SSCL-N-735

LOAD TRANSPORTATION LIMITS

Ron Hoffmann

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Abstract

In July of this year, the author made a preliminary route reconnaissance for transporting large loads from the Texas gulf coast to the SSC Laboratory site near Waxahachie. The results of the reconnaissance were reported to the Physics Research Division (Ray Stefanski) in a memorandum dated August 3, 1990. As a result of that work, the author was asked to perform a study and provide recommendations regarding the size and weight of loads which can be most readily transported over the Texas road systems. The results of this study were reported to the Physics Research Division (Ray Stefanski) in a memorandum dated October 5, 1990. The October 5th memorandum is the first attached to this note while the August 3rd memorandum is the second.

Summary of Recommendations

1. Limit the height of the load on its transporter to sixteen feet and investigate and adjust the line of march as necessary to avoid points of lesser clearance.

2. Loads twenty-four feet wide or less can most readily be transported, however, with good planning and thorough investigation and adjustment of the line of march, loads as wide as thirty-two or thirty-four feet can probably be accommodated.

3. Loads weighing sixty-five short tons or less can most readily be transported. Specialized equipment is available which can accommodate loads as great as two hundred fifty short tons, however some compromises may be required on horizontal clearance (load width) and maneuvering due to the length of the equipment.

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Conventional Construction Division

TO: Ray Stefanski

FROM: Ron Hoffmann

DATE: October 5, 1990

SUBJECT: Load Transport Limits

REFERENCE: Memorandum of August 3, 1990 from Ron Hoffmann to Ray Stefanski, subject: Route Reconnaissance.

INTRODUCTION

This memorandum attempts to provide guidance regarding the size and weight of loads which can be transported over Texas roads without encountering the problems discussed in the referenced memorandum.

SUMMARY OF RECOMMENDATIONS

1. Limit the load height on its transporter to 16 feet and investigate and adjust the proposed line of march as necessary to avoid points of lesser vertical clearance.

2. A load width of 24 feet can must easily be transported, however, with good planning and a thorough investigation of the line of march, load widths of 32 or 34 feet can probably be accommodated.

3. Loads as great as 65 short tons can be readily transported. Specialized equipment is available which can accommodate loads as great as 250 short tons, however some compromises may be required on horizontal clearance and maneuvering due to the length of the equipment.

INFORMATION SOURCES

The following references were used in compiling this memorandum:

Ref.-1. Texas State Department of Highways and Public Transportation, Bridge Division Operation and Planning Manual, File D-5,

Ref.-2. Texas State Department of Highways and Public Transportation, Highway Design Division Operations and Procedures Manual 1-86, Part IV Design,

Ref.-3. Jake's Crane, Rigging, & Transport International; 6109 S. Industrial Rd., Las Vegas, NV 89016; phone (800) 553-5253; Mr. Kent Goodman, and

Ref.-4. Daily Express, Inc., P. O. Box 39, Carlisile, Pennsylvania 17013-0039, phone (717) 243-5757, Mr. Robert D. Miller.

While references 1. & 2. are not actual records of existing conditions, they are excellent indications of what can be expected of most of the Texas road systems. When actual load characteristics and the proposed line of march are known, Texas has records, by county, of the existing conditions which should be consulted before transport plans are finalized.

It should be emphasized that references 3 & 4 are not the only transporters of heavy loads, but are used herein to demonstrate what is available, how complicated (and more costly) it becomes as the weight of the item to be transported increases, and what has already been accomplished in the heavy load transport area.

TEXAS ROAD SYSTEMS

Texas divides its road systems into four categories;

1. FREEWAYS which are urban or rural, access controlled, multi-lane, divided, arterial highways, and include portions of the Texas State and United States Highways as well as the Interstate Highways. Included also are the on, off, and interconnecting ramps and the frontage roads associated with the Freeways.

2. MULTI-LANE RURAL HIGHWAYS which are rural, non-access controlled, multi-lane, divided or undivided, arterial highways, and include portions of the Texas State and United States Highways.

3. TWO LANE RURAL HIGHWAYS which are rural, non-access controlled, two lane, undivided, arterial and collector highways and local roads, and include portions of the Texas State and United States Highways as well as the Farm Roads.

4. URBAN STREETS which are roadways in developed areas that provide access to abutting property as well as movement of vehicular traffic and are access controlled only through driveway locations, pavement markings and the possible use of curbed medians. They may be two lane or multi-lane, divided or undivided, streets and include the urban portions of Farm Roads and the Texas State and United States Highways which are not Freeways.

Travel lane widths, shoulder or curb lane widths, and vertical and horizontal clearances differ for each of these road categories as do the load carrying capacities of their pavements and bridges. These aspects are discussed in the following paragraphs with recommendations provided for planning.

HEIGHT OF THE LOAD

With regard to vertical clearances, Ref.-1 states:

"All new highway grade separation structures, including railroad underpasses, shall provide 16'-6" minimum vertical clearance over the usable roadway.

"No exceptions shall be made to this policy for structures over main lanes of interstate or controlled access highways except within cities where the 16'-6" vertical clearance is provided on an interstate loop around the particular city. On all other systems of highways with separations involving interchange facilities, other highways, public roads, city streets or railroads, 16'-6" minimum vertical clearance should be provided. Where this minimum clearance is impracticable or excessively expensive to provide, exceptions may be made. In such cases, the vertical clearance shall be held as near as practicable to the 16'-6" and should be at least 15'-6". In no case shall the vertical clearance be less than 14'-6".

"The above specified clearances apply over the entire usable width of roadway including usable shoulders and include an allowance of six inches for future pavement overlays."

Ref.-2 reiterates this policy but adds that in the case of urban streets, existing structures that provide at least 14'-0" clearance may be retained.

In view of the above it is recommended that the vertical height of the load on its transporter be limited to 16'-0" (16'-6" less the 6" allowance for future pavement overlays) and that the proposed line of march be investigated and adjusted if necessary to avoid any points of lesser vertical clearance.

WIDTH OF THE LOAD

With regard to horizontal clearances at railroad underpasses, Ref.-1 states:

"Clearances for highway underneath a railroad structure should follow those outlined for vehicular structures in Section 2-201except as follows;

"Since the railroad loading on the longer spans of the railroad structure would in most cases increase the cost of the work appreciably (both of the structure and of the railroad or the highway approaches to the structure) it would be proper to design the highway to provide adequate shoulder widths with introduced guardrail on the approaches to and through the length of the separation structure, and to place the face of the pier or abutment for the separation structure four to six feet and at least two feet outside the face of the guardrail.

"For the usual conditions a minimum of about 16 feet from the edge of the traffic lane to the face of pier is recommended. Greater clearance should be provided where the overall cost of the structure will not be materially increased."

Section 2-201, referenced in the above quote, states:

"The horizontal clearance for rural section should be 30 feet from the edge of travel lanes to face of pier or bent. Outside clearance may be 16 feet in urban areas where the traffic speed is less than 50 miles per hour. On low-volume roads, with ADT (average daily traffic) *less than 750 minimum obstruction clearance is 7'; 16 feet desirable. For curbed medians the distance from face of curb to pier should not be less than 6'-6". In no case should the distance from outside curb to face of pier be less than 4'-0"."*

Regarding bridge widths, Ref.-1 states;

"As a rule except for the very lowest traffic count structures all bridges will carry the full usable shoulder width of the approach roadway across the structure. More specifically, the bridge widths, measured between the nominal face of railings, shall conform to those indicated in the Highway Design Division Manual (Ref.-2) *for the various types of roads and traffic volumes and are summarized in Table 2-A. The basis for the various bridge widths is explained in the following paragraphs."*

Excerpts from these explanatory paragraphs regarding Freeways are;

"For 4-lane divided highway or 6-lane divided highway with depressed median a structure carrying traffic in one direction will have a 4' inside or left shoulder, 10' outside or right shoulder and provide 12' for each lane of traffic."

"Direct connection structures (ramps from freeway to freeway) *shall provide 4' left shoulder and 8' right shoulder widths. The lane width is 14' for 1-lane structures and 12' for each lane of 2-lane direct connection."*

"Ramp structures other than direct connections should have a 4' left shoulder, 6' right shoulder and a 14' traffic lane. These standard widths indicated are desirable and adjustments may be needed for special conditions of traffic or geometric alignment."

"The recommended widths of rural frontage roads varies with the traffic count and are shown on Table 2-A. The bridge widths should match the approach roadway width including usable shoulders."

Regarding Multi-lane Rural Highways;

"Design of multi-lane non controlled access facilities is dependent on traffic volume. Lane widths are fixed at 12' whereas shoulder widths vary from 4' to 10' depending on the type of cross section. The bridge widths should match the approach roadway width including usable shoulders. The various roadway and bridge widths are shown in Table 2-A."

Regarding Two-Lane Rural Highways other than Farm Roads;

"Two 12' lanes with shoulders that vary from 4' to 8' constitutes the roadway and bridge width and varies depending on ADT. The bridge width matches the width of approach roadway including usable shoulders. See Table 2-A"

Regarding Farm Roads;

"These roads utilize bridge widths that vary from 24' to 40' depending on the design year ADT which is considered to be the projected traffic at completion of the project. See Table 2-A."

Regarding City Streets;

"Where a structure carries a city street section the structure width should match the city curb and gutter dimensions with a four to six foot sidewalk provided as needed for city pedestrian traffic."

Table - A at the end of this memorandum provides a compilation of bridge and railroad underpass widths which can be expected on various road systems and the width of load which they will pass. The table is based on interpretations of the above quotes plus Chapter 3 of Ref.-2 which deals with urban streets. In the table, the widths of the bridges and underpasses are shown as formulas

which consists of the left hand clearance plus the width of the travel lanes plus the right hand clearance. The load widths are two feet less than the width of the bridge or underpass which should allow adequate clearance for passage in most instances.

Table - B at the end of this memorandum is derived from Table - A and indicates the areas of possible interference for various widths of load. Examination of the table indicates that a load width limit of 24 feet will have the fewest problems; the only significant impediment being a possible bridge on a freeway on/off ramp included in the line of march. Load widths of 32 or 34 feet will have significantly more impediments but are probably doable with good planing and a thorough investigation and adjustment of the line of march.

WEIGHT OF THE LOAD

Ref.-1 states;

"All on-system bridges shall be designed for HS20-44 Loading, except Farm Road bridges on roads with less than 50 vehicles per day design year traffic, which may be designed for H15-44 Loading if100% state funds are used.

"Loadings referred to above are as specified in the latest edition of the Standard and Interim Specification for Highway Bridges as adopted by the American Association of State Highway and Transportation Officials."

HS20-44 Loading specifies a single truck load consisting of an 8,000 lb. front axle followed at 14 feet by a 32,000 lb. axle which is followed at 14 to 30 feet by another 32,000 lb. axle. Truck trains are represented by a lane loading which consists of a uniform load of 640 lbs. per foot plus a concentrated axle load of 18,000 lbs. for determining maximum moments and 26,000 lbs. for determining maximum shears in the bridge structure. Load lanes are considered to be 10 feet wide and the number of load lanes for which the bridge structure is designed depends on its total width, not how many travel lanes it carries. Bridges having total widths up to and including 30 feet are designed for 2 load lanes; and over 30 feet, up to and including 42 feet, for 3 load lanes.

H15-44 Loading specifies loads which are 75% of those in the preceding paragraph and the third axle of the single truck load is omitted. Due to their limited load carrying capacity, bridges designed to this loading or less should be avoided.

In order to transport heavier-than-normal loads, a transporter must be used whose configuration (number of axles, width of axles, spacing of axles, and load distribution to those axles) is such that it will not induce stresses in the pavements or bridge structures in excess of those induced by the design loads. Figures 1 and 2 at the end of this memorandum are reproduced from information received from References 3 and 4 respectively. Figure 1 shows a series of single lane, flatbed and lowboy trailers with load carrying capacities of as much as 65 short tons; the higher the capacity, the longer and more complex the trailer.

Figure 2 shows specialized modular equipment, intended to operate on two load lanes, for transporting loads up to 250 short tons. Again, the higher the capacity, the longer and more complicated the equipment. It should be noted that the longer the equipment, the greater the horizontal clearance that will be required for bridges and underpasses located on curves in the road. This has not been taken into account in the previous discussion of load width.

