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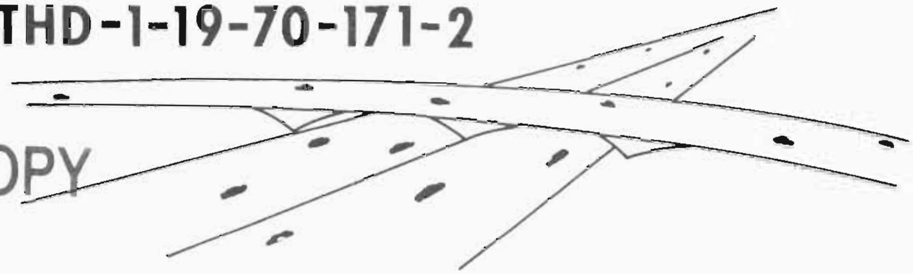

DEPARTMENTAL RESEARCH

Report Number: 171-2

EXTENSIONS OF THE ROADWAY DESIGN SYSTEM - PRELIMINARY LOCATION AND DESIGN STUDIES

TEXAS HIGHWAY DEPARTMENT

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Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

This report gives the results of investigations into the possibility of extending the existing Roadway Design System (RDS) for precise final design to accommodate preliminary location and design studies. It was found that more detailed design is now required during the preliminary phases and that the extensions already made to the system provide the flexibility needed at this stage and a reduction in the amount of input data needed. Additional changes to the system were proposed which would provide more graphic capabilities and extensions into the areas of hydraulic design, cost tabulations, and evaluations of level of service, operation costs, noise pollution and air pollution.

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EXTENSIONS OF THE ROADWAY DESIGN SYSTEM - PRELIMINARY LOCATION AND DESIGN STUDIES

by

Larry G. Walker
and
Clifford J. Powers

Research Report 171-2
Extension of the TIES Road Design System

Research Study 1-19-70-171

Conducted by
Division of Automation
Texas Highway Department
In cooperation with the
U.S. Department of Transportation
Federal Highway Administration

May 1973

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Federal Highway Administration.

SUMMARY

The objective of this study was to investigate the possibility of extending the existing Roadway Design System (RDS) for precise final roadway design to accommodate preliminary location and design studies.

It was found that the preliminary designs of today must be more detailed and, therefore, the extensions already made to the system as outlined in the report "Extensions of the Roadway Design System - Final Report" provide considerable capabilities for preliminary design activities and a reduction in the amount of input data needed. The investigations also indicated that additional changes to the system would provide even more flexibility. These proposed extensions are as follows:

1. Line printer plot of profiles and/or cross-sections.
2. Line printer plot or digital plot of catch points.
3. Plot command for plotting offset lines either parallel to centerlines or connecting pairs of offset points.
4. Automated cost tabulations.
5. Generation of data required for designing hydraulic structures.
6. Automation and reduction of the amount of input design data required.
7. Evaluation of level of service, operation costs, noise pollution and air pollution.

These proposed extensions should be approached on the basis of need, practicality and ease of accomplishment. The first three justify these bases and should be accomplished at an early date. The remainder of these enhancements need to be more specifically designed and studied from the standpoint of cost benefit.

IMPLEMENTATION

The overall objective of this study was to investigate the possibility of extending the existing Roadway Design System (RDS) for precise design into the area of preliminary location and design. Since the study revealed that more detailed design is now needed for preliminary location, the RDS can already be used for such purposes. A sample problem is given to show how this can be carried out. Additional extensions to the system are proposed and studies should be made so that some of these can be implemented at an early date.

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EXTENSIONS OF THE ROADWAY DESIGN SYSTEM - PRELIMINARY LOCATION AND DESIGN STUDIES

This report presents the results of investigations into the possibilities of extending an existing system for precise final roadway design, RDS, to use for preliminary location and design studies.

The Roadway Design System (RDS) is a tool for highway designers. It gives the designer ready access to nearly 300 subprograms which he may use in any sequence he chooses to develop complete highway designs. The computer oriented system makes use of a variety of other automated devices for data capture and acquisition and makes extensive use of computer graphics. The primary objective in the development of RDS was a tool with sufficient flexibility and capability to handle the detailed final design of multi-lane freeway type projects as well as simplier projects. Graphic representation and storage and retrieval of designs were also prime considerations. The following list of capabilities provided to the designer illustrates the overall range of capabilities of RDS. The design can:

1. Reduce geodetic traverses and control mapping
2. Establish horizontal alignments
3. Control roadway section shapes
4. Compute, store, and plot geometric layouts
5. Reduce, store, and plot terrain data
6. Combine terrain and design data into completed design cross-sections
7. Compute earthwork quantities and construction data
8. Generate a variety of plots.

Modularity and expandability were also prime considerations in the RDS development. The system includes a number of system utilities which facilitate expansions into new areas of three-dimensional highway design computations. This has been demonstrated by expanding RDS to include a powerful set of capabilities for computing the three-dimensional aspects of bridge structures and passing key data to design routines. The bridge capabilities are detailed in the report entitled "Extensions of the Roadway Design System - Bridge Design."

The purpose of the study reported here was to explore the possibilities of extending RDS to include capabilities for preliminary design. The modular architecture of RDS with its system utilities and generalized routines for storage and retrieval of the dimensional aspects of highways offered much promise for adapting to preliminary design processes. The basic premise of this study was that preliminary design would involve a subset of the RDS precise design capabilities which use less detail and simplified data processes. This report will show that this premise represents a rather narrow view of the capabilities of RDS for preliminary design.

The study proposal recognized the need for a broad system for identification and objective evaluation of the cost and economic factors affecting highway location and design. It identified the following tools that should be included in such a system:

1. Storage of terrain and other environmental data affecting designs.
2. Storage of design data and cost factors.
3. Procedure for automatic cross-sectioning or other terrain evaluation method for selected routes to be used with road design processes.
4. Simplified roadway design processes making use of the files and procedures of the preceding items.

5. Procedure for determining right of way requirements and acquisition costs.
6. Procedure for determining hydraulic facility requirements and cost.
7. Procedure for determining highway structure costs.
8. Graphic capabilities making use of computer processes and automatic line plotting equipment for use in preparing schematic layouts of route alignments and designs for public hearing purposes.
9. Mathematical modeling procedures for determining maintenance and operating costs related to selected routes.

The actual objectives stated for the study were more limited in scope even though they contribute to the broader system illustrated above. These specific objectives are as follows:

1. Identify the requirements for the terrain and design storage mentioned in Items 1 and 2 above and the automatic cross-sectioning capability mentioned in Item 3.
2. Study the applicability of existing Roadway Design Subsystem processes to Items 4, 5, 8 and 9 above.
3. Adapt and demonstrate this applicability as time permits. This will be done by simulating the terrain and design data files and the automatic cross-sectioning capability.
4. Prepare a report including the results of requirements and adaptation studies and projecting future research needs.

This study has revealed a broad applicability of RDS to preliminary design activities and has generated some extensions of the system which have already been incorporated into Version 4.0 of RDS. These system programming extensions are discussed in more detail in a companion report entitled "Extensions of the

Roadway Design System - Final Report". The remainder of this report discusses the following topics:

1. Preliminary Design Requirements
2. Extensions to RDS for Preliminary Location and Design
3. Other Contributions of RDS to Preliminary Location and Design
4. Example Problem
5. Conclusions and Recommendations.

Preliminary Design Requirements

The activities involved in a highway project from its inception to its final geometric design are numerous and varied. After a project has been selected for development, its funding must be established, and it must be properly identified and developed in accordance with required procedures of local, State and Federal governments. Approval of a variety of disciplines and the interested public must also be obtained. These preliminary activities may be classified as engineering, social, economic and environmental investigations, the end product of which is a safe and adequate highway which serves the transportation needs of the public while minimizing disruption to the environment. The more immediate product of RDS as originally developed is a set of plans and specifications which represent the dimensional and qualitative description of the road to be constructed. This latter aspect is primarily a detailed engineering function whereas preliminary location and design deals with all of the above factors. Since RDS deals with the dimensional and qualitative aspects of roadways, extensions must be limited to these factors for the most part; but the contribution of RDS to other phases of the preliminary location and design process will be noted.

Highway design organizations divide or group their design activities in a variety of ways. For example, for a highway to be constructed between given termini, separate analyses may be required on progressively more restrictive areas such as regions, bands, corridors, routes and alignments. Alternatives are compared in the latter four cases and the degree of design detail increases from case to case.

The Texas Highway Department defines four design stages; these stages are:

1. Route Studies
2. Location and determination of right of way and schematic requirements
3. Preparation of right of way data
4. Preparation of plans, specifications and estimates.

RDS as originally developed was directed toward stages 3 and 4. These extensions being discussed here are applicable to stages 1 and 2. These stages represent two levels of utilization for RDS extensions which were identified in interviews with designers. These two levels actually are different only in degree of refinement of the engineering study.

The first level represents rough preliminary designs directed toward selection of proposed routes and preliminary comparisons of alternate routes. All of the RDS capabilities are applicable to this level of preliminary design, but some needed extensions were identified to reduce the amount of data required to accomplish preliminary designs and to facilitate comparison of alternative designs. This level of engineering study may apply to bands, corridors, routes or alignments. RDS with appropriate extensions can provide a convenient tool for accomplishing this rough level of engineering study of dimensional aspects and costs for any alternative consideration.

The second level of preliminary design is a more precise design directed toward establishing locations and schematics for route and design public hearings. Opinions of designers differ somewhat at this level, but the public hearing and approval processes required tend to indicate the necessity of precise designs at this stage for each alternate route. In other words preliminary design becomes final design. The more detailed the design, the more applicable it is to the original versions of RDS and the extensions mentioned in the previous paragraph will also provide another degree of flexibility.

The next section of this report discusses individual extensions that are applicable to levels 1 and 2 of preliminary design as discussed here and also extensions which relate to other aspects of preliminary design activities in the area of social and environmental effects.

Extensions to RDS for Preliminary Location and Design

The limited scope of this study sought to identify feasible extensions of the system that would facilitate preliminary design and location and to implement and demonstrate some of these as time permitted. As will be demonstrated later in this report, RDS presently has considerable capabilities for preliminary design activities. However, several extensions have been made and several more are proposed. The proposed extensions would need to be carefully considered and justified.

