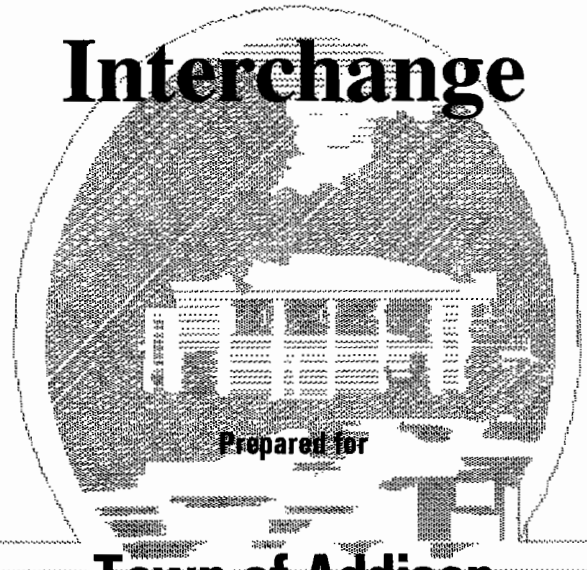
Design Report for

Belt Line Road/Dallas Parkway Interchange



Prepared for

Town of Addison

TOWN OF ADDISON

Prepared by

BARTON-ASCHMAN ASSOCIATES, INC.

DESIGN REPORT FOR BELT LINE ROAD/DALLAS PARKWAY INTERCHANGE

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Barton-Aschman Associates, Inc.
October, 1995

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1.
INTRODUCTION

The Town of Addison is located within one of the fastest growing areas in Texas. Already recognized as a leading business, retail, and commercial center, the Town continues to experience significant growth in retail, restaurant, and commercial development. The Town is also attracting new residential communities that could double its population over the next decade.

Increased traffic volumes have accompanied the growth in Addison and the surrounding area. The primary transportation network serving the Town and its local access requirements must also serve the regional travel needs of the area. These sometimes conflicting functions coupled with the increasing traffic volumes have increased traffic congestion along the Town's primary arterials.

The Town's leaders placed a high priority on the effective and efficient movement of traffic within and through the Town. The Town continually assesses travel and safety conditions on its roadway system and implements improvements to facilitate improved traffic conditions. The Town continues to improve conditions at intersections throughout the Town with the implementation of capacity improvements at the critical intersections along Belt Line Road.

At the heart of the transportation system serving Addison is the intersection of The Dallas North Tollway (DNT) and Belt Line Road. Belt Line Road is a major regional arterial thoroughfare serving North Dallas County. The Dallas North Tollway is a controlled access toll facility serving travel between downtown Dallas and northern Dallas and southern Collin Counties. Major ingress and egress ramps to the DNT at Belt Line characterize the importance of the interaction between these two major traffic carriers.

STUDY PURPOSE

The purpose of the study was to identify and evaluate alternatives for improving traffic conditions at the Dallas North Tollway/Belt Line Road intersection and based on the results of the evaluations develop a preferred alternative for implementation. The criteria used for evaluation includes Level of Service improvement, auto emissions reduction, and construction cost.

BACKGROUND

Although technically within the city limits of the City of Dallas, the intersection, nonetheless, serves as the gateway to Addison from the north and south and is the critical intersection for east/west travel within the Town. Increasing levels of congestion at this intersection during the peak hours now negatively impact traffic operation at nearby intersections. Because of its importance to the overall transportation system in the area, congestion at this intersection impacts the effectiveness of the entire transportation system

Realizing the importance of this intersection to transportation in Addison, the Town Council retained Barton-Aschman Associates, Inc. to develop and analyze alternatives for improving traffic conditions at this intersection.

2.
DEVELOPMENT OF ALTERNATIVES

Alternatives for evaluation were developed based on comments received from the Town of Addison and field investigations. The alternatives were developed using the following criteria:

- Elevated roadway sections should not be considered.
- Access to adjacent properties should be maintained.
- No existing movements should be eliminated.
- Alternatives should consider relatively low-cost traffic system management improvements as well as major (high cost) improvements to the intersection.
- Innovative alternatives should be considered.

Using these criteria, conceptual alternatives were developed and reviewed with Town of Addison staff. These conceptual alternatives included the following :

- TSM improvements to provide dual left-turn lanes from the DNT Frontage roads.
- Depressing the DNT frontage roads to allow through movements on the frontage roads to avoid the traffic signals at the intersection .
- Depressing the DNT frontage roads and reconfiguring the left-turn lanes from the frontage roads to allow concurrent let turns.
- Reconfiguring the left lanes on the frontage roads to allow concurrent left-turns (no grade separation on frontage roads).
- Reconfigure the intersection to create a Single Point Urban Interchange (SPUI) .

The SPUI is a new form of signalized urban interchange that can provide significant added capacity over conventional diamond urban interchanges. The SPUI is particularly well-suited for restricted right-of-way environments. The SPUI is relatively new and, to date, there are none operating in the Dallas/Ft. Worth Area.

A preliminary evaluation of each of these conceptual alternatives was conducted to determine which alternatives should be considered for detailed analysis. The results of this evaluation were reviewed with Town staff. Based on this review of the conceptual alternatives, depressing the frontage roads

to provide grade-separation for the frontage road through movements was eliminated for the following reasons:

- Extensive relocation of utilities.
- A preliminary profile of the grade separation indicates that the terminus points of the vertical curves necessary to achieve the required clearance under Belt Line Road would negatively impact the operation of the ingress and egress ramps to and from the Tollway.
- The grade separation would negatively impact access to adjacent properties.
- Cost.

The remaining three alternatives are discussed below and illustrated in Figures 1 thru 3.

Alternative 1

Alternative 1 is a relatively low cost Transportation System management (TSM) approach to improving traffic conditions at the intersection. Currently, both the northbound and southbound frontage roads have five approach lanes; one U-turn, one shared left and through lane, two through lanes, and one exclusive right turn lane. This alternative would modify the intersection to allow left-turns from the U-turn lane, providing two lanes to service the high volumes of left-turns at the intersection. This alternative requires no new right-of-way and only minor modifications to the intersection. Alternative 1 is illustrated in Figure 1.

Alternative 2

Alternative 2 reconfigures the frontage roads to provide a U-turn lane, dual left-turn lanes, three through lanes, and an exclusive right for both the northbound and southbound frontage roads. In addition, the left-turn lanes are realigned to allow concurrent left-turns from the frontage roads. This provides the opportunity for more efficient traffic signal operation. The approaches on Belt Line Road remain unchanged in this alternative. This alternative requires additional right-of-way along the frontage roads, and modifications to the existing bridge. Alternative 2 is illustrated in Figure 2.

Alternative 3

Alternative 3 creates a full single point urban intersection. In addition to the improvements presented in Alternative 2, the approaches on Belt Line Road are reconfigured to provide exclusive dual left-turn lanes (aligned to run concurrently), three through lanes, and an exclusive right-turn lane on both the eastbound and westbound approaches. This alternative requires additional right-of-way along the north side of Belt Line Roads and a reduction in the width of the median on Belt Line. Alternative 3 is presented in Figure 3.

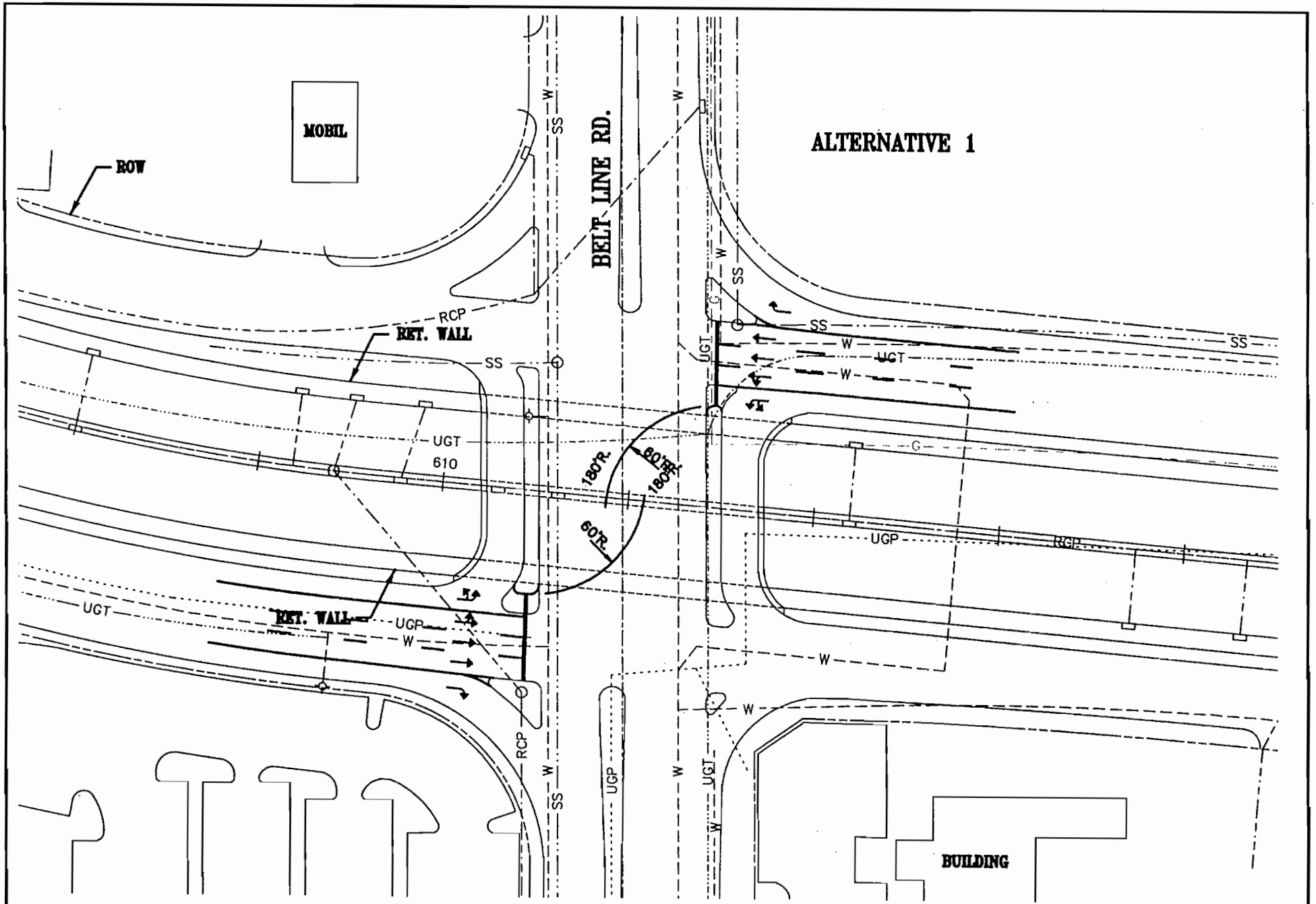

ALTERNATIVE 1
MOBIL
ROW
BELT LINE RD.
RCP
RET. WALL
SS
UGT
610
UGP
W
G
180°R.
60°R.
BUILDING

FIGURE 1

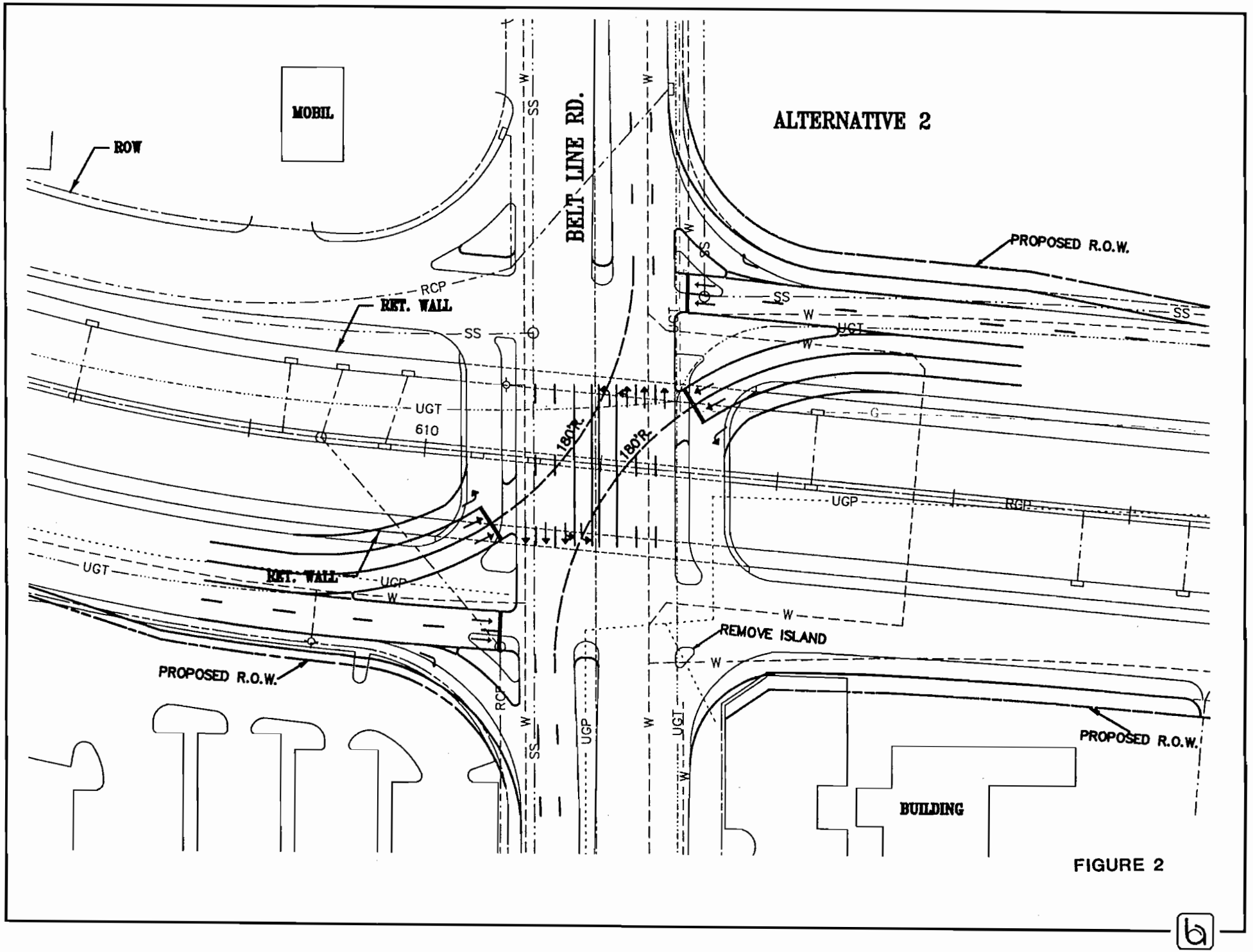

ALTERNATIVE 2
MOBIL
ROW
BELT LINE RD.
RCP
RET. WALL
SS
W
UGT
610
180'R
180'R
UGP
RCP
RET. WALL
UGT
UGP
W
PROPOSED R.O.W.
REMOVE ISLAND
PROPOSED R.O.W.
PROPOSED R.O.W.
BUILDING

