4. Summarize conclusions as follows:

   a) The inability of Route 1 to provide a gradient within the required 6%, while simultaneously satisfying the cut and fill requirements, makes Route 1 and any adjacent or somewhat similar route unacceptable alternatives.

   b) Knowing the implications of Route 1 in terms of cut, fill, and allowable grade, it is therefore necessary to explore several other alternative routes to attempt to establish a technically acceptable alignment.

Investigation of Routes 2 and 3 -- After examination and preliminary sketching, it is apparent that Routes 2 and 3 might offer more gradual grades and be worth investigating. These routes are shown sketched in Figure 3-4 and are examined in greater detail below.

Route 2. Using the procedures outlined earlier as a guide for checking the route's technical feasibility, and as shown in Figures 3-5A and 3-5B,

1. Convert the sketch of Route 2 into a series of tangents and curves.

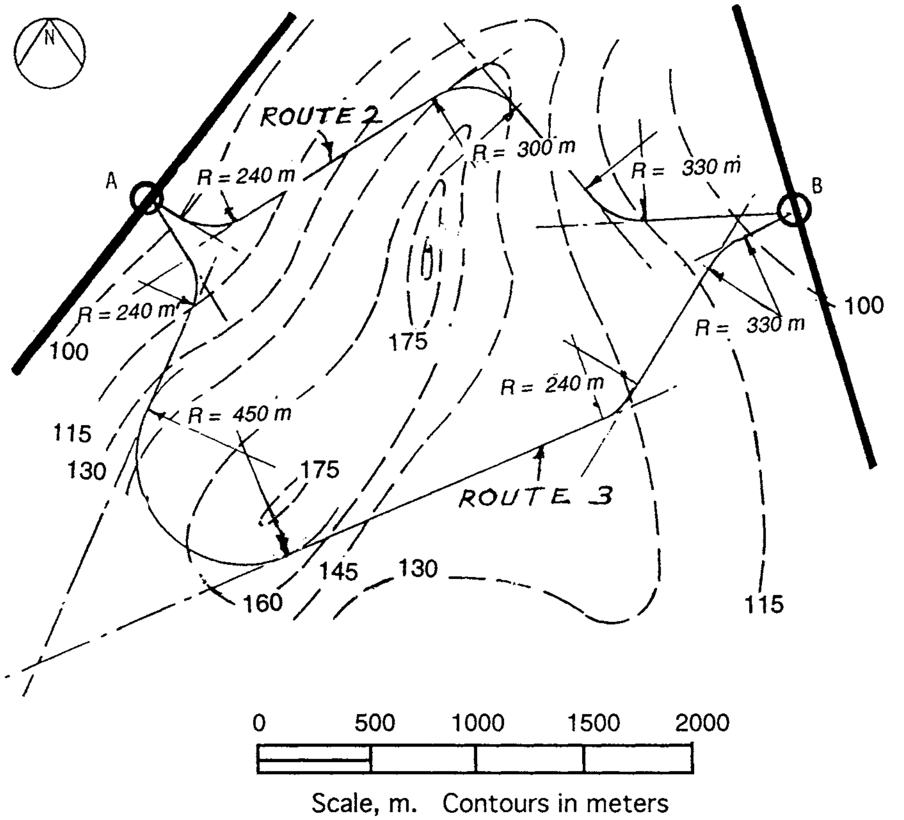
2. Check for the minimum allowable radius based upon design speed and superelevation.

3. Check for intersection angle with existing road (within 15^{o} of right angle).

4. Construct the existing grade profile.

5. Establish a vertical alignment with a maximum grade of 6% and maximum height of cut and fill of 6 m, and within specified grade limits at intersections.

Judging by the design controls established earlier, it can be seen from Figures 3-5A and 3-5B that Route 2 is a technically feasible alternative. Also, the cuts and fills appear to balance fairly well. The horizontal and vertical alignment could, of course, be adjusted slightly and each engineer will arrive at a slightly different geometric design, at least from these preliminary efforts.



