090516

2209.13

REPORT TO THE COMMITTEE ON PUBLIC WORKS UNITED STATES SENATE

RELEASED

72-0100 24 19

Construction Of A Tunnel And Roadway On Interstate Route 70 In Colorado B-164497(3)

Federal Highway Administration
Department of Transportation

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

90455 090516

MAY 30, 1972

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-164497(3)

Dear Mr. Chairman:

This is our report on the construction of a tunnel and a section of roadway on Interstate Route 70 in Colorado, which you requested by letter dated August 12, 1971.

The report, which is summarized in the digest, discusses the construction problems encountered by the contractor and the reasons for the cost growth of the tunnel and the approach roads.

Your attention is invited to the fact that the Federal Highway Administration, the Colorado State Office of the Department of Highways, and the contractor have not been given an opportunity to formally examine and comment on this report. This fact should be taken into consideration in any use made of the information presented.

We plan to make no further distribution of this report unless copies are specifically requested, and then we shall make distribution only after your agreement has been obtained or public announcement has been made by you concerning the contents of the report.

We trust that the information furnished will serve your purposes.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

The Honorable Jennings Randolph
Chairman, Committee on Public Works
United States Senate

Contents

ABBREVIATIONS

FHWA	Federal Highway Administration
GAO	General Accounting Office

COMPTROLLER GENERAL'S
REPORT TO THE COMMITTEE
ON PUBLIC WORKS
UNITED STATES SENATE

CONSTRUCTION OF A TUNNEL AND
ROADWAY ON INTERSTATE ROUTE 70
IN COLORADO
1 Federal Highway Administration 63
2 Department of Transportation 29
B-164497(3)

D I G E S T

WHY THE REVIEW WAS MADE

At the request of the Senate Committee on Public Works, the General Accounting Office (GAO) reviewed the construction of a tunnel and a section of roadway on Interstate Route 70 in Colorado to determine the reasons for (1) increases in the estimated cost of the projects and (2) construction problems that delayed the timely completion of the projects.

Although this section of Interstate Route 70 is planned to include two two-lane parallel tunnels--one for the eastbound traffic and one for the westbound traffic--only the westbound tunnel and the approach roads are now under construction. When completed, the tunnels and approach roads--called the Straight Creek Tunnel--will connect the Interstate Highway System east of the Continental Divide with the partially completed system west of the Continental Divide at Dillon, Colorado.

The section of highway included in GAO's review is about 11.5 miles long, including a 1.7-mile tunnel, and is located in mountainous country about 60 miles west of Denver, Colorado. (See map on p. 6.) The tunnel is being constructed at an elevation of about 11,000 feet and is to be about 45 feet high--the equivalent of a five-story building--and about 40 feet wide.

FINDINGS AND CONCLUSIONS

The total estimated cost of constructing the two tunnels increased from about $28.8 million in 1959 to about $157.6 million in September 1971--an increase of $128.8 million. The total estimated cost to construct the approach roads increased from about $6.3 million in 1962 and 1963 to about $15.1 million in September 1971, an increase of $8.8 million. The increases resulted from unanticipated construction problems.

Tunnel construction

In October 1967 the State received bids for the construction of the westbound tunnel. The low bid was $54.1 million--about $11.8 million over the State's then most recent estimate and about $4 million over a $50 million limit established by the Federal Highway Administration. As a result of this limitation, the State negotiated the reduction or deletion of certain items from the low bid. A construction contract was awarded to the low bidder for $49.6 million. The contractor was to complete the work in November 1970. (See p. 10.)

Excavation began in March 1968. During excavation the contractor informed the State that unexpected mountain pressures on the tunnel had occurred and that the characteristics of the rock encountered in certain areas were different from those anticipated. Examples of the effects of these and related problems follow.

--Supports within the tunnel were needed in areas where none were anticipated.

--Heavier supports were needed in areas where stresses were greater than those expected, and supports installed appeared in imminent danger of failure.

--An excavation method using a shield in which employees could work safely from possible rockfalls was unsuccessful because the shield became lodged in place because of sagging rock. A different excavation method is being used now.

Because of these problems the rate of excavation was reduced substantially. (See p. 11.)