Extensions Included in Version 4.0 of RDS. The following is a list of the extensions which have already been incorporated into RDS:

A. Preliminary design involves evaluation of alternatives whereas in the final design the final location has been selected. The ability to easily revise and modify the designer's choices and the evaluation of alternatives were considered to be most important. For this reason capability for updating any type of data by roadway has been added, and vertical and horizontal alignments can be revised by data element. This update capability may be exercised by using the Design Data Delete Form, Figure 1.

B. A large part of the decisions the preliminary designer makes are related to terrain profiles. For this reason the profile plotting capabilities

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DISTRICT ________ RES. NO. ________
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CO. ________ HWY. ________

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
DESIGN DATA DELETE INPUT FORM

SHEET ________ OF ________
DATE ________
PREPARED BY ________

	ROADWAY		HORIZONTAL ALIGNMENT OR OFFSET	VERTICAL ALIGNMENT	ROADBED TEMPLATE	SUPER-ELEVATION	WIDENING	MEDIAN	SLOPE SELECTION	SPECIAL DITCH GRADE	DESIGN EXCEPTIONS	COMPACTION FACTOR	ADDED QUANTITIES	FORCED BALANCE	RIGHT OF WAY AND MAXIMUM SLOPE INTERCEPT
10 11	12	13 14 15	16 17 18 19 20	21 22 23 24 25	26 27 28 29 30	31 32 33 34 35	36 37 38 39 40	41 42 43 44 45	46 47 48 49 50	51 52 53 54 55	56 57 58 59 60	61 62 63 64 65	66 67 68 69 70	71 72 73 74 75	76 77 78 79 80
0 0															
	12	13 14 15	16 17 18 19 20	21 22 23 24 25	26 27 28 29 30	31 32 33 34 35	36 37 38 39 40	41 42 43 44 45	46 47 48 49 50	51 52 53 54 55	56 57 58 59 60	61 62 63 64 65	66 67 68 69 70	71 72 73 74 75	76 77 78 79 80

Figure 1. Design Data Delete Input Form

Form 1367

of RDS Version 4.0 were expanded to include the capability for multiple profile plots from either baseline or offset alignment and also capability for design profile plots.

C. Earlier versions of RDS were based on cross-sections taken on a baseline and entered as such into the system. This restricts the capabilities of the system to modify alignments and to explore alternate routes or locations. The capability for creating cross-sections along any alignment was recognized as a need. Accessing routines for RDS have been created in a companion research study (Implementation of Numerical Ground Image System) and will be added to RDS at an early date. These routines will be able to access numerical ground image files created from scan profile terrain data as illustrated in Figure 2. The numerical ground image (NGI) capabilities will also be implemented in the companion research effort mentioned above.

D. Earlier versions of RDS had capabilities for computing the horizontal positional relationships between alignments or between the baseline and alignments which are defined by offset data. In Version 4.0 these functions have been made more accessible to the user and the amount of input required on his part has been reduced.

E. The Bridge Design Subsystem of RDS contributes to the preliminary designer in that he may extend his preliminary design data into preliminary dimensional computations for bridge location and structural member design. One very important capability of the bridge design subsystem is that of computing vertical clearance between structures and roadways below. This capability is available if preliminary bridge design is done.

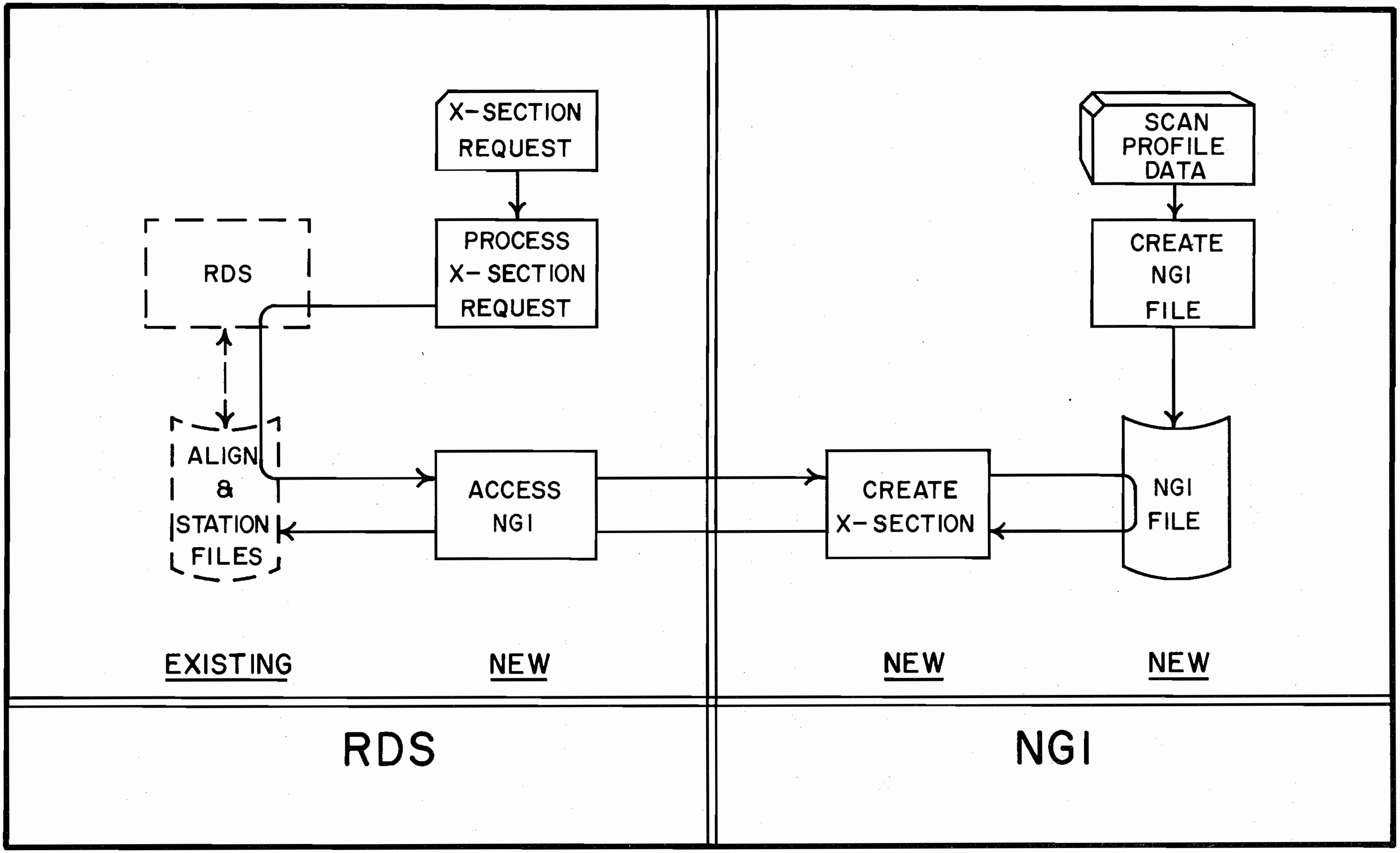


Figure 2. Schematic of Proposed RDS/NGI Interface

F. One other capability was identified and developed in the study. It is a procedure rather than a capability of RDS. This involves the use of standardized templates for defining the shape of roadway surfaces, slope sections and median sections. This procedure is demonstrated in the Example Problem. It simply involves developing a standard set of template data for each type of preliminary design typical section. These sets of data can be filed and used for any preliminary design project. Similar techniques would be advantageous in many cases for precise design with RDS.

Proposed Extensions. The following is a list of extensions that are proposed for RDS:

A. A line printer plot of profiles and/or cross-sections would be a worthwhile addition to the system particularly for the preliminary designer. It would speed up his access to these data which are the basis of many design decisions. This is particularly true in the case of remote terminal users.

B. A line printer plot of catch point distances around a straight line base would help the designer in estimating right of way cost and also in establishing right of way lines. This capability could be extended to estimate right of way costs when the designer input average distance from catch point to right of way line and right of way cost factors between any set of limits he specifies. A further extension would provide a line plot (digital) of catch points which could be combined with alignment plots and used for precisely locating right of way lines.

C. A new plot command is needed for plotting offset lines either parallel to centerlines or connecting pairs of offset points. Parallel lines should have limits and should follow the centerline between the specified limits. This new command would have many uses in connection with RDS, but it would be particularly useful in preliminary design phases for preparing schematic layouts for public hearings and other review purposes.

D. Cost estimating is an important part of preliminary design. The present RDS phases compute a number of quantities and parameters which would contribute to the computation of still other quantities such as base material, pavement materials, sodding and guard post quantities. Entry of appropriate factors and cost information by the designer could produce fairly complete cost tabulations.

E. Another preliminary design activity which is related to RDS is the design of hydraulic structures. It would be possible to generate a considerable part of data required for hydraulic design through RDS and NGI. The information on channel shapes, slopes and roadway clearances could be passed to a system such as the Texas Hydraulic System (THYSYS) for design of hydraulic structures.

F. Another set of extensions to RDS would involve measures to automate and reduce the amount of input of design data. For example, degree of curve could be made a function of horizontal deflection angles, and length of vertical curves could be made a function of per cent change of grade. Superelevation could then become a function of horizontal alignment data with overlaps of superelevation transition and vertical and horizontal curvature resolved automatically. These would serve to reduce input and to facilitate evaluation of more alternatives. Also in some cases it may be desirable to set certain constraints and let the system establish grade lines based on the terrain profiles and specified clearance over other roadways. Still more capabilities could be given to the designer if he could establish horizontal and vertical PI's from graphic plots or interactively on a cathode ray tube device. Such capabilities must be justified on the basis of savings to the designer.

G. The architecture of RDS which designs the three-dimensional aspects of the roadway and captures them in a master project file for further applications lends itself to another set of possibilities for preliminary design activities. Evaluations of level of service, operation costs, noise pollution and air pollution are functions of the geometry of the highway. This may also be true to some extent of maintenance cost and the safety benefits. These features of RDS would suggest the possibility of adding extensions to compute these values or to interface with other systems for these purposes.

