Units in 1954 that the discipline was formally recognized. Each E&WP Unit had an engineering geologist on the staff and the states added geologists to their staffs as the need dictated. The importance of their contribution became more generally acknowledged in all phases, i.e. preliminary examination, planning and operation. Handbook guidance for the procedures in making geological investigations and sampling for analysis was issued in 1963 and additional technical information on the description of materials and exploration methods and equipment was issued soon thereafter.

SCS engineering geologists actively participate in professional organizations dedicated toward the perfection of their science and procedures. They have contributed to the knowledge and utilized the experience of other agencies and individuals to bring the most modern methods to field operations.

Soil Mechanics

With the varying physical properties of the earth materials used in SCS construction, SCS engineers early recognized the need to identify and characterize their physical properties. The advent of the flood control and watershed protection projects prompted the establishment of small soil mechanics laboratories to assist with the analysis and provide design criteria on complex dam sites. Early laboratories were located at the E&WP Units at Spartanburg, SC, Albuquerque, NM, and Portland, OR.

About 1954, the Soil Mechanics Laboratory in Albuquerque was moved to Lincoln, NE, and the National Soil Mechanics Unit was established with Rey Decker as the head. The Soil Mechanics Unit worked closely with the State Conservation Engineers and the E&WP Unit Design Engineers in establishing procedures for sampling sites proposed for earth dams and channels. Soil samples were forwarded to the Lincoln laboratory for testing and the preparation of recommendations pertaining to their intended use. As more and more data on soil materials were accumulated, the laboratory was able to develop helpful correlations to perfect the design process. Criteria for sampling underwent continuous evaluation and improvements were made reducing the cost of the site investigation and improving the quality of the data. The recommendations prepared for specific sites included a stability analysis for consideration by the design engineer.

Additional soil analysis was continued at the Fort Worth and Portland Technical Centers as the work load dictated. Coordination of the technical procedures was accomplished by the Washington office staff soil mechanics engineer. Depending upon the work load and complexity of the work, some states added soil mechanics engineers to their state engineering staffs.

A particular contribution that was made by SCS soil mechanic engineers was the work done in identifying and determining the properties of dispersed soils. These problem materials have long posed serious stability and erosion problems and the contribution of SCS engineers Loren Dunnigan and James Talbot and consultant James Sherard has been recognized by the profession through the presentation of the prestigious Normal Medal by the American Society of Civil Engineers for the paper "Filters for Silts and Clays."

Sedimentation Geology

Sedimentation studies have always been important to the work of the Soil Conservation Service, and from the very first, sedimentation geologists were attached to the technical staffs. Much of the knowledge of sedimentation as well as its application to the planning and operational phases of the SCS program was relatively new. The sedimentation geologist has the responsibility to determine the effects of sediment on SCS programs and conversely, the effect of SCS programs on the sediment yield.

Reservoir sedimentation surveys received much attention since they provided basic data. When analyzed, the information could be projected for estimates at other proposed impoundment sites. Early work by Henry M. Eakin and Carl B. Brown was important in establishing procedures, and during the period that SCS was authorized to conduct research, considerable attention was given to the further development of equipment and survey methods.

The advent of new programs of flood prevention and water resource development gave extra emphasis to the need for more refined estimates. Additional attention was given to the conduct of reservoir sedimentation surveys and the correlation of the results with the geologic, topographic, climatic, land use and vegetative characteristics of the watershed.

The Agricultural Research Service and U.S. Geological Survey have important responsibilities associated with sediment studies. The Corps of Engineers and the USDI Bureau of Reclamation also have interests in sedimentation processes and estimates. These and other federal agencies cooperated in the studies, and Federal Inter-Agency Sedimentation Conferences provide valuable technical exchange.

SCS sedimentation geologists continue to associate information from measurement of erosion, suspended sediment loads, and the measurement of the volumes deposited in the reservoirs to improve their knowledge of sediment delivery ratios and trap efficiencies in reservoirs.

Another important function of the sedimentation geologist is the conduct of flood plain damage surveys. Here they utilize their knowledge of sediment properties and productivity and patterns of deposition to evaluate damages resulting from infertile deposition, swamping, scour, and effects on stream channels. Here again, the conduct of damage surveys provides a base for the development of procedures leading to continued refinements and precision.

Structural Engineering

Traditionally, engineers have had the responsibility for the design and construction of permanent structures. The functional requirements of conservation systems required the development of new types of structures with unique problems. Difficult site conditions often required special solutions. Insofar as possible, site investigations established the criteria for the design--often especially established for the individual structure. In other instances, standard plans were adequate when modified for size and capacity.

With the establishment of electronic communication and data transfer and the harnessing of the power of computers, designs can now be quickly adapted for site conditions and made available to state and field offices. As the software programs and computer hardware are improved, the potential for improved structural design is great.

Landscape Architecture

The beauty of a well tended agricultural landscape has long been recognized. Early in the 1900's, USDA's Extension Service encouraged landscaping rural homesteads.

The deterioration of the rural landscape, most apparent during the decade of the thirties, was widely noticed. The causes of this deterioration were often attributed to the marginal income of the farm community as "there is little incentive for farm families to invest in the appearance of farmsteads and farms when foreclosure or sale is just around the corner." Equally important was the ugliness of the eroded and gullied lands that became more widely recognized. The application of conservation practices, especially contour farming, strip cropping and terracing, as well as the improvement of grasslands and timber tracts did much to improve the rural scene and was quickly noted and appreciated by a wider audience. In the 1960's, SCS assembled a series of color photographs, one from each state, entitled "America the Beautiful." This series was highly acclaimed and was widely exhibited. Among the many places where the full series was exhibited and observed by the author were the International Agricultural Exhibit at Cairo, Egypt, Dulles Airport at Washington, DC, and the U.S. Embassy in New Delhi, India. Many companies and individuals selected favorites for use in their offices and homes. Probably the impact of this series has not been fully appreciated.

In 1965 President Johnson, with the strong supporting interest of Lady Bird Johnson, the First Lady, assigned Secretary of Agriculture Orville Freeman the responsibility for Federal leadership for beautification on privately owned rural lands. SCS was given an important role since natural beauty is a normal product of effective soil and water conservation practices. The Resource Conservation and Development projects together with the pilot and P.L. 566 flood control projects gave even more opportunities for incorporating visual composition in the design of works of improvement.

Though it has been reported that landscape architects were on the staff when the agency was created, it was not until 1971 that a landscape architect was added to the staff of the Engineering Division and later supplemented with staff positions in the regions and states. Originally the primary purpose was to enhance the beauty surrounding major water resource structures including related recreation facilities. As appreciation of the benefits grew among the SCS staff and district officials, more attention to the visual aspects was included and environmental design is now incorporated in the day-to-day conservation activities.

Environmental Engineering

Environmental concerns were largely responsible for the establishment of the Soil Conservation Service. The dust storms of the early 1930's dramatically demanded the attention of the nation and the Congress. The depreciation of the agricultural resource finally became recognized and the initial effort was the control of wind and water erosion. These measures had considerable related beneficial impact through the improvement of landscape features, i.e., improvement of cultivated areas, grasslands, and forests. The impacts on fish and wildlife by the improved coverand water impondments were also significant.

SCS engineers provided considerable data to the newly formed Environmental Protection Agency (EPA) when it was first established and faced with the task to rapidly initiate techniques and standards.

Since SCS is the water agency within the Department of Agriculture, SCS engineers have long been concerned with its quality, its conservation, and its disposal. Therefore they were in an excellent position to provide leadership when agricultural waste disposal became a national concern. Similarly, they have had an impact on the programs to preserve groundwater quality and agricultural chemical control.

