INTERN EXPERIENCE AT
RABA-KISTNER CONSULTANTS, INC.

AN INTERNSHIP REPORT

by

William Thomas Johnson, Jr.

Submitted to the College of Engineering
of Texas A & M University
in partial fulfillment of the requirement for the degree of

DOCTOR OF ENGINEERING

December 1981

Major Subject: Civil Engineering

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December 1981

ABSTRACT

Intern Experience at

Raba-Kistner Consultants, Inc. (December 1981)

William Thomas Johnson, Jr., B.S.C.E., A & M College of Texas

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This internship report describes the author's one year internship at Raba-Kistner Consultants, Inc. in San Antonio, Texas. The primary internship objective was to develop the engineering managerial skills necessary to function effectively in a directorship position.

The author's responsibilities were the management and direction of a professional staff of engineers and a geologist. Both administrative and technical experience was gained while solving problems in geotechnical and materials engineering areas. This report discusses the author's activities in his assignment as Director, Geotechnical Engineering and later as Director, Engineering for a professional organization having over eighty-five professional and technical employees.

In evaluating the internship, the author found that he had benefited greatly from the experience by increasing his managerial, technical, and personal relationship skills. Further, the author found that he had guided his directorate effectively, efficiently, and economically in the production of a reasonable profit to the company. The author found that the internship fulfilled all the objectives set forth by him, his internship supervisor, and his academic committee.

ACKNOWLEDGEMENTS

The author's sincere appreciation is extended to all the people who contributed to making the internship a meaningful experience.

Special thanks and gratitude go to Dr. Harry M. Coyle, P.E., Chairman of the author's academic committee, for his helpful counsel and guidance through the academic work preceding the internship and for his understanding and efforts during the preparation of this report. The author also extends special thanks and gratitude to his intern supervisor, Dr. Carl F. Raba, Jr., P.E., for his leadership and guidance throughout the internship, and especially for providing the opportunity and means for the author to participate in the Doctor of Engineering program.

The interest, help, and advice of the author's academic committee, Dr. Wayne A. Dunlap, P.E., Dr. Milden J. Fox, Jr., P.E., Dr. Thomas W. Comstock, Dr. Christopher Mathewson, P.E., and Dr. Earl D. Bennett, Graduate Council Representative, is appreciated. Mr. Charles Plum is thanked for substituting during the final month when Dr. Bennett was not available to serve due to other university commitments. Dr. Charles H. Samson, Jr., P.E., is thanked for his encouragement, advice, and help during the initial preparation of the author's study program. Sincere thanks are expressed to Mrs. Kathy Shearer for her enthusiastic support and encouragement.

The internship would not have been a success without the whole-hearted cooperation, understanding, and support of the management staff of Raba-Kistner Consultants, Inc., and the members of the author's staff, Dr. "Paul" Palaniappan, P.E., Messers Richard W. Bullion, P.E., Stephen E. Berchelmann, Michael B. Couch, E.I.T., and David L. Pickett, E.I.T. The author's heartfelt thanks is extended to all of them.

The author acknowledges the members of the administrative, clerical, and support staff who worked with the author during the internship period. Mrs. Sandra L. Ramagos deserves special thanks for typing this report.

TO MY WIFE, BARBARA

Who endured many trying hours

during my pursuit of this degree

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

CHAPTER I

INTRODUCTION

PURPOSE OF REPORT

This is the report of the experience of William T. Johnson, Jr. while in an internship program at Raba-Kistner Consultants, Inc. in San Antonio, Texas. The internship covered the period from September 1980 through September 1981.

The 1979-1980 Graduate Catalog of Texas A & M University states that "the objectives of the internship are two-fold:

> A. To enable the student to demonstrate the ability to apply both knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization or industry in which the internship is served, and,
>
> B. To enable the student to function in a non-academic environment in a position in which he or she will become aware of the organizational approach to problems in addition to those of traditional engineering design or analysis. These may include, but are not limited to problems of management, labor relations, public relations, environmental protection, and economics" *(1).

The purpose of this report "is to establish that the objectives of the internship have been met" as required on Page 11 of The Doctor of Engineering Program Details, College of Engineering, April 1979 (2).

CAREER GOALS

From experience gained as a practicing professional engineer for a number of years, certain inadequacies and shortcomings of

*Citations on the following pages follow the general style of the Journal of the American Concrete Institute.

the author's knowledge became evident as managerial and executive responsibilities increased. These deficiencies became more apparent with the passage of time and the broadened base of knowledge dictated by the changes in the business environment. The author felt a strong need for the revitalization and advancement of his technical knowledge and a formalized and more complete understanding of the managerial, planning, and decision making elements demanded for mere existence in today's business world. There was also a need for further knowledge and expertise to evaluate the economic, social, political, environmental and legal influences shaping modern technology. To the author, the Doctor of Engineering program seemed to be the vehicle which would upgrade and expand his capabilities and set the stage for increased productivity and broadened leadership because it is tailored to the needs of the engineer engaged in day-to-day professional practice.

The author's educational program had a fourfold objective: (1) to update and increase his technical knowledge and abilities in the areas of geotechnical and materials engineering; (2) to expand his knowledge in other areas related to engineering; (3) to strengthen his knowledge and enhance his capabilities for a better appreciation and application of the techniques of management, finance, personnel and labor relations, law, ethics, communications and related areas needed in today's business environment; and (4) to learn from and associate with some of today's leaders in education, engineering and public affairs.

INTERNSHIP PRIMARY OBJECTIVES

The primary objective of the internship was to develop in the intern engineering managerial skills necessary to function effectively in his assigned directorship position as well as in management areas of greater responsibility.

During the internship, the author was to demonstrate and apply technical, managerial and leadership abilities in the innovative and creative solution of technical, organizational and managerial problems. Geotechnical and materials engineering, project management, division directorship and other objectives were to be pursued.

ORGANIZATION OF REPORT

Shortly after the internship began on September 8, 1980, the author submitted a detailed listing of objectives for the internship to the Chairman of his Academic Committee (Appendix A). Periodic status or progress reports which discussed specific project accomplishments were submitted during the course of the internship. This final report is not a compilation of the interim reports. This report discusses in detail the activities of the author, documents the work performed and establishes that the objectives of the internship have been fulfilled.

This report is divided into three parts. The first consists of two chapters: an introduction and a description of the organizational structure of the internship organization and the author's job descriptions. The second part contains four chapters which discuss in detail the accomplishments of the four major objectives of the internship in the areas of Geotechnical Engineering, Materials Engineering, Project Management, and Civil and Professional Activities. The final part contains two chapters which evaluate the internship and summarize the report.

CHAPTER II

THE INTERNSHIP FIRM AND THE INTERNSHIP POSITION

INTRODUCTION

The internship of the author was fulfilled with the firm of Raba-Kistner Consultants, Inc., 10526 Gulfdale, San Antonio, Texas. Raba-Kistner Consultants, Inc. is a professional organization founded in 1968. It is a multidisciplined firm that has a supporting staff of over 85 engineers, geologists, scientists, chemists and technicians.

The author was initially assigned to function primarily as Director, Geotechnical Engineering, and secondarily as a Project Manager. The official company job description is included in this report as Appendix B. The author reported directly to Carl F. Raba, Jr., Ph.D., P.E., President, for internship purposes. Dr. Raba was the industrial supervisor for the author's internship activities. The organizational chart of the company is shown in Figure 1. The basic function of the Director of Geotechnical Engineering is the responsibility for the profitable utilization of the engineering staff through the efficient and economical use of engineering and corporate resources. The principal duties or responsibilities of the Director, Geotechnical Engineering are to serve as Project Manager on all complex and sensitive geotechnical engineering projects, to assign specific technical staff members as Project

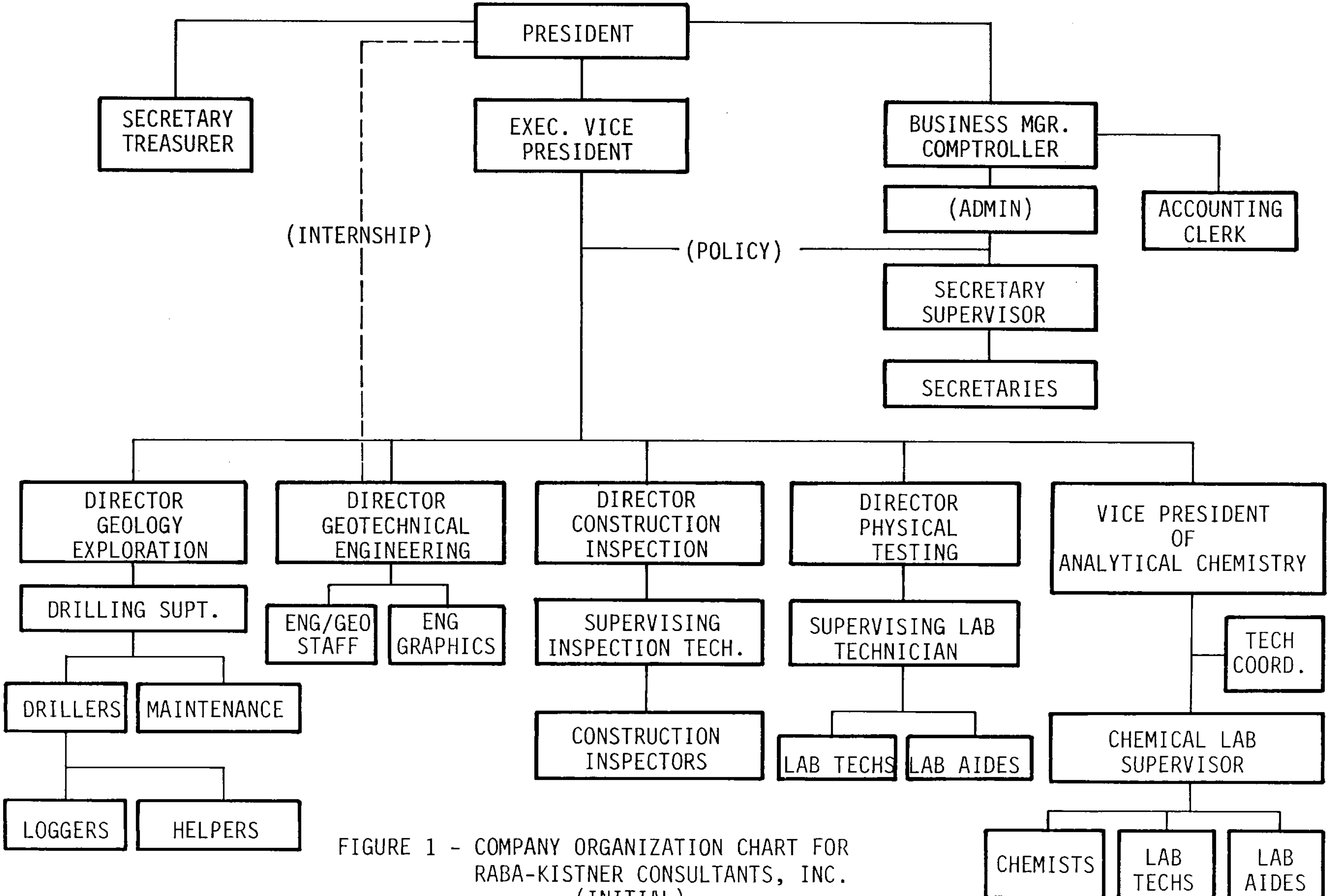


FIGURE 1 - COMPANY ORGANIZATION CHART FOR RABA-KISTNER CONSULTANTS, INC. (INITIAL)

Managers to capitalize on each individual's academic and practical expertise, to review the progress of Project Managers for compliance with budget and time elements, and to be responsible for the timely completion and accuracy of all engineering reports.

COMPANY REORGANIZATION

On October 20, 1980, Raba-Kistner Consultants, Inc. was reorganized into four functional areas. As the result of the reorganization, the author was assigned to the newly created position of Director of Engineering and assumed the additional responsibility for the firm's construction materials and testing areas which required professional engineering supervision or review. An Engineering Geologist and two Staff Materials Engineers were ultimately transferred to, or employed in, this functional area. With the reorganization, appropriate authority and responsibility for product, personnel, and fiscal accountability were transferred to the head of each new functional area. The revised company organizational chart is shown on Figure 2. Since the job description for the old position was written for general rather than specific tasks, the job description for the new position remained unchanged except the title was changed from Director, Geotechnical Engineering to Director, Engineering (3). Dr. Raba, in his new position as Chairman of the Board, continued tc be the industrial supervisor for the author's internship.

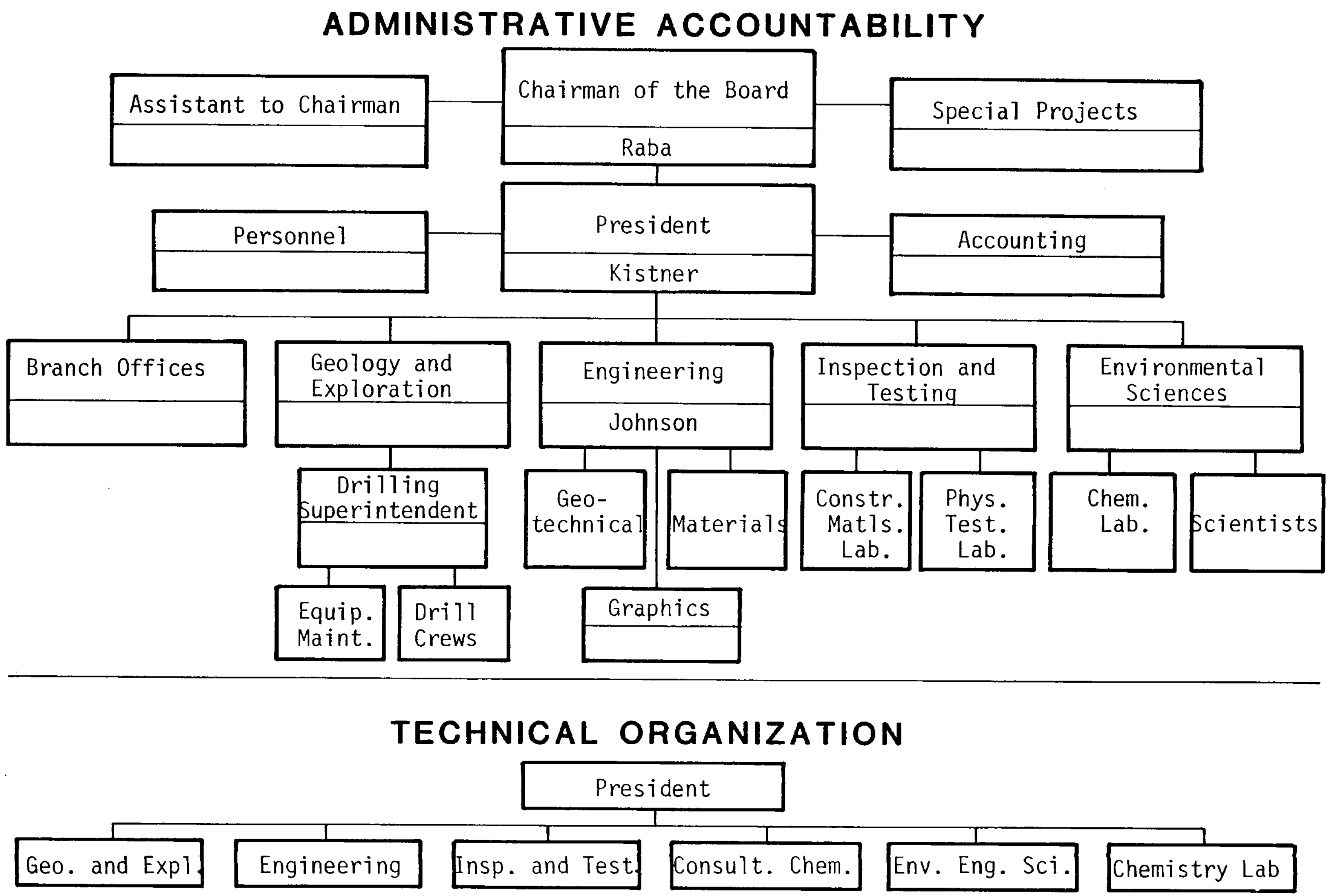


FIGURE 2 - COMPANY ORGANIZATION CHART FOR RABA-KISTNER CONSULTANTS, INC. (AFTER REORGANIZATION)

THE INTERNSHIP FIRM

The firm was formed in 1968 in San Antonio, Texas by Dr. Carl F. Raba, Jr., P.E. as Raba and Associates, Consulting Engineers, Inc. Initially, it offered services only in the field of geotechnical engineering. The firm quickly moved to offering construction materials engineering services and was joined early in 1974 by Mr. Richard W. Kistner, P.E. to supervise and coordinate the materials engineering function. In 1977 Mr. Kistner became a partner in the firm and the name was changed to Raba-Kistner Consultants, Inc., henceforth referred to as R-KCI. Today, as a result of planned expansion in related technical and scientific disciplines, R-KCI has grown into a comprehensive, technology--oriented, consulting firm offering the services of geotechnical, materials, and environmental engineers as well as geologists, scientists and chemists. Currently, R-KCI employs over 85 professional and technical personnel, over 25 percent of whom have earned academic degrees. The firm's corporate headquarters is located in San Antonio with branch offices in El Paso and Victoria.

Geology and Exploration   This functional area is headed by Mr. Edward G. Miller, R.E.G., Senior Vice President of the firm. The geologic staff of R-KCI provides complete geologic services and has extensive experience with diverse types of projects including foundation investigation for industrial, institutional, and commercial buildings. The staff also provides exploration programs, geologic mapping and design parameters for embankments, dams for water supply and flood control, and impoundments for industrial waste and solid waste disposal sites. In addition, R-KCI has developed its geological expertise as applied to specialized studies for planning residential, commercial, and industrial developments.

R-KCI maintains an array of diversified exploratory equipment for performing rock coring and soil sampling necessary to the gathering of subsurface data used for geologic, geotechnical, and environmental analyses. An assortment of truck and skid mounted drill rigs are available. On occasion, both types of rigs have been mounted on barges of various sizes for marine exploration.

Engineering The professional engineering staff is headed by the author, Mr. William T. Johnson, Jr., P.E. This group provides services in the areas of Geotechnical and Materials Engineering.

The geotechnical engineering group is composed of two registered professional engineers and an engineering geologist. This group has extensive experience and provides complete soils and foundation engineering services and analyses. Typical projects range from subdivision soil surveys to foundation design recommendations for the most economical and suitable foundation system for major multi-story structures. Other services include the evaluation of existing, and the design of new, roadway and airfield pavement cross-sections, design of dams and embankments, slope stability analyses, seepage analyses, sheeting and shoring, and recommendations for construction site dewatering.

The materials engineering group is composed of two civil engineering graduates who should qualify for registration as professional engineers in the spring of 1982 by the Texas State Board of Registration for Professional Engineers. These engineers act as Project Managers and are involved in quality assurance/quality control for projects under construction. They also provide engineering supervision for the firm's construction materials technicians. Typical technical activities include lime and cement stabilization of soils, reinforcing steel placement inspection, inspection of fill and earthwork construction, concrete mix designs, and the inspection of concrete batch plant operations and on-site concrete placement operations. Other areas of involvement are structural steel fabrication and erection inspections and the nondestructive testing of bolted and welded connections, welder certifications, and inspection of pre-stressed concrete construction of both pre-tensioned and post-tensioned types.

Inspection and Testing This functional group is headed by Mr. Donald T. Fetzer. These operations are independent from, but supportive of, the engineering department in the areas of field inspection services, physical testing of construction materials, and geotechnical laboratory testing.

R-KCI employs a staff of more than twenty-five full and part time technicians and maintains a fully equipped physical testing laboratory to test soils, aggregates, concrete, asphalt, and steel. Construction materials field inspection and laboratory testing services are conducted regularly on foundations and structures, fill sites, parking lots, and city and county street and road work. Other services available are roof inspections, blast monitoring, concrete coring, new source evaluations, and brick testing. Geotechnical testing includes soil classification; unconfined, triaxial, and direct shear strength tests; and consolidation, swell, and permeability tests. Laboratory research and development of fly ash and chemical admixtures used in concrete is also done.

Environmental Sciences and Analytical Chemistry This section of the firm is directed by Mr. Carlton R. Williams, P.E.

Since 1968, Raba-Kistner Consultants, Inc. has been active in the various phases of development of landfills and research in environmental problems. R-KCI has participated as the geotechnical consultant, the geologic consultant, the chemical consultant, and the environmental consultant on many of these projects. R-KCI has been involved in municipal sanitary landfills, private solid waste landfills, wastewater disposal ponds and industrial landfills, as well as in research involving the disposal of domestic wastes, and in the comprehensive chemical analyses of fly ash leachates and fly ash. All analyses are conducted using the latest equipment and standard methods.

The Chemical/Environmental Sciences Laboratory of Raba-Kistner Consultants, Inc. is supervised by Dr. Robert L. Smith, an experienced chemist. It is well equipped with state-of-the-art instrumentation and has a highly qualified staff of laboratory technicians and analytical chemists. The technical expertise within the company available to the laboratory includes an environmental engineer, a physicist, biologists, engineering geologists, and geotechnical engineers. The laboratory is certified by the States of New Mexico and Oklahoma (Texas does not certify laboratories) and is participating in a number of quality assurance programs. The laboratory has extensive experience in performing services such as water and wastewater analysis, environmental sample analysis, landfill leachate monitoring, industrial and hazardous waste analysis, geochemical exploration analysis, petroleum waste sample analysis, fly ash and cement analysis. Also, the laboratory does general chemistry testing by EPA, Standard Methods, ASTM and other approved methods.

The instrumental laboratory is equipped with modern analytical instruments including a Perkin-Elmer 5000 Atomic Absorption Spectrophotometer with an HGA 2200 Graphite Furnace and hydride system, a Hewlett-Packard 5992B Gas Chromatograph-Mass Spectrometer with computer interface, a Perkin-Elmer Sigma 1 B Gas Chromatograph with EC, FID and HW detector and a Leco Carbon/Sulfer analyzer. The wet chemistry laboratory has the general chemistry testing facilities necessary to perform conventional wet chemistry testing and sample preparation for instrumental analysis.

CHAPTER III

GEOTECHNICAL ENGINEERING

INTRODUCTION

Approximately seventy percent of the author's time was utilized in the management and supervision of geotechnical engineering activities.

The overall management and control responsibilities of the firm's geotechnical engineering projects and activities can be divided into five basic areas. The successful accomplishment of these responsibilities became the internship objectives for the geotechnical engineering areas. The five performance areas were further divided into subobjectives. These objectives and sub-objectives are shown on Figure 3.

THE PROFESSIONAL STAFF

The geotechnical professional staff is composed of three people. Mr. Richard W. Bullion is a Registered Professional Engineer with the title of Senior Project Engineer. He possesses considerable experience in general geotechnical engineering design work involving shallow foundations, moderately deep drilled pier footings, soil stabilization and pavement design. Dr. E. A. "Paul" Palaniappan has the title of Geotechnical Project Engineer. He received his Professional Engineer's license during the period of the author's internship. He holds a degree of Doctor of Philosophy in Civil

GEOTECHNICAL ENGINEERING OBJECTIVES

- Manage professional and graduate engineers and engineering geologists.

    Administrative and technical

    Optimum utilization of corporate resources

    Increase subordinate skill levels

- Develop project estimates and operating budgets to increase profitability.

- Supervise and coordinate the professional staff to solve problems relative to foundation systems for:

    Light structures on shallow foundations

    Heavy multi-level structures on deep foundations

    Slope stability situations

    Retaining walls and bulkheads

- Update and/or develop the corporate geotechnical design and procedures manual.

- Develop or supervise engineering improvements to existing corporate systems or components.

FIGURE 3 - GEOTECHNICAL ENGINEERING OBJECTIVES

Engineering. He has expertise in the areas of driven piles and deep drilled pier footings in addition to general geotechnical engineering design experience. Mr. Stephen E. Berchelmann has a degree in Geology with experience in engineering geology. He is an associate member of the Association of Engineering Geologists.

MANAGEMENT

The accomplishment of the objective of administrative and technical management of the professional staff to the optimum utilization of corporate resources is illustrated by the chart in Figure 4. Taking the first month of the internship--September 1980--as a base month and computing and plotting percentage changes from this base, a measure of activity can be illustrated. The solid line connecting the solid circles depicts the number of geotechnical studies managed or supervised by the author during the internship period. This line represents an increase in numbers of studies over the base month by as much as 46 percent in the June 1981 period. There were only two months during the internship period when there were fewer projects than in the base month. Overall, the average number of studies for the year was 14 percent greater than the base month.

Similarly, the dashed line connecting the solid triangles depicts the fee dollar value of the geotechnical engineering studies managed or supervised by the author during the internship period. The chart shows a significant increase in the value of the

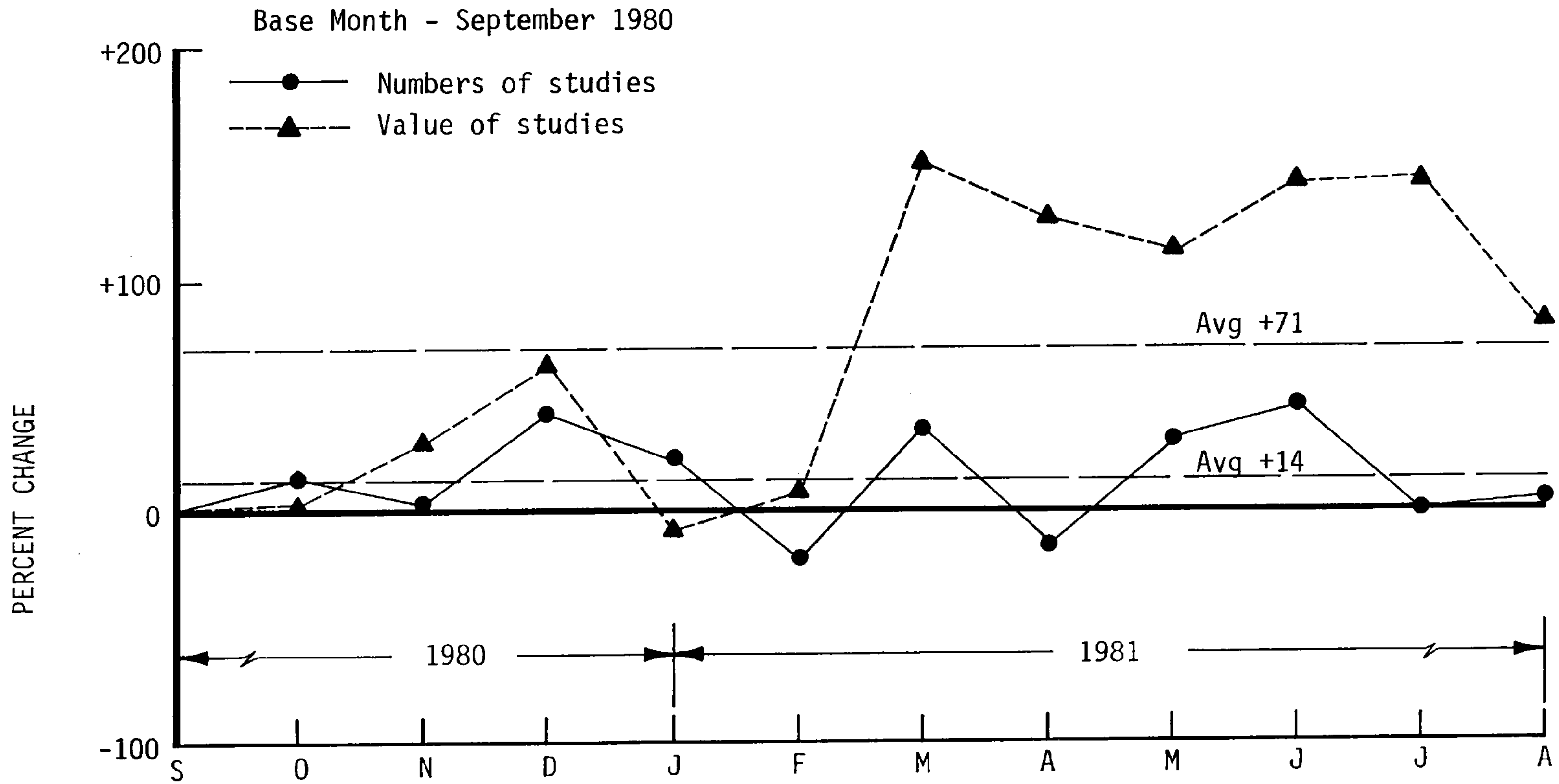


FIGURE 4 - GEOTECHNICAL ENGINEERING STUDIES COMPLETED

geotechnical projects beginning early in 1981. Although there was not a great increase in the number of studies, the size and complexity of the studies increased significantly with only one month showing less than 100 percent greater than the base month. The monthly overall average fee value of geotechnical studies for the internship year was 71 percent greater than the base month.