Disagreements occurred between the contractor and the State as to the responsibility for the problems encountered and for the increased construction costs. Subsequently the contractor submitted a $14 million claim to the State for extra costs incurred and charged that the State had provided inadequate construction plans and had failed to administer the contract properly.

The State settled the contractor's claim for $5 million and modified the contract to provide that the remaining work, with certain exceptions, be on a cost-type basis. The Highway Administration believed that contract settlement and modification was in the public interest,

although it did not believe that the contractor was properly managing the work. (See p. 13.)

As of September 1971 the estimated construction cost for the westbound tunnel was $92.9 million. As of February 1972 the tunnel was about 80 percent complete. The estimated cost to construct the eastbound tunnel is $64.7 million, so that the estimated cost for the two tunnels is $157.6 million. The Federal share of construction costs is 91 percent. (See p. 9.)

The completion date for the westbound tunnel has been extended from December 1970 to January 1973. Construction of the eastbound tunnel is expected to begin in July 1973 and to be completed by July 1976.

Approach road construction

During 1962 and 1963 the State awarded contracts totaling about $6.3 million for the construction of about 9.8 miles of approach roads to the eastbound and westbound tunnels. After construction of the western approach road was started, landslides developed. Attempts to correct the situation have been started and are being continued.

As of July 1971 approximately $4.7 million was spent on the landslide problem. State officials estimate that $1.5 million more will be needed to complete the work. If the attempts to stabilize the slide area are not successful, the State will be faced with a continuing maintenance problem in future years.

In addition, the estimated cost of the roadway construction, excluding the cost of controlling slides, increased from $6.3 million to about $8.9 million, an increase of about $2.6 million. The total estimated cost for the approach roads, including the cost of controlling the slides, as of September 1971, was about $15.1 million. (See p. 15.)

Need to improve contracting procedures

The six bids received for the tunnel construction contract ranged from $54.1 million to $63.6 million. The Highway Administration determined that it would not participate in a contract exceeding $50 million, as previously stated. No explanation for the limitation was given. To meet this limitation, the State negotiated with the low bidder to delete or reduce certain work items.

Some of the items deleted or reduced from the bid later were reinstated in the contract at a price which was $467,000 more than the original bid price. GAO believes that it is unsound to delete necessary items from a proposed construction contract--knowing that such items would have to be reinstated at a later date--and then to reinstate such items on a noncompetitive basis. (See p. 17.)

