REPORT TO

THE CONGRESS OF THE UNITED STATES

NEED FOR IMPROVED REVIEWS OF QUANTITY ESTIMATES PREPARED BY ARCHITECT-ENGINEERS FOR SOLICITATION OF CONSTRUCTION BIDS

CORPS OF ENGINEERS (CIVIL FUNCTIONS)
DEPARTMENT OF THE ARMY

BY
THE COMPTROLLER GENERAL
OF THE UNITED STATES

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

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To the President of the Senate and the
Speaker of the House of Representatives

The accompanying report presents our review of the policies and procedures of the Army Corps of Engineers (Civil Functions) for reviewing quantity estimates prepared by independent architect-engineers for use in the solicitation of bids for construction contracts.

Although the importance of accuracy in estimating quantities is stressed in the Corps' regulations, the Chief of Engineers had not, at the time of our review, established Corps-wide procedures for the review of work performed by architect-engineers. The division and district offices we visited had issued, in varying degrees, written instructions for such reviews, but they had not issued instructions concerning the reviews to be made of quantity estimates. Nor had the Office of the Chief of Engineers made a review to determine how well the field offices had implemented the delegation of responsibility for the review of architect-engineers' work.

We believe that, regardless of the absence of specific instructions from the Office of the Chief of Engineers, the division and district offices, in carrying out their responsibilities, should have made adequate reviews of the quantity estimates.

In one district we found that adequate reviews were not being made of the estimates of expected quantities of excavation, embankment, or available construction materials prepared by independent architect-engineer firms. Consequently, the Corps was unaware that the quantity estimate by an architect-engineer, used in the solicitation of bids for the Summersville dam, dikes, and spillway at Summersville, West Virginia,

--was prepared on the basis of interpretations of geological and engineering data that were inconsistent with interpretations previously made by the Corps, and

--included errors in the calculation of estimated quantities.

We found that the contract price of $15.4 million for the construction of the Summersville dam, dikes, and spillway was substantially increased primarily because the quantity estimate prepared by an architect-engineer firm was inaccurate and did not show the full scope and magnitude of the work to be performed.

As a result, the Corps increased the contract price by $8.2 million through negotiation, rather than through competitive bidding, and thereby lost the benefits normally attained through formal advertising.

We estimate that about $5.3 million of this increase in costs could have been subjected to competitive bidding. This portion of the increase was directly associated with increased work which could have been foreseen prior to contract award. An adequate review of the quantity estimate, in our opinion, would have disclosed

--a substantial underestimate of the quantity of materials to be excavated for the dam foundation,

--a substantial overestimate of the available rock in designated sources, and

--the need to locate additional sources of rock.

In addition to the loss of the benefit of full and free competition from procurement through formal advertising, costs of about $348,500 were incurred which could have been avoided. These costs consisted of about $276,000 for equipment which was idle because it could not be used for some of the additional work and about $72,500 for additional administrative expenses.

We found no evidence, during our review of the negotiation of the contract modifications, that the contractor had realized an unreasonable profit on the entire contract as a result of the contract modifications. It is not possible, however, to establish whether the total contract costs were as low as they would have been if the entire work had been contracted for on the basis of formal advertising.

In order to minimize the necessity for negotiated contract modifications, we proposed that the Chief of Engineers issue guidelines requiring the districts to review the work of architect-engineers. Such a review should include

--verifying the accuracy of the calculations on a selective basis, and

--reviewing the bases for the calculations and reconciling differences in interpretation of geological and engineering data.

We further proposed that a statement of the nature and extent of the review be made a part of the official files.

The Department of the Army concurred in our report, in general, and advised us that the Chief of Engineers was preparing instructions to the field offices in accordance with our proposals. These instructions were issued on February 17, 1967, and, if effectively implemented, they should reduce the necessity for negotiated contract modifications.

We are reporting this matter to the Congress because of its continuing concern about procurement through negotiated contracts and to illustrate that the inherent advantages of procurement through formal advertising may be lost through substantial negotiated changes.

Copies of this report are being sent to the Director, Bureau of the Budget; the Secretary of Defense; and the Secretary of the Army.

Comptroller General
of the United States

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INTRODUCTION

The General Accounting Office has reviewed the contract for the construction of the dam, dikes, and spillway at the Summersville Reservoir Project, Gauley River, West Virginia, administered by the Huntington District, Ohio River Division, Corps of Engineers (Civil Functions), Department of the Army. We also reviewed the designs, plans, specifications, and quantity estimate prepared by an architect-engineer for the dam, dikes, and spillway. Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Because we noted that the price of $15.4 million for the advertised construction contract was increased by about $8.2 million for additional work through negotiations with the contractor and that the cost of the additional work was not subject to the benefits afforded by formal advertising, we initiated a review primarily directed toward determining whether the Corps should have recognized the need for the additional work before the construction contract was awarded and should have provided for the work in the contract.

After we had obtained sufficient information to determine the cause of the large increase in the contract price, we directed our examination to the review of quantity estimates prepared by architect-engineers, which appeared to warrant particular

attention, and we did not attempt to evaluate the Corps' procedures for the preparation of plans and specifications or the overall administration of the contract. Our review was conducted at the Corps' Huntington District Office in Huntington, West Virginia; the Ohio River Division Office in Cincinnati, Ohio; and the Office of the Chief of Engineers in Washington, D.C. We examined applicable design memorandums, contract drawings and specifications, computations of estimated quantities, records of negotiations, and findings of fact supporting the contract modifications. We also held discussions with appropriate officials of the Corps and an architect-engineer firm. In addition, we obtained information on certain review procedures in four other districts and two other division offices.

