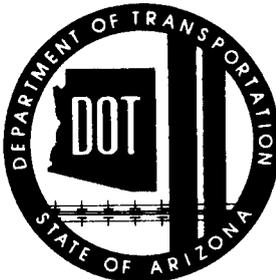


PHASE I REPORT

I-10 CORRIDOR REFINEMENT STUDY

16TH STREET TO SOUTHERN AVENUE



ARIZONA
DEPARTMENT OF TRANSPORTATION

Submitted by

DMJM

in association with

JACK E. LEISCH & ASSOCIATES

APPROVED FOR SUBMITTAL
DATE: 10/14/03
BY: [Signature]
JACK E. LEISCH & ASSOCIATES

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February 1987

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EXECUTIVE SUMMARY

Phase I of the I-10 Corridor Refinement Study involves the analysis and evaluation of the future operations of the following sections of this facility:

- o I-10 from Buckeye Road to Southern Avenue.
- o I-17 from 16th Street to the I-10 Interchange.

The Final Report of the I-10 Corridor Study - 40th Street to Baseline Road, submitted to the Arizona Department of Transportation during October, 1986, by DMJM in association with Jack E. Leisch & Associates (JEL), recommended a Collector-Distributor (C-D) road system on the I-10 Corridor from the Hohokam Expressway to the Superstition Freeway. Subsequently, the I-17/I-10 Corridor Study prepared by JHK & Associates recommended the extension of the C-D road system on I-10 from the Hohokam Expressway to the I-10/I-17 interchange.

The purpose of this study was to conduct a geometric and operational assessment of the currently programmed improvements to I-10 from Buckeye Road to 40th Street and the recommended improvements from 40th Street to Southern Avenue. This evaluation formed the basis for determining the adequacy of the programmed improvements to accommodate the forecasted design year traffic and the need for future modification and/or for the extension of the C-D road system.

A Level of Service (LOS) analysis was performed for each of the freeway segments, ramp junctions and weaving areas for the 2005 design year. Freeway segments of the I-10 Corridor which would experience future operation deficiencies (LOS E & F) include:

- o I-10 Eastbound, 24th Street to Hohokam Expressway.
- o I-10 Westbound, Hohokam Expressway to 24th Street.

Conversely, the segments which would experience satisfactory operations (LOS C & D) in the future include:

- o I-10 in both directions, north of its interchange with I-17.
- o I-17 in both directions, west of its interchange with I-10.
- o I-10 in both directions, east of the Hohokam Expressway.

The evaluation of the I-10 Corridor indicates the future need for the extension of the C-D road system from the Hohokam Expressway to the interchange at I-17. This is a critical time in the planning process to develop and assess alternative improvement schemes, including collector-distributor roadways. This is essentially to ensure that: This section of I-10 will be in balance with the remainder of the system; the required right-of-way is preserved; minimum reconstruction of the programmed section is necessary to accommodate future traffic demand, and; the useful life of the facility is extended beyond 2005.

Based on this study, it is recommended that the following actions be undertaken:

- o Proceed with the programmed construction of I-10 from the I-17 interchange to 40th Street and open to traffic.
- o The C-D road system should be incorporated into the long range improvement plan (15-20 years hence) for I-10 from the I-17 interchange to the Superstition Freeway.
- o Proceed with the design and construction of Phase I, Project 1 (40th Street to Baseline Road) as quickly as possible and open to traffic.
- o Proceed with Phases II and III of this study to determine the concept and design for the C-D road system to provide the framework for future improvements and right-of-way reservations.

I. INTRODUCTION

SCOPE OF STUDY

Phase I of the I-10 Corridor Refinement Study, consisting of the analysis and evaluation of the future operations on this facility, is summarized in this report. The limits of the project, as shown in Figure 1, include:

- o I-10 from Buckeye Road to Southern Avenue.
- o I-17 from 16th Street to the I-10 Interchange.

The first phase of this project evaluates the design year operational and geometric features of this section of the I-10 Corridor. Included are a combination of the currently programmed improvements between Buckeye Road and 40th Street and the recommended improvements between 40th Street and Southern Avenue. A "single line" plan of the I-10 Corridor showing the programmed and proposed improvements is presented in Figure 2. This assessment formed the basis for determining the adequacy of the programmed improvements to accommodate the forecasted design year traffic. Recommendations were developed regarding the need for future modifications or improvements and/or for the extension of the collector-distributor (C-D) road system on I-10 from the Hohokam Expressway to the I-17 interchange. Phase II of this study involves the development of alternative improvement schemes and Phase III, the preparation of functional plans of the selected alternatives.