CHAPTER 1

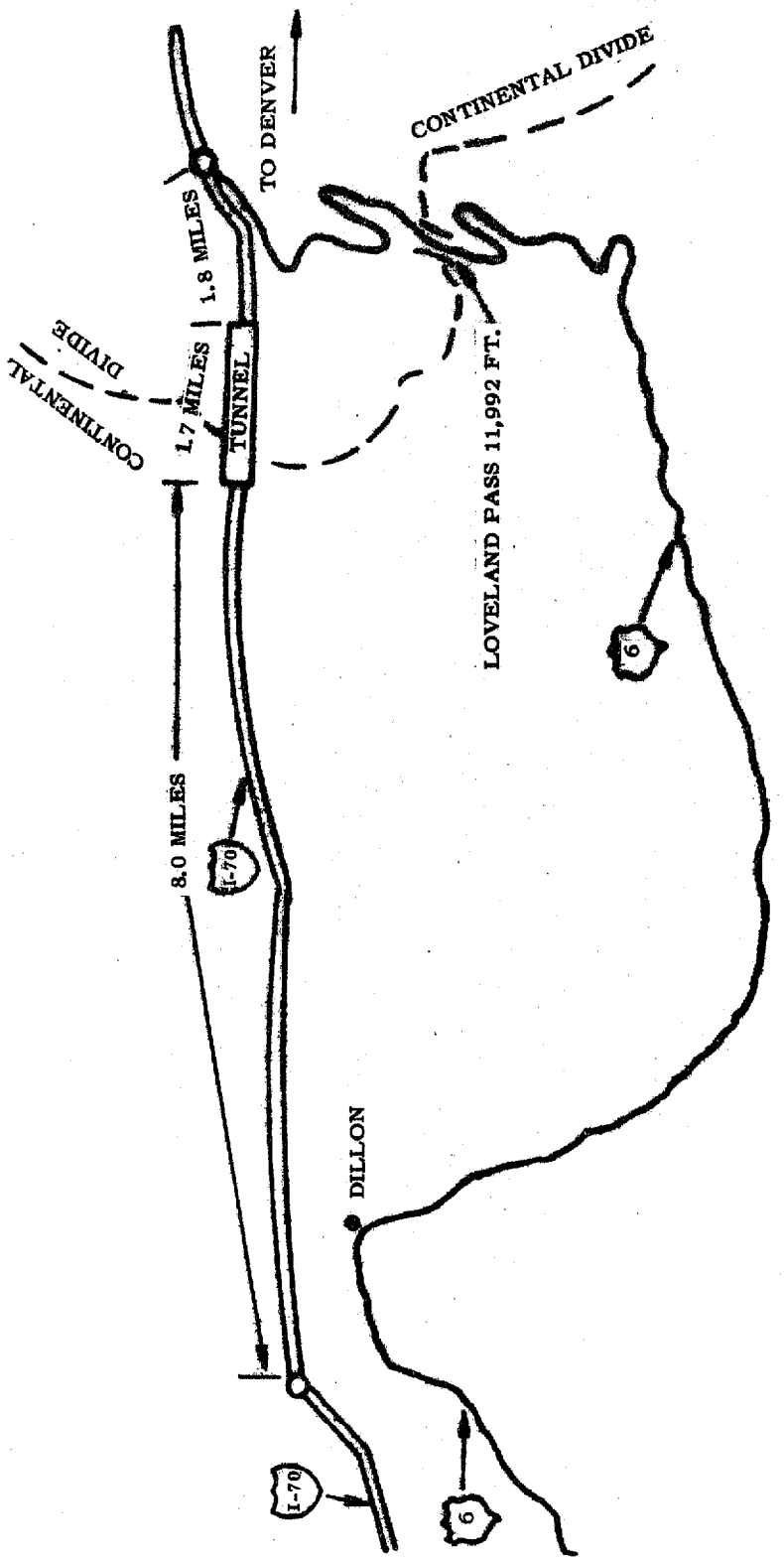
INTRODUCTION AND SCOPE

At the request of the Chairman, Senate Committee on Public Works, dated August 12, 1971, the General Accounting Office reviewed the construction of a tunnel and a section of roadway on Interstate Route 70 in Colorado. Our objective was to determine the reasons for (1) increases in the estimated cost of the projects and (2) construction problems that delayed the completion of the projects.

Although this section of Interstate 70 is planned to include two two-lane parallel tunnels--one for the eastbound traffic and one for the westbound traffic--only the westbound tunnel and the approach roads are now under construction. When completed, the tunnels and approach roads--called the Straight Creek Tunnel--will connect the Interstate Highway System east of the Continental Divide with the partially completed system west of the Continental Divide at Dillon.

The section of highway included in our review is about 11.5 miles long, including a 1.7-mile tunnel, and is located in mountainous country about 60 miles west of Denver. A map showing the location of the tunnel and approach roads, as well as the existing highway, is presented on the following page.

Our review was conducted at the Federal Highway Administration (FHWA) Headquarters Office in Washington, D.C.; the FHWA Regional Office and Division Office in Denver; and the Colorado State Office of the Department of Highways in Denver.


TO DENVER
CONTINENTAL DIVIDE
1.8 MILES
TUNNEL
1.7 MILES
CONTINENTAL DIVIDE
LOVELAND PASS 11,992 FT.
6
8.0 MILES
I-70
DILLON
I-70
6

CHAPTER 2

SELECTION OF HIGHWAY ROUTE

In February 1959 the State hired an engineering consultant firm to study and determine the most feasible location for about a 100-mile segment of an interstate highway west of Denver between the towns of Dotsero and Empire Junction in Colorado. The tunnel and approach roads discussed in this report were part of the route covered by the location study.

The consultant selected eight possible routes for the highway. For each route selected the consultant planned for the construction of a tunnel under the Continental Divide. Six of the possible routes were eliminated for various reasons, such as unacceptable grades, poor exposure for winter maintenance, or unstable landslide areas. The two remaining routes were selected for further study. One route was the Straight Creek Tunnel located in the vicinity of Loveland Pass, and the other route was located several miles to the north.