Computer Modeling and Software

From the advent of electronic data processing equipment, SCS engineers have recognized their potential in reducing planning time and cost. The small programmable electronic calculators came into widespread use and often permitted designs to be completed in the field without extra trips to the office. Many field engineers developed their own programs adapted to their special conditions.

When hydrology and hydraulic modeling were needed to design watershed projects, the capabilities of computers were apparent. About 1954 both the CTU and DU were working on software to reduce costs and improve quality in planning and design. In 1958 a program for determining water surface profiles was introduced. Complex hydrology programs were developed through contracts proposed and monitored by the SCS staff. Improvements in communications and data transmission capability between the design and field offices made the developments even more useful.

In 1984 the Engineering Division established the Engineering Software Work Group to develop a plan for automating engineering design and construction drawings in the 3,000 SCS field offices. The plan was approved in June 1987 and software development of Field Office Engineering Software (FOES) began with a projected completion date of 1993. FOES is considered to be the largest software effort ever undertaken by SCS. The activities include 13 teams of SCS technical staff, involving about 80 employees representing the National Headquarters, National Technical Centers, and state staffs.

SCS has always been a production oriented organization. Because of this, it has not been easy to commit staff and time to the maintenance of technical materials. During the mid 1980's, the acceleration of software development has produced the policy that all nationally developed SCS software would be maintained through specifically assigned staff responsibilities. Leadership will be provided by the discipline leaders and the National Engineering Technology Development and Maintenance Staff. It will be a challenge to budget sufficient staff resources on a continuing basis to properly maintain the Service's software.

DEVELOPMENT OF ENGINEERING APPLICATIONS FOR SCS PROGRAMS

Erosion Control

Soil erosion control was the first and principal interest of the newly organized Soil Conservation Service. Techniques for the installation of terraces and gully control devices were known to professionals, but even the need for such measures was not recognized by the general farm community. A number of demonstrations had been installed by the Extension Service and the agricultural colleges, but in many areas the practices had not caught on. The drought of the 1930's combined with some extreme rainfall events did much to gain attention. The demonstration projects and ECW camps together with the educational activities of the Extension Service generated interest. Many farmers first agreed to conservation measures not so much because they were concerned about soil loss, but because the heavy rains washed out their newly planted crops and the washes and gullies that formed in the fields interfered with their farming practices.

A prime need for the implementation of a successful erosion control program was the development of machinery for farm use that overcame the problems the farmer met in adopting conservation measures. For many years the SCS Engineering Division had a staff member who worked with agricultural colleges and machinery manufacturers to encourage the development of needed equipment for both farm operations and construction. This task is now mostly done by the private equipment manufacturers.

In some areas strip cropping and contour farming combined with vegetative practices gave adequate protection. On these sites, engineering skills were needed for planning and layout.

Many farmers resisted terraces since the conventional measure of a good farmer was the straightness of his furrows. Farmers generally would first accept contour farming and later when they found that some reinforcement was needed, they accepted the need for terraces. Many still farmed with horses or small tractors and power for on-farm terracing was limited. For awhile there was great interest in "plow" terraces since the farmer could build these with his own equipment. However in most instances they were not built to the necessary height and frequently had very crooked alignments.

As contractors equipped with better machinery became available, much of the terracing work was more adequately constructed and alignments were improved to ease farm operation. Continued progress and availability of earth-moving equipment permitted gradual acceptance of parallel terraces and bench leveling.

Except in areas with permeable soils, a water disposal system was needed to convey the runoff from the terraces to a lower stable channel. Some of the early demonstrations relied on drop structures but it was soon apparent that in most instances, well shaped vegetative channels were adequate, could be installed at lower cost, and were more acceptable to the farmer. The flow characteristics of vegetated waterways carried high priority for research and the procedures developed by SCS have received worldwide acceptance.

As the size of farming equipment increased, there was more pressure to eliminate turnarounds and to utilize all the area available for cultivated crops. The use of herbicides sometimes destroyed the vegetated waterways and an alternate outlet design was needed. Increased attention was given to land forming to provide smooth contours as nearly parallel as practical and the installation of parallel terraces with buried pipe drainage outlets. The temporary storage capacity of the terraces was used to reduce the peak flow, thereby reducing the size of the pipe needed and allowing additional infiltration in the terrace channel because of the longer period of ponding.

Gullies have always been a great concern in the farm community and their rapid advancement led many farmers into the conservation movement. Here again many of the early methods relied on structural control until the possibilities of some vegetative measures were noted. Brush dams and diversions were early popular mechanical measures--now largely supplanted by vegetative control. Drop structures, drop inlets, and chutes are still required to control difficult sites.

Farm ponds have always been a principal measure involving engineers. Progress over the years has included the improvement in site selection, better runoff prediction, the use of trickle tubes and temporary detention storage to reduce flow through earth spillways, and improved construction standards and inspections.

Irrigation

When SCS was authorized to assist farmers with their irrigation problems in 1938, many SCS engineers, having a strong farm background and having been educated in western colleges, had a good working knowledge of irrigation methods. And in 1939, strong leadership in the technical field was provided by the transfer of research personnel from the Bureau of Agricultural Engineering. In 1939, a Division of Farm Irrigation in the Washington office was established and W. W. McLaughlin, long-time chief of the BAE, was appointed director. In 1942 though still assigned to the Washington Office, his headquarters were established at Berkeley, CA. In 1940, he reported that the principal lines of investigation included: irrigation requirements, evaporation studies, spreading water for storage underground, rainfall disposal, snow surveying, alkali reclamation, conveyance of water, design and invention of irrigation apparatus, laws, customs and regulations, and the engineering and economic feasibility of irrigation enterprises. His division remained in the research group but the close association had its influence on operations programs. The first regional irrigation engineers were located in the West and as the practice moved eastward, they were gradually added to the staffs of other regions.

In 1946, Dr. McLaughlin was succeeded by George D. Clyde, previously Dean of the School of Engineering and Technology, Utah State University, and his headquarters were transferred to Logan, Utah. Dr. Clyde was a strong advocate of close relations between research and operations and in April 1952, he and his assistant, Wayne D. Criddle, promoted and attended a conference of the regional irrigation engineers at Albuquerque, NM. At that time, Tyler Quackenbush was the Irrigation Engineer on the Washington staff and there were irrigation engineers in the regional engineering divisions at

Spartanburg, SC; Fort Worth, TX; Lincoln, NE; Albuquerque, NM; and Portland, OR. This was the first national meeting of any of the engineering specialists from the regions. The conference served to bring field problems to the attention of the research personnel and to establish the first tentative steps to prepare standards for irrigation practices. Later the Washington and regional irrigation engineers were included in the national meetings of the SCS research staff and as a result, close relationships developed. Dr. Clyde regarded the field operations of SCS as the largest and most practical laboratory that ever existed to study irrigation. Research personnel assisted in training meetings for state staffs and were available for consultation and help with difficult technical problems.

An example of the latter was a problem on the Eden Valley Wheeler Case project on which SCS had development responsibility. The Bureau of Reclamation had classified a large area of very sandy land as irrigable and SCS was obligated to prepare it for sale to veterans. Since surface irrigation was not practical and sprinklers could not be economically justified, a joint study came up with a subirrigation design which was successfully applied.

In 1954 the transfer of research activities to ARS largely ended this close interaction, though the transferred personnel without exception continued close informal relationships and cooperation. The success of the early collaboration continues to influence relationships between SCS and ARS.