Other Contributions of RDS to Preliminary Location and Design

Although the primary thrust of RDS and the extensions addressed to preliminary location and design center around engineering studies and dimensional descriptions of the road to be constructed, RDS offers a significant contribution to the broad goals for highway projects as outlined in the process guidelines in FHWA Policy and Procedure Memorandum 90-4. By offering the designer a tool that enables him to evaluate more alternatives and to be more thorough in the evaluation contributes to safe, fast and efficient transportation. The extensive integration of photogrammetric mapping coupled with automated data acquisition and measurement capabilities augments the study of the socio-economic and environmental factors defined in PPM 90-4. One of the extensions to RDS proposed in the previous section offers potential for contribution to the study and evaluation of air and noise pollution and economic effects. The geometric computational capabilities of RDS linked with extensive graphic capabilities offer considerable facility for preparing schematic and other graphic materials for review by the interested public and public agencies. The capabilities for plotting perspective views of finished roadways make another important contribution in this area particularly when linked with the photo-montage capability developed by others that enables the plotted finished roadway to be superimposed on a photograph taken prior to construction. The flexibility of RDS offers a broad range of other contributions to the preliminary design process.

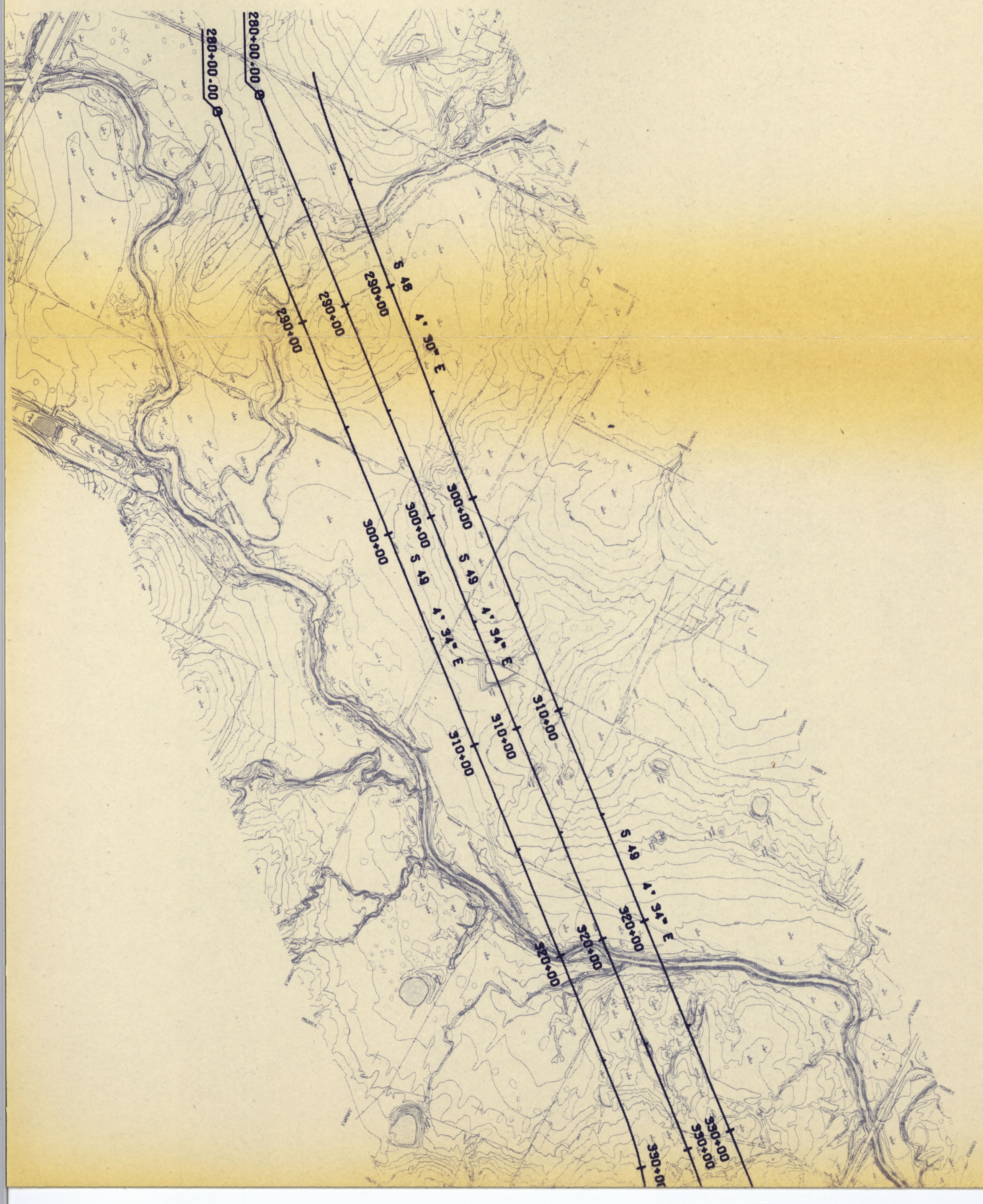
Example Problem

A 4.5 mile length of four-lane, controlled access, divided highway with frontage roads each side was picked to demonstrate the present capabilities of RDS for a stage 1 or level 1 type of preliminary design as discussed in the section entitled "Preliminary Design Requirements". A schematic drawing of the alignment selected for this demonstration is shown in Figure 3. The sample problem will show that this design can be accomplished with a relatively small amount of input with present RDS capabilities. Comments are given to indicate that some of the proposed extensions offered will considerably reduce even this amount of input. The resulting output will also be discussed.

First Run

Assume that an NGI model of the terrain which includes the proposed location and any alternate locations that might be considered has already been stored in an NGI master file which can be referenced by RDS. Also assume that maps are available showing the area of the location in question with sufficient planimetric features and having a surface coordinate base. The steps for this run would be:

