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BY THE U S GENERAL ACCOUNTING OFFICE

**Report To The Administrator,
Environmental Protection Agency**

**Better Procedures Needed For Inspections
At Sewage Treatment Construction Projects**

The Environmental Protection Agency (EPA), which makes grants to municipalities to build sewage treatment plants, oversees these projects by hiring U S Army Corps of Engineers staff to monitor resident inspection activities during construction

GAO believes that the Corps monitoring work needs improvement At the 18 projects GAO evaluated in five States, the Corps reviewers had varying perceptions as to their role, did not always perform enough work to satisfy themselves that the resident inspectors performed their work properly, or did not always report their review results to the grantees States, and EPA Resident inspectors hired by the grantees did not systematically record construction deficiencies, generally involving soil and concrete tests Also, resident inspectors maintained limited records that frequently did not show that needed followup actions were taken GAO recommends several actions to provide for better monitoring reviews and resident inspections



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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, DC 20548

RESOURCES COMMUNITY
AND ECONOMIC DEVELOPMENT
DIVISION

B-207211

The Honorable Anne M. Gorsuch
Administrator, Environmental
Protection Agency

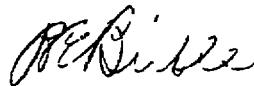
Dear Ms. Gorsuch:

This report summarizes our views on how effectively the U.S. Army Corps of Engineers was performing its monitoring reviews at Environmental Protection Agency (EPA) grantees, and whether resident inspectors were adequately keeping records of construction deficiencies. The report contains recommendations to you on pages 16 and 29.

As you know, 31 U.S.C. §720 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are providing copies of this report to the Corps of Engineers; Chairmen, House Committee on Public Works and Transportation and the Senate Committee on Environment and Public Works; other congressional committees and individual Members of Congress; the Director, Office of Management and Budget; and your Director, Office of Water Program Operations.

Sincerely yours,


for J. Dexter Peach
Director

D I G E S T

Daily monitoring of sewage treatment plant construction, funded by grants from the Environmental Protection Agency (EPA), is the responsibility of full-time resident inspectors. Their job is to assure that construction follows engineering plans and specifications so that the completed treatment facility operates properly and meets water pollution goals. Although grantees employ the resident inspectors and have primary responsibility for monitoring plant construction, EPA provides oversight for the projects.

Since 1978 EPA has used the U.S. Army Corps of Engineers to monitor resident inspection work and perform many other construction management functions. It has paid the Corps about \$76.4 million through fiscal year 1982.

GAO reviewed the construction inspection function because it affords some degree of control over whether the project is built properly so that it can abate or eliminate water pollution. GAO reviewed 18 projects in five States to evaluate (1) how well the Corps was carrying out its inspection monitoring function and (2) the adequacy of the resident inspectors' recordkeeping process to record construction deficiencies.

CORPS OF ENGINEERS REVIEWERS NEED
STANDARD OPERATING PROCEDURES

The EPA/Corps national interagency agreement broadly defines the Corps' construction monitoring responsibility. The Corps provides its onsite reviewers with only general guidance for performing their work. This has resulted in varying perceptions by the Corps reviewers as to what their role is. In some cases the Corps reviews were not detailed enough to ensure that the resident inspectors performed their work properly or the review results were not always reported to the grantees, States, and EPA. Properly performed monitoring reviews would help give EPA assurance that the projects were built

in accordance with approved plans and specifications and that the Federal Government received full value for its investment.

GAO believes that the Corps was performing a necessary and useful monitoring function which helps ensure the integrity of treatment plant construction. However, the Corps' work needs some improvement to become more effective.

Corps reviewers interviewed by GAO perceived their roles differently. On the Alabama and Florida projects, for example, one reviewer said that his role was to ensure that grants were administered in accordance with grant requirements and regulations. He said he did not review actual construction work. Another reviewer said that his role was to ensure that construction work was in accordance with design and specifications, that it was of acceptable quality, and that the Government was getting its money's worth.

The Corps believes that because its reviewers are experienced, they do not need specific operating procedures and guidelines on what they should look at or as criteria for assessing the adequacy of what they find. GAO found cases where reviewers at the construction site did not review the resident inspector's daily reports, or did not review material test results.

A Corps reviewer in California did not notice that one grantee had no records of soil tests and that the log of test results the resident inspector set up at another California site did not show whether retests were in fact made and what the results were. At a site in Illinois, the Corps reviewer had not physically reviewed the concrete test reports but only asked the resident inspector if there were any problems. The resident inspector said that no problems existed, but GAO found that the 7-day concrete test for a roof showed results below standards and that the 28-day test result was missing.

RESIDENT INSPECTORS NEED
RECORDKEEPING GUIDANCE FOR
RECORDING CONSTRUCTION
DEFICIENCIES

Good documentation of the quality of construction work and materials, especially any deficiencies, problems, or disagreements, is very

important on any construction job (1) to preclude deficiencies from going untreated in the event that the resident inspector forgets them or is absent from the construction site and (2) to help resolve disputes. Without adequate resident inspections, projects may be constructed that are not in accordance with the approved plans and specifications and could result in treatment facilities that do not perform as expected.

EPA has issued a general construction inspection guide to all grantees which only suggests that an accurate daily inspection report should be prepared. EPA has not instructed resident inspectors to document day-to-day construction deficiencies or to properly maintain such important records as material test reports, correspondence, or deficiency reports.

Because of the lack of instructions, the resident inspectors at the sites GAO visited generally did not systematically record construction deficiencies. Frequently, when deficiencies were recorded, records did not show that corrective actions were taken. Inspectors relied extensively on their memories to assure that appropriate actions were taken.

At the eight projects reviewed in Florida and Alabama, GAO noted wide disparities in documentation and recordkeeping by the resident inspectors. Only two kept formal, detailed diaries of construction activities, two kept informal diaries, and four kept none. At a California project the inspectors kept virtually no written record of construction deficiencies and relied on their memories and verbal orders to the construction contractor.

At an Illinois project the resident inspector was not aware that some materials did not meet specifications. In one instance, concrete was poured in September 1981 but test results had not been received as of January 1982 when GAO visited the site. The missing test results showed that the concrete had failed to meet specifications; further testing was requested by the engineering firm.

For six sites in California and Arizona that maintained soil compaction records, GAO could

not find records of passing retests for 21 percent of the failures

In some cases, the lack of good recordkeeping by resident inspectors has made the Corps' job more difficult. Corps inspectors told GAO that one of the principal means of determining whether resident inspectors are doing their job is by reviewing their records. As noted above, resident inspectors' records, on some projects, generally provided little information on problems they had found and what they had done about them.

Improvements in the resident inspectors' records and management controls would greatly assist the Corps in its review. The records on concrete and soil, or other material tests, need to be improved so that they clearly show test failures, retest results, and/or other resolutions. The Corps can then review these records during its periodic visits.

RECOMMENDATIONS

GAO recommends that the Administrator, EPA, with the assistance of the Corps of Engineers:

- Develop and implement standard operating procedures for monitoring the resident inspectors' activities. These procedures should provide specific guidance on how to review the residents' inspection activities; establish time frames for monitoring, when feasible, critical construction events; and provide criteria for assessing the adequacy of the residents' inspection activities.
- Establish recordkeeping guidelines for resident inspectors on construction grant projects for documenting construction deficiencies, highlighting the deficiencies that need followup, and maintaining important construction records. The Administrator should issue these guidelines to grantees suggesting better documenting by resident inspectors, and if residents do not follow the guidance, EPA should include as a condition in its grant awards that the resident inspectors follow the guidance.

Although written comments were not obtained, GAO discussed these matters with EPA and Corps program officials. They generally agreed with GAO's recommendation on developing and implementing standard operating procedures.

EPA officials believed that existing guidance was adequate for resident inspectors to document construction deficiencies. GAO believes that more definitive guidance is needed.