PROJECT ESTIMATES AND OPERATING BUDGETS

In order to measure the accomplishment of the objective in this area, the number of geotechnical engineering proposals submitted and accepted was tabulated. The results are shown in Figure 5. These data had not been collected and summarized within the firm prior to 1981. The proposal acceptance rate was a minimum of 42 percent and a maximum of 93 percent. This resulted in an overall average of 56 percent for the data period. During the internship, the author implemented some changes in the proposal format used by the company. The author established the scope of work and budget estimate, and prepared the formal proposals for approximately 15 percent of the projects. For those proposals prepared by others, the author reviewed and approved each project proposal before it was transmitted to the client.

DESIGN, SUPERVISION AND COORDINATION

As a general rule, geotechnical engineering studies are of short duration. From the time of authorization, the rendering of

GEOTECHNICAL ENGINEERING PROPOSALS

1981 Month	Number Submitted	Number Accepted	Acceptance Rate - %
January	31	22	71
February	12	5	42
March	31	15	48
April	14	13	93
May	30	13	43
June	24	10	42
July	16	12	75
August	11	7	64
September	19	11	58
TOTALS	193	109	56

FIGURE 5 - GEOTECHNICAL ENGINEERING PROPOSALS

the formal written engineering report requires about four weeks. Some studies are completed in shorter time periods, however. Geotechnical engineering clients of Raba-Kistner Consultants, Inc. are informed that exploratory drilling cannot be scheduled prior to project authorization. Then they are advised that they should make time allowances as follows to arrive at the estimated date of report delivery:

a. Five work days for drilling.

b. Ten work days for laboratory testing.

c. Six work days for engineering analysis and report writing.

d. Two work days for final review and typing of report.

The geotechnical engineering staff members were working on several studies at any one time, with each study in a different stage of the project cycle between authorization and completed report. The author was working on or supervising twenty to forty studies at any one time during the internship period.

The firm was engaged in many types of geotechnical engineering studies during the author's internship. A partial listing of the general types of studies completed by the professional geotechnical engineering staff during the internship year are shown in Figure 6. A large number were more or less routine subdivision soil surveys prepared to meet the requirements of the Housing and Urban Development or Veterans Administration agencies. The next highest grouping included projects for apartments, condominiums and large architect-designed homes. Except for the homes, these were

TYPES OF GEOTECHNICAL ENGINEERING STUDIES

Type	Numbers
Apartment/Condominium/Homes	22
Subdivision Soil Surveys	54
Retail/Shopping Centers	14
Regional Malls	2
Warehousing/Industrial Parks	9
Offices/Banks (1-2 Story)	8
Multi-Story Structures (3-9 Story)	14
High-Rise Structures (10 Story and Over)	10
Reconnaisance/Preliminary Investigations	8
Retaining Wall/Deep Excavation Studies	3
Pavement Studies/Designs	4
Schools, Churches	8
City, State, Federal Projects	9
Environmental	11
Water Storage Tanks	3
Microwave Tower and Antenna Foundations	3
Foreign Language Report Studies	2

FIGURE 6 - TYPES OF GEOTECHNICAL ENGINEERING STUDIES

multiple unit two story structures with occasional three story units included. Major geotechnical engineering effort was expended for two large regional mall projects and for each of several high-rise structures of ten stories and higher. In addition to supervising and coordinating the professional staff in the accomplishment of these projects, the author personally reviewed field and laboratory data and prepared analyses from these data involving two foreign language reports submitted for review by clients. One was in Spanish for which the author had to arrange for translation of the printed data into technical English so the analyses could be made. The other report was written in Chinese and translation was provided by the client.

Some of the more interesting or unusual projects are described in more detail in the following pages.

Datapoint Corporation Campus Figure 7 shows the site plan for the development of a campus-type world headquarters for Datapoint Corporation, a major electronics and computer manufacturing firm. A photograph of the architect's rendering of the Datapoint Corporation campus-styled world headquarters complex, scheduled for completion in early 1985, is shown in Figure 8. Encompassing more than one million square feet, the Datapoint Corporation high technology center will be located at the northwest quadrant of Interstate Highway 10 and De Závala Road in San Antonio, Texas. There will be three major phases of construction, with the first beginning in October 1981. This project is believed to be the largest industrial construction

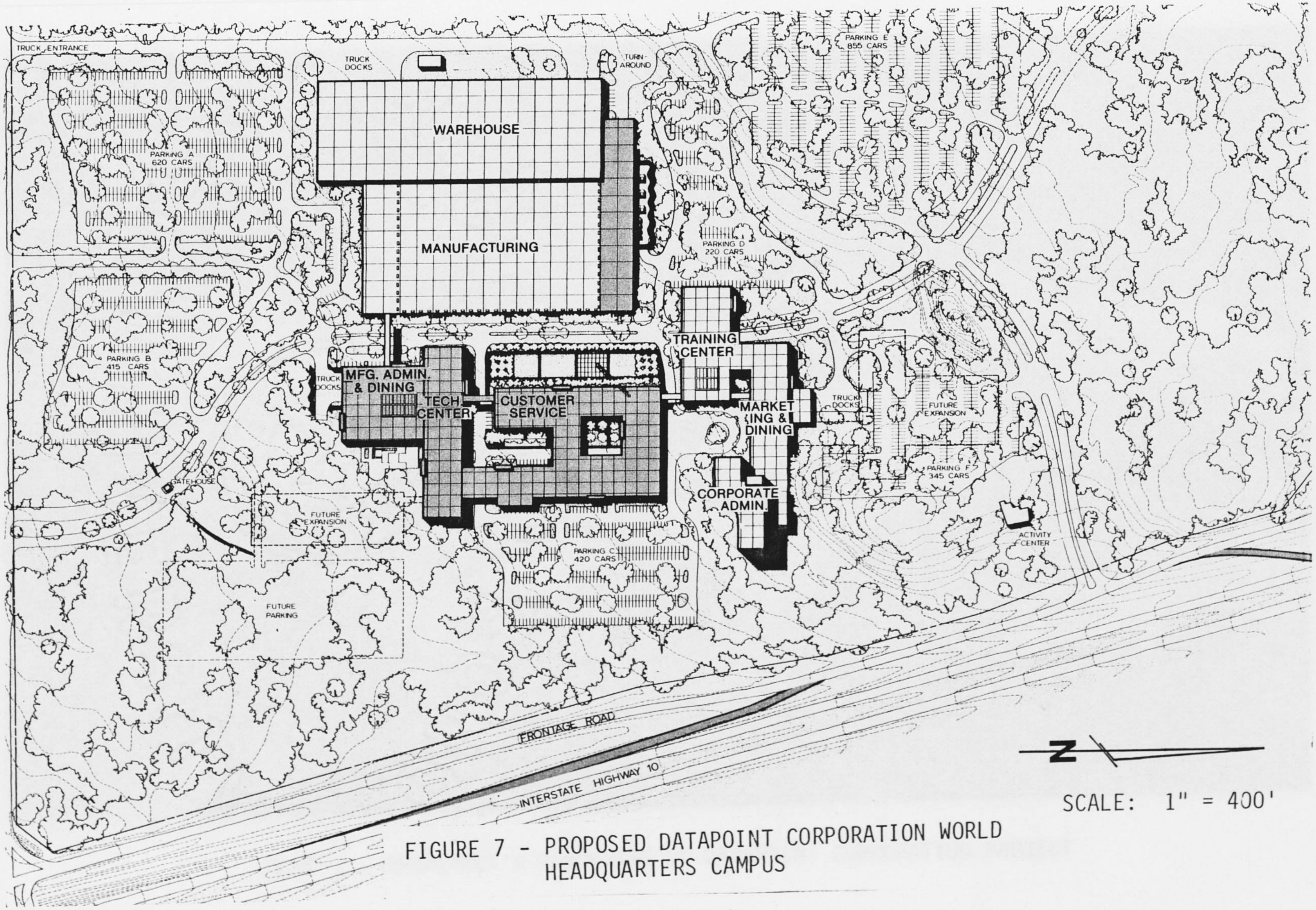


FIGURE 7 - PROPOSED DATAPOINT CORPORATION WORLD HEADQUARTERS CAMPUS

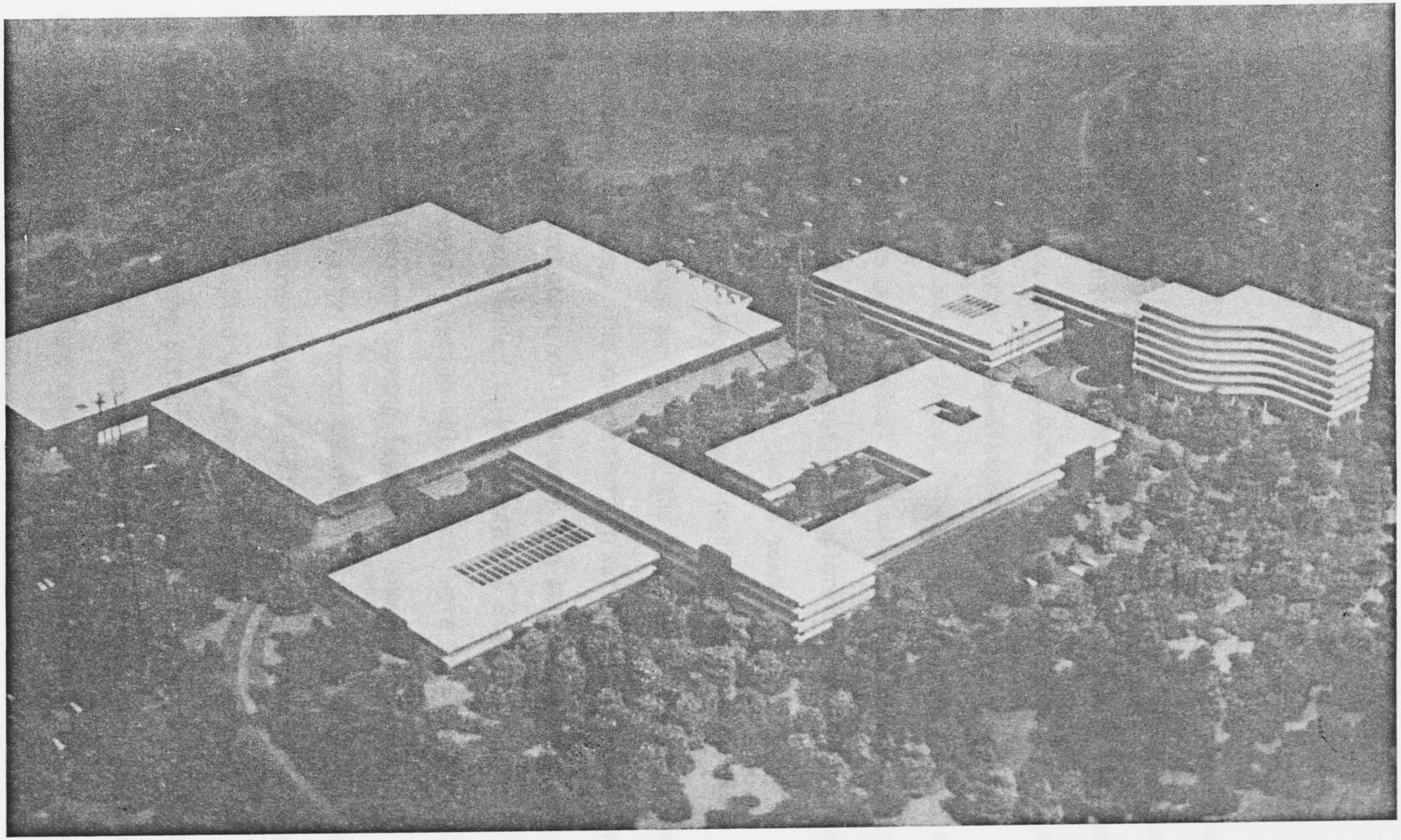


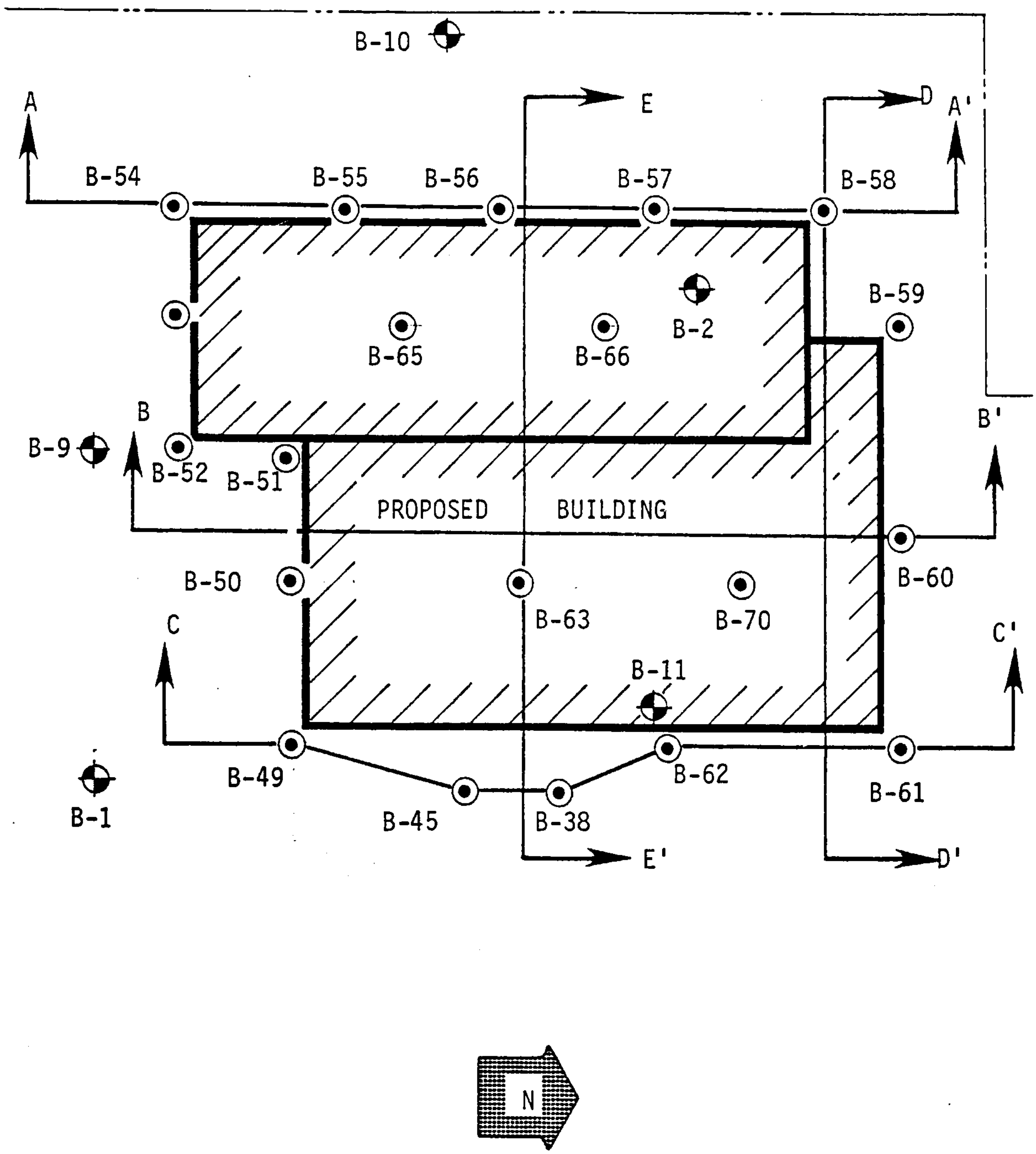
FIGURE 8 - ARCHITECT'S RENDERING OF DATAPOINT CORPORATION PROJECT

project in the history of San Antonio. The final construction costs are estimated to be in excess of fifty million dollars.

During November 1980, the author was a member of the Raba-Kistner Consultants, Inc. marketing team to secure the geotechnical investigation and engineering for this project. The design management, architectural, and structural engineering firms for this project were all Chicago based. Raba-Kistner Consultants, Inc. was selected to perform the services. The author negotiated the scope of services and the geotechnical fee schedule for this project. The author designed and laid out the exploration drilling program in conjunction with the project design team.

Exploration drilling was begun in late November for the manufacturing/warehousing complex, the original Phase I of the development program. The manufacturing/warehousing facility was to be a single structure of just over ten acres in size. The superstructure was planned to be structural steel rigid frame with 43-ft by 43-ft bays. Design column loads were 80 kips per column. The planned exploratory boring layout is shown on Figure 9.

The proposed site sloped toward the southeast with a change in elevation of approximately 15-ft across the area. The established finished floor elevation would require a cut 4-ft deep at the northwest corner of the structure and a 12-ft thick fill at the southeast corner. Due to economic considerations, it had been decided that the structure should be built with soil supported



PLAN OF BORINGS
SCALE: 1" = 200'

FIGURE 9 - BORING PLAN LAYOUT

floors. There was a differential movement restriction in the floor to less than 0.5-in. within the 43-ft column spacings. Cracks in the floor would be acceptable; however, there could be no vertical displacement between the edges of the crack. Based on these criteria a rigid-engineered beam and slab foundation system was necessary.

Exploration drilling was scheduled for 20-ft depths except on the northwest side where deeper penetrations were planned. The exploratory borings and laboratory tests revealed that the underlying soils at this site were swelling clays of plastic to highly plastic characteristics. The soils encountered at this site could be grouped into three generalized strata with similar physical and engineering properties as described below.

Stratum I consists of firm to very stiff dark gray or dark brown clays and extends to depths of 2 to 7-ft. These clays are plastic with a tested maximum liquid limit of 62 and plasticity index of 40. The cohesive shear strength of specimens tested in unconfined compression varied from 1.3 to 5.8 tsf. The results of Standard Penetration Tests conducted in this stratum varied from 6 to 12 blows per foot.

Stratum II consists of very stiff tan and gray clays and extends to depths of 9 to 44-ft. These clays are plastic to highly plastic with a tested maximum liquid limit of 69 and plasticity index of 46. The cohesive shear strength of specimens tested in unconfined compression varied from 1.6 to 3.5 tsf. The results of Standard Penetration Tests conducted in this stratum varied from 16 to in excess of 50 blows per foot.

Stratum III consists of hard light tan limestone and extends to the maximum depths explored in Borings B-38, B-49, B-50, B-53 and B-59. This stratum was not encountered in other borings. The results of Standard Penetration Tests conducted in this stratum were in excess of 50 blows per foot.

Earlier reconnaissance and preliminary geologic studies had reported that two suspected faults crossed the area planned for development, with both passing through the manufacturing/warehousing site. Subsequent geologic analysis of the depth to the top of the limestone stratum confirmed the presence of both faults. However, neither the faulting nor the depths to the limestone had a significant influence on the foundation design for this facility.

The anticipated ground movements at the proposed finish grade elevation at this site were estimated using the Texas Highway Department procedure for Potential Vertical Rise (THD, TEX-124-E) (4). Total vertical movements in the order of 1.7 to 2.4-in. were estimated for both the theoretically dry soil profile and existing soil moisture condition. For the foundation system proposed, differential vertical movements rationally may be estimated to be equal to one-half the expected total movements.

The real geotechnical engineering considerations for this structure were to design a subgrade that could be constructed and field controlled which would limit potential differential swells beneath the soil supported floor slabs to the design criteria of less than 0.5-in.

The use of lime slurry pressure injection stabilization to a depth of 7-ft would be expected to reduce the potential vertical movements to 1.0 to 1.4-in. The remaining reduction in swell potential would have to be taken care of at the time of site earthwork construction through careful selection and placement of fill soils and the possible over excavation and recompaction in those cut areas having zones of very dense clays of high swelling potential.

The author served as project manager for this project and personally did many of the design analyses and calculations. Only relatively small floor areas are considered in the standard accepted design procedures for soil supported floor slabs (5, 6). In this part of the project, the author learned how to apply his knowledge of swelling clays to the analysis and design of a soil subgrade to support a movement sensitive floor system of extraordinary size. The engineering report was completed and delivered to the design team before the end of December 1980.

The fourth construction phase of this project was to be the corporate headquarters tower--an eight story structure planned to be founded on underreamed footings on rock at depths of 42 to 45-ft below the existing surface. The footings would be required to support maximum column loads of 1900 kips. Early exploratory borings for this structure showed that four major piers for the tower would be on a fault line and located in a zone of very fractured and broken rock. To obtain the desired supporting capacity, these four pier shafts would have to be approximately twice the diameter and have approximately twice the penetration depths as adjacent piers of equal loading. Under the direction of the internship supervisor, who acted as project manager for this portion of this project, the author performed a considerable number of the computations required in the analysis of the foundation for this structure.

In this part of the project, the author was introduced to new concepts and techniques in foundation design. He learned how to apply them to analyze and design composite foundation elements which provide support in both end bearing and skin friction.

Before final design was completed, the owner had an opportunity to acquire more land along the western side of the project site and consequently relocated the entire complex toward the northwest. This relocated the corporate tower away from the faulted and broken zone and also allowed a change in finished floor grades for the warehousing and manufacturing facility to significantly reduce both the cut and the fill requirements. A reevaluation of the floor movement criteria allowed the superstructure of the warehousing/ manufacturing facility to be founded on drilled piers with the floor to remain as a soil supported slab-on-grade. Site earth moving work has started on this project under the close inspection of the author and materials engineers and technicians of the firm. The foundation piers are scheduled to be bid on December 1, 1981.

San Antonio International Airport Terminal Facilities The city of San Antonio presently has underway an expansion program for its International Airport. Geotechnical exploration was done by the firm of Raba-Kistner Consultants, Inc. for the Phase I portion of the project. That engineering report was completed and reported in 1979. Since the initial reporting, the terminal building facilities have been relocated and expanded in plan area, thereby requiring a new geotechnical engineering study. The author negotiated the additional scope of services and new geotechnical fees with the project management organization. Three additional borings were drilled to supplement seven which could be reused from the Phase I program. The plan layout of the new terminal facilities and the boring locations are shown on Figure 10.

The borings were drilled to depths of 65 to 73-ft below existing grade. This field investigation was conducted following established accepted geotechnical engineering procedures. Based upon the initial seven borings and the three new borings, the soils encountered at this site were grouped into four generalized strata with similar physical and engineering properties.

Stratum I consists of highly plastic, stiff to very stiff dark gray clays. Stratum II consists of very stiff tan clays which are

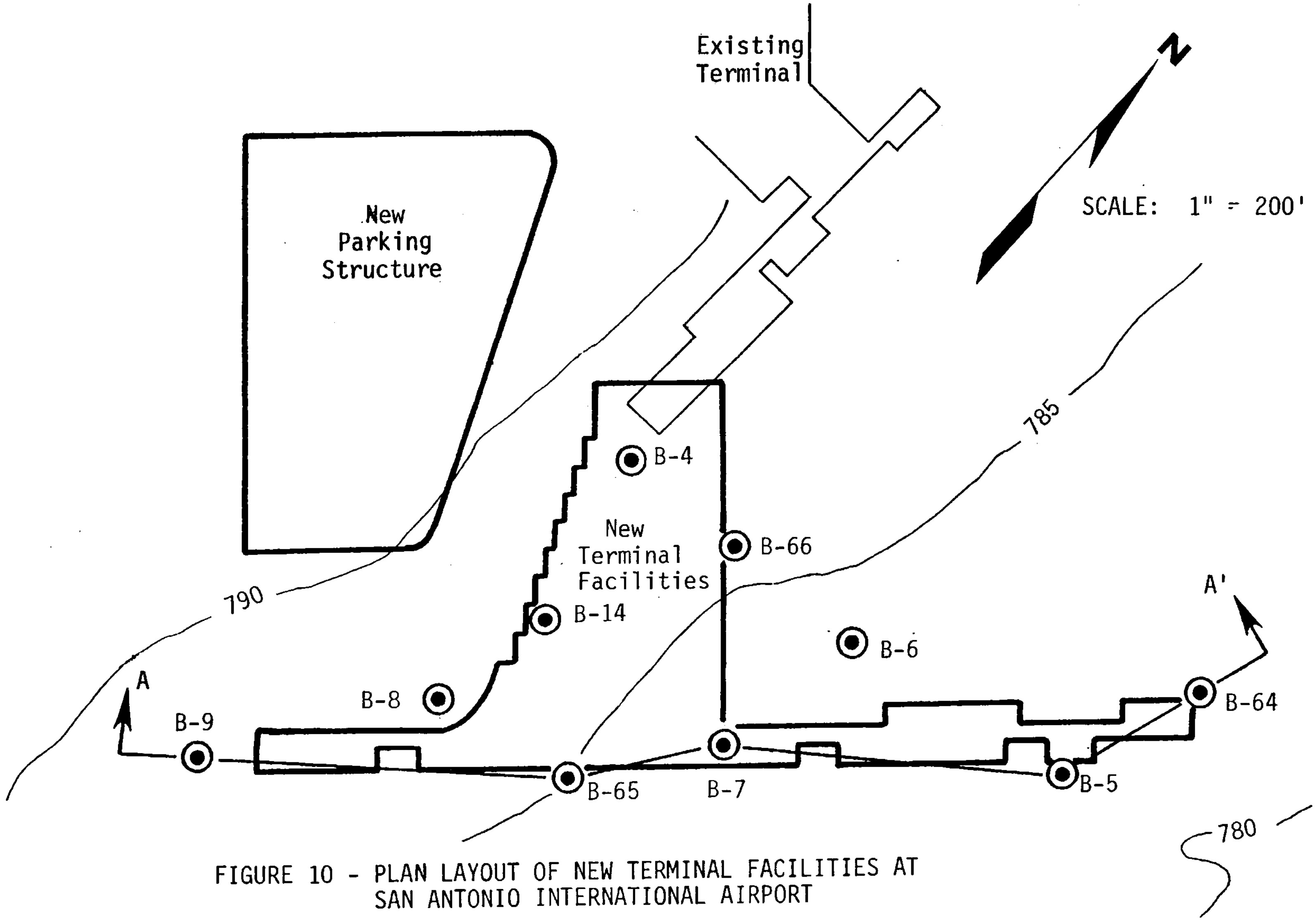


FIGURE 10 - PLAN LAYOUT OF NEW TERMINAL FACILITIES AT SAN ANTONIO INTERNATIONAL AIRPORT

moderately plastic to plastic. This stratum is interstratified by gravel layers which are generally water bearing. Stratum III consists of plastic to highly plastic very stiff tan and gray clays. This stratum is interstratified by marl seams. Therefore, the cohesive shear strength of the specimens tested varied over a considerable range. Stratum IV consists of hard tan and gray or blue marl and extends to 73-ft, the maximum depth explored. This stratum is interstratified by tan or tan and gray clay seams. The marl and the clay seams are moderately plastic to plastic. Groundwater seepage was observed at depths of 10 to 24-ft in the exploratory borings at the time of the field investigation.

The shallow clays underlying this site are highly plastic and have a high potential for swelling. Therefore, a structure supported directly upon these clays will be subjected to differential vertical movements associated with seasonal changes in the moisture contents of the foundation clays.

The Stratum IV marl will provide high bearing capacities and a volumetrically stable foundation without subjecting the proposed terminal building to swelling movements. The Stratum IV marl was encountered at elevations varying from EL 725 to EL 750 feet.

The expanded airport terminal building is planned to have two levels above ground and one below. The column loads will vary from 200 to 1500 kips per column. The main terminal facility will be a structure approximately 120-ft by 500-ft. Loading or access ramps for aircraft will be along a structure approximately 50-ft wide and 1200-ft long. The engineering design analysis considered rigid-engineered beam and slab foundations and drilled footings. The recommended optimum foundation system for the heavily loaded portion of the structure would be supported by drilled-and-under-reamed footings founded on top of the Stratum IV marl, where a high net allowable bearing capacity was appropriate to use for proportioning the footings.

Difficulties were encountered during construction of the nearby new parking structure due to variable completion depths for the foundation piers. The initial geotechnical studies for this structure were directed to providing recommendations for a foundation system extending to a given depth or to a predetermined elevation for the footing elements for the entire structure. The analyses of the soil strength and stability characteristics across the site would not permit this type of recommendation. Consequently, the recommendation was to extend the footings to the top of the marl formation. This concept will place footings at variable depths across the extent of the building structure and will complicate the bidding and construction process. However, no other viable alternative is available. Footing depths will vary across the site by as much as 25-ft.

The author acted as Project Manager for this study and supervised the analyses and design calculations utilized in producing the finalized geotechnical study. In this project, the author broadened his knowledge to include some marls and marly soils. A sharpening of analytical skills and expanded design experience was also realized.

These new terminal facilities are estimated to have a construction cost of about 55 million dollars. The project is nearing the completion of structural and architectural design and is due to be advertised for bidding in the early part of 1982.

Mall de las Aguilas, Eagle Pass, Texas This is to be a new major regional mall, the first for the City of Eagle Pass, Texas. As initially planned, this mall is to be approximately 1800-ft long and 100-ft wide. It is to have a common finished floor elevation throughout. There is an approximate 30-ft change in elevation across the existing site. Extensive cut and fill operations will be required to establish the desired finished floor elevation.