Drainage

Until 1938, SCS was not authorized to do drainage work. However for a number of years the USDA BAE had been conducting research on drainage problems. On June 25, 1935, the first CCC drainage camp was authorized and was administered by the BAE. During the next few months a total of 46 drainage camps were established in the southern and eastern states. These camps were authorized to rehabilitate main drainage canals serving districts or groups and provide adequate outlets for the private lands. No work was performed on private lands. S. H. McCrory was Chief of the Bureau, and L. A. Jones was Chief of the Division of Drainage. John G. Sutton, later the SCS chief drainage engineer, was district engineer for the BAE at that time and supervised 36 of these camps.

Thirty-eight of these CCC drainage camps were transferred to SCS on July 1, 1939, and in 1941 drainage was approved as a conservation practice to be included in conservation farm plans. Drainage activities were further expanded by the Flood Control Act of 1944 and the Federal Watershed Protection and Flood Prevention Act of 1954.

As irrigated areas continued to expand and flood control projects came into being, drainage technology became more and more important in the planning and application stages. SCS drainage engineers were recognized leaders and the drainage handbook they prepared became an important document used throughout the profession. In 1972 this handbook was reprinted in its entirety by the Water Information Center, Inc., "to make it available to all persons and organizations interested in the management of water resources for the benefit of man."

Flood Control and Soil and Water Resource Development

The Watershed Protection and Flood Prevention Act further expanded the engineering responsibilities and established the Soil Conservation Service as a major agency in the protection and development of small watersheds.

Suddenly, planning engineers were needed to conduct engineering preliminary examinations and meet with other professionals to prepare plans that met the objectives of the local sponsoring organization. Hydrologists and hydraulic engineers, geologists, sedimentationists, agricultural engineers, and others worked with other professionals in studying alternative approaches to the problems. Watershed plans had to be prepared which would permit evaluation by Congressional committees to authorize funds for construction.

These programs plus the river basin studies, flood hazard analysis, flood insurance studies, and the later organized Resource Conservation and Development (RC&D) program were administered by the Watershed Projects Division which had on their staffs a number of engineers to facilitate program operations. The detailed design and construction remained the responsibility of the Engineering Division.

Design engineers were involved with developing plans and specifications for complex structures of a size not previously constructed by SCS. Construction engineers carried greater responsibilities in inspection and documentation as well as involvement in safety and providing quantity of work data for contractor payments.

In the 1950's when hydrology and hydraulic modeling were needed to design watershed projects, SCS engineers provided leadership in computer modeling.

Water Quality

In the late 1980's, the Department of Agriculture and SCS developed policies involving water quality and quantity for both surface and ground water.

Environmental engineers and geologists initially provided leadership in addressing the issue. However, it was quickly recognized that the involvement of drainage and irrigation engineers was essential. As the program developed it became apparent that all of the engineering disciplines are needed in the planning, structure design, construction, and operation and maintenance. The key for the future is how to implement this program at the field level.

The 1985 Farm Bill

The 1985 Farm Bill included provisions that required farmers to develop plans to reduce erosion on highly erosive croplands and to protect existing wetlands.

Many professionals believed engineering staff involvement would be minimal because most work involved conservation planning, management practices, and followup. As implementation proceeded, it became obvious that low initial cost engineering practices were essential to the program and assistance from agricultural engineers and other engineering disciplines was needed. In addition, the wetland issue required accelerated engineering training of the staffs at the state, area, and field office levels.

DEVELOPMENT OF ENGINEERING MANAGEMENT

The overall management of an engineering project involves the planning, design, construction, operation, and maintenance of the facility.

Design

The design function is a composite of all the engineering specialties in that it utilizes the expertise of all of the applicable fields to produce an engineering design that meets the requirements of a plan. In SCS, the design engineers have a special responsibility to develop effective, durable, economical, and safe hydraulic structural plans that will meet the conservation objective.

In the early days of the Service, the design responsibility was in the hands of the field engineers since at that time, structural works were of a relatively simple type well within their capabilities. As described earlier, when unusual structures were required, the design was approved by a more experienced engineer. The first design engineers were attached to a few of the erosion control projects and the early regional engineering divisions. The specialty received additional recognition with the initiation of the Engineering Standards Unit in 1949.

As programs for water development and conservation became more and more complex, the design function grew in importance and design problems arose for which there were not conventional solutions. Especially in the area of hydraulics, problems were encountered that required ingenious approaches that needed to be verified through research and field trials prior to adoption in important structures. Fortunately the relationships that had developed between research and operations personnel when SCS had some research responsibility continued. Collaborative efforts led to successful results.

Engineers always realized that a more conservative design was required for large dams as compared to small farm ponds and in the 1950's a classification system was first proposed, based upon the potential for downstream damage should the dam fail. The hazard class system that was eventually developed by SCS has been widely adopted by the profession. It was incorporated unchanged in the Corps of Engineers 1974 guidelines for inspection of nonfederal dams. Different private and government organizations have modified the system somewhat but the basic principles are still in use.

One concept pioneered by SCS was the use of earth spillways on important storage structures. From the very beginning of SCS, earth spillways were used on small farm ponds. Most were satisfactory but with larger drainage areas, some spillway erosion was experienced because of the prolonged flow. The first approach to this problem was to install "trickle tubes" or primary structural outlets that had a limited flow capacity but utilized some of the storage capacity of the reservoir to reduce the frequency of flow through the earth spillway. Field experience from the hundreds of thousands of earth spillways built by SCS led to increased confidence in their practicability for successfully handling infrequent flows. Field experience provided increasingly refined design. The principle of limiting flow volume (flow duration and magnitude) provided assurance of maximum performance without the danger of breaching. Consideration of the frequency of operation and stability evaluation for infrequent storm occurrence provided for a reasonable risk of maintenance level. The majority of the flood control dams constructed by SCS could not have been economically justified without dependence on earth spillways to convey large infrequent flows.

Drop inlets have been widely used by SCS for erosion control in cases where vegetative measures would not be effective. The "standard" design had an open vertical riser connected to a horizontal pipe or monolithic outlet. Some of these were found to be dangerous and a few reports of fatalities when people were being caught and washed through these structures created concern. The size of the inlets being constructed also increased and it was obvious that some sort of a safer design was needed. Safety fences around or racks installed over the inlets collected trash and interfered with flow. The development of a covered top inlet for risers on conduit spillways is an excellent example of collaboration between research and operations. The design was originally conceived by the SCS design staff and the hydraulic elements were tested and refined by the St. Anthony Falls Hydraulic Laboratory. The design assumptions to prevent clogging by trash were verified and refined by the Outdoor Hydraulic Laboratory at Stillwater, OK.

Industry too cooperated in the development of solutions of problems that arose. Special note should be made of the cooperation of the American Concrete Pipe Association in producing reinforced concrete pressure pipe with a special gasketed joint that provided the extensibility and watertightness required for conduits in SCS dams built on yielding foundations. Metal pipe manufacturers produced special appurtenances and fittings (inlet riser fittings, watertight couplers, antiseep collars, etc.) that were needed for certain classes of SCS dams.

The advent of computers in some respects revolutionized SCS design, in that it permitted consideration and evaluation of many more optional solutions and provided a means for rapid completion of the design. A catalog of standard drawings for structural components has provided a rapid source of construction drawings meeting common needs.