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ABBREVIATIONS

A/E	architect/engineer
ASCE	American Society of Civil Engineers
EPA	Environmental Protection Agency
GAO	General Accounting Office
psi	pounds per square inch
SOP	standard operating procedure

CHAPTER 1

INTRODUCTION

Billions of gallons of polluted wastewater are generated each day from homes, businesses, and industries across the country. Left untreated, this contaminated waste may enter the Nation's waterways, kill fish and other aquatic life, and leave the water unfit for human use. To prevent the continued degradation of the Nation's waters and to restore already contaminated rivers, lakes, streams, and ocean shorelines, wastewater must be treated to remove damaging pollutants. The Environmental Protection Agency's (EPA's) construction grant program helps communities build the wastewater treatment plants needed to control water pollution, and the U.S. Army Corps of Engineers helps EPA monitor the actual construction of the treatment plants

EPA's CONSTRUCTION GRANTS PROGRAM

The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1251, et seq.) directs the Nation's water cleanup program. The act's primary objective is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The act sets two specific national goals. One, the "swimmable-fishable" goal, is to restore polluted waters, wherever attainable, to a quality that allows for the protection and propagation of fish, shellfish, and wildlife and for recreational use by July 1983. The other goal is to eliminate all discharges of pollutants into the Nation's waters by 1985.

The construction of wastewater treatment plants is the principal means being used to achieve the Nation's clean water goals. The Water Pollution Control Act amendments of 1956 (Public Law 84-660) created the wastewater treatment construction grants program and authorized Federal financial assistance of up to 30 percent of the cost of constructing municipal wastewater treatment plants. Subsequent amendments increased the Federal share of the construction costs to 55 percent. The 1972 amendments increased the Federal contribution to 75 percent and authorized a total of \$18 billion for the program. The 1977 and 1981 amendments authorized an additional \$25.5 billion and \$9.6 billion, respectively, through fiscal year 1985. Starting in fiscal year 1984 the Federal share will decline to 55 percent.

A wastewater treatment plant is often the single largest physical asset owned by a municipality. The cost of constructing a plant depends on both its size and the complexity of the treatment process. Plants range in size from a few hundred thousand gallons to several hundred million gallons of wastewater flow each day. Construction costs can range from several hundred thousand dollars to several hundred million dollars.

LPA administers the construction grants program and awards grants from funds allotted to each State on the basis of need.

The States, within parameters established by the 1972 amendments and EPA, determine how the funds will be distributed to municipalities.

Once awarded a construction grant, the grantee is responsible for managing the project to assure its successful completion. The grantee is to provide and maintain competent and adequate engineering supervision and inspection of the project to ensure that the construction conforms to approved plans and specifications. Depending on the grantee's size and expertise, the engineering supervision is provided either by the grantee's staff or by the architect/engineering (A/E) firm. In many cases the firm providing the engineering supervision during construction is the same firm that designed the project.

The resident engineer, as the term is used in this report, is the engineer at the project responsible for overseeing inspection activities and making engineering decisions about deviations from specifications. The resident inspector is the onsite inspector and usually works under the resident engineer's supervision.

THE U.S. ARMY CORPS OF ENGINEERS' ROLE

As the grantor agency, EPA makes site visits as frequently as practicable to review program accomplishments and management control systems and provide needed technical assistance. Recognizing its manpower shortage in the construction grants program and considering its monitoring responsibility, EPA entered into a national interagency agreement in January 1978 with the Army Corps of Engineers to assure that EPA projects are constructed in accordance with high standards of engineering practice and applicable Federal requirements. The Corps provides three major services: it reviews whether designed projects can be adequately bid upon and can be constructed; it actively manages the construction of the projects; and it provides full-time onsite inspections at large construction projects. Active management of projects consists of numerous activities, including change order reviews, claim reviews, payment processing, bid reviews, contract awards, audit resolution, administrative completions, and interim inspections. These inspections encompass reviewing the resident inspector's performance and physical construction, grantee records and record systems, and construction and outlay schedules. EPA performs the final inspection which includes a test of the treatment facility's ability to operate properly.

The specific functions to be carried out by the Corps are provided for in each of the 10 separately developed regional agreements between an EPA regional office and the geographically adjacent Corps division office. Corps responsibilities and procedures for dealing with grantee projects and project documents vary from region to region and State to State.

The agreement between EPA and the Corps will continue for the duration of the construction grants program unless either agency terminates it.

EPA reimburses the Corps for its construction management work. The table below shows the cost of the Corps' work since 1978.

<u>Fiscal year</u>	<u>Amount</u>
	(in millions)
1978	\$ 2.1
1979	14.1
1980	18.4
1981	22.1
1982	<u>19.7</u>
Total	<u>\$76.4</u>

The Clean Water Act of 1977, which amended the 1972 act, extended considerably the initial act's emphasis on States' assuming responsibility for conducting the construction grants program. Delegation agreements can be entered into between the EPA region and the State after the regional administrator is assured that the State can and will administer the full gamut of construction grants program activities in accordance with EPA requirements. Functions delegated under the agreement are phased in. Generally, grant application and award functions and design activities are delegated initially. The review and approval of facility plans and construction inspections are deferred until later. During the phase-in period, the EPA region and the State conduct extensive training of State personnel, and EPA monitors the State's grant certification procedures.

OBJECTIVES, SCOPE, AND METHODOLOGY

Our objective was to evaluate how effectively the Corps' monitoring was ensuring that the resident inspectors were performing their construction inspection activities. We did not evaluate how the Corps was performing its other responsibilities under its national agreement with EPA. We selected the inspection function because it represents a major construction control over the large Federal financial investment in wastewater treatment projects. Another objective was to evaluate the adequacy of the resident inspectors' recordkeeping process to record construction deficiencies.

We visited 18 wastewater treatment construction sites in five States: six in California, five in Florida, three each in Illinois and Alabama, and one in Arizona. These projects were judgmentally selected based on their location (to obtain geographical dispersion and involve various Corps district and area offices), the percentage of completion (between 10 and 88 percent complete as of September 30, 1981), and the size of the project (we included two projects exceeding \$50 million in Federal grant funds

and several small projects costing about \$5 million). The projects generally involved either new construction or the expansion of an existing waterwater treatment plant. Details on the 18 projects are included in appendix I.

We reviewed the EPA/Corps agreements for EPA's 10 regions. As these agreements were basically similar, we believe that our work at the three regions we looked at in detail gives us an adequate basis to make programwide recommendations.

At the three EPA regional offices included in our review--Atlanta (region IV), Chicago (region V), and San Francisco (region IX)--we reviewed the construction grants program administration handbook, reviewed EPA/Corps agreements, reviewed State delegation agreements, and discussed the program with the Construction Grants Management Branch staff, Water Division.

Our review included three Corps division offices: the South Atlantic Division Office in Atlanta, the North Central Division Office in Chicago, and the South Pacific Division Office in Los Angeles. The 18 projects involved Corps inspectors from five Corps district offices: Jacksonville, Mobile, Chicago, Los Angeles, and San Francisco. We interviewed division program managers, Corps district engineers and comptrollers, Corps area office supervisors, and the Corps inspectors responsible for the interim inspections at the 18 sites. In California, we talked with the State employees the Corps hired to perform some inspections. In assessing Corps activity, we reviewed Corps policies, procedures, reports, and detailed project inspection reports.

Most of our work was performed at the offices of the 18 selected grantees and, where applicable, their representative A/E firms and at the construction sites. At these locations, we generally performed the following work:

1. Discussed the program and the projects with grantee, A/E, and Corps personnel.
2. Accompanied and observed the Corps inspector as he performed a monitoring inspection.
3. Observed ongoing construction work.
4. Discussed the project with the responsible resident engineer and/or the onsite inspector.
5. Reviewed records maintained at the construction site by the resident engineer or the onsite inspector to control and document project construction.