FIGURE 2

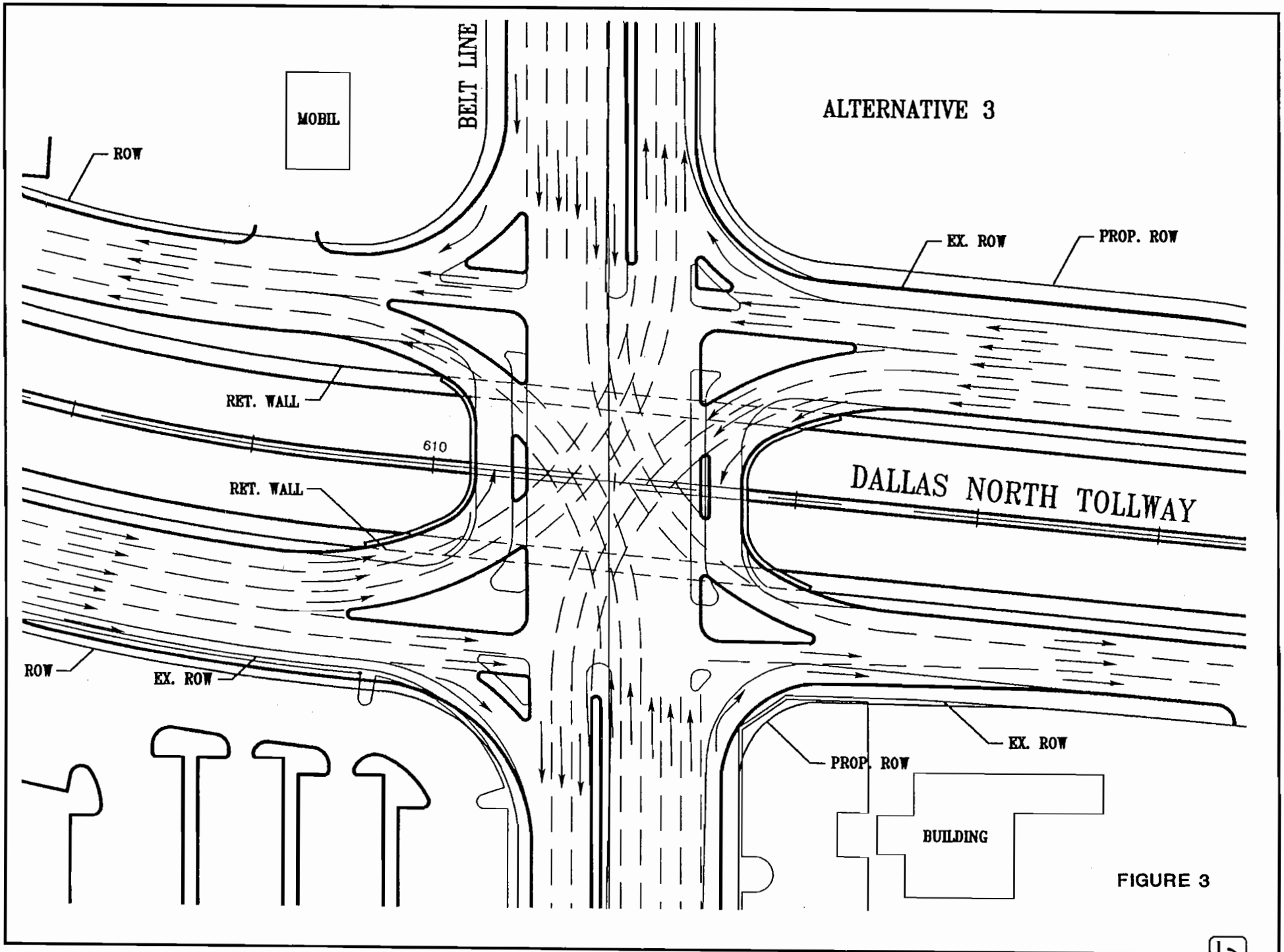

ALTERNATIVE 3
BELT LINE
MOBIL
ROW
EX. ROW
PROP. ROW
RET. WALL
610
RET. WALL
DALLAS NORTH TOLLWAY
ROW
EX. ROW
EX. ROW
PROP. ROW
BUILDING

FIGURE 3

3.
ROADWAY DESIGN

There are many factors to consider in the roadway design for any modifications to the Belt Line Road/Dallas Parkway intersection. Jurisdictional interests, right-of-way needs, the effect on existing utilities, and drainage considerations are among the factors to be investigated and addressed.

AFFECTED GOVERNMENTAL AGENCIES

Modifications to the Belt Line Road/Dallas Parkway intersection and the Belt Line Road Bridge over Dallas North Tollway will involve multiple jurisdictions and will probably require the execution of inter-local agreements between the jurisdictions. The jurisdictions are represented by their respective engineering or public works department or agencies. The affected governmental agencies are as follows:

- Texas Turnpike Authority - The Texas Turnpike Authority is the owner/operator of the Dallas North Tollway. Modifications to the Belt Line Bridge should be coordinated with the Turnpike Authority. The Turnpike Authority is located at:

  3015 Raleigh Street
  Dallas, Texas 75219
  (214) 522-6200

- Town of Addison - A portion of Belt Line Road west of Dallas North Tollway lies within the corporate limits of the Town of Addison. Street construction and modifications are administered through the Public Works Department located at:

  16801 Westgrove Drive
  Addison, Texas 75001
  (214) 450-2886

- City of Dallas - Belt Line Road over Dallas North Tollway and east of the Tollway lie within the City of Dallas. The Public Works and Transportation Department exercises control over street construction while Dallas Water Utilities is responsible for water and wastewater facilities. These two agencies are each located at:

  320 E. Jefferson Boulevard
  Dallas, Texas 75203
  (214) 670-4245 (Public Works)
  (214) 948-4592 (Water Utilities)

- Dallas County - Although not directly involved, Dallas County, through its Public Works Department, may have an interest in any proposed modifications at Belt Line and Dallas Parkway.

- Dallas Area Rapid Transit - DART may have an interest in the operational aspects of any proposed modifications at Belt Line and Dallas Parkway.

AFFECTED PROPERTIES

Northeast Corner - Prestonwood Tower lies within the City of Dallas. Belt Line Road and Dallas Parkway at this corner lie within the City of Dallas.

Southeast Corner - Bed, Bath & Beyond (formerly Sakowitz) lies within the Town of Addison along with northbound Dallas Parkway. Belt Line Road at this corner lies within the City of Dallas.

Southwest Corner - Mobil Self-Serve is located in the Town of Addison. Belt Line Road and southbound Dallas Parkway are situated in the Town of Addison also.

Northwest Corner - Spectrum Center lies within the Town of Addison along with westbound Belt Line Road. Southbound Dallas Parkway at this corner is located in the City of Dallas.

AFFECTED UTILITIES

The existing utilities and facilities located at or adjacent to the Belt Line/Dallas Parkway intersection are:

- Water mains
- Sanitary sewers
- TU Electric
- Lone Star Gas
- Southwestern Bell Telephone
- Storm drainage
- Traffic signals
- Median irrigation

- Water mains are located along Belt Line Road (however, not in the area of the bridge structure) and along Dallas Parkway. The depth of these mains in their current locations should provide adequate cover after any pavement widening. Facilities related to the water mains such as fire hydrants, water valves, water vaults, water meters and water valve manholes will require adjustments or relocation to accommodate pavement widening. Dallas Water Utilities and Town of Addison facilities are involved.

- Sanitary sewer facilities will involve adjustments to manholes and cleanouts but should not require any main reconstruction. Dallas Water Utilities and Town of Addison facilities are involved.

- TU Electric has overhead lines on wooden poles along the north side of Belt Line Road. The proposed pavement widening will require relocation of these facilities and these can be termed routine. A line of steel transmission towers runs along the west side of northbound Dallas Parkway. In Alternatives 2 and 3 one tower conflicts with the proposed U-turn for northbound Dallas Parkway. Relocation of this tower will require significant effort, time and money. TU Electric has four street lights in the Belt Line Road median that will be affected by the pavement widening. It is assumed that TU Electric's franchise agreements with the Town of Addison and the City of Dallas require relocations without cost to the Town or City.

- Lone Star Gas has facilities along Belt Line Road west of Dallas Parkway that may be affected by the proposed pavement widening. The existing depth is not known, but there should be no significant problems.

- Southwestern Bell Telephone has extensive underground facilities along Belt Line Road. The depth of these facilities is not known, but it is assumed that the depth provides sufficient cover to allow pavement widening without extensive relocations.

- Storm drainage mains belonging to the Town of Addison and the City of Dallas are located under existing street pavement. The proposed pavement widening will not affect the existing drainage patterns, will not significantly increase run off, and will only require relocation of existing storm drain inlets.

- Traffic signals at the Belt Line/Dallas Parkway intersection are owned and operated by the City of Dallas. The proposed intersection modifications will require a complete redesign of the signal layout and operation at this intersection.

- Median irrigation systems currently exist in the medians in both the City of Dallas and the Town of Addison. These facilities will be completely removed and reconstructed as part of the pavement widening.

DESIGN CONSIDERATIONS

Design considerations for this project will include:

- Belt Line Road Bridge
- Pavement widening
- Additional right-of-way
- Existing driveways
- Traffic control during construction

- The proposed left-turn and U-turn movements will require modifications to the Belt Line Road Bridge. These modifications involve additional structural analysis and relocation or adjustment of attached lighted roadway signs for Dallas North Tollway.

  The existing clearance of the Belt Line bridge for northbound Dallas North Tollway is signed as 15'-7" while the southbound is signed as 17'-0". The proposed structural modifications will decrease the clearance by approximately 4" in each direction.

- Pavement widening is proposed along the east side of northbound Dallas Parkway north and south of Belt Line Road, along the west side of southbound Dallas Parkway north of Belt Line Road, along the north side of Belt Line Road east and west of Dallas Parkway and along the median in Belt Line Road east and west of Dallas Parkway. The south curb line of Belt Line is proposed to remain unchanged.

  The majority of the existing pavement on Dallas Parkway and Belt Line Road will remain in place. Curbs will be removed in selected areas and new pavement will be added using steel dowels. The transverse and longitudinal slopes of the proposed pavement widening will match the existing.

- Additional right-of-way will not be needed along the south side of Belt Line Road (Mobil Self-Serve and Bed, Bath & Beyond frontage). Along the east side of Dallas Parkway south of Belt Line Road (Bed, Bath & Beyond), additional right-of-way with a maximum width of 11-feet will be needed to accommodate the pavement widening. The estimated additional right-of-way is approximately 3500 square feet and approximately 31 parking spaces may be eliminated.

  It appears that additional right-of-way will be needed along the Belt Line Road and Dallas Parkway frontages of Spectrum Center. The Belt Line frontage will require an additional 8-feet while the Dallas Parkway frontage will require an additional 11-feet. The estimated additional right-of-way is approximately 6500 square feet with no resulting loss of parking.

  Prestonwood Tower will have a relatively small right-of-way impact. Right-of-way needed for the proposed widening consists of a corner clip and slivers of new right-of-way along

Dallas Parkway and Belt Line Road. The estimated additional right-of-way at this corner is approximately 1000 square feet with a resulting displacement of about 10 parking spaces.

- There are four existing driveways that will be directly affected by the proposed pavement widening. There is no proposed construction at the southwest corner of Belt Line and Dallas Parkway that will affect driveways. The same is true for the southeast corner.

  Spectrum Center has two driveways on Belt Line Road and none on Dallas Parkway that will be affected by the proposed pavement widening. The same is true for Prestonwood Tower at the northeast corner of Belt Line and Dallas Parkway.

- Traffic control during construction will be handled in a similar manner to recent and proposed construction along Belt Line Road in the Town of Addison.

  The existing lane configuration will be maintained during construction in which the outside lane pavement widening will occur first. Upon completion of the outside lane pavement, traffic will be shifted to the north and then construction around the median will take place. At the conclusion of construction activities, median irrigation and landscaping will take place.

4.
TRAFFIC OPERATIONS ANALYSIS

The Belt Line Road and Dallas Tollway frontage roads were simulated using TRAF-NETSIM, a microscopic street network simulation model. TRAF-NETSIM was developed for the U.S. Department of Transportation, Federal Highway Administrative (FHWA), and has been nationally accepted for traffic operations analysis. The model accumulates statistics on a vehicle by vehicle basis for stopped delay, total delay, average delay, average queue, maximum queue, fuel consumption, and vehicle emission rates. TRAF-NETSIM simulates the movements of individual vehicles over one second time increments using probablistic techniques to randomize the simulation. The "drivers" are subject to car-following theory, lane-change rules and gap acceptance rules taken from a random population with random characteristics. TRAF-NETSIM was used to provide a common reference for evaluating proposed alternatives with existing conditions.

PROCEDURE

The following steps were completed for TRAF-NETSIM analysis:

1. A field study of the site was made to determine the physical and operational aspects of the existing conditions.

2. Data collection efforts included:

    - PM peak hour turning movement counts were performed on Friday, March 23, 1995 from 4:00 PM to 6:00 PM.