Based on the information obtained from References 3 and 4, loads as great as 65 short tons can be readily transported. Specialized equipment is available which can transport loads as great as 250

short tons but the length of the equipment may present problems in horizontal clearance and maneuvering.

cc Jim Sanford
Tim Toohig
Bob Tener
Mike Harris

TABLE-A

TYPE FACILITY	ADT	TRAVEL LANES	BRIDGE WIDTH	UNDERPASS WIDTH	LOAD WIDTH Br.	LOAD WIDTH Un.
A. MULTI-LANE CONTROLLED ACCESS						
MAIN FREEWAY LINES		2 @ 12	4 + 24 + 10 = 38	16 + 24 + 16 = 56	36	54
DIRECT CONNECT RAMPS		1 @ 14	4 + 14 + 8 = 26	16 + 14 + 16 = 46	24	44
OTHER RAMPS		1 @ 14	4 + 14 + 6 = 24	16 + 14 + 16 = 46	22	44
FRONTAGE ROAD	<400	2 @ 10	4 + 20 + 4 = 28	8 + 20 + 8 = 36	26	34
FRONTAGE ROAD	>400,<750	2 @ 11	6 + 22 + 6 = 34	10 + 22 + 10 = 42	32	40
FRONTAGE ROAD	>750	2 @ 12	8 + 24 + 8 = 40	12 + 24 + 12 = 48	38	46
B. MULTI LANE NON CONTROLLED ACCESS						
NARROW MEDIAN	>5,000, <20,000	2 @ 12	2 + 24 + 8 = 34	6 + 24 + 12 = 42	32	40
DEPRESSED MEDIAN	>5,000, <20,000	2 @ 12	4 + 24 + 8 = 36	6 + 24 + 12 = 42	34	40
C. TWO LANE RURAL						
OTHER THAN FARM RDS	<400	2 @ 10	4 + 20 + 4 = 28	6 + 20 + 6 = 32	24	30
OTHER THAN FARM RDS	>400, <750	2 @ 11	6 + 22 + 6 = 34	6 + 22 + 6 = 34	32	32
OTHER THAN FARM RDS	>750, <2,200	2 @ 12	8 + 24 + 8 = 40	6 + 24 + 6 = 36	38	34
OTHER THAN FARM RDS	>2,200, <7,500	2 @ 12	8 + 24 + 8 = 40	6 + 24 + 6 = 36	38	34
FARM ROADS	<50	2 @ 9	3 + 18 + 3 = 24	4 + 18 + 4 = 26	22	24
FARM ROADS	>50, <400	2 @ 10	4 + 20 + 4 = 28	4 + 20 + 4 = 28	24	24
FARM ROADS	>400,<750	2 @ 11	6 + 22 + 6 = 34	4 + 22 + 4 = 30	32	28
FARM ROADS	>750	2 @ 12	8 + 24 + 8 = 40	4 + 24 + 4 = 32	38	30
D. URBAN STREETS						
ARTERIAL, CURBED, DIVIDED		2 @ 11	1 + 22 + 5 = 28	4 + 22 + 4 = 30	26	28
ARTERIAL, UNCURBED, DIVIDED		2 @ 11	4 + 22 + 4 = 30	4 + 22 + 4 = 30	28	28
ARTERIAL, CURBED		2 @ 11	5 + 22 + 5 = 32	4 + 22 + 4 = 30	30	28
ARTERIAL, UNCURBED		2 @ 11	4 + 22 + 4 = 30	4 + 22 + 4 = 30	28	28
COLLECTOR, CURBED		2 @ 10	5 + 20 + 5 = 30	4 + 20 + 4 = 28	28	26
COLLECTOR, UNCURBED		2 @ 10	3 + 20 + 3 = 26	4 + 20 + 4 = 28	24	26
LOCAL, CURBED		2 @ 9	5 + 18 + 5 = 28	4 + 18 + 4 = 26	26	24
LOCAL, UNCURBED		2 @ 9	2 + 18 + 2 = 22	4 + 18 + 4 = 26	20	24

TABLE-B

LOAD WIDTH	TYPE FACILITY	LIMITING STRUCTURE
>20	LOCAL URBAN STREET, UNCURBED	BRIDGE
>22	FREEWAY ON/OFF RAMP	BRIDGE
	FARM ROAD, ADT <50	BRIDGE
>24	FREEWAY DIRECT CONNECT RAMP	BRIDGE
	TWO-LANE RURAL ROAD, ADT <400	BRIDGE
	FARM ROAD, ADT >50, <400	BRIDGE OR UNDERPASS
	FARM ROAD, ADT <50	UNDERPASS
	COLLECTOR URBAN STREET, UNCURBED	BRIDGE
	LOCAL URBAN STREET, CURBED OR UNCURBED	UNDERPASS
>26	FREEWAY FRONTAGE ROAD, ADT <400	BRIDGE
	ARTERIAL URBAN STREET, CURBED, DIVIDED	BRIDGE
	COLLECTOR URBAN STREET, CURBED OR UNCURBED	UNDERPASS
	LOCAL URBAN STREET, CURBED,	BRIDGE
>28	FARM ROAD, ADT >400, <750	UNDERPASS
	ARTERIAL URBAN STREET, CURBED, DIVIDED OR UNDIVIDED	UNDERPASS
	ARTERIAL URBAN STREET, UNCURBED, DIVIDED OR UNDIVIDED	BRIDGE OR UNDERPASS
	COLLECTOR URBAN STREET, CURBED	BRIDGE
>30	TWO-LANE RURAL ROAD, ADT <400	UNDERPASS
	FARM ROAD WITH ADT >750	UNDERPASS
	ARTERIAL URBAN STREET, CURBED	BRIDGE
>32	FREEWAY FRONTAGE ROAD, ADT >400, <750	BRIDGE
	MULTI-LANE NON ACCESS CONTROLLED, NARROW MEDIAN	BRIDGE
	TWO-LANE RURAL ROAD, ADT >400, <750	BRIDGE OR UNDERPASS
	FARM ROAD, ADT >400, <750	BRIDGE
>34	FREEWAY FRONTAGE ROAD, ADT <400	UNDERPASS
	MULTI-LANE, NON ACCESS CONTROLLED, DEPRESSED MEDIAN	BRIDGE
	TWO LANE RURAL ROAD, ADT >750, <2,200	UNDERPASS
	TWO LANE RURAL ROAD, ADT >2,200, <7,500	UNDERPASS
>36	FREEWAY, MAIN LANES	BRIDGE

FIGURE-1

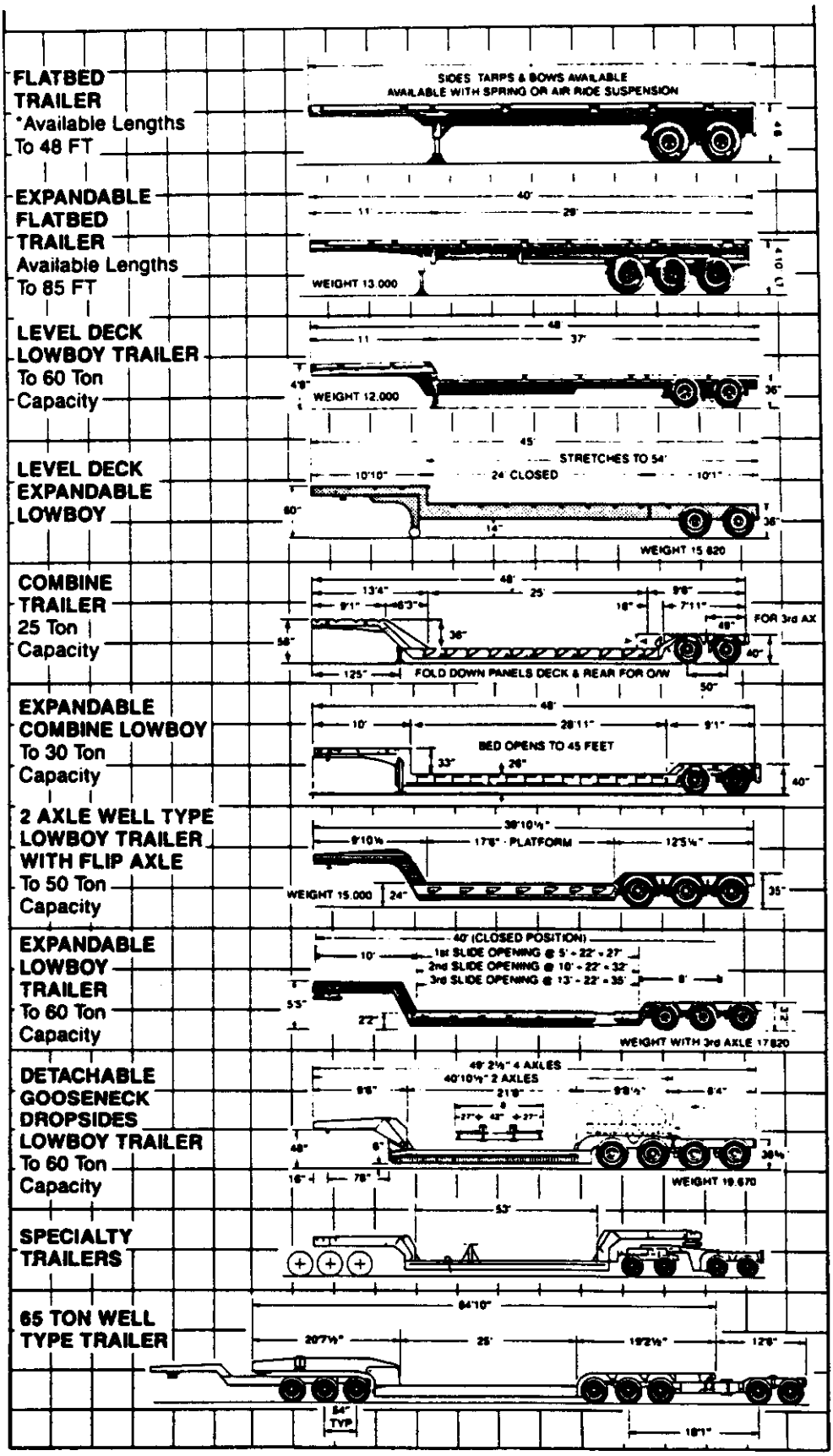
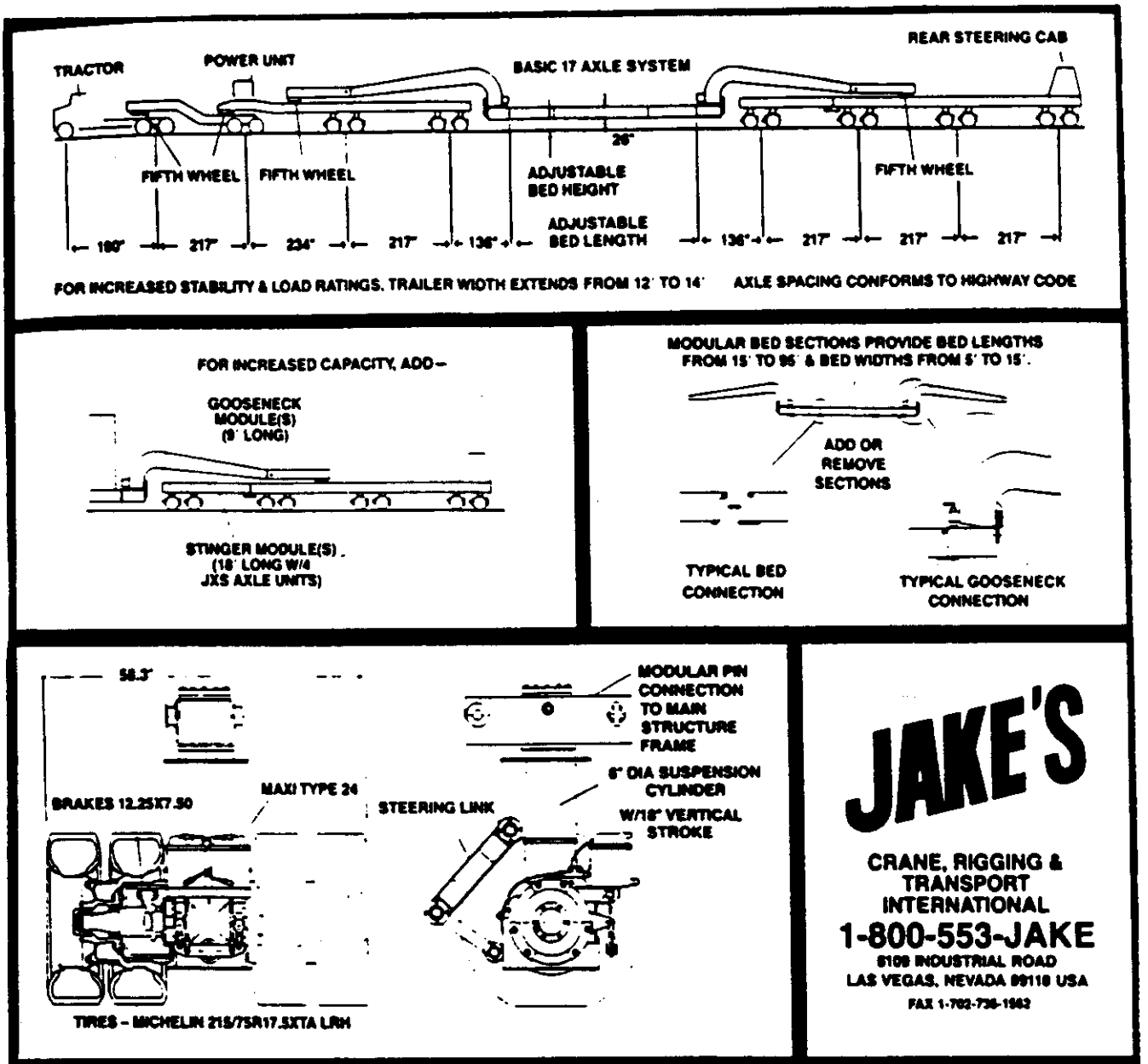