Construction

Some of the engineers assigned to equipment supervision in the early days were in reality the predecessors of the present construction engineers. Heavy construction equipment was not commonly available and the government acquired a considerable amount of earth-moving equipment, tractors, drag lines, etc., to facilitate the work in the projects and CCC camps. To utilize the labor force available, transportation equipment and supplies of construction equipment and tools had to be provided and maintained. Training of operators and the conduct of safety programs were also important.

Until SCS became involved in major construction works required by the flood control and watershed protection and RC&D projects, construction inspection could be carried out by the field engineers attached to the projects, CCC Camps and soil conservation districts. Only spot checks were necessary to assure quality and adherence to the plan on the early works that were constructed by the farmers or local contractors hired by the farmers.

As larger and more complex structures were encountered and the construction done by contract, it became necessary to develop a cadre of construction inspectors with facilities to make construction surveys, sample and test construction materials, enforce safety requirements, assure that contract specifications are met, and to report the quantities of work performed for payment. Generally the contracts were let by local sponsoring organizations. Depending upon local conditions and the desires and competence of the sponsors, there have been a number of different arrangements for conducting the work. Usually an SCS inspector had the total responsibility or supervised or spot checked the work of inspectors provided by the sponsoring organization.

Together with other flood control and resource conservation and development programs, the number of dams constructed by the SCS under project activities now exceeds 10,000.

Operation and Maintenance

The responsibility for operation and maintenance of engineering structures installed with the help of the SCS lies with the land owner or project sponsors. They are subject to state laws regarding inspections, maintenance and repair as they apply to important works. SCS engineers assist project sponsors in developing operation and maintenance plans and as requested, in providing technical advice on specific problems.

Because of the large number of high-hazard dams constructed with SCS engineering assistance, the staff has always felt a responsibility to take an active role in promoting programs to insure the safety of downstream interests. When dam safety became a national concern in the 1970's, SCS engineers cooperated with the Corps of Engineers, the Bureau of Reclamation, state authorities, and private organizations in developing an inventory of large dams and a recommended procedure for a national inspection program.

It is recognized that there are a great many dams in the United States that need rehabilitation and modification to meet current dam safety standards. Only the very highest priority high-hazard dams are being updated because of the lack of funds available to the owners and sponsors. If funding became available, the work load of the SCS staff in providing technical assistance to the sponsors in rehabilitating this important part of the nation's infrastructure would be tremendous.

Presently, the SCS state staff spends considerable time in assuring that dams continue to be safe and in evaluating alternatives when it is judged that repairs are needed. In 1983, SCS policy required that all future high-hazard dams include an Emergency Action Plan (EAP). This plan must be completed by the sponsor prior to the construction of the dam.

In the 1980's, the Association of State Dam Safety Officials (ASDSO) was organized and developed into the leading dam safety advocate for state dam safety legislation and programs. In 1988, the SCS Engineering Division brought to the attention of the ASDSO that the EAP's for many high-hazard dams were not kept up to date and were not being reviewed and tested. State and

Federal agencies agreed that this was a major problem and neededaction. Efforts were initiated by SCS to involve ASDSO with SCS state staffs in encouraging sponsors to update and test their EAP's. In addition, all sponsors of SCS-assisted projects were encouraged to develop and EAP for any high-hazard dam constructed prior to 1983.

At their 1989 annual conference in Albuquerque, the ASDSO presented the ASDSO National Award of Merit to Donald L. Basinger, Director, Engineering Division, SCS, for leadership in dam safety. The president of ASDSO stated,

> *through the SCS's successful national dam safety program and its work with ASDSO, dam safety in the United States is on the rise.*

SCS LEADERSHIP IN THE ENGINEERING PROFESSION

USDA-SCS has the responsibility for a national program for soil and water conservation. As priorities and programs change, engineers will continue to be vital to all soil and water conservation activities.

SCS engineers and geologists have continually exhibited leadership in their specialized fields and have maintained relationships with other professional organizations and societies to advance the technology and practice. Some examples are:

Consensus Standards

For many years SCS has developed standards and specifications for all the engineering conservation practices and has worked with various professional societies and commercial organizations to assure state-of-the-art practice. Each specification is updated often. Since 1964, SCS engineers have been in the lead and have directed the use of ASTM (American Society for Testing Materials) standards for all SCS engineering work instead of the still available federal standards. In 1968, the Federal Government encouraged the use of consensus industry standards for use by all agencies.

In the 1980's, the SCS engineering staff at the National Headquarters and the four NTC's made major contributions in developing ASTM standards through leadership on ASTM committees. In addition to consensus standards for materials, SCS engineers have been working with technical and professional societies to establish consensus technical standards for systems of soil and water conservation measures. The goal is to have Federal-state standards and specifications for all conservation practices that will be acceptable to all groups.

Technical Materials

SCS engineering handbooks, technical releases, and notes are being used worldwide. Many requests for these materials come from students and individuals, from libraries and other agencies, and from foreign governments and international offices. Traditionally, requests have come to and were filled by state offices, the Engineering Division, the Information Division or Central Supply. Because of the great demand for these materials, a change in the distribution system was necessary. Now most technical materials are sold by the National Technical Information Service in Springfield, VA. Some complimentary copies are provided by SCS offices as the circumstances dictate.

Currently the Engineering Division is participating with about 15 countries in an international effort with the Food and Agricultural Organization (FAO) of the United Nations (UN) to collect and share technical materials with developing countries. The effort is called Inventory of Proven Operational Technology (IPOT). It has great potential to expedite U.S. Agency for International Development and World Bank projects by reducing the duplication of development of technical materials for their projects worldwide.

SCS has planned and installed more earthfill dams and vegetated emergency spillways than any organization in the world. With this experience came a recognized responsibility to develop and share new cost-effective technology for these dams and emergency spillways. Some recent innovations include:

Sand and Gravel Filter Criteria

Over the years much has been learned about the mechanics of failure in earthfill dams. One of the most significant improvements in design has been the development of filter criteria to protect against all types of cracking and seepage. With the leadership of SCS engineers, these criteria have been included in the ASTM standards for the entire engineering and construction community.

Filter Diaphragms

Traditional design to prevent seepage along principal spillway conduits has been to install impervious rigid collars around the conduits. However, observations at many site have shown significant deficiencies associated with rigid collars, especially those made of reinforced concrete. In 1984, SCS developed and implemented a new design to replace the rigid collars with filter diaphragms composed of sands and gravels. This new filter diaphragm intercepts and safely conveys any seepage that might occur along the principal spillway to a suitable outlet. It is probable that this innovation will gain acceptance in the engineering profession worldwide as a major improvement in the design of small earthfill dams.

Spillway Studies

Because of the large number of dams designed and constructed by SCS, there are many emergency spillway discharge events from major storms over the nation. Many opportunities exist to study the damage resulting from major flows in these spillways. SCS began observing, recording and analyzing these events in the 1960's, and major improvements in emergency spillway layout and design in both earth and rock spillways are being made. The intention is to report these improvements to the engineering profession through technical papers presented and published for peer comments and reference.

In addition, special studies are being made of principal spillway conduit materials, which will lead to improved life of projects. The studies have focused on projects in Kansas and surrounding states because of the large number of project dams available for study.

SOME PERSONAL OBSERVATIONS

One of the most attractive features to young engineers employed by the Soil Conservation Service is the opportunity to visualize a project, prepare or assist with its design, supervise construction, and finally have the opportunity to see and evaluate the finished product. They need not be constrained to only one part of the process.

It is a mistake to associate certain disciplines with certain programs. The team approach has been proven successful. All disciplines should be a part of the team responsible for policy, planning, implementation, and evaluation.