    - Existing timing plans were provided by the City of Dallas and verified in the field.

    - A vehicle delay study was performed on Friday, March 24, 1995 from 4:00 PM to 6:00 PM.

    - The Texas Turnpike Authority provided "As Built" plans of the study location.

- Lane configurations were verified in the field.

3. Existing conditions using TRAF-NETSIM were modeled and calibrated.

4. Meeting were held with the Town of Addison representatives to discuss the proposed alternatives. It was determined Alternatives 1 and 3 would be modeled using TRAF-NETSIM.

5. Measure of Effectiveness were determined for each alternative.

6. Results and conclusions were documented.

ON-SITE DATA COLLECTION

Data collection consisted of turning movement counts and a stopped-delay study at Belt Line Road and Dallas Tollway frontage roads. Data collection was performed on Friday, March 24, 1995 from 4:00 PM to 6:00 PM during the peak hour to represent worst case conditions. The turning movement counts are shown in figure 4.

Stopped-time delay is determined by measuring the number of cars stopped on each approach every 15 seconds. These 15-second "snapshots" provide a sample of the number of cars that are stopped. By assuming that each stopped vehicle stays stopped for the full 15 seconds, each counted vehicle represents 15 vehicle-seconds of stopped delay. The sum of all the vehicles counted in this way is the total stopped delay. The stopped-delay study was used to compare the results of simulation with actual field performance.

CALIBRATION

The TRAF-NETSIM model was calibrated based on stopped delay and maximum queue per approach. Driver performance characteristics such as maximum acceleration and mean queue discharge headway were varied from the respective default values to replicate observed conditions at the study location. The simulation model was considered calibrated once the stopped delay and maximum queue were brought to within an acceptable range of the data collected. In general, the TRAF-NETSIM default values were found to be more sluggish than what was measured in the field at the study location.

RESULTS

Stopped delay, total delay, maximum queue, and vehicle emissions for the different scenarios studied are reported below. The stopped delay is defined as the average time that a vehicle is stopped with

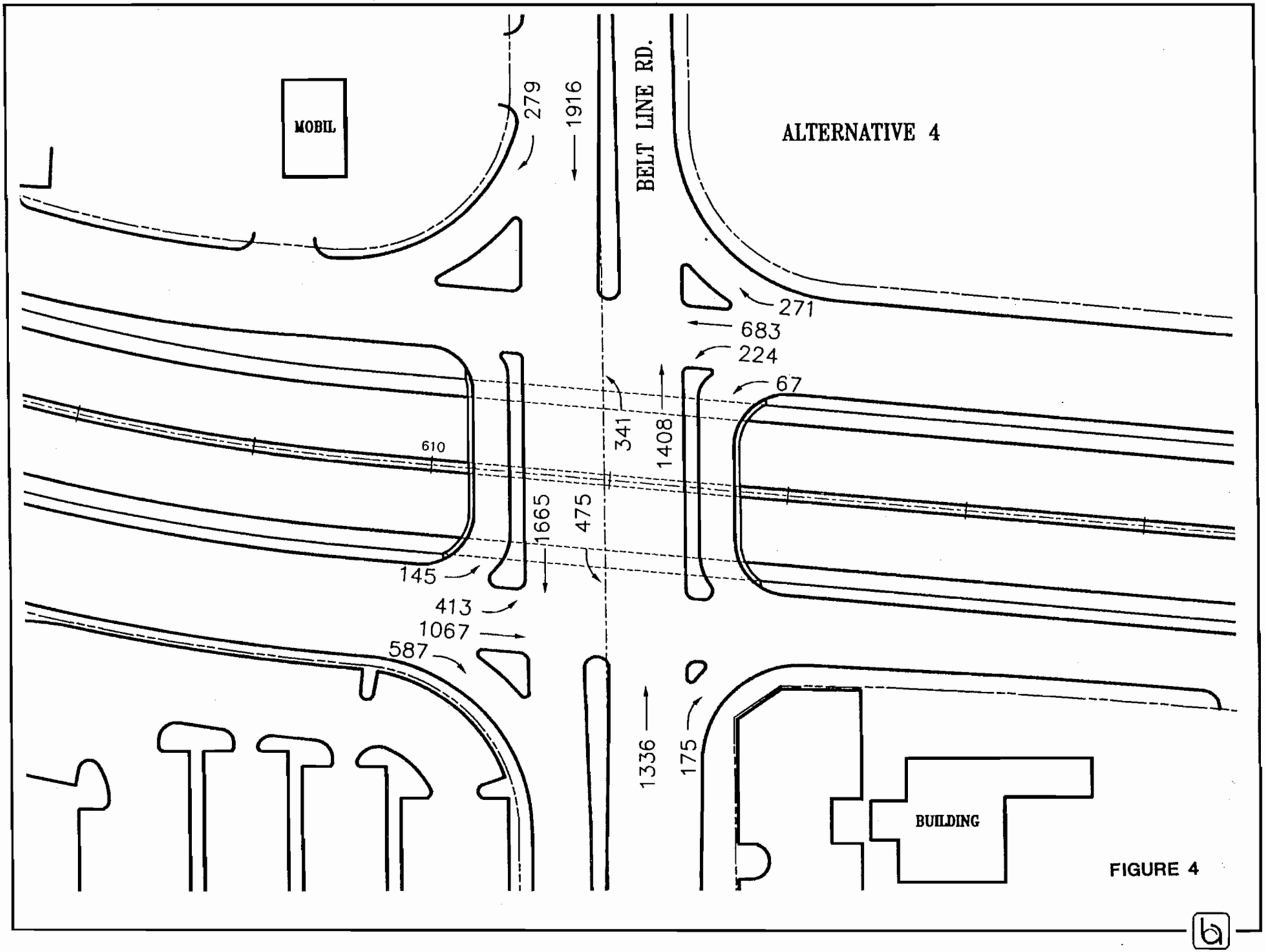

ALTERNATIVE 4
MOBIL
BELT LINE RD.
279
1916
271
683
224
67
610
341
1408
1665
475
145
413
1067
587
1336
175
BUILDING

FIGURE 4

locked wheels at an approach, and average total delay is defined as the average difference between the total approach time of a vehicle and the free flow travel time on an approach. The maximum queue is defined as the maximum queue that occurs during the simulation time.

Existing Conditions

Based on the TRAF-NETSIM analysis the results for existing conditions are shown in Table 1. The existing phasing is the standard Texas Transportation Institute (TTI) phasing with a 120 second cycle.

Table 1: Existing Conditions Measures of Effectiveness

Intersection	Stopped Delay		Total Delay		CO (kg/hr)	Max. Queue
	Avg. Delay	LOS	Avg. Delay	LOS		
Belt Line Eastbound	39.82	D	52.40	E	119.95	65
Belt Line Westbound	144.86	F	190.60	F	87.36	125
Southbound Frontage	146.45	F	192.70	F	46.53	73
Northbound Frontage	70.30	F	92.50	F	111.26	98
OVERALL	**84.56**	**F**	**111.27**	**F**	**365.10**	**361.00**

Alternative 1

Based on the TRAF-NETSIM analysis, the results for Alternative 1, are shown in Table 2. Alternative 1 was analyzed using existing signal timing and phasing.

Table 2: Alternative 1, Island Modifications Only Measures of Effectiveness

Intersection	Stopped Delay		Total Delay		CO (kg/hr)	Max. Queue
	Avg. Delay	LOS	Avg. Delay	LOS		
Belt Line Eastbound	40.36	E	53.10	E	120.60	65
Belt Line Westbound	147.90	F	194.60	F	90.93	126
Southbound Frontage	110.80	F	145.90	F	54.49	56
Northbound Frontage	38.08	D	50.10	D	104.43	63
OVERALL	**69.75**	**F**	**91.78**	**F**	**370.45**	**310.00**

Alternative 2

TRAF-NETSIM analysis was not performed for Alternative 2. Alternative 2 creates single point left turns for the frontage roads movements but not Belt Line Road movements. This would allow the frontage roads to run the left-turns concurrently; however Belt Line would have to remain as the existing phasing. This will improve traffic operations from Alternative 1, but the phasing alternatives would be limited possibly confusing to drivers.

Alternative 3

Based on the TRAF-NETSIM analysis, the results for Alternative 3 are shown in Table 3. The results are based on a cycle length equivalent to the existing cycle length of 120 seconds, and a four phase sequence. Protective/Permissive left-turn signal operation cannot be used with single point interchanges. A longer clearance interval is required for this design than traditionally used with TTI phasing. In the four phase sequence analyzed the left-turn movements proceed their adjacent through movements. Leading left-turns were used for the analysis because this phasing is commonly used and familiar to drivers. However, lagging left-turns could be used. The advantage to lagging left-turns is that a smaller clearance interval would be required and create a more efficient use of signal time.

Table 3: Alternative 3, SPUI Measures of Effectiveness

Intersection	Stopped Delay		Total Delay		CO (kg/hr)	Max. Queue
	Avg. Delay	LOS	Avg. Delay	LOS		
Belt Line Eastbound	24.59	C	32.36	C	99.77	50
Belt Line Westbound	33.23	D	43.72	D	74.20	51
Southbound Frontage	43.95	E	57.83	E	69.00	38
Northbound Frontage	55.51	E	73.05	E	94.05	84
OVERALL	**38.63**	**D**	**50.83**	**D**	**337.02**	**223**

TRAFFIC OPERATIONS ANALYSIS CONCLUSIONS

Based upon the analysis performed in this study, Alternative 3 shows significant reductions in stopped delay, total delay, carbon monoxide emissions, and maximum queue. Alternative 1 shows reductions in the overall measures of effectiveness.

Alternative 1, island modifications only, was analyzed using the existing phasing and timing so that an easy comparison could be made with existing conditions. This alternative will increase the capacity of the frontage roads. The measures of effectiveness for stopped delay, average total delay, and maximum queue show an overall improvement in traffic operations for the interchange. There is a very minimum increase on the measures of effectiveness on Belt Line reflected in the table. This increase is caused by TRAF-NETSIM modeling procedures.

Alternative 1 reduces stop delay and average total delay by 17.5% and overall maximum queue by 14% and increases carbon monoxide emissions by 1.5%.

Alternative 3, SPUI, will produce significant reductions in the measure of effectiveness for the overall operation of the interchange. This alternative is expected to significantly increase capacity from the existing oversaturated conditions. The analysis was done based on the existing cycle length; however the phasing and timing was optimized. While it is recommended that the frontage roads use the same cycle length and coordinate with adjacent intersections to provide progression along Belt Line, the increase in capacity this option provides will allow flexibility in the phasing and cycle lengths.

On Belt Line, adjacent intersections to the interchange, Montfort and Quorum Drive, are very close in proximity to the frontage roads. During field observations it was observed that queues along Belt Line come very close to adjacent intersections. For short periods of time, the flow of traffic through adjacent intersections was impeded by the queues at the frontage roads. The single point intersection significantly reduces queue length along Belt Line Road. This reduction in queue length is expected to eliminate the chance of vehicles queuing into adjacent intersections and impeding traffic operations under normal traffic conditions. The actual effect at Montfort and Quorum goes beyond the scope of this project.

Alternative 3 reduces stop delay and average total delay by 54%, carbon monoxide emission rates by 7.6% and overall maximum queue by 38%.

5.
ENGINEER'S OPINION OF PROBABLE COST

The cost associated with the improvements in each alternative vary directly with the complexity of the alternative. The benefit derived from each alternative also increases with the cost and complexity of a specific alternative. The following tables show the Engineer's Opinion of Probable Cost for each of the three alternatives.

Table 4: Alternative 1, Island Modifications Only Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
MOBILIZATION	LS	1	$10,000.00	$10,000.00
REMOVE OLD CONC (CURB)	LF	95	$4.00	$380.00
REMOVE OLD CONC (MED)	SY	425	$7.00	$2,975.00
REMOVE OLD CONC (SIDEWALK)	SY		$4.00	$0.00
REPLACE CONC PAV (8")	SY	42.7	$108.00	$4,612.00
CONC. CURB & GUTTER	LF	40	$3.00	$120.00
CONC MED	SY	18	$27.00	$486.00
MARKING AND STRIPING	LS	1	$10,000.00	$10,000.00
SIGNING MODIFICATIONS	LS	1	$10,000.00	$10,000.00
TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
TRAFFIC SIGNAL MODIFICATINS	LS	1	$25,000.00	$25,000.00
SUBTOTAL				$73,573.00
CONTINGENCY @ 15%				$11,037.00
GRAND TOTAL				**$84,610.00**

Table 5: Alternative 2, Single Point Left-Turns Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
MOBILIZATION	LS	1	$10,000.00	$10,000.00
REMOVE OLD CONC (CURB)	LF	1,440	$4.00	$5,760.00
REMOVE OLD CONC (MED)	SY	279.7	$7.00	$1,958.00
REMOVE OLD CONC (SIDEWALK)	SY	511.1	$4.00	$2,044.00
REPLACE CONC PAV (8")	SY	805.1	$40.00	$86,951.00
CONC. CURB	LF	1,085	$3.00	$3,255.00
CONC MED	SY	390.6	$27.00	$10,545.00
SIDEWALK	SY	511.1	$24.00	$12,267.00
BRIDGE MODIFICATIONS	SF	5,000	$50.00	$250,000.00
MARKING AND STRIPING	LS	1	$10,000.00	$10,000.00
SIGNING MODIFICATIONS	LS	1	$10,000.00	$10,000.00
SUBTOTAL				$402,780.00
CONTINGENCY @ 15%				$60,420.00
SUBTOTAL				**$463,200.00**
R.O.W. 7000 SF @ $30.00/SF				$210,000.00
GRAND TOTAL				**$673,200.00**

Table 6: Alternative 3, SPUI Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
MOBILIZATION	LS	1	$10,000.00	$10,000.00
CLEAR & GRUB	LS	1	$20,000.00	$20,000.00
REMOVE OLD CONC (CURB)	LF	3,340	$4.00	$13,360.00
REMOVE OLD CONC (MED)	SY	600	$7.00	$4,200.00
REMOVE OLD CONC (SIDEWALK)	SY	790	$4.00	$3,160.00
REPLACE CONC PAV (8")	SY	4,000	$40.00	$160,000.00
REMOVE & REPLACE INLETS	EA	4	$4,000.00	$16,000.00
CONC CURB	LF	3,950	$3.00	$11,850.00
BRICK PAVERS	SY	800	$30.00	$24,000.00
CONC MED	SY	900	$27.00	$24,300.00
FIRE HYDRANT RELOCATION	EA	4	$600.00	$2,400.00
SIDEWALK	SY	950	$24.00	$22,800.00
WATER VALVE/METER RELOCATION	EA	20	$150.00	$3,000.00
BRIDGE MODIFICATIONS	SF	7,000	$50.00	$350,000.00
MARKING AND STRIPING	LS	1	$10,000.00	$10,000.00
TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
SIGNING MODIFICATIONS	LS	1	$10,000.00	$10,000.00
SIGNAL MODIFICATIONS	LS	1	$100,000.00	$100,000.00
SUBTOTAL				$795,070.00
CONTINGENCY @ 15%				$119,230.00
SUB TOTAL				**$914,300.00**
R.O.W. 11,000 SF @ $30/SF				$330,000.00
GRAND TOTAL				**$1,244,300.00**

6.
RECOMMENDATIONS

Based upon design considerations, construction costs and traffic analysis Alternative 3, a Single Point Urban Interchange (SPUI), is recommended for the Belt Line Road and Dallas Parkway interchange. A SPUI will create additional capacity that will provide flexibility to provide efficient traffic flow along Belt Line Road. This recommendation is expected to reduce stop delay and average total delay by 54%, carbon monoxide emission rates by 7.6% and overall maximum queue by 38% from existing conditions.