1. Establish horizontal alignments on the maps and prepare input for generating these alignments. The input sheets are illustrated on page 15.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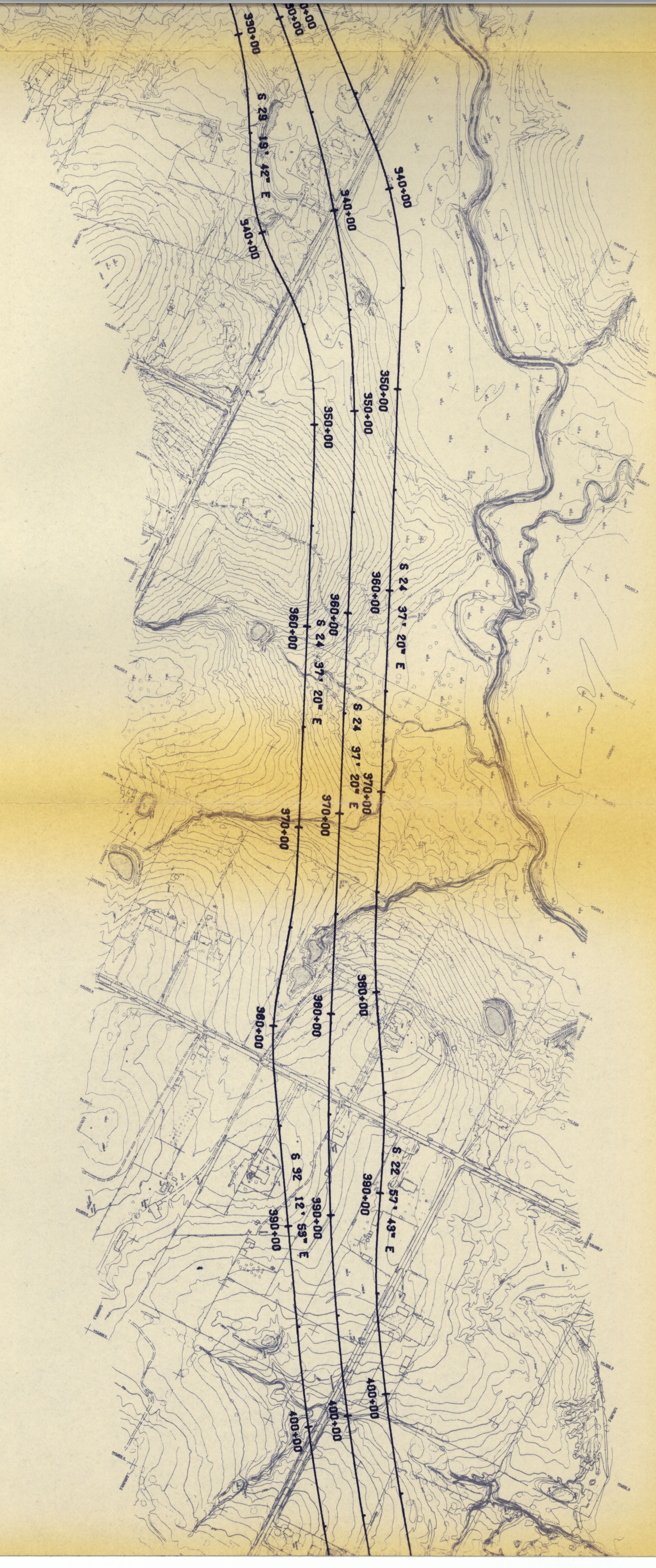
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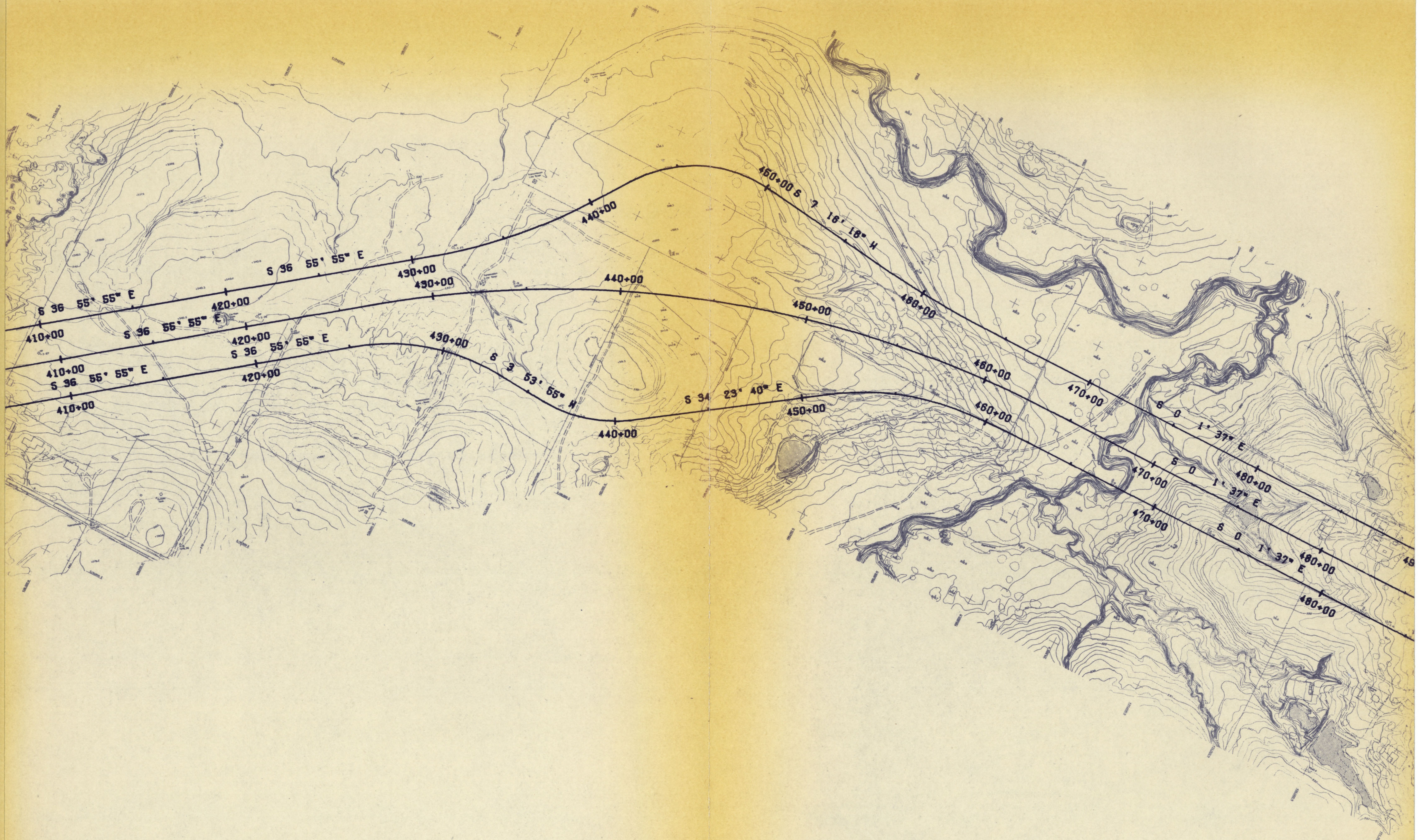
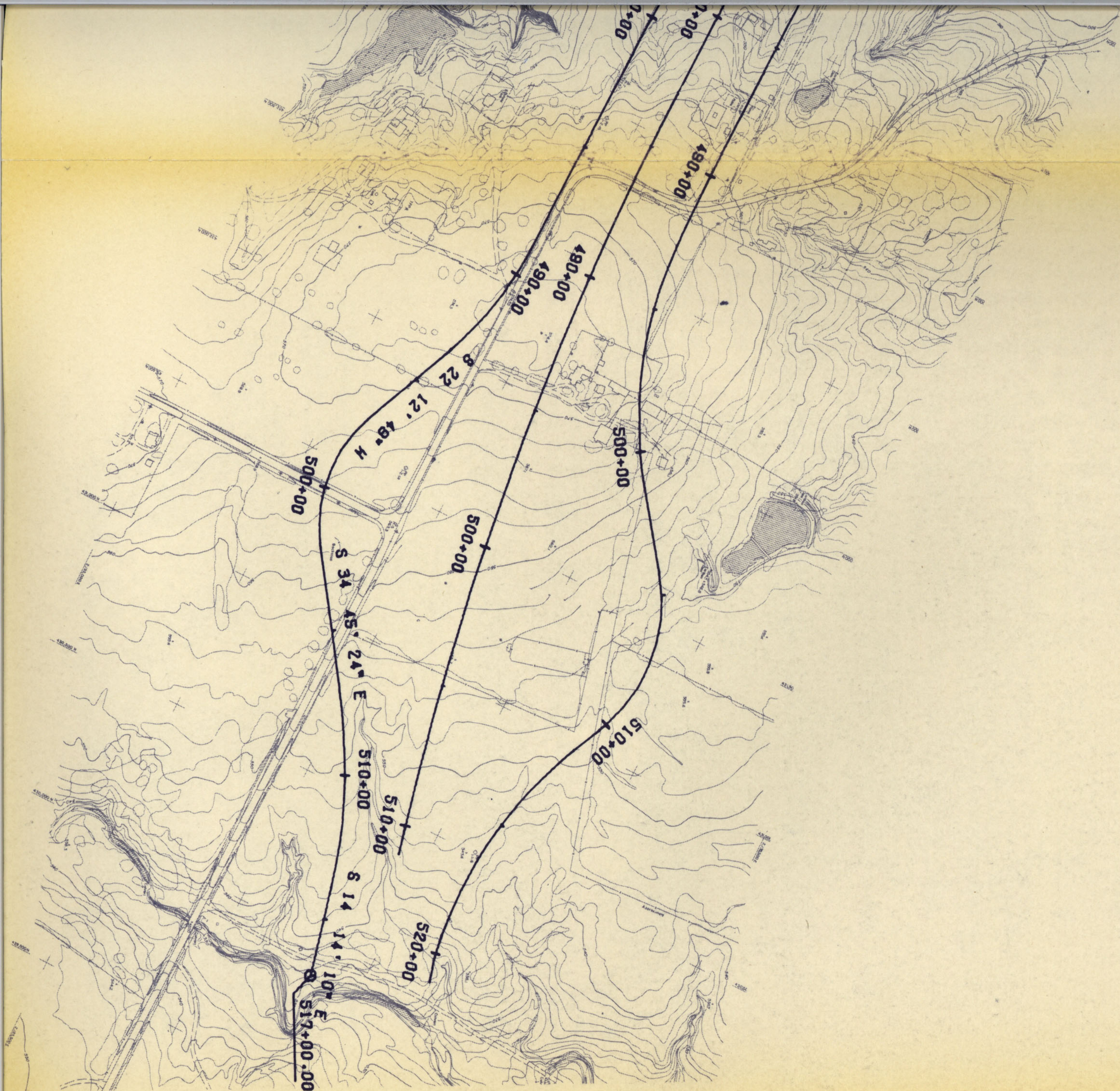


Figure 3. Schematic Drawing of Sample Problem Alignments



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TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
HORIZONTAL ALIGNMENT INPUT FORM

CONTROL & SECTION: 2266024 RD

DISTRICT ____ RES. NO. ____ I.P.E. ____ PROJ. ____ CO. ____ HWY. ____

SHEET ____ OF ____ DATE ____ PREPARED BY ____

	ROADWAY	P.I. NO.	STATION	BEG. STA. I.D.	DEGREE OF CURVE DEG	MIN	SEC	RADIUS OR FORWARD TANGENT	SPIRAL IN	OUT	P.I. COORDINATES X	Y	GEOM. POINT STOR. NUMBER	RND BRG OR HOLD
05	G	1	27014	PDT							123401750	450670056	1	
	G	2			1						128760000	446025000	2	
	G	3				30					130930000	441290000	3	
	G	4			1						134116299	437050718	4	
	G	5				30					134118773	431802646	5	
	G	6									134568538	430029887	6	
	B	1	27014										1	
	B	2			1								2	
	B	3				30							3	
	B	4			1								4	
	B	5				30							5	
	B	6											6	
	A	1	27650								124099388	450500704		
	A	2			2						124299931	450199948		
	A	3									125712717	448931372		
	A	4			10						127722370	447189208		
	A	5			8						128500593	447071083		
	A	6			1	30					130473276	442766634		
	A	7			2						130853914	442155217		
	A	8			2						131178563	441388830		
	A	9						112591559			131550730	440797011		
	A	10			2						133626024	438036261		
	A	11			8						134535209	437393004		
	A	12			1						134347035	435918265		
	A	13						112591559			134348424	432976977		

Form 1329

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
HORIZONTAL ALIGNMENT INPUT FORM

CONTROL & SECTION: 2266024 RD

DISTRICT ____ RES. NO. ____ I.P.E. ____ PROJ. ____ CO. ____ HWY. ____

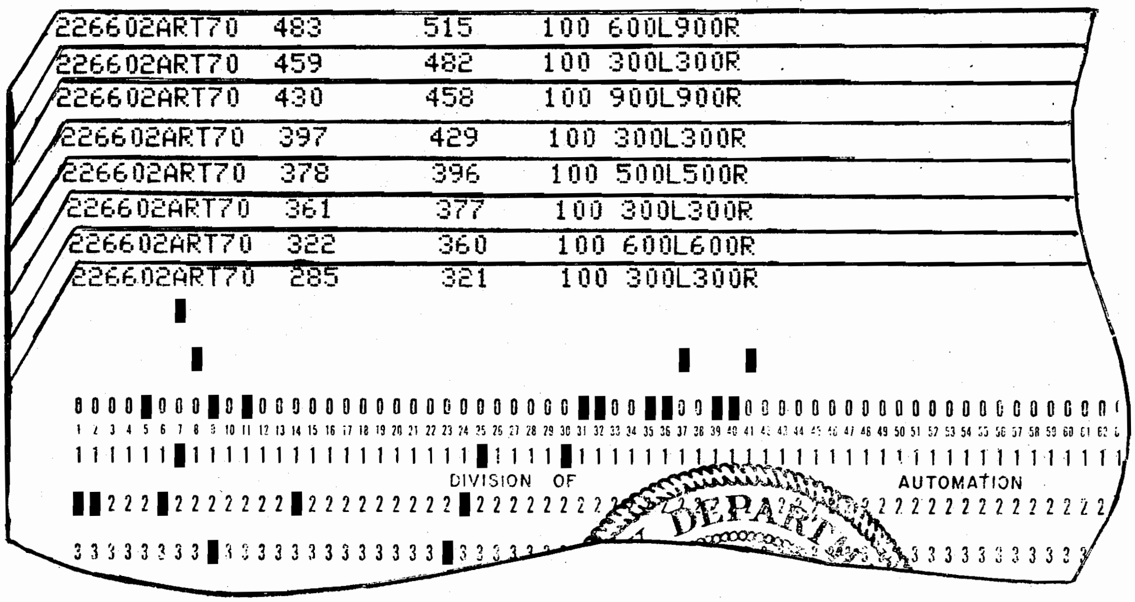
SHEET ____ OF ____ DATE ____ PREPARED BY ____