We discussed program responsibilities with construction grants officials who monitor EPA wastewater treatment grants at the Arizona Department of Health Services, Bureau of Water Quality Control, and at the California Water Resource Control Board. At the

Alabama Water Improvement Commission, we discussed the duties delegated to the State of Alabama with the Director and the Chief, Municipal Waste Control.

At Tampa, Florida, we discussed with representatives of the American Society of Civil Engineers and a major engineering consultant firm, industry standards for the work and recordkeeping of resident engineers and onsite inspectors

We obtained oral comments on a draft of this report from EPA and Corps headquarters officials. From EPA's Municipal Construction Division we met with the Acting Director, the Program Policy Branch Chief, and a civil engineer of the Branch. From the Corps Construction Branch of the Construction-Operations Division, we met with the Branch Chief, the Chief of the Grants Management Section, and a civil engineer of the Division. Where appropriate, their views were considered in preparing the report.

Our review was performed in accordance with generally accepted government audit standards.

CHAPTER 2

CORPS OF ENGINEERS REVIEWERS NEEDED

STANDARD OPERATING PROCEDURES

The EPA/Corps national and regional agreements contain a list of activities that EPA expects the Corps of Engineers to carry out under its monitoring responsibility. The Corps has provided its reviewers with only general guidance for performing these activities. This has resulted in varying perceptions by the Corps reviewers as to what their role is and, in some cases, in reviews that were not properly performed or were not reported to the grantees, States, and EPA. The Corps needs to have specific guidelines and procedures for such items as (1) the key monitoring activities that Corps reviewers should do, (2) critical time periods for monitoring certain activities, and (3) criteria on what is adequate inspection and recordkeeping by resident engineers/inspectors. Properly performed monitoring reviews would help give EPA assurance that the projects are built in accordance with approved plans and specifications and that the Federal Government receives full value for its investment.

GUIDANCE PROVIDED IN REGIONAL AGREEMENTS

The Corps construction review responsibility is broadly defined in the national EPA/Corps agreement as evaluating and assisting the grantee in the management of its construction program. The regional agreements between EPA and the Corps for individual States do not provide much additional guidance.

The national EPA/Corps agreement states that the Corps will schedule and conduct announced and unannounced interim inspections on an as-needed basis during the construction phase of the grant (This report refers to the interim inspections as monitoring reviews in order to distinguish them from the inspection activities carried out by the resident inspector.) All active projects must be inspected at least once each quarter. To evaluate and assist the grantee in construction management, the Corps must check such items as grantee supervision and inspections done by the construction contractor and resident inspector, and must ensure that the resident inspector is fulfilling contract requirements.

The EPA/Corps agreements for Alabama and Florida do not provide much guidance for performing the quality assurance reviews. Each agreement contains one paragraph on the procedures for arranging interim inspections and for reporting deficiencies, as follows

Alabama - * * * Formal inspections will be scheduled in advance with the grantee and the Alabama Water Improvement Commission. Informal inspections need not be scheduled and will be made monthly. Deficiencies will be discussed directly with the grantee. Copies of the inspection report will be sent to

the Commission and the grantee. The Commission will be responsible for resolving Corps comments. Those comments that cannot be resolved between the Corps and the Commission will be forwarded to EPA for resolution * * *.

Florida - * * * Field review will be performed by the respective Corps field offices. The Corps field office will prepare letters on problems when encountered and submit to the grantee with copy to the State Department of Governmental Resources and the Corps office in Jacksonville. If resolution cannot be provided, the problem will be referred through Corps South Atlantic Division to EPA for resolution. Inspections will be scheduled by the Corps field offices which will coordinate the schedule with all interested parties. Unresolved deficiencies and comments will be submitted by letter through Corps office in Jacksonville and the Corps South Atlantic Division to EPA for resolution * * *

Since July 1976, EPA Region V (Chicago) and the North Central Division Corps of Engineers have entered into three interagency agreements. The specificity of the guidance in each of the agreements, however, varied. The July 1976 agreement provided that the Corps conduct monitoring inspection to assure the adequacy of supervision and administration of the construction by the grantee and its agents. The agreement contained a specific reporting format and instructions on how to complete the forms. The detailed instructions specified what needed to be checked and how it was to be done.

The second agreement provided that the Corps perform onsite surveillance inspections of two major areas, quality assurance and contract administration. Reviewers were to monitor compliance with EPA and contract requirements and determine whether engineering and construction standards were adhered to. The agreement contained a detailed reporting format primarily in the form of a checklist but did not contain the detailed instructions and guidance (the "how to") contained in the first interagency agreement. According to a Corps Division program manager, the earlier level of detail disappeared because the Corps and EPA had become familiar with the program and the Corps' role and believed that such details were no longer necessary.

Under the third agreement effective in February 1981, the Corps is required to provide advisory services to grantees and their consultants and, through its construction oversight activities, assure that projects are constructed in accordance with high standards of engineering and construction practice and applicable Federal requirements. This agreement contained a new set of narrative forms and instructions that replaced the checklists in the previous agreement. The checklist, which was developed to allow expedient review and evaluation, did not provide room for comment and allowed for a variety of interpretations between reviewers, supervisors, Corps districts, and EPA. The Corps district then

developed a set of standard forms with specific guidance in an effort to ensure consistent reviews.

VARIATIONS IN CORPS REVIEWERS'
PERCEPTIONS OF ROLES

The 18 Corps reviewers we talked with perceived their roles for performing quality assurance reviews differently. Some perceived themselves as a construction inspector, others as a contract administrator, project engineer, or management engineer. Corps reviewers on the Alabama and Florida projects we reviewed gave us various responses on how they viewed their roles.

- One reviewer said his role was to ensure that the grantees administered their grants in accordance with grant requirements and regulations. He said he did not inspect actual construction work.
- One reviewer viewed his role as ensuring that construction work is in accordance with design and specifications and is of acceptable quality and that the Government is getting its money's worth. He also reviewed change orders.
- Three other reviewers defined their responsibilities differently. One reviewer said his responsibility was to ensure that the project was constructed in accordance with plans and specifications and that the Government is getting its money's worth and to assist all parties to the grant in seeing that the project runs smoothly. The second reviewer said his responsibility was to assist in the administration, ensure that the project is constructed in accordance with plans and specifications, and ensure that the A/E firm does its job. The third reviewer said his responsibility was to monitor the A/E's performance and to ensure that the grantee did not spend grant funds on unnecessary additions to the project.

The Construction Branch Chief and a supervisory civil engineer of the Chicago Corps District told us that they recognized the quality assurance function as their role, but the reviewers also saw their role as one of helping the grantee. For example, the Construction Operations Division Chief, the Construction Branch Chief, and two program managers of the Corps North Central Division said that they were "the eyes and ears of EPA" in assuring that adequate construction management is implemented at the project site. They also believed that the Corps is responsible for attempting to resolve any problem that arises. Chicago district inspection staff viewed their role similarly. One inspector saw his role as trying to assure that the resident engineer was providing adequate quality assurance; supporting the resident engineer's effort to get the construction done properly; making sure grant agreements were met; trying to maintain job site safety; looking out for the interests of the Government; and helping the grantee obtain a quality product.

INCONSISTENCIES IN CORPS REVIEWS

The Corps believes that its reviewers have enough experience to perform the monitoring function without further guidance. As a result, the Corps has not provided specific operating procedures to direct the Corps reviewers as to how to carry out their monitoring function. Rather, the Corps reviewers use their individual judgment as to what they should look at and how they should assess the adequacy of what they find.