STUDY BACKGROUND

During October, 1986, DMJM, in association with Jack E. Leisch & Associates (JEL), submitted a final report on the I-10 Corridor Study - 40th Street to Baseline Road to the Arizona Department of Transportation (ADOT). In the development of the improvement plan, a number of variations of three concept alternatives, shown schematically in Figure 3, were prepared and evaluated:

STUDY AREA

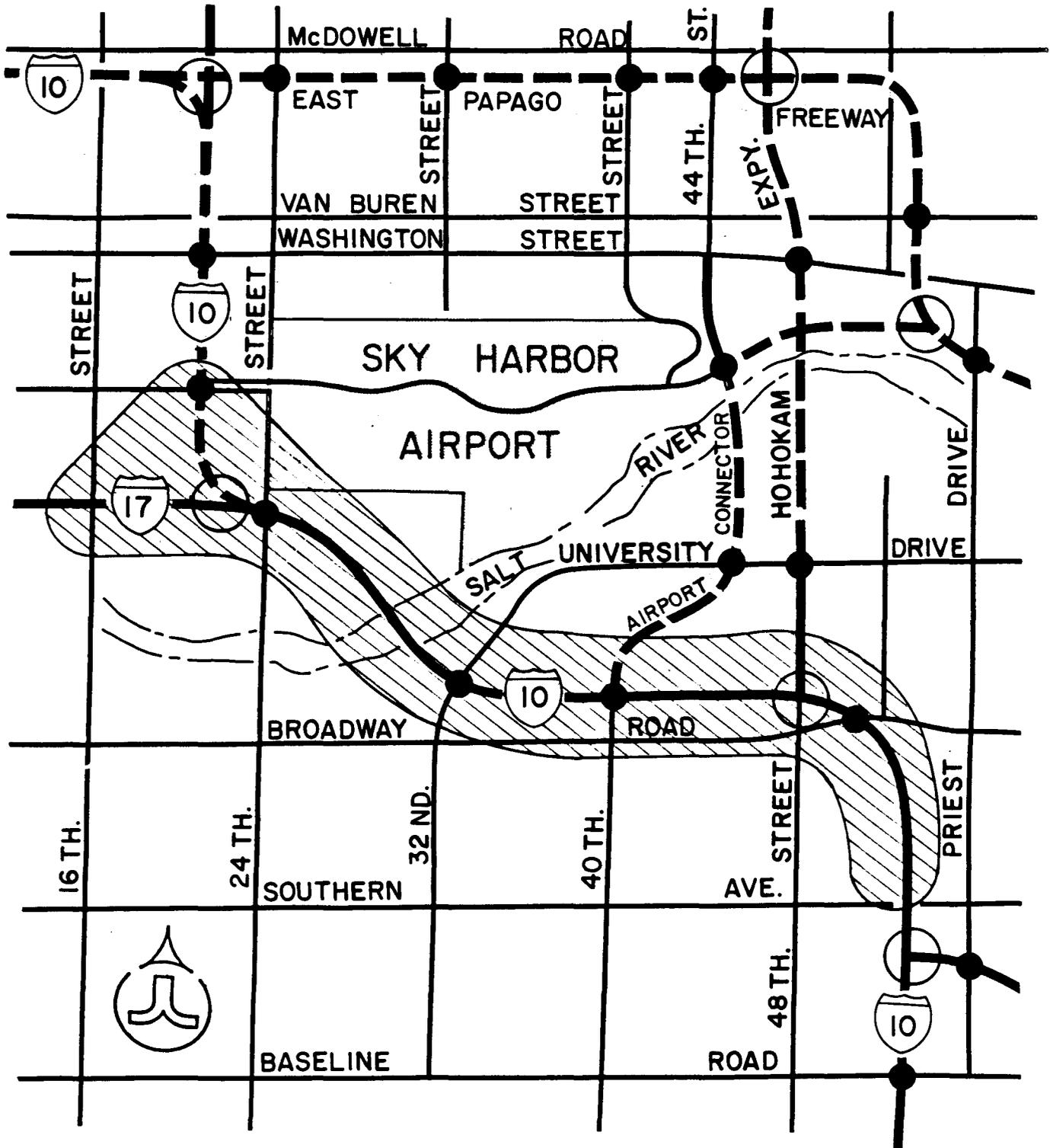
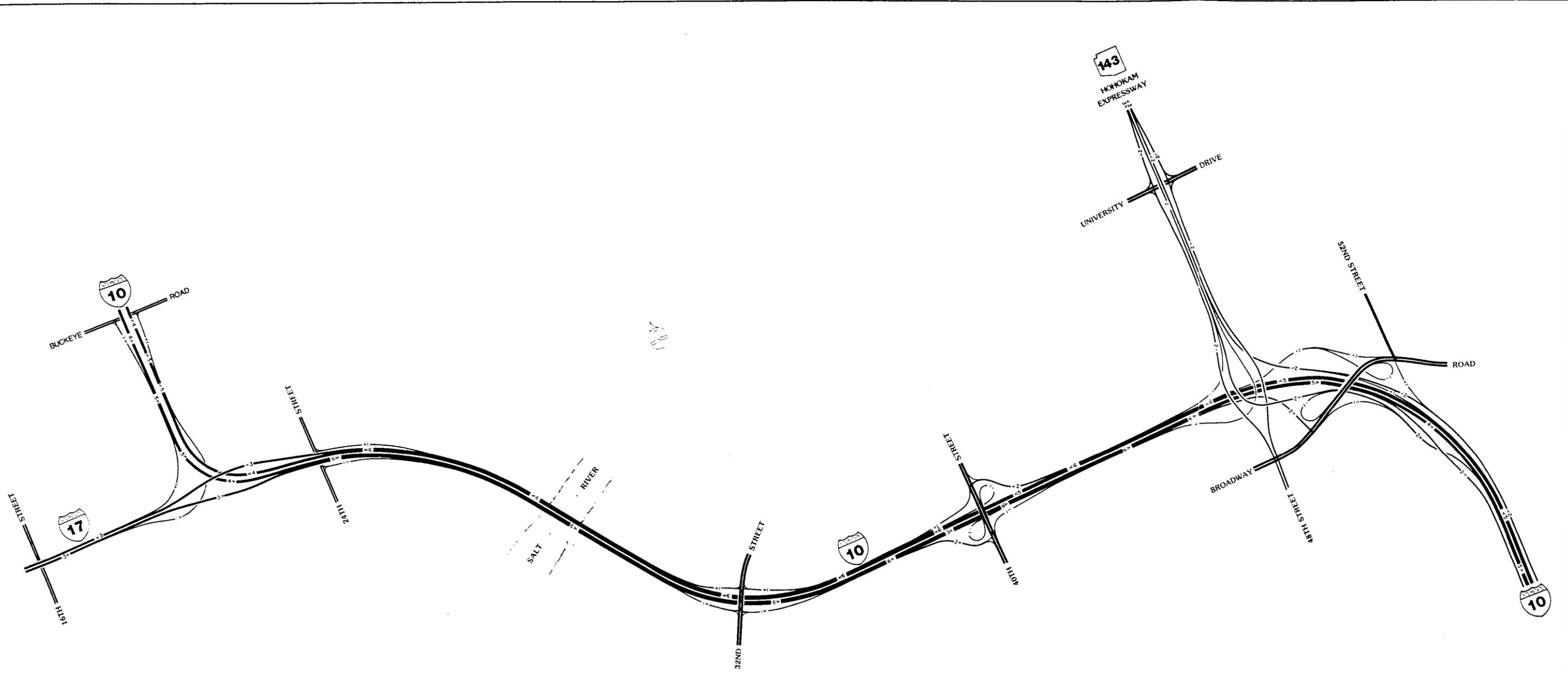