	ROADWAY	P.I. NO.	STATION	BEG. STA. I.D.	DEGREE OF CURVE DEG	MIN	SEC	RADIUS OR FORWARD TANGENT	SPIRAL IN	OUT	P.I. COORDINATES X	Y	GEOM. POINT STOR. NUMBER	RND BRG OR HOLD
05	A	14			4						134380143	432281249		
	A	15			10						135026772	431423164		
	A	16			4						134675612	430640088		
	A	17			6						134774973	429890463		
	A	18			12						135409725	429313904		
	A	19									135281458	428605064		
	D	1	27600	PDT							123712819	450135701		
	D	2			5						127863180	446537761		
	D	3			8						128617072	445032820		
	D	4			8						129133940	444729000		
	D	5			2						129980056	442882752		
	D	6			4						130162186	442251362		
	D	7						116591559			131223845	440566171		
	D	8			5						132985768	438222308		
	D	9			8						132921157	437274210		
	D	10			4						133882881	435869362		
	D	11						5529578			133917324	435306837		
	D	12			5						133918765	432254877		
	D	13			12						133595294	431462769		
	D	14			3						134231151	430546415		
	D	15			8						134436292	429737857		
	D	16			12						134259656	428991026		
	D	17									134645777	428514082		

Form 1329

Note that this input would be greatly reduced by the proposed extensions. These alignments are for the baseline (cross-section centerline), main lanes, and two separate frontage roads.

2. Request generation of cross-sections along the baseline from NGI. The required request cards are shown here.



3. Request terrain profile plots along the three centerlines. Note that the line printer plot proposed would greatly facilitate remote operations and would be satisfactory for establishing profile grades. The profile plot request input sheet is shown here.

PRO-FILE PLOT	FROM STATION	TO STATION	SCALE HORIZ. (FT/IN)	SCALE VERT. (FT/IN)	SPACE BOT. (IN)	SPACE TOP (IN)	ROADWAY	FIRST PROFILE O/D	FIRST PROFILE DIST. OR ROADWAY	SECOND PROFILE O/D	SECOND PROFILE DIST. OR ROADWAY	THIRD PROFILE O/D	THIRD PROFILE DIST. OR ROADWAY	FOURTH PROFILE O/D	FOURTH PROFILE DIST. OR ROADWAY	FIFTH PROFILE O/D	FIFTH PROFILE DIST. OR ROADWAY
PROF	28500.	51500.	200.	20.	1.	1.	G	Φ	A	Φ	B	Φ	D				

The following is a list of the output from the first run.

1. Horizontal alignment listing
2. Terrain cross-section listings
3. Profile plot and listing.

<u>Standardized Template Data</u>

For purposes of this level 1 preliminary design, standard sections will be adequate for estimating earthwork quantities and right of way requirements and for evaluating needs for grade or other design revisions. The typical section desired is illustrated in Figures 4 and 5. The following input sheets are the necessary standardized input.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
TEMPLATE INPUT FORM

CONTROL & SECTION: 2266024 RD
DISTRICT ______ RES. NO. ______
I.P.E. ______ PROJ. ______
CO. ______ HWY. ______
SHEET ______ OF ______
DATE ______
PREPARED BY ______

Card	ROADWAY	STATION	TEMP. STORE / RECALL NO.	CARD NUMBER	S/F	SURF. DEPTH	PROFILE GRADE POINT	CENTERLINE POINT	LEFT PIVOT POINT	RIGHT PIVOT POINT	SEGMENT SLOPE OPTION	SEGMENT SLOPE	SEGMENT DIST.	SEGMENT SLOPE OPTION	SEGMENT SLOPE	SEGMENT DIST.	SEGMENT SLOPE OPTION	SEGMENT SLOPE	SEGMENT DIST.	SEGMENT SLOPE OPTION	SEGMENT SLOPE	SEGMENT DIST.
30			1	1	S		3	4	4	4		+02	40		+02	12	H	-1666	24	H	+1667	24
			1	2								-02	12		-02	40						
			2	1	S		3	3	3	3	V	-9999	1		-02	35		-02	5			
			3	1	S		2	2	2	2		+02	5		+02	35	V	+9999	1			

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
CUT / FILL SELECTION TABLES

CONTROL & SECTION: 2266024 RD
DISTRICT ______ RES. NO. ______
I.P.E. ______ PROJ. ______
CO. ______ HWY. ______
SHEET ______ OF ______
DATE ______
PREPARED BY ______

FILL TABLE

Card	INDEX	A WIDTH	A VERT. DIST.	A SLOPE	B WIDTH	B VERT. DIST.	B SLOPE	C WIDTH	C VERT. DIST.	C SLOPE	D WIDTH	D VERT. DIST.	D SLOPE	E WIDTH	E VERT. DIST.	E SLOPE
35	A		999	-400		23	-600		10	-400		999	-300			
	F (F, G, H, J, K)															
	L (L, M, N, P, Q)															
	R (R, S, T, U, V)															
	W (W, X, Y, Z)															

CUT TABLE

Card	INDEX	A WIDTH	A VERT. DIST.	A SLOPE	B WIDTH	B VERT. DIST.	B SLOPE	C WIDTH	C VERT. DIST.	C SLOPE	D WIDTH	D VERT. DIST.	D SLOPE	E WIDTH	E VERT. DIST.	E SLOPE
40	A		1	-600		999	+400		12	-600		12	+600		999	+300
	F (F, G, H, J, K)															

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
SLOPE SELECTION INPUT FORM

CONTROL & SECTION: 2266024 RD
DISTRICT ______ RES. NO. ______
I.P.E. ______ PROJ. ______
CO. ______ HWY. ______
SHEET ______ OF ______
DATE ______
PREPARED BY ______

Card	ROADWAY	BEGIN STATION	END STATION	C OR F	L R B	STORE / RECALL NUMBER	BENCH TOLERANCE	REF MAX	MAX. DIST. FROM CENTER-LINE	MIN. DIST. FROM CENTER-LINE	NO. FIXED SLOPES	OPTION	SLOPE	OPTION	SLOPE	OPTION	SLOPE
45						01					1	C	A		B		
						02							A				
						03					1	C	A		E		
						04							D				
						05					2	C	C	C	D		E
						06					1	C	B		C		D

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
MEDIAN DESIGN INPUT FORM

CONTROL & SECTION: 2266024 RD
DISTRICT ______ RES. NO. ______
I.P.E. ______ PROJ. ______
CO. ______ HWY. ______
SHEET ______ OF ______
DATE ______
PREPARED BY ______

Card	ROADWAY	BEGINNING STATION	ROADWAY	ENDING STATION	LEFT RDWY	RIGHT RDWY	STORAGE / RECALL	OPTION	LEFT SEG. 1 HOR. DIST.	LEFT SEG. 1 VERT. DIST.	LEFT SEG. 2 HOR. DIST.	LEFT SEG. 2 VERT. DIST.	LEFT SEG. 3 HOR. DIST.	LEFT SEG. 3 VERT. DIST.	INTC	INTC	RIGHT SEG. 3 HOR. DIST.	RIGHT SEG. 3 VERT. DIST.	RIGHT SEG. 2 HOR. DIST.	RIGHT SEG. 2 VERT. DIST.	RIGHT SEG. 1 HOR. DIST.	RIGHT SEG. 1 VERT. DIST.
50							01		4	-1									7	+12	7	-12
							02		7	-12	7	+12									4	-1