The principal officials of the Department of Defense responsible for the administration of activities discussed in this report are listed in appendix I.

BACKGROUND

The Summersville Reservoir Project was authorized by the Flood Control Act of 1938 (43 U.S.C. 390) as an integral unit in the comprehensive flood control plan for the Ohio River Basin. The project is located on the Gauley River about 40 miles east of Charleston, West Virginia. Construction, which was initiated in 1960 when work began on the diversion tunnel, was completed in 1966 at a cost of about $47.2 million.

The dam, dikes, and spillway cost about $23.6 million. The remaining costs of about $23.6 million are primarily for the outlet works (tunnel and control valves), relocations, land and damages, recreation facilities, engineering and design, and supervision and administration. The dam rises 365 feet above the stream bed and is 2,280 feet long. Basically, the dam is composed of a rock-fill embankment which provides mass and stability and an impervious core of compacted silt and clay soils which prevents water seepage through the dam. The project includes two dikes, one 2,025 feet long and the other 3,300 feet long, located about 1 mile west of the dam where the existing contour of the rim of the reservoir is lower than the top elevation of the dam. The spillway is located about a half mile west of the dam in a natural depression in the rim of the reservoir.

Preliminary surveys and investigations of the Summersville project were performed by the Huntington District, and a series of design memorandums were issued. These included a general design memorandum and feature design memorandums on such subjects as feasibility of the project, site locations, and geological and soil conditions, and they served as a basis for various technical and administrative approvals of the project and for preparation of the design and specifications.

Because the District did not have the capacity to do the work, in March 1958 a contract for architect-engineer services was negotiated pursuant to Corps policy which permits the use of private architect-engineers when excessive workload or other factors make it impractical to accomplish the work within the Corps' organization. The Corps paid $227,760 for these services which included preparation of the designs of access roads, a diversion tunnel, a dam, dikes, and spillway. The contract also required the architect-engineer to prepare detailed design drawings, plans, specifications, and quantity estimates for each construction feature to serve as a basis for the solicitation of bids for construction. The detailed plans, specifications, and quantity estimate prepared by the architect-engineer were approved by the Huntington District Engineer in April 1961.

When engineering and design services are to be performed by a private architect-engineer firm, the Chief of Engineers has assigned to the district engineers full responsibility for specifying standards and criteria for the investigations and design and for technical control and review of such work.

Construction contracts are generally awarded by the Corps through formal advertising procedures. Bid schedules are prepared to show the major construction features, and bids are solicited for some construction features on a lump-sum basis while, for other construction features where actual quantities are expected to vary from estimates, bids are solicited on a unit-price basis. The contract for construction of the Summersville dam, dikes, and spillway provided for negotiation of revised unit prices when the actual quantity of a construction item was more than 115 percent or less than 87 percent of the estimated quantity, or when conditions

changed. We were advised by an official of the Office of the Chief of Engineers that these percentages represent the normal variance of actual quantities from estimated quantities.

The invitation for bids on the contract for the construction of the dam, dikes, and spillway of the Summersville Reservoir Project was issued on April 10, 1961. The bids were opened on May 16, 1961, and a contract, with an estimated price of $15,372,993, was entered into on May 23, 1961. Subsequently, the contract price was increased by an estimated $8,604,193 primarily to provide for increases in the quantities of materials. Construction is essentially complete, and the dam, dikes, and spillway were accepted for beneficial occupancy by the Corps on March 16, 1966. The final contract amount was $23,551,034--an increase of $8,178,041 over the original contract price.

FINDING

NEED FOR PROCEDURES FOR THE REVIEW OF QUANTITY ESTIMATES

We found that the Office of the Chief of Engineers, and the division and district offices we visited, had not issued written procedures for the review of quantity estimates prepared by architect-engineers. We found that the Huntington District was not making adequate reviews of the estimates of expected quantities of excavation, embankment, or available construction materials prepared by independent architect-engineer firms. Consequently, the Corps was unaware that the quantity estimate prepared by an architect-engineer to be used in the solicitation of bids for construction of the Summersville dam, dikes, and spillway (1) was prepared on the basis of interpretations of geological and engineering data that were inconsistent with interpretations previously made by the Corps and (2) included errors in the calculation of the estimated quantities.

We found that the contract price of $15.4 million for the construction of the Summersville dam, dikes, and spillway was increased by about $8.2 million by negotiation primarily because the quantity estimate was inaccurate and did not show the full scope and magnitude of the work to be performed. As a result, the Corps could not avail itself of the benefits normally attained through formal advertising procedures for the contract, as revised.

We estimate that about $5.3 million of this increase in costs could have been subjected to competitive bidding. This portion of the increase was directly associated with increased work which could have been foreseen prior to contract award. An adequate review, in our opinion, would have disclosed (1) a substantial underestimate of the quantity of materials to be excavated for the

dam foundation, (2) a substantial overestimate of the available rock in designated sources, and (3) the need to locate additional sources of rock.