FIGURE 1



PROGRAMMED AND PROPOSED IMPROVEMENTS

I-10 CORRIDOR REFINEMENT STUDY

FIGURE 2

DMJM / Adam, Hamlyn, Anderson
 IN ASSOCIATION WITH
 JACK E. LEISCH & ASSOCIATES
 PREPARED FOR ARIZONA DEPARTMENT OF TRANSPORTATION
 SCALE 1" = 500'
 JANUARY 1997

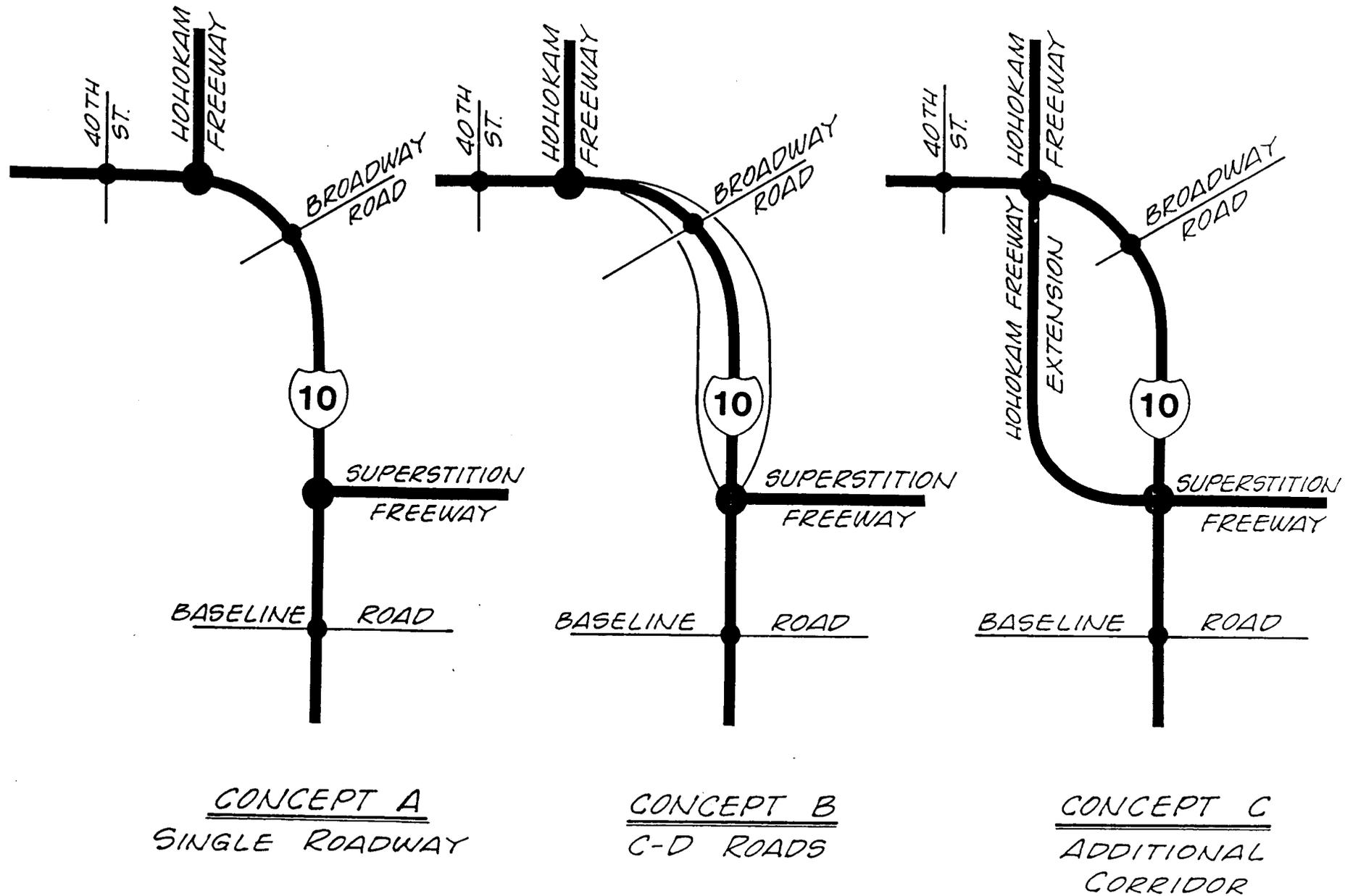


Figure 3
CONCEPT ALTERNATIVES

- o Concept A - Single Roadway
- o Concept B - C-D Roads
- o Concept C - Additional Corridor

Alternative B, which included a C-D Road system on the I-10 Corridor from the Hohokam Expressway to the Superstition Freeway, was selected as the most viable alternative. Concept B provided additional lane capacity, improved levels of service and eliminated the critical lane changing in this section of I-10. Geometric plans (1" = 100'), profiles, drainage, utilities investigations and capacity analyses were prepared to document the applicability of the design. The overall improvement plan was divided into three major construction phases, with seven projects in the first phase.

DMJM/JEL was directed to prepare contract plans for Project 1 of Phase I, which included the addition of ramps at 32nd Street and modifications to the 48th Street/Broadway road interchanges. Subsequently, JHK & Associates completed the I-17/I-10 Corridor Study, which recommended the extension of the C-D road system on I-10 from the Hohokam Expressway to the I-10/I-17 interchange. Since only concept sketches of the C-D road system were presented in the JHK report, it raised questions regarding the need for and feasibility of such a system, and if required, its compatibility with the C-D road plans east of the Hohokam Expressway. Due to these questions, work on the contract plans for Project 1 was "put on hold" until the completion of Phase I of this study.

DATA COLLECTION AND ANALYSIS PROCEDURES

The future (planned and programmed) geometric and operational features of the facility were inventoried to serve as a basis for evaluating the capabilities of the system to accommodate the design year traffic demands. Operating performance was also evaluated for each segment of the freeway system. The elements considered in the analysis were:

Geometric Features

- o Horizontal Alignment
- o Stopping Sight Distance
- o Cross Section

Operational Feature

- o Lane Continuity
- o Lane Balance
- o Ramp Sequence

Operating Performance
(Level of Service)

- o Basic Freeway Segments
- o Ramp Junctions
- o Weaving Sections
- o Signalized Intersections

The elements were analyzed using data obtained from the following sources:

- o Reports and data from the I-17/I-10 Corridor Study prepared by JHK & Associates (December, 1986).
- o Contract plans for the section of I-10 currently under construction.
- o Reports and data from the I-10 Corridor Study prepared by DMJM and JEL.