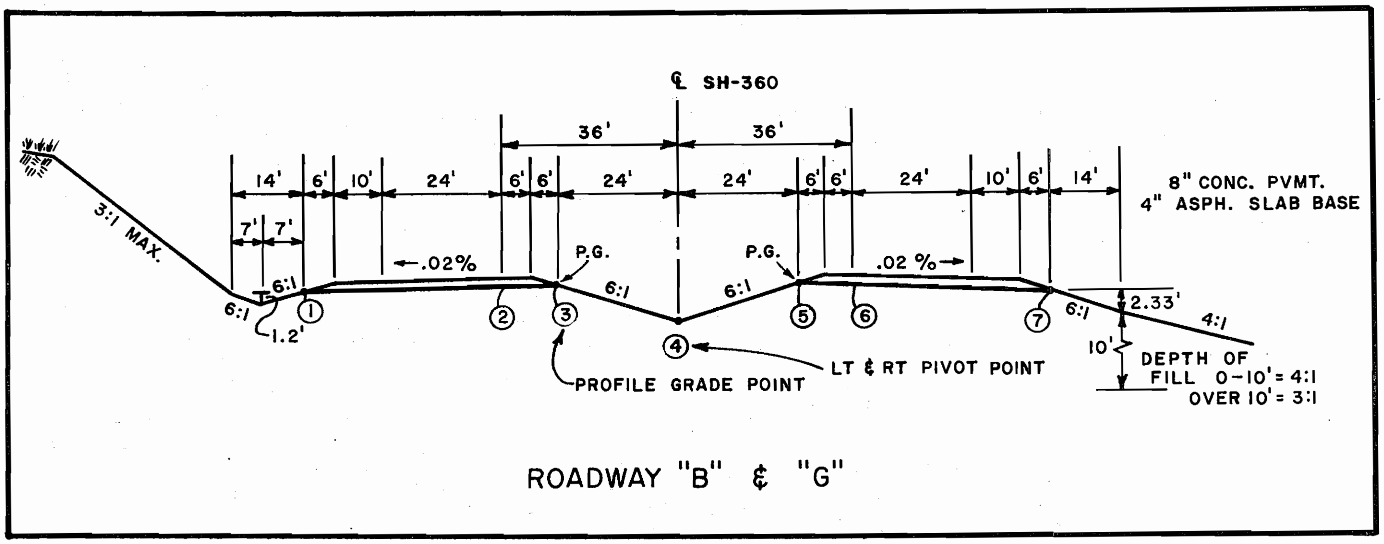


Figure 4. Typical Section for the Main Lanes of the Example Problem

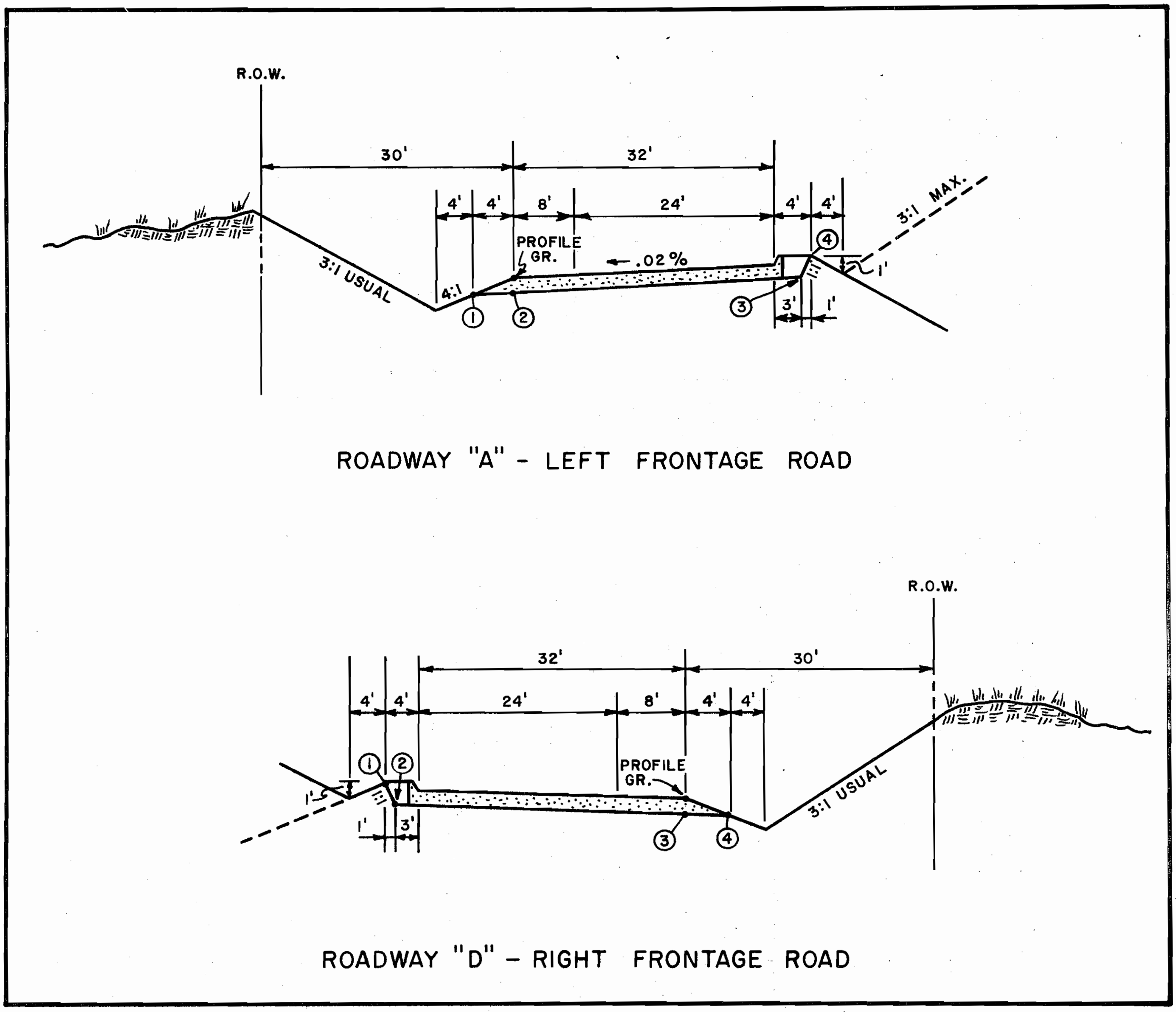


Figure 5. Typical Section for the Frontage Roads of the Example Problem

This input may be used for any preliminary design that requires the same typical sections. For other cases, standardized packages can be developed and maintained for insertion in preliminary design runs.

Second Run

In the second run, the engineer determines and defines design profile grades for the main lanes and frontage roads. The following input sheets show his selection.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
PROFILE GRADE INPUT FORM

CONTROL & SECTION: 2 2 6 6 0 2 A R D

DISTRICT____ RES. NO.____ I. P. E.____ PROJ.____ CO.____ HWY.____

SHEET____ OF____ DATE____ PREPARED BY____

	ROADWAY	P.I. NO.	VERTICAL P.I. STATION	VERTICAL P.I. ELEVATION	FIRST VERTICAL CURVE LENGTH	SECOND VERTICAL CURVE LENGTH	ELEV. CORR.	VERT. TOLER.
1 0	B	1	269+00.	591.20	0		-1.	.
	B	2	292+00.	541.08	800		-1.	.
	B	3	321+00.	557.90	1200		-1.	.
	B	4	343+00.	529.96	800		-1.	.
	B	5	398+00.	554.16	800		-1.	.
	B	6	420+00.	542.28	800		-1.	.
	B	7	455+00.	511.10	1200		-1.	.
	B	8	474+00.	541.50	600		-1.	.
	B	9	488+00.	550.00	1200		-1.	.
	B	10	518+00.	536.17	0		-1.	.

Main Lanes

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
PROFILE GRADE INPUT FORM

CONTROL & SECTION: 2 2 6 6 0 2 A R D

DISTRICT____ RES. NO.____ I. P. E.____ PROJ.____ CO.____ HWY.____

SHEET____ OF____ DATE____ PREPARED BY____

	ROADWAY	P.I. NO.	VERTICAL P.I. STATION	VERTICAL P.I. ELEVATION	FIRST VERTICAL CURVE LENGTH	SECOND VERTICAL CURVE LENGTH	ELEV. CORR.	VERT. TOLER.
1 0	A	1	276+40.	558.81	0		-.83	.
	A	2	294+25.	540.00	400		-.83	.
	A	3	299+70.	559.00	600		-.83	.
	A	4	307+00.	539.00	400		-.83	.
	A	5	312+00.	559.00	600		-.83	.
	A	6	317+70.	532.00	400		-.83	.
	A	7	372+00.	534.00	400		-.83	.
	A	8	383+25.	578.00	800		-.83	.
	A	9	397+50.	562.00	400		-.83	.
	A	10	402+50.	542.00	400		-.83	.
	A	11	424+00.	540.00	300		-.83	.
	A	12	429+00.	536.00	300		-.83	.
	A	13	432+00.	524.00	300		-.83	.
	A	14	435+00.	532.00	300		-.83	.
	A	15	439+00.	527.00	300		-.83	.
	A	16	445+00.	538.00	400		-.83	.
	A	17	449+00.	533.00	300		-.83	.
	A	18	454+00.	518.00	200		-.83	.
	A	19	464+00.	502.00	400		-.83	.
	A	20	476+00.	500.00	400		-.83	.
	A	21	484+00.	540.00	400		-.53	.
	A	22	494+00.	567.00	300		-.83	.
	A	22	497+50.	569.00	400		-.83	.
	A	23	505+00.	550.00	300		-.83	.
	A	24	508+00.	555.00	400		-.83	.
	A	25	518+00.	542.62	0		-.83	.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
PROFILE GRADE INPUT FORM

CONTROL & SECTION: 2 2 6 6 0 2 A R D

DISTRICT____ RES. NO.____ I. P. E.____ PROJ.____ CO.____ HWY.____

	ROADWAY	P.I. NO.	VERTICAL P.I. STATION	VERTICAL P.I. ELEVATION	FIRST VERTICAL CURVE LENGTH	SECOND VERTICAL CURVE LENGTH	ELEV. CORR.	VERT. TOLER.
1 0	D	1	280+00.	540.00	0		-.83	.
	D	2	292+00.	551.00	300		-.83	.
	D	3	298+50.	543.00	300		-.83	.
	D	4	325+00.	536.00	600		-.83	.
	D	5	334+00.	553.00	600		-.83	.
	D	6	344+00.	560.00	400		-.83	.
	D	7	348+00.	551.00	400		-.83	.
	D	8	355+00.	572.00	400		-.83	.
	D	9	364+00.	538.00	600		-.83	.
	D	10	376+00.	557.00	400		-.83	.
	D	11	386+00.	583.00	800		-.83	.
	D	12	399+00.	545.00	400		-.83	.
	D	13	404+00.	560.00	400		-.83	.
	D	14	412+00.	546.00	600		-.83	.
	D	15	418+00.	546.00	300		-.83	.
	D	16	430+00.	536.00	400		-.83	.
	D	17	442+00.	546.00	400		-.83	.
	D	18	447+00.	534.00	400		-.83	.
	D	19	455+00.	532.00	600		-.83	.
	D	20	464+00.	503.00	600		-.83	.
	D	21	472+00.	507.00	800		-.83	.
	D	22	484+00.	561.00	600		-.83	.
	D	23	491+00.	575.50	800		-.83	.
	D	24	505+00.	556.50	400		-.83	.
	D	25	509+00.	546.00	400		-.83	.
	D	26	518+00.	537.86	0		-.83	.

Left Frontage Road

Right Frontage Road

The profile data shown here is rather lengthy because the frontage roads closely follow the terrain. It should be noted that the proposed automated grade line features would significantly reduce this input.

The designer must also establish the limits for the standardized roadway, slope and median templates as discussed in the previous section. The following input sheets show his selection.