FLATBED TRAILER
*Available Lengths To 48 FT
SIDES TARPS & BOWS AVAILABLE
AVAILABLE WITH SPRING OR AIR RIDE SUSPENSION
EXPANDABLE FLATBED TRAILER
Available Lengths To 85 FT
WEIGHT 13,000
LEVEL DECK LOWBOY TRAILER
To 60 Ton Capacity
WEIGHT 12,000
LEVEL DECK EXPANDABLE LOWBOY
STRETCHES TO 54'
24' CLOSED
WEIGHT 15,620
COMBINE TRAILER
25 Ton Capacity
FOR 3rd AX
FOLD DOWN PANELS DECK & REAR FOR O/W
EXPANDABLE COMBINE LOWBOY
To 30 Ton Capacity
BED OPENS TO 45 FEET
2 AXLE WELL TYPE LOWBOY TRAILER WITH FLIP AXLE
To 50 Ton Capacity
PLATFORM
WEIGHT 15,000
EXPANDABLE LOWBOY TRAILER
To 60 Ton Capacity
40' (CLOSED POSITION)
1st SLIDE OPENING @ 5' - 22' - 27'
2nd SLIDE OPENING @ 10' - 22' - 32'
3rd SLIDE OPENING @ 13' - 22' - 35'
WEIGHT WITH 3rd AXLE 17,620
DETACHABLE GOOSENECK DROPSIDES LOWBOY TRAILER
To 60 Ton Capacity
4 AXLES
2 AXLES
WEIGHT 19,670
SPECIALTY TRAILERS
65 TON WELL TYPE TRAILER
TYP

FIGURE-2



TYPICAL JXS HIGHWAY PAYLOADS* (1,000 lbs.)

LOAD SUPPORT CONFIGURATIONS**		TRLR DIRECT	SCHNABEL	SIDE-BEAM BRIDGE		OPEN GOOSENECK		CLOSED GOOSENECK	
		Any Length Load	Any Length Load	16' Clear Span	55' Clear Span	16' Clear Deck	55' Clear Deck	16' Clear Deck	55' Clear Deck
12' WIDE:	13 AXLE	270	228	234	201	219	200	NA	NA
	17 AXLE	363	317	320	285	NA	NA	280	260
	21 AXLE	456	351	394	352	NA	NA	NA	NA
14' WIDE:	13 AXLE	301	260	265	232	251	230	NA	NA
	17 AXLE	407	362	364	329	NA	NA	324	304
	21 AXLE	500	408	450	408	NA	NA	NA	NA

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Conventional Construction Division

TO: **Ray Stefanski**

FROM: **Ron Hoffmann** R.A.H.

DATE: **August 3, 1990**

SUBJECT: **Route Reconnaissance**

REFERENCE: **Letter of Dec. 9, 1988 from Chip Belding of Belding Corp. to Bob Shovan of FNAL, subject: Moving (8) eight coils 33 ft in diameter - 7 ft high, weighing 100 tons each from water at Galveston, Texas to Waxahachie, Texas.**

INTRODUCTION:

In 1988, the Belding Corporation made a preliminary study for moving large magnet coil sections from the Gulf coast to Waxahachie. Their findings and estimates are reported in the referenced letter which is attached to the end of this memorandum for convenience. Using this letter as a starting point, the author made a reconnaissance on July 26 & 27 to determine what complications would be encountered if the items to be transported were the cryogenic pressure vessels for the central barrel and end caps of the calorimeter shown in Figure 1 of this memorandum. In the course of the reconnaissance several problem areas were encountered and investigated for alternate solutions which are discussed herein and included in the proposed line-of-march. A general discussion, summary and recommendations are also included, with maps, sketches and photographs provided in the appendices.

LOAD ASSUMPTIONS:

The desire has been expressed to ship the three pressure vessels complete, that is one central barrel and two end caps. The vessel for the central barrel could be broken down into three pieces which would be about the same overall size as the end cap vessels but this requires onsite facilities to assemble them and some factions in the collaboration would like to avoid this. In order for the reconnaissance to cover both aspects, two loads have been considered; a light or low load which has been designated as LL, and a heavy or high load which has been designated as HL.

LL has been assumed to consist of an end cap vessel or a one-third section of the central barrel vessel and is considered to be a vertical cylinder 34.1 ft in diameter by 11.2 ft high mounted on a transporter in such a manner that a vertical clearance of 15.25 ft is required to pass the load. The gross weight of the load is considered to be in the order of 150 tons.

HL has been assumed to consist of the complete central barrel vessel of the calorimeter and is considered to be a horizontal cylinder 34.1 ft in diameter by 30.2 ft long mounted on a transporter in such a manner that a vertical clearance Of 38.25 ft is required to pass the load. The gross weight of the load is considered to be in the order of 300 tons.

PROPOSED LINE-OF-MARCH:

Maps are provided in Appendix A of the areas through which the line-of-march passes. Bridges have been noted as two types, significant and lesser. Significant bridges are considered to be those which are long enough to be required to support the whole load while lesser bridges are considered to be those which are short enough to be required to support only about half of the load.

Mile 000.0 Texas Highway (TH)35 bridge over the Brazos River near East Columbia. See Problem Area #1

HL & LL Proceed east on TH35. Cross one significant bridge over creek. Go through West Columbia.

Mile 003.8 Junction TH35 & TH36.

HL & LL Proceed north on TH36. Cross two lesser bridges over creeks. Go through Damon, Guy, Needville, and Pleak.

Mile 034.1 Junction TH36 & United States Highway (US)59. US59 overpasses TH36 with diamond interchange. See problem area #2.

HL Avoid underpass by going east on US59 on-ramp to US59 eastbound lanes, cross over to US59 westbound lanes on temporary crossover, exit US59 westbound on off-ramp to TH36, and proceed north on TH36.

LL Proceed north on TH36 under the overpass.

Mile 035.9 Junction TH36 & US90 Alt. in Rosenberg. See Problem Area #3.

HL & LL Proceed west on TH36/US90 Alt. for one block to junction with Texas Farm Road (FR)723. Proceed north on FR723. Cross one significant bridge over river.

Mile 040.9 Junction FR723 & FR359.

HL & LL Proceed north on FR359. Cross three lesser bridges over creeks. Go through Fulshear.

Mile 056.4 Junction FR359 & Interstate Highway (IH)10. IH10 overpasses FR359 with diamond interchange. See problem area #4.

HL & LL Avoid underpass by going east on IH10 on-ramp to IH10 eastbound lanes, corss over to IH10 westbound lanes on temporary crossover,

exit IH10 westbound on off-ramp to FR359, and proceed north on FR359.

Mile 056.9 Junction FR359 & US90.

HL & LL Proceed west on FR359/US90.

Mile 057.2 Junction FR359 & US90.

HL & LL Proceed north on FR359. Cross four lesser bridges over creeks. Go through Pattison and Monaville.

Mile 079.2 Junction FR359 & US290.

HL & LL Proceed west on US290. Cross four significant bridges over rivers and creeks. Go through Hempstead.

Mile 083.0 Junction US290 & TH6.

HL & LL Proceed north on TH6. Cross four significant bridges over rivers and creeks. Go through Howth.

Mile 098.7 Junction TH6 & Business TH6 to Navasota.

HL & LL Proceed north on TH6. Cross one lesser and three significant bridges over rivers and creeks. Cross one railroad overpass. Other overpasses can be avoided by using the off and on ramps of the diamond interchanges.

Mile 121.0 Junction TH6 & Business TH6 to College Station and Bryan.

HL & LL Proceed north on TH6. Cross one significant bridge over river. Other overpasses and underpasses can be avoided by using the off and on ramps of the diamond interchanges and the frontage road.

Mile 132.2 Woodville Road overpasses TH6 and its frontage road. No interchange. See Problem Area #5.

HL Avoid underpass by turning north on temporary road, cross Woodville Road at a convenient grade, return south to TH6 on temporary road, and proceed north on TH6.

LL Proceed north on TH6 under the overpass.

Mile 133.3 Junction TH6 & Business TH6 from Bryan. Northbound Business TH6 overpasses TH6. See Problem Area #6.

HL Avoid underpass by temporary crossovers to and back from the frontage road. Proceed north on TH6.

LL Proceed north on TH6 under the overpass.

Mile 138.5 Railroad overpasses TH6. See Problem Area #7.

HL Avoid underpass via temporary ramps to grade crossing. Proceed north on TH6. Cross railroad overpass. Go through Hearne.

LL Proceed north on TH6 under the overpass. Cross railroad overpass. Go through Hearne.

Mile 148.7 Junction TH6, US79, US190, and FR391. At this junction TH6 comes from the south and goes north; US90 cones from the south and goes west; US79 comes from the north and goes west; and FR391 comes from the east, overpasses TH6, and goes west. See Problem Area #8.

HL Avoid underpass by turning west on Wheelock, proceeding two blocks to Cedar, then north on Cedar seven blocks to Davis, and then two blocks east on Davis back to TH6. Proceed north on TH6.

LL Proceed north on TH6 under the overpass.

Mile 150.9 Junction TH6 & US79. At this junction TH6 comes from the south and goes north while US79 comes from the east and goes south. Both lanes of US79 overpass the northbound lanes of TH6. The southbound lanes of TH6 are unimpaired. See Problem Area #9.

HL Avoid underpass by crossing over from the northbound lanes of TH6 to the southbound lanes, then proceed north the wrong way for 0.7 miles, then cross back over to the northbound lanes and proceed north on TH6. Go through Calvert and Hammond.

LL Proceed north on TH6 under the overpass. Go through Calvert and Hammond.

Mile 167.3 Junction TH6 & TH14.

HL & LL Proceed north on TH14. Cross one significant bridge and six lesser bridges. Go through Bremond, Kosse, Thornton, Groesbeck and Mexia.

Mile 209.0 Junction TH14 & TH171.

HL & LL Proceed west on TH171. Cross three lesser bridges. Go through Tehuacana, Coolidge, Hubbard, and Malone.

Mile 238.2 Junction TH171 & FR308. See Problem Area #10.

HL & LL Proceed north on FR308. Cross eight lesser bridges. Go through Irene, Mertens, and Milford.

Mile 254.0 Junction FR308 & US77.

HL & LL Proceed north on US77. Go through Italy.

Mile 259.3 Junction US77 & TH34. See Problem Area #11.

HL & LL Proceed west on TH34.

Mile 260.3 Junction TH34 & IH35E.

HL & LL Proceed north on IH35E Cross one significant bridge.

Mile 264.0 Farm road overpasses IH35E; no interchange. See Problem Area #12.

HL Avoid underpass by turning east on temporary road, crossing farm road at a convenient grade, and returning west to IH35E on temporary road. Proceed north on IH35E.