Note: Tangents and curves are sketched to show approximate route alinements only.

FIGURE 3-4

INITIAL DEVELOPMENT SKETCHES OF ROUTES 2 AND 3 RESULTING FROM EXAMINATION OF ROUTE 1

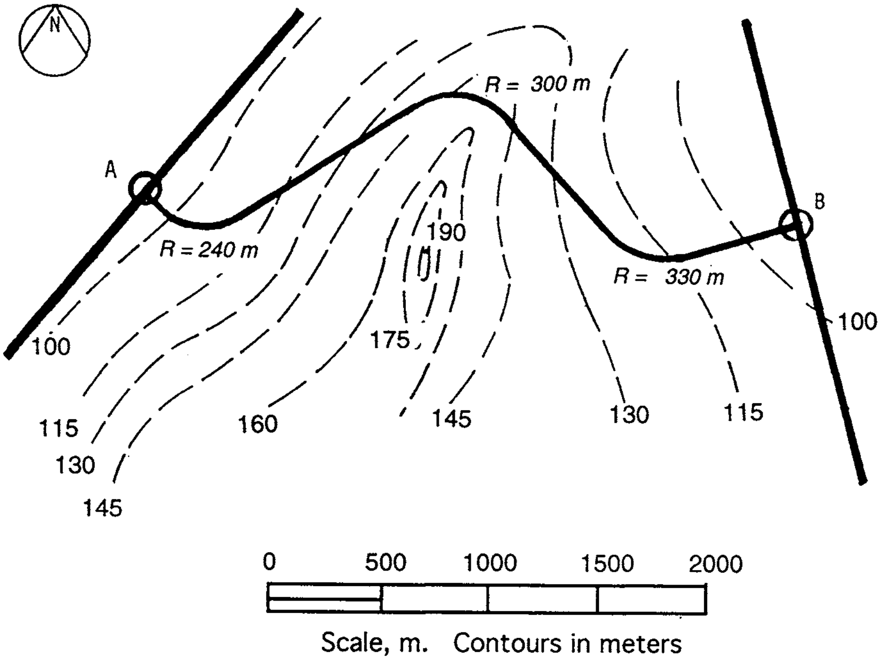


FIGURE 3 -5A

PLAN OF ROUTE 2

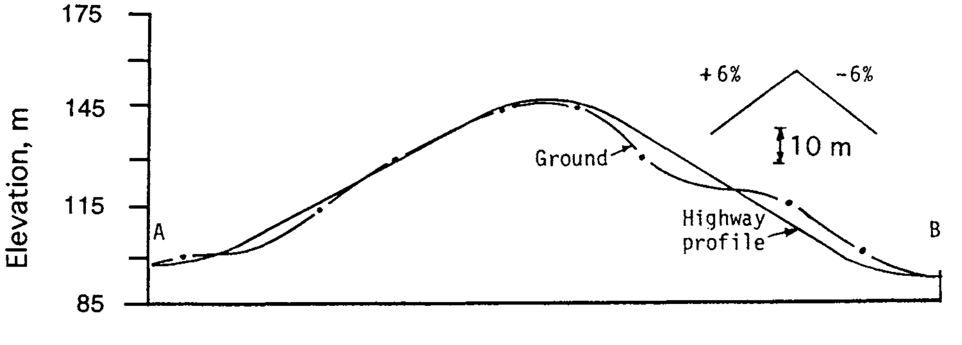


FIGURE 3-5B

PROFILE ALONG ROUTE 2

Route 3. Using the same approach as that used for Route 2, an alignment for Route 3 is developed from the initial sketch. The procedure for developing Route 3 is shown in Figures 3-6A and 3-6B, indicating that Route 3 is a technically feasible route also.