- o Relevant aerial photographs.
- o Existing traffic volume data for study corridor.
- o Year 2005 traffic forecasts prepared by MAGTPO.

EVALUATION CRITERIA

The 1984 AASHTO Policy on Geometric Design of Highways and Streets and the latest design policies and standards from ADOT formed the basis for developing the design standards and operational criteria used in evaluating the programmed facility. These standards and criteria are summarized in Tables 1A-1D, Appended.

II. EVALUATION OF THE FACILITY

DEVELOPMENT OF DESIGN YEAR TRAFFIC

There are several different traffic projection model runs available from MAGTPO which have been used in various evaluation studies of this section of I-10. Model 2005-34 was used in the I-10 Corridor Study by DMJM/JEL. Models 2005-34 and 2005-48B were utilized in the I-17/I-10 Corridor Study by JHK. Model 2005-34 predicts ADT's approximately 5 percent higher on I-10 than Model 2005-48B. The MAG model is currently being updated using new socio-economic data. Preliminary development of this model indicates a substantial growth in the southeast valley and forecasts higher traffic volumes for the area which this facility is to serve. In addition, approximately eleven million square feet of commercial floor space is under construction or planned for completion by the year 2005 in the areas immediately north and south of I-10 between 32nd Street and 48th Street. The population and employment forecasts for the traffic analysis zones used as a basis for all current MAG models only partially accounts for the employment potential in this area. Therefore, MAG Model 2005-34 was selected as the primary basis for the traffic assignments in this study. Year 2005 AM and PM design hour volumes are shown on Exhibit 1.

GEOMETRIC AND OPERATIONAL EVALUATION

All geometric and operational features of the I-10 Corridor were evaluated. This assessment formed the basis for determining the adequacy of the programmed improvements to accommodate the forecasted design year traffic. Only those features having a potential impact on the operating performance of the facility (Level of Service) are identified on Exhibit 1.

The spacing of the entrance-exit ramps on I-10 between Buckeye Road and I-17 in both the east and westbound directions are minimal from the standpoint of comfortable and efficient lane changing. However, the weaving analysis, based on the forecasted volumes, indicates a satisfactory Level of Service (LOS C) in these two segments. If future operations in these segments become critical due to higher

than projected weaving volumes, an alternative traffic routing should be considered. The closure of the ramps to Buckeye Road and the re-routing of traffic to and from Buckeye Road via 16th Street and 24th Street would resolve this problem.