The design of a SPUI will be "new" to most drivers and pedestrians in this area. Care should be given throughout the design process to insure safety to pedestrians and motorist. Basic signal phasing for a SPUI is not conducive to pedestrians crossing the road. Pedestrian safety should be emphasized with crosswalks and stop bars and consideration should be given to an actuated pedestrian phase or a pedestrian overpass. Enhanced traffic control devices, such as pavement markings to delineate lane lines, turning paths, stop bars, cross walks, lighting and traffic guidance signs should be considered. With these safety issues in mind during the design process a single point interchange can be safe and efficient to the motorist and significantly improve traffic conditions.

BARTON-ASCHMAN ASSOCIATES, INC.
5485 Belt Line Road, Suite 199, Dallas, Texas, 75240, (214) 991-1900, (214) 490-9261 fax

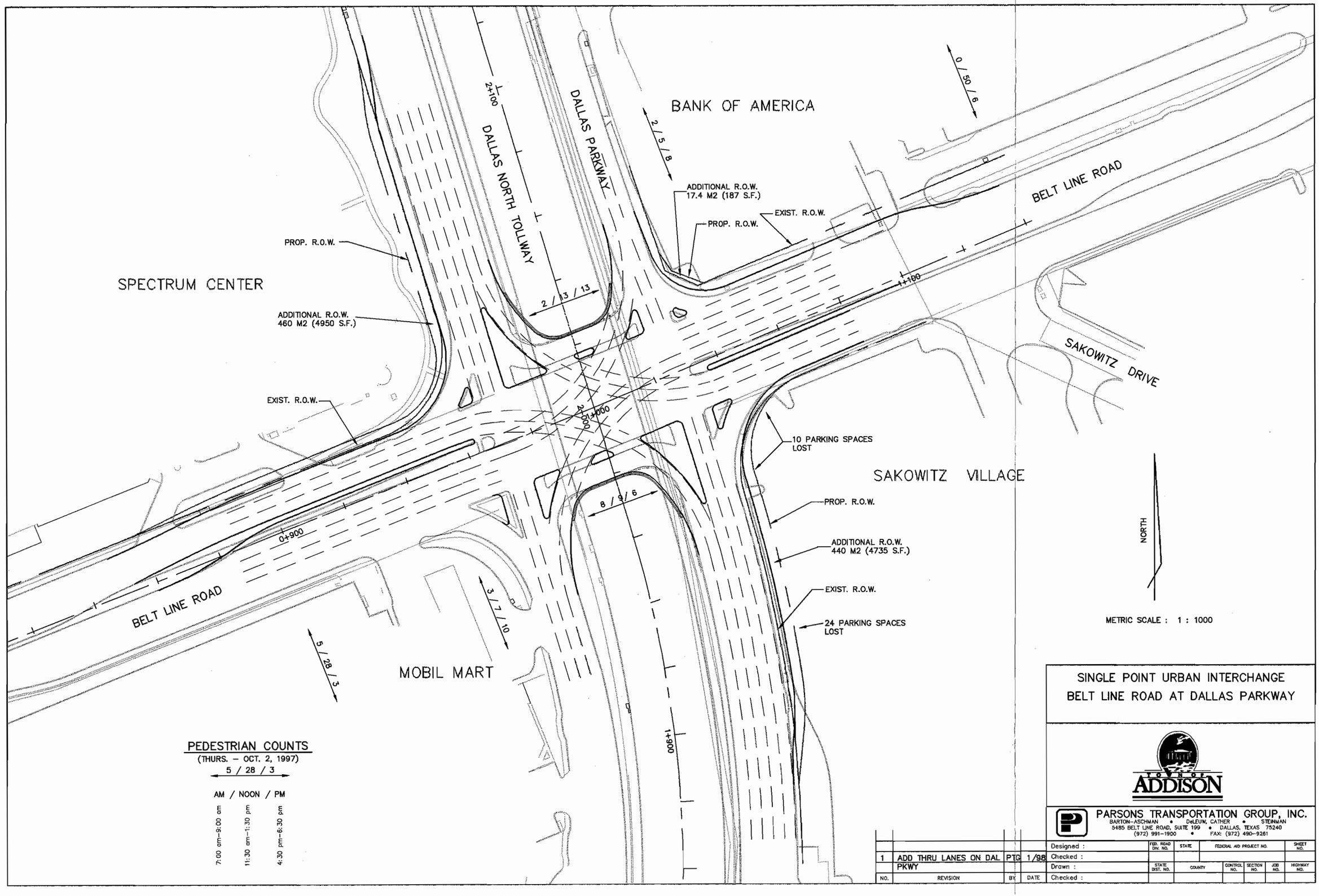
DESIGN REPORT FOR BELT LINE ROAD/DALLAS PARKWAY INTERCHANGE

PREPARED FOR

Town of Addison

PREPARED BY

Barton-Aschman Associates,Inc.



PEDESTRIAN COUNTS

(THURS. – OCT. 2, 1997)

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AM	NOON	PM
7:00 am–9:00 am	11:30 am–1:30 pm	4:30 pm–6:30 pm

SINGLE POINT URBAN INTERCHANGE
BELT LINE ROAD AT DALLAS PARKWAY

TOWN OF ADDISON

PARSONS TRANSPORTATION GROUP, INC.
BARTON-ASCHMAN • DeLEUW, CATHER • STEINMAN
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(972) 991-1900 • FAX: (972) 490-9261

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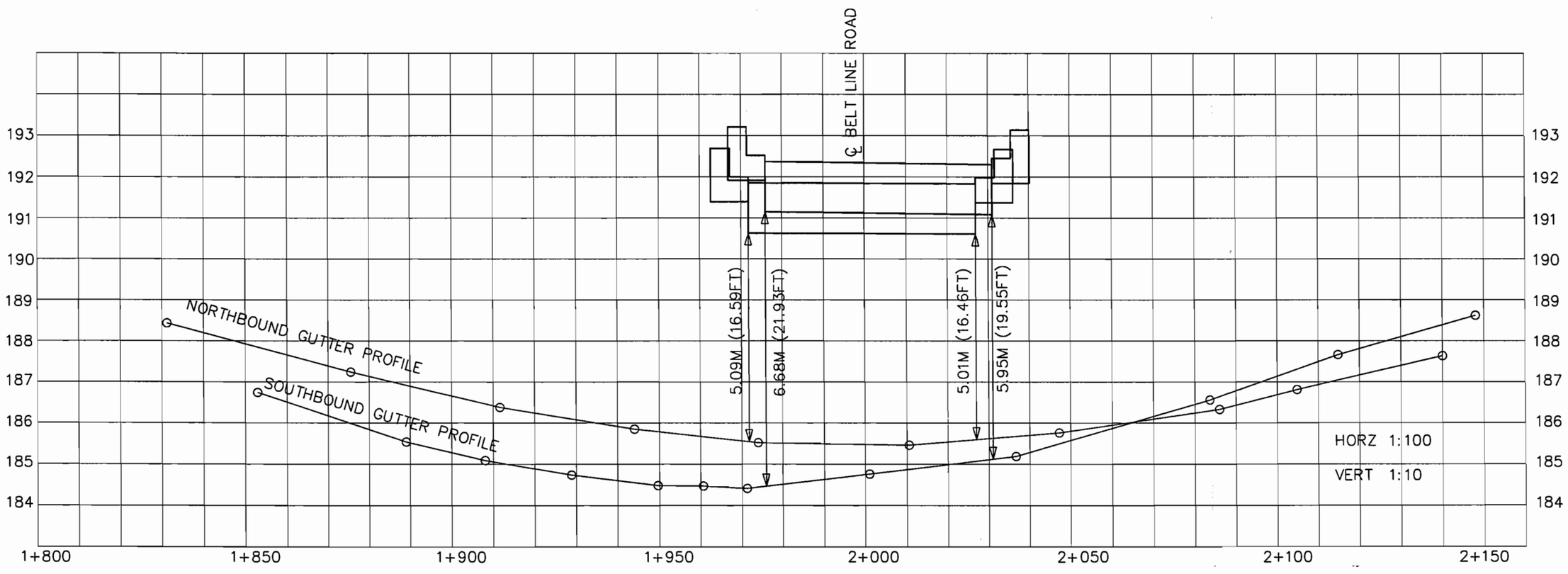

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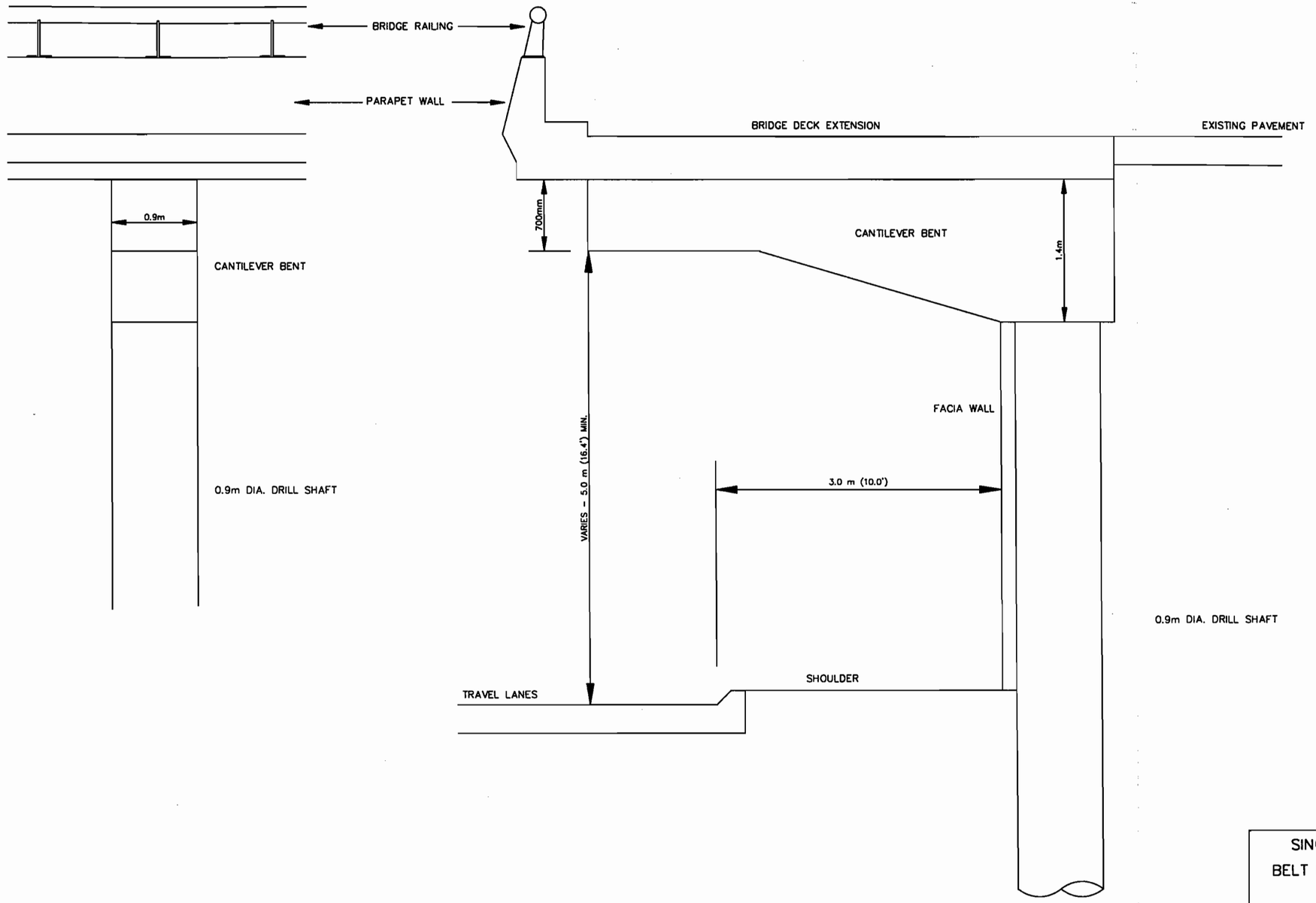