Screening and Selection of Routes for Preliminary Design -- Both Routes 2 and 3 appear to be technically feasible, based upon the allowable grade, cut and fill depths, and horizontal and vertical alignments, while Route 1 clearly is inadequate. It is often useful to screen the proposed routes at this point in order to summarize in concise form the reasons why one or another route should be considered further. Table 3-1 lists a number of major criteria and comments on how each route meets each criterion. The conclusion, as indicated above, is that both Routes 2 and 3 are technically feasible and that a preliminary design and economic analysis should be conducted as a basis for determining the prefered alternative. The three routes investigated are depicted in Figure 3-7.

Highway Centerline Traverse -- At the current stage of the design (i.e., development of a preliminary alignment), the intersecting angles and centerline dimensions may be scaled, but the traverse should "close" at least approximately so that the data given to a field survey party will be adequate for performing a more detailed ground survey. The centerline dimensions and intersecting angles, together, provide a check on the traverse angles and distances to ensure that "closure" occurs, (i.e., that the beginning and end points coincide within a reasonable degree of accuracy). This process is described in basic texts on surveying and is not discussed further here.

Important Note: Particularly when maximum depths of cut and height of fill are specified, it may not be possible to obtain an alignment which conforms to the design designation and controls. In these cases, the designer must decide if bridges or tunnels will be permitted or if controls on grade, design speed, or other determinants of the alignment can be relaxed.