LL Proceed north on IH35E to Mile 273.2. Cross one significant bridge.

Mile 264.7 Junction IH35E & FR329.

HL Proceed east on FR329. Go through Forreston.

Mile 265.2 Junction FR329 & US77.

HL Proceed north on US77. Cross one significant bridge.

Mile 272.5 Junction US77 & IH35E northbound frontage road. See Problem Area #13.

HL Proceed north on IH35E frontage road.

Mile 273.2 See Problem Area #13.

HL Cross over from northbound IH35E frontage road to southbound IH35E frontage road via temporary crossovers. Proceed north on southbound IH35E frontage road, the **wrong way** for 0.2 miles.

LL Cross over from northbound IH35E lanes to southbound IH35E frontage road via temporary crossovers. Proceed north on southbound IH35E frontage road, the **wrong way** for 0.2 miles.

Mile 273.4 Junction IH35E southbound frontage road & FR66.

HL & LL End of line-of-march for this reconnaissance.

PROBLEM AREAS:

Maps are provided in Appendix A which indicate the location of the problem areas.

Problem Area #1 - Mile 000.0 Having only the sketchy information in the referenced letter and no detailed local map of the area, the author was unable to determine the intended point of off-loading from water transport to land transport. For purposes of this reconnaissance it has been assumed that the off-loading point is the TH35 bridge over the Brazos River. Pictures 1 thru 7 of Appendix C show this area. Additional

investigation in this regard must be made before this end of the line-of-march can be finalized.

Problem Area #2 - Mile 034.1 The TH36 underpass under US59 has a clearance of only 16.25 ft. This is a problem for the HL only. The underpass can be locally circumvented by going east on the US59 on-ramp to the US59 eastbound lanes, crossing over to the US59 westbound lanes on a temporarily constructed crossover, then exiting the US59 westbound lanes on the off-ramp to TH36, and proceeding north on TH36. Sketch 1 of Appendix B shows the circumvention. Photographs 8 and 9 of Appendix C show the underpass and the area of the temporary crossover construction.

Problem Area #3 - Mile 035.9 The route proposed in the referenced letter proceeded west from Rosenberg on TH36 to Sealy and then back east to Brookshire on IH10 and US90. This route is not possible. There are two minimal clearance railroad underpasses on TH36/US90 Alt. as it proceeds west through Rosenberg which will pass neither the HL nor the LL. The area is congested and there in no room for local circumvention. The line-of-march had to be changed to take either FR723 north to FR359, or US90 Alt. east through Richmond to FR359. For purposes of this reconnaissance, the route north on FR723 was chosen because it is shorter and avoids congested areas even though it crosses the Brazos River on a farm-road-class bridge. A cost trade study should be made of the two routes before this area of the line-of-march is finalized.

Problem Area #4 - Mile 056.4 The FR359 underpass under IH10 has a clearance of only 14.75 ft. This is a problem for both the HL and the LL. The underpass can be locally circumvented in the same manner as described in Problem Area #2.

Problem Area #5 - Mile 132.2 The TH6 underpass under Woodville Road has clearance to pass the LL but not the HL. The underpass can be locally circumvented by going north on a temporarily constructed road across the frontage road and along Woodville Road to a convenient grade with Woodville Road, crossing Woodville Road, and then proceeding back to TH6 on a temporarily constructed road. Sketch 2 of Appendix B shows the circumvention.

Problem Area #6 - Mile 133.3 The TH6 underpass under northbound Business TH6 from Bryan has clearance to pass the LL but not the HL. The underpass can be locally circumvented by crossing over to the frontage road on a temporarily constructed crossover, proceeding on the frontage road to a point past the underpass, and then crossing back to the TH6 northbound lanes on another temporarily constructed crossover.

Problem Area #7 - Mile 138.5 The TH6 underpass under the railroad about 10 miles south of Hearne has clearance to pass the LL but not the HL. The underpass can be locally circumvented by temporarily constructing off and on ramps adjacent to TH6 to a convenient grade crossing with the railroad. Photographs 10 and 11 of Appendix C show the underpass and its approaches.

In an attempt to solve this problem area without temporary construction, an alternate route was investigated which would go west on TH21 from Bryan to FR50, north on FR50 to US79/US190, and then back to TH6 on US79/US190. This alternate was abandon when another railroad underpass, with less local circumvention potential, was found on TH21 between OSR and FR50. Another alternate route was investigated which would come from the south on TH36 to US79/US190 and then go east on US79/US190 back to TH6. This alternate was also abandon upon the discovery of a even worse railroad underpass on TH36 just south of its junction with US79/US190.

Problem Area #8 - Mile 148.7 The TH6 underpass under FR391 in Hearne has clearance to pass the LL but not the HL. The underpass can be locally circumvented on the streets of Hearne by turning west at Wheelock prior to reaching the underpass, going two blocks on Wheelock to Cedar, then going seven blocks north on Cedar to Davis, and then going two blocks east on Davis back to TH6. This route was chosen by the author based on space at the city street intersections which is anticipated to be required to make the turns. Further study in this area should be performed before the line-of-march is finalized. Photographs 12 through 16 of Appendix C show the underpass and the route of circumvention.

Problem Area #9 - Mile 150.9 The northbound lanes of TH6 underpass US79 about 2 miles north of Hearne. The clearance of the underpass is not marked but is estimated by the author to be in the order of 20 ft. This is a problem for the HL only. Since the southbound lanes of TH6 are unimpaired at this junction, the underpass can be locally circumvented by crossing over from the northbound lanes of TH6 to the southbound lanes south of the underpass; then proceeding north,the **wrong way** in the southbound lanes of TH6 for 0.7 miles; and then crossing back over to the northbound lanes of TH6 north of the underpass. This plan of circumvention must be approved by the Texas Department of Public Safety before finalization of this area of the line-of-march. Photograph 17 of Appendix C shows the underpass. Sketch 3 of Appendix B shows the circumvention.

Problem Area #10 - Mile 238.2 The route proposed in the referenced letter proceeded on TH171 "..northwest to Brandon; then north on Route 77..." As shown on Map 3 of Appendix A, Brandon is not on TH171 nor US77; its on TH22. Two alternate routes in this area were investigated by the author; the first going northwest from Malone on TH171 to IH35, north on IH35 to US77, and then north on US77 to Milford; the second going north from Malone on FR308 through Mertens to Milford. The second alternate route was chosen because it is far less inhibited by congested areas and does not have non-interchange-underpasses which must be circumvented for the HL as does the first alternate route. Photographs 18 and 19 of Appendix C show these underpasses.

Problem Area #11 - Mile 259.3 The route proposed in the referenced letter proceeds "...north on Route 77 to the site at Waxahachie." The US77 bridge over Chambers Creek three miles north of Italy is a through-truss type bridge with a vertical clearance of 14.67 ft and a total width of approximately 21 ft. Photograph 20 of Appendix C shows the bridge. Neither the HL nor the LL can pass this bridge. The bridge would have to be replaced or the line-of-march would have to be changed. For purposes of this reconnaissance the later alternative was chosen as the least expensive.

Problem Area #12 - Mile 264.0 About four miles north of the junction of IH35E and TH34, IH35E underpasses a farm road. The clearance of this underpass is sufficient to pass the LL but not the HL. The underpass can be circumvented in a manner similar to that described in Problem Area #5. There are ruminants of old roads in the area which may be of use in the temporary construction.

Problem Area #13 - Mile 272.5 The referenced letter ended the route at Waxahachie. The ultimate goal of the line-of-march is the West Campus of the SSCL. In order to reach this goal the author has assumed that FR66 will be improved from IH35E to the site and all that need be included in this reconnaissance is a way to reach FR66 on the west side of IH35E. Both the overpass over IH35E for FR66 and the one a mile to the south are inhibited for our use by the sharp turns required to get on and off of them.

Photographs 21 through 23 of Appendix C illustrate this problem. There is, however, an area just south of the FR66 overpass where the northbound frontage road, the northbound lanes, the southbound lanes, and the southbound frontage road of IH35E are all at approximately the same grade and temporary crossovers can be constructed at minimal expense. This solution requires traversing the southbound frontage road of IH35E in the **wrong direction** for about 0.2 miles. This plan must be approved by the Texas Department of Public Safety before this area of the line-of-march can be finalized. Photographs 24 through 27 of Appendix C show the area of the proposed crossovers.

GENERAL DISCUSSION:

Horizontal Clearances In all cases the width of the paved lanes is at least 12 ft except for FR308 from Mertens to Milford where the lanes narrow to 10 ft. But even here, as elsewhere, the width of the right-of-way is adequate for either load. There will be some tight squeezes in some of the urban areas which need further investigation but the author expects no problems in this regard.

Pavement Loads Pavement loads depend upon the design of the transporter. The line-of-march traverses interstate, US, Texas state, and Texas farm road systems. The transporter design must be coordinated with the Texas State Department of Highways and Public Transportation. It is the opinion of the author that a transporter can be designed for either of the loads which will minimize the amount of pavement improvement and/or repair required.

Bridges There are approximately 19 significant and 27 lesser bridges on the line-of-march. Of the 19 significant bridges over which the LL passes, 2 are on the Interstate Highway System, 4 are on the United States Highway System, 12 are on the Texas State Highway System, and 1 is on the Texas Farm Road System. For the HL, this distribution is, 1 on the Interstate Highway System, 5 on the United States Highway System, 12 on the Texas State Highway System, and 1 on the Texas Farm Road System. The distribution of the lesser bridges is 12 on the Texas State Highway System, and 15 on the Texas Farm Road System for both the HL and the LL. The final determination of the need for the bracing or replacing these bridges must be the result of a coordinated effort between the transport designer and the Texas State Department of Highways and Public Transportation. Due to the loads being considered in this reconnaissance being somewhat greater than in the referenced letter, the author feels that the cost of bridge bracing and replacement will be, at least, proportionately higher.

Overhead Wires Based on sample area counts, it is estimated that there are 925 overhead wire crossings, each having an average of 5 wires consisting of guywires, local power distribution wires and telephone cables. In addition, it is estimated that there are 25 overhead high-voltage power transmission crossings of the types shown in photographs 28 and 29 of Appendix C, and 30 overhead traffic signals either suspended by wires or mounted on ridged structures. All of these wire crossings and traffic signals are estimated to be high enough to pass the LL, but none are estimated to be able to pass the HL. To pass the HL, the interruption of the service which is provided by these wires would have to be coordinated with both the provider and the user, the wires and their associated obstructions removed for passage of the HL, and then all of it put back to the satisfaction of the owner after the HL has passed. The author estimates that this will require at least 32,000 man-hours of electrical construction work plus about 4,000 man-hours of engineering/ coordination effort. At about $100 per hour for salaries, benefits, material, equipment, overhead, profit, etc. this item adds at least $3.6M to the cost.

Tree Trimming The LL will pass all areas with minimal, if any, tree trimming required. Tree trimming will definitely be required for the passage of the HL especially in some of the urban areas through which the line-of-march passes. Many of the trees which will have to be cut back are beautiful old shade trees which the townsfolk will not be too happy about us whacking on.

Public Sentiment The LL can pass through most areas more quickly and with less disruption to the local residents. The HL's passing will be accompanied by disruptions in power, telephone, cable and possibly other television, traffic flow, and, more or less, the beauty of the community .

CONCLUSIONS:

Based on the intelligence gained by this reconnaissance, the following conclusions can be drawn:

1. Loads which require vertical clearances in excess of what can be accommodated on most state and interstate highway systems cause problems which have expensive solutions.

2. If higher than normal loads must be transported, the secondary road systems are better; their junctions with other secondary roads and railroads are usually at grade.