Since the facility is presently under construction, a specific evaluation of the signing and accident potential could not be conducted. However, the geometry of the facility should provide for simplified guide signing, since the design provides for lane balance, lane and route continuity, and acceptable ramp sequencing. The segments of the freeway which impact the operating performance have a potential for a higher than average accident rate.

LEVEL OF SERVICE EVALUATION

The Year 2005 traffic projections were converted to AM and PM peak hour directional design hour volumes (DDHV) using the following factors, based on present traffic characteristics as well as projected::

- o Peak Hour Factor (PHF) = 0.95
- o Peak Hour volumes as a percent of daily volume (K) = 7%
- o Peak Hour directional distribution (D) = 58% for the major directional flow and 42% for the minor direction.

In determining Level of Service (LOS) for the basic freeway segments, ramp junctions, weaving areas and signalized intersections, specific volume and geometric characteristics were used in the analysis. The LOS for each element is displayed on Exhibit 1.

The most critical segments of the I-10 Corridor which would experience operational deficiencies include:

- o I-10, eastbound, 24th Street to 32nd Street - LOS E
- o Eastbound entrance ramp from 24th Street - LOS F
- o I-10, westbound, 32nd Street to 24th Street - LOS E
- o Westbound entrance ramp from 32nd Street - LOS F
- o I-10, eastbound, 32nd Street to 40th Street (weaving section) - LOS E

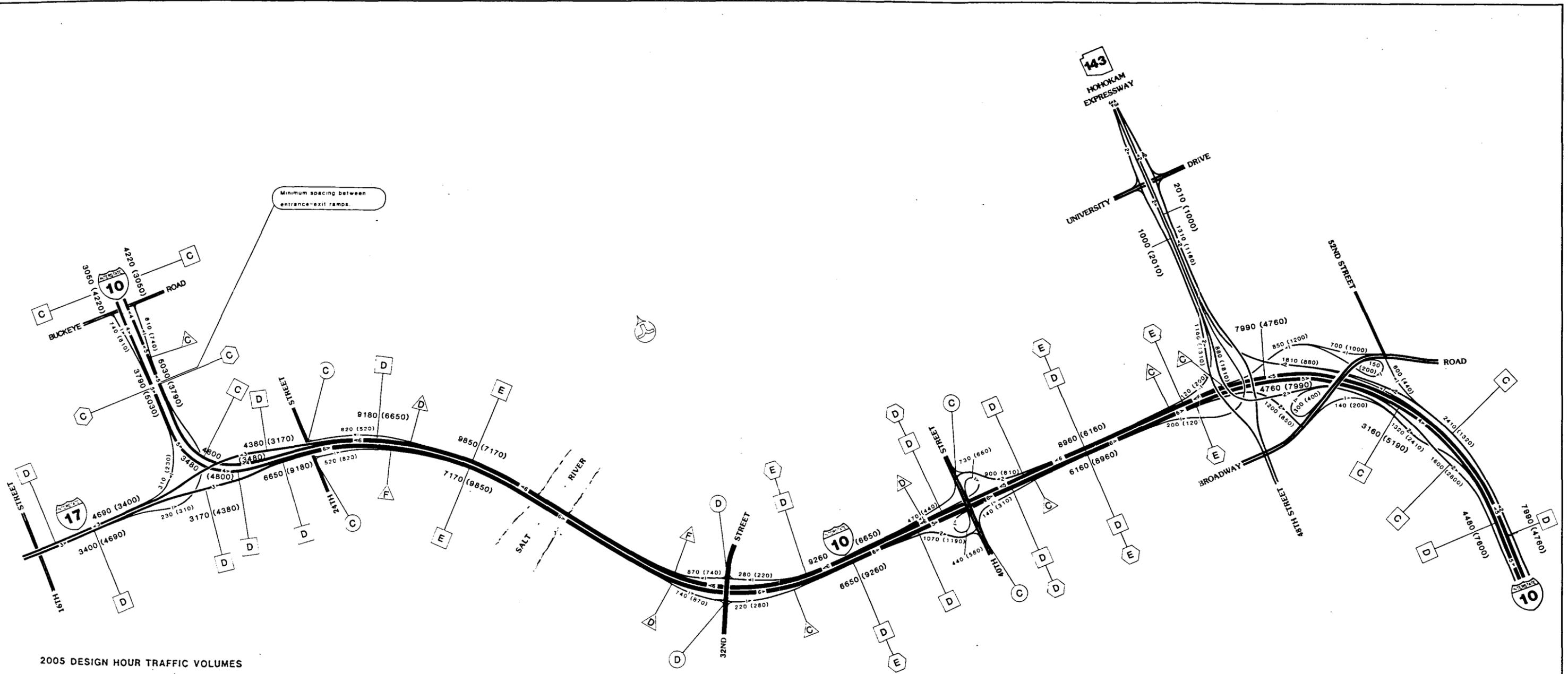
- o I-10, westbound, 40th Street to 32nd Street (weaving section) - LOS E
- o I-10, eastbound, 40th Street to the Hohokam Expressway (weaving section) - LOS E
- o I-10, westbound, Hohokam Expressway to 40th Street (weaving area) - LOS E

For a generalized evaluation of the I-10 basic freeway segments, the following capacity values can be used:

**BASIC FREEWAY SEGMENTS
(70 MPH DESIGN SPEED)**

<u>LOS</u>	<u>VOLUME PER LANE</u>	
	<u>MSF(1)</u>	<u>DDHV(2)</u>
C	1550	1340
D	1850	1600
E	2000	1750

- NOTE:
- (1) MSF - Maximum Service Flow in passenger cars per hour per lane (pcphpl).
 - (2) DDHV - Directional Design Hour Volume in mixed vehicles per hour per lane (VPHPL).
 - (3) Capacity calculations were based on a Design Speed of 70 MPH as most of the geometric features of the I-10 Corridor fall in this category, with the exception of segments at the I-10/I-17 interchange.
 - (4) The calculations used to derive these values can be found in Table 2, Appended.