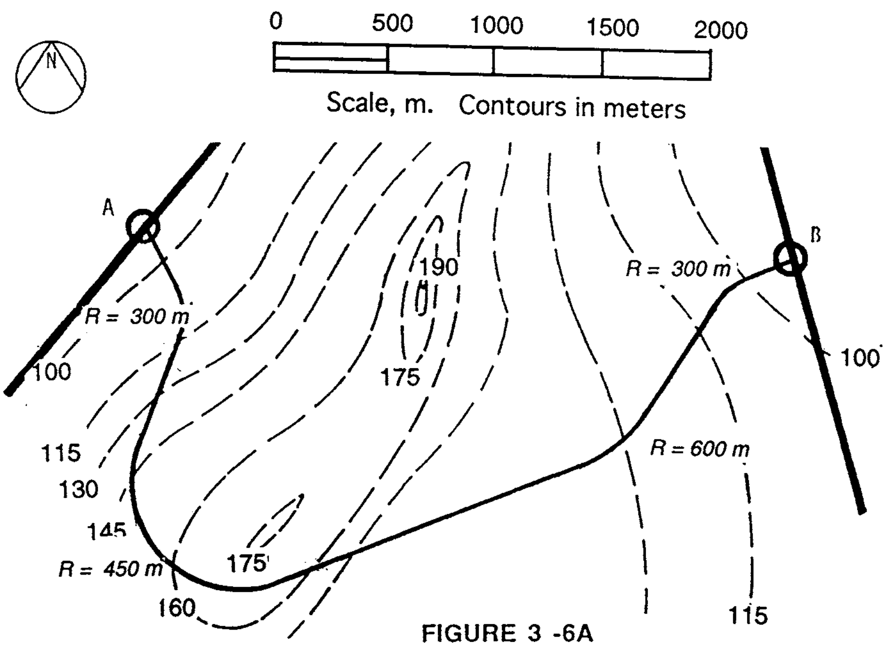


FIGURE 3 -6A

PLAN OF ROUTE 3

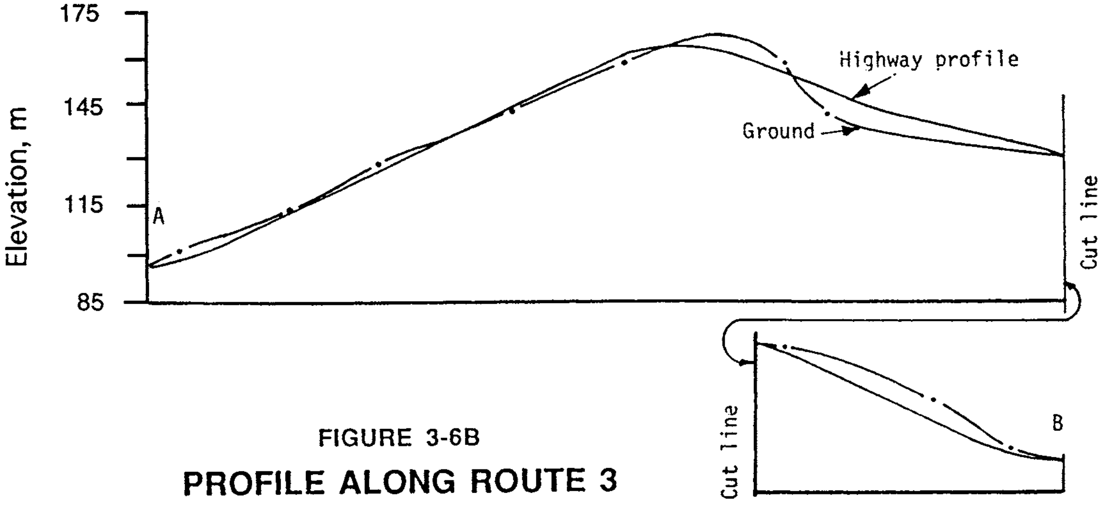


FIGURE 3-6B

PROFILE ALONG ROUTE 3

CRITERIA	SCREENING EVALUATION		
	ROUTE 1	ROUTE 2	ROUTE 3
Length of route (approximate)	*3030 m*	*3540 m*	*4180 m*
Conformance with design controls	*Not possible with specified grade control*	*Acceptable*	*Acceptable*
Cut and fill balance	*Excessive cut required to comply with design controls*	*Acceptable*	*Acceptable*
Need for bridges or other special structures	*None*	*None*	*None*
Environmental impacts	*Excessive cuts and associated slopes*	*No essential difference between Routes 2 and 3*	
Potential high cost items	*Excessive cuts and fills*	*None evident*	*None evident*
Minimize total cut and fill and minimize uphill haul	*Some uphill haul is likely with each alternative*		
Conclusion: *Route 1 is unacceptable due to the need for excessive excavation required to attain the specified grade control. Routes 2 and 3 appear technically feasible and should be further investigatedby means of an initial economic analysis before a detailed design is undertaken*			

TABLE 3-1

SCREENING EVALUATION OF ALTERNATIVES

FIGURE 3-7

OBLIQUE VIEW OF
ALTERNATIVE ROUTES 1, 2 AND 3

NON-STANDARD SITUATIONS

Particularly in mountainous terrain, it may often be the case that an acceptable alignment that conforms to the specified controls is difficult to attain without extreme measures such as deep cuts, use of bridges or even tunnels, particularly where the highway must traverse a number of valleys. Usually the solution entails either provision of horizontal curves with radii less than the allowable, and associated speed restrictions, or the provision of bridges. In cases where these design alternatives exist, a more detailed analysis must be carried out, yet the principles described earlier apply. An example of how a bridge may provide a better solution than a horizontal curve of substandard radius is shown in Figure 3-8. Again, the final decision will rest upon construction, maintenance, and user cost estimates and comparisons.

DRAINAGE PROVISIONS

An initial drainage design indicating the main locations of catchment areas, ditches, culverts, and bridges is an important part of the preliminary highway design because the alignment may have to be changed if the road cannot be adequately drained, or if it adversely affects existing drainage patterns.