In addition to the loss of the benefit of full and free competition from procurement through formal advertising, costs of about $348,500 were incurred which could have been avoided. These costs consisted of about $276,000 for equipment which was idle because it could not be used for some of the additional work and about $72,500 for additional administrative expenses.

The construction contract was awarded through formal competitive bidding procedures pursuant to the requirements of section 2(c) of the Armed Services Procurement Act, 1947 (10 U.S.C. 2304(a)). In 1955 the Subcommittee for Special Investigations of the Committee on Armed Services, House of Representatives, in a report on the implementation of this section of the act, stated:

> "Free, open, competitive advertised procurement is the tradition of the American Government. It is founded on experience; it is based upon the proposition that the widest distribution will produce the most satisfactory results, both as to price and as to performance. The use of negotiation is in derrogation [SIC] of that method."

The importance of accuracy in estimating quantities is stressed in the Corps' regulations which state:

> "The matter of bid quantities is extremely important. Every effort should be made to estimate the correct number of units for each bid item, for only in this manner can a contractor make an accurate evaluation of the project, which in turn results in a bid which is in the best interest of the Government."

However, the Chief of Engineers had not established Corps-wide procedures for the review of work performed by architect-engineers. The division and district offices we visited had

issued, in varying degrees, written instructions for the review of plans and specifications, but not for the review of quantity estimates.

The Office of the Chief of Engineers had not made a review to determine how well the field offices had implemented the delegation of responsibility for the review of architect-engineers' work. We believe, however, that, regardless of the absence of specific instructions from the Office of the Chief of Engineers, the division and the district offices, in carrying out their responsibilities, should have made adequate reviews of the quantity estimates.

We found that, when estimated quantities for a project were computed by the Huntington District, the amounts were independently verified in the District office and the bases for the computations were reviewed at various supervisory levels in that office. However, computations of estimated quantities prepared by architect-engineers were normally accepted by the Huntington District as submitted and only a limited review was made of the basis, reasonableness, or accuracy of the computations.

We believe that the establishment of Corps-wide procedures for the review of work performed by architect-engineers would minimize the chances of a recurrence of a situation similar to that described in this report.

We found no evidence that the contractor had realized an unreasonable profit on the entire contract as a result of the contract modifications. It is not possible, however, to establish whether the total contract costs were as low as they would have been if the entire work had been contracted for on the basis of formal advertising.

The following schedule summarizes, for certain items, the quantity estimates used in the invitation for bids and the actual

quantities required, and it shows the portions of the differences which we believe could have been detected before the invitation for bids was issued if the estimate had been adequately reviewed by the District. Also shown are the costs to the Government (based on contract prices) which could have been subjected to competitive bidding because they were directly associated with the work which could have been foreseen. The differences are discussed in succeeding sections of this report.

	Foundation excavation	Rock in designated quarries available for construction
	(in millions of cubic yards)	
Estimated quantity	1.038	8.082
Actual quantity	2.778	6.269
Under (over) estimate	1.740	(1.813)
Variation	168%	(22%)
Increased work which could have been foreseen prior to contract award	1.100	(1.762)
Variation	106%	(22%)
Cost of increased work which could have been subjected to competitive bidding	$1,828,000	$3,506,000
	$5,334,000	

Underestimate of quantities to be excavated for the foundation of the dam

On the basis of our review we concluded that, if the Huntington District had adequately reviewed the architect-engineer's quantity estimate prior to issuing the invitation for bids, the District would have known that the estimate of 1 million cubic yards of material to be excavated for the dam foundation was understated by about 1.1 million cubic yards.

We were informed by Huntington District officials that the architect-engineer's work was reviewed to a limited extent. We were informed, also, that the plans and specifications were reviewed for compliance with the Corps' engineering criteria and requirements and that the quantity estimates were reviewed for general reasonableness of total quantities. However, a review was not made of the bases for the computation of quantities or of the accuracy of the estimates.

In September 1962, after the contractor had begun excavating for the foundation of the dam, it became apparent to the Huntington District that the actual quantity of excavation would exceed the estimated quantity by a substantial amount. In order to determine the magnitude of the overrun, the Huntington District prepared an estimate using the same data that were available to the architect-engineer and found that an overrun of about 1.1 million cubic yards could be expected. The actual overrun in excavation was about 1.74 million cubic yards. The negotiated increase to the contract price for the additional excavation work totaled about $3,828,000. This amount includes about $1,828,000 for the excavation of about 1.1 million cubic yards which the District could have foreseen if the quantity estimate had been adequately reviewed before the award of the contract for construction of the dam.

Neither the Huntington District's estimate, which disclosed that an overrun of about 1.1 million cubic yards could be expected, nor our review fully disclosed the reasons for the entire 1.74 million cubic yard overrun. However, the higher actual overrun was due in part to a field decision, made subsequent to the Huntington District's analysis, to widen and deepen the trench, which increased the required excavation by about 300,600 cubic yards.

We compared the estimate prepared by the architect-engineer with the estimate prepared by the Huntington District, but we were unable to fully ascertain the reasons for the differences between the two estimates because of the differing methods used in preparing them.