Based on the work we performed at the 18 projects, we gained the general impression that the Corps' presence at the project sites had resulted in improved resident inspections. However, we identified instances in which the Corps was not always carrying out reviews of activities that EPA generally considers part of an adequate monitoring effort, to assure that construction deficiencies, changes, or problems were detected and received appropriate attention. On the eight interim inspections in Florida and Alabama,

- one reviewer did not review the resident engineer's daily inspection reports,
- three reviewers did not review material test results,
- four reviewers did not assure that the project schedule was up to date,
- three reviewers did not assure that stockpiled materials and equipment were properly stored, and
- four reviewers did not determine whether site drainage and erosion and dust control were adequate.

The eight Corps reviewers completed their work in an average of less than 5 hours, spending most of their time watching construction work rather than reviewing resident engineer/inspector records on construction activity that had taken place since the last Corps review. For example, the three reviewers in Alabama looked at some daily inspection reports, but none of them reviewed all of the daily inspection reports prepared since their last review. These daily reports are the basic records of inspection services and project construction activities and document construction deficiencies and A/E followup actions on deficiencies. The daily inspection reports include the time resident engineers/inspectors spent at the construction site, grantee visits to the construction site, construction delays, construction problems, and days the contractor worked.

Although our review did not disclose any problems resulting from the above omissions, the failure of the Corps reviewers to review the daily inspection reports could result in their not detecting construction problems. In commenting on the Corps reviews at his site, a project engineer in charge of the resident engineers/inspectors at one project told us the Corps reviewer's

work was so cursory that it would be easy to hide deficiencies from him. The Corps reviewers told us that they did what they considered necessary to fulfill their function.

For the seven California and Arizona projects, we studied resident engineer/inspector records on concrete compression tests and soil compaction tests. We chose these tests because of their importance and because records were available from an independent testing laboratory. Insufficient soil compaction under a structure can result in excessive settling which can eventually cause the structure to crack. Concrete strength is specified to meet design stress requirements, and insufficient strength can result in structural failures. The resident engineer is responsible for (1) assuring that the tests are made, (2) following up on failures to assure that rework and retests or other appropriate actions are taken, and (3) maintaining records of test results to show that contract specifications are met. The Corps guidelines, however, do not specifically require a review of test results on concrete and soil although the guidelines contain a general requirement to review material test data.

Both soil compaction and concrete strength requirements are determined by the design engineer. Soil compaction requirements at the sites we visited were generally consistent. Requirements were 90-95 percent compaction under a structure or a road surface. Concrete strength compression requirements varied from 2,500 to 4,700 pounds per square inch (psi) and were tested by concrete cylinder samples broken 28 days after the pour. Generally, the concrete specifications did not allow any tolerance below the specified 28-day strength. The largest tolerance in the seven projects was that 10 percent of the tests could be less than the specified strength, but no test could be less than 500 psi of the specified strength.

We analyzed the residents' followup on failing tests and their maintenance of test records. At every site we visited, we identified problems. At some sites, certain test records were missing, the records did not show whether retests were taken when failures occurred, or no retests were taken. For some soil compaction test failures, the log showed that the area had been retested, but the original test documents showed that the retests were taken at different locations or elevations.

For example, at the Sepulveda Water Reclamation Plant, the resident engineer/inspector had not performed a required followup core test on a concrete failure 9 months after the test result was available. The test result was 3,650 psi, or 350 psi below the requirement. Soil compaction records did not show that passing retests were taken for 15 (36 percent) of 42 test failures. The original test results for three failures had not been recorded in the soil compaction log. The required compaction for each was 90 percent. One test showed a compaction of 83 percent where the test location was covered by a structure. The other two locations

tested at 76 and 82 percent, but the locations were covered by additional fill over a sewer.

Corps guidelines, however, provide little direction on what, when, and how inspectors should review and do not specifically require a review of the completeness of the test records. Checklist reviews are required on California projects when they are 10 and 50 percent complete. One item on the checklist requires the Corps reviewer to determine whether the resident engineer/inspector maintains a log of tests and retests. This checklist requirement fits the description of how one Corps reviewer said he reviewed soil and concrete data. He determined whether the resident had a policy of testing, retesting, and recording the results by looking to see if the resident maintained records on tests and retests. But he did not check the completeness of test data nor did he determine whether retests were accomplished for all failures. For example, at the Perris Valley water reclamation plant and the Wildcat Hill wastewater treatment plant, soil compaction test records did not show passing retests on 13 (23 percent) of 56 failures and 8 (22 percent) of 36 failures, respectively. None of these problems were mentioned in Corps inspection reports.

Corps guidelines do not identify critical time periods for monitoring certain activities. But a Corps review of soil compaction test records and procedures after soil tests are complete and the structure is nearly complete is too late to bring about practical corrective action. At the Sepulveda site, for example, the Corps reviewer reviewed soil compaction test results for the first time when we accompanied him on his interim inspection. This review took place 10 months after tests had begun. At that time, the contractor was finishing slab pours and backfilling to original grade around all structures.

Corps staff responsible for reviewing the three projects in Illinois told us that they did not regularly, independently review material test results in detail and assess resident engineer actions when material did not meet specifications. The staff said that they relied on the resident inspector's statement that the tests were properly done and that they were not required to independently review test results.

For example, the Corps reviewers responsible for the Elgin, Illinois, project were unaware that concrete used for the building's roof did not initially meet project specifications. The concrete was poured on September 4, 1981, and the resident engineer noted in his diary that he was concerned with the adequacy of the concrete. Preliminary test results reviewed by the resident engineer's firm later in September indicated that the concrete may not have met specifications. When we initially visited the project in January 1982, neither the resident engineer nor his firm had received the final test results, which should have been available in October 1981. According to a testing laboratory representative test results are mailed when the tests are completed, but the testing laboratory does not maintain a record of when the mailing takes

place. On January 21, 1982, the resident engineer requested a copy of the final concrete test results from the testing laboratory. The final test results indicated that the concrete failed to meet specifications, as shown in the following table.

<u>Tested concrete batches for roof</u>	<u>Specified compressive strength</u>	<u>Results of specified test</u>
	-----(psi)-----	
1	4,000	3,170
1	4,000	3,180
2	4,000	3,780
2	4,000	3,680
3	4,000	3,820

The Corps staff visited the project in October, November, and December 1981 and January 1982 but did not comment upon or appear aware of the deficient and missing test results. In fact, the November 1981 Corps report stated that in regard to concrete testing, "results are satisfactory after some retest and adjustments to meet require(d) specifications." The Corps reviewer said that he looked at the test reports and asked the resident engineer if there were any problems. The resident engineer responded with the comments cited in the inspection report. The reviewer stated that he did not verify the retests and adjustments that were made and was not aware of the deficient test results for the roof slab concrete.

In January 1982, before the final test results were known, we notified the Corps reviewers about the missing and potentially deficient concrete test results and requested that they follow up on this problem. Before our request, the reviewers had prepared their January report which stated that other than the project sign being improperly posted, the construction management system (resident engineering services) seemed to be in order. In February the Corps performed an in-depth review covering the areas of grantee records, construction management and preparation for startup, and contract monitoring. The February report cited the concrete problems and concluded that "The construction management of this project is of inferior quality." The Corps reported in March that the concrete was retested using a rebound hammer test and "the lab report showed the concrete having sufficient strength."

INCONSISTENCIES IN REPORTING AND FOLLOWING UP DEFICIENCIES

The national EPA/Corps agreement requires Corps reviewers to assure resolution of all problems they identify. However, the reviewers do not always report all observed deficiencies or do not report whether deficiencies previously noted were corrected.

Instructions for completing inspection reports contain criteria for determining the seriousness of problems affecting the grant. The criteria define "serious" problems as problems requiring immediate attention, such as disputes with the contractor or the A/E firm, strikes, or deviations from plans and specifications. A second category, "troubling" problems, is defined as problems requiring attention and followup but no immediate action. Examples of troubling problems include minor deviations from the plans and specifications and delays in receiving equipment.