The identification of runoff areas likely to affect the highway geometric design (particularly the horizontal and vertical alignments) is of crucial importance for a satisfactory design. The highway, as well as being affected by the characteristics of the watershed such as slope and ground conditions, will itself affect the flow of surface and, perhaps, subsurface drainage in its vicinity. The provision of adequate drainage ditches, culverts, and bridges is therefore of vital importance.See the bibliography in Chapter 1 for a selection of drainage-related guidelines

One way of conducting a preliminary drainage design is to define the characteristics of the major precipitation catchment areas; estimate quantities of runoff; locate ditches, culverts, and bridges; check several "worst case" ditch, culvert, and bridge dimensions; and ensure that adjacent drainage patterns of the surrounding topography are not adversely affected by changes in flow patterns. This process may be complex, depending on the location, topography, ground conditions, and environmental factors. The reader should consult the appropriate texts and manuals and, wherever possible, obtain first-hand knowledge of local practices and conditions. A preliminary drainage design may be made, however, to the extent necessary to define the basic configuration, dimensions, and construction costs and to indicate where a field survey crew should examine various features in greater detail. An example of this approach is included in the project described in Chapter 4, and examples of typical drainage facilities related to terrain and highway characteristics are shown in Figure 3-9.

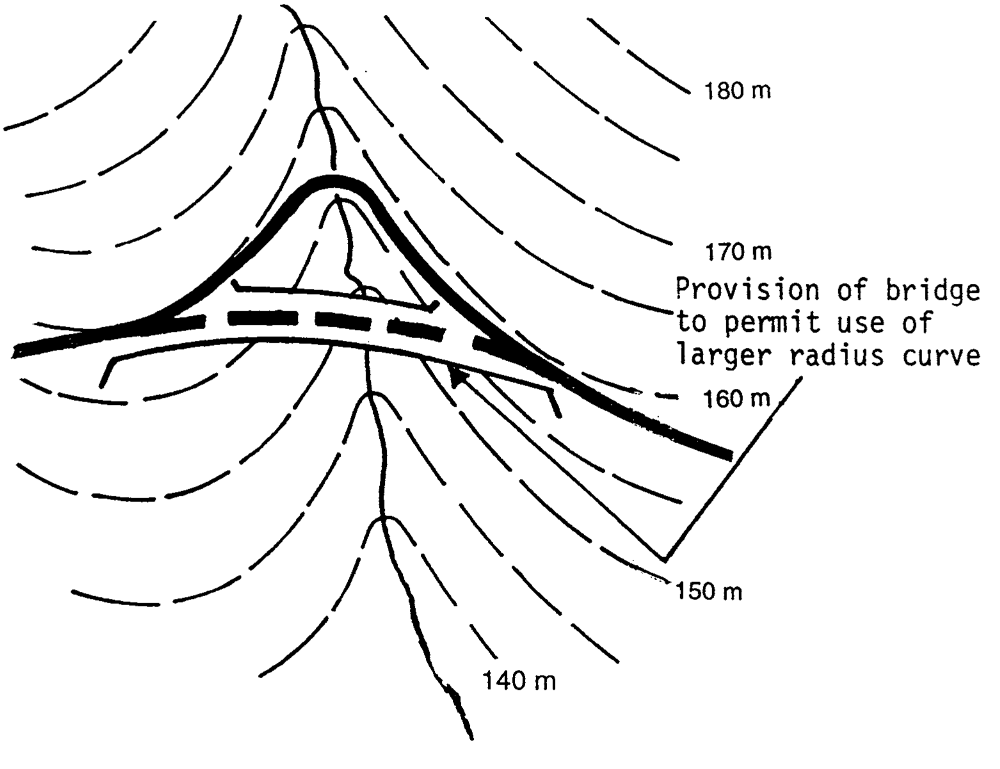
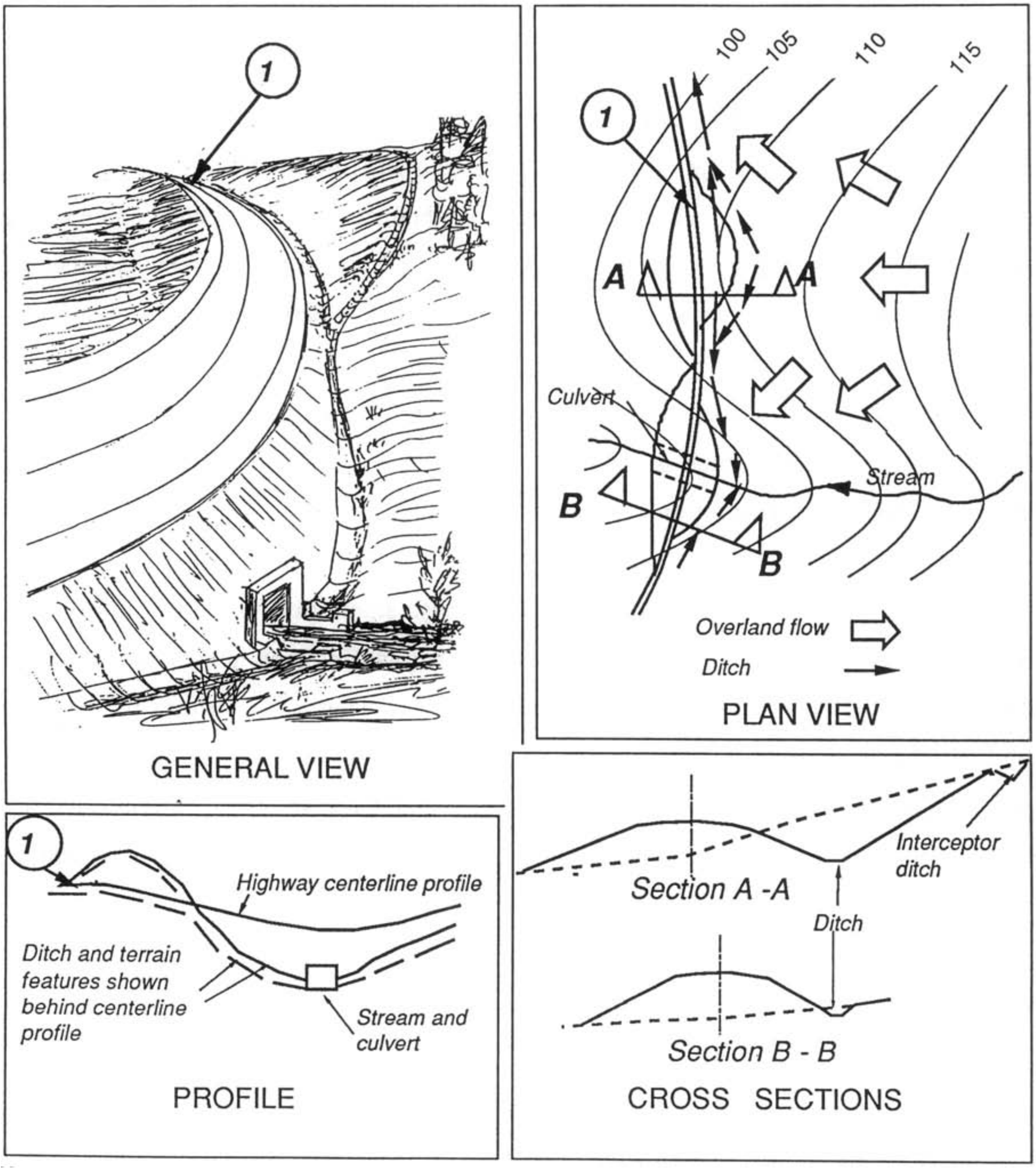


FIGURE 3-8

EXAMPLE OF WHERE A BRIDGE MAY HELP TO IMPROVE GEOMETRICS



Note: Guardrail and other features are not shown in these diagrams.
Diagrams are not to scale.

FIGURE 3 -9

EXAMPLES OF DRAINAGE FEATURES - DIAGRAMMATIC