The consultant ultimately selected the Straight Creek Tunnel route because it was the most direct route between Dotsero and Empire Junction and (1) had a better grade alignment and a shorter total length of maximum grades, (2) had greater potential for completing the work in stages, and (3) required construction of a shorter tunnel and fewer major structures than did the other route. In addition, the estimated construction costs for the Straight Creek route were considerably less than those for the other route.

The consultant and the State considered that a route over the Continental Divide was not feasible because:

--It was not possible to build a four-lane highway over the divide that met all the interstate highway standards. For example, the interstate curvature requirements would have had to be waived to construct eight switchback curves needed to cross the divide.

--The highway should be kept at the lowest level possible because the frequency of storms at high altitudes resulted in substantial accumulations of snow.

--Many motorists would be afforded substantial relief from their fear of heights if a low-level crossing of the divide were provided.

FHWA officials stated that interstate standards could be met for the route only by constructing tunnels. The State made no request to FHWA for a waiver of the interstate standards.

CHAPTER 3

CONSTRUCTION OF TUNNEL AND APPROACH ROADS

The State and its contractor encountered problems in the construction of the tunnel and the approach roads that resulted in delaying completion of that section of the highway and in significantly increasing costs. The estimated increase in construction costs is shown below.

	Estimated cost (millions)
Tunnel:	
September 1971 estimate for one two-lane tunnel	$ 92.9
February 1972 estimate for second two-lane tunnel	64.7
Total for two tunnels	157.6
1959 estimate for two tunnels	28.8
Increase over 1959 estimate	$128.8
Approach roads:	
September 1971 estimate	$ 15.1
Contracts awarded in 1962 and 1963	6.3
Increase over contracts	$ 8.8
Total estimated construction costs of tunnels and approach roads	$172.7
Total estimated increase	$137.6
Federal share of total estimated construction costs (91 percent)	$157.2

The estimated completion date of the first tunnel has been extended from December 1970 to January 1973. The estimated completion date of the approach roads is also January 1973. Construction of the second tunnel is expected to begin in July 1973 and to be completed by July 1976.

Details concerning the problems encountered in the construction of the tunnel and approach roads and the reasons for the cost growth of the projects are presented in the following sections of this report.

TUNNEL CONSTRUCTION

In October 1967 the State received six bids for a contract for the construction of the two-lane westbound tunnel. Contract specifications provided for a 1.7-mile tunnel about 45 feet high--the equivalent of a five-story building--and about 40 feet wide, to be constructed at an elevation of about 11,000 feet.

The State's estimated cost and the amounts of the bids received follow.

State's estimate	$42,279,000
Company A	54,140,486
Company B	55,113,270
Company C	55,731,960
Company D	56,400,421
Company E	59,531,179
Company F	63,613,895

The cost increase from the $29 million estimated in 1959 for two tunnels to the 1967 State estimate of about $42 million for one tunnel was attributable, in part, to major design changes. Part of the design changes resulted from (1) research on the ventilation that would be required for a tunnel at such a high altitude and (2) geological and engineering work, including the excavation of a pilot tunnel through the mountain in 1964. We could find no record in the State's files of a 1967 estimate for the construction of the second tunnel.

About October 30, 1967, FHWA informed the State that it would not participate in a contract exceeding $50 million. As a result the State negotiated the reduction or deletion of certain items from the low bid to reduce the bid price below $50 million. On November 2, 1967, the State awarded the low bidder a contract in the amount of $49.6 million. FHWA determined that Federal-aid highway funds would be used for 91 percent of construction costs and State funds for the remainder.

The contract for the construction of the westbound tunnel also provided for the (1) installation of such tunnel facilities as lighting and other utilities, (2) excavation of a short distance at each end of the mountain for the eastbound tunnel, and (3) construction of portal and ventilation buildings for both tunnels at the east and west entrances.

The contract required that construction of the westbound tunnel be completed in 3 years. Accordingly the tunnel should have been completed by November 1970.