The Chicago Corps District Conservation Branch Chief told us that a reportable deficiency is anything not in accordance with the plans or specifications or that deviates from good construction practice. He said that reviewers should use professional judgment in determining whether to report minor deficiencies.

The Corps reviewers we interviewed stated that not all problems and deficiencies they find are reported. Major deficiencies are reported but minor deficiencies are reported only if they continue to occur. The Corps staff defined a deficiency as a deviation from the contract documents. However, the distinction between a major and minor deficiency is not that clear. For example, one reviewer believed that a deficiency was minor if construction could continue and the deficiency could be corrected later with little cost or effort. He considered the deficiency major if it needed a great deal of money or effort to correct.

The supervisor for two Corps Illinois area offices stated that the definition of a reportable deficiency depends on who is expected to act upon it and that some problems are mentioned just to alert the grantee to them. He said that the Corps prepares the reports for the grantees and their engineers but no one takes action on the reports or seems to care about them. EPA receives all reports but does not follow them up with the Corps. According to the Municipal Engineering Section Chief, the EPA official responsible for construction inspections, EPA only needs to be informed of major problems that the Corps cannot resolve. Examples of these problems include serious delays, mounting claims against the grantee, or the appearance of mismanagement or fraud.

Corps reviewers were not documenting the resolution of all previously reported deficiencies in subsequent reports, contrary to the instructions in the region V interagency agreement. However, the reviewers claim that they followed up on all deficiencies but did not always report the resolution.

For the eight projects we reviewed in Florida and Alabama, although EPA/Corps Region IV agreements require Corps reviewers to report deficiencies, neither EPA nor the Corps had defined reportable deficiencies. As a result, each Corps reviewer established his own definition of reportable deficiencies. For example, the eight Corps reviewers interviewed gave us different definitions of reportable major deficiencies.

--One Alabama reviewer said that a major deficiency is something that requires replacement or major rework. The second reviewer said it is something that would cost money, affect the quality of the work, or be a repetitive minor deficiency that is not corrected. The third reviewer said it is something that affects the project adversely by either increasing cost, delaying project completion, or evidencing structural damage.

--One Florida reviewer said that a major deficiency is any deficiency that has not been corrected within a reasonable period of time. Another said he did not have a definition but used his engineering judgment to determine a major deficiency. Another said a major deficiency is one that interferes with the primary purpose or operation of the system as it was designed.

Corps reviewers generally did not report deficiencies on the eight projects reviewed in Alabama and Florida. For example, the Corps reported only three deficiencies on five of the projects:

- Construction of one pumping station was behind schedule.
- A construction progress schedule had not been submitted to the Corps.
- An EPA construction sign and bulletin board needed to be installed.

The following are examples of deficiencies or problems not reported by Corps reviewers:

- Actual gravel used to date in constructing a pipeline was three times the total amount of gravel estimated for the entire pipeline. The estimated cost of the gravel was \$34,150 whereas actual cost to date was \$98,557.
- Due to a design error, about 50 feet of 30-inch pipe was procured that was not needed and could not be returned
- A minority contractor left the project after receiving repeated instructions to correct unsatisfactory brick work

Although there was no evidence that proper actions or follow-up actions were not taken on items such as those above, reporting such deficiencies would have assured that the grantee was aware of these construction management problems and might have been able to prevent them in the future.

VIEWS ON THE NEED FOR OPERATING PROCEDURES FOR MONITORING REVIEWS

Three of eight Corps reviewers we interviewed in Alabama and Florida said that standard operating procedures (SOP's) for the

reviews would benefit them; the other five said SOP's would not. The five reviewers believe that only general guidance is needed for them to perform adequate onsite inspections because of their prior construction experience and access to Corps construction manuals

EPA Region IV has not required the Corps to develop SOP's, but the Deputy Chief and EPA-Corps program manager of the Construction Grants Management Branch agreed that the Corps needs to develop SOP's for performing monitoring reviews and reporting deficiencies. EPA Region IV officials said the region was responsible for evaluating the Corps' performance but had not done so, and that they were unaware of the problems disclosed by our review. However, they said that an ongoing evaluation of the Corps begun in April 1982 involves evaluations of four projects and of the Corps district offices responsible for four project reviews.

District and deputy district engineers from the Corps Jacksonville and Mobile District Offices were noncommittal on the need for SOP's for performing quality assurance reviews but said that any such SOP's should be developed by Corps personnel experienced in review work.

The Construction Operations Division Chief, the Construction Branch Chief, and two program managers of the Corps North Central Division acknowledged that some type of national, detailed, item-by-item minimum Corps review standard or guidance would be helpful, but they could not agree on the format of the guidance. Some Corps reviewers and their supervisor believed that telling inspectors to look for commonly found deficiencies would be just as helpful. The Corps Chicago District EPA coordinator and another supervisor were in favor of having a uniform national statement of procedure detailing the minimum effort so that the reviewers would be doing the same things to assure that construction is adequate. The Corps North Central Division staff agreed that an SOP would be helpful but believed that it should not be any more detailed than the guidance contained in the current region V interagency agreement.

The Chief, Construction-Operations Division, Corps South Pacific Division, in a letter to us dated April 21, 1982, agreed that additional guidance on construction management monitoring would be helpful and said that he plans to implement this suggestion. However, he did not believe in guidelines that provide a checklist for the Corps reviewers to follow

CONCLUSIONS

From our work at the 18 projects, we believe that the Corps is performing a necessary and useful monitoring function that helps ensure the integrity of treatment plant construction. However, the Corps' work needs some improvement to become more effective.

Corps inspectors are not always performing adequate monitoring reviews to make sure that construction deficiencies, changes, and problems are detected and reported by the resident inspectors. Corps guidelines do not provide clear or detailed guidance to its inspectors on items they should review and on criteria for assessing the adequacy of what they find.

The interagency agreement between EPA and the Corps and EPA's handbook of procedures are the only guidelines available to Corps reviewers, but together they provide only general information on how the reviews should be done. Standard operating procedures, on the other hand, would help guide the Corps reviewers in deciding how and when to test the resident inspections, including reviewing critical construction events, and provide some measure of the adequacy of the resident inspectors' work.

Consistently performed monitoring reviews would also benefit EPA by providing it with an improved control mechanism to ensure the integrity of sewage treatment plant construction. With the advent of increased EPA delegation of the construction grants program to the States, the SOP's could also be used by State personnel as they take over the inspection function.

RECOMMENDATION

We recommend that the EPA Administrator, with the assistance of the Corps of Engineers, develop and implement standard operating procedures for monitoring the resident inspectors' activities. These procedures should provide specific guidance on how to review the residents' inspection activities; establish time frames for monitoring, when feasible, critical construction events; and provide criteria for assessing the adequacy of the residents' inspection activities

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The acting director of EPA's Municipal Construction Division and the Branch Chief of the Corps Construction-Operations Division both agreed with our suggested recommendation that SOP's should be developed and implemented. They cautioned, however, that because construction activity does not always take place when it is scheduled, it may be very difficult for Corps reviewers to time their monitoring visits with a critical construction event. The Branch Chief of the Corps Grants Management Section also mentioned that it is not cost effective for the Corps to be present at these construction events because it is physically impossible to do so given the limited number of Corps reviewers and their other construction management responsibilities

We recognize that it is not the Corps' responsibility to be present at all critical construction events and that the Corps must, to a large degree, rely on the resident inspector to make sure that construction work is adequately performed. The intention of our

recommendation is to have the Corps reviewers' visits coincide when feasible with major construction events, such as soil compaction tests and concrete pourings.

The Corps officials also pointed out that they will use the results of our work in evaluating the performance of two of their division offices. They said their visits will begin in January 1983 and last about a week at each location.