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COST ESTIMATE

ADDISON - SPUI :BELT LINE ROAD AND DALLAS NORTH TOLLWAY
October 15, 1997

ITEM-NBR	DESCRIPTION	UNITS	UNIT COST	QUANTITY	COST
100-5002	PREP R.O.W.	KM	$50,000.00	0.5	$25,000.00
104-5001	REMOV CONC (PAV)	M2	$11.43	1000	$11,430.00
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416-0506	DRILL SHAFT (36 IN)	LF	$77.49	400	$30,996.00
420-0551	CL C CONC (PARAPET WALL)	CY	$882.86	105	$92,700.30
420-5014	CL C CONC BENT	M3	$395.00	150	$59,250.00
422-5001	REINF CONC SLAB	M2	$71.79	1000	$71,790.00
423-5007	RET WALL	M2	$375.00	200	$75,000.00
450-0695	RAIL (TY C411)	M	$209.98	200	$41,996.00
464-5005	RC PIPE (CL III) (600MM)	M	$124.32	30	$3,729.60
465-0741	INLET (COMPL) (TY II) (10')	EA	$2,400.00	3	$7,200.00
496-0502	REMOV INLET	EA	$572.00	3	$1,716.00
5004-5001	TEMP SED FNC	M	$1.00	2000	$2,000.00
5004-5003	TEMP SED FNC (REMOV)	M	$1.00	2000	$2,000.00
500-5001	MOBILIZATION	LS	$75,000.00	1	$75,000.00
502-5001	BARRICADE, SIGNS, TRAFF	MO	$4,000.00	12	$48,000.00
530-5001	DRVWY'S (Conc)(150mm)	M2	$30.08	200	$6,016.00
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662-0542	WZPM (CLB)	EA	$2.30	500	$1,150.00
662-0543	WZPM (CLB)	EA	$2.33	200	$466.00
662-0581	WZPM (TAB)	EA	$6.83	1500	$10,245.00
662-0582	WZPM (TAB)	EA	$1.00	750	$750.00
666-0517	REFL	EA	$99.48	24	$2,387.52

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666-5041	REFL	M	$2.50	250	$625.00
666-5044	REFL	M	$8.63	75	$647.25
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678-5006	PAV SURV & PREP	M	$5.73	75	$429.75
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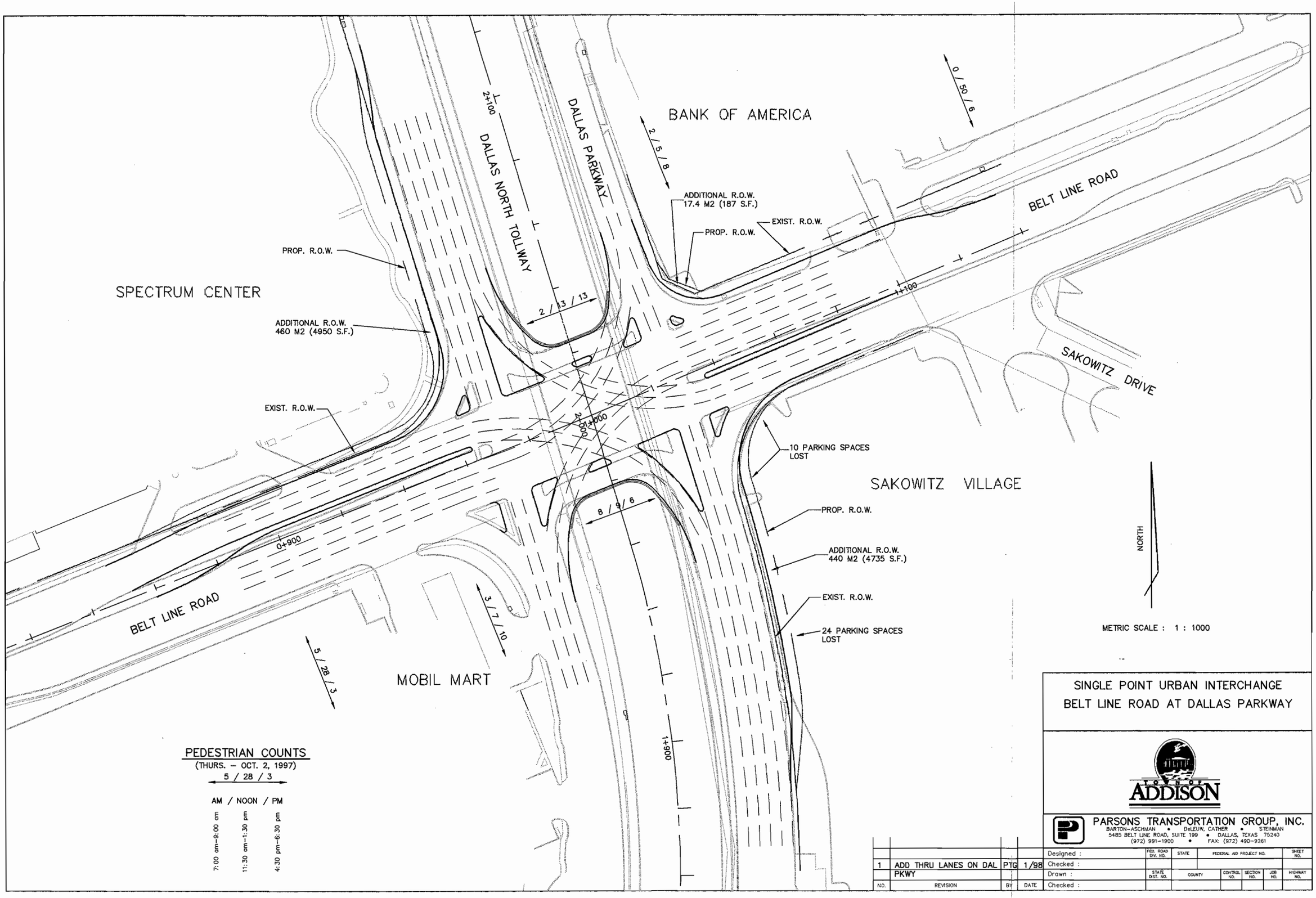
686	SIGNAL SYSTEM	LS	$125,000.00	1	$125,000.00
	LANDSCAPE	LS	$75,000.00	1	$75,000.00
	UTIL RELOC	LS	$175,000.00	1	$175,000.00

SUBTOTAL	$1,142,067.38
CONTINGENCY AND ENGINEERING	$342,620.21
RIGHT-OF-WAY	$540,000.00
TOTAL	**$2,024,687.59**



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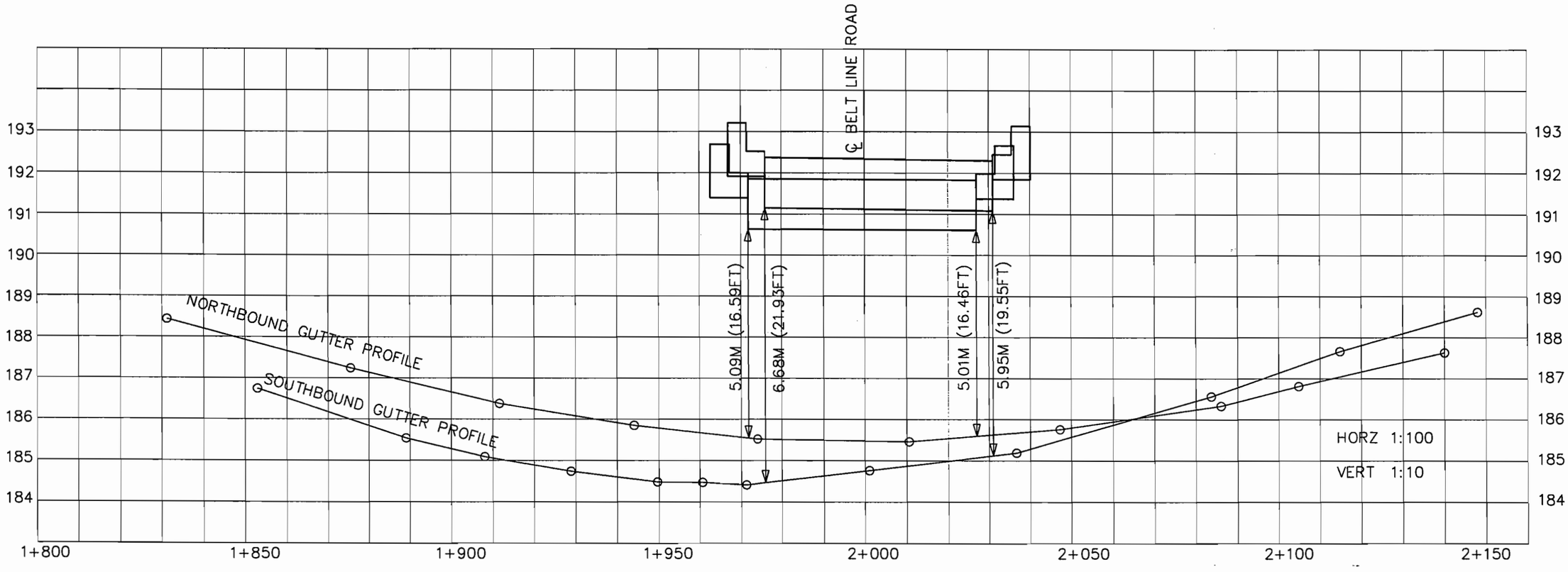

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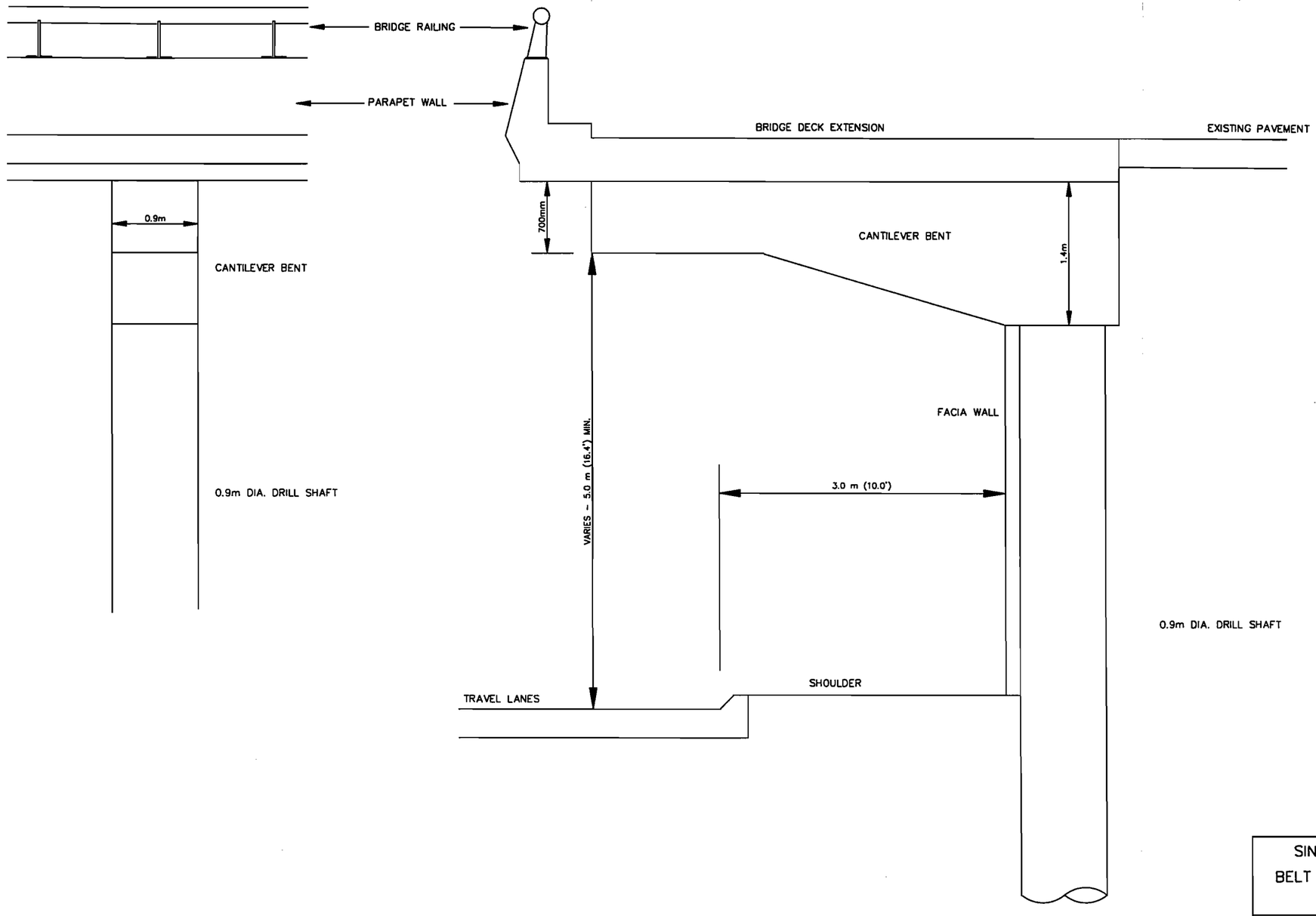

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	RIGHT-OF-WAY				$540,000.00
	TOTAL				**$2,024,687.59**

DESIGN REPORT FOR BELT LINE ROAD/DALLAS PARKWAY INTERCHANGE

PREPARED FOR

Town of Addison

PREPARED BY

Barton-Aschman Associates,Inc.

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1.
INTRODUCTION

The Town of Addison is located within one of the fastest growing areas in Texas. Already recognized as a leading business, retail, and commercial center, the Town continues to experience significant growth in retail, restaurant, and commercial development. The Town is also attracting new residential communities that could double its population over the next decade.

Increased traffic volumes have accompanied the growth in Addison and the surrounding area. The primary transportation network serving the Town and its local access requirements must also serve the regional travel needs of the area. These sometimes conflicting functions coupled with the increasing traffic volumes have increased traffic congestion along the Town's primary arterials.

The Town's leaders placed a high priority on the effective and efficient movement of traffic within and through the Town. The Town continually assesses travel and safety conditions on its roadway system and implements improvements to facilitate improved traffic conditions. The Town continues to improve conditions at intersections throughout the Town with the implementation of capacity improvements at the critical intersections along Belt Line Road.