Work on the tunnel was started in December 1967; however, actual excavation was not started until March 1968. Initial plans provided for two methods of excavation. The contractor planned to excavate the more stable rock areas within the mountain through the use of a conventional, time-proven, top heading and bench operation. Under this method, the top half of the tunnel is excavated and lined with concrete and then the bottom half is excavated and lined with concrete.

Where the ground was less stable, the contractor planned to construct a large shield within which the men would work on the full face of the tunnel and would be protected from possible rockfalls. As excavation of the tunnel proceeded, the required supports would be installed, the tunneled area would be lined with concrete, and the shield would be moved forward for further excavation.

In a 1964 report the State indicated that preliminary studies for the tunnel were probably the most comprehensive made for any tunnel, anywhere. Part of these preliminary studies were based on the excavation of a pilot tunnel 10 feet high and 10 feet wide; the tunnel was excavated to determine the geological characteristics within the Continental Divide.

After construction started in December 1967, however, the contractor encountered unexpected problems which extended the time for completion of the tunnel and which resulted in significantly increased construction costs. The contractor informed the State that unexpected mountain pressures on the tunnel had occurred and that the characteristics of the rock encountered in certain areas were different from those anticipated. Some of the effects of these and related problems follow.

In March 1968 the contractor began excavating the top half of the western part of the tunnel. By October 1968 it had excavated about 4,100 feet. During the intervening period the contractor found that the top half of the tunnel could not be supported as provided for in the plans and specifications. Originally the contractor planned to support about 2,100 of the 4,100 feet of this area with steel supports; however, as excavation progressed, the contractor determined that steel supports were required for the entire length.

In December 1968 the contractor began excavating the bottom half of the western part of the tunnel. In February 1969, after 1,600 feet had been excavated, a failure occurred in the side walls of the tunnel. Because of the instability of the side walls, the contractor determined that additional supports were needed. The need for the installation of the additional supports resulted in reducing the excavation rate from an estimated 60 feet a day to 35 feet a day. By December 1969 the excavation of the entire western part of the tunnel was completed.

In December 1968 the contractor began excavating the top half of the eastern part of the tunnel. In December 1969 the contractor, after excavating 2,100 feet, suspended operations because of unstable rock formations. The average daily excavation rate during this period was about one third of that anticipated. During the period of this excavation, extreme and unexpected pressures from the mountain were exerted on the steel supports far in excess of their capacities, which resulted in deforming the supports. In certain areas failure of the supports appeared imminent. Consequently about 850 feet of the excavated area had to be reexcavated to install heavier supports and, in some cases, different types of supports. By December 1969 the contractor had excavated about 50 percent of the top half of the eastern part of the tunnel.

The contractor had planned to excavate about 2,000 feet in the eastern half of the tunnel by using a shield in which employees could work and could be safe from possible rockfalls. This section of the tunnel was recognized as having rock formations that were subject to collapse. The shield, constructed by the contractor, was 42 feet high, 47 feet wide, and 28 feet long; it weighed 550 tons and cost over $1 million. Use of the shield began in August 1969, but, after about 70 feet of excavation, the shield became inoperative because the roller bearings on which it moved were stuck in place. The shield then was redesigned, but, after being advanced a few more feet, it became lodged in place because of sagging rock. The shield method of excavation then was discontinued, and part of the shield was bolted to the tunnel as a support and other parts were dismantled and removed.

Excavation within the tunnel was discontinued from about December 1969 to February 1971 while changes in excavation methods were being considered. In February 1971 excavation of the remaining 1,800 feet was started using a different method. This method involves the excavation of a number of small tunnels--drifts--one on top of the other, to form what

eventually will look like an arch. The drifts, which vary in size from about 6 to 9 feet square, are filled with concrete. The arch is expected to support the mountain while the tunnel is being excavated within it.

Other problems that had an effect, to a lesser extent, on the delay in the construction and on the cost of the project were strikes, cave-ins, fires, and poor ventilation from working at high altitudes.

As a result of the problems encountered by the contractor, disagreements occurred between the contractor and the State concerning the responsibility for the problems encountered and the increased construction costs and concerning whether the costs would be eligible for payment under the provisions of the contract. In September 1970 the contractor charged the State with breach of contract and claimed that the State (1) did not have an adequate design for the tunnel, (2) had disrupted the contractor's schedule and sequence of operation, (3) had failed to disclose in the plans and specifications that the design required unusual and expensive construction procedures, (4) had delayed and suspended the contractor's operations without providing proper compensation, and (5) had failed to recognize changed conditions and to properly administer the contract.