CHAPTER 3

RESIDENT INSPECTORS NEED RECORDKEEPING

GUIDELINES FOR RECORDING CONSTRUCTION DEFICIENCIES

The resident inspectors at the 18 sites we visited did not systematically record construction deficiencies. Frequently, when deficiencies were recorded, records did not show that corrective actions were taken. The inspectors relied extensively on their memories to assure that appropriate actions were taken. EPA has issued a construction inspection guide to all grantees which simply suggests that an accurate daily inspection report should be prepared, but EPA has not issued specific instructions for resident inspectors requiring them to document day-to-day construction deficiencies or to properly maintain such important records as material test reports, correspondence, or deficiency reports. EPA contends that because it is operating a grant program rather than a contract program, it cannot require grantees to prescribe specific instructions to resident engineers. EPA, however, can develop and issue guidance to grantees on documenting construction deficiencies, and if residents do not follow the guidance, EPA can make the documentation procedure a condition of the grant.

Professional engineers in both government and private industry agree that resident inspectors need to maintain certain key records in order to adequately protect the grantee. Yet, no recordkeeping standards exist to guide resident inspectors. To assure that all necessary records are kept at all construction sites, standards need to be developed.

Good documentation of the quality of construction work and materials, especially any deficiencies, problems, or disagreements, is very important on any construction job. This type of sound recordkeeping is necessary to preclude deficiencies from going untreated in the event that the resident inspector forgets them or is absent from the construction site. The resident inspector's records may also be used in court cases or to settle disputes in situations where there are disagreements over responsibility for construction failures.

Without adequate resident inspections, projects may be constructed that are not in accordance with the approved plans and specifications. The result could be treatment facilities that do not perform as expected.

WHAT GUIDANCE DOES THE GRANTEE GET?

Neither EPA's implementing regulations or guidelines nor grantee contracts with A/E's specify what construction records are to be maintained by the resident engineer or inspector at the construction site. The only reference to construction records in EPA's implementing regulation is in 40 CFR 30.805, which states in part:

"* * * The grantee shall maintain books, records, documents, and other evidence and accounting procedures and practices, sufficient to reflect properly (1) the amount, receipt, and disposition by the grantee of all assistance received for the project, including both federal assistance and any matching share or cost sharing, and (2) the total costs of the project, including all direct and indirect costs of whatever nature incurred for the performance of the project for which the EPA grant has been awarded. In addition, contractors of grantees, including contractors for professional services, shall also maintain books, documents, papers, and records which are pertinent to a specific EPA grant award * * *."

The only other reference to the duties of the resident engineer is contained in 40 CFR 35.935-8, which states:

"* * * the Grantee will provide and maintain competent and adequate engineering supervision and inspection of the project to ensure that the construction conforms with the approved plans and specifications."

EPA's handbook of procedures for the construction grants program does not specify the grantees' responsibilities for maintaining construction records. Those responsibilities are only implied by the section on "Monitoring of Construction Activities," which states in part that during interim inspections, "the EPA or State inspector shall determine that:

--the grantee is providing competent and adequate supervision and inspection and is maintaining appropriate inspector's logs;

--approved plans, specifications and change orders are available at the project site;

--reasonable tests of materials and equipment are being conducted and noted in logs or reports (slump tests of concrete for example),

--project accounting records are maintained and they distinguish between allowable and nonallowable costs supported by receipts or certified contractor invoices."

Grantee contracts with A/E firms add little in the way of specific guidance for maintaining construction-related records. For example, the contracts between two Florida grantees and their respective A/E firms stated that the engineers must maintain books, records, documents, and other evidence directly pertinent to performance on EPA grant work under this agreement in accordance with accepted professional practices. None of the six contracts we

reviewed in Alabama and Florida contained specific instructions on construction recordkeeping.

At two of the three Illinois projects, the contractual duties and responsibilities of the resident engineer were vague. Neither contract defined the records the resident should maintain. For example, the engineering agreement for the DuPage County Department of Public Works project under the caption "DETAILED INSPECTION OF CONSTRUCTION" stated that "* * * routine inspection of construction work shall be done by a representative of the Engineer's and by such additional Inspectors of Construction as may be required for inspecting the construction * * *." The contract further provided that "The Engineers shall endeavor to guard the owner against defects and deficiencies in the work of the construction contractors, but not to guarantee the performance of construction contractors."

In contrast, the engineering contract for the construction portion of the Urbana and Champaign Sanitary District project was fairly specific. It stated that "A Resident Project Representative and assistants will be furnished and will act as directed by the ENGINEER in order to provide more extensive representation at the PROJECT site during the Construction Phase." The duties, responsibilities, and limitations on the authority of the resident inspector were set forth in an exhibit to the contract. The exhibit provided that the resident would:

- Conduct onsite observations of the work in progress as a basis for determining that the project is proceeding in accordance with the contract documents.
- Verify that tests required by the contract documents are conducted and that the contractor maintains adequate test records.
- Maintain orderly files for correspondence, reports of job conferences, shop drawings and other submissions, reproductions or original contract, and other project-related documents
- Keep a diary or logbook, recording daily activities, decisions, observations in general, and specific observations in more detail, as in the case of observing test procedures.

RECORDKEEPING DISPARITIES AT THE 18 PROJECTS

At the projects we visited, resident engineers/inspectors showed a wide disparity in documentation and recordkeeping. Of the eight resident engineers/inspectors we visited in Florida and Alabama.

--Only two kept formal, detailed daily diaries; two kept informal diaries; and four did not keep diaries.

--All kept daily inspection reports, but the currency, content, and specificity varied considerably.

--Six did not keep an ongoing log to show when and how each construction deficiency was corrected; one kept a tickler file for this purpose; another used a system to notify the contractor by mail of any deficiencies, required the contractor to respond by mail as to what corrective action it had taken or planned to take, and maintained copies of this correspondence in a permanent file.

Although daily diaries or reports detailing construction activities were maintained, resident engineers were not recording all deficiencies or problems and their resolution. Construction materials were being tested to assure compliance with specifications, but the disposition of all deficient material test results was not consistently documented. The following sections describe examples of inadequate recordkeeping of general construction activity and material tests in projects we visited in the other four States.

General construction work

For the projects in California and Arizona, the resident inspectors generally did not systematically record construction deficiencies.

At the Wildcat Hill project, the resident engineer and his inspectors kept virtually no written record of construction deficiencies. They relied on their memories and verbal orders to the contractor. When the resident engineer was about to leave the project, the grantee became concerned that the new resident engineer would not be aware of deficiencies and therefore could not follow up on them. The grantee wanted the resident to prepare a list of deficiencies before he left. He did not. The new resident started such a list when he took over in January 1982. The grantee told us that he was not aware of any problems as a result of this turnover but the potential was real.

At the San Jose project, the inspectors sporadically noted deficiencies in the daily reports only if it was important to establish blame or to prove that the contractor had been placed on notice. No separate log of deficiencies was maintained. The resident inspector had complete confidence in his memory and claimed to need no mechanism to remind himself of items needing correction.

The resident engineer's daily diary for the DuPage County project showed 11 construction deficiencies, but the resolution of

3 of these deficiencies was not noted in the diary. The resident's deficiency letter file showed that 10 of 13 uncorrected problems that prompted contractor letters were not noted in the daily diary. Also, the resident engineer did not keep a log of all construction deficiencies and their resolution.

At the Urbana and Champaign Sanitary District project, the resident engineer also attempted to resolve problems or deficiencies verbally. If a problem was not corrected at the time it was observed and was severe enough to stop work on the affected item until the problem was corrected, it would be cited in the diary. If the problem was corrected on the spot, it may not have been cited in the diary. In addition, if this type of problem was not corrected in about 10 days, the resident engineer would send a letter to the contractor requesting correction. The resident engineer documented less serious problems on a list for followup before completion of the project. He did not, however, record the follow-up or resolution of these deficiencies. We reviewed 31 weeks of daily diary entries and found 23 construction deficiencies indicated by the resident engineer. The diary did not disclose the resolution of seven of these items, although the resident engineer told us that each situation was either satisfactorily resolved or was awaiting better weather to resolve.