3. Local populations will be less disturbed if the load can pass through quickly with minimal advanced preparation and minimal post-passing clean-up being required

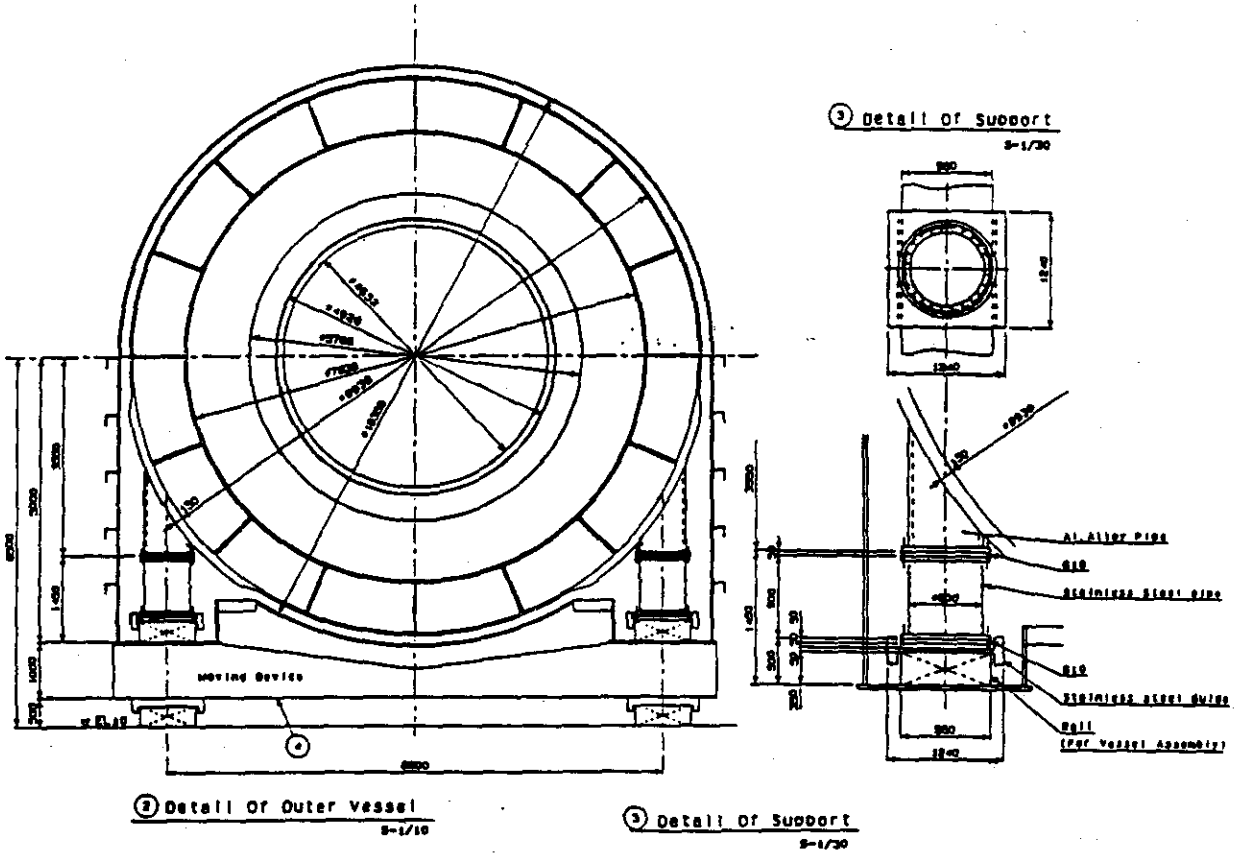
4. Heavy loads can probably be better transported over state and interstate-type systems because of the greater load carrying capacity of their pavements and bridges.

5. While transporting either the LL or the HL over the line-of-march proposed herein can be accomplished, HL transportation will be at much greater expense in dollars and in public sentiment.

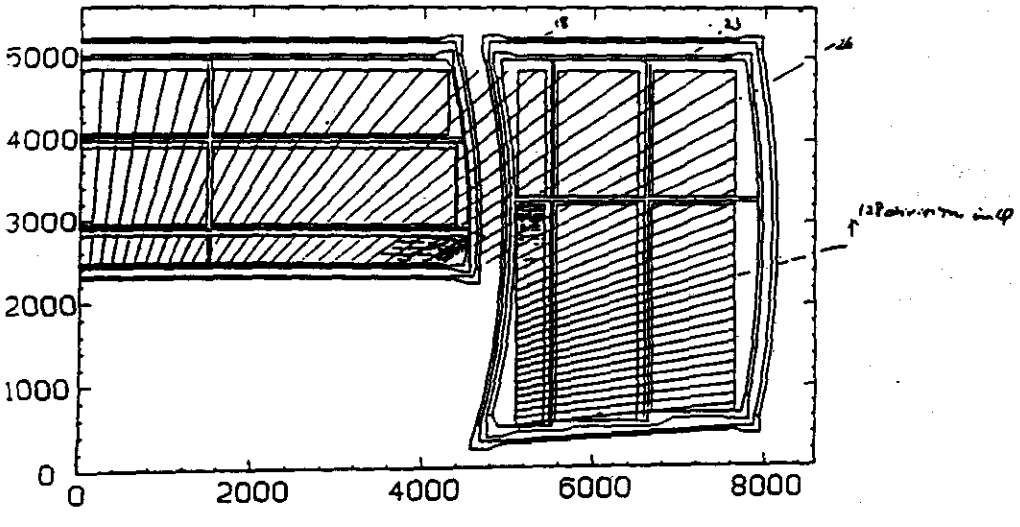
RECOMMENDATIONS:

It is the authors opinion that one-piece shipment of the cryogenic pressure vessel for the.central barrel of the calorimeter is feasible but not desirable.