CONTROL & SECTION: 226602A RD

DISTRICT ____ RES. NO. ____ I.P.E. ____ PROJ. ____ CO. ____ HWY. ____

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
TEMPLATE INPUT FORM

SHEET ____ OF ____ DATE ____ PREPARED BY ____

	ROADWAY	STATION	TEMP. STORE / RECALL NO.	CARD NUMBER	S/F	SURF. DEPTH	PROFILE GRADE POINT	CENTERLINE POINT	LEFT PIVOT POINT	RIGHT PIVOT POINT	SEGMENT SLOPE OPTION	SLOPE	DIST.	SEGMENT SLOPE OPTION	SLOPE	DIST.	SEGMENT SLOPE OPTION	SLOPE	DIST.	SEGMENT SLOPE OPTION	SLOPE	DIST.
30	A	284+00	3																			
	A	526+00	3																			
	B	285+00	1																			
	B	515+00	1																			
	D	285+00	2																			
	D	517+00	2																			

CONTROL & SECTION: 226602A RD

DISTRICT ____ RES. NO. ____ I.P.E. ____ PROJ. ____ CO. ____ HWY. ____

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
SLOPE SELECTION INPUT FORM

SHEET ____ OF ____ DATE ____ PREPARED BY ____

	ROADWAY	BEGIN STATION	END STATION	C OR F	L R B	STORE / RECALL NUMBER	BENCH TOLERANCE	REF MAX	MAX. DIST. FROM CENTER-LINE	MIN. DIST. FROM CENTER-LINE	NO. FIXED SLOPES	OPTION SLOPE (×16)
45	A	284+00	526+00	C	L	1						
	A	284+00	526+00	F	L	2						
	A	284+00	526+00	C	R	3						
	A	284+00	526+00	F	R	4						
	B	285+00	515+00	C	B	5						
	B	285+00	515+00	F	B	6						
	D	285+00	517+00	C	R	1						
	D	285+00	517+00	F	R	2						
	D	285+00	517+00	C	L	3						
	D	285+00	517+00	F	L	4						

CONTROL & SECTION: 226602A RD

DISTRICT ____ RES. NO. ____ I.P.E. ____ PROJ. ____ CO. ____ HWY. ____

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
MEDIAN DESIGN INPUT FORM

SHEET ____ OF ____ DATE ____ PREPARED BY ____

	ROADWAY	BEGINNING STATION	ROADWAY	ENDING STATION	LEFT RDWY	RIGHT RDWY	STORAGE / RECALL	OPTION	Left Seg. 1 Hor. Dist.	Left Seg. 1 Vert. Dist.	Left Seg. 2 Hor. Dist.	Left Seg. 2 Vert. Dist.	Left Seg. 3 Hor. Dist.	Left Seg. 3 Vert. Dist.	INTC	INTC	Right Seg. 3 Hor. Dist.	Right Seg. 3 Vert. Dist.	Right Seg. 2 Hor. Dist.	Right Seg. 2 Vert. Dist.	Right Seg. 1 Hor. Dist.	Right Seg. 1 Vert. Dist.
50	B	285+00		325+00	A	B	1															
	B	356+00		425+00	A	B	1															
	B	463+00		488+00	A	B	1															
	B	285+00		325+00	B	D	2															
	B	356+00		425+00	B	D	2															
	B	459+00		490+00	B	D	2															

Other parameters the designer must define are superelevation, compaction factors, and the limits of design exception parameters. The superelevation parameters could be automated with the proposed extensions. The following input forms define the superelevation, compaction factors and design exceptions.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
SUPERELEVATION & WIDENING INPUT FORM

CONTROL & SECTION: 2266024 R D

DISTRICT____ RES. NO.____
I.P.E.____ PROJ.____
CO.____ HWY.____

SHEET____ OF____
DATE____
PREPARED BY____

	ROADWAY	STATION	TRANS LENGTH	B OR E	SUPER RATE	L OR R	TRANSITION TYPE
20	B	32950.	300	B	.04	R	1
	B	35200.	300	E	.04	R	1
	B	38100.	200	B	.02	L	1
	B	40450.	200	E	.02	L	1
	B	42750.	300	B	.04	R	1
	B	46250.	300	E	.04	R	1
	B	48350.	200	B	.02	L	1
	B	51000.	200	E	.02	L	1

	ROADWAY	STATION	WIDENING NO.	WIDENING	SEGMENT NUMBER	TRANS LENGTH	B OR E
25							

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
VOLUME COMPUTATION PARAMETERS

CONTROL & SECTION: 2266024 R D

DISTRICT____ RES. NO.____
I.P.E.____ PROJ.____
CO.____ HWY.____

SHEET____ OF____
DATE____
PREPARED BY____

	ROADWAY	STATION	COMPACTION FACTOR
70	G	28500.	1.15

	ROADWAY	FROM STATION	TO STATION	ADDED CUT	ADDED FILL	ADDED FILL COMPACTION FACTOR
71						

	ROADWAY	FORCED BALANCE STATION
72		

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
DESIGN EXCEPTIONS INPUT FORM

CONTROL & SECTION: 2266024 R D

DISTRICT____ RES. NO.____
I.P.E.____ PROJ.____
CO.____ HWY.____

SHEET____ OF____
DATE____
PREPARED BY____

	ROADWAY	BACK STATION	O.O AREA STATION	O.O AREA STATION	AHEAD STATION
60	A	32075.	32085.	32270.	32280.
	A	47200.	47210.	47400.	47410.
	B	31915.	31975.	32350.	32415.
	B	46530.	46580.	47020.	47060.
	D	31880.	31870.	32070.	32080.
	D	46520.	46530.	46730.	46740.

The next step in the design is to request the design output. The following input sheets shown request horizontal position computations to establish the horizontal relationship between the separate alignments, earthwork design computations, volume computations separated by roadways, volume listings, line printer haul plots, and cross-section plots at 500' increments through the job at a scale of 50' per inch horizontal and 20' per inch vertical.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
EARTHWORK REQUEST INPUT FORM

CONTROL & SECTION: 226602A R

DISTRICT____ RES. NO.____ I.P.E.____ PROJ.____ CO.____ HWY.____

SHEET____ OF____ DATE____ PREPARED BY____

(9–12)	FROM BASELINE STATION (13–21)	TO BASELINE STATION (22–30)	HORIZONTAL POSITION CALCULATION: YES OR NO (31–33)	HORIZ. ROADWAYS INCLUDED A	B	C	D	E	F	ROW & MAX. SLOPE INTCP. UPDATE (40–42)	EARTHWORK DESIGN (YES OR NO) (43–45)	VOLUME & HAUL: VOLUMES (YES OR NO) (46–48)	ROADWAYS INCLUDED IN VOLUME A	B	C	D	E	F	LIST EVEN STATIONS ONLY (VOLUME) (55–57)	HAUL PLOT, PRINTER (YES OR NO) (58–60)	HAUL PLOT, DIGITAL (YES OR NO) (61–63)	CONSTRUCTION STAKING REPORT: YES OR NO (64–66)	ROADWAYS INCLUDED A	B	C	D	E	F	HUB NO (73)	AUXILIARY LISTINGS (74–80)
ERWK	28500.	51500.	YES	X	X		X				YES	YES	X	X		X				YES	YES									

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
CROSS-SECTION / PROFILE PLOT INPUT FORM

CONTROL & SECTION: 226602A R

DISTRICT____ RES. NO.____ I.P.E.____ PROJ.____ CO.____ HWY.____

SHEET____ OF____ DATE____ PREPARED BY____

CROSS-SECT. PLOT (9–12)	FROM BASELINE STATION (13–21)	TO BASELINE STATION (22–30)	SCALE HORIZ. (FT/IN) (31–34)	SCALE VERT. (FT/IN) (35–38)	SPACE HOR. (IN) (39–41)	SPACE VER. (IN) (42–44)	LABEL SPACING (IN) (45–48)	MOVE ℄ (49)	OMIT ℄ (50)	PLOT ORIG (51)	PLOT DES (52)	PLOT FINAL (53)	INCRFM (54–55)	PLOTTING LIMITS LEFT (FT) (56–59)	PLOTTING LIMITS RT. (FT) (60–63)	LIST (64)	ROW (65)
XSEC	28500.	51500.	50.	20.	1.	1.	2.			3	2		5				

ENTER AN X IN COLUMN 65 FOR PLOT OF ROW LIMITS.

The following output is generated by the preceding input data.

1. Design data listing
2. Design cross-section listing
3. Volume computation listing
4. A mass haul printer plot
5. Original and design cross-section plots.

Since this example problem used frontage roads that closely follow the terrain, the ROW requirements are determined more by frontage road locations than by catch points. The present capabilities of RDS for right of way estimation are illustrated by the following command structured geometry computations. These commands define and compute an area bounded by right of way lines thirty feet outside the frontage roads.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

CONTROL & SECTION: 2266 024 RG

DISTRICT_____ RES. NO._____
I. P. E._____ PROJ._____
CO._____ HWY._____

SHEET_____ OF _____
DATE _____
PREPARED BY _____

CARD NO.	COMMAND	A	B	C	D	E	F	X—COORDINATE OR CORRECTION	Y—COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	BEAR, AZ, OR SKEW
	CMNT							THE PRELIMINARY DESIGN INDICATES A R.O.W.			
	CMNT							LINE 30 FT OUTSIDE THE FRONTAGE ROADS			
	CMNT							WILL BE A GOOD ESTIMATE			
	SKIP	3									
	CMNT							STORE ROW LINES			
	PONT	10				A			28506.22	-30.	
	PONT	11				A			29906.43	-30.	
	PONT	12				A			32400.23	-30.	
	PONT	13				A			32728.14	-30.	
	PONT	14				A			32957.59	-30.	
	PONT	15				A			33666.93	-30.	
	PONT	16				A			37771.97	-30.	
	PONT	17				A			38257.49	-30.	
	PONT	18				A			38510.51	-30.	
	PONT	19				A			38957.83	-30.	
	PONT	20				A			39335.38	-30.	
	PONT	21				A			39795.67	-30.	
	PONT	22				A			40732.07	-30.	
	PONT	23				A			43116.64	-30.	
	PONT	24				A			44006.06	-30.	
	PONT	25				A			44241.21	-30.	
	PONT	26				A			45016.11	-30.	
	PONT	27				A			45707.11	-30.	
	PONT	28				A			46436.98	-30.	
	PONT	29				A			48159.66	-30.	
	PONT	30				A			49265.94	-30.	
	PONT	31				A			50125.70	-30.	
	PONT	32				A			50418.34	-30.	
	PONT	33				A			51029.82	-30.	
	PONT	34				A			51142.83	-30.	