SCS has a national engineering delivery system to be envied. Whereas, many Federal and private sector organizations have regional and branch offices that are autonomous, the SCS system promotes uniform engineering quality, minimizes duplication of efforts, and shares tools and techniques nationwide.

It is also gratifying that the engineering organization provides a great deal of training and support to the technical staffs. Whenever a difficult technical problem is encountered, it can be referred to peers or upward in the organization for advice and assistance. The numbers and varied experience of the engineering personnel can usually provide the needed guidance. In the rare instance when this is not possible, SCS is prepared to refer the problem to research institutions and commercial companies for solution or establishing the state of the art.

The loss of the research function in 1953 had an adverse effect on the rapid perfection of new engineering techniques. When research and operations personnel were closely associated, problems could immediately be addressed and priorities established. The close working relationship which had developed between research and operations personnel continued for some time after their separation (especially with the researchers who had been with SCS) and though efforts to continue these personal associations have been made, the effectiveness of the system declined somewhat. However, an example of close collaboration between SCS and ARS engineers is the working relationship developed on top priority soil erosion and water quality models.

The Service should give more encouragement to all engineering personnel throughout the organization to actively participate in professional societies. Of course, this carries the corresponding responsibility to prepare and present technical papers. It is of interest to note that in 1989 Soil and Water Transactions of the American Society of Agricultural Engineers, the SCS was barely represented. Of the 136 papers published, only two SCS employees had contributed. Participation in technical societies not only provides the opportunity for professionals to keep on the cutting edge of their technology but also brings the technical excellence of SCS to the attention of other professionals in both the private and public sector. The personal relationships acquired through participation pay great dividends in cooperative efforts and assure SCS of a strong voice in promoting its programs.

There have been periods in the past when policy did not permit the names of the authors of technical publications, papers, and handbooks to be noted. As a result, many technical developments conceived and perfected by SCS engineers have been rewritten and presented by others. With the passage of time, these other individuals become recognized for work that properly should have been credited to an SCS engineer or group. It is strongly recommended that reports of engineering techniques and processes developed by Service engineers carry acknowledgement for the individual or groups that participated in its preparation.

Maintaining qualified area engineering staffs is highly cost effective. This is especially true as the service is faced with implementation of programs such as RC&D, 1985 Farm Bill, and technical assistance on water quality and quantity, without additional field office staff. Much of the demand for complex technical engineering assistance to local units of government can most effectively be handled by engineers located at the area office level.

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Pridgeon, T.O. . . . . Asst. Erosion Specialist, ... Lindale, TX
Quate, Graham S. . . . . Asst. Ag. Engineer, ... Albuquerque, NM
Quertermous, R.M. . . . . Asst. Ag. Engineer, ... Conway, AR
Ramser, C. E. . . . . Acting in Charge, ... Watershed Studies, Washington, DC
Rau, William M. . . . . . Ag. Engineer, Stafford, AZ
Reese, Carroll A. . . Jr. Ag. Engr., La Crosse, WI
Reese, Robert J. . . . . Jr. Ag. Engineer, ... State College, PA
Reid, Earl C. . . . . . Jr. Ag. Engineer, Conway, AR
Reynolds, F. S. . . . . . . Ag. Engineer, Dalhart, TX
Rich, Lowell R. . . . . Asst. Ag. Engineer, ... Albuquerque, NM
Richards, R. S. . Sr. Draftsman, Santa Paula, CA
Ricker, Conny C. . Asst. Ag. Engr., Paducah, KY
Riddell, Glen E. . . . . Chief Erosion Spec., ... Conway, AR
Riesbol, H. S. . . . . Assoc. Ag. Engr., Guthrie, OK
Roberts, W. M. . . . . Jr. Erosion Spec, ... La Crosse, WI
Robinson, Frank . . . . Jr. Ag. Engineer, ... Albuquerque, NM
Roth, Arthur T. . . . Jr. Ag. Engineer, Indiana, PA
Russell, David A. . . . . Asst. Ag. Engineer, ... Champaign, IL
Ryan, Dennis M. . . . Jr. Ag. Engr., La Crosse, WI
Ryerson, Gerald E. . . Ag. Engineer, La Crosse, IL
Sally, J.F. . . . . Jr. Ag. Engineer, Bath, NY
Sauser, Cyril J. . . . . Assoc. Ag. Engineer, ... Albuquerque, NM
Scheiin, R. G. . . Jr. Erosion Spec., La Crosse, WI
Schiff, Leonard . Jr. Ag. Engr., Santa Paula, CA
Schlaudt, Edo A. . . . . Asst. Ag. Engineer, ... High Point, NC
Schoenlabor, L. H. . . . . Asst. Ag. Engineer, ... Bethany, MO
Seavy, Louis M. . . Jr. Engineer, Washington, DC
Shockley, Dale R. . . . . Asst. Ag. Engineer, ... Albuquerque, NM
Small, Warner B. Asst. Ag. Engineer, Albion, NE
Smith, Dwight D. . Asst. Ag. Engr., Bethany, MO
Smith, Henry N. . . . . Erosion Spec., Lindale, TX
Smith, Sam, Jr. . . . . Jr. Ag. Engineer, ... New Brunswick, NJ
Solomon, Lester . . . . . Asst. Erosion Specialist, ... Paducah, KY
Spencer, C. B. Chief Erosion Spec., Lindale, TX
Springer, Dale E. . Asst. Ag. Engr., Bethany, MO
Stager, Walter E. . . . . Jr. Erosion Specialist, ... New Brunswick, NJ
Staley, John N. . . . . . . Asst. Erosion Specialist, ... La Crosse, WI
Stambaugh, V. W. . . . . Assoc. Ag. Engineer, ... Colorado Springs, CO
Steen, Enoch R. . . Jr. Erosion Spec., Dalhart, Tx
Stephenson, N. P. . . Erosion Spec., Lindale, TX
Stevenot, Edward W. . . . . Jr. Ag. Engineer, ... Santa Paula, CA
Stoker, John R. . . . . Asst. Ag. Engineer, ... Colorado Springs, CO
Stokes, Charles M. . . . . Chief Erosion Specialist, ... Stafford, AZ
Stott, Hester M. . . . . . . Asst. Erosion Specialist, ... High Point, NC