2005 DESIGN HOUR TRAFFIC VOLUMES
 XXX - AM
 (XXX) - PM

OPERATIONAL FEATURES

— OPERATIONAL DEFICIENCIES

LEVEL OF SERVICE*

□ — MAINLINE SEGMENTS
 △ — RAMP TERMINALS
 ○ — WEAVING SEGMENTS
 ○ — INTERSECTIONS

EVALUATION OF PROGRAMMED GEOMETRIC AND OPERATIONAL FEATURES

I-10 CORRIDOR REFINEMENT STUDY

* SEGMENTS WHICH OPERATE AT A LEVEL OF SERVICE BETTER THAN 'C' HAVE NOT BEEN LABELED.

EXHIBIT 1

DMJM / Adam, Hamlyn, Anderson
 in association with
JACK E. LEISCH & ASSOCIATES

Prepared for
ARIZONA DEPARTMENT OF TRANSPORTATION

SCALE
 0 40 80
JANUARY 1987

III. ASSESSMENT OF PLAN AND RECOMMENDATIONS

GENERAL SUMMARY OF ASSESSMENT

The programmed section of I-10 from the I-10/I-17 interchange to 40th Street would operate at capacity (LOS E) in the year 2005 based on the land use projections used in the traffic model. Assuming that planned improvements on the section of I-10 between 40th Street and Baseline Road are completed over a time frame of 15 years, this section would accommodate a higher traffic demand than the programmed section of I-10 to the west. By the year 2005, the section of I-10 east of the Hohokam Expressway is projected to operate in the LOS range of C to D, while most of the segments of I-10 west of the Hohokam Expressway would be operating at capacity (LOS E). Likewise, sections of I-17 and I-10 west and north of the I-17/I-10 interchange would be operating in the LOS range of C to D.

RECOMMENDATION FOR C-D ROADS

The evaluation of the I-10 Corridor indicates the future need for the extension of the C-D road system west of the Hohokam Expressway. Two C-D road system concepts should be considered as portrayed on Exhibit 2:

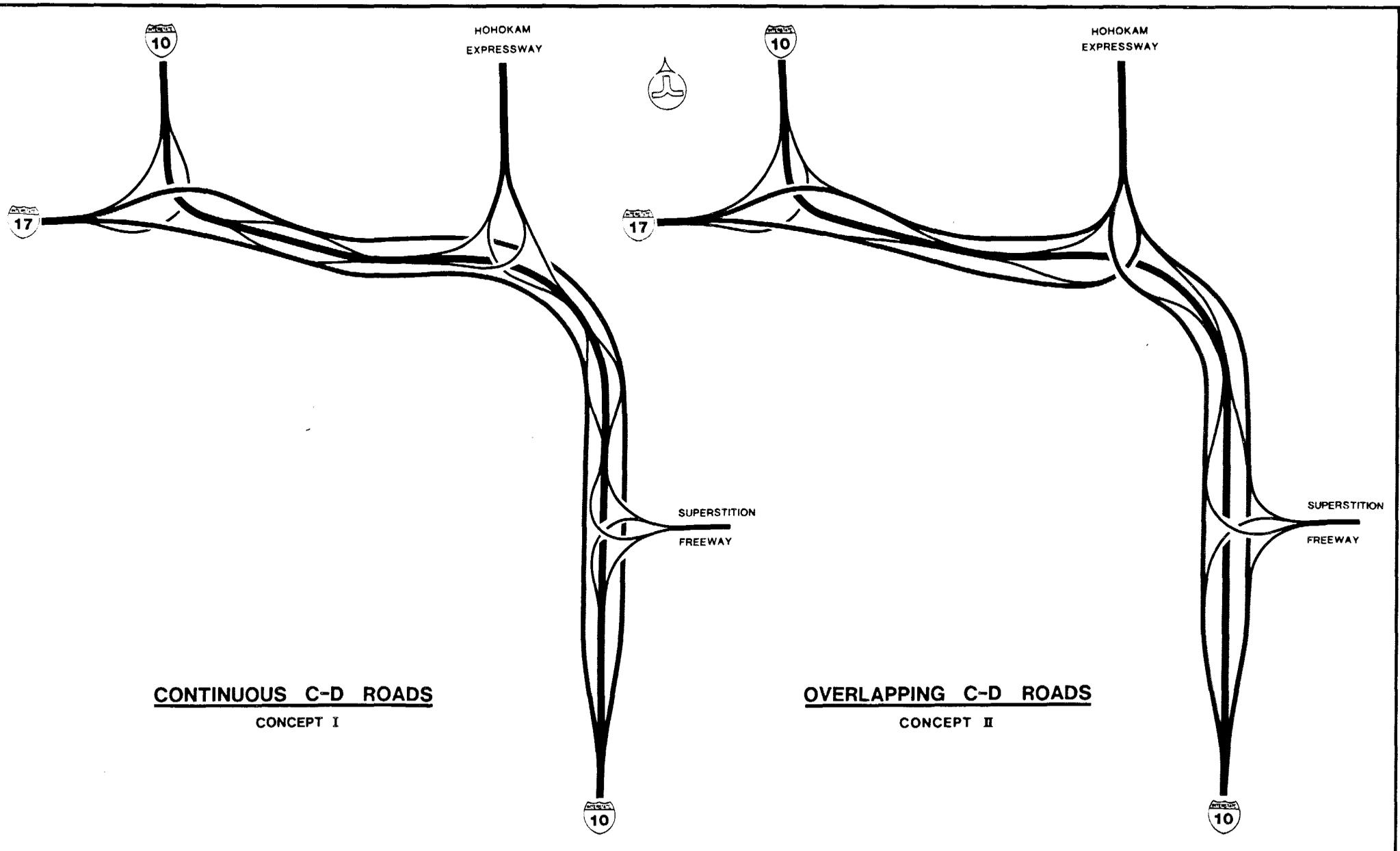
- o Concept I - A continuous C-D road system extending on the I-10 Corridor from 16th Street to Baseline Road.
- o Concept II - An overlapping C-D road system from 16th Street to Baseline Road which is discontinuous at the Hohokam Expressway.