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

CONTROL & SECTION: 2266 024 RG

DISTRICT_____ RES. NO._____
I. P. E._____ PROJ._____
CO._____ HWY._____

SHEET_____ OF _____
DATE _____
PREPARED BY _____

CARD NO.	COMMAND	A	B	C	D	E	F	X—COORDINATE OR CORRECTION	Y—COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	BEAR, AZ, OR SKEW
	PONT	35				A			51935.42	-30.	
	PONT	36				A			52096.86	-30.	
	PONT	37				D			51626.02	+30.	
	PONT	38				D			51388.10	+30.	
	PONT	39				D			50704.08	+30.	
	PONT	40				D			50193.52	+30.	
	PONT	41				D			49718.77	+30.	
	PONT	42				D			49347.48	+30.	
	PONT	43				D			48902.67	+30.	
	PONT	44				D			46243.77	+30.	
	PONT	45				D			45908.23	+30.	
	PONT	46				D			45135.97	+30.	
	PONT	47				D			44077.90	+30.	
	PONT	48				D			43599.23	+30.	
	PONT	49				D			43324.10	+30.	
	PONT	50				D			42507.49	+30.	
	PONT	51				D			40500.00	+30.	
	PONT	52				D			39539.86	+30.	
	PONT	53				D			38231.31	+30.	
	PONT	54				D			37828.39	+30.	
	PONT	55				D			37587.68	+30.	
	PONT	56				D			37161.14	+30.	
	PONT	57				D			35569.25	+30.	
	PONT	58				D			35132.61	+30.	
	PONT	59				D			34970.17	+30.	
	PONT	60				D			34558.37	+30.	
	PONT	61				D			33314.55	+30.	
	PONT	62				D			32865.16	+30.	
	PONT	63				D			28500.00	+30.	

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

CONTROL & SECTION: 2266 024 RG

DISTRICT_____ RES. NO._____
I. P. E._____ PROJ._____
CO._____ HWY._____

SHEET_____ OF _____
DATE _____
PREPARED BY _____

CARD NO.	COMMAND	A	B	C	D	E	F	X—COORDINATE OR CORRECTION	Y—COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	BEAR, AZ, OR SKEW
	CMNT							TOTAL ESTIMATED R.O.W.			
	AREA	10	11	12	13						-542.95
	AREA	14	15	16	17				+746.19		+3847.71
	AREA	18	19	20	21				+2894.78		-2834.78
	AREA	22	23	24	25			-11229.15		-2834.78	
	AREA	26	27	28	29			+746.19		-5699.57	
	AREA	30	31	32	33			-11199.15	-1402.39		+602.95
	AREA	34	35	36	37				-1402.39	-924.92	
	AREA	38	39	40	41				-1879.85		+507.46
	AREA	42	43	44	45				-1115.91		-5499.57
	AREA	46	47	48	49			-1402.39		+746.19	
	AREA	50	51	52	53			-1115.91		+11689.15	
	AREA	54	55	56	57			+1462.39		-2834.78	
	AREA	58	59	60	61			-686.19		+746.19	
	AREA	62	63	10				-1115.91			

Note that this ROW computation and additional cost computations could be obtained with much less input by using the proposed automated catch point feature and ROW cost factors. Structure cost must also be considered in preliminary design and the proposed hydraulic computation interfaced with the THYSYS System would enable him to pass data for the sizing and cost estimates on drainage structures within this run.

A feature that has been added in the bridge design subsystem of RDS which computes the vertical clearance on the structures would have been beneficial to the designer in this run.

Third Run

Review of the output from the second run would enable the designer to make any changes he may desire. Usually the changes would be restricted to changes of profile grade. This type of revision can be made with a small amount of input for this run.

In run two the design passes under the cross road at Station 340+00. For run three the designer wanted a comparison of a design which passed over the cross road. The designer accomplished this comparison by deleting the existing vertical alignment and design exceptions for the main lanes and entering new data. A new design output and cross-section plots were also requested for this design. The input data is shown below.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
DESIGN DATA DELETE INPUT FORM

CONTROL & SECTION: 2 2 6 6 0 2 A R D

DISTRICT ______ RES. NO. ______
I.P.E. ______ PROJ. ______
CO. ______ HWY. ______

SHEET ______ OF ______
DATE ______
PREPARED BY ______

10–11	ROADWAY (12)	13–15	HORIZONTAL ALIGNMENT OR OFFSET (16–20)	VERTICAL ALIGNMENT (21–25)	ROADBED TEMPLATE (26–30)	SUPER-ELEVATION (31–35)	WIDENING (36–40)	MEDIAN (41–45)	SLOPE SELECTION (46–50)	SPECIAL DITCH GRADE (51–55)	DESIGN EXCEPTIONS (56–60)	COMPACTION FACTOR (61–65)	ADDED QUANTITIES (66–70)	FORCED BALANCE (71–75)	RIGHT OF WAY AND MAXIMUM SLOPE INTERCEPT (76–80)
00	B			YES							YES				

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
PROFILE GRADE INPUT FORM

CONTROL & SECTION: 226602ARD

DISTRICT ____ RES. NO. ____
I.P.E. ____ PROJ. ____
CO. ____ HWY. ____

SHEET ____ OF ____
DATE ____
PREPARED BY ____

	ROADWAY	P.I. NO.	VERTICAL P.I. STATION	VERTICAL P.I. ELEVATION	FIRST VERTICAL CURVE LENGTH	SECOND VERTICAL CURVE LENGTH	ELEV. CORR.	VERT. TOLER.
10	B	1	26900	59120	0		-1	
	B	2	292+00	541.00	800		-1	
	B	3	321+00	557.90	1200		-1	
	B	4	327+50	547.00	500		-1	
	B	5	344+00	562.00	1200		-1	
	B	6	360+00	538.00	800		-1	
	B	7	398+00	554.16	800		-1	
	B	8	424+00	539.00	400		-1	
	B	9	455+00	511.10	1200		-1	
	B	10	474+00	541.50	600		-1	
	B	11	488+00	550.00	1200		-1	
	B	12	518+00	536.17	0		-1	

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
DESIGN EXCEPTIONS INPUT FORM

CONTROL & SECTION: 226602ARD

DISTRICT ____ RES. NO. ____
I.P.E. ____ PROJ. ____
CO. ____ HWY. ____

SHEET ____ OF ____
DATE ____
PREPARED BY ____

	ROADWAY	BACK STATION	O.O AREA STATION	O.O AREA STATION	AHEAD STATION
60	B	319+15	319+75	323+50	324+15
	B	338+50	338+90	340+60	341+00
	B	465+30	465+80	470+20	470+60

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
EARTHWORK REQUEST INPUT FORM

CONTROL & SECTION: 226602AR

DISTRICT ____ RES. NO. ____
I.P.E. ____ PROJ. ____
CO. ____ HWY. ____

SHEET ____ OF ____
DATE ____
PREPARED BY ____

	FROM BASELINE STATION	TO BASELINE STATION	HORIZONTAL POSITION CALCULATION: YES OR NO	HORIZONTAL POSITION CALCULATION: ROADWAYS INCLUDED (A B C D E F)	ROW & MAX. SLOPE INTCP. UPDATE	EARTHWORK DESIGN (YES OR NO)	VOLUME & HAUL CALCULATIONS: VOLUMES (YES OR NO)	VOLUME & HAUL CALCULATIONS: ROADWAYS INCLUDED IN VOLUME (A B C D E F)	VOLUME & HAUL CALCULATIONS: LIST EVEN STATIONS ONLY (VOLUME)	VOLUME & HAUL CALCULATIONS: HAUL PLOT, PRINTER (YES OR NO)	VOLUME & HAUL CALCULATIONS: HAUL PLOT, DIGITAL (YES OR NO)	CONSTRUCTION STAKING REPORT: YES OR NO	CONSTRUCTION STAKING REPORT: ROADWAYS INCLUDED (A B C D E F)	HUB NO	AUXILIARY LISTINGS
ERWK	320+00	370+00	NO			YES									
	285+00	515+00	NO			NO	YES	X X X	YES	YES					

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
CROSS-SECTION / PROFILE PLOT INPUT FORM

CONTROL & SECTION: 226602AR

DISTRICT ____ RES. NO. ____
I.P.E. ____ PROJ. ____
CO. ____ HWY. ____

SHEET ____ OF ____
DATE ____
PREPARED BY ____

CROSS-SECT. PLOT	FROM BASELINE STATION	TO BASELINE STATION	SCALE: HORIZ. (FT/IN)	SCALE: VERT. (FT/IN)	SPACE: HOR. (IN)	SPACE: VER. (IN)	LABEL SPACING (IN)	MOVE ℄	OMIT ℄	PLOT: ORIG	PLOT: DES	PLOT: FINAL	INCREM	PLOTTING LIMITS: LEFT (FT)	DIRECTION	PLOTTING LIMITS: RT. (FT)	DIRECTION	LIST	ROW
XSEC	320+00	370+00	50	20	1	1	2			3	2		5						

Actually such a comparison might involve alignment changes on the frontage road and revision of hydraulics. The flexibility of RDS offers opportunity to redesign on any such basis to refine the detail of design and to use the powerful graphics capability for preparing schematics for hearings or other reviews. The comparison of any other route or alignment would be a similar process and the results of each could be retained and compared as necessary. Also, much of the data generated for this preliminary type design would be useful in a final design using the full capabilities of RDS.

Conclusions and Recommendations

RDS Version 4.0 has been shown to be a very flexible tool for use in all facets of engineering studies of a project and for communicating with the public and public agencies through the use of graphics. This version gives the designer access to all of the RDS capabilities including the extensions which have already been accomplished. Contributions of the system to the socio-economic and environmental studies for a project have also been noted. An important point which was established in the course of the study is that more precise design must take place at the preliminary stage than in the past because of the increased review activities in the development of highway projects.

The proposed extensions to RDS for preliminary route location and design offer to enhance the flexibility of RDS as a tool, reduce designer input to accomplish preliminary designs and give him better or easier access to the system. These proposed extensions are repeated here:

1. Line printer plot of profiles and/or cross-sections
2. Line printer plot or digital plot of catch points
3. Plot command for plotting offset lines either parallel to centerlines or connecting pairs of offset points
4. Automated cost tabulations
5. Generation of data required for designing hydraulic structures
6. Automation and reduction of the amount of input design data required
7. Evaluation of level of service, operation costs, noise pollution and air pollution.

They are listed in the order that they should be approached based on need, practicality and ease of accomplishment. The first three can be justified on these bases and should be accomplished at an early date. The remainder of these enhancements need to be more specifically designed and studied from the standpoint of cost benefit.

The possibilities for use of RDS in preliminary location and design are very broad and have by no means been covered in this discussion. The best approach to discovering this broad range is through applying the system in actual preliminary design cases. The thorough evaluation of more alternatives through use of RDS will serve to produce safe, fast, and efficient transportation.