Struble, Vern T. .... Erosion Spec., Indiana, PA
Sturgeon, Ralph A. . Ag. Engineer, Conway, AR
Tagge, Herman F. Erosion Spec., La Crosse, WI
Tardy, Fred E. ...Jr. Engineer, Washington, DC
Taylor, Benjamin L. .Ag. Engineer, Meridian, MS
Taylor, Delbert H. .... Asst. Erosion Specialist, ...Lindale, TX
Teare, D. W. . Asst. Ag. Engineer, Champaign, IL
Tetrud, William H. . .Jr. Ag. Engr., La Crosse, WI
Teute, William E. . .Asst. Ag. Engineer, Bath, NY
Thalmann, V.W. ... Asst. Ag. Engr., Conway, AR
Thigpin, Robert L. .Jr. Ag. Engineer, Temple, TX
Thomas, Calvin D. . .Jr. Ag. Engr., La Crosse, WI
Thomas, Horace L. ... Asst. Erosion Specialist, ...La Crosse, WI
Thompson, Fred A. .... Jr. Ag. Engineer, ... Spartanburg, SC
Thornthwaite, C.W. ....Acting in Charge, ...Climatic Investigations, Washington, DC
Tillotson, R. J. . . Jr. Ag. Engineer, Bethany, MO
Tribou, Henry R. . .Jr. Ag. Engr., High Point, NC
Tschudy, Lionel C. ... Ag. Engineer, Huron, SD
Utz, Ervin J. . Acting in Charge, Erosion Control, ... Washington, DC
Vail, Theodore P. ....Asst. Ag. Engineer, ... New Brunswick, NJ
Van Doren, Loyal, Jr. .... Jr. Ag. Engineer, ...La Crosse, WI
Varnell, Earle H. .... Erosion Spec., Lindale, TX
Voelker, Eugene I. .... Jr. Ag. Engineer, ... New Brunswick, NJ
Voelker, Eugene I. .... Jr. Ag. Engineer, ... New Brunswick, NJ
Wackerbarth, H. F. ....Asst. Ag. Engineer, ... Stafford, AZ
Walker, Walter H. ...... Chief Erosion Specialist, ...Muskogee, OK
Wallace, Harry M. .... Chief Ag. Engineer, ...Muskogee, OK
Walter, Davis H. ...... Asst. Erosion Specialist, ...Indiana, PA
Wanser, Henry M. .... Chief Erosion Specialist, ...Pullman, WA
Warner, William C. ... Asst. Erosion Specialist, ...Greensboro, NC
Waters, Louis W. ....Asst. Ag. Engineer, ...Santa Paula, CA
Watson, Alvin C. ...Asst. Ag. Engr., Indiana, PA
Welch, C. H., Jr. ...... Asst. Erosion Specialist, ...La Crosse, WI
Weld, William A. ....Asst. Ag. Engineer, ...Greensboro, NC
Weston, Earl P. ...... Chief Erosion Specialist, ... Stillwater, OK
White, Robert G. ... Jr. Ag. Engr., Bethany, MO
Whitmus, Harold V. . . Sr. Draftsman, Huron, SD
Wickes, Dean R. ...... Acting Chief,Research, ...Washington, DC
Wiggins, James E. . . Jr. Ag. Engr., Danville, VA
Wight, George D. ..... Asst. Erosion Specialist, ...La Crosse, WI
Wilder, Carlos B. ...Jr. Ag. Engr., Americus, GA
Wilson, Norman W. .Ag. Engineer, Dadeville, AL
Witherell, Robert E. . .Ag. Engineer, Stafford, AZ
Wolfe, Emerson . Jr. Ag. Engineer, Bethany, MO
Wolfe, Peter E. .... Jr. Erosion Specialist, ...New Brunswick, NJ
Womble, William R. .Asst. Ag. Engr., Minden, LA
Wood, James B. ..... Asst. Erosion Specialist, ...Spartanburg, Sc
Woodburn, Russell ...... Assoc. Ag. Engineer, ...Paducah, KY
Woodruff, C. M. ... Coop. Agent (Erosion Asst.), ... Bethany, MO
Woodyard, Donald H. ...... Senior Draftsman, ... Stillwater, OK
Worthington, J.P. ....Asst. Ag. Engineer, ...Albuquerque, NM
Wrenn, Frank G. Asst. in Research, Dadeville, AL
Wright, C.W. .Asst. Ag. Engr., Albuquerque, NM
Wright, Irvin D. .... Jr. Ag. Engineer, Albion, NE
Yeo, Herbert W. ....Asst. Ag. Engineer, ...Albuquerque, NM
Yesland, Alfred . Jr. Ag. Engineer, Pullman, WA
Young, Vilas D. . Asst. Ag. Engr., Zanesville, OH
Zwerner, Gene A. .Jr. Engineer, Washington, DC

Note: Some of the Erosion Specialists were not engineers by training but their duties required an understanding of engineering techniques as well as expertise in agronomy and soil science.

ENGINEERS AND RELATED PROFESSIONALS IN TECHNICAL LEADERSHIP POSITIONS SOIL CONSERVATION SERVICE

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. . . . George D. Clyde
. . . . Chester J. Francis
. . . . John T. Phelan
. . . . Neil F. Bogner
. . . . Buell M. Ferguson
. . . . Donald L. Basinger
. . . . *Gerald D. Seinwill

Deputy Director . . . . *Wendell B. Moody

Asst. Director . . . . Samuel B. Andrews
. . . . William X. Hull
. . . . John G. Bamesburger
. . . . John T. Phelan
. . . . Harold C. Enderlin
. . . . Neil F. Bogner
. . . . R.C. Barnes
. . . . Robert M. Pasley
. . . . Donald L. Basinger
. . . . Wendell B. Moody

Agricultural Engineering . . . . T.B. Chambers
. . . . R.L. McGrath
. . . . C.L. Hamilton
. . . . Arnold Davis
. . . . James J. Coyle
. . . . R.C. Barnes, Jr.
. . . . Richard E. Highfill
. . . . *Lee P. Herndon

Civil Engineering . . . . Raymond H. Davis
(Work Plans) . . . . Alfred M. Hedge
. . . . Richard E. Reinke
. . . . William G. Shannon
. . . . Clarence E. Ghormley
. . . . Arthur B. Holland
. . . . Richard E. Highfill
. . . . Edgar H. Nelson
. . . . Joseph S. Haugh

Construction . . . . John S. Grant
. . . . W.A. Holweg
. . . . H.R. McCall
. . . . Hans G. Jepson
. . . . Chester J. Francis
. . . . John G. Bamesberger

. . . . Melvin M. Culp
. . . . Paul E. Nylander
. . . . *Mervin R. Ice

Design . . . . Wallace Ashby
. . . . Chester J. Francis
. . . . John G. Bamesberger
. . . . Melvin M. Culp
. . . . Alan S. Payne
. . . . David C. Ralston
. . . . *James R. Talbot
. . . . *John A. Bevard

Drainage . . . . Lewis A. Jones
. . . . Roger D. Marsden
. . . . John G. Sutton
. . . . Louis W. Herndon
. . . . Walter J. Ochs
. . . . Richard O. Wenberg

Engineering Geology . . . . Victor H. Jones
. . . . Earl F. Dosch
. . . . Alfonso F. Geiger
. . . . Peter V. Patterson
. . . . Louis Kirkaldie
. . . . James B. Hyland

Environment, Water Quality & . . . . J.B. Thomas
Waste Management . . . . Louis Brandt
. . . . Charles E. Fogg
. . . . *James N. Krider

Erosion Control Specialists . . . . . Lewis A. Jones
. . . . Glenn L. Fuller
. . . . G.W. Musgrave
. . . . Alva D. Brandt
. . . . Forrest G. Bell
. . . . Gilbert B. Posey

Climatic Investigations C. Warren Thornthwaite
& Erosion Ecology . . . . Lois Olson
. . . . David I. Blumenstock
. . . . Benjamin Holtzman
. . . . Otto E. Guthe
. . . . Arthur C. Ringland

Hydraulics
. . . . Harold L. Cook
. . . . Melvin M. Culp
. . . . Harold O. Ogrosky
. . . . Harvey H. Richardson

* Incumbent - Occasionally, some individuals have had dual technical or dual area responsibilities. Titles have frequently changed but the responsibility or technical field as presently understood is indicated. Names have been compiled from scattered lists, reports, and the memories of a number of SCS veterans. It is likely that some have been missed.