This is a critical time in the planning process to develop and assess alternative improvement schemes, including collector/distributor roadways which would correct future operational deficiencies in the section of I-10 west of the Hohokam Expressway. Such a process is necessary to:

1. Insure that the programmed improvement can be integrated into a balanced system with the planned section on I-10 east of the Hohokam Expressway.

2. Determine the design of the 40th Street structure over I-10.
3. Determine the need to acquire or preserve the required right-of-way in the I-10 Corridor.
4. Extend the useful life of the facility beyond 2005.
5. Put this section of I-10 in balance with the remainder of the system.

Based on the forecasted traffic demands on this section of I-10, it is recommended that Phases II and III of this study be performed to address the future operational problems of the most heavily used section of freeway in the metropolitan area.



CONTINUOUS C-D ROADS
CONCEPT I

OVERLAPPING C-D ROADS
CONCEPT II

C-D ROAD ALTERNATIVE CONCEPTS
I-10 CORRIDOR STUDY

EXHIBIT 2

DMJM/Adam, Hamlyn, Anderson
in association with
JACK E. LEISCH & ASSOCIATES
JANUARY, 1987 SCALE: SCHEMATIC DRAWING

IV. RECOMMENDATIONS AND CONCLUSIONS

Based on the findings of this study, it is recommended that the following actions be undertaken:

1. Proceed with the programmed construction of I-10 from the I-17 interchange to 40th Street and open to traffic.
2. Incorporate the C-D road system into the long range improvement plan (15-20 years hence) for the I-10 Corridor from the I-17 interchange to the Superstition Freeway.
3. Proceed with the design and construction of Phase I, Project 1 (40th Street to Baseline Road) as quickly as possible and open to traffic. (As a result of the draft presentation of this report, the scope of work for the Phase I, Project 1 construction plans was revised, eliminating the design elements having potential conflict with an ultimate C-D road plan.)
4. Proceed with Phases II and III of this study to determine the concept and design for the C-D road system to provide a framework for further improvements and right-of-way reservations.

APPENDIX

CRITERIA FOR EVALUATION OF GEOMETRIC FEATURES

Feature	Rating			1984 AASHTO Policy Page Reference
	Good	Fair	Poor	
HORIZONTAL ALIGNMENT <ul style="list-style-type: none"> ● Design Speed ● Degree of Curve 	70 mph 3°	55-70 mph 3°-5°	55 mph 5°	187-191
STOPPING SIGHT DISTANCE <ul style="list-style-type: none"> ● Design Speed 	65 mph	50-65 mph	50 mph	305-315
CROSS SECTION <ul style="list-style-type: none"> ● Deficiencies 	Engineering Review of Field Inventory			666
EXIT DESIGN (Taper/Parallel) <ul style="list-style-type: none"> ● Curve at Nose ● Length 	3°/3° 500'/ 600'	(3°-5°)/(3°-5°) 400'-500'/ 400'-600'	5°/ 5° 400'/ 400'	1037-1045
ENTRANCE DESIGN (Taper/Parallel) <ul style="list-style-type: none"> ● Curve at Merge ● Length 	5°/5°	5°-8°/5°-8° 700'-900'/ 500'-700'	8°/8° 700'/ 500'	1037-1045