The resident engineer at the Elgin Sanitary District project told us that all deficiencies were documented in the daily diary; however, the followup and correction of deficiencies were not always documented. As on the other two projects, the resident kept no cumulative log of all construction deficiencies and their resolution. He did maintain a list of followup items needing corrections and believed that most of these items could be corrected in a short period of time. The resident engineer's daily diary identified 24 deficiencies or problems, but it recorded the resolution of only 7. According to the resident, the remaining 17 items were either resolved or were being resolved, but the resolution actions were not cited in the daily diary.

Controls over material tests

Project specifications call for certain materials such as concrete to be tested to ensure that they meet the grantee's specifications. Resident engineers or their firms are responsible for reviewing the test results to assure that the materials meet specifications and, if they do not, to determine whether to accept or reject the material.

At the Elgin, Illinois, project, the resident engineer was unaware, until our visit, that some materials did not meet specifications. In one instance, concrete was poured on September 4, 1981, but when we visited the site in January 1982, neither the resident engineer nor his office had received the final test results. The preliminary test results, reviewed by his office on September 17, 1981, indicated potential low strength concrete

At our request, the resident engineer on January 21, 1982, requested copies of the missing test results. On January 27, 1982, after receiving the test results, which indicated that the concrete did not comply with the specifications, the engineering firm notified the contractor that further testing was needed.

While at the site, we also noted that the resident engineer did not have the results of two of the five concrete block prism tests, which measure the strength of the concrete block used in load-bearing walls. The test results obtained at our request indicated that one of the specimens failed to meet the specified strength. In addition, two of three previously tested concrete block prisms failed to meet specifications. The resident engineer stated and the testing lab agreed that the specimens were damaged in transit to the testing lab. The resident engineer, however, had not documented the transit damage.

At the Sepulveda project, the contract specification required that all 28-day tests meet a 4,000 psi requirement. As of February 10, 1982, 11 tests had failed to meet this requirement. The resident engineer said that the following actions should be taken on all such failures: (1) determine whether the 28-day test results were close enough to the 4,000 psi requirement that, in the resident's judgment, the requirement would be met over time, (2) if not, withhold progress payments for the pour and formally notify the contractor so that he would proceed with subsequent concrete pours in that area at his own risk (in case the concrete had to be removed), and (3) follow up with core tests (a small core is taken out of the concrete) at a later time to see if the concrete had come up to specification.

The resident inspector had not consistently followed this practice. For 3 of the 11 tests that failed, the resident engineer said that the concrete would meet requirements in time. For the remaining eight, the inspector had withheld progress payments for only two and had issued a notice of noncompliance on one of the two.

The inspector had not cored two of the eight. He had not cored one because of structural concerns about boring a column, but he could have used an alternative test to get an indication of the column's strength without damaging the structure. There was no evidence that this was done. No reason was given why the other failed structure was not cored.

Most of the six core tests were not done until about 3 months after the initial test data was available. Three failed the core test. The inspector had previously issued a notice of noncompliance for one of these three. No progress payment had been withheld and no notice of noncompliance had been issued on the other two. The basic reason for the resident inspector's failure to take prompt followup action was that the residents were simply maintaining files of the concrete test results. The recordkeeping system

was not fashioned to alert the inspectors to test results that remained unresolved and needed further attention.

Control over soil tests

For six of the seven sites in California and Arizona that maintained soil compaction records, we could find no records of passing retests for 21 percent of the failures

--The resident inspector at the San Francisco W-3 project told us that he did not maintain soil compaction records.

--At the Point Loma project, the test records did not show the required soil compaction, and we could not determine if a test passed or failed without reviewing the contract. Those tests needing resolution were not easily identified because of the variety of separate contracts and soil compaction specifications at this project. The records were not designed to help the resident inspector keep track of failures.

--At the Wildcat Hill, Livermore, and San Jose Creek sites, to determine whether a particular failure had been retested, we had to read all subsequent records, looking for the notation that a result was actually a retest. These records did not focus attention on failures and therefore did not act to remind the inspector to make sure they were resolved. This reminder is especially important if test personnel change. For example, at Wildcat Hill the soil compaction test technician went on vacation before the contractor had reworked an area that failed its compaction test. The person standing in for the technician did not notice that the area needed retesting. When the technician returned, he forgot to retest the area.

WHAT RECORDS SHOULD BE MAINTAINED BY THE RESIDENT ENGINEER?

In some cases, the lack of good recordkeeping by resident engineers and inspectors has made the Corps of Engineers reviewers' jobs more difficult. Corps reviewers told us that one of the principal means of determining whether resident inspectors are doing their job is by reviewing their records. We found, however, that resident inspectors' records generally provided little information on problems they have found and what they have done about them. For example, the resident engineer at the Wildcat Hill project did not maintain any records on construction deficiencies until recently. Based on the soil and concrete test result files we reviewed, the Corps would have difficulty in quickly determining the status of test failures, and in some cases even identifying test failures.

Improvements in the resident inspectors' records and management controls would greatly assist the Corps in its review. The

records on concrete and soil, or other material tests, need to be improved so that they clearly show test failures, retest results, and/or other resolutions. The resident needs to have a comprehensive record on construction deficiencies or problems and their resolution. More important than just having better records, however, is making these records a part of a system that the resident can use to assure followup. The Corps can also use this system during its periodic visits. If the Corps finds problems such as a deficiency not being recorded, the problem is not just one of recordkeeping--it indicates a breakdown in the resident's management control.

Recognizing the need for better records, one Corps reviewer prepared a memorandum outlining the construction records which he suggested should be maintained by resident engineers and inspectors and made available to him during his inspection. Corps officials at the Jacksonville District Office endorsed the reviewer's position. The records which the Jacksonville district considers necessary are listed below.

1. Documentation supporting construction-related actions, copies of letters sent, received, etc.
2. EPA, State, and grantee financial receipts and disbursement records and backup documentation.
3. Record of easements, land acquisitions, and right-of-way permits.
4. Inspection records of delays in work, notices to proceed, stop orders, and notices of unacceptable performance of material.
5. Records of factory material tested.
6. Copies of approved contract documents, including a complete set of plans and specifications available at the job site and kept current with change orders and corrections clearly marked.
7. Records of required field test reports.
8. Records of all payment estimates.
9. Progress charts for each contract supported by calculations.
- 10 Overall project progress charts supported by calculations.
11. Inspectors' daily logs.
12. Sewer rehabilitation progress charts where applicable.

Arizona, California, and Corps management engineers involved in monitoring the construction grants program gave us some suggestions as to the records that resident inspectors should maintain, and most saw certain key records as necessary:

1. Daily inspection reports.
2. Shop submittals and shop log (submittals by contractor of detailed data for equipment and/or material to be used in the project).
3. Change order file.
4. Records of construction deficiencies and resolutions.
5. Log of deviations (list of all deviations from design specifications and plans granted to the contractor).
6. Test result files with clear indication of need for retesting.

A representative of the American Society of Civil Engineers (ASCE) and a noted consulting firm agreed with us that improvements are needed in documentation and recordkeeping by resident engineers/inspectors, and the two organizations are working toward resolving the problem. This individual is a Senior Associate with Greelee and Hansen Engineers in Tampa, Florida, also a fellow with the ASCE and serves on the ASCE Construction Division, Committee on Contract Administration, Subcommittee on the Resident Engineer. He and his colleagues on the ASCE committee are in the process of defining the roles of the resident engineer and his or her staff. He said that they still have a long way to go but feel that a positive and long-needed start has been made.

He told us that the committee members are currently motivated entirely by a need they see to define the role of resident engineers, i.e., what they are and what they do. He explained that the committee first wants to establish the resident engineer as an important entity and later on (perhaps 2 years from now) develop standards for recordkeeping.