For the portions of the two estimates which we could compare, we found that a mistake by the architect-engineer in the dimensions of the area to be excavated for the dam foundation caused the estimate to be understated by about 424,000 cubic yards. The architect-engineer's computations for a part of the material to be removed were based on a dam with a base width of 1,000 feet. The dam, as designed for the specific sections involved, is about 1,750 feet wide at its widest point and over 1,000 feet wide at its narrowest point. The use of the wrong width of the dam resulted in an underestimate of at least 380,000 cubic yards. The architect-engineer could not explain why the base width of 1,000 feet had been used. Also, in computing the amount of excavation in a trench beneath the center of the dam, the architect-engineer used incorrect slopes and widths, thereby underestimating the amount of excavation for this trench by at least 44,000 cubic yards. The architect-engineer could not explain the use of incorrect slopes and widths.

The increase of 1.1 million cubic yards in the quantity of materials to be excavated for the foundation of the dam, as estimated by the Huntington District and discussed above, would normally be expected to cause a corresponding increase in the embankment required. We were told by a Huntington District official that, after encountering the large overrun in excavation, the Huntington District reviewed the architect-engineer's estimate of materials required for the embankment of the dam and found that the amount computed by the architect-engineer--10,814,000 cubic yards--was within reasonable limits. We were advised by the Huntington District officials that the only apparent explanation for the underestimate in excavation without a corresponding underestimate of embankment was that the architect-engineer used a greater depth in computing embankment than in computing excavation quantities. The architect-engineer offered no explanation.

Overestimate of available rock

On the basis of our examination we believe that, if the computation and bases for the architect-engineer's estimate of 8.082 million cubic yards of rock available for construction from the designated quarry areas had been adequately reviewed by the Huntington District, such a review would have shown that the architect-engineer's estimate was overstated by about 1.762 million cubic yards and that there was a need to locate an additional source of rock.

The actual deficiency in the designated sources was about 1.813 million cubic yards and the requirements for rock were increased, so that about 2.5 million cubic yards of rock had to be obtained from a new source.

The Huntington District negotiated an increase of $3,646,000 in the contract price for the additional work of obtaining about 2.5 million cubic yards of rock from the new source rather than from the original designated source. We estimate that about $3,506,000 of this increase could have been subjected to competitive bidding if the architect-engineer's estimate had been adequately reviewed and the new source of rock had been designated in the invitation for bids.

In December 1961, about 6 months after the start of construction, the contractor proposed development of a new quarry to obtain about 3.3 million cubic yards of rock. Following receipt of this proposal, the Huntington District undertook a supplementary drilling program to establish whether a sufficient quantity of suitable material was available in quarry number 1.

Because the results of this drilling program indicated that sufficient suitable material was not available, the Huntington

District initiated negotiations with the contractor for the development of an alternate quarry. When agreement on the terms and conditions of a contract modification could not be reached, the Huntington District, as provided for in the contract, unilaterally directed the contractor to develop the additional source of rock. Huntington District personnel estimated that the additional source yielded about 2.5 million cubic yards of rock which was used in constructing the dam.

The following tabulation shows the source and estimated quantities of available rock as computed by the architect-engineer and the shortages which we believe could reasonably have been anticipated if the estimate prepared by the architect-engineer had been adequately reviewed.

Source	Estimated quantity	Shortage which could have been anticipated
	(cubic yards)	
Quarry number 1	6,316,000	1,403,700
Quarry number 2	970,000	263,300
Core trench excavation	16,900	-
Riverbed excavation	163,000	49,000
Spillway excavation	570,000	-
Tunnel excavation	45,800	45,800
Total	8,081,700	1,761,800

Quarry number 1--Both the design criteria furnished by the Huntington District to the architect-engineer and the design memorandum on the design of the dam, dikes, and spillway prepared by the architect-engineer provided for the use of fresh rock in the construction of the dam and dikes. At a conference in January 1960, between representatives of the Corps and the

architect-engineer, fresh rock was defined as "*** rock formation(s) free from fracture and having tight bedding planes with no weathering between beds and only slight oxidization along joints."

The design memorandum on geology and soils dated November 1959, prepared by the Huntington District and available to the architect-engineer during the preparation of his estimate, stated that the upper 10 to 12 feet of rock in quarry number 1 was weathered and easily crumbled. The report of tests conducted by the Ohio River Division Laboratories, dated February 1959 and included in the November 1959 design memorandum, showed that the upper 13 feet of rock was weathered and poorly cemented.

During our review we found that the architect-engineer's estimate of the quantity of fresh rock available in quarry number 1 was based on a depth of weathering of only 4 feet. The difference in the average depth of weathering of about 10.4 feet as shown in the data available to the architect-engineer and the depth of weathering actually used by the architect-engineer in preparing the estimate resulted in an overestimate of about 1.4 million cubic yards of available rock.

The architect-engineer advised that he did not have sufficient information available to explain the reasons for using an average depth of weathering of 4 feet when he had been furnished data which indicated that weathering had progressed to a much greater depth.

We believe that, if the Huntington District had adequately reviewed the quantity estimate, it would have found that the architect-engineer based his estimate on a depth of weathering that varied substantially from the Huntington District's prior determination and that the rock did not meet the criteria of fresh rock as defined by the Huntington District.