At the heart of the transportation system serving Addison is the intersection of The Dallas North Tollway (DNT) and Belt Line Road. Belt Line Road is a major regional arterial thoroughfare serving North Dallas County. The Dallas North Tollway is a controlled access toll facility serving travel between downtown Dallas and northern Dallas and southern Collin Counties. Major ingress and egress ramps to the DNT at Belt Line characterize the importance of the interaction between these two major traffic carriers.

STUDY PURPOSE

The purpose of the study was to identify and evaluate alternatives for improving traffic conditions at the Dallas North Tollway/Belt Line Road intersection and based on the results of the evaluations develop a preferred alternative for implementation. The criteria used for evaluation includes Level of Service improvement, auto emissions reduction, and construction cost.

BACKGROUND

Although technically within the city limits of the City of Dallas, the intersection, nonetheless, serves as the gateway to Addison from the north and south and is the critical intersection for east/west travel within the Town. Increasing levels of congestion at this intersection during the peak hours now negatively impact traffic operation at nearby intersections. Because of its importance to the overall transportation system in the area, congestion at this intersection impacts the effectiveness of the entire transportation system

Realizing the importance of this intersection to transportation in Addison, the Town Council retained Barton-Aschman Associates, Inc. to develop and analyze alternatives for improving traffic conditions at this intersection.

2.
DEVELOPMENT OF ALTERNATIVES

Alternatives for evaluation were developed based on comments received from the Town of Addison and field investigations. The alternatives were developed using the following criteria:

- Elevated roadway sections should not be considered.
- Access to adjacent properties should be maintained.
- No existing movements should be eliminated.
- Alternatives should consider relatively low-cost traffic system management improvements as well as major (high cost) improvements to the intersection.
- Innovative alternatives should be considered.

Using these criteria, conceptual alternatives were developed and reviewed with Town of Addison staff. These conceptual alternatives included the following :

- TSM improvements to provide dual left-turn lanes from the DNT Frontage roads.
- Depressing the DNT frontage roads to allow through movements on the frontage roads to avoid the traffic signals at the intersection .
- Depressing the DNT frontage roads and reconfiguring the left-turn lanes from the frontage roads to allow concurrent let turns.
- Reconfiguring the left lanes on the frontage roads to allow concurrent left-turns (no grade separation on frontage roads).
- Reconfigure the intersection to create a Single Point Urban Interchange (SPUI) .

The SPUI is a new form of signalized urban interchange that can provide significant added capacity over conventional diamond urban interchanges. The SPUI is particularly well-suited for restricted right-of-way environments. The SPUI is relatively new and, to date, there are none operating in the Dallas/Ft. Worth Area.

A preliminary evaluation of each of these conceptual alternatives was conducted to determine which alternatives should be considered for detailed analysis. The results of this evaluation were reviewed with Town staff. Based on this review of the conceptual alternatives, depressing the frontage roads

to provide grade-separation for the frontage road through movements was eliminated for the following reasons:

- Extensive relocation of utilities.
- A preliminary profile of the grade separation indicates that the terminus points of the vertical curves necessary to achieve the required clearance under Belt Line Road would negatively impact the operation of the ingress and egress ramps to and from the Tollway.
- The grade separation would negatively impact access to adjacent properties.
- Cost.

The remaining three alternatives are discussed below and illustrated in Figures 1 thru 3.

Alternative 1

Alternative 1 is a relatively low cost Transportation System management (TSM) approach to improving traffic conditions at the intersection. Currently, both the northbound and southbound frontage roads have five approach lanes; one U-turn, one shared left and through lane, two through lanes, and one exclusive right turn lane. This alternative would modify the intersection to allow left-turns from the U-turn lane, providing two lanes to service the high volumes of left-turns at the intersection. This alternative requires no new right-of-way and only minor modifications to the intersection. Alternative 1 is illustrated in Figure 1.

Alternative 2

Alternative 2 reconfigures the frontage roads to provide a U-turn lane, dual left-turn lanes, three through lanes, and an exclusive right for both the northbound and southbound frontage roads. In addition, the left-turn lanes are realigned to allow concurrent left-turns from the frontage roads. This provides the opportunity for more efficient traffic signal operation. The approaches on Belt Line Road remain unchanged in this alternative. This alternative requires additional right-of-way along the frontage roads, and modifications to the existing bridge. Alternative 2 is illustrated in Figure 2.

Alternative 3

Alternative 3 creates a full single point urban intersection. In addition to the improvements presented in Alternative 2, the approaches on Belt Line Road are reconfigured to provide exclusive dual left-turn lanes (aligned to run concurrently), three through lanes, and an exclusive right-turn lane on both the eastbound and westbound approaches. This alternative requires additional right-of-way along the north side of Belt Line Roads and a reduction in the width of the median on Belt Line. Alternative 3 is presented in Figure 3.

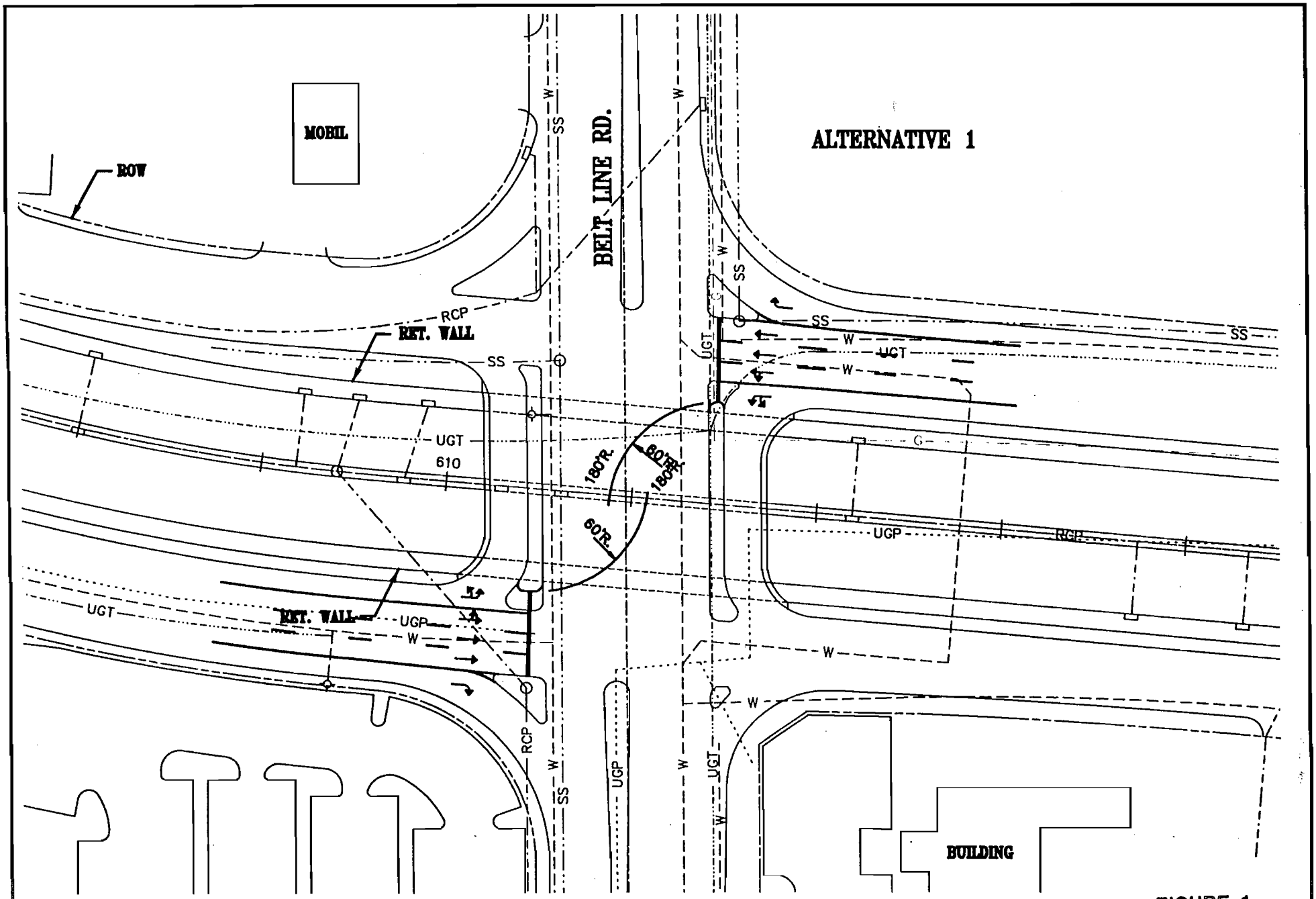
ALTERNATIVE 1
MOBIL
ROW
BELT LINE RD.
RCP
RET. WALL
SS
UGT
610
180°R.
60°R.
UGP
W
G
BUILDING

FIGURE 1

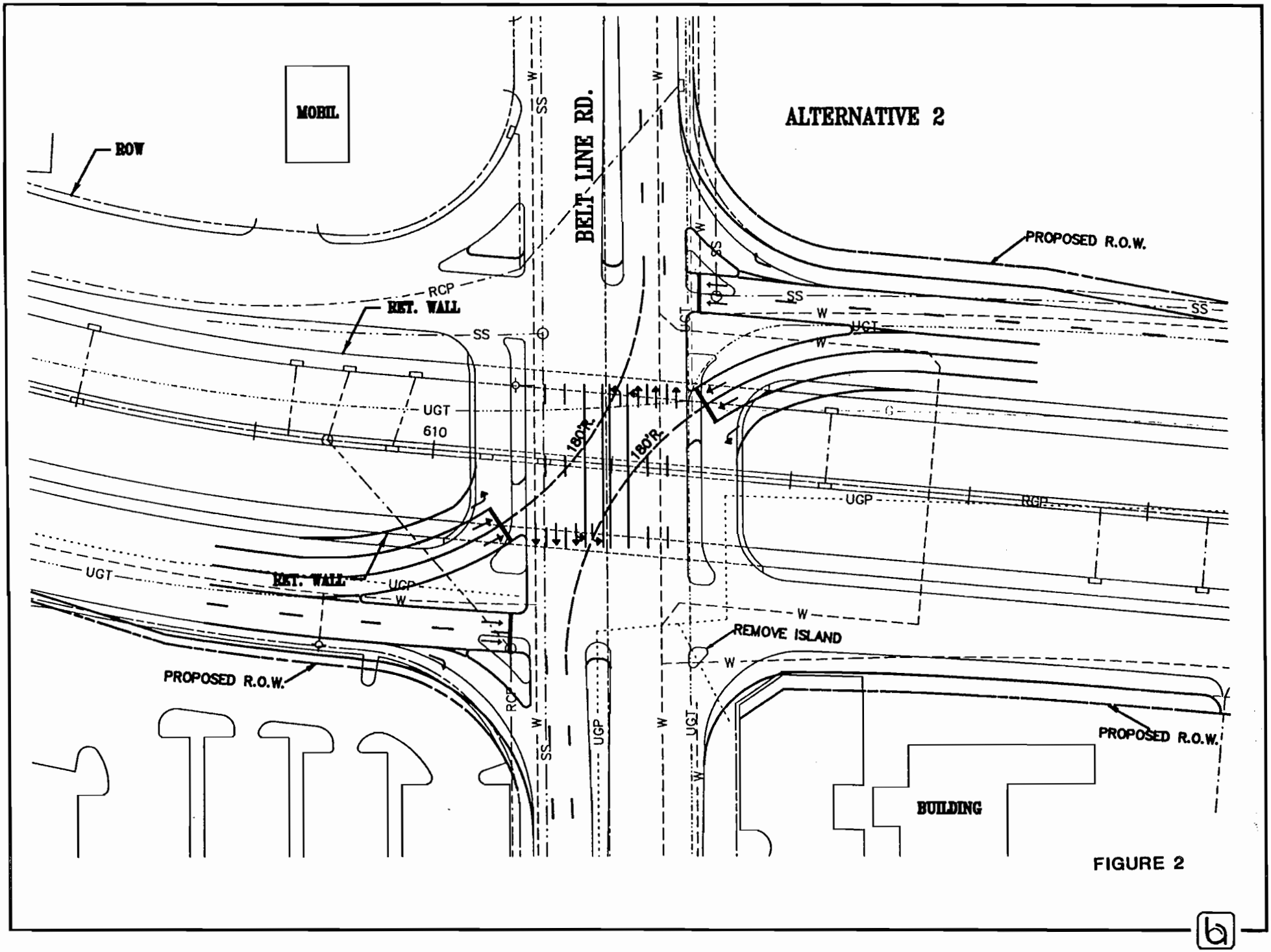
ALTERNATIVE 2
MOBIL
ROW
BELT LINE RD.
PROPOSED R.O.W.
RCP
RET. WALL
SS
W
UGT
610
180'R
UGP
REMOVE ISLAND
BUILDING