Hydrology .... William C. Ackerman
.... C. E. Ramser
.... Dav B. Krimgold
.... H. T. Cory
.... T. B. Chambers
.... George W. Mmxgrave
.... Harold O. Ogrosky
.... Kenneth M. Kent
.... Robert E. Rallison
.... *Norman Miller
.... *Helen F. Moody
.... *Donald E. Woodward

Irrigation .... W. W. McLan
.... John G. Sutton
.... Frank Kimball
.... George D. Clyde
.... Tyler H. Quackenbush
.... Ralph H. Brownscombe
.... Carl L. Anderson
.... Swayne F. Scott
.... Richard W. Van Klaveren

Landscape Architecture .... J. J. Columbus
.... Sally Schauman
.... *Ronald W. Tuttle

Mechanical Engineering .... Everett Wilcox
.... S. B. Andrews

Mechanical Equipment .... R. B. Gray
.... Gerald E. Ryerson
.... E. J. Thomas

Geology and Ground Water . . *Jerry M. Bernard

Sedimentation Geology .... Henry M. Eakin
.... Gilbert C. Dobson
.... Carl B. Brown
.... Louis C. Gottschalk
.... John W. Roehl
.... John N. Holeman
.... William F. Mildner
.... C. Donald Clarke

Information Systems .... *Jackie D. Diggs

Soils Engineering .... Rey Decker
.... David C. Ralston
.... *James R. Talbot

Water Management ...... *William J. Carmack
.... *Ronald L. Marlow

Water Quality .... *Wildon Fontenot
.... *Frederick D. Theurer
.... *George H. Comer

Water Supply .... George D. Clyde (Logan)
Forecasting .... William C. Shannon
.... Arthur B.Holland
.... Robert E. Rallison
.... R.A. Work (Portland)
.... Manes Barton (Portland)
.... *D.E. Johnson (Portland)

Ecological Science Division
Wetland Hydrology ..... *Donald E. Woodward

Cartography and Geographic Information Systems Divison
Hydraulics .... *Roger Cronshey

Technology Information Systems Divison
Technology Support Team ..... *Gylan Dickey
.... *Russ Shepherd
.... *Frank Geter
.... *Kenneth Brashear
.... *Carol Drungil

Decision Support Model
Development Team .... *Ed Seely

Practice Design
Development Team .... *Harvey Metz
.... *Ken Carpenter
.... *Philip Smith

System Building and
Support Team .... *Scott Snover
.... *Dennis Miyoshi

SCS ENGINEERS AND GEOLOGISTS IN RESEARCH

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V. S. Aronovici ....Pomona, CA
Willis Barrett .... Logan, UT
Fred W. Blaisdell ....St. Paul, MN
Harry F. Blaney ....Los Angeles, CA
George B. Bradshaw ....Boise, ID
Carl B. Brown ....Washington, DC
John R. Carreker ....Athens, GA
George D. Clyde .... Logan, UT
Ashton Cod ....Bozeman, MT
William . Cone ....Fort Collins, CO
Howard L. Cook ....Washington, DC
Earl W. Cowley
Wayne D. Criddle .... Logan, UT
Sterling Davis ....Boise, ID
G. C. Dobson ....Washington, DC
William W. Donnan ....Los Angeles, CA
Maurice Donnelley ....Riverside, CA
Henry M. Eakin ....Washington, DC
Talcott W. Edminister .... Blacksburg, VA
Hans A. Einstein .... Pasadena, CA
Leonard J. Erie .... Brookings, SD
Ross Eskelson .... Logan, UT
Claude L. Fly
Jack Frost .... Medford, OR
Dean Fuhriman .... Logan, UT
W. V. Garstka .... Salt Lake City, UT
Louis M. Glymph .... Spartanburg, SC
Fred Hamilton ....Lincoln, NE
Lloyd L. Harold .... OH
Karl Harris .... Phoenix, AZ
Robert B. Hickok ....Lafayette, IN
Clyde E. Houston .... Reno, NV
O. W. Israelson .... Logan, UT
C. B. Jarvis
Lewis A. Jones ....Washington, DC
Dov B. Krimgold ....Washington, DC
Cyril W. Lauritzen .... Logan, UT
H. R. Leach
W. C. Lowdermilk ....Washington, DC
James Marr ....Boise, ID
Walter W. McLaughlin .... Berkeley, CA
Steven J. Mech .... Pendleton, OR
Walter R. Meyer ....Garden City, KS
Howard E. Middleton ....Washington, DC
G.W. Musgrave ....Washington, DC
Lloyd E. Myers .... Reno, NV
H. E. Middleton ....Washington, DC
Don Mitchell .... Logan, UT
A. T. Mitchelson .... Berkeley, CA
Dean C. Muckel .... Berkeley, CA
G. W. Musgrave ....Washington, DC
Earl Neff ....Sidney, MT
Mark L. Nichols ....Washington, DC
Lois Olson ....Washington, DC
Claude H. Pair ....Boise, ID
Ralph L. Parshall ....Fort Collins, CO
Donald A. Parsons ....Washington, DC
Greg Pearson .... Logan, UT
H. Burke Peterson .... Phoenix, AZ
Charles E. Ramser ....Washington, DC
William O. Ree ....Stillwater, OK
August R. Robinson ....Fort Collins, CO
Carl H. Rohwer ....Fort Collins, CO
Hayden Rouse .... Gunnison, CO
Hunter Rouse .... Pasadena, CA
Gerald E. Ryerson ....Washington, DC
Leonard Schiff .... Bakersfield, CA
Fred Scobey .... Berkeley, CA
Dwight L. Smith .... Bethany, MO
Janes H. Stallings ....Washington, DC
Homer J. Stockwell .... Twin Falls, ID
Norris P. Swanson ....Lincoln, NE
G. W. Thornthwaite ....Washington, DC
Fred M. Tileston .... Pendleton, OR
Russell E. Uhland ....Washington, DC
Vito Vanoni .... Pasadena, CA
J. L. Weber
Ivan D. Wood .... Denver, CO
Neil P. Woodruff .... Manhattan, KS
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SPECIALIZED ENGINEERING UNITS

Engineering Standards Unit
Head .... Melvin M. Culp
.... Woody L. Cowan
Engineer .... Carroll A. Reese
.... Paul D. Doubt

Design Section (Unit)
Head .... Paul D. Doubt
.... Edwin S. Alling
.... Scott D. Snover
Design Engineer .... Richard Matthews
.... Rulon Jensen
.... Charles E. Fogg
.... Hun Jin Goon
.... Arthur R. Gregory
.... Gerald E. Oman
.... Norman P. Hill
.... Elwood Lanier
.... John A. Brevard
.... Fred Theurer
.... James Haglund
.... George Kalkanis

Soil Mechanics Laboratory (Lincoln, NE)
Head .... Rey S. Decker
.... Lorn P. Dunnigan

Central Technical Unit (Hydrology Unit)
Head .... Woody L. Cowan
.... Roy G. Andrews
.... Kenneth M. Kent
.... Robert E.Maclay
.... Robert M. Pasley
.... Norman Miller
.... Donald E. Woodward

Hydrologist .... Victor Mockus
.... H. N. Holtan
.... J. H. Dawes, Jr.
.... Melvin H. Kleen
.... William H. Sammons
.... Wendell A. Styner
.... Robert M. Pasley
.... Edward Richer
.... Marc Boysen
.... Erland B. Warnick
.... Harvey Richardson
.... Roger G. Cranshey
Geologist .... Victor H. Jones
.... Alfonso F. Geiger
.... John N. Holeman
.... James R. Thompson
.... Donald H. Hixson
.... Frederick K. Heller
.... William F. Mildner
.... Robert Boyce

National Engineering Staff
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.... Douglas E. Hawkins