Table 1A

CRITERIA FOR EVALUATION OF OPERATIONAL FEATURES

Feature	Rating			1984 AASHTO Policy Page Reference
	Good	Fair	Poor	
LEVEL OF SERVICE <ul style="list-style-type: none"> ● Quality of Operation 	A - C	D	E - F	274-275
LANE CONTINUITY <ul style="list-style-type: none"> ● Position of a Basic Through Lane 	...Does not change	--	..Changes	986-987
LANE BALANCE <ul style="list-style-type: none"> ● Exit or Entrance 	...Has lane balance	--	..Does not have lane balance	986-1002
RAMP SEQUENCE <ul style="list-style-type: none"> ● EN-EN, EX-EX ● EN-EX ● EX-EN 	1200' 2500' 800'	800'-1200' 1500'-2500' 600'- 800'	800' 1500' 600'	1034-1036
SIGNING <ul style="list-style-type: none"> ● One Panel ● Two Panels ● Three Panels ● Proper Advance Signing 	3-5 message units 6-7 message units -- ...Has proper advance signing	6 message units 8-9 message units 9 message units --	6 message units 9 message units 9 message units ...Does not have proper advance signing	Manual on Uniform Traffic Control & Devices pp. 2E-1--2E-26
ACCIDENTS <ul style="list-style-type: none"> ● Per 1 million vehicle miles 	1.5	1.5 - 2.1	2.1	ADOT Accident Rates

Table 1B

CRITERIA FOR ANALYSIS OF ROADWAY FEATURES

CROSS-SECTIONAL ELEMENTS

Roadway Features	Rating	
	Desirable	Considerations for Safety Improvements
Shoulder Width <ul style="list-style-type: none"> ● 4-lane Sections ● 6-8 Lane Sections 	10'-12' Right 4'-8' Left 10'-12' Both sides	10' Right 4' Left 10' Either side
Shoulder Cross Slope <ul style="list-style-type: none"> ● Superelevation ● Break in Cross Slope 	.02-.06 ● Algebraic difference .04	.02 .06 ● Algebraic difference .07
Median <ul style="list-style-type: none"> ● Width ● Slope ● Concrete or Flexible Barrier 	.22' 6:1 - 10:1 ● Installed on median 40	.22' 6:1, 10:1 ● Not installed on median 40
Side Slopes	<ul style="list-style-type: none"> ● 3:1, with appropriate toe of slope design, or protected 	<ul style="list-style-type: none"> ● 3:1, and not protected
Ditches	<ul style="list-style-type: none"> ● Traversable or protected 	<ul style="list-style-type: none"> ● Not traversable and not protected
Pavement Condition	<ul style="list-style-type: none"> ● Stable ● Has good skid resistance 	<ul style="list-style-type: none"> ● Deteriorating ● Polished

Table 1C

CRITERIA FOR ANALYSIS OF ROADWAY FEATURES

APPURTENANCES

Roadway Features	Rating	
	Desirable	Considerations for Safety Improvements
Sign Supports	<ul style="list-style-type: none"> ● 30' off roadway with appropriate side slopes ● Breakaway or protected by guardrail 	<ul style="list-style-type: none"> ● Within 30' of roadway and not breakaway or protected by guardrail
Bridge Piers	<ul style="list-style-type: none"> ● 30' off roadway with appropriate side slopes ● Adequately protected 	<ul style="list-style-type: none"> ● Within 30' of roadway and not adequately protected
Light Standards	<ul style="list-style-type: none"> ● 30' off roadway with appropriate side slopes ● Breakaway or protected by guardrail 	<ul style="list-style-type: none"> ● Within 30' of roadway and not breakaway or protected by guardrail
Guardrail <ul style="list-style-type: none"> ● Terminals ● Post Spacing ● Design ● Condition 	<ul style="list-style-type: none"> ● Flared with breakaway cable terminal ● Crash cushion ● 6'-3" ● Blocked out ● Undamaged 	<ul style="list-style-type: none"> ● Does not meet current standards ● Not 6'-3" ● Not blocked out ● Damaged, rusted, etc.
Drainage Structure	<ul style="list-style-type: none"> ● 30' off roadway with appropriate side slopes ● Safe design ● Protected by guardrail 	<ul style="list-style-type: none"> ● Within 30' of roadway of hazardous design and not protected by guardrail

Table 1D

TABLE 2

**BASIC FREEWAY SEGMENTS
I-10 CORRIDOR STUDY**

GENERALIZED ANALYSIS COMPUTATIONS

DDHV = MSF x N x Fw x Fhv x Fp x PHF

N = 1.0

Fw = 1.0

Fhv = 0.91 - Assume: 10% trucks, level grade, Ft = 2

Fp = 1.0

PHF = 0.95

DDHV = MSF x 0.8645 (VOLUME PER LANE)

LOS	70 MPH DESIGN SPEED VOLUME PER LANE		60 MPH DESIGN SPEED VOLUME PER LANE	
	MSF	DDHV	MSF	DDHV
C	1550	1340	1400	1210
D	1850	1600	1700	1470
E	2000	1730	2000	1730

LANES	70 MPH DESIGN SPEED DDHV AT LOS			60 MPH DESIGN SPEED DDHV AT LOS		
	C	D	E	C	D	E
2	2680	3200	3460	2420	2940	3460
3	4020	4800	5190	3630	4410	5190
4	5360	6400	6920	4840	5880	6920
5	6700	8000	8650	6050	7350	8650
6	8040	9600	10380	7260	8820	10380
7	9380	11200	12110	8470	10290	12110

DDHV = Directional Design Hour Volume in mixed vehicles per hour (VPH).

MSF = Maximum Service Flow in passenger cars per hour per lane (pcphpl).

LOS = Level of Service.

Calculations based on the 1985 Highway Capacity Manual, Special Report 209, Published by the Transportation Research Board.