FIGURE 2

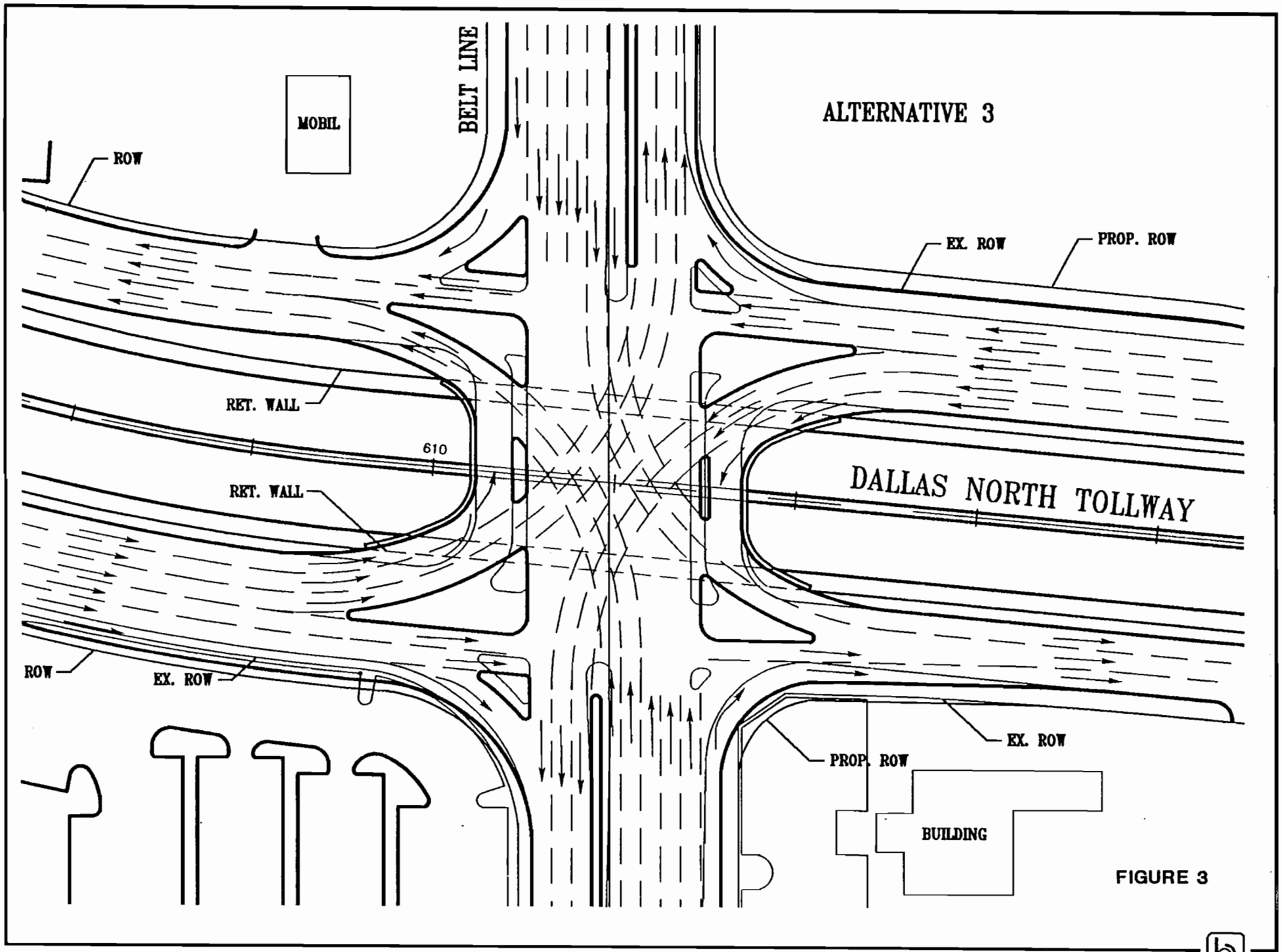
ALTERNATIVE 3
BELT LINE
MOBIL
ROW
EX. ROW
PROP. ROW
RET. WALL
610
RET. WALL
DALLAS NORTH TOLLWAY
ROW
EX. ROW
EX. ROW
PROP. ROW
BUILDING

FIGURE 3

3.
ROADWAY DESIGN

There are many factors to consider in the roadway design for any modifications to the Belt Line Road/Dallas Parkway intersection. Jurisdictional interests, right-of-way needs, the effect on existing utilities, and drainage considerations are among the factors to be investigated and addressed.

AFFECTED GOVERNMENTAL AGENCIES

Modifications to the Belt Line Road/Dallas Parkway intersection and the Belt Line Road Bridge over Dallas North Tollway will involve multiple jurisdictions and will probably require the execution of inter-local agreements between the jurisdictions. The jurisdictions are represented by their respective engineering or public works department or agencies. The affected governmental agencies are as follows:

- Texas Turnpike Authority - The Texas Turnpike Authority is the owner/operator of the Dallas North Tollway. Modifications to the Belt Line Bridge should be coordinated with the Turnpike Authority. The Turnpike Authority is located at:

  3015 Raleigh Street
  Dallas, Texas 75219
  (214) 522-6200

- Town of Addison - A portion of Belt Line Road west of Dallas North Tollway lies within the corporate limits of the Town of Addison. Street construction and modifications are administered through the Public Works Department located at:

  16801 Westgrove Drive
  Addison, Texas 75001
  (214) 450-2886

- City of Dallas - Belt Line Road over Dallas North Tollway and east of the Tollway lie within the City of Dallas. The Public Works and Transportation Department exercises control over street construction while Dallas Water Utilities is responsible for water and wastewater facilities. These two agencies are each located at:

  320 E. Jefferson Boulevard
  Dallas, Texas 75203
  (214) 670-4245 (Public Works)
  (214) 948-4592 (Water Utilities)

- Dallas County - Although not directly involved, Dallas County, through its Public Works Department, may have an interest in any proposed modifications at Belt Line and Dallas Parkway.

- Dallas Area Rapid Transit - DART may have an interest in the operational aspects of any proposed modifications at Belt Line and Dallas Parkway.

AFFECTED PROPERTY OWNERS

Northeast Corner - Prestonwood Tower lies within the City of Dallas. Belt Line Road and Dallas Parkway at this corner lie within the City of Dallas.

Southeast Corner - Bed, Bath & Beyond (formerly Sakowitz) lies within the Town of Addison along with northbound Dallas Parkway. Belt Line Road at this corner lies within the City of Dallas.

Southwest Corner - Mobil Self-Serve is located in the Town of Addison. Belt Line Road and southbound Dallas Parkway are situated in the Town of Addison also.

Northwest Corner - Spectrum Center lies within the Town of Addison along with westbound Belt Line Road. Southbound Dallas Parkway at this corner is located in the City of Dallas.

AFFECTED UTILITIES

The existing utilities and facilities located at or adjacent to the Belt Line/Dallas Parkway intersection are:

- Water mains
- Sanitary sewers
- TU Electric
- Lone Star Gas
- Southwestern Bell Telephone
- Storm drainage
- Traffic signals
- Median irrigation

- Water mains are located along Belt Line Road (however, not in the area of the bridge structure) and along Dallas Parkway. The depth of these mains in their current locations should provide adequate cover after any pavement widening. Facilities related to the water mains such as fire hydrants, water valves, water vaults, water meters and water valve manholes will require adjustments or relocation to accommodate pavement widening. Dallas Water Utilities and Town of Addison facilities are involved.

- Sanitary sewer facilities will involve adjustments to manholes and cleanouts but should not require any main reconstruction. Dallas Water Utilities and Town of Addison facilities are involved.

- TU Electric has overhead lines on wooden poles along the north side of Belt Line Road. The proposed pavement widening will require relocation of these facilities and these can be termed routine. A line of steel transmission towers runs along the west side of northbound Dallas Parkway. In Alternatives 2 and 3 one tower conflicts with the proposed U-turn for northbound Dallas Parkway. Relocation of this tower will require significant effort, time and money. TU Electric has four street lights in the Belt Line Road median that will be affected by the pavement widening. It is assumed that TU Electric's franchise agreements with the Town of Addison and the City of Dallas require relocations without cost to the Town or City.

- Lone Star Gas has facilities along Belt Line Road west of Dallas Parkway that may be affected by the proposed pavement widening. The existing depth is not known, but there should be no significant problems.

- Southwestern Bell Telephone has extensive underground facilities along Belt Line Road. The depth of these facilities is not known, but it is assumed that the depth provides sufficient cover to allow pavement widening without extensive relocations.

- Storm drainage mains belonging to the Town of Addison and the City of Dallas are located under existing street pavement. The proposed pavement widening will not affect the existing drainage patterns, will not significantly increase run off, and will only require relocation of existing storm drain inlets.

- Traffic signals at the Belt Line/Dallas Parkway intersection are owned and operated by the City of Dallas. The proposed intersection modifications will require a complete redesign of the signal layout and operation at this intersection.

- Median irrigation systems currently exist in the medians in both the City of Dallas and the Town of Addison. These facilities will be completely removed and reconstructed as part of the pavement widening.

DESIGN CONSIDERATIONS

Design considerations for this project will include:

- Belt Line Road Bridge
- Pavement widening
- Additional right-of-way
- Existing driveways
- Traffic control during construction

- The proposed left-turn and U-turn movements will require modifications to the Belt Line Road Bridge. These modifications involve additional structural analysis and relocation or adjustment of attached lighted roadway signs for Dallas North Tollway.

  The existing clearance of the Belt Line bridge for northbound Dallas North Tollway is signed as 15'-7" while the southbound is signed as 17'-0". The proposed structural modifications will decrease the clearance by approximately 4" in each direction.

- Pavement widening is proposed along the east side of northbound Dallas Parkway north and south of Belt Line Road, along the west side of southbound Dallas Parkway north of Belt Line Road, along the north side of Belt Line Road east and west of Dallas Parkway and along the median in Belt Line Road east and west of Dallas Parkway. The south curb line of Belt Line is proposed to remain unchanged.

  The majority of the existing pavement on Dallas Parkway and Belt Line Road will remain in place. Curbs will be removed in selected areas and new pavement will be added using steel dowels. The transverse and longitudinal slopes of the proposed pavement widening will match the existing.

- Additional right-of-way will not be needed along the south side of Belt Line Road (Mobil Self-Serve and Bed, Bath & Beyond frontage). Along the east side of Dallas Parkway south of Belt Line Road (Bed, Bath & Beyond), additional right-of-way with a maximum width of 11-feet will be needed to accommodate the pavement widening. The estimated additional right-of-way is approximately 3500 square feet and approximately 31 parking spaces may be eliminated.

  It appears that additional right-of-way will be needed along the Belt Line Road and Dallas Parkway frontages of Spectrum Center. The Belt Line frontage will require an additional 8-feet while the Dallas Parkway frontage will require an additional 11-feet. The estimated additional right-of-way is approximately 6500 square feet with no resulting loss of parking.

  Prestonwood Tower will have a relatively small right-of-way impact. Right-of-way needed for the proposed widening consists of a corner clip and slivers of new right-of-way along

Dallas Parkway and Belt Line Road. The estimated additional right-of-way at this corner is approximately 1000 square feet with a resulting displacement of about 10 parking spaces.

- There are four existing driveways that will be directly affected by the proposed pavement widening. There is no proposed construction at the southwest corner of Belt Line and Dallas Parkway that will affect driveways. The same is true for the southeast corner.

  Spectrum Center has two driveways on Belt Line Road and none on Dallas Parkway that will be affected by the proposed pavement widening. The same is true for Prestonwood Tower at the northeast corner of Belt Line and Dallas Parkway.

- Traffic control during construction will be handled in a similar manner to recent and proposed construction along Belt Line Road in the Town of Addison.

  The existing lane configuration will be maintained during construction in which the outside lane pavement widening will occur first. Upon completion of the outside lane pavement, traffic will be shifted to the north and then construction around the median will take place. At the conclusion of construction activities, median irrigation and landscaping will take place.

4.
TRAFFIC OPERATIONS ANALYSIS

The Belt Line Road and Dallas Tollway frontage roads were simulated using TRAF-NETSIM, a microscopic street network simulation model. TRAF-NETSIM was developed for the U.S. Department of Transportation, Federal Highway Administrative (FHWA), and has been nationally accepted for traffic operations analysis. The model accumulates statistics on a vehicle by vehicle basis for stopped delay, total delay, average delay, average queue, maximum queue, fuel consumption, and vehicle emission rates. TRAF-NETSIM simulates the movements of individual vehicles over one second time increments using probablistic techniques to randomize the simulation. The "drivers" are subject to car-following theory, lane-change rules and gap acceptance rules taken from a random population with random characteristics. TRAF-NETSIM was used to provide a common reference for evaluating proposed alternatives with existing conditions.

PROCEDURE

The following steps were completed for TRAF-NETSIM analysis:

1. A field study of the site was made to determine the physical and operational aspects of the existing conditions.

2. Data collection efforts included:

    - PM peak hour turning movement counts were performed on Friday, March 23, 1995 from 4:00 PM to 6:00 PM.

    - Existing timing plans were provided by the City of Dallas and verified in the field.

    - A vehicle delay study was performed on Friday, March 24, 1995 from 4:00 PM to 6:00 PM.

    - The Texas Turnpike Authority provided "As Built" plans of the study location.

- Lane configurations were verified in the field.

3. Existing conditions using TRAF-NETSIM were modeled and calibrated.

4. Meeting were held with the Town of Addison representatives to discuss the proposed alternatives. It was determined Alternatives 1 and 3 would be modeled using TRAF-NETSIM.

5. Measure of Effectiveness were determined for each alternative.

6. Results and conclusions were documented.

ON-SITE DATA COLLECTION

Data collection consisted of turning movement counts and a stopped-delay study at Belt Line Road and Dallas Tollway frontage roads. Data collection was performed on Friday, March 24, 1995 from 4:00 PM to 6:00 PM during the peak hour to represent worst case conditions. The turning movement counts are shown in figure 4.

Stopped-time delay is determined by measuring the number of cars stopped on each approach every 15 seconds. These 15-second "snapshots" provide a sample of the number of cars that are stopped. By assuming that each stopped vehicle stays stopped for the full 15 seconds, each counted vehicle represents 15 vehicle-seconds of stopped delay. The sum of all the vehicles counted in this way is the total stopped delay. The stopped-delay study was used to compare the results of simulation with actual field performance.

CALIBRATION

The TRAF-NETSIM model was calibrated based on stopped delay and maximum queue per approach. Driver performance characteristics such as maximum acceleration and mean queue discharge headway were varied from the respective default values to replicate observed conditions at the study location. The simulation model was considered calibrated once the stopped delay and maximum queue were brought to within an acceptable range of the data collected. In general, the TRAF-NETSIM default values were found to be more sluggish than what was measured in the field at the study location.