He agreed with our observation that some resident engineers/inspectors maintain very poor records, including the nature of things recorded and the manner in which records are maintained and safeguarded. He further agreed that the resident engineers/inspectors should record all construction deficiencies noted during their inspections (at least in their diaries) and that all records should be well maintained and safeguarded.

He also believes that some type of ongoing record is needed showing all deficiencies noted during inspections, how and when the deficiencies were communicated to the constructor, and how and when the deficiencies were resolved. He agreed with us that

this type of record is necessary to preclude deficiencies from going untreated in the event that the resident engineer forgets them or is absent from the construction site.

We also talked with a project manager with Roy Jorgensen Associates, Inc., Engineering and Management Consultants, who is currently working as a consultant to the Tampa Water Resources and Public Works Department. He has prepared and is administering a training course to construction inspectors employed by that department. He considers accurate and complete recordkeeping by construction inspectors to be of paramount importance. He told us that recently much concern has been expressed about the legal importance of good recordkeeping. He is currently developing a syllabus for recordkeeping by resident engineers and inspectors, which he will soon use for training classes. Inspectors will be required to address 13 separate information items for every inspection they conduct.

- 1 Date, project number, contractor, inspection time
2. Weather conditions
- 3 Work performed by contractor.
4. Deficiencies and corrective measures.
5. Significant delays and causes
6. Material and equipment deliveries to the site
7. Disputes
- 8 Instructions received or given.
9. Description of accidents.
- 10 Details of extra work done by contractor outside the scope of the contract.
- 11 Visitors.
12. Record of men and equipment
- 13 Tests

The EPA Region V Chief, Municipal Engineering Section, believes it would be advantageous for LPA to formally define the role and responsibility of the resident engineer and the required documentation to be maintained. He believes there should be some provision for following up and resolving identified deficiencies but did not believe a formal management control system was necessary. He believes, however, that it would be extremely difficult for EPA to formally define the resident engineer's role and responsibility for two reasons. First, regulating the resident

engineering function would be against EPA's current philosophy of deregulation and regulatory simplification. Second, he believes that the professional engineering societies would fight such a move, since their current philosophy is that the resident engineer is there to observe construction and see that the contractor builds the project the way it should be, and that the contractor is responsible for managing the construction.

Corps North Central Division officials believe that it would be very difficult for EPA to develop resident engineering standards since EPA is currently reducing its regulations rather than increasing them. In addition, the duties and responsibilities of the resident engineer vary with the expertise and desires of the grantee. The level of required resident engineering documentation varies with the responsibility and authority assigned to the resident engineer.

According to Corps inspection staff, all engineering firms have essentially the same basic system of records. Although resident engineers keep these records, there is great variation in how well they are kept. The inspection staff believes that standardized records, although a nice idea, would not change this variability and are unnecessary if construction activity is sufficiently documented.

One Government agency has established resident engineering standards. The General Services Administration in its Public Building Service Handbook, dated February 10, 1981, required its construction engineers (equivalent to resident engineers) to, among other things, keep a daily diary detailing delays and difficulties encountered, work not approved, and inspection tests performed. The diary should include the type, location, and number of tests performed and the results if known. In addition, the construction engineer should insist on timely submission of test results. The construction engineer is also expected to (1) maintain a running list of items which do not meet contract requirements, making sure that all items are corrected before being covered by other work, and (2) document the correction of all deficiencies.

CONCLUSION

EPA has not issued specific instructions for resident inspectors requiring them to document day-to-day construction deficiencies or to properly maintain such important records as material test reports, correspondence, or deficiency reports. EPA provides grantees with a construction inspection guide but does not mandate its use. EPA contends that because it is operating a grant program rather than a contract program, it cannot require grantees to prescribe specific instructions to resident engineers. EPA, however, can develop and issue guidance to grantees on documenting construction deficiencies, and if resident inspectors are not following the guidance, EPA can make the documentation procedure a condition of the grant.

The resident inspectors at the sites we visited maintained a number of records, but they did not systematically record construction deficiencies or the results of any corrective action to assure timely followup on problems identified. Such records could be used to alert resident inspectors to identified problems until resolved and could also be used by the Corps during its monitoring reviews. Since such records would be designed to draw attention to problems and their resolutions, the Corps could review these areas much more quickly than now.

RECOMMENDATION

We recommend that the EPA Administrator, with the assistance of the Corps of Engineers, establish recordkeeping guidelines for resident inspectors on construction grant projects for documenting construction deficiencies, highlighting the deficiencies that need followup, and maintaining important construction records. The Administrator should issue these guidelines to grantees suggesting better documenting of resident inspections, and if residents do not follow the guidance, EPA should include as a condition in its grant awards that the resident inspectors follow the guidance.

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The acting Chief of EPA's Municipal Construction Division told us that no need existed for additional guidelines or standards because the inspection guide which EPA sends to grantees requires that daily inspection reports be prepared. He also said that because EPA is operating a grant program, it does not have the authority to tell resident inspectors what to do.

The construction inspection guide requires that the daily inspectors report include the following: weather, moisture, and soil conditions; details of each activity; difficulties encountered by the resident or the contractor; controversial matters; deficiencies and construction safety and labor violations; instructions given and received; information on construction progress; details on equipment received and stored at the site; and record tests and test results. The guide, however, does not specifically require that the inspector's report show the construction deficiencies that need followup. The guide should be revised to require that these deficiencies be highlighted to help ensure followup.

DETAILS OF THE 18 PROJECTSINCLUDED IN GAO'S REVIEW

<u>Grantee and project location</u>	<u>Total project cost</u>	<u>EPA grant amount</u>	<u>Purpose of grant</u>	<u>Percent complete as of 9/30/81</u>
Region IV				
Alexander City, Alabama	\$ 6,694,379	\$ 5,020,784	To increase the capacity of the wastewater treatment (WWT) plant	10
Dothan, Alabama	11,720,014	8,415,011	To construct a new WWT plant	21
Tuscaloosa, Alabama	4,764,902	3,573,676	To construct new pumping stations	16
Bay County, Florida, Panama City	2,997,590	2,242,568	To construct a new WWT plant	80
Daytona Beach, Florida	28,120,870	21,090,652	To construct a new WWT plant	82
Tallahassee, Florida	17,025,941	13,121,271	To increase existing capacity of the WWT plant and sludge handling facility	46
Miami/Dade Water and Sewer Authority, Dade County, Florida	100,432,596	72,226,538	To construct a new WWT plant	82
Tampa, Florida	25,567,885	19,175,914	To construct two new interceptors and a pumping station	57
Region V				
DuPage County Department of Public Works, Woodridge, Illinois	28,860,500	21,848,525	To construct an intercepting sewer and an addition to present WWT plant	14
Sanitary District of Egin, Illinois	1,290,600	967,950	To construct an addition to the laboratory and administration building	24
Urbana and Champaign Sanitary District, Urbana and Champaign, Illinois	31,597,400	23,698,050	To upgrade WWT plants	88

<u>Grantee and project location</u>	<u>Total project cost</u>	<u>FPA grant amount</u>	<u>Purpose of grant</u>	<u>Percent complete as of 9/30/81</u>
Region IX				
Flagstaff, Arizona	\$23,192,232	\$17,394,174	To increase the capacity of existing WWT plant	70
Livermore, California	10,447,000	7,782,000	To increase the capacity of existing WWT plant	18
Los Angeles, California	89,221,000	66,915,750	To construct a new WWT plant	13
San Diego, California	18,940,200	14,205,150	To improve existing WWT plant capacity	17
City and County of San Francisco, California	5,649,255	4,185,750	To construct an interceptor	26
Easter Municipal Water District of Herut, California	7,658,419	5,205,230	To construct a new WWT plant	26
Los Angeles County Sanitation District #2, Los Angeles, California	20,080,000	15,060,000	To increase the capacity of a WWT plant	44

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