The contractor also informed the State that, unless arrangements were made to correct the design for the tunnel and to compensate the contractor for the extra costs incurred because of the above-mentioned actions, it would terminate operations and would seek relief in court. Shortly after the charges were made, the contractor submitted a claim to the State in the amount of $14 million for extra costs incurred as a result of the State's actions. During preliminary negotiations between the contractor and the State concerning the claim, this amount was reduced to $11.3 million.

FHWA officials informed us that, because an agreement could not be reached between the State and the contractor as to whether the contractor's claims were valid, FHWA considered that it was in the best interest of both the State and the Federal Government to settle out of court and to permit the contractor to complete the project. On December 16, 1970, the State modified the contract to provide for (1) completion of the remainder of the work by the contractor on a cost basis, (2) an extension of 500 days to complete work under the contract, and (3) the payment of $5 million to the contractor in settlement of the $11.3 million claim.

The modified contract provided that, for future work, except for completion of some work already started by the contractor and some work being done by a subcontractor, the contractor be paid for (1) the costs of specific overhead items, labor, materials, and equipment and (2) specified unrecovered costs of mobilization and construction facilities.

FHWA officials informed us that they believed that the settlement was in the public interest although they felt that the project may have been mismanaged by the contractor. The situation was summarized by an FHWA headquarters official in June 1970 when he stated:

> "*** the Straight Creek Constructors have managed to mismanage the tunnel construction operations to a point where the contractor group reportedly has lost money on the project to date, and now stands to lose a tremendous sum and to cost the public a great additional sum either in costs to complete or in loss of funds so far invested in the tunnel project or in non-availability of the facility for its intended use. Somehow a means must be found to diminish any such public losses and to provide some assistance to the contractor in his effort to complete the work if he is cooperative."

In an internal memorandum from the District Engineer in Denver to the Division Engineer in Colorado, dated January 19, 1971, FHWA recognized that greater efforts were needed by the State in administering the contract and that such efforts should be more concerted when the State operated on a cost basis. The letter pointed out that contract administration had been a recurring problem and highlighted the fact that the State had not visited the construction site for over 2 months. In an effort to monitor the contract more closely, the State, in mid-1971, hired a consultant to assess the contractor's operations and to offer suggestions to improve the management of the project.

Since starting work on the project in mid-July 1971, the consultant has submitted two reports to the State. Some of the comments contained in the consultant's report are set forth below.

1. Poor planning and lining out of the work--The consultant indicated that the contractor was not compiling detailed plans which showed a description of how the work would be performed or the estimated costs of the various work items.

2. Poor working conditions--The lighting in the tunnel was very poor, and the road inside the tunnel was sloppy, muddy, and full of holes.

3. Poor utilization of men and equipment--The consultant stated that he had observed 10 men doing a job that could have been done by four men and that he had observed improper use of certain equipment.

The consultant's comments were similar to previous comments made by FHWA personnel to the State during their visits to the construction site.

Current status

According to a State official, the construction of the westbound tunnel, as of February 1972, was about 80 percent complete. As previously noted approximately 1,800 feet of what is considered to be the worst rock in the eastern part of the tunnels have not been excavated except for starting some of the drifts. About 46 percent of the total length of the tunnel has been lined with concrete. All the ventilation and approximately 86 percent of the buildings and cross passages have been completed.

Both State and FHWA officials told us that they were optimistic that the tunnel construction problems would be overcome. State officials said that the State had never considered abandoning the tunnel because of the many problems encountered or because of the increasing costs.

CONSTRUCTION OF APPROACH ROADS

During 1962 and 1963 the State awarded contracts in the total amount of $6.3 million for the construction of about 9.8 miles of approach roads to the eastbound and westbound tunnels--1.8 miles to the eastern ends and 8 miles to the western ends.