Quarry number 2--We believe that, if the Huntington District had adequately reviewed the geological information used in the architect-engineer's computation of materials available from quarry number 2, it would have concluded that additional geological investigation was necessary to make a reliable estimate of the quantity of available rock. We believe that, if the additional geological investigation had been performed, the estimate of available rock in quarry number 2 would have been reduced by about 263,300 cubic yards as discussed below.

The Corps' regulations, as noted above, state that every effort should be made to estimate the correct number of units for each bid item. Since geological investigations serve as a basis for the quantity estimate of available rock, we believe that the geological investigations should be adequate to develop the location and amounts of suitable construction materials within reasonable limits of accuracy. The Corps' Engineer Manuals state that a common method of obtaining information on subsurface conditions involves the drilling and recovery of cores or samples of the material.

Huntington District geologists stated that a minimum of three cores which penetrate the same identifiable layer of rock (termed as a "key bedding plane") are necessary to determine the thickness of the rock and the angle and direction that the strata of rock is inclined from the horizontal. They stated that they considered this information to be essential in computing estimated quantities of rock in quarries.

In quarry number 2, the architect-engineer considered only two cores in arriving at the estimated quantity of rock fill, although another core from just outside the quarry boundary was available, which was used in the architect-engineer's computations of other materials available from this area.

At our request, Huntington District geologists inspected the graphic presentation of the three cores to determine whether the use of this information would result in the computation of a quantity different from that developed from the use of two cores. The geologists concluded that information from the three cores was insufficient to estimate, within acceptable limits, the quantity of rock in quarry number 2 and that the need for additional cores was evident. However, regardless of the number of cores used, the Huntington District geologists' conclusion was based primarily on the absence of a key bedding plane in the three available cores.

The architect-engineer was responsible for the adequacy of the subsurface investigation, but the records do not disclose that further subsurface exploration was considered. On the basis of the difference between the depth of rock considered in the architect-engineer's computation and the depth established by the Huntington District from additional cores obtained after award of the contract, we believe that the estimate of available rock would have been reduced by about 263,300 cubic yards if the Huntington District had adequately reviewed the basis for the architect-engineer's estimate and had required the additional geological investigation before issuing the invitation for bids, instead of after the shortage was found during construction.

Rock available from tunnel and riverbed excavation--During our review of the computation of quantities of available rock, we found that 45,800 cubic yards anticipated from excavation of the tunnel and 49,000 cubic yards anticipated from excavation of the riverbed should not have been included in the estimated quantities. Notes on the architect-engineer's computations of quantities, furnished to the Corps and included as an appendix to a design memorandum,

stated that it would be impractical to separate the sandstone from the shale expected to be excavated in the tunnel. However, the 45,800 cubic yards of sandstone were erroneously included in the estimate of available rock.

Although the Huntington District, before advertising for bids, estimated that 30 percent or 49,000 cubic yards of the 163,000 cubic yards of material in the riverbed could not be used as rock fill, the entire amount was included in the estimate of available rock computed by the architect-engineer, and its inclusion was not detected because the Huntington District did not adequately review the quantity estimate.

Idle equipment--We believe that, if the Huntington District had found the overstatement of available rock (by adequately reviewing the quantity estimate) and had located the additional source of rock and disclosed its location to the prospective bidders, costs of about $276,000 for idle equipment could have been avoided.

Quarry number 1, which was to supply most of the rock fill for the dam, was located at an elevation higher than that of the dam. The contractor acquired light equipment to haul the rock because it would be going downhill when loaded and would not need as much power as for an uphill haul. When it became evident that a new source of rock was needed, a new quarry was designated which was located below the elevation of the dam. This required an uphill haul and the light equipment did not have the power to make the uphill haul with sufficient load to make it worthwhile. The contractor was forced to leave this equipment idle while heavier equipment, subsequently acquired, was used to haul rock from the new quarry.

The modifications to the contract provided for a lump-sum payment of about $276,000 for the idle time of the light equipment. If the need for the new quarry had been known and its location disclosed in the invitation for bids, the bidders would have been put on notice of the need for heavier equipment.

Other administrative and engineering costs

After the Huntington District had determined that the actual excavation quantities would substantially exceed the estimated quantities and after the shortage of rock in the designated sources became known, the resident engineer maintained detailed records on equipment, labor hours, and materials used by the contractor. The records were used in negotiating the prices of the additional work. Huntington District office personnel advised us that administrative and other costs for the additional recordkeeping and for settling the contractor's claims totaled about $46,500. In addition, the Huntington District contracted with an engineering firm, at a cost of $26,000 to prepare an independent estimate of the total cost of construction of the dam, dikes, and spillway under the revised conditions, for use in evaluating the contractor's claims and as an aid in negotiating the pricing of the modifications to the contract.

Review of negotiation of increased contract costs

We reviewed the data the District used in negotiating the price of the additional work and other data bearing on the costs incurred under the contract. These data included (1) detailed records, which the District had maintained, of the equipment, labor hours, and materials used by the contractor, (2) a statement of the contractor's costs, prepared by a certified public accountant and submitted by the contractor, (3) an independent estimate, prepared by an engineer firm, of the cost of the work under the revised conditions, and other related data. We found no evidence that the contractor had realized an unreasonable profit on the entire contract, including the contract modifications.

It is not possible, however, to establish whether the total contract costs, that is, the amount of the competitively awarded

contract plus the negotiated prices for the various contract modifications, were as low as they would have been if the entire work had been contracted for on the basis of formal advertising.