The soil conditions at the site were investigated by forty-two borings drilled to depths of 5 to 25.5-ft below the existing grade following a scope of work proposed by the author and accepted by the designing firm of Carter and Burgess of Fort Worth, Texas. These borings revealed that the site is underlaid by very stiff light brown silty clays and clayey silts and sands which are interstratified by siltstone seams. These silty clays are moderately plastic with a tested maximum liquid limit of 52 and plasticity index of 30. The results of Standard Penetration Tests conducted in this stratum varied from 11 to in excess of 50 blows per foot. The existing site terrain and the proposed finished grade elevations require extensive site soil work. The major portion of the mall site will be on fill with maximum depths of fill on the order of 15 to 20-ft anticipated in the vicinity of the major "anchor" stores. The maximum depths of the cuts are anticipated to be on the order of 10-ft.

The single story mall type retail structures will create light to moderately heavy loads to be carried by the foundation sytem. Maximum column loads on the order of 75 kips are anticipated.

The long narrow shape of this mall facility as shown in Figure 11 made it a somewhat unusual project. No unusual construction problems are anticipated for this site. The author acted as Project Manager for this project.

The project was sited in a new development area with no previous construction history and where only general soils information was available (7). An unusual geotechnical feature for this site was the requirement for an electrical resistivity survey on one portion of the site to estimate the corrosivity of the subsurface soils and the effect they might have on buried metallic utility lines. This allowed R-KCI, for the first time in the geotechnical area, to utilize remote sensing techniques and equipment to estimate the properties of the subsurface soils by the use of electrical resistivity measurements. The schematic layout of the electrical resistivity exploration program is shown in Figure 12. Three electrical resistivity vertical profiles were taken at locations VP-1, VP-2 and VP-3. The vertical profile data was correlated against

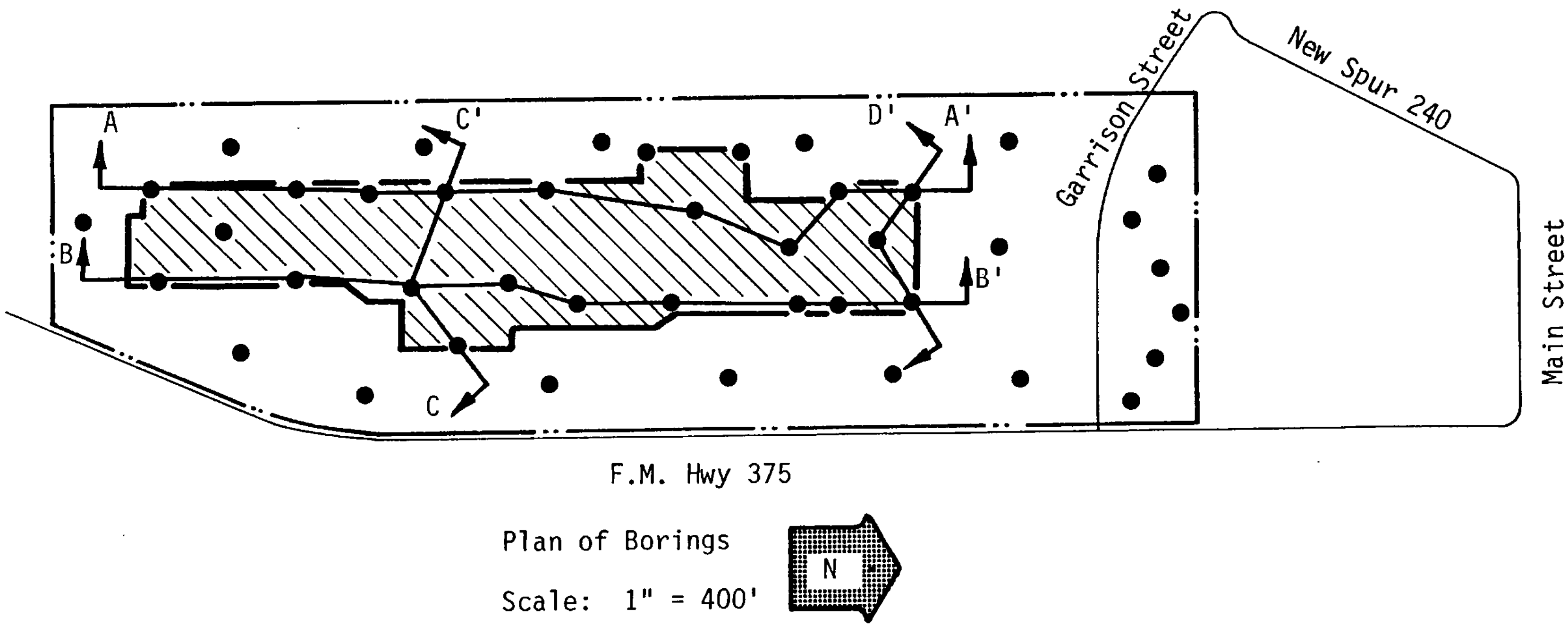


FIGURE 11 - PLAN LAYOUT AND BORING LOCATIONS FOR MALL DE LAS AGUILAS
EAGLE PASS, TEXAS

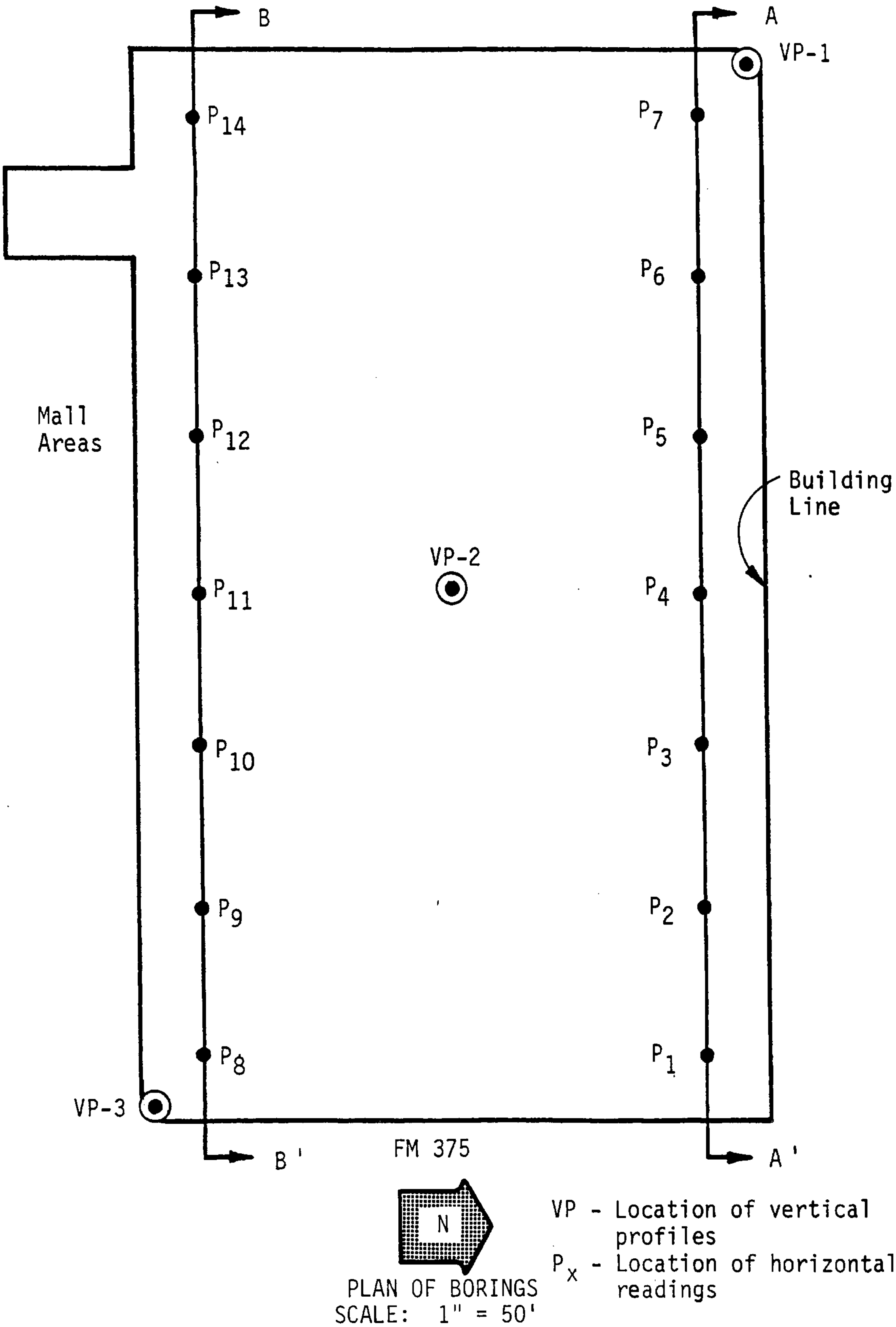


FIGURE 12 - SCHEMATIC LAYOUT OF ELECTRICAL RESISTIVITY EXPLORATION PROGRAM

stratigraphic data obtained from exploratory borings previously drilled at the same locations. Horizontal profiles were then taken along lines A-A' and B-B'.

Figures 13 and 14 show the interpretation of the results of this remote sensing program. Electrical resistivity readings of less than 750 ohms/cm indicate a high potential to corrode buried unprotected metallic piping (8). The results of this survey indicated that the brown clays are very corrosive to buried metallic piping but the corrosiveness diminishes as the clay fraction decreases and the silty and sandy fraction increases. There was very little corrosiveness indicated for the silts or sands existing at this site.

During the sedimentation period of the land in the area of this site by the Rio Grande River, the clays, silts and sands were generally layered. However, it appeared that at this site, the corrosive clays were placed in a rather low flow environment, probably in a bend of the river where the sands and silts were deposited first and then the clays to form the rather exaggerated hump in the center of Profile B and the more gentle swell in Profile A.

It is regrettable that soil samples were not retained from the exploration phase so the remote sensing results could be checked against laboratory chemical analyses. The author learned how to design an electrical resistivity investigation program and how to evaluate and report the results of the survey.

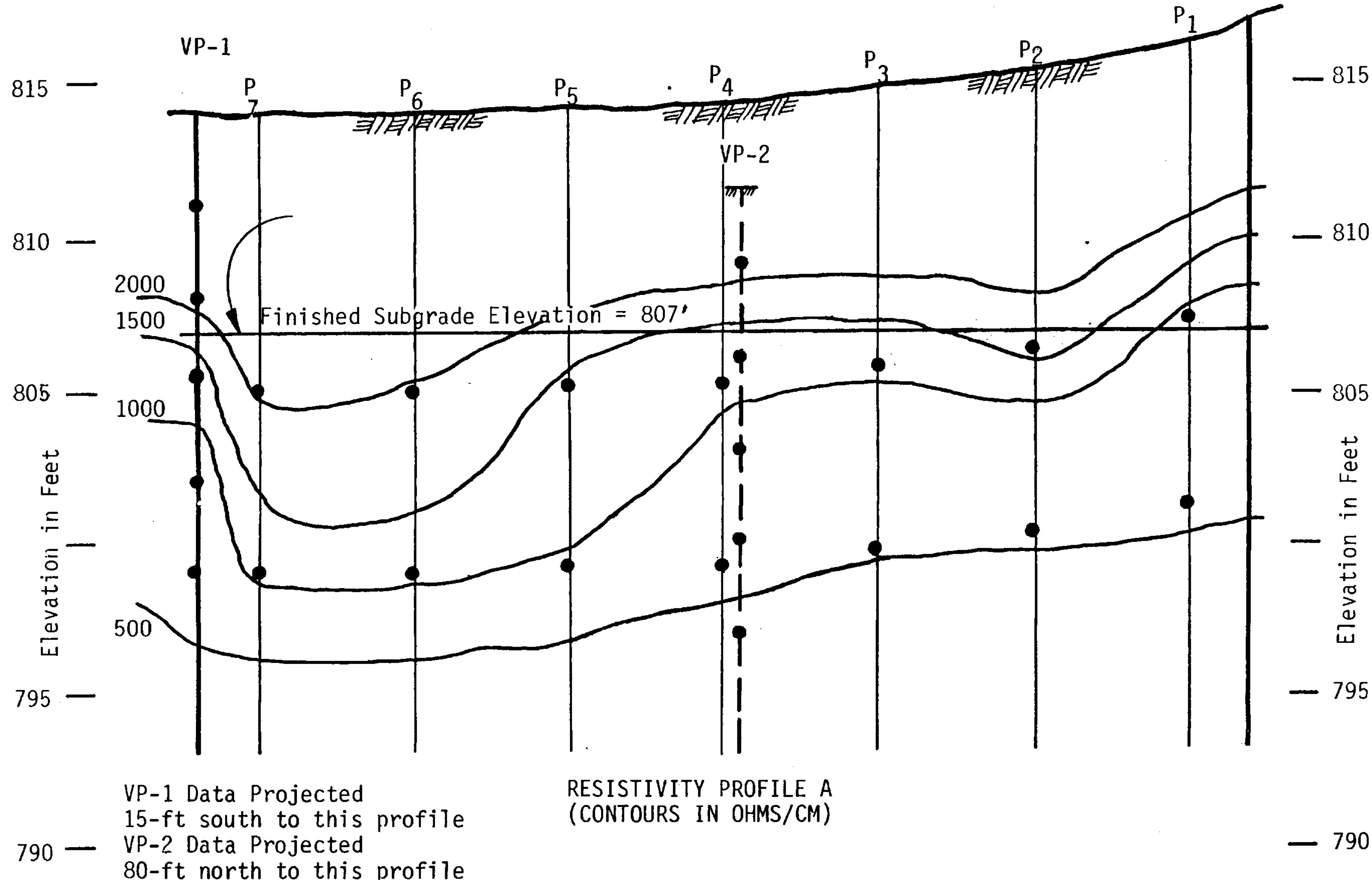


FIGURE 13 - RESISTIVITY PROFILE A

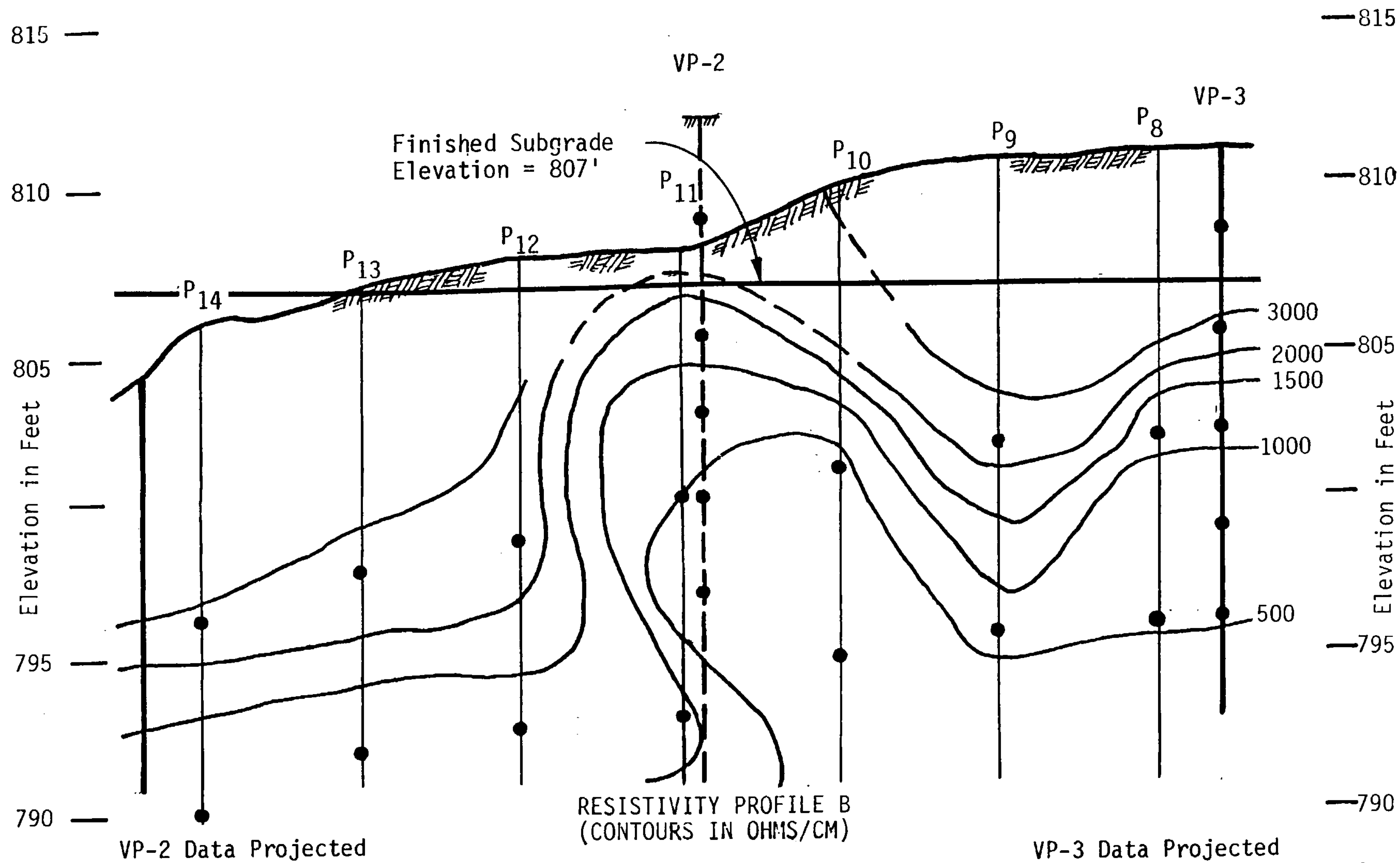


FIGURE 14 - RESISTIVITY PROFILE B

The Regency Garden Office Building This project started as a routine geotechnical investigation for a rectangular 100-ft by 120-ft three story office building. The scope of work proposed to the client was for four borings, one at each corner of the proposed building. To limit expenses, the client approved a much reduced scope for the investigation.

Two borings were drilled at opposite corners of the proposed building site. The first encountered weathered light tan limestone at 1-1/2-ft below the surface, continued in limestone with some tan clay seams and was terminated at 21-1/2-ft. The second boring encountered limestone at 1/2-ft depth, penetrated hard light tan limestone with thin tan clay seams and was terminated at 11-ft.

On the basis of these two borings, a qualified report was prepared and submitted to the client. The report recommended either of two foundation systems: (1) a rigid-engineered beam and slab foundation with beams set at a depth of 12-in. at an allowable bearing capacity of 3600-lbs per sq ft; or (2) shallow spread footings set on solid hard light tan limestone proportioned for a gross allowable bearing capacity at 9800-lbs per ft.

During the course of design the building configuration was changed, the building size increased, and the building resited. The structural engineer elected to use slab-on-grade floors and shallow spread footings to support the superstructure. Rock anchors were specified beneath several of the spread footings to dissipate wind loads.

Building construction started with leveling and preparing the site using select base material as structural fill. When excavation for the spread footings was started, several excavations were extended to considerable depths below planned elevation without encountering the expected rock surface.

The discovery and reporting of these conditions naturally caused considerable concern for the building contractor, the owner, the structural engineer, and the geotechnical engineer who in this case was the author of this report.

Drilling rigs from the firm's geology and exploration division were immediately rescheduled and sent to the site. Borings at three of the proposed locations for the rock anchors revealed that the limestone rock was broken and blocky with intermittent thick seams of brown clays. Borings drilled at several of the other spread footing locations did not encounter solid limestone until penetrating to depths of 18 to 28-ft.

Geologic interpretation of the findings of these several borings indicated the final siting of the structure had placed it either at the edge of a geologically ancient sinkhole which had been filled and sealed with geologically younger depositional material. Or, the building had been sited across a faulted zone having only lateral displacement and no vertical displacement. Both of the initial two borings had completely straddled this geologic anomaly. Figure 15 shows the locations of the initial and subsequent borings and the interpretation of the limit of geologic anomaly.

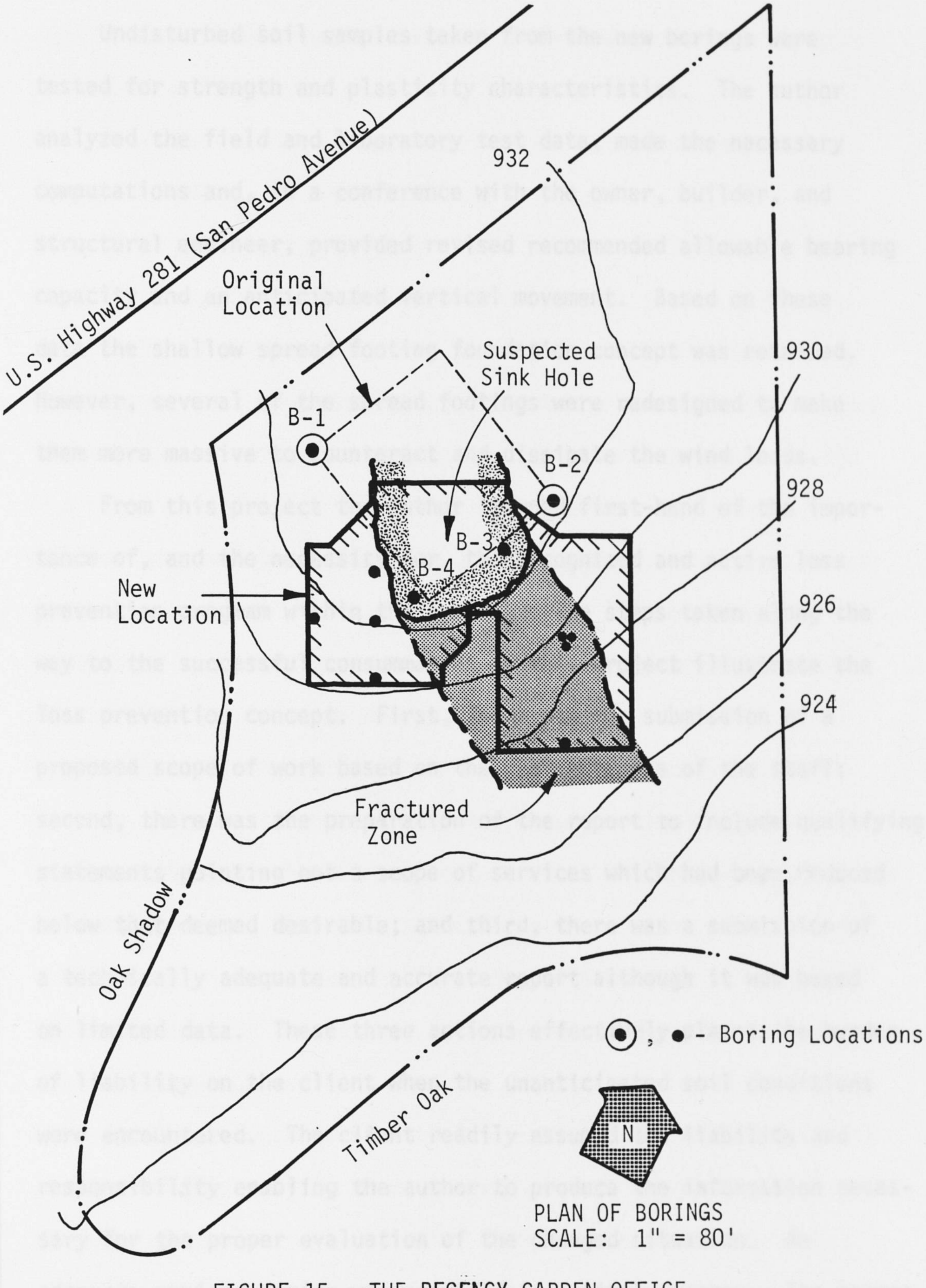


FIGURE 15 - THE REGENCY GARDEN OFFICE
BUILDING SITE LAYOUT

Undisturbed soil samples taken from the new borings were tested for strength and plasticity characteristics. The author analyzed the field and laboratory test data, made the necessary computations and, in a conference with the owner, builder, and structural engineer, provided revised recommended allowable bearing capacity and an anticipated vertical movement. Based on these data the shallow spread footing foundation concept was retained. However, several of the spread footings were redesigned to make them more massive to counteract and dissipate the wind loads.

From this project the author learned first-hand of the importance of, and the necessity for, the recognized and active loss prevention program within the company. The steps taken along the way to the successful consummation of this project illustrate the loss prevention concept. First, there was the submission of a proposed scope of work based on the best estimate of the staff; second, there was the preparation of the report to include qualifying statements pointing out a scope of services which had been reduced below that deemed desirable; and third, there was a submission of a technically adequate and accurate report although it was based on limited data. These three actions effectively placed the burden of liability on the client when the unanticipated soil conditions were encountered. The client readily assumed the liability and responsibility enabling the author to produce the information necessary for the proper evaluation of the changed situation. An adequate revised design was provided in a timely manner. The management aspects of the loss prevention program will be more fully discussed in Chapter V.

Construction then proceeded. Completion is scheduled for December 1981.

First International Plaza This project is located in downtown San Antonio, Texas. The proposed project is for a twenty-eight story high-rise tower and an associated four to five story parking garage. Upon completion, this tower structure will become the tallest building in San Antonio, Texas. A photograph of the architect's rendering of this project is shown in Figure 16. Another unique feature is that it is planned to have the heaviest loaded piers known in the San Antonio area. The maximum pier loads will be in the order of 4300 kips. A settlement criterion not to exceed 1.0-in. on the piers was required.

Soil conditions at the site were investigated by twelve borings. Figure 17 shows the boring locations in relation to the site and the general building footprints. The borings were drilled to depths varying from 100 to 125-ft below existing grade. The exploratory borings revealed that the soils at this site may be grouped into four generalized strata of similar physical and engineering properties.

Stratum I consists of 2 to 7-ft soft to very stiff brown clay, dark gray clay or brownish-gray clay. Stratum II consists of moderately plastic to plastic, firm to very stiff tan silty clay, or tan clay with caliche. This stratum normally produces an

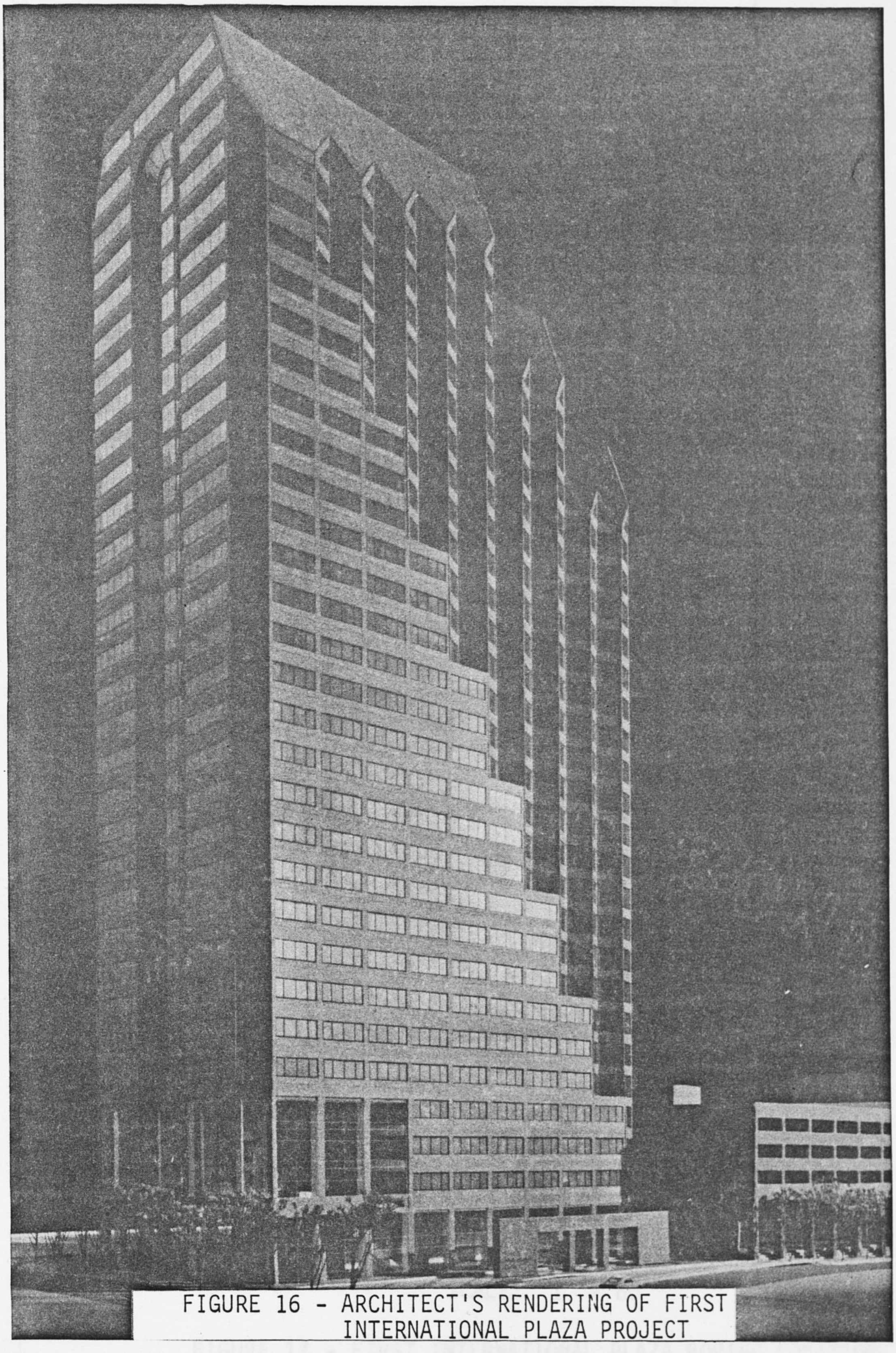
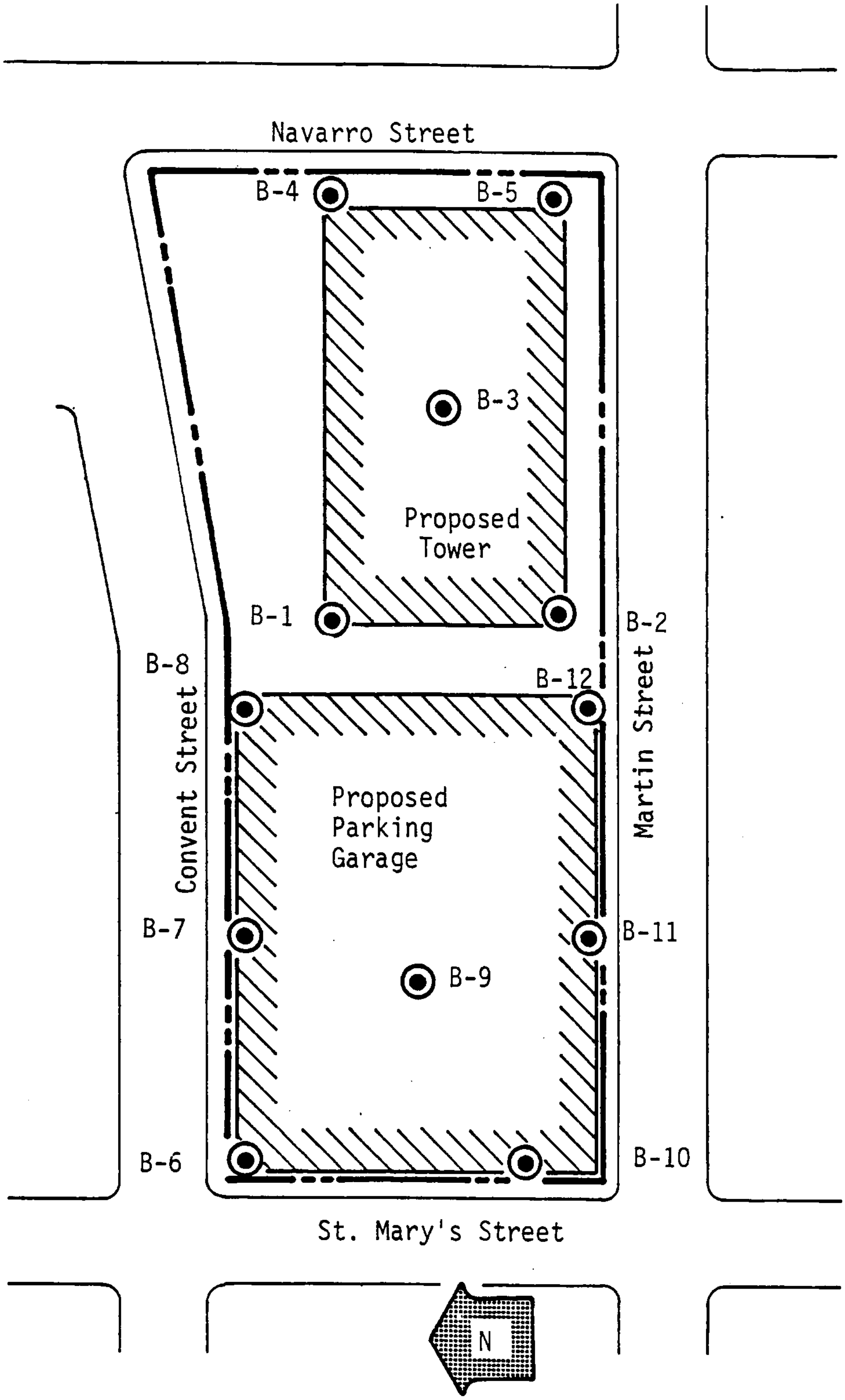


FIGURE 16 - ARCHITECT'S RENDERING OF FIRST INTERNATIONAL PLAZA PROJECT



PLAN OF BORINGS
SCALE: 1" = 80'

FIGURE 17 - FIRST INTERNATIONAL PLAZA BORING LOCATIONS

extensive amount of water and appears at this project site to have direct hydraulic access to the nearby San Antonio River.

Stratum III consists of plastic to highly plastic, very stiff tan and gray clay, which is the result of weathering of the underlying Taylor marl formation. Stratum IV, starting about 45-ft below the surface, consists of very stiff to hard blue clay shale. This stratum is the beginning of the unweathered basal Taylor marl formation underlying most of the city of San Antonio.

Within the Stratum IV blue clay shale beneath the tower, three zones, or sub-strata, were identified based on the shear strength, soil modulus, and plasticity characteristics.

Zone A shale extends to a depth of approximately 65-ft. This zone is interstratified by high strength seams and layers. The unconfined compression test specimens generally failed in the plastic mode characteristic of clays; however, those taken from the high strength layers exhibited brittle failure.

The clay shale in Zone B extends from approximately 65-ft to approximately 80-ft below the surface. It is a higher plasticity and lower density zone within the Stratum III clay shales. All specimens tested from this zone exhibited a bulging or plastic flow type failure which is characteristic of clay.

The Zone C clay shale extends from approximately 80-ft to 125-ft, the maximum depth explored. The clay shale in this zone, which is drier and of higher density, exhibited lower plasticity characteristics than did the clay shale from other zones. In general, the specimens tested in unconfined compression exhibited the brittle failure characteristic of rock specimens.

Adequate bearing capacities to support the design pier loads for this building exist after short penetrations into the Stratum IV hard blue clay shale formation. The soil modulus values, plasticity characteristics, and the settlement criterion not to exceed 1-in. will require that the foundation piers for this structure be set on or into a harder zone within the clay shale formation at depths of 80 to 82-ft below the surface. These foundation depths also make this project unique within the San Antonio area. No other structure is known to have foundation elements extending to this depth. This project has another unique feature for the San Antonio area in that two of the heavily loaded piers will be instrumented with strain gauges so measurements can be made of the load transfer from the pier shafts to the surrounding soil. Ten piers within the building structure, including the two instrumented piers, will be monitored for settlement. During the construction of the building, surveyed elevations will be made on the selected piers after the placement of every fourth floor level.

The author, under the guidance of the internship supervisor, participated extensively in the evaluation and analysis of the soil test data and the computation of bearing capacities. The author gained valuable experience in the geotechnical analysis and design of this high-rise structure.

Pier Instrumentation Project One of the most interesting and exciting projects the author helped design and direct was the pier instrumentation project. It involved the installation of strain gauges in deep foundation elements for the First International Tower structure.

Involvement in this project was a very interesting and educational experience for the author. During the author's academic phases of the Doctor of Engineering program, he studied the results of data obtained from instrumented pier/pile projects, saw how the results were interpreted and subsequently could be applied to the rational design of foundation elements in practical situations. Most of the instrumentation studies were on precast piles driven to relatively shallow depths and then test loaded.

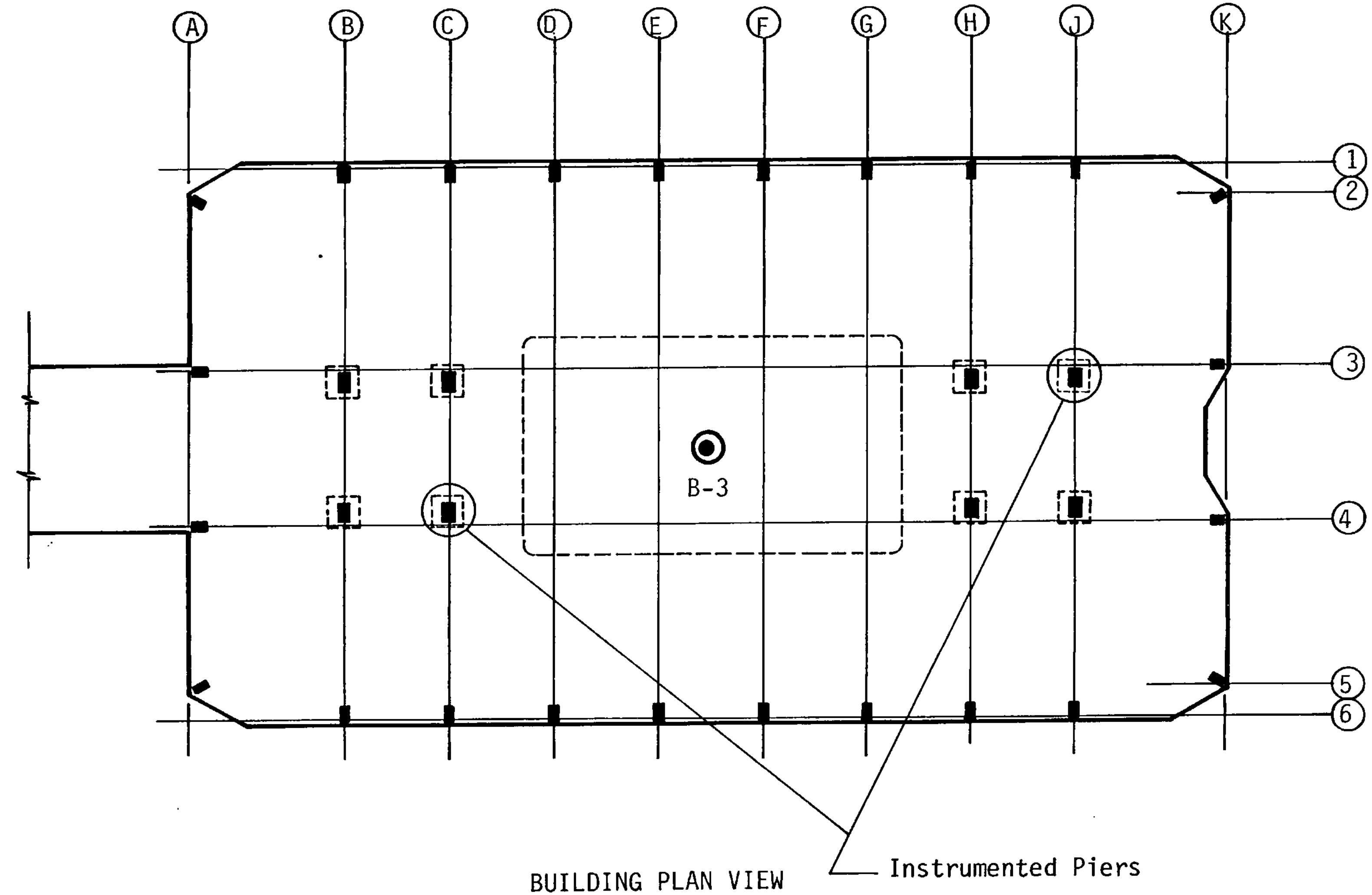
This project was most exciting to the author in that it involved the instrumentation of large auger drilled and belled pier or cassion shafts, heavily reinforced, and completed by the placement of concrete cast-in-place under field conditions. He would have the opportunity to conduct the instrumentation installation phase, participate in the gathering of the field data, and, subsequently, evaluate and analyze the data. These data, when analyzed, will provide much enlightenment to the engineering profession in the mechanism of load transfer from a foundation shaft into the supporting soil of this geologic formation.

All pier shafts to support the heavy loads imposed by the design of the tower structure were carried to the top of a hard dense layer at 80 to 82-ft below the ground surface where the maximum allowable bearing capacity for design was 35,900-lbs per sq ft. These footing depths are the deepest known to the author for the San Antonio area.

Early in the investigation and design program for the project, it had been decided between Dr. Raba and the project design team that ten strain gauges--five pairs--would be installed in each of two pier shafts. The installation of two strain gauges at each elevation was to provide redundancy to cover the possibility of gauge failure.

The author had the assignment as Project Engineer for the instrumentation project and was assisted by Mr. Mark A. Rugen, Staff Physicist, in the installation of the strain gauges and the check out of circuitry. The author selected Piers C-4 and J-3 to be instrumented since they were to be two of the most heavily loaded and would be on opposite ends of the tower structure. They are located as shown on Figure 18. Pier C-4 on the west end of the building was to have a calculated design load of 4200 kips. Pier J-3 was located under the east end of the building and was to have a calculated design load of 4300 kips.

In order to be compatible with construction efforts and planning, and to be able to obtain as much accurate and usable data as possible, strain gauge pairs were planned for installation as follows:



BUILDING PLAN VIEW

FIGURE 18 - LOCATIONS OF INSTRUMENTED PIERS

(1) As near as possible to the top of the completed pier shaft consistent with planned cut-off elevations and where it would still provide a 1-ft protective embedment in the shaft concrete. This gauge pair would measure any load applied to the pier shaft including the pier caps.

(2) The top of the very stiff tan and gray clay layer and below the water bearing gravels. Installation below the water bearing zone was selected to minimize the possibility of water damage to the gauges.

(3) At the top of the blue clay shale basal formation, the primary foundation formation for large structures in the downtown San Antonio area.

(4) At the bottom of Zone A, the first hard layer in the primary formation. The difference in measured load between this gauge pair and the one above would give an excellent measure of the actual load transfer (friction) carrying capacity of this layer.

(5) At the top of the underream of the belled footing. Theoretically, there would be no load transfer to the soil between this point and the bottom of the footing. The load carried in point bearing at the bottom of the foundation element theoretically would be any load not transferred in side friction above the top of the bell.

The general location of the strain gauges is shown on Figure 19 along with the generalized soil profile and the engineering properties of the various soil strata.

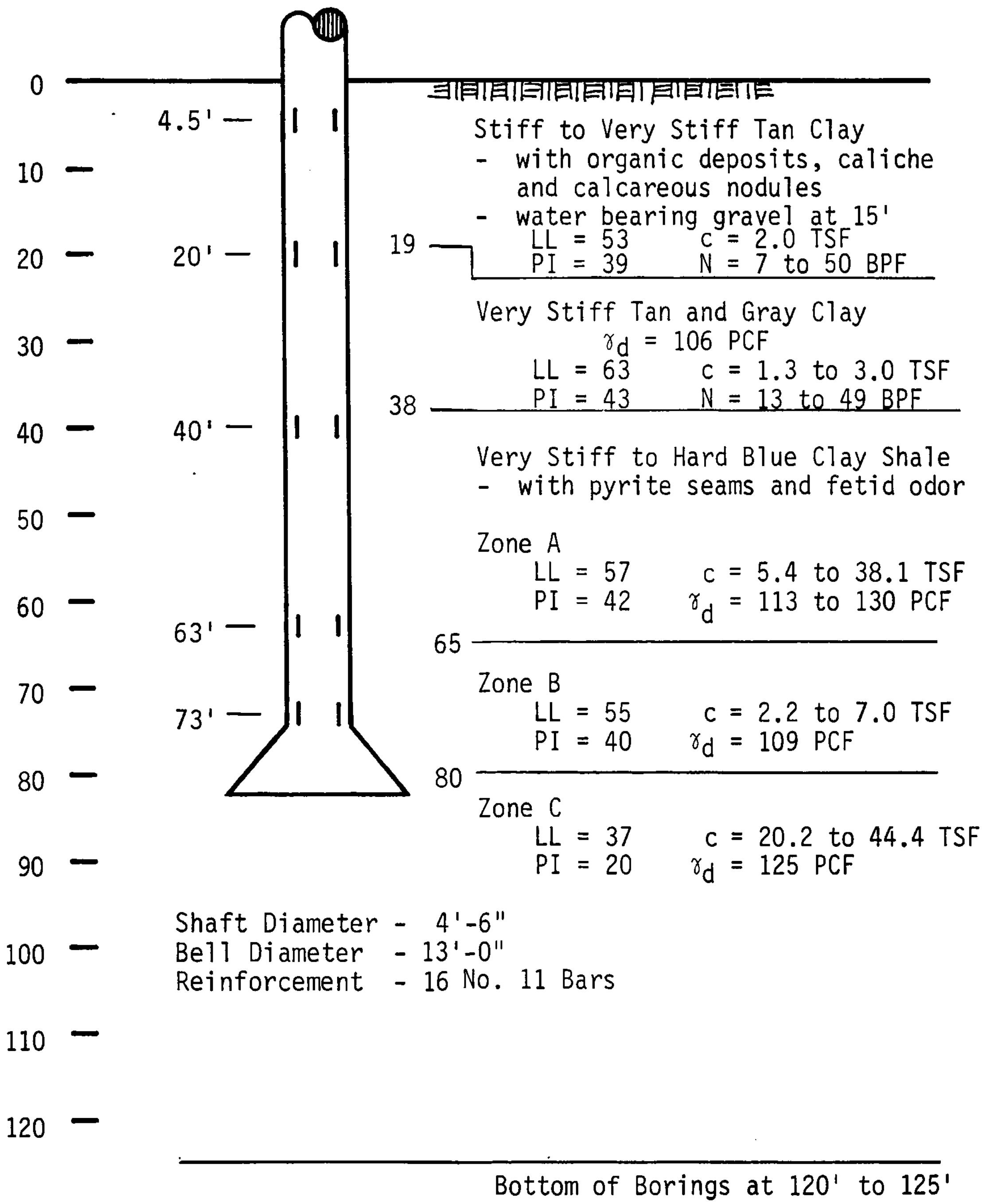


FIGURE 19 - GENERALIZED SOIL PROFILE PIER DESIGN DATA AND STRAIN GAUGE LOCATIONS

The exploratory borings had indicated that the stratigraphic layering across the construction site was very smooth and level. This fact was confirmed during the drilling and completing of several of the other supporting pier elements. Consequently, the design depths of installation for the strain gauge pairs were 4-1/2-ft, 20-ft, 40-ft, 63-ft, and 73-ft below the top of the reinforcing steel pier cage. Signal cable conductors were ordered for these lengths plus 5-ft for adjustments in gauge elevations plus the distance necessary to reach a permanent termination panel box in a protected location.

The strain gauge chosen for this study was the Carlson Elastic Wire Strain Meter which is intended for embedment in concrete to measure interior strain and temperature (9, 10). The body of the elastic wire strain meter is covered with a rubber sleeve to prevent bonding with the concrete. The model chosen for this study, the SA-10, has flanges spaced ten inches apart to bond the meter to the concrete. The conductor cable for the strain meter is a neoprene covered flexible cable of Type 16/4SO with varying lengths (15-ft to 123-ft) depending on the intended location within the pier. The coils of the strain meter are encased in a corrugated brass tube which is completely filled with corrosion-resistant oil. A small space is left for minor oil expansion. A separate sealing chamber is provided for terminating the rubber covered cables that connect the strain meter to the terminals of the readout instrument.

The strain gauges were tied to a reinforcing bar of the pier's reinforcing cage composed of sixteen No. 11 size reinforcing bars so they would measure vertical movements due to the loading. A schematic of the gauge installation is depicted in Figure 20. A photograph of the author holding a strain gauge ready for installation showing its relative size and configuration is shown in Figure 21. A completed gauge installation is shown in Figure 22. The entire installation of the instrumentation was completed on the inside of the reinforcing cage while the cage was on the ground as shown in Figure 23. The extra signal cable was bundled and secured to the top of the reinforcing cage as shown in Figure 24. Due to the possibility of damage to gauges, concrete could not be allowed to free-fall from the top of the pier shafts during concrete placement operations. Tremie placement of concrete was required for the instrumented piers. Protective bars were installed above each strain gauge to provide protection to the gauge during tremie insertion. Figure 25 shows the type of protective bars used in Pier J-3, the first completed. The process of inserting the tremie into this instrumented cage caused the author to believe that the depicted bars did not provide adequate protection to the gauges. For Pier C-4, larger, straight bars were used for the protective guides.

Each of the piers chosen for instrumenting had a design shaft diameter of 4-ft 6-in., a relatively large size for the San Antonio area. A feeling of the relative size of the shaft can be gained from Figures 26 and 27 by comparing the size of the drilling auger

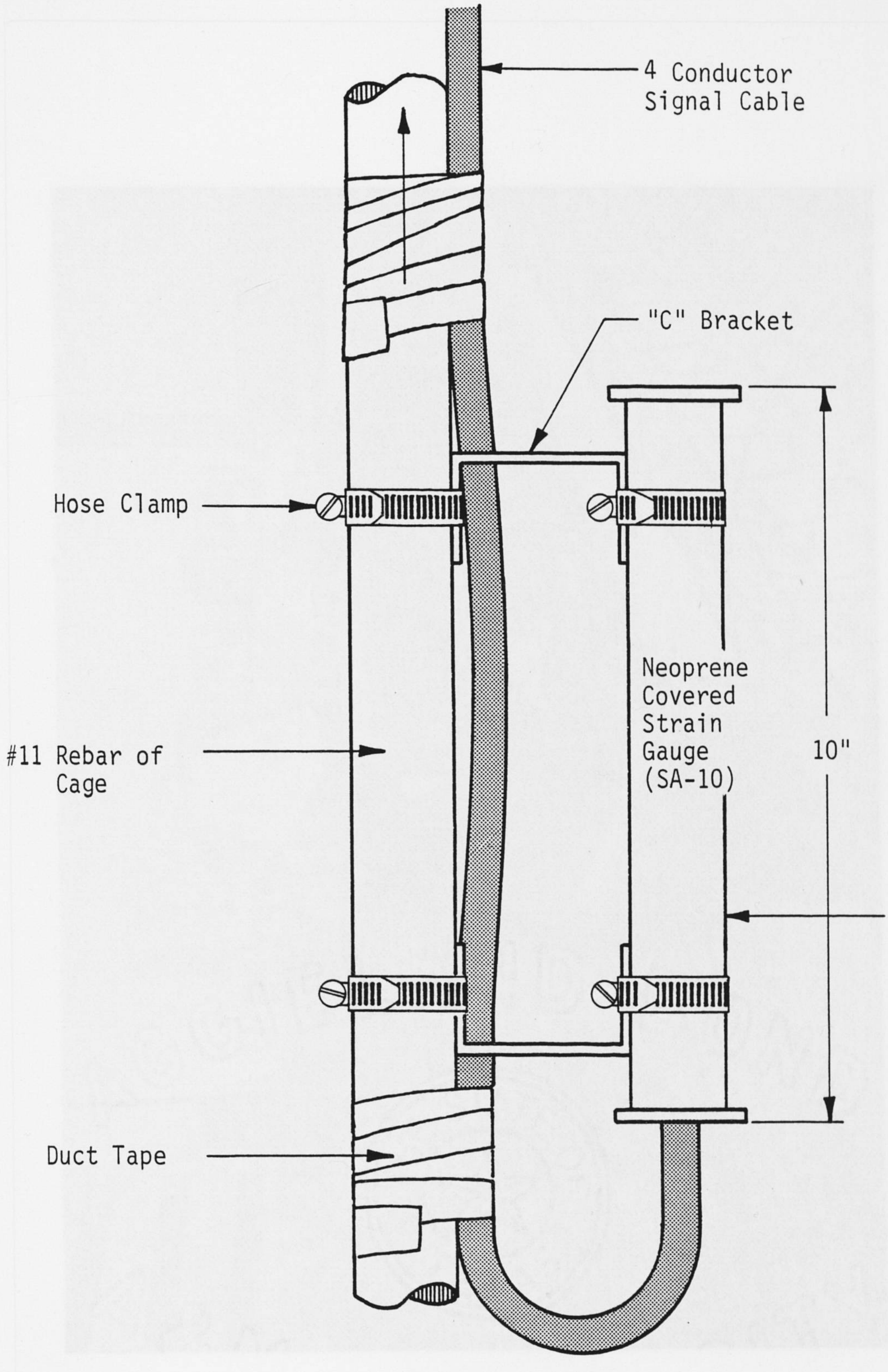


FIGURE 20 - SCHEMATIC OF STRAIN GAUGE INSTALLATION

(NOT TO SCALE)

FIGURE 21 - RELATIVE SIZE AND CONFIGURATION OF STRAIN GAUGE

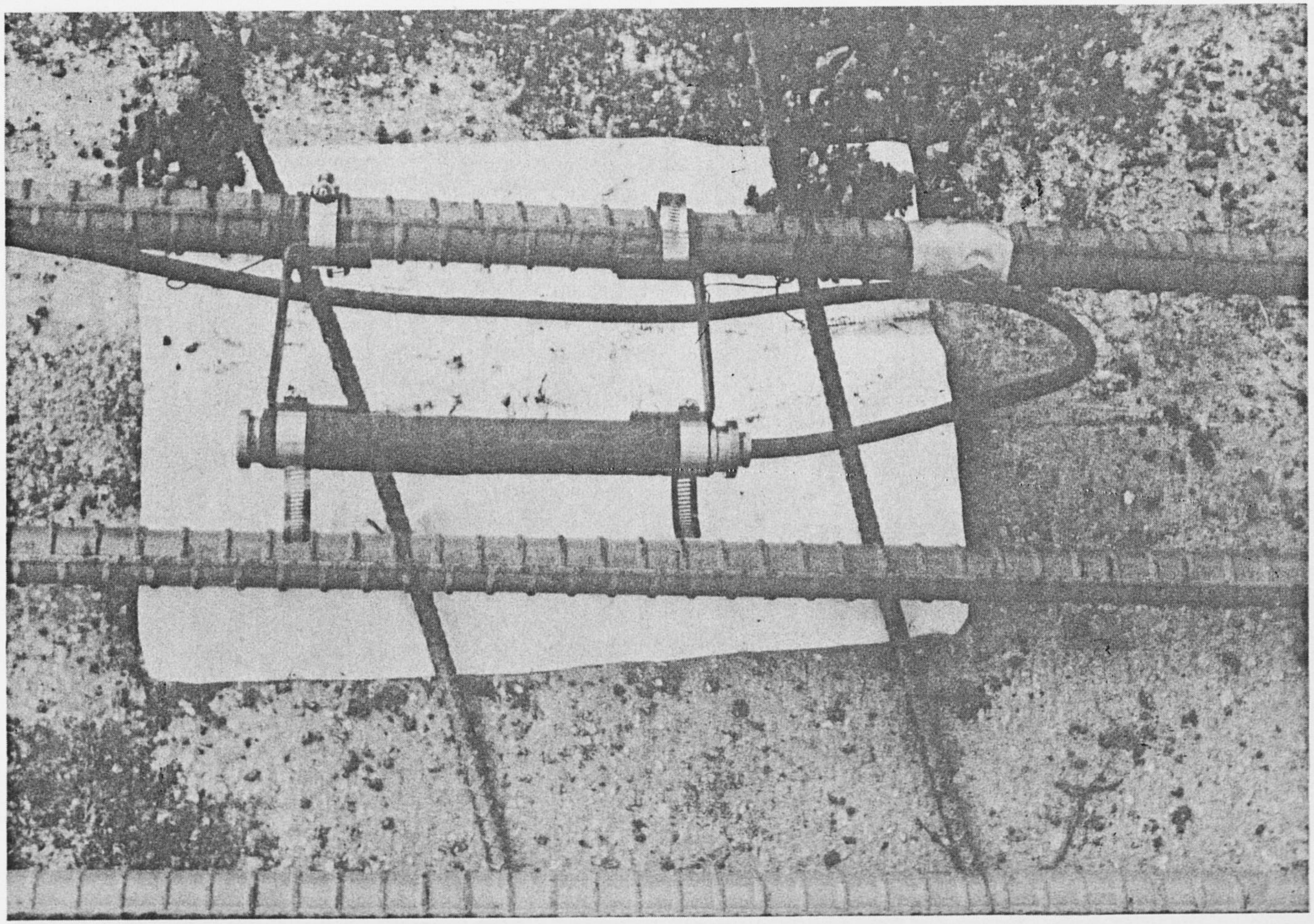


FIGURE 22 - STRAIN GAUGE PLACEMENT IN REINFORCING CAGE

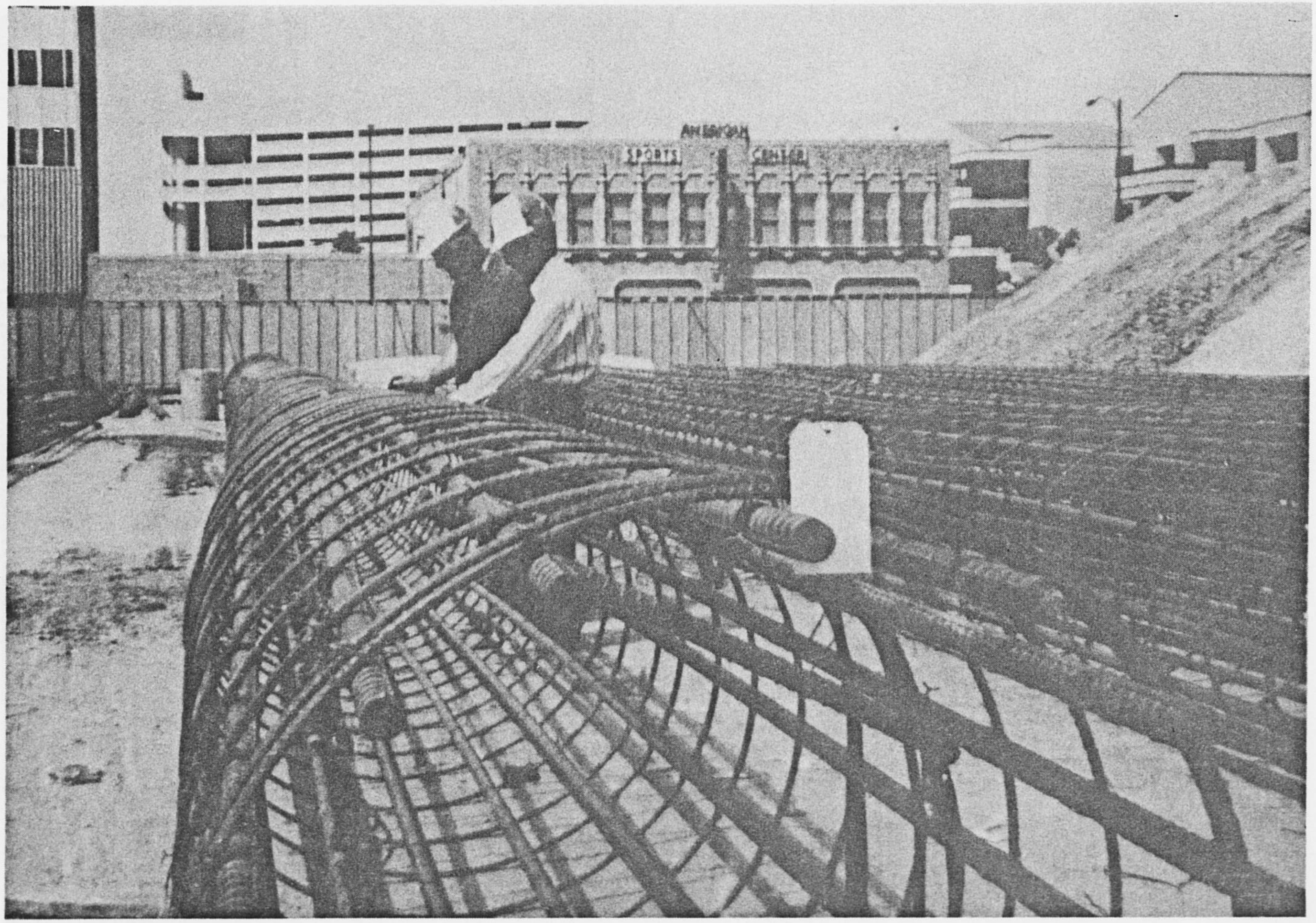


FIGURE 23 - REINFORCING CAGE INSTRUMENTED WHILE ON GROUND

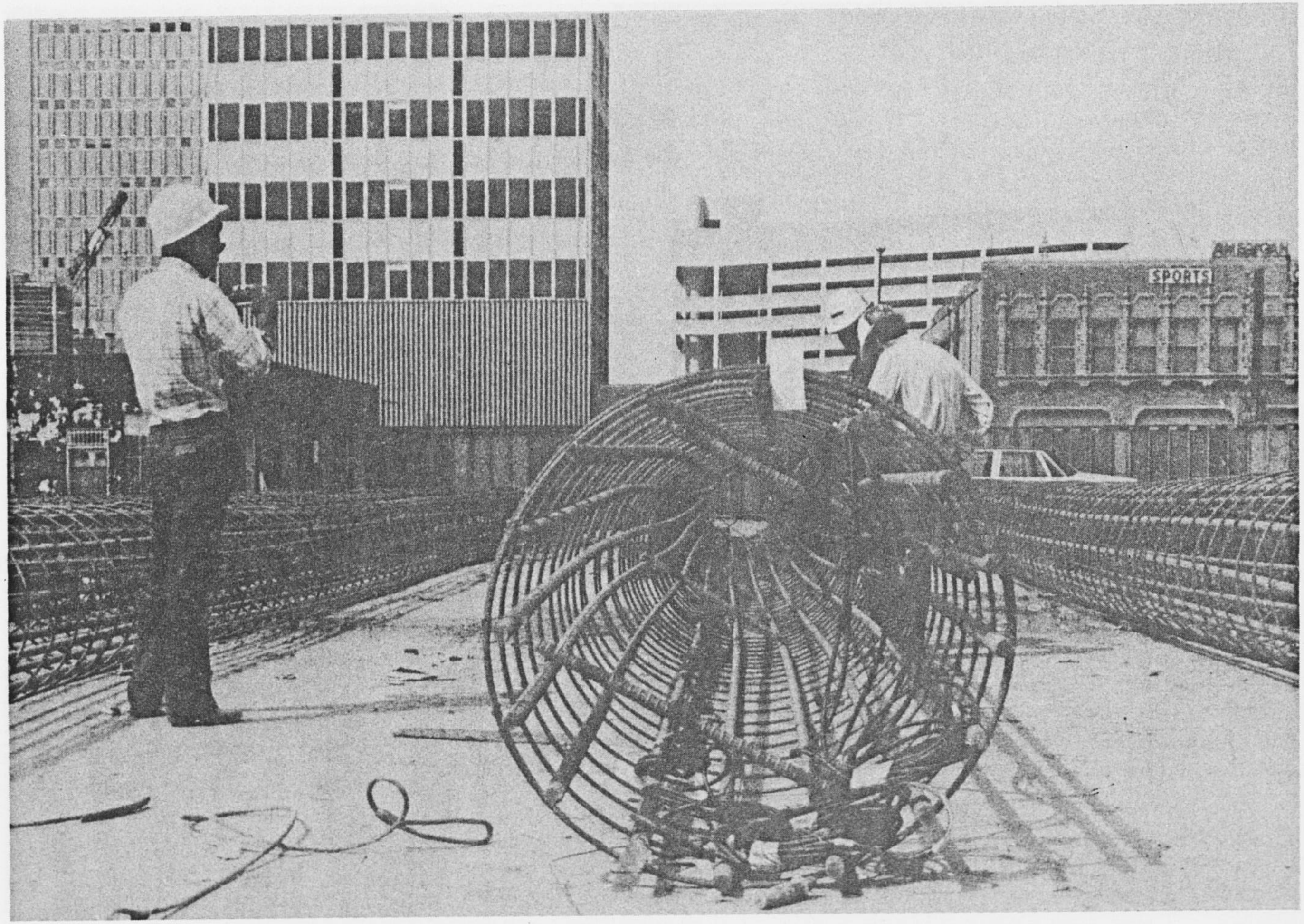


FIGURE 24 - TOP OF REINFORCING CAGE SHOWING CABLES STRUNG THROUGH CAGE
TO PROTECT IT DURING TREMIE INSERTION

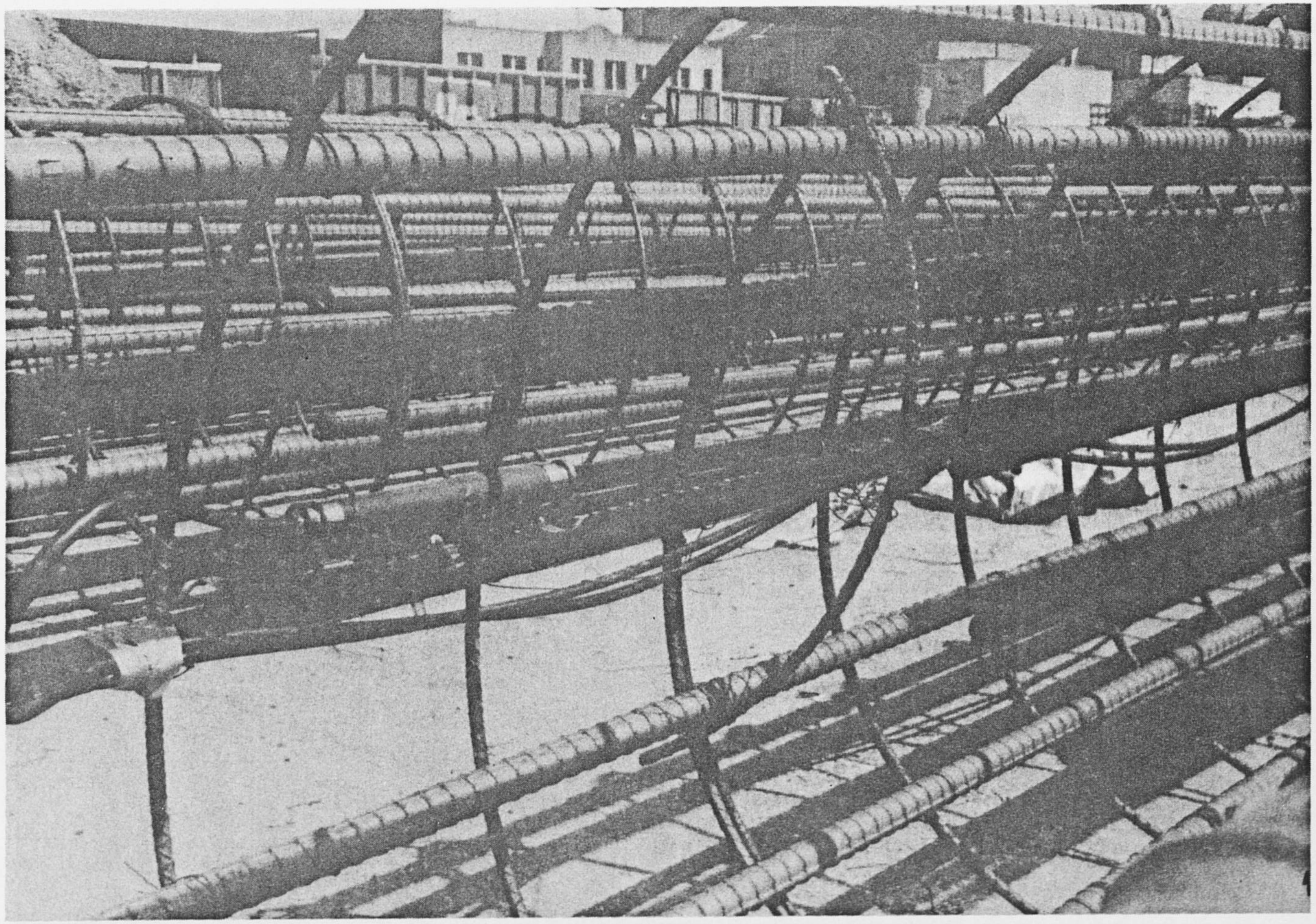


FIGURE 25 - REINFORCING BAR INSTALLED ABOVE STRAIN GAUGE
TO PROTECT IT DURING TREMIE INSERTION

FIGURE 26 - PIER DRILLING AUGER SHOWING RELATIVE SIZE OF SHAFT

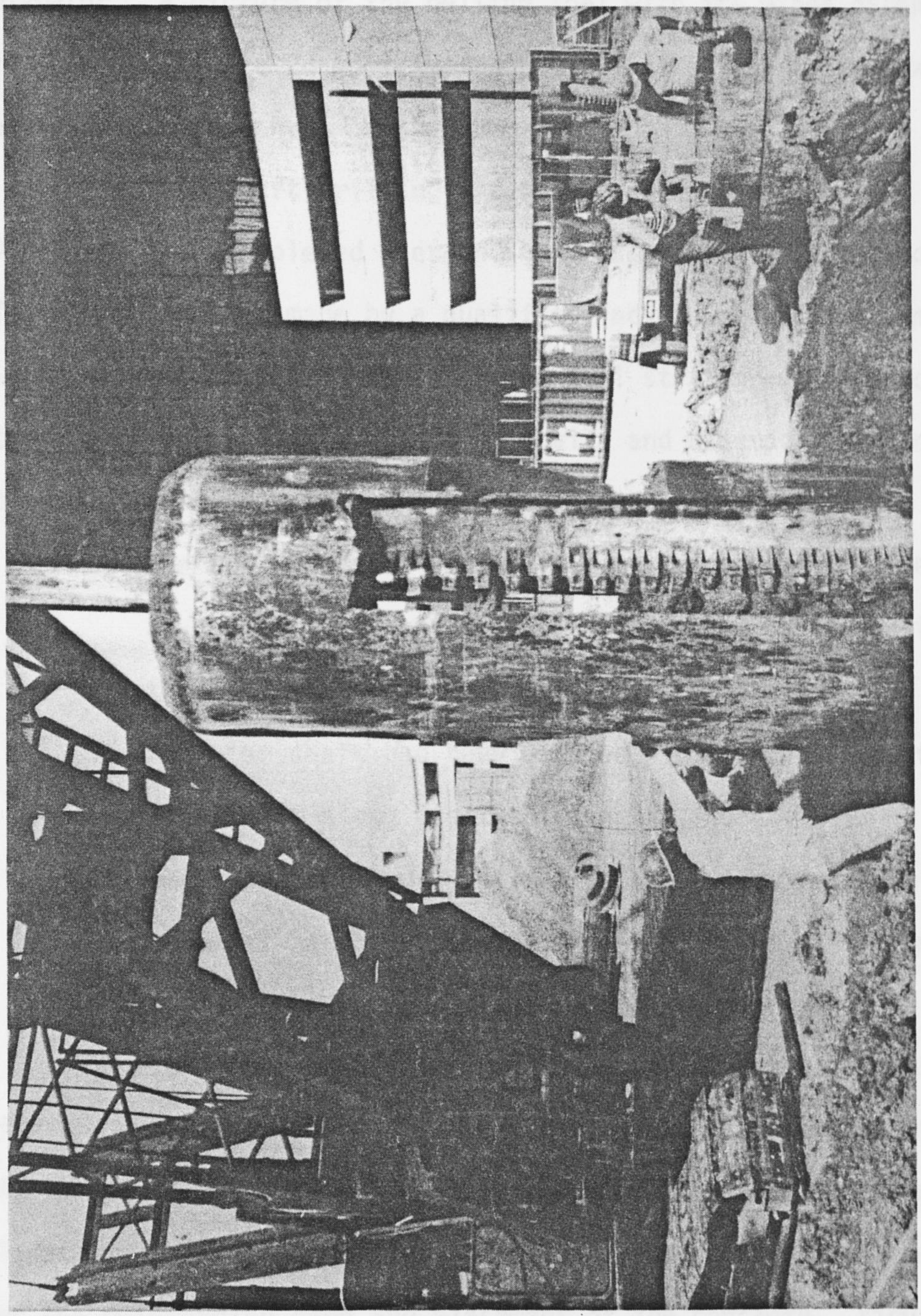


FIGURE 27 - BOTTOM HOLE BELL CUTTING TOOL

and the closed bell cutting tool to the size of the workmen. For each shaft the designed underreamed footing or bell was 13-ft in diameter. A picture of the belling tool with its wings extended is shown in Figure 28 to illustrate the size of the cavity excavated at foundation depth.

After the shaft drilling and underreaming operation was finished, each completed pier and bell was visually inspected. The inspection was made by a qualified individual who was familiar with the geotechnical aspects of the soil stratigraphy, structural configuration, foundation design details and assumptions. Inspection was made prior to placing concrete to ensure that:

(1) the bell had been underreamed to the specified dimensions at the correct depth established by the design criteria;

(2) the bell was concentric with the pier shaft;

(3) the pier shaft had been drilled plumb within specified tolerances along its total length; and

(4) excessive cuttings, buildup and soft, compressible material had been removed from the bottom of the excavation.

The author personally performed the visual inspections required for the underreamed bell for Pier C-4. When all the requirements for proper depth, size, plumbness and cleanliness had been accomplished, the author certified the pier as ready for the placement of the reinforcing cage and placement of the concrete. Figure 29 shows the start of the descent into the pier shaft for inspection by the author and a staff engineer. When drilled, some of the pier

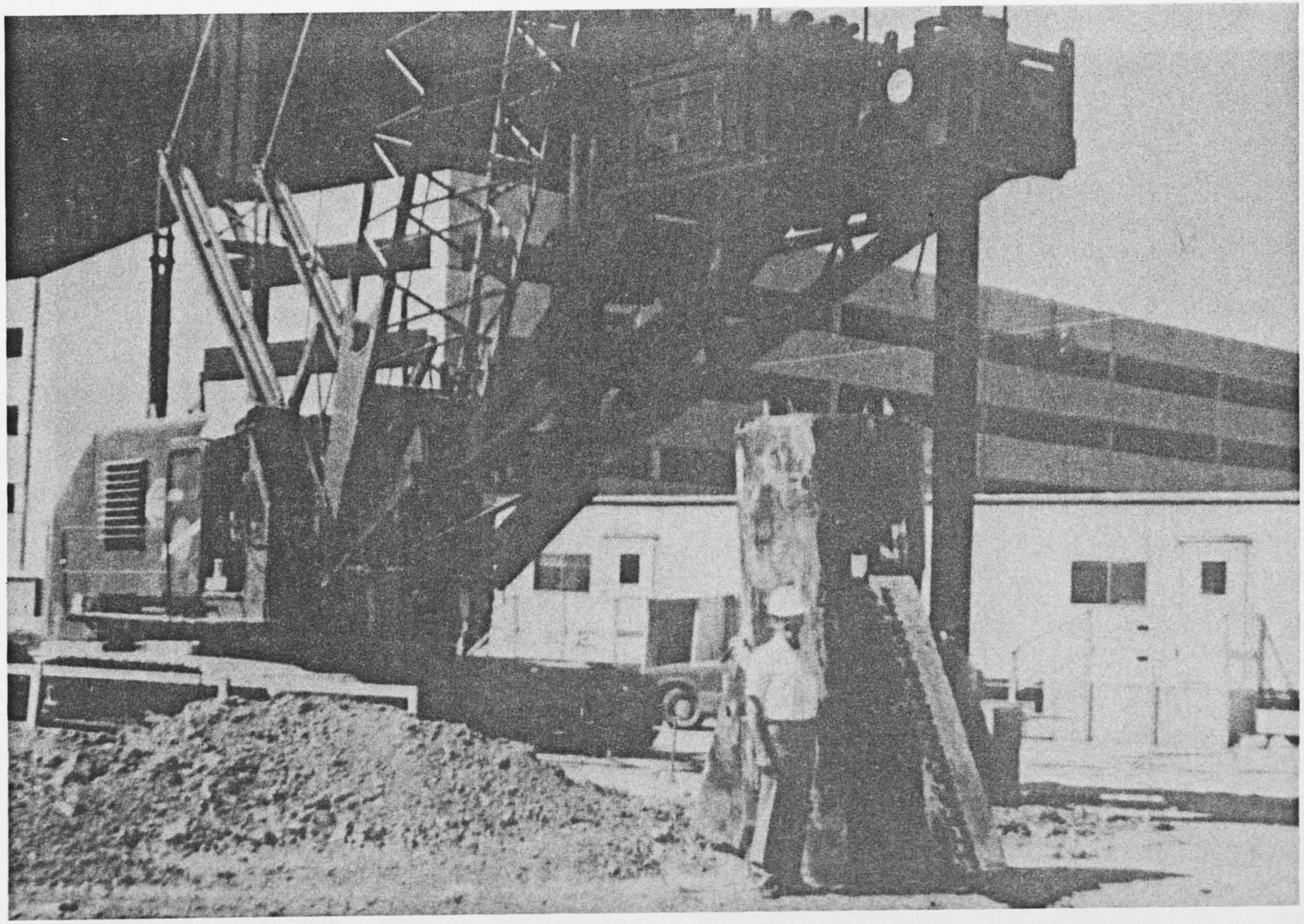


FIGURE 28 - OPEN BELLING TOOL SHOWING RELATIVE SIZE OF BELL CUT

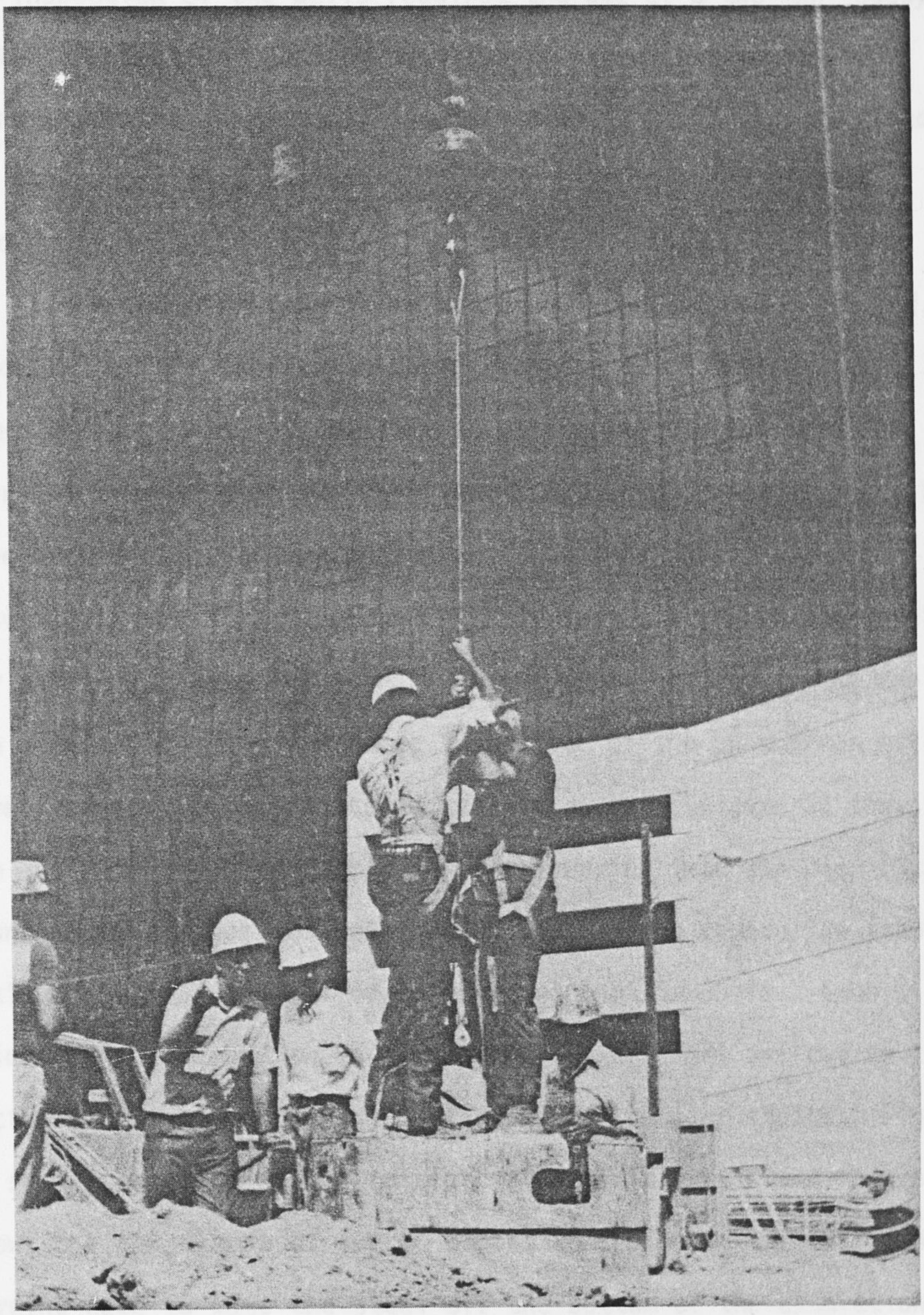


FIGURE 29 - DESCENT INTO SHAFT FOR INSPECTION OF BELL

shafts produced fetid odors and some gasses. For safety reasons, the inspection of the bells required the use of a two-man "buddy-system" inspection team and positive retrievable type safety harness for the inspectors. Additionally, 100 CFM of compressed air was pumped into the bottom of each pier for five minutes before any inspector entered the shafts.

After the piers and bells had been inspected and certified, placement of the steel reinforcing cage could proceed. Figure 30 shows the beginning of the lifting of the reinforcing cage for Pier C-4. Because of the cage length and weight a significant bow developed during lifting operations. Commensurate slack was provided in the signal conductor cable installation to compensate for this bow. Note the bundled excess cable secured at the top of the reinforcing cage. A close inspection of the photograph will reveal several of the installed strain gauges. Figure 31 shows the instrumented pier cage ready for lowering into the pier excavation. Note the spliced reinforcing bars in the cage. The standard maximum shipping length for reinforcing bars is 60-ft. Each reinforcing cage had an additional 20 or more feet spliced to the bottom to reach the 80 plus foot depth of the pier shafts. Figure 32 shows the start of the reinforcing cage insertion and Figure 33 shows the attachment of spacer blocks to the bottom of the reinforcing cage to keep the steel off the bottom of the excavation. Spacer blocks were attached to the outside of the cage at several levels to help center the cage in the shaft and keep the steel from contact with the soil as shown in Figure 34.

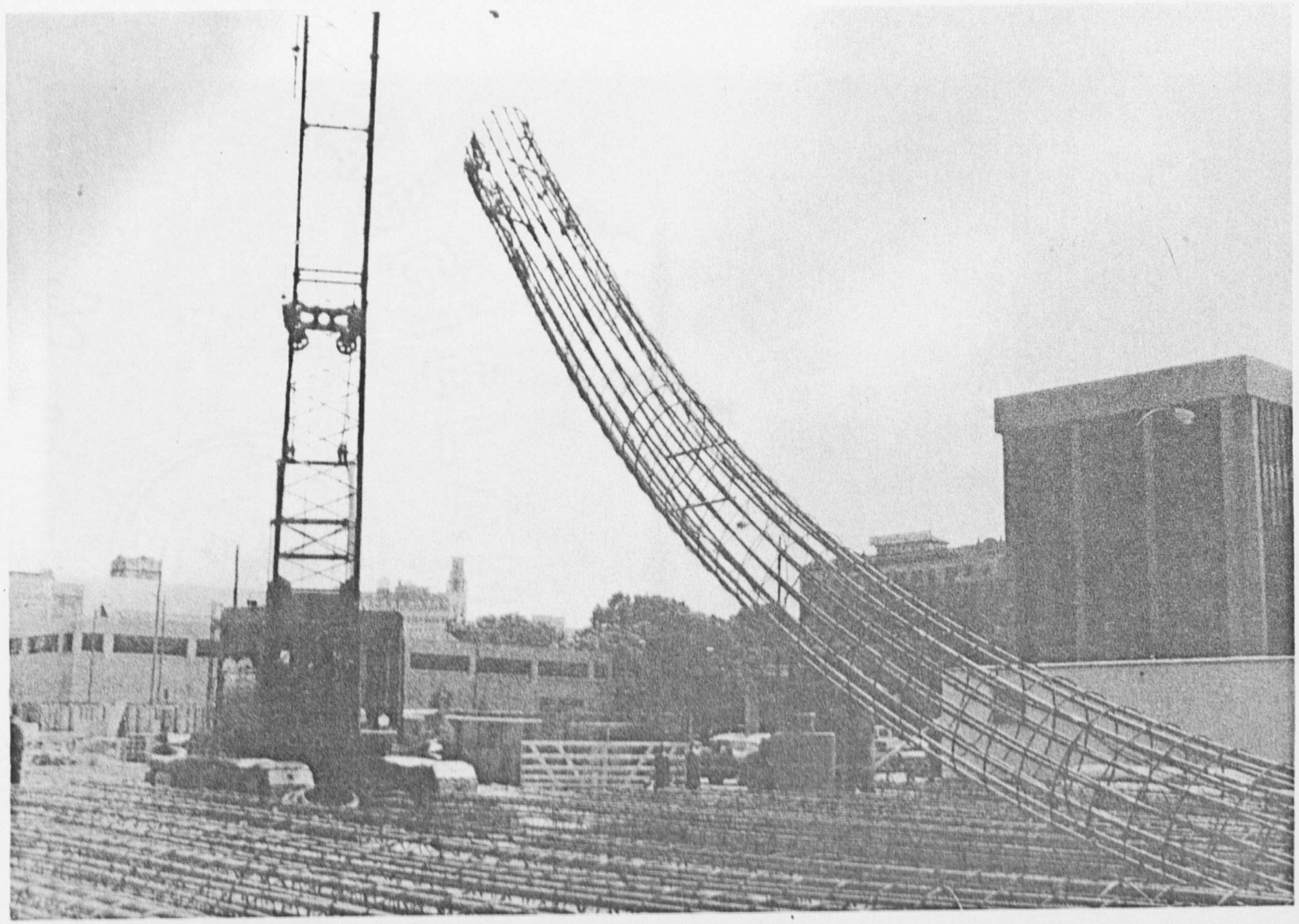


FIGURE 30 - INSTRUMENTED REINFORCING CAGE BEING LIFTED

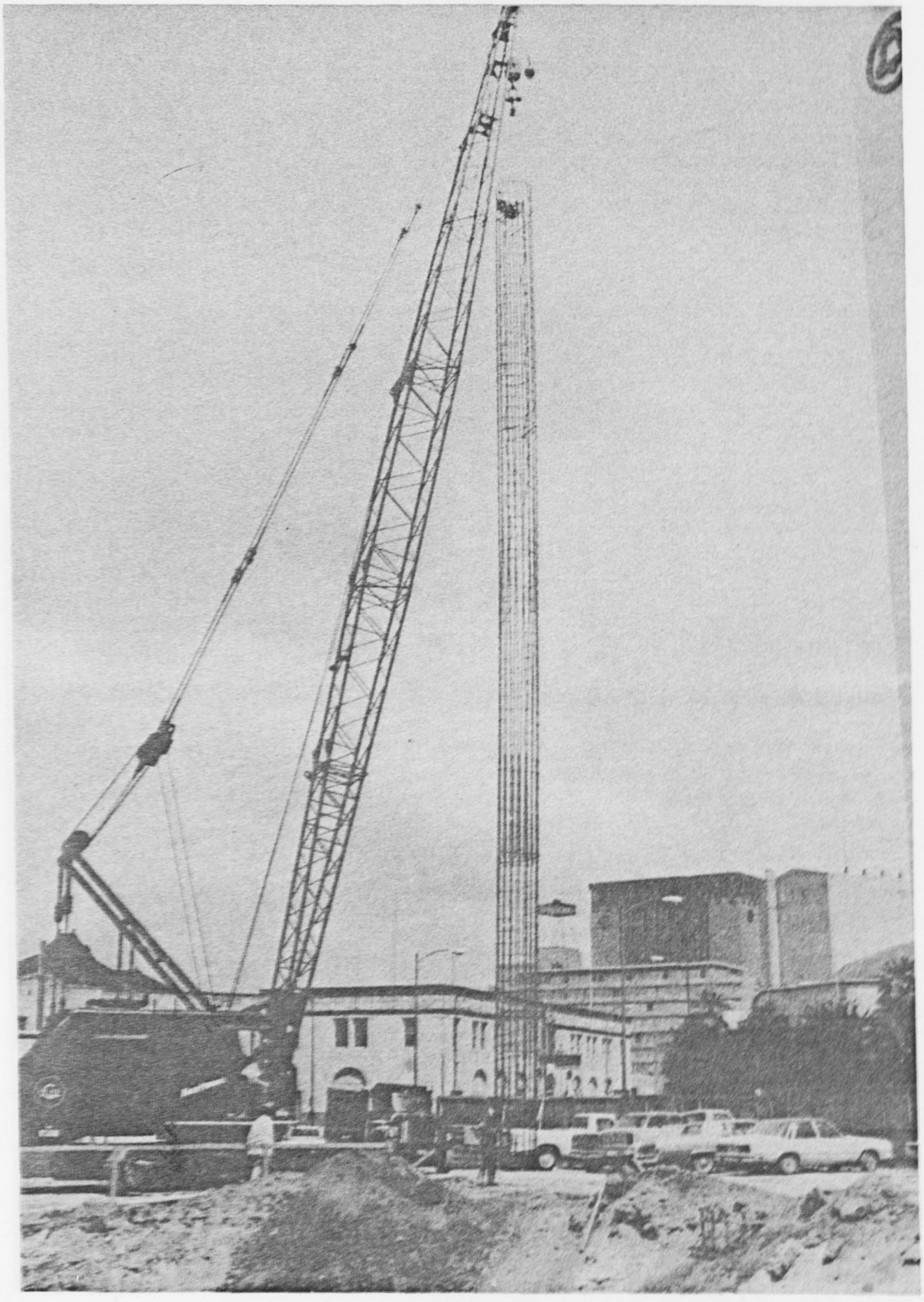


FIGURE 31 - INSTRUMENTED REINFORCING CAGE READY FOR LOWERING INTO PIER EXCAVATION

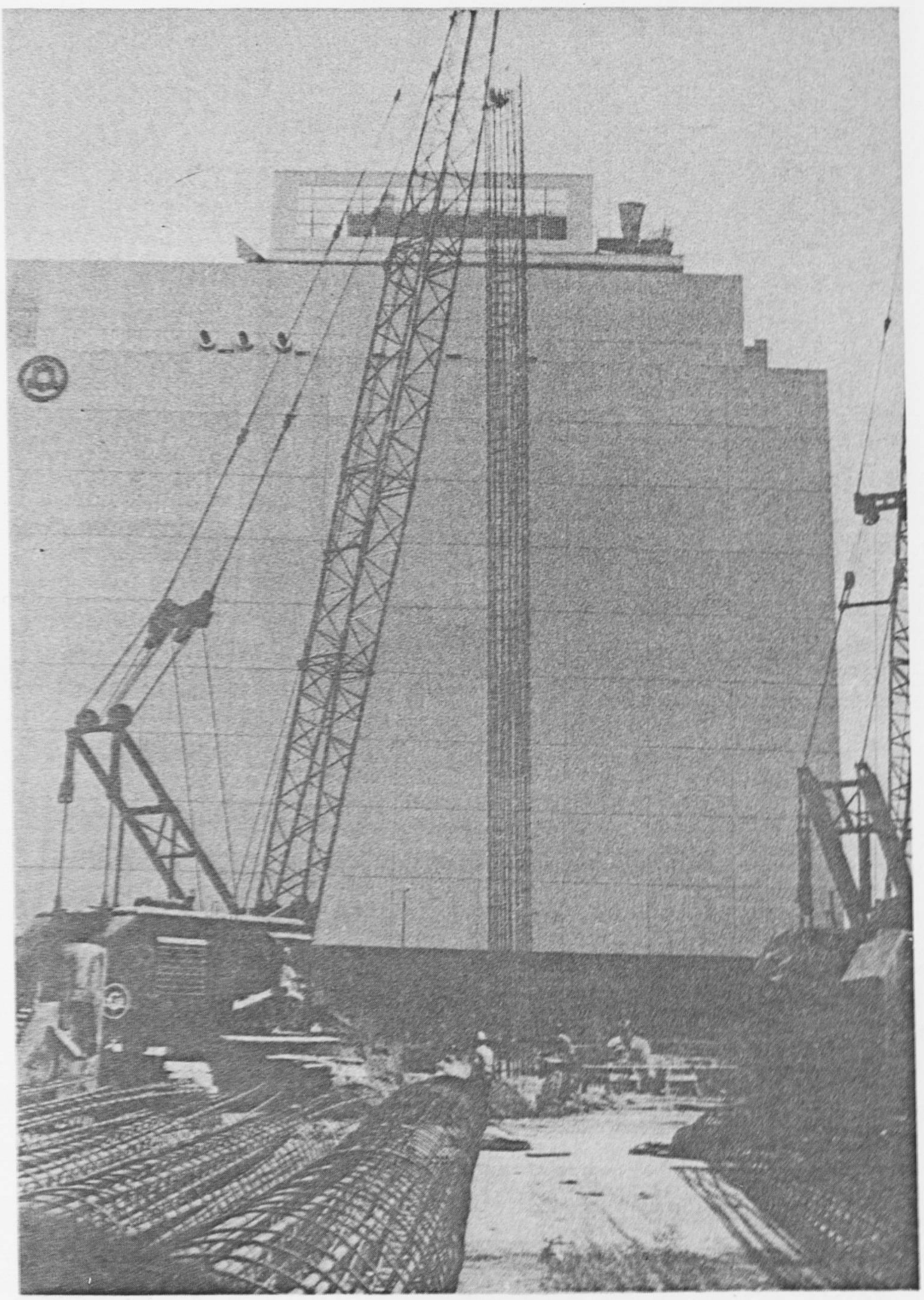


FIGURE 32 - INSTRUMENTED REINFORCING CAGE BEING LOWERED INTO PIER SHAFT

FIGURE 33 - INSTRUMENTED CAGE BEING PLACED IN PIER SHAFT

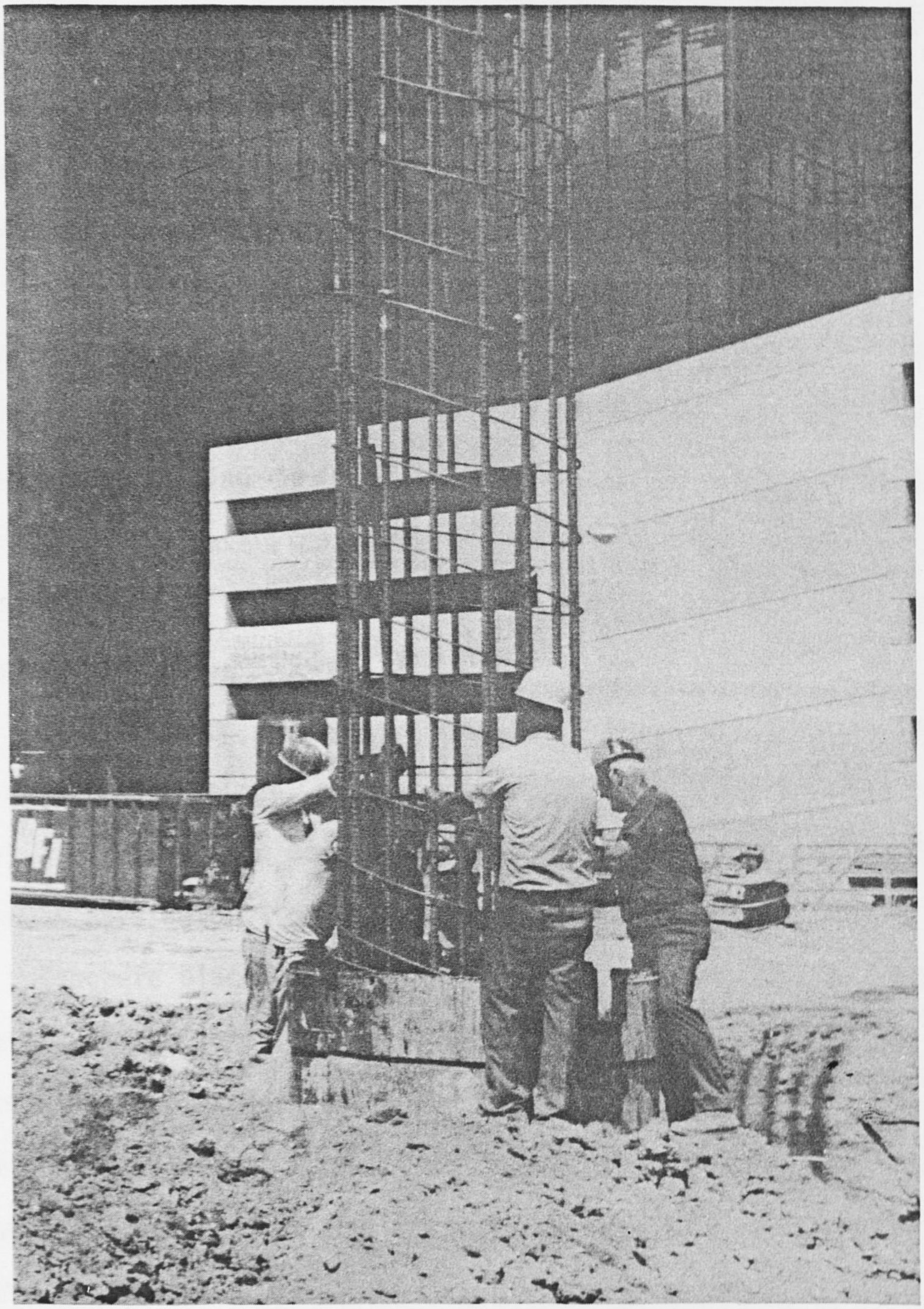


FIGURE 34 - INSTRUMENTED CAGE BEING PLACED
AND CENTERED IN PIER SHAFT

With the reinforcing cage placed and centered, the tremie was then carefully inserted inside the reinforcing cage as shown in Figure 35. Extreme care was taken to insure that the bottom of the tremie did not dislodge the protective bars and damage the strain gauges. At this point in the procedure, the operations were conducted mostly by feel and almost entirely in the dark. The tremie was approximately 65-ft long, passed through four levels of strain gauges and ended approximately 10 to 12-ft above the last or bottom set of gauges. All the gauges were thus protected from falling concrete, assuming no gauges had been knocked off during the insertion of the tremie and that the tremie was so centered that it would not discharge concrete onto the bottom two gauges.

At this point in the operation, nothing further could be done to adjust, straighten, protect, or otherwise correct any damage that might have been done to the gauges. The author spent several anxious days before the gauges could be checked out.

Concrete placement then proceeded in a rather routine fashion through a funnel top in the tremie as shown in Figure 36. The concrete was placed to above the bottom of the tremie and the pier shaft filled to approximately 50-ft from the surface. The tremie was then raised and concrete placement continued through holes or windows provided in it. The tremie was removed completely when the concrete reached approximately 10-ft below pier cut-off depth. Concreting then continued to overfilling the casing. The

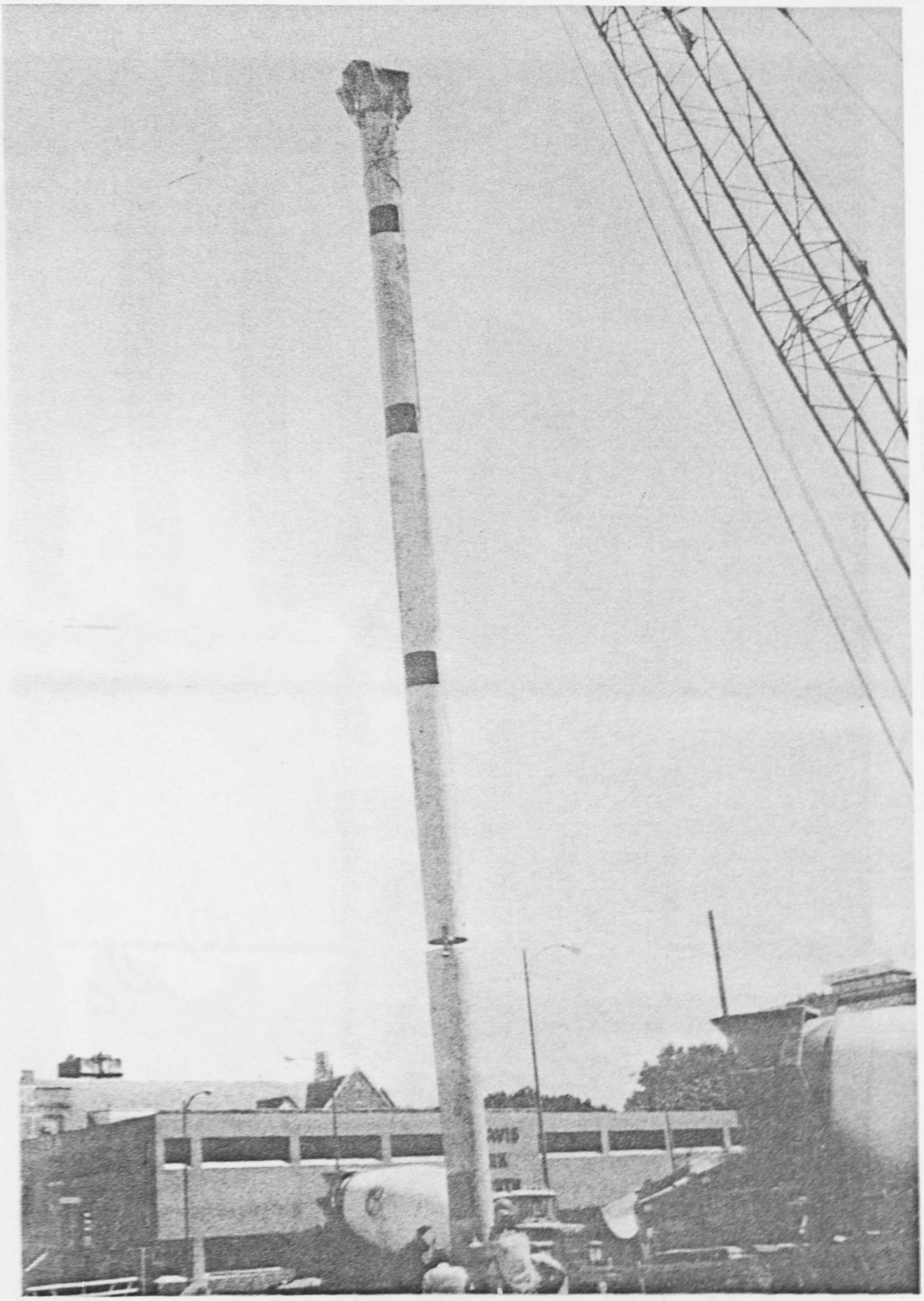


FIGURE 35 - TREMIE BEING LOWERED INSIDE INSTRUMENTED CAGE

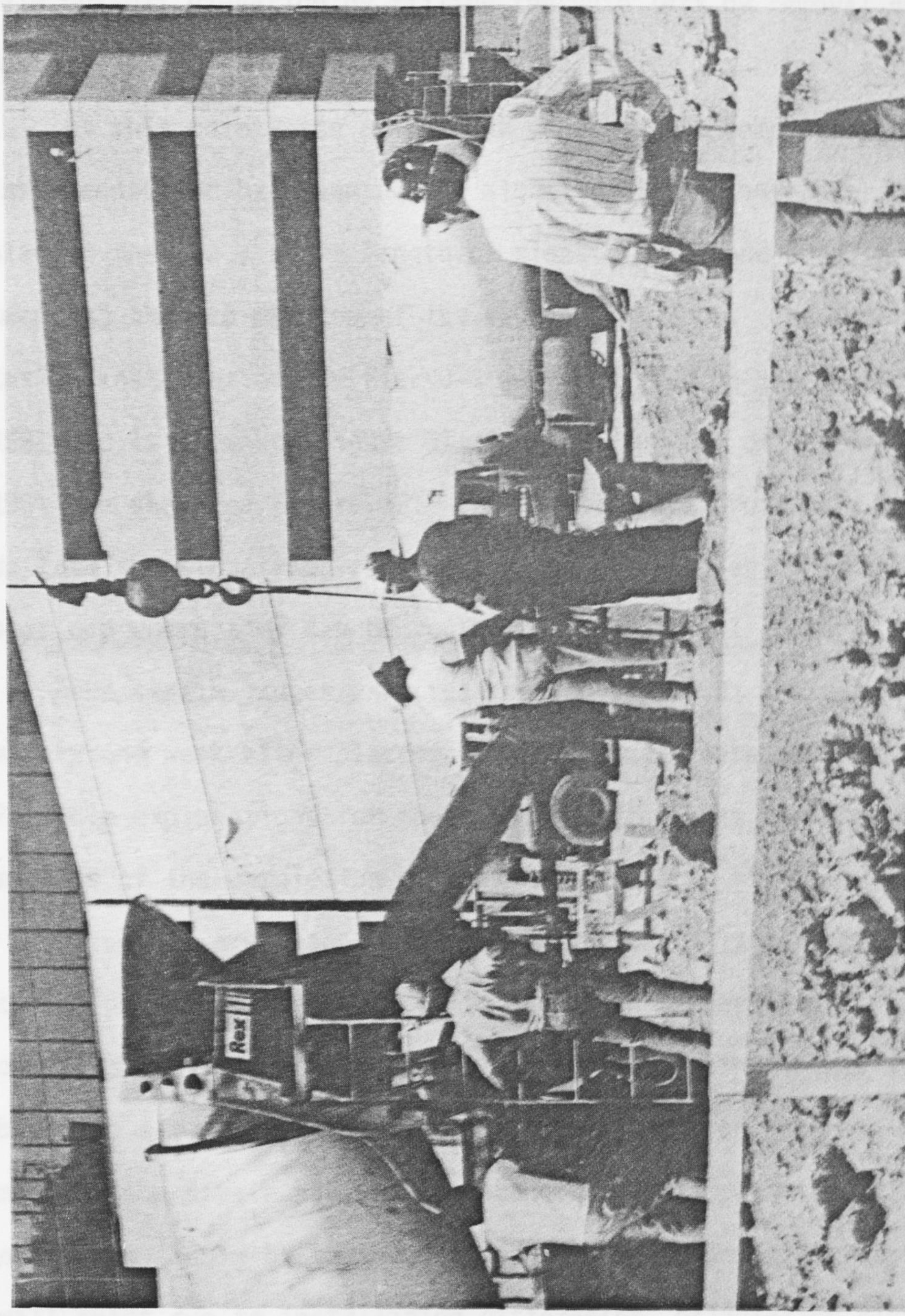


FIGURE 36 - CONCRETE PLACEMENT IN PIER SHAFT

casing sealing out water from the upper soil stratum was then extracted. The overfill allowed the concrete to slump to approximate cut-off elevation by filling the void left by removal of the casing.

At this point, the author and an assistant completed the instrumentation by cleaning the signal cables of any concrete, placing them in a short length of plastic pipe, and bundling and securing them to the top of the reinforcing cage. The instrumentation installation for Pier J-3 was completed on September 24, 1981 and is shown on Figure 37; and for Pier C-4 on September 25, 1981 and shown on Figure 38. The plastic pipe provides a conduit to take the signal cables from the top of the pier out through the pier cap where they can be routed to the terminal location.

The strain gauges were read on September 30, 1981, approximately one week after placement. Four gauges were not operating. Possible explanations for these apparent failures have not been made as of the completion of this report.

Readings are planned to be made periodically during the curing period of the concrete to establish temperature equilibrium conditions. Since the method of measuring strain in this study is based on a length change of the strain meters, an accurate measurement of the strain at zero-load condition is imperative. Ideally, no strain should be measured under zero-load; however, strains will exist due to installation differences, orientation differences, temperature, and concrete expansion and contraction due to hydration and curing.

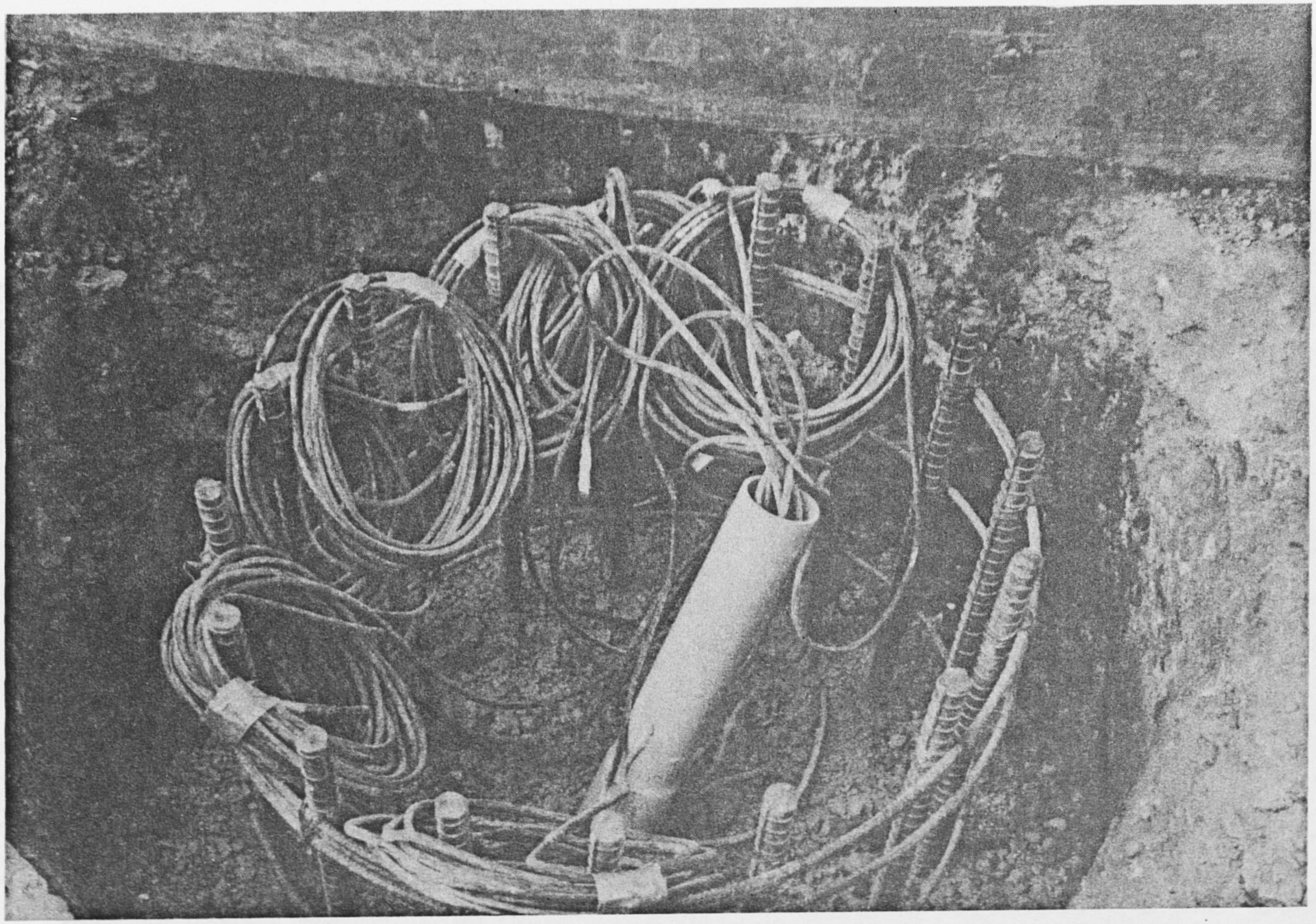


FIGURE 37 - COMPLETED JOB OF INSTRUMENTATION ON PIER J-3

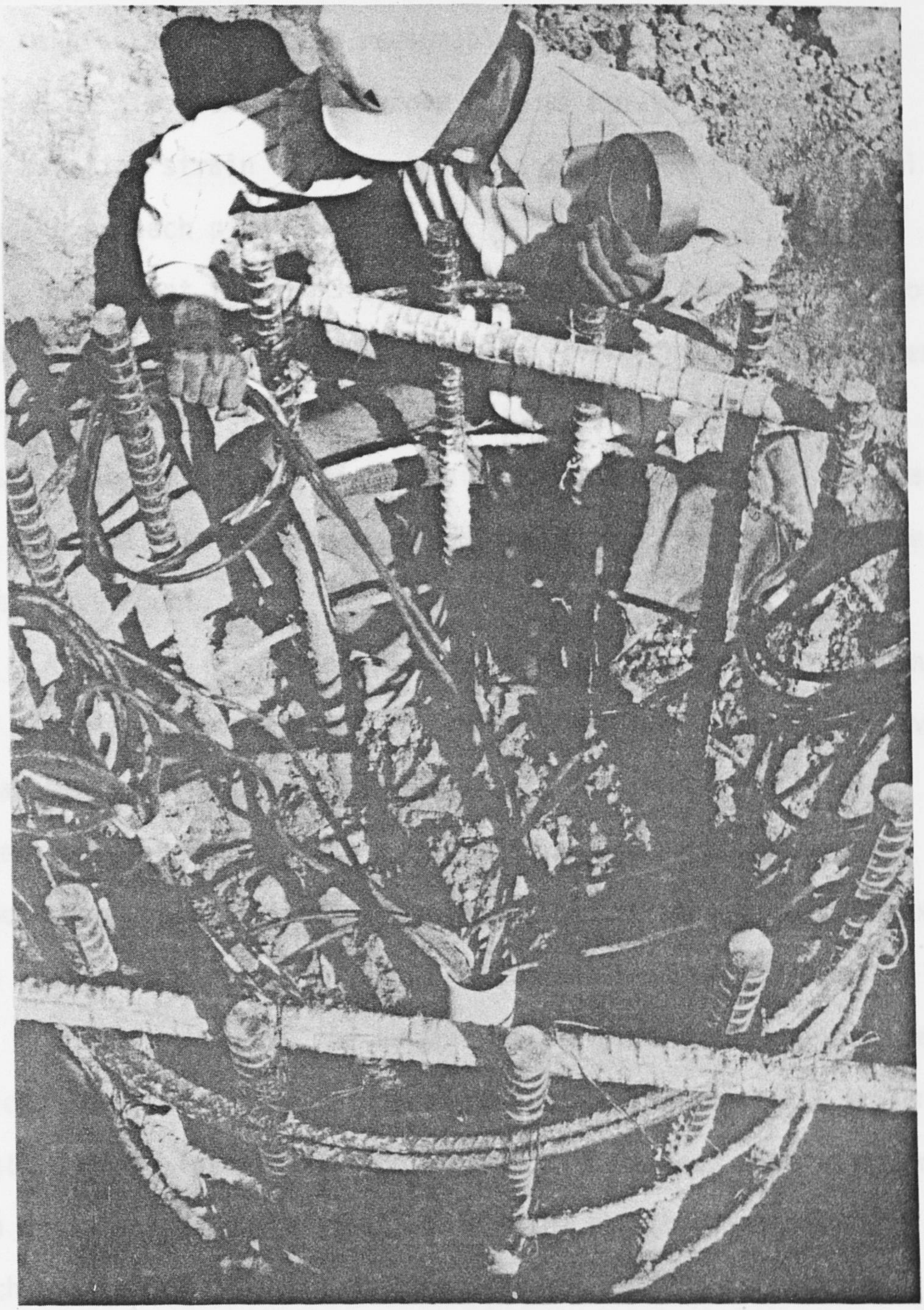


FIGURE 38 - COMPLETED JOB OF INSTRUMENTATION ON PIER C-4

The strain meters installed for this study can account for temperature changes since a calibration constant was provided by the manufacturer. It can reasonably be expected that after a period of time some of the above effects should stabilize. The existing strain is to be measured just prior to the initial loading of each pier.

Subsequent readings are to be taken after the completion of concreting of the fourth floor and for every four floor increment during construction. Changes in elevation of the top of the instrumented piers and eight additional piers are to be surveyed at the same construction phase points in order to determine the pier settlement.

A program for the periodic reading of strains and surveying of elevations is planned to be carried out over a period of five years to provide a long term data base for studying the load transfer phenomenon. After coordinating and supervising the successful installation of the strain gauges, the author is anxious to analyze the results of this instrumentation program.

In this project, the author learned procedures and considerations involved in the technical design and the practical implementation of an instrumentation program. He learned that it was not an easy task to successfully effect the necessary coordination and scheduling of the activities of several related but diverse organizations. All of the organizations involved in this instrumentation activity are related in the respect that they are all part of the overall construction industry. For this project, the organizations involved were the project architect, the project engineer, the strain gauge manufacturer, the general contractor, the pier drilling organization, the reinforcing steel supplier, the concrete supplier, and the installing firm of Raba-Kistner Consultants, Inc. Each knows the others exist; however, usually none knows how the others operate and perform. The author learned the following lessons in the techniques of management: first, that of explaining to on-site construction personnel, in easily understandable terms, the reasons for the project; second, that of coordinating the efforts of people who are not technically knowledgeable, and sometimes not practically informed, toward the accomplishment of work unfamiliar to them. The completion of this project provided the author with a background of knowledge which he can utilize to design and implement instrumentation requirements in other areas such as load tests on piles, beams, floors, and other structural elements of either concrete or steel.

DESIGN AND PROCEDURES MANUAL

One of the first tasks undertaken in the internship by the author was to review the corporate geotechnical design and procedures manual for content and timeliness. Practically every section of the manual was up-to-date and complete with annotated references. In most cases there were sample calculations.

The author was able to expand and update the reference material and examples for the design of piles/piers in both sands and clays as a result of the knowledge acquired in his academic program. Further, he instructed the professional staff about the latest research and thinking in the area of swell potential and computation of Potential Vertical Rise.

The design manual had very little information relating to pavement design. The author and Mr. Richard Bullion, Senior Project Engineer, worked on the development of some pavement guidelines and pavement design procedures. A section for pavement design for the corporate design manual was recently completed and has been made a part of the manual.

From the requirement for the development of corrosivity data for the Eagle Pass Mall project described earlier, the author and Mr. Stephen Berchelmann, Engineering Geologist, have developed a section for the design manual for corrosivity evaluations for buried pipe and concrete. These evaluation and design procedures are based on using both remote sensing electrical resistivity field data and in-house chemical laboratory testing. The availability of this new section of the corporate procedures manual greatly aided in the development of scope of work and fee estimates for several sewer line projects being planned by the City of San Antonio. Raba-Kistner Consultants, Inc. has been awarded contracts for work on nine of the ten projects to be accomplished by the city.

EDUCATION IMPROVEMENT OF STAFF

The awareness of the existence of new theories involving engineering analyses and design concepts improves the abilities of engineers to better function in their fields. Most of the professional staff were aware of an instrument, known as the pressuremeter, that is used to measure in situ engineering strength and modulus parameters of soils, and that these measured parameters may be used in the design of foundation elements.

The author, with the approval of the Chairman of the Board, organized a seminar which was designed to instruct the professional staff about the pressuremeter concept to a stage of familiarity with the device, its capabilities, advantages and drawbacks. An instructor was obtained to conduct an in-house seminar for the staff. A two day program was planned and arrangements were made to have a working pressuremeter available for demonstration, training, and field measurements of soil properties. The first day's session instructed the professional staff about the system, the data obtainable from it and how the data were interpreted and used in foundation design. This session was well received and the author and the staff became well informed about the pressuremeter concept.

The second day's session was to be one using the instrument to make field measurements of the soil properties in situ in a bore hole specifically drilled for this seminar session.

Unfortunately, the instrument supplier did not send a detailed instruction manual with the instrument. The device could not be made to operate as planned and the field phase of the seminar was cancelled.

Although the full benefit from the planned seminar was not achieved, the professional staff knows what the instrument looks like and has been educated concerning its capabilities for use in foundation design.

CHAPTER IV

MATERIALS ENGINEERING

INTRODUCTION

One of the major objectives of the Doctor of Engineering internship program is to enable the student to demonstrate his ability to apply his knowledge and technical training by making an identifiable contribution to the organization in which the internship is served. The major objective of the author's internship activities in the Materials Engineering area was to establish a structural steel inspection and testing capability within the firm.

Prior to the author's efforts in this area, Raba-Kistner Consultants, Inc. did not have the capability of inspecting and testing structural steel members and fabrication procedures. The establishment of these capabilities was considered as a major asset to the firm's overall inspection/testing program. The establishment of the firm's structural steel inspection/testing program was based primarily on the author's previous experience and expertise in this area. The author's certification as a Certified Welding Inspector (CWI) by the American Welding Society (AWS) was essential to the successful establishment and functioning of the firm's structural steel inspection/testing program.

TECHNICIAN TRAINING ACTIVITIES

In December 1980, the author initiated an instruction and study program designed to prepare a Level II Construction Materials

Technician to become qualified as a structural steel inspector (11, 12, 13, 14, 15, 16, 17, 18). A major objective of both the classroom and field instruction portions of this program was to assist the technician in his preparation for the national examination for Certified Welding Inspectors by the American Welding Society.

The technician selected for this training program had unsuccessfully taken this examination in October 1980. Under the author's guidance and direction, the technician was trained to witness the qualifying welding of individuals for certification by the American Welding Society. The technician was given the responsibility of supervising the preparation of welder's test plates and witnessing the qualifying welding. The author's continued instruction and guidance aided the technician in his successful completion of the national examinations required for certification as a Certified Welding Inspector. At the present time, the author and the technician are the only Certified Welding Inspectors employed by Raba-Kistner Consultants, Inc. However, other individuals, including some engineers, are gaining experience in this area and intend to prepare for and take the required examinations in the near future. The training program initiated by the author has proved successful on a limited basis and is currently being expanded to provide the opportunity for other technicians and engineers to gain from the author's experience.

STEEL INSPECTION PROJECTS

In October 1980, the firm was selected to perform structural steel fabrication and erection inspections for a major structure in San Antonio, Texas. This contract was awarded mainly due to the author's qualifications and availability and the marketing efforts of him and other members of the firm.

The firm had previously been engaged to perform construction materials engineering services during the construction of this building. The required inspection/testing services included inspection of drilled piers, surface and foundation soils, and structural concrete placements. The additional selection of the firm to perform the structural steel inspection and testing for this structure was gratifying. The building was a fourteen story steel moment frame office building. The author performed shop fabrication and field erection inspections of the structural steel members in this building, while giving on-the-job-instruction to the trainee steel inspection technician. The technician learned quickly and performed the later investigations under the direct supervision and random checking of the author. The fabrication shop inspection was completed in January 1981. Field erection inspection continued through March and nondestructive ultrasonic testing of the welded moment connections and column splices was begun. The mechanical testing of the bolted connections and the nondestructive ultrasonic testing of the welded connections for the project was completed in April 1981. The author supervised the activities of the technicians and interpreted the results of the nondestructive testing.

The successful completion of this project with no construction delays or discrepancies established the structural steel inspection and testing capability within R-KCI. It demonstrated to the local construction industry that a viable capability existed within the firm. Since the completion of the first project, R-KCI has become recognized as being capable of performing this materials engineering work and has been successful in being selected to perform these services on five other steel framed building projects.

FLY ASH CONCRETE

The introduction and use of fly ash for concrete making in the San Antonio service area began about four years ago. It had not been afforded wide-spread acceptance by the engineering and building elements of the local construction industry prior to the author's entering the academic phase of the Doctor of Engineering program.

Fly ash is a part of the residue resulting from the combustion of coal or lignite when it is used as a boiler fuel for electrical power generating plants. Under certain conditions and applications, the fly ash has pozzolanic, and sometimes cementitious, properties which can be useful in covenite. Cement shortages experienced in recent years and a new local source for fly ash has resulted in its extensive use by the local concrete industry.

During the last few years, R-KCI had been extensively involved in privately funded research on the properties of fly ash and its use in the manufacture of concrete. R-KCI has gained knowledge and expertise from the research and has become recognized as one of the few experts in fly ash concrete.

During the internship period, the author learned how to design concrete mixes using fly ash. He gained extensive and valuable experience in the area of manufacturing, transporting, and evaluating fly ash concretes.

CHAPTER V

PROJECT MANAGEMENT

INTRODUCTION

Most of the internship objectives in the area of project management shown in Figure 3 became integrated into the day to day activities of the geotechnical engineering and materials engineering functions. There was almost daily activity in the preparation of statements or scopes of work for technical proposals. Figure 5 in Chapter III shows the number and success rate of geotechnical engineering proposals prepared and submitted by or under the author's direction. Each of these proposals required the development of the scope of services, the estimation of costs, the preparation of work schedules, and the final negotiation and execution of contracts and/or written agreements.

ENVIRONMENTAL PROJECTS

The environmental projects shown in Figure 4 of Chapter III were for projects under EPA supervision. The author was responsible for marketing for ten EPA sewer line projects and was successful in obtaining nine of the jobs. The marketing plan required extensive preparation and face-to-face negotiation on the author's part to successfully obtain the work under a project scope and fee schedule deemed to be appropriate and profitable.

The author was able to interact with and provide information to the Environmental Engineering Sciences group in some environmental studies and in the development and preparation of permit applications for a solid waste disposal site. Further, the author was able to make contributions to the analytical chemistry division in its research projects on cement, fly ash, and concrete chemical admixtures.

STANDARD SCOPES OF SERVICES

After being assigned the duties of Director of Engineering, and assuming Materials Engineering responsibilities, the author became aware that written descriptions or lists of duties did not exist within the company for the various field functions governing the activities of field technicians. The author compiled a list of duties and responsibilities for technicians engaged in structural steel inspection and structural concrete inspection. Descriptions of these duties were refined and have now been prepared as a standardized "Scope of Services - Structural Steel Inspection" and "Scope of Services - Structural Concrete Inspection". A copy of each of these scope of services is shown in Figures 39 and 40.

These papers serve not only as a description of the duties and responsibilities for the construction materials technicians, but also are planned to be provided to the clients to define the scope of services they can expect from field technicians of the company. Although they have not been used in the preparation of formal contractual agreements, it is certainly possible that they

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Consulting Geotechnical and Materials Engineers, Geologists and Chemists
San Antonio, El Paso and Laredo

RABA-KISTNER CONSULTANTS, INC.

SCOPE OF SERVICES - STRUCTURAL STEEL INSPECTION

The following is a resume of our normal services performed under inspection of Class "A" structural steel:

We check shop material control procedures, fabrication equipment capability, qualification of workmen assigned to the job, material quality, fitup and connections of attachments, and fabrication procedures. We check in detail weld joint preparation, type of weld metal and welding technique, and quality and quantity of completed weldments. We determine compliance with the detailed drawings and specifications, with the objective of approving only a finished product that conforms in every respect to the requirements set forth.

Field inspection consists of checking each structural member for proper size, location, position, vertical and horizontal alignment. We examine all bolted and welded connections, assuring complete and strict compliance with the detailed erection drawings, job specifications, A.I.S.C. and A.W.S. Specifications and Suggested Good Practices. The inspector utilizes visual and mechanical inspection as well as such methods of nondestructive testing as radiographic, ultrasonic, magnetic particle, and dye penetrant inspection procedures when applicable.

FIGURE 39 - SCOPE OF SERVICES - STRUCTURAL STEEL INSPECTION

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RABA-KISTNER CONSULTANTS, INC.

SCOPE OF SERVICES - STRUCTURAL CONCRETE INSPECTION

Concrete Plant Inspection duties of a Raba-Kistner Consultants, Inc. technician are as follows:

- Check aggregate stock piles for proper size, gradation and cleanliness.
- Determine moisture contents of aggregates and make proper adjustments in batch weights.
- Check scales for proper calibration and zero points.
- Observe batching procedures for every load designated for the project.
- Check admixture concentrations and dosage rates and calibration of admixtures dispensers.
- Periodically determine the wet loose unit weight variations of the aggregate when lightweight aggregates are used.
- Check concrete in each truck before it leaves the plant for proper slump mixing.
- File a report for each day's operations showing the results of the above tests and inspection services.

Concrete Field Inspection duties of a Raba-Kistner Consultants, Inc. technician are as follows:

- Check each load of transit mix for proper slump mixing and class of concrete (if more than one strength classification is being used at the same time).
- Maintain continuous inspection of slump and placement procedures for assurance of compliance with specifications. Indiscriminate addition of water will not be permitted.
- Determine concrete wet unit weights for both regular and lightweight concretes as a check of proper yield if desired.
- Determine air content as required throughout the course of the day's inspection.
- Sample concrete for the purpose of casting compressive strength cylinder at the required frequency.
- Perform slump tests at the beginning of each pour and whenever necessary throughout the pour. When test specimens are prepared, the slump is determined and reported as part of the test data.
- Prepare concrete test cylinders or beams in the number and frequency prescribed in the specifications.
- File a report for each day's inspection, giving the location of pour, number of cubic yards, number of test specimens cast, etc.

FIGURE 40 - SCOPE OF SERVICES - STRUCTURAL CONCRETE INSPECTION

could be used for this purpose. An appropriate fee or price for services could be based on the total service offered. An appropriately reduced fee rate could be established from agreed deletions of various items from these lists.

Planned for development in the near future are the following Scopes of Services:

(1) Drilled Pier Inspection;

(2) Inspection of Fill and Compaction Control;

(3) Reinforcing Steel Placement Inspection;

(4) Post-tensioned Reinforcement Inspection.

For the company, each of these written duties and responsibilities is expected to improve the efficiency of field work and the accuracy and completeness of reporting. For the contractor, they will promote a better understanding of what he is paying for and should get. For both, they should result in a significant reduction in disagreements and misunderstandings between the company field inspectors and the construction superintendents and contractor management personnel.

PROFIT CENTER RESPONSIBILITY

The change in the corporate structure of R-KCI consolidated the geotechnical engineering and materials engineering functions under the direction of the Director of Engineering. In this corporate restructuring, each of the four newly created directorships became a profit center. The author, as a directorate head, was charged with financial management and fiscal accountability.

As the Director of Engineering, the author is provided each month with a Statement of Income and a Statement of Departmental Expenses. Combined, these two statements are sometimes called the Profit and Loss Statement. The Statement of Income for the current period and the year to date reports the direct income credited to each employee, as well as general departmental income from such sources as report reproduction; and trip charges, travel, and per diem back-charged to the clients. The Statement of Departmental Expenses reports direct salary costs for each employee and other direct expense cost items for the current month and year to date. Individual dollar value figures and their percentage of the total figures are reported for each income and cost line item.

The author uses these statements as a management tool to evaluate the productivity of each direct employee versus his costs. A comparison of the Current Period percentage to the Year to Date percentage quickly highlights changes in employee billing amounts. If significant variations appear, investigation of the reasons for the variation is made immediately. Corrective actions are taken quickly. Unusual expense items can be identified quickly as well as any item which has had unusual cost activity during the reporting period. These statements, prepared on a monthly basis summarizing the past month's activities, provide the manager with an effective and valuable tool for both short term and long term management of resources and for budget preparations.

These statements are also used by the author to compute the overhead cost burden for the department. The overhead cost burden is a part of the hourly rate multiplier used in establishing billing rates for each direct employee.

At the end of each month's statement is a line item of "Net Profit (Loss)". This indicates to the author how effectively and profitably he has or has not managed the resources made available to him.

CORPORATE LOSS PREVENTION PHILOSOPHY

A portion of this author's duties involved making design analyses and calculations. It was easy for the author to become engrossed in the intimate details of project work and the manipulation of numbers. However, his major responsibilities lay in the management role. The author had to direct or orient his activities toward accomplishing management objectives, both defined and unstated.

In any successful consulting engineering business operating today, the principals and executive managers must exhibit more than just technical excellence. They must concern themselves with, and be proficient in, such other well known and accepted areas as marketing strategy and business acumen. The business philosophy of R-KCI certainly expresses and practices these three business tenets or principles. For the initial learning stage of organizational management responsibilities assigned to the author, he was guided by Dr. Raba, the intern supervisor, and tutored by the senior management staff. The author quickly learned the organizational approach to management and problem solving utilized by Raba-Kistner Consultants, Inc. and became an active and productive departmental manager.

The organizational philosophy of R-KCI includes one other major principle necessary to insure the viable and economic future of any of today's business organizations. This was the implementation of improved business practices which were directed toward professional liability loss prevention.

The soil and foundation engineer in private practice today finds himself faced with the possibility of having to answer extravagant, and often unfounded, claims for errors, omissions, or professional negligence. Frequently these claims result from construction and/or materials failures over which he has little or no control.

No engineer professes that he is perfect and the law should not expect him to be. It is expected that the engineer will exercise his best judgment and care in preparing designs and selecting materials and that he perform in accordance with generally accepted standards within his profession (19).

Errors and omissions insurance is not the answer to the loss prevention problem. An insurance company may pay in many cases. However, it can in no way compensate a firm for time lost preparing for, participating in, and legal defense costs due to legal proceedings, depositions, and court appearances. Neither will it account for lost productivity, lowered morale, and blemished reputations.

Technical excellence alone is no defense against a professional liability suit since the vast majority of claims cases have little or nothing to do with technical errors or omissions. Most relate to erroneous construction cost estimates, failure to deliver reports on time, providing guidance or advice that was not asked for, and accepting guilt when unwarranted. All of these are based in poor business practices. Effective professional liability loss prevention practices are founded in effective business management (20, 21).

The author's position and assigned duties required him to assume the responsibility and accountability for the successful accomplishment of four principles necessary for the continued existence of any business endeavor. These are a marketing strategy, business astuteness, technical excellence, and limitation of liability.
The author has gained considerable knowledge of how these principles interact and has learned how to use them to produce successful and profitable jobs.

CHAPTER VI

CIVIC AND PROFESSIONAL ACTIVITIES

INTRODUCTION

The first internship objective for participation in civic and professional activities was to address organizations on subjects which would illustrate the author's expertise and increase the appreciation of the engineering profession. The second objective was to participate actively in civic and professional activities.

AWS EDUCATIONAL SEMINAR

In the spring of 1981, the San Antonio Section of the American Welding Society planned an educational seminar on welding inspection to prepare individuals for the Certified Welding Inspector examination. This seminar was of special interest to welding supervisors, quality assurance managers, and quality control inspectors. It was designed to provide the student with sufficient understanding of welding inspections. The instructional program was divided into eight 3-hour sessions.

The author was requested to teach in the seminar. He accepted responsibility for instruction in two of the program sessions. The subjects covered were Weld and Weld Related Discontinuities, Selection of Samples for Welding Tests, Destructive Testing of Welds, Proof and Leak Tests, Nondestructive Testing/Radiographic Inspection, and Qualification of NDT Personnel. The instructional outline is included as Appendix B.

There were twenty-eight students enrolled for the seminar. Fourteen of these students subsequently took the National AWS Certified Welding Inspectors Examination in the spring of 1981. Of the fourteen who took the examination, two were awarded Certified Welding Inspectors Certificates, nine achieved Certified Associate Welding Inspector rank and three failed the examination.

TEXAS SOCIETY OF PROFESSIONAL ENGINEERS

The San Antonio Chapter of the Texas Society of Professional Engineers (TSPE) meets monthly on the first Monday evening of each month with a social followed by a business meeting and technical session. The author attended most of these meetings during the internship year.

AMERICAN WELDING SOCIETY

For the first half of the internship year the San Antonio Section meetings of the American Welding Society were held on the same evenings as the TSPE meetings. Largely due to the efforts of the author, the San Antonio Section membership was persuaded to change their meeting date to the first Tuesday of each month. Since the meeting change became effective, the author has attended most of the section meetings. They also have a social period followed by a business meeting and a technical session.

TEXAS COUNCIL OF ENGINEERING LABORATORIES

From February 6 - 8, 1981, the author attended the annual meeting of the Texas Council of Engineering Laboratories (TCEL) as the official representative of the firm and actively participated in the activities. On February 11, 1981, following the meeting, the author was asked if he would serve on two TCEL committees during 1981. The author agreed and was subsequently appointed to the two committees. The first is the Practice Committee, whose objectives are: (1) to plan and sponsor a workshop of loss prevention case studies, and (2) to conduct a survey of the overhead cost items of TCEL firms. There were six members appointed to this committee. The second is the Geotechnical Testing Committee, whose objectives are: (1) to review pending/planned accreditation procedures for geotechnical testing laboratories (ASFE, ASTM, AALA, etc.), and (2) to encourage the presentation of papers in the materials technical sessions of the Texas Section meetings of the ASCE that relate to geotechnical testing programs. There were five members appointed to this committee.

AMERICAN COUNCIL OF INDEPENDENT LABORATORIES

The San Antonio, Texas Laboratory Members of the Southern Division of the American Council of Independent Laboratories hosted the division spring meeting from April 12 through 15, 1981. The author was appointed to the host committee to help organize the spring meeting and plan for extra-curricular activities for the members who would attend the meeting. The author was intimately involved in planning and arranging the activities and acted as a greeter for the pool-side reception the first evening of the meeting. He was also the host official aboard one of the buses engaged for transporting the ACIL members and their families to the location engaged for dinner, dancing and entertainment. The author was commended individually by many of the ACIL members and officially by the President of the ACIL Southern Division.

CHAPTER VII

EVALUATION OF INTERNSHIP

The evaluation of the internship must be made on how effectively the primary objective of the internship was accomplished, that of developing in the intern the engineering management skills necessary to function effectively in his assigned directorship position as well as in other management areas. This is best shown by evaluating in four broad areas. This chapter addresses each area.

Technical and Administrative Management of a Professional Engineering Staff

When the author's internship started as Director, Geotechnical Engineering he had both the technical and administrative management responsibility for a professional staff of two engineers. The intimate technical direction of professionals was a new experience for the author although he had general management responsibility for large organizations composed of professional, technical, and administrative people while in the military service. The diversity, size and complexity of geotechnical engineering studies assigned the author greatly exceeded his past experiences. The corporate reorganization which added three professionals to his staff, and the functions of materials engineering and fiscal accountability was another order of magnitude increase in responsibility and authority. These increased responsibilities provided a tremendous learning experience for the author, expanded his abilities and capabilities and allowed him to successfully function at levels of greater responsibility.

Establishment of a Structural Steel Inspection and Testing Capability

The author brought with him knowledge, expertise and experience developed over the previous eight years while participating in and later managing a portion of an established and functioning program. He improved his interpersonal skills through the direction and training of a technician for steel inspection work. He improved his marketing skills by soliciting and securing structural steel inspection and testing work. Further, he enhanced his managerial skills by organizing and directing the successful completion of the work so that the local construction industry recognized that an experienced and viable service exists within the firm.

Increase Company Efficiency and Effectiveness Through Improved Management

During the internship period the author was able to observe areas for possible changes and improved management that could increase productivity. He was able to analyze functions, perceive and devise improvements, and implement new management plans. The implementation of a proposal numbering and indexing system reduced the time expended by the clerical and professional staff in the retrieval of correspondence. The system provided information which, when analyzed, led to an increased effectiveness in the marketing of services. The development of scope of services documents has afforded improved management of field personnel and increased productivity for the field inspection services.

Develop Professional Growth Through Participation in Professional and Civic Organizations

The author's attendance at, and participation in, the functions of several professional organizations such as TSPE, ASCE and AWS stimulated him to greater awareness of the concerns and problems faced by other professionals in other organizations. Attendance at Chamber of Commerce functions, receptions, and banquets honoring prominent individuals or civic projects thrust the author into a position of increased visibility within the business community. These activities provided the opportunity for association with leaders in engineering, education and public affairs which expanded the author's experience and knowledge and broadened his concepts, thus allowing him to grow and better fulfill his responsibilities.

Other Accomplishments and Learning Outcomes

During the progress of the internship, the author learned much of the overall corporate business philosophy for developing and continuing a successful and growing consulting engineering firm. That philosophy, although not formally stated, has been summed up by the author as "Work better, not harder, to produce a quality service at a profit". The author has learned and applied management techniques to enhance that philosophy.

The author learned about the loss prevention concept and of its necessity for insuring the health and stability of consulting engineering firms, particularly those offering geotechnical engineering services. The author gained considerable knowledge and practical experience in business concepts and operations to produce successful and profitable jobs.

As a profit center manager, the author learned in practical application how to use financial statements to better manage and control the use of resources.

These unexpected benefits added depth and breadth to the author's technical, business and management skills.

Summary

The author is satisfied that all the objectives of the internship have been adequately and successfully fulfilled. The internship was a most gratifying and satisfying experience for the author, in which he grew and expanded his abilities to function effectively in today's changing professional, business, civic, social, and political environment.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

INTRODUCTION

This report described William T. Johnson, Jr.'s internship experience at the firm of Raba-Kistner Consultants, Inc. The first purpose of the internship was to enable the student to demonstrate his ability to apply his knowledge and expertise to make an identifiable contribution to the intern organization. The second purpose was to enable the student to function in a non-academic environment where he would become aware of the organizational approach to problems beyond that of traditional engineering concepts.

The internship firm, Raba-Kistner Consultants, Inc., is a professional organization of more than 85 professional and technical people which furnishes engineering services in several specialty areas. The firm is a relatively young, growing organization of excellent potential which is recognized as one of the leaders in the San Antonio business world.

The author's responsibilities were directed primarily to management and supervisory functions. However, the author did devote significant time to the area of personal production of engineering design analyses and calculations.

Prior to the entry into the Doctor of Engineering Program, the author's eight years of private practice experience was approaching that state where the passage of a year contrived only repeats of previous experiences. The academic phase of the program revitalized and expanded the author's technical knowledge. The internship phase provided the author many new and varied learning experiences in several areas. Some of these experiences are related in some detail in the four chapters of the second part of this report. These learning outcomes will be only briefly mentioned in this chapter.

During the intership period, the author had involvement in projects whose construction costs will approach one billion dollars.

GEOTECHNICAL ENGINEERING

Approximately seventy percent of the author's time was utilized in geotechnical engineering endeavors in which he directed the production of, and checked the accuracy of, over three hundred geotechnical studies. These studies ranged upward from simple subdivision soil surveys to major projects studies, such as a campus-style corporate headquarters development project and a twenty-eight story office building which included instrumentation of two of the deep foundation elements. Geographically, most of the studies were in the San Antonio area. However, there were projects located in El Paso, Austin, Laredo, McAllen, and Victoria, Texas, Vera Cruz, Mexico and Peking, China.

The author learned to apply his knowledge of the properties of swelling clays and of soil supported floor system design to a project of extraordinary size--a ten acre manufacturing and warehousing facility. New concepts and techniques for analysis and design of foundation elements in faulted and fractured rock were learned from the Datapoint Corporate Tower project. Experience in analysis and design in marl and shale formations was gained in the passenger terminal at the San Antonio International Airport and the First International Tower high-rise structure. Remote sensing techniques and applications to geotechnical work were learned in the Eagle Pass Mall project. In the Regency Garden Office Building project, the author learned first-hand of the importance of, and necessity for, a consulting engineering firm to have an active loss prevention program. In the project for the instrumentation of deep piers, the author learned procedures and considerations involved in the technical design and the practical implementation of such programs. And, he learned the practical applications of management and communication skills to successfully coordinate and consummate large complicated projects.

MATERIALS ENGINEERING

In the materials engineering area, the author established a competent, viable structural steel inspection and testing capability within the firm. This capability has become recognized by the construction industry in San Antonio.

This was more of a pure production element on the part of the author. However, he sharpened his personnel management abilities and gained experience in teaching and dealing with people. The author learned several techniques used in marketing when beginning at an initial start-up position.

The author directed the activities of two materials engineers involved in quality assurance/quality control services for on-going construction projects. He also provided, on a day-by-day basis, answers and advice on materials engineering questions directed by the field technicians and the clients.

The technicians and clients expected the author to be knowledgeable in the area of fly ash concrete. The author has learned the basic facts of fly ash as related to its use in concrete. He is continuing a program to broaden and deepen his knowledge and application of fly ash technology.

BUSINESS AND MANAGEMENT

The author implemented several management improvements within his directorate and produced two standard scope of services documents. These documents are to be used to improve the productivity of field technicians, to improve relations with clients, and to market the company's services.

There were two major, but unexpected, learning outcomes for the author in this area. The first was how to interpret and use, as a management tool, accounting documents and profit and loss statements. Through them, the author learned to direct and manage a professional staff to increased productivity and, thereby, increased profitability. The second was recognizing the need for improved business practices in project management to reduce exposure to conflicts that could lead to professional liability allegations or claims. The author learned to be continuously alert to such situations and to take immediate action as required to prevent or abate losses.

CONCLUSIONS

In evaluating the internship, the author found that it fulfilled all the objectives set forth by the intern, his internship supervisor, and his academic committee chairman. The author increased his management capabilities significantly and was able to function effectively and profitably at a level at least one order of magnitude greater than his previous experiences.

Based on the author's previous experience, he found that the Doctor of Engineering Program provided him the vehicle to revitalize, upgrade, and expand his skills. Engineers who have been out of school for several years should seriously consider entering the program.

In conclusion, the author believes that the internship was an unqualified success. This conclusion is shared by the intern supervisor and has been expressed by him in a letter to the Chairman of the Academic Committee. This letter is included in this report as Appendix C.

REFERENCES

1. Texas A & M University. Graduate Catalog 1979-1980. College Station, Texas: March 1979.

2. Texas A & M University, College of Engineering. Doctor of Engineering Program Details. College Station, Texas: April 1979.

3. Raba-Kistner Consultants, Inc. Job Description Manual. San Antonio, Texas: November 1978.

4. State Department of Highways and Public Transportation. Manual of Testing Procedures, Volume I, Austin, Texas: Revised January 1978.

5. National Academy of Sciences, Building Research Advisory Board. Criteria for Selection and Design of Residential Slabs-on-Ground, Report No. 33 to the Federal Housing Administration, Washington, D.C.: 1967.

6. Post-Tensioning Institute. Design and Construction of Post-Tensioned Slabs-on-Ground. Phoenix, Arizona: October 1978.

7. United States Department of Agriculture, Soil Conservation Service in Cooperation with Texas Agricultural Experiment Station. Soil Survey of Maverick County, Texas. Washington D.C.: U. S. Government Printing Office, 1977.

8. United States Department of Agriculture, Soil Conservation Service in Cooperation with the Texas Agricultural Experiment Station and City of San Antonio. Soil Handbook for Soil Survey - Metropolitan Area San Antonio, Texas: National Cooperative Soil Survey, San Antonio, Texas: April 1964.

9. Terrametrics, Inc. Applied Geotechnical Instrumentation. Golden, Colorado: 1980.

10. Carlson, R. W. Manual for the Use of Stress Meters, Strain Meters, and Joint Meters in Mass Concrete, Part 1, Golden, Colorado: Terrametrics, Inc., 1966.

11. American Welding Society. Structural Welding Code - Steel, D1.1-80. Miami, Florida: 1980.

12. American Welding Society. Symbols for Welding and Nondestructive Testing, A2.4-79. Miami, Florida: 1979.

13. American Welding Society. Welding Procedure and Performance Qualifications, B3.0-77. Miami, Florida: 1977.

14. American Welding Society. Guide for the Nondestructive Inspection of Welds, B1.0-77. Miami, Florida: 1977.

15. American Welding Society. Standard Methods for Mechanical Testing of Welds, B4.0-77. Miami, Florida: 1977.

16. American Welding Society. Welding Terms and Definitions, A3.0-80. Miami, Florida: 1980.

17. American Welding Society. Welding Inspection, Second Edition. Miami, Florida: 1980.

18. American Institute of Steel Construction, Inc. Manual of Steel Construction, Eighth Edition. Chicago, Illinois: 1980.

19. Associated Soil and Foundation Engineers, Inc. The ABC's of Limitation of Liability. Silver Springs, Maryland: 1972.

20. Robert E. Meyer. Loss Abatement Through Project Management. Presentation to Loss Prevention Seminar of the Association of Soil and Foundation Engineers, Silver Springs, Maryland: October 16, 1979.

21. Association of Soil and Foundation Engineers. A Guide to Establishing Quality Control Policies and Procedures in Geotechnical Engineering Practice. ASFE Peer Review Program, Silver Springs, Maryland: October 1980.

APPENDIX A

RABA·KISTNER
CONSULTANTS, INC.
10526 Gulfdale
P.O. Box 32217
San Antonio, Texas
78216
(512) 342-4216

Consulting Geotechnical and Materials Engineers, Geologists and Chemists
San Antonio, El Paso and Laredo

OBJECTIVES OF THE DOCTOR OF ENGINEERING INTERNSHIP FOR WILLIAM T. JOHNSON, JR., P.E.

INTRODUCTION

The internship will be fulfilled as Director, Geotechnical Engineering for the firm of Raba-Kistner Consultants, Inc., 10526 Gulfdale, San Antonio, Texas. The official job description for that position is attached as Enclosure 1. The organizational chart for the company is attached as Enclosure 2. The job title and organizational element names may change before the internship is completed but the responsibilities should remain essentially the same. In this capacity, Mr. Johnson will function primarily as Director and secondarily as a Project Manager. He will report directly to Dr. Carl F. Raba, Jr., Ph.D., P.E., President, Raba-Kistner Consultants, Inc. for internship purposes. Dr. Raba will be the Industrial Supervisor for Mr. Johnson's internship.

INTERNSHIP OBJECTIVES

The primary objective of the internship is to develop the engineering managerial skills necessary to function effectively in his present directorship position as well as in management areas of greater responsibility.

During the internship, Mr. Johnson is to demonstrate and apply technical, managerial and leadership abilities in the innovative and creative solution of technical, organizational and manageral problems. Geotechnical and materials engineering, project management division directorship and other objectives will be pursued.

GEOTECHNICAL ENGINEERING OBJECTIVES

Some of the geotechnical engineering objectives to be accomplished are:

(a) Manage professional and graduate engineers and engineering geologists from both the administrative and technical standpoints. This will include the optimum utilization of corporate resources and the increase of the subordinate skill level.

(b) Develop project estimates and operating budgets for the working group, thus increasing the profitability.

(c) Supervise and coordinate the activities of the professional staff in the solution of problems relative to foundation systems for light structures supported on shallow foundations,

Carl F. Raba, Jr., Ph.D., P.E.
Richard W. Kistner, P.E.

heavy multi-level structures supported on deep foundations, slope stability situations, retaining walls and bulkheads.

(d) Update and/or develop the corporate geotechnical design and procedures manual (much of which will be proprietary information.

(e) Develop or supervise engineering improvements to existing corporate systems or components.

MATERIALS ENGINEERING OBJECTIVE

The materials engineering objective is to establish a structural steel inspection and testing capability within the company. Specifically, utilize expertise possessed in this general area to train and initially supervise technicians in the performance of welding inspection and certification, structural steel fabrication inspection, structural steel erection inspection, limited nondestructive testing of bolted and welded joints and interpretation of results of nondestructive testing utilizing ultra-sonic, radiographic, magnetic particle and dye-penetrant examination techniques.

PROJECT MANAGEMENT OBJECTIVES

Project Management type objectives include:

(a) Prepare a Statement (Scope) of Work for unsolicited proposals or a technical proposal in response to a Request for Proposals in the areas of geotechnical and materials engineering.

(b) Estimate costs, prepare, negotiate, modify or execute joint venture agreements, contracts, subcontracts, and/or service agreements.

(c) Develop and apply work measurement and methods engineering techniques and procedures.

(d) Assess and understand human relations principles applicable to the work environment.

(e) Discern and apply job analysis techniques.

(f) Interview, employ and assign personnel as required, evaluate performance and recommend promotion and/or merit salary increases.

CIVIC AND PROFESSIONAL OBJECTIVES

Personal, professional, civic and community objectives as a means to develop his total professional growth during the internship includes but will not be limited to:

(a) Address civic or professional organizations on subjects which will illustrate his expertise, and which will increase the appreciation of the engineering profession.

(b) Participate actively in professional activities (i.e., Texas and National Society of Professional Engineers, American Welding Society, Texas Council of Engineering Laboratories, American Council of Independent Laboratories, American Society of Testing and Materials) and in civic and community activities (i.e., Knights of Columbus).

REPORT OF INTERNSHIP

The final objective of the internship is to prepare a Professional Internship Report which will summarize Mr. Johnson's experience and document the work performed. The report will establish that the objectives of the internship have been satisfactorily fulfilled. The report will also satisfy the requirements of the College of Engineering with regard to format, mechanics, and submission of file copies.

The duration of the internship will be a nine month period beginning in September 1980 and ending in May 1981, a two semester period. An interim progress report will be furnished to the Committee Chairman two weeks prior to the close of each semester.

* * * * * * * * * * * * *

Respectfully submitted,

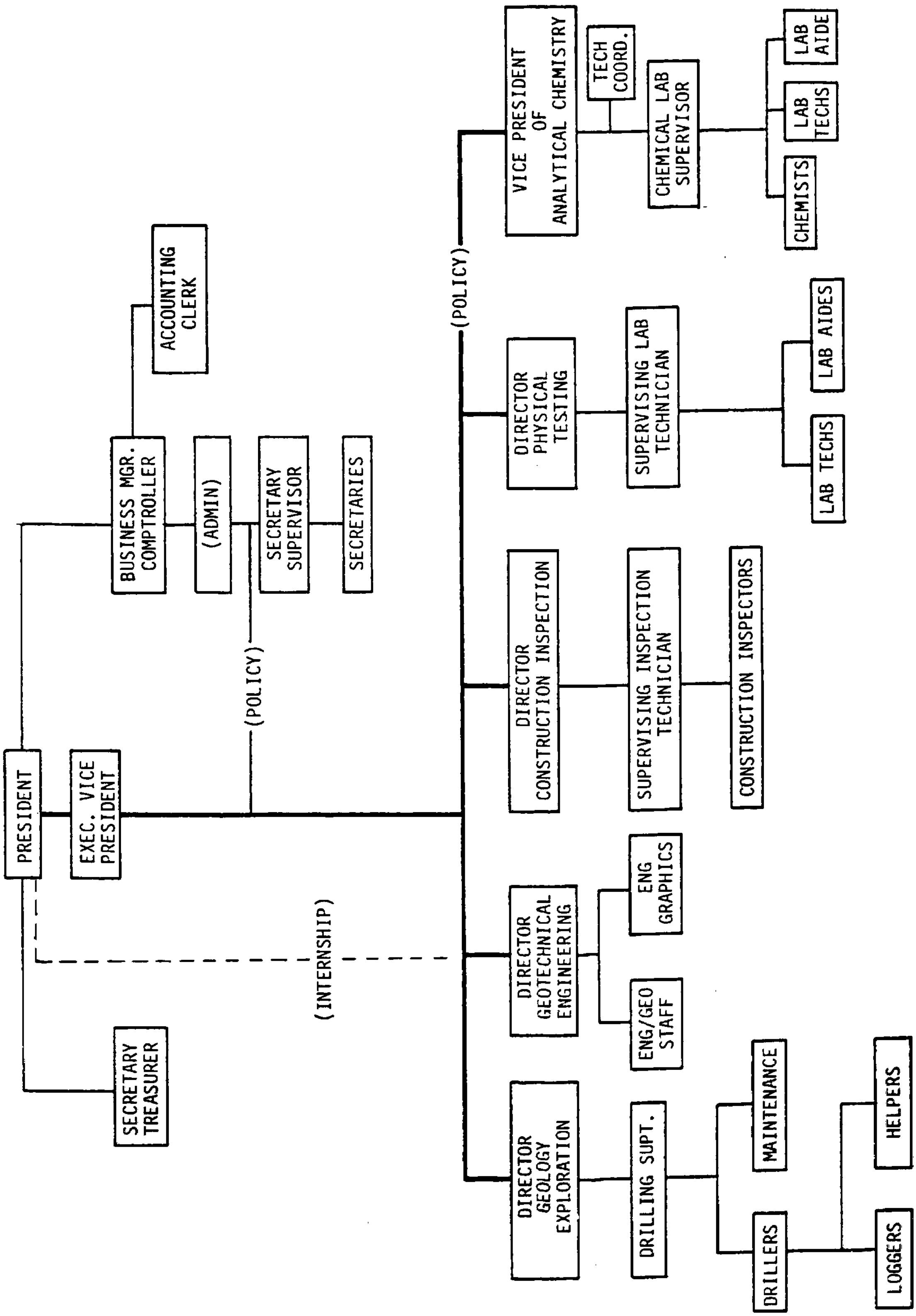
William T. Johnson, Jr., P.E.

Approved:

Carl F. Raba, Jr., Ph.D., P.E.
President
Raba-Kistner Consultants, Inc.

Approved:

Harry M. Coyle, Ph.D., P.E.
Professor, Civil Engineering
Chairman of Committee



PRESIDENT
EXEC. VICE PRESIDENT
SECRETARY TREASURER
BUSINESS MGR. COMPTROLLER
ACCOUNTING CLERK
(ADMIN)
SECRETARY SUPERVISOR
SECRETARIES
(POLICY)
(INTERNSHIP)
(POLICY)
DIRECTOR GEOLOGY EXPLORATION
DRILLING SUPT.
MAINTENANCE
DRILLERS
HELPERS
LOGGERS
DIRECTOR GEOTECHNICAL ENGINEERING
ENG GRAPHICS
ENG/GEO STAFF
DIRECTOR CONSTRUCTION INSPECTION
SUPERVISING INSPECTION TECHNICIAN
CONSTRUCTION INSPECTORS
DIRECTOR PHYSICAL TESTING
SUPERVISING LAB TECHNICIAN
LAB AIDES
LAB TECHS
VICE PRESIDENT OF ANALYTICAL CHEMISTRY
TECH COORD.
CHEMICAL LAB SUPERVISOR
LAB AIDE
LAB TECHS
CHEMISTS

JOB DESCRIPTION

Title: DIRECTOR OF GEOTECHNICAL ENGINEERING

Reports Directly to: President

Primary Functions

Responsible for the profitable utilization of the engineering staff and corporate resources. Individually responsible for the accuracy of all engineering calculations and reports.

Under the direction of the President, responsible for the efficient and economical use of engineering and corporate resources in the analysis and solution of engineering problems and preparation of engineering reports to satisfy all deadlines.

Principal Duties and Responsibilities

A. Serves as Project Manager on all complex or sensitive geotechnical engineering projects;

B. Assigns specific technical staff members as Project Managers in a manner that capitolizes upon each individual's academic and practical expertise;

C. Insures data file for each project includes at least:

(1) Reporting deadline;
(2) Scope of services;
(3) Financial allowances and estimate; and
(4) To whom the reports and statement are to be mailed.

D. Periodically reviews progress of Project Managers to insure the financial estimate will not be exceeded and the deadline will be satisfied. If required, responsible for contacting the client to update the estimate and/or reporting schedule;

E. Coordinate and evaluate overall scheduling/priorities and evaluation of support provided by Directors of Field Exploration and Laboratory Testing;

F. Responsible for the accuracy of all engineering reports;

G. Co-signs all engineering reports with Project Manager and Principal Engineer (President or Executive Vice President), and

H. Serves as Project Manager on selected routine engineering assignments in order to maintain a fully productive schedule. (This position is approximately twenty-five percent unbillable coordination and seventy-five percent billable production.

APPENDIX B

LECTURE NOTES FOR AWS SEMINAR

March 1981

WELD AND WELD RELATED DISCONTINUITIES

A discontinuity is an interruption of the typical structure of a weldment, such as inhomogeneity in the mechanical, metallurgical, or physical characteristics of the material or weldment. A discontinuity is by nature not necessarily a defect.

A weld that does not meet any or all of the specific requirements of a particular specification or code is considered a defective weld. It is impossible to assess without reference to some particular standard or requirement related to the intended use of the weld. Not all weld discontinuities are defects.

CLASSIFICATION OF BASE METAL DISCONTINUITIES

(1) Dimensional
(2) Weldment
(3) Weld metal or welded joint
(4) Base metal

(1) Dimensional Discontinuities

a. Distortion
b. Incorrect weld size
c. Incorrect weld profile
d. Incorrect final dimensions
e. Excessive weld reinforcement

(2) Weldment and related discontinuities in weld

a. Porosity
b. Slab inclusions
c. Tungsten inclusions
d. Incomplete fusion
e. Inadequate joint penetration
f. Undercut
g. Cracks
h. Surface irregularities
i. Other irregularities

(3) Mechanical and chemical weld metal properties
(4) Base metal properties

(Define the discontinuity, explain the possible cause and outline possible corrective actions.)

DIMENSIONAL DISCONTINUITIES

- Distortion
- Incorrect Joint Preparation
- Incorrect Weld Size
- Incorrect Weld Profile
  - Overlap
  - Excess concavity
  - Excessive weld reinforcement
- Incorrect Final Dimensions

WELDMENT AND RELATED DISCONTINUITIES

- Porosity
  - Uniformly scattered porosity
  - Cluster porosity
    - Linear porosity Slag Inclus
  - Slag Inclusions
  - Tungsten Inclusions
  - Incomplete Fusion
  - Inadequate Joint Penetration
  - Undercut
  - Cracks
    - Weld metal cracking
      - (1) Transverse weld cracks
      - (2) Longitudinal weld cracks
      - (3) Crater cracks
    - Base metal cracking
  - Surface Irregularities
  - Other Irregularities

The more uniform the surface of a weld, the better the eye appeal.

MECHANICAL AND CHEMICAL WELD METAL PROPERTIES

- Filler Metal Properties
- Base Metal Properties
  - Edge Laminations
  - Lamellar Tearing
  - Arc Strikes

SELECTION OF SAMPLES FOR WELDING TESTS

Complete Sampling: Costly and time consuming.
Partial Sampling
Specified Partial Sampling
Random Partial Sampling
Inspection by Attributes

DESTRUCTIVE TESTING OF WELDS

Some of these tests are, of necessity, destructive in nature and are performed on sample weldments for qualification of welding procedures, the qualification of welders and welding operators, and for quality control. Tests may be chemical, metallographic, mechanical or any combination thereof.

> No matter how carefully codes and specifications are written, much is left to the judgment of the inspector. In fairness to himself, the manufacturer, and his employer, he should equip himself with a thorough knowledge on which to base is decisions. The inspector has the sole responsibility of confirming that the weld joint properties are in accordance with the specification. Acceptance of material that have test results that do not meet specification can only be made by an authorized engineer.
>
> The destructive testing technique must, therefore, be used with some form of partial sampling, rather than complete sampling.

CHEMICAL TESTS

Chemical composition or corrosion resistance.

CORROSION TESTS

METALLOGRAPHIC TESTS

Macro-Specimens
Micro-Specimens

HARDNESS TESTS

Brinell: consists of impressing a special hardened steel ball into the specimen under test, using a definite load for a definite time and accurately measuring the diameter of the impression. Brinell hardness numbers can be multiplied by 500 to obtain the approximate tensile strength of the material being tested.

Rockwell: hardness numbers are based on the difference between the depths of penetration at major and minor loads.

Vickers: consists of impressing a square-based pyramid indentor into the surface of a specimen under a pre-determined load.

MECHANICAL TESTS

The quality of welds depends to a large extent on competent inspection and adequate testing. Experience indicates that mechanical tests for weld strength and other weld properties are reliable tests to determine the quality of welds.

Specification should state:

(1) one or more tests that are required
(2) AWS or other applicable standard
(3) limiting numerical values
(4) interpretation, if any, of the properties

Mechanical Properties
- Tensile Strength
- Yield Point and Yield Strength
  - Yield Point
    - Drop of the Beam Method
    - Total Strain Method Using Extensometer
  - Yield Strength
    - Offset Method
    - Extension Under Load Method

Ductility

Standard Tension Test

TESTS OF WELDED JOINTS

Bend Specimens: Face, root, side, and longitudinal guided bends.

Face-bend specimens are placed with the face of the weld directed toward the gap. Root-bend specimens are placed with the root of the weld directed toward the gap. Side-bend specimens are placed with that side showing the greater defects.

Tensile Strength Specimens

Notched-Bar Impact Tests

PROOF AND LEAK TESTS

Closed Containers: Some form of internal pressure. Compressed air (pneumatic test) or water pressure (hydrostatic test).

Open Containers: Tested hydrostatically and visually examined for leakage.

Structural Weldments: Proof tested by setting them up and loading them in a testing machine.

NONDESTRUCTIVE TESTING - RADIOGRAPHY

Radiography is a method of nondestructive testing that utilizes radiation to penetrate an object. Some radiation will be absorbed, some will be scattered and some radiation will be transmitted through the test object onto the recording device.

Permanent image on a photographic film. Electromagnetic radiation, such as x-rays and gamma rays.

The basic process of radiographic inspection involves: (1) the making of the radiograph, and (2) the interpretation of the radiograph.

(1) Source
(2) Object
(3) Film
(4) Trained person capable of producing an exposure in the most advantageous manner
(5) Chemically processing
(6) Skilled person capable of interpreting the radiographic images.

The heart of radiography is the source of radiation exposure. Radiation cannot be detected by any of mankind's natural senses. X-rays are produced by machines; gamma rays are emitted from the disintegrating nuclei of radioactive substances. In common use are cobalt 60, cesium 137, and iridium 192. All radiation producing sources are hazardous and special precautionary measures should be taken when entering or approaching a radiographic area.

THE TEST OBJECT

The amount of mass is related to the density or object composition as well as to the amount or thickness of the object. As the energy of the radiation source is increased, the more easily will it penetrate thicker or more dense materials. The dark regions on the radiograph represent the more easily penetrated parts of the test object, while the lighter regions represent the more difficult to penetrate regions of the test object.

THE FILM AND FILM HOLDER

The film emulsion is not only sensitive to x- and gamma radiation but is also very sensitive to light.

The production of successful radiographs is highly dependent upon a trained person capable of making reliable exposures--safely.

Exposure geometry:

(1) Radiation source small
(2) Distance great
(3) Film close
(4) Alignment perpendicular
(5) Plan of maximum interest parallel

Radiation sources can be hazardous. Special precautions must be taken while working with radiation. The radiographer or qualified person making the exposure must be trained in the aspects of radiation safety.

Personnel engaged in nondestructive testing activities, including radiographic personnel, be certified as to their abilities and levels of technical competence. The welding inspector should assure himself that all necessary requirements have been satisfactorily met.

PROCESSING THE FILM

The chemical processing of the film is an essential element of the radiographic process. Improper processing may make it impossible to read the film and may render useless the most careful radiographic exposure work.

Radiographic films are only as good as the processing they receive.

In all instances involving film handling, cleanliness is of utmost importance. Irrelevant to the weld "artifacts".

SKILLED PERSON TO INTERPRET

Evaluation is called "film interpretation" and the person performing the interpretation is a "film interpreter". Practical considerations usually allow something less than perfection for most products. The art of film interpretation, therefore, is a judgment process.

The degree of skill required of a film interpreter is obtained through long experience or extensive training or combinations of both. THe interpreter must possess a basic knowledge of the radiographic techniques used.

Certification of the film interpreter.
Radiographic contrast and radiographic definition

APPENDIX C

Consulting Geotechnical, Materials and Environmental Engineers
Geologists, Scientists and Chemists

Raba-Kistner
Consultants, Inc.
10526 Gulfdale/P.O. Box 32217/San Antonio, Texas 78216
(512) 342-4216

Carl F. Raba, Jr., Ph.D., P.E.
Richard W. Kistner, P.E.
Edward G. Miller, R.E.G.
Robert L. Smith, Ph.D.
Donald T. Fetzer
William T. Johnson, Jr., P.E.
Carlton R. Williams, P.E.
Richard W. Bullion, P.E.
E.A. Palaniappan, Ph.D., P.E.
Richard T. Thiesen
Francis Y. Huang, Ph.D.
Mark A. Rugen

November 6, 1981

Dr. Harry M. Coyle, P.E.
Professor of Civil Engineering
Department of Civil Engineering
Texas A & M University
College Station, Texas 77843

Re: Doctor of Engineering Internship
William T. Johnson, Jr., P.E.

Dear Dr. Coyle:

Under my direction, Mr. Johnson completed his internship at Raba-Kistner Consultants, Inc. on September 30, 1981. In my opinion, he has achieved the goals set out in his "Objectives of the Doctor of Engineering Internship" presented to you earlier as a requirement for the degree.

It might be best to briefly review Mr. Johnson's history with our firm prior to as well as during his internship. He joined our firm in December 1979, as Director of Geotechnical Engineering. He functioned in this capacity for a period of approximately 1.5 months prior to being transferred to Texas A & M University as a fulltime student and member of our firm. Upon returning to our San Antonio office in September 1980, he began the Internship Program.

Shortly after Mr. Johnson returned to San Antonio, our corporate structure was modified and geotechnical engineering and materials engineering were consolidated under his direction. This corporate restructuring, which was necessary from a technical and business standpoint, provided Mr. Johnson with responsibilities and authority at least one order of magnitude above his previous experience levels. It also satisfied his primary internship objectives of developing the "...engineering managerial skills necessary to function effectively in his present directorship position as well as in management areas of greater responsibility".

In his new role as Director of Engineering, Mr. Johnson was responsible for the profitable utilization of our entire engineering staff and that division's corporate resources. The technical and support staff consisted of engineers (one with a Ph.D. degree), geologists, draftpersons, and secretarial personnel. In his technical involvement he had supervision over a wide range of projects in different geographical locations. These projects varied from a geotechnical analysis of foundation conditions for a low-rise multiunit hotel in Peking, China to the development of in-house American Welding Society certified inspectors and the subsequent structural steel fabrication and erection inspection of several multistory structures. He was also responsible for the instrumentation of deep footings supporting a 28-story downtown office complex.

Mr. Johnson was also charged with an expanded and more detailed business-financial accountability with respect to marketing, negotiating contracts, budgeting, project forecasting and cost analyses. He supervised the majority of the comprehensive negotiations between our firm and the Environmental Protection Agency and City of San Antonio on the largest project ever undertaken within the city. The combined estimated construction cost is about 250 million dollars and consists of about 52 miles of new sanitary sewer lines as well as a regional tertiary sewage treatment plant.

In summary, it is my opinion as Mr. Johnson's Intern Supervisor, that he has fully achieved the objectives of the Doctor of Engineering Internship Program. He has distinguished himself as an engineer and engineering manager within our firm participating at higher levels than in his previous career. He has satisfactorily worked in a nonacademic environment solving engineering problems of significant magnitude and sensitivity; he has satisfactorily functioned as an engineering manager concerned with recruitment and employment of engineering and technical employees; he has satisfactorily functioned as an engineering contract negotiator; and he has satisfactorily functioned with profit center responsibility.

My experience with the Doctor of Engineering Program and Mr. Johnson's progression through it have only strengthened my opinion of the program. I hope that we will have additional employees in the future who may be considered worthy to participate in the program.

I look forward to answering any other questions that you or other members of the committee may have of me as Mr. Johnson's Intern Supervisor at the defense of his internship report on November 17, 1981.

Very truly yours,

Carl F. Raba, Jr.

Carl F. Raba, Jr., Ph.D., P.E.
Chairman of the Board

Copies submitted: Above (4)
Mr. William T. Johnson, Jr., P.E.

VITA

Name:	William Thomas Johnson, Jr.
Born:	March 7, 1928 Terrell, Texas
Parents:	William Thomas and Velma Ewalt Johnson
Family:	Married Barbara Louise Tate May 3, 1952 and have five children - Dorothy G., William C., Deborah L., Rebecca A., and Stephen P. Johnson
Permanent Address:	203 Honeysuckle Lane San Antonio, Texas 78213
Education:	Bachelor of Science in Civil Engineering from The Agricultural and Mechanical College of Texas, 1951 Master of Engineering in Civil Engineering from The Agricultural and Mechanical College of Texas, 1956
Experience:	1951 - 1971 Commissioned Officer, United States Air Force. Duty assignments of continually increasing responsibilities in engineering and engineering related fields of planning management, technical, and educational. Foreign service in Korea, Alaska, Germany, Spain, and Vietnam. Retired from active military service in May 1971 with rank of Lieutenant Colonel. 1971 - Present Prior to internship, in private practice as a geotechnical and materials engineer
Professional Qualifications:	Registered Professional Engineer in North Carolina (#4246 by examination) and Texas (#32006 by comity) Certified Welding Inspector: American Welding Society (#77051481)

The typist for this report was Mrs. Sandra L. Ramagos.
The graphics for this report were prepared by Mr. Jimmy Huizar.