RESULTS

Stopped delay, total delay, maximum queue, and vehicle emissions for the different scenarios studied are reported below. The stopped delay is defined as the average time that a vehicle is stopped with

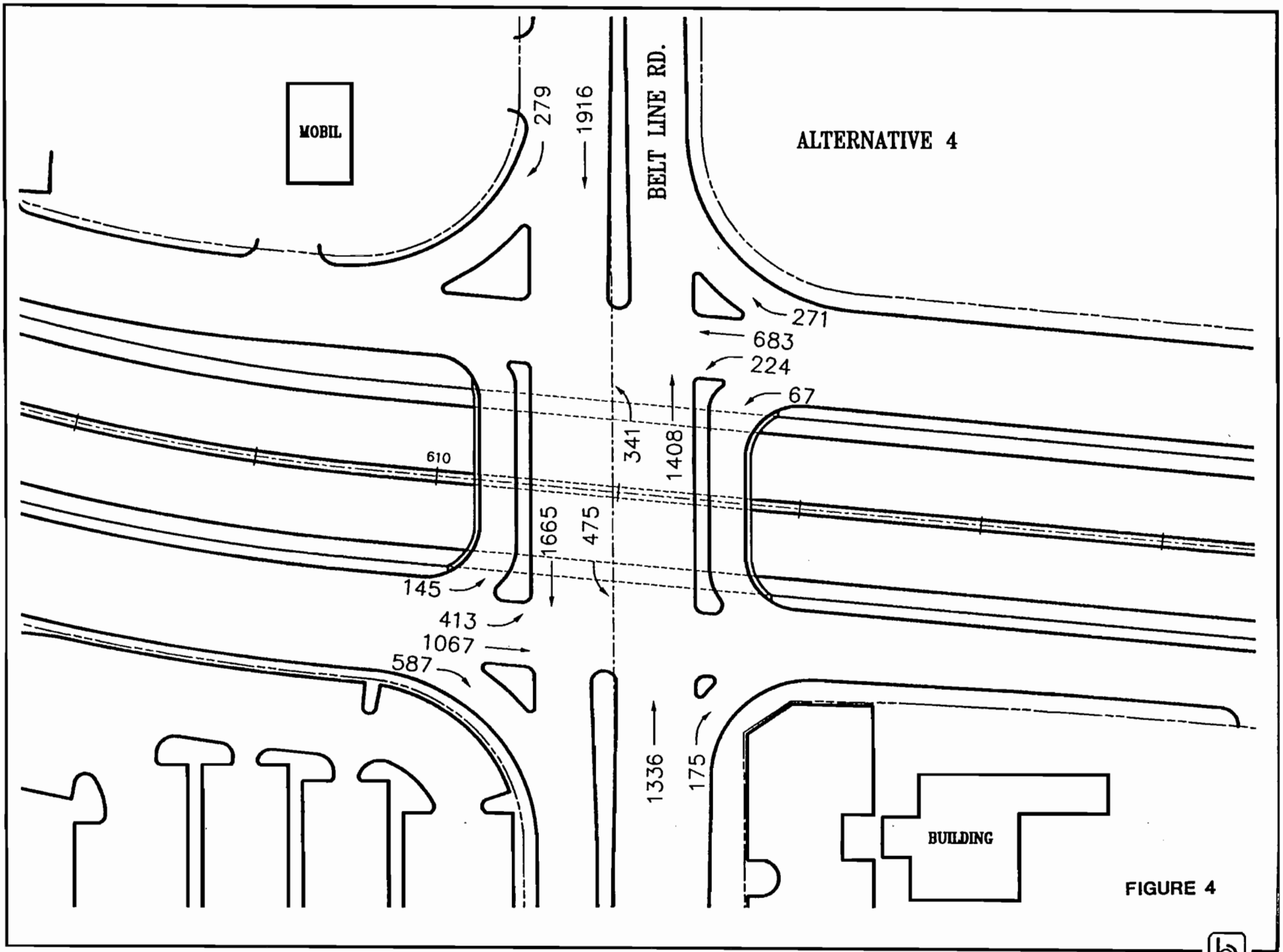
MOBIL
279
1916
BELT LINE RD.
ALTERNATIVE 4
271
683
224
67
610
341
1408
1665
475
145
413
1067
587
1336
175
BUILDING

FIGURE 4

(b)

locked wheels at an approach, and average total delay is defined as the average difference between the total approach time of a vehicle and the free flow travel time on an approach. The maximum queue is defined as the maximum queue that occurs during the simulation time.

Existing Conditions

Based on the TRAF-NETSIM analysis the results for existing conditions are shown in Table 1. The existing phasing is the standard Texas Transportation Institute (TTI) phasing with a 120 second cycle.

Table 1: Existing Conditions Measures of Effectiveness

Intersection	Stopped Delay		Total Delay		CO (kg/hr)	Max. Queue
	Avg. Delay	LOS	Avg. Delay	LOS		
Belt Line Eastbound	39.82	D	52.40	E	119.95	65
Belt Line Westbound	144.86	F	190.60	F	87.36	125
Southbound Frontage	146.45	F	192.70	F	46.53	73
Northbound Frontage	70.30	F	92.50	F	111.26	98
OVERALL	**84.56**	**F**	**111.27**	**F**	**365.10**	**361.00**

Alternative 1

Based on the TRAF-NETSIM analysis, the results for Alternative 1, are shown in Table 2. Alternative 1 was analyzed using existing signal timing and phasing.

Table 2: Alternative 1, Island Modifications Only Measures of Effectiveness

Intersection	Stopped Delay		Total Delay		CO (kg/hr)	Max. Queue
	Avg. Delay	LOS	Avg. Delay	LOS		
Belt Line Eastbound	40.36	E	53.10	E	120.60	65
Belt Line Westbound	147.90	F	194.60	F	90.93	126
Southbound Frontage	110.80	F	145.90	F	54.49	56
Northbound Frontage	38.08	D	50.10	D	104.43	63
OVERALL	**69.75**	**F**	**91.78**	**F**	**370.45**	**310.00**

Alternative 2

TRAF-NETSIM analysis was not performed for Alternative 2. Alternative 2 creates single point left turns for the frontage roads movements but not Belt Line Road movements. This would allow the frontage roads to run the left-turns concurrently; however Belt Line would have to remain as the existing phasing. This will improve traffic operations from Alternative 1, but the phasing alternatives would be limited possibly confusing to drivers.

Alternative 3

Based on the TRAF-NETSIM analysis, the results for Alternative 3 are shown in Table 3. The results are based on a cycle length equivalent to the existing cycle length of 120 seconds, and a four phase sequence. Protective/Permissive left-turn signal operation cannot be used with single point interchanges. A longer clearance interval is required for this design than traditionally used with TTI phasing. In the four phase sequence analyzed the left-turn movements proceed their adjacent through movements. Leading left-turns were used for the analysis because this phasing is commonly used and familiar to drivers. However, lagging left-turns could be used. The advantage to lagging left-turns is that a smaller clearance interval would be required and create a more efficient use of signal time.

Table 3: Alternative 3, SPUI Measures of Effectiveness

Intersection	Stopped Delay		Total Delay		CO (kg/hr)	Max. Queue
	Avg. Delay	LOS	Avg. Delay	LOS		
Belt Line Eastbound	24.59	C	32.36	C	99.77	50
Belt Line Westbound	33.23	D	43.72	D	74.20	51
Southbound Frontage	43.95	E	57.83	E	69.00	38
Northbound Frontage	55.51	E	73.05	E	94.05	84
OVERALL	**38.63**	**D**	**50.83**	**D**	**337.02**	**223**

TRAFFIC OPERATIONS ANALYSIS CONCLUSIONS

Based upon the analysis performed in this study, Alternative 3 shows significant reductions in stopped delay, total delay, carbon monoxide emissions, and maximum queue. Alternative 1 shows reductions in the overall measures of effectiveness.

Alternative 1, island modifications only, was analyzed using the existing phasing and timing so that an easy comparison could be made with existing conditions. This alternative will increase the capacity of the frontage roads. The measures of effectiveness for stopped delay, average total delay, and maximum queue show an overall improvement in traffic operations for the interchange. There is a very minimum increase on the measures of effectiveness on Belt Line reflected in the table. This increase is caused by TRAF-NETSIM modeling procedures.

Alternative 1 reduces stop delay and average total delay by 17.5% and overall maximum queue by 14% and increases carbon monoxide emissions by 1.5%.

Alternative 3, SPUI, will produce significant reductions in the measure of effectiveness for the overall operation of the interchange. This alternative is expected to significantly increase capacity from the existing oversaturated conditions. The analysis was done based on the existing cycle length; however the phasing and timing was optimized. While it is recommended that the frontage roads use the same cycle length and coordinate with adjacent intersections to provide progression along Belt Line, the increase in capacity this option provides will allow flexibility in the phasing and cycle lengths.

On Belt Line, adjacent intersections to the interchange, Montfort and Quorum Drive, are very close in proximity to the frontage roads. During field observations it was observed that queues along Belt Line come very close to adjacent intersections. For short periods of time, the flow of traffic through adjacent intersections was impeded by the queues at the frontage roads. The single point intersection significantly reduces queue length along Belt Line Road. This reduction in queue length is expected to eliminate the chance of vehicles queuing into adjacent intersections and impeding traffic operations under normal traffic conditions. The actual effect at Montfort and Quorum goes beyond the scope of this project.

Alternative 3 reduces stop delay and average total delay by 54%, carbon monoxide emission rates by 7.6% and overall maximum queue by 38%.

5.
ENGINEER'S OPINION OF PROBABLE COST

The cost associated with the improvements in each alternative vary directly with the complexity of the alternative. The benefit derived from each alternative also increases with the cost and complexity of a specific alternative. The following tables show the Engineer's Opinion of Probable Cost for each of the three alternatives.

Table 4: Alternative 1, Island Modifications Only Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
MOBILIZATION	LS	1	$10,000.00	$10,000.00
REMOVE OLD CONC (CURB)	LF	95	$4.00	$380.00
REMOVE OLD CONC (MED)	SY	425	$7.00	$2,975.00
REMOVE OLD CONC (SIDEWALK)	SY		$4.00	$0.00
REPLACE CONC PAV (8")	SY	42.7	$108.00	$4,612.00
CONC. CURB & GUTTER	LF	40	$3.00	$120.00
CONC MED	SY	18	$27.00	$486.00
MARKING AND STRIPING	LS	1	$10,000.00	$10,000.00
SIGNING MODIFICATIONS	LS	1	$10,000.00	$10,000.00
SUBTOTAL				$38,573.00
CONTINGENCY @ 15%				$5,786.00
GRAND TOTAL				**$44,358.00**

Table 5: Alternative 2, Single Point Left-Turns Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
MOBILIZATION	LS	1	$10,000.00	$10,000.00
REMOVE OLD CONC (CURB)	LF	1,440	$4.00	$5,760.00
REMOVE OLD CONC (MED)	SY	279.7	$7.00	$1,958.00
REMOVE OLD CONC (SIDEWALK)	SY	511.1	$4.00	$2,044.00
REPLACE CONC PAV (8")	SY	805.1	$40.00	$86,951.00
CONC. CURB	LF	1,085	$3.00	$3,255.00
CONC MED	SY	390.6	$27.00	$10,545.00
SIDEWALK	SY	511.1	$24.00	$12,267.00
BRIDGE MODIFICATIONS	SF	5,000	$40.00	$200,000.00
MARKING AND STRIPING	LS	1	$10,000.00	$10,000.00
SIGNING MODIFICATIONS	LS	1	$10,000.00	$10,000.00
SUBTOTAL				$352,780.00
CONTINGENCY @ 15%				$52,917.00
GRAND TOTAL				**$405,697.00**

Table 6: Alternative 3, SPUI Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
MOBILIZATION	LS	1	$10,000.00	$10,000.00
CLEAR & GRUB	LS	1	$20,000.00	$20,000.00
REMOVE OLD CONC (CURB)	LF	3,340	$4.00	$13,360.00
REMOVE OLD CONC (MED)	SY	600	$7.00	$4,200.00
REMOVE OLD CONC (SIDEWALK)	SY	790	$4.00	$3,160.00
REPLACE CONC PAV (8")	SY	4,000	$40.00	$160,000.00
REMOVE & REPLACE INLETS	EA	4	$4,000.00	$16,000.00
CONC CURB	LF	3,950	$3.00	$11,850.00
BRICK PAVERS	SY	800	$30.00	$24,000.00
CONC MED	SY	900	$27.00	$24,300.00
FIRE HYDRANT RELOCATION	EA	4	$600.00	$2,400.00
SIDEWALK	SY	950	$24.00	$22,800.00
WATER VALVE/METER RELOCATION	EA	20	$150.00	$3,000.00
BRIDGE MODIFICATIONS	SF	7,000	$50.00	$350,000.00
MARKING AND STRIPING	LS	1	$10,000.00	$10,000.00
TRAFFIC CONTROL	LS	1	$10,000.00	$10,000.00
SIGNING MODIFICATIONS	LS	1	$10,000.00	$10,000.00
SIGNAL MODIFICATIONS	LS	1	$100,000.00	$100,000.00
SUBTOTAL				$795,070.00
CONTINGENCY @ 15%				$119,230.00
SUB TOTAL				$914,300.00
R.O.W. 11,000 SF @ $30/SF				$330,000.00
GRAND TOTAL				**$1,244,300.00**

6.
RECOMMENDATIONS

Based upon design considerations, construction costs and traffic analysis Alternative 3, a Single Point Urban Interchange (SPUI), is recommended for the Belt Line Road and Dallas Parkway interchange. The SPUI will provide the most cost effective solution to the congestion problem currently experienced. A SPUI will create additional capacity that will provide flexibility to provide efficient traffic flow along Belt Line Road. This recommendation is expected to reduce stop delay and average total delay by 54%, carbon monoxide emission rates by 7.6% and overall maximum queue by 38% from existing conditions.

The design of a SPUI will be "new" to most drivers and pedestrians in this area. Care should be given throughout the design process to insure safety to pedestrians and motorists. Basic signal phasing for a SPUI is not conducive to pedestrians crossing the road. Pedestrian safety should be emphasized with crosswalks and stop bars and consideration should be given to an actuated pedestrian phase or a pedestrian overpass. Enhanced traffic control devices, such as pavement markings to delineate lane lines, turning paths, stop bars, cross walks, lighting and traffic guidance signs should be considered. With these safety issues in mind during the design process a single point interchange can be safe and efficient to the motorist and can significantly improve traffic conditions.