The Department of the Army, in a letter to us dated January 16, 1967 (see app. II), commenting on the matters discussed in a draft of this report, stated:

> "Discussion
>
> a. Lack of competitive bidding on work added to the contract by negotiation. It is not possible at this time to determine what the low bid for this work would have been if more correct quantity estimates in the Invitation for Bids had given the Government the advantage of competitive bidding on all the work subsequently performed. However, the conclusion in the [draft] Report that the contractor had not realized an unreasonable profit on the entire contract and other evidence cited in the [draft] Report strongly indicated that the work was performed at about the lowest unit prices that could be expected. Therefore, it may be assumed that there was no significant added cost to the Government through lack of competition on the negotiated work."

In this connection, the Department of the Army reasons that, since the contractor did not realize an unreasonable profit on the entire contract, it may therefore be assumed that there was no significant added cost to the Government through lack of competition on the negotiated work. We do not believe this is a valid assumption. The contract price which would have resulted from bidding for the total work under formal advertising procedures is not known and can never be known. It is known, however, that additional costs of about $348,500 were incurred because of the erroneous estimates. (See pp. 18 and 20 of the report.) Also, it is possible that this contractor and other bidders may have found ways to

reduce their bids, which would have resulted in a lower price to the Government, if they had known the full scope of the contract, including the additional work, at the time of bidding.

We believe it pertinent to point out that the negotiation with a contractor of change-order costs for work not provided for in a competitively awarded contract takes place in a sole-source environment and that the negotiation, even when based on price analyses, provides no assurance that the negotiated costs are not greater than they would have been if the change-order work had been provided for in the competitively awarded contract. When the challenge and stimulus of competition are lacking, a contractor's estimate of his probable costs may not reflect the most economical performance of which he is capable. Furthermore, the contractor is in a very strong bargaining position and he may have special reasons to press his advantage. The contract work may not have proceeded as planned, or he may have bid low to win the contract hoping to recoup his costs and to profit on changes.

Discussion with the architect-engineer

We met with representatives of the architect-engineer firm and informed them that our review of Corps' records had raised questions concerning the bases for the quantity estimate used to solicit bids which we had been unable to resolve in our review of the Corps' records. We presented some 25 specific questions concerning these matters, which included such questions as (1) why a 1,000-foot base width of the dam was used when computing excavation quantities, (2) why weathering to a depth of 4 feet in quarry number 1 was used in estimating the amount of available rock, when the information supplied by the Huntington District stated that weathering had progressed to an average of 10 to 12 feet, and (3) did they

consider the geological investigations in quarry number 2 adequate, and, if not, why did they not ask the Huntington District for additional investigations?

In a subsequent meeting the representatives of the architect-engineer firm advised us that they would prefer not to comment on the questions because they were unable to locate documentation of the bases for the assumptions and computations we had asked about.

They said that the information necessary to answer our questions should have been a matter of record but that evidently they had failed to document their files as fully as their standards require. However, they stated that their review of the available records raised essentially the same questions as we had raised.

Review instructions and practices

For those cases in which architect-engineers are engaged for engineering and design services, the Chief of Engineers has delegated to the district engineers full responsibility for specifying standards and criteria for the investigations and design and for the technical control and review of such work. However, at the time of our review, no written instructions had been issued by the Office of the Chief of Engineers prescribing guidelines for the nature or extent of such reviews.

After we established that the Huntington District had made an inadequate review of the quantity estimate prepared by the architect-engineer, we examined into the instructions and practices of other districts and divisions. Our examination included the Ohio River Division and its Pittsburgh District, the Southwestern Division and its Fort Worth and Tulsa Districts, and the North Pacific Division and its Seattle District.

The Ohio River, the Southwestern, and the North Pacific Divisions had not issued written procedures for the nature or extent of the reviews to be made by the districts of quantity estimates prepared by architect-engineers. Officials in these divisions advised us that they did not make a review of the detail or test the accuracy of the quantity estimates on the premise that the district offices have competent personnel making quantity estimates and have procedures requiring independent verification of the quantity estimates before submission to the divisions.

The five districts had not issued written procedures for the nature and extent of the reviews to be made of quantity estimates. We were advised that quantity estimates prepared by district personnel were independently reviewed and were verified for mathematical accuracy and that quantity estimates prepared by architect-engineers were reviewed on a test basis. We examined selected projects and found no evidence of a systematic approach to the review, and the nature and extent of the reviews were not documented nor indicated in the files. We did note some correspondence with the architect-engineers requesting that certain changes be made in the quantity estimates. Also, we were advised that the quantity estimates prepared by district personnel were subject to a closer review and evaluation than those prepared by architect-engineers.

Proposals and agency comments

We have found that contracting for work on the basis of formal advertising generally results in benefits to the Government. To secure the fullest possible benefits from such contracting and to reduce the necessity for negotiated contract modifications, the invitation for bids for a contract should specify, to the maximum

extent practicable, all the work to be performed under the contract. We therefore proposed that the Chief of Engineers have a study made of the implementation by division and district engineers of the delegation of responsibility for the review of work performed by architect-engineers and that specific procedures be issued requiring the districts to review quantity estimates prepared by architect-engineers. We believe that such a review should include (1) reviewing the bases for the calculations and reconciling any differences in the interpretations of geological and engineering data and (2) verifying the accuracy of the calculations on a selective basis.