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.... Scott D. Snover
Civil Engineer .... George Kalkanis
.... John A. Brevard
.... Hun J. Goon
.... Fred Theurer
.... James Haglund
Agr. Engineer .... Oscar Perez
.... Richard L. Phillips
.... Homer C. Moore
.... Walter K. Twitty
Head Hydro. .... Norman A. Miller
.... Donald Woodward
Hydrologist .... Harvey Richardson
.... George Comer
.... Roger G. Cronshey
.... Mark Boysen
.... William Merkel
.... Helen Moody

Geologists:
Groundwater .... Robert C. Boyce
Sedimentation .... Wm. F. Mildner
Landscape Architect .... Gary Wells

Technology Development
Head .... Douglas E. Hawkins

Software Maintenance
Head .... Scott D. Snover
Computer Analyst ...... Jacqueleyne D. Diggs
.... Ron Marlow
.... David Butler

Technology Development Staff
Head .... Donald E. Woodward
Hydrology Engineer .... H. H. Richardson
.... Roger G. Cronshey
.... William H. Merkel
.... Cory Wright
.... Helen Moody
.... David Ferguson
.... Fred Theurer
.... George Comer
Civil Engineer .... John A. Brevard
.... Hun J. Goon
Agricultural Engineer .... Oscar Perez

Technology Development
Leader .... Fred Theurer
.... George Comer
Computer Supervisor .... Margaret K. Wolf
Analyst .... Jacqueleyne D. Diggs
.... David Ferguson
.... Cory Wright

REGIONAL OR MULTISTATE HEADQUARTERS

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.... Dwight S. McVicker
.... Kenneth M. Kent
.... Elwin D. Butler
.... Buell M. Ferguson
.... Eugene J. Pope
.... Wendell Moody
.... Robert Gray
.... *Michael Schendel

Agricultural Engineering .... H. G. Bobst
.... Grant Woodward
.... Richard J. Patronsky
.... Roger C. Moe
.... Owen J. Kuittem

Construction .... Edward E. Stipsky
.... Eugene J. Pope
.... Wendell B. Moody
.... *Joseph F. Calder

Design .... W.R. Edgington
.... C.A. Reese
.... E.S. Alling
.... Axel C. Boilesen
.... Richard Barnett
.... *Dennis L. Hurtz

Drainage .... Earl W. Cowley
.... Tyler H. Quackenbush
.... John T. Phelan
.... William F. Long
.... Guy B. Fasken
.... Richard J. Patronsky
.... John F. Rice
.... *Thomas A. Keep

Environment, Water Quality
& Waste Disposal .... Richard J. Patronsky
.... Ray Cope
.... Malvern Allen
.... *William H. Boyd

Engineering Geology .... Oliver J. Scherer
.... Donald H. Hickson
.... Richard L. Bateman
.... *James L. Kearney

Grouting .... Ray Cope

Hydrology .... Kenneth M. Kent
.... William J. Owen
.... *Robert O. Kluth

Hydrologist .... *Roel C. Vining

Irrigation .... H.G. Bobst
.... Earl W. Cowley
.... Tyler H. Quackenbush
.... John T. Phelan
.... Glenn E Stucky
.... Grant Woodward
.... Keith H. Beauchamp
.... Eugene J. Pope
.... Paul E. Lucas
.... Robert L. Gray
.... Gylan L. Dickey
.... *Leland A. Hardy

Landscape Architecture .... *Gary Wells

Equipment Supervisor ..... Dwight S. McVicker

Planning .... I. T. Hermanson
.... Richard Barnett
.... Paul O. Nielsen
.... J. P. Cavanaugh
.... *Robert M. Bartels

Recreation .... Charles V. Bohart

River Basins .... P. V. Nielsen

Sedimentation Geology ...... Victor O. Kohler
.... W. J. Abrams
.... Eldon M. Thorp
.... Charles D. Clarke
.... Jerry M. Bernard
.... *Lyle Steffin

Soils Engineering .... Clarence E. Dennis
.... Greg Cunningham

Soil Mechanics Laboratory . Lorn P. Dumnigem
.... *Phillip M. Jones

Zone Engineers .... Clarence D. Brehm
.... Dayton R. Vallicott
.... Eugene H. Sperry
.... Steven J. Kortan
.... Victor B. Fredenhagen

Albuquerque, New Mexico

Regional Engineer or Head ...... B. P. Fleming
.... F. D. Matthews
.... John G. Bamesberger
.... Dale Shockley (Acting)

Agr. Engineering

Construction

Design

Drainage .... Rey S. Decker

Eng. Geology .... Parry Reicher
.... Daniel H. Griswold

Hydrology .... J. H. Dorrah, Jr.

Irrigation .... Dale Shockley
.... Ralph Brownscombe

Soil Mechanics .... Rey S. Decker

Watershed Geology .... Eldon M. Thorp

Watershed Planning ..... Harold M. Elmendorf

Zone Engineers .... Orville Hosmer
.... Merrit Penwell
.... William Bennett
.... Stewart Robeson
.... Charles Stokes
.... Dale Shockley

Unit discontinued 1956

Williamsport, Upper Darby, Broomall, & Chester, Pennsylvania

Regional Engineer or Head .... C. A. Frye
.... Walter S. Atkinson
.... Fred Larson
.... Harold M. Kautz
.... Neil F. Bogner
.... Arthur B. Holland
.... Edward L. Helmey
.... James N. Krider
.... *Lloyd E. Thomas

Agricultural Engineering ...... Glenn E. Stucky
.... Donald McCandless
.... William Annable
.... *Fred Schuetz

Construction .... Glenn W. Grubb
.... Neil F. Bogner
.... H. P. Parker
.... Edward L. Helmey
.... Lloyd Thomas
.... John Robb
.... *Wendell Scheib

Design .... R. S. Calkins
.... Gerald E. Oman
.... Lloyd Thomas
.... *James Stingel

Drainage .... Elmer W. Gain
.... Donald E. McCandless
.... Richard D. Wenberg
.... *Rodney White

Engineering Geology .... R. F. Fonner
.... T. J. Ackard
.... Louis Kirkaldie
.... *John Moore

Environment Water Quality
& Waste Management .... Glenn E. Stucky
.... James N. Krider
.... James J. Burke
.... Malvern Allen
.... Frank Geter

Hydrology .... V. McKeever
.... Norman Miller
.... D. E. Woodward
.... *Paul I. Wella

Irrigation .... Gail W. Eley
.... Glen E. Stucky
.... J. N. Krider
.... Gaylan L. Dickey
.... *Leland A. Hardy

Landscape Architecture ..... Ronald W. Tuttle
.... Betty B. Sanders
.... *Robert Escheman

Planning .... John H. Wetzel
.... C. E. Smith
.... T. J. Lewis
.... Karl F. Otte, Jr.
.... James Stingel
.... *Salvador Palalay

Recreation .... W. H. Appel
.... H. G. Uhlig

Sedimentation Geology .... J. L. Hunt
.... *Thomas A. Iivari

Soil Engineering .... R. E. Nelson
.... H. W. Hall
.... *William Hughey

Water Quality Specialist .... *Carl DuPoldt

National CADD Specialist ...... Ken Carpenter

Zone Engineers .... Robert Caulkins
.... Gail W. Eley
.... William R. Moore
.... S. J. Smith, Jr.
.... K. S. Werkman
.... K. P. Wilson

Spartanburg, South Carolina

Regional Engineer or Head ...... Arvy Carnes
.... Thomas B. Chambers

Agricultural Engineering .... E. M. Davis

Construction .... E. N. Everett

Design .... Carroll A. Reese

Drainage .... H. G. Edwards
.... E. A. Schlaudt

Engineering Geology .... F. K. Heller

Hydrology .... N. E. Leach