Landslides developed after construction of the western approach road was started. When the slides first developed, corrective actions were initiated, and they were continued, but without complete success. As of July 1971 approximately $4.7 million had been spent in an attempt to stabilize the slides. According to State personnel another $1.5 million will be needed to complete the work. The State plans to move the approach road further away from the slide area and to attempt to completely stabilize the slides. According to State personnel, if this attempt is not successful, the State may be faced with a continuing maintenance problem in future years.

The estimated cost of constructing the approach roads, exclusive of the cost of controlling slides, has increased from $6.3 million to about $8.9 million, an increase of about $2.6 million. As of September 1971 the total estimated costs for the approach roads, including the cost of controlling the slides, were about $15.1 million.

CHAPTER 4

CONTRACTING PROCEDURES RESULTED IN INCREASED COSTS

In a memorandum dated November 3, 1967, FHWA advised the State of an earlier determination by FHWA that it would not participate in a contract exceeding $50 million for the construction of the westbound tunnel. No explanation for the limitation was given. To meet this limitation, the State negotiated with the contractor for the deletion of the ventilation fans and motors and for the deletion or reduction of certain other items of work. In consideration of these changes, the contractor agreed to reduce its bid to $49,576,412--a reduction of about $4.5 million. FHWA informed the State that the contract could be awarded for $49.6 million, with Federal participation. FHWA recognized that some of the deleted items would have to be reinstated at a later date. FHWA instructed the State to purchase the fans and motors later and assured the State that FHWA would participate in the costs. The contract was awarded on November 2, 1967.

Some of the items deleted or reduced from the plans and specifications later were acquired and installed at higher prices than those included in the contractor's bid. The additional cost resulting from items which had been acquired and installed at the time of our review was about $467,000.

One of the major items deleted from the contractor's bid price was $1,154,738 for installation of part of the tunnel's ventilation system. The State subsequently purchased the parts for the system at a cost of $1,240,000 and on July 3, 1969, issued a change order to the contractor for the installation of the equipment at a cost of $162,000. Thus the cost of purchasing and installing the equipment amounted to $1,402,000, or $247,262 more than the amount included in the contractor's bid.

Another item eliminated from the contractor's bid price was $120,000 for the placement of 100,000 cubic yards of material to form a berm--a shelf or ledge on a slope. In May 1971 a contract change order was issued for the placement of the berm on a cost basis. According to cost figures furnished to us by the State, the cost of the berm amounted to $333,000, an increase of $213,000 over the contractor's bid price. Part of the cost increase resulted because the slide problem on the approach roads required the contractor to

alter its construction schedule and to place the material during the winter months, which reduced normal efficiency of both men and equipment.

As of September 1971 the only other item that the State had acquired at a higher price than that included in the contractor's bid was the emergency electric generator system. The increased cost for this item was about $7,000.

At the completion of our fieldwork, several other deleted items remained to be acquired for the project. It appears, therefore, that the total additional costs to acquire and install these deleted items will be considerably greater than the costs that were incurred up to September 1971.

- - - -

FHWA did not, in our opinion, exercise a prudent procurement practice when it determined a cost ceiling for the contract without any apparent reason. We believe that it is unsound to delete necessary items from a proposed contract--knowing that such items would have to be reinstated at a later date--and then to reinstate such items on a noncompetitive basis.

United States Senate
COMMITTEE ON PUBLIC WORKS
WASHINGTON, D.C. 20510

August 12, 1971

Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
Washington, D. C. 20548

Dear Mr. Staats:

An Interstate highway construction project in the State of Colorado involving considerable construction problems and cost escalation has recently been brought to the attention of the Committee. The project which is planned to be a section of Interstate 70 involves the construction of a tunnel through a mountain and a section of highway leading to the tunnel.

According to the information available to us, the cost of one of the tubes of the tunnel has increased from about $52 million to about $80 million. In addition to the problems and related cost increases encountered in constructing the tunnel, we understand there have also been considerable difficulties encountered in the construction of the roadway on one side of the tunnel because of the instability of the soil in the area.

Would your office undertake a review of this project and advise the Committee on the facts of the situation. Your past services to the Committee have always enabled us to meet our legislative responsibilities more effectively and your report on this matter will undoubtedly be as helpful.

With personal regards,

Truly,

Jennings Randolph

Jennings Randolph
Chairman

.S. GAO, Wash., D.C.