We proposed further that the procedures require that a statement of the nature and extent of the reviews be made a part of the official files and require that district engineers, in transmitting the plans, specifications, and/or cost estimates to division engineers for approval, specifically state that the required reviews have been made.

The Department of the Army, in a letter to us dated January 16, 1967 (see app. II), in commenting on a draft of this report, concurred, in general, in our findings and advised us that the Chief of Engineers was preparing instructions to the field substantially in accordance with our proposals. These instructions were issued on February 17, 1967, and, if effectively implemented, should reduce the necessity for negotiated contract modifications.

The draft of this report was also submitted for comment to the architect-engineer firm and to the contractor. They advised us that they could make no constructive or meaningful comments because of the loss of knowledgeable personnel or the lack of information in their files.

APPENDIXES

PRINCIPAL OFFICIALS OF THE DEPARTMENT OF DEFENSE AND THE DEPARTMENT OF THE ARMY RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
DEPARTMENT OF DEFENSE		
SECRETARY OF DEFENSE:		
Robert S. McNamara	Jan. 1961	Present
Thomas S. Gates, Jr.	Dec. 1959	Jan. 1961
Neil H. McElroy	Oct. 1957	Dec. 1959
DEPARTMENT OF THE ARMY		
SECRETARY OF THE ARMY:		
Stanley R. Resor	July 1965	Present
Stephen Ailes	Jan. 1964	July 1965
Cyrus R. Vance	July 1962	Jan. 1964
Elvis J. Stahr, Jr.	Jan. 1961	June 1962
Wilber M. Brucker	July 1955	Jan. 1961
CHIEF OF ENGINEERS:		
Lt. Gen. William F. Cassidy	July 1965	Present
Lt. Gen. Walter K. Wilson, Jr.	May 1961	June 1965
Lt. Gen. Emerson C. Itchner	Oct. 1956	May 1961
DIVISION ENGINEER, OHIO RIVER DIVISION:		
Brig. Gen. Willard Roper	Oct. 1966	Present
Col. John C. H. Lee (acting)	June 1966	Oct. 1966
Brig. Gen. Walter P. Leber	Apr. 1963	June 1966
Brig. Gen. Jackson Graham	Feb. 1961	Feb. 1963
Col. Chester L. Landaker (acting)	Nov. 1960	Feb. 1961
Brig. Gen. William W. Lapsley	Aug. 1958	Nov. 1960
Col. Rudolph E. Smyser, Jr.	Aug. 1956	July 1958

PRINCIPAL OFFICIALS OF THE DEPARTMENT OF DEFENSE

AND THE DEPARTMENT OF THE ARMY

RESPONSIBLE FOR

ADMINISTRATION OF ACTIVITIES

DISCUSSED IN THIS REPORT (continued)

	Tenure of office	
	From	To
DEPARTMENT OF THE ARMY (continued)		
DISTRICT ENGINEER, HUNTINGTON DISTRICT:		
Col. William D. Falck	July 1965	Present
Col. Harrington W. Cockran, Jr.	Aug. 1962	July 1965
Col. Steven Malevich	Aug. 1959	Aug. 1962
Col. Herrol J. Skidmore	May 1956	Aug. 1959
Col. George T. Derby	June 1953	Apr. 1956

DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 20310

16 JAN 1967

Mr. J. T. Hall, Jr.
Assistant Director
Civil Accounting and Auditing Division
United States General Accounting Office

Dear Mr. Hall:

This is in reference to your letter of 7 November 1966, forwarding five copies of your proposed report to the Congress entitled, "Need for Improvement in the Review of Quantity Estimates Used in the Award of Construction Contracts, Corps of Engineers (Civil Functions), Department of the Army."

The above mentioned report has been reviewed and attached is a statement of the comments of the Department of the Army. Inasmuch, as indicated therein, the Chief of Engineers has initiated action in response to your proposed recommendations, you may wish to consider revising them in finalizing your report.

The opportunity of commenting on your draft report is appreciated.

Sincerely yours,

Alfred B. Fitt

Alfred B. Fitt
Special Assistant (Civil Functions)

Incl
Comment of
the D/A

REPORT TO THE CONGRESS OF THE UNITED STATES
"NEED FOR IMPROVEMENT IN THE REVIEW OF
QUANTITY ESTIMATES USED IN THE AWARD
OF CONSTRUCTION CONTRACTS"
CORPS OF ENGINEERS (CIVIL FUNCTIONS)
DEPARTMENT OF THE ARMY

Comments of the Department of the Army in
Connection With Subject Report

Analysis of GAO Report

The draft report of the General Accounting Office (hereinafter referred to as the Report) discloses four principal findings or contentions relating to the contract for construction of the dam, dikes and spillway of the Summersville Reservoir Project, Gauley River, West Virginia, under the supervision of the District Engineer, U. S. Army Engineer District, Huntington, Corps of Engineers, Department of the Army. Although not explicitly set forth in such manner in the Report, these findings may be stated briefly as follows:

Finding No. 1: That a private architect-engineer firm, retained by the Huntington District to complete designs and prepare plans, specifications and quantity estimates for the project, underestimated the quantity of material to be excavated from the dam foundation by about 1.1 million cubic yards, which resulted in a negotiated increase in contract price of about $1,828,000 after construction was underway.

