxide emissions
SSTS	Section Seven Tracking System
STAMINA 2	A model for noise calculations developed by the Federal Highway Administration
SWPPP	Storm Water Pollution Prevention Plan
TIP	Transportation Improvement Program
TRIS	Toxic Chemical Release Inventory
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound emissions
VKT	Vehicle Kilometers Travelled
VPD	Vehicles per day
VPH	Vehicles per hour
WHPP	Wetland Protection Program