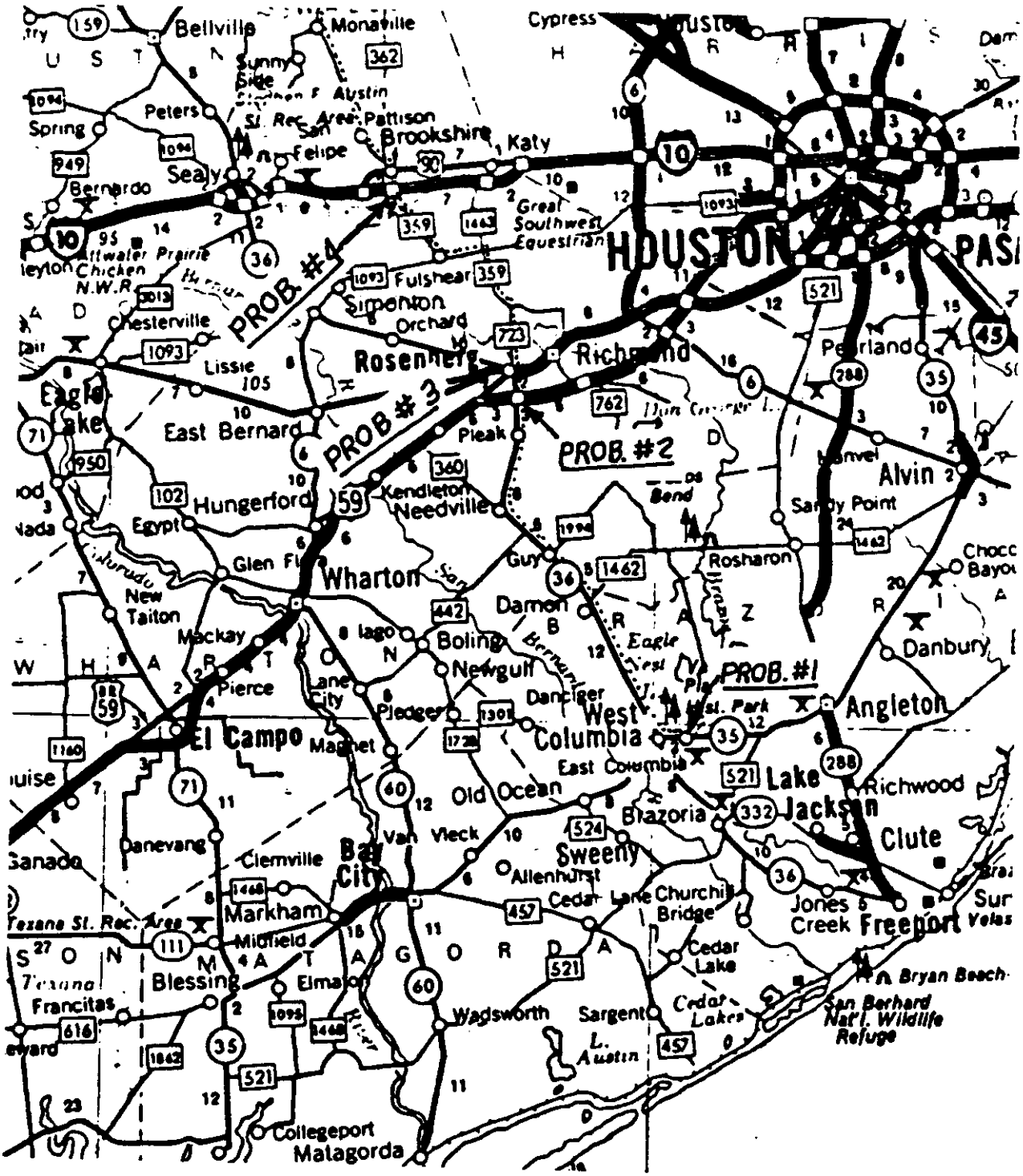
FIGURE 1



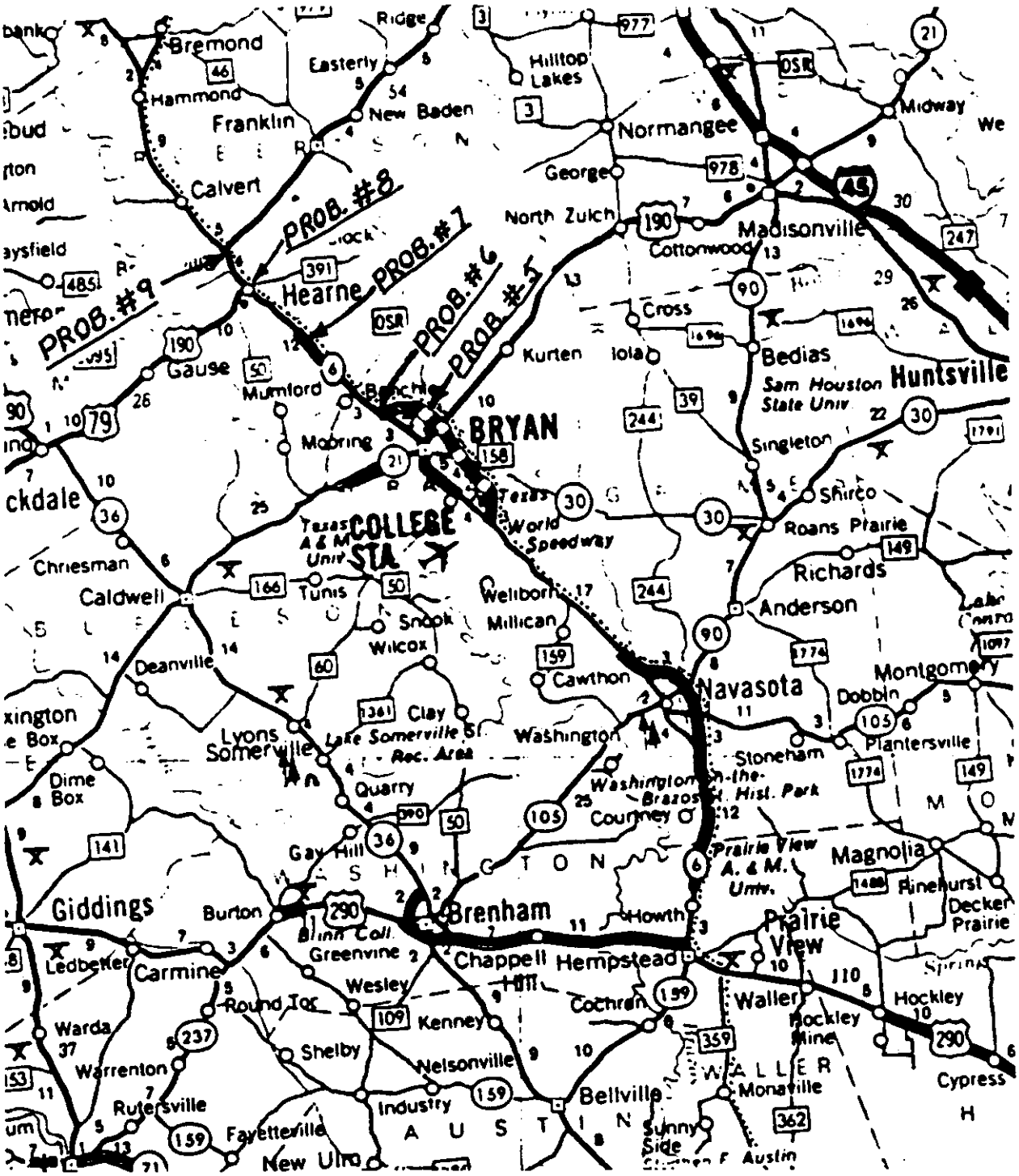
SDC LAC/EØI/V2



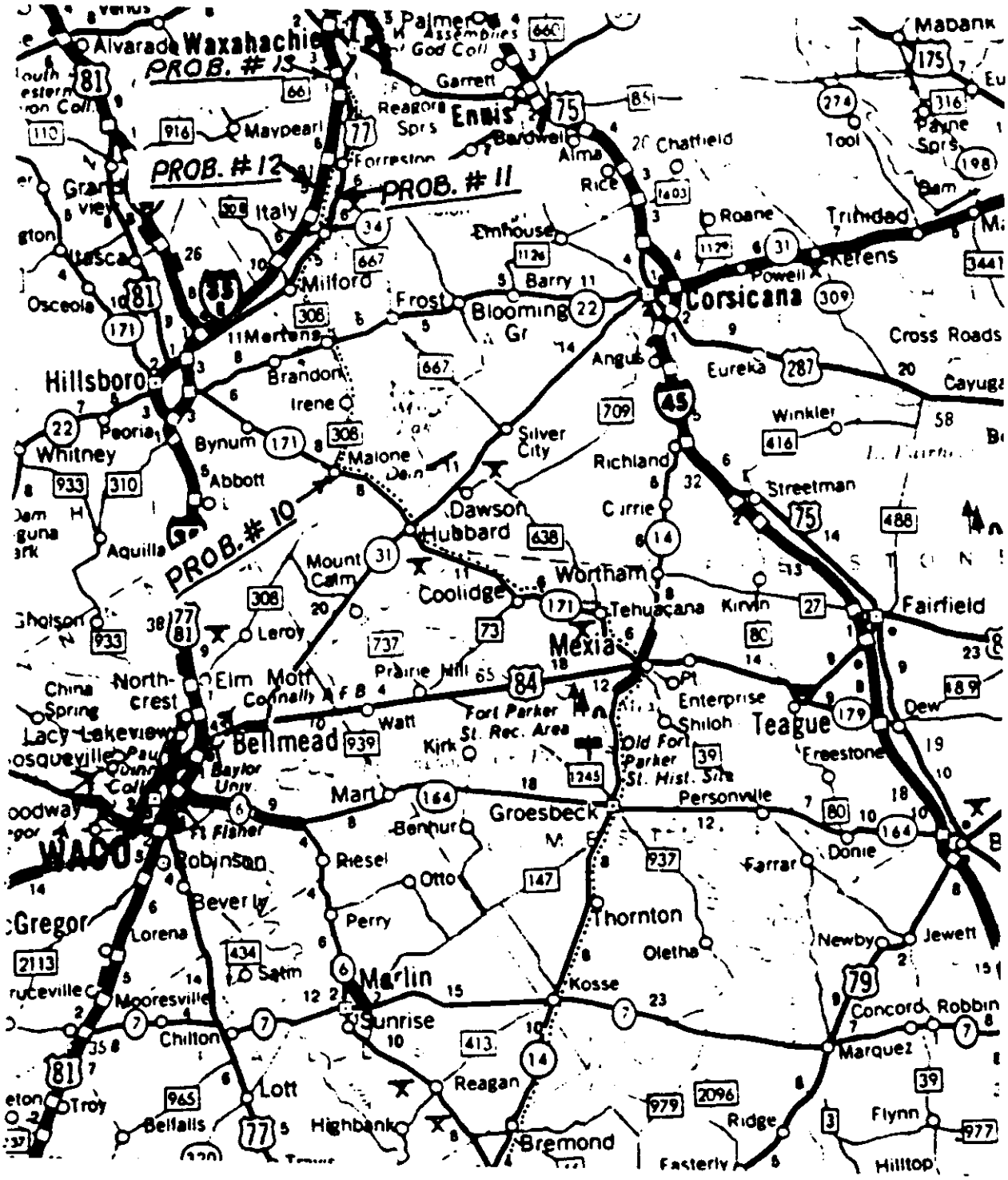
APPENDIX A
MAP 1



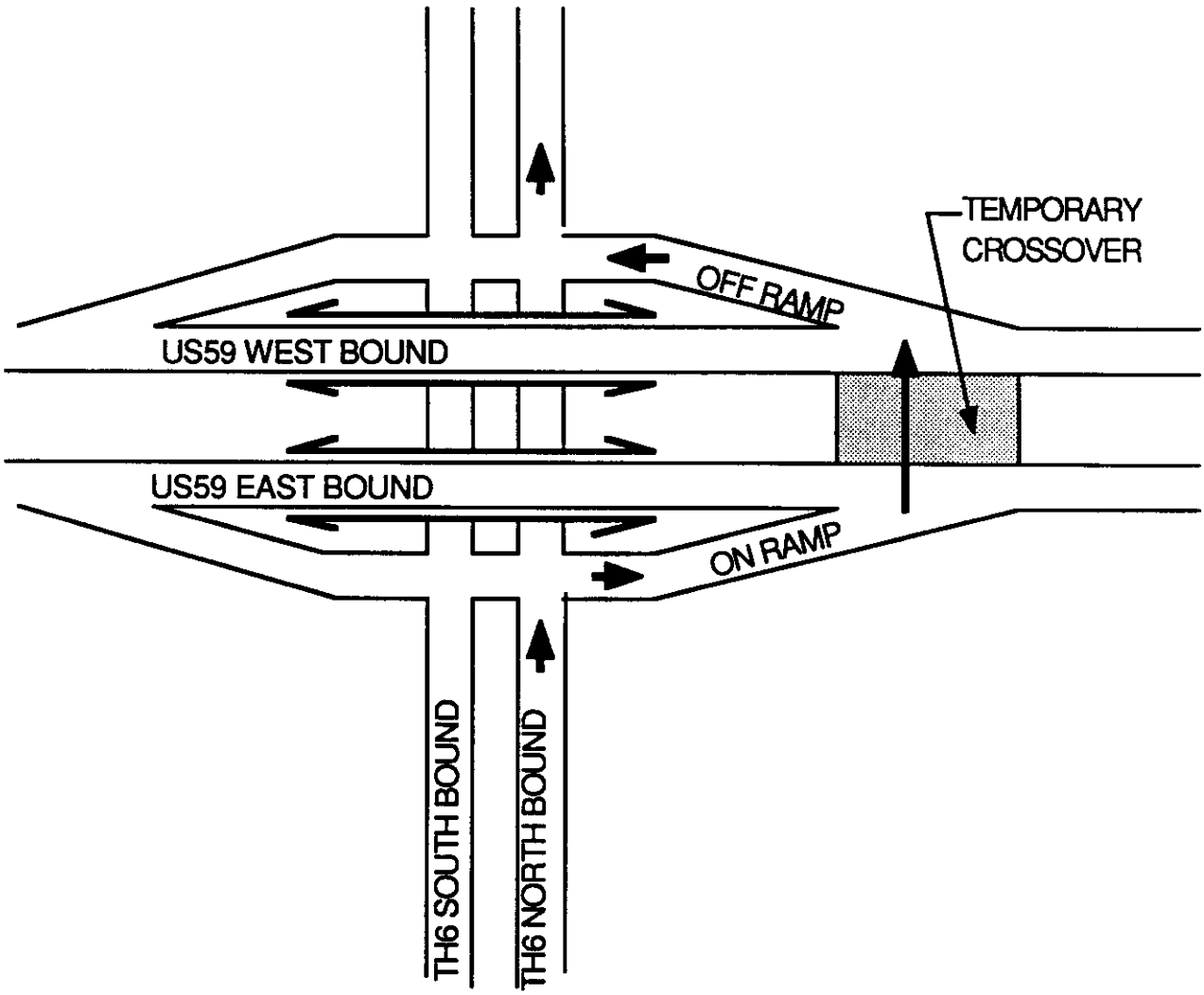
APPENDIX A
MAP 2



APPENDIX A
MAP 3



APPENDIX B
SKETCH 1



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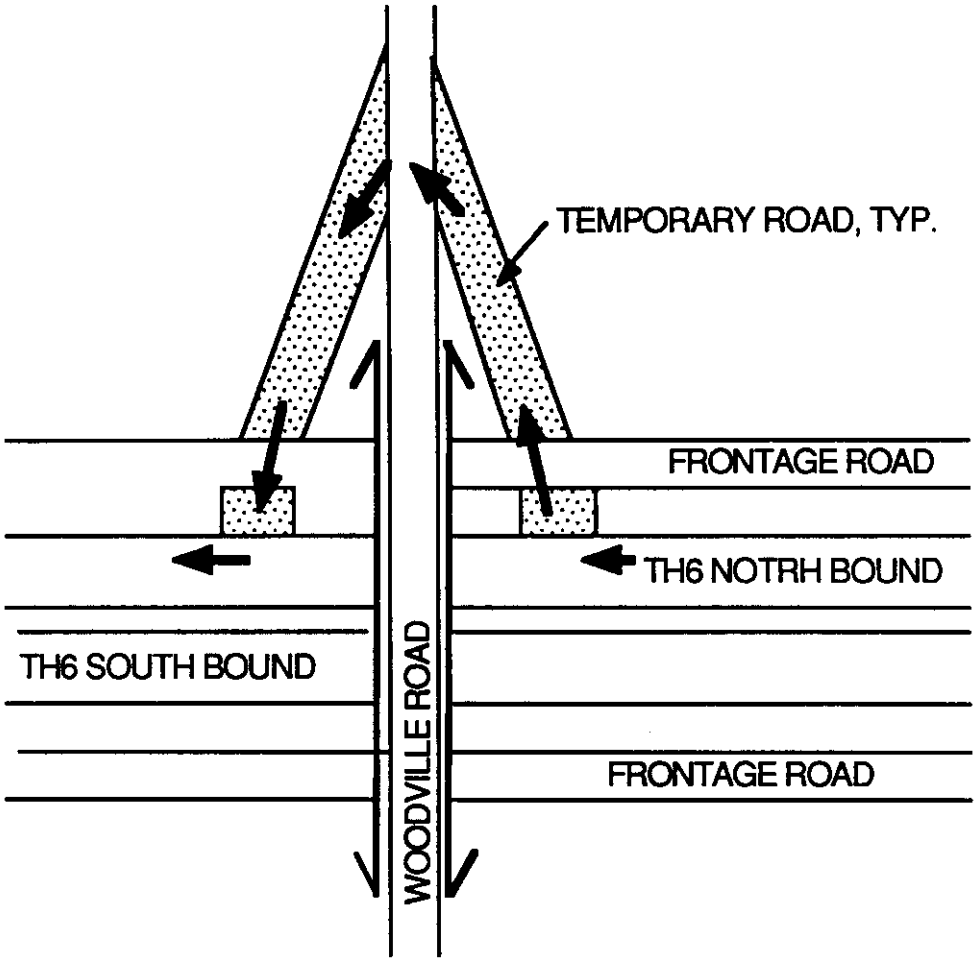
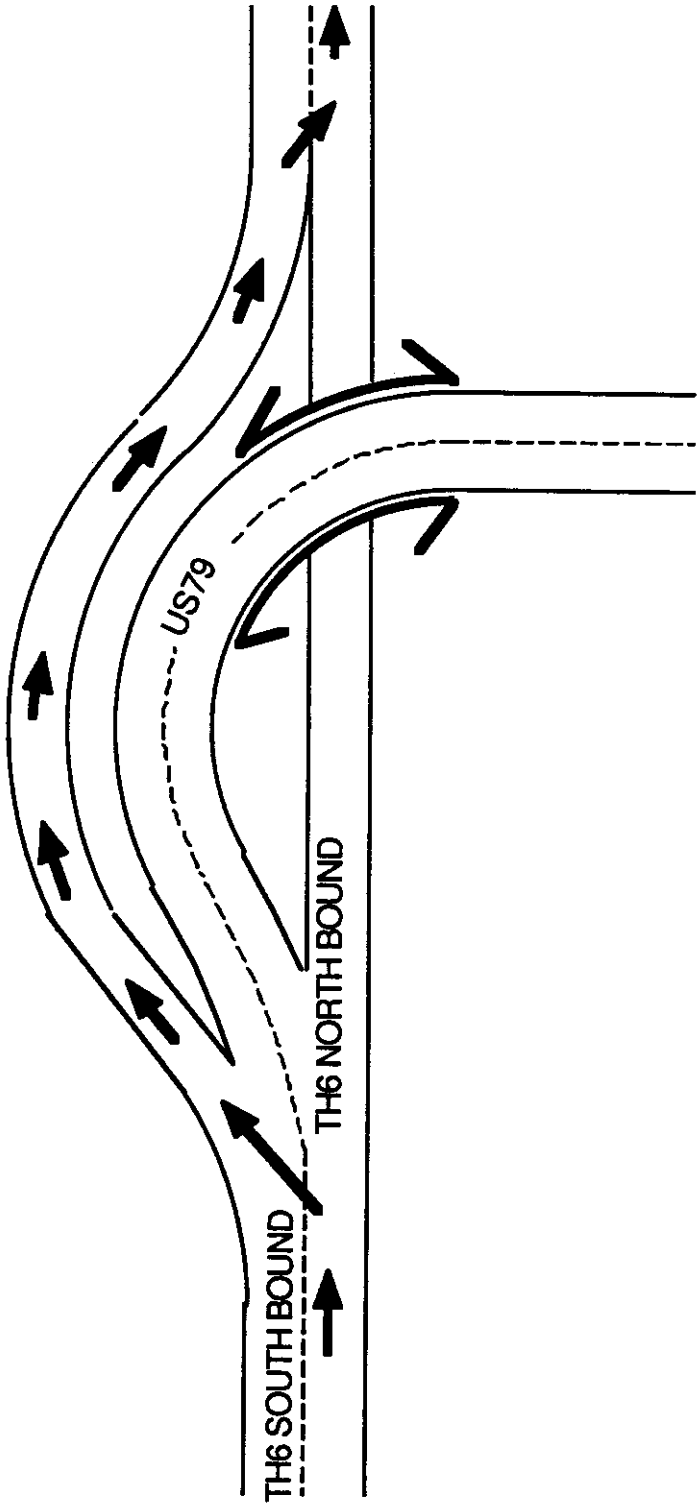
SKETCH 2



APPENDIX B
SKETCH 3



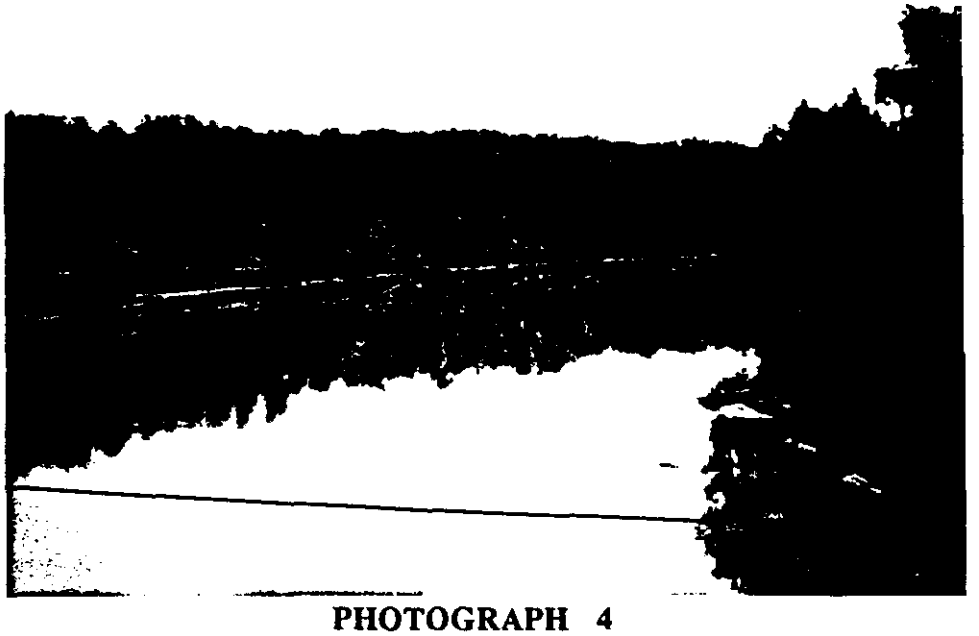
APPENDIX C

PHOTOGRAPH 1
Brazos River looking south from TH35 bridge.

PHOTOGRAPH 2
West bank of Brazos River south of TH35 bridge.

APPENDIX C

PHOTOGRAPH 3
East bank of Brazos River south of TH35 bridge.



PHOTOGRAPH 4
Brazos River looking north from TH35 bridge.

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PHOTOGRAPH 5
East bank of Brazos River north of TH35 bridge.

PHOTOGRAPH 6
West bank of Brazos River north of TH35 bridge.

APPENDIX C

PHOTOGRAPH 7
Looking east under TH35 Brazos River bridge at 8' deep girders.

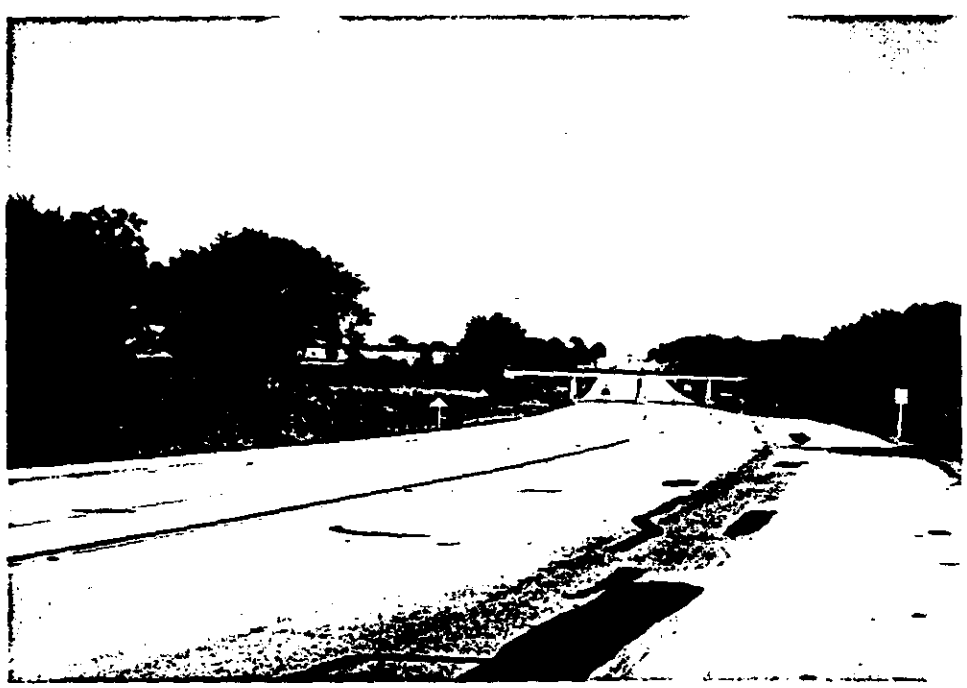
APPENDIX C

PHOTOGRAPH 8
Looking north at the US59 overpass over TH36.

PHOTOGRAPH 9
Looking east on US59 from the top of the overpass over TH36.

APPENDIX C

PHOTOGRAPH 10
Looking north at railroad underpass on TH6 south of Hearne.



PHOTOGRAPH 11
Looking south at railroad underpass on TH6 south of Hearne.

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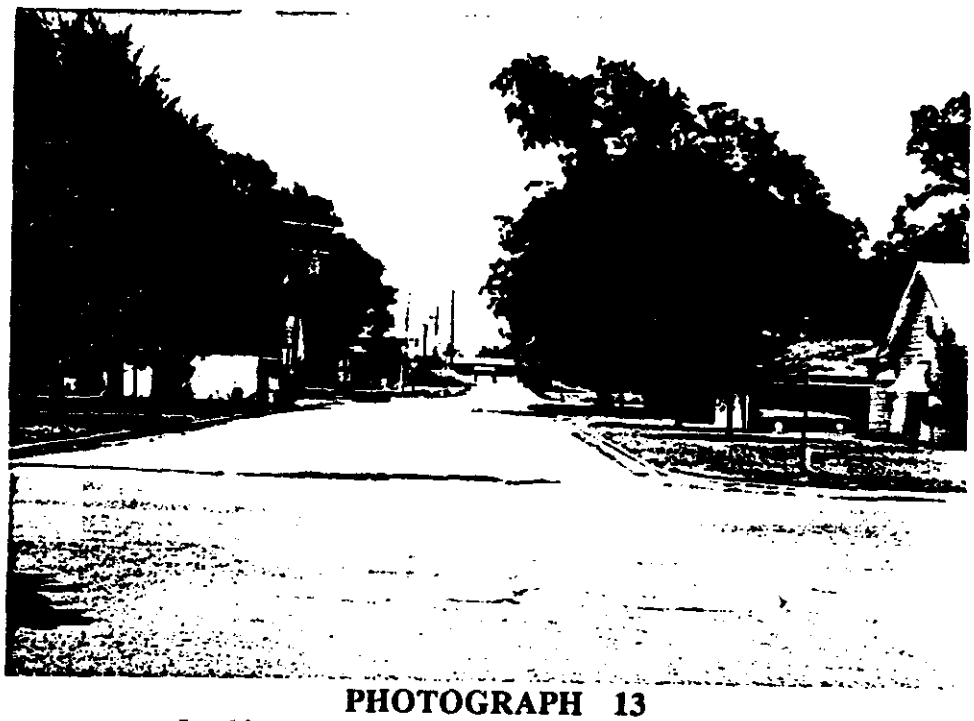
PHOTOGRAPH 12
Looking north at FR391 overpass over TH6 in Hearne.



PHOTOGRAPH 13
Looking east on Wheelock from Cedar in Hearne.

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APPENDIX C

PHOTOGRAPH 14
Looking north on Cedar from Wheelock in Hearne.

PHOTOGRAPH 15
Looking south on Cedar from Davis in Hearne.

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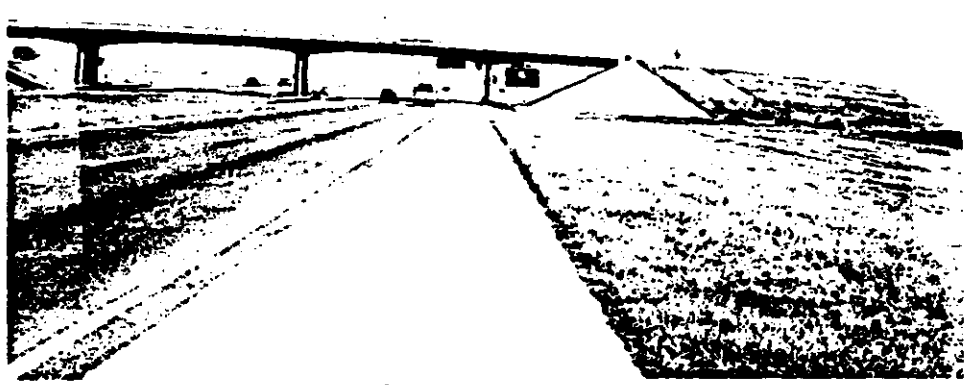
PHOTOGRAPH 16
Looking east on Davis from Cedar in Hearne.

PHOTOGRAPH 17
Looking north at US79 overpass over northbound lanes of TH6.

APPENDIX C

PHOTOGRAPH 18
Looking north at railroad underpass on IH35 between TH171 and US77.



PHOTOGRAPH 19
Looking north at farm road underpass on IH35 between TH171 and US77.

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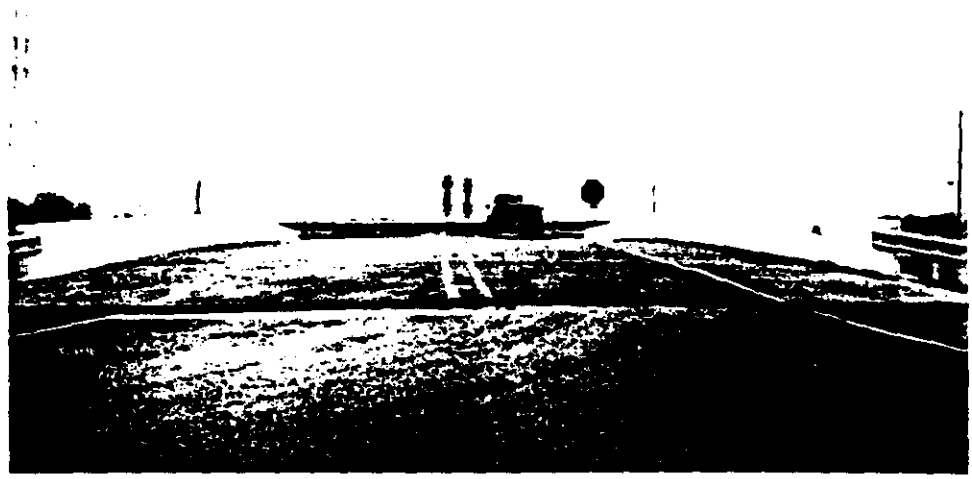
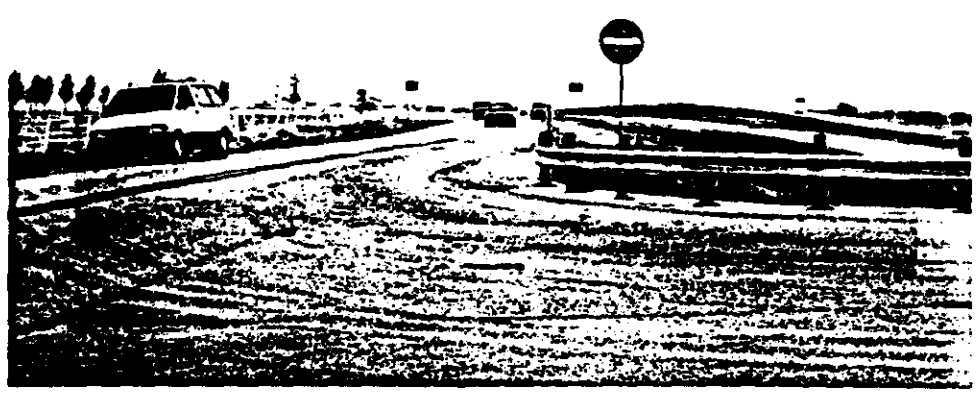
PHOTOGRAPH 20
Looking north at US77 bridge over Chambers Creek.

PHOTOGRAPH 21
Looking north on US77 at approach to overpass over IH35E one mile south of FR66.

APPENDIX C



PHOTOGRAPH 22
Looking east across overpass over IH35E one mile south of FR66.



PHOTOGRAPH 23
Looking north on IH35E southbound frontage road from overpass one mile south of FR66

APPENDIX C

PHOTOGRAPH 24
Looking south on northbound frontage road of IH35E just south of FR66.

PHOTOGRAPH 25
Looking northwest across IH35E from northbound frontage road just south of FR66.

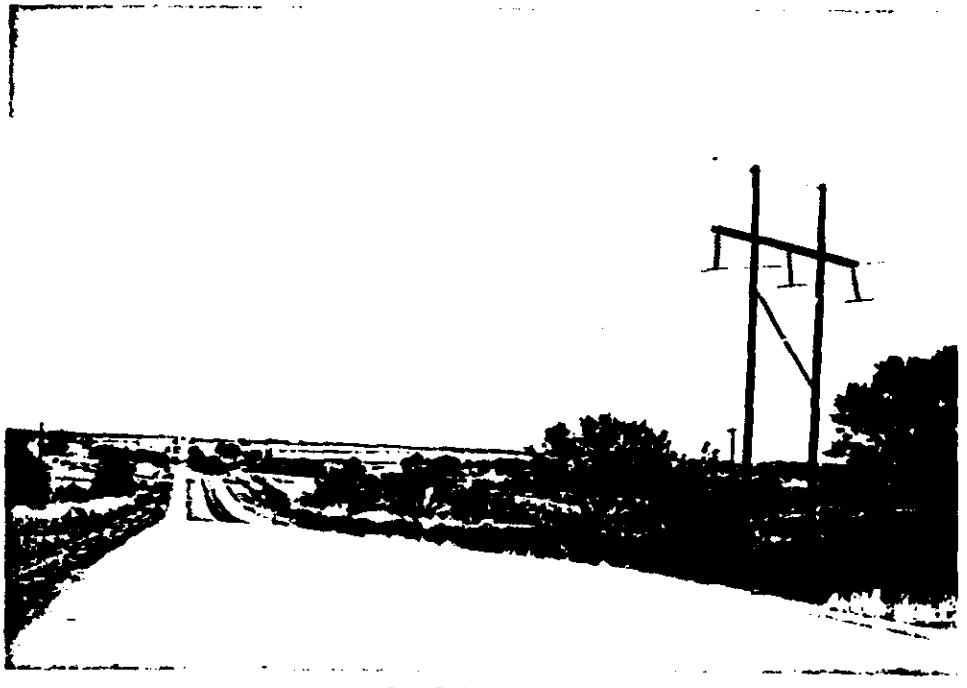
APPENDIX C

PHOTOGRAPH 26
Looking southeast across IH35E from southbound frontage road just south of FR66.

PHOTOGRAPH 27
Looking north on southbound frontage road of IH35E just south of FR66.

APPENDIX C

PHOTOGRAPH 28
Typical high voltagt transmission line on towers



PHOTOGRAPH 29
Typical high voltagt transmission line on poles.

SSC DETECTOR SOLENOID DESIGN NOTE #38

Title: Overland Transportation of Solenoid Modules

BELDING CORPORATION

130 WEST GRAND LAKE BOULEVARD
P.O. BOX No. 227
WEST CHICAGO, IL 60185-0227

Suburban: (312) 231-5200
Chicago: (312) 287-0104
FAX: (312) 231-0318

December 9, 1988

Mr. Bob Shovan
Fermi National Accelerator Laboratory
M S 318
P. O. Box 500
Batavia, IL 60510

Reference: Moving eight (8) coils
33 ft. in diameter - 7 ft. high
Weighing 100 tons each
From the water at Galveston, Texas
to Waxahachie, Texas

Dear Mr. Shovan:

Our people believe that the State of Texas would cooperate in every way possible to allow this move to be done. Their suggestion is as follows:

Rather than Galveston, go up the Brasos River at Freeport to Columbia. This stretch has been navigable for barging nuclear products and heavy reactors in the past. We would offload in Columbia, and move up Highway 36 to Sealy.

Then: move West on interstate #10 to Brookshire, then North on Route 359 to Sauney Stand; North on Route 6 to Hearne; then North on Route 14 to Mexia.

From Mexia, take Route 171 Northwest to Brandon; then North on Route 77 to the site at Waxahachie.

Possible cost for this move:

Engineering fee to the State of Texas, which would include examining bridges and possibly moving light and telephone wires for proper clearances: $25,000

BELDING
CORPORATION
130 WEST GRAND LAKE
WEST CHICAGO IL 60185

Mr. Bob Shovan
Fermi National Accelerator Lab

December 9, 1988

Actual road improvements, cost of moving poles, bracing bridges or ramping other approaches,etc. $50,000

Cost for moving each piece Approximately $30,000

I hope this information will be helpful to you. Please call us at any time for help.

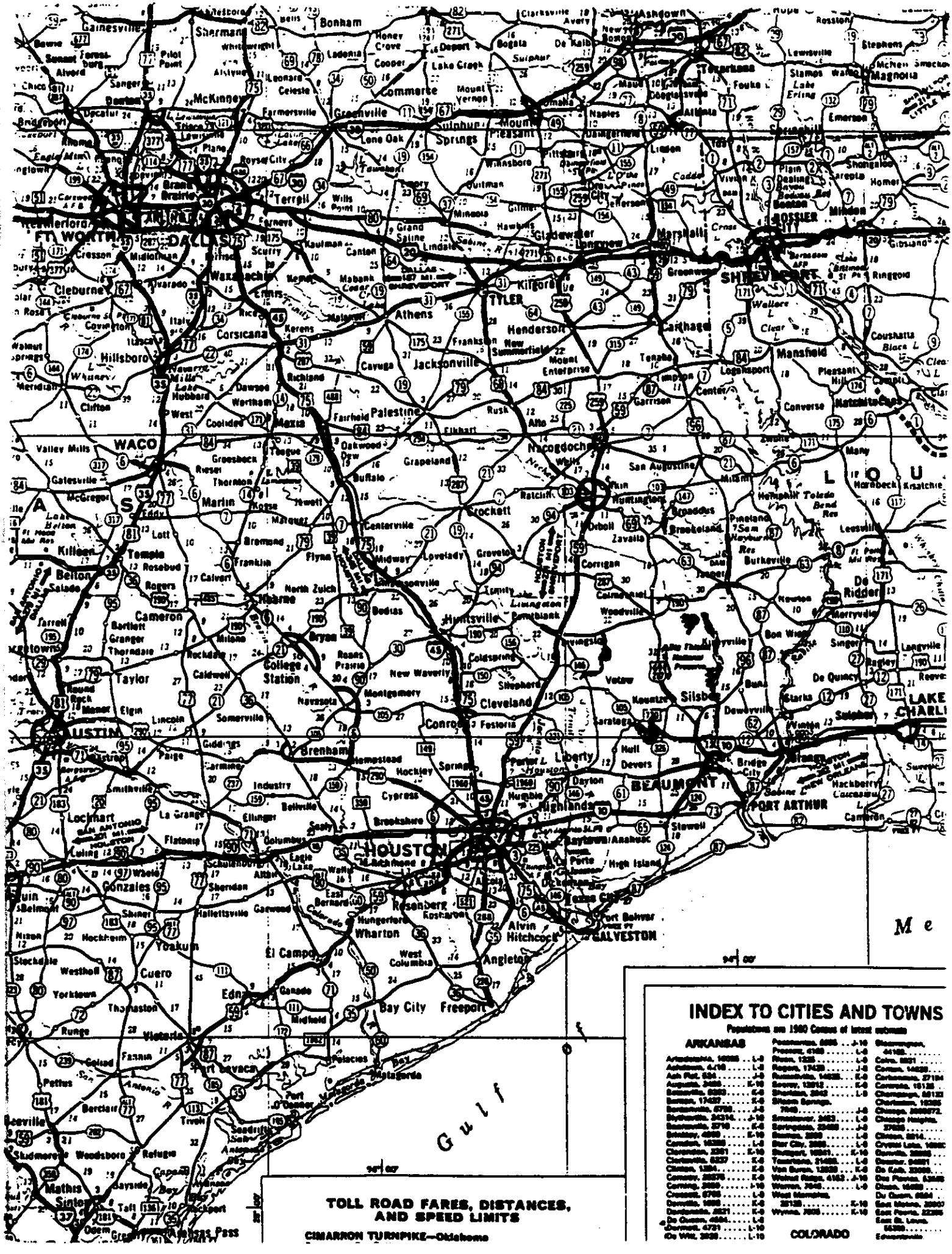
Sincerely yours,

BELDING CORPORATION

Chip

Chip Belding
Chairman of the Board & CEO

el


INDEX TO CITIES AND TOWNS
Populations are 1980 Census of latest estimate
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COLORADO
TOLL ROAD FARES, DISTANCES, AND SPEED LIMITS
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Gulf
FT. WORTH
DALLAS
SHREVEPORT
TYLER
WACO
AUSTIN
HOUSTON
BEAUMONT
PORT ARTHUR
GALVESTON
LAKE CHARLES
Nacogdoches
Palestine
Athens
Henderson
Jacksonville
Corsicana
Cleburne
Hillsboro
Waxahachie
Terrell
Greenville
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Commerce
Mount Pleasant
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Mansfield
Huntsville
Conroe
Cleveland
Liberty
Silsbee
Orange
Lufkin
Crockett
Centerville
Bryan
College Station
Brenham
Cameron
Taylor
Temple
Killeen
Belton
Marlin
Waco
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Victoria
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Yoakum
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Wharton
Rosenberg
Alvin
Angleton
Freeport
Bay City
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Hackberry
Cameron
Lake Charles
Sulphur
Vidor
Bunkie
Pineland
Burkeville
Hemphill
Toledo Bend Res
Sam Rayburn Res
Lake Livingston
Lake Conroe
Lake Houston
Lake Jackson
Lake Somerville
Lake Bastrop
Lake Austin
Lake Travis
Lake Buchanan
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Lake Cypress Springs
Lake Bob Sandlin
Lake Cypress
Lake Sam Rayburn