Finding No. 2: That the architect-engineer firm overestimated the quantity of acceptable sandstone that would be available for the construction of embankments for the dam and two dikes from the two quarry areas designated in the Invitation for Bids for the construction contract by about 1.759 million cubic yards, which resulted in a negotiated increase of about $3,506,000 in the contract price after construction started. $276,000 of this increase was caused by the need to develop a new (third) quarry site after construction was underway to obtain sufficient suitable material and represents a lump sum payment for plant rental on contractor's idle equipment mobilized for work in the two quarry sites originally designated, but which was not suitable for use with the new quarry site.

Finding No. 3: That the Huntington District did not check the architect-engineer quantity estimates, that such checking should have revealed the errors described in Findings 1 and 2 above, and that the Corps of Engineers has not issued instructions requiring checking of such estimates.

Finding No. 4:

[see GAO note]

As a corollary to the above Findings, the Report asserts that a principal effect of the items discussed in the Findings was to deprive the Government of the advantages of competitive bidding on approximately $6,000,000 worth of construction which was accomplished under negotiated contract modifications. (It should be understood that this work, accomplished under the negotiated contract changes, represented work required to construct the project as originally designed and the total costs involved do not represent losses to the Government). The Report concludes that the contractor did not realize an unreasonable profit on the revised contract and that it is not possible to determine what the lowest responsible bid might have been if the Invitation for Bids had more closely reflected the scope of the work actually required.

GAO Report Recommendations

The Report makes two recommendations to the Chief of Engineers based upon the above findings:

a. That the Chief of Engineers issue instructions setting forth specific procedures requiring Districts to review quantity estimates prepared by architect-engineers.

b. That the Chief of Engineers re-emphasize the need for accuracy in preparing quantity estimates and the need for a final determination, before issuance of Invitations for Bids, that all significant changes have been included in the estimates.

Results of Department of Army Review

Except for the prediction of the consequences of XXX
[see GAO note]
XXX (Finding No. 4), the Department of the Army generally concurs in the findings of the Report.

GAO note: Material deleted from the letter was concerned with matters included in the report draft which are not included in the final report.

Specifically, we concur that:

a. The architect-engineer underestimated the amount of excavation required for the dam foundation.

b. The architect-engineer overestimated the quantity of suitable rockfill material available in the two designated quarry areas.

c. The Huntington District did not detect the mistakes of the architect-engineer listed above and as a result of these errors in the quantity estimates, it became necessary to negotiate major contract modifications after construction was underway.

d. The Corps of Engineers has not issued specific instructions regarding checking quantity estimates prepared by architect-engineers and that such instructions should be issued.

e. As a general policy, the bid documents issued with the Invitation for Bids should contain the latest information available, including up-to-date quantity estimates.

[see GAO note]

Discussion

a. Lack of competitive bidding on work added to the contract by negotiation. It is not possible at this time to determine what the low bid for this work would have been if more correct quantity estimates in the Invitation for Bids had given the Government the advantage of competitive bidding on all the work subsequently performed. However, the conclusion in the Report that the contractor had not realized an unreasonable profit on the entire contract and other evidence cited in the Report strongly indicated that the work was performed at about the lowest unit prices that could be expected. Therefore, it may be assumed that there was no significant added cost to the Government through lack of competition on the negotiated work.

b. Added cost to the Government through failure to detect the architect-engineer's mistakes. Because of other changes in quantities of materials necessitated by changed subsurface conditions discovered after work was underway (a normal expectation in this type of work), and which also caused negotiated changes in the contract, it is not possible to define accurately the actual extra costs to the Government for additional administrative costs incurred because of the architect-engineer's mistakes in quantity estimates. However, it appears that the total additional costs to the Government were in the order of $300,000, including the amount of $276,000 paid to the contractor as plant rental on idle equipment that could not be used in connection with the new quarry and because of delays occasioned by the need to change project plans after construction was underway.

GAO note: Material deleted from the letter was concerned with matters included in the report draft which are not included in the final report.

c.

[see GAO note]

Summary

The Department of the Army concurs that the Huntington District did not review the quantity estimate prepared by the architect-engineer for Summersville Dam and that mistakes in the estimate eventually resulted in an excess cost to the Government of approximately $300,000 on a total contract of approximately $23,615,000. As stated in the Report, the importance of accuracy in estimating quantities is stressed in the Corps of Engineers regulations and procedures have been established to provide a thorough check on estimates prepared by District personnel. The proposed Report of the General Accounting Office has been useful in pointing out a weakness in the Corps of Engineers operating

GAO note: Material deleted from the letter was concerned with matters included in the report draft which are not included in the final report.

procedure that allowed an architect-engineer's estimate to go unchecked. We concur in the recommendations to the Chief of Engineers contained in the Report. The Chief of Engineers is currently preparing instructions to the field re-emphasizing the importance of good estimates of quantities in Invitations for Bids and establishing procedures for checking architect-engineer quantity estimates. In line with the recommendations of the Report, these instructions will include requirements for (1) reviewing the bases for the calculations and reconciling any differences in the interpretation of any physical or engineering data, (2) verifying the accuracy of calculations on a selective basis, and (3) making the nature, extent and results